GEORGIA DEPARTMENT OF NATURAL RESOURCES

ENVIRONMENTAL PROTECTION DIVISION

Air Protection Branch
Ambient Monitoring Program

2015 Five-Year Network Assessment of Ambient Air Monitoring Program

Table of Contents

Executive Summary

The Ambient Monitoring Program of the Air Protection Branch of the Environmental Protection Division (EPD) has monitored air quality in the State of Georgia for over forty years. The list of compounds monitored has grown to more than 200 pollutants using several types of samplers at sites statewide. This report is GA EPD's Five-Year Assessment of those samplers and their networks, and is prepared in part to fulfill the requirements specified in the federal monitoring regulations (40CFR58). The first assessment was due July 1, 2010. This Network Assessment document is prepared and submitted along with the 2015 Annual Monitoring Network Plan to fulfill these requirements.

All monitoring networks operated by the GA EPD's Ambient Air Monitoring Program were evaluated to determine if they meet the monitoring objectives as defined by the regulations. Considerations were given to: Number of Parameters Monitored; Trends Impacts; Measured Concentrations; Deviation form NAAQS; Monitor-to-Monitor Correlations; Air Quality Index; Population Requirements, Changes, Sensitive sub-populations; Health Effects; Area Served; Emission Inventory with modeling of emissions data; Exceedance Probability; Meteorological data; PAMS network.

Each pollutant that GA EPD monitors is discussed with summary of pollutant, monitoring technique, analysis method, and quality assurance schedule. Each network is also discussed in detail. Each monitoring station is outlined with a metropolitan statistical area (MSA) map (if applicable), spatial scale map, aerial photo, site address, site established date, latitude/longitude, elevation, site photos, all parameters monitored at that station, monitoring objective of each sampler, sampling schedule of each sampler, probe inlet height of each sampler, spatial scale of each sampler, the date that each monitor began sampling, and future recommendations for that monitoring station. A list of the current inventory is included.

As a whole, GA EPD has one of the most comprehensive ambient air monitoring programs in the nation. GA EPD meets or exceeds current ambient air monitoring requirements. There are adequate ambient air monitoring stations in populated areas, including where sensitive subgroups reside. Networks for criteria and non-criteria pollutants meet specified ambient air monitoring objectives. As new ambient air monitoring regulations and implementation rules go into effect, it will place more and more burden on the states, taxing already limited resources. States will have to make adjustments to be able to carry out the required monitoring. It appears that GA EPD will be able to meet additional ambient air monitoring requirements for the new and proposed rules with adjustments to its current monitoring network; however, GA EPD may be limited on resources and may be required to consolidate sites or move monitors to meet the new regulations.

Georgia EPD's Ambient Air Monitoring Networks

Since the last Five-Year Assessment, several state funded and a few federally funded ambient air monitoring samplers were discontinued due to GA EPD budget constraints. One third of the monitoring sites across the state (33%) were discontinued between 2008 and 2014. Currently, the GA EPD Ambient Air Monitoring Program operates 41 monitoring sites statewide for the measurement of criteria, non-criteria, and hazardous air pollutants. The continuous monitoring network is comprised of 20 ozone (O_3), 17 continuous $PM_{2.5}$ (10 TEOM and 7 BAM), 1 continuous PM_{10} (BAM), 1 PM_{coarse}, 7 sulfur dioxide (SO_2), 3 nitrogen oxide (NO), 3 nitrogen dioxide NO_2), 3 oxides of nitrogen (NOx), and 1 reactive oxides of nitrogen (NOy), 3 carbon monoxide (CO), 2 PAMS VOCs, 1 black carbon (aethalometer), and 16 meteorological data stations. In addition, there are manual sampling networks in place for the measurement of

$PM_{2.5}$ (24 FRM, 7 Speciation), Air Toxics (7 VOCs, 5 metals, 1 PM_{10} metals, 6 semi-VOCs, 3 carbonyls), 3 PAMS VOCs, 4 lead, and 2 PM_{10}.

The objectives of Georgia EPD's Ambient Air Monitoring Networks are:

- Provide air pollution data to the general public in a timely manner. Meteorologists provide daily Air Quality Index (AQI) forecasts, and health advisories when warranted, to the public through the news media as well as the GA EPD Ambient Air Monitoring Program's website. On this website (http://www.air.dnr.state.ga.us/amp/index.php), hourly air quality measurements from all continuous monitoring samplers are electronically transmitted and posted, including ozone and $PM_{2.5}$ data.

- Support compliance with ambient air quality standards and emissions strategy development. Data from GA EPD's criteria pollutant monitors are used for comparing an area's air pollution levels against the National Ambient Air Quality Standards (NAAQS) to determine attainment status classification. In addition, the data are utilized for the development of attainment and maintenance plans, evaluation of the regional air quality models used in developing emission strategies, and the tracking of trends in air pollution abatement control measures aimed at improving air quality. In monitoring locations near major air pollution sources, source-oriented monitoring data provide insight into how well industrial sources are controlling their pollutant emissions.

- Support for air pollution research studies. GA EPD's ambient air monitoring data have been used to supplement data collected by researchers working on health effects assessments and atmospheric processes, and for monitoring methods development work.

To fulfill the objectives of the Five-Year Assessment, several analyses were performed. Eight of these produced quantifiable results which were used to determine the relative importance of each monitor within the GA EPD Ambient Air Monitoring Network. These assessments include: trends and longevity of parameters monitored, measured concentrations, deviation of criteria pollutants at each site from NAAQS, number of parameters monitored, monitor-to-monitor correlations, change in population, area served by particular networks, and number of days with an Air Quality Index (AQI) > 100. Monitors were scored within each of these assessments to determine their relative importance. A weighted average of the eight scores was calculated for each monitor and a total rank assigned. The top ranking sites are considered the most important sites within the monitoring network while the lowest ranking sites are considered least important and most likely to be recommended for elimination or consolidation with another site. South DeKalb received the highest total rank and is considered the most important site in the monitoring network. Yorkville, Kennesaw, Dawsonville, and Gwinnett Tech were the next highest ranking sites. General Coffee received the lowest rank of all the sites in the monitoring network. Columbus-UPS, DMRC, Columbus-Ft. Benning, and Columbus-Crime Lab were the next lowest ranking sites.

Glossary

Aerosols	A gaseous suspension of fine solid or liquid particles
AM	Annual Mean
Anthropogenic	Resulting from human activity
APB	Air Protection Branch
AQCR	Air Quality Control Region
AQS	Air Quality System
ARITH MEAN	Arithmetic Mean
BAM	Beta Attenuation Monitor
CAA	Clean Air Act
CFR	Code of Federal Regulations
CO	Carbon Monoxide
CV	Coefficient of Variation
EPA	Environmental Protection Agency
EPD	Environmental Protection Division
FEM	Federal Equivalent Method
FRM	Federal Reference Method- the official measurement technique for a given pollutant
GEO MEAN	Geometric Mean
HAP	Hazardous Air Pollutant
LOD	Limit of Detection
$\mu g/m^3$	Micrograms per cubic meter
m/s	Meter per second
MSA	Metropolitan Statistical Area, as defined by the US Census Bureau
NAAQS	National Ambient Air Quality Standard
NAMS	National Ambient Monitoring Site
NATTS	National Air Toxics Trends Station
NCore	National Core Multipollutant Monitoring Network
NMHC	Non-Methane Hydrocarbons
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
NO_y	Reactive oxides of Nitrogen
NWS	National Weather Service
ODC	Ozone depleting Chemicals
O_3	Ozone
PAH	Polycyclic Aromatic Hydrocarbons
PAMS	Photochemical Assessment Monitoring Station
Pb	Lead
$PM_{2.5}$	Particles with an aerodynamic diameter of 2.5 microns or less
PM_{10}	Particles with an aerodynamic diameter of 10 microns or less
$PM_{10-2.5}$	Particles with an aerodynamic diameter between 2.5 and 10 microns
ppm	Parts Per Million
Precursor	A substance from which another substance is formed
PUF	Polyurethane Foam
QTR	Calendar Quarter
Rawinsonde	A source of meteorological data for the upper atmosphere
SLAMS	State and Local Air Monitoring Site
SO_2	Sulfur Dioxide
SPMS	Special Purpose Monitoring Site

TEOM	Tapered Element Oscillating Microbalance
TNMOC	Total Non-Methane Organic Compounds
TRS	Total Reduced Sulfur
UV	Ultraviolet
VOC	Volatile Organic Compound
w/m^2	Watts per square meter

Agency Contacts

Access to More Information about the Ambient Air Monitoring Network

While this report includes a great deal of information about the Ambient Air Monitoring Network, much more information is readily available, including summaries of the pollutant data from the monitors around the state.

Agency Contacts for Georgia Environmental Protection Division

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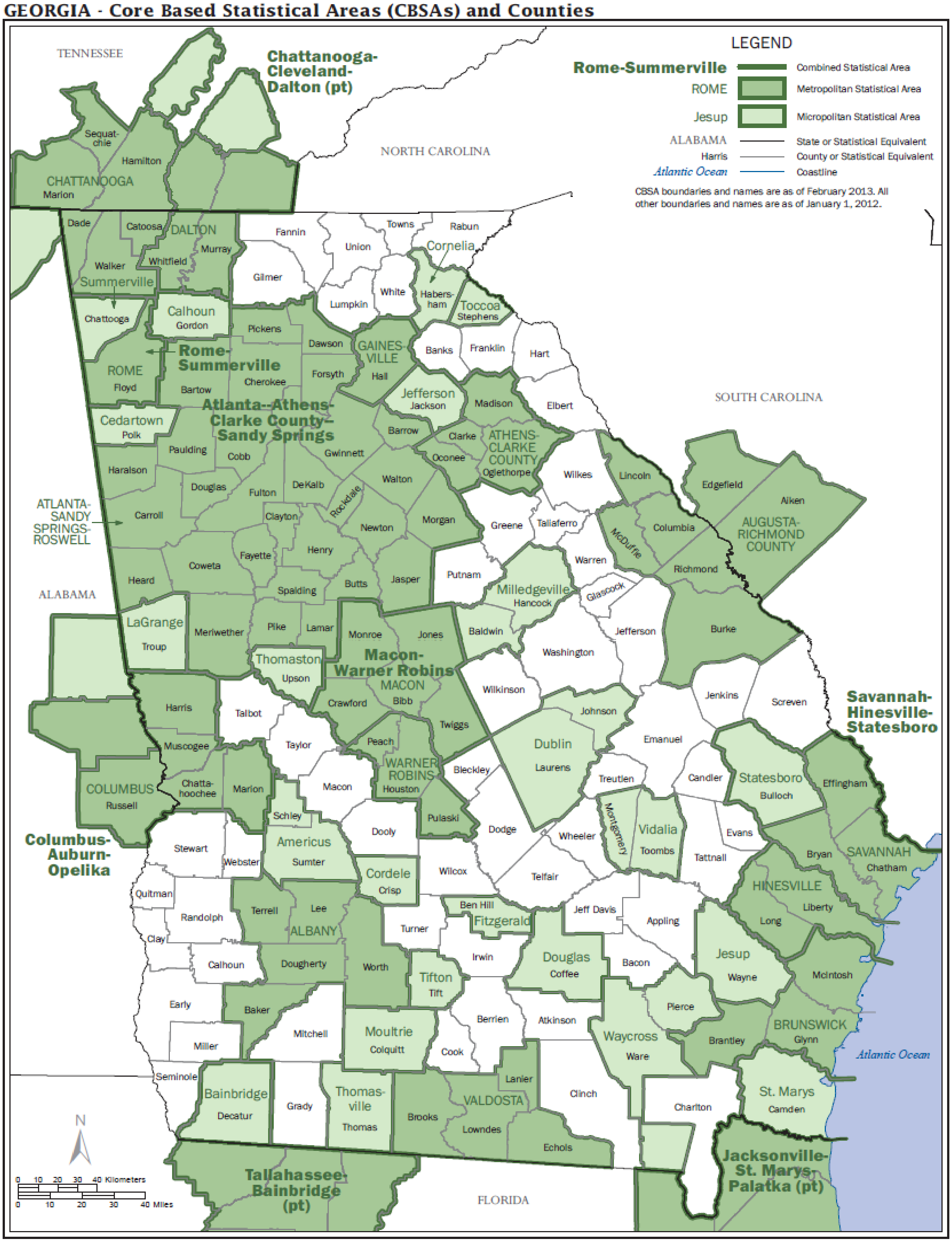
1.0 Introduction

The Five-Year Network Assessment is written as part of the requirements for the Environmental Protection Agency's (EPA) amended ambient air monitoring regulations established on October 17, 2006. It will show Georgia Environmental Protection Division (GA EPD) Ambient Air Monitoring Program's assessment to meet EPA's regulations for monitoring air quality in the state of Georgia. The purposes of the Five-Year Network Assessment include: 1) ensuring that Georgia's Ambient Air Monitoring Program meets the monitoring objectives defined Appendix D of 40CFR58, 2) evaluation of the network's existing sites efficiency in meeting objectives and relative costs, 3) determining if new sites are needed or if existing sites are no longer needed and can be terminated, 4) determine whether discontinuing ambient air monitors would adversely impact data users and health studies, 5) determine if new technologies are appropriate for the network, 6) determine whether the existing and proposed sites support air quality characterization in areas with high populations of susceptible individuals (such as children and Environmental Justice areas), 7) determine whether changes need to be made to the $PM_{2.5}$ population-oriented network, 8) develop recommendations for network improvements. This document will provide a comprehensive look at Georgia's ambient air monitoring network. Several assessments were performed on Georgia's network including: Trends Impacts; Measured Concentrations; Deviation from the NAAQS; Number of Parameters Monitored; Monitor-to-Monitor Correlations; Air Quality Index Assessment; Population Requirements, Changes, Sensitive sub-populations; Health Assessment; Area Served; Modeling Criteria Pollutants; Emission Inventory Assessment with modeling of emissions data; Meteorological Assessment; PAMS network Assessment; and Exceedance Probability Assessment. The Five-Year Network Assessment will outline the established sites across the state of Georgia, as well as the proposal to maintain and discontinue sites in the state's ambient air quality surveillance system.

As early as 1957, the state of Georgia has monitored air pollutants. Prior to the Clean Air Act of 1970, the state health department conducted air monitoring. In the early 1970's, the Georgia Environmental Protection Division assumed responsibilities for ambient air monitoring to facilitate the identification and control of air contaminants in Georgia. The sampling network currently consists of 41 stations located throughout Georgia. The air monitoring data are used to determine whether air quality standards are being met, to assist in enforcement actions, to determine the improvement or decline of air quality, to determine the extent of allowable industrial expansion, and to provide air pollution information to the public. A list of all active monitoring sites with detailed site information, site map and photos, parameters measured at each site, and recommendations for each site is included in the attached Appendix A. The site information also includes the statistical area represented by each site, which was derived from the following map (Figure 1.1).

GEORGIA - Core Based Statistical Areas (CBSAs) and Counties



U.S. DEPARTMENT OF COMMERCE Economics and Statistics Administration U.S. Census Bureau

Figure 1.1: Map of Statistical Areas in Georgia

Section 2.0 describes the pollutants, analysis methods, and quality assurance schedules. Section 3.0 gives a description of the networks. Section 4.0 outlines the standards applied to criteria pollutant concentrations established by the EPA and the state of Georgia to protect human health (primary standards) and plants, animals and property (secondary standards). Section 5.0 describes the monitoring objectives and spatial scales. Section 6.0 provides a list of site evaluations performed on the monitoring stations. The remaining sections detail each assessment. The Appendix A includes the comprehensive list of sites with their detailed information. The Appendix B includes an inventory of the current ambient monitoring equipment. The Appendix C displays 2011-2013 wind roses and pollution roses from across the state (historical climatological wind roses are also available upon request). The Appendix D gives a list of monitors that have been shut down, the date the monitors were shut down, and the last Annual Plan that included those monitors.

1.1 Mandate

This document is produced in response to duties mandated to air monitoring agencies in 40 CFR 58.10:

> ***40 CFR § 58.10 Annual monitoring network plan and periodic network assessment.***
>
> > *(A)(1)(d) The State, or where applicable local, agency shall perform and submit to the EPA Regional Administrator an assessment of the air quality surveillance system every 5 years to determine, at a minimum, if the network meets the monitoring objectives defined in appendix D to this part, whether new sites are needed, whether existing sites are no longer needed and can be terminated, and whether new technologies are appropriate for incorporation into the ambient air monitoring network. The network assessment must consider the ability of existing and proposed sites to support air quality characterization for areas with relatively high populations of susceptible individuals (e.g., children with asthma), and, for any sites that are being proposed for discontinuance, the effect on data users other than the agency itself, such as nearby States and Tribes or health effects studies. For PM2.5, the assessment also must identify needed changes to population-oriented sites. The State, or where applicable local, agency must submit a copy of this 5-year assessment, along with a revised annual network plan, to the Regional Administrator. The first assessment is due July 1, 2010.*

1.2 Procedures for Making Changes to the Monitoring Network

In some circumstances, violating monitors must be shut down or moved. While the Ambient Monitoring Program of GA EPD makes every effort to maintain continued operation of required and/or violating monitors, it operates as a guest or leaseholder at all monitoring stations. GA EPD does not hold ownership rights to the land at any of its monitoring stations. Per EPA rules, if GA EPD loses its lease or is otherwise forced to leave a given site, that site's monitoring may be discontinued without EPA pre-approval or public notice.

GA EPD has no plans to create or implement the Community Monitoring Zone program at present. Any future plan would be subject to public notice and comment before petitioning EPA for approval.

1.3 Memorandum of Agreement

As stated in the Memorandum of Agreement dated January 13, 2009, "The purpose of the Memorandum of Agreement (MOA) is to establish the Chattanooga-Hamilton County-Walker

County Metropolitan Statistical Area (MSA) Criteria Pollutant Air Quality Monitoring Agreement between CHCAPCB [Chattanooga-Hamilton County Air Pollution Control Bureau] and GAEPDAPB [Georgia Environmental Protection Division Air Protection Branch] (collectively referred to as the “affected agencies”) to collectively meet United States Environmental Protection Agency (EPA) minimum monitoring requirements for particles of an aerodynamic diameter of 10 micrometers and less (PM10), particles of an aerodynamic diameter of 2.5 micrometers and less (PM2.5), and ozone; as well as other criteria pollutant air quality monitoring deemed necessary to meet the needs of the MSA as determined reasonable by all parties. This MOA will establish the terms and conditions of this collective agreement to provide adequate criteria pollutant monitoring for the Chattanooga–Hamilton County-Walker Co, GA MSA as required by 40 CFR 58 Appendix D, Section 2, (e) (October 17, 2006).”

The Memorandum of Agreement dated November 8, 2007 states, “The purpose of the Memorandum of Agreement (MOA) is to establish the Augusta-Richmond County Metropolitan Statistical Area (MSA) Criteria Pollutant Air Quality Monitoring Agreement between SCDHEC [South Carolina Department of Health and Environmental Control] and GA EPDAPB [Georgia Environmental Protection Division Air Protection Branch] (collectively referred to as the “affected agencies”) to collectively meet United States Environmental Protection Agency (EPA) minimum monitoring requirements for particles of an aerodynamic diameter of 10 micrometers and less (PM10), particles of an aerodynamic diameter of 2.5 micrometers and less (PM2.5), and ozone; as well as other criteria pollutant air quality monitoring deemed necessary to meet the needs of the MSA as determined reasonable by all parties. This MOA will establish the terms and conditions of this collective agreement to provide adequate criteria pollutant monitoring for the Augusta–Richmond County MSA as required by 40 CFR 58 Appendix D, Section 2, (e) (October 17, 2006).”

For the Columbus GA-AL MSA, both the Alabama Department of Environmental Management and the Georgia Environmental Protection Division have agreed to fully cover EPA’s regulations for monitoring their respective state.

1.4 Air Quality Index (AQI)

The Air Quality Index (AQI) is a method of reporting air quality that converts concentration levels of pollution to a simple number scale of 0-500. Intervals on the AQI scale are related to potential health effects of the daily measured concentrations of the major pollutants. Certain stations in the SLAMS network provide data for daily index reporting. Index reporting is required for all urban areas with a population exceeding 350,000, which in Georgia include the Atlanta MSA, the Augusta Georgia-South Carolina MSA, and the Chattanooga Tennessee-Georgia MSA. The Georgia Environmental Protection Division provides this service to the general public for ten statewide areas with the Georgia Ambient Monitoring Program website (http://www.air.dnr.state.ga.us/amp/index.php). The areas are as follows: Athens, Atlanta, Augusta, Columbus, Macon, North Georgia (Fort Mountain, Dawsonville, Summerville), Savannah, South Central Georgia (Leslie), South Coastal Georgia (Brunswick), and EPA’s CASTNET site (Pike County). The Chattanooga Tennessee-Georgia MSA AQI reporting is covered by the Chattanooga-Hamilton County Air Pollution Control Bureau. Refer to Section 13.0 for AQI Assessment.

1.5 QAPP and QMP

As part of the requirements for EPA, GA EPD has submitted the appropriate Quality Assurance Project Plans (QAPP) and Quality Monitoring Plans (QMP). The following table shows the current status of submittals and approvals of these documents.

Table 1.1: List of Georgia EPD's QAPPS

QAPP ID	QAPP Title	Submittal	Approval
GA-AAQMP-QAPP-NR-12-2014	Quality Assurance Project Plan of the Georgia Ambient Air Quality Monitoring Project for the Near Road Monitoring Network (December 2014 Version)	12-31-2014	To be approved by EPA
GA-AAQMP-QAPP-CAP-02-2014	Quality Assurance Project Plan of the Georgia Ambient Air Quality Monitoring Project for the Criteria Air Pollutants (February 2014 Version)	3-31-2014	To be approved by EPA
GA-AAQMP-QAPP-PM25-01-2013	Quality Assurance Project Plan of the Georgia Ambient Air Quality Monitoring Project for $PM_{2.5}$ (January 2013 Version)	1-29-2013	8-20-2014
GA-AAQMP-QAPP-NATTS-03-2011	Quality Assurance Project Plan for the Georgia National Air Toxics Trends Project (March 2011 Version)	4-26-2011	4-22-2014
GA-AAQMP-QAPP-NCORE-01-2010	Quality Assurance Project Plan of the Georgia Ambient Air Quality Monitoring Project for the National Core Multi- Pollutant Network (June 2010 Version)	6-30-2010	5-23-2011
GA-AAQMP-QAPP-PAMS-02-2010	Quality Assurance Project Plan of the Georgia Ambient Air Quality Monitoring Project for the Photochemical Assessment Monitoring Stations State of Georgia (February 2010 Version)	2-24-2010	7-21-2010

1.6 Public Notice and Comment Procedures

Future changes to the monitoring network are subject to a required public notice and comment process before EPA approval is sought for the changes. Any public comments submitted in response to the document's notice and comment process will be submitted to EPA along with the final document. Persons wishing to comment on GA EPD's proposed changes and documentation are required to submit their comments, in writing, to GA EPD.

Comments must be received by the GA EPD no later than 30 days after the date on which the document is published on http://www.georgiaair.org/airpermit/html/hottopics.htm and http://www.air.dnr.state.ga.us/amp/. Should the comment period end on a weekend or holiday, comments will be accepted up until the next working day. GA EPD, in soliciting comments for the final draft before submittal to EPA as required by 40CFR58, will consider all comments received on or prior to that date. After the comment period has expired, GA EPD will consider all comments received. GA EPD's responses to comments and any other relevant information will then be made available for public review during normal business hours at the office of the Air Protection Branch.

1.7 Use of Data

GA EPD collects ambient air monitoring data covering both criteria and non-criteria pollutants. This data is used by several different groups and has many uses from public health studies to making regulatory decisions. The data is used to provide air pollution information to the public, including the Air Quality Index (discussed above in Section 1.4 and in Section 13.0), the GA

EPD Ambient Monitoring Program website (http://www.air.dnr.state.ga.us/amp/index.php) with hourly readings of continuous data, and finally producing a forecast of the air quality which is reported in AirNow and various news reports to the public. The data is used to assist in enforcement actions with permitting and compliance, and to determine the extent of allowable industrial expansion. State modelers as well as private consultants use the air monitoring data to help make these determinations. The ambient air monitoring data has been used by non-governmental planning groups, such as the Clean Air Campaign and Clean Air Coalition, and intergovernmental groups, such as Atlanta Regional Commission, to make recommended improvements for cities across the state. The ambient air monitoring data is used to determine whether National Ambient Air Quality Standards as defined by EPA are being met, and if the state of Georgia has areas of nonattainment according to these standards.

GA EPD routinely has requests of the ambient air monitoring data from other states, various universities, research institutes, and federal agencies such as Centers for Disease Control. The data is used to determine the improvement or declination of air quality, and how the air quality is related to human and environmental health. In addition, the data has been used in international studies to compare with major cities around the world.

Annually, the GA EPD Ambient Monitoring Program provides an Ambient Air Surveillance report that summarizes and analyzes the previous year's ambient air data, including a risk assessment, for the general public. In addition, GA EPD produces an Ambient Air Monitoring Plan on an annual basis. The Ambient Air Monitoring Plan details the location and site specific data for each monitor in GA EPD's ambient monitoring network, as well as GA EPD's plans for changes to the network. This document is made available for public review and comment regarding placement of ambient air monitors and collection of ambient air data. Both the Ambient Air Surveillance Report and Ambient Air Monitoring Plan are also found on the website listed above.

1.8 New Technologies

At a few sites across the state, GA EPD is planning to add new monitoring equipment in which new technologies will be put to use. At the Rome site, GA EPD plans to put a Thermo Scientific federal equivalent method (FEM) $PM_{2.5}$ sampler that has tapered element oscillating microbalance (TEOM) with a filter dynamics measurement system (FDMS). At the near-road network sites (Georgia Tech and DMRC), GA EPD plans to use the Teledyne photolytic NO_2 sampler, which measures trace levels of NO_2. Also, at the near-road sites, GA EPD will be installing the multi-angle absorption photometer (MAPP) black carbon samplers.

1.9 Georgia EPD Budget

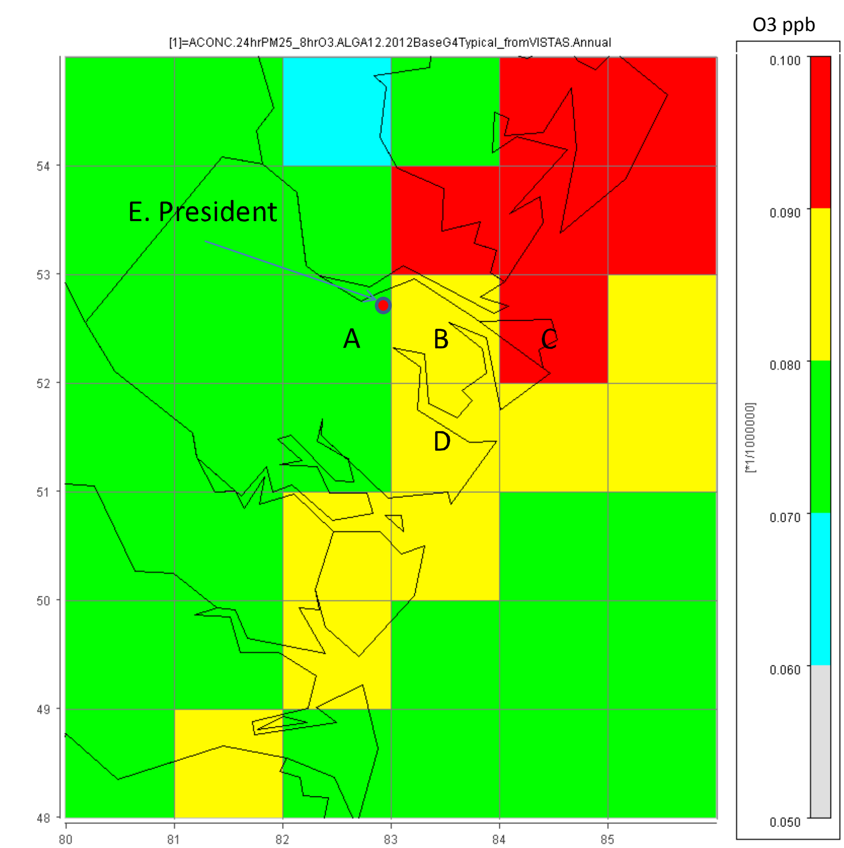
GA EPD's budget is made up of a combination of three sources: state funds, federal funds, and fee funds. In recent years, GA EPD has had budget constraints, and since the last Five-Year Assessment, several state funded and a few federally funded ambient air monitoring samplers were discontinued. There was total reduction of approximately 30% in total number of sites across the state. Much consideration went into deciding which samplers would be discontinued, including whether they are used for attainment designation and federally mandated, as well as the number of pollutants measured. Nine of the 15 state funded Georgia Air Toxics sites were discontinued. Although these Air Toxics samplers do not collect criteria pollutant data, the data collected at these sites is included in the annual risk assessment for the state. In addition, three meteorological sites, all four of the Acid Rain sites, three SO_2 monitors, five $PM_{2.5}$ monitors, and eleven PM_{10} monitors were discontinued. A complete list of the monitors that have been shut down since the last publication of the Five-Year Assessment can be found in Appendix D of this document.

EPA has revised or proposed to revise some of the criteria pollutant standards and monitoring rules. These revisions to the monitoring rules will require GA EPD to adjust the current ambient air monitoring network and install additional monitors in the existing network. Currently, GA EPD meets and exceeds the monitoring requirements. As the new rules are implemented, however, GA EPD may be limited on resources and may be required to consolidate sites or move monitors to meet the new regulations.

1.10 Monitoring Site Waivers

Renewal of Savannah Ozone Monitoring Waiver:
As part of GA EPD's 2013 Ambient Air Monitoring Plan, GA EPD reviewed the ozone monitoring rules and submitted the following paragraph and figure to EPA regarding adding an ozone monitor to the Savannah MSA:

According to the 2010 census, the Savannah MSA population was 347,611. However, since the 2012 estimated population was 361,941 and the 2010-2012 ozone design value was greater than or equal to 85% of the ozone standard (0.064 ppm), the Savannah MSA will need an additional ozone monitor (Table D-5 of Appendix D to 40CFR58). GA EPD has performed modeling of ozone concentrations to determine the proper placement and is evaluating where to place the additional ozone monitor in the Savannah MSA. The following figure shows the areas in red to have the highest modeled concentrations. This is a CMAQ model of the maximum 8-hour ozone values based on 2012 BaseG4 Typical from VISTAS Annual values.



The following excerpt was taken from EPA's comments to the 2013 Ambient Air Monitoring Plan regarding adding an ozone monitor to the Savannah MSA:

Minimum O_3 Monitoring Requirements
40 CFR Part 58, Appendix D, Table D-2

The network described in the 2013 Network Plan meets the minimum O_3 monitoring requirements specified by 40 CFR Part 58, Appendix D, Table D-2 in all areas but the Savannah MSA. According to the latest available census figures, the Savannah MSA's 2012 population estimate was 361,941. As outlined in your plan, a second O_3 monitoring site is now required in this MSA since the most recent 3-year design value is greater than or equal to 85 percent of the NAAQS (0.064ppm). We recognize that the current design value is exactly 85 percent of the NAAQS and could potentially be below that after this ozone season ending on October 31, 2013. We are working with your agency and the South Carolina Department of Health and Environmental Control to determine whether exploratory ozone monitoring is warranted and/or feasible in South Carolina just north of the Savannah MSA in order to capture the modeled maximum concentration as shown on page eight in your plan. The EPA recommends that the EPD not establish another permanent site in the Savannah MSA until we have an opportunity to explore available options. We plan to work with your agency and with South Carolina in the near future to jointly find a site that can be used to satisfy the additional ozone monitoring requirement for this MSA. The site selected through that process can be included in the 2014 network plan. The EPA approves no other changes to the O_3 monitoring network.

The Savannah MSA site location and ozone monitoring is pending EPA's initiation at this time.

Renewal of Lead Monitoring Waiver

As part of GA EPD's 2013 Ambient Air Monitoring Plan, GA EPD requested to close the source-oriented lead monitor in the Cartersville area (13-015-0003). This request was approved by EPA, and a waiver was granted to discontinue monitoring at this location. The following paragraph and figure were submitted to EPA in the 2013 Ambient Air Monitoring Plan:

To meet the lead monitoring rule (40CFR58, Appendix D, paragraph 4.5), GA EPD placed an ambient lead monitor near the Gerdau Ameristeel US Inc., in Cartersville (13-015-0003). According to this rule, the monitor was designated as a source-oriented monitor, which was expected to have shown the maximum lead concentration in ambient air and to exceed the National Ambient Air Quality Standard (NAAQS). Before the site was established, it was determined that the estimated 2005 lead emissions from the Gerdau Ameristeel facility were 1.41 tons/year (refer to 2009 Ambient Air Monitoring Plan for details). Since the lead monitor began collecting data on December 9, 2009, the highest 3-month rolling average has been 0.0265 µg/m^3, and the highest monthly average has been 0.0388 µg/m^3. These values are well below the standard of 0.15 µg/m^3 (graph is shown below), and this sampler has not shown to have the maximum lead concentration or exceed the NAAQS as expected. The Gerdau Ameristeel US Inc. facility has implemented a pollution prevention plan per 40CFR63.10685(a)(1) that includes minimizing the amount of lead in the scrap selection, and not charging scrap that contains scrap from lead-containing components (Operating Permit, Section 6.2.10). Therefore, GA EPD requests to close the lead monitor at the Cartersville (13-015-0003) site.

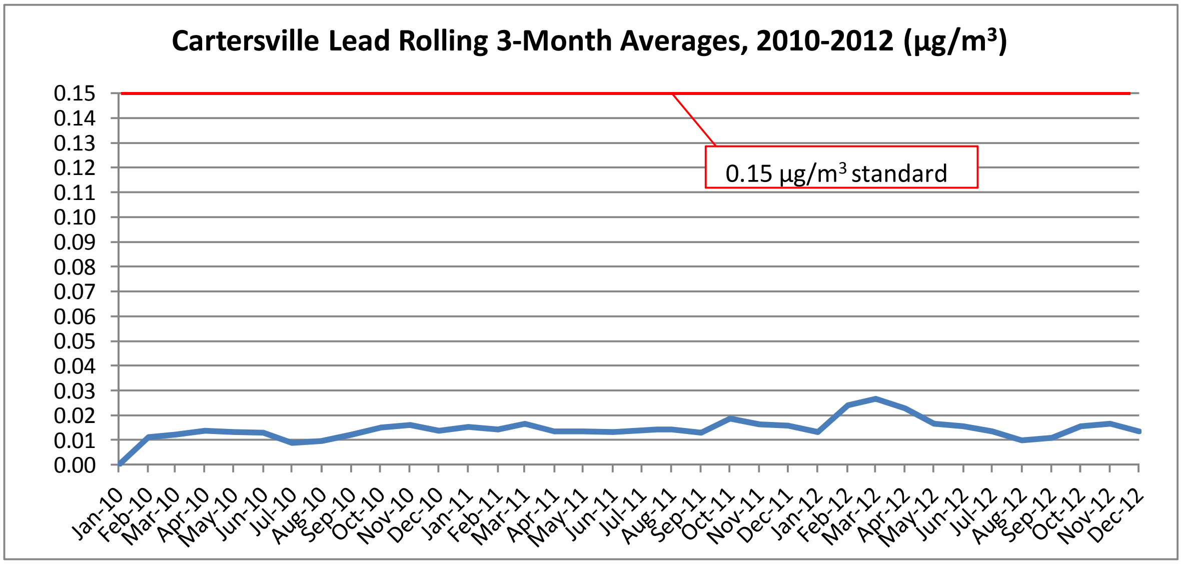


Figure 1.2: Cartersville Lead, 2010-2012

In addition, to prepare this document, the state lead emissions inventory was checked for emissions information on Gerdau Ameristeel. No lead emissions information was available to report.

The following excerpts were taken from EPA's comments to the 2013 Ambient Air Monitoring Plan regarding monitoring lead in the Cartersville area:

Pb Monitoring Requirements
40 CFR Part 58, Appendix D, 4.5

40 CFR Part 58, Appendix D, 4.5 requires that "At a minimum, there must be one source-oriented SLAMS [state and local air monitoring station] site located to measure the maximum Pb concentration in ambient air resulting from each non-airport Pb source which emits 0.50 or more tons per year and from each airport which emits 1.0 or more tons per year…" Monitoring is ongoing at the Gerdau steel mill in Cartersville and the Exide Technologies facility in Columbus. These are the only non-airport sources in the state, which emit over 0.50 tons per year. The EPD has requested a waiver of the source-oriented monitoring requirement near the Gerdau steel mill in Cartersville, which the EPA approves. This approval is discussed in detail in the "Monitoring Network Changes Proposed by the GA EPD" section.

Monitoring Network Changes Proposed by GA EPD

In its 2013 Network Plan, the state listed in Section 1.7 additional changes being proposed in the network as well as listing the changes that have occurred as a result of the EPA's approval in 2012. Those changes listed in your plan that were approved last year have been verified. The changes to the SO_2, NO_2, CO, Pb and $PM_{2.5}$ networks listed in section 1.7 are approved. Also, on pages 8-9 in section 1.8, the EPD has requested to permanently discontinue several monitors that have been mothballed since the end of 2008. We approve the permanent closure of the total reduced sulfur monitor in Brunswick at site 13-127-0006. We also approve the permanent closure of the O_3 and meteorological monitoring in Fayetteville at site 13-113-0001. We grant a waiver to discontinue Pb monitoring at the Gerdau Ameristeel facility in Bartow County based on the historical data record. However, this waiver should be renewed at the time of each five-year network assessment or upon learning of process changes at the facility that may increase the emissions.

1.11 Inventory of Ambient Monitoring Equipment

As part of the requirements for the Five-Year Assessment, GA EPD has included a list and evaluation of the current ambient monitoring equipment. See attached Appendix B for the inventory listing.

1.12 List of Sites

The following table gives a complete list of the current air monitoring network and the parameters that are sampled at each site.

SITE ID	SITE NAME	COUNTY	O_3	CO	$PM_{2.5}$ FRM	$PM_{2.5}$ Cont.	$PM_{2.5}$ Spec.	PM Coarse	NO/ NOx	NO_2	NOy	SO_2	Pb	PM_{10}	PM_{10} Cont.	PAMS VOC	VOC	SVOC	Carb- onyls	Meteo- rology	Aethal- ometer	Metals
Rome MSA																						
131150003	Coosa Elementary	Floyd			S	S	X					S										
Brunswick MSA																						
131270006	Risley Middle	Glynn	S		S															NR		
Valdosta MSA																						
131850003	Mason Elem.	Lowndes			S	S																
Warner Robins MSA																						
131530001	Robins Air Base	Houston			S	S																
Dalton MSA																						
132130003	Fort Mountain	Murray	S																	NR		
Albany MSA																						
130950007	Turner Elem.	Dougherty			S	S																
Gainesville MSA																						
131390003	Boys and Girls Club	Hall			S	S																
Athens-Clark County MSA																						
130590002	College Station Rd.	Clarke	S		S	S																
Macon MSA																						
130210007	Allied Chemical	Bibb			S		X															
130210012	Forestry	Bibb	S		S	S						S					NR	NR		NR		NR
Columbus Georgia- Alabama MSA																						
132150001	Health Dept.	Muscogee			S																	
132150008	Airport	Muscogee	S		S	S																
132150009	UPS	Muscogee											S									
132150010	Fort Benning	Muscogee											S									
132150011	Cusseta Elementary	Muscogee			S		X						S									
132151003	Crime Lab	Muscogee																		NR		
Savannah MSA																						
130510021	E. President St.	Chatham	S									S					NR	NR	NR	NR		NR
130510091	Mercer Middle	Chatham			S																	
130511002	W. Lathrop & Augusta Ave.	Chatham				S						S								NR		
Augusta-Richmond County, Georgia-South Carolina MSA																						
130730001	Evans	Columbia	S																	NR		
132450091	Bungalow Rd.	Richmond	S		S	S	X					S		S						NR		

SITE ID	SITE NAME	COUNTY	O_3	CO	$PM_{2.5}$ FRM	$PM_{2.5}$ Cont.	$PM_{2.5}$ Spec.	PM Coarse	NO/ NOx	NO_2	NOy	SO_2	Pb	PM_{10}	PM_{10} Cont.	PAMS VOC	VOC	SVOC	Carb-onyls	Meteo-rology	Aethal-ometer	Metals
Atlanta-Sandy Springs-Marietta MSA																						
130630091	Forest Park	Clayton			S																	
130670003	Kennesaw	Cobb	S		S																	
130770002	Newnan	Coweta	S			S														NR		
130850001	Dawsonville	Dawson	S														NR	NR	NR	NR		NR
130890002	South DeKalb	DeKalb	S/P/C	S/P/C	S/C	S/C	T/C	C	S/P	S/P	S/P/C	C			C	P	N	N	P/N	P/C	N	N
130890003	DMRC	DeKalb							R	R			S				R				R*	
130970004	W. Strickland St.	Douglas	S																	NR		
131210039	Fire Station #8	Fulton			S									S								
131210055	Confederate Ave.	Fulton	S			S						S								NR		
131210056	Georgia Tech	Fulton		R	R					R										R	R*	
131350002	Gwinnett Tech	Gwinnett	S		S	S																
131510002	McDonough	Henry	S			S																
132230003	Yorkville	Paulding	S/P	S/P	S	S			S/P	S/P						P	NR	NR		P		NR
132470001	Conyers	Rockdale	S/P						S/P	S/P						P				P		
Chattanooga Tennessee-Georgia MSA																						
132950002	Maple Street	Walker			S	S	X															
Not in an MSA																						
130550001	Summerville	Chattooga	S																			
130690002	General Coffee	Coffee					X										NR	NR				NR
132611001	Leslie	Sumter	S																			
133030001	Sandersville	Washington			S																	
133190001	Gordon	Wilkinson			S																	

Monitoring Types: S=SLAMS; P=PAMS; C=NCore; X=Supplemental Speciation; T=STN; N=NATTS; R=Near-road; NR=Non-Regulatory; G=General Information

*Will be sampling in near future

Table 1.2: 2015 Georgia Air Monitoring Network

2.0 Pollutant Description, Analysis Method, and Quality Assurance Schedule

All monitors have known precision, accuracy, interferences, and operational parameters. The monitors as well as all measurement devices are carefully calibrated at predetermined frequencies, varying from daily to quarterly. Calibration standards are traceable to National Institute of Standards and Technology (NIST) master standards.

Monitoring and analysis are performed according to a set of standard operating procedures. Field personnel will typically visit manual sampling sites at least once every six days to replace sample media and check the operation and calibration of monitors. Personnel will check continuous monitors at least twice monthly for correct instrument operation.

Quality assurance activities are carried out to determine the quality of the collected ambient data, improve the quality of the data, and evaluate how well the entire monitoring system operates. The goal of quality assurance activities is to produce high quality air pollution data with defined completeness, precision, accuracy, representativeness and comparability.

Specialized data-collection and storage equipment is used at most sites to collect the data. A computerized telemetry system aids in assembly of the data for submission to the U.S. EPA. This enhances data validity, minimizes travel costs, and allows data to be available by computer at the program's main office immediately. Numerous manual and automated checks are performed to ensure that only valid data are reported.

2.1 Particulate Matter

Atmospheric particulate matter is defined as any airborne material, except uncombined water (liquid, mist, steam, etc.) that exists in a finely divided form as liquid or solid at standard temperature (25°C) and pressure (760mmHg) and has an aerodynamic diameter of less than 100 micrometers. Three sizes of particulate matter are to be monitored: PM_{10}, $PM_{2.5}$, and PMcoarse (10-2.5). PM_{10} is particulate matter with an aerodynamic diameter less than or equal to 10 micrometers (μm). The U.S. EPA defines $PM_{2.5}$ as solid particles and liquid droplets found in the air that are less than 2.5 micrometers (μm) or microns in diameter. Individually, these particles and droplets are invisible to the naked eye. Collectively, however, they can appear as clouds or a fog-like haze. Particulate matter less than or equal to 2.5 μm in diameter is referred to as "fine" particles ($PM_{2.5}$). $PM_{10-2.5}$ is also called PMcoarse. The PMcoarse fraction has a diameter between 2.5 and 10 micrometers (μm) or microns. In comparison, a human hair is 70-100 μm in diameter.

Particulates are emitted by many human activities, such as fuel combustion, motor vehicle operation, industrial processes, grass mowing, agricultural tilling, and open burning. Natural sources include windblown dust, forest fires, volcanic eruptions, and pollen. Particulates emitted directly from a source may be either fine (less than 2.5 μm) or larger (2.5-60 μm), but particles formed in the atmosphere will usually be fine. Typically, fine particles originate by condensation of materials produced during combustion or atmospheric reactions in which gaseous pollutants are chemically converted to particles.

Particulate matter can cause health problems affecting the breathing system, including aggravation of existing lung and heart disease, limitation of lung clearance, changes in form and structure of organs, and development of cancer. Individuals most sensitive to the effects of particulate matter include those with chronic obstructive lung or heart disease, those suffering from the flu, asthmatics, the elderly, children, and mouth breathers.

Health effects from inhaled particles are influenced by the depth of penetration of the particles into the respiratory system, the amount of particles deposited in the respiratory system, and the chemical composition of the deposited particles. The risks of adverse health effects are greater when particles enter the tracheobronchial and alveolar portions of the respiratory system. Healthy respiratory systems can trap particles larger than 10 µm more efficiently before they move deeply into the system, and can more effectively remove the particles that are not trapped before they can lodge deeply in lung tissue.

Particulate matter also can interfere with plant photosynthesis by forming a film on leaves that reduces exposure to sunlight. Particles also can cause soiling and degradation of property, which can be costly to clean and maintain. Suspended particles can absorb and scatter light, causing reduction of visibility. This is a national concern, especially in areas such as national parks, historic sites, and scenic attractions.

a. Particulate Matter (PM_{10}) Integrated

At sites where Particulate Matter (PM_{10}) is monitored on an integrated basis, Georgia EPD uses EPA-approved reference or equivalent methods. The low-volume samplers collect particulate matter on a pre-weighed quartz microfiber filter for 24 hours. Ambient air is sampled through an impaction inlet device that only allows particles with 10 microns or less in diameter to reach the filter media. The flow rate is controlled by an electronic mass-flow controller, which uses a flow sensor installed below the filter holder to monitor the mass flow rate and to control the speed of the motor accordingly. The filter is returned to the state laboratory for gravimetric analysis after the sample is collected. The change in the filter weight corresponds to the mass of PM_{10} particles collected. That mass, divided by the total volume of air sampled, corresponds to the mass concentration of the particles in the air. The sampling frequency varies by site. These monitors are used to determine attainment of the PM_{10} standard. These analyzers are subjected to quarterly checks and are audited by EPD's Quality Assurance Unit on a semi-annual basis.

b. Particulate Matter (PM_{10}) Continuous

At sites where Particulate Matter (PM_{10}) is monitored on a continuous basis, Georgia EPD uses an EPA-approved equivalent method. The monitor consists of three basic components: the central unit, the sampling pump, and the sampling inlet hardware. The sampling inlet is designed to cut out particles larger than 10 microns in size. The monitor uses beta ray attenuation to calculate collected particle mass concentrations. The beta rays are attenuated as they collide with particles collected on filter tape. The decrease in signal detected by the scintillation counter is inversely proportional to the mass loading on the filter tape. The pump turns on at the beginning of the hour and runs for 50 minutes. During the last 10 minutes of the hour, the pump is turned off while the tape transport operates, and the final mass reading is collected and self-tests are performed. These monitors are used to determine attainment of the PM_{10} standard. These analyzers are subjected to monthly flow checks and are audited by EPD's Quality Assurance Unit on a semi-annual basis.

c. Fine Particulate Matter ($PM_{2.5}$) Integrated

At sites where mass $PM_{2.5}$ samples are taken on an integrated basis, the samples are measured using very similar techniques utilized for measuring PM_{10}. The official reference method requires that samples are collected on Teflon filters with a $PM_{2.5}$ sampler for 24 hours. A specialized particle size sorting device is used to filter the air, collecting only particles 2.5 microns in size and smaller. The filters are weighed in a laboratory before and after the sampling period. The change in the filter weight corresponds to the mass weight of $PM_{2.5}$ particles collected. That mass weight, divided by the total volume of air sampled, corresponds to the mass concentration of the particles in the air for that 24-hour period. The reference method filters are used for attainment determinations. However, due to the delay in collecting each filter, shipping it to the laboratory, and weighing, weeks may pass before the results are known. Although this method is very accurate, it is not useful for real-time determinations of $PM_{2.5}$ concentrations in ambient air. Because the data is collected using the Federal Reference Method, the data is appropriate to use for making attainment decisions relative to the $PM_{2.5}$ NAAQS. The sampling frequency for integrated $PM_{2.5}$ sampling varies by site, based on EPA rules, and is listed with each individual site's information in Appendix A to this document and in Table 2.1 below. On a semi-annual basis, EPD's Quality Assurance Unit audits these $PM_{2.5}$ samplers.

d. Fine Particulate Matter ($PM_{2.5}$) Continuous

At sites where $PM_{2.5}$ is monitored on a continuous basis, Georgia EPD uses two types of instruments. One of the two types of continuous instruments is the beta attenuation method using the MetOne BAM-1020, adapted from PM_{10} service to $PM_{2.5}$ service by use of an inline BGI "Sharp Cut Cyclone". The inlet is designed to cut out particles that are larger than 2.5 microns in size. The beta rays are attenuated as they collide with particles collected on filter tape. The decrease in signal detected by the scintillation counter is inversely proportional to the mass loading on the filter tape. The pump turns on at the beginning of the hour and runs for 50 minutes. During the last 10 minutes of the hour, the pump is turned off while the tape transport operates, and the final mass reading is collected and self-tests are performed. The sampling method for the BAM type of continuous $PM_{2.5}$ monitor was approved as Federal Equivalent Method (FEM) in Notices of the Federal Register/Vol.73; No.49 dated March 12, 2008 when used with a "Very Sharp Cut Cyclone". When GA EPD begins operating the continuous BAM as an FEM with a "Very Sharp Cut Cyclone", these samplers will be used for making attainment decisions relative to the NAAQS. GA EPD began sampling the BAM as FEM at the South DeKalb site (13-089-0002) as of January 1, 2011, and at the Albany-Turner Elementary site (13-095-0007) on January 1, 2013. Therefore, these two samplers (South DeKalb and Albany-Turner Elementary) are the only two continuous $PM_{2.5}$ samplers that can be compared to the NAAQS at this time.

At the other locations where Georgia EPD samples $PM_{2.5}$ on a continuous basis, GA EPD uses the Thermo Scientific tapered element oscillating microbalance (TEOM) Series 1400/1400a monitors. These monitors use an inline $PM_{2.5}$ cyclone for particle size selection and an inline Sample Equilibration System (SES), which uses a diffusion drying technique to minimize water vapor interference with the particle mass measurement. The instrument oscillates the sample filter on a microbalance continuously while particles are collected from ambient air. By measuring the change in the oscillation frequency, the change in filter mass can be determined. The sampling method for the TEOM type of continuous $PM_{2.5}$ monitor was approved as Federal Equivalent Method (FEM) in Notices of the Federal Register/Vol.74; page 28696 dated June 17, 2009 when used with a "Filter Dynamics Measurement System (FDMS)". The FDMS component estimates and adjusts for the volatile component of the mass. GA EPD will begin sampling the TEOM at the Rome site (13-115-0003) with a "Filter Dynamics Measurement System (FDMS)" configuration in summer 2015. This TEOM will be collocated with a $PM_{2.5}$ federal reference method (FRM) sampler, and will be investigated to be used as an FEM (federal equivalent method) sampler. If the TEOM correlates well with the FRM sampler, then GA EPD may propose to run this TEOM as an FEM by January 1, 2016. At that point, if the TEOM is set up as an FEM, the $PM_{2.5}$ data could be compared to the National Ambient Air Quality Standards (NAAQS) for attainment purposes. Currently, the other TEOMs in the ambient air monitoring network are not configured to sample with the federal equivalent method. Therefore, data collected from the other TEOM samplers cannot be used for making attainment decisions relative to the NAAQS.

At this time, GA EPD is considering configuring the Athens and Macon-Forestry TEOMs as FEMs. If GA EPD determines that these two TEOMs should be reconfigured as FEMs, then those monitors would also be compared to the NAAQS for attainment designations.

Both types of continuous samplers are used to support development of air quality models and forecasts, including the Air Quality Index (AQI), and to provide the public with information about pollutant concentrations in real time. Both types of analyzers are subject to monthly flow checks and are audited by EPD's Quality Assurance Unit on a semi-annual basis.

e. Fine Particulate Matter ($PM_{2.5}$) Speciation

Particle speciation measurements require the use of a wide variety of analytical techniques, but all generally use filter media to collect the particles to be analyzed. Laboratory techniques currently in use are gravimetric (micro weighing); X-ray fluorescence and particle-induced X-ray emission for trace elements; ion chromatography for anions and selected cations; controlled combustion for carbon; and gas chromatography/mass spectroscopy (GC/MS) for semi-volatile organic particles. Samples are collected for 24 hours and shipped to an EPA-appointed laboratory for analysis. The sampling frequency varies by site and is detailed in Table 2.1 below. On a quarterly basis, EPD's Quality Assurance Unit subjects these samplers to audits.

f. Coarse Particulate Matter ($PM_{10-2.5}$)

As part of the NCore requirements (discussed in Section 3.1 and Appendix C of the previous 2014 Ambient Air Monitoring Plan), the South DeKalb site began PMcoarse sampling as of January 1, 2011. GA EPD uses the 'Met One Instruments BAM-1020 $PM_{10-2.5}$ Measurement System Automated Equivalent Method: EQPM-0709-185 consisting of 2 BAM-1020 monitors, the first of which (PM2.5 measurement) is configured as a PM2.5 FEM (EQPM-0308-170). The second BAM-1020 monitor (PM10 measurement) is configurable as a PM2.5 FEM (EQPM-0308-170), but set to monitor PM10. The BAM-1020 monitors are collocated to within 1-4 meters of one another. The BAM-1020 performing the PM2.5 measurement is equipped with Met One Instruments, Inc. P/N BX-Coarse interface board and accessories; the units are interconnected to provide concurrent sampling and to report PM10-2.5 concentrations directly to the user. Both units are operated in accordance with BAM-1020 PM-Coarse Addendum Rev. 5-5 or later and the BAM-1020 Operations Manual Rev. D or later' (Federal Register: Vol.74, page 24241, 06/15/09).

The sampling frequency of the integrated (FRM), continuous (BAM and TEOM), and speciated $PM_{2.5}$ samplers is detailed in Table 2.1 below, and the attached Appendix A for clarity. The $PM_{2.5}$ samplers highlighted in yellow are the only $PM_{2.5}$ samplers that are used for comparison to the NAAQS for attainment purposes.

Table 2.1: $PM_{2.5}$ Sampling Frequency

Site ID	Common Name	City	County	Integrated	Continuous	Speciation
Rome MSA						
131150003	Coosa Elementary	Rome	Floyd	$PM_{2.5}$ (Daily)	TEOM $PM_{2.5}$	6 Day
Brunswick MSA						
131270006	Risley Middle	Brunswick	Glynn	$PM_{2.5}$ (3 Day)		
Valdosta MSA						
131850003	Mason Elem.	Valdosta	Lowndes	$PM_{2.5}$ (3 Day)	BAM $PM_{2.5}$	
Warner Robins MSA						
131530001	Robins Air Base	Warner Robins	Houston	$PM_{2.5}$ (3 Day)	BAM $PM_{2.5}$	
Albany MSA						
130950007	Turner Elem.	Albany	Dougherty	2 $PM_{2.5}$ (Daily, Daily)	FEM BAM $PM_{2.5}$	
Gainesville MSA						
131390003	Boys and Girls Club	Gainesville	Hall	$PM_{2.5}$ (3 Day)	BAM $PM_{2.5}$	
Athens-Clark County MSA						
130590002	College Station Rd.	Athens	Clarke	$PM_{2.5}$ (3 Day)	TEOM $PM_{2.5}$	
Macon						
130210007	Allied Chemical	Macon	Bibb	2 $PM_{2.5}$ (Daily, 12 Day)		6 Day
130210012	Forestry	Macon	Bibb	$PM_{2.5}$ (3 Day)	TEOM $PM_{2.5}$	
Columbus Georgia- Alabama MSA						
132150001	Health Dept.	Columbus	Muscogee	$PM_{2.5}$ (3 Day)		
132150008	Airport	Columbus	Muscogee	$PM_{2.5}$ (3 Day)	TEOM $PM_{2.5}$	
132150011	Cusseta Elementary	Columbus	Muscogee	$PM_{2.5}$ (3 Day)		6 Day
Savannah MSA						
130510091	Mercer Middle	Savannah	Chatham	$PM_{2.5}$ (3 Day)		
130511002	W. Lathrop & Augusta Ave.	Savannah	Chatham		TEOM $PM_{2.5}$	
Augusta Georgia-South Carolina MSA						
132450091	Bungalow Rd.	Augusta	Richmond	$PM_{2.5}$ (3 Day)	TEOM $PM_{2.5}$	6 Day
Atlanta MSA						
130630091	Georgia DOT	Forest Park	Clayton	$PM_{2.5}$ (3 Day)		
130670003	National Guard	Kennesaw	Cobb	$PM_{2.5}$ (Daily)		
130770002	Univ. of West GA	Newnan	Coweta		TEOM $PM_{2.5}$	
130890002	South DeKalb	Decatur	DeKalb	2 $PM_{2.5}$ (Daily, 12 Day)	FEM BAM $PM_{2.5}$	3 Day
131210039	Fire Station #8	Atlanta	Fulton	$PM_{2.5}$ (3 Day)		
131210055	Confederate Ave.	Atlanta	Fulton		TEOM $PM_{2.5}$	
131210056	Georgia Tech-Near Road	Atlanta	Fulton	$PM_{2.5}$ (3 Day)		
131350002	Gwinnett Tech	Lawrenceville	Gwinnett	$PM_{2.5}$ (3 Day)	TEOM $PM_{2.5}$	
131510002	County Extension	McDonough	Henry		TEOM $PM_{2.5}$	
132230003	Yorkville	Yorkville	Paulding	$PM_{2.5}$ (3 Day)	TEOM $PM_{2.5}$	
Chattanooga Tennessee-Georgia MSA						
132950002	Maple Street	Rossville	Walker	$PM_{2.5}$ (3 Day)	BAM $PM_{2.5}$	6 Day
Not In An MSA						
130690002	General Coffee State Park	Douglas	Coffee			6 Day
133030001	Co. Health Dept.	Sandersville	Washington	$PM_{2.5}$ (3 Day)		
133190001	Police Dept.	Gordon	Wilkinson	$PM_{2.5}$ (3 Day)		

Highlighted samplers used for comparison to NAAQS

2.2 Carbon Monoxide (CO)

Carbon monoxide (CO) is a colorless and poisonous gas produced by incomplete burning of carbon-containing fuel. Most atmospheric CO is produced by incomplete combustion of fuels used for vehicles, space heating, industrial processes, and solid waste incineration. Transportation accounts for a large part of CO emissions. Boilers and other fuel burning heating systems are also significant sources.

Breathing carbon monoxide affects the oxygen-carrying capacity of the blood. Hemoglobin in the blood binds with CO more readily than with oxygen, starving the body of vital oxygen. Individuals with lung and heart diseases or anemia are particularly sensitive to CO health effects. Low concentrations affect mental function, vision, and alertness. High concentrations can cause fatigue, reduced work capacity and may adversely affect fetal development. Chronic exposure to CO at concentrations as low as 70 parts per million (ppm) (80 mg/m^3) can cause cardiac damage. Other health effects associated with exposure to CO include central nervous system effects and pulmonary function difficulties. Ambient CO apparently does not adversely affect vegetation or materials.

Carbon monoxide (CO) is monitored using EPA-approved reference or equivalent methods. These analyzers are self-contained and capable of measuring ambient CO on a continuous, real-time basis using the non-dispersive infrared analysis and gas filter correlation techniques. CO is monitored using specialized analyzers based on the principle that CO absorbs infrared radiation. The sample is drawn through the sample bulkhead and the optical bench. Radiation from an infrared source is chopped and then passed through a gas filter alternating between CO and N_2. The radiation then passes through a narrow bandpass interference filter and enters the optical bench where absorption by the sample gas occurs. The infrared radiation then exits the optical bench and falls on an infrared detector. The N_2 side of the filter wheel produces a measure beam which can be absorbed by the CO in the cell. The chopped detector signal is modulated by the alternation between the two gas filters with amplitude related to the concentration of CO in the sample cell. Thus, the gas filter correlation system responds specifically to CO. The sampler is equipped with a microprocessor that enables digital measurement of CO, automatic compensation for changes in temperature and pressure, and internal diagnostics. These analyzers are subjected to weekly zero, precision, and span (ZPS) checks, quarterly multipoint calibrations, and are audited by EPD's Quality Assurance Unit on an annual basis.

2.3 Ozone (O_3)

Ozone (O_3) is a clear gas that forms in the troposphere (lower atmosphere) by chemical reactions involving hydrocarbons (or volatile organic compounds) and nitrogen oxides in the presence of sunlight and high temperatures. Even low concentrations of tropospheric ozone are harmful to people, animals, vegetation and materials.

Ozone is formed through independent processes in the upper atmosphere (stratosphere). Stratospheric ozone shields the earth from harmful effects of ultraviolet solar radiation. Stratospheric ozone can be damaged by the emission of chlorofluoro-hydrocarbons (CFCs) such as Freon. This report, and the operations of the Ambient Monitoring Program, is only concerned with tropospheric ozone.

Ozone is the major component of a complex mixture of compounds known as photochemical oxidants. Ozone is not usually emitted directly into the atmosphere, but is formed by a series of complex reactions involving hydrocarbons, nitrogen oxides, and strong sunlight. Ozone concentrations are generally higher during the daytime, when temperatures are moderate or hot, and during seasons when the sunlight is more intense.

Ozone is a pulmonary irritant, affecting the respiratory mucous membranes, as well as other lung tissues and respiratory functions. Ozone has been shown to impair normal function of the lung causing shallow, rapid breathing and a decrease in pulmonary function. Other symptoms of exposure include chest tightness, coughing and wheezing. People with asthma, bronchitis, or emphysema probably will experience breathing difficulty when exposed to short-term concentrations above 0.076 ppm. Continued or repeated long-term exposure may result in permanent lung structure damage.

Ozone damages vegetation by injuring leaves. Ozone also accelerates material aging, cracking rubber, fading dyes and eroding paint.

Georgia's ozone analyzers continuously measure the concentration of ozone in ambient air using the ultraviolet (UV) photometric method and are EPA-approved for regulatory air monitoring programs. The degree to which the UV light is absorbed is directly related to the ozone concentration. The ambient air is drawn into the sample bulkhead and is split into two gas streams. One gas stream flows through an ozone scrubber to become the reference gas. The reference gas then flows to the reference solenoid valve. The sample gas flows directly to the sample solenoid valve. The solenoid valves alternate the reference and sample gas streams between the two cells every 10 seconds. When cell A contains reference gas, cell B contains sample gas and vice versa. The UV light intensities of each cell are measured by detectors A and B. When the solenoid valves switch the reference and sample gas streams to opposite cells, the light intensities are ignored for several seconds to allow the cells to be flushed. The sampler calculates the ozone concentration for each cell and outputs the average concentration to both the front panel display and the analog or digital output. Data gained from the continuous monitors is used to determine compliance with the NAAQS for ozone.

According to 40 CFR Part 58, the State of Georgia operates ozone monitors each year from March 1st through October 31st, with the exception of the NCore (National Core Monitoring Network) ozone monitor. The NCore ozone monitor, located at the South DeKalb site (13-089-0002), samples year round, also according to 40 CFR Part 58. During the monitoring season, analyzers are subjected to weekly ZPS checks and quarterly multipoint calibrations. On an annual basis, EPD's Quality Assurance Unit audits these samplers.

As part of the Clean Air Status and Trends Network (CASTNET), EPA established a monitoring site in Georgia in 1988. The CASTNET site is part of a national air quality monitoring network put in place to assess long-term trends in atmospheric deposition and ecological effects of air pollutants. The CASTNET site is one of 85 regional sites across rural areas of the United States and Canada measuring nitrogen, sulfur, and ozone concentrations, and deposition of sulfur and nitrogen. Like the South DeKalb ozone monitor, the CASTNET ozone monitor also collects data year-round. As of 2011, the CASTNET ozone monitor met the Code of Federal Regulations (40 CFR), and met quality assurance and completeness criteria. Therefore, as of 2011, data collected by this monitor can be used for comparison to the NAAQS.

2.4 Sulfur Dioxide (SO_2)

Sulfur dioxide (SO_2) is a colorless, corrosive, harmful gas with a pungent odor. Sulfur oxides contribute to the formation of acid rain and the formation of particles that reduce visibility. The main sources of SO_2 are combustion of fossil fuels containing sulfur compounds and the manufacture of sulfuric acid. Other sources include refining of petroleum and smelting of ores that contain sulfur.

The most obvious health effect of sulfur dioxide is irritation and inflammation of body tissues brought in contact with the gas. Sulfur dioxide can increase the severity of existing respiratory diseases such as asthma, bronchitis, and emphysema. Sulfuric acid and fine particulate sulfates, which are formed from sulfur dioxide, also may cause significant health problems. Sulfur dioxide causes injury to many plants. A bleached appearance between the veins and margins on leaves indicates damage from SO_2 exposure. Commercially important plants sensitive to SO_2 include cotton, cucumber, alfalfa, sweet potatoes, tulips, apple trees, and several species of pine trees.

Sulfur dioxide is measured in the ambient air using EPA-approved reference method instruments as defined in 40 CFR Part 53. Georgia's sulfur dioxide network consists of continuous instruments using a pulsed ultraviolet (UV) fluorescence technique. This monitoring technique is based on measuring the emitted fluorescence of SO_2 produced by its absorption of UV radiation. Pulsating UV light is focused through a narrow bandpass filter allowing only light wavelengths of 1,900 to 2,300 angstrom units (Å) to pass into the fluorescence chamber. SO_2 absorbs light in this region without any quenching by air or most other molecules found in polluted air. The SO_2 molecules are excited by UV light and emit a characteristic decay radiation. A second filter allows only this decay radiation to reach a photomultiplier tube. Electronic signal processing transforms the light energy impinging on the photomultiplier tube into a voltage which is directly proportional to the concentration of SO_2 in the sample stream being analyzed. The sampler outputs the SO_2 concentration to the front panel display and analog or digital output. These analyzers are subjected to weekly ZPS checks, quarterly multipoint calibrations, and are audited by EPD's Quality Assurance Unit on an annual basis.

2.5 Nitrogen Oxides (NOx)

Several gaseous oxides of nitrogen are normally found in the atmosphere, including nitrous oxide (N_2O), nitric oxide (NO) and nitrogen dioxide (NO_2). Nitrous oxide is a stable gas with anesthetic characteristics and typical ambient concentrations well below the threshold concentration for a biological effect. Nitric oxide is a colorless gas with ambient concentrations generally low enough to have no significant biological effect. Nitrogen dioxide is reddish-brown but is not usually visible at typical ambient concentrations.

The most significant nitrogen oxide emissions result from the burning of fossil fuels such as coal, oil, and gasoline, due to the oxidation of atmospheric nitrogen and nitrogen compounds in the fuel. The primary combustion product is NO, which reacts in the atmosphere to form NO_2.

At high concentrations, nitrogen dioxide has significant health effects as a pulmonary irritant, especially upon asthmatics and children. At concentrations more typical in Georgia, though, NO_2 is primarily of concern because of its role in the formation of ground-level ozone. In warm, sunny conditions, it reacts with hydrocarbons in the atmosphere to form ozone. Ironically, the same reaction can run in reverse in the absence of sunlight, though, meaning that urban areas with strong NO emissions and daytime ozone problems will often have virtually zero ozone present at night. Yet the next morning, the store of unreacted NO_2 that builds up in these areas overnight can cause rapid ozone formation once the sun rises. Therefore, urban areas often have summertime ozone concentrations with dramatic afternoon peaks contrasting against periods overnight where no ozone is present. Areas without strong local NO sources, like rural areas and national parks, tend to have ozone present around the clock, but in moderate concentrations that are steadier throughout a twenty-four hour period.

Some types of vegetation are very sensitive to NO_2, including oats, alfalfa, tobacco, peas, and carrots. Chronic exposure causes chlorosis (yellowing) and acute exposure usually causes irregularly shaped lesions on the leaves.

Nitric oxide and nitrogen dioxide do not directly damage materials. However, NO_2 can react with moisture in the air to produce nitric acid, which corrodes metal surfaces and contributes to acid rain. High concentrations of NO_2 may reduce visibility.

Oxides of nitrogen, particularly NO_2, are monitored using specialized analyzers that continuously measure the concentration of oxides of nitrogen in ambient air using the ozone-phase chemiluminescent method. Nitric oxide (NO) and ozone (O_3) react to produce a characteristic luminescence with intensity linearly proportional to the NO concentration. Infrared light emission results when electronically excited NO_2 molecules decay to lower energy states. NO_2 must first be converted to NO before it can be measured using the chemiluminescent reaction. NO_2 is converted to NO by a molybdenum NO_2-to-NO converter heated to about 325^{o}C. The ambient air sample is drawn into the sample bulkhead. The sample flows through a particulate filter, a capillary, then to the mode solenoid valve. The solenoid valve routes the sample either straight to the reaction chamber (NO mode) or through the NO_2-to-NO converter and then to the reaction chamber (NO_x mode). Dry air enters the dry air bulkhead through a flow sensor, and then through a silent discharge ozonator. The ozonator generates the necessary ozone concentration needed for the chemiluminescent reaction. The ozone reacts with the NO in the ambient air to produce electronically excited NO_2 molecules. A photomultiplier tube housed in a thermoelectric cooler detects the NO_2 luminescence. The NO and NO_2 concentrations calculated in the NO and NO_x modes are stored in memory, and the difference between the concentrations are used to calculate the NO_2 concentration. The sampler outputs NO, NO_2, and NO_x concentrations on the front panel display and the analog or digital outputs. There are two major instrument designs. While they are closely related, they do not monitor the same species. NO_x analyzers measure NO, NO_2, and NO_x. NO_y analyzers measure NO and NO_y, but cannot measure NO_2. The NO_y analyzers are also specialized for measuring trace-level concentrations; as such, they cannot measure higher concentrations. Because of these tradeoffs, it is necessary to operate a network of both instrument types to get a complete picture of local conditions.

Of the oxides of nitrogen, only NO_2 is regulated under the NAAQS. Therefore, only the NO_x type analyzers produce data directly relevant to the standard. These analyzers are subjected to weekly ZPS checks, quarterly multipoint calibrations, and are audited by EPD's Quality Assurance Unit on an annual basis.

2.6 Lead (Pb)

Lead (Pb) is a toxic heavy metal element occurring in the atmosphere as a constituent of small particles. The major source of atmospheric lead used to be the combustion of gasoline containing the additive tetraethyl lead as an antiknock agent. The use as a gasoline additive has been banned in all applications except aviation gasoline. This ban has dramatically decreased concentrations of lead in the ambient air. Significant remaining sources include coal combustion and sandblasting of highway structures and water tanks. Lead is also used in some batteries, paints, insecticides, and newspaper inks.

Lead persists and accumulates in the environment and the human body. It may be inhaled, ingested, and eventually absorbed into the bloodstream and distributed to all body tissues. Exposure to low concentrations interferes with blood production and specific enzyme systems. It is believed to cause kidney and nerve cell damage, and severe lead poisoning is known to cause brain damage in children.

Since lead is a particulate, the measurement for ambient air lead concentrations is performed using a manual method, unlike measurements for the gaseous pollutants discussed earlier (ozone, SO_2, NO_2 and CO). Samples are collected on 8" x 10" pre-weighed fiberglass filters with a high-volume total suspended (TSP) sampler for 24 hours, collecting particles with diameters of 100 microns or less. High volumes of ambient air in the flow range of 40-60 cubic feet per minute are sampled at a constant rate during the sampling period. This produces a uniform distribution of particles deposited on the sample filter downstream of the sampler inlet. Samples collected with the TSP high-volume sampler can be used to determine the average ambient TSP concentration over a sampling period followed by subsequent analysis to determine the identity and quantity of inorganic metals present in the TSP. The filter sample is shipped to a laboratory for analysis using inductively coupled plasma mass spectroscopy (commonly known as ICP-MS). Data gained from the criteria lead samplers is used to determine compliance with the National Ambient Air Quality Standards for lead. On a semi-annual basis, EPD's Quality Assurance Unit audits these samplers.

In addition to the criteria lead network sites, lead is monitored as a trace metal in the Georgia Air Toxics Monitoring Network, the National Air Toxics Trends Station (NATTS), and with the $PM_{2.5}$ speciation samplers. With the Air Toxics Network, samples are obtained with a high-volume sampler collecting total suspended particles in the ambient air. The NATTS lead is sampled using a PM_{10} sampler, and particles are sampled up to 10 microns in size. With the $PM_{2.5}$ speciation sampler, samples are collected that include particles up to 2.5 microns in size. All three of these additional sampling techniques also collect 24-hour samples on pre-weighed filters, have samples sent to a laboratory for analysis, and are analyzed with ICP-MS. On an annual basis, EPD's Quality Assurance Unit audits these lead samplers.

2.7 Volatile Organic Compounds (VOCs)

All Volatile Organic Compounds (VOCs) contain carbon, the basic chemical element found in living beings. Carbon-containing chemicals are called organic. Volatile chemicals escape into the air easily. Many VOCs are also hazardous air pollutants, which can cause very serious illnesses. VOCs are released from burning fuel (gasoline, oil, coal, natural gas, etc.), solvents, paints, glues, and other products used at work or at home. Cars are an important source of VOCs. VOCs include chemicals such as benzene, toluene, methylene chloride and methyl chloroform. In addition to ozone (smog) effects, many VOCs can cause serious health problems such as cancer and other effects directly. Some VOCs such as ethylene may also harm plants.

VOCs are collected and analyzed with two different methods. One method is with the Air Toxics Network in which the VOCs are collected with a canister. A SUMMA® polished canister is evacuated to a near-perfect vacuum and attached to a sampler with a pump controlled by a timer. The canister is filled to greater than 10 psig. The samples are collected for a 24-hour period, every 6 or 12 days depending on the site. The Air Toxics VOCs canister is analyzed using a gas chromatograph with mass spectroscopy detection (GC/MS), using method TO14/15, at the EPD laboratory. The second method of VOCs collection and analysis is with the PAMS network in which VOCs are collected and analyzed on-site with a gas chromatograph/flame ionization detector (GC/FID). During June, July, and August, the PAMS VOCs samples are collected continuously on an hourly basis. Also throughout the year with the PAMS network, a 24-hour VOCs sample is collected every 6 days and analyzed with the GC/FID method at the EPD laboratory. The VOC samplers in the PAMS network are subjected to quarterly checks and audited every six months. The Air Toxics VOCs samplers are subjected to quarterly checks and are audited by EPD's Quality Assurance Unit on an annual basis.

2.8 Carbonyls

Carbonyl compounds define a large group of substances, which include acetaldehyde and formaldehyde. These compounds can act as precursors to ozone formation. They can be formed from the breakdown of certain organic pollutants in outdoor air, from forest fires and wildfires, as well as from vehicle exhaust.

The carbonyls are sampled with two types of methods. One type is an absorbent cartridge filled with dinitrophenylhydrazine (DNPH)-coated silica that is attached to a pump to allow approximately 180 liters of air to be sampled. The cartridge is then analyzed using high performance liquid chromatography (HPLC). For the PAMS network, during June, July, and August, four integrated 3-hour carbonyls samples are taken every third day. A 24-hour integrated carbonyls sample is also taken every 6 days throughout the year at the South DeKalb NATTS site. The other method used for collecting carbonyls is the canister sampler that is used for sampling volatile organic compounds. Acrolein is a carbonyl compound that is collected using this canister method, described above, and analyzed with the GC/MS method. The PAMS and NATTS carbonyls samplers are subjected to quarterly checks and audited by EPD's Quality Assurance department every six months. Also at select Air Toxics sites, carbonyls samples are collected on a DNPH cartridge for a 24-hour period, every 12 days. The Air Toxic carbonyls samplers are subjected to quarterly checks and audited by EPD's Quality Assurance Unit annually.

2.9 Semi-Volatile Organic Compounds

Polycyclic aromatic hydrocarbons (PAHs), also called semi-volatile organic compounds are chemical compounds that consist of fused, six-carbon aromatic rings. They are formed by incomplete combustion of carbon-containing fuels such as wood, coal, diesel fuels, fat or tobacco. The PUF (polyurethane foam) sampler used for sampling for semi-volatile organic compounds is a timed sampler. The sampler is calibrated to collect 198 to 242 liters (L) of air per minute. A multi-layer cartridge is prepared which collects both the particulate fraction and the volatile fraction of this group of compounds. The plug, filter and absorbent are extracted at a remote laboratory and analyzed using gas chromatography. The semi-VOCs samplers are subjected to quarterly checks and audited by EPD's Quality Assurance Unit annually.

2.10 Aethalometer

The aethalometer is a continuous sampler used for sampling black carbon. Black carbon is particulate aerosol formed from the incomplete combustion of fossil fuels, biomass, and biofuels. Diesel engines are a large contributor of black carbon. With the sampling for black carbon, attempts can be made to determine the anthropogenic portion of carbon sources in ambient air pollution. Operating at 60 watts/110V AC, the aethalometer uses quartz tape to perform an optical analysis to determine the concentration of carbon particles passing through an air stream. The analysis is conducted using spectrophotometry, measuring the wavelength of the light energy absorbed and plotting the results on the site computer. These parameters are subjected to quarterly checks and audited by EPD's Quality Assurance Unit every six months.

2.11 Meteorological Parameters

GA EPD has seventeen meteorological stations across the state. Surface meteorological measurements, including wind speed and wind direction, are measured at every location. In addition, as part of the Photochemical Assessment Monitoring Sites (PAMS) around the metropolitan Atlanta area, a complete suite of meteorological instrumentation is used to characterize meteorological conditions. All PAMS stations measure hourly-averaged scalar wind speed and vector-averaged wind direction at the 10-meter level, and hourly-averaged surface temperature, relative humidity and barometric pressure at the 2-meter level. Several sites include instruments to record hourly-averaged precipitation, global solar radiation, and total ultraviolet radiation. In addition, the standard deviation of the wind direction is computed at the NCore site (South DeKalb). These parameters are audited by the EPD's Quality Assurance Unit on an annual basis. For upper air measurement, GA EPD uses a SODAR PA5-LR system in conjunction with balloon rawinsonde data collected from NWS at Peachtree City. This upper air system proves especially useful for monitoring low-level winds during smoke transport events.

3.0 Description of Networks

3.1 NCore

The National Core (NCore) Multipollutant Monitoring network is a network measuring several pollutants including particles, gases, and meteorology. These stations provide data on several pollutants at lower detection limits. The NCore Network addresses the following monitoring objectives:

- timely reporting of data to the public through AIRNow, air quality forecasting, and other public reporting mechanisms
- support development of emission strategies through air quality model evaluation and other observational methods
- accountability of emission strategy progress through tracking long-term trends of criteria and non-criteria pollutants and their precursors
- support long-term health assessments that contribute to ongoing reviews of the National Ambient Air Quality Standards (NAAQS)
- compliance through establishing nonattainment/attainment areas by comparison with the NAAQS
- support multiple disciplines of scientific research, including; public health, atmospheric and ecological

The NCore site for the State of Georgia is the South DeKalb site (13-089-0002) in DeKalb County. Site selection was due July 1, 2009, and this site was approved by EPA on October 30, 2009. The site was fully operational by January 1, 2011. The NCore sampling equipment at the South DeKalb site includes: $PM_{2.5}$ FRM, $PM_{2.5}$ continuous, PM_{coarse}, $PM_{2.5}$ speciation, ozone (collecting data year-round), trace level carbon monoxide, trace level sulfur dioxide, trace level nitrogen oxide, total reactive nitrogen (NOy), wind direction, wind speed, temperature, and relative humidity. The DMRC site (13-089-0003) is located approximately 2 kilometers away from the South DeKalb site, and is the location of the NCore lead sampler. Refer to GA EPD's previous (2014) Ambient Air Monitoring Plan, Appendix C, Ambient Air Monitoring Plan for National Core (NCore) Multipollutant Monitoring Station for full description.

3.2 Sulfur Dioxide

On June 2, 2010, EPA strengthened the sulfur dioxide (SO_2) standard to include a 1-hour primary standard of 75 ppb, and new SO_2 ambient monitoring requirements for the 1-hour standard (Federal Register: Vol. 75, No. 119, 06/22/10). The rule was written to use a hybrid approach combining air quality modeling and monitoring. The rule includes refined dispersion modeling to determine if areas with sources that have the potential to cause or contribute to a violation of the new SO_2 standard can comply with the standard. The final monitoring regulations require monitors to be placed in Core Based Statistical Areas (CBSAs) based on a population weighted emissions index (PWEI) for the area. The final rule requires three monitors in CBSAs with index values of 1,000,000 or more; two monitors in CBSAs with index values less than 1,000,000 but greater than 100,000; and one monitor in CBSAs with index values greater than 5,000. According to this monitoring rule, GA EPD will need five monitors to accommodate the new SO_2 rule. Two monitors should be in place in the Atlanta-Sandy Springs-Marietta CBSA, one in the Augusta-Richmond County, GA-SC CBSA, one in the Macon CBSA, and one in the Savannah CBSA. According to 40 CFR 58.10 (a) (6), the Annual Plan submitted by July 1, 2011

was to include a plan for establishing SO_2 monitoring sites to meet the new monitoring requirements of Appendix D. These sites were to be operational by January 1, 2013. In addition, the SO_2 5-minute maximum for every hour was to start being reported as of August 23, 2010.
To accommodate the rule change, GA EPD started sampling in the Augusta-Richmond County, GA-SC MSA at the Augusta-Bungalow Road site (13-245-0091) as of January 14, 2013. GA EPD will continue monitoring at the Confederate Avenue site (13-121-0055), the South DeKalb site (13-089-0002), and the Macon-Forestry site (13-021-0012). In addition, GA EPD will continue sampling with both monitors in the Savannah MSA (Savannah-E. President Street, 13-051-0021 and Savannah-L&A, 13-051-1002) and at the Rome-Coosa Elementary site (13-115-0003) since these three monitors have concentrations close to or above 85% of the new SO_2 standard. As of August 1, 2010, GA EPD began collecting 5-minute maximum data with these SO_2 samplers.

The South DeKalb site (13-089-0002) began sampling trace level sulfur dioxide as of October 1, 2010. This sampler also began collecting SO_2 5-minute maximum data on October 1, 2010. This is to accommodate the NCore requirements for this site.

3.3 Nitrogen Dioxide

On January 22, 2010, EPA revised the nitrogen dioxide (NO_2) National Ambient Air Quality Standard and monitoring requirements. According to 40 CFR 58.10 (a) (5), the Annual Plan submitted by July 1, 2012 would include a plan for establishing NO_2 monitoring sites to meet the new monitoring requirements of Appendix D. These sites were to be operational by January 1, 2013 (Federal Register, Vol. 75, No. 26, 02/09/10). Then on October 5, 2012, EPA proposed to change the establishment dates of these monitors, and that the first phase of near-road monitoring site establishment would be January 1, 2014. The second phase of site establishment would be January 1, 2015, and the third phase would be January 1, 2017 (Docket No. EPA-HQ-OAR-2012-0486). These monitors are to be set up in CBSAs with 500,000 or more population (additional monitor with CBSA population above 2,500,000), average traffic counts of 250,000 vehicles or greater, and represent a microscale (no more than 50 meters from the edge of the nearest traffic lane). According to these requirements, GA EPD would need to have two near-road NO_2 monitors in the Atlanta-Sandy Springs-Marietta MSA and one near-road NO_2 monitor in the Augusta-Richmond County, GA-SC MSA.

GA EPD began monitoring near-road NO_2 at the first near-road site on the Georgia Institute of Technology campus (site ID 13-121-0056) in the Atlanta-Sandy Springs-Marietta MSA as of June 15, 2014. For details regarding the establishment of the first near-road NO_2 monitor in the Atlanta-Sandy Springs-Marietta MSA, refer to Appendix E of the 2014 Ambient Air Monitoring Plan. According to EPA's schedule, GA EPD established the second near-road monitoring site in the Atlanta-Sandy Springs-Marietta MSA on January 1, 2015 at the established DMRC site (13-089-0003). For details regarding the establishment of the second near-road site, refer to the GA EPD's Addendum to the 2014 Ambient Air Monitoring Plan.

For the Augusta-Richmond County, GA-SC MSA, there are no AADT counts reaching 250,000 vehicles. According to the 2011 AADT estimates, the highest traffic count (traffic counter 0223) is approximately 82,850 vehicles near the intersection of I-20 and I-520. However, the population for the Augusta-Richmond County, GA-SC MSA is above 500,000. Therefore, a near-road NO_2 monitor will be placed in this MSA. GA EPD has analyzed the AADT estimates and has been evaluating suitable locations to meet the near-road NO_2 monitoring requirement in the Augusta-Richmond County, GA-SC MSA by January 1, 2017.

In addition, with these NO_2 requirements, GA EPD would need one area-wide NO_2 monitor in the Atlanta-Sandy Springs-Marietta MSA. These monitors should be placed in CBSAs with a population of 1,000,000 or more, and are expected to have the highest concentrations representing a neighborhood or larger spatial scale. Currently GA EPD has three NO_2 monitors in the Atlanta-Sandy Springs-Marietta MSA, which has a population above 1,000,000. These monitors are located at the three PAMS sites: South DeKalb (13-089-0002), Yorkville (13-223-0003), and Conyers (13-247-0001). Of the three NO_2 monitors currently collecting data, the South DeKalb site has historically collected the highest concentrations, is located within an urban area, represents the urban spatial scale, and operates year round. Therefore, the South DeKalb NO_2 monitor satisfies the area-wide requirement.

3.4 Carbon Monoxide

On August 12, 2011, EPA finalized changes to the monitoring requirements for the carbon monoxide (CO) monitoring network. According to these changes, EPA is requiring that a CO monitor be collocated with an NO_2 near-road monitor in urban areas with populations of one million or more. EPA specified that in areas with 2.5 million or more, the CO monitors should be operational by January 1, 2015 (Federal Register: Vol. 76, No. 169, Page 54293, 08/31/11). For the State of Georgia, this monitoring requirement would be one CO monitor located in the Atlanta-Sandy Springs-Marietta MSA, collocated with the NO_2 near-road monitor. GA EPD began monitoring CO at the new near-road site at Georgia Institute of Technology (13-121-0056) along with the NO_2 monitor on June 15, 2014.

GA EPD has two other CO monitors at Photochemical Assessment Monitoring Stations (PAMS) in the Atlanta-Sandy Springs-Marietta MSA. One location is at the South DeKalb site (13-089-0002), and the other is at the Yorkville site (13-223-0003).

3.5 Lead

Georgia EPD's ambient lead monitoring network currently consists of monitors located at four sites. One of these lead monitoring sites is located in the Atlanta-Sandy Springs-Marietta MSA at the DMRC site in DeKalb County (13-089-0003) and consists of two collocated monitors. Three of these lead monitoring sites are in the Columbus Georgia-Alabama MSA in Muscogee County. There is one monitor located at the Cusseta Elementary School (13-215-0011), one at Columbus-UPS (13-215-0009), and one at Columbus-Fort Benning (13-215-0010). In addition, the Columbus-Fort Benning (13-215-0010) criteria lead monitor is collocated with a second criteria lead monitor.

On December 14, 2010, EPA revised the requirements for measuring lead in the ambient air. The emission threshold for placing lead monitors near industrial facilities was lowered from 1.0 tons per year (tpy) to 0.5 tpy. In addition, EPA is requiring that lead monitors be placed at the NCore sites. The new lead monitors were required to be operational by December 27, 2011 [40CFR58, Docket No. EPA-HQ-OAR-2006-0735, 12/14/10].

GA EPD meets the requirement of monitoring lead at an NCore site. The NCore site for the State of Georgia is the South DeKalb site (13-089-0002), and the criteria lead monitor is located at the nearby established DMRC site (13-089-0003).

For the monitors to be placed near industrial facilities that emit greater than 0.5 tpy, EPA had compiled a list of lead sources from the 2011 National Emissions Inventory (NEI). The industrial facilities listed in Georgia are shown in the table below.

Table 3.1: EPA Required Ambient Air Lead Monitoring for Georgia

State	County	Site Name	Emissions (tpy)	Data Source
GA	Floyd	Temple Inland Rome	0.59	2011 NEI
GA	Pierce	Gilman Building Products Co- Blackshear	0.50	2011 NEI
GA	Fulton	R. M. Clayton Water Reclamation Center	0.62	2011 NEI

Emissions data from 2011 National Emissions Inventory (NEI)

The Georgia Environmental Protection Division (GA EPD) researched all available data for these facilities and, where necessary, contacted the facilities for further information. As a result of GA EPD's research, the following were discovered:

1. Temple Inland Rome Linerboard Mill – GA EPD received updated calculations of 2011 lead emissions from Temple-Inland Rome. These calculations show a total of 186 pounds of lead emitted per year (0.093 tons/year). Refer to the following tables for details.

2. R.M. Clayton Water Reclamation Center – The facility provided lead calculations for 2010 and 2011. These calculations showed maximum lead emissions of 9.327 pounds per year (0.0046 tons/year) in 2011. Refer to the following tables below for details.

3. Gilman Building Products, Blackshear – The company submitted updated emission estimates indicating lead emissions of 16.03 pounds/year from each kiln. The Blackshear lumber mill operates 3 kilns, resulting in 48.09 pounds per year (0.02 tons/year) of lead emissions.

4. No other facilities in Georgia have estimated lead emissions equal to or exceeding 0.5 tons/ year.

The following tables are provided as supporting documentation for the above lead emission findings.

The first table below shows the revised 2011 lead emission rates for Temple Inland Rome, R.M. Clayton Water Reclamation Center, and Gilman Building Products – Blackshear.

Table 3.2: Changes to GA 2011 NEI Lead Data

Changes to GA 2011 NEI Lead Data			
Facility Name	Temple Inland Rome	R.M. Clayton Water Reclamation Center	Gilman Building Products - Blackshear
City	Rome	Atlanta	Blackshear
State	GA	GA	GA
2011 NEI Emissions (tpy)	0.517	0.62	0.52
Revised Emissions Data	0.061	0.0046	0.024
Latitude	34.254592	33.4625	31.319722
Longitude	85.325569	84.458333	82.216667

Temple Inland Rome submitted calculations for their 2011 lead emissions, with updated emission factors for lead emissions from lime kilns 1 and 2. The new calculations were based on the recommended median lead emission factor (EF) listed in the National Council for Air and Stream Improvement (NCASI) air toxics emissions database. The detailed emission calculations as submitted are given in the table below.

Table 3.3: Lead Emission Calculations for Temple Inland Rome

Source Group	Material	Activity	Activity Units of Measure (UOM)	EF Final	EF Final UOM	Control Efficiency	Amount Emitted	UOM
Lime Kilns	FuelOil2-MGal (non-cofired)	0	Mgal-FuelOil2 (non-cofired)	1.260E-003	lb/10e3 gal	0.00 %	4.99E-005	lbs
	FuelOil5-MGal (non-cofired)	0	Mgal-FuelOil5 (non-cofired)	1.510E-003	lb/10e3 gal	0.00 %	7.29E-005	lbs
	NatGas-MMSCF (non-cofired)	5	NatGas (non-cofired)-MMSCF	5.000E-004	lb/10e6 scf	0.00 %	2.50E-003	lbs
	TCaO-onGas	81,639	TCaO-onGas	2.860E-004	lb/T CaO	0.00 %	23.35	lbs
	TCaO-onOil	234	TCaO-onOil	2.860E-004	lb/T CaO	0.00 %	6.70E-002	lbs
	FuelOil2-MGal (non-cofired)	0	Mgal-FuelOil2 (non-cofired)	1.260E-003	lb/10e3 gal	0.00 %	0.00	lbs
	FuelOil5-MGal (non-cofired)	0	Mgal-FuelOil5 (non-cofired)	1.510E-003	lb/10e3 gal	0.00 %	0.00	lbs
	NatGas-MMSCF (non-cofired)	4	NatGas (non-cofired)-MMSCF	5.000E-004	lb/10e6 scf	0.00 %	1.98E-003	lbs
	TCaO-onGas	85,693	TCaO-onGas	2.860E-004	lb/T CaO	0.00 %	24.51	lbs
	TCaO-onOil	2	TCaO-onOil	2.860E-004	lb/T CaO	0.00 %	0.00	lbs
Power	NatGas-MMSCF	184	NatGas-MMSCF	5.000E-004	lb/10e6 scf	0.00 %	0.09	lbs
	Coal-Tons	124,589	Coal-Tons	4.200E-004	lb/Ton Coal	0.00 %	52.33	lbs
	FuelOil2-MGal	2	MGal-FuelOil2	1.260E-003	lb/10e3 gal	0.00 %	2.61E-003	lbs
	FuelOil5-MGal	60	MGal-FuelOil5	1.510E-003	lb/10e3 gal	0.00 %	0.09	lbs
	NatGas-MMSCF	142	NatGas-MMSCF	5.000E-004	lb/10e6 scf	0.00 %	0.07	lbs

	Bark-MMBTU	5,492,549	Bark-MMBTU	1.970E-006	lb/10e6 BTU	0.00 %	10.82	lbs
	FuelOil2-MGal	20	MGal-FuelOil2	1.260E-003	lb/10e3 gal	0.00 %	0.03	lbs
	FuelOil5-MGal	601	MGal-FuelOil5	1.510E-003	lb/10e3 gal	0.00 %	0.91	lbs
	OCCRejects-MMBTU	220,965	MMBTU-OCCRejects	1.970E-006	lb/10e6 BTU	0.00 %	0.44	lbs
	Sludge-MMBTU	0	Sludge-MMBTU	1.970E-006	lb/10e6 BTU	0.00 %	0.00	lbs
	TDF-MMBTU	0	MMBTU-TDF	1.970E-006	lb/10e6 BTU	0.00 %	0.00E+000	lbs
RB&SDT5	FuelOil2-MGal (non-cofired)	16	Mgal-FuelOil2 (non-cofired)	1.260E-003	lb/10e3 gal	0.00 %	1.96E-002	lbs
	FuelOil5-MGal (non-cofired)	72	Mgal-FuelOil5 (non-cofired)	1.510E-003	lb/10e3 gal	0.00 %	0.11	lbs
	TBLS	886,798	TBLS	9.810E-006	lb/T BLS	0.00 %	8.70	lbs
	TBLS	886,798	TBLS	6.900E-007	lb/T BLS	0.00 %	0.61	lbs
Total							**122.14**	**lbs**

0.061	**tons**

Gilman Building Products LLC (Blackshear) submitted updated emission values. Their actual emissions were about 0.008 tpy to 0.024045 tpy depending on the number of kilns the facility operates. The detailed emission calculations as submitted are given below.

Gilman operates as a saw mill. The mill operates three direct fired kilns where cut lumber is dried. The fuel utilized is wood waste. The burning of wood waste to generate steam for the drying process is the only activity causing or contributing to lead emissions.

Each kiln at maximum production utilizes 42000 Tons of wood waste per year; therefore, the total lead emissions per year from each kiln is as follows:

Table 3.4: Lead Emission Calculations for Gilman Building Products LLC (Blackshear, Dudley and Fitzgerald)

Wood Waste utilized/Kiln/Yr At Maximum Operation	42,000 Tons/Yr
Heat Value of Wood	4000 Btu/lb of Wood
Total Heat generation per Kiln	336,000MMBtu/Yr
AP-42 Emission Factor for Wood waste	0.0000477 lbs of Lead/MMBtu
Lead Emissions per kiln	336,000X0.0000477= 16.03 Lbs

Since the mill has three kilns, lead emissions from the facility are:
16.03 lb/yr/kiln x 3 kilns = 48.03 lb/yr

R.M. Clayton Water Reclamation Center provided the following calculation details for 2007, 2008, 2009, 2010 and 2011 lead emissions. Thus, showing that their maximum potential lead emissions for 2011 would be 9.32 lbs.

Table 3.5: R.M. Clayton Water Reclamation Center Lead Emissions Calculations for 2007-2011

Year	Sludge Incinerated (tpy)	Amount of Sludge Landfilled (metric tonne/year)	Sludge Processed (tpy)	Lead Content of Sludge (mg/kg dry weight)		Scrubber Removal Efficiency (%)	Maximum Potential of (Pb)	
				Minimum	Max		kg/yr	Lb/yr
2007	12,444.0	6,524.0	18,968.0	22.2	134.6	99.63%	9.44	20.82
2008	14,748.0	4,306.0	19,054.0	0.9	90.1	99.63%	6.35	14
2009	10,860.1	9,123.7	19,983.8	30.1	76.7	99.63%	5.67	12.5
2010	13,378.7	6,671.5	20,050.2	49.4	77	99.63%	5.71	12.59
2011	14,931.0	2,289.0	17,220.0	32.7	66.4	99.63%	4.23	9.32

3.6 $PM_{2.5}$ Speciation Trends Network (STN)

With the monitoring of ambient levels of $PM_{2.5}$, EPA wanted to expand the sampling to characterize the make-up of the $PM_{2.5}$ sample. With this information, air quality modeling can be analyzed to help implement the NAAQS standards; health studies can be interpreted with the constituents of the sample, as well as understanding the make-up of regional haze. According to EPA, there are to be 54 Speciation Trends sites across the United States. One of these samplers is located in the State of Georgia, at the South DeKalb site, with site ID 13-089-0002. This sampler began monitoring on October 1, 2000, and samples every three days. There are six more $PM_{2.5}$ speciation monitors in the State of Georgia, located in Rome (started 3/1/02), Macon (started 3/1/02), Columbus (started 5/1/02), Augusta (started 3/2/02), Rossville (started 3/23/05), and Douglas (started 3/1/02). These are in place to provide supplemental speciation data in the overall chemical speciation network, and take samples every 6 days. All of the $PM_{2.5}$ speciation samplers monitor for 53 species. The speciation samplers are subjected to monthly checks and audited by EPD's Quality Assurance Unit on a quarterly basis.

3.7 Photochemical Assessment Monitoring Stations (PAMS)

Ozone is the most prevalent photochemical oxidant and an important contributor to smog. The understanding of the chemical processes in ozone formation and the specific understanding of the atmospheric mixture in various nonattainment areas nationwide was considered essential by EPA for solving the ozone nonattainment problems and developing a suitable strategy for solving those problems. As such, the 1990 Amendments to the Clean Air Act included additional requirements for monitoring of ozone precursors in areas declared in serious, severe, or extreme nonattainment of the ambient ozone standard. In February 1993, due in part to the Clean Air Act Amendments of 1990, the Photochemical Assessment Monitoring Stations (PAMS) network was created as a method for obtaining more comprehensive ozone data. Along with ozone, the PAMS network monitors for oxides of nitrogen (NOx), reactive oxides of nitrogen (NOy), carbon monoxide (CO), volatile organic compounds (VOCs), selected carbonyl compounds, and meteorological parameters. Stated in Title 40, Part 58 of the Code of Federal

Regulations (40 CFR Part 58), the increased monitoring of ozone and its precursor concentrations allows for the characterization of precursor emissions within the area, transport of ozone and its precursors, and the photochemical processes leading to nonattainment. By expanding on the study of ozone formation, PAMS monitoring sites better serve as a means to study trends and spatial and diurnal variability.

On November 6, 1991, the Atlanta nonattainment area was classified as serious, with the 1-hour ozone standard (56FR56694). By 2003, the area was labeled in severe nonattainment of the 1-hour ozone standard (68FR55469) effective January 1, 2004, but by June 14, 2005, was listed as maintenance/attainment (70FR34660). With the 8-hour ozone standard, the Atlanta nonattainment area was classified as marginal, effective June 15, 2004 (69FR23857) and then as moderate nonattainment effective April 7, 2008 (73FR12013). On June 23, 2011, EPA promulgated its determination [76 FR 36873] that the metro Atlanta nonattainment area had attained the 1997 8-hour ozone NAAQS. EPA published the redesignation in the federal register as a final rule on December 2, 2013 (78 FR 72040). On May 21, 2012, EPA published a final rule in the federal register designating a new 15-county Atlanta area marginal nonattainment for the 2008 8-hour ozone NAAQS.

The GA PAMS network consists of three sites; Yorkville (13-223-0003), South DeKalb (13-089-0002), and Conyers (13-247-0001). Yorkville is a Type 1 site. This site characterizes the upwind background, transported ozone, and precursor concentrations entering the Atlanta area. The site is located in the predominant morning upwind direction approximately 40 miles from the Atlanta urban fringe area in Paulding County, and should not be influenced by local VOC and NOx emissions. The site provides urban scale measurements. Data from the Yorkville site is used for the future development and evaluation of control strategies, identification of incoming pollutants, corroboration of NOx and VOC emission inventories, establishment of boundary conditions for future photochemical grid modeling and mid-course control strategy changes, development of incoming pollutant trends, and determination of attainment with NAAQS for O_3, $PM_{2.5}$, CO, and NO_2. South DeKalb is a Type 2 site. This site monitors the magnitude and type of precursor emissions and is located immediately downwind of the area of maximum precursor emissions receiving the predominant morning downwind wind. This site is located in DeKalb County in order to provide neighborhood scale measurements in the area that the precursors have the greatest impact. The data measurements generated at South DeKalb are used principally for development and evaluation of imminent and future control strategies, corroboration of NOx and VOC emission inventories, augmentation of RFP tracking, verification of photochemical grid model performance, characterization of ozone and toxics air pollutant exposures, development of pollutant trends (particularly toxic air pollutants and annual ambient speciated VOC trends to compare with trends in annual VOC emission estimates), and determination of attainment with NAAQS for O_3, $PM_{2.5}$, CO, and NO_2. Conyers acts as the Type 3 site. This site monitors the maximum ozone concentrations occurring downwind from the area of maximum precursor emissions, in Rockdale County. The site is an urban scale location based on the afternoon winds occurring between 1:00 PM and 4:00 PM, when titration of the precursors has occurred and the ozone is at its highest concentration. The data measurements are used in determination of attainment with the NAAQS for O_3 and NO_2, evaluation of future photochemical grid modeling applications, future development and evaluation of control strategies, development of pollutant trends, and characterization of ozone pollutant exposures.

The PAMS VOCs are collected and analyzed with a Gas Chromatograph/Flame Ionization Detector (GC/FID) at the Yorkville (13-223-0003), Conyers (13-247-0001), and South DeKalb (13-089-0002) sites. Throughout the year, a 24-hour VOCs sample is collected every 6 days at all three PAMS sites. During June, July, and August, an hourly VOCs sample is collected at the Yorkville and South DeKalb sites. The PAMS carbonyls samples are analyzed by drawing approximately 180 liters of air through an absorbent cartridge filled with dinitrophenylhydrazine (DNPH)-coated silica. The cartridge is then analyzed using High Performance Liquid Chromatography (HPLC). During June, July, and August, four integrated 3-hour carbonyls samples are taken every third day at the South DeKalb (13-089-0002) site. A 24-hour integrated carbonyls sample is also taken every 6 days throughout the year at the South DeKalb (13-089-0002) site. The VOCs sampler and carbonyls samplers in the PAMS network are audited every six months by the Quality Assurance Unit. The Quality Assurance Unit audits the PAMS meteorological equipment on an annual basis.

3.8 Air Toxics

In addition to its required monitoring duties, Georgia EPD measures more compounds in ambient air than are required by the Federal Clean Air Act. In 1993 the EPD began to monitor a number of compounds that, while thought to carry some health risk, have no established ambient air standard. A reassessment of the toxic monitoring program occurred, and in 1996 the EPD embarked on an ambitious project of establishing a statewide hazardous air pollutant-monitoring network. The network was not designed to monitor any one particular industry, but to provide information concerning trend, seasonal variation, and rural versus urban ambient concentration of air toxics. To evaluate the rural air quality, two background sites were proposed: one in North Georgia and one in South Georgia. The majority of the other sites were located in areas with documented emissions to the atmosphere of Hazardous Air Pollutants (HAPs) exceeding one million (1,000,000) pounds per year as indicated by the 1991 Toxic Release Inventory. By 2003 the Air Toxics Network consisted of fifteen sites statewide (including the NATTS site discussed below). Due to budget constraints and lack of available personnel, at the end of 2008, the Air Toxics Network was reduced to six sites (including the NATTS site discussed below): Macon-SE (13-021-0012), Savannah-E.President's St. (13-051-0021), Dawsonville (13-085-0001), South DeKalb (13-089-0002), Yorkville (13-223-0003), and General Coffee (13-069-0002).

Toxic air pollutants, also known as Hazardous Air Pollutants, are those pollutants that are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects. Air toxic compounds are released from many different sources, including mobile sources (such as vehicles), stationary industrial sources, small area sources, indoor sources (such as cleaning materials), and other environmental sources (such as wildfires). The lifetime, transportation, and make-up of these pollutants are affected by weather (rain and wind) and landscape (mountains and valleys). They can be transported far away from the original source, or be caught in rain and brought down to waterways or land.

Examples of toxic air pollutants include benzene, which is found in gasoline; perchlorethlyene, which is emitted from some dry cleaning facilities; and methylene chloride, which is used as a solvent and paint stripper by a number of industries. Examples of other listed air toxics include dioxin, asbestos, toluene, and metals such as cadmium, mercury, chromium, and lead compounds.

People exposed to toxic air pollutants at sufficient concentrations and durations may have an increased chance of getting cancer or experiencing other serious health effects. These health effects can include damage to the immune system, as well as neurological, reproductive (e.g., reduced fertility), developmental, respiratory, and other health problems. These effects can vary depending on how often one is exposed, how long one is exposed, the person's health that is exposed, and the toxicity of the compound. Some of the substances tend to have only one critical effect, while others may have several. These air pollutants also affect the environment.

Wildlife experience symptoms similar to those in humans. Many air pollutants can also be absorbed into waterways and have toxic effects on aquatic wildlife. In addition to exposure from breathing air toxics, some toxic air pollutants such as mercury can deposit onto soils or surface waters, where plants take them up, are ingested by animals, and are eventually magnified up through the food chain. Through this process, known as bioaccumulation, larger animals build up concentrations of these pollutants in their tissues that may be thousands of times higher than that found in the most polluted water or soil. Like humans, animals may experience health problems if exposed to sufficient quantities of air toxics over time. Humans who eat animals that have accumulated large concentrations of these pollutants are at the very top of this bioaccumulative food chain and as such are at particular risk for experiencing health effects.

The Air Toxics equipment samples for metals, semi-volatile organic compounds, volatile organic compounds, and three sites (Savannah, Dawsonville, and South DeKalb) have carbonyls samplers. The samplers run once every twelve days following a pre-established schedule that corresponds to a nationwide sampling schedule. On the twelfth day the sampler runs midnight to midnight and takes a 24-hour composite sample.

The high-volume sampler used for sampling metals is a timed sampler. The sampler is calibrated to collect 1000 to 2000 liters (L) of air per minute. Particulate material is trapped on an 8.5” x 11” quartz fiber filter. The particulates include dust, pollen, diesel fuel by-products, particulate metal, etc. The filters are pre-weighed at a remote laboratory prior to use and weighed again after sampling. The filters are subjected to a chemical digestion process and are analyzed on an inductively coupled plasma mass spectrometer (ICP/MS).

The PUF (polyurethane foam) sampler used for sampling for semi-volatile organic compounds is a timed sampler. The sampler is calibrated to collect 198 to 242 liters (L) of air per minute. A multi-layer cartridge is prepared which collects both the particulate fraction and the volatile fraction of this group of compounds. The plug, filter and absorbent are extracted at a remote state laboratory and analyzed using gas chromatography.

The canister sampler used for sampling Volatile Organic Compounds (VOCs) is a timed sampler. A polished canister is evacuated to a near-perfect vacuum and attached to a sampler with a pump controlled by a timer. The canister is filled to greater than 10 psig. The canister is analyzed using a gas chromatograph with mass spectroscopy detection (GC/MS).

The carbonyl samplers at the Air Toxics Network (ATN) sites sample approximately 180 liters of air through an absorbent cartridge filled with dinitrophenylhydrazine (DNPH)-coated silica. The cartridge is then analyzed using high performance liquid chromatography (HPLC). All of these air toxic parameters are subjected to quarterly checks and are audited by EPD’s Quality Assurance Unit on an annual basis.

3.9 National Air Toxics Trends Station (NATTS)

The National Air Toxics Trends Stations (NATTS) program is a nationwide monitoring project for the assessment of national trends and variations of several selected air toxics. The location of the station in Georgia is the South DeKalb site (13-089-0002). With the exception of the aethalometer, samples are collected from midnight to midnight for a 24-hour sample, every 6 days. The aethalometer is a continuous sampler used for sampling black and organic carbon. Operating at 60 watts/110V AC, the aethalometer uses quartz tape to perform an optical analysis to determine the concentration of carbon particles passing through an air stream. The analysis is conducted using spectrophotometry, measuring the wavelength of the light energy absorbed and plotting the results on the site computer.

The PM_{10} sampler used for sampling toxic metal particles less than or equal to 10 microns in diameter is a timed sampler. Collecting 1020 to 1240 liters (L) of air per minute, the sampler uses an 8.5” x 11” quartz glass fiber filter to trap particulate matter. The sample is analyzed using inductively coupled plasma mass spectrometry (ICP/MS). With ICP/MS, an argon gas is used to atomize and ionize the elements in a sample. The resulting ions are used to identify the isotopes of the elements and a mass spectrum is used to identify the element proportional to a specific peak formed from an isotope.

The volatile organic compound (VOCs) samples are collected with a canister method. A polished canister is evacuated to a near-perfect vacuum and attached to a sampler with a pump controlled by a timer. The canister is filled to greater than 10 psig. The canister is analyzed using a gas chromatograph with mass spectroscopy detection (GC/MS).

The PUF (polyurethane foam) sampler used for sampling for semi-volatile organic compounds is a timed sampler. The sampler is calibrated to collect 198 to 242 liters (L) of air per minute. A multi-layer cartridge is prepared which collects both the particulate fraction and the volatile fraction of this group of compounds. The plug, filter and absorbent are extracted at a remote laboratory and analyzed using a gas chromatograph with an electron capture detector (ECD).

The carbonyls are sampled with two types of methods. One type is an absorbent cartridge filled with dinitrophenylhydrazine (DNPH)-coated silica that is attached to a pump to allow approximately 180 liters (L) of air to be sampled. The cartridge is then analyzed using high performance liquid chromatography (HPLC). A 24-hour integrated carbonyls sample is taken every 6 days throughout the year. The other method used for collecting carbonyls is the canister sampler that is used for sampling volatile organic compounds. Acrolein is a carbonyl compound that is collected using this canister method, described above, and analyzed with the GC/MS method. These parameters are subjected to quarterly checks and audited by EPD’s Quality Assurance Unit every six months.

3.10 Near-Road

On February 9, 2010, EPA revised the nitrogen dioxide (NO_2) National Ambient Air Quality Standard and monitoring requirements. Included in these revisions was the establishment of near-road monitoring sites. The sites were to be set up in CBSAs with 500,000 or more population (additional monitor with CBSA population above 2,500,000), annual average daily traffic counts of 250,000 vehicles or greater, and represent a microscale (no more than 50 meters from the edge of the nearest traffic lane) (75 FR 6474). With these requirements, GA EPD needed to have two near-road monitoring sites in the Atlanta-Sandy Springs-Marietta MSA and one near-road monitoring site in the Augusta-Richmond County, GA-SC MSA. According to the U.S. Census Bureau (http://www.census.gov/compendia/statab/cats/population.html), the Atlanta-Sandy Springs-Marietta MSA had a 2010 population of 5,268,860, and the Augusta-Richmond County, GA-SC MSA had a 2010 population of 556,877. On October 5, 2012, EPA proposed that the first phase of site establishment would be January 1, 2014. The second phase of site establishment would be January 1, 2015, and the third phase would be January 1, 2017 (Docket# EPA-HQ-OAR-2012-0486).

GA EPD began operating the initial near-road site on the Georgia Institute of Technology campus (site ID 13-121-0056) in the Atlanta-Sandy Springs-Marietta MSA as of June 15, 2014. At the Georgia Tech site, samplers are in place to monitor NO_2/NO/NOx, CO, $PM_{2.5}$, wind speed and wind direction, and black carbon will be monitored in the near future. For details regarding the establishment of the first near-road site in the Atlanta-Sandy Springs-Marietta MSA, refer to Appendix E of the ‘2014 Ambient Air Monitoring Plan’. According to EPA’s schedule, GA EPD set up the second near-road monitoring site in the Atlanta-Sandy Springs-Marietta MSA on January 1, 2015 at the established DMRC site (13-089-0003). At the DMRC site, NO_2/NO/NOx and volatile organic compounds are monitored for the near-road network, and black carbon will be monitored in the near future. For details regarding the establishment of the second near-road site, refer to GA EPD's Addendum to the '2014 Ambient Air Monitoring Plan'.

For the third phase of near-road sites to be established, a site is to be located in the Augusta-Richmond County, GA-SC MSA. There are no AADT counts reaching 250,000 vehicles in the Augusta-Richmond County, GA-SC MSA. According to the 2014 AADT estimates (http://geocounts.com/gdot/), the highest traffic count (traffic counter 0223) is approximately 82,215 vehicles near the intersection of I-20 and I-520. However, the population for the Augusta-Richmond County, GA-SC MSA is above 500,000. Therefore, a near-road monitoring site will be placed in this MSA. GA EPD has analyzed the AADT estimates and has been evaluating suitable locations to meet the near-road monitoring requirement in the Augusta-Richmond County, GA-SC MSA by January 1, 2017.

4.0 Standards

Measuring pollutant concentrations in ambient air and comparing the measured concentrations to corresponding standards determine ambient air quality status for the six criteria pollutants. The six criteria pollutants are sulfur dioxide, particulate matter ($PM_{2.5}$ and PM_{10}), carbon monoxide, ozone, nitrogen dioxide, and lead. The U.S. EPA (Environmental Protection Agency) defines the ambient air as that portion of the atmosphere, external to buildings, to which the general public has access.

The National Ambient Air Quality Standards (NAAQS) are divided into primary and secondary standards. For a list of the most current standards, please refer to EPA's website http://www.epa.gov/air/criteria.html. Primary standards are those established to protect public health. Secondary standards are those established to protect the public welfare from adverse pollution effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility, climate, property, transportation, economy, personal comfort and well-being. The scientific criteria upon which the standards are based are reviewed periodically by the EPA, which may reestablish or change the standards according to its findings. Note that there are hundreds of compounds that are generally considered pollutants when found in ambient air but whose health and welfare effects are not well enough understood for ambient standards to be defined.

A pollutant measurement that is greater than the ambient air quality standard for a specific averaging time is called an exceedance. This is not a synonym for a violation, however. For each pollutant, there are specific rules for a given time period before a pattern of exceedances is considered a violation of the NAAQS that may result in regulatory actions to further clean up the area's air. This distinction is made to allow for certain limited exceedances of the standard that may occur, for example, during an unusual weather pattern, reserving regulatory action for cases where the exceedances are too large or too frequent.

5.0 Monitoring Objectives and Spatial Scale

Federal regulations indicate that a minimum of four monitoring objectives should be met in establishing an ambient air monitoring network. The network is to have stations that monitor: (1) the highest pollutant concentrations; (2) the representative concentrations in areas of high population density; (3) the impact of major pollution emissions sources; and (4) the general background concentration levels. The physical siting of the air monitoring station must achieve a spatial scale of representativeness that is consistent with the monitoring objective. The spatial scale results from the physical location of the site with respect to the pollutant sources and categories. It estimates the size of the area surrounding the monitoring site that experiences uniform pollutant concentrations.

The categories of spatial scale are:
Micro Scale: An area of uniform pollutant concentrations ranging from several meters up to 100 meters.
Middle Scale: Uniform pollutant concentrations in an area of about 100 meters to 0.5 kilometer.
Neighborhood Scale: An area with dimensions in the 0.5 to 4.0 kilometer range.
Urban Scale: Citywide pollutant conditions with dimensions ranging from 4 to 50 kilometers.
Regional Scale: An entire rural area of the same general geography (this area ranges from tens to hundreds of kilometers).

Monitoring objectives and associated spatial scales are taken from Appendix D of 40 CFR Part 58, Table D-1, and summarized in Table 5.1 below.

Table 5.1: Monitoring Objective and Spatial Scale

Monitoring Objective	Appropriate Spatial Scale
Highest concentration or source impact	Micro, Middle, Neighborhood, or (less frequently) Urban
Population oriented	Neighborhood or Urban
General/background, regional transport, welfare related impacts	Urban or Regional

6.0 Site Evaluations

Georgia EPD performs site evaluations annually at each ambient air monitoring site. The following table details when the site evaluations were performed and a summary of the comments that the evaluator made about each site. When deficiencies are found at a site, the Operations Units are notified and actions are taken to correct those deficiencies. Therefore, steps have been taken to correct any deficiencies noted in the following table.

Table 6.1: Site Evaluations

SITE ID	COMMON NAME	COUNTY	SITE EVALUATION DATE	COMMENTS
Rome MSA				
131150003	Rome	Floyd	1/29/2015	The two tall oaks form an obstruction to the northwest of the samplers. However, over 90% of the monitoring path is not affected by the trees.
Brunswick MSA				
131270006	Brunswick	Glynn	11/5/2014	Samplers meet siting criteria. No deficiencies.
Valdosta MSA				
131850003	Valdosta	Lowndes	2/10/2014	Samplers meet siting criteria. The BAM door appears to have been previously broken and rigged into place with plastic tape. The door was found in place, but completely separated from the hinge other than the plastic tape applied to the outside of the sampler housing. The door should be replaced to ensure sampler is shielded from the weather. There is water damage to the housing wall below the vent outlet. A new sampler housing may be necessary.
Warner Robins MSA				
131530001	Warner Robins	Houston	7/29/2015	Samplers meet siting criteria. Shrubs and trees higher than inlets are less than 20m away. Dead vines on the fence enclosure are higher than inlets. Recommend vines are removed and brush cleared further back.
Dalton MSA				
132130003	Fort Mountain	Murray	12/10/2014	Samplers meet siting criteria. Few trees to the south are inside 10X height differential with the MET tower. Ground slopes off severely to the north and east.
Albany MSA				
130950007	Albany	Dougherty		Samplers meet siting criteria. No deficiencies.
Gainesville MSA				
131390003	Gainesville	Hall	11/11/2014	Samplers meet siting criteria. No deficiencies.
Athens-Clark County MSA				
130590002	Athens	Clarke	2/4/2015	Samplers did not meet siting criteria. Construction near site ceased since last survey. 2025, SASS, and URG now on deck. URG and SASS operation ceases since last survey. Water damage around a/c ports.
Macon MSA				
130210007	Macon-Allied	Bibb	8/13/2014	Samplers meet siting criteria. Bradford pear drip line 13.3m from Collaocated Partisol 2025 inlet. Center of roadway 20.1m from Met One SASS. Edge of roadway 19m from SASS.
130210012	Macon-Forestry	Bibb	3/3/2014	Samplers meet siting criteria. The meteorological tower is bent in several spots and is difficult to lower safely. The metal and PUF samplers need at least 0.3m further elevation to meet inlet siting requirements of 2-7 meters. The floor around the door is rotting out. The floor covering is cracked and has a hole. White dust was emitted from the hole when walking near it entering the shelter

SITE ID	COMMON NAME	COUNTY	SITE EVALUATION DATE	COMMENTS
Columbus MSA				
132150001	Columbus-Health Dept.	Muscogee	7/29/2014	Sampler meets siting criteria. No deficiencies.
132150008	Columbus-Airport	Muscogee	7/29/2014	Samplers meet siting criteria. No deficiencies.
132150009	Columbus-UPS	Muscogee	2/27/2014	Samplers meet siting criteria. The former site has been activated to monitor lead emissions from the Exide battery plant to the NW. Cusseta Rd. is 200 meters to the SW. The platform needs to be replaced and the fence door and part of the fence is bent.
132150010	Columbus-Ft. Benning	Muscogee	2/24/2015	Samplers meet siting criteria. No deficiencies.
132150011	Columbus-Cusseta	Muscogee	2/27/2014	Samplers meet siting criteria. No deficiencies.
132151003	Columbus-Crime Lab	Muscogee	2/24/2015	Only meteorological instruments are being run at the site presently.
Savannah MSA				
130510021	Savannah-E. President St.	Chatham	6/23/2014	Samplers meet siting criteria. Shelter moved since last survey with new air toxics samplers on new deck adjacent. PUF sampler with motor NP-26298 and Metals sampler with motor 1171 remain at previous location on stands. Drip line is ~14m distant across roadway from current location of inlets.
130510091	Savannah-Mercer	Chatham	6/17/2014	Sampler meets siting criteria. 134288 appears to be out of service while undergoing occasional attempts at repair.
130511002	W. Lathrop & Augusta Ave.	Chatham	5/13/2014	Samplers meet siting criteria. Trees are growing back. SO2 analyzer intermittently displays alarm for low lamp voltage. Anemometer and SO2 analyzer changed since last survey.
Augusta MSA				
130730001	Evans	Columbia	7/9/2014	Sampler meets siting criteria. Integrity and sample lines are routed on floor of shelter, along ground outside, and then up tower to inlet. Recommend lines are replaced and routed up and out at top of wall of shelter to avoid contamination, improve response and standardize with other sites. A port in an appropriate spot has been made for data wiring. Recommend lines are routed out the new port. Site access involved carrying heavy equipment up a steep slope of mud and wet grass. Door jamb rotting, paint peeling.
132450091	Augusta	Richmond	9/25/2014	Samplers meet siting criteria. CSN, PM2.5, and PM10 samplers are now located on a platform directly adjacent to shelter. Vines, weeds and briars should be cut back. There is trash inside enclosure from frequent littering by passersby. The ram elevator motor is weak and required manual assistance to exchange the filter cartridge.
Atlanta-Sandy Springs-Marietta MSA				
130150003	Cartersville	Bartow	6/23/2014	Sampling began in December 2009 and was discontinued at the site in March 2014
130630091	Forest Park	Clayton	12/4/2014	Sampler meets siting criteria. No deficiencies.
130670003	National Guard	Cobb	1/20/2015	Samplers meet siting criteria. No deficiencies.
130770002	Newnan	Coweta	2/12/2015	Samplers meet siting criteria. No deficiencies.
130850001	Dawsonville	Dawson	11/10/2014	Samplers do not meet siting criteria. Trees to the south are inside of the required height distance differential between obstacles and all inlets. Met tower is inside 10x height differential with a few trees to the north. Silica Gel needs replacing.
130890002	South DeKalb	DeKalb	4/17/2014	Samplers do not meet siting criteria. The tall trees to the north are inside twice the height-distance differential for the samplers. The predominant wind direction is not from the north, however. Chromium sampling was discontinued in 2013. The two chromium samplers are still present at site.

SITE ID	COMMON NAME	COUNTY	SITE EVALUATION DATE	COMMENTS
130890003	DMRC	DeKalb	11/25/2014	Samplers meet siting criteria. A concrete pad, 7 meters east of the Hi-Vol platform, has been poured for the soon to be near road site trailer. The EPA has installed solar power panels next to the existing Hi-Vol platform, to the north. The small pine trees next to the fence toward the NE have been cut down since the last survey.
130970004	Douglasville	Douglas	4/8/2014	Samplers meet siting criteria. There is a slight amount of water infiltration on the inside south side of the trailer. As a result, there is a small amount of water in the floor and the siding near the floor has become slightly warped. The water appears to be gaining access through the vent hole on the side of the shelter during heavy rains. There is no outside damage to the shelter that would allow water in.
131210039	Fire Station #8	Fulton	4/30/2014	Samplers meet siting criteria. There are not any deficiencies compromising sampling quality. The white pine tree northeast of the sampler is closer than twice height-distance differential but is not in the path of prevailing winds. All other criteria are met.
131210055	Confederate Ave.	Fulton	7/22/2014	Samplers meet siting criteria. No deficiencies.
131210056	GA Tech	Fulton	7/1/2014	Samplers meet siting criteria. This site is designated as a NO2 Near Road Site and sampling began in June 16, 2014. The met tower had not been extended at the time of survey.
131350002	Gwinnett Tech	Gwinnett	2/18/2015	Samplers meet siting criteria. The sampling trailer is surrounded on west (25 meters away) and northeast (22 meters away) by college parking lot. The parking lot to the east is for car auto mechanic classes. The trailer floor has a few rips in it near the door. The trailer floor is bucking up slightly because of water infiltration on plywood support. A small wooden board is broken on the Partisol platform. Three small trees, 2.5 meters tall, have been planted 10-12 meters north of the trailer since last survey.
131510002	McDonough	Henry	7/8/2014	Samplers meet siting criteria. No deficiencies.
132230003	Yorkville	Paulding	1/28/2015	Samplers meet siting criteria. No deficiencies.
132470001	Conyers	Rockdale	7/10/2014	Samplers meet siting criteria. No deficiencies.
Chattanooga Tennessee-Georgia MSA				
132950002	Rossville	Walker	12/3/2014	Samplers meet siting criteria. No deficiencies.
Not in an MSA				
130550001	Summerville	Chattooga	2/4/2015	Sampler meets siting criteria. Two tiles on the trailer floor next to the door are missing and the plywood floor beneath is rotting out. The trailer is to be replaced in 2015.
130690002	General Coffee	Coffee	10/22/2014	Samplers meet siting criteria. No deficiencies.
132611001	Leslie	Sumter	3/2/2015	Sampler does not meet siting criteria. Shelter floor buckled. Water damage to ceiling, around door jamb, and along base of walls. The drip-line is now 7.2m East of inlet. Trees should be removed or shelter relocated in clearing away from trees. Parking enclosure for heavy equipment >20m from inlet.
133030001	Sandersville	Washington	5/6/2014	Sampler meets siting criteria. Partisol 2000 DNR #135374 on site but not in service. Other equipment does not belong to EPD. Power cords lie where water puddles when it rains. Rooftop is muddy and slippery when wet. Partisol 2025 seal rotted and broken.
133190001	Gordon	Wilkinson	4/4/2014	Samplers meet siting criteria. No deficiencies.

7.0 Types of Assessments

To fulfill the objectives of the Five-Year Assessment, several different analyses were performed on different aspects involving ambient air monitoring. These analyses include: comparison of the number of parameters monitored at each site; trends and longevity of parameters monitored; measured concentrations of criteria pollutants with values above NAAQS; deviation of criteria pollutants at each site from NAAQS; comparing monitor-to-monitor correlations using concentrations of different monitors; area served by particular networks; emission inventory; population statistics including change in population, population served, and sensitive subpopulations (children and environmental justice areas). In addition, other resources were explored to ensure that GA EPD is meeting the above listed objectives. The Air Quality Index (AQI), including health related statistics, comprehensive meteorological data, the PAMS network, and the Georgia Air Toxics Network were explored.

Each assessment that produced quantifiable results for the sites examined in that assessment was ranked with an appropriate ranking method. One of two ranking methods was used with each of the quantifiable assessments. The proportionality ranking method was used when the weight of each ranking seemed to lend itself to be compared to a proportion of the highest and lowest ranking. The formula used for the proportionality ranking was (Value-Min)/(Max-Min). The binning ranking method was used when each site’s ranking had a certain limit with which that the site could be compared. For example, the binning method was used such that if the absolute value of the design value was equal to the NAAQS=1, within 85% NAAQS=0.5, less than 85% NAAQS=0.

For these assessments, the data was used through the end of 2013, and the sites were used as they were set up through 2013. With assessments in which the data is not as complete when compared to the other sites in that assessment, notations have been made. In addition, there may have been some changes with the sites since 2013. Due to the timeliness of the document, the site set up and data was evaluated and discussed as it was set up by the end of 2013.

7.1 Trends Impact Assessment: Procedure

The Trends Impact Assessment focuses on site monitors with a long, unbroken history. When examining trends, it takes several years to establish a good base. The longer a site has been running continuously, the better suited that site will be for a trends impact study, simply due to a greater duration for observing patterns. Often sites will change the means of sampling and analysis methodology, making them poor contenders for a trends study. Trends are determined by plotting annual averages by site for a specific parameter on a graph. A line graph provides the best visual assessment, allowing trends to be determined by following a monitor’s averages from year to year and comparing the result to neighboring sites and across the state. This assessment does not compare parameters to the national ambient air quality standards (NAAQS), but compares the annual averages for each parameter assessed.

The Trends Impact Assessment evaluated each of Georgia EPD’s ambient air monitoring sites for overall duration. In addition, ozone, carbon monoxide, sulfur dioxide, nitrogen dioxide, PM_{10} (integrated and continuous), $PM_{2.5}$ (integrated, continuous, and speciation mass), lead, and National Air Toxics Trends Station (NATTS) benzene and formaldehyde were examined for their trends in data and the length of time each monitor has been sampling data. The first table displays all of the ambient air monitoring sites in Georgia as of 2013, as well as their start date and proportionality ranking. The proportionality ranking considered the longest running site as having the most value and was ranked the highest. All of the other sites were given a ranking compared to the longevity, or number of years since established, of the longest running site. Following the list of all of the sites, each of the above listed criteria parameters is graphed and displayed in a table for longevity analysis.

As of 2013, there were 40 ambient air monitoring sites in 30 counties across the state of Georgia. There are several sites in Georgia with a long running history. Of the 40 sites, almost half have collected data since the 1980's. The longest running site is the Columbus-Health Department site, which was established in 1957. With this type of analysis, this site would rank the highest. The lowest ranking sites would be the sites that were mostly recently established. This would be the UPS site in Columbus, GA which began sampling in 2012. It should be noted that due to the timing of the publication of this document, a site was added to Georgia's air monitoring network after 2013 that was not included here. The GA Tech near-road site was added June 2014.

Table 7.1: Georgia Monitoring History

Sites Arranged by Start Date					
Rank	**Site Location**	**City**	**County**	**Start Date**	**Proportionality**
1	Health Dept.	Columbus	Muscogee	1957	1.000
2	Maple Street	Rossville	Walker	1967	0.818
3	Savannah L&A	Savannah	Chatham	1972	0.727
4	Fire Station #8	Atlanta	Fulton	1973	0.709
5	Allied Chemical	Macon	Bibb	1974	0.691
5	South DeKalb	Decatur	DeKalb	1974	0.691
5	Coosa Elementary	Rome	Floyd	1974	0.691
5	Co. Health Dept.	Sandersville	Washington	1974	0.691
9	Bungalow Rd.	Augusta	Richmond	1976	0.655
9	Mercer Middle	Savannah	Chatham	1976	0.655
11	Georgia DOT	Forest Park	Clayton	1978	0.618
11	Monastery	Conyers	Rockdale	1978	0.618
13	Crime Lab	Columbus	Muscogee	1980	0.582
14	Union High	Leslie	Sumter	1981	0.564
15	Airport	Columbus	Muscogee	1982	0.545
16	GA Forestry	Dawsonville	Dawson	1985	0.491
17	DMRC	Decatur	DeKalb	1986	0.473
18	Risley Middle	Brunswick	Glynn	1987	0.455
19	Fish Hatchery	Summerville	Chattooga	1990	0.400
20	Turner Elementary	Albany	Dougherty	1991	0.382
20	Cusseta Elementary	Columbus	Muscogee	1991	0.382
20	Confederate Ave.	Atlanta	Fulton	1991	0.382
23	E. President St.	Savannah	Chatham	1995	0.309
23	Gwinnett Tech	Lawrenceville	Gwinnett	1995	0.309
25	Yorkville	Yorkville	Paulding	1996	0.291
26	Forestry	Macon	Bibb	1997	0.273
26	W. Strickland St.	Douglasville	Douglas	1997	0.273
28	Police Dept.	Gordon	Wilkinson	1999	0.236
28	National Guard	Kennesaw	Cobb	1999	0.236

28	Boys and Girls Club	Gainesville	Hall	1999	0.236
28	Fort Mountain	Chatsworth	Murray	1999	0.236
28	Univ. of West GA	Newnan	Coweta	1999	0.236
28	County Extension	McDonough	Henry	1999	0.236
28	Mason Elementary	Valdosta	Lowndes	1999	0.236
35	General Coffee	Douglas	Coffee	2000	0.218
35	Robins Air Base	Warner Robins	Houston	2000	0.218
37	College Station Rd.	Athens	Clarke	2002	0.182
38	Riverside Park	Evans	Columbia	2005	0.127
39	Fort Benning	Columbus	Muscogee	2011	0.018
40	UPS	Columbus	Muscogee	2012	0.000

7.2 Ozone

The following table examines the longevity of Georgia EPD's ozone monitors. The annual averages for all of these ozone monitors are plotted below the table to display the trend in ozone data across the entire network. The analysis includes all of the ozone monitors that were sampling data as of 2013.

The longest running ozone site is the South DeKalb site, due primarily to its urban location. The South DeKalb site was established in 1974, making it the most important site in conducting a trends analysis. The Conyers site follows closely after with its starting date of 1978. Four sites were established in the 1980's with the vast majority installed in the 1990's. According to the Trends Impact assessment, the most recently established sites, Fort Mountain, Athens, Summerville, and Evans, are most susceptible to termination. These five sites established during the new millennium, have a shorter history, and are therefore less reliable when trying to determine trends.

Table 7.2: Ozone Monitoring History

Ozone				
Rank	**Site Location**	**City**	**County**	**Start Date**
1	South DeKalb	Decatur	DeKalb	1974
2	Monastery	Conyers	Rockdale	1978
3	Airport	Columbus	Muscogee	1983
4	GA Forestry	Dawsonville	Dawson	1987
5	Union High	Leslie	Sumter	1988
6	Bungalow Rd.	Augusta	Richmond	1989
7	Confederate Ave.	Atlanta	Fulton	1991
8	Risley Middle	Brunswick	Glynn	1995
8	E. President St.	Savannah	Chatham	1995
8	Gwinnett Tech	Lawrenceville	Gwinnett	1995
11	Yorkville	Yorkville	Paulding	1996
12	Forestry	Macon	Bibb	1997
13	W. Strickland St.	Douglasville	Douglas	1997
14	National Guard	Kennesaw	Cobb	1999
14	Univ. of West GA	Newnan	Coweta	1999
14	County Extension	McDonough	Henry	1999
17	Fort Mountain	Chatsworth	Murray	2000
18	College Station Rd.	Athens	Clarke	2002
19	Fish Hatchery	Summerville	Chattooga	2004
20	Riverside Park	Evans	Columbia	2005

Figure 7.1 displays the annual average 1-hour ozone concentrations for all active sites as of 2013. Again, this is not a comparison to the NAAQS. Trends in ozone levels seem to be fairly consistent among all of the established sites in Georgia. During the late 1970's and early 1980's, the few sites that were monitoring showed some minor fluctuation, but trends can be observed forming in the late 1980's and early 1990's as more sites are added. Levels fell in 1987 and continued to do so until 1989, rising again until 1991. This rise and fall pattern continued over the years until 1996. With eleven sites and five more added during the decade, the latter half of the 1990's showed a major cohesive increase in O_3 levels. In 2000, levels show a rapid decline that does not even out until 2005 when a slow increasing trend begins. Overall, ozone has risen and fallen at a steady rate. Upon observation, annual averages have stayed below 0.077 ppm and began to level off and drop again in 2007. After a sharp decline until 2009 average concentrations rose again until in 2011, and have since been in decline. The highest readings tend to be around the metro Atlanta area, and the lowest levels have consistently been in the coastal cities (e.g. the Savannah and Brunswick sites).

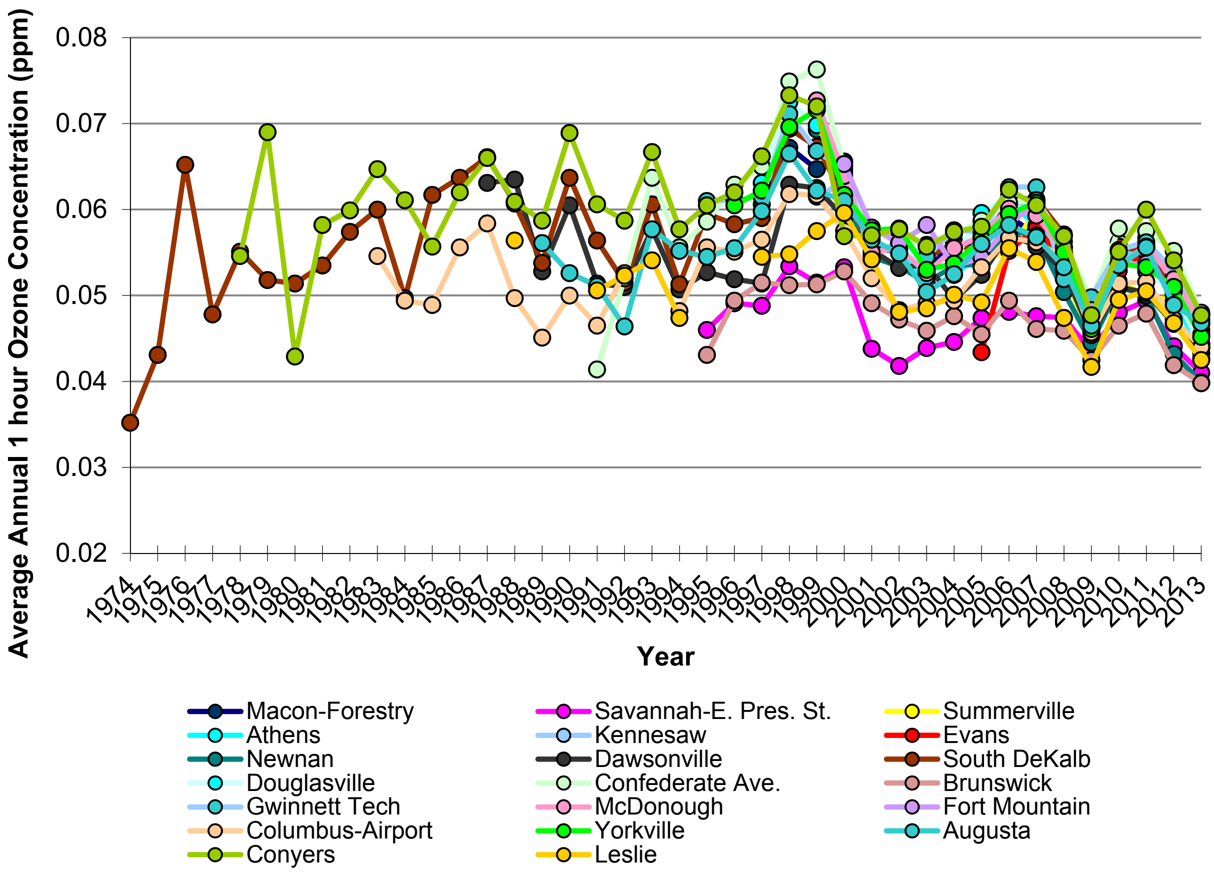


Figure 7.1: Ozone Trend in Data

7.3 Carbon Monoxide

In the following table, the longevity of Georgia EPD's carbon monoxide monitors is examined. The annual averages for all of these carbon monoxide monitors are plotted below the table to display the trend in carbon monoxide data across the entire network. It should be noted that due to the timing of the publication of this document, a site was added to Georgia's air monitoring network after 2013 that was not included here. The GA Tech near-road site monitoring CO was added June 2014.

Table 7.3: Carbon Monoxide Monitoring History

Carbon Monoxide				
Rank	Site Location	City Name	County	Start Date
1	Yorkville	Yorkville	Paulding	2002
2	South DeKalb	Decatur	DeKalb	2003

Figure 7.2 shows the annual average 1-hour CO concentration for all active sites as of 2013. The Yorkville site was established in 2002 and the South DeKalb site was added the following year. The Yorkville site shows a slight increasing trend in the most recent years while the South DeKalb average annual concentrations show a slight decline.

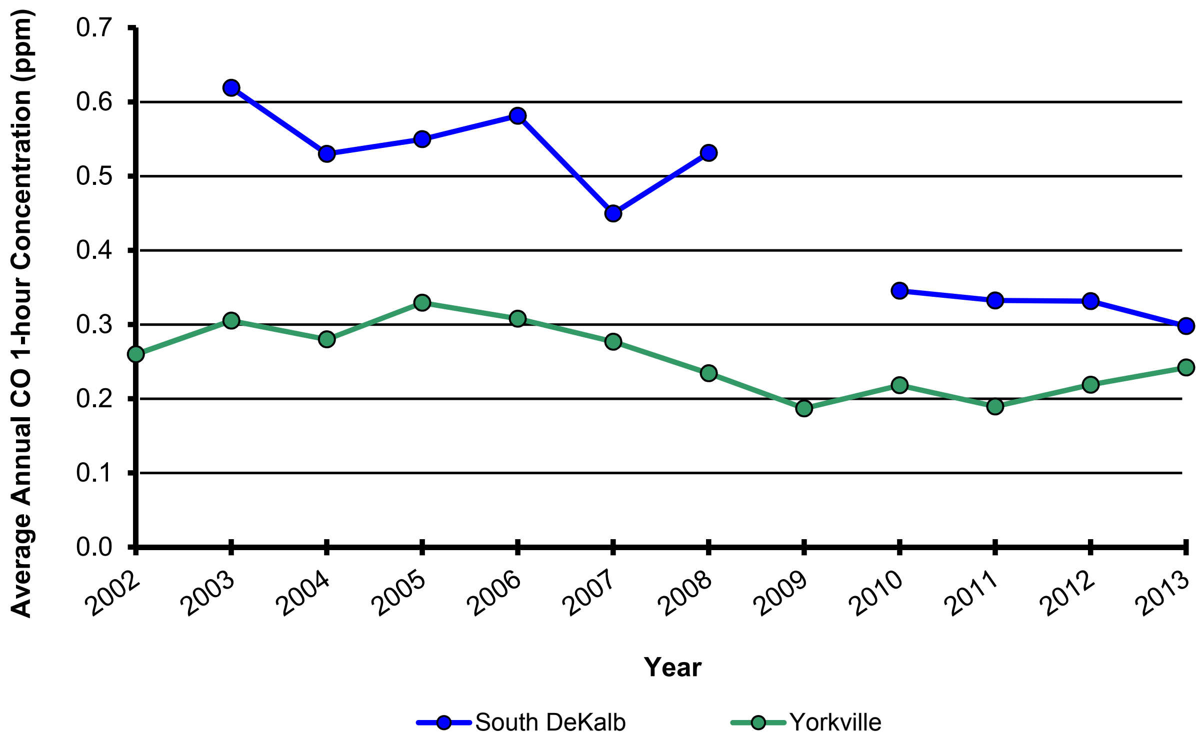


Figure 7.2: Carbon Monoxide Trend in Data

7.4 Sulfur Dioxide

The following table examines the longevity of Georgia EPD's sulfur dioxide monitors. The annual averages for all of these sulfur dioxide monitors are plotted below the table to display the trend in sulfur dioxide data across the entire network. The analysis includes all of the sulfur dioxide monitors that were sampling data as of 2013.

Table 7.4: Sulfur Dioxide Monitoring History

Sulfur Dioxide				
Rank	**Site Location**	**City Name**	**County**	**Start Date**
1	Coosa Elementary	Rome	Floyd	1975
2	Confederate Ave.	Atlanta	Fulton	1991
3	E. President St.	Savannah	Chatham	1995
4	GA Forestry Commission	Macon	Bibb	1997
5	Savannah L&A	Savannah	Chatham	1998
6	South DeKalb	Decatur	DeKalb	2010
7	Bungalow Rd.	Augusta	Richmond	2013

Figure 7.3 shows the annual average 1-hour SO_2 concentrations for all active sites as of 2013. The Rome site was established in 1975 and is the longest surviving SO_2 site in Georgia. In 1975, the yearly SO_2 average for Rome was 48.4 ppb followed by a sharp decline to 14.4 ppb in 1976. A gradual decreasing trend has continued since. As more monitors were added in the 1990's, SO_2 stayed fairly level with annual averages below 5.0 ppb, and reaching as low as 0.33 ppb at the South DeKalb site in 2013.

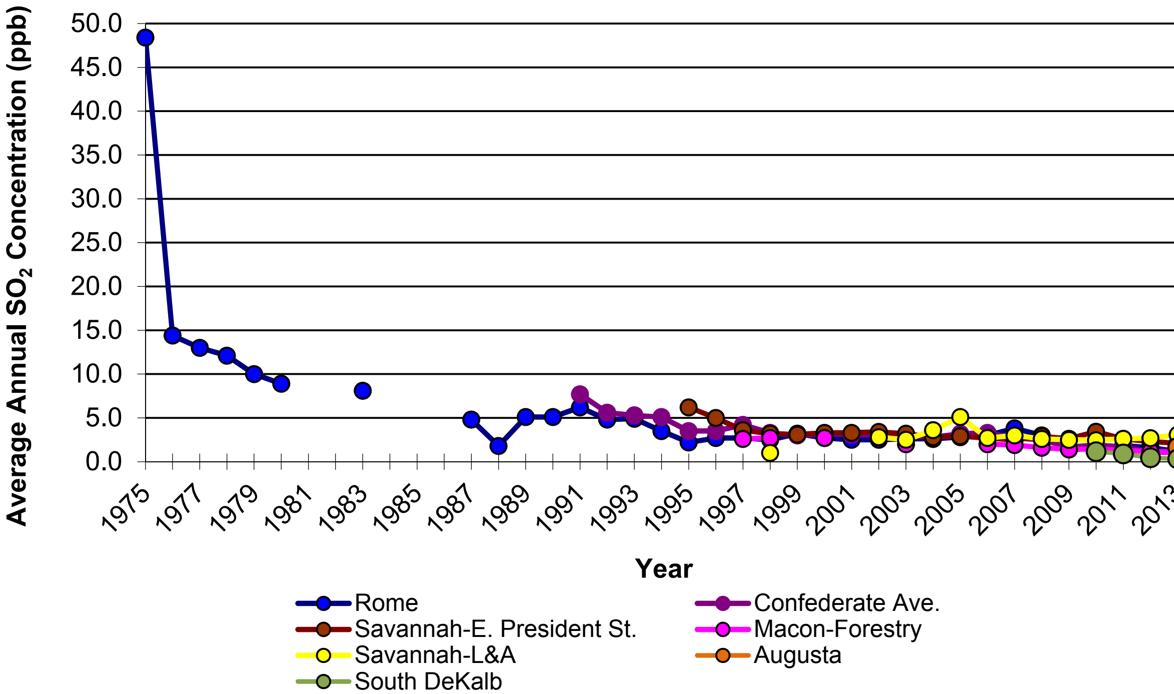


Figure 7.3: Sulfur Dioxide Trend in Data

7.5 Nitrogen Dioxide

The following table examines the longevity of Georgia EPD's nitrogen dioxide monitors. The annual averages for all of these nitrogen dioxide monitors are plotted below the table to display the trend in nitrogen dioxide data across the entire network. The analysis includes all of the nitrogen dioxide monitors that were sampling data as of 2013. It should be noted that due to the timing of the publication of this document, a site was added to Georgia's air monitoring network after 2013 that was not included here. The GA Tech near-road site monitoring NO_2 was added June 2014.

Table 7.5: Nitrogen Dioxide Monitoring History

Nitrogen Dioxide				
Rank	**Site Location**	**City Name**	**County**	**Start Date**
1	South DeKalb	Decatur	DeKalb	1982
2	Monastery	Conyers	Rockdale	1994
3	Yorkville	Yorkville	Paulding	1996

Figure 7.4 shows the annual average 1-hour NO_2 concentrations for all sites active as of 2013. South DeKalb's NO_2 site was established in 1982, while the Conyers and Yorkville sites were added in 1994 and 1996, respectively. Conyers and Yorkville show lower levels of NO_2 and less fluctuation relative to the South DeKalb site.

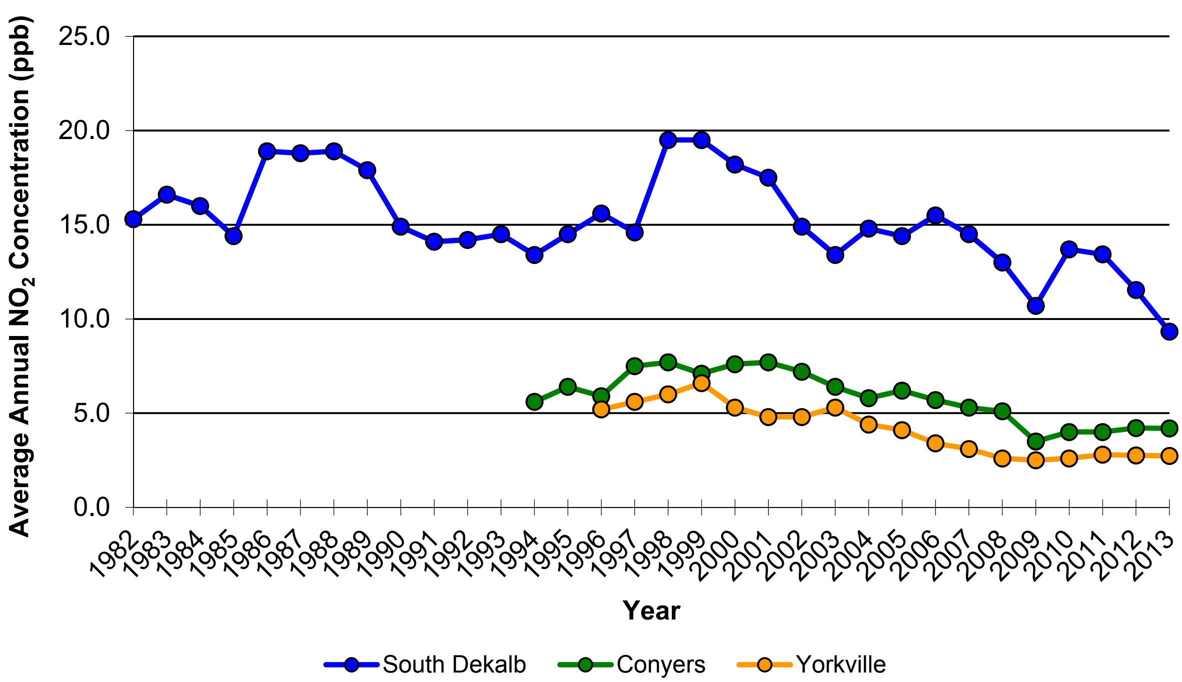


Figure 7.4: Nitrogen Dioxide Trend in Data

7.6 PM_{10}

Table 7.6 shows the start date of Georgia EPD's PM_{10} (integrated and continuous) monitors. Integrated samples are collected every 6 days. The Fire Station #8 site began operation in late 1987 and ran until 2006. Then it was shut down until 2013. Continuous samples are collected hourly.

Table 7.6: PM_{10} Monitoring History (Integrated and Continuous)

Particulate Matter 10 Integrated				
Rank	**Site Location**	**City Name**	**County**	**Start Date**
1	Fire Station #8	Atlanta	Fulton	1987*
2	Bungalow Rd.	Augusta	Richmond	1996
3	South DeKalb	Atlanta	DeKalb	2011

*was shut down from 9/26/06 to 1/3/13

The annual average concentrations of the PM_{10} integrated (24-hour) and continuous (1-hour) monitors that were sampling as of 2013 are plotted in Figure 7.5. Some variation in concentrations at the Augusta site is apparent from 1997 until 2007 then concentrations begin a steady decline. The South DeKalb site has a relatively short record but concentrations appear to be in decline. The Fire Station #8 site's concentration has declined drastically since it began operation in late 1987; however, there is a lapse in the data from 2006 until 2013.

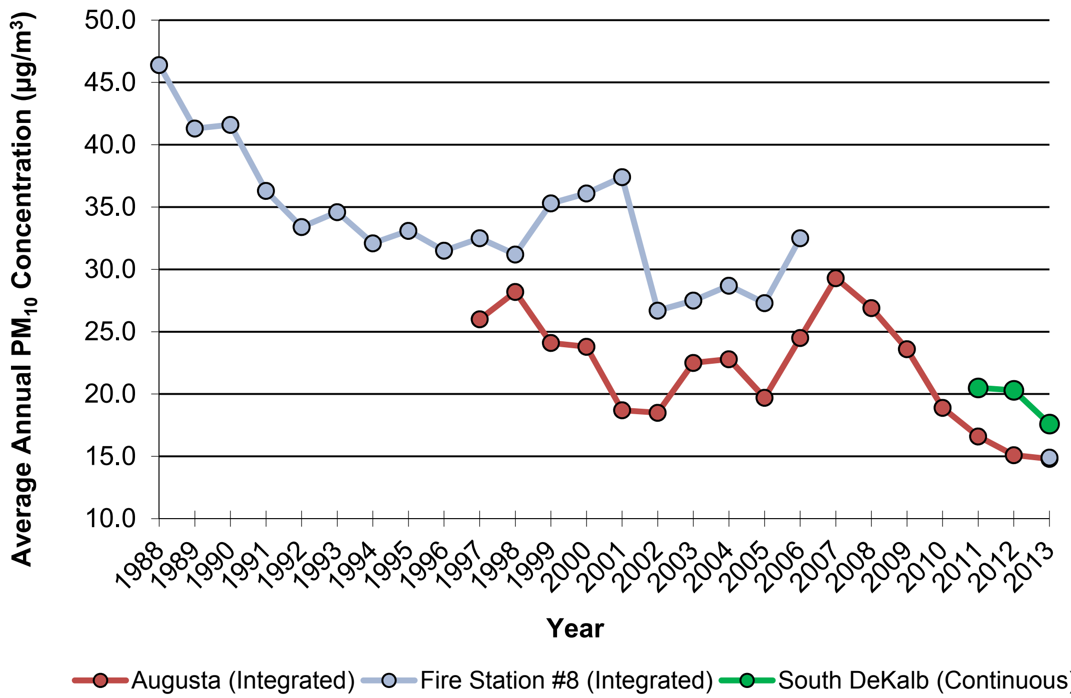


Figure 7.5: PM_{10} Trend in Data

7.8 $PM_{2.5}$ (Federal Reference Method)

The following table examines the longevity of Georgia EPD's $PM_{2.5}$ FRM (Federal Reference Method) monitors. The annual averages for all of these $PM_{2.5}$ monitors are plotted below the table to display the trend in $PM_{2.5}$ data across the entire network. The analysis includes all of the $PM_{2.5}$

FRM monitors that were sampling data as of 2013. It should be noted that due to the timing of the publication of this document, a site was added to Georgia's air monitoring network after 2013 that was not included here. The GA Tech near-road site monitoring $PM_{2.5}$ was added in January 2015.

Table 7.7: $PM_{2.5}$ Monitor History

Particulate Matter 2.5 Federal Reference Method				
Rank	**Site Location**	**City Name**	**County**	**Start Date**
1	Allied Chemical	Macon	Bibb	1999
1	GA Forestry Commission	Macon	Bibb	1999
1	Mercer Middle	Savannah	Chatham	1999
1	Georgia DOT	Forest Park	Clayton	1999
1	National Guard	Kennesaw	Cobb	1999
1	South DeKalb	Decatur	DeKalb	1999
1	Turner Elementary	Albany	Dougherty	1999
1	Fire Station #8	Atlanta	Fulton	1999
1	Risley Middle	Brunswick	Glynn	1999
1	Boys and Girls Club	Gainesville	Hall	1999
1	Health Dept.	Columbus	Muscogee	1999
1	Cusseta Elementary	Columbus	Muscogee	1999
1	Yorkville	Yorkville	Paulding	1999
1	Bungalow Rd.	Augusta	Richmond	1999
1	Co. Health Dept.	Sandersville	Washington	1999
1	Police Dept.	Gordon	Wilkinson	1999
17	Maple Street	Rossville	Walker	2000
17	Gwinnett Tech	Lawrenceville	Gwinnett	2000
17	Robins Air Base	Warner Robins	Houston	2000
17	Mason Elementary	Valdosta	Lowndes	2000
21	Airport	Columbus	Muscogee	2003
22	College Station Rd.	Athens	Clarke	2005
23	Coosa Elementary	Rome	Floyd	2009

The $PM_{2.5}$ FRM monitors are used for attainment purposes, and use a method of collection that is approved by EPA. In 1999, sixteen samplers were established; with four more added the following year. From 2003 to 2009, three more $PM_{2.5}$ FRM monitors were added to the network. As of 2013, there were a total of 23 $PM_{2.5}$ FRM monitors. The Fire Station #8 monitor did not collect data from the end of September of 2006 until the beginning of December 2008. Over a fifteen-year stretch, the yearly averages of the FRM 24-hour data follow a fairly distinguishable trend (Figure 7.6). The majority of the samplers started with higher averages (between 18 $\mu g/m^3$ and 22 $\mu g/m^3$) in 1999 and decreased until 2002. From 2003 to 2006, averages fluctuate but stay within the 11 $\mu g/m^3$ to 19 $\mu g/m^3$ range. A gradual decline is apparent from 2006 to 2009, and in 2010 concentrations increased but since 2011 they have been in decline.

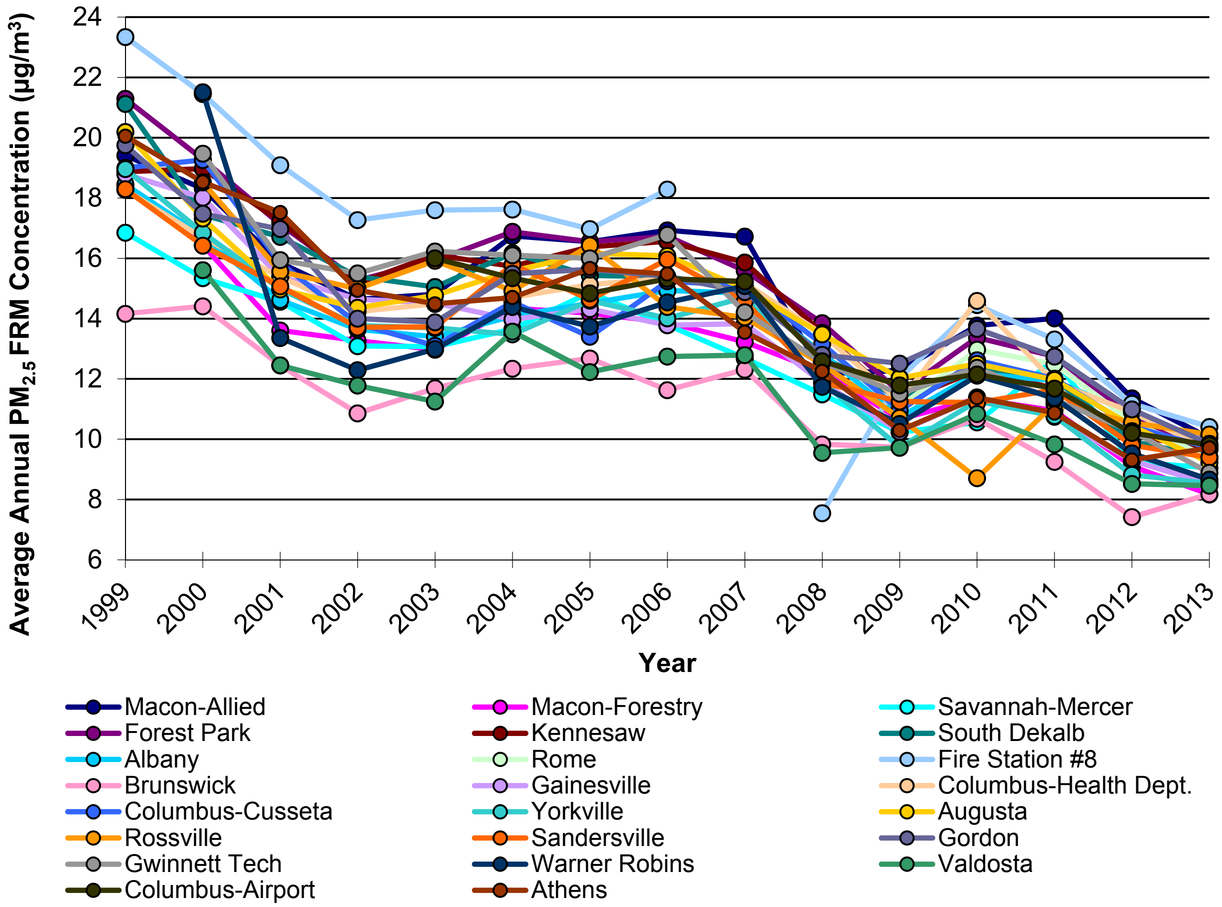


Figure 7.6: $PM_{2.5}$ FRM Trend in Data

7.9 $PM_{2.5}$ (Continuous)

In the following table, the duration of Georgia EPD's $PM_{2.5}$ (Continuous) monitors are examined. The annual averages for all of these $PM_{2.5}$ monitors are plotted below the table to display the trend in $PM_{2.5}$ data across the entire network. The analysis includes all of the $PM_{2.5}$ continuous monitors that were sampling data as of 2013.

Table 7.8: $PM_{2.5}$ Continuous Monitor History

Particulate Matter 2.5 Continuous				
Rank	**Site Location**	**City Name**	**County**	**Start Date**
1	South DeKalb	Atlanta	DeKalb	2002
2	Forestry	Macon	Bibb	2003
2	Airport	Columbus	Muscogee	2003
2	Savannah L&A	Savannah	Chatham	2003
2	Bungalow Rd.	Augusta	Richmond	2003
2	Univ. of West GA	Newnan	Coweta	2003
2	Gwinnett Tech	Lawrenceville	Gwinnett	2003
2	County Extension	McDonough	Henry	2003
2	Yorkville	Yorkville	Paulding	2003
10	College Station Rd.	Athens	Clarke	2004
11	Confederate Ave.	Atlanta	Fulton	2005
12	Co. Health Dept.	Rossville	Walker	2007
13	Turner Elementary	Albany	Dougherty	2008
13	Boys and Girls Club	Gainesville	Hall	2008
13	Air Force Base	Warner Robins	Houston	2008
16	Mason Elementary	Valdosta	Lowndes	2008
17	Coosa Elementary	Rome	Floyd	2009

Continuous samples provide almost instant data, allowing someone to judge the air quality the very day of its collection instead of waiting weeks, as the FRM must allow. These samplers are used for general informational purposes about the air quality in an area and for air quality forecasting. GA EPD has two sites that monitor continuous $PM_{2.5}$ samplers with Federal Equivalent Monitors (FEMs): South DeKalb and Albany. These monitors can be used for attainment purposes along with the FRMs. The South DeKalb site began sampling with the FEM as of 2011, while the Albany FEM started in 2013. The other $PM_{2.5}$ continuous monitors in the network are not being run as FEMs, and the data for the other continuous monitors is not used for attainment purposes.

In general, the continuous $PM_{2.5}$ 1-hour data (Figure 7.8) resembles the $PM_{2.5}$ FRM 24-hour data (Figure 7.7). There is a general increase in concentrations from 2003 to 2006, and then a general decrease through to 2009. There have been a few outliers from the bulk of data, however overall the concentrations declined in 2013. Based on length of record, the Rome continuous $PM_{2.5}$ monitor would be considered the least important for a trends analysis for this assessment.

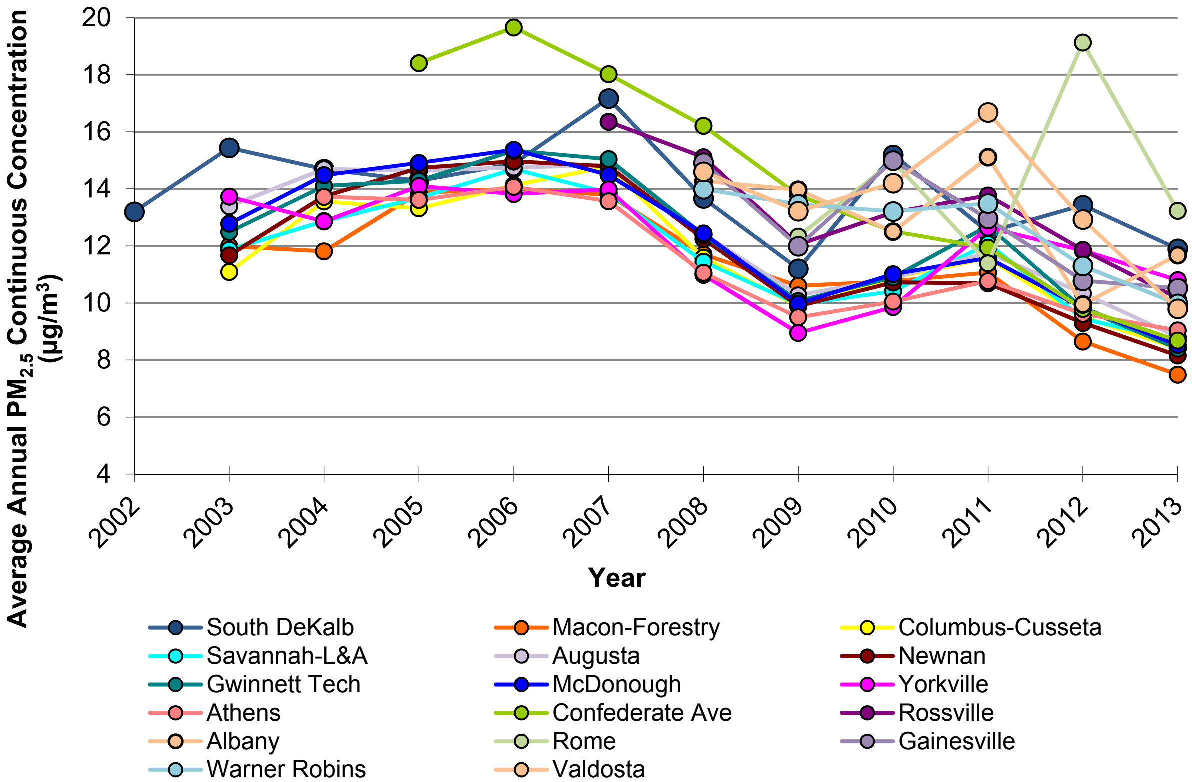


Figure 7.8: $PM_{2.5}$ Continuous Trend in Data

7.10 $PM_{2.5}$ (Speciation)

The following table examines the duration of Georgia EPD's $PM_{2.5}$ (Speciation) monitors. The annual averages of the mass readings for all of these $PM_{2.5}$ Speciation monitors are plotted below the table to display the trend in $PM_{2.5}$ data across the entire network. The analysis includes all of the Speciation $PM_{2.5}$ monitors that were sampling data as of 2013.

Table 7.9: $PM_{2.5}$ Speciation Monitor History

Particulate Matter 2.5 Speciation				
Rank	**Site Location**	**City Name**	**County**	**Start Date**
1	South DeKalb	Decatur	DeKalb	2001
2	College Station Rd.	Athens	Clarke	2002
2	Allied Chemical	Macon	Bibb	2002
2	Cusseta Elementary	Columbus	Muscogee	2002
2	Bungalow Rd.	Augusta	Richmond	2002
2	General Coffee State Park	Douglas	Coffee	2002
7	Co. Health Dept.	Rossville	Walker	2005
8	Coosa Elementary	Rome	Floyd	2009

The South DeKalb site was established before the remaining speciation monitors, making it the most valuable site for observing trends. After the South DeKalb site was established in 2001, the rest of the sites were established the following year with the exception of the Rossville and Rome sites which were added in 2005 and 2009, respectively. Figure 7.9 shows that the average annual $PM_{2.5}$ speciation mass concentrations peaked in 2006 and 2007 and then decreased from 2007 to 2009. After an increase in 2010, concentrations again declined through 2013. This figure includes exceedances in 2007 that are normally excluded for regulation purposes in order to accurately represent annual trends. For the purposes of the trends impact analysis, the Rome site is the least valuable because it has the shortest monitoring history, beginning in 2009, and could be eliminated if necessary.

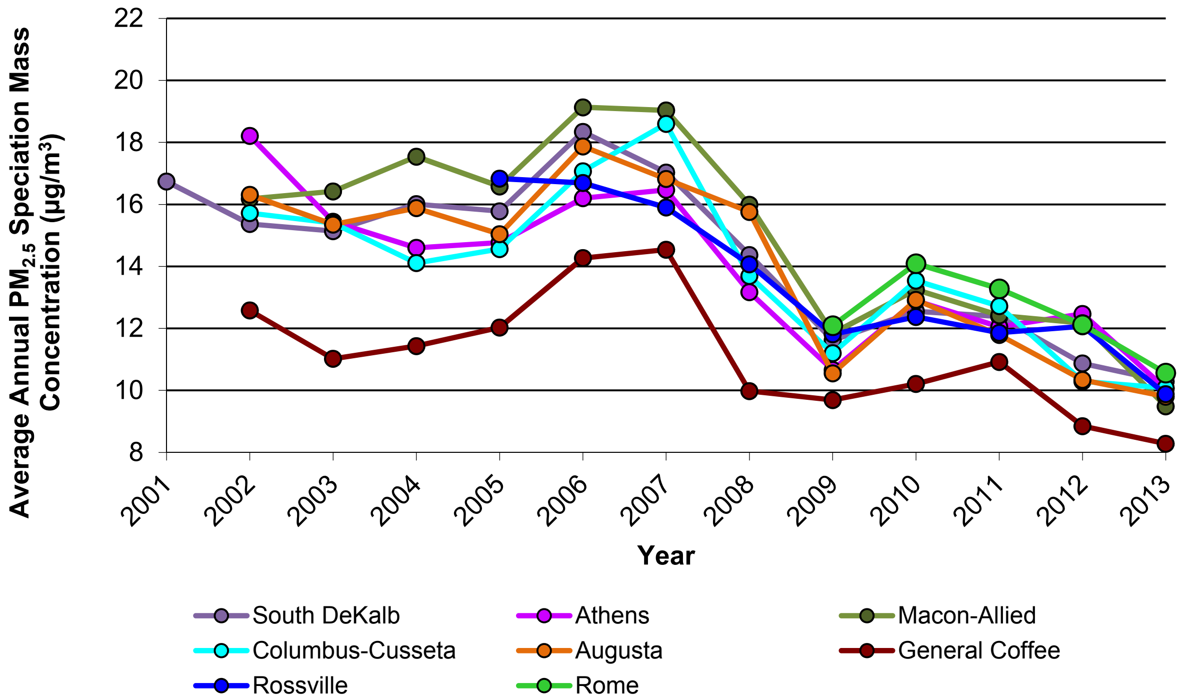


Figure 7.9: $PM_{2.5}$ Speciation Mass Trend in Data

7.11 Lead

The following table examines the longevity of Georgia EPD's lead monitors. The annual averages for all of these lead monitors are plotted below the table to display the trend in lead data across the entire network. The analysis includes all of the lead monitors that were sampling data as of 2013.

Table 7.10: Lead Monitor History

Lead				
Rank	**Site Location**	**City Name**	**County**	**Start Date**
1	DMRC	Decatur	DeKalb	1986
2	Cusseta Elementary	Columbus	Muscogee	1991
3	UPS	Columbus	Muscogee	2012
3	Fort Benning	Columbus	Muscogee	2012

The longest running lead site is the DMRC site located in DeKalb County which has been collecting data since 1986. The Columbus-Cusseta Elementary site in Muscogee County was added in 1991. Figure 7.10 shows that the annual lead concentrations at the DMRC site seemed to drop slightly in the first few years after its establishment but have been fairly stable since. The Columbus-Cusseta Elementary site showed a more fluctuating pattern during the 1990s. From 2003 to 2007, the laboratory detection levels changed and both sites' concentrations were reported at that laboratory detection limit of 0.10 µg/m^3. Then in 2009, the laboratory analysis method and detection limit changed, causing the concentrations to drop significantly. In 2012, two sites (Columbus-UPS and Columbus-Fort Benning) were reopened in the Columbus area to monitor a local source. The values for these sites in 2012 were higher than the rest of the network, however, the 2013 values were at least half those seen in 2012.

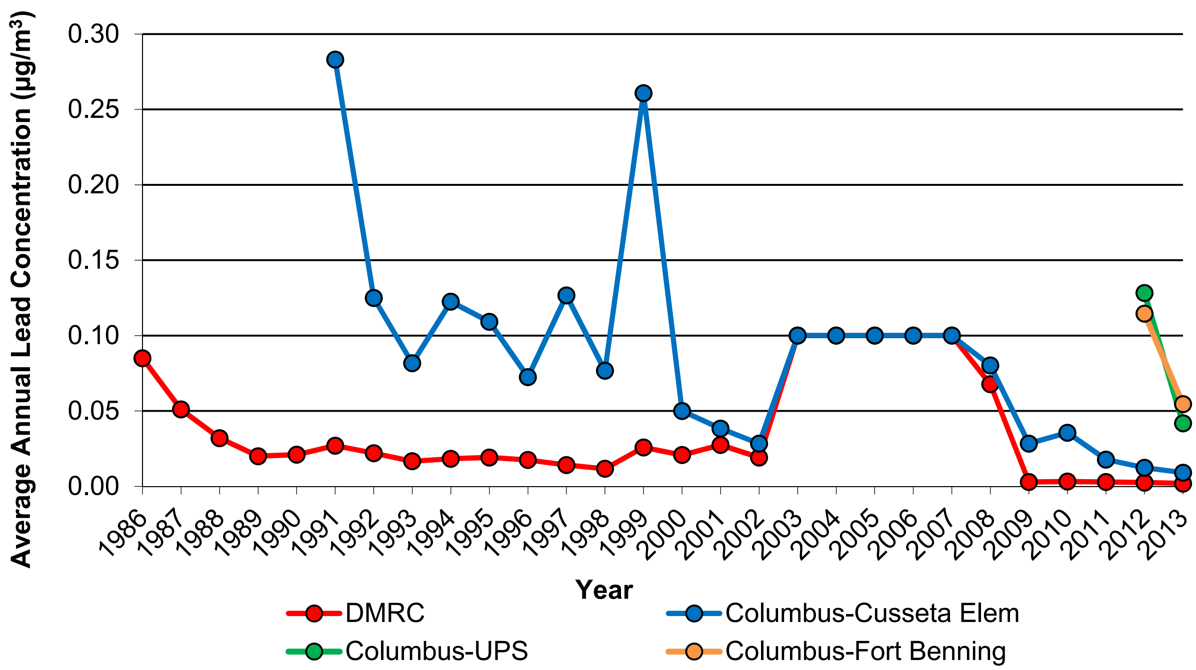


Figure 7.10: Lead Trend in Data

7.12 NATTS

The National Air Toxics Trends Station (NATTS) network was established in 2003 and is intended for long-term operation for the purpose of discerning national trends. The NATTS Network consists of 23 sites in the contiguous 48 states with one site located in Georgia. The South DeKalb site was chosen for the NATTS network due to its metro Atlanta location, making it a well-populated area and a prime location for observing the effects of air toxics on the public. Similar to Georgia's Air Toxics Network, the same air toxic compounds are monitored, as well as black carbon, and carbonyls.

All of these air toxic pollutants can have negative effects on human health, ranging from causing headaches, nausea, dizziness, cancer, birth defects, problems breathing, and other serious illnesses. These effects can vary depending on frequency of exposure, length of exposure, health of the person that is exposed, along with the toxicity of the compound. These air pollutants also affect the environment. Wildlife experiences symptoms similar to those in humans. Pollutants accumulate in the food chain. Many air pollutants can also be absorbed into waterways and have toxic effects on aquatic wildlife. Some of the substances tend to have only one critical effect, while others may have several. Some of the effects may occur after a short exposure and others appear after long-term exposure or many years after being exposed. Exposure is not only through direct inhalation of the pollutant, but also through the consumption of organisms such as fish that have absorbed the pollutant.

To compare the South DeKalb site to the other five Air Toxics sites, one compound of each of three groups were chosen to represent that category. The volatile organic compound representative is benzene, the semi-volatile organic compound is naphthalene, and the metal is arsenic. The following graphs compare the compounds at the NATTS network site, South DeKalb, with other Georgia sites that monitor air toxics as of 2013.

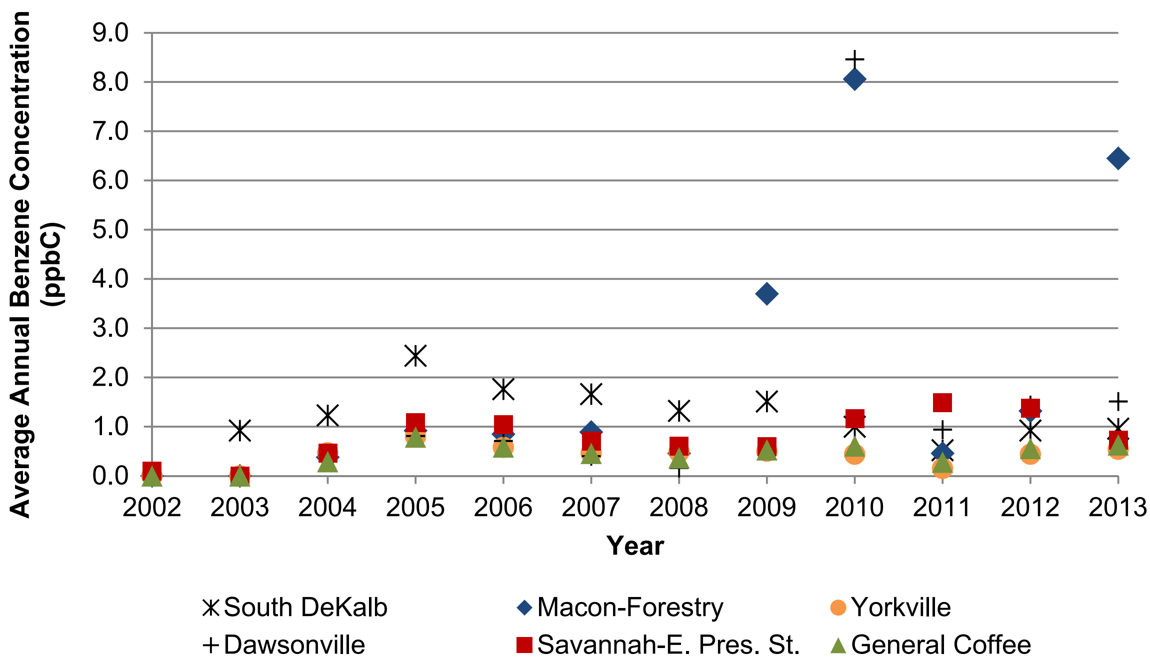


Figure 7.11: Comparison of Benzene Trend in Data

The majority of annual benzene concentrations have remained below 2.0 ppbC for the past twelve years. Macon-Forestry had relatively high values in 2009, 2010, and 2013 (3.7, 8.06, and 6.45 ppbC, respectively). Dawsonville also showed a high annual concentration in 2010 (8.46 ppbC). However, in general, annual concentrations at all sites seem to follow the same trend which shows concentrations increasing through 2005 and then leveling out after a slight decrease in 2008.

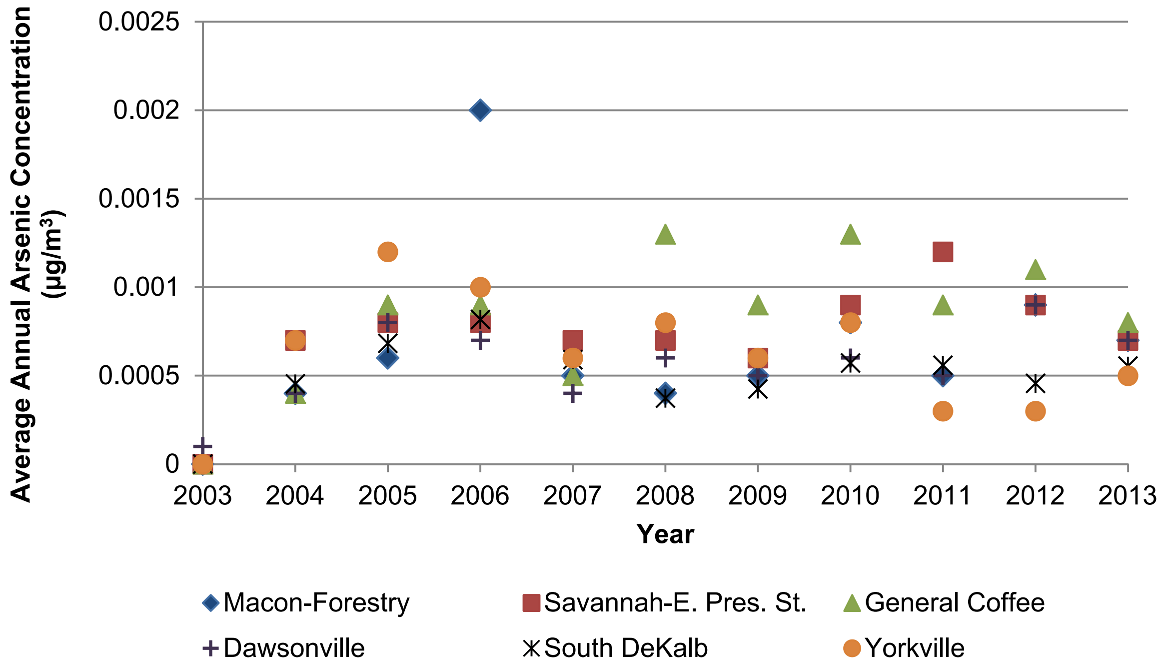


Figure 7.12 Comparison of Arsenic Trend in Data

Average annual arsenic concentrations have remained below 0.0015 µg/m³ for the past eleven years with the exception of the Macon-Forestry site in 2006 (0.002 µg/m³). 2003 shows the lowest average annual concentrations for all sites while most subsequent year's averages range between 0.0005 and 0.0015 µg/m³.

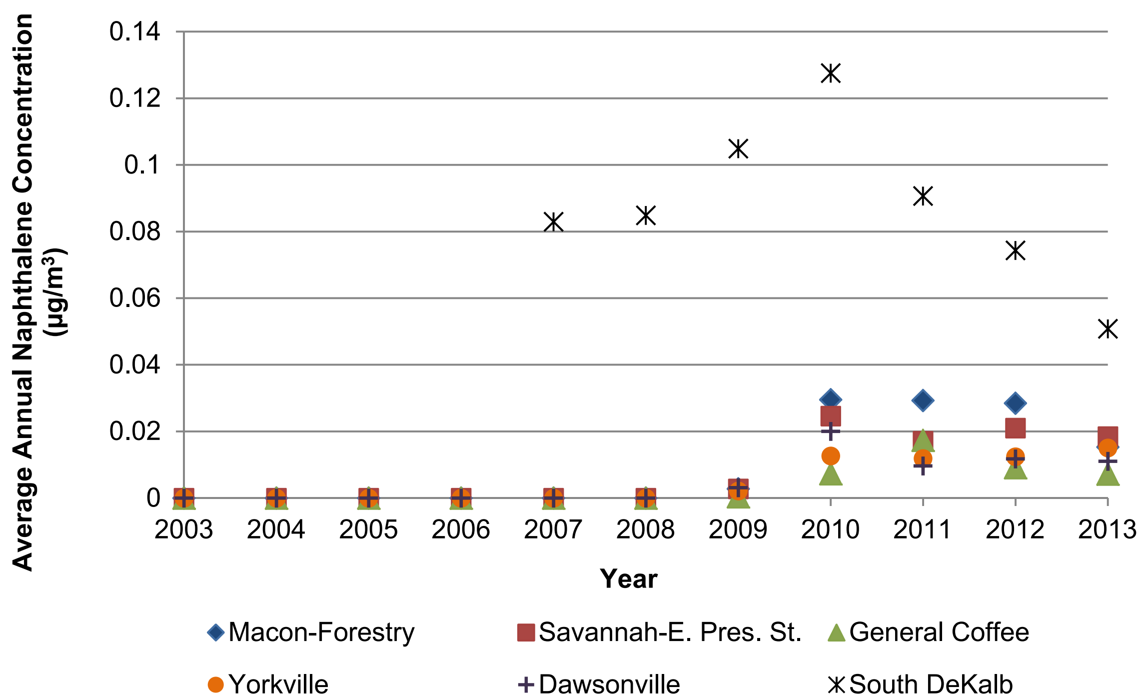


Figure 7.13 Comparison of Naphthalene Trend in Data

Average annual naphthalene concentrations remained 0 μg/m^3 from 2003 until 2007, when the South DeKalb site started collecting naphthalene data. The South DeKalb site has consistently had much greater concentrations of naphthalene detected compared to the other Air Toxics sites. There was a slight increase in 2009 followed by major increases in annual concentrations for all sites in 2010. From 2010 through 2013 annual concentrations remained in the same range for the Air Toxics sites, while the South DeKalb site shows a decrease each year.

7.13 Concluding Points

For the Trends Assessment, all of Georgia's ambient air monitoring sites across the state were ranked according to how long each site has been collecting data. As of 2013, there were 40 sites in 30 counties across the state. There are several sites in Georgia with a long running history. Of the 40 sites, almost half the sites have collected data since the 1980's. The longest running site is the Columbus-Health Department site, which was established in 1957. With the Trends Assessment, this site would rank the highest. The lowest ranking sites would be the sites that were most recently established. These include the Columbus-Fort Benning and the Columbus-UPS sites, which began sampling ambient air data in 2011 and 2012, respectively. With this assessment, these sites could be recommended for elimination.

In addition to the overall duration of each site, each of the criteria pollutants were evaluated for longevity and trends in the data. Even though the South DeKalb site is not the longest running site in Georgia's network, it is consistently one of the longest running sites for almost all of the criteria pollutants. The South DeKalb site was established in 1974, and as of 2013 collects data for ozone, sulfur dioxide (SO_2), carbon monoxide (CO), $PM_{2.5}$ (FRM, continuous, and speciation), PM_{10}, PM_{coarse}, nitrogen dioxide (NO_2), and also collects data as part of the NATTS, PAMS, and NCore networks.

8.0 Measured Concentrations: Procedure

With the Measured Concentrations analysis, the $PM_{2.5}$ and Ozone sites were examined. These sites were chosen since the concentrations at these sites can cause the design values to be above the National Ambient Air Quality Standards, or NAAQS. With this type of analysis, the sites with the highest average concentrations are considered the most important and ranked highest, and the sites with the lowest concentrations are considered the least important and ranked lowest. This aids to identify sites from a regulatory perspective based on maximum concentrations. The sites that measure the higher concentrations are more important for assessing compliance with the NAAQS and population exposure.

The NAAQS for $PM_{2.5}$ and ozone are calculated differently. $PM_{2.5}$ has both a 24-hour standard and an annual standard. The NAAQS for $PM_{2.5}$ 24-hour standard is three year average of the 98^{th} percentile, and the NAAQS for the $PM_{2.5}$ Annual standard is the three year average of the annual means. The NAAQS for ozone is the three year average of the 4^{th} daily maximum value of the 8-hour averages. For this analysis, to give a more comprehensive look at the data, five-year averages from 2009 to 2013 of the $PM_{2.5}$ 98^{th} percentile, $PM_{2.5}$ annual means, and ozone 4^{th} maximum values were used. The sites with the highest average concentrations were given the highest ranking score for that parameter. All three parameter scores were then totaled for each site. Sites with the highest total score were considered most important for this analysis.

Table 8.1: $PM_{2.5}$ 24-Hour Site Rankings Measured Concentrations

Measured Concentrations $PM_{2.5}$ 98th Percentile 2009-2013			
Site ID	Site Name	Average (µg/m3)	Proportion
130950007	Albany	28.2	1.00
132150011	Columbus-Cussetta	26.6	0.81
130510091	Savannah-Mercer	25.9	0.71
130210007	Macon-Allied	25.6	0.68
133030001	Sandersville	24.7	0.57
132150008	Columbus-Airport	24.0	0.47
133190001	Gordon	23.8	0.45
132150001	Columbus-Health Dept.	23.6	0.43
132450091	Augusta	23.5	0.41
131210039	Fire Station #8	23.3	0.38
131150003	Rome	22.7	0.31
130630091	Forest Park	22.6	0.29
131850003	Valdosta	22.3	0.26
132950002	Rossville	22.1	0.23
131530001	Warner Robins	22.1	0.23
130890002	South DeKalb	22.0	0.22
130590002	Athens	22.0	0.22
130670003	Kennesaw	21.9	0.21
131270006	Brunswick	21.8	0.19
131350002	Gwinnett	21.7	0.18
130210012	Macon-Forestry	21.5	0.15
132230003	Yorkville	20.4	0.02
131390003	Gainesville	20.3	0.00

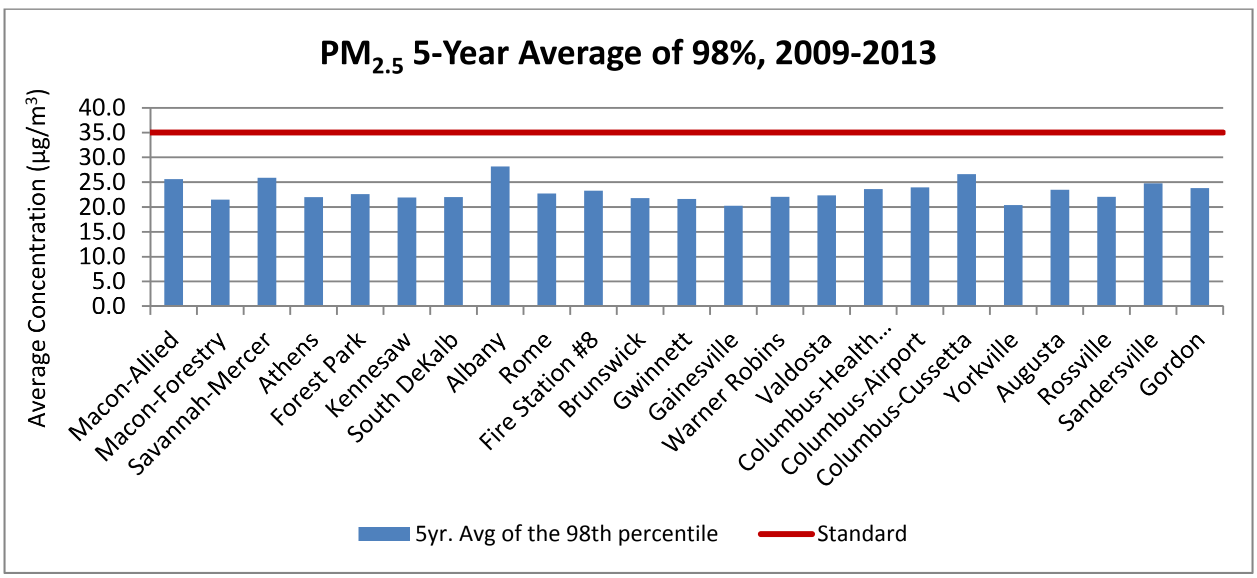


Figure 8.1: PM2.5 24-Hour Measured Concentrations

For the $PM_{2.5}$ 24 hour design values, the Savannah-Mercer, Albany, and Columbus-Cusseta sites would rank the highest. The Gainesville and Yorkville sites would rank the lowest for the $PM_{2.5}$, 24-hour values.

Table 8.2: $PM_{2.5}$ Annual Site Rankings Measured Concentrations

$PM_{2.5}$ Annual Mean 2009-2013 Average of 5 Yr. Averages			
Site ID	Site Name	Average (µg/m^3)	Proportion
130210007	Macon-Allied	12.3	1.00
131210039	Fire Station # 8	12.3	0.99
133190001	Gordon	12.0	0.90
132150001	Columbus-Health Dept.	11.7	0.81
130630091	Forest Park	11.6	0.79
131150005	Rome	11.4	0.71
130950007	Albany	11.3	0.70
132450091	Augusta	11.2	0.66
132150011	Columbus-Cussetta	11.1	0.64
132150008	Columbus-Airport	11.1	0.63
130890002	South DeKalb	11.0	0.60
130670003	Kennesaw	10.9	0.59
131350002	Gwinnett	10.8	0.54
133030001	Sandersville	10.6	0.49
131530001	Warner Robins	10.4	0.44
130590002	Athens	10.3	0.38
130510091	Savannah-Mercer	10.2	0.38
132950002	Rossville	10.2	0.35
130210012	Macon-Forestry	10.0	0.32
13139003	Gainesville	10.0	0.31
132230003	Yorkville	9.8	0.25
131850003	Valdosta	9.5	0.14
131270006	Brunswick	9.0	0.00

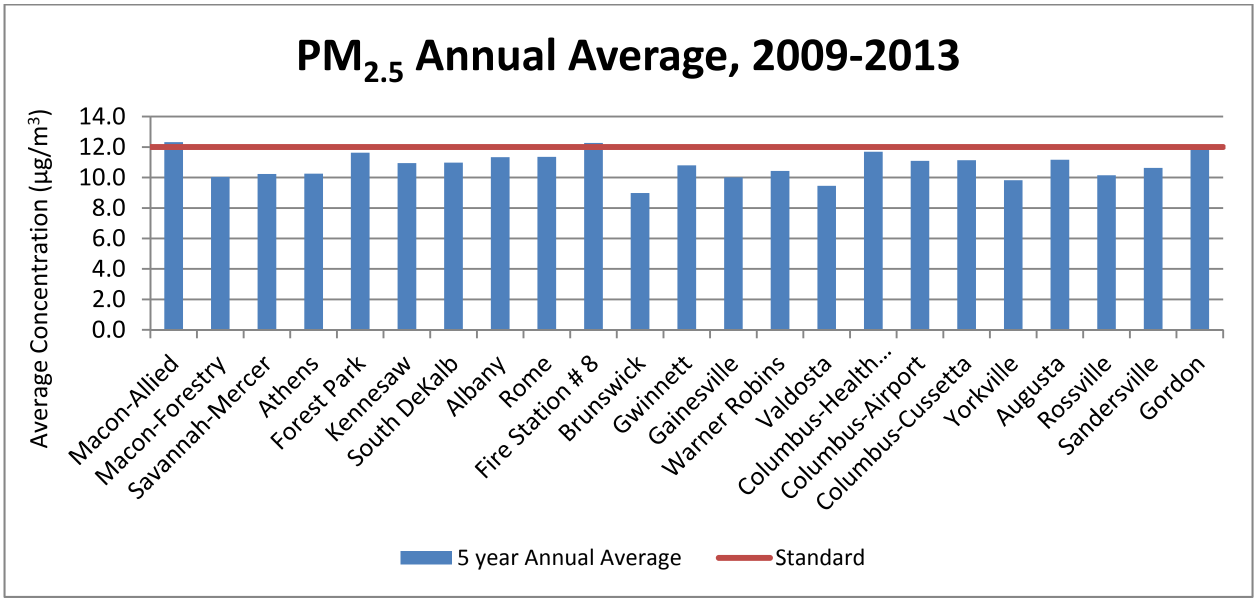


Figure 8.2: $PM_{2.5}$ Annual Measured Concentrations

For the $PM_{2.5}$ Annual design values, the Macon-Allied and Fire Station # 8 sites would rank the highest, and the Brunswick, Valdosta and Yorkville sites would rank the lowest.

Table 8.3: Ozone Sites Ranked, Measured Concentrations

Five Year Average 2009-2013 of 4th Max Ozone			
Site ID	**Site Name**	**Average (ppb)**	**Proportion**
131210055	Confederate Ave.	0.079	1.00
131510002	McDonough	0.078	0.95
130890002	South DeKalb	0.076	0.84
132470001	Conyers	0.076	0.84
130670003	Kennesaw	0.075	0.79
131350002	Gwinnett	0.075	0.79
130970004	Douglasville	0.072	0.63
130210012	Macon-Forestry	0.071	0.58
130590002	Athens	0.069	0.47
132130003	Fort Mountain	0.069	0.47
132230003	Yorkville	0.069	0.47
132450091	Bungalow Road	0.069	0.47
130730001	Evans	0.067	0.37
130850001	Dawsonville	0.066	0.32
130550001	Summerville	0.065	0.26
132150008	Columbus Airport	0.065	0.26
132611001	Leslie	0.064	0.21
130510021	Savannah–E. Pres. St.	0.063	0.16
130770002	Newnan	0.063	0.16
131270006	Brunswick	0.06	0.00

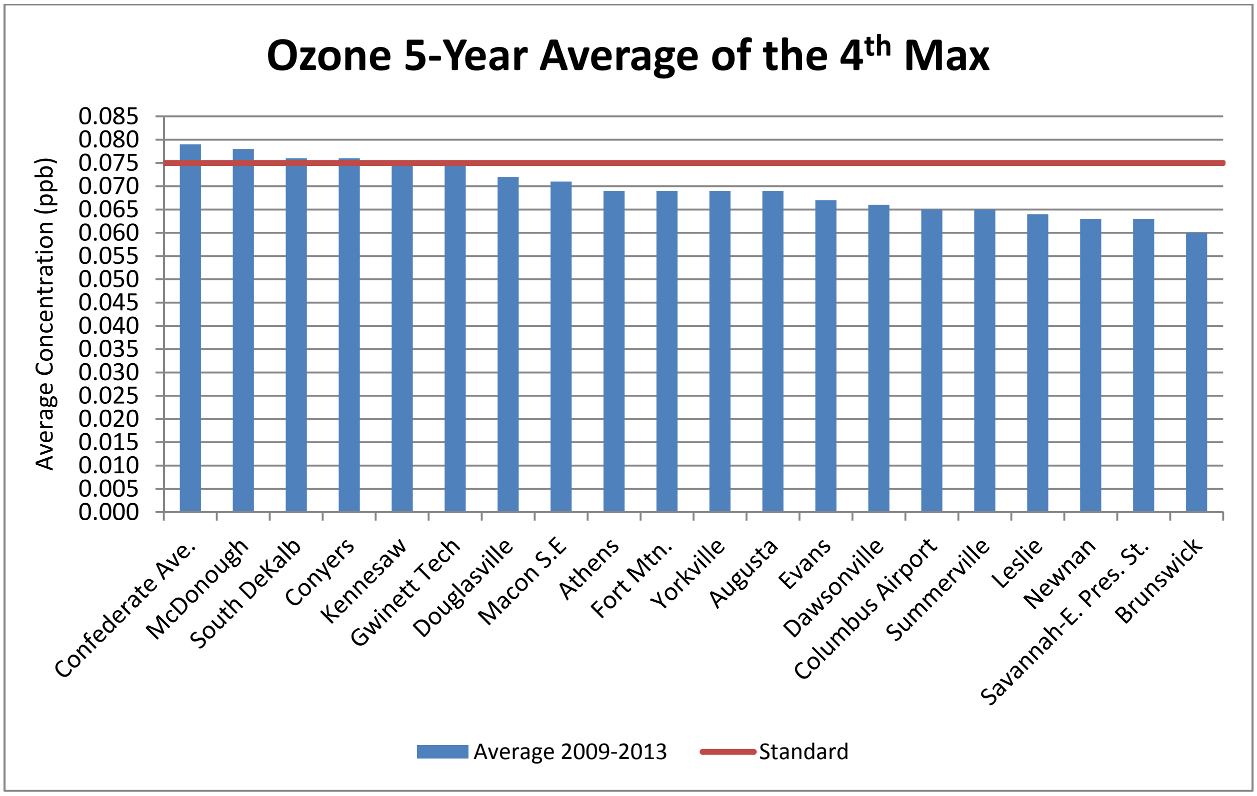


Figure 8.3: Ozone Measured Concentrations

With the ozone design values, the Brunswick, Savannah-E. Pres. St., and Newnan sites would rank the least important. The Confederate Ave, McDonough, and South DeKalb sites show the highest design values across the timeframe and would rank the highest with this type of assessment.

8.1 Concluding Points

With the Measured Concentrations Assessment, monitors that measure the highest concentrations are ranked higher than monitors with lower concentrations. Those sites with the lowest concentrations could be recommended for elimination or consolidation. For this assessment, the $PM_{2.5}$ and ozone monitor concentrations were examined. For $PM_{2.5}$, there is both a 24-hour and an annual standard; therefore, both standards were included in the assessment. For the $PM_{2.5}$ 24-hour standard, the 98th percentile was used, and for the Annual standard, the annual average was used to compare sites. For the ozone concentrations, the 4th max was used for comparisons. In all three cases, the 2009 to 2013 data was used from AQS.

For the $PM_{2.5}$ 24 hour design values, the Savannah-Mercer, Albany, and Columbus-Cusseta sites would rank the highest. The Gainesville and Yorkville sites would rank the lowest for the $PM_{2.5}$, 24-hour values. For the $PM_{2.5}$ Annual design values, the Macon-Allied and Fire Station # 8 sites would rank the highest, and the Brunswick, Valdosta and Yorkville sites would rank the lowest. With the ozone analysis, McDonough, South DeKalb and Confederate Avenue sites ranked the highest, and the Brunswick and Savannah sites ranked the lowest.

Table 8.4 gives the total score for each site. Albany received the highest overall score while Savannah-E. Pres. St., Newnan, and Brunswick ranked the lowest. With this assessment, these three sites could be recommended to be shut down or consolidated.

Table 8.4: Sum of $PM_{2.5}$ 24 Hour, $PM_{2.5}$ Annual, and Ozone scores for each site

Site ID	Site Name	$PM_{2.5}$ 24 Hour Score	$PM_{2.5}$ Annual Score	Ozone Score	Total Score
130950007	Albany	1.00	0.70		1.70
130210007	Macon-Allied	0.68	1.00		1.68
130890002	South DeKalb	0.22	0.60	0.84	1.66
132611001	Kennesaw	0.21	0.59	0.79	1.59
132450091	Augusta	0.41	0.66	0.47	1.54
131350002	Gwinnett	0.18	0.54	0.79	1.51
132150011	Columbus-Cussetta	0.81	0.64		1.45
131210039	Fire Station #8	0.38	0.99		1.37
132150008	Columbus-Airport	0.47	0.63	0.26	1.37
133190001	Gordon	0.45	0.90		1.35
132150001	Columbus-Health Dept.	0.43	0.81		1.24
130510091	Savannah-Mercer	0.71	0.38		1.09
130630091	Forest Park	0.29	0.79		1.09
130590002	Athens	0.22	0.38	0.47	1.07
133030001	Sandersville	0.57	0.49		1.06
130210012	Macon-Forestry	0.15	0.32	0.58	1.05
131150005	Rome	0.31	0.71		1.02
131210055	Confederate Ave.			1.00	1.00
131510002	McDonough			0.95	0.95
132470001	Conyers			0.84	0.84
132230003	Yorkville	0.02	0.25	0.47	0.74
131530001	Warner Robins	0.23	0.44		0.66
130970004	Douglasville			0.63	0.63
132950002	Rossville	0.23	0.35		0.58
132130003	Fort Mountain			0.47	0.47
131850003	Valdosta	0.26	0.14		0.41
130730001	Evans			0.37	0.37
130850001	Dawsonville			0.32	0.32
131390003	Gainesville	0.00	0.31		0.31
130550001	Summerville			0.26	0.26
130210007	Leslie			0.21	0.21
131270006	Brunswick	0.19	0.00	0.00	0.19
130770002	Newnan			0.16	0.16
130510021	Savannah-E. Pres. St.			0.16	0.16

9.0 Deviation from the NAAQS: Procedure

Another type of analysis that can be performed to determine a site's importance is the Deviation from the National Ambient Air Quality Standards (NAAQS) analysis. These standards pertain to the criteria pollutants (carbon monoxide, lead, nitrogen dioxide, particulate matter, ozone, and sulfur dioxide). Therefore, the following tables and graphs reflect these specific parameters and their specific calculations to compare to the NAAQS. With this type of analysis, all of the sites are ranked according to a binning method for each of the criteria pollutants. This method examined the percentage of each site's concentrations compared to each standard. If the absolute value of the pollutant's average was equal to the standard, it was given a rank of 1. If absolute value of the pollutant's average was ≥85% of the standard, it was given a 0.5. If the pollutant's average was <85% of the standard, it was ranked as a 0. The sites with the least amount of deviation from the NAAQS rank the highest in this type of analysis and are considered more valuable for the network in determining attainment of the standard. These results are shown in the table for each pollutant's averages. The actual design values have been included in the tables and graphs to show the comparison to the NAAQS as well.

For the ozone, $PM_{2.5}$, and SO_2 calculations, 3-year averages were examined from 2009-2011 through 2011-2013 averages. In the ozone, $PM_{2.5}$, and SO_2 graphs, the values are shown as a value of how far the design values deviate from the NAAQS; therefore, the 'zero' would actually represent the standard. For the PM_{10}, lead, CO, and NO_2 graphs, the past five years (2009 to 2013) are compared to the actual standard as indicated. The data was used through 2013 and NAAQS standards as of 2013 were used in this analysis due to the inception and deadline of the document.

9.1 Ozone

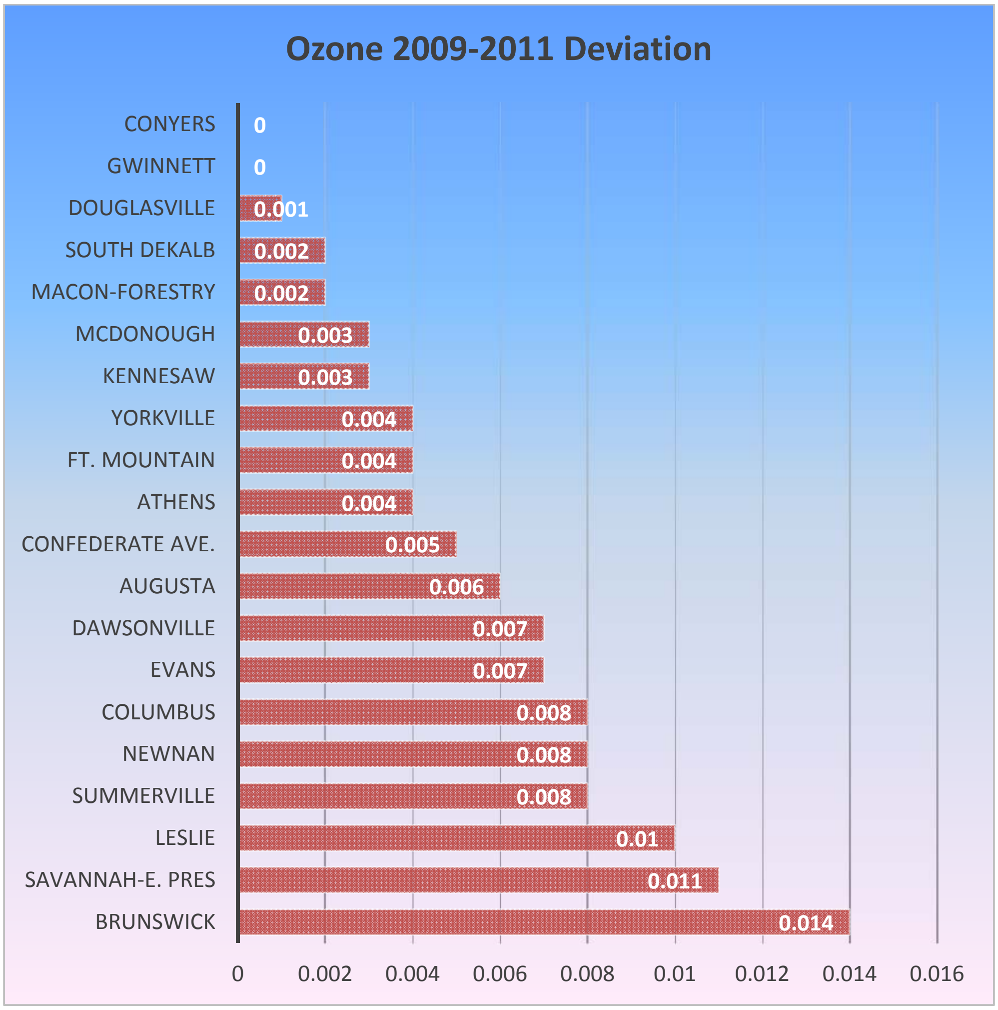
The following table displays the three-year design values for ozone from 2009 to 2013. Also displayed in the table is the rank of each monitor. These rankings were determined with a binning method as described above. For the ozone standard, the 85% threshold in the table below is 0.064 ppm. Each three-year design value was ranked, and then each of these rankings was added across the years for a total ranking per site.

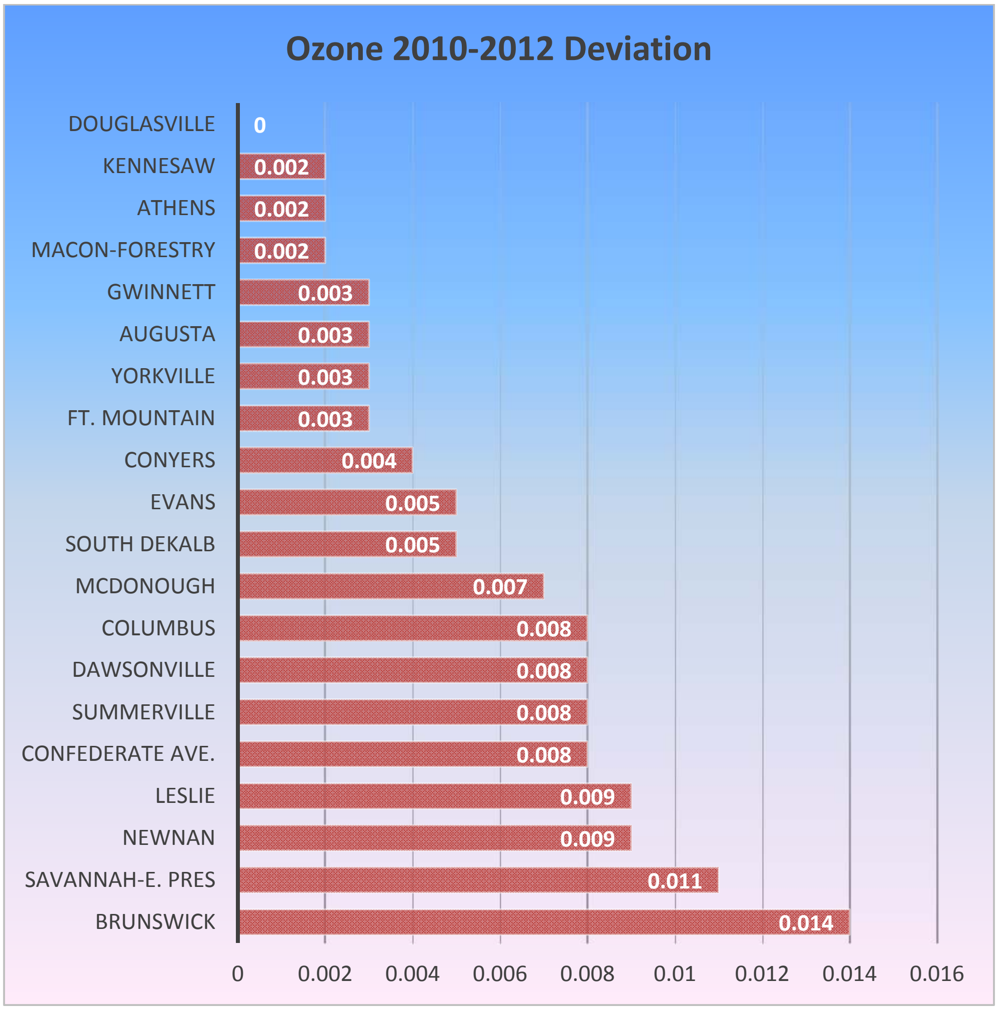
Ozone Sites	2009-2011 (ppm)	Absolute Value from NAAQS	Rank	2010-2012 (ppm)	Absolute Value from NAAQS	Rank	2011-2013 (ppm)	Absolute Value from NAAQS	Rank	Total Ranking
Macon-SE	0.073	0.002	**0.5**	0.073	0.002	**0.5**	0.071	0.004	**0.5**	**1.5**
Savannah-E Pres St	0.064	0.011	**0.5**	0.064	0.011	**0.5**	0.062	0.013	**0.0**	**1.5**
Summerville	0.067	0.008	**0.5**	0.067	0.008	**0.5**	0.065	0.010	**0.5**	**1.5**
Athens	0.071	0.004	**0.5**	0.073	0.002	**0.5**	0.068	0.007	**0.5**	**1.5**
Kennesaw	0.078	0.003	**0.5**	0.077	0.002	**0.5**	0.073	0.002	**0.5**	**1.5**
Evans	0.068	0.007	**0.5**	0.070	0.005	**0.5**	0.068	0.007	**0.5**	**1.5**
Newnan	0.067	0.008	**0.5**	0.066	0.009	**0.5**	0.062	0.013	**0.0**	**1.0**
Dawsonville	0.068	0.007	**0.5**	0.067	0.008	**0.5**	0.064	0.011	**0.5**	**1.5**
South DeKalb	0.077	0.002	**0.5**	0.080	0.005	**0.5**	0.075	0	**1.0**	**2.0**
Douglasville	0.074	0.001	**0.5**	0.075	0	**1.0**	0.071	0.004	**0.5**	**2.0**
Confederate Ave	0.080	0.005	**1.0**	0.083	0.008	**0.5**	0.080	0.005	**0.5**	**2.0**
Brunswick	0.061	0.014	**0.0**	0.061	0.014	**0.0**	0.058	0.017	**0.0**	**0.0**
Gwinnett	0.075	0	**1.0**	0.078	0.003	**0.5**	0.077	0.002	**0.5**	**2.0**
McDonough	0.078	0.003	**0.5**	0.082	0.007	**0.5**	0.080	0.005	**0.5**	**2.0**
Ft. Mountain	0.071	0.004	**0.5**	0.072	0.003	**0.5**	0.068	0.007	**0.5**	**1.5**
Columbus-Airport	0.067	0.008	**0.5**	0.067	0.008	**0.5**	0.064	0.011	**0.5**	**1.5**
Yorkville	0.071	0.004	**0.5**	0.072	0.003	**0.5**	0.069	0.006	**0.5**	**1.5**
Augusta	0.069	0.006	**0.5**	0.072	0.003	**0.5**	0.069	0.006	**0.5**	**1.5**
Conyers	0.075	0	**1.0**	0.079	0.004	**0.5**	0.077	0.002	**0.5**	**2.0**
Leslie	0.065	0.010	**0.5**	0.066	0.009	**0.5**	0.063	0.012	**0.0**	**1.0**

Figure 9.1: Ozone Design Values and Ranking

As explained above, for this assessment, the sites with the highest ranking would be considered most important for comparing to the standard. The highest ranking sites were the South DeKalb, Douglasville, Confederate Avenue, Gwinnett, McDonough, and Conyers sites, with a ranking of 2.0. The lowest ranking ozone site is the Brunswick site, with a ranking of 0.0. The remaining sites had rankings of 0.5 to 1.5, indicating that these sites had design values that were above 85% of the NAAQS (0.075ppm), or above the NAAQS for each three-year average used in the assessment.

The following graphs show how each ozone monitor deviates from the standard of 0.075 ppm. To aide in displaying this data graphically, the standard of 0.075 ppm is shown in the following graphs as 0. Then, the extent of each site’s deviation from the NAAQS is shown as the distance from 0. If the site’s monitor was 0.075 ppm, then it would be displayed in the graph as 0. The sites that were closest to the standard of 0.075 are considered most important. The sites are shown in order of importance. The absolute value from the standard determined its order of importance and not whether it was above or below the standard. For regulatory purposes, the sites with the highest values would be of concern to determine whether or not those areas are in attainment of the standard. However, for this type of analysis shown here, sites with values closest to the standard are considered more valuable for NAAQS evaluation.


Ozone 2009-2011 Deviation
CONYERS 0
GWINNETT 0
DOUGLASVILLE 0.001
SOUTH DEKALB 0.002
MACON-FORESTRY 0.002
MCDONOUGH 0.003
KENNESAW 0.003
YORKVILLE 0.004
FT. MOUNTAIN 0.004
ATHENS 0.004
CONFEDERATE AVE. 0.005
AUGUSTA 0.006
DAWSONVILLE 0.007
EVANS 0.007
COLUMBUS 0.008
NEWNAN 0.008
SUMMERVILLE 0.008
LESLIE 0.01
SAVANNAH-E. PRES 0.011
BRUNSWICK 0.014
0 0.002 0.004 0.006 0.008 0.01 0.012 0.014 0.016


Ozone 2010-2012 Deviation
DOUGLASVILLE 0
KENNESAW 0.002
ATHENS 0.002
MACON-FORESTRY 0.002
GWINNETT 0.003
AUGUSTA 0.003
YORKVILLE 0.003
FT. MOUNTAIN 0.003
CONYERS 0.004
EVANS 0.005
SOUTH DEKALB 0.005
MCDONOUGH 0.007
COLUMBUS 0.008
DAWSONVILLE 0.008
SUMMERVILLE 0.008
CONFEDERATE AVE. 0.008
LESLIE 0.009
NEWNAN 0.009
SAVANNAH-E. PRES 0.011
BRUNSWICK 0.014
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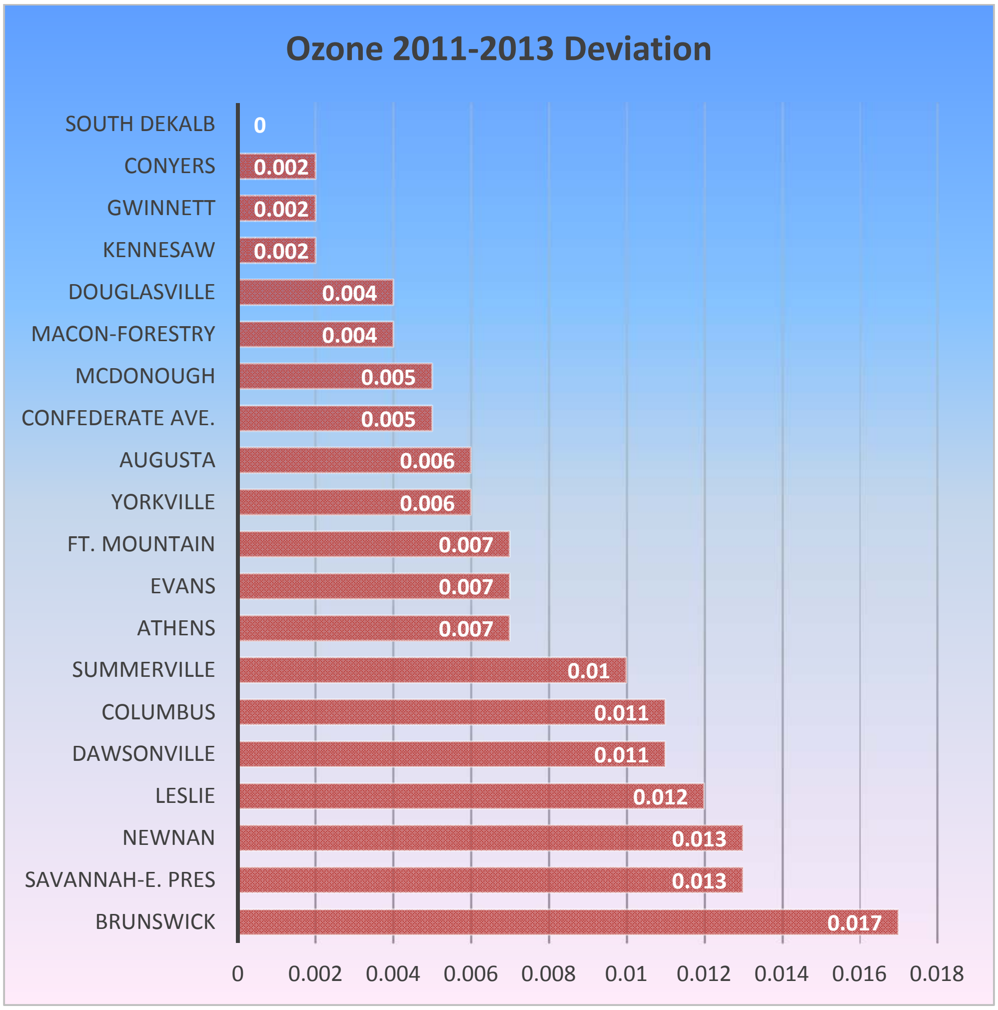


Figure 9.1: Ozone Deviation from the NAAQS (Absolute Value)

For the ozone monitoring sites, the locations with design values closest to the NAAQS for the last three years have consistently been the South DeKalb, Gwinnett, Conyers, and Douglasville sites. The Brunswick and Savannah-E. Pres. sites are consistently the least important ozone sites with this type of analysis, having the most deviation from the NAAQS. Also of note are the Newnan and Leslie ozone sites, having the next to least important position with the last two design values.

9.2 $PM_{2.5}$ 24-Hour

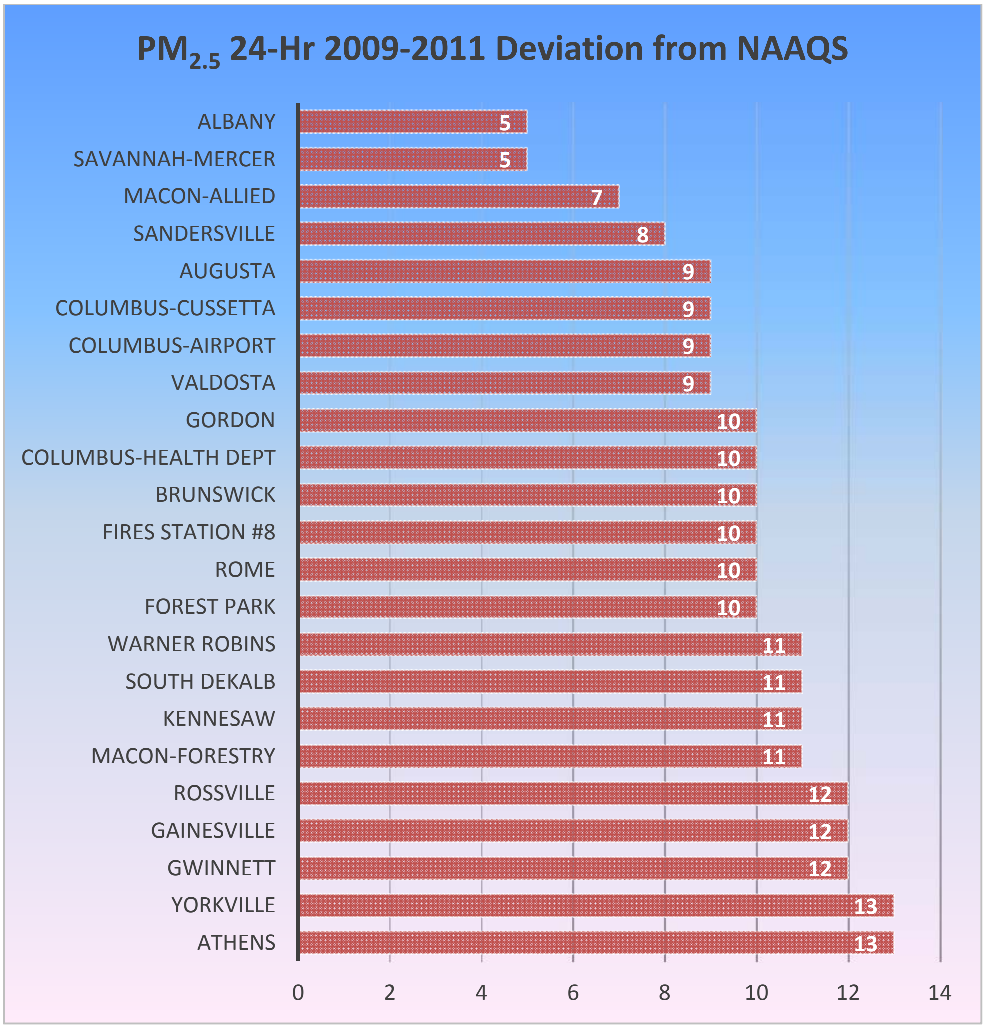
The following table displays the 2009 to 2013 24-hour $PM_{2.5}$ three-year design values in micrograms per cubic meter (µg/m^3). The National Ambient Air Quality Standard for 24-hour $PM_{2.5}$ is 35 µg/m^3. The ranking for each monitor is also displayed in the table. These rankings were determined with a binning method as described above. Each three-year design value was ranked, and then each of these rankings was added across the years for a total ranking per site.

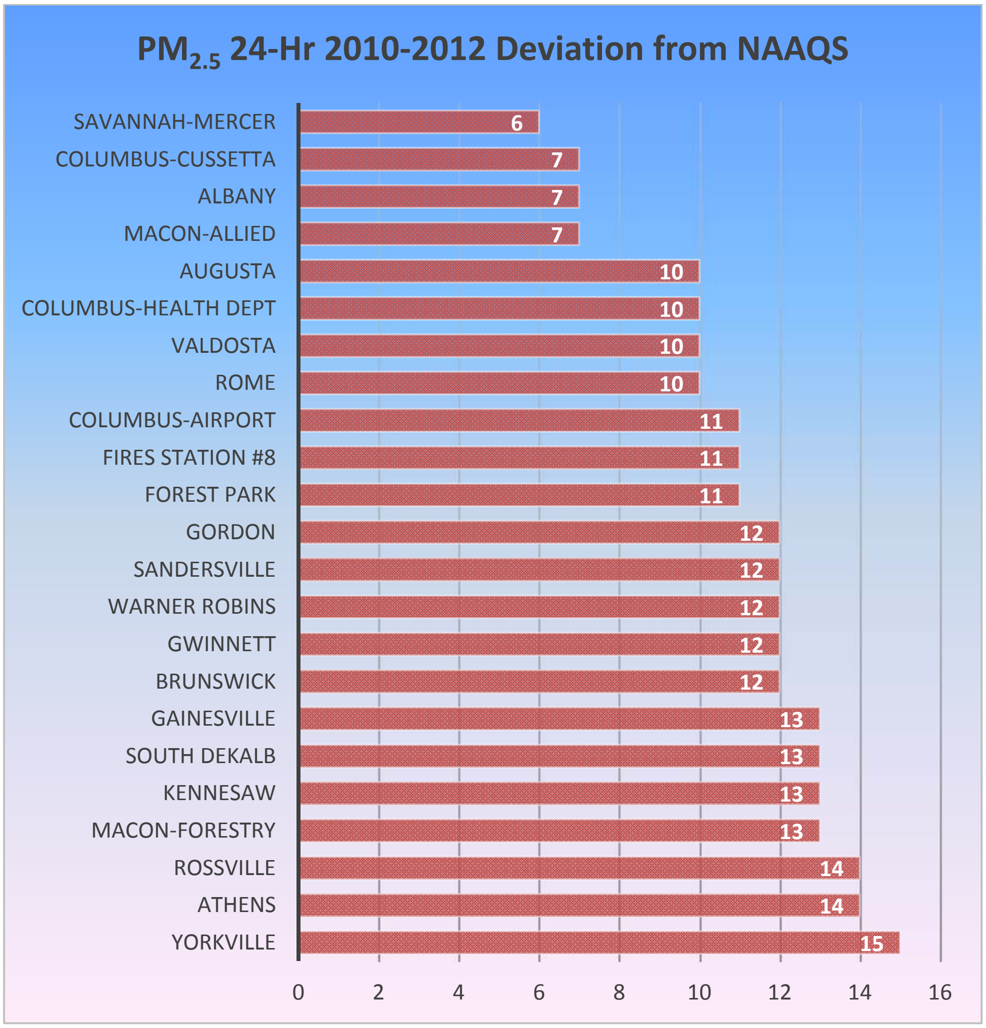
$PM_{2.5}$ 24-Hour	2009-2011	Absolute Value from NAAQS	Rank	2010-2012	Absolute Value from NAAQS	Rank	2011-2013	Absolute Value from NAAQS	Rank	Total Ranking
Macon-Allied	28	7	0	28	7	0	25	10	0	0.0
Macon-Forestry	24	11	0	22	13	0	20	15	0	0.0
Savannah-Mercer	30	5	0.5	29	6	0	28	7	0	0.5
Athens	22	13	0	21	14	0	23	12	0	0.0
Forest Park	25	10	0	24	11	0	21	14	0	0.0
Kennesaw	24	11	0	22	13	0	21	14	0	0.0
South DeKalb	24	11	0	22	13	0	21	14	0	0.0
Albany	30	5	0.5	28	7	0	26	9	0	0.5
Rome	25	10	0	25	10	0	22	13	0	0.0
Fire Station #8	25	10	0	24	11	0	22	13	0	0.0
Brunswick	25	10	0	23	12	0	20	15	0	0.0
Gwinnett	23	12	0	23	12	0	21	14	0	0.0
Gainesville	23	12	0	22	13	0	19	16	0	0.0
Warner Robins	24	11	0	23	12	0	20	15	0	0.0
Valdosta	26	9	0	25	10	0	21	14	0	0.0
Columbus-Health Dept	25	10	0	25	10	0	23	12	0	0.0
Columbus-Airport	26	9	0	24	11	0	23	12	0	0.0
Columbus-Cusseta	26	9	0	28	7	0	27	8	0	0.0
Yorkville	22	13	0	20	15	0	20	15	0	0.0
Augusta	26	9	0	25	10	0	22	13	0	0.0
Rossville	23	12	0	21	14	0	22	13	0	0.0
Sandersville	27	8	0	23	12	0	24	11	0	0.0
Gordon	25	10	0	23	12	0	23	12	0	0.0

Table 9.2: $PM_{2.5}$ 24-Hour Design Values and Ranking

With the 24-hour $PM_{2.5}$ data, almost all the sites have a ranking of 0, with 24-hour design values below 85% of the NAAQS (29.75 $\mu g/m^3$). The Savannah-Mercer and Albany sites have a rank of 0.5.

The following graphs show the data in the same way that the ozone data was displayed. The standard is shown as 0, and how far the absolute value of each site's concentration deviates from that standard is shown as the extent from 0. For the 24-hour $PM_{2.5}$ data, the standard is 35 $\mu g/m^3$. Therefore, the graphs depict the information in the above table and show the difference of the average compared to the standard of 35 $\mu g/m^3$.


PM2.5 24-Hr 2009-2011 Deviation from NAAQS
ALBANY 5
SAVANNAH-MERCER 5
MACON-ALLIED 7
SANDERSVILLE 8
AUGUSTA 9
COLUMBUS-CUSSETTA 9
COLUMBUS-AIRPORT 9
VALDOSTA 9
GORDON 10
COLUMBUS-HEALTH DEPT 10
BRUNSWICK 10
FIRES STATION #8 10
ROME 10
FOREST PARK 10
WARNER ROBINS 11
SOUTH DEKALB 11
KENNESAW 11
MACON-FORESTRY 11
ROSSVILLE 12
GAINESVILLE 12
GWINNETT 12
YORKVILLE 13
ATHENS 13
0 2 4 6 8 10 12 14


PM2.5 24-Hr 2010-2012 Deviation from NAAQS
SAVANNAH-MERCER 6
COLUMBUS-CUSSETTA 7
ALBANY 7
MACON-ALLIED 7
AUGUSTA 10
COLUMBUS-HEALTH DEPT 10
VALDOSTA 10
ROME 10
COLUMBUS-AIRPORT 11
FIRES STATION #8 11
FOREST PARK 11
GORDON 12
SANDERSVILLE 12
WARNER ROBINS 12
GWINNETT 12
BRUNSWICK 12
GAINESVILLE 13
SOUTH DEKALB 13
KENNESAW 13
MACON-FORESTRY 13
ROSSVILLE 14
ATHENS 14
YORKVILLE 15
0 2 4 6 8 10 12 14 16

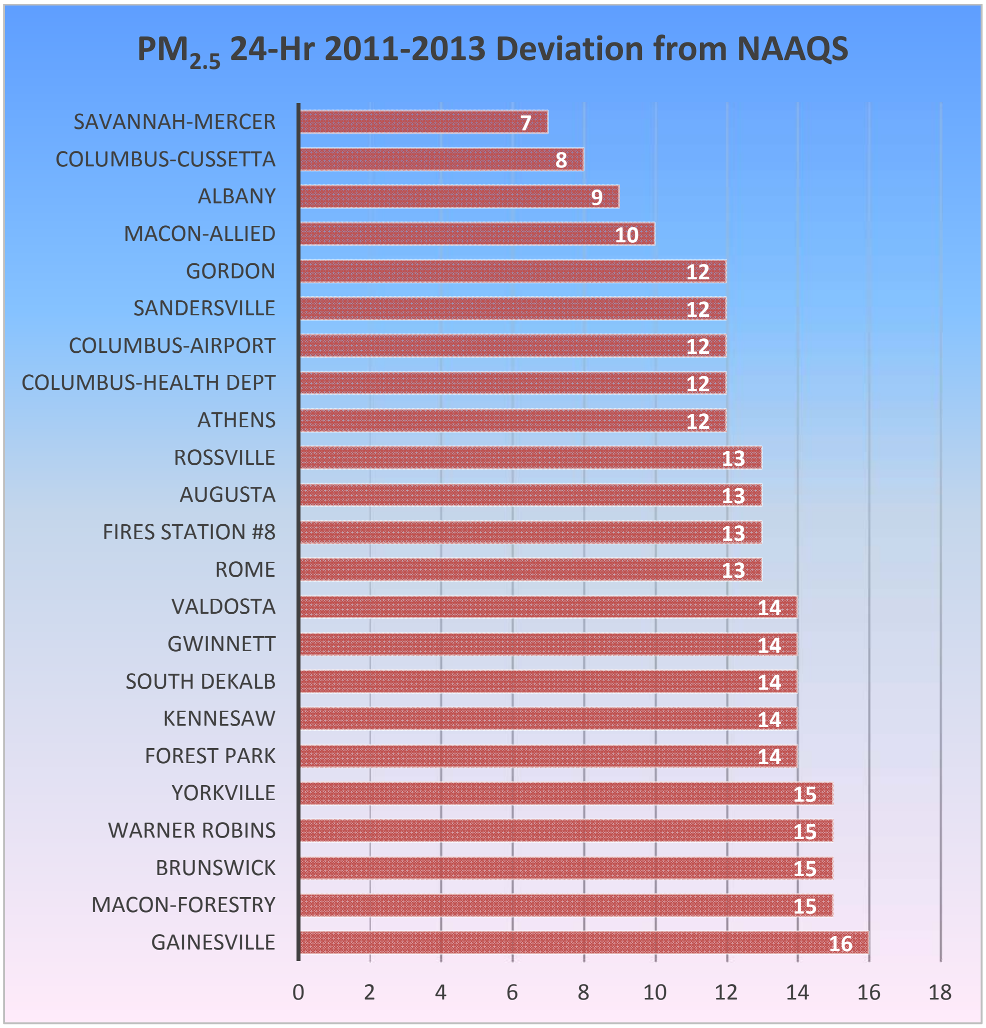


Figure 9.2: $PM_{2.5}$ 24-Hour Deviation from the NAAQS (Absolute Value)

9.3 $PM_{2.5}$ Annual

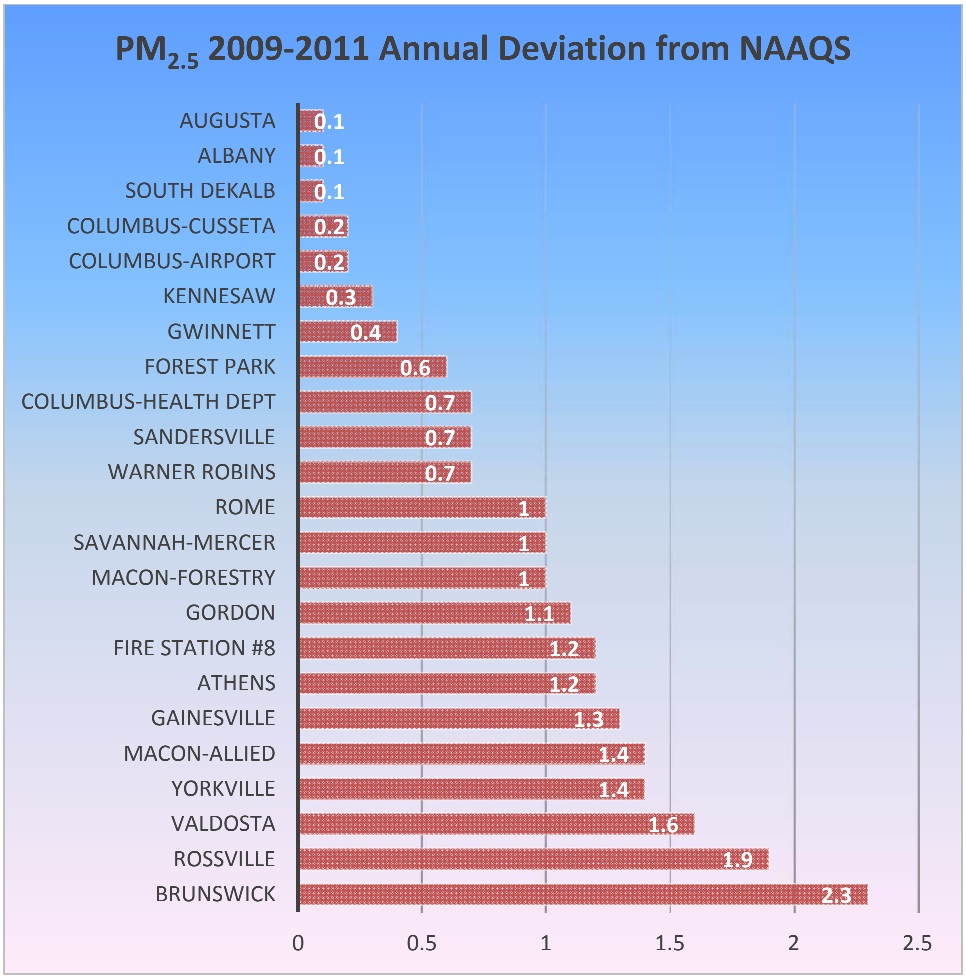
The following table displays the three-year design values for annual $PM_{2.5}$ from 2009 to 2013. Also shown in the table are the rankings for each monitor in Georgia EPD's $PM_{2.5}$ network. These rankings were determined with a binning method as described above. Each three-year design value was ranked, and then each of these rankings were added across the years for a total ranking per site. Since the $PM_{2.5}$ annual standard is 12.0 μg/m^3, a range of 12.0-12.9 μg/m^3 was ranked with a 1.0. The ±85% threshold of 10.2 up to 11.9 was ranked 0.5, and 13.0 to 14.8 μg/m^3 would be ranked 0.5. Values 15% above and 15% below the standard are given the same rank. Values outside of 10.2 μg/m^3 and 14.8 μg/m^3 would have a rank of 0.0.

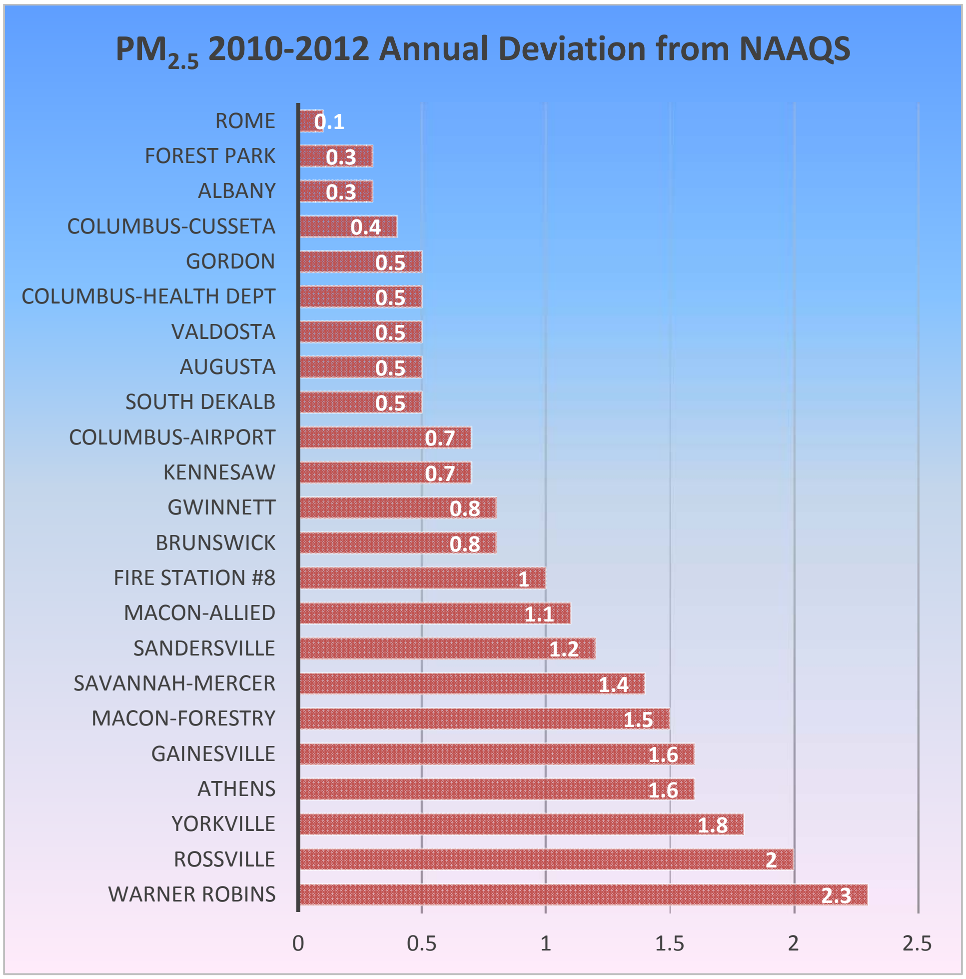
Table 9.3: $PM_{2.5}$ Annual Design Values and Ranking

$PM_{2.5}$ Annual	2009-2011 (μg/m³)	Absolute Value from NAAQS	Rank	2010-2012 (μg/m³)	Absolute Value from NAAQS	Rank	2011-2013 (μg/m³)	Absolute Value from NAAQS	Rank	Total Ranking
Macon-Allied	13.4	1.4	**0.5**	13.1	1.1	**0.5**	11.8	0.2	**0.5**	**1.5**
Macon-Forestry	11.0	1.0	**0.5**	10.5	1.5	**0.5**	9.4	2.6	**0.0**	**1.0**
Savannah-Mercer	11.0	1.0	**0.5**	10.6	1.4	**0.5**	10.2	1.8	**0.5**	**1.5**
Athens	10.8	1.2	**0.5**	10.4	1.6	**0.5**	9.9	2.1	**0.5**	**1.5**
Forest Park	12.6	0.6	**1.0**	12.3	0.3	**1.0**	11.1	0.8	**0.5**	**2.5**
Kennesaw	11.7	0.3	**0.5**	11.3	0.7	**0.5**	10.4	1.6	**0.5**	**1.5**
South DeKalb	11.9	0.1	**0.5**	11.5	0.5	**0.5**	10.5	1.5	**0.5**	**1.5**
Albany	12.1	0.1	**1.0**	11.7	0.3	**0.5**	10.9	1.1	**0.5**	**2.0**
Rome	13.0	1.0	**0.5**	12.1	0.1	**1.0**	10.8	1.2	**0.5**	**2.0**
Fire Station #8	13.2	1.2	**0.5**	13.0	1.0	**0.5**	11.6	0.4	**0.5**	**1.5**
Brunswick	9.7	2.3	**0.0**	11.2	0.8	**0.5**	8.2	3.8	**0.0**	**0.5**
Gwinnett	11.6	0.4	**0.5**	11.2	0.8	**0.5**	10.1	1.9	**0.5**	**1.5**
Gainesville	10.7	1.3	**0.5**	10.4	1.6	**0.5**	9.5	2.5	**0.0**	**1.0**
Warner Robins	11.3	0.3	**0.5**	9.7	2.3	**0.0**	9.9	2.1	**0.0**	**0.5**
Valdosta	10.4	1.6	**0.5**	12.5	0.5	**1.0**	8.9	3.1	**0.0**	**1.5**
Columbus-Health Dept	12.7	0.7	**1.0**	12.5	0.5	**1.0**	10.8	1.2	**0.5**	**2.5**
Columbus-Airport	11.8	0.2	**0.5**	11.3	0.7	**0.5**	10.5	1.5	**0.5**	**1.5**
Columbus-Cusseta	11.8	0.2	**0.5**	11.6	0.4	**0.5**	10.7	1.3	**0.5**	**1.5**
Yorkville	10.6	1.4	**0.5**	10.2	1.8	**0.5**	9.3	2.7	**0.0**	**1.0**
Augusta	12.1	0.1	**1.0**	11.5	0.5	**0.5**	10.5	1.5	**0.5**	**2.0**
Rossville	10.1	1.9	**0.0**	10.0	2.0	**0.0**	10.5	1.5	**0.5**	**0.5**
Sandersville	11.3	0.7	**0.5**	10.8	1.2	**0.5**	10.2	1.8	**0.5**	**1.5**
Gordon	13.1	1.1	**0.5**	12.5	0.5	**1.0**	11.2	0.8	**0.5**	**2.0**

The majority of three-year averages were above 85% of the NAAQS, which is 10.2 μg/m³, giving a ranking of 0.5 for that three-year average. Also, before the 2011-2013 averages, several sites had averages above the standard (12.0 μg/m³), giving that site a ranking of 1.0. As a result, all the sites had a total ranking of at least 0.5. The highest ranking sites for the $PM_{2.5}$ annual standard are Forest Park, Columbus-Health Dept, each with a ranking of 2.5.

The following graphs display the difference between the three-year averages and the standard. Therefore, the '0' represents the $PM_{2.5}$ annual standard of 12.0 μg/m³.


PM2.5 2009-2011 Annual Deviation from NAAQS
AUGUSTA 0.1
ALBANY 0.1
SOUTH DEKALB 0.1
COLUMBUS-CUSSETA 0.2
COLUMBUS-AIRPORT 0.2
KENNESAW 0.3
GWINNETT 0.4
FOREST PARK 0.6
COLUMBUS-HEALTH DEPT 0.7
SANDERSVILLE 0.7
WARNER ROBINS 0.7
ROME 1
SAVANNAH-MERCER 1
MACON-FORESTRY 1
GORDON 1.1
FIRE STATION #8 1.2
ATHENS 1.2
GAINESVILLE 1.3
MACON-ALLIED 1.4
YORKVILLE 1.4
VALDOSTA 1.6
ROSSVILLE 1.9
BRUNSWICK 2.3
0
0.5
1
1.5
2
2.5


PM2.5 2010-2012 Annual Deviation from NAAQS
ROME 0.1
FOREST PARK 0.3
ALBANY 0.3
COLUMBUS-CUSSETA 0.4
GORDON 0.5
COLUMBUS-HEALTH DEPT 0.5
VALDOSTA 0.5
AUGUSTA 0.5
SOUTH DEKALB 0.5
COLUMBUS-AIRPORT 0.7
KENNESAW 0.7
GWINNETT 0.8
BRUNSWICK 0.8
FIRE STATION #8 1
MACON-ALLIED 1.1
SANDERSVILLE 1.2
SAVANNAH-MERCER 1.4
MACON-FORESTRY 1.5
GAINESVILLE 1.6
ATHENS 1.6
YORKVILLE 1.8
ROSSVILLE 2
WARNER ROBINS 2.3
0
0.5
1
1.5
2
2.5

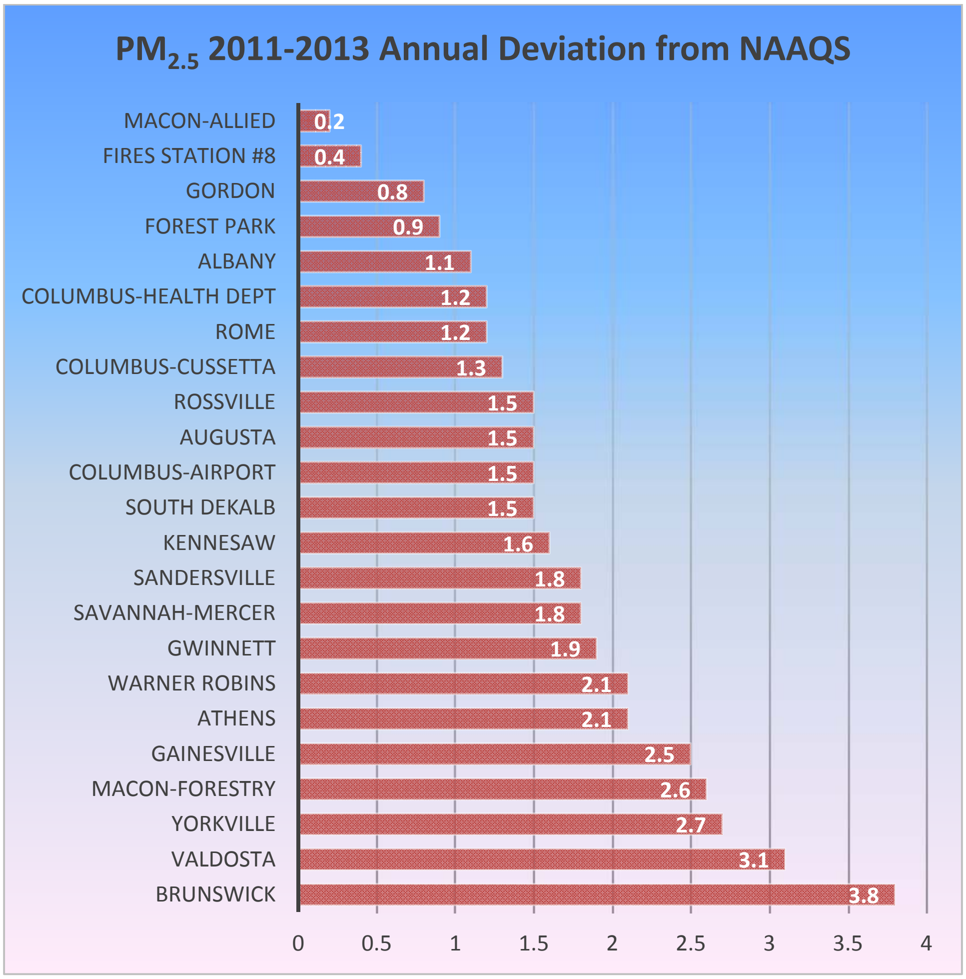


Figure 9.3: $PM_{2.5}$ Annual Deviation from the NAAQS (Absolute Value)

9.4 Sulfur Dioxide

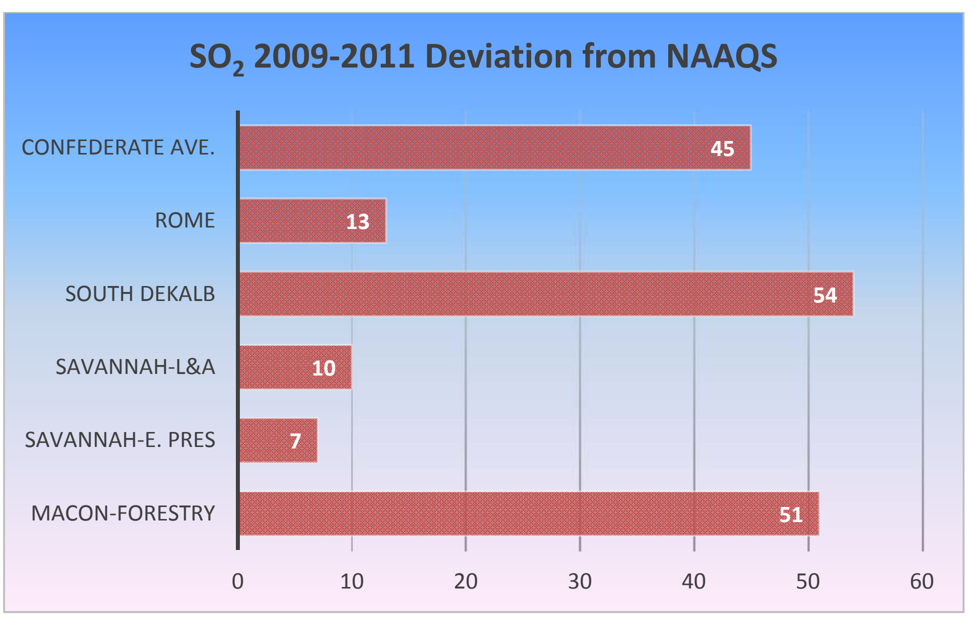
The sulfur dioxide (SO_2) National Ambient Air Quality standard compares the 99th percentile of 1-hour daily maximum concentrations, averaged for three years, compared to 75 ppb. The following table and graphs show these three-year averages from 2009-2011 to 2011-2013 compared to 75 ppb. As of 2013, there were seven SO_2 samplers collecting data in Georgia. The Augusta monitor started collecting samples in 2013; therefore, the table and graph including Augusta is not a three-year average.

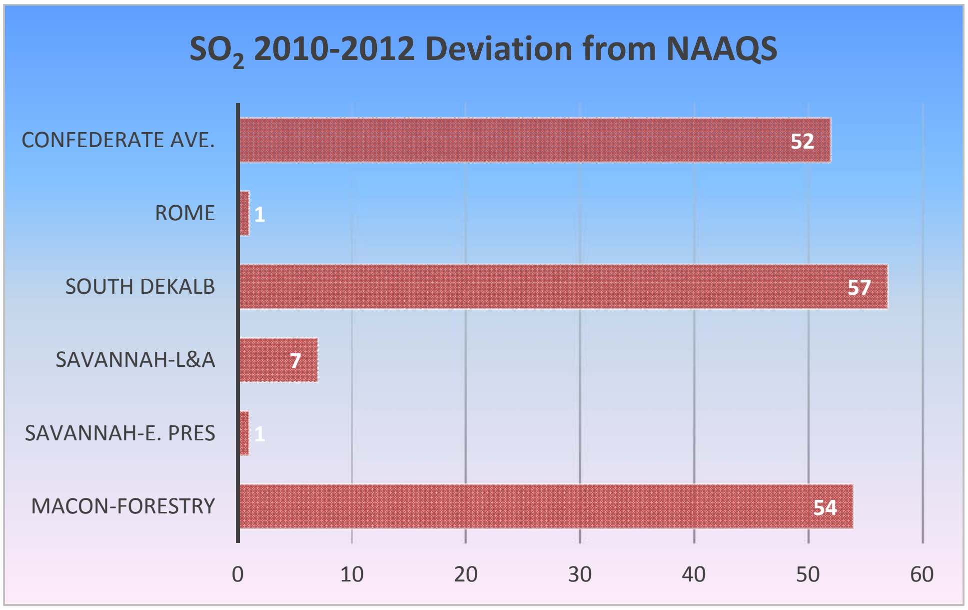
Table 9.4: Sulfur Dioxide and Ranking

SO_2 99th Percentile of daily 1-hr maxes, 75 ppb	Deviation from the NAAQS									
Site	**2009-2011**	**Absolute Value from NAAQS**	**Rank**	**2010-2012**	**Absolute Value from NAAQS**	**Rank**	**2011-2013**	**Absolute Value from NAAQS**	**Rank**	**Total Rank**
Macon-Forestry	24	51	**0.0**	21	54	**0.0**	17	58	**0.0**	**0.0**
Savannah-E Pres.	68	7	**0.5**	74	1	**0.5**	66	9	**0.5**	**1.5**
Savannah-L&A	65	10	**0.5**	68	7	**0.5**	79	4	**0.5**	**1.5**
South DeKalb*	21	54	**0.0**	18	57	**0.0**	12	63	**0.0**	**0.0**
Rome	62	13	**0.0**	74	1	**0.5**	67	8	**0.5**	**1.0**
Confederate Ave.	30	45	**0.0**	23	52	**0.0**	14	61	**0.0**	**0.0**
Augusta+							63	12	**0.0**	**0.0**

*started 2010
+started 2013

The Savannah-L&A and Savannah-E Pres sulfur dioxide sites would rank the highest in this analysis, with a ranking of 1.5. The Rome site would have the second highest ranking of 1.0. Even though the Augusta site has only collected one year of SO_2 data as of this analysis, it should be noted that the 2013 value was 63 ppb, right at the threshold of 85% of the standard (64 ppb). The remaining three sites in the Macon and Atlanta areas rank as the least important with 0.0 with this type of analysis. The following graphs display the amount of deviation from the standard of 75 ppb, with the absolute value of the 99th percentile of the 1-hour daily maximum concentrations, averaged for three years, as shown in the above table. Again, the '0' in these graphs represent the 75 ppb standard. Until the 2011-2013 average, most of the concentrations have been well below the standard.





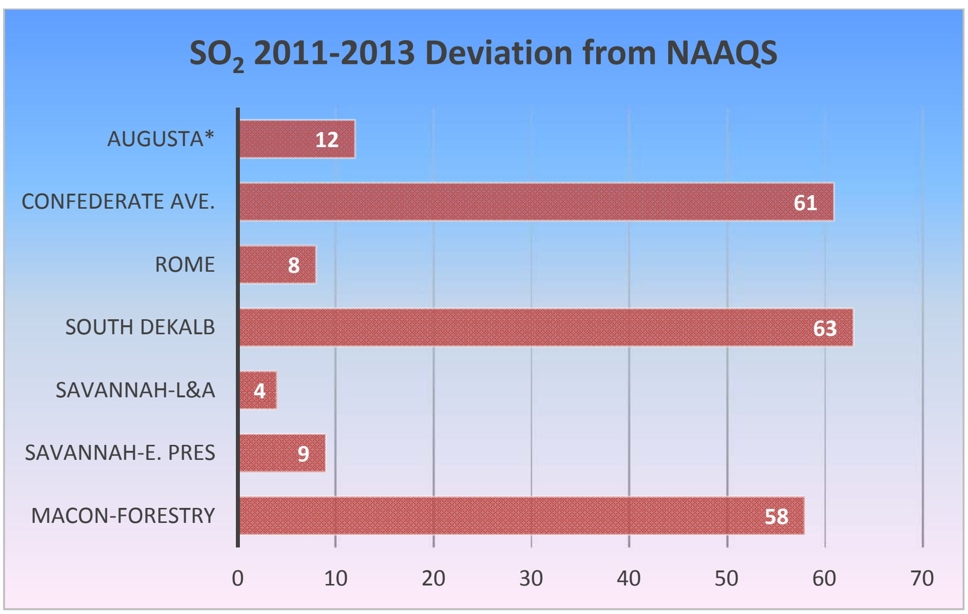


Figure 9.4: Sulfur Dioxide Deviation from the NAAQS (Absolute Value)

9.5 Lead

For the criteria lead, the NAAQS is 0.15 µg/m^3 maximum, for a rolling three-month average, for a three-year period. GA EPD has four sites that collect criteria lead data. One location is in DeKalb County, at the DMRC site, and three samplers are located in Muscogee County, at the UPS, Fort Benning and Cusseta Elementary sites in Columbus. The following table displays the maximum quarterly averages for all the sites from 2009 to 2013. The ranking system for lead is similar to the system used for the $PM_{2.5}$ Annual standard (above). A range of 0.1500 to 0.1599 µg/m^3 was ranked with a 1.0. The ±85% threshold of 0.1275 up to 0.1499 was ranked 0.5, and 0.1600 to 0.1725 µg/m^3 would be ranked 0.5. Values outside of 0.1274 µg/m^3 and 0.1726 µg/m^3 would have a rank of 0.0.

Table 9.5: Lead Values and Ranking

Lead 1st Max, 3-month rolling avg, 0.15 µg/m^3	**Deviation from the NAAQS**															
Site	**2009**	**Absolute Value from NAAQS**	**Rank**	**2010**	**Absolute Value from NAAQS**	**Rank**	**2011**	**Absolute Value from NAAQS**	**Rank**	**2012**	**Absolute Value from NAAQS**	**Rank**	**2013**	**Absolute Value from NAAQS**	**Rank**	**Total Rank**
DMRC	0.0029	0.1471	**0.0**	0.0040	0.1460	**0.0**	0.0039	0.1461	**0.0**	0.0031	0.1469	**0.0**	0.0027	0.1473	**0.0**	**0.0**
Columbus-UPS										0.2300	0.0800	**0.5**	0.0594	0.0906	**0.0**	**0.5**
Columbus-Ft Benning										0.1704	0.0204	**0.5**	0.1222	0.0278	**0.5**	**1.0**
Columbus-Cusseta	0.0284	0.1216	**0.0**	0.0698	0.0802	**0.0**	0.0708	0.0792	**0.0**	0.0259	0.1241	**0.0**	0.0225	0.1275	**0.0**	**0.0**

The Columbus-Ft Benning lead site ranks the highest with this ranking system, with a 1.0. The second highest ranking site is the Columbus-UPS site, with 0.5. The DMRC and Columbus-Cusseta sites would both have a ranking of 0.0 with the binning method since they have concentrations outside the ±85% threshold of the standard of 0.15 µg/m^3 (0.1275 µg/m^3). The following graph displays the three-month averages since the lead data was collected and analyzed with this method in December 2009. This data is depicted differently than the above data, due to the three-month rolling average method. The averages are compared to the standard, shown with a red line, and the actual values are shown instead of absolute values. The green and orange lines are the Columbus-UPS and Columbus-Ft Benning sites, also showing how these sites had three-month averages above the standard in 2012.

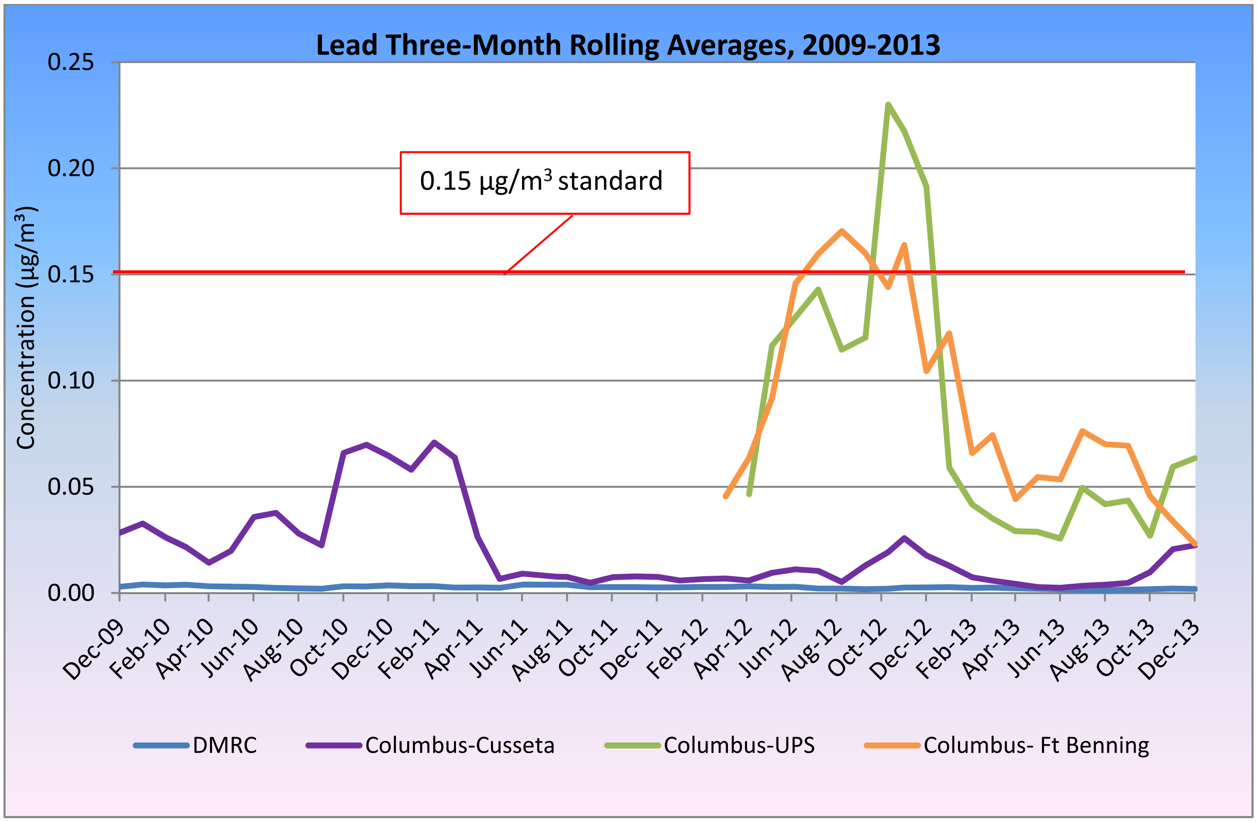


Figure 9.5: Lead Deviation from the NAAQS

9.6 PM_{10}

For PM_{10}, the NAAQS compares the highest 24-hour concentration to 150 µg/m^3. The standard of 150 µg/m^3 is not to be exceeded more than once per year on average over three years. For a comprehensive look at the data, five years of the highest maximum concentrations were examined. As of 2013, GA EPD operates three PM_{10} monitors, located at the South DeKalb, Fires Station #8, and Augusta sites. As can be seen in the following table and graph, Georgia's monitors do not come close to the standard of 150 µg/m^3. The same evaluation and ranking technique was used on the PM_{10} data, as was used with the ozone and $PM_{2.5}$ data explained above. All the PM_{10} sites have a rank of 0. Since all the data is significantly below the standard, this data is not shown as an absolute value, but the actual value as it compares to the standard (shown with red line).

Table 9.6: PM_{10} Values and Ranking

PM_{10} 1st Max, 150 µg/m^3	Deviation from the NAAQS										
Site	2009	Rank	2010	Rank	2011	Rank	2012	Rank	2013	Rank	Total Rank
South DeKalb					46	0	43	0	44	0	0
Fire Station #8									39	0	0
Augusta	46	0	43	0	46	0	36	0	37	0	0

The following graph displays the first maximum PM_{10} data shown in the table above for the three sites from 2009 to 2013. All three sites have yearly maximum concentrations at least 100 µg/m^3 below the standard.

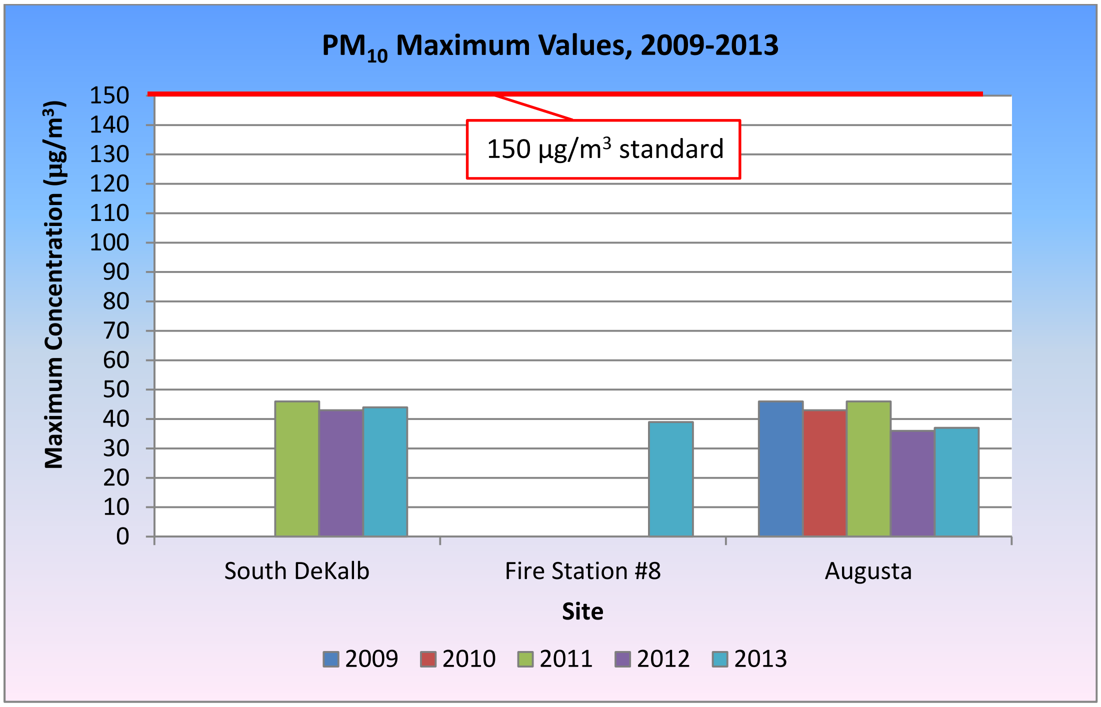


Figure 9.6: PM_{10} Deviation from the NAAQS

9.7 Nitrogen Dioxide

With the nitrogen dioxide (NO_2) samplers, there are two forms of the standard. One design value is calculated as a three-year average of the 98th percentile of daily one-hour maximums. The three-year standard is 100 ppb. The other design value is an annual average that is compared to 53 ppb. All three sites that were collecting data in 2013 had both design values well below this standard. The following tables and graphs display these values. Since all the data is significantly below the standard, this data is not shown as an absolute value, but the actual value as it compares to the standard (shown with red line).

Table 9.7.1: Nitrogen Dioxide 1-Hr Design Values and Ranking

NO_2 98th Percentile of daily 1-hr maxes, 100 ppb	Deviation from the NAAQS						
Site	**2009-2011**	**Rank**	**2010-2012**	**Rank**	**2011-2013**	**Rank**	**Total Rank**
South DeKalb	55	**0**	56	**0**	51	**0**	**0**
Yorkville	17	**0**	17	**0**	17	**0**	**0**
Conyers	20	**0**	20	**0**	19	**0**	**0**

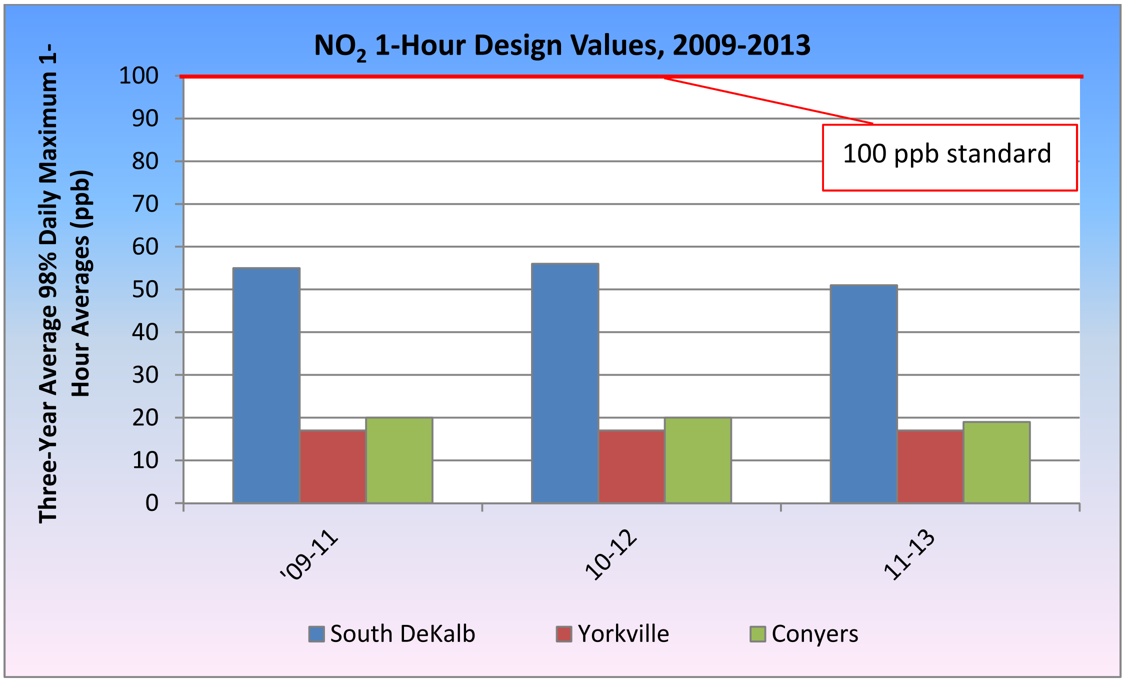


Figure 9.7.1: Nitrogen Dioxide Deviation from the NAAQS for 1-Hour Standard

The nitrogen dioxide sites would rank equally in this analysis. With the binning method, all sites would rank '0', with concentrations less than 85% of the standard of 53 ppb. The following table and graph display the annual averages and how those values compare to the standard, which is shown with a red line. Since all the data is significantly below the standard, this data is not shown as an absolute value, but the actual value as it compares to the standard (shown with red line).

Table 9.7.2: Nitrogen Dioxide Annual Design Values and Ranking

NO_2 Annual, 53 ppb	Deviation from the NAAQS										
Site	**2009**	**Rank**	**2010**	**Rank**	**2011**	**Rank**	**2012**	**Rank**	**2013**	**Rank**	**Total Rank**
South DeKalb	10.66	**0**	13.66	**0**	13.43	**0**	11.54	**0**	9.33	**0**	**0**
Yorkville	2.47	**0**	2.64	**0**	2.8	**0**	2.76	**0**	2.37	**0**	**0**
Conyers	3.52	**0**	4	**0**	4	**0**	4.21	**0**	4.19	**0**	**0**

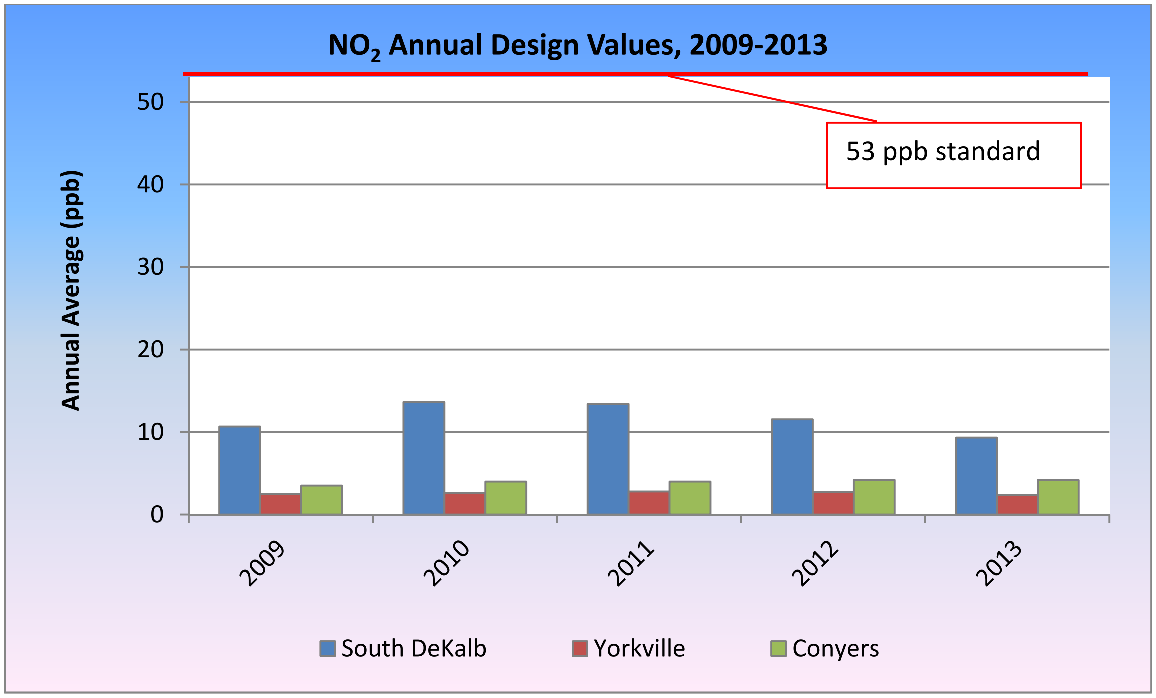


Figure 9.7.2: Nitrogen Dioxide Deviation from the NAAQS for Annual Standard

9.8 Carbon Monoxide

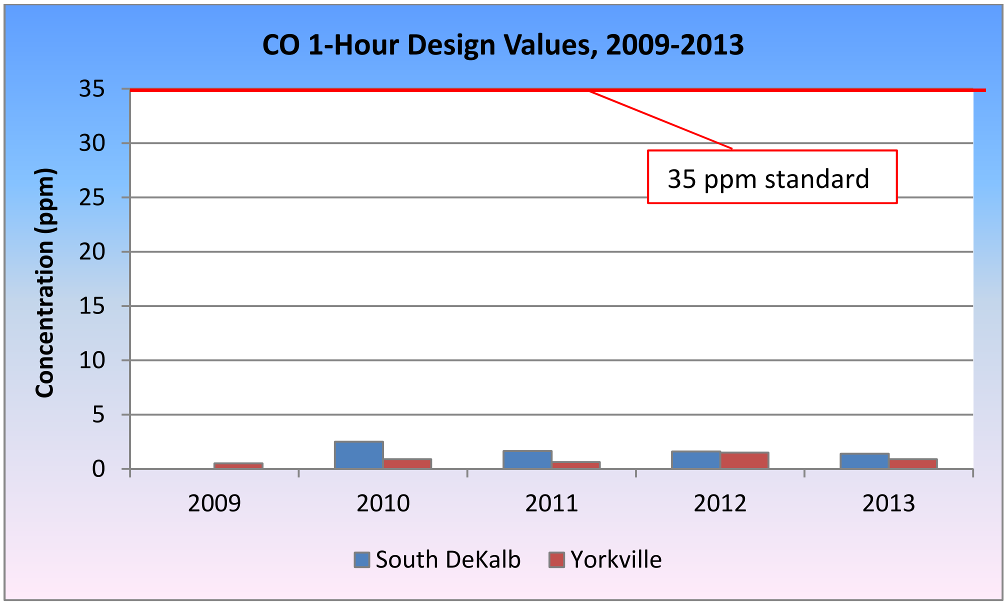
For the carbon monoxide (CO) data analysis, both sites that were sampling carbon monoxide data through 2013 were examined. The two sites collecting carbon monoxide data are the South DeKalb site in DeKalb County, and the Yorkville site in Paulding County. The carbon monoxide data collected for several years has been consistently below the standard. The following tables display the first maximum values for the 1-hour and 8-hour readings for 2009 through 2013. Eighty-five percent of the 1-hr standard is 29.75 ppm, and 85% of the 8-hour standard is 7.65 ppm. Since all the data is significantly below the standard, this data is not shown as an absolute value, but the actual value as it compares to the standard (shown with red line in graph below).

Table 9.8: Carbon Monoxide Values and Rankings

CO 1-hour, 35 ppm	Deviation from the NAAQS										
Site	2009	Rank	2010	Rank	2011	Rank	2012	Rank	2013	Rank	Total Rank
South DeKalb			2.514	0	1.649	0	1.613	0	1.407	0	0
Yorkville	0.512	0	0.903	0	0.634	0	1.500	0	0.900	0	0

CO 8-hour, 9 ppm	Deviation from the NAAQS										
Site	2009	Rank	2010	Rank	2011	Rank	2012	Rank	2013	Rank	Total Rank
South DeKalb		0	2.1	0	1.5	0	1.4	0	1.2	0	0
Yorkville	0.5	0	0.5	0	0.6	0	0.7	0	0.7	0	0

The carbon monoxide sites would rank equally in this analysis. With the binning method, all sites would rank '0' since they have concentrations less than 85% of the standard of 35 ppm for the 1-hour and 9 ppm for the 8-hour. The following graphs display the highest 1-hour and 8-hour averages that are shown in the above table and how those values compare to the standard, which is shown with a red line.



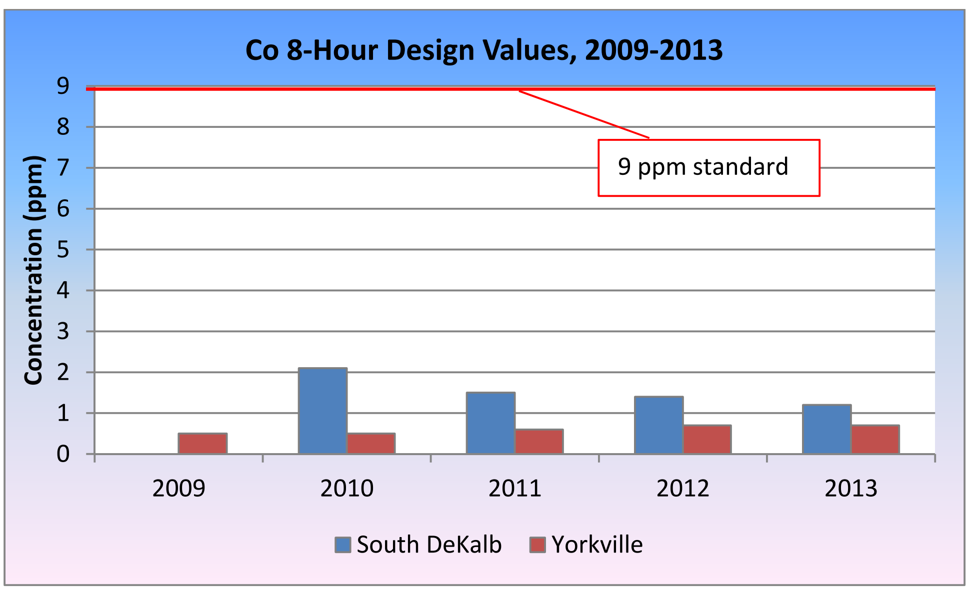


Figure 9.8: Carbon Monoxide Deviation from the NAAQS

For carbon monoxide, both the South DeKalb and Yorkville sites have averages significantly lower than the standards. With the Yorkville site in a rural area, it is expected that the average would be lower than the South DeKalb site, which is located in an urban area.

9.9 Concluding Points

Table 9.9: Summary Table Showing Total Rank for Each Site

	$PM_{2.5}$ Annual	$PM_{2.5}$ 24-Hour	Ozone	SO_2	Lead	PM_{10}	NO_2 1-hour	NO_2 Annual	CO 1-hour	CO 8-hour	Total Rank
South DeKalb	1.5	0	2	0		0	0	0	0	0	3.5
Gwinnett	1.5	0	2								3.5
Augusta	2	0	1.5	0		0					3.5
Savannah-E Pres St			1.5	1.5							3
Athens	1.5	0	1.5								3
Rome	2	0		1							3
Columbus-Airport	1.5	0	1.5								3
Kennesaw	1.5	0	1.5								3
Macon-Forestry	1	0	1.5	0							2.5
Forest Park	2.5	0									2.5
Albany	2	0.5									2.5
Columbus-Health Dept	2.5	0									2.5
Yorkville	1	0	1.5				0	0	0	0	2.5
Savannah-Mercer	1.5	0.5									2
Gordon	2	0									2
Douglasville			2								2
Confederate Ave			2	0							2
McDonough			2								2
Conyers			2				0	0			2
Macon-Allied	1.5	0									1.5
Savannah-L&A				1.5							1.5
Summerville			1.5								1.5
Fire Station #8	1.5	0				0					1.5
Valdosta	1.5	0									1.5
Columbus-Cusseta	1.5	0			0						1.5
Sandersville	1.5	0									1.5
Evans			1.5								1.5
Dawsonville			1.5								1.5
Fort Mountain			1.5								1.5
Gainesville	1	0									1
Newnan			1								1
Leslie			1								1
Columbus-Ft Benning					1						1
Brunswick	0.5	0	0								0.5
Warner Robins	0.5	0									0.5
Rossville	0.5	0									0.5
Columbus-UPS					0.5						0.5
DMRC					0						0

With the Deviation from the NAAQS assessment, the pollutants that have averages at the NAAQS levels have the highest rankings. Therefore, the sites that monitor ozone, $PM_{2.5}$, SO_2, and lead show the most value. Although sites that monitor PM_{10}, CO and NO_2 are required by EPA, these sites would have less value when comparing to the NAAQS to determine compliance. Therefore, those sites with concentrations far below the NAAQS for several years could be recommended for elimination. Table 9.9 sums the ranks of each pollutant monitored for each site. The South DeKalb, Gwinnett, and Augusta sites have the highest total rank while the DMRC site has the lowest rank. According to this analysis, the DMRC lead site could be recommended for elimination as it has had concentrations consistently below the NAAQS for several years (2009-2013).

10.0 Number of Parameters Monitored: Procedure

For the Number of Parameters Monitored Assessment type, the sites with more parameters are considered more valuable and rank higher than sites with fewer parameters. The term parameter refers to sampler in this assessment. The number of parameters measured at each site were explored and displayed a few different ways to analyze the sites. First, the percent of GA EPD's network with the same number of parameters is shown. Then the number of sites with the same number of parameters is examined. Finally, each site is listed with the number of parameters monitored at that site. Following the graphs is a table showing the rankings of each site. The sites were ranked with a proportionate ranking, with the site with the most parameters ranking the highest. A limitation to this assessment method is that it does not "weight" the parameters, and some pollutant measurements may be more useful than others. Also, samplers such as VOC monitors, which give an array of specimens, were viewed as one parameter in this analysis. All collocated monitors were counted as an individual parameter, separate from the primary monitor.

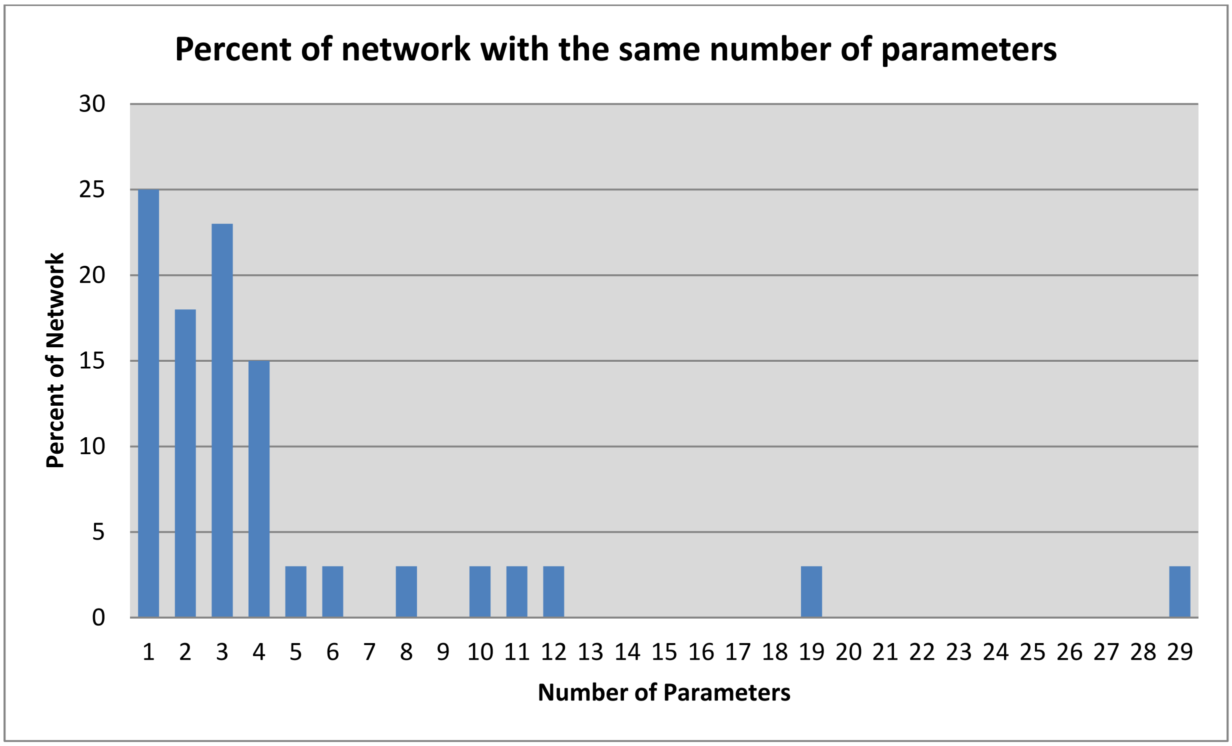


Figure 10.1: Percent of Network with Same Number of Parameters

From a percentage standpoint, the majority of Georgia's ambient air monitoring network monitors for less than three parameters. Twenty-five percent of the ambient air monitoring sites monitor for one parameter. Two parameters are measured by eighteen percent of the monitoring network's sites. Twenty-three percent of the network's sites measure three parameters. To create more efficiency within the ambient air monitoring network, with this assessment, it would be recommended to combine sites or eliminate sites that monitor only one parameter. Sites that monitor for several parameters are more valuable for air quality analyses, creating models, and evaluating emissions. In addition, sites with several parameters are more cost-efficient.

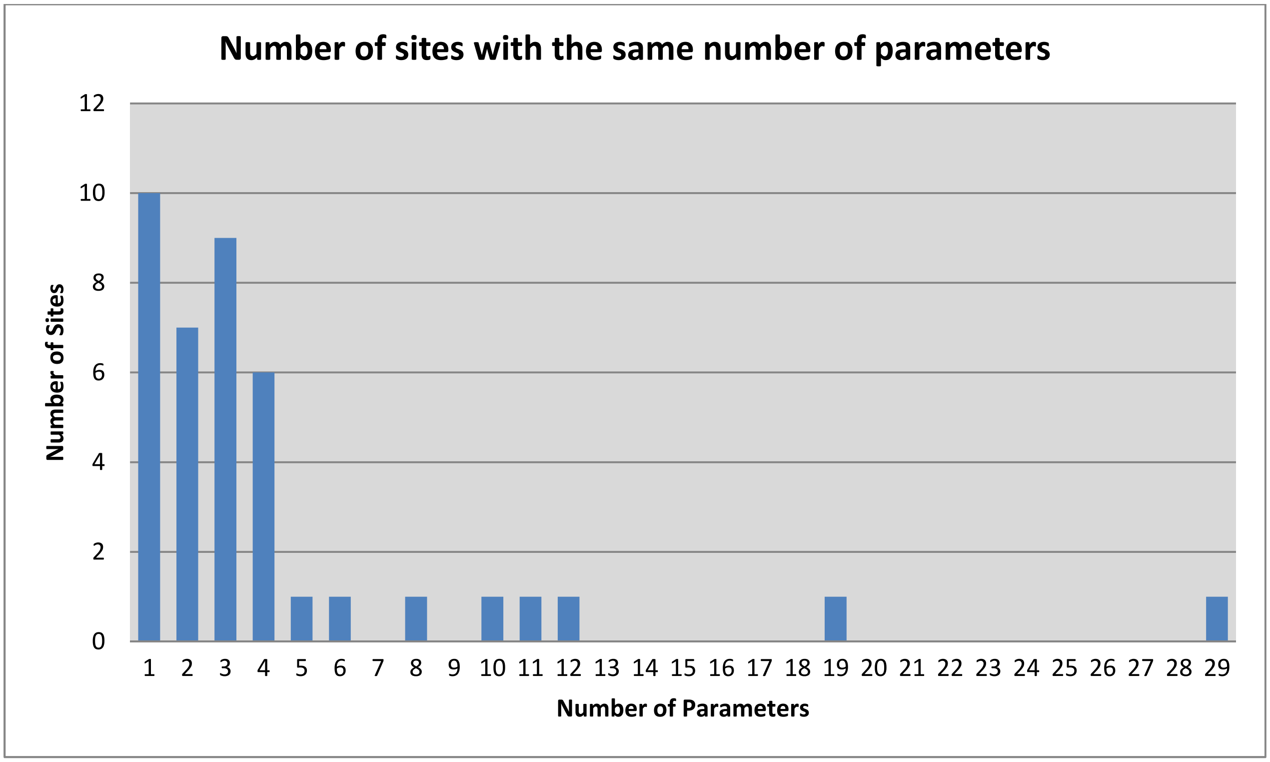


Figure 10.2: Number of Sites with the Same Number of Parameters

The above graph shows the same information as shown in Figure 10.1, however the information is shown differently. To give a different perspective, the actual number of sites and how many parameters are measured at each site is shown, as opposed to the percentage of the network. There are ten sites that monitor only one parameter. There are seven sites that monitor two parameters. Nine sites monitor three parameters. There is one site that measures twenty-nine parameters. The following graph shows each site and how many parameters are measured at that site.

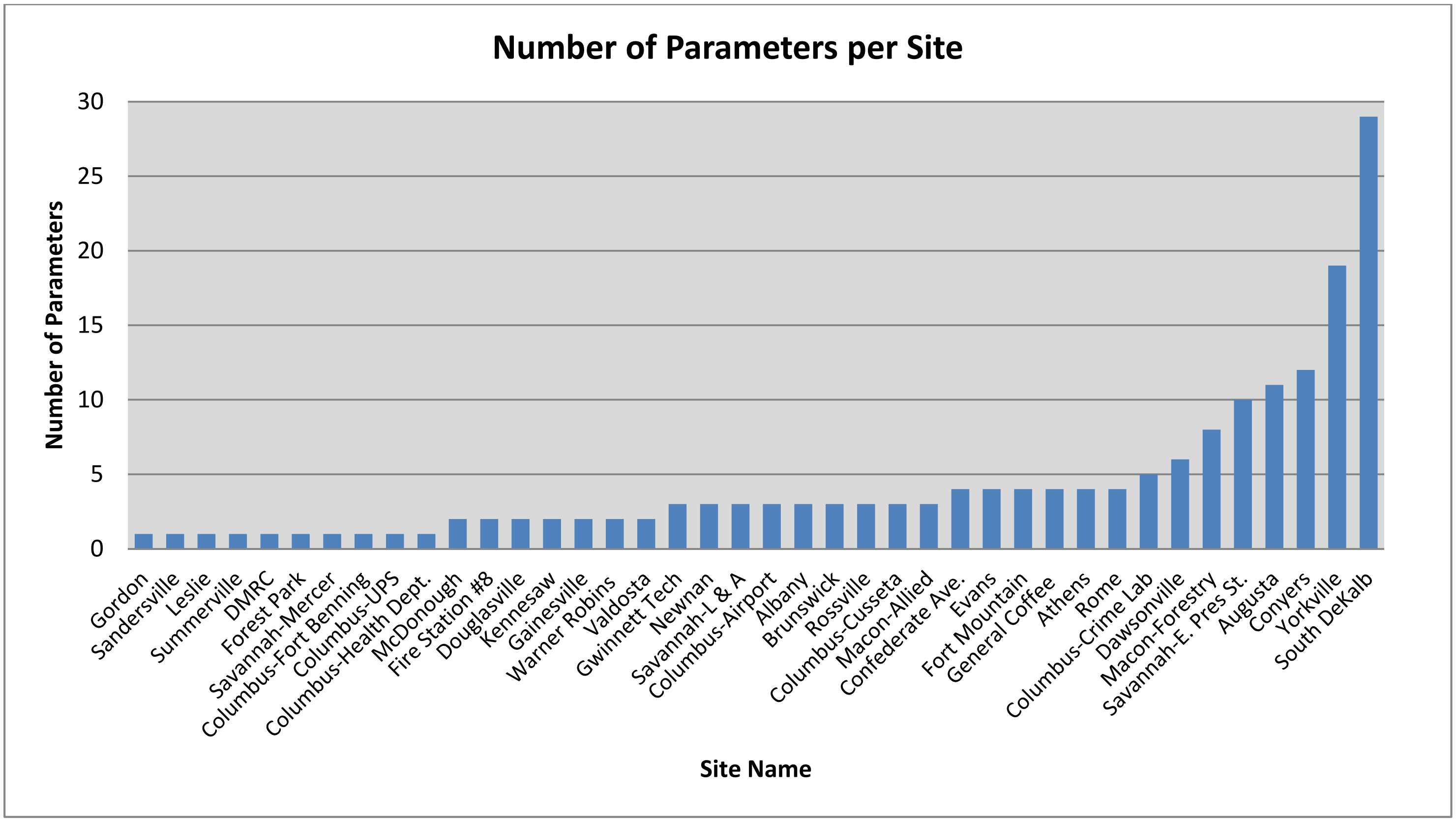


Figure 10.3: Number of Parameters per Site

The above figure is a view of the actual number of parameters monitored at each air monitoring site in the entire state of Georgia. The top ranking sites are the South DeKalb, Yorkville, and Conyers sites. The South DeKalb site monitors 29 parameters. The Yorkville site measures 19 parameters. The Conyers site measures 12 parameters. In addition, the number of parameters monitored at the Augusta, Savannah-E. President Street, Macon-Forestry, Dawsonville and Columbus-Crime Lab sites range from 11 to 5 parameters. All of the other 32 sites monitor four or less parameters. The above information is shown in the following table with the appropriate ranking.

Site	Number of Parameters	Proportionate Ranking		Site	Number of Parameters	Proportionate Ranking
South DeKalb	29	1.00		Savannah-L & A	3	0.07
Yorkville	19	0.64		Newnan	3	0.07
Conyers	12	0.39		Gwinnett	3	0.07
Augusta	11	0.36		Valdosta	2	0.04
Savannah-E. President	10	0.32		Warner Robins	2	0.04
Macon-Forestry	8	0.25		Gainesville	2	0.04
Dawsonville	6	0.18		Kennesaw	2	0.04
Columbus-Crime Lab	5	0.14		Douglasville	2	0.04
Rome	4	0.11		Fire Station #8	2	0.04
Athens	4	0.11		McDonough	2	0.04
General Coffee	4	0.11		Columbus-Health Dept.	1	0.00
Fort Mountain	4	0.11		Columbus-UPS	1	0.00
Evans	4	0.11		Columbus-Fort Benning	1	0.00
Confederate Ave.	4	0.11		Savannah-Mercer	1	0.00
Macon-Allied	3	0.07		Forest Park	1	0.00
Columbus-Cusseta	3	0.07		DMRC	1	0.00
Rossville	3	0.07		Summerville	1	0.00
Brunswick	3	0.07		Leslie	1	0.00
Albany	3	0.07		Sandersville.	1	0.00
Columbus-Airport	3	0.07		Gordon	1	0.00

Table 10.1: Number of Parameters Monitored per Site and Rankings

10.1 Concluding Points

With the Number of Parameters Monitored assessment, each site was examined and ranked according to how many parameters were monitored at that site as shown in Table 10.1. A large portion of sites across the state of Georgia monitor fewer than four parameters per site. One reason to peform the Number of Parameters Monitored type of assessment is to consider which sites are more cost-effective. The sites that would be most cost-effective would be the sites with the highest number of parameters monitored. These sites would include the South DeKalb, Yorkville, Conyers, and Augusta sites. In addition, sites with more parameters monitored can aide in analyzing the data for sources, modeling of the data, and emission inventory. The sites with the least amount of parameters monitored would have the lowest ranking. This list of sites would include the ten sites that monitor only one parameter. This could be an opportunity to add more parameters to those sites or combine sites to increase the data set at one site. In addition, this could be an opportunity to eliminate single parameter sites to improve cost effectiveness.

11.0 Monitor-to- Monitor Correlations: Procedure

The Monitor-to-Monitor Correlations assessment type compares concentrations of one type of monitor to concentrations of another monitor of the same type. In this analysis, $PM_{2.5}$ and ozone were used for the comparisons. Samplers were compared within each Metropolitan Statistical Areas (MSA) that had more than one $PM_{2.5}$ or ozone monitor. The Pearson correlation coefficient (r^2) was used to determine the correlation between each monitoring pair. The Environmental Protection Agency has determined that an r^2 >0.75 suggests redundancy. The site pairs were ranked according to their r^2 values, with sites that had a higher correlation (r^2) being considered redundant.

11.1 $PM_{2.5}$

The relationship between paired sites within their respective MSA was analyzed with regression correlations. Only integrated $PM_{2.5}$ sites which are used for comparison to NAAQS were included in this analysis. These sites collect data on daily, 3-day, and 6-day schedules; therefore, the use of a weekly average was used for comparison.

A weekly average was calculated for each sampler from the years 2009 through 2013 and was used to calculate the average weekly $PM_{2.5}$ concentration for all years for each site. The r^2 between each paired site was then calculated and a rank assigned according to the r^2 value. Site pairs with an r^2 value >0.75 were given a 0, sites pairs with an r^2 value of 0.45 to 0.74 were given a 0.5, and site pairs with an r^2 value <0.44 were ranked with a 1. The distances between sites were calculated in Excel using latitude and longitude coordinates.

Tables 11.1 through 11.3 show site pairs for each MSA, the distance between the sites, the r^2 value and the rank. Figures 11.1, 11.3, and 11.5 show the $PM_{2.5}$ correlation matrix for each MSA. Figures 11.2 and 11.4 plot the r^2 and distance between for each site pair for each MSA (with greater than two sites).

Table 11.1 displays the Atlanta MSA. The South DeKalb-Kennesaw pair shows the highest correlation (r^2=0.92) and was given a rank of 0. This indicates that this pair of monitors collects similar data and one could be eliminated, according to this assessment. Figure 11.1 gives a visual representation of the r^2 values in Table 11.1. Figure 11.2 plots the r^2 versus distance between each site pair. The red line indicates the 0.75 r^2 value.

Atlanta Metropolitan Statistical Area ($PM_{2.5}$)						
Site ID	Common Name	Site ID	Common Name	Distance (miles)	R-Squared	Rank
130890002	South DeKalb	131210039	Fire Station #8	12	0.7	0.5
131210039	Fire Station #8	130670003	Kennesaw	18	0.73	0.5
131210039	Fire Station #8	131350002	Gwinnett	24	0.68	0.5
131210039	Fire Station #8	132230003	Yorkville	36	0.67	0.5
131210039	Fire Station #8	130630091	Forest Park	14	0.71	0.5
130630091	Forest Park	130670003	Kennesaw	31	0.74	0.5
131350002	Gwinnett	132230003	Yorkville	56	0.79	0
131350002	Gwinnett	130630091	Forest Park	31	0.78	0
131350002	Gwinnett	130670003	Kennesaw	31	0.77	0

132230003	Yorkville	130630091	Forest Park	44	0.82	0
132230003	Yorkville	130670003	Kennesaw	26	0.81	0
130890002	South DeKalb	131350002	Gwinnett	23	0.78	0
130890002	South DeKalb	132230003	Yorkville	46	0.8	0
130890002	South DeKalb	130630091	Forest Park	8	0.77	0
130890002	South DeKalb	130670003	Kennesaw	29	0.92	0

Table 11.1: Atlanta MSA $PM_{2.5}$ Correlations and Rankings

	South DeKalb	Fire Station #8	Gwinnett	Yorkville	Forest Park	Kennesaw
South DeKalb	1.00					
Fire Station #8	0.70	1.00				
Gwinnett	0.78	0.68	1.00			
Yorkville	0.80	0.67	0.79	1.00		
Forest Park	0.77	0.71	0.78	0.82	1.00	
Kennesaw	0.92	0.73	0.77	0.81	0.74	1.00

Figure 11.1 Correlation Matrix of Atlanta MSA $PM_{2.5}$

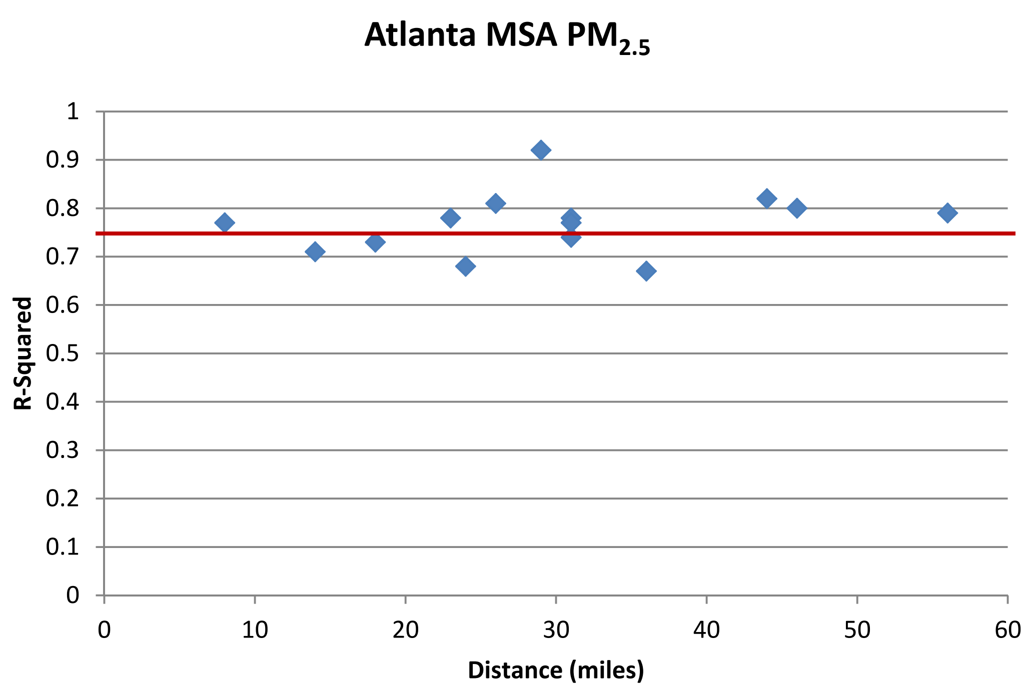


Figure 11.2: Atlanta MSA $PM_{2.5}$ Correlations

In Table 11.2, the r^2 values for and distances between the $PM_{2.5}$ monitoring pairs in the Columbus MSA are shown. All monitoring pairs have an r^2 of 0.64 or less, indicating low correlation between sites in this MSA. Figure 11.3 gives a visual representation of the r^2 values from Table 11.2. Figure 11.4 plots the r^2 versus the distances between each monitoring pair. The red line indicates the 0.75 r^2 value.

Columbus Metropolitan Statistical Area $PM_{2.5}$						
Site ID	Common Name	Site ID	Common Name	Distance (miles)	R-Squared	Rank
132150001	Columbus-Health Dept.	011130001	Alabama	2	0.33	1
132150001	Columbus-Health Dept.	132150008	Columbus-Airport	3	0.45	0.5
132150001	Columbus-Health Dept.	132150011	Columbus-Cussetta	5	0.52	0.5
132150008	Columbus-Airport	132150011	Columbus-Cussetta	6	0.64	0.5
132150008	Columbus-Airport	011130001	Alabama	5	0.59	0.5
132150011	Columbus-Cussetta	011130001	Alabama	5	0.54	0.5

Table 11.2: Columbus MSA $PM_{2.5}$ Correlations and Rankings

	Columbus-Health Dept.	Columbus-Airport	Columbus-Cussetta	Alabama
Columbus-Health Dept.	1.00			
Columbus-Airport	0.45	1.00		
Columbus-Cussetta	0.52	0.64	1.00	
Alabama	0.33	0.59	0.54	1.00

Figure 11.3: Columbus MSA $PM_{2.5}$ Correlation Matrix

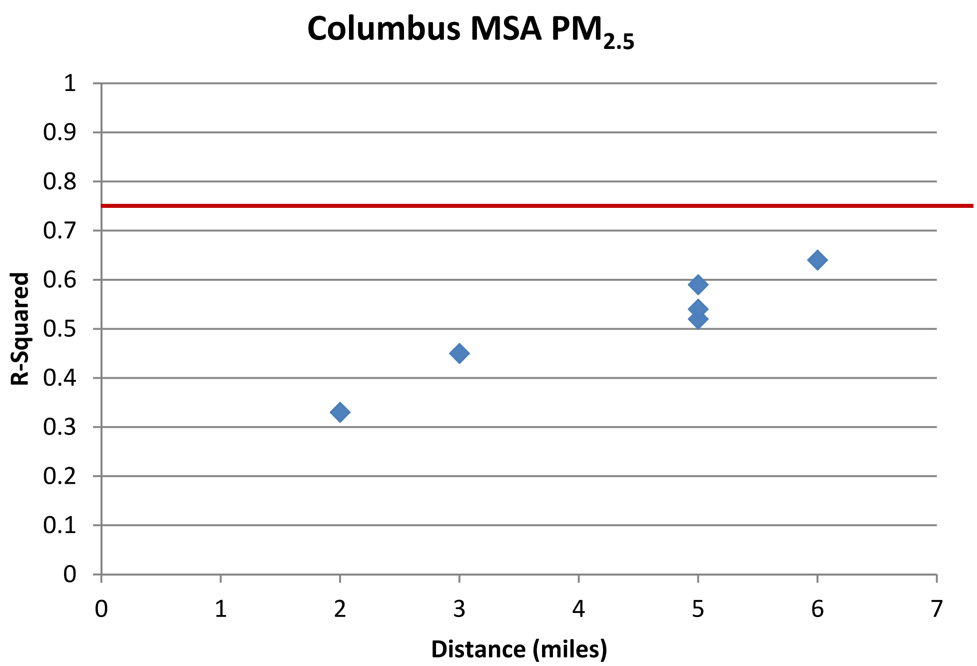


Figure 11.4: Columbus MSA $PM_{2.5}$ Correlations

Table 11.3 shows the r^2 values for the $PM_{2.5}$ samplers in the Macon MSA. The r^2 between these two monitors is 0.84 with a rank of 0. Figure 11.5 displays the correlation matrix for Macon-Forestry and Macon-Allied.

Macon Metropolitan Statistical Area $PM_{2.5}$						
Site ID	Common Name	Site ID	Common Name	Distance (miles)	R-Squared	Rank
130210012	Macon-Forestry	130210007	Macon-Allied	6	0.84	0

Table 11.3: Macon MSA $PM_{2.5}$ Correlations and Rankings

	Macon-Allied	Macon-Forestry
Macon-Allied	1.00	
Macon-Forestry	0.84	1.00

Figure 11.5: Columbus MSA $PM_{2.5}$ Correlation Matrix

From the above tables and figures, it is easy to glean an overall postulation of the sites that collect similar $PM_{2.5}$ data or data that are closely related in the Atlanta, Columbus, and Macon MSAs. Monitors with similar data (an r^2 value of 0.75 or above) may be considered redundant.

There are some sites in the Atlanta and Macon MSAs with high r^2 values meaning those sites are collecting data that is closely related. Therefore, based on this single analysis there may be justification to eliminate monitors in the $PM_{2.5}$ network based on the monitor-to-monitor correlation.

11.2 Ozone

Correlations between paired ozone sites were calculated using hourly data from 2009 through 2013. The average hourly ozone concentrations were calculated for each year for each site, and then an average of all years was calculated for each site. Sites were paired within each MSA, r^2 values were calculated for each pair, and a rank assigned according to the r^2 value.

Tables 11.4 through 11.6 show site pairs for each MSA, the distance between the sites, the r^2 value and the rank. Figures 11.6, 11.8, and 11.9 show the ozone correlation matrix for each MSA. Figure 11.7 plots the r^2 and distance between for each site pair for the Atlanta MSA (the only MSA with more than two ozone sites).

Table 11.4 displays the Atlanta MSA. Ozone site pairs with an r^2 >0.94 were given a rank of 0, r^2 between 0.88 and 0.94 were given a rank of 0.5 and an r^2 <0.88 was given a rank of 1. The South DeKalb/Confederate Ave. and South DeKalb/Conyers pairs show the highest correlations (r^2=0.97) and were given a rank of 0. This indicates that this pair of monitors collects similar data and one could be eliminated, according to this assessment. Figure 11.3 gives a visual representation of the data from Table 11.4. The red line indicates the 0.75 r^2 value.

Atlanta Metropolitan Statistical Area (O_3)						
Site ID	Common Name	Site ID	Common Name	Distance (miles)	R-Squared	Rank
130670003	Kennesaw	130850001	Dawsonville	40	0.86	1
130770002	Newnan	130850001	Dawsonville	78	0.87	1
130850001	Dawsonville	130890002	South DeKalb	49	0.86	1
130850001	Dawsonville	130970004	Douglasville	60	0.87	1
130850001	Dawsonville	131210055	Confederate Ave	48	0.87	1
130850001	Dawsonville	131350002	Gwinnett	29	0.85	1
130850001	Dawsonville	131510002	McDonough	65	0.85	1
130890002	South DeKalb	130970004	Douglasville	28	0.86	1
130890002	South DeKalb	132230003	Yorkville	46	0.87	1
130970004	Douglasville	131350002	Gwinnett	43	0.85	1
130970004	Douglasville	131510002	McDonough	42	0.86	1
131350002	Gwinnett	132230003	Yorkville	56	0.86	1
131510002	McDonough	132230003	Yorkville	61	0.87	1
130670003	Kennesaw	130770002	Newnan	43	0.93	0.5
130670003	Kennesaw	130890002	South DeKalb	29	0.94	0.5
130670003	Kennesaw	130970004	Douglasville	21	0.90	0.5
130670003	Kennesaw	131350002	Gwinnett	31	0.94	0.5

130670003	Kennesaw	131510002	McDonough	48	0.94	0.5
130670003	Kennesaw	132230003	Yorkville	26	0.88	0.5
130670003	Kennesaw	132470001	Conyers	43	0.93	0.5
130770002	Newnan	130890002	South DeKalb	33	0.93	0.5
130770002	Newnan	130970004	Douglasville	24	0.89	0.5
130770002	Newnan	131210055	Confederate Ave	31	0.94	0.5
130770002	Newnan	131350002	Gwinnett	55	0.92	0.5
130770002	Newnan	131510002	McDonough	34	0.94	0.5
130770002	Newnan	132230003	Yorkville	40	0.89	0.5
130770002	Newnan	132470001	Conyers	41	0.94	0.5
130850001	Dawsonville	132230003	Yorkville	64	0.89	0.5
130850001	Dawsonville	132470001	Conyers	54	0.89	0.5
130970004	Douglasville	131210055	Confederate Ave	24	0.89	0.5
130970004	Douglasville	132230003	Yorkville	20	0.92	0.5
130970004	Douglasville	132470001	Conyers	42	0.87	0.5
131210055	Confederate Ave	132230003	Yorkville	42	0.88	0.5
132230003	Yorkville	132470001	Conyers	61	0.88	0.5
130670003	Kennesaw	131210055	Confederate Ave	25	0.96	0
130890002	South DeKalb	131210055	Confederate Ave	4	0.97	0
130890002	South DeKalb	131350002	Gwinnett	23	0.96	0
130890002	South DeKalb	131510002	McDonough	19	0.96	0
130890002	South DeKalb	132470001	Conyers	15	0.97	0
131210055	Confederate Ave	131350002	Gwinnett	23	0.96	0
131210055	Confederate Ave	131510002	McDonough	23	0.96	0
131210055	Confederate Ave	132470001	Conyers	19	0.95	0
131350002	Gwinnett	131510002	McDonough	37	0.95	0
131350002	Gwinnett	132470001	Conyers	26	0.95	0
131510002	McDonough	132470001	Conyers	12	0.96	0

Table 11.4: Atlanta Ozone Correlations and Rankings

The following graph plots the r^2 versus distance for the Atlanta MSA monitor pairs. The red line indicates the 0.75 r^2 value.

	Kennesaw	Newnan	Dawsonville	South DeKalb	Douglasville	Confederate Ave	Gwinnett	McDonough	Yorkville	Conyers
Kennesaw	1.00									
Newnan	0.93	1.00								
Dawsonville	0.86	0.87	1.00							
South DeKalb	0.94	0.93	0.86	1.00						
Douglasville	0.90	0.89	0.87	0.86	1.00					
Confederate Ave	0.96	0.94	0.87	0.97	0.89	1.00				
Gwinnett	0.94	0.92	0.85	0.96	0.85	0.96	1.00			
McDonough	0.94	0.94	0.85	0.96	0.86	0.96	0.95	1.00		
Yorkville	0.88	0.89	0.89	0.87	0.92	0.88	0.86	0.87	1.00	
Conyers	0.93	0.94	0.89	0.97	0.87	0.95	0.95	0.96	0.88	1.00

Figure 11.6: Atlanta MSA Ozone Correlation Matrix

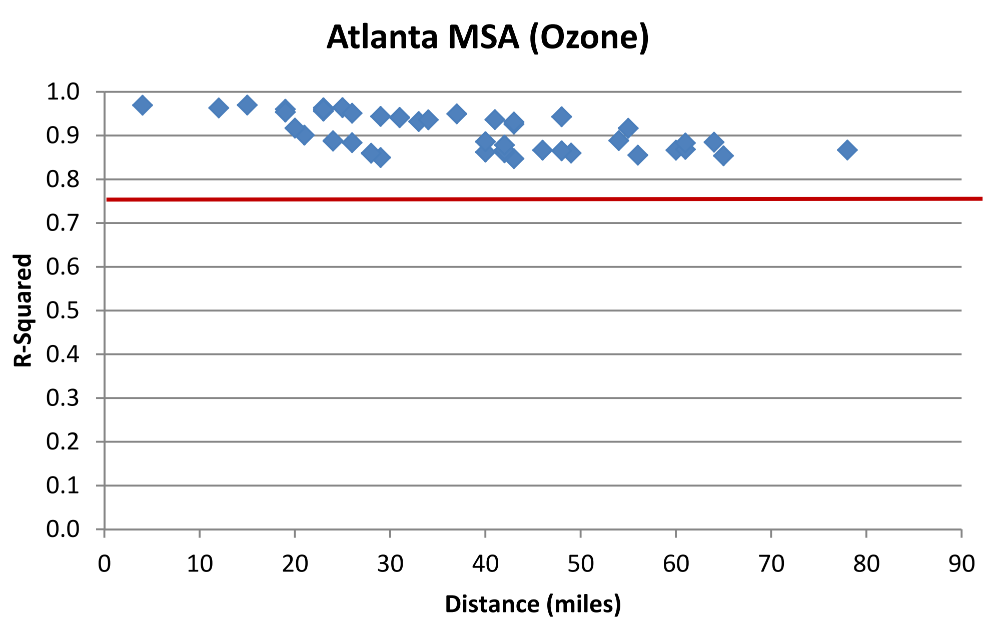


Figure 11.7: Atlanta MSA Ozone Correlations

In Table 11.5, the r^2 value for the ozone samplers in the Columbus MSA is shown. There is a high correlation between the Columbus-Airport site and the Alabama site (0.91) indicating that both of these samplers collect very similar data and one of these monitors could be eliminated according to this assessment.

Columbus Metropolitan Statistical Area (O_3)						
Site ID	Common Name	Site ID	Common Name	Distance (miles)	R-Squared	Rank
132150008	Columbus-Airport	11130002	Alabama	9	0.91	0.5

Table 11.5: Columbus MSA Ozone Correlations and Rankings

	Columbus-Airport	Alabama
Columbus-Airport	1.00	
Alabama	0.91	1.00

Figure 11.8: Columbus MSA Ozone Correlation Matrix

Table 11.6 shows the r^2 value for the ozone samplers in the Augusta MSA. There is a high correlation between the Evans and Augusta site (0.95) indicating that both of these samplers collect very similar and data and one of these monitors could be eliminated according to this assessment.

Augusta Metropolitan Statistical Area (O_3)						
Site ID	Common Name	Site ID	Common Name	Distance (miles)	R-Squared	Rank
130730001	Evans	132450091	Augusta	12	0.95	0

Table 11.6: Augusta Ozone Correlations and Rankings

	Evans	Augusta
Evans	1.00	
Augusta	0.95	1.00

Figure 11.9: Augusta MSA Ozone Correlation Matrix

From the tables and figures above, it is easy to glean an overall postulation of the sites that collect similar ozone data or data that are closely related in the Atlanta, Columbus, and Augusta MSAs. For the purpose of this report, the Environmental Protection Agency has placed the standard of 0.75 as the range at which an r-squared value suggests redundancy between the two sites being correlated. With this assessment, all of the sites with ozone monitors have higher r-square values, meaning that sites are collecting data that is closely related. Therefore, based on this single analysis there may be justification to eliminate monitors in the ozone network based on the monitor-to-monitor correlation.

11.3 Concluding Points

For the Monitor-to-Monitor Correlation assessment, all of the sites within each MSA that had at least two $PM_{2.5}$ or two ozone samplers were paired and a correlation coefficient (r^2) was calculated. Each site was ranked according to the r^2 value within each MSA. If a pair of sites has an r^2 value above 0.75, the data being collected may be redundant. Conversely, a pair of sites with a low r^2 value would suggest that the concentrations being monitored are unique and would have more value for spatial coverage including assessment of local emissions or transport. Figure 11.10 shows the sum of the $PM_{2.5}$ and Ozone ranks for each site. Dawsonville had the highest overall rank while Macon-Forestry, Macon-Allied, Evans, and Augusta had the lowest ranks, indicating that they are more highly correlated to nearby sites.

Site ID	Common Name	$PM_{2.5}$ Rank	Ozone Rank	Total Rank
130850001	Dawsonville		8	8
132230003	Yorkville	0.5	6	6.5
130970004	Douglasville		6.5	6.5
130890002	South DeKalb	2	4	6
130670003	Kennesaw	1	4.5	5.5
130770002	Newnan		5	5
131350002	Gwinnett	0.5	4	4.5
131510002	McDonough		4	4
131210055	Confederate Ave.		2.5	2.5
132470001	Conyers		2.5	2.5
131210039	Fire Station #8	2		2
132150001	Columbus-Health Dept.	2		2
132150008	Columbus-Airport	1.5	0.5	2
132150011	Columbus-Cussetta	1.5		1.5
130630091	Forest Park	1		1
130210012	Macon-Forestry	0		0
130210007	Macon-Allied	0		0
130730001	Evans		0	0
132450091	Augusta		0	0

Figure 11.10: Total of Ozone and $PM_{2.5}$ Ranks for each Site

12.0 Population Assessment

As part of the Five-Year Network Assessment, several aspects concerning the levels of population across the state need to be addressed. There are network requirements that should be met according to Appendix D of part 58 of the Federal Register published October 17, 2006. For ozone, $PM_{2.5}$, and PM_{10} networks, each metropolitan statistical area (MSA) above a certain population, and each monitor above a certain percentage of the NAAQS, should have a certain number of that type of monitor in each MSA. Another aspect to consider is change in population. The changes in population over time and shifts in population within an area need to be assessed to ensure that GA EPD is meeting population oriented requirements for monitoring ambient air. In addition, it is GA EPD's responsibility to evaluate if proposed or existing sites support air quality characterization in areas with high populations of susceptible individuals.

The following three-part table (Table 12.1) is taken from the Federal Register and shows the requirements for monitoring ozone, PM_{10}, and $PM_{2.5}$ according to population and comparison to the National Ambient Air Quality Standards (NAAQS).

Table D–2 of Appendix D to Part **58**— SLAMS Minimum O_3 Monitoring Requirements

MSA population[1,2]	**Most recent 3-year design value concentrations ≥85% of any O_3NAAQS**[3]	**Most recent 3-year design value concentrations <85% of any O_3NAAQS**[3,4]
>10 million	4	2
4–10 million	3	1
350,000–<4 million	2	1
50,000–<350,000[5]	1	0

[1]Minimum monitoring requirements apply to the Metropolitan statistical area (MSA).
[2]Population based on latest available census figures.
[3]The ozone (O_3) National Ambient Air Quality Standards (NAAQS) levels and forms are defined in 40 CFR part 50.
[4]These minimum monitoring requirements apply in the absence of a design value.
[5]Metropolitan statistical areas (MSA) must contain an urbanized area of 50,000 or more population.

Table D–4 of Appendix D to Part **58**—PM_{10}Minimum Monitoring Requirements (Approximate Number of Stations Per MSA)[1]

Population category	**High concentration**[2]	**Medium concentration**[3]	**Low concentration**[4,5]
>1,000,000	6–10	4–8	2–4
500,000–1,000,000	4–8	2–4	1–2
250,000–500,000	3–4	1–2	0–1
100,000–250,000	1–2	0–1	0

[1]Selection of urban areas and actual numbers of stations per area will be jointly determined by EPA and the State agency.
[2]High concentration areas are those for which ambient PM10 data show ambient concentrations exceeding the PM_{10}NAAQS by 20 percent or more.
[3]Medium concentration areas are those for which ambient PM10 data show ambient concentrations exceeding 80 percent of the PM_{10}NAAQS.
[4]Low concentration areas are those for which ambient PM10 data show ambient concentrations less than 80 percent of the PM_{10}NAAQS.
[5]These minimum monitoring requirements apply in the absence of a design value.

Table D–5 of Appendix D to Part **58**—$PM_{2.5}$ Minimum Monitoring Requirements

MSA population[1,2]	**Most recent 3-year design value ≥85% of any $PM_{2.5}$ NAAQS[3]**	**Most recent 3-year design value <85% of any $PM_{2.5}$ NAAQS[3,4]**
>1,000,000	3	2
500,000–1,000,000	2	1
50,000–<500,000[5]	1	0

[1]Minimum monitoring requirements apply to the Metropolitan statistical area (MSA).
[2]Population based on latest available census figures.
[3]The $PM_{2.5}$ National Ambient Air Quality Standards (NAAQS) levels and forms are defined in 40 CFR part 50.
[4]These minimum monitoring requirements apply in the absence of a design value.
[5]Metropolitan statistical areas (MSA) must contain an urbanized area of 50,000 or more population.

Table 12.1: Tables D-2, D-4, and D-5 of Appendix D to Part 58

Table 12.2 below displays the requirements for O_3, $PM_{2.5}$, and PM_{10} and how they pertain to the state of Georgia. Each MSA in Georgia is outlined as are the locations where GA EPD has monitors that are not in an MSA. These areas are micropolitan statistical areas. Population based on the most current official 2010 census, estimated population for 2013 [from the US Census Bureau, American Community Survey five-year estimate (http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml)], percent change in population from 2000 to 2013, and ranks based on population change are shown. Sites were ranked proportionately and sites with the highest percent change in population were given the highest rank. The 2009-2011, 2010-2012, 2011-2013, and 2012-2014 design values for the ozone, $PM_{2.5}$, and PM_{10} monitors across the GA EPD network were calculated from data extracted from EPA's Air Quality System (AQS). The number of required ambient air monitors per MSA is labeled 'Req'. The column labeled 'Act' shows the number of monitors GA EPD has in place, as well as neighboring states that share an MSA. The percentage of the NAAQS that was used to compare to the actual design value is shown for each pollutant in each pollutant heading. Since $PM_{2.5}$ has a daily standard and an annual standard, both are shown in the table.

Network Requirements (from Appendix D, Part 58)

	Pop. (2000 Census)	Pop. (2010 Census)	Pop. (2013 Estimate)	Percent Change in Pop from 2000 to 2013(%)	Rank by Pop Change	O3 Table D-2 4th Max Average, 3yrs (ppm) 85%= 0.06375						PM2.5 Table D-5 98% Average, 3yrs (µg/m^3) 85%= 29.75						PM2.5 Table D-5 Annual Average, 3 yrs (µg/m^3) 85%= 10.20						PM10 Table D-4 1st Max, 3 yrs (µg/m^3) 80%= 120					
						2009-2011	**2010-2012**	**2011-2013**	**2012-2014**	**Req**	**Act**	**2009-2011**	**2010-2012**	**2011-2013**	**2012-2014**	**Req**	**Act**	**2009-2011**	**2010-2012**	**2011-2013**	**2012-2014**	**Req**	**Act**	**2009-2011**	**2010-2012**	**2011-2013**	**2012-2014**	**Req**	**Act**
Rome MSA	90,565	96,317	95,821	5.80	0.085					0	0	25	25	22	20	0	1	13.0	12.1	10.8	**10.3**	1	1					0	0
Brunswick MSA	93,044	112,370	113,807	22.32	0.328	0.061	0.061	0.058	0.057	0	1	25	23	20	18	0	1	9.7	11.2	8.2	8.1	0	1					0	0
Valdosta MSA	119,560	139,588	142,897	19.52	0.287					0	0	26	25	21	17	0	1	10.4	12.5	8.9	8.7	0	1					0	0
Warner Robins MSA	110,765	139,900	186,214	68.12	1.000					0	0	24	23	20	19	0	1	11.3	9.7	9.9	9.2	0	1					0	0
Dalton MSA	120,031	142,227	142,212	18.48	0.271	0.071	0.072	0.068	**0.066**	1	1					0	0					0	0					0	0
Albany MSA	157,833	157,308	155,694	-1.36	0.020					0	0	30	28	26	25	0	1	12.1	11.7	10.9	**10.3**	1	1					0	0
Gainesville MSA	139,277	179,684	187,745	34.80	0.511					0	0	23	22	19	17	0	1	10.7	10.4	9.5	8.9	0	1					0	0
Athens MSA	166,079	192,541	197,905	19.16	0.281	0.071	0.073	0.068	**0.064**	1	1	22	21	23	23	0	1	10.8	10.4	9.9	9.8	0	1					0	0
Macon MSA	222,368	232,293	231,259	4.00	0.059					1	1					0	2					1	2					0	0
Allied Chemical												28	28	25	22			13.4	13.1	11.8	**10.9**								
Macon-SE						0.073	0.073	0.071	**0.067**			24	22	20	18			11.0	10.5	9.4	8.7								
Columbus GA-AL MSA	281,768	294,865	316,554	12.35	0.181					1	1GA 1AL					0	3GA 1AL					1	3GA 1AL					0-1	0
Health Dept												25	25	23	21			12.7	12.5	10.8	**10.2**								
Airport						0.067	0.067	0.064	0.062			26	24	23	21			11.8	11.3	10.5	10.0								
UPS																													
Fort Benning																													
Cusseta Elem												26	28	27	25			11.8	11.6	10.7	10.1								
Crime Lab																													
Savannah MSA	293,000	347,611	366,047	24.93	0.366					1	1					0	1					0	1					0-1	0
Sav-E.Pres						0.064	0.064	0.062	0.059																				
Mercer												30	29	28	20			11.0	10.6	10.2	9.3								
L&A																													

Augusta-Richmond County, GA-SC MSA	499,684	556,877	580,270	16.13	0.237					2	2GA 2SC					1	1GA 1SC					1	1GA 1SC					1-2	1
Evans						0.068	0.07	0.068	**0.064**																				
Bungalow Rd						0.069	0.072	0.069	**0.065**			26	25	22	20			12.1	11.5	10.5	10.0			46	46	46	37		
Atlanta-Sandy Springs-Roswell MSA	4,247,981	5,268,860	5,522,942	30.01	0.441					3	10					2	6					3	6					2-4	2
Forest Park												25	24	21	20			12.6	12.3	11.1	**10.3**								
Kennesaw						0.078	0.077	0.073	**0.069**			24	22	21	20			11.7	11.3	10.4	10.0								
Newnan						0.067	0.066	0.062	0.060																				
Dawsonville						0.068	0.067	0.064	**0.064**																				
South DeKalb						0.077	0.08	0.075	**0.072**			24	22	21	19			11.9	11.5	10.5	9.9					46	80		
DMRC																													
Douglasville						0.074	0.075	0.071	**0.067**																				
Fire Station#8												25	24	22	21			13.2	13.0	11.6	**11.0**					39+	39+		
GA Tech																													
Conf Ave						0.08	0.083	0.08	**0.076**																				
Gwinnett Tech						0.075	0.078	0.077	**0.072**			23	23	21	19			11.6	11.2	10.1	9.5								
McDonough						0.078	0.082	0.08	**0.077**																				
Yorkville						0.071	0.072	0.069	**0.064**			22	20	20	18			10.6	10.2	9.3	8.7								
Conyers						0.075	0.079	0.077	**0.077**																				
Chattanooga TN-GA MSA	476,531	528,143	541,744	13.68	0.201	0.073	0.076	0.071	**0.069**	2**	2TN **	23	21	22	22	1**	1GA 3TN **	10.1	10.0	10.5	**10.3**	2**	1GA 3TN **	42	42	42	33	1-2**	1TN **
Not in an MSA																													
Chattooga (Summerville Micro)	25,470	26,015	25,138	-1.30	0.019	0.067	0.067	0.065	0.062	0	1																		
General Coffee (Douglas Micro)	45,022	50,731	43,220	-4.00	0.059																								
Leslie (Americus Micro)	36,966	37,829	36,453	-1.39	0.020	0.065	0.066	0.063	0.061	0	1																		
Sandersville (Washington Co)	21,176	21,187	20,676	-2.36	0.035							27	23	24	20	0	1	11.3	10.8	10.2	9.7	0	1						
Gordon (Wilkinson Co)	10,220	9,563	9,432	-7.71	0.113							25	23	23	22	0	1	13.1	12.5	11.2	**10.6**	0	1						
Totals										**12**	**25**					**4**	**28**					**10**	**28**					**4**	**4**

**Covered by Memorandum of Agreement with Chattanooga-Hamilton County-Walker Metropolitan Statistical Area Criteria Pollutant Air Quality Agreement
+Not 3 years

Table 12.2: Network Requirements for Ozone, $PM_{2.5}$, and PM_{10} and Population Change

The population during the official 2010 census, the 2013 estimate, and the percent change in population of the remaining micropolitan statistical areas in which GA EPD does not have monitors are shown in Table 12.3.

Micropolitan Statistical Areas without monitors	Population (2010 Census)	Population (2013 Estimate)	Percent Change in Population
Bainbridge	28,283	27,676	-2.15
Calhoun	52,800	55,409	4.94
Cedartown	42,108	41,308	-1.90
Cordele	22,162	23,521	6.13
Cornelia	43,056	43,181	0.29
Dublin	57,398	58,106	1.23
Fitzgerald	27,866	17,576	-36.93
Hinesville-Ft Stewart	69,943	80,184	14.64
Jesup	29,509	30,187	2.30
LaGrange	64,233	67,776	5.52
Moultrie	45,279	45,781	1.11
St Marys	47,641	50,799	6.63
Statesboro	67,761	71,190	5.06
Thomaston	27,530	26,918	-2.22
Thomasville	45,778	44,692	-2.37
Tifton	42,434	40,537	-4.47
Toccoa	25,493	25,910	1.64
Vidalia	37,032	36,297	-1.98
Waycross	54,006	54,782	1.44

Table 12.3: Population Change in Micropolitan Statistical Areas without Monitors

In Table 12.2, one can see that GA EPD exceeds the requirements for the number of ozone, $PM_{2.5}$, and PM_{10} monitors. Georgia shares three MSAs with neighboring states: Chattanooga TN-GA MSA, Columbus GA-AL MSA, and Augusta-Richmond County, GA-SC MSA. These states also collect ozone, $PM_{2.5}$ and PM_{10} data within these MSAs. The monitor with the highest concentrations in each MSA is used to compare to the NAAQS regardless of which state the monitor is located. GA EPD does not currently have a PM_{10} or ozone monitor in the Chattanooga TN-GA MSA; however, Georgia has an agreement with Tennessee to use the data from their PM_{10} and ozone monitors. According to 40CFR58, Appendix D, GA EPD would be required to have 12 ozone monitors for its population by area and the percentage of each pollutant compared to the NAAQS. Currently, the network consists of 25 ozone monitors, including two that are covered by Tennessee in the Chattanooga TN-GA MSA, one in Alabama in the Columbus, GA-AL MSA, and two in South Carolina in the Augusta-Richmond County, GA-AL MSA. GA EPD would be required to have 4 $PM_{2.5}$ monitors for the daily standard and 11 for the annual standard. GA EPD currently has 28 $PM_{2.5}$ monitors, including three in Tennessee, in the Chattanooga TN-GA MSA, one in South Carolina in the Augusta-Richmond County, GA-SC MSA, and one in Alabama in the Columbus GA-AL MSA. In addition, four PM_{10} monitors would be required and GA EPD's network, along with one in Tennessee, currently has four monitors.

Table 12.2 shows that most of Georgia's MSAs experienced population growth from the 2000 census to the estimated 2013 population. The Warner Robins MSA saw the biggest increase, with 68.12%. Therefore, the Warner Robins MSA ranked the highest according to this assessment. The next biggest areas to have an increase in population were the Gainesville and Atlanta-Sandy Springs-Roswell MSAs with 34.8% and 30.01% increases, respectively. The only MSA to experience a decrease in percent population from 2000 to 2013 was Albany (-1.36%). In addition, all of the areas with monitors that are 'Not in an MSA' had a decrease in population with Gordon having the largest decrease in population (-7.71%) and lowest rank.

On December 17, 2014, EPA proposed to strengthen both the primary and secondary ozone standards. EPA is proposing to strengthen the 8-hour primary ozone standard, designed to protect public health, to a level within the range of 0.065-0.070 parts per million (ppm). EPA is also proposing to strengthen the secondary standard, designed to protect sensitive vegetation and ecosystems, including forests, parks, wildlife refuges and wilderness areas to within a range of 0.065-0.070 ppm (Federal Register, Vol. 79, No. 242, page 75233). As these rules are finalized, GA EPD will make adjustments to the ozone monitoring network as necessary.

12.1 Population Change

In order to assess population change, the 2010 census and the American Community Survey 5-year estimated population for 2013 were compared. Figure 12.1 shows the 2013 total estimated population for each census tract. According to the United States Census Bureau, "census tracts are small, relatively permanent statistical subdivisions of a county or equivalent entity that are updated by local participants prior to each decennial census as part of the Census Bureau's Participant Statistical Areas Program. Census tracts generally have a population size between 1,200 and 8,000 people, with an optimum size of 4,000 people" (www.census.gov). The ambient air monitoring stations are shown with a white triangle. The darker the color green, the higher the estimated population for that census tract.

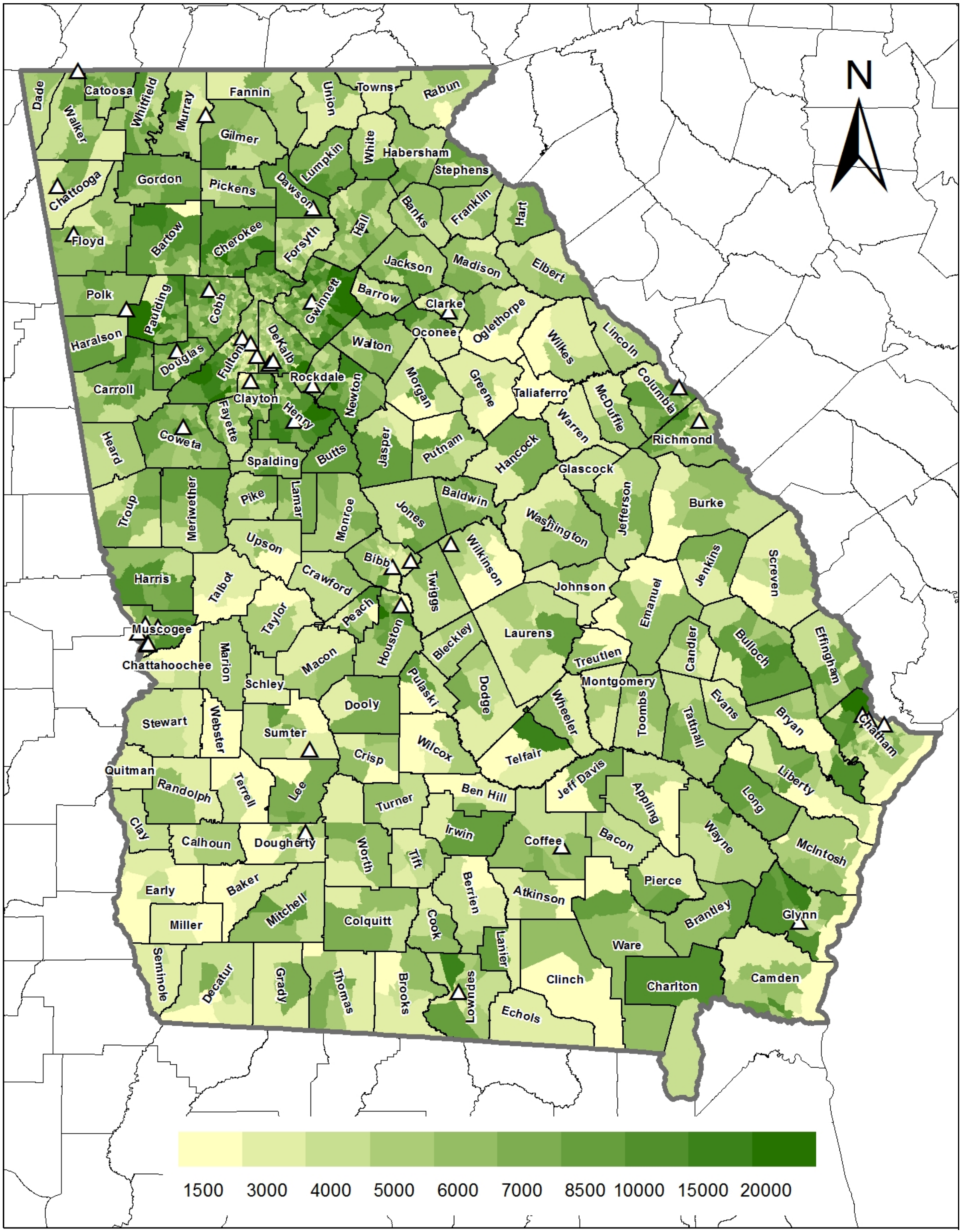


Figure 12.1: 2013 Georgia Total Estimated Population by Census Tract

Figure 12.2 shows the percent change in population for each census tract between 2010 and 2013. The darker blue colors represent a negative percent change in population, while the darker orange represent a positive percent change in population. The total population of Georgia increased about 3.2% from 2010 to 2013, with a total estimated population of 9,994,759 in 2013. Overall changes in population were calculated for each county by summing the population changes for each census tract within the county. Long County had the highest overall increase in population (+16%) and Taliaferro County had the greatest overall decrease in population (-13%) between 2010 and 2013.

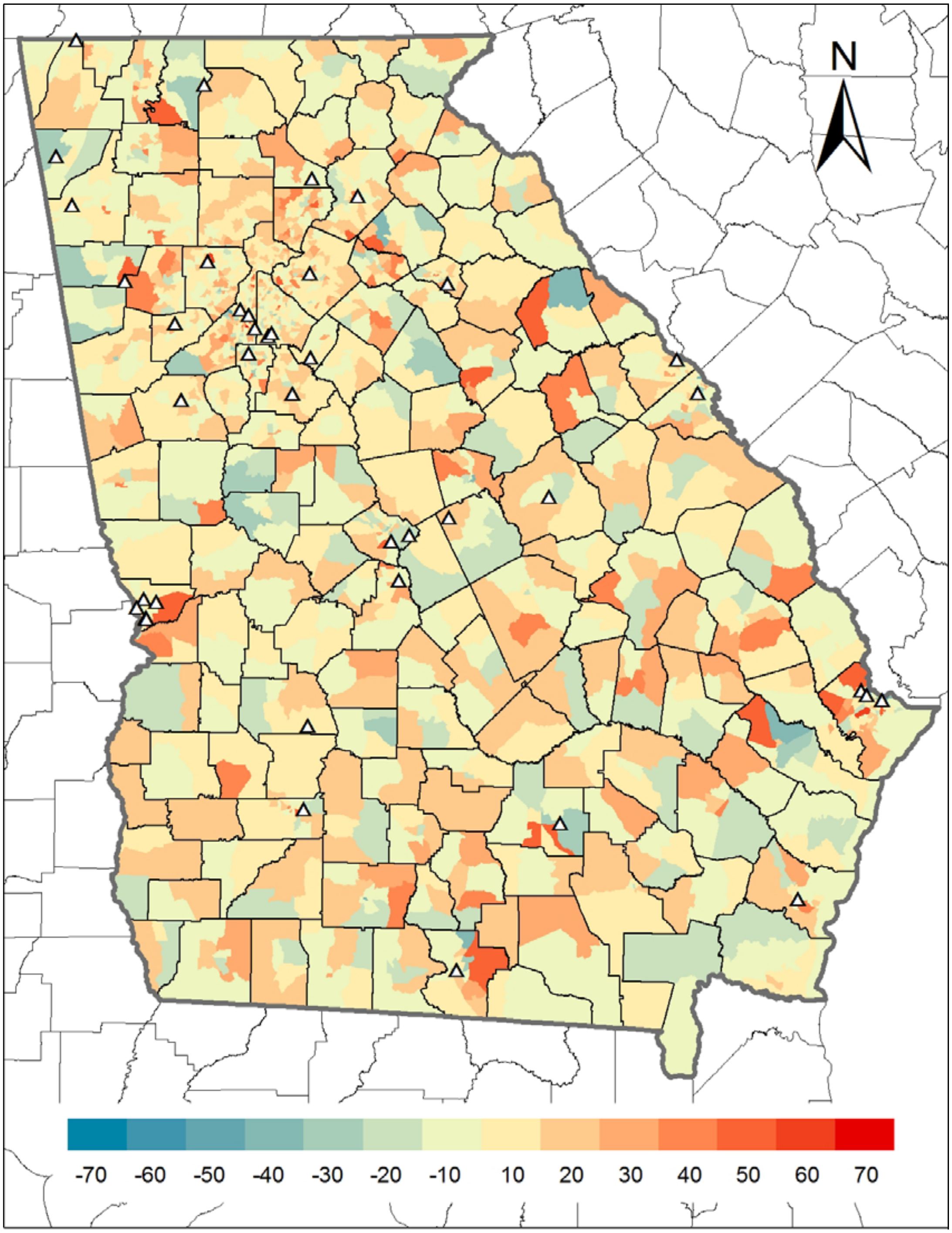


Figure 12.2: Georgia Percent Population Change by Census Tract from 2010 to 2013

Figures 12.3 through 12.7 show a closer view of the percent change in population from 2010 to 2013 for each of five major MSAs in Georgia (Atlanta-Sandy Springs-Roswell, Augusta-Richmond County, GA-SC, Columbus, GA-AL, Macon, and Savannah) by census tract.

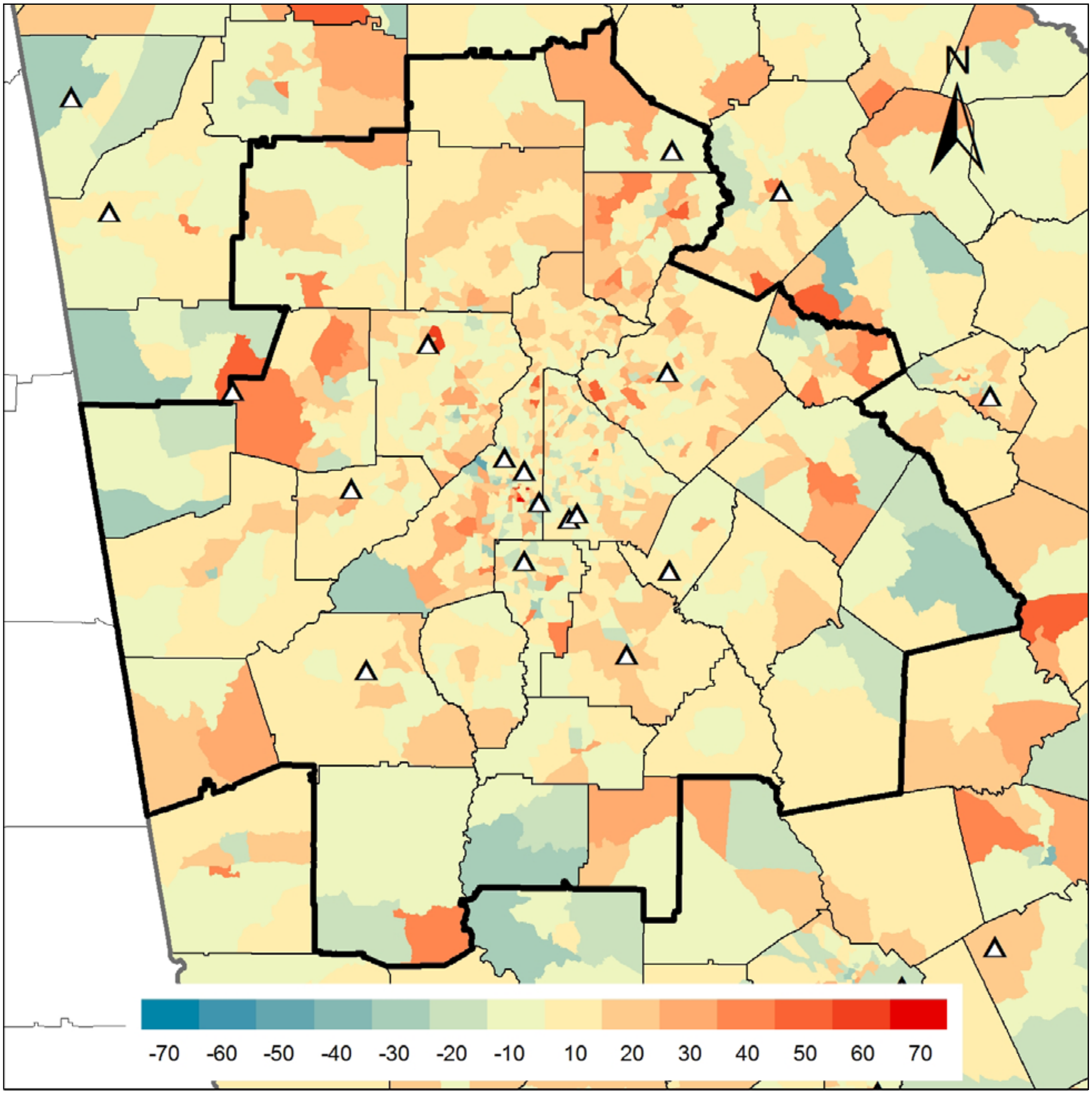


Figure 12.3: Atlanta-Sandy Springs-Roswell MSA Percent Population Change by Census Tract from 2010 to 2013

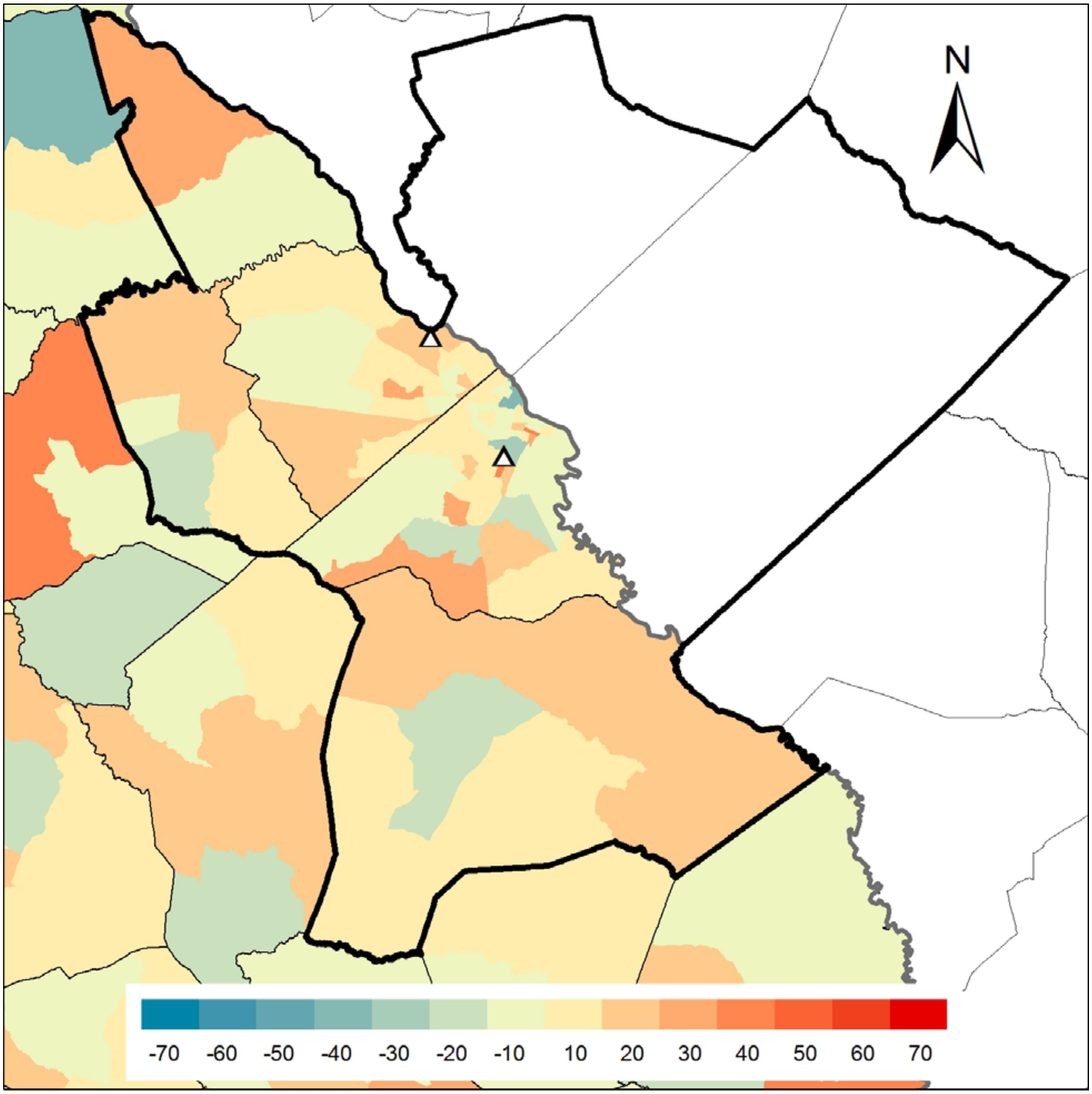


Figure 12.4: Augusta-Richmond County, GA-SC MSA Percent Population Change by Census Tract from 2010 to 2013

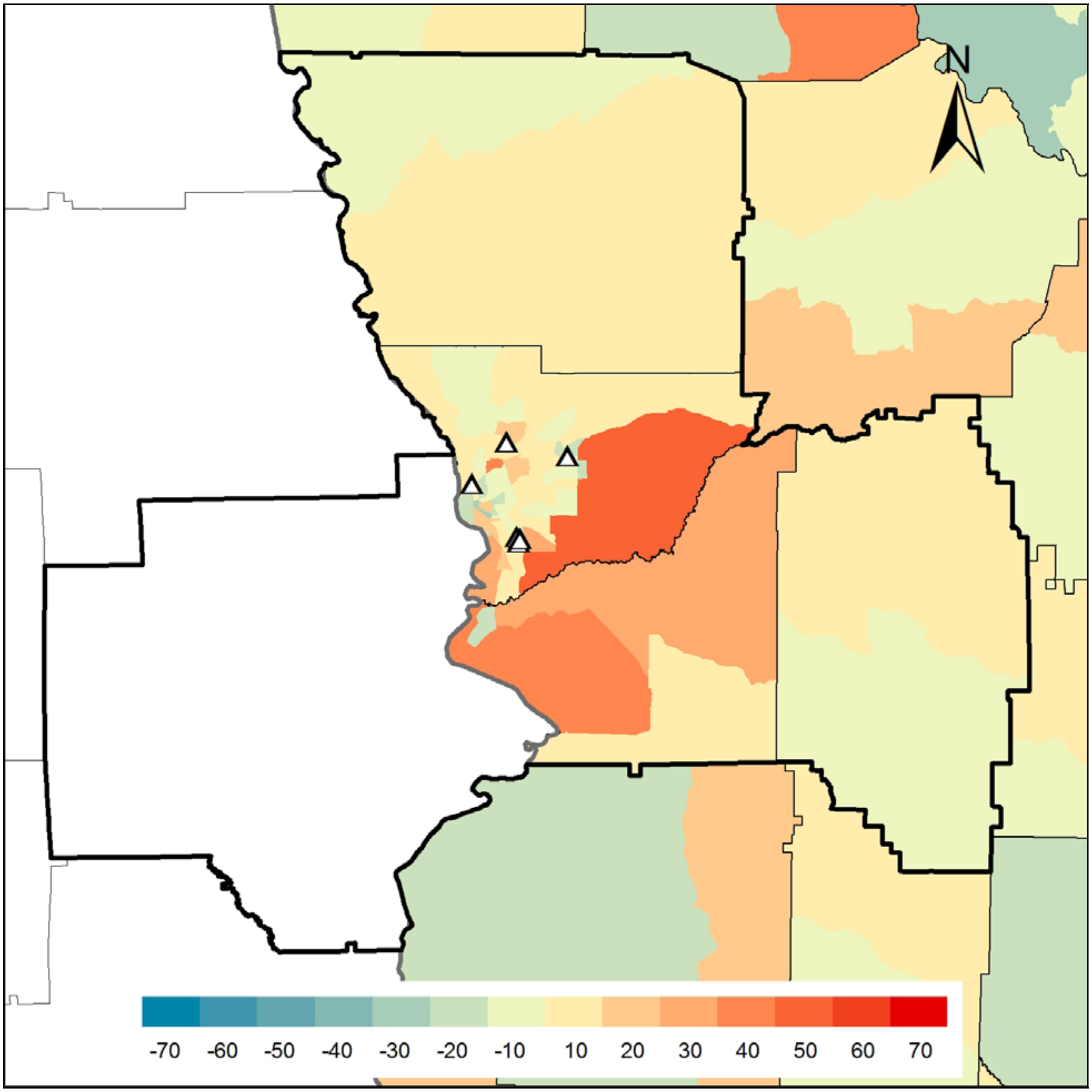


Figure 12.5: Columbus GA-AL MSA Percent Population Change by Census Tract from 2010 to 2013

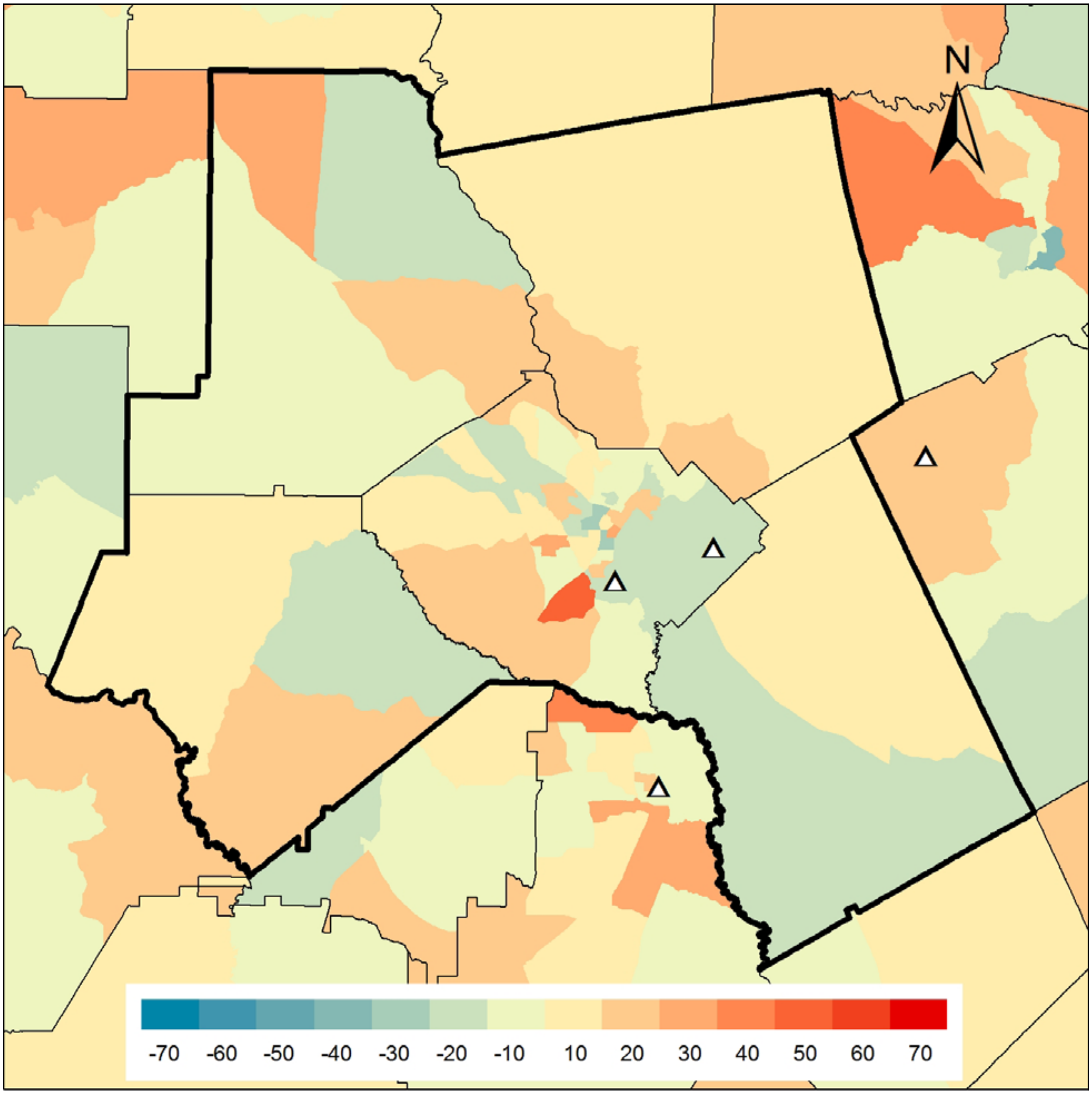


Figure 12.6: Macon MSA Percent Population Change by Census Tract from 2010 to 2013

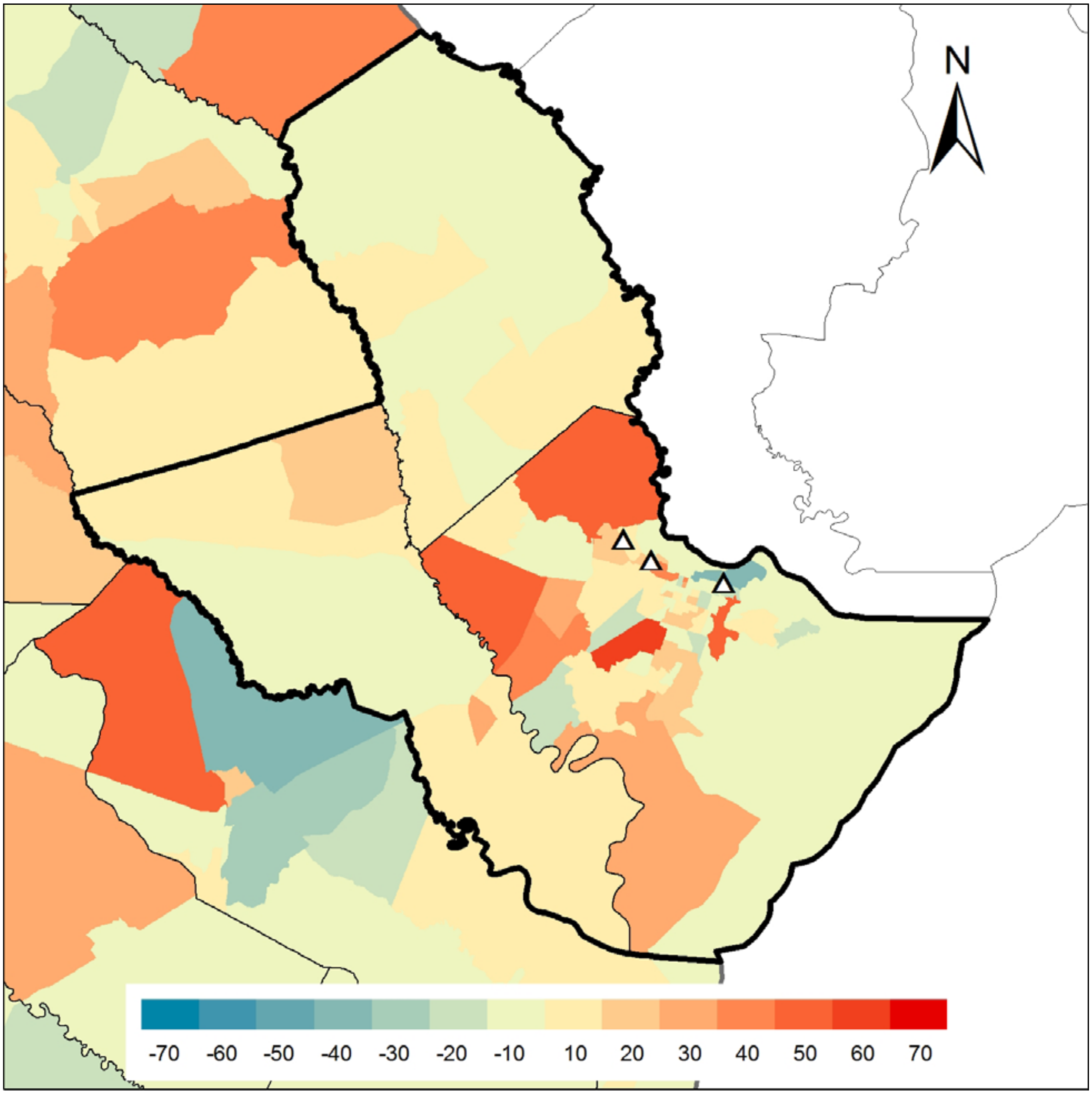


Figure 12.7: Savannah MSA Percent Population Change by Census Tract from 2010 to 2013

12.2 Sensitive Sub-Populations

To meet the requirements set forth by EPA, GA EPD needs to consider its ability to support air quality characterization for areas with high populations of susceptible individuals. In particular, the guidance recommends the assessment of areas with large populations of children, the elderly, people with low income, and minorities. The following sections address each of these groups of susceptible individuals.

12.2.1 Children

Due to a child's continuing lung and immune system development, children are considered one subset of the population that is more susceptible to poor ambient air quality. Because a child's respiratory system is developing and therefore more sensitive, this may lead to a breathing ailment with less exposure to a pollutant. In general, children spend more time outdoors, with higher risk of exposure. In addition, children tend to breathe more rapidly, also causing them to be at a higher risk of exposure to air pollutants.

Figures 12.8 through 12.15 were created using ArcMap and show the 2013 estimated population demographics for age for each census tract. Georgia's ambient air monitors are indicated on each map by white triangles.

Figure 12.8 shows the percent of the population under the age of five for each census tract in Georgia. Overall, the percent of the population under 5 years of age is relatively low, ranging from 0 to 24 percent. Most of the census tracts are in the range of 4-8%, and the majority of Georgia's ambient air monitors are located within tracts of this range. The census tracts with the highest percent populations under 5 years of age are located in Liberty County, Chattahoochee County and Chatham County.

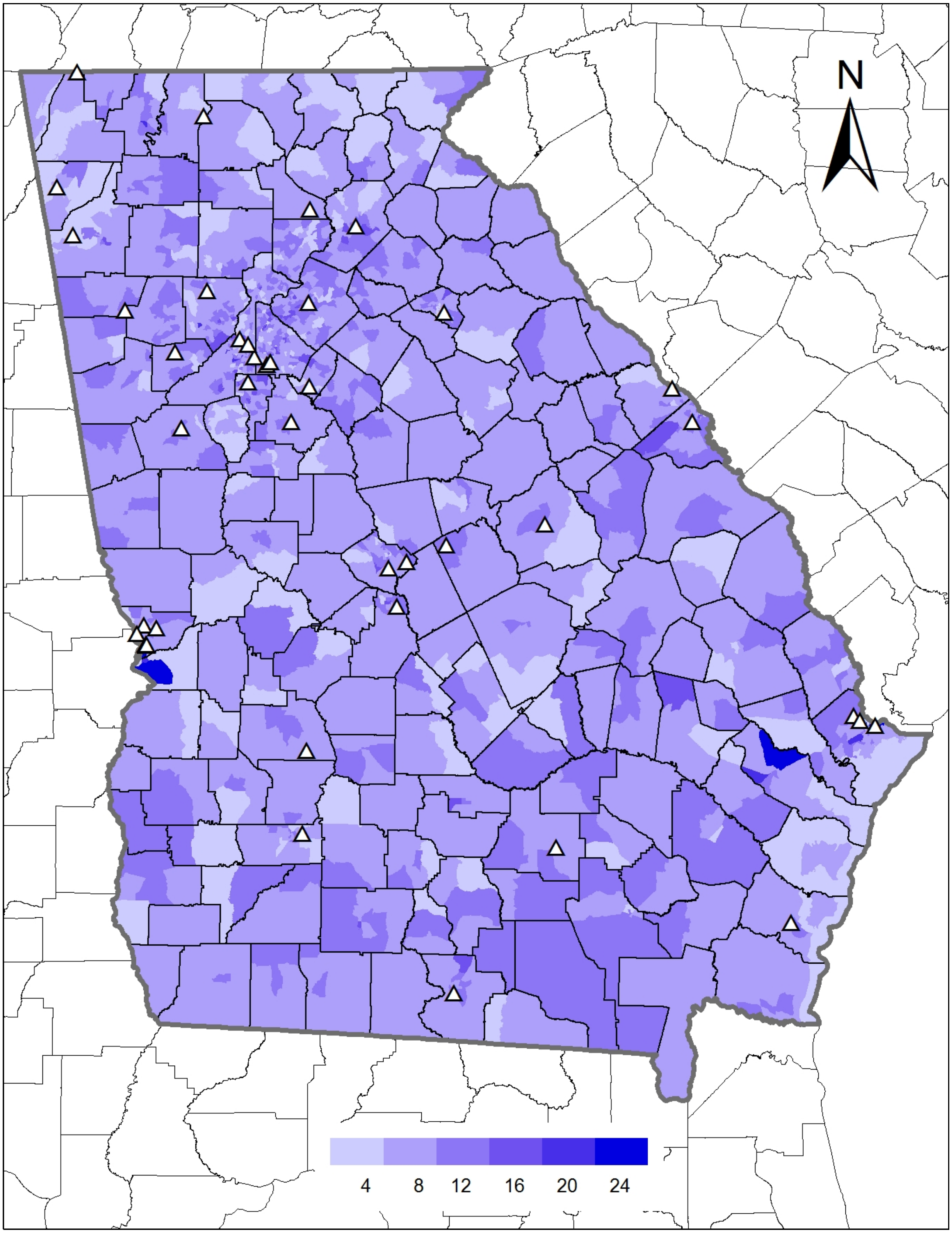


Figure 12.8: Percent of Georgia's Population under 5 Years of Age

Figure 12.9 shows the percent of Georgia's population that is under the age of 18 for each census tract. Most of the census tracts are in the 30-40% range with a total range of 0-60%. The majority of Georgia's ambient air monitors are located in tracts with 20-30% and 30-40% of the population under the age of eighteen. In addition, the Georgia Ambient Air Monitoring Program has several sites located at or near schools. The Rome site is near Coosa High School, the Gainsesville site is near Fair Street Elementary School, the Valdosta site is at Mason Elementary, the Albany site is at Turner Elementary, Columbus-Cusseta is at Cusseta Elementary, the Brunswick site is at Risley Middle, Savannah-Mercer is at Mercer Middle, and Leslie is at Union High School. In addition, one site, Gwinnett Tech, is located on a college campus (Gwinnett Technical College). The census tracts with the highest percent population under 18 years of age are located in Fulton County (58%), Liberty County (58%), and Chatham County (50%).

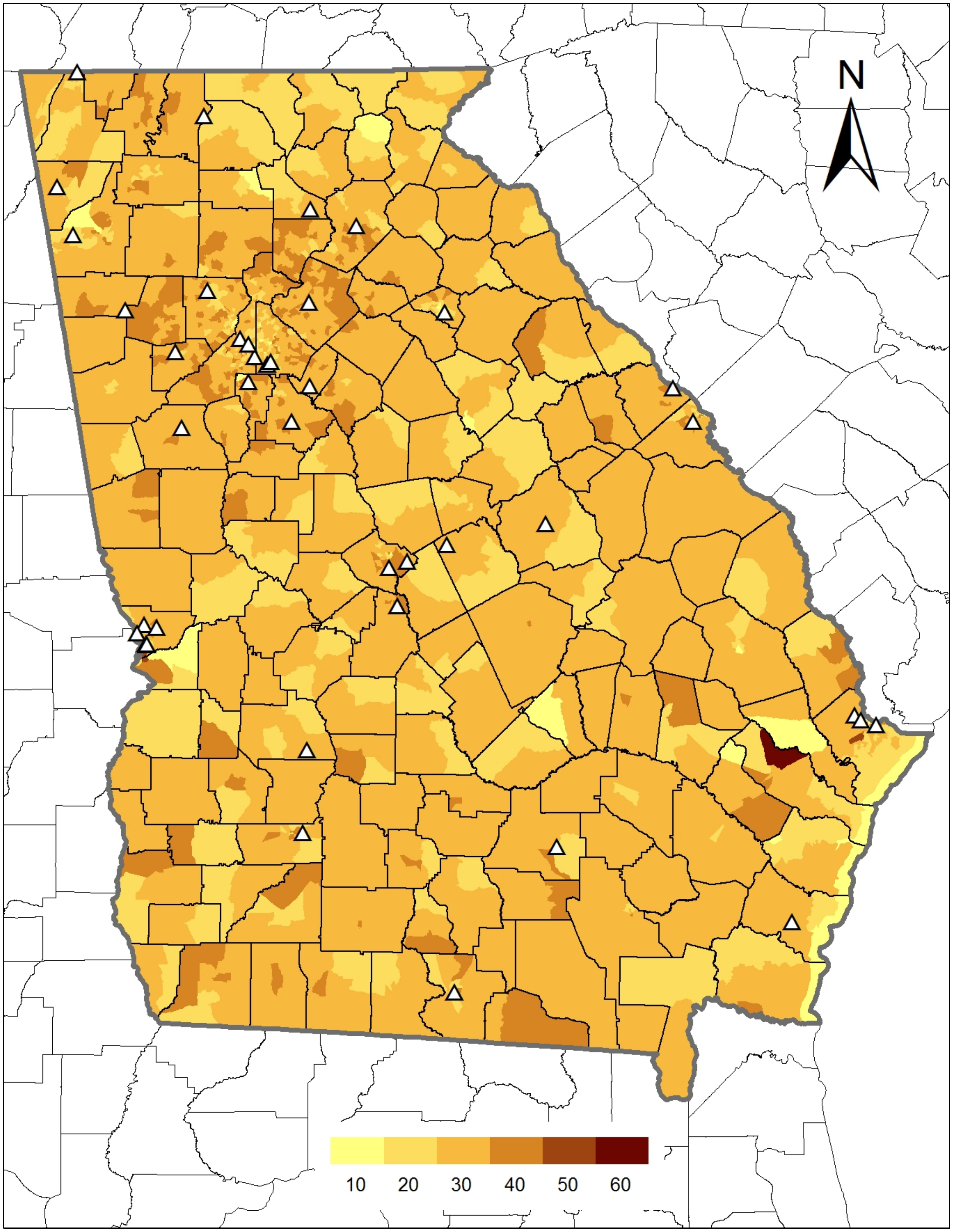


Figure 12.9: Percent of Population Under 18 Years of Age in Georgia

12.2.2 Elderly

Figure 12.10 shows the percent of Georgia's population that is over the age of 65 for each census tract. Most of the tracts are in the 5-10% and 10-15% ranges with a total range of 0-50%. The majority of Georgia's ambient air monitors are located in census tracts in the 5-10% and 10-15% range. The tracts with the hightest percentages of persons over the age of 65 are located in Greene and Chatham Counties (50% and 49%, respectively). More air monitors may be needed in the Northeastern part of the state and in Greene County to monitor where a higher percentage of the population is elderly.

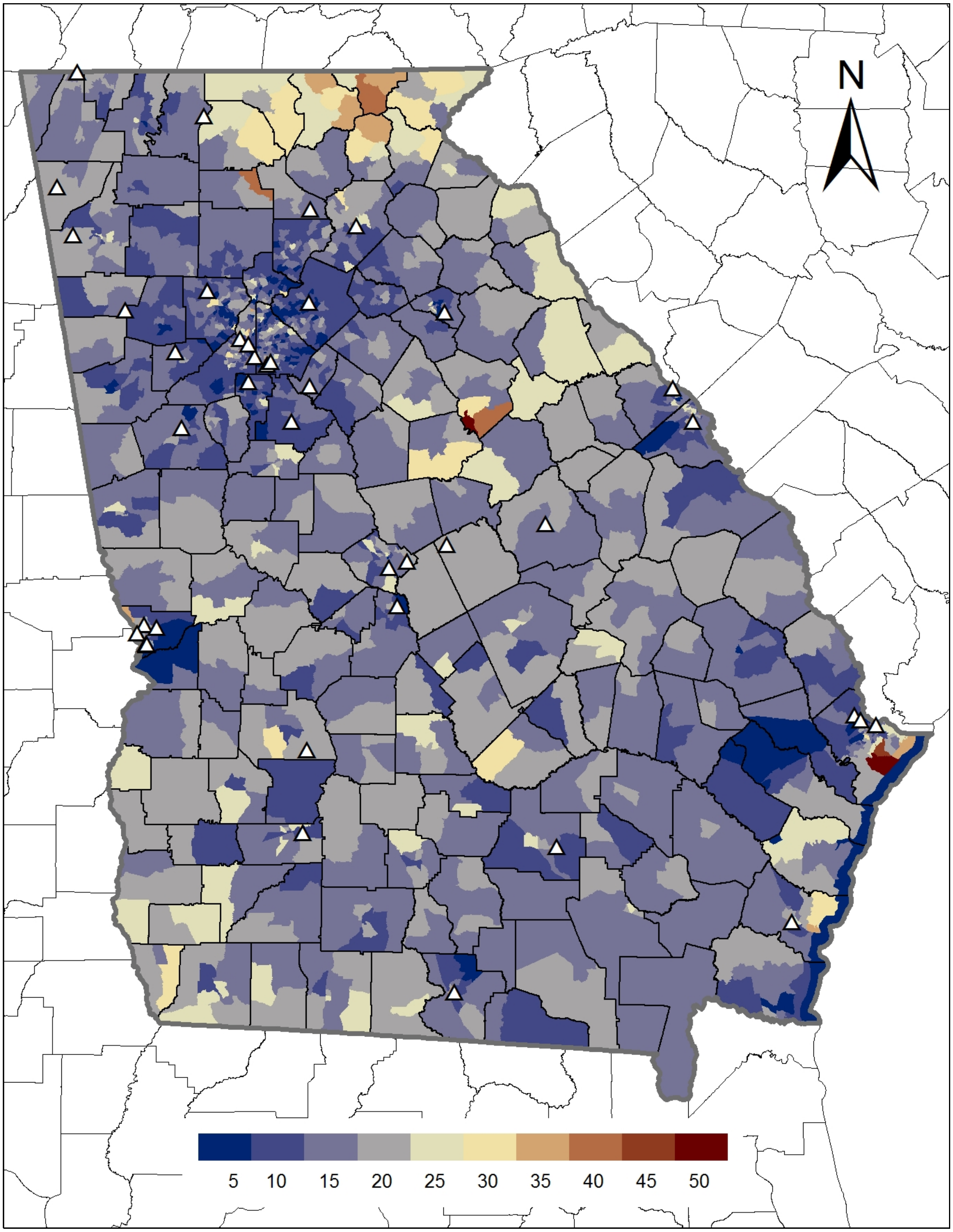


Figure 12.10: Percent of Georgia's Population over 65 Years of Age

In Figures 12.11 through 12.15, below, how well each age group is represented by ambient air monitors in Georgia's largest MSAs (Atlanta-Sandy Springs-Roswell, Augusta-Richmond County, GA-SC, Columbus, GA-AL, Macon, and Savannah) is explored.

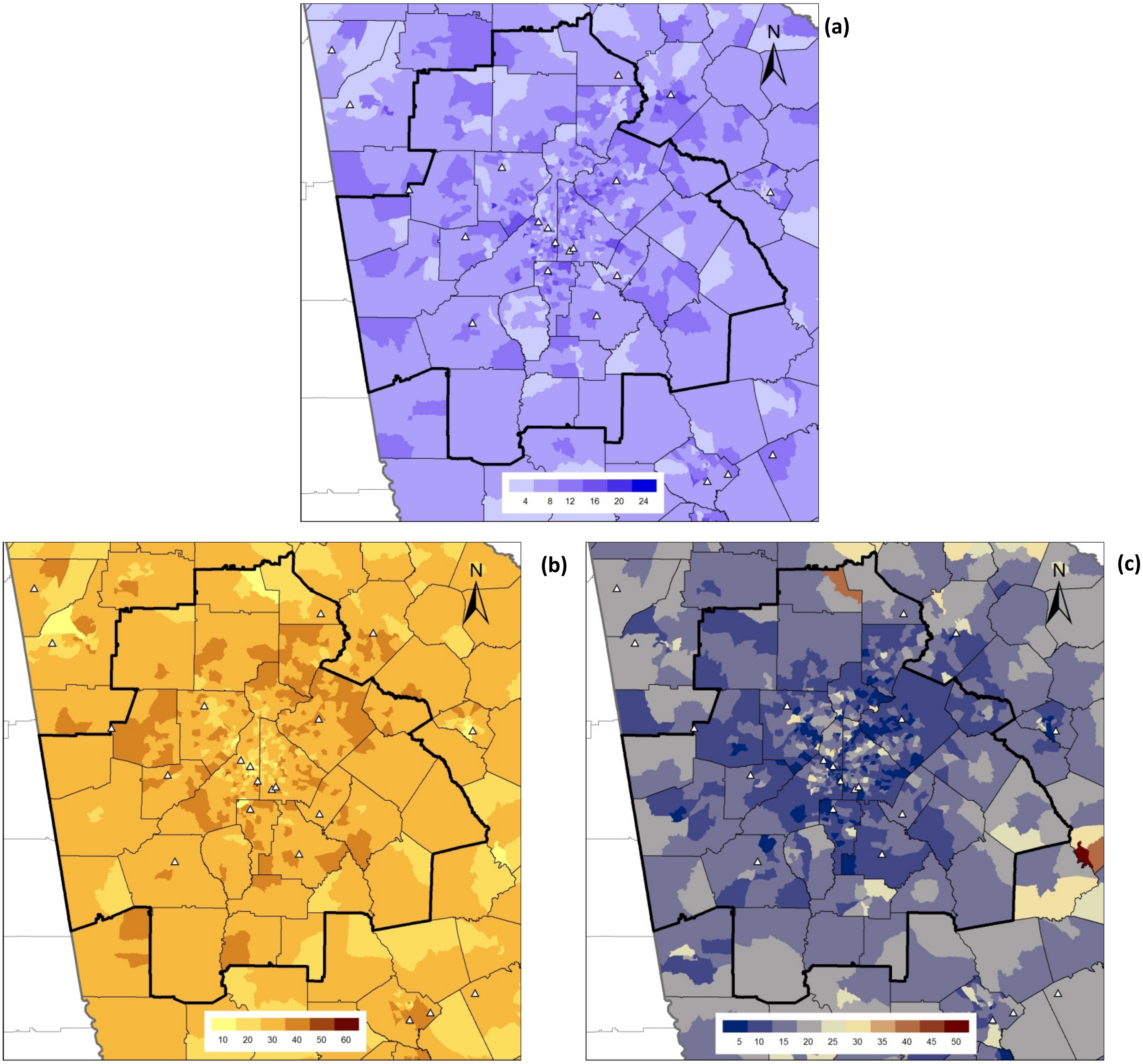


Figure 12.11: Percent of the Population in the Atlanta-Sandy Springs-Roswell MSA (a) under 5 Years, (b) under 18 Years, and (c) over 65 Years

The majority of the ambient air monitors in the Atlanta-Sandy Springs-Roswell MSA are located within census tracts where 4-8% of the population is under 5 years of age (Figure 12.11a), where 20-30% of the population is under 18 years of age (Figure 12.11b) and where 5-10% of the population is over 65 years of age (Figure 12.11c).

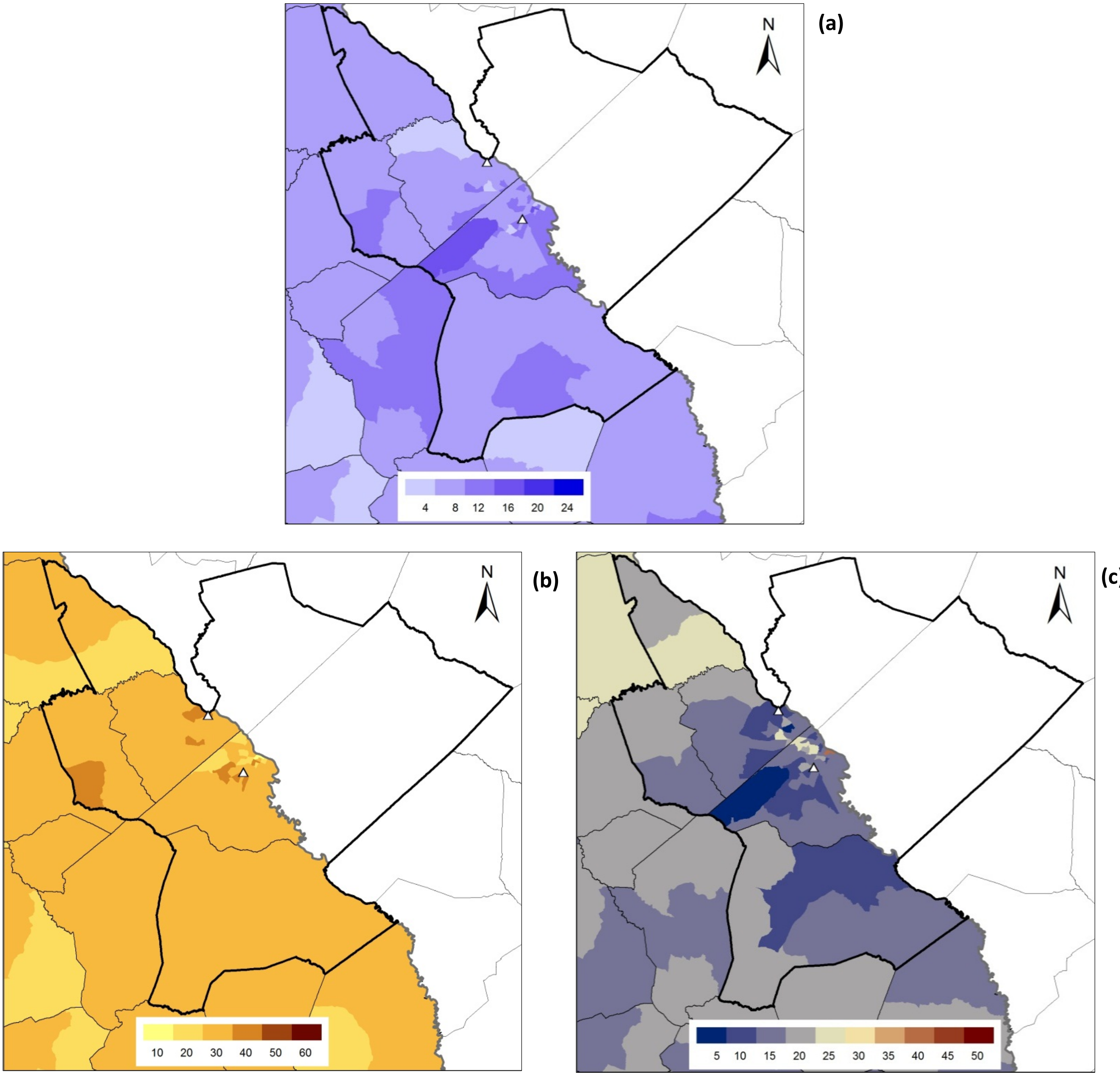


Figure 12.12: Percent of the Population in the Augusta-Richmond County, GA-SC MSA (a) under 5 Years, (b) under 18 Years, and (c) over 65 Years

Both ambient air monitors in the Augusta-Richmond County, GA-SC MSA are located within census tracts with 4-8% of the population under 5 years (Figure 12.12a). For percent of the population under 18 years, one monitor is located in the 20-30% range and the other is located in the 30-40% range (Figure 12.12b). For percent of the population over 65 years, one monitor is in a census tract with 5-10% of population over 65 years, and the other is in the 10-15% range (Figure 12.12c).

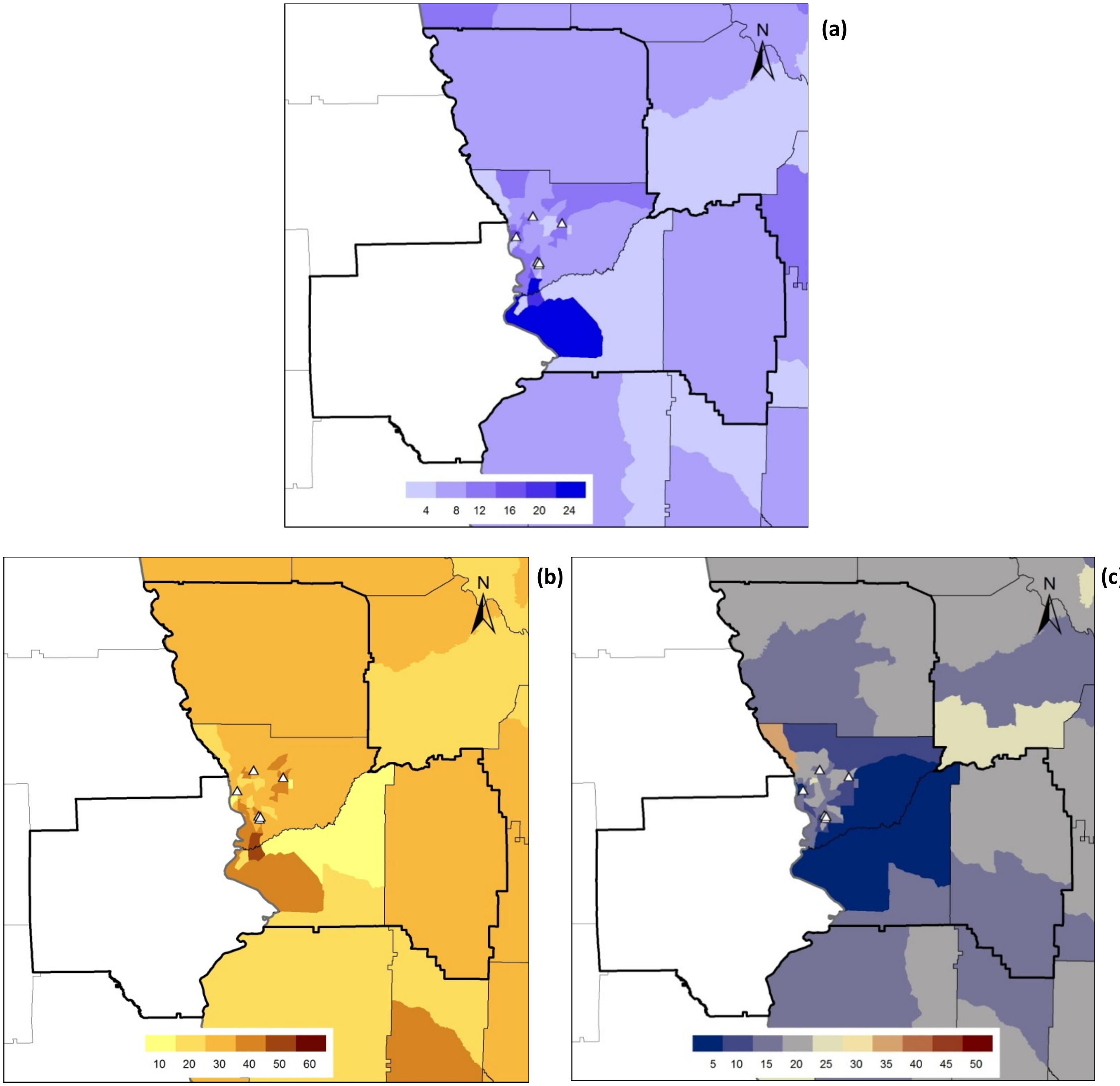


Figure 12.13: Percent of the Population in the Columbus, GA-AL MSA (a) under 5 Years, (b) under 18 Years, and (c) over 65 Years

The majority of ambient air monitors in the Columbus, GA-AL MSA are in the 8-12% range for percent of population under 5 years of age (Figure 12.13a). For population under 18 years of age, the majority of monitors are in census tracts in the 20-30% range (Figure 12.13b). For population over 65 years, the majority of monitors are in census tracts in the 10-15% range (Figure 12.13c).

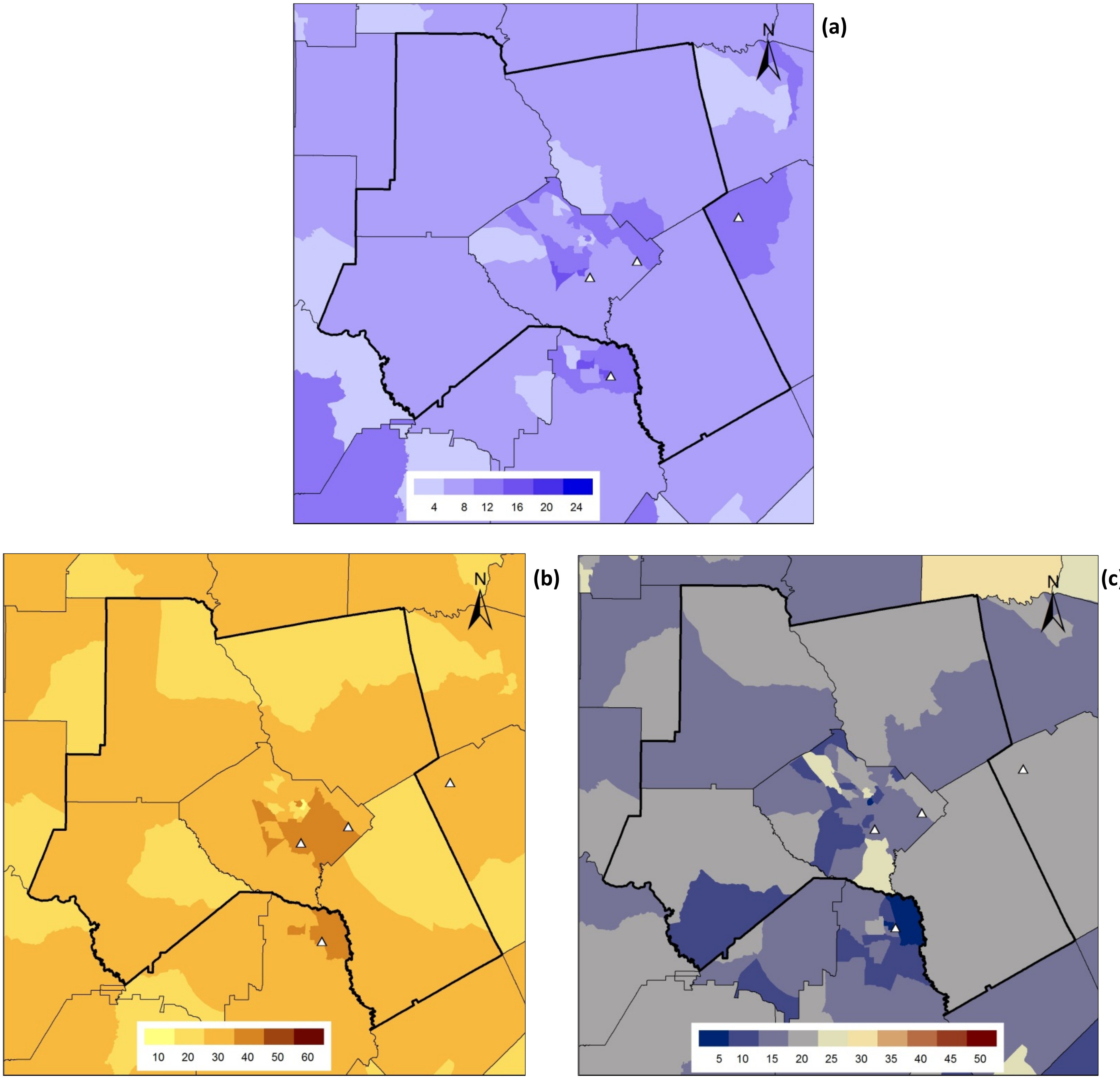


Figure 12.14: Percent of the Population in the Macon MSA (a) under 5 Years, (b) under 18 Years, and (c) over 65 Years

Both monitors in the Macon MSA are located in census tracts with 4-8% of the population under 5 years of age (Figure 12.14a), with 30-40% of the population under 18 years (Figure 12.14b), and with 10-15% of the population over 65 years (Figure 12.14c)

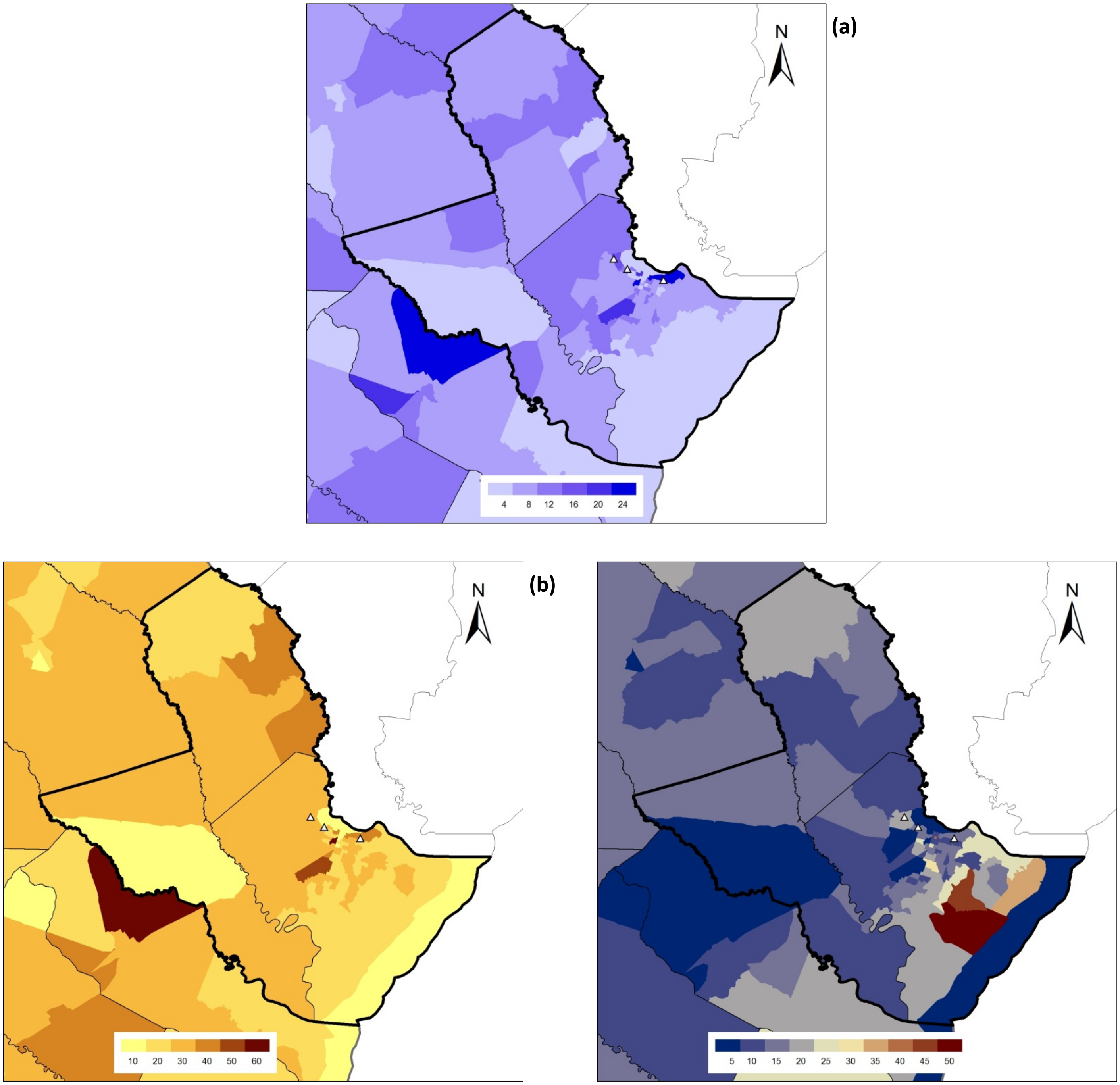


Figure 12.15: Percent of the Population in the Savannah MSA (a) under 5 Years, (b) under 18 Years, and (c) over 65 Years

In the Savannah MSA, one monitor is located in a census tract with 8-12% of the population under 5 years, one with 12-16%, and the other monitor is located in an area with 20-24% of the population under 5 years (Figure 12.15a). For percent of the population under 18 years, two monitors are located in an area with 20-30% of the population under 18 years and the other is in an area with 30-40% of the population under 18 years (Figure 12.15b). For percent of the population over 65 years, two monitors are in an area with 10-15% of population over 65 years, and the other monitor is in an area with 15-20% of population over 65 years (Figure 12.15c).

This assessment considered GA EPD's ability to support air quality characterization for areas with high populations of susceptible individuals, in particular, children under 5 years of age, children under 18 years of age, and adults over 65 years of age. The above maps showing these demographics across the state appear to indicate sufficient coverage to support air quality characterization for these age groups. In addition, several of Georgia's air monitors are located at or near schools, as listed above, further supporting sufficient coverage.

12.2.3 Low-Income and Minority Populations

Another sensitive sub-population that GA EPD considered in this assessment involves areas with low-income populations and minorities. GA EPD must assess its ability to support air quality characterization for areas with high populations of susceptible individuals.

12.2.3.1 Asthma Prevalence

To examine one aspect of air quality with regards to low-income and minority areas, the following tables were taken from a Centers for Disease Control (CDC) study involving asthma related to the level of income and ethnicity (http://www.cdc.gov/asthma/brfss/2010/brfssdata.htm). In addition, asthma prevalence by age group is shown in the tables below. The tables show the self-reported current levels and lifetime levels of asthma.

The first two tables show the self-reported current levels and lifetime levels of asthma along with five categories of ethnicity. The tables show the ethnicity and prevalence of asthma with each ethnicity in the study.

State	Race/Ethnicity	Sample Size	Prevalence (percent)	Standard Error	95% CI* (percent)	||	Prevalence (number)	95% CI* (number)
GA	White NH	4,029	7.7	0.63	(6.4 - 8.9)	||	384,021	(320,989 - 447,053)
GA	Black NH	1,296	8.1	0.96	(6.2 - 10.0)	||	128,272	(97,899 - 158,644)
GA	Other NH	126	10.0	5.12	(0.0 - 20.1)	||	26,079	(0 - 54,582)
GA	Multirace NH	62	11.5	4.88	(1.8 - 21.3)	||	9,247	(1,138 - 17,356)
GA	Hispanic	167	5.5	2.80	(0.0 - 11.1)	||	17,883	(0 - 36,283)

*CI denotes confidence interval
http://www.cdc.gov/asthma/brfss/2010/brfssdata.htm

Table 12.4: Adult Self-Reported Current Asthma Prevalence Rate (Percent) and Prevalence (Number) by Race/Ethnicity and State or Territory: BRFSS 2010

State	Race/Ethnicity	Sample Size	Prevalence (percent)	Standard Error	95% CI* (percent)	||	Prevalence (number)	95% CI* (number)
GA	White NH	4,042	11.7	0.76	(10.2 - 13.2)	||	585,950	(507,532 - 664,367)
GA	Black NH	1,299	11.4	1.16	(9.1 - 13.6)	||	179,305	(142,091 - 216,520)
GA	Other NH	126	12.7	5.35	(2.1 - 23.3)	||	33,173	(2,868 - 63,479)
GA	Multirace NH	62	25.0	7.39	(10.2 - 39.8)	||	20,074	(6,666 - 33,482)
GA	Hispanic	168	7.9	2.97	(2.1 - 13.8)	||	25,641	(5,908 - 45,374)

*CI denotes confidence interval
http://www.cdc.gov/asthma/brfss/2010/brfssdata.htm

Table 12.5: Adult Self-Reported Lifetime Asthma Prevalence Rate (Percent) and Prevalence (Number) by Race/Ethnicity and State or Territory: BRFSS 2010

With this study, White Non-Hispanic, Black Non-Hispanic, Other Non-Hispanic, Multirace Non-Hispanic, and Hispanic groups were examined for percent prevalence of asthma. In both the current and lifetime rates of prevalence, the Multirace Non-Hispanic group had the highest percentage rate of asthma (11.5% and 25.0%, respectively).

The next two tables show the age group and prevalence of asthma in each age group category from 18 to 65+ years of age.

State	Age Group	Sample Size	Prevalence (percent)	Standard Error	95% CI* (percent)	||	Prevalence (number)	95% CI* (number)
GA	18-24	118	6.5	2.24	(2.1 - 10.9)	||	24,349	(7,628 - 41,070)
GA	25-34	514	8.9	1.94	(5.1 - 12.7)	||	112,723	(61,403 - 164,043)
GA	35-44	802	7.1	1.05	(5.0 - 9.1)	||	154,031	(108,207 - 199,856)
GA	45-54	1,185	6.0	0.81	(4.5 - 7.6)	||	84,914	(62,123 - 107,705)
GA	55-64	1,262	9.4	0.96	(7.6 - 11.3)	||	95,597	(75,903 - 115,291)
GA	65+	1,807	8.6	0.78	(7.1 - 10.1)	||	89,858	(73,380 - 106,336)

*CI denotes confidence interval
http://www.cdc.gov/asthma/brfss/2010/brfssdata.htm

Table 12.6: Adult Self-Reported Current Asthma Prevalence Rate (Percent) and Prevalence (Number) by Age and State or Territory: BRFSS 2010

GA	18-24	118	15.0	3.66	(7.7 - 22.2)	||	56,083	(27,701 - 84,466)
GA	25-34	514	15.2	2.26	(10.8 - 19.6)	||	192,151	(130,180 - 254,122)
GA	35-44	803	10.1	1.21	(7.7 - 12.5)	||	219,310	(165,733 - 272,887)
GA	45-54	1,189	9.4	1.01	(7.4 - 11.4)	||	132,967	(103,765 - 162,169)
GA	55-64	1,267	12.2	1.09	(10.0 - 14.3)	||	123,598	(100,862 - 146,333)
GA	65+	1,814	10.8	0.86	(9.1 - 12.5)	||	113,898	(95,423 - 132,373)

*CI denotes confidence interval
http://www.cdc.gov/asthma/brfss/2010/brfssdata.htm

Table 12.7: Adult Self-Reported Lifetime Asthma Prevalence Rate (Percent) and Prevalence (Number) by Age and State or Territory: BRFSS 2010

For the current asthma prevalence rate in Georgia, the age group of 55-64 years had the highest rate (9.4%), and for the lifetime asthma prevalence rate, the age group of 25-34 years had the highest rate (15.2%).

The next two tables show the level of income and prevalence of asthma at each level of income in the study.

State	Income	Sample Size	Prevalence (percent)	Standard Error	95% CI* (percent)	‖	Prevalence (number)	95% CI* (number)
GA	< $15,000	574	17.7	3.30	(11.2 - 24.2)	‖	97,025	(56,037 - 138,013)
GA	$15-$24,999	943	7.6	1.05	(5.5 - 9.6)	‖	78,570	(57,197 - 99,942)
GA	$25-$49,999	1,318	8.7	1.17	(6.4 - 11.0)	‖	131,814	(95,201 - 168,427)
GA	$50-$74,999	729	7.1	1.27	(4.6 - 9.6)	‖	68,447	(43,604 - 93,290)
GA	>=$75,000	1,365	5.2	0.71	(3.8 - 6.6)	‖	122,641	(89,549 - 155,733)

*CI denotes confidence interval
http://www.cdc.gov/asthma/brfss/2010/brfssdata.htm

Table 12.8: Adult Self-Reported Current Asthma Prevalence Rate (Percent) and Prevalence (Number) by Income and State or Territory: BRFSS 2010

State	Income	Sample Size	Prevalence (percent)	Standard Error	95% CI* (percent)	‖	Prevalence (number)	95% CI* (number)
GA	< $15,000	576	20.0	3.33	(13.4 - 26.5)	‖	109,468	(67,375 - 151,562)
GA	$15-$24,999	947	11.1	1.40	(8.3 - 13.8)	‖	115,762	(86,369 - 145,155)
GA	$25-$49,999	1,320	12.5	1.33	(9.9 - 15.1)	‖	190,067	(147,640 - 232,495)
GA	$50-$74,999	731	11.9	1.60	(8.8 - 15.0)	‖	114,346	(82,310 - 146,381)
GA	>=$75,000	1,368	8.9	1.00	(7.0 - 10.9)	‖	211,435	(163,410 - 259,459)

*CI denotes confidence interval
http://www.cdc.gov/asthma/brfss/2010/brfssdata.htm

Table 12.9: Adult Self-Reported Lifetime Asthma Prevalence Rate (Percent) and Prevalence (Number) by Income and State or Territory: BRFSS 2010

In this study, income levels of <$15,000 through ≥$75,000 were examined. In both the current and lifetime asthma prevalence rates, the lowest income (<$15,000) have the highest rates of asthma prevalence. With current asthma prevalence rates, the prevalence was 17.7% and with the lifetime rates, the prevalence was 20.0%

12.2.3.2 Census Tracts Demographics

Figures 12.16 through 12.22 (below) were created using ArcMap and show the 2013 estimated population demographics for poverty and minorities for each census tract. Georgia's ambient air monitors are indicated by white triangles in all maps.

Figure 12.16 shows the percent of Georgia's population that is below poverty for each census tract. Most of the tracts are in the 10-20% range with a total range of 0-100%. The census tracts with the hightest percentages of persons below poverty are located in DeKalb and Chatham counties (100% and 92%, respectively). The majority of Georgia's ambient air monitors are located in census tracts in the 10-20% range.

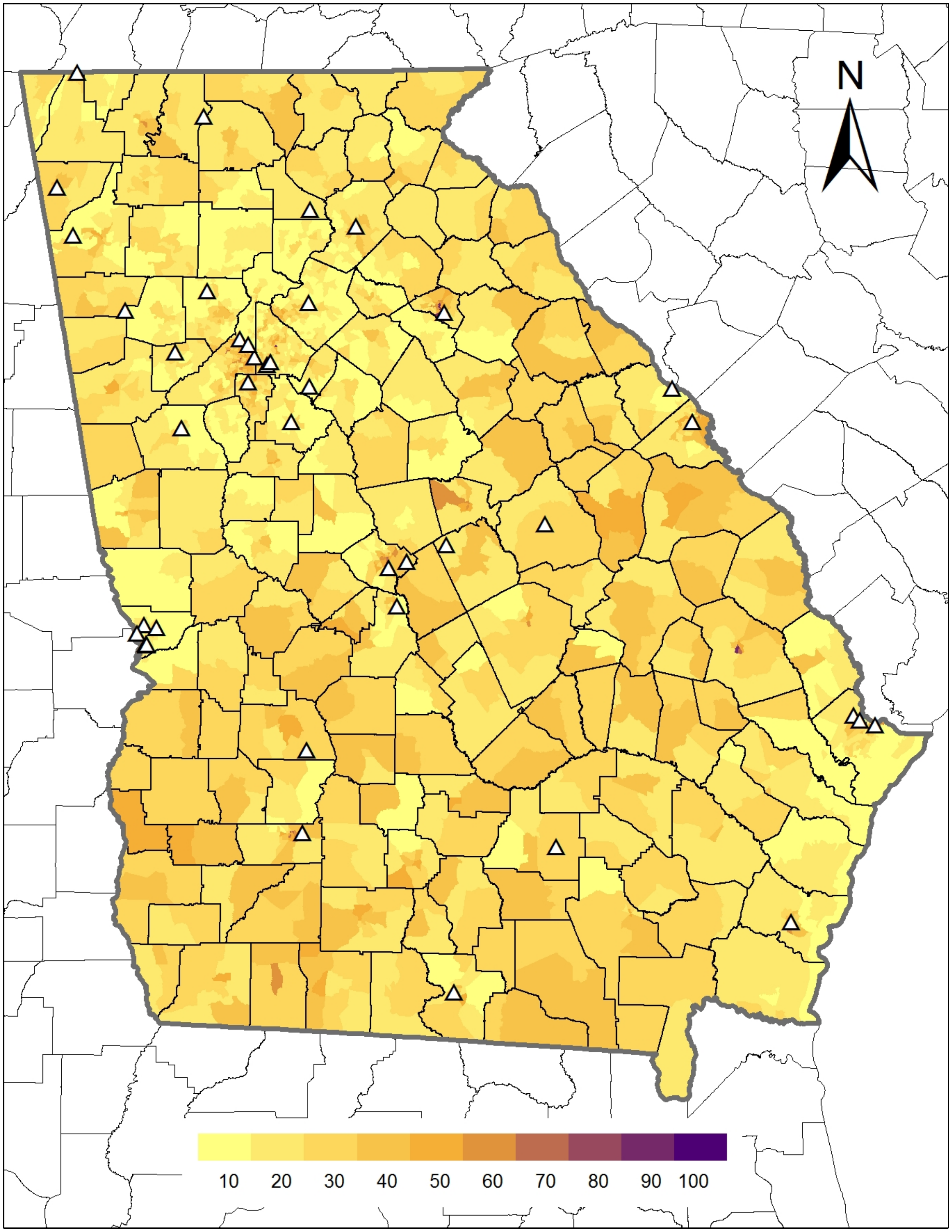


Figure 12.16: Georgia Map Indicating Percent of Population below Poverty for Each Census Tract

Figure 12.17 shows the percent minoirty of each census tract in Georgia. Most of the tracts are in the 10-20% range with a total range of 0-100%. The majority of Georgia's ambient air monitors are located in census tracts in 10-20% range. The tracts with the hightest percentages of minorities are located in DeKalb and Fulton counties, both with 100%.

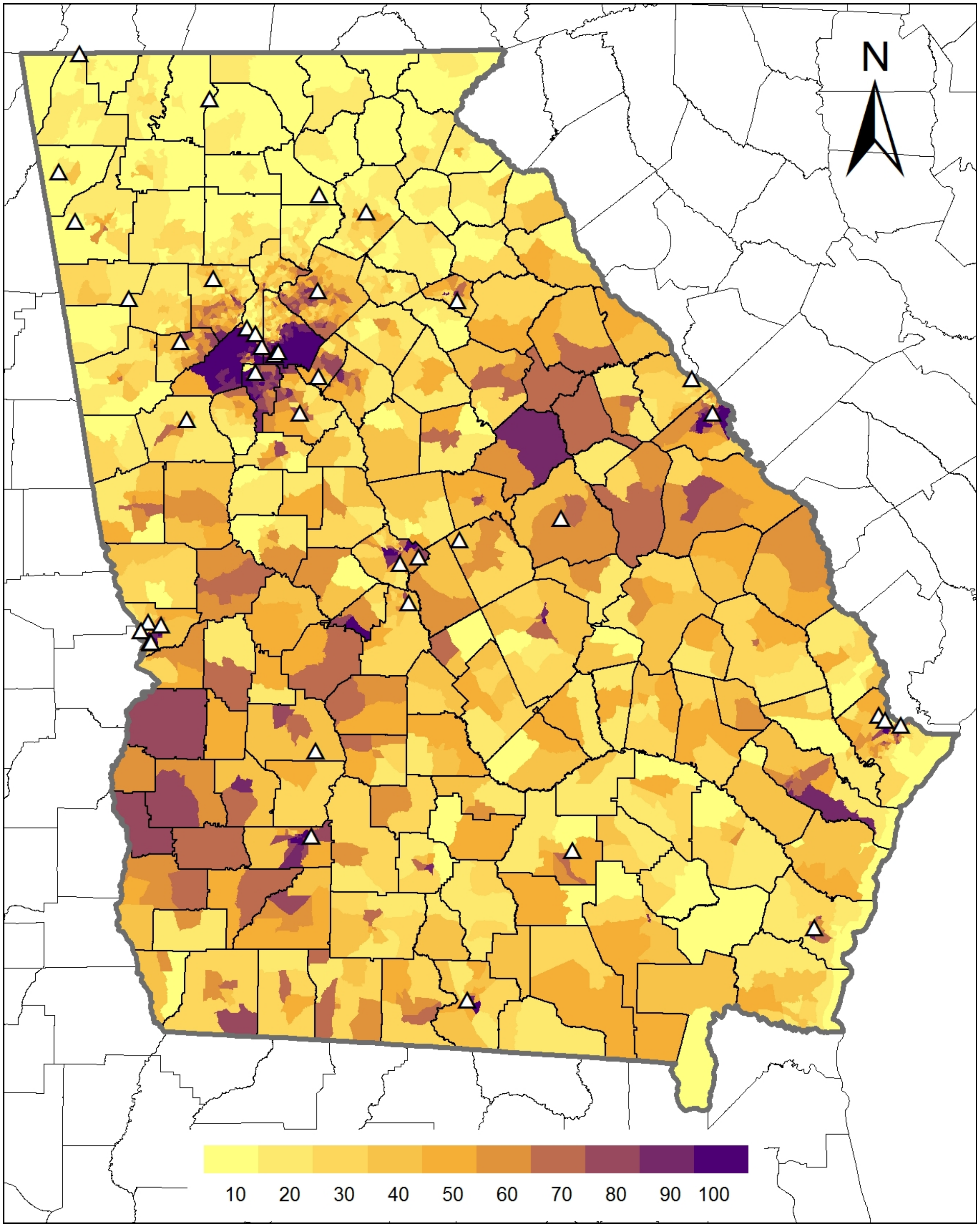


Figure 12.17: Percent Minority by Census Tract in Georgia

In Figures 12.18 through 12.22, below, Georgia's largest MSAs (Atlanta-Sandy Springs-Roswell, Augusta-Richmond County, GA-SC, Columbus, GA-AL, Macon, and Savannah) are examined more closely for ambient air monitors in areas with percent below poverty and percent minority demographics.

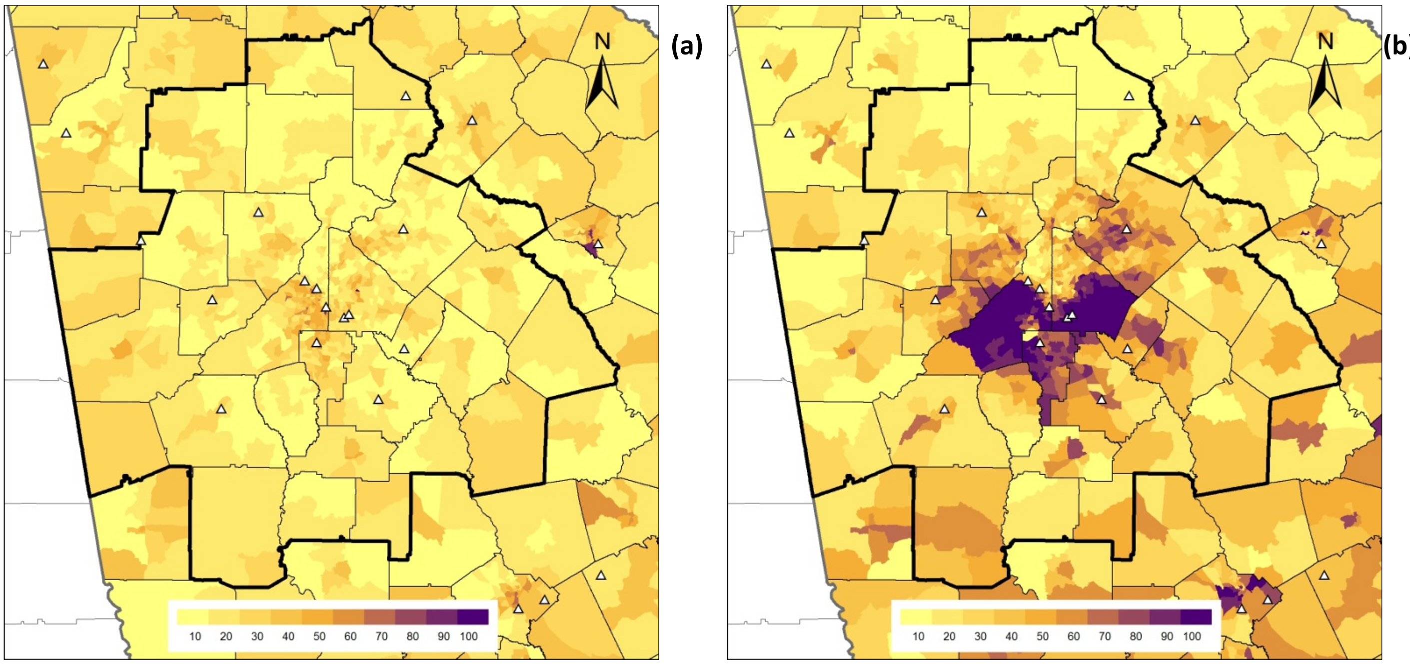


Figure 12.18: Percent of the Population in the Atlanta-Sandy Springs-Roswell MSA (a) below Poverty and (b) Minority

The majority of the ambient air monitors in the Atlanta-Sandy Springs-Roswell MSA are located within census tracts where 10-20% and 20-30% of the population is below poverty (Figure 12.18a) and where 40-50% and 60-70% of the population is a minority (Figure 12.18b).

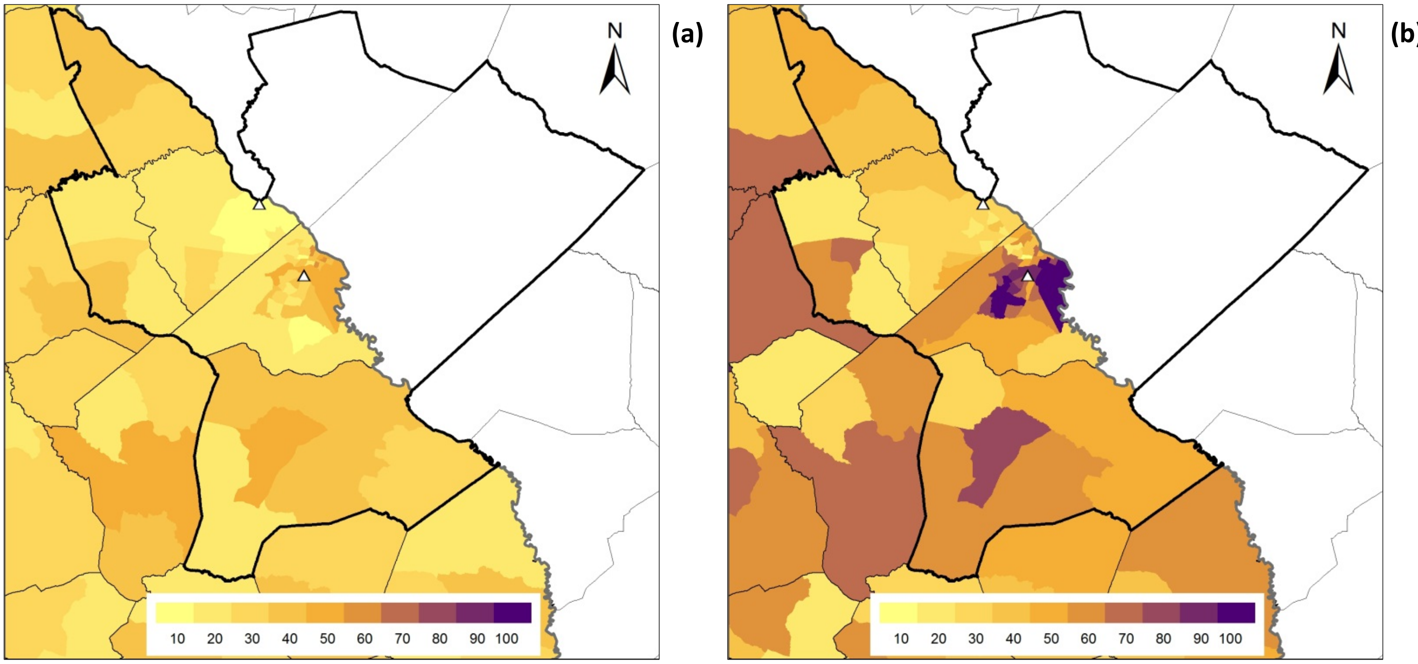


Figure 12.19: Percent of the Population in the Augusta-Richmond County GA-SC MSA (a) below Poverty and (b) Minority

Ambient air monitors in the Augusta-Richmond County GA-SC MSA are located within census tracts with 0-10% and 20-30% of the population below poverty (Figure 12.19a). For percent minority, Figure 12.19b shows one monitor is located in the 20-30% range and the other is located in the 60-70% range.

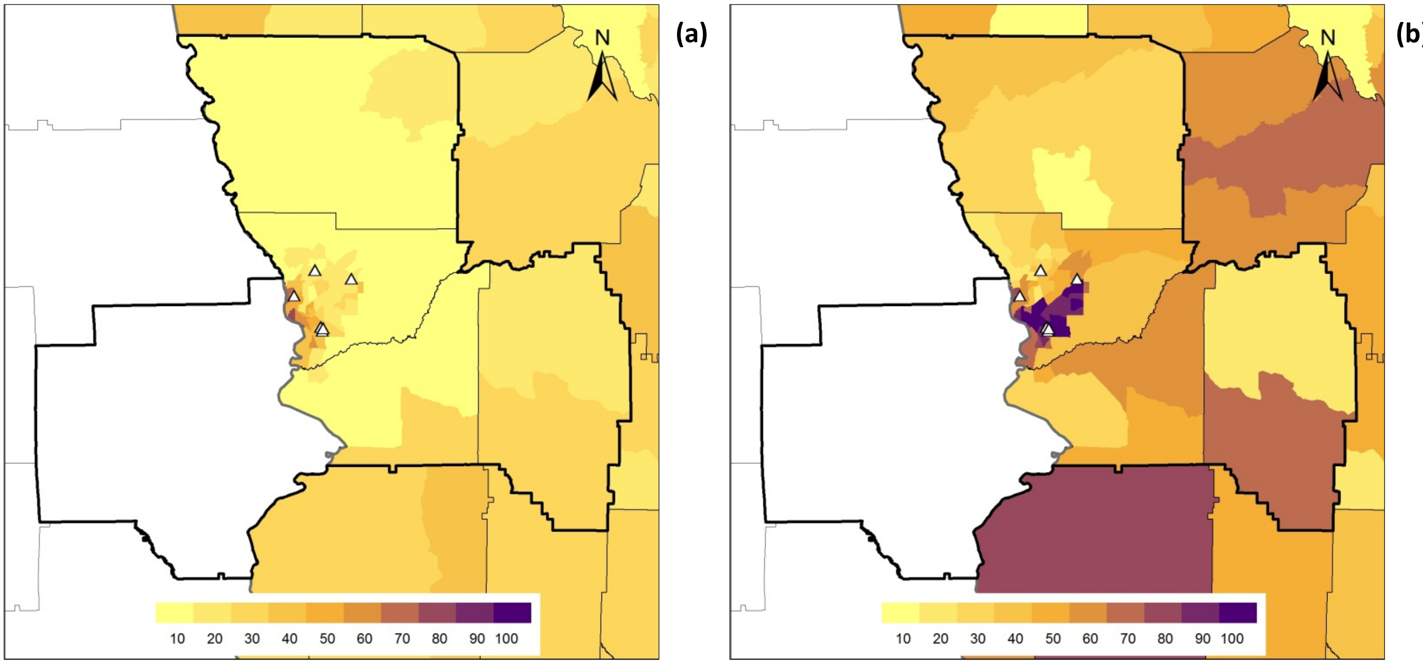


Figure 12.20: Percent of the Population in the Columbus, GA-AL MSA (a) below Poverty and (b) Minority

In the Columbus GA-AL MSA, two monitors are in the 10-20%, one is in the 30-40%, and three are in the 40-50% range for percent of population below poverty (Figure 12.20a). For percent minority (Figure 12.20b), the majority of monitors are located in census tracts in the 50-60% and 90-100% range.

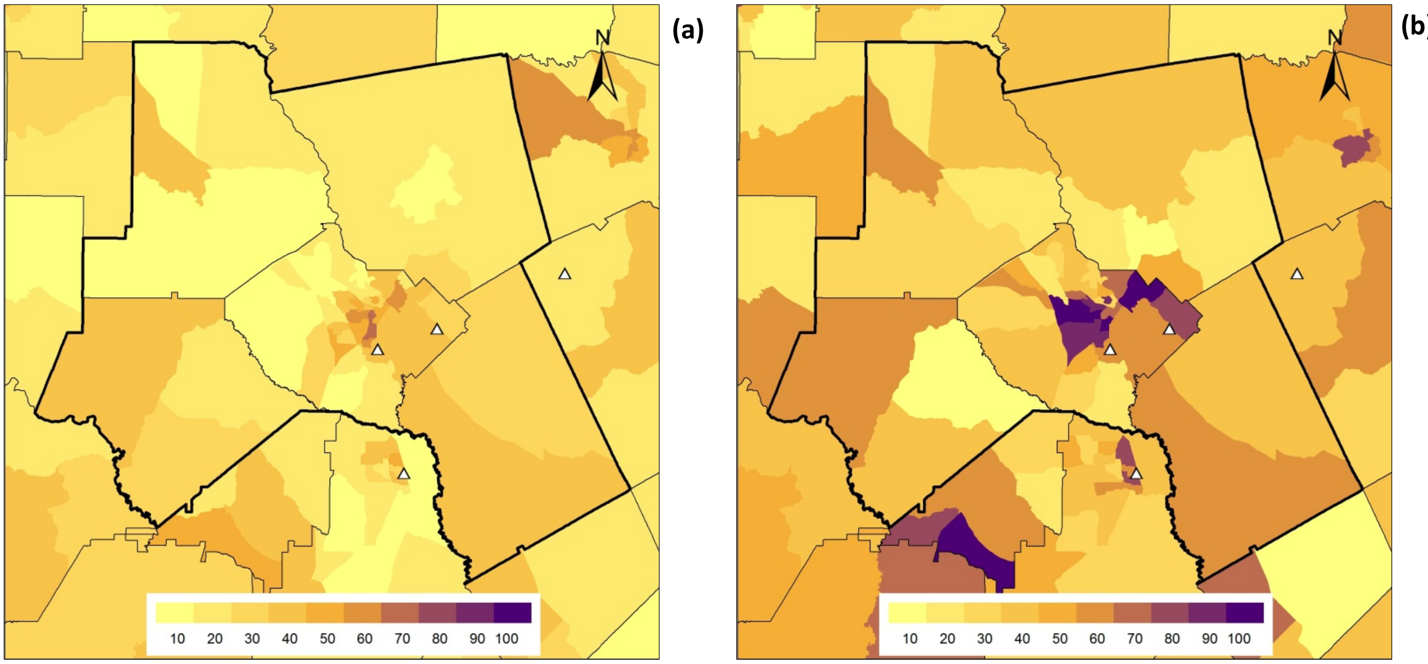


Figure 12.21: Percent of the Population in the Macon MSA (a) below Poverty and (b) Minority

Both ambient air monitors in the Macon MSA are located in census tracts with 30-40% of population below poverty (Figure 12.21a) and 50-60% of minority population (Figure 12.21b).

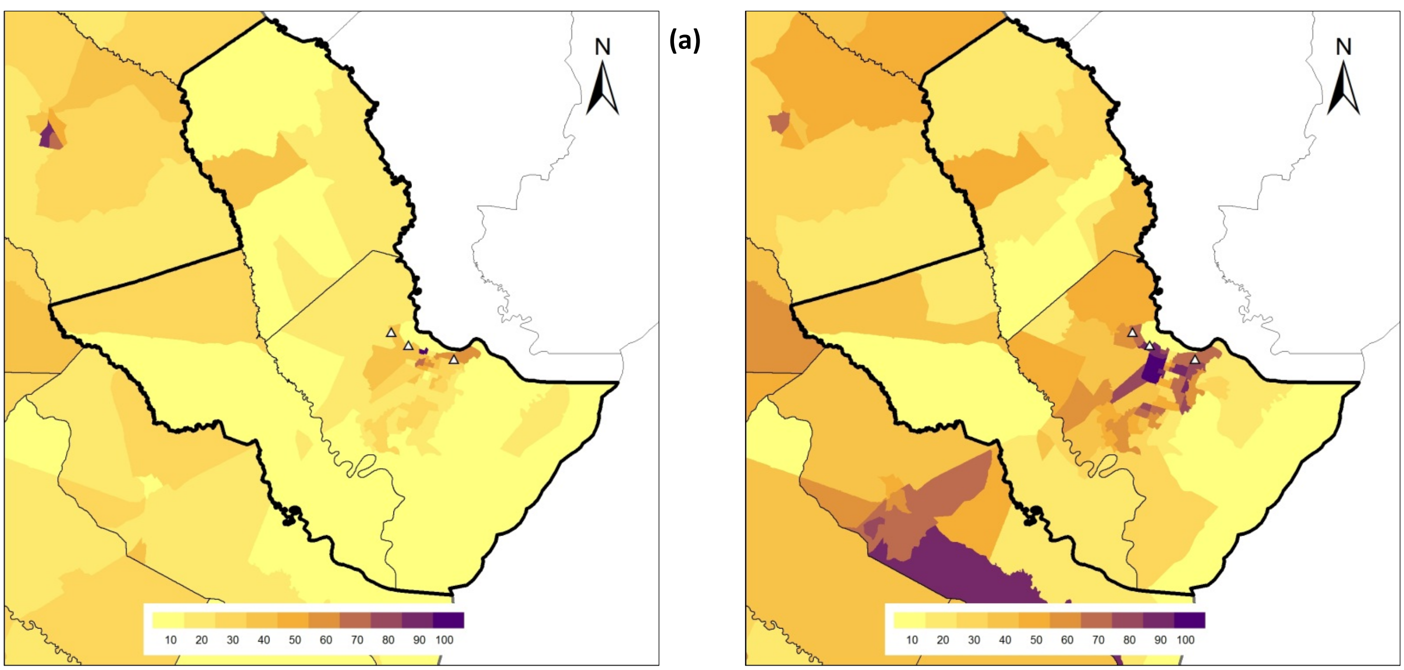


Figure 12.22: Percent of the Population in the Savannah MSA (a) below Poverty and (b) Minority

Two of the ambient air monitors in the Savannah MSA are located in an area with 30-40% population below poverty and the other is in an area with 50-60% population below poverty

(Figure 12.22a). Two ambient air monitors are located in areas with 60-70% minority population and the third with 80-90% minority population (Figure 12.22b).

With this assessment of the location of GA EPD’s ambient air monitors, it appears that there is sufficient coverage in areas with populations below poverty and minority populations. As part of the 5-Year Assessment, GA EPD is required to ensure its ability to support air quality characterization for areas with high populations of susceptible individuals. This assessment considered the maps produced with ArcMap and the U.S. Census Bureau’s demographic statistics. For the bigger MSAs across the state of Georgia, there is good representation of these areas with populations below poverty and minority populations with the placement of the ambient air monitors. In most cases, across the state of Georgia, there is good representation of areas with populations below poverty and minority population with the placement of the ambient air monitors.

13.0 Air Quality Summary

National Ambient Air Quality Standards (NAAQS)

The NAAQS are established for each pollutant for which air quality criteria have been issued. The EPA is to set standards where “the attainment and maintenance are requisite to protect public health” with “an adequate margin of safety.” In 1971, the EPA established standards for six “criteria” pollutants as required by the Clean Air Act. The standards have changed over time to keep up with improvements in scientific knowledge and as this document is written are shown in the following table. There have been proposed changes, and for the most up to date standards refer to EPA’s website (http://www.epa.gov/air/criteria.html).

Pollutant [final rule cite]		Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide [76 FR 54294, Aug 31, 2011]		primary	8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Lead [73 FR 66964, Nov 12, 2008]		primary and secondary	Rolling 3 month average	0.15 $\mu g/m^3$ (1)	Not to be exceeded
Nitrogen Dioxide [75 FR 6474, Feb 9, 2010] [61 FR 52852, Oct 8, 1996]		primary	1-hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		primary and secondary	Annual	53 ppb (2)	Annual Mean
Ozone [73 FR 16436, Mar 27, 2008]		primary and secondary	8-hour	0.075 ppm (3)	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particle Pollution Dec 14, 2012	$PM_{2.5}$	primary	Annual	12 $\mu g/m^3$	annual mean, averaged over 3 years
		secondary	Annual	15 $\mu g/m^3$	annual mean, averaged over 3 years
		primary and secondary	24-hour	35 $\mu g/m^3$	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24-hour	150 $\mu g/m^3$	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide [75 FR 35520, Jun 22, 2010] [38 FR 25678, Sept 14, 1973]		primary	1-hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

(1) Final rule signed October 15, 2008. The 1978 lead standard (1.5 µg/m3 as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated

nonattainment for the 1978, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.
(2) The official level of the annual NO2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.
(3) Final rule signed March 12, 2008. The 1997 ozone standard (0.08 ppm, annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years) and related implementation rules remain in place. In 1997, EPA revoked the 1-hour ozone standard (0.12 ppm, not to be exceeded more than once per year) in all areas, although some areas have continued obligations under that standard ("anti-backsliding"). The 1-hour ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is less than or equal to 1.
(4) Final rule signed June 2, 2010. The 1971 annual and 24-hour SO2 standards were revoked in that same rulemaking. However, these standards remain in effect until one year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.

http://www.epa.gov/air/criteria.html

Table 13.1: National Ambient Air Quality Standards

As shown in Table 13.1, there are two categories for ambient air quality standards, primary and secondary. Primary standards are intended to protect the most sensitive individuals in a population. These "sensitive" individuals include children, the elderly, and people with chronic illnesses. The secondary standards are designed to protect public welfare or the quality of life. This includes visibility protection, limiting economic damage, damage to wildlife, the climate, or man-made material. The varied averaging times are to address the health impacts of each pollutant. Short-term averages are to protect against acute effects. Long-term averages are to protect against chronic effects.

The Georgia ambient air monitoring network provides information on the measured concentrations of criteria and non-criteria pollutants at pre-selected locations. The 2013 Georgia Air Sampling Network collected data at 40 locations in 30 counties, including all sites monitored during segmented sections of the year. Monitoring occurs year-round, although some pollutants have various required monitoring periods. Ozone, with the exception of the South DeKalb site, is sampled from March through October, and the continuous (hourly) Photochemical Assessment Monitoring Stations (PAMS) volatile organic compounds are sampled from June through August. Please note that not all pollutants are monitored at all sites. All official monitoring performed in support of the National Ambient Air Quality Standards (NAAQS) must use U.S. EPA-defined reference methods described in 40 CFR, Appendix L, or equivalent methods designated in accordance with Part 53 of that chapter. All data collected in the network undergoes an extensive quality assurance review and is then submitted to the Air Quality System (AQS) database that is maintained by the EPA.

Air Quality Index (AQI)

The Air Quality Index (AQI) is a national air standard rating system developed by the U.S. Environmental Protection Agency. The AQI is used throughout Georgia to provide the public, on a daily basis, with an analysis of air pollution levels and possible related health risks. Generally, an index scale of 0 to 500 is used to assess the quality of air, and these numbers are synchronized with a corresponding descriptor word such as: Good, Moderate, Unhealthy for Sensitive Groups, Unhealthy, Very Unhealthy, and Hazardous.

To protect public health the EPA has set an AQI value of 100 to correspond to the NAAQS for the following pollutants: Ozone (O_3), Sulfur Dioxide (SO_2), Carbon Monoxide (CO), Particulate Matter 10 (PM_{10}), Particulate Matter 2.5 ($PM_{2.5}$), and Nitrogen Dioxide (NO_2). The AQI for a reporting region equates to the highest rating recorded for any pollutant within that region. For example, if EPA reports an AQI level of 90 for ozone for a given metropolitan area, residents of the area would know that the ozone level for the region is at the high end of the moderate range. Those residents would also know that ozone is the pollutant with the highest AQI reading for that hour, and that all other measured pollutants are therefore in the good or moderate range. On days when two or more pollutants have AQI values greater than 100, the pollutant with the highest index level is reported, but information on any other pollutants above 100 may also be reported. Therefore, the larger the AQI value, the greater level of air pollution present, and the greater expectation of potential health concerns. Table 13.2 below shows how the recorded concentrations correspond to the AQI index values, descriptors and health advisories.

GA EPD determines the index number on a daily basis for each of the pollutants and reports the number to AirNow (www.airnow.gov). The highest of the figures and corresponding pollutant are reported for each major metropolitan area in Georgia.

Maximum Pollutant Concentration									
$PM_{2.5}$ (24hr) µg/m^3	PM_{10} (24hr) µg/m^3	SO_2 (24hr) ppm	O_3 (8hr) ppm	O_3 (1hr) ppm	CO (8hr) ppm	NO_2 (1hr) ppm	AQI Value	Descriptor	EPA Health Advisory
0 – 12.0	0 – 54	0 – 0.034	0 – 0.059	None	0 – 4.4	None	0 to 50	Good (green)	Air quality is considered satisfactory, and air pollution poses little or no risk.
12.1 – 35.4	55 – 154	0.035 – 0.144	0.060 – 0.075	None	4.5 – 9.4	None	51 to 100	Moderate (yellow)	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people. For example, people who are unusually sensitive to the condition of the air may experience respiratory symptoms.
36.5 – 55.4	155 – 254	0.145 – 0.224	0.076 – 0.095	0.125 – 0.164	9.5 – 12.4	None	101 to 150	Unhealthy for Sensitive Groups (orange)	Members of sensitive groups (people with lung or heart disease) are at greater risk from exposure to particle pollution. Those with lung disease are at risk from exposure to ozone. The general public is not likely to be affected in this range.
55.5 – 150.4	255 – 354	0.225 – 0.304	0.096 – 0.115	0.165 – 0.204	12.5 – 15.4	None	151 to 200	Unhealthy (red)	Everyone may begin to experience health effects in this range. Members of sensitive groups may experience more serious health effects.
150.5 – 250.4	355 – 424	0.305 – 0.604	0.116 – 0.374	0.205 – 0.404	15.5 – 30.4	0.65 – 1.24	201 to 300	Very Unhealthy (purple)	AQI values in this range trigger a health alert. Everyone may experience more serious health effects. When the AQI is in this range because of ozone, most people should restrict their outdoor exertion to morning or late evening hours to avoid high ozone exposures.
250.5 – 500.4	425 – 604	0.605 – 1.004	None	0.405 – 0.604	30.5 – 50.4	1.25 – 2.04	301 to 500	Hazardous (maroon)	AQI values over 300 trigger health warnings of emergency conditions. The entire population is more likely to be affected.

Table 13.2: Detailed AQI Values by Pollutant

It is important to note that the AQI value is designed for short-term use only. The value corresponding with each day provides the public with an indicator. People with asthma, lung disease, heart disease, and other susceptible populations can use the daily AQI to stay informed of the current conditions. This can certainly provide a jogger with the information needed to determine whether it is safe to exercise outside or not. However, this system only addresses air pollution in terms of acute health effects over time periods of 24 hours or less and does not provide an indication of chronic pollution exposure over months or years. As the AQI index is a valuable tool for public use, it cannot be used to determine whether a site is in attainment or not. Real-time data that support the Air Quality Index require continuous samplers. Continuous samplers produce hourly averaged data that is available fifteen minutes after the end of each hour. The immediate availability of this data allows the public to make informed decisions regarding their outdoor physical activities. At this time, Georgia EPD uses continuous $PM_{2.5}$ samplers that are not set up as being fully equivalent to the reference method. This means that data from these continuous $PM_{2.5}$ samplers cannot be used for determining if an area is in attainment of the NAAQS; only data from the reference method may be used. As a result, sites that may have a high number of days above the AQI value of 100 may not necessarily be in nonattainment, though often times a correlation is observed.

Index reporting is required for all urban areas with a population exceeding 350,000, which in Georgia include the Atlanta-Sandy Springs-Marietta MSA, the Augusta-Richmond County Georgia-South Carolina MSA, and the Chattanooga Tennessee-Georgia MSA. As an added service to the public, Georgia EPD calculates AQI values for the Albany, Athens, Columbus, Macon, and Savannah areas. Although the Chattanooga Tennessee-Georgia MSA AQI reporting is covered by the Chattanooga-Hamilton County Air Pollution Control Bureau, the information from this MSA is included in this discussion.

In Figure 13.1, the numbers of days each MSA in the state of Georgia had AQI values above 100 are shown. The data was extracted from AQS using all available historical data. This figure applies current AQI standards to all years, so historical data may show more exceedances than in the past because current AQI thresholds are lower. The Atlanta-Sandy Springs-Marietta MSA consistently has the highest number of days above 100. There was a consistent increase across the state from 1998 through 2000, and then in 2004 the values dropped. There was some fluctuation again, but in general the values declined in 2008, rose slightly in 2011 and declined again in 2013.

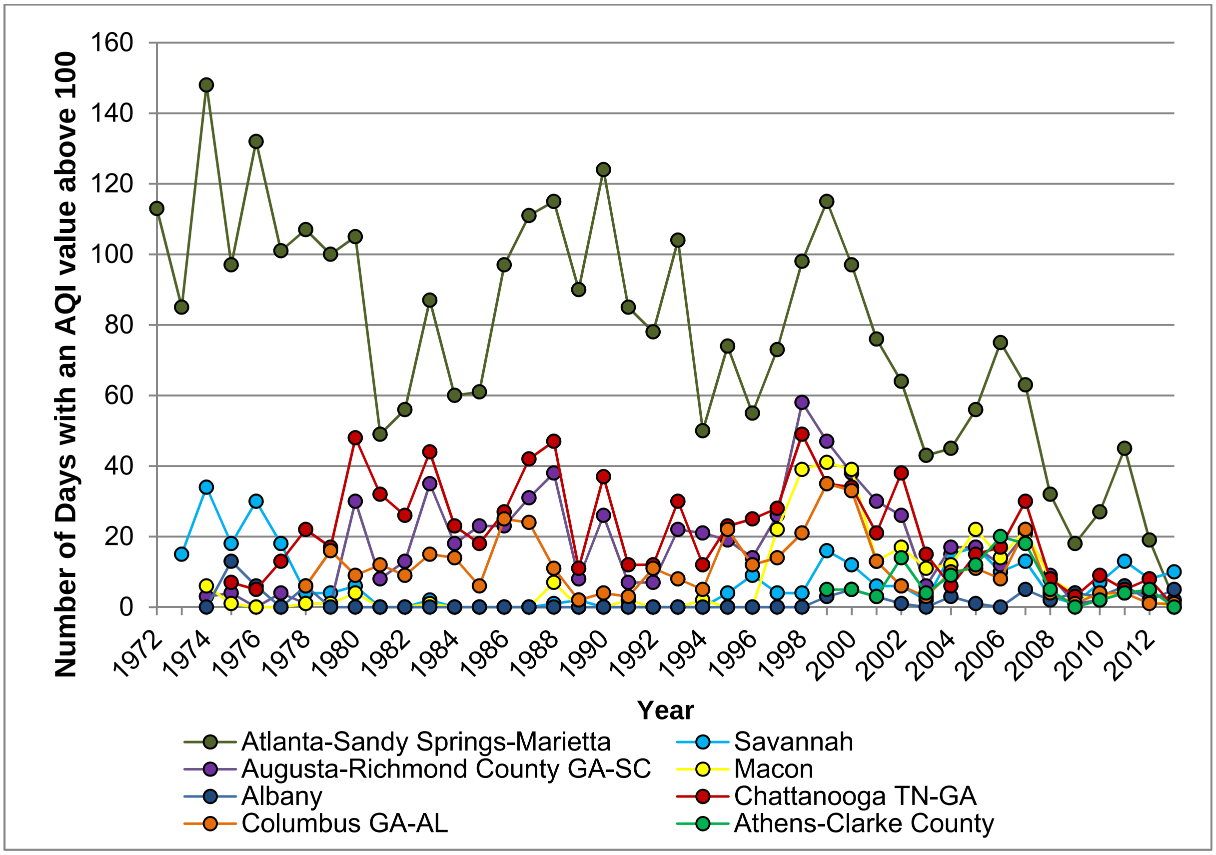


Figure 13.1: Number of Days with an AQI value above 100 across Georgia from 1972 to 2013

The following table outlines each metropolitan statistical area (MSA) as defined by the U.S. Census Bureau, in which Georgia EPD currently has ambient air monitors. The table was taken from EPA's guide, 'Designing a Network Assessment for an Ambient Air Monitoring Program' (U.S. EPA 2009). The column entitled 'Status of NAAQS and Major Risk Issues' addresses whether a site is in Attainment or Nonattainment for each of the criteria pollutants listed above. If an area was previously a nonattainment area and then meets the standards and additional redesignation requirements in the CAA [Section 107(d)(3)(E)], the area is labeled as 'Maintenance'. The classification 'Attainment/Unclassifiable' is defined as meeting the standard or expected to be meeting the standard despite a lack of monitoring data. With the drafting of this document in January 2015, the most current designations of the standards were used in the assessment. The next column, 'Extent of NAAQS Violations', cites the location of a violation within the MSA. Violations are identified by county, and in some cases, a partial section of a county.

In Table 13.3, 'Days above 100 on the AQI' was calculated using data pulled from EPA's Air Quality System (AQS) for the years 2011 through 2013. A three year average is a better representation of changes in air quality since year to year changes can be variable. The AQS AQI index provides the daily maximum for each MSA. However, the AQI value provided with the summary report does not specify the parameter. In order to determine which criteria pollutant the daily AQI value was representing, the AirData website (http://www.epa.gov/airdata/index.html/) was used as a secondary source, as values reported in AQS were compared to the like values in the AirData graphs and tables. For each

MSA, the total days for each year were totaled and then the average was taken for all three years. With the Columbus GA-AL, Augusta-Richmond County, and Chattanooga TN-GA MSAs, it should be noted that each MSA is included in its entirety, including sites in the respective adjoining states.

The final category, 'Contributions to Downwind Violations' examines the act of air pollution from an area relocating to another area based on wind patterns. An attempt was made to determine an impact on areas of nonattainment using wind roses found in Appendix C to study the direction of the wind in a given quarter or year. Though wind roses were examined, in some cases evidence was inconclusive, and the potential of downwind violations in neighboring areas are shown in the following table.

For maps of the areas listed below, refer to Figures 13.2 through 13.4.

Table 13.3: Criteria Pollutants Current Status of the NAAQS and the 2011-2013 Average AQI
(as of January 2015)
(P) indicates the status applies to only part of that county

Rome MSA

Pollutant	Status of NAAQS and Major Risk Issues	Extent of NAAQS Violations	Days Above 100 on the AQI	Contributions to Downwind Violations
Ozone	Attainment	N/A	N/A	N/A
CO	Attainment	N/A	N/A	N/A
SO_2	Attainment	N/A	0.00	N/A
NO_2	Attainment	N/A	N/A	N/A
$PM_{2.5}$-24-Hour	Attainment/Unclassifiable	N/A	0.00	N/A
$PM_{2.5}$-Annual	Attainment	N/A		N/A
PM_{10}	Attainment	N/A	N/A	N/A
Pb	Attainment	N/A	N/A	N/A

Brunswick MSA

Pollutant	Status of NAAQS and Major Risk Issues	Extent of NAAQS Violations	Days Above 100 on the AQI	Contributions to Downwind Violations
Ozone	Attainment	N/A	0.00	N/A
CO	Attainment	N/A	N/A	N/A
SO_2	Attainment	N/A	N/A	N/A
NO_2	Attainment	N/A	N/A	N/A
$PM_{2.5}$-24-Hour	Attainment/Unclassifiable	N/A	0.00	N/A
$PM_{2.5}$-Annual	Attainment	N/A		N/A
PM_{10}	Attainment	N/A	N/A	N/A
Pb	Attainment	N/A	N/A	N/A

Valdosta MSA

Pollutant	Status of NAAQS and Major Risk Issues	Extent of NAAQS Violations	Days Above 100 on the AQI	Contributions to Downwind Violations
Ozone	Attainment	N/A	N/A	N/A
CO	Attainment	N/A	N/A	N/A
SO_2	Attainment	N/A	N/A	N/A
NO_2	Attainment	N/A	N/A	N/A
$PM_{2.5}$-24-Hour	Attainment/Unclassifiable	N/A	0.00	N/A
$PM_{2.5}$-Annual	Attainment	N/A		N/A
PM_{10}	Attainment	N/A	N/A	N/A
Pb	Attainment	N/A	N/A	N/A

Warner Robins MSA

Pollutant	Status of NAAQS and Major Risk Issues	Extent of NAAQS Violations	Days Above 100 on the AQI	Contributions to Downwind Violations
Ozone	Attainment	N/A	N/A	N/A
CO	Attainment	N/A	N/A	N/A
SO_2	Attainment	N/A	N/A	N/A
NO_2	Attainment	N/A	N/A	N/A
$PM_{2.5}$-24-Hour	Attainment/Unclassifiable	N/A	0.00	N/A
$PM_{2.5}$-Annual	Attainment	N/A		N/A
PM_{10}	Attainment	N/A	N/A	N/A
Pb	Attainment	N/A	N/A	N/A

Dalton MSA

Pollutant	Status of NAAQS and Major Risk Issues	Extent of NAAQS Violations	Days Above 100 on the AQI	Contributions to Downwind Violations
Ozone	Maintenance	Murray County	0.00	N/A
CO	Attainment	N/A	N/A	N/A
SO_2	Attainment	N/A	N/A	N/A
NO_2	Attainment	N/A	N/A	N/A
$PM_{2.5}$-24-Hour	Attainment/Unclassifiable	N/A	N/A	N/A
$PM_{2.5}$-Annual	Attainment	N/A		N/A
PM_{10}	Attainment	N/A	N/A	N/A
Pb	Attainment	N/A	N/A	N/A

Albany MSA

Pollutant	Status of NAAQS and Major Risk Issues	Extent of NAAQS Violations	Days Above 100 on the AQI	Contributions to Downwind Violations
Ozone	Attainment	N/A	N/A	N/A
CO	Attainment	N/A	N/A	N/A
SO_2	Attainment	N/A	N/A	N/A
NO_2	Attainment	N/A	N/A	N/A

$PM_{2.5}$-24-Hour	Attainment/Unclassifiable	N/A	4.33	Potentially Valdosta
$PM_{2.5}$-Annual	Attainment	N/A		
PM_{10}	Attainment	N/A	N/A	N/A
Pb	Attainment	N/A	N/A	N/A

Gainesville MSA

Pollutant	Status of NAAQS and Major Risk Issues	Extent of NAAQS Violations	Days Above 100 on the AQI	Contributions to Downwind Violations
Ozone	Attainment	N/A	N/A	N/A
CO	Attainment	N/A	N/A	N/A
SO_2	Attainment	N/A	N/A	N/A
NO_2	Attainment	N/A	N/A	N/A
$PM_{2.5}$-24-Hour	Attainment/Unclassifiable	N/A	0.00	N/A
$PM_{2.5}$-Annual	Nonattainment	Hall County		N/A
PM_{10}	Attainment	N/A	N/A	N/A
Pb	Attainment	N/A	N/A	N/A

Athens-Clarke County MSA

Pollutant	Status of NAAQS and Major Risk Issues	Extent of NAAQS Violations	Days Above 100 on the AQI	Contributions to Downwind Violations
Ozone	Attainment	N/A	2.00	Potentially South Carolina
CO	Attainment	N/A	N/A	N/A
SO_2	Attainment	N/A	N/A	N/A
NO_2	Attainment	N/A	N/A	N/A
$PM_{2.5}$-24-Hour	Attainment/Unclassifiable	N/A	1.00	Potentially South Carolina
$PM_{2.5}$-Annual	Attainment	N/A		
PM_{10}	Attainment	N/A	N/A	N/A
Pb	Attainment	N/A	N/A	N/A

Macon MSA

Pollutant	Status of NAAQS and Major Risk Issues	Extent of NAAQS Violations	Days Above 100 on the AQI	Contributions to Downwind Violations
Ozone	Attainment	N/A	2.67	Potentially Gordon and Sandersville
CO	Attainment	N/A	N/A	N/A
SO_2	Attainment	N/A	0.00	N/A
NO_2	Attainment	N/A	N/A	N/A
$PM_{2.5}$-24-Hour	Attainment/Unclassifiable	N/A	0.00	N/A
$PM_{2.5}$-Annual	Attainment	N/A		N/A
PM_{10}	Attainment	N/A	N/A	N/A
Pb	Attainment	N/A	N/A	N/A

Columbus Georgia-Alabama MSA

Pollutant	Status of NAAQS and Major Risk Issues	Extent of NAAQS Violations	Days Above 100 on the AQI	Contributions to Downwind Violations
Ozone	Attainment	N/A	0.33	Potentially Phenix City, AL
CO	Attainment	N/A	N/A	N/A
SO_2	Attainment	N/A	N/A	N/A
NO_2	Attainment	N/A	N/A	N/A
$PM_{2.5}$-24-Hour	Attainment/Unclassifiable	N/A	1.67	Potentially Phenix City, AL
$PM_{2.5}$-Annual	Attainment	N/A		N/A
PM_{10}	Attainment	N/A	N/A	N/A
Pb	Attainment	N/A	N/A	N/A

Savannah MSA

Pollutant	Status of NAAQS and Major Risk Issues	Extent of NAAQS Violations	Days Above 100 on the AQI	Contributions to Downwind Violations
Ozone	Attainment	N/A	0.00	N/A
CO	Attainment	N/A	N/A	N/A
SO_2	Attainment	N/A	6.67	N/A
NO_2	Attainment	N/A	N/A	N/A
$PM_{2.5}$-24-Hour	Attainment/Unclassifiable	N/A	3.67	Potentially South Carolina
$PM_{2.5}$-Annual	Attainment	N/A		N/A
PM_{10}	Attainment	N/A	N/A	N/A
Pb	Attainment	N/A	N/A	N/A

Augusta-Richmond County Georgia-South Carolina MSA

Pollutant	Status of NAAQS and Major Risk Issues	Extent of NAAQS Violations	Days Above 100 on the AQI	Contributions to Downwind Violations
Ozone	Attainment	N/A	2.00	Potentially South Carolina
CO	Attainment	N/A	N/A	N/A
SO_2	Attainment	N/A	0.33	N/A
NO_2	Attainment	N/A	N/A	N/A
$PM_{2.5}$-24-Hour	Attainment/Unclassifiable	N/A	1.00	Potentially South Carolina
$PM_{2.5}$-Annual	Attainment	N/A		
PM_{10}	Attainment	N/A	0.00	N/A
Pb	Attainment	N/A	N/A	N/A

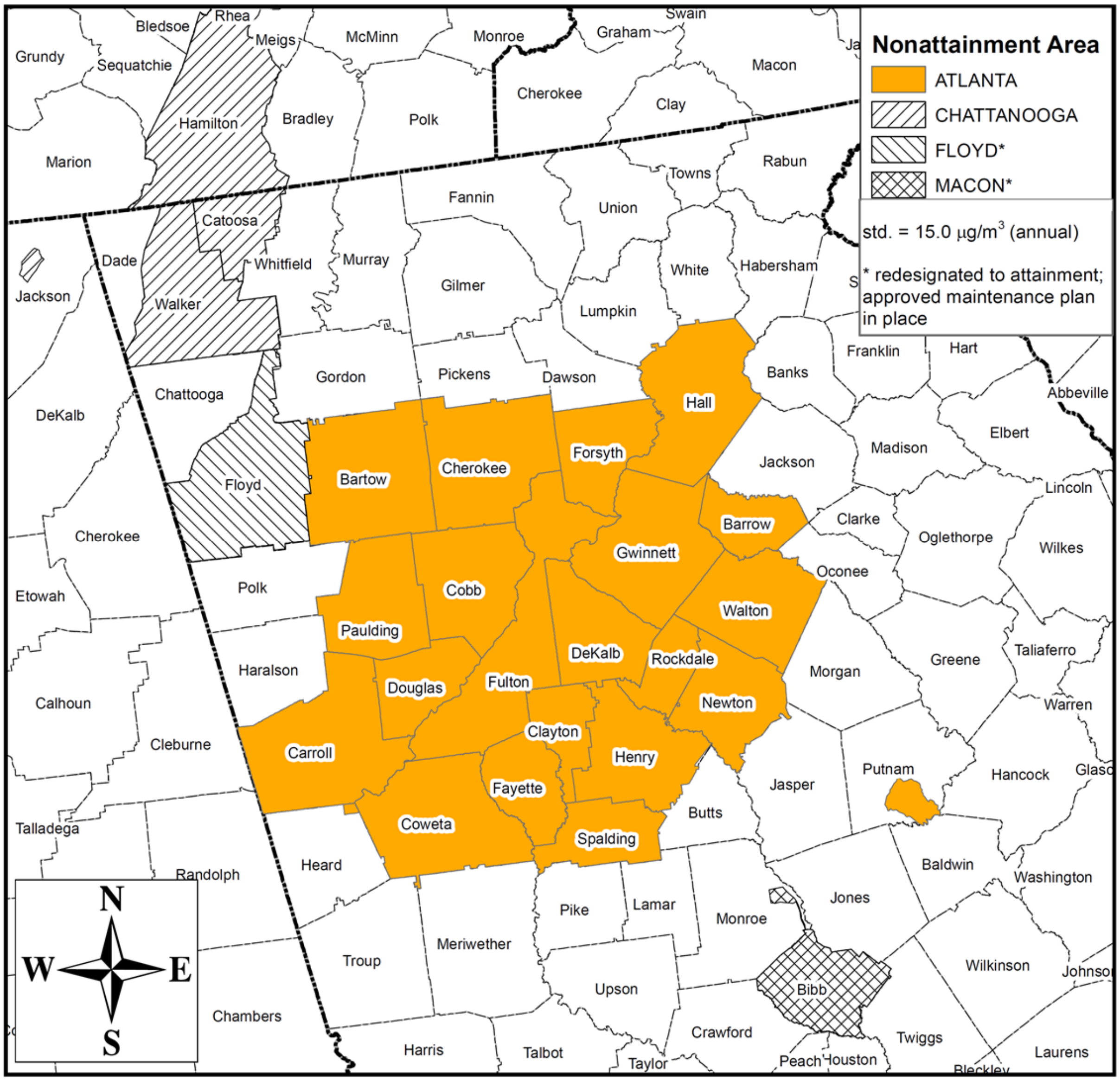
Atlanta-Sandy Spring-Marietta MSA

Pollutant	Status of NAAQS and Major Risk Issues	Extent of NAAQS Violations	Days Above 100 on the AQI	Contributions to Downwind Violations
Ozone	Marginal Nonattainment	Bartow, Cherokee, Clayton, Cobb, Coweta, DeKalb, Douglas, Fayette, Forsyth, Fulton, Gwinnett, Henry, Newton, Paulding, Rockdale	20.67	Potentially Gainesville, Macon, Athens-Clarke County MSAs
CO	Attainment	N/A	0.00	N/A
SO_2	Attainment	N/A	0.00	N/A
NO_2	Attainment	N/A	0.00	N/A
$PM_{2.5}$-24-Hour	Attainment/Unclassifiable	N/A	1.33	Potentially Gainesville, Macon, Athens-Clarke County MSAs
$PM_{2.5}$-Annual	Nonattainment	Barrow, Bartow, Carroll, Cherokee, Clayton, Cobb, Coweta, DeKalb, Douglas, Fayette, Forsyth, Fulton, Gwinnett, Hall, Heard(P),Henry, Newton, Paulding, Putnam(P),Rockdale, Spalding, Walton Counties		
PM_{10}	Attainment	N/A	0.00	N/A
Pb	Attainment	N/A	0.00	N/A

Chattanooga Tennessee-Georgia MSA

Pollutant	Status of NAAQS and Major Risk Issues	Extent of NAAQS Violations	Days Above 100 on the AQI	Contributions to Downwind Violations
Ozone	Attainment	N/A	3.33	Potentially Rome and Dalton MSAs
CO	Attainment	N/A	N/A	N/A
SO_2	Attainment	N/A	N/A	N/A
NO_2	Attainment	N/A	N/A	N/A
$PM_{2.5}$-24-Hour	Attainment/Unclassifiable	N/A	1.00	N/A
$PM_{2.5}$-Annual	Attainment	N/A		Potentially Rome and Dalton MSAs
PM_{10}	Attainment	N/A	N/A	N/A
Pb	Attainment	N/A	N/A	N/A

To show the air quality assessment in relation to the NAAQS in Table 13.3, the areas of attainment/unclassifiable, nonattainment, and those redesignated to attainment are displayed in Figures 13.2 through 13.4. Redesignated areas are areas that were formerly nonattainment but which have achieved the specific standard and have been redesignated to attainment by EPA. These areas have EPA-approved plans for maintaining attainment with the standard. Figure 13.7, taken from EPA's website, shows nonattainment areas and those redesignated to attainment for the 1997/2006 $PM_{2.5}$ annual standard. For the $PM_{2.5}$ 24-hour standard the entire state of Georgia is in attainment.

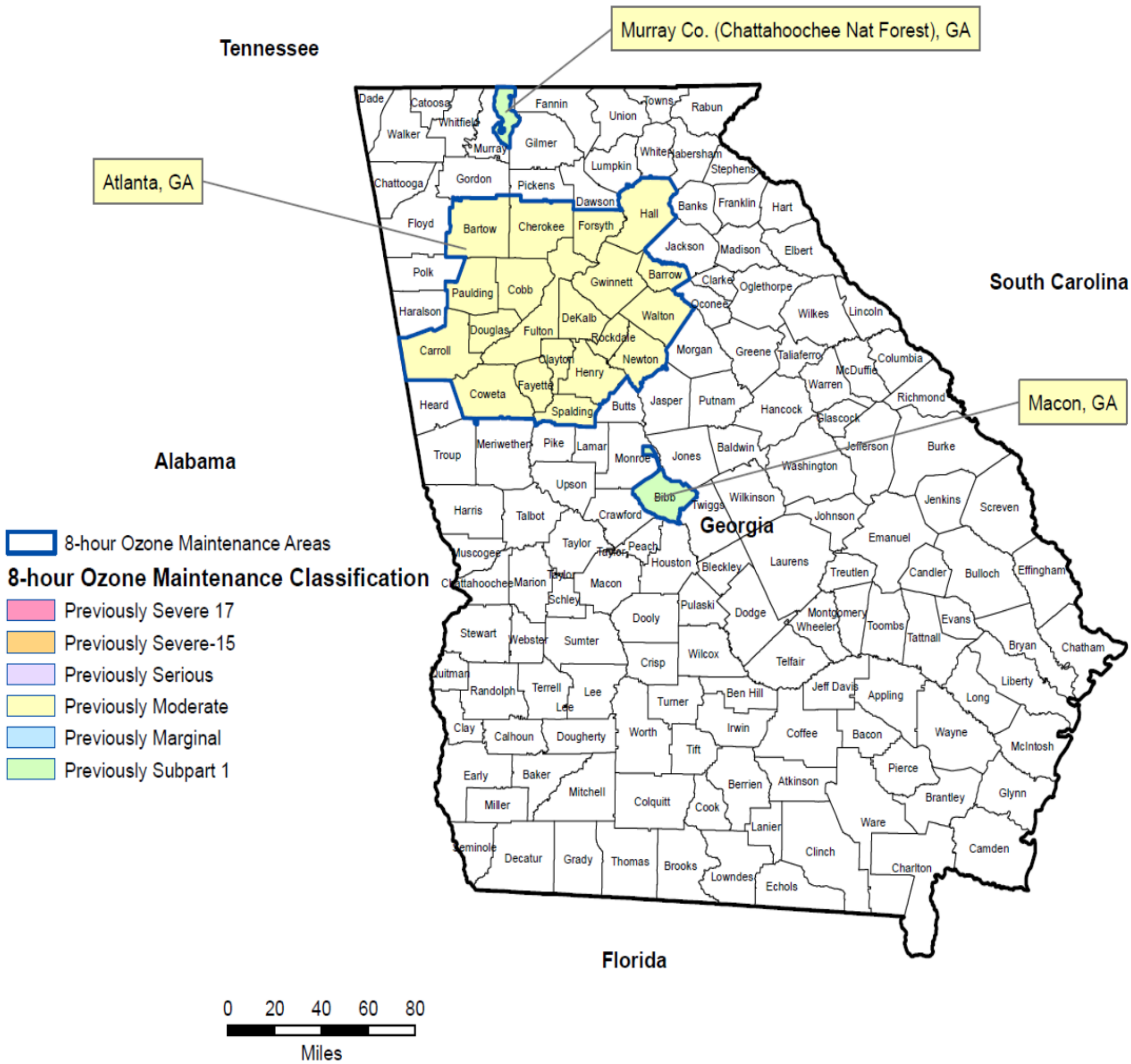


(http://www.georgiaair.org/airpermit/html/planningsupport/naa.htm)

Figure 13.2: Georgia's $PM_{2.5}$ Nonattainment Area Map

The $PM_{2.5}$ annual standard attainment and nonattainment designations require three years of monitoring data. EPA officially declared several areas of Georgia in nonattainment of the annual standard. Nonattainment areas included the metro Atlanta area. This includes Barrow, Bartow, Carroll, Cherokee, Clayton, Cobb, Coweta, DeKalb, Douglas, Fayette, Forsyth, Fulton, Gwinnett, Hall, Henry, Newton, Paulding, Rockdale, Spalding, and Walton Counties, along with portions of Heard and Putnam Counties. Several counties have been redesignated to attainment and have a maintenance plan in place. These include Walker and Catoosa Counties, which are a part of the metro Chattanooga Tennessee–Georgia MSA, all of Bibb County and portions of Monroe County which are part of the Macon MSA, and finally Floyd County.

In July 1997, the U.S. EPA issued an 8-hour ozone standard intended to eventually replace the older 1-hour standard. This 8-hour standard is attained when the average of the fourth highest concentration measured is equal to or below 0.08 ppm (up to 0.085 ppm with the third digit truncated, or cut off) averaged over three years (62 FR 38894, July 18, 1997). Areas that EPA designated attainment with the 1-hour standard were immediately exempt from that standard, and thereafter are subject to the 8-hour standard. In the summer of 2005, the metro Atlanta area was designated attainment with the 1-hour standard. At this time, only the 8-hour ozone standard is applicable in Georgia. The data showed that the Atlanta area met the 1997 8-hour ozone standard, and GA EPD submitted a revised maintenance state implementation plan (SIP) to EPA for this standard. EPA approved GA EPD's SIP, and the Atlanta area was redesignated as in attainment of the 1997 8-hour standard of 0.085 ppm in December 2013. Figure 13.3 shows the Georgia 8-hour ozone maintenance areas for the 1997 standard.

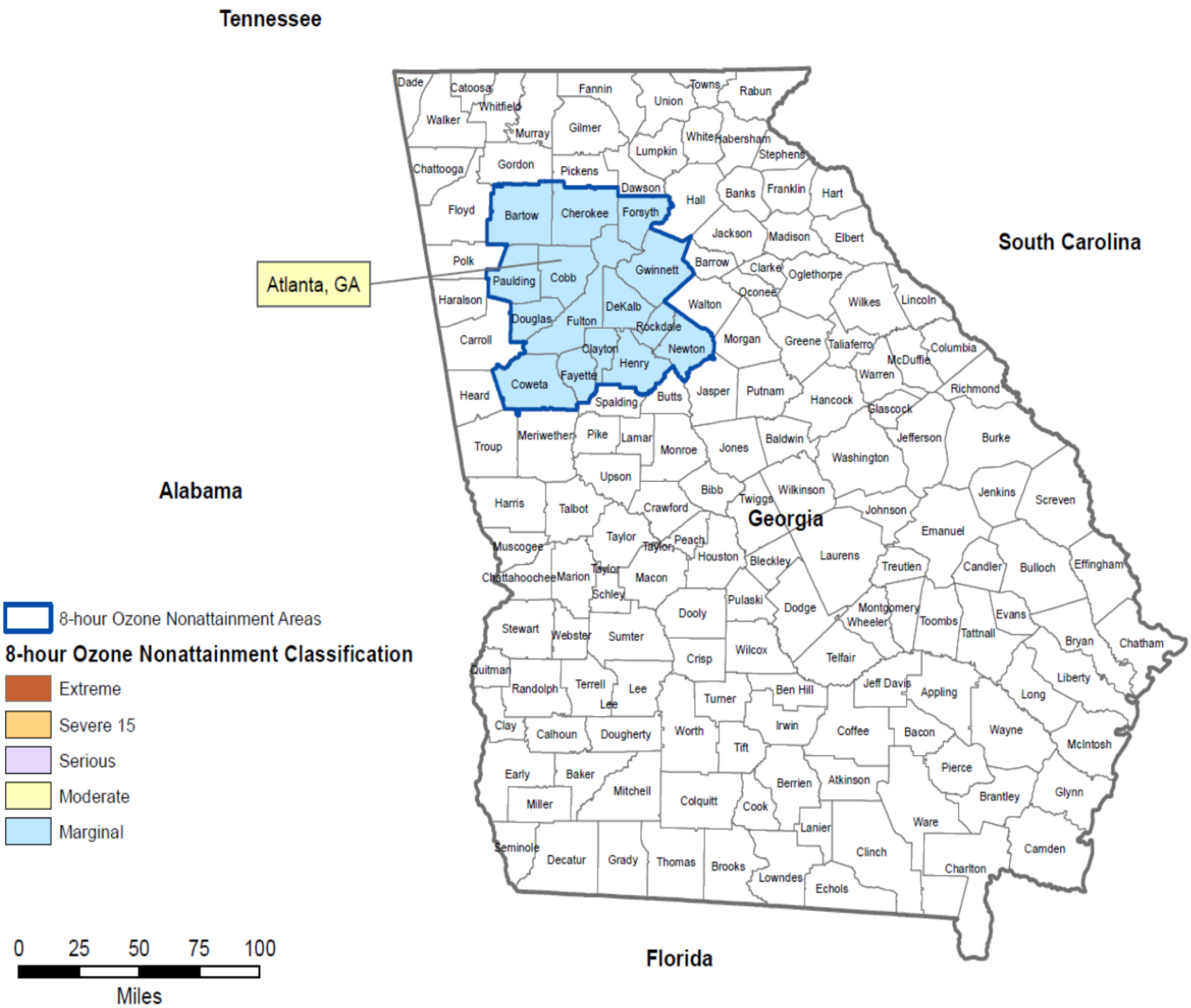


(http://www.epa.gov/airquality/greenbook/ga8m.html)

Figure 13.3: Georgia's 8-hour Ozone Maintenance Areas (1997 Standard)

On March 27, 2008, the ozone primary standard level was lowered to 0.075 ppm for the 8-hour averaging time, fourth maximum value, averaged over three years (Federal Register, Vol. 73, No. 60, page 16436). With the implementation of the 2008 ground-level ozone standard, the boundary of the Atlanta nonattainment area is defined as a 15-county area. Because the Atlanta area was defined with a 'marginal' designation compared to the 2008 ground-level ozone standard, a SIP is not required.

The following map shows the Georgia 15-county 8-hour ozone nonattainment area as of 2013 for the 2008 standard.



(http://www.epa.gov/airquality/greenbook/ga8_2008.html)

Figure 13.4: Georgia's 8-Hour Ozone Nonattainment Area Map (2008 Standard)

In summary, $PM_{2.5}$ and ozone are important pollutants affecting the air quality of the state of Georgia. They are the primary cause of AQI values above 100. In addition, there are areas of Georgia that are in nonattainment because of $PM_{2.5}$ and ozone. $PM_{2.5}$ affects the Atlanta and Chattanooga MSAs while ozone affects the Atlanta MSA. Due to the nonattainment status of these areas and their higher AQI values, these areas are continually under surveillance for comparisons to the $PM_{2.5}$ and ozone standards.

14.0 Health Assessment

Exposure to air pollution can cause a wide variety of health effects. Each pollutant, or group of pollutants, can have differing effects, depending on the length of exposure, route of exposure, and health of the person exposed. The following section briefly explains the health impacts of each pollutant.

Carbon Monoxide

Once carbon monoxide (CO) is inhaled; it enters the blood stream, where it binds chemically to hemoglobin. Hemoglobin is the component of blood that is responsible for carrying oxygen to the cells. When CO binds to hemoglobin, it reduces the ability of hemoglobin to do its job, and in turn reduces the amount of oxygen delivered throughout the body. The percentage of hemoglobin affected by CO depends on the amount of air inhaled, the concentration of CO in air, and the length of exposure. The level of CO usually found in ambient air primarily affects people with cardiovascular disease. Negative health effects of CO include weakening the contractions of the heart, in turn reducing blood flow to various parts of the body. In a healthy person, this effect significantly reduces the ability to perform physical activities. In persons with chronic heart disease, this effect can threaten the overall quality of life, because their systems may be unable to compensate for the decrease in oxygen. CO pollution is also likely to cause such individuals to experience chest pain during activity. Adverse effects have also been observed in individuals with heart conditions who are exposed to CO pollution in heavy freeway traffic for one or more hours. In addition, fetuses, young infants, pregnant women, elderly people, and individuals with anemia or emphysema are likely to be more susceptible to the effects of CO. For these individuals, the effects are more pronounced when exposure takes place at high altitude locations, where oxygen concentration is lower. CO can also affect mental functions, visual acuity, and the alertness of healthy individuals, even at relatively low concentrations.

Nitrogen Dioxide

Exposure to high levels of nitrogen dioxide (NO_2) for short durations (less than three hours) can lead to respiratory problems. Asthma sufferers, in particular, are sensitive to NO_2. This sensitivity was expressed in a study that examined changes in airway responsiveness of exercising asthmatics during exposure to relatively low levels of NO_2. Other studies also indicate a relationship between indoor NO_2 exposures and increased respiratory illness rates in young children, but definitive results are still lacking. In addition, many animal analyses suggest that NO_2 impairs respiratory defense mechanisms and increases susceptibility to infection. Several other observations also show that chronic exposure to relatively low NO_2 pollution levels may cause structural changes in the lungs of animals. These studies suggest that chronic exposure to NO_2 could lead to adverse health effects in humans, but specific levels and durations likely to cause such effects have not yet been determined.

Sulfur Dioxide

Exposure to sulfur dioxide (SO_2) can cause impairment of respiratory function, aggravation of existing respiratory disease (especially bronchitis), and a decrease in the ability of the lungs to clear foreign particles. It can also increase mortality, especially if elevated levels of particulate matter (PM) are present. Individuals with hyperactive airways, cardiovascular disease, and asthma are most sensitive to the effects of SO_2. In addition, elderly people and children are also likely to be sensitive to SO_2. The effects of short-term peak exposures to SO_2 have been evaluated in controlled human exposure studies. These studies show that SO_2 generally increases airway resistance in the lungs, and can cause significant constriction of air passages in sensitive asthmatics. These impacts have been observed in subjects engaged in moderate to heavy exercise while exposed to relatively high peak concentrations.

These changes in lung function are accompanied by perceptible symptoms such as wheezing, shortness of breath, and coughing in these sensitive groups. The presence of particle pollution appears to aggravate the impact of SO_2 pollution. Several studies of chronic effects have found that people living in areas with high particulate matter and SO_2 levels have a higher incidence of respiratory illnesses and symptoms than people living in areas without such a combination of pollutants.

Ozone

Ozone and other photochemical oxidants such as peroxyacetyl nitrate (PAN) and aldehydes are associated with adverse health effects in humans. Peroxyacetyl nitrate and aldehydes cause irritation that is characteristic of photochemical pollution. Ozone has a greater impact on the respiratory system, where it irritates the mucous membranes of the nose, throat, and airways; ninety percent of the ozone inhaled into the lungs is never exhaled. Symptoms associated with exposure include cough, chest pain, and throat irritation. Ozone can also increase susceptibility to respiratory infections. In addition, ozone impairs normal functioning of the lungs and reduces the ability to perform physical exercise. Recent studies suggest that even at lower ozone concentrations some healthy individuals engaged in moderate exercise for 6 to 8 hours may experience symptoms. All of these effects are more severe in individuals with sensitive respiratory systems, and studies show that moderate levels may impair the ability of individuals with asthma or respiratory disease to engage in normal daily activities. The potential chronic effects of repeated exposure to ozone are of even greater concern. Laboratory studies show that people exposed over a six to eight hour period to relatively low ozone levels develop lung inflammation. Animal studies suggest that if exposures are repeated over a long period (e.g. months, years, lifetime), inflammation of this type may lead to permanent scarring of lung tissue, loss of lung function, and reduced lung elasticity.

Lead

Exposure to lead occurs mainly through inhalation and ingestion of lead in food, water, soil, or dust. It accumulates in the blood, bones, and soft tissues. Lead can adversely affect the kidneys, liver, nervous system, and other organs. Excessive exposure to lead may cause neurological impairments, such as seizures, mental retardation, and behavioral disorders. Even at low doses, lead exposure is associated with damage to the nervous systems of fetuses and young children, resulting in learning deficits and lowered IQ. Recent studies also show that lead may be a factor in high blood pressure and subsequent heart disease. Lead can also be deposited on the leaves of plants, presenting a hazard to grazing animals. Lead deposition in soil puts children at particular risk exposure since they commonly put hands, toys, and other items in their mouths, which may come in contact with the lead containing dust and dirt.

Particulate Matter (PM_{10} and $PM_{2.5}$)

Marked increases in daily mortality have been statistically associated with very high 24-hour concentrations of PM_{10}, with some increased risk of mortality at lower concentrations. Small increases in mortality appear to exist at even lower levels. Risks to sensitive individuals increase with consecutive, multi-day exposures to elevated PM_{10} concentrations. The research also indicates that aggravation of bronchitis occurs with elevated 24-hour PM_{10} levels, and small decreases in lung function take place when children are exposed to lower 24-hour peak PM_{10} levels. Lung function impairment lasts for 2-3 weeks following exposure to PM_{10}.

$PM_{2.5}$ can penetrate into the sensitive regions of the respiratory tract, which make them a health concern. Recently published community health studies indicate that significant respiratory and cardiovascular-related problems are associated with exposure to fine particle levels below the existing particulate matter standards. In addition, fine particles are likely to cause the most serious health effects, which include premature death, hospital admissions from respiratory causes, and increased respiratory problems. Long-term exposure to particulate matter may increase the rate of respiratory and cardiovascular illnesses and reduce the life span of an individual. Some data also suggests that fine particles can pass through lung tissues and enter the bloodstream (American Lung Association, 2008). Therefore, children, the elderly, and individuals with cardiovascular disease or lung diseases such as emphysema and asthma are especially vulnerable.

PAMS

The Photochemical Assessment Monitoring Stations (PAMS) monitor some of the pollutants discussed above, carbon monoxide, ozone, and oxides of nitrogen, as well as volatile organic compounds (VOCs), selected carbonyl compounds, and monitoring of meteorological parameters.

Carbonyl and VOCs define a large group of substances that can act as precursors to ozone formation. Depending on the amount inhaled, exposure to these compounds can cause irritation to the eyes, ears, nose, and throat, dizziness, and damage to the lungs. Some examples of potential health effects are discussed in the following paragraph. Formaldehyde is a health concern because of its respiratory irritancy and potential as a carcinogen. It may cause irritation of the eye, nose, throat, and skin, and has the potential under certain exposure scenarios to cause cancers of the nose and throat (ATSDR, 1999). Acetaldehyde, an intermediate product of plant respiration and a product of incomplete combustion, is ubiquitous in the environment. Acetaldehyde, like formaldehyde, is also a concern as an upper respiratory irritant, and because of its potential to cause nasal tumors in animal studies (U.S. EPA, 1987; U.S. EPA, 1991). With large amounts of exposure, benzene can cause problems in the blood, including anemia, excessive bleeding, and harm to the immune system (ATSDR, 1997). Tetrachloroethene acts as a central nervous system depressant. Trichloroethylene can cause nervous system effects, abnormal heartbeat, coma, and possibly death (ATSDR, 2003). At very low concentrations, acrolein is an upper respiratory irritant, and at very high concentrations, it may produce more serious damage to the lining of the upper respiratory tract and lungs (ATSDR, 2005a; U.S. EPA, 2003).

Air Toxics

Air Toxics include VOCs and carbonyls discussed above, as well as semi-volatile organic compounds and metals. Air toxic pollutants can have negative effects on human health, ranging from causing headaches, nausea, dizziness, cancer, birth defects, problems breathing, damage to lungs and nasal cavities, and other serious illnesses. These effects can vary depending on frequency, length of time, and health of the person that is exposed, along with the toxicity of the compound. These air pollutants also affect the environment. Wildlife experiences symptoms similar to those in humans. Pollutants accumulate in the food chain. Many air pollutants can also be absorbed into waterways and have toxic effects on aquatic wildlife. Some of the substances tend to have only one critical effect, while others may have several. Some of the effects may occur after a short exposure and others appear after long-term exposure or many years after being exposed. Exposure is not only through direct inhalation of the pollutant, but also through the consumption of organisms such as fish that have absorbed the pollutant.

Health Effects

The following table was taken from EPA's Air Compare website. It can be used as a guide that outlines the health concerns or each group of sensitive populations that can be affected when the Air Quality Index is Code Orange or Code Red. The table also shows which pollutant, or pollutants, effect each health concern or sensitive population. It is used as an illustration, with the understanding that some individuals can be more sensitive than others.

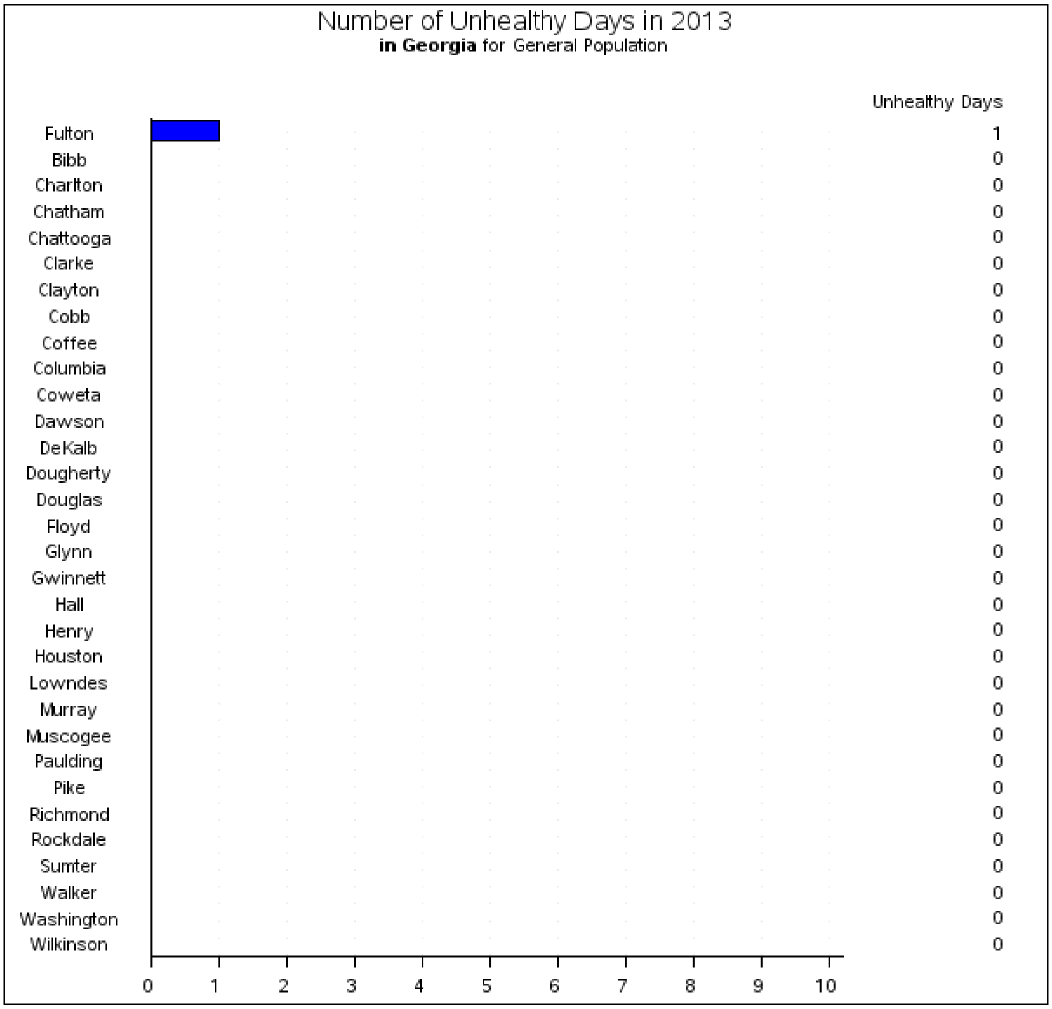
Health Concern	Pollutant and AQI Category				
	Ozone	Particle Pollution	Sulfur Dioxide	Carbon Monoxide	Any Pollutant
	Code Orange	Code Orange	Code Orange	Code Orange	Code Red
Asthma or other Lung Disease	X	X	X		X
Heart Disease		X		X	X
Children (with no specific health concern)	X	X			X
Older Adults (with no specific health concern)	X	X			X
Active Outdoors (with no specific health concern)	X		X		X
General Population (with no specific health concern)					X

Source: http://www.epa.gov/aircompare/index.htm

Figure 14.1: Health Concerned Affected by Pollutant

Figure 14.1 summarizes the health concerns that are affected by higher pollution levels of ozone, particulate matter, sulfur dioxide, and carbon monoxide. The table shows which pollutants that can cause concern when the Air Quality Index (AQI) levels are 101-150, or Code Orange, and 151-200, or Code Red. The AQI is used as a way to measure air quality, which is reported in values from 0 to 500. The higher the AQI value, the greater the level of air pollution, which would lead to greater health concerns. When AQI values are between 101 and 150 (Code Orange), members of sensitive groups may experience health effects of specific pollutants. These sensitive groups are generally children and older adults, although the general population can also be effected if active outdoors. The general population that would not be exercising outdoors is not likely to be affected when the AQI is in this range. However, the general population, along with the sensitive and exercising groups, are more likely to be affected when the AQI values are above 150.

The following figures were also derived from EPA's Air Compare website. Each county that collects ambient air monitoring data across the state of Georgia is shown. In the following figure, the number of unhealthy days in 2013 for the general population is shown.

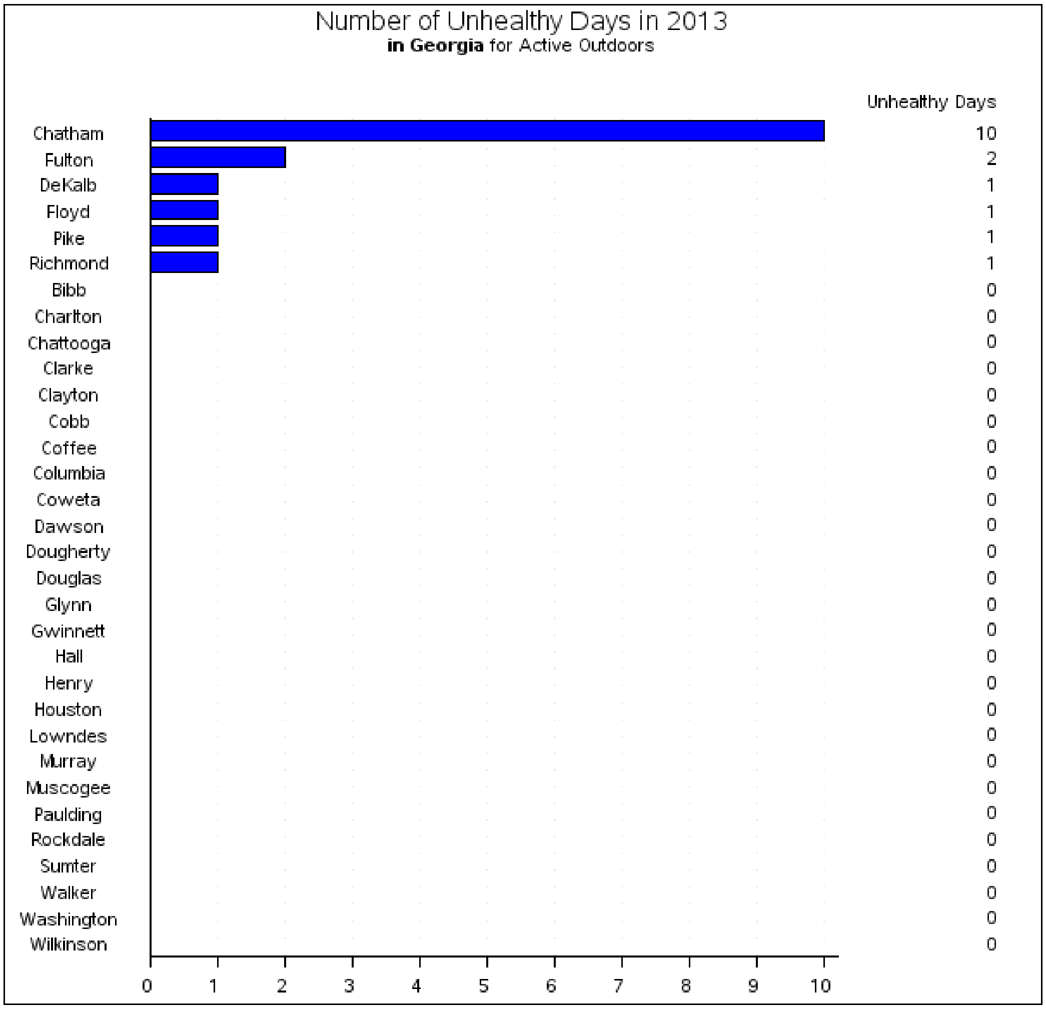


Source: http://www.epa.gov/aircompare/index.htm

Figure 14.2: Number of Unhealthy Days in 2013 for General Population

For the general population to be affected, the AQI value would need to exceed 150. As shown in Figure 14.1, any of the criteria pollutants would effect the general population if the AQI value were above 150, or Code Red. There was one day in 2013 above this value, which occurred in Fulton County.

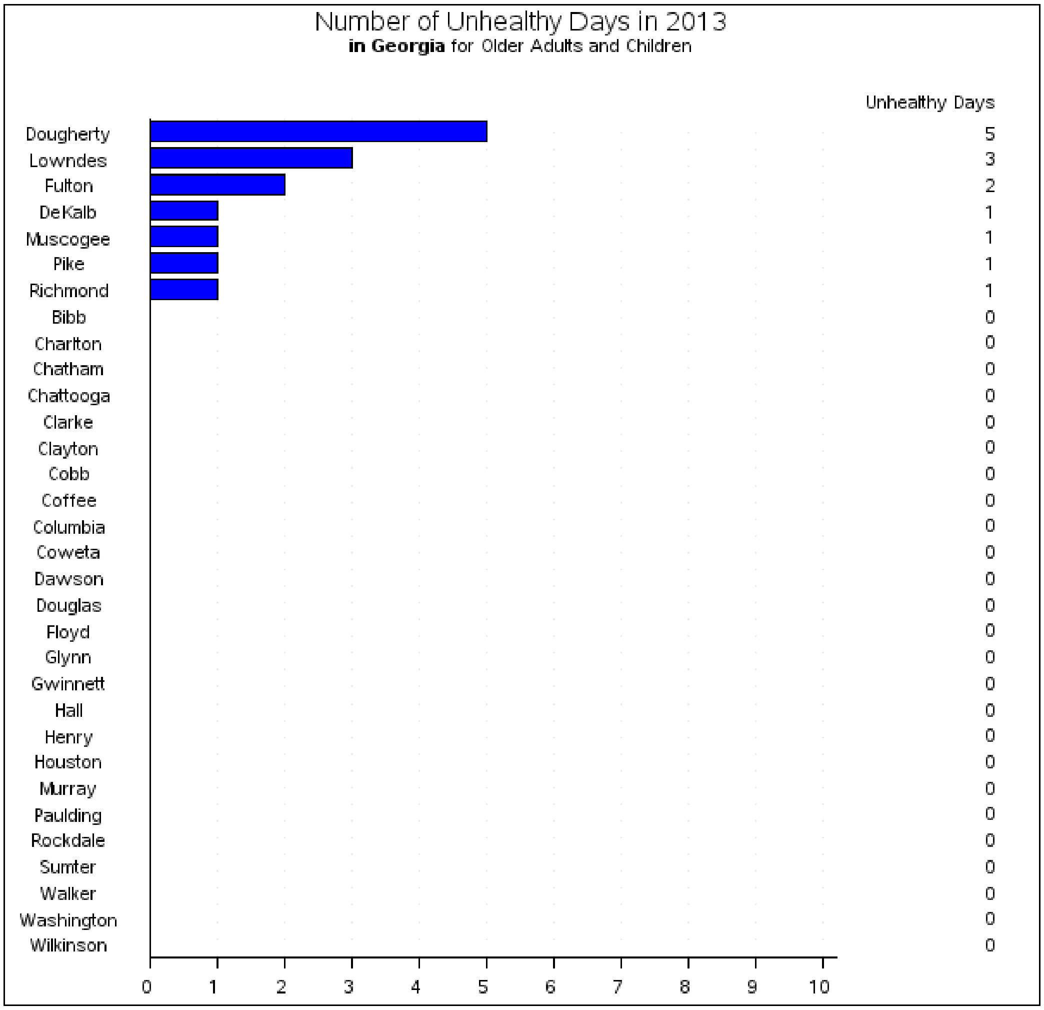
Figure 14.3 shows the number of unhealthy days in Georgia in 2013 for the population who participates in outdoor activity. An AQI value between 101 and 150 affects this population, with ozone and sulfur dioxide being the primary pollutants that contribute to unhealthy days (Figure 14.1). Six counties had at least one unhealthy day, with Chatham County reporting the highest number (10 days).



Source: http://www.epa.gov/aircompare/index.htm

Figure 14.3: Number of Unhealthy Days in 2013 for Active Outdoors

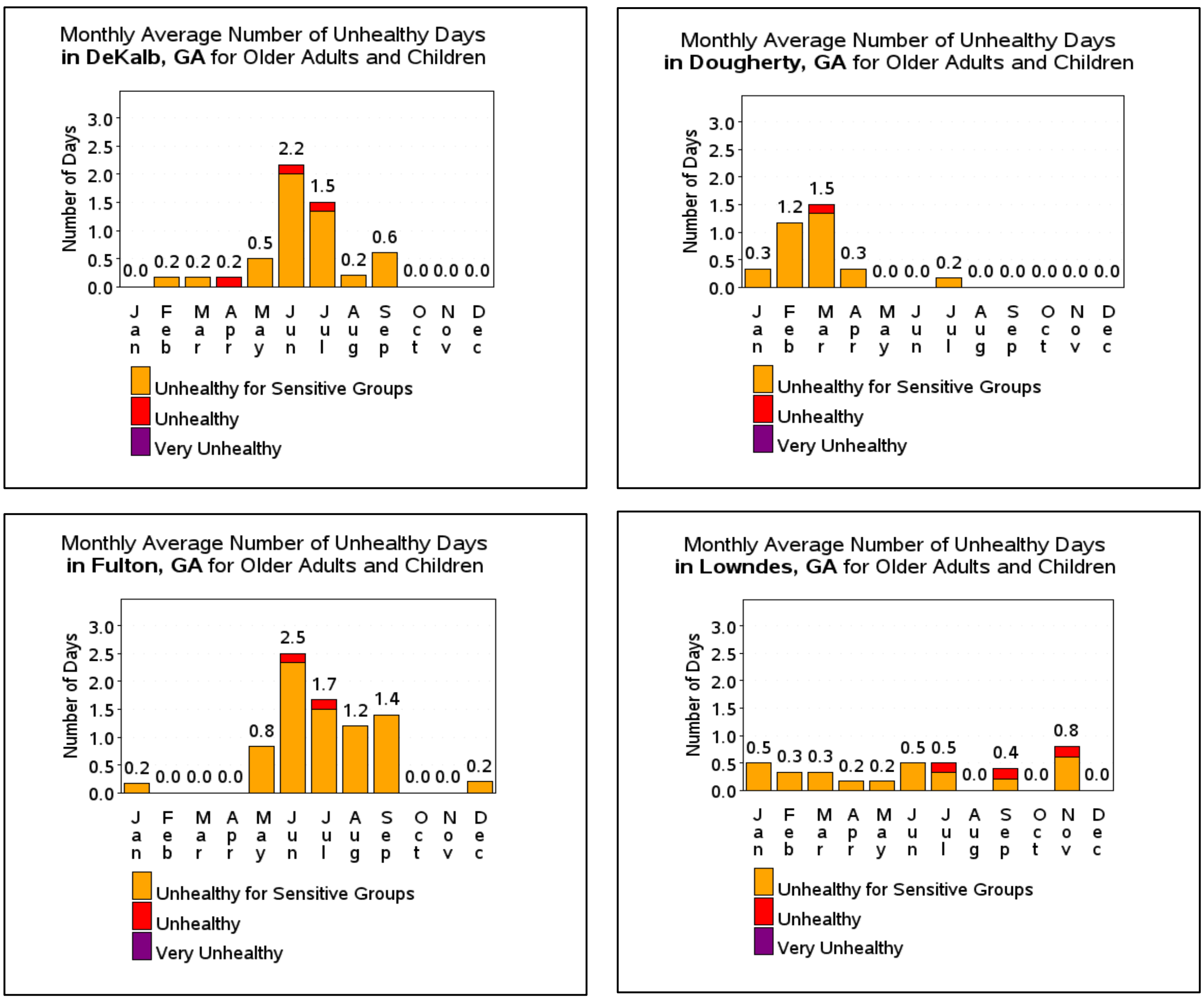
In the following figure, the number of unhealthy days in Georgia in 2013 for older adults and children is shown. An AQI value between 101 and 150 affects this population, with ozone and particle pollution being the primary contributors to unhealthy days (Figure 14.1). There were seven counties that had at least one unhealthy day in 2013. Dougherty County showed the highest number of unhealthy days (5).



Source: http://www.epa.gov/aircompare/index.htm

Figure 14.4: Number of Unhealthy Days in 2013 for Older Adults and Children

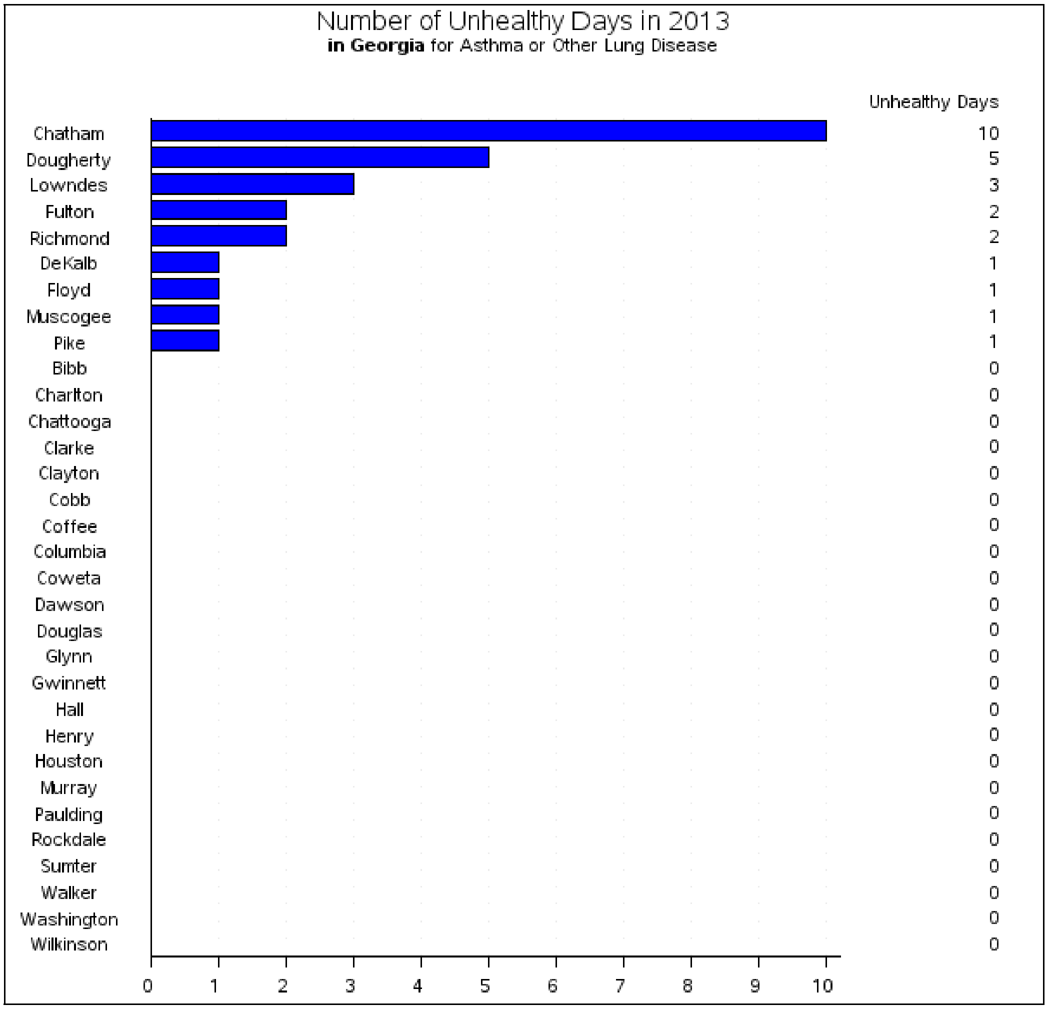
The following figure shows the top four counties with the highest number of unhealthy days for older adults and children (DeKalb, Dougherty, Fulton, and Lowndes Counties). These graphs break down the average number of days for the past five years in each county according to unhealthy for sensitive groups (shown in orange), unhealthy air (shown in red), and very unhealthy air (shown in purple) by month. Each bar shows the total number of unhealthy days for that month averaged over the past five years. If a bar contains more than one color, the proportion of orange, red, and purple days is shown that make up the total number of unhealthy days for that month. The monthly average break down shows the most effect on older adults and children would be during the summer months for DeKalb and Fulton Counties. For Dougherty County, the late winter months is the time of year that would most affect older adults and children, and the effect is almost evenly distributed across the year for Lowndes County.



Source: http://www.epa.gov/aircompare/index.htm

Figure 14.5: Monthly Average for Top Four Counties for Number of Unhealthy Days in 2013 for Older Adults and Children

The following figure shows the number of unhealthy days in 2013 in Georgia for people who suffer from asthma and other lung diseases.

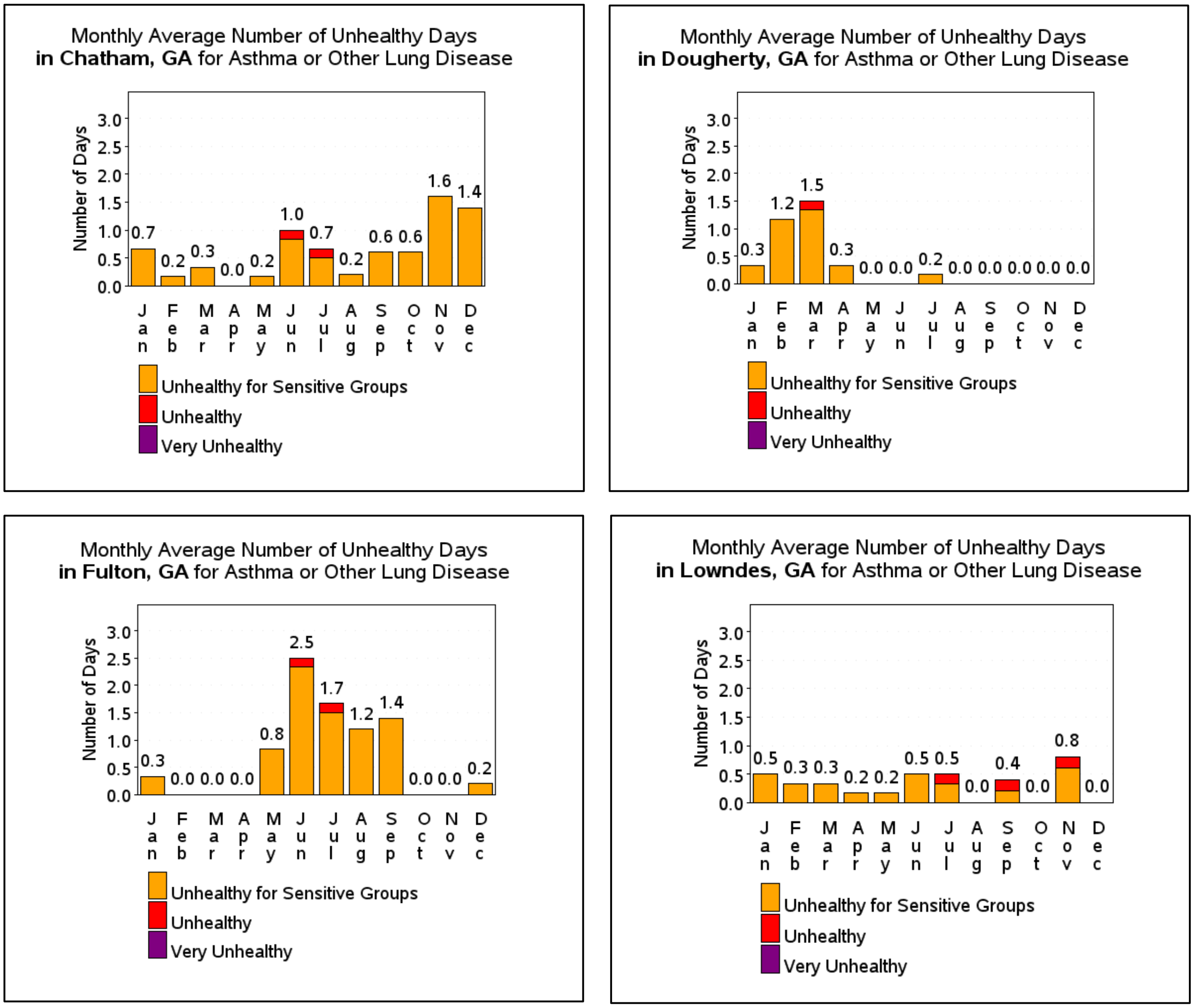


Source: http://www.epa.gov/aircompare/index.htm

Figure 14.6: Number of Unhealthy Days in 2013 for People with Asthma and Other Lung Disease

People who suffer from asthma and other lung diseases can be affected by ozone, particle pollution, and sulfur dioxide, with the AQI value between 101 and 150 (Figure 14.1). Nine counties had at least one unhealthy day for asthma and other lung disease sufferers. The maximum number of unhealthy days occurred in Chatham County (10 days). In general, individuals who suffer from asthma and other lung diseases are one of the most sensitive groups, along with older adults and children.

The following figures show the top four counties with the highest number of unhealthy days for people with asthma or other lung diseases (Chatham, Dougherty, Fulton, and Lowndes Counties). These graphs break down the average number of days in each county according to unhealthy for sensitive groups (shown in orange), unhealthy air (shown in red), and very unhealthy air (shown in purple) by month. This is a monthly average for the past five years, and each bar shows the proportion of orange, red, and purple days for that month. The highest five-year average was 2.5 days in Fulton County, occurring in June. The other five year averages ranged from 0.0 to 1.7 days per month.



Source: http://www.epa.gov/aircompare/index.htm

Figure 14.7: Monthly Average for Top Four Counties for Number of Unhealthy Days in 2013 for People with Asthma and Other Lung Disease

The Georgia Department of Public Health reports that in 2010, 9% of Georgia's children, age 0 to 17 years had asthma (http://dph.georgia.gov/asthma-surveillance). In addition, about 14.5% of children in Georgia had been told at some point that they had asthma. In 2012, the adult asthma prevalence rate in Georgia was 13%, corresponding to 965,918 people (http://www.cdc.gov/asthma/brfss/2012/tableL1.htm). Children and older adults are more likely to be hospitalized with asthma.

The following tables give estimated prevalence of asthma according to adult age groups for Georgia in 2012 for current and lifetime asthma prevalence (Tables 14.1 and 14.2, respectively) (http://www.cdc.gov/asthma/brfss/2012/brfssdata.htm).

Age Group	Sample Size	Prevalence (percent)	Standard Error	95% CI* (percent)	Prevalence (number)	95% C* (number)
18-24	307	9.3	1.82	(5.7 - 12.9)	94,020	(56,401 - 131,639)
25-34	572	7.8	1.36	(5.1 - 10.5)	102,144	(65,971 - 138,317)
35-44	740	6.6	1.08	(4.5 - 8.7)	89,580	(60,040 - 119,119)
45-54	1,138	9	1.05	(6.9 - 11.1)	125,692	(95,878 - 155,506)
55-64	1,332	9	1.01	(7.0 - 10.9)	99,007	(76,306 - 121,709)
65+	1,917	8	0.76	(6.5 - 9.5)	92,092	(74,369 - 109,815)

* CI denotes confidence interval

Source: http://www.cdc.gov/asthma/brfss/2012/brfssdata.htm

Table 14.1: Adult Self-Reported Current Asthma Prevalence Rate (Percent) and Prevalence (Number) by Age: BRFSS 2012

The age group with the highest current asthma prevalence in Georgia was 18-24 with 9.3% prevalence.

Age Group	Sample Size	Prevalence (percent)	Standard Error	95% CI* (percent)	Prevalence (number)	95% CI* (number)
18-24	308	20.2	2.73	(14.8 - 25.5)	203,813	(142,540 - 265,087)
25-34	575	12.8	1.71	(9.5 - 16.2)	168,991	(122,006 - 215,976)
35-44	742	9.7	1.31	(7.2 - 12.3)	133,158	(96,644 - 169,672)
45-54	1,142	13.4	1.24	(11.0 - 15.9)	188,603	(152,608 - 224,598)
55-64	1,337	12.8	1.18	(10.4 - 15.1)	141,722	(114,337 - 169,107)
65+	1,922	10.6	0.87	(8.9 - 12.3)	123,281	(102,874 - 143,688)

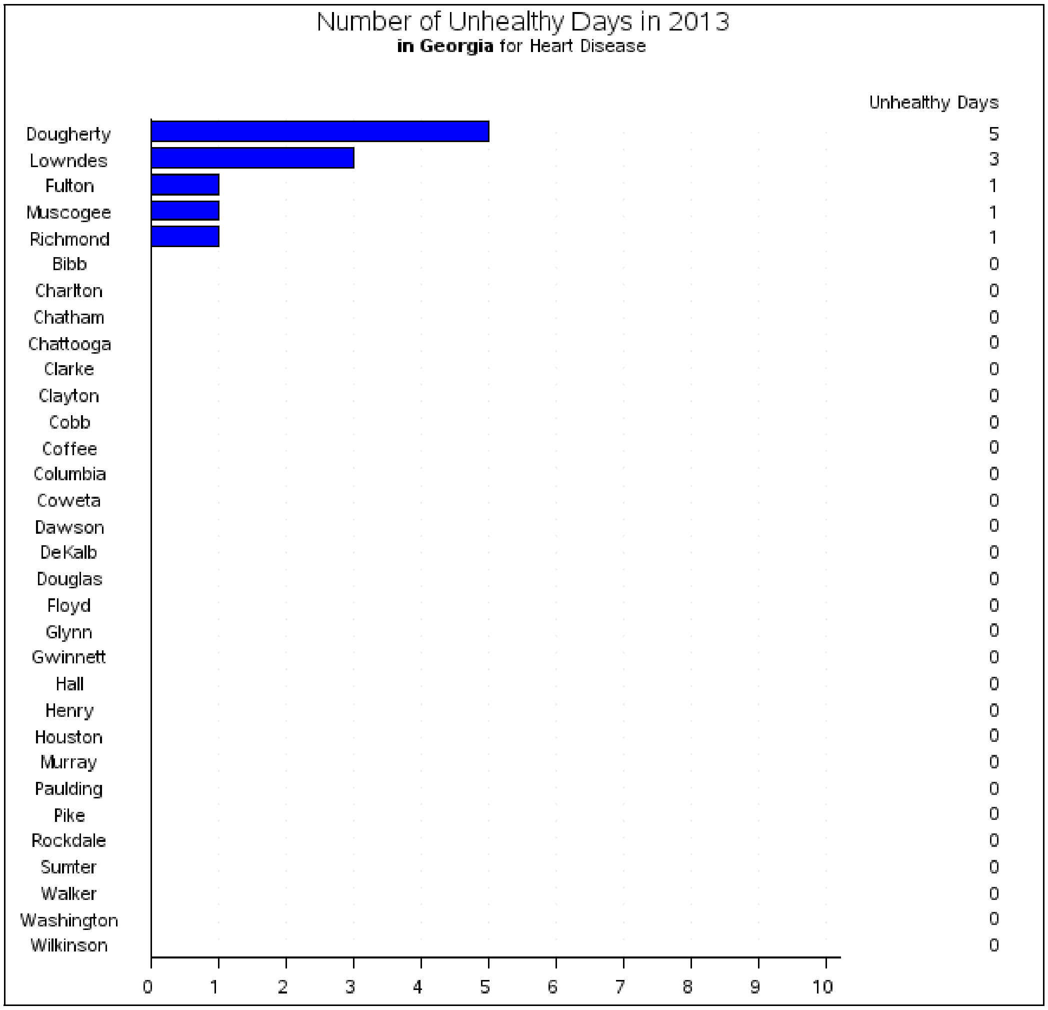
* CI denotes confidence interval

Source: http://www.cdc.gov/asthma/brfss/07/brfssdata.htm

Table 14.2: Adult Self-Reported Lifetime Asthma Prevalence Rate (Percent) and Prevalence (Number) by Age: BRFSS 2012

For lifetime asthma prevalence in Georgia, the age group with the highest asthma prevalence was also 18-24 with prevalence of 20.2%.

Figure 14.8 shows the number of unhealthy days in 2013 in Georgia for people who suffer from heart disease. For this group, particle pollution and carbon monoxide are the pollutants of concern. In general the AQI value would be between 101 and 150 for this group to be affected (Figure 14.1). However, more sensitive individuals could be affected with lower AQI values.

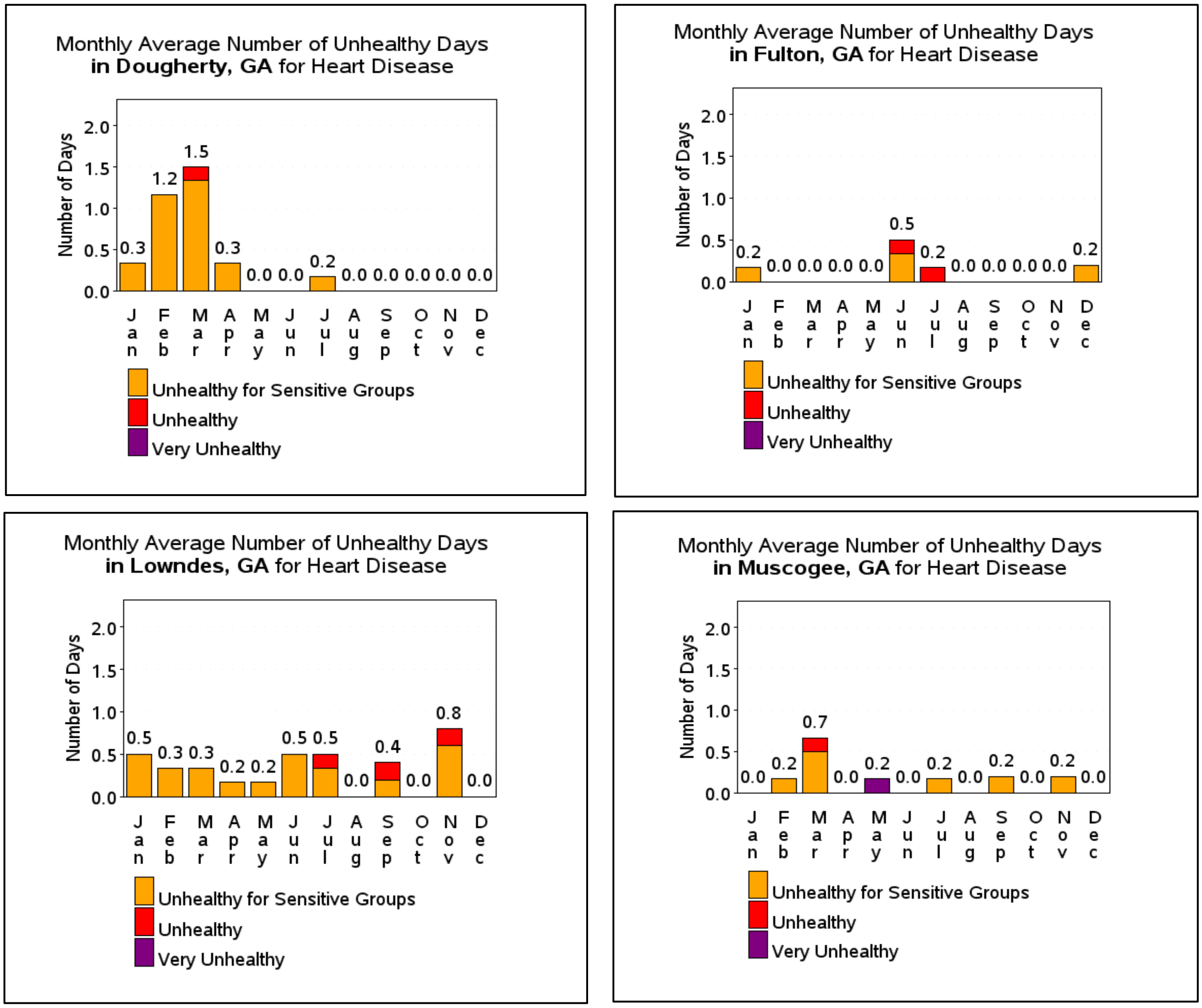


Source: http://www.epa.gov/aircompare/index.htm

Figure 14.8: Number of Unhealthy Days in 2013 for People with Heart Disease

There were five counties that experienced unhealthy days for people with heart disease, with Dougherty County having the maximum days (5).

The following figure shows the top four counties with the highest number of unhealthy days for people with heart disease (Dougherty, Fulton, Lowndes, and Muscogee Counties). The highest five-year average occurred in March (1.5 days) in Dougherty County. The other five-year averages range from 0.0 to 1.2 days per month to potentially affect people with heart disease.



Source: http://www.epa.gov/aircompare/index.htm

Figure 14.9: Monthly Average of Top Four Counties for Number of Unhealthy Days in 2013 for People with Heart Disease

Several counties across the state had at least one day in 2013 with unhealthy levels of ambient air that could contribute to asthma or other lung disease, heart disease, or that could affect children or older adults. The number of days went up to 10 for the year for some counties. The ability to collect this information for the public and provide the data for sensitive populations is valuable to the citizens of Georgia and exhibits the importance of having these ambient air monitors. As part of the monitoring objectives for Georgia EPD, this information is provided to the public, as well as to researchers for health effects studies.

15.0 Area Served Assessment

For the Area Served Assessment, the EPA 'Network Assessment Analyses and Tools' developed by EPA for the 2010 network assessment was used as a reference. The explanation for this tool in the 'Draft Network Assessment and Tools Documentation' for the Area Served Tool states, *'The area served tool uses a spatial analysis technique known as Voronoi or Thiessen polygons to show the area represented by a monitoring site. The shape and size of each polygon is dependent on the proximity of the nearest neighbors to a particular site. Data from the [2013] Census were used to determine which census tract centroids were within each polygon. The total tract area represented by the polygon was calculated as well as the total population and population density. An individual population estimate was created for each tract and for each year by using the [2013] census' individual tract composition within a county…Those census data can be accessed at http://factfinder.census.gov/.'*

For this analysis, the ozone and $PM_{2.5}$ networks were examined. Each site was ranked according to the surrounding area served by the monitor, which is shown in square miles. Sites that cover a larger area are ranked higher than sites that cover a smaller area. A proportionality ranking was used for each network. Within each section, a table displays the site identification number, 2013 population served by the monitor, area in square miles served by each monitor, latitude, longitude, and rank. Since the areas covered are overlapping state boundaries, the assessment includes all the sites in Georgia, as well as the sites surrounding the state. The yellow dots indicate the location of each monitor and the polygon drawn in blue indicates the area served by that monitor.

15.1 Ozone Area Served

The first assessment is an examination of the ozone network. The map shows the whole state of Georgia, with the polygons around each monitor, indicating the monitoring area that is represented by that monitor. In Figure 15.1, yellow circles indicate Georgia ozone monitors while the purple circle indicates the EPA CASTNET site. This is a federal site not run by Georgia EPD; however, since it monitors ozone in Georgia it is included in this analysis.

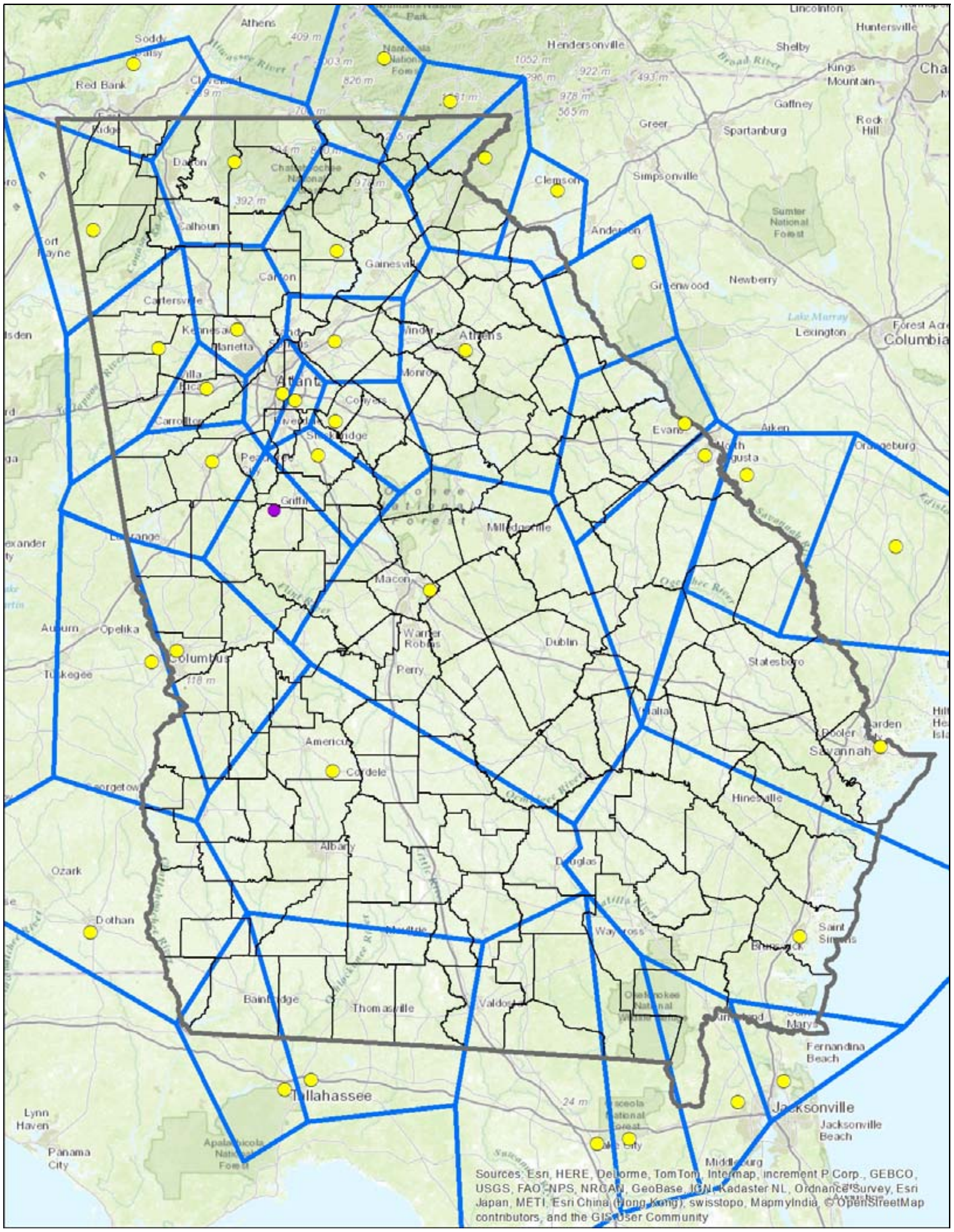


Figure 15.1: Ozone Area Served with Monitors Sampling in 2013, All of Georgia

Along Georgia's borders, the maps indicate that some of Georgia's ozone monitors cover areas in surrounding states and some of the other states' ozone monitors cover areas in Georgia. In the following table, the sites from other states are shown along with Georgia's ozone sites for informative purposes. Georgia's sites are highlighted in yellow, and ranked accordingly. The sites are listed in order of rank.

Monitor	2013 Population	Area (sq mi)	Latitude	Longitude	Rank
010690004	47539	6578.81	31.190657	-85.423117	
011130002	63229	4407.37	32.467971	-85.083841	
120310077	48328	1487.60	30.477725	-81.587339	
120310106	27751	2238.94	30.378217	-81.840900	
120730002	234485	2429.44	30.484444	-84.199444	
120030002	53220	2643.00	30.201111	-82.441111	
120730001	45875	5221.71	30.439722	-84.346389	
120230002	174417	7081.49	30.178056	-82.619167	
131270006	408689	11198.99	31.169735	-81.495881	1.000
130210012	731227	10606.28	32.805408	-83.543521	0.945
130510021	548609	10319.61	32.069230	-81.048769	0.919
132611001	491238	9725.17	31.954298	-84.081059	0.864
130590002	456471	4934.32	33.918067	-83.344495	0.424
130550001	251557	3196.21	34.474293	-85.408003	0.264
132150008	321388	3125.48	32.521302	-84.944795	0.258
132450091	316814	3006.26	33.433349	-82.022217	0.247
132130003	284547	2937.64	34.785197	-84.626422	0.240
130730001	238261	2736.37	33.582144	-82.131189	0.222
132230003	309553	2686.75	33.928500	-85.045340	0.217
130850001	523607	2644.28	34.376317	-84.059766	0.213
130770002	388435	2541.82	33.404040	-84.745988	0.204
132319991	248255	2151.21	33.178700	-84.405200	0.168
130670003	1188240	1500.80	34.015482	-84.607407	0.108
131350002	1451913	1289.62	33.961270	-84.069010	0.089
132470001	453129	1224.69	33.591077	-84.065294	0.083
131510002	377197	1072.99	33.433575	-84.161708	0.069
130970004	503577	772.21	33.743656	-84.779192	0.041
131210055	1147738	543.56	33.720192	-84.357056	0.020
130890002	714845	323.61	33.687970	-84.290480	0.000
370750001	42521	1821.92	35.257930	-83.795620	
371139991	34991	1196.65	35.060800	-83.430600	
450290002	12272	4563.54	33.007866	-80.965038	
450030003	54776	3054.92	33.342226	-81.788731	
450010001	39284	1906.39	34.325318	-82.386376	
450730001	128893	1834.51	34.805261	-83.237700	
450770002	45011	1105.82	34.653606	-82.838659	
470651011	148592	2069.48	35.233476	-85.181581	

Table 15.1: List of Ozone Monitors with Area Served in Square Miles

With the Area Served Assessment for ozone sites, the Brunswick monitor (13-127-0006) ranks the highest with 11198.99 square miles covered by this ozone site. The South DeKalb site (13-089-0002) ranks the lowest with 323.61 square miles of coverage with the ozone monitor. For the ozone network, the southeast area of the state has a larger section where the polygons intersect that is not represented by an ozone monitor. According to this assessment, this area of the state may not have adequate ozone monitoring coverage. The addition of an ozone monitor in the Valdosta MSA may be helpful to cover the southeastern part of the state.

15.2 $PM_{2.5}$ Area Served

In the following section, the Georgia's $PM_{2.5}$ sites and the area covered by each monitor are examined. The yellow dots indicate the existing $PM_{2.5}$ sites, and the blue polygons represent the area surrounding the site that is covered by each monitor. The map shows the entire state and the coverage of each monitor in the state.

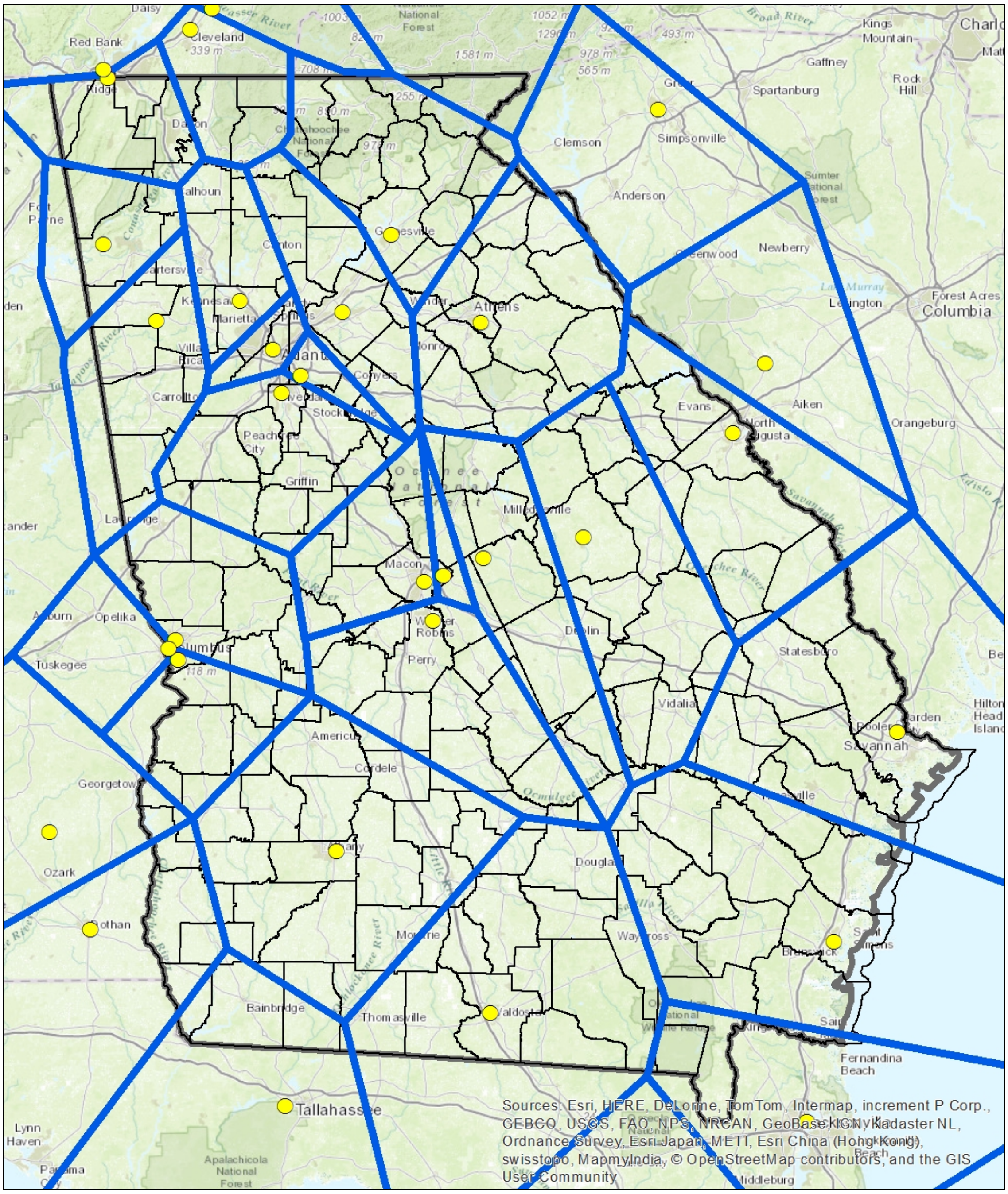


Figure 15.6: $PM_{2.5}$ Area Served with Monitors Sampling in 2013, All of Georgia

The following table shows the same statistics as shown with the ozone network. Along Georgia's borders, the maps indicate that some of Georgia's $PM_{2.5}$ monitors cover areas in surrounding states and some of the other states' $PM_{2.5}$ monitors cover areas in Georgia. In the following table, the sites from other states are shown along with Georgia's $PM_{2.5}$ monitors for informative purposes. Georgia's $PM_{2.5}$ sites are highlighted in yellow, and ranked accordingly. The sites are listed in order of rank.

Monitor	2013 Population	Area (sq mi)	Latitude	Longitude	Rank
016900003	37104	12324.01	31.22600	-85.39100	
010500002	11230	8773.95	31.66400	-85.60600	
120730012	65902	13378.66	30.42600	-84.73200	
120310032	63830	8068.08	30.35600	-81.63700	
130510091	561767	12244.65	32.11076	-81.16185	1.000
131850003	348365	11635.82	30.84860	-83.29325	0.949
131270006	312598	11297.71	31.16973	-81.49588	0.920
130950007	448846	7949.08	31.57692	-84.10019	0.637
132450091	447243	5630.65	33.43403	-82.02226	0.441
133030001	196599	5832.18	32.97488	-82.80876	0.458
130590002	458351	5285.36	33.91806	-83.34440	0.412
131390003	496680	4233.84	34.30034	-83.81390	0.323
130630091	1248348	3665.35	33.60987	-84.39103	0.275
132230003	404881	3589.14	33.92855	-85.04548	0.268
132150008	297647	3129.70	32.52127	-84.94463	0.230
131530001	307199	4432.45	32.60560	-83.59791	0.340
131350002	1803388	2906.69	33.96307	-84.06919	0.211
133190001	230181	4034.18	32.88183	-83.33378	0.306
130210007	306072	2347.86	32.77746	-83.64110	0.164
132150011	131633	2358.34	32.43112	-84.93175	0.164
132950002	305803	2349.52	34.97890	-85.30090	0.164
131150003	214105	2198.21	34.26124	-85.32296	0.151
132150001	65852	1944.59	32.48354	-84.98098	0.129
130670003	1145755	1885.68	34.01548	-84.60741	0.124
131210039	1184237	589.11	33.80233	-84.43558	0.015
130890002	722645	455.26	33.68808	-84.29018	0.004
130210012	61535	413.40	32.80541	-83.54352	0.000
371730002	20185	4311.38	35.43600	-83.44400	
450450015	15181	5479.55	34.84400	-82.41500	
450370001	13621	5150.55	33.74000	-81.85400	
470110103	115053	1962.89	35.27800	-84.75400	

Table 15.2: List of $PM_{2.5}$ Monitors and Area Served

With the Area Served Assessment for the $PM_{2.5}$ network, the Savannah site (13-051-0091) ranks the highest with 12244.65 square mile coverage. The Macon site (13-021-0012) ranks the lowest with this assessment, with a 413.40 square mile coverage. For the $PM_{2.5}$ network, the southeast area of the state has a larger section where the polygons intersect that is not represented by a $PM_{2.5}$ monitor. According to this assessment, this area of the state may not have adequate $PM_{2.5}$ monitoring coverage.

16.0 Emissions Assessment

In order to determine if GA EPD's current ambient air monitoring network is located in areas to collect maximum emissions data, an emissions assessment was performed. Data from EPA's website, http://www.epa.gov/air/emissions/where.htm, was used to determine the location of each facility in Georgia that emits one of five pollutants (NOx, PM_{10}, $PM_{2.5}$, SO_2, and VOCs). Facilities were grouped by source type and mapped in ArcGIS. An arbitrary threshold of 500tons/year was selected to separate major emissions source types from minor ones. Source types that emitted greater than 500 tons/year of the selected pollutant were displayed on the map, while source types that emitted less were grouped into the 'Other' category.

Modeled 2007 and 2018 typical anthropogenic emissions of CO, PM_{10}, SO_2, $PM_{2.5}$, VOCs, NH_3, and NO_x were compared for each county in Georgia along with the difference and percent change between 2007 and 2018. In addition, CO, PM_{10}, O_3, SO_2, NO_2, $PM_{2.5}$, and VOCs were modeled, along with meteorological conditions, to predict the spatial distribution of concentrations in 2018.

The Georgia EPD Data and Modeling Unit created emission trend charts and ambient air concentration maps with data extracted from emission inventories and air quality modeling outputs that were developed as part of the Southeastern Modeling, Analysis, and Planning (SEMAP) project. The SEMAP project was a collaboration among ten Southeastern U.S. states to address planning needs for ozone, particulate matter, and regional haze state implementation plans (SIPs).

Air quality models use emission inventory data and meteorological data to estimate ambient air concentrations. For the purpose of SIP development, air quality models are typically run for a "base year" and "future year". For the SEMAP project, 2007 was the "base year" and 2018 was the "future year". The base year meteorology was used for both the base year and future year air quality modeling.

Emission inventories typically contain annual emissions with units of tons-per-year (TPY). The SEMAP emission inventory consists of five major anthropogenic source categories: Point, Area, Onroad, Nonroad, and Fire. Point sources are large (e.g. > 25 TPY NOx) stationary emission sources such as electricity generating units (EGUs) and non-EGUs (AMEC, 2013a). Area sources refer to smaller stationary sources whose individual emissions are not big enough to be point sources, but their collective emissions are sufficiently big to make a significant impact on air quality (TranSystems, 2012a). Onroad sources include passenger vehicles and trucks and were estimated with MOVES 2010b (AMEC, 2013b). Nonroad sources include construction equipment, ships, trains, and airports (TranSystems, 2012a). Fire sources include burning activities such as prescribed burning and wild fires (AMEC, 2012). Once the annual emission inventories were developed, the SEMAP contractor ran Sparse Matrix Operator Kernel Emissions (SMOKE) version 2.6 and 3.0 to generate hourly, gridded, speciated emission data for the air quality model (GT, 2014). The Weather Research and Forecasting (WRF) model version 3.1.1 was used to generate meteorological fields for the air quality model (AER, 2011). The 2018 projection inventories were prepared for all sectors except fires, which were held constant in the future (AMEC, 2014a; AMEC, 2014b; TranSystems, 2012b).

The SEMAP contractor conducted air quality modeling for the base year (2007) and the future year (2018) with the Community Multi-scale Air Quality Model (CMAQ), version 5.0 (GT, 2014). Figure 16.1 shows the 36-km modeling domain which covers the entire continental U.S. and the 12-km modeling domain which covers the Eastern U.S. CMAQ produces hourly pollutants concentrations by accounting for pollutant influx from the domain boundaries, advection, diffusion, chemical reactions, emissions, and deposition. The base year modeling results were evaluated against observed ambient concentrations and showed acceptable model performance.

The Georgia EPD Data and Modeling Unit used the SEMAP emission inventories and CMAQ modeling results to produce GIS maps for this report.

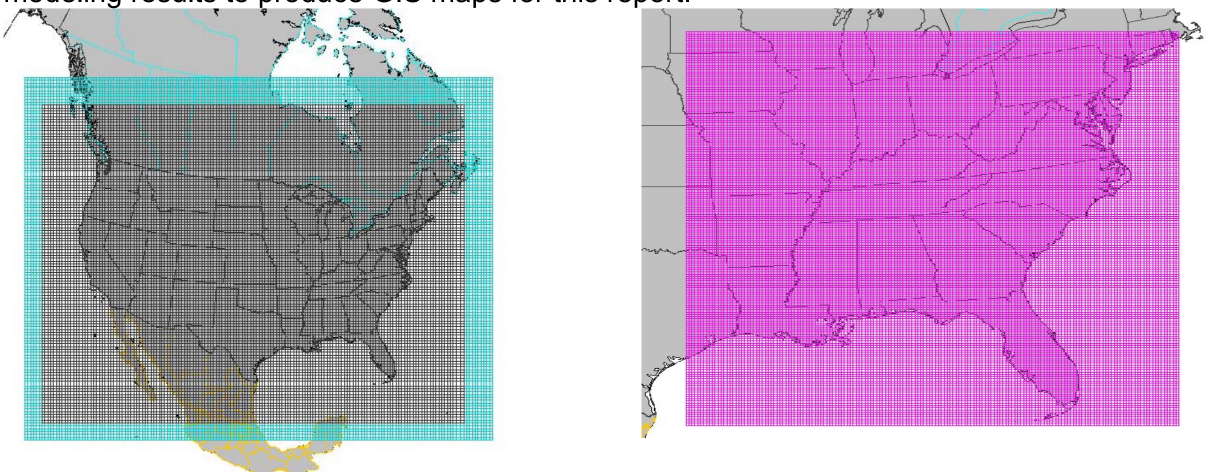


Figure 16.1: 36-km (left) and 12-km (right) SEMAP Air Quality Modeling Domains

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TranSystems (2012a), Area and Nonroad 2007 Base Year Inventories – Revised Final Report. Prepared for SESARM by TranSystems Corporation.

16.1 Sulfur Dioxide

The following map shows the location of the source types that emit sulfur dioxide (SO_2) in Georgia. The source types displayed include those that as a whole produce over 500 tons/year of SO_2. These source types include aviation, electricity via combustion, paper plants, ceramics plants, chemical plants, breweries, glass plants, food processing plants, sugar mills, textile plants, wastewater treatment facilities, and other industrial sources.

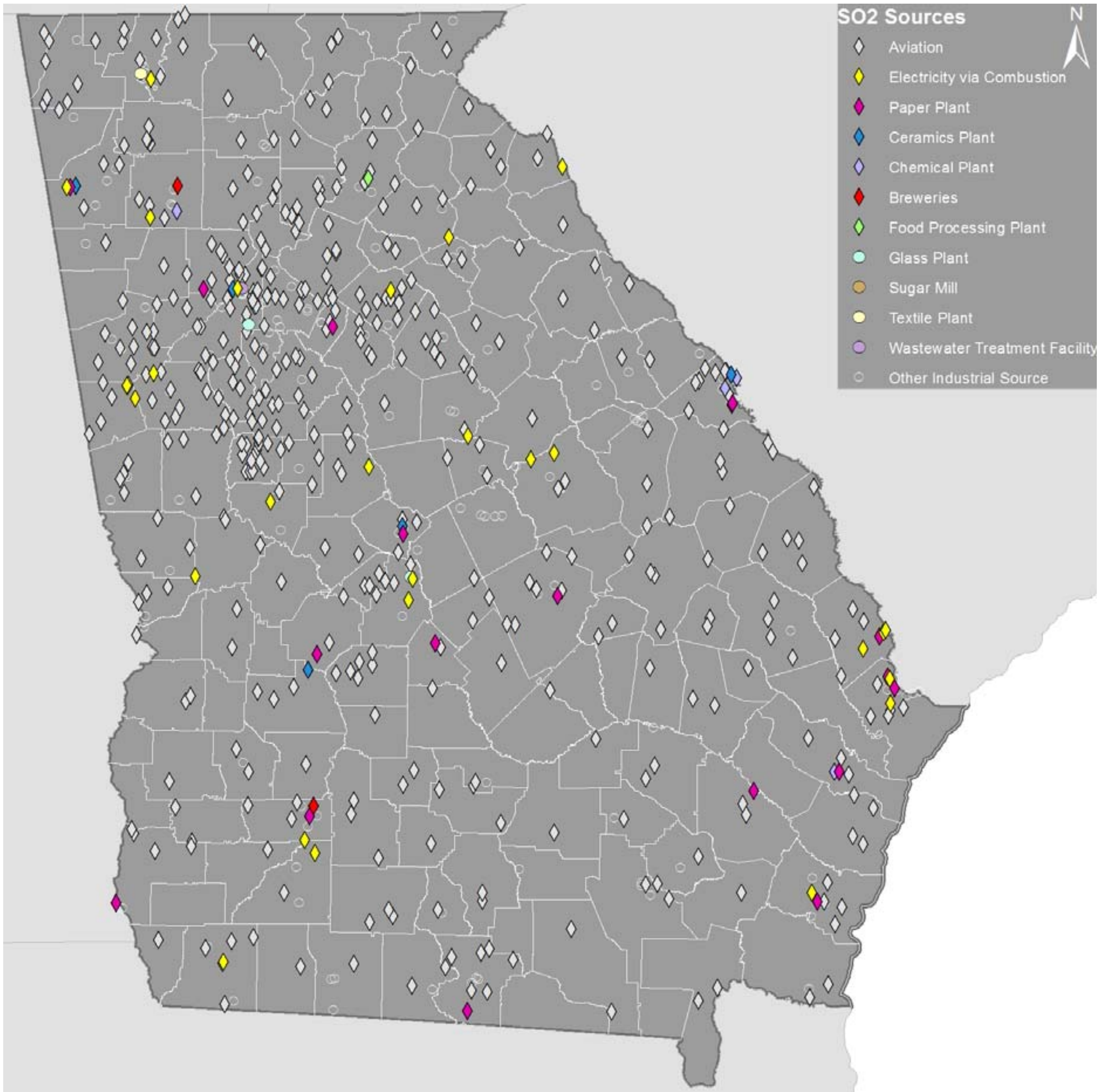


Figure 16.2: SO_2 Emitting Facilities in Georgia

In the following figure, the total modeled anthropogenic sulfur dioxide typical emissions are shown for 2007 and 2018. Emissions are shown in tons per year (TPY) at the county level, and the counties with the highest levels are shown in red. In addition, the difference between 2007 and 2018 emissions is shown using the formula 2018 emissions – 2007 emissions. The percent change in emissions between 2007 and 2018 is shown using the formula (2018/2007-1) X 100.

2007 and 2018 GA Annual Total Anthropogenic SO_2

Difference = 2018-2007 and % Changes = (2018/2007 -1)*100

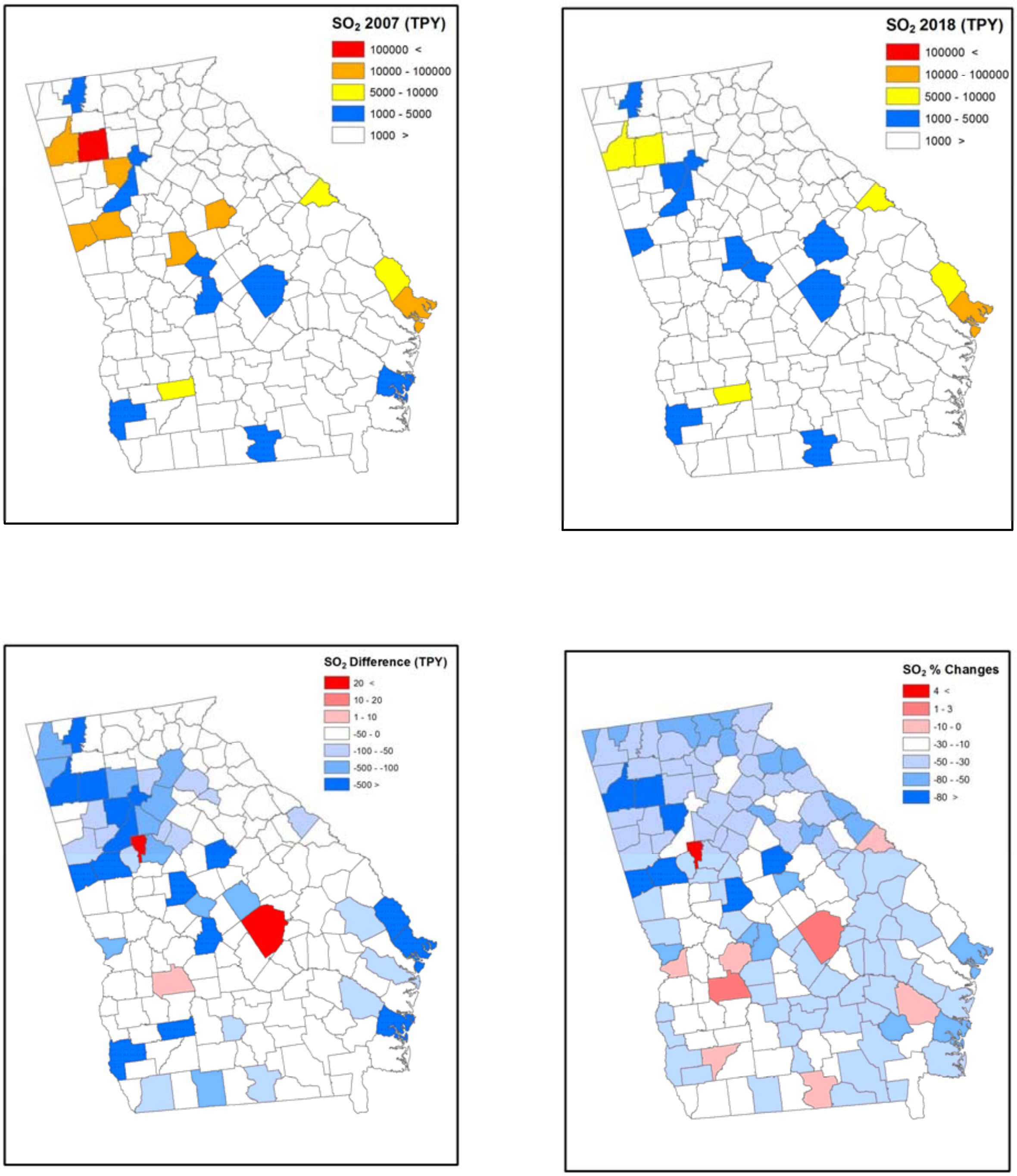


Figure 16.3: Sulfur Dioxide 2007 and 2018 Typical Emissions

The areas with the highest levels of emissions seem to be in the outskirts of the Atlanta-Sandy Springs-Roswell MSA and in the Savannah MSA. With the modeled 2007 data, the counties with the highest levels were Bartow (red); Floyd, Cobb, Coweta, Heard, Monroe, Putnam, and Chatham (orange). In the modeled 2018 data, there were a few changes. Floyd County and the counties on the outskirts of the Atlanta-Sandy Springs-Roswell MSA have a decrease in emissions. The Savannah MSA, however, shows no modeled change in emissions from 2007 to 2018.

The following model output shows projected concentrations of sulfur dioxide at the fourth highest daily 1-hour maximums based on 2007 data. The concentrations are shown in parts per billion, and the darker color represents higher levels of concentration. These models take into account meteorological conditions based on 2007 data. The current locations of GA EPD's ambient air monitors are shown with white triangles.

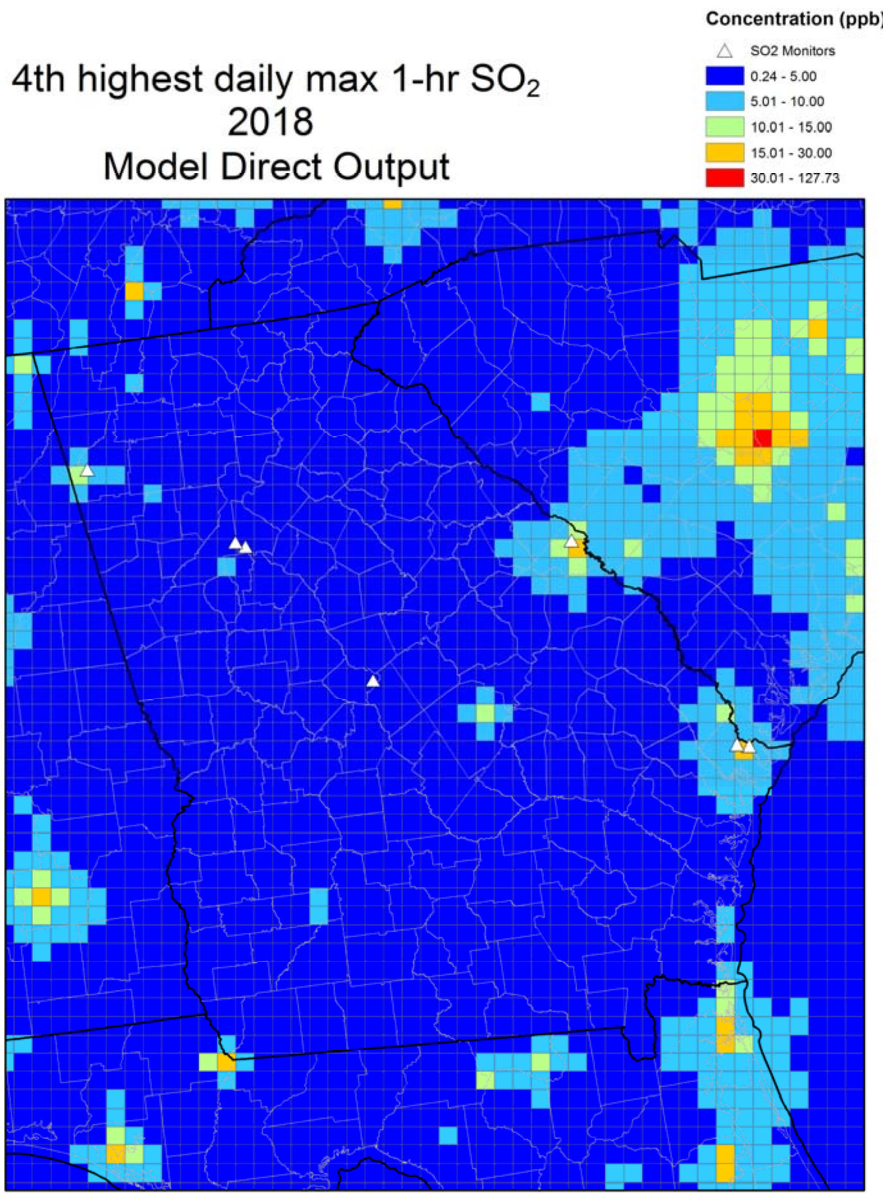


Figure 16.4: Sulfur Dioxide, Modeled 2018 1-Hour 4th Highest Daily Maximum

With the above model, the 99th percentile, 4th highest maximums of sulfur dioxide emissions for 2018 are predicted to be highest in the Rome MSA, Dublin County, Augusta-Richmond County, GA-SC MSA, and the Savannah MSA. GA EPD has strategically placed SO_2 monitors in the areas with the highest predicted 2018 SO_2 emissions (Augusta-Richmond County, GA-SC MSA, and the Savannah MSA).

16.2 PM_{10}

The following map shows the location of the source types that emit PM_{10} in Georgia. The source types displayed include those that as a whole produce over 500 tons/year of PM_{10} emissions. These source types include sawmills, paper plants, electricity via combustion, wood product plants, ceramics plants, foundries, and other industrial sources.

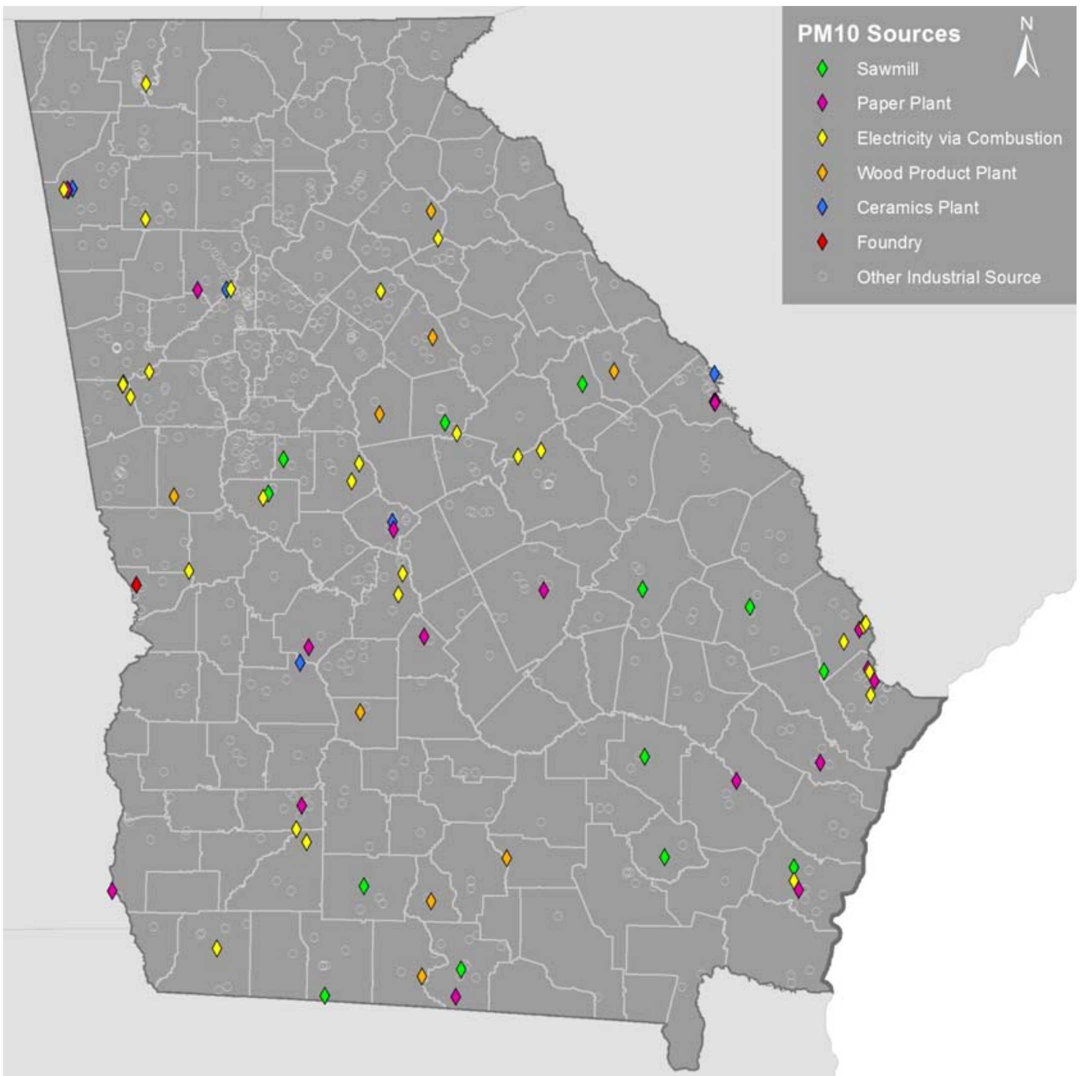


Figure 16.5: PM_{10} Emitting Facilities in Georgia

The following figure shows the total primary anthropogenic PM_{10} typical emissions for 2007 and 2018. Emissions are shown in tons per year (TPY) at the county level; the counties with the highest levels are shown in red. In addition, a difference between 2007 and 2018 emissions is shown using the formula 2018 emissions - 2007 emissions. The percent change in emissions from 2007-2018 is shown using the formula (2018/2007-1) X 100.

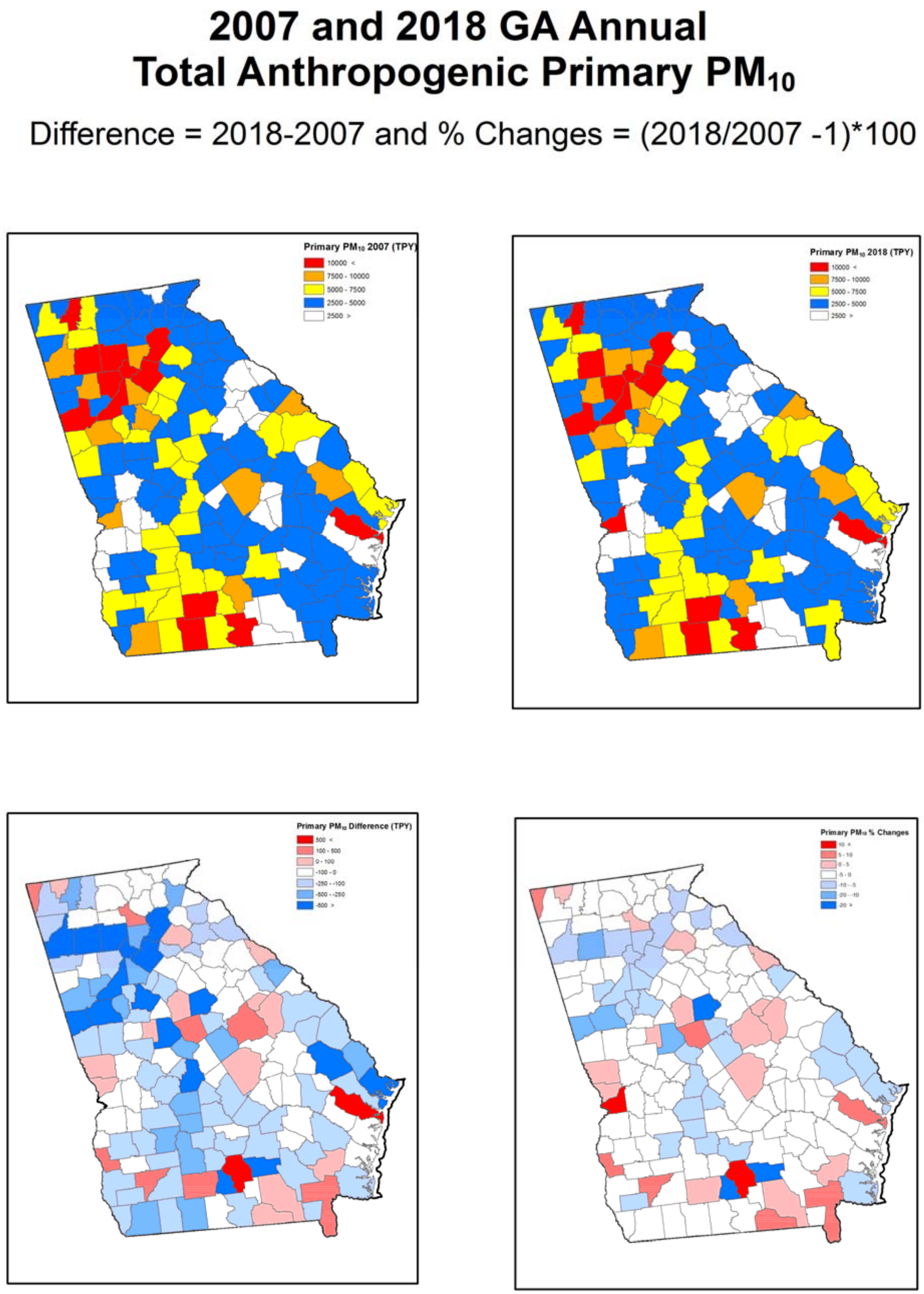


Figure 16.6: PM_{10} 2007 and 2018 Typical Emissions

According to the 2007 and 2018 typical anthropogenic primary PM_{10} emissions maps shown above, the areas with the highest PM_{10} emissions are primarily around the Atlanta-Sandy Springs- Roswell MSA, Dalton MSA, Gainesville MSA, Hinesville MSA, Thomasville and Moultrie Micropolitan Statistical Areas, and part of the Valdosta MSA. These areas are shown in red in the top two maps and represent greater than 10,000 TPY of emissions. There does not appear to be much change in the PM_{10} emissions levels from 2007 to 2018.

The following model outputs show projected concentrations of PM_{10} at the second highest daily maximum based on 2007 data. The concentrations are shown in micrograms per cubic meter ($\mu g/m^3$), areas in red have higher concentrations and dark blue the lowest. These models take into account meteorological conditions based on 2007 data. The current locations of GA EPD's ambient air monitors are shown with white triangles.

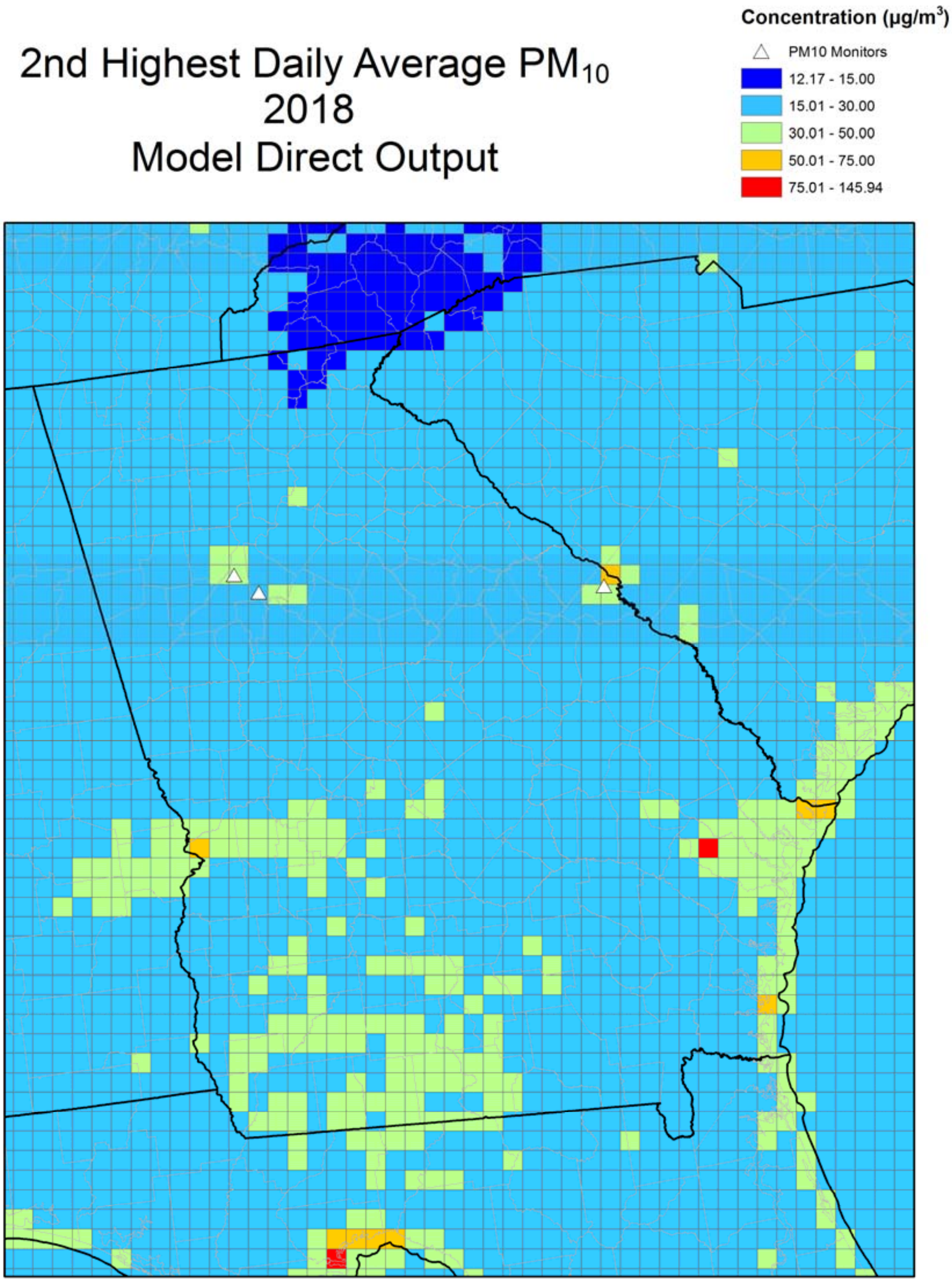


Figure 16.7: PM_{10}, Modeled 2018, 2nd Highest Average

According to the modeled 2018 2nd highest average, the areas with the highest PM_{10} emissions are primarily in the Augusta-Richmond County, GA-SC MSA and the southern parts of the state. GA EPD has a PM_{10} monitor located in the Augusta-Richmond County, GA-SC MSA; however, the areas to be considered for locating PM_{10} monitors, according to the modeled highest emissions, are the Hinesville MSA (shown in red), and the Columbus, GA-AL MSA and Brunswick MSA (shown in orange). PM_{10} monitors are currently located in MSAs with higher populations, according to the Federal Register (40CFR58).

16.3 $PM_{2.5}$

The following map shows the location of the source types that emit $PM_{2.5}$ in Georgia. The source types displayed include saw mills, paper plants, electricity via combustion, wood product plants, ceramics plants, and other industrial sources.

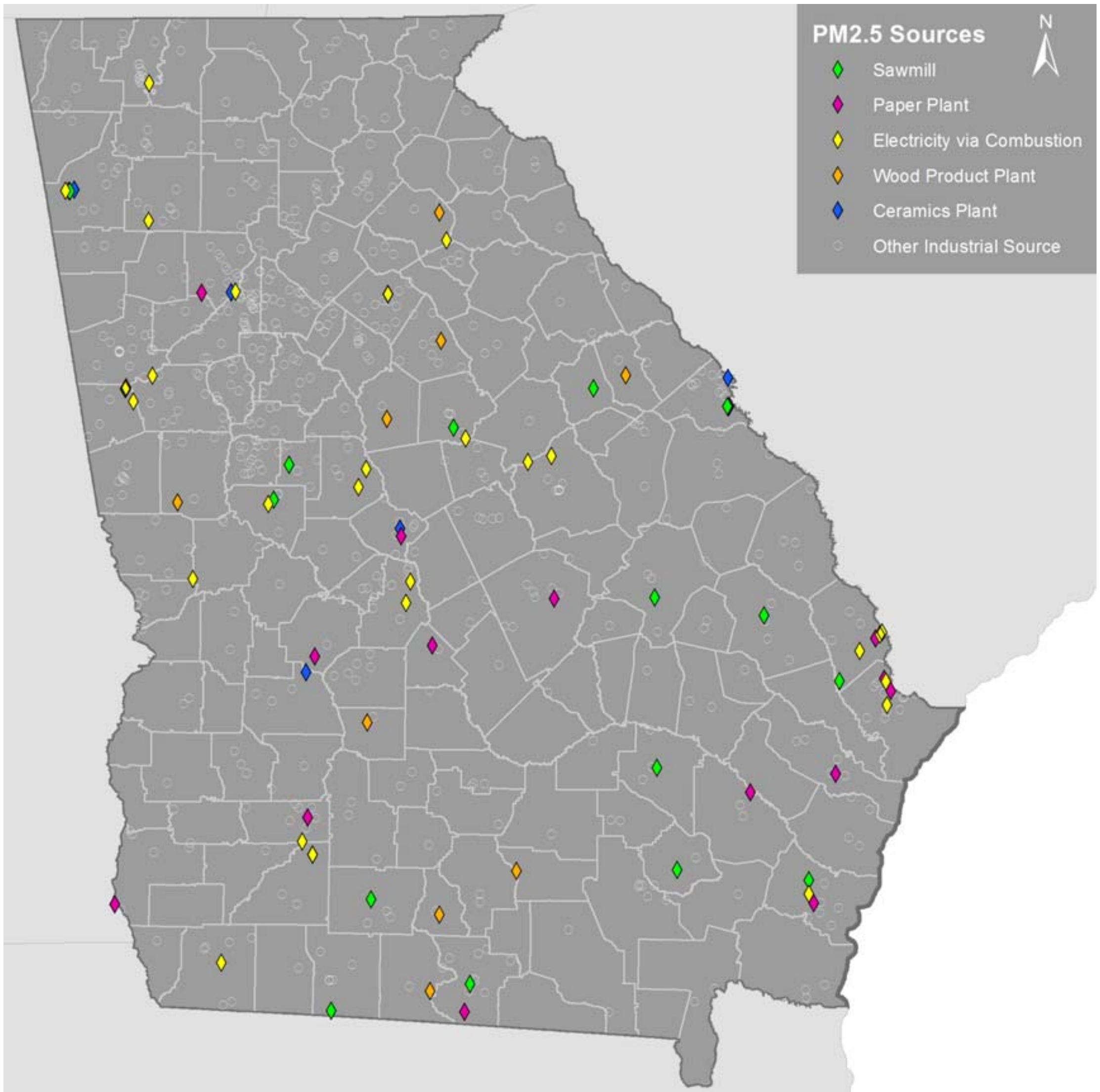


Figure 16.8: $PM_{2.5}$ Emitting Facilities in Georgia

In the following figure, the total anthropogenic $PM_{2.5}$ typical emissions are shown for 2007 and 2018. Emissions are shown in tons per year (TPY) at the county level, and the counties with the highest levels are shown in red. In addition, a difference between 2007 and 2018 emissions is shown using the formula 2018 emissions - 2009 emissions. A percent change in emissions is shown using the formula (2018/2009-1) X 100.

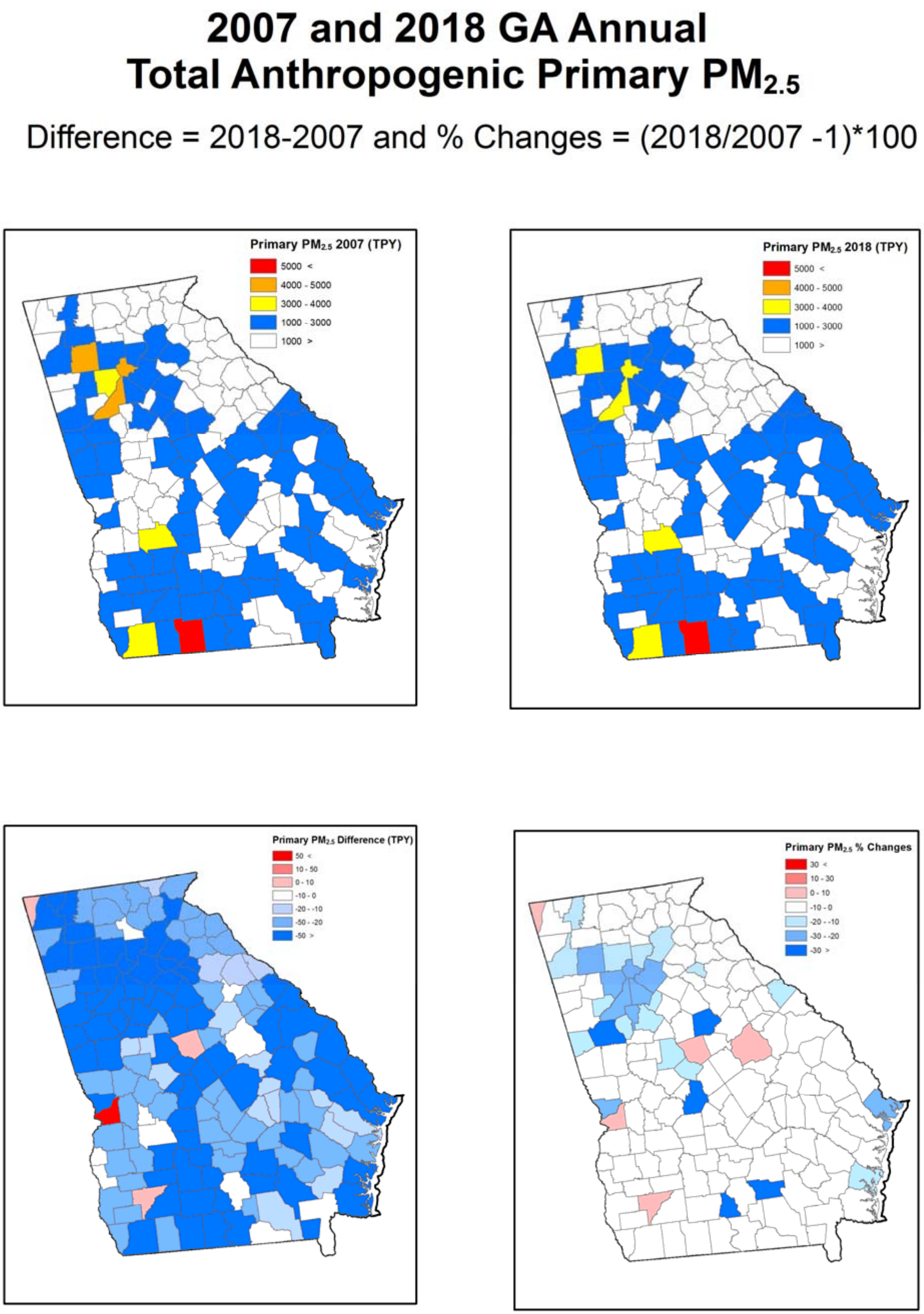


Figure 16.9: $PM_{2.5}$ 2007 and 2018 Typical Emissions

According to the 2007 and 2018 typical anthropogenic primary $PM_{2.5}$ emissions maps shown above, the area with the highest typical anthropogenic $PM_{2.5}$ emissions is Thomas County, shown in red. Thomas County has over 5000 TPY of typical $PM_{2.5}$ emissions in in 2007 and 2018. The other areas of the state show little change from 2007 to 2018. Bartow and Fulton Counties (shown in orange for 2007) and Cobb County (shown in yellow for 2007) show a decrease of $PM_{2.5}$ emissions in 2018.

The following model outputs show projected concentrations of $PM_{2.5}$ at both the eighth highest daily average, or 98^{th} percentile, and the annual average based on 2007 data. The concentrations are shown in micrograms per cubic meter ($\mu g/m^3$), areas with higher concentrations are shown in red. These models take into account meteorological conditions based on 2007 data. The current locations of GA EPD's ambient air monitors are shown with white triangles.

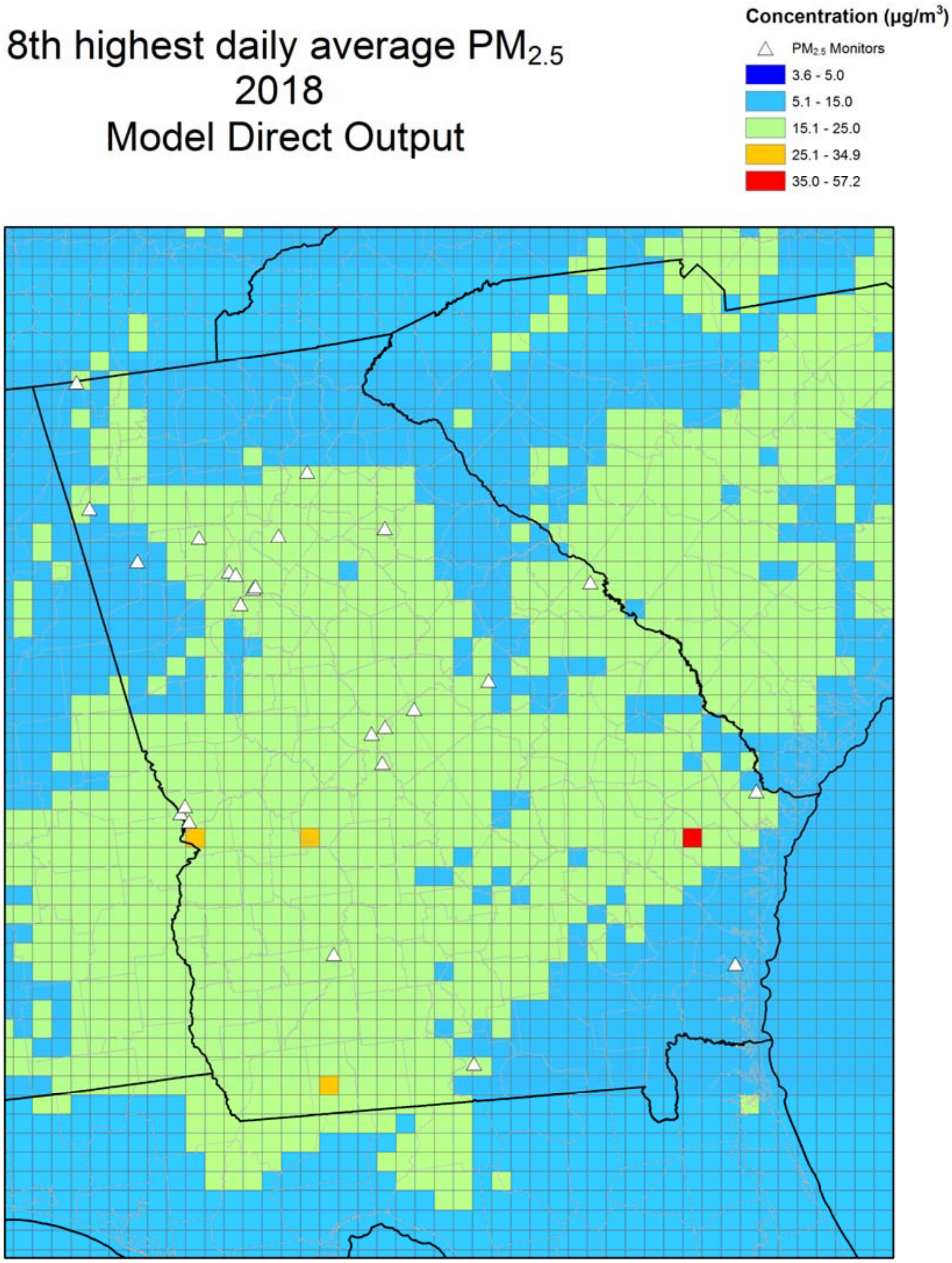


Figure 16.10: $PM_{2.5}$, Modeled 2018, 8th Highest Daily Average

The modeled 8th highest daily average, or 98th percentile, of $PM_{2.5}$ shows the Liberty County area in the Hinesville MSA (shown in red), part of the Columbus, GA-AL MSA, part of the Macon County, and Grady County (shown in orange) as areas of concern. The red colored area has a predicted $PM_{2.5}$ level of 35.0-57.2 µg/m^3. The orange colored areas have a predicted $PM_{2.5}$ level of 25.1-34.9 µg/m^3. For the daily standard (98th percentile) of $PM_{2.5}$, it appears that the Brunswick and Yorkville sites are not in the best locations to collect this data. In these areas, the predicted concentrations are between 5.1-15.0 µg/m^3 of $PM_{2.5}$ data. The Liberty County area in the Hinesville MSA (shown in red) does not have a $PM_{2.5}$ monitor. However, with this area being modeled with the highest concentration, it seems that the Hinesville MSA could possibly need a $PM_{2.5}$ monitor.

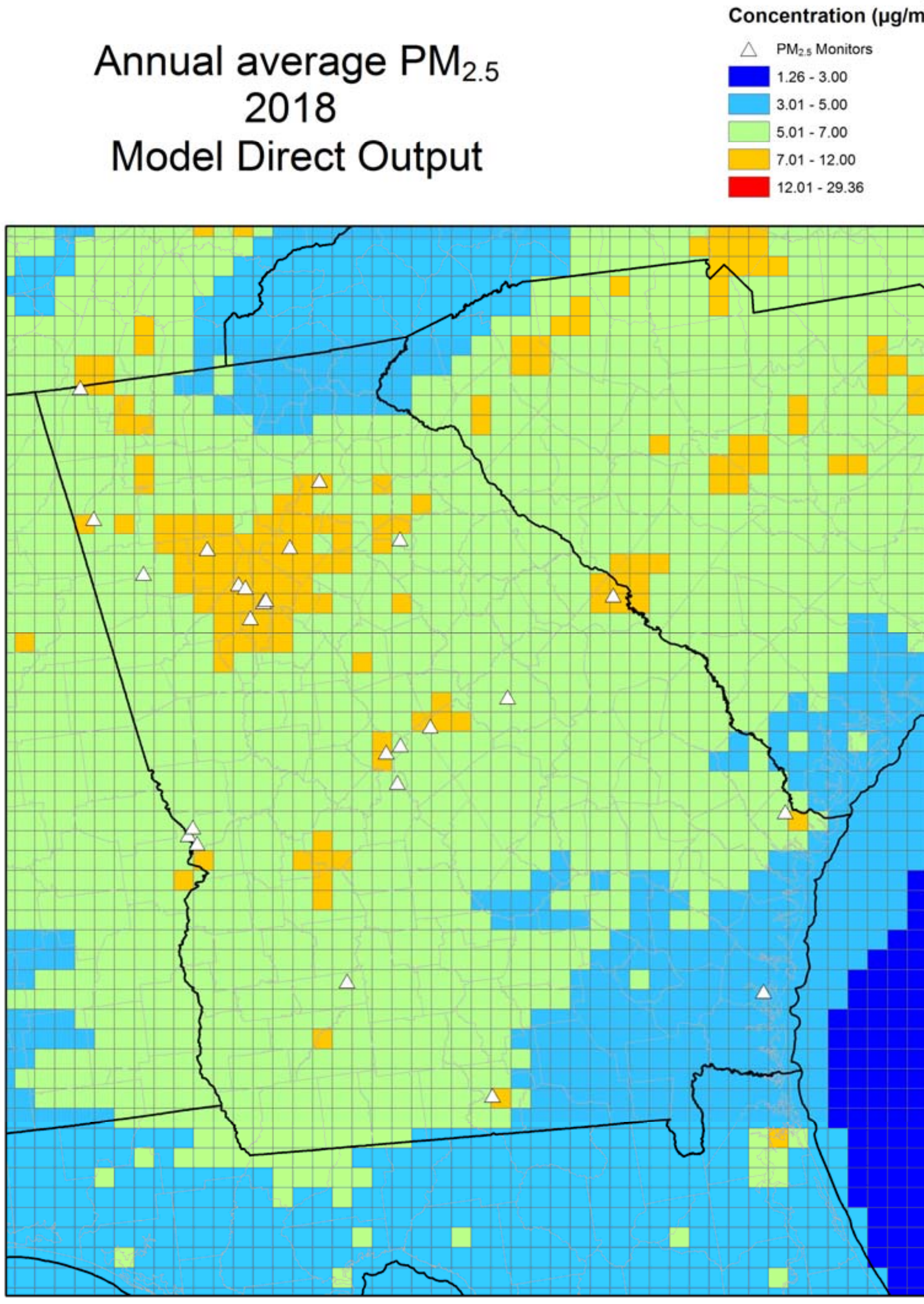


Figure 16.11: $PM_{2.5}$, Modeled 2018, Annual Average

The modeled $PM_{2.5}$ annual averages predict the highest areas to be in different locations than the daily 98th percentile model showed. For the annual average model, primarily the Atlanta-Sandy Springs- Roswell MSA and north of that MSA are predicted to have higher $PM_{2.5}$ annual concentrations. Overall, it appears that most of the state is sufficiently covered for monitoring higher levels of annual $PM_{2.5}$ concentrations.

As stated above with the PM_{10} Emission Assessment, GA EPD currently meets the monitoring requirements for $PM_{2.5}$. The Emission Assessment is one part of overall analysis. Decisions will be made about changing the placement of these monitors or adding monitors to the network based on several factors and the overall assessment.

16.4 Carbon Monoxide

The following map shows the location of the source types that emit CO in Georgia. The source types displayed include aviation, electricity via combustion, cement plants, ceramics plants, compressor stations, fabricated metal plants, saw mills, paper plants, steel mills, wood product plants, and other industrial sources.

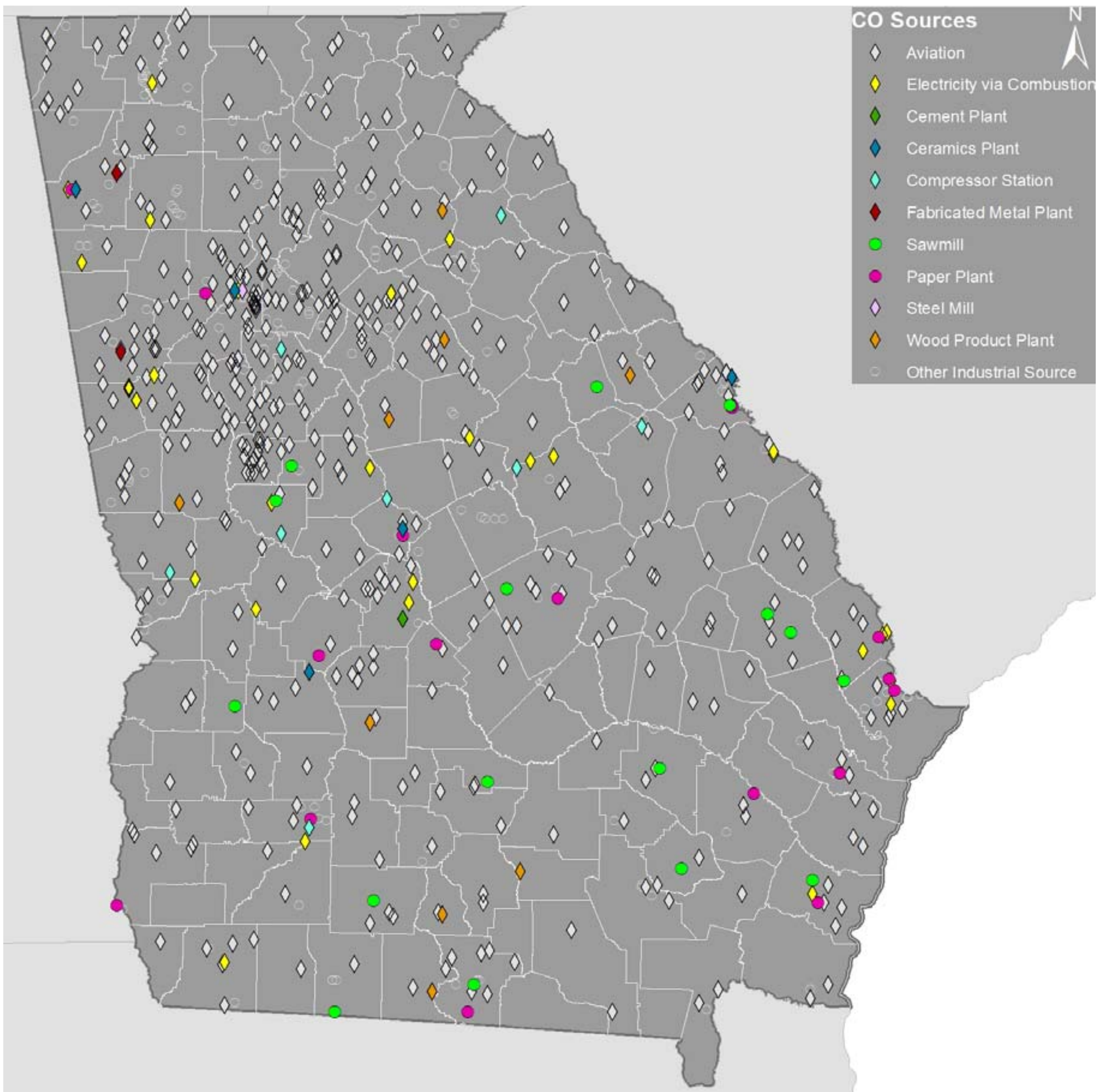


Figure 16.12: CO Emitting Facilities in Georgia

In the following maps, the total anthropogenic carbon monoxide typical emissions are shown for 2007 and 2018. Emissions are shown in tons per year (TPY) at the county level, and the counties with the highest levels are shown in red. In addition, a difference between 2007 and 2018 emissions is shown using the formula 2018 emissions - 2007 emissions. A percent change in emissions is shown using the formula (2018/2007-1) X 100.

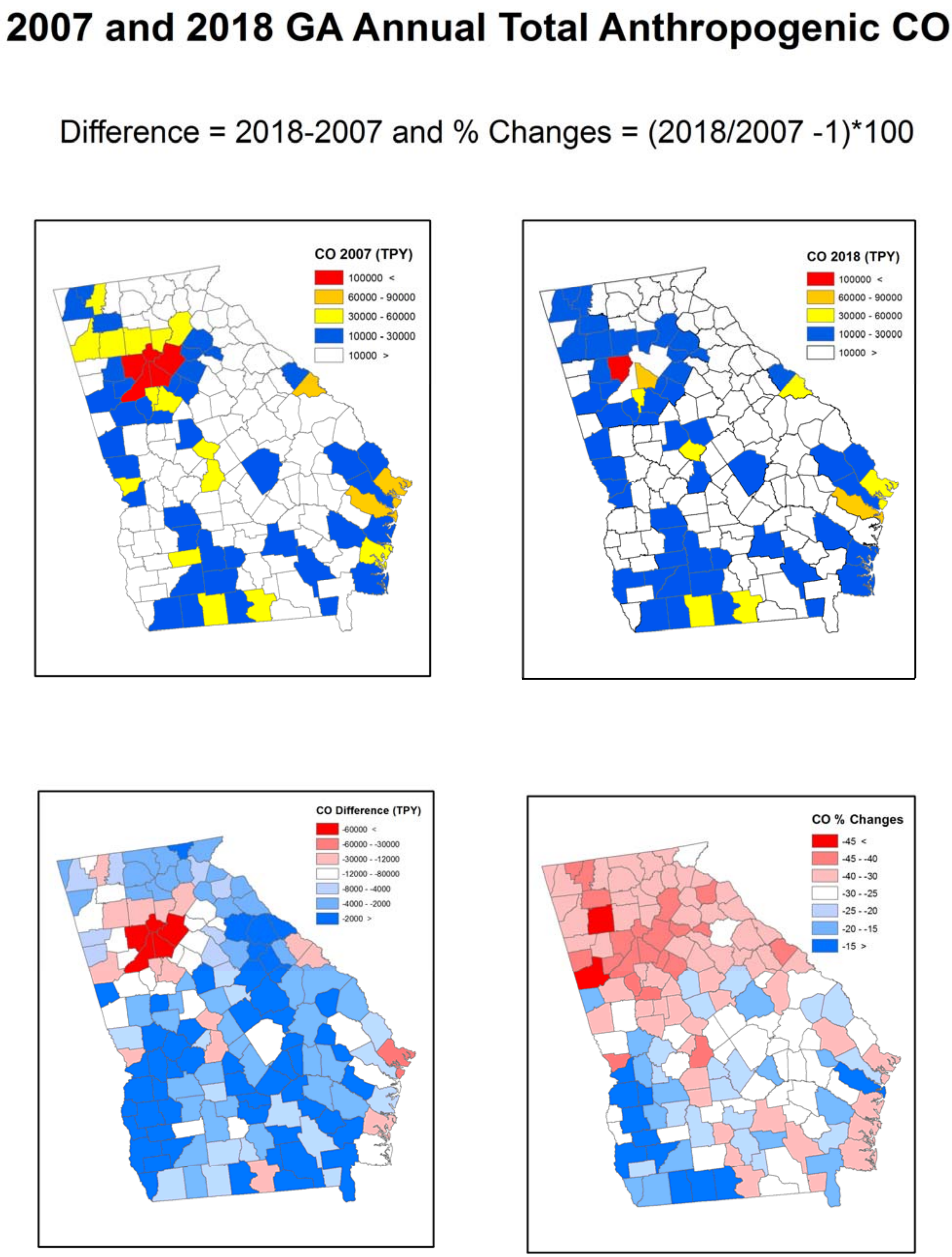


Figure 16.13: CO 2007 and 2018 Typical Emissions

For the CO emissions in Georgia, the Atlanta-Sandy Springs-Roswell MSA (shown in red) and the Savannah MSA, Augusta-Richmond County, GA-SC, and Hinesville MSA (shown in orange) have the highest emissions for 2007. In 2018, the predicted CO emissions for parts of the Atlanta-Sandy Springs-Roswell have a dramatic decrease, and several other areas also have a predicted decrease.

In the following model outputs, projected concentrations of carbon monoxide at both the second maximum for 1-hour average and second maximum for 8-hour average based on 2007 data are shown. The concentrations are shown in parts per billion, higher concentration levels are shown in red. These models take into account meteorological conditions based on 2007 data. The current locations of GA EPD's ambient air monitors are shown with white triangles.

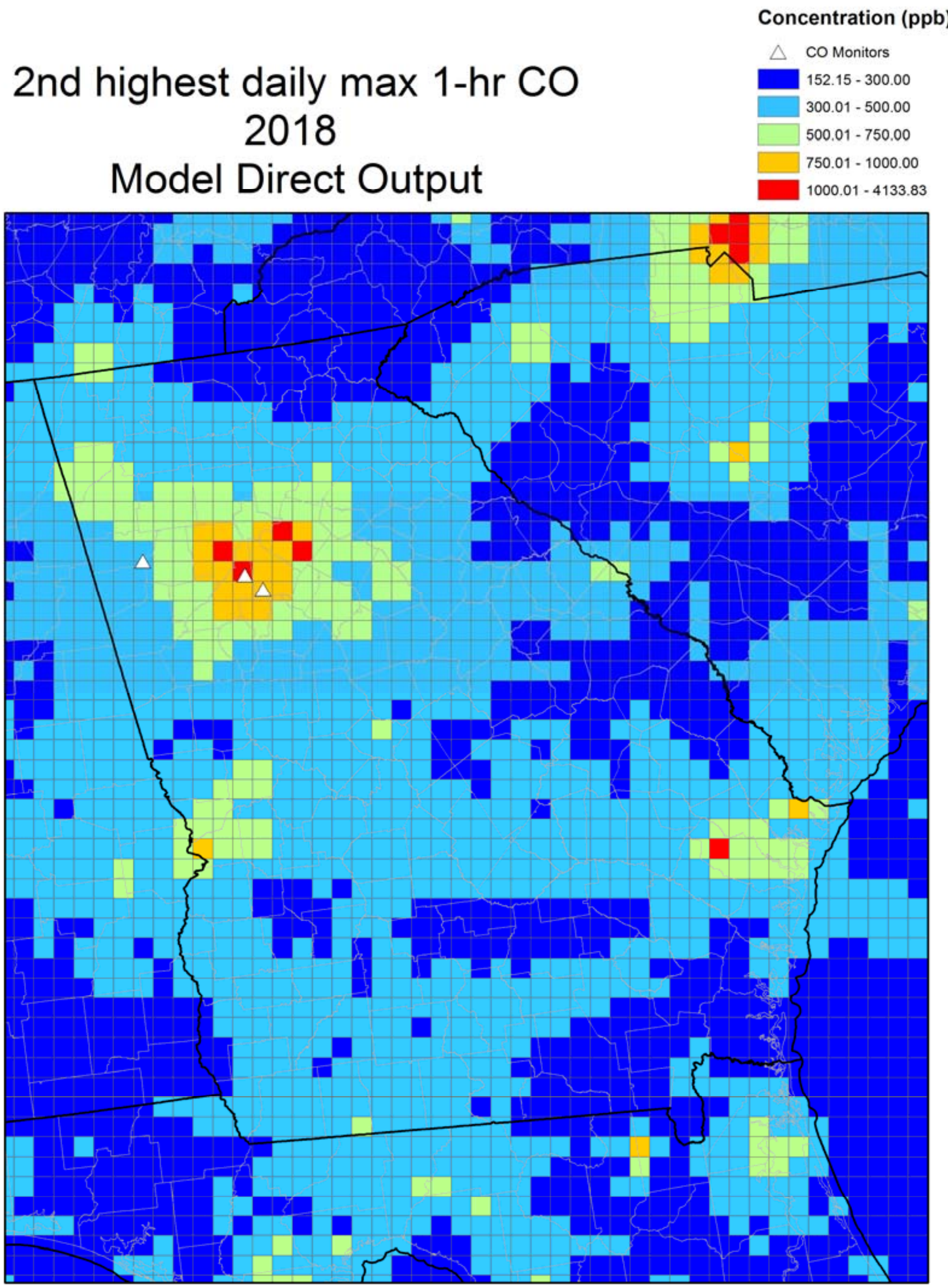


Figure 16.14: CO, Modeled 2018, 1-Hour 2nd Highest Daily Maximum

With the above map, the concentrations of carbon monoxide are predicted for the 1-hour average of second highest daily maximums. For the 1-hour predicted concentrations, some areas of the Atlanta-Sandy Springs-Roswell MSA and the Hinesville MSA have the highest level of emissions (shown in red). Also, the Columbus, GA-AL MSA and the Savannah MSA have the second highest level of predicted CO emissions (shown in orange). GA EPD may need to consider adding a CO monitor in the Hinesville MSA to collect the highest predicted level of CO.

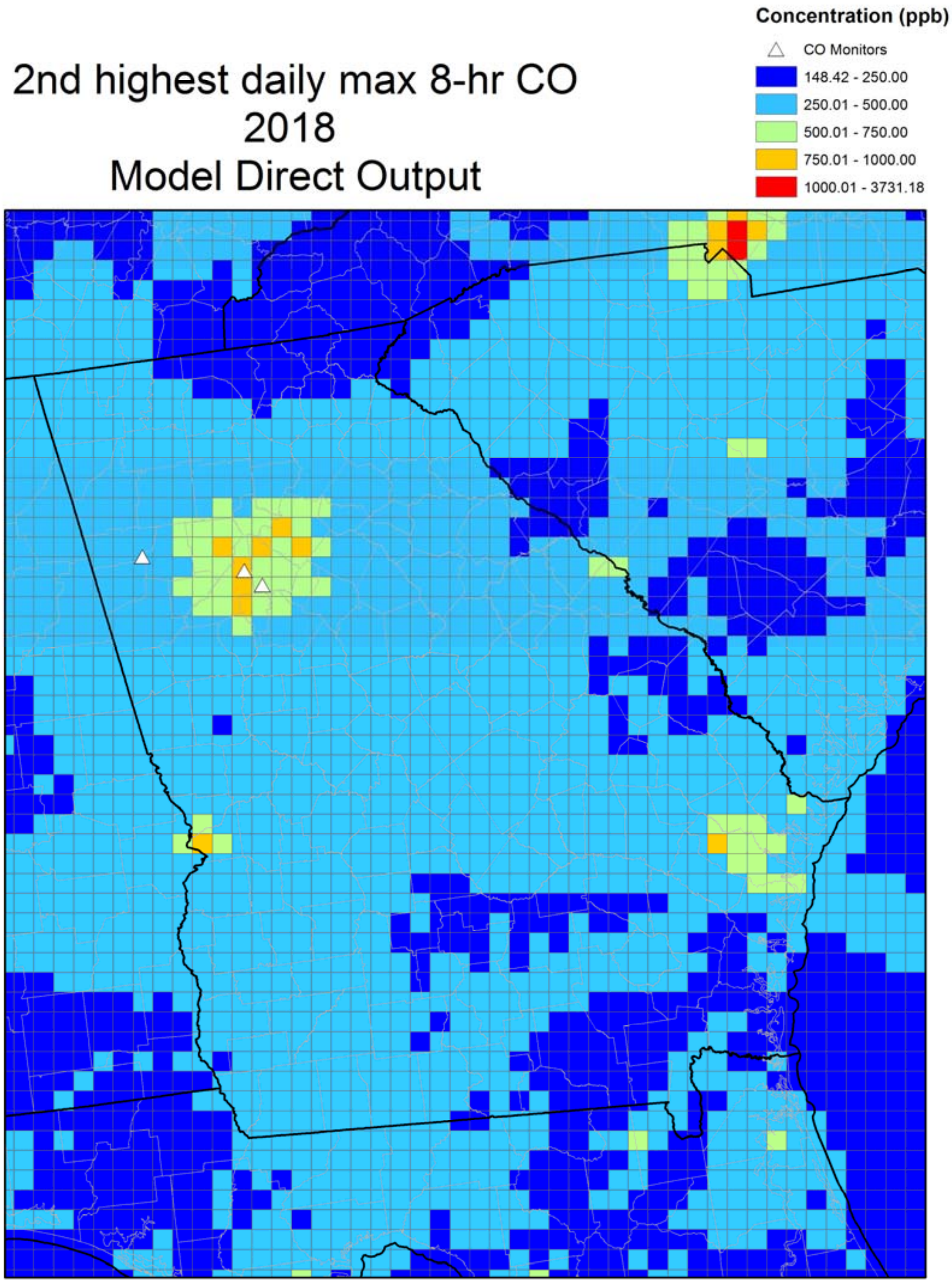


Figure 16.15: CO, Modeled 2018, 8-Hour 2nd Highest Daily Maximum

The 8-hour second highest daily maximums of CO are predicted in the above map. For the 8-hour predicted levels, there are no areas in Georgia with the highest level of emissions. There are a few areas that have the second highest level of predicted emissions, 750.1-1000.0 ppb. These areas are the Atlanta-Sandy Springs-Roswell MSA, Hinesville MSA, and the Columbus, GA-AL MSA. GA EPD may need to consider adding a CO monitor to the Columbus MSA and the Hinesville MSA.

16.5 Ozone

The following model outputs show predicted concentrations of ozone at the fourth highest daily 8-hour maximum based on 2007 data. The concentrations are shown in parts per billion, higher concentration levels are shown in red. These models take into account meteorological conditions based on 2007 data. The current locations of GA EPD's ambient air monitors are shown with white triangles.

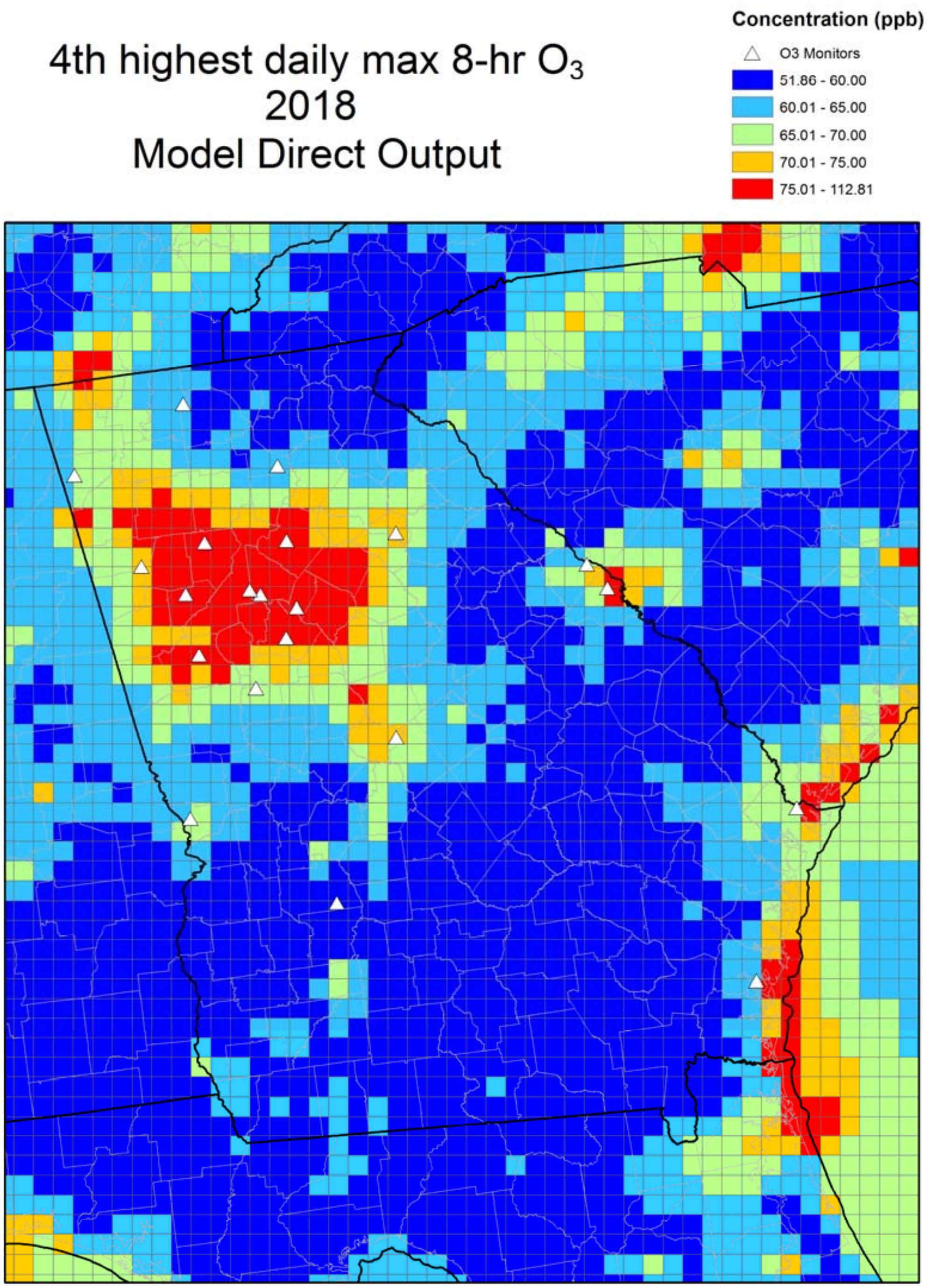


Figure 16.16: Ozone, Modeled 2018 4th Highest Daily Maximum

It appears that GA EPD has ozone monitors in most of the areas of the state where the highest levels of 4th highest daily maximum of the 8-hour ozone values are predicted to be in 2018. There are two monitors (Confederate Avenue and South DeKalb sites) in the core of the Atlanta-Sandy Springs-Roswell MSA that appear to be overlapping. One of these monitors may not be needed since these two monitors are so close in proximity. The ozone monitor (shown in blue) located in the Americus Micropolitan Statistical Area is in an area with predicted lower comparable emissions and may not be needed according to this assessment. The northern part of the Macon MSA may need an ozone monitor to collect data at the highest predicted 2018 level.

During the process of writing this document, on November 25, 2014, EPA proposed to strengthen the 8-hour primary and secondary ozone standards, designed to protect public health, to a level within the range of 0.065-0.070 parts per million (ppm) (79FR75233). Final decisions for this rule are expected to be made and signed by EPA by November 2015. At that time, GA EPD will make adjustments to the ozone network accordingly.

16.6 NOx

The following map shows the location of the source types that emit oxides of nitrogen in Georgia. The source types displayed include aviation, electricity via combustion, rail yards, paper plants, wood product plants, compressor stations, ceramics plants, chemical plants, steel mills, breweries, glass plants, fertilizer plants cement plants, and other industrial facilities.

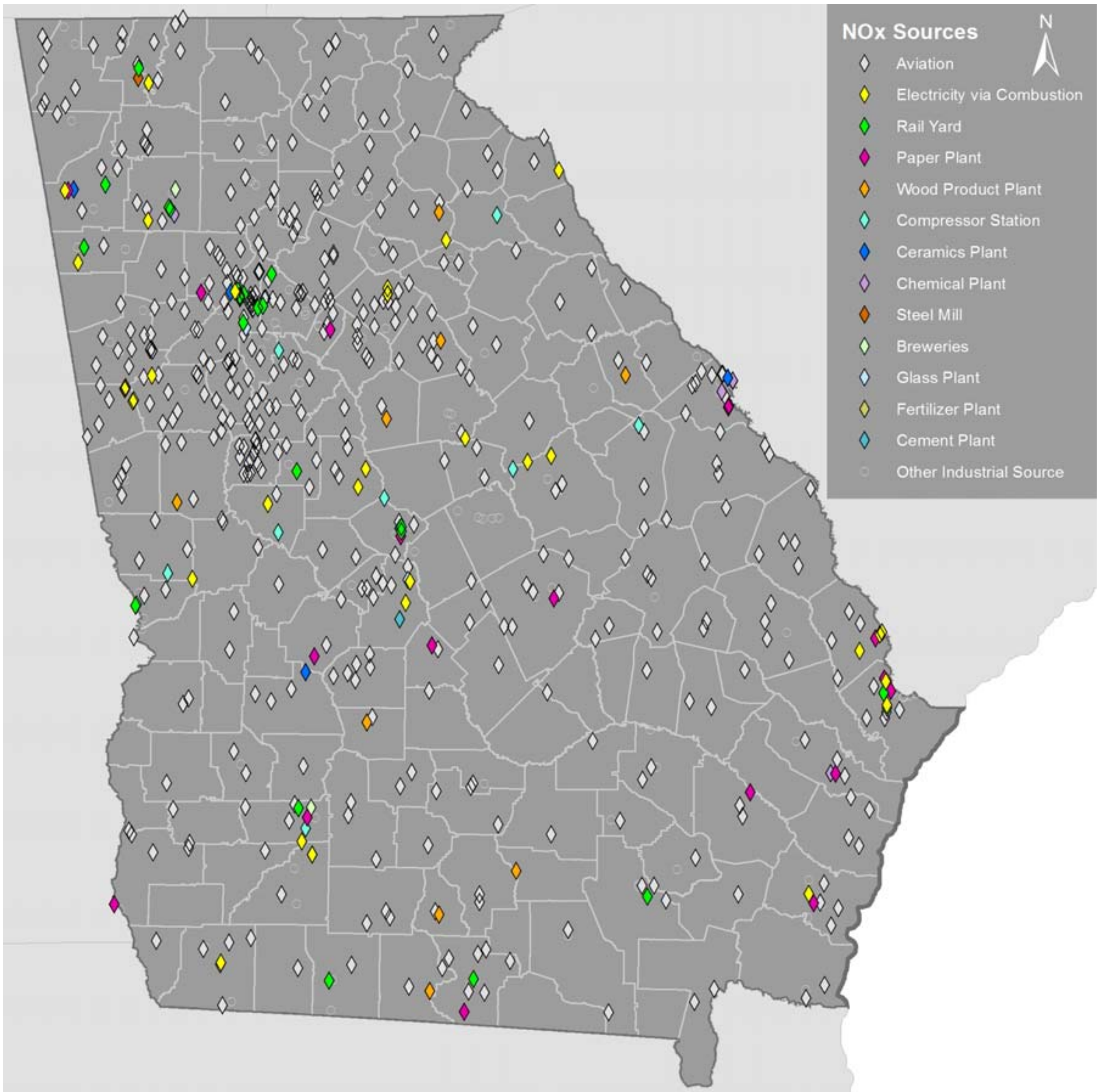


Figure 16.17: NOx Emitting Facilities in Georgia

In the following maps, the total anthropogenic oxides of nitrogen typical emissions are shown for 2007 and 2018. Emissions are shown in tons per year (TPY) at the county level, and the counties with the highest levels are shown in red. In addition, a difference between 2007 and 2018 emissions is shown using the formula 2018 emissions - 2007 emissions. A percent change in emissions is shown using the formula (2018/2007-1) X 100.

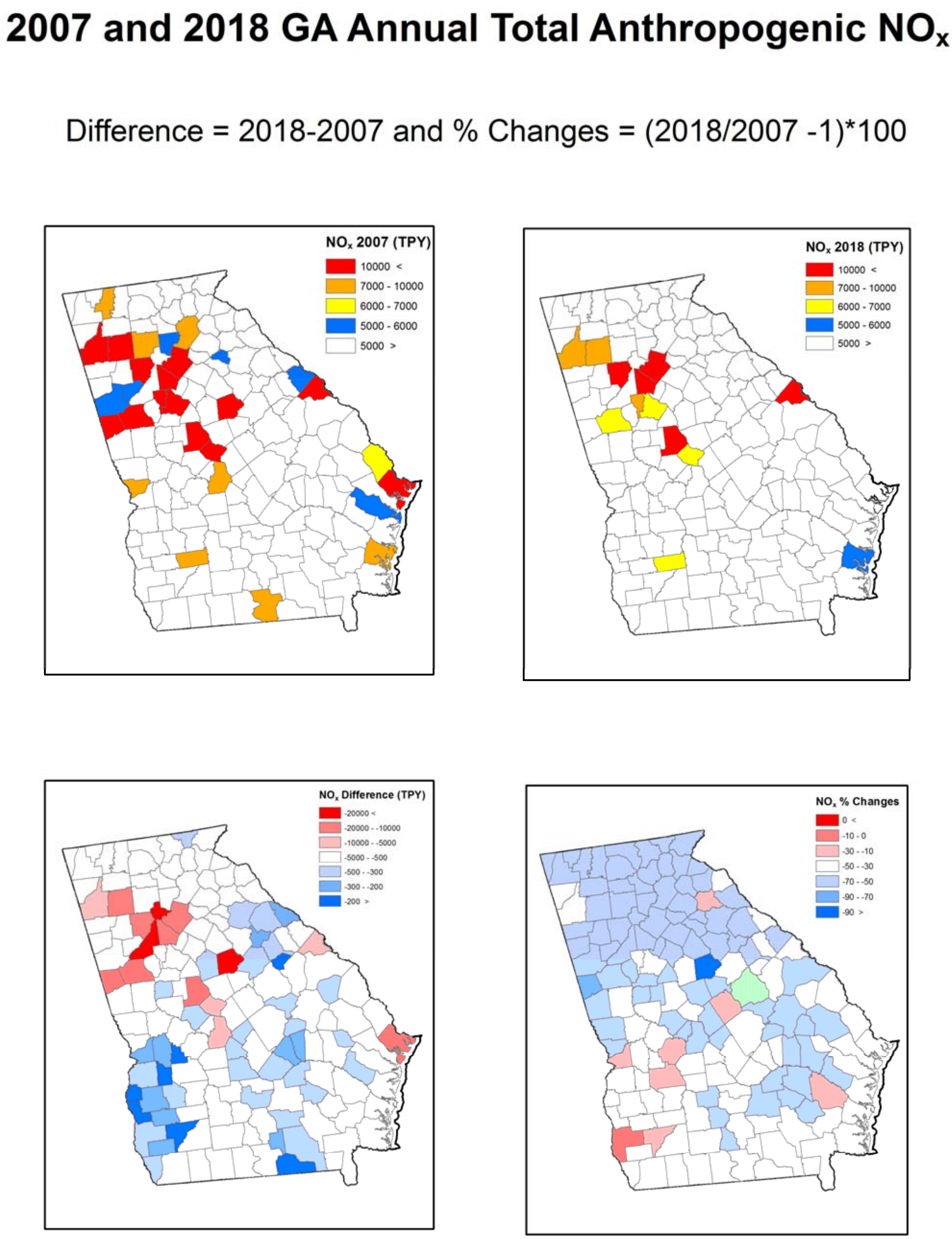


Figure 16.18: NOx 2007 and 2018 Typical Emissions

The NOx emissions models show that part of the Atlanta-Sandy Springs-Roswell MSA, the Rome MSA, part of the Savannah MSA, part of the Augusta-Richmond County, GA-SC MSA, part of the Macon MSA, and Putnam County have over 10,000 TPY of typical predicted emissions in 2007 (shown in red). In 2018, the predicted NOx emissions levels in most of these areas have significant decreases, with levels dropping to none or half the 2007 level.

The following model outputs show projected concentrations of nitrogen dioxide at the 8th highest daily 1-hour maximum based on 2007 data. The concentrations are shown in parts per billion, and the darker color represents higher levels of concentration. These models take into account meteorological conditions based on 2007 data. The current locations of GA EPD's ambient air monitors are shown with white triangles.

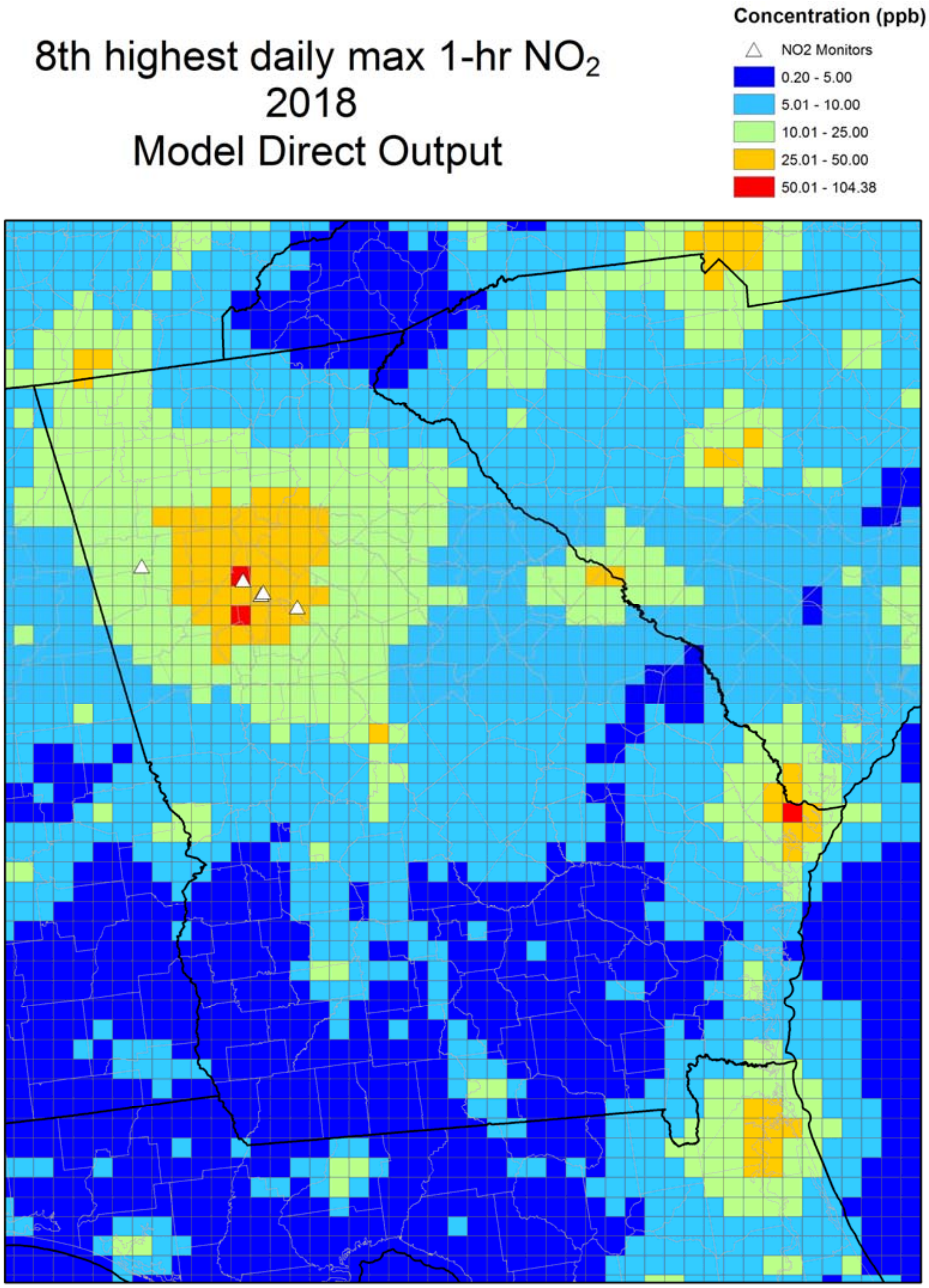


Figure 16.19: NO_2, Modeled 2018 8th Highest Daily 1-Hour Maximum

In the above map, the areas with the 8th highest daily 1-hour maximums of NO_2 are predicted. The Atlanta-Sandy Springs-Roswell MSA and the Savannah MSA have the highest predicted levels, 50.01-104.38 ppb. The Atlanta-Sandy Springs-Roswell MSA has three monitors that are part of the PAMS network, and two monitors that are part of the Near-road network. With the Savannah MSA predicted to have one of the highest levels, this area could need a monitor to collect NO_2 data. There are a couple of areas across the state that have the second highest predicted level of 25.01-50.00 ppb. The Macon MSA, Augusta-Richmond County, GA-SC MSA, and the Chattanooga, TN-GA MSA have predicted levels in this second highest range.

16.7 Volatile Organic Compounds

In the following map, the source types that emit volatile organic compounds (VOCs) in Georgia are shown. The source types displayed include aviation, electricity via combustion, sawmills, paper plants, compressor stations, wood product plants, and other industrial facilities.

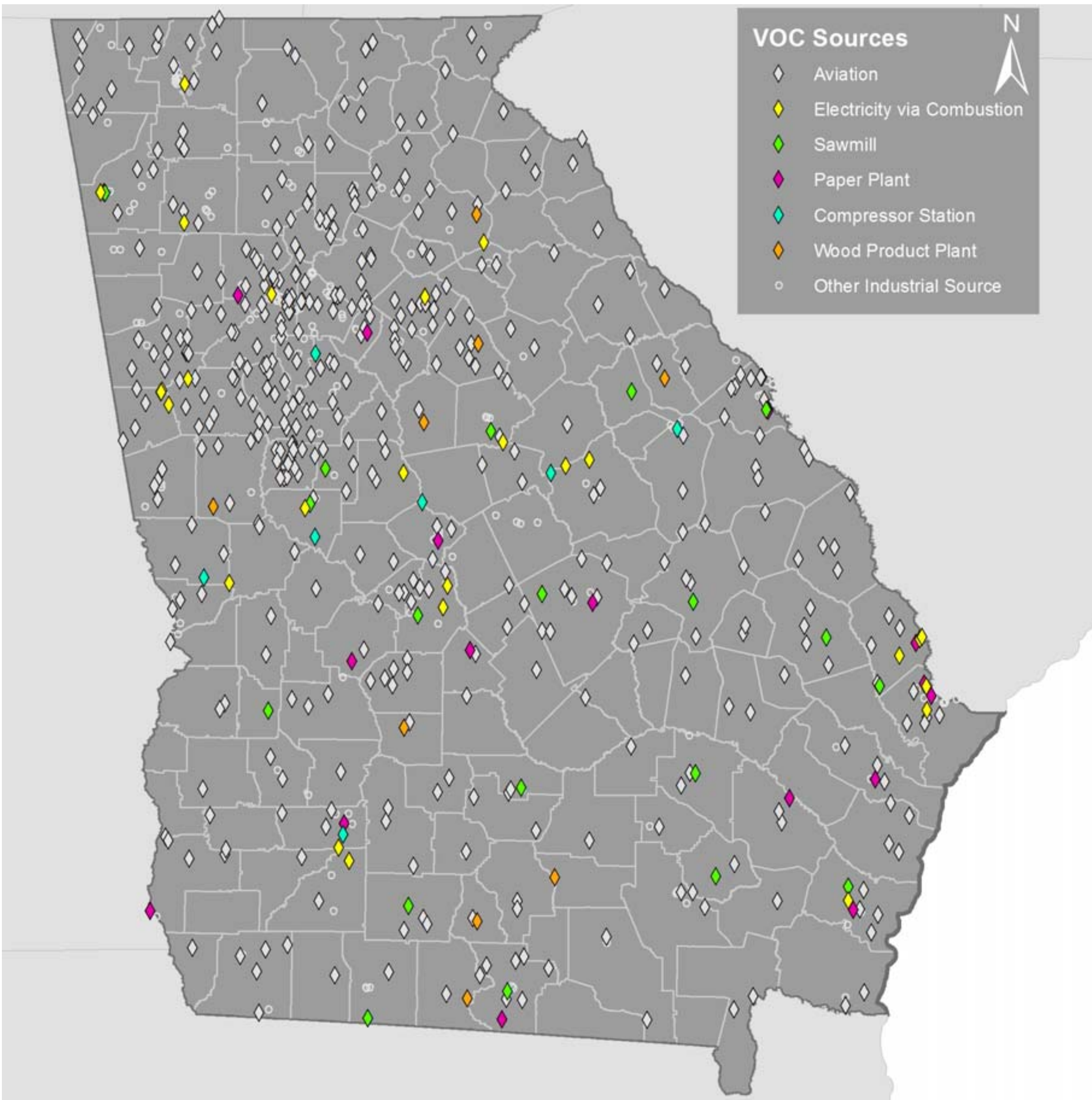


Figure 16.20: VOCs Emitting Facilities in Georgia

The following maps show the total anthropogenic VOCs for typical emissions for 2007 and 2018. Emissions are shown in tons per year (TPY) at the county level, and the counties with the highest levels are shown in red. In addition, a difference between 2007 and 2018 emissions is shown using the formula 2018 emissions - 2007 emissions. A percent change in emissions is shown using the formula (2018/2007-1) X 100.

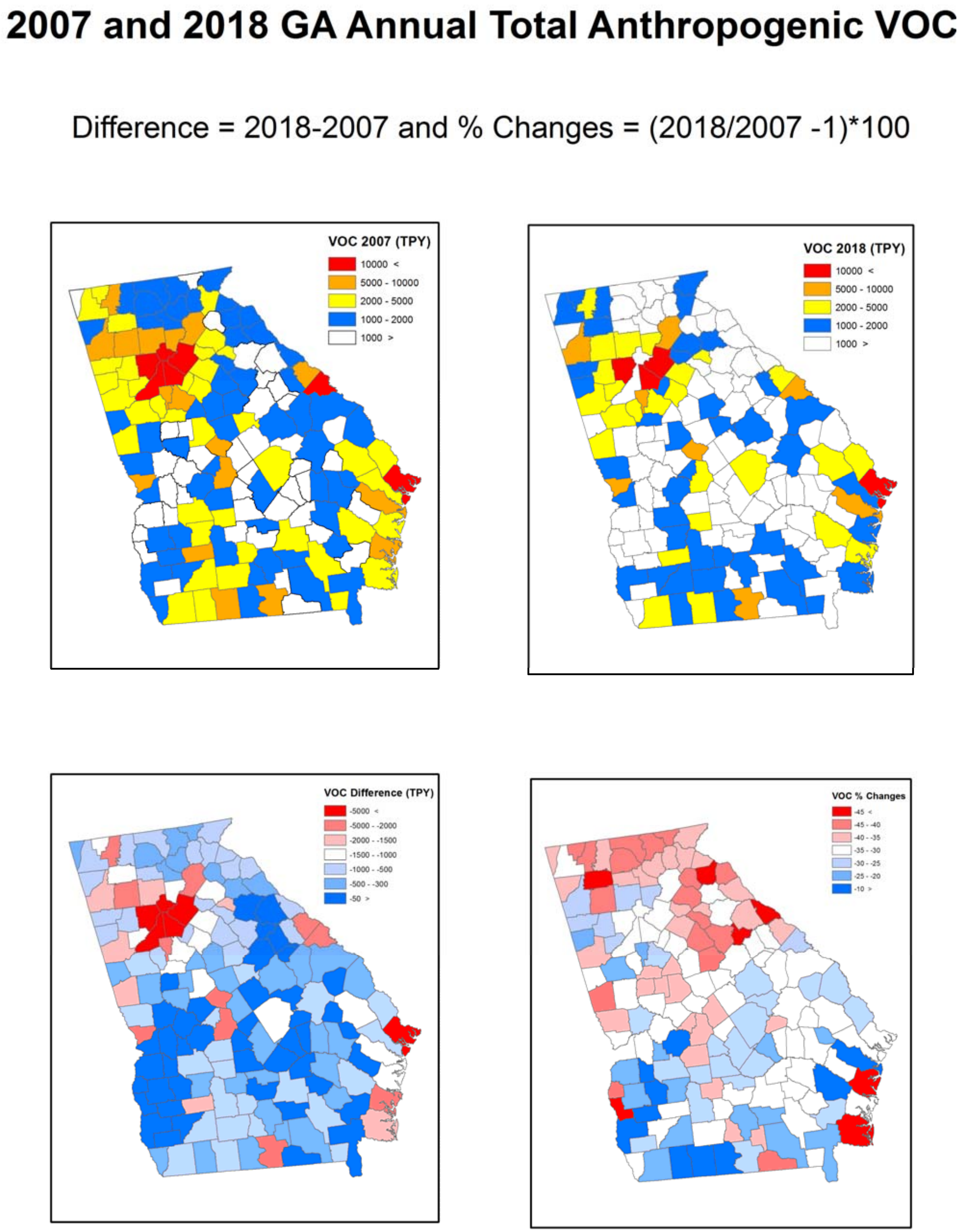


Figure 16.21: VOCs 2007 and 2018 Typical Emissions

According to the 2007 and 2018 typical anthropogenic primary VOCs emissions maps shown above, the areas with the highest typical anthropogenic VOCs emissions are parts of the Atlanta-Sandy Springs-Roswell MSA, part of the Augusta-Richmond County, GA-SC MSA, and the Savannah MSA. The total emissions per county are >10,000 TPY, shown in red. There is a predicted overall decrease in VOCs emissions across the state in 2018. It should be noted that biogenic (natural) sources in Georgia are more important in regards to emissions than anthropogenic (man-made) sources.

The two following model outputs show predicted 2018 concentrations of the annual average VOCs and the average VOCs during ozone season (March 1-Ocotber 31) based on 2007 data. The specific VOCS used for the model include ethane, isoprene, toluene, benzene, formaldehyde, and paraffin carbon species representing propane and isopentane. The concentrations are shown in parts per billion, and the darker color represents higher levels of concentration. These models take into account meteorological conditions based on 2007 data. The current locations of GA EPD’s ambient air monitors are shown with white triangles.

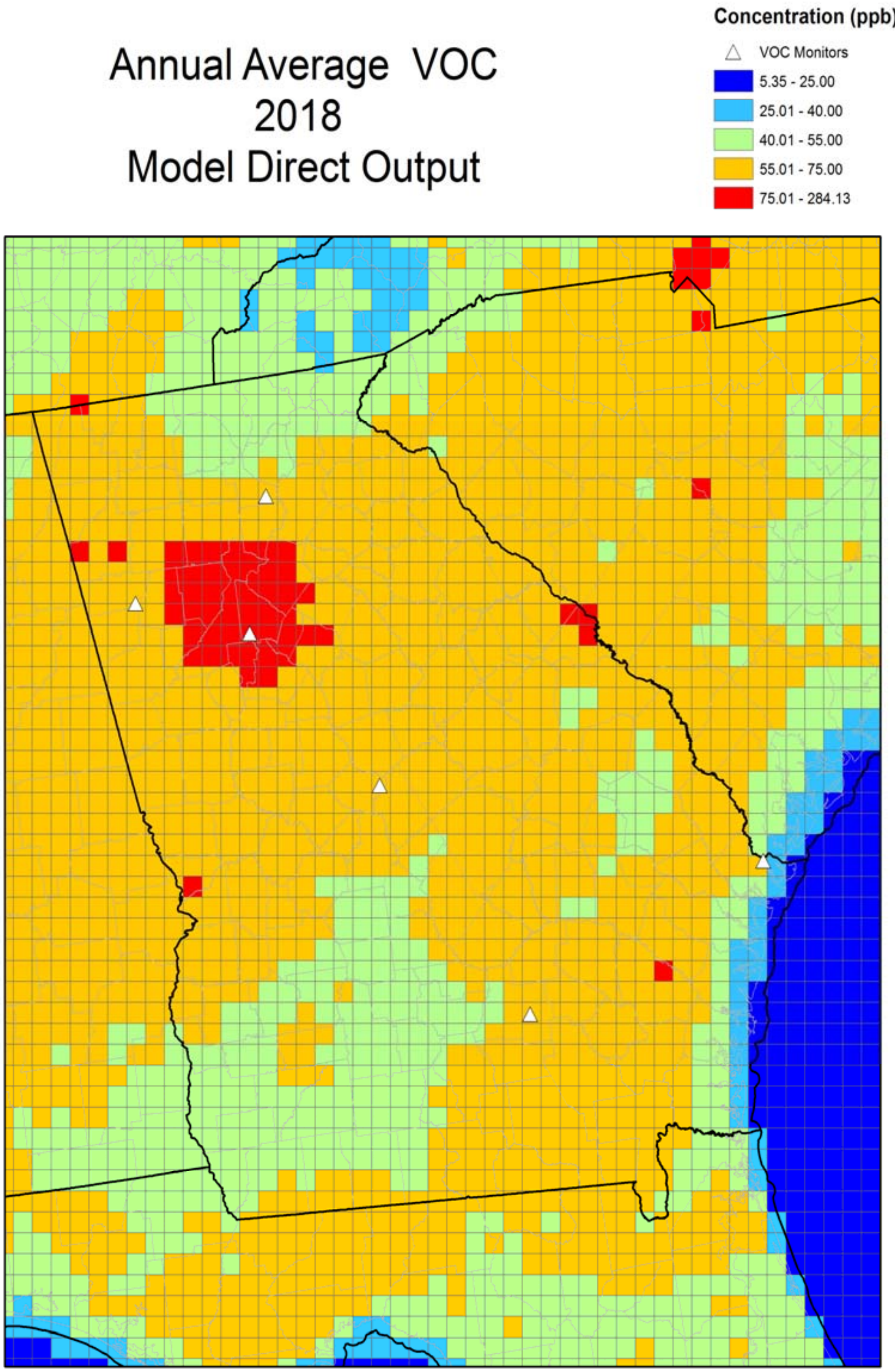


Figure 16.22: VOCs, Modeled 2018 Annual Average

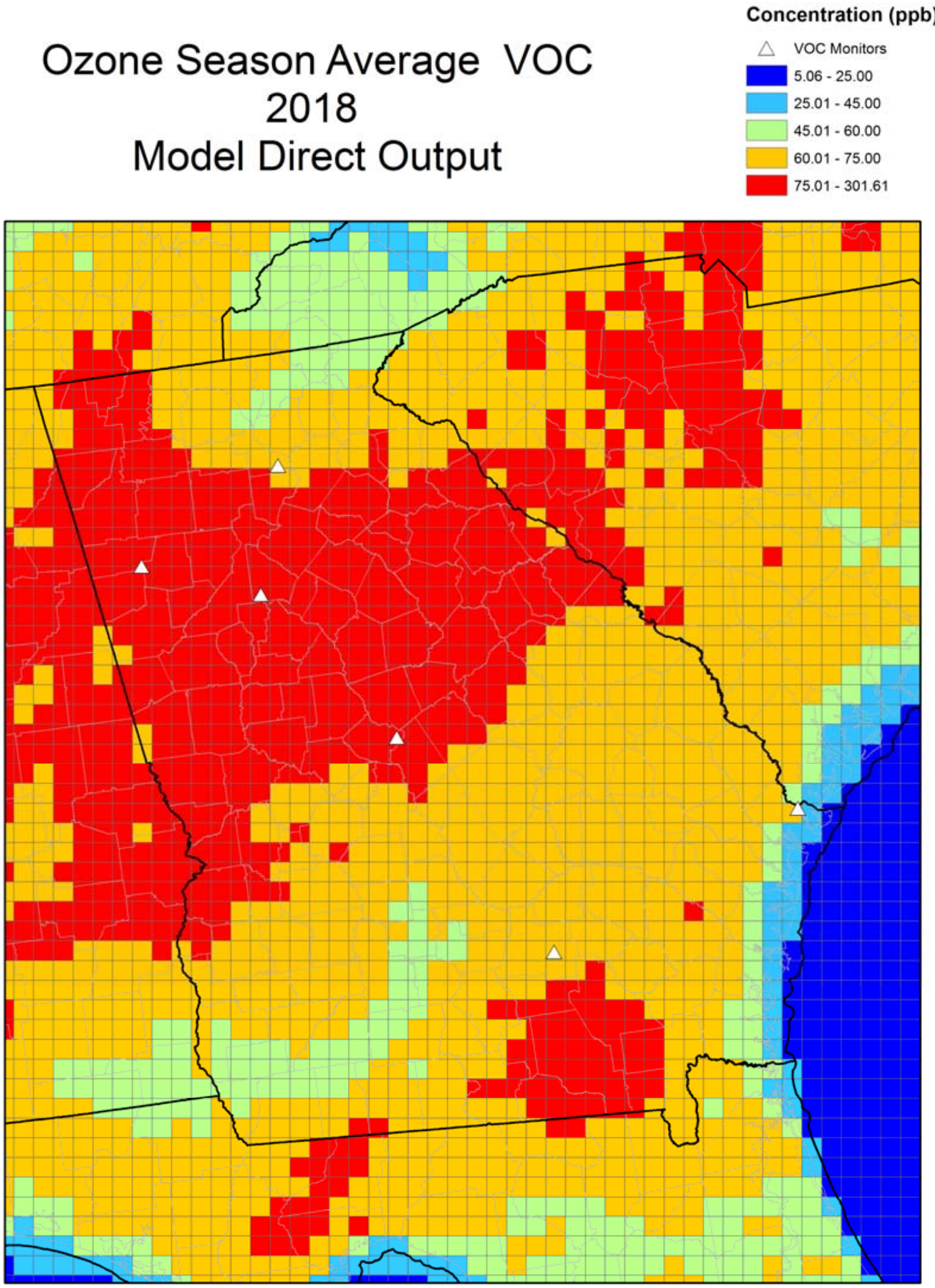


Figure 16.23: VOCs, Modeled 2018 Ozone Season Average

In the above maps, almost the entire state has at least the second highest level of 2018 predicted VOCs for both annual average and ozone season average (shown in orange). The ozone season VOCs has a larger area with the highest level of VOCs predicted (shown in red). It appears that GA EPD may need to add VOCs samplers to sufficiently monitor VOCs concentrations.

In summary, based on the above modeling results GA EPD may need to consider adding monitors to the following locations: PM_{10} monitors in the Hinesville MSA, the Columbus GA-AL MSA, and the Brunswick MSA; a $PM_{2.5}$ monitor in the Hinesville MSA; CO monitors in the Columbus GA-AL MSA and the Hinesville MSA; an additional ozone monitor in the northern part of the Macon MSA; an NO_2 monitor in the Savannah MSA and possibly the Macon MSA, the Augusta-Richmond County, GA-SC MSA, and the Chattanooga TN-GA MSA; and VOCs monitors across the northern half of the state. According to the modeling results for $PM_{2.5}$, Brunswick and Yorkville were not the most optimal sites to monitor $PM_{2.5}$.

16.8 Emissions Trends

The following graphs display the trends in the emissions data described above. Each graph shows one pollutant and the type of emissions contributing to that pollutant. These pollutants include VOCs, SO_2, PM_{10}, $PM_{2.5}$, NOx, NH_3 and CO. The emission types are Area Sources, Electric Generating Units (EGUs), Non-Electric Generating Units (Non-EGUs), Nonroad Sources, Onroad Sources, and Fires.

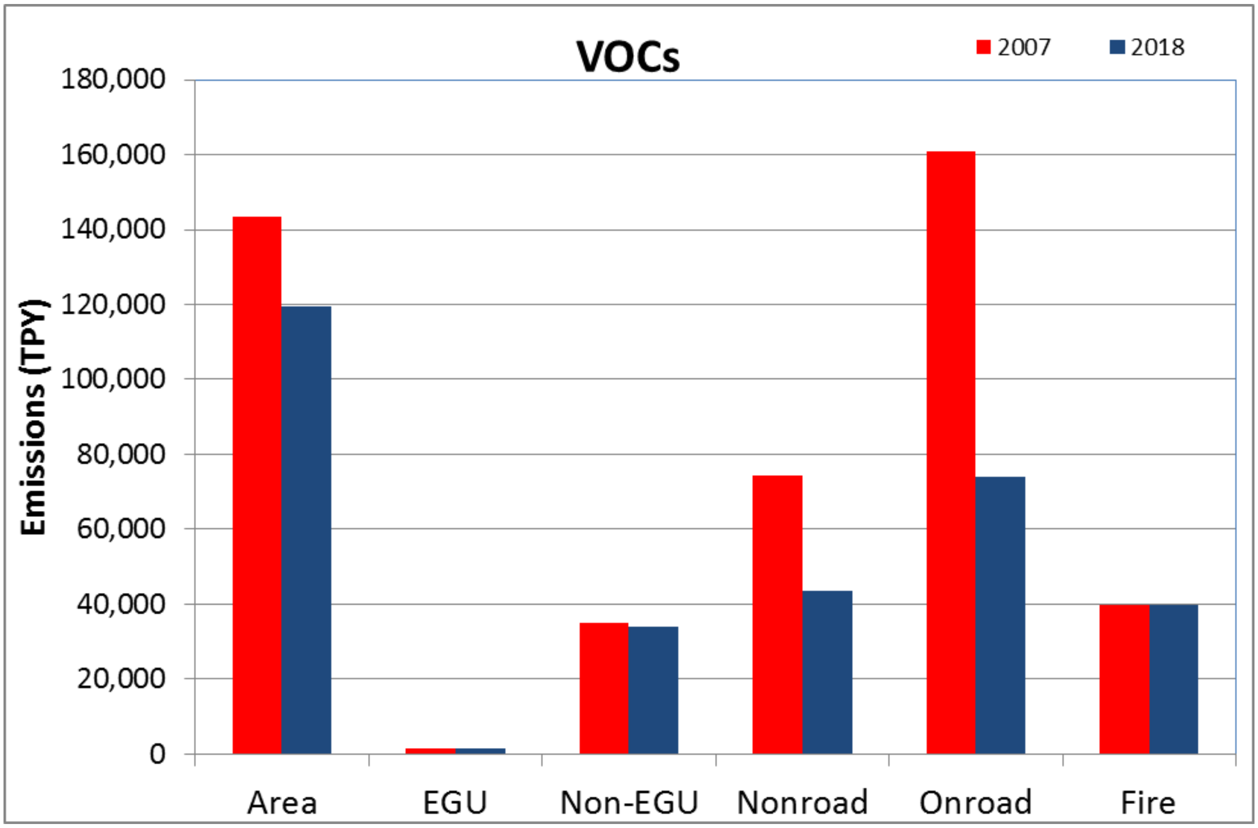


Figure 16.24: VOCs Emissions Trends in Georgia, 2007-2018

The largest sources of VOCs emissions in 2007 were Area Sources and Onroad Sources. In 2007, the Onroad emissions were at 160,000 TPY. There is expected to be a significant decrease in the Onroad emissions, and by the year 2018 the level could be half the level they were in 2007. The fire emissions levels seem to remain from 2007 to 2018 (40,000 TPY).

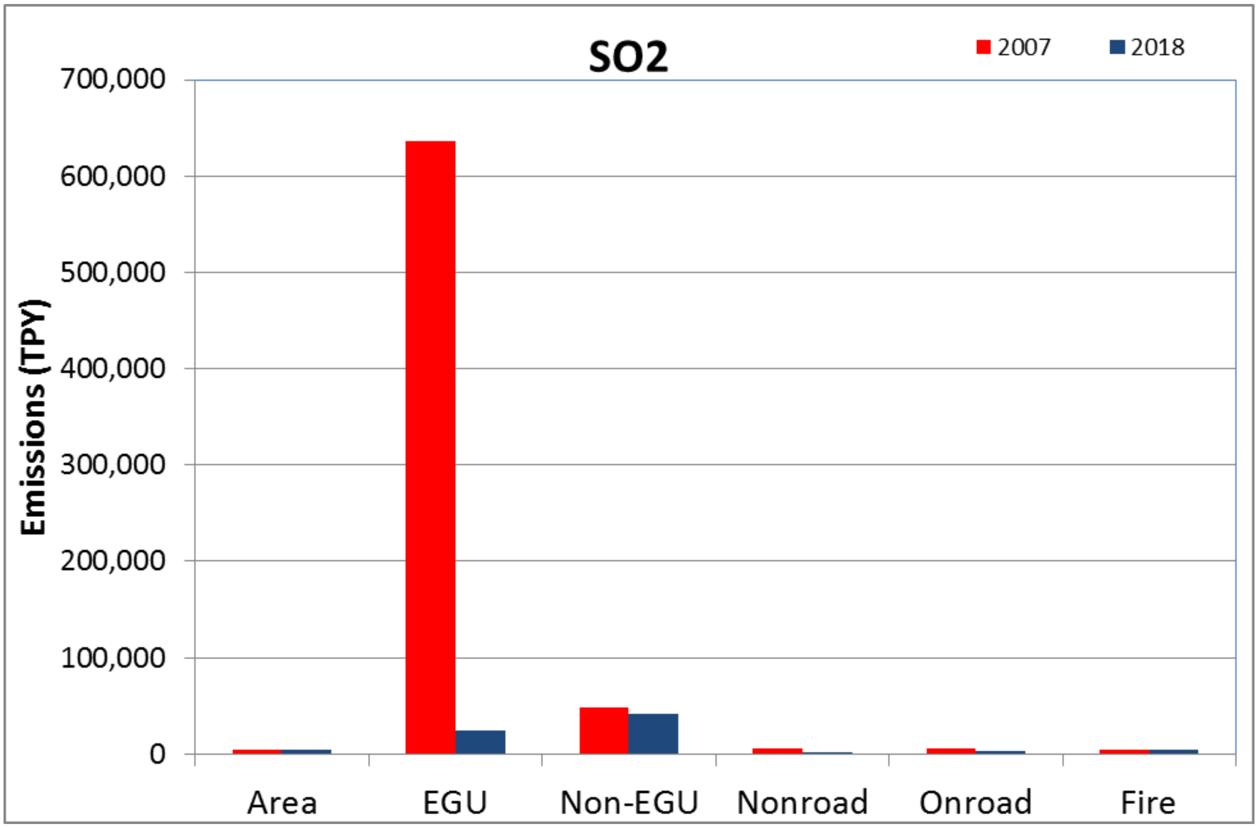


Figure 16.25: SO_2 Emissions Trends in Georgia, 2007-2018

SO_2 emissions are almost entirely attributed to EGUs and Non-EGUs. From 2007 to 2018, EGUs are expected to have a dramatic decrease from over 600,000 to about 40,000 TPY. The other contributors remain at approximately the same level from 2007 to 2018.

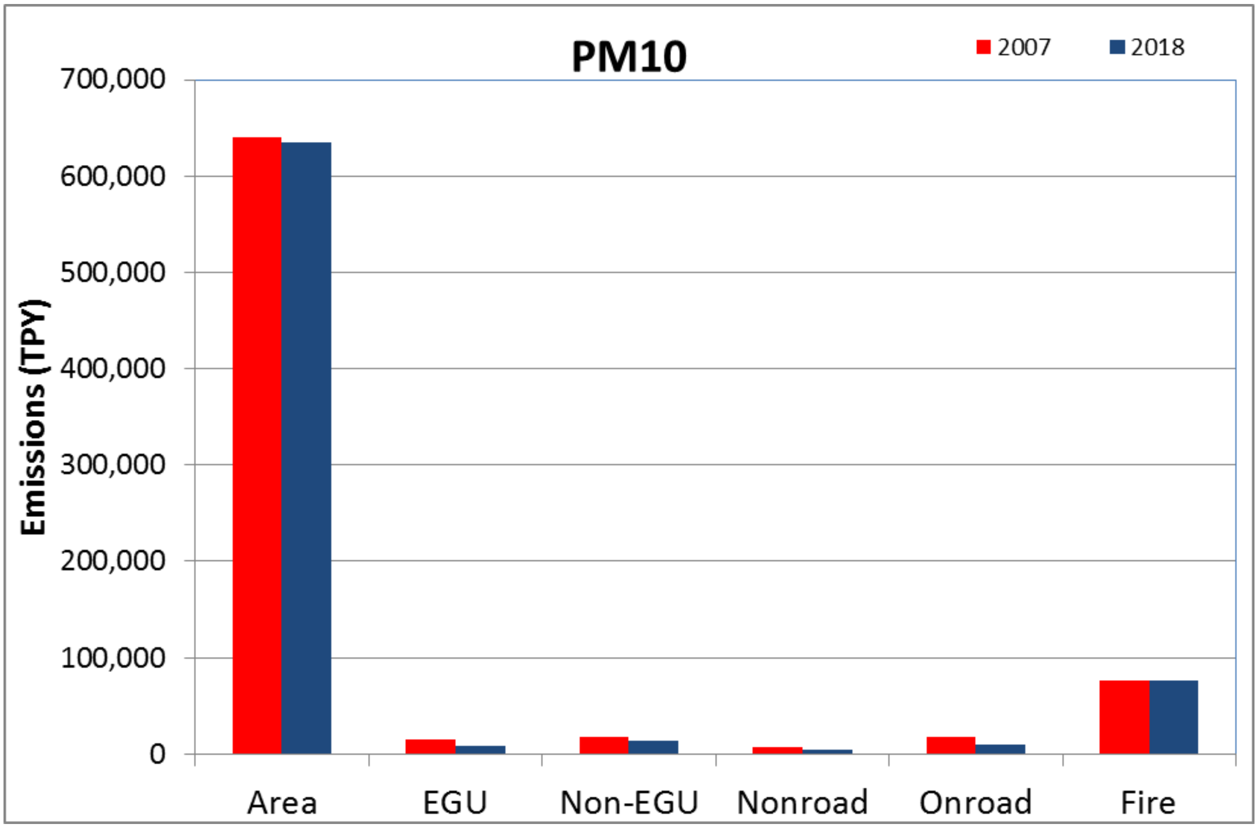


Figure 16.26: PM_{10} Emissions Trends in Georgia, 2007-2018

For the PM_{10} emissions, Area Sources are the highest contributing sources. Levels of emissions are expected to remain about the same level from 2007 to 2018, around 640,000 TPY.

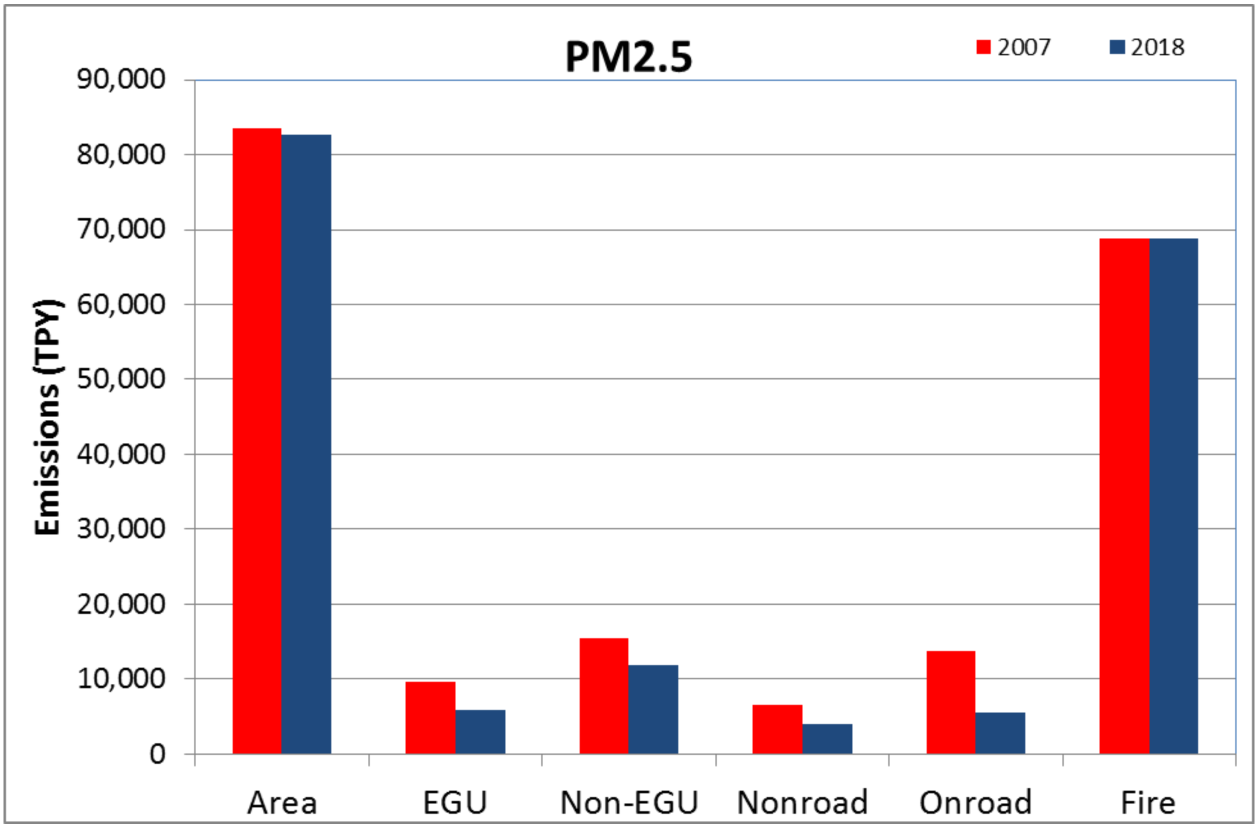


Figure 16.27: $PM_{2.5}$ Emissions Trends in Georgia, 2007-2018

The majority of the $PM_{2.5}$ emissions are from Area Sources and Fires. Both of these sources are significantly higher than the other sources, with emission levels at about 80,000 and 70,000 TPY respectively. $PM_{2.5}$ emission levels from Area Sources and Fires are expected to remain about the same from 2007 to 2018. The other sources of $PM_{2.5}$ are expected to show a decrease from 2007 to 2018.

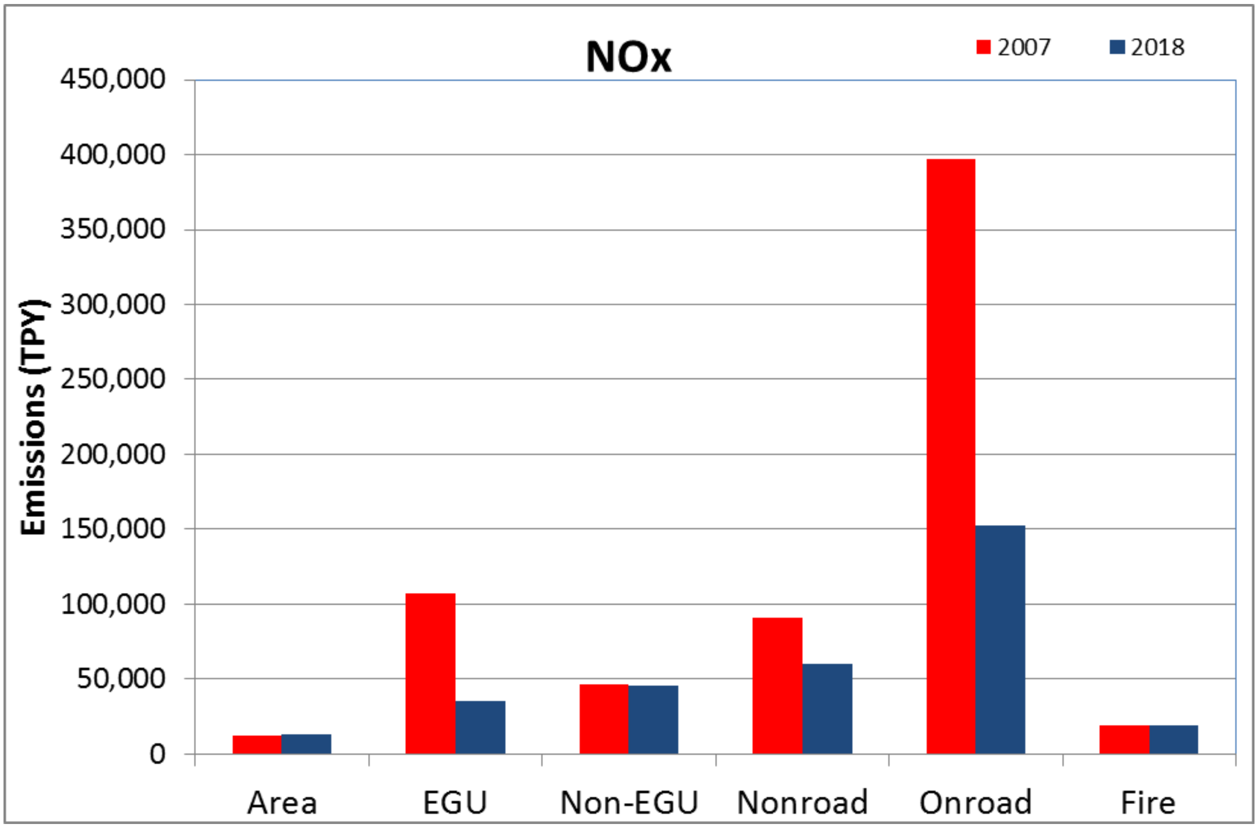


Figure 16.28: NOx Emissions Trends in Georgia, 2007-2018

Onroad emissions are the largest contributors to NOx pollution in Georgia. There is an expected decrease of more than half, from about 400,000 to 150,000 TPY, from 2007 to 2018.

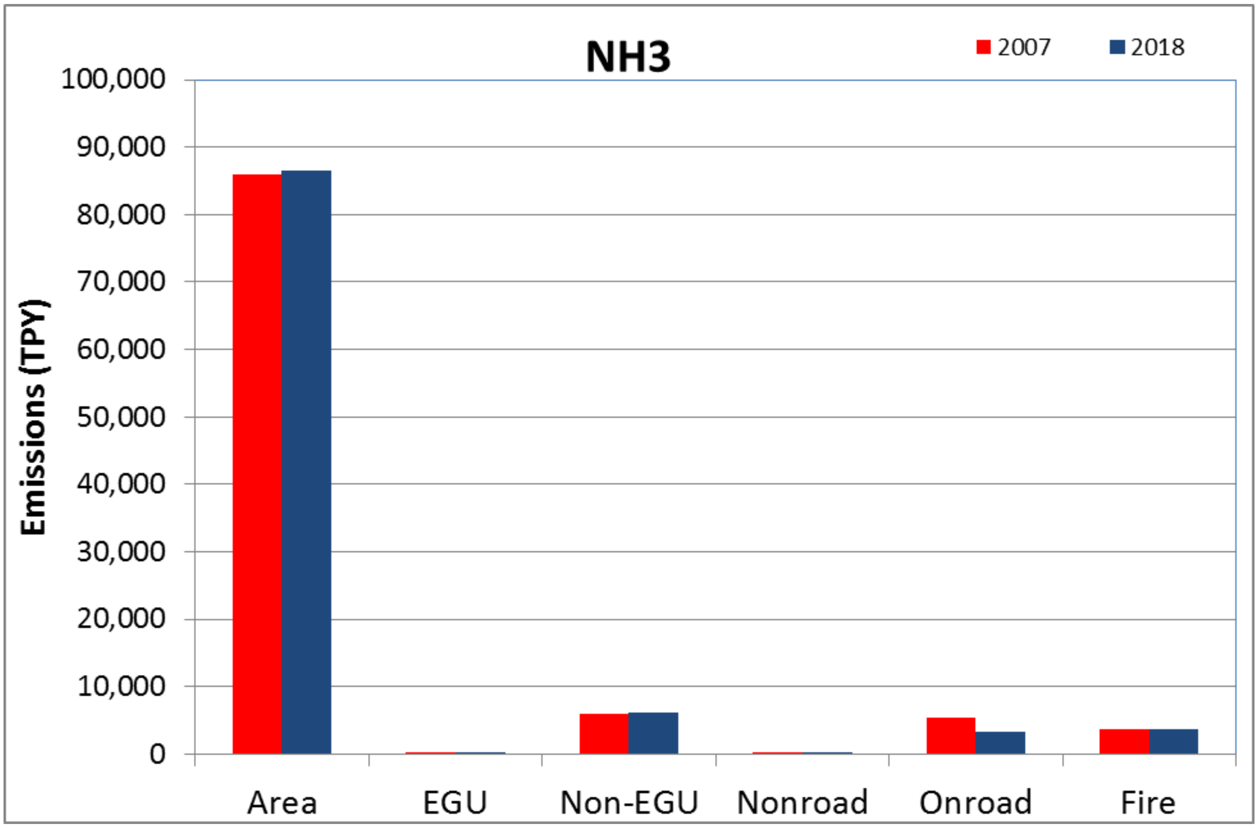


Figure 16.29: NH_3 Trends in Georgia, 2007-2018

There does not appear to be much change in the NH_3 emissions levels from 2007 to 2018. The largest contributor to the NH_3 emissions are the Area Sources, with about 85,000 TPY.

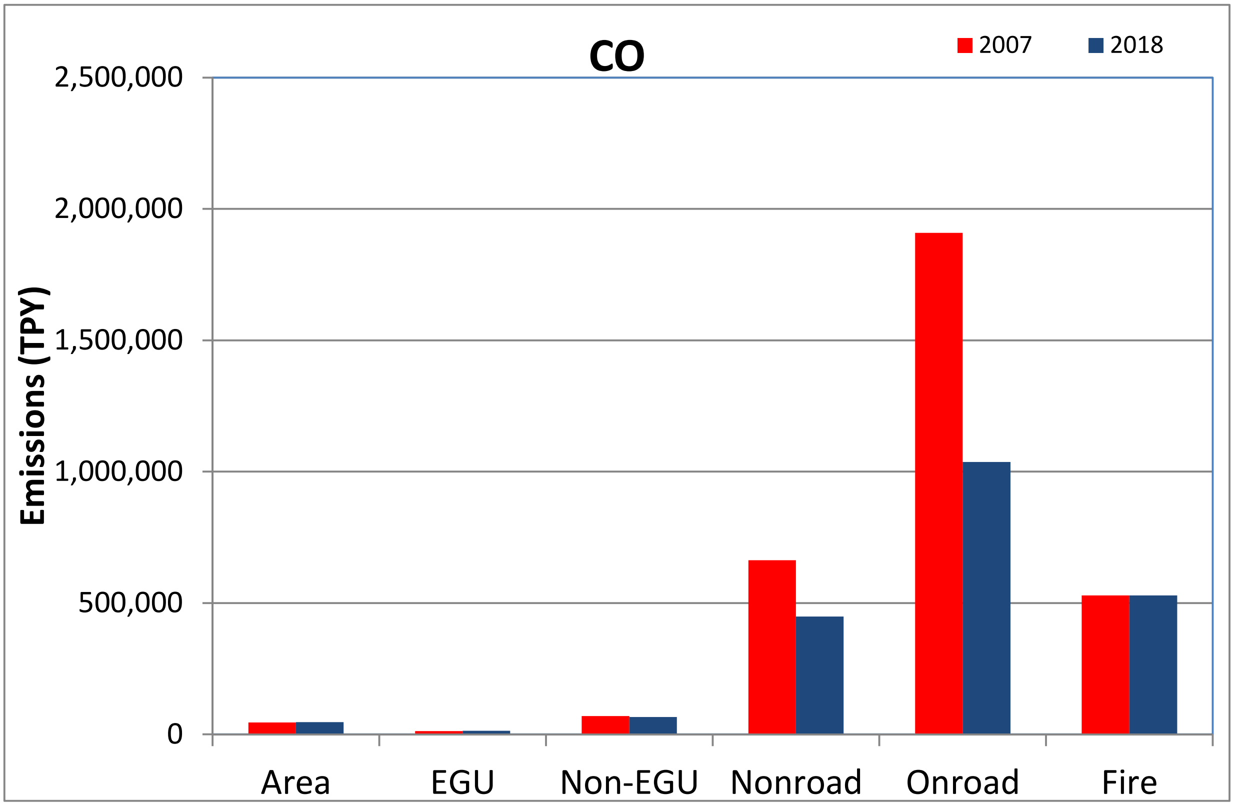


Figure 16.30: CO Emissions Trends in Georgia, 2007-2018

As can be seen in the above graph, the largest levels of CO emission in Georgia are from Onroad emissions, with about 1.9 million TPY in 2007. However, those Onroad emission levels are expected to show a decrease of half that level by 2018, and drop to about 1 million TPY.

17.0 Meteorological Assessment

17.1 State Climatology and Meteorological Summary for 2009 through 2013

The climate of central Georgia, which includes the metropolitan areas of Atlanta, Columbus, and Macon, involves summers of warm, humid weather, and variable temperatures during the winter months. The average date of first freeze is in mid-November. The average date of the last freeze in the spring is mid to late March. Average amounts of rainfall reach between 45 and 50 inches, with September and October averaging as the driest months and the wettest being March. The climate across Northern Georgia is largely a function of terrain. Most of the northern half of the state is made up of rolling hills with elevation ranging from 400 ft. to between 800 and 1100 feet. The northeast region of the state occupied by the Appalachian Mountains is termed the “Northeast Georgia Mountains” and has a climate similar to the rest of North Georgia.

17.1.1 2009

According to the National Weather Service office in Peachtree City, Georgia, 2009 was a year of weather anomalies for North and Central Georgia. Meteorological extremes ranged from large hail produced in super cells during a severe weather outbreak in mid-February to a record 100-year flood event on the Chattahoochee River in mid-late September.

After three consecutive years of drought, conditions in January hinted that more of the same was in store for the dry region (Table 17.1 and 17.2). Rainfall deficits ranged from -1.99 inches in Athens to -3.66 inches in Macon. In February, the severe weather season began early, with two severe thunderstorm events occurring on the 18th and 27-28th. However, precipitation totals were again below average in Athens (-0.72 inches), Atlanta (-0.98 inches), and Macon (-2.23 inches). Nevertheless, record rainfall in Columbus on the last day of the month, along with the fifth wettest February 28th in Atlanta, established a drought-reversing trend for the next several months. The first heavy snowfall in seven years occurred in March, with a daily and monthly record set in Columbus of 6.5 inches. Surprisingly, this heavy snow event stretched from Columbus to Athens and was accompanied by thunderstorms through its duration. Two more heavy precipitation events during mid and late March contributed to monthly surpluses in all four cities. With all the cloud cover and precipitation, temperatures averaged near or within a degree above normal for all four locations. Plentiful rainfall continued over the next two months, as April totals exceeded the average in all four cities. Ample precipitation continued in May, as Atlanta, Columbus, and Macon all posted wetter than average totals.

Hot summertime conditions occurred in June, as all four cities recorded average monthly temperatures of more than two degrees above normal. High temperatures reached 90 degrees (F) or above on 17 to 23 days among the four locations. Uncharacteristically, this hot weather led to June being the warmest summer month in all four locations. During this heat wave, precipitation became quite scarce. Atlanta recorded only 0.02 inches of rainfall during the final eighteen days of the month. The drier than normal conditions continued through July as all four locations posted rainfall deficits. An excess of rainfall returned to parts of north and central Georgia in August, due in part to the remnants of Tropical Storm Claudette on the 16-17th.

		J	F	M	A	M	J	J	A	S	O	N	D	Yearly +/-
Atlanta	2009	2.88	3.70	7.13	5.18	4.54	2.34	5.02	6.14	8.94	8.71	5.75	9.10	**+19.23**
1971-2000	30 yr avg	5.0	4.68	5.38	3.62	3.95	3.63	5.12	3.67	4.09	3.11	4.10	3.82	
Athens	2009	2.70	3.67	7.05	4.47	3.58	1.66	1.33	2.70	9.86	9.14	5.17	8.87	**+12.37**
1971-2000	30 yr avg	4.6	4.39	4.99	3.35	3.86	3.94	4.41	3.78	3.53	3.47	3.71	3.71	
Macon	2009	1.34	2.32	7.78	5.66	5.73	2.82	2.19	3.83	10.68	6.37	3.89	8.98	**+16.54**
1971-2000	30 yr avg	5.0	4.55	4.90	3.14	2.98	3.54	4.32	3.79	3.26	2.37	3.22	3.93	
Columbus	2009	2.49	5.44	12.70	6.53	5.10	3.79	3.83	8.26	5.30	6.39	6.75	13.62	**+31.63**
1971-2000	30 yr avg	4.7	4.48	5.75	3.84	3.62	3.51	5.04	3.78	3.07	2.33	3.97	4.40	

(Data compiled by National Weather Service Office in Peachtree City)

Table 17.1: Temperature and Rainfall Statistics for Select Georgia Cities in 2009

City	Mean Temperature for 2009	Normal Mean Temperature	Mean Temperature Departure from Normal	Total Rainfall for 2009	Normal Total Rainfall	Total Rainfall Departure from Normal
Atlanta	62.1	62.1	0.0	69.43"	50.20"	+19.23"
Athens	62.3	61.5	+0.8	60.20"	47.83"	+12.37"
Macon	65.3	63.7	+1.6	61.54"	45.00"	+16.54"
Columbus	64.8	65.1	-0.3	80.20"	48.57"	+31.63"

(Data compiled by National Weather Service Office in Peachtree City)

Table 17.2: Comparison of Monthly Rainfall Amounts for 2009 and the 30 Year Average for Select Cities in Georgia

Extreme weather occurrences for 2009 continued during September. A persistent low-pressure system located over the lower Mississippi Valley brought a week with prolonged periods of heavy rain (Figure 17.1). This resulted in an 8-day period from the 14th through the 22nd, which produced many rainfall totals in excess of ten inches across north and central GA, including 18.62 inches in Tucker (Table 17.3, Figure 17.2). The epic flood which resulted set or broke several high water marks in the local watersheds that dated back to 1919. This historic event saw the Sweetwater Creek Basin rise to the 500-year flood level.

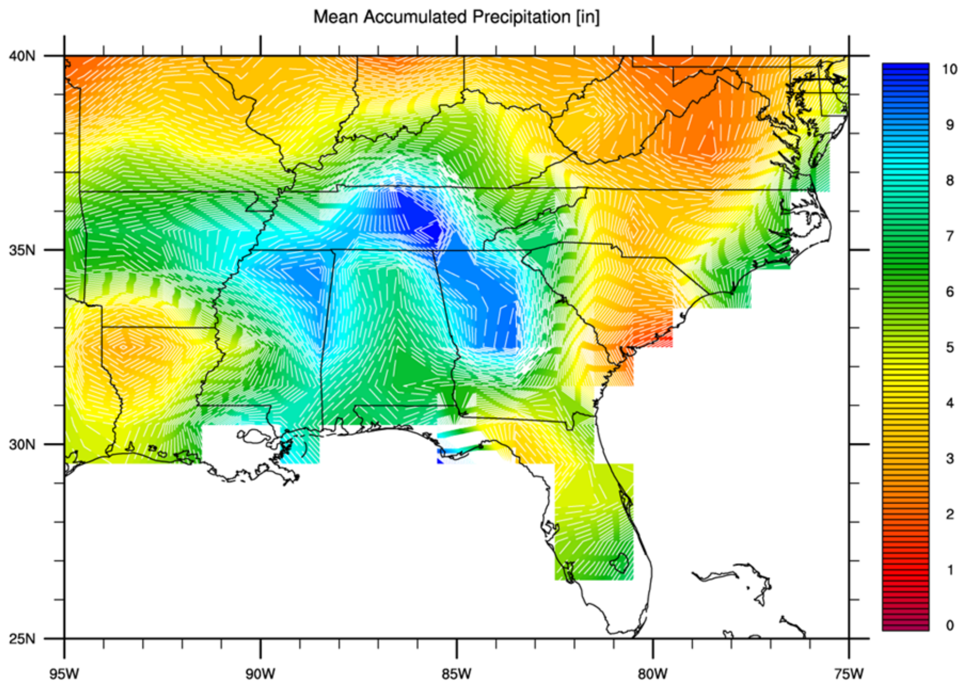


Figure 17.1: NCEP/NCAR/GPCC Composite Mean Accumulated Precipitation for September 2009

Monitoring Site	Maximum Daily Total [In]	Three Day Total September 19-21 [In]	Storm Total September 14-22 [In]
Augusta	1.10 (18th)	0.41	1.77
Columbus	0.86 (19th)	0.96	1.87
Conyers	2.77 (21st)	5.16	7.34
South DeKalb	2.13 (21st)	4.98	8.21
Tucker	7.55 (21st)	10.99	18.62
Yorkville	1.24 (20th)	3.58	4.09

Table 17.3: Rainfall Accumulations from the EPD Meteorological Network for September 14-22, 2009

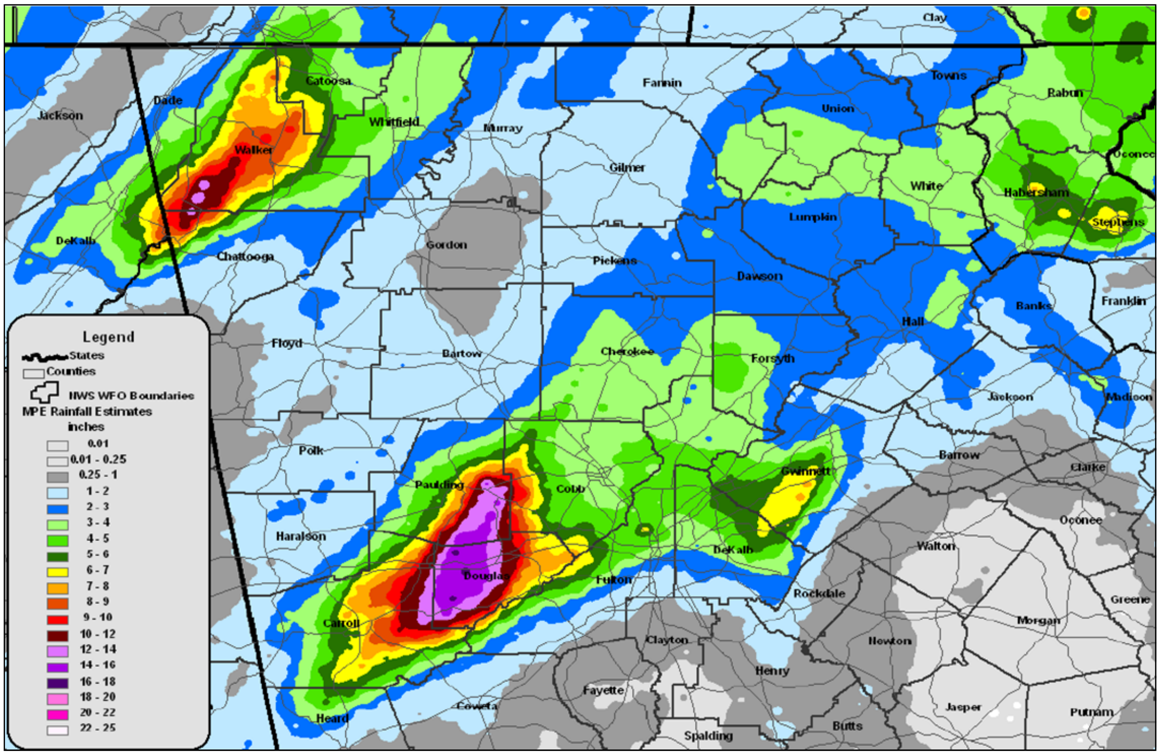


Figure 17.2: Southeast River Forecast Center 24 hour Multisensor Rainfall Estimates for 8AM September 20 to 8AM September 21, 2009

A strengthening El Nino/Southern Oscillation (ENSO) warm episode in the tropical Pacific shifted storm track position, which continued the very wet pattern across the southeastern U.S. in October. A series of four potent storm systems brought record rainfall again to north and central Georgia. A mid-October polar outbreak contributed to cooler than normal temperatures.

Although not as wet as the previous two months, November also received well above average rainfall. One storm in particular resulting from the remnants of Tropical Storm Ida on the 9^{th}-11^{th} produced most of the monthly precipitation. As the El Nino continued to strengthen, a persistent cycle of low pressure systems once again became established in December. Four of these systems originating along the Texas Gulf coast, then tracking east-northeastward produced significant precipitation across northern and central Georgia in the range of 1 to 4 inches. All four cities had above normal rainfall for the year, with Columbus setting a record with 80.20 inches. Atlanta had its second wettest year on record and Macon came in third wettest since records were kept.

Seasonal composite means across the southeast for 2009 are seen in Figures 17.3 through 17.6. The images depict NCEP/NCAR reanalysis data for the following surface meteorological parameters: air temperature, relative humidity, accumulated precipitation, wind speed and wind direction. The averages are in agreement with the climatological assessment for 2009 from the National Weather Service at Peachtree City.

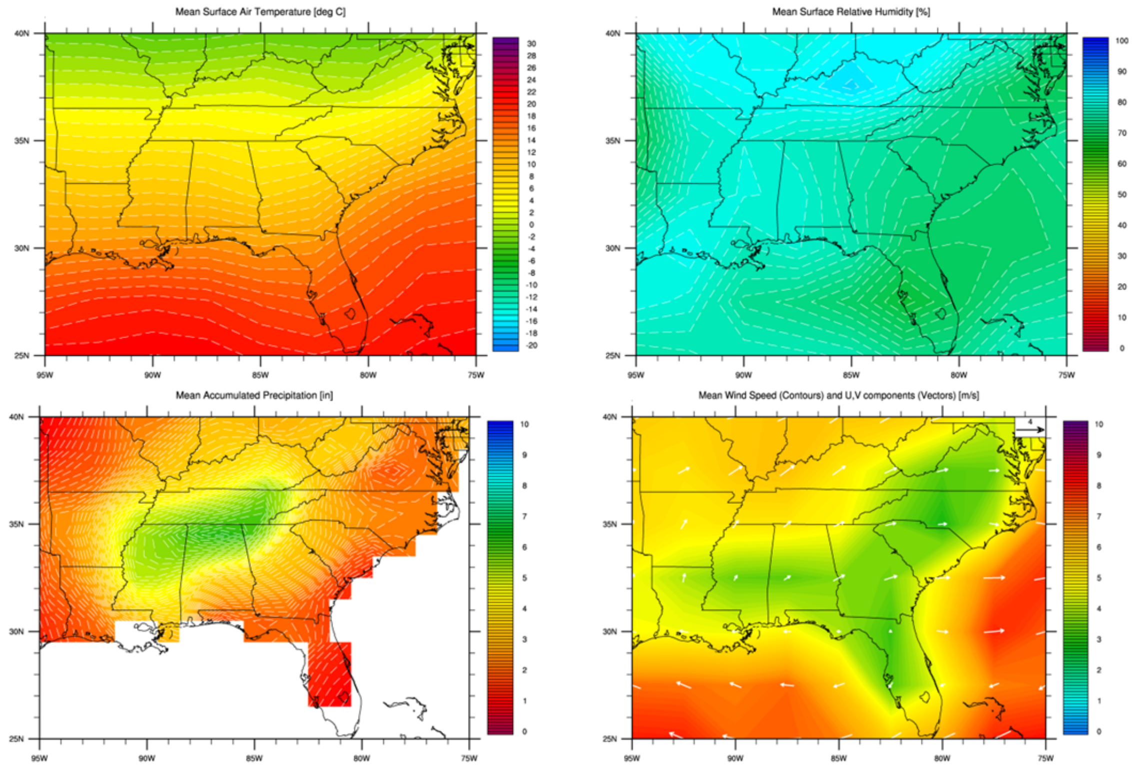


Figure 17.3: NCEP/NCAR Composite Means for Surface a) Air Temperature, b) Relative Humidity, c) Accumulated Precipitation, and d) Wind Speed and Direction for December 2008- February 2009

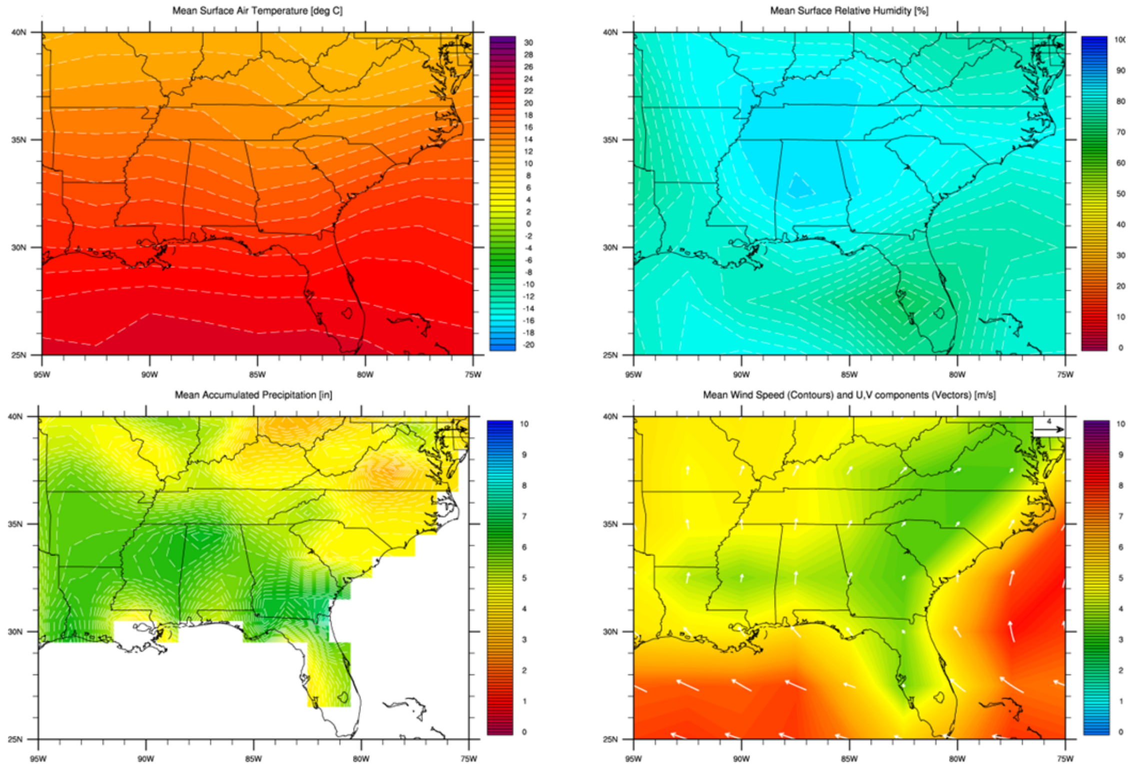


Figure 17.4: NCEP/NCAR Composite Means for Surface a) Air Temperature, b) Relative Humidity, c) Accumulated Precipitation, and d) Wind Speed and Direction for March-May 2009

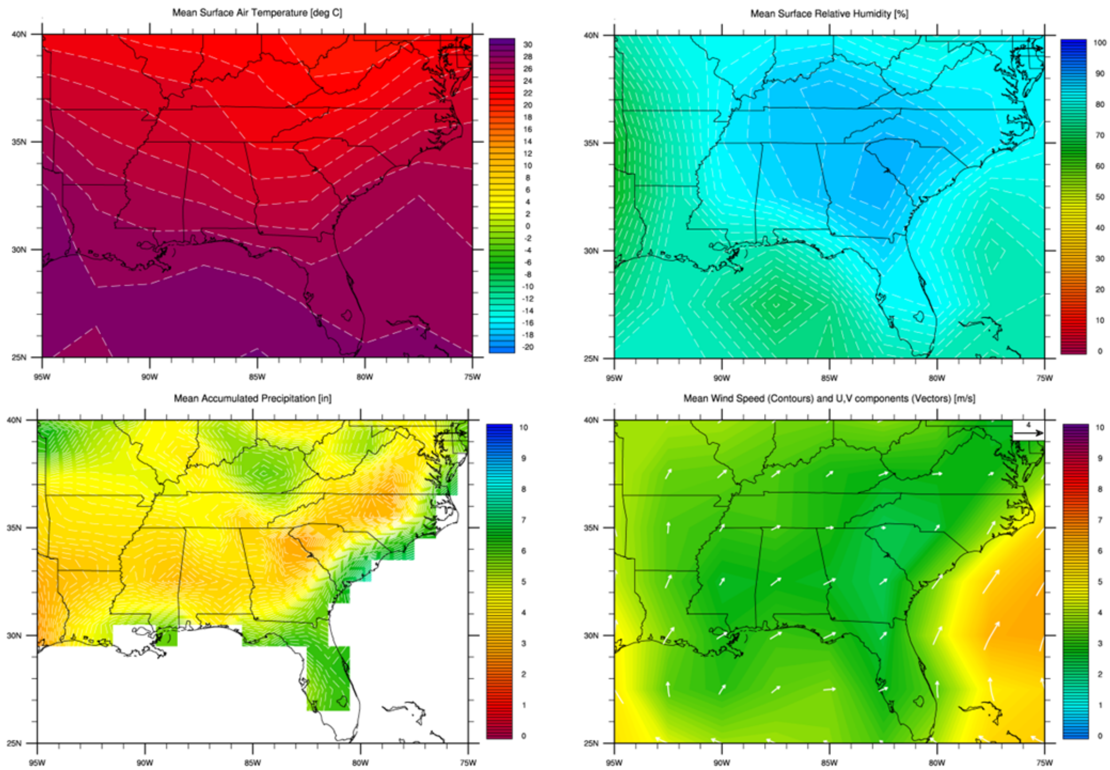


Figure 17.5: NCEP/NCAR Composite Means for Surface a) Air Temperature, b) Relative Humidity, c) Accumulated Precipitation, and d) Wind Speed and Direction for June-August 2009

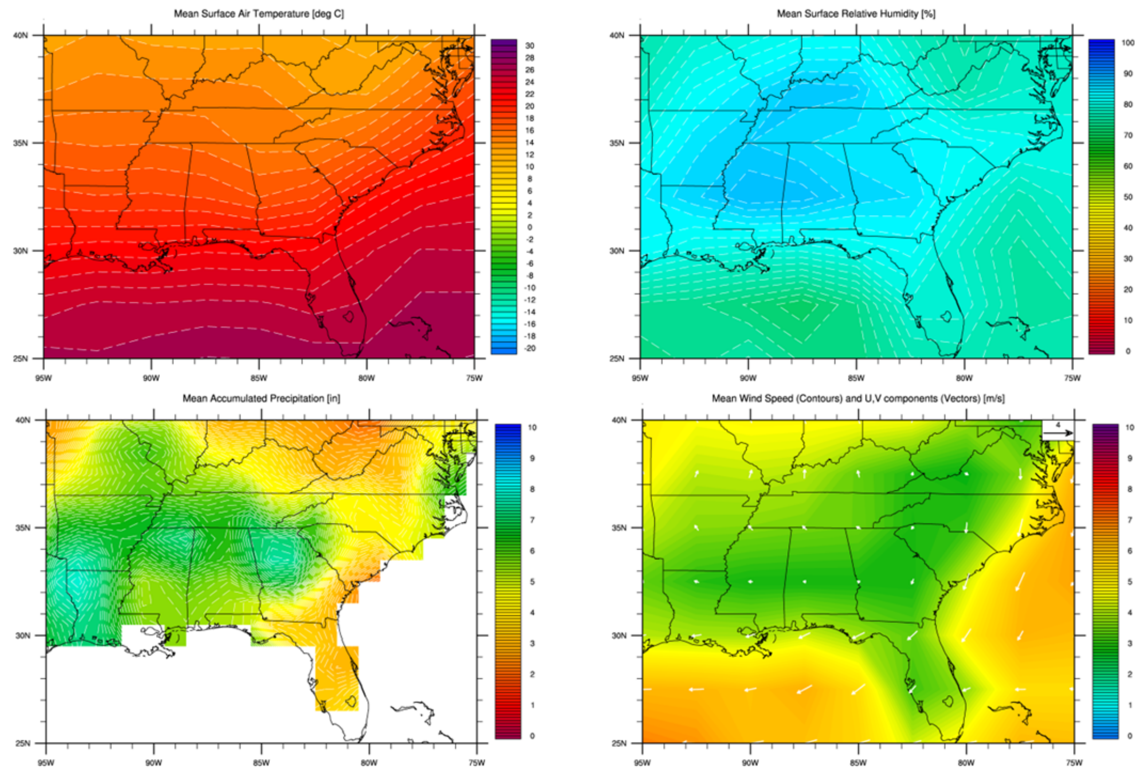


Figure 17.6: NCEP/NCAR Composite Means for Surface a) Air Temperature, b) Relative Humidity, c) Accumulated Precipitation, and d) Wind Speed and Direction for September-November 2009

17.1.2 2010

The National Weather Service (NWS) Forecast Office in Peachtree City, Georgia reports that January began with the arrival of an arctic air mass that dominated the first half of the month. A second cold outbreak at the end of the month allowed Atlanta to reach its coldest January since 1985. Departures from normal ranged from -2.5 degrees in Athens to -5.2 degrees in Columbus. Record rainfall on the 16th, 21st, and 24th contributed to monthly surpluses in all four cities (see Table 17.4).

The much colder than average temperatures continued through February with three more arctic blasts. For the second consecutive month, Atlanta and Athens recorded an average monthly temperature below 40 degrees. This had not occurred in either city since December 1981 and January 1982. Negative departures from normal were even greater than in January. Precipitation was also below average in all four locations. Record and near record rainfall on the 5th, with 2.65 inches at Athens and 1.93 inches in Atlanta was not enough to offset a drier than average month. On the 12th, a low pressure system tracking across the Northern Gulf of Mexico produced the heavy snow event of the winter. Snowfall totaled 4.5 inches in Athens, 3.6 inches in Atlanta, 3.0 inches in Macon, and 2.0 inches in Columbus. Temperatures moderated a bit in March, but still remained well below average in all four cities. Again, monthly precipitation was below normal in the four cities with deficits ranging from -1.14 inches in Atlanta to -2.66 inches in Athens.

In April, La Nina evolved and strengthened in the equatorial Pacific. Characteristically, temperatures abruptly rebounded to well above average readings. Record and near record warmth occurred early in the month. Drier than average conditions continued for the third straight month, as all four climate sites recorded rainfall deficits ranging from -1.06 inches in Atlanta to -2.23 inches in Columbus. The significantly above average monthly temperatures continued in May. However, substantial rains returned with a half inch or more falling in one or more of the climate sites on the 3rd, 21st, 28th, 29th, and 30th. A potent storm system on the 3rd brought record daily rainfall to all four cities.

Positive temperature anomalies increased again in June, as Atlanta and Columbus experienced their 2nd and 4th warmest June, respectively. Temperatures soared to record and near record highs on the 15th, as Macon set a new record with 100°F breaking the old record of 99°F set in 1963. Rainfall generally remained in abundance with all of the locations except Columbus recording surpluses for the 2nd straight month. The heat persisted through July and August with all four cities continuing their lengthy string of significantly warmer than normal monthly departures. The broad, persistent ridge of high pressure stretching from Texas to New England, which was responsible for this heat, also put rainfall at a premium from mid through late summer. Three out of the four cities posted rainfall deficits in each of these two months with amounts ranging from -0.75 inches in Atlanta to -3.01 inches in Athens for July, and from -0.22 inches in Macon to -1.33 inches in Columbus for August.

September brought little relief from the hot, dry pattern. Again, the four climate sites posted much warmer than normal monthly averages. Additionally, 13 record high temperatures were either tied or broken on 10 separate days in Atlanta, Columbus, and Macon. By mid-month, mild to moderate drought conditions expanded into much of South and West Georgia as the unusually dry, hot conditions continued. After a hot summer, two polar outbreaks occurring in late September and early October brought relief to North and Central Georgia. Low temperatures fell into the 40s and 50s while daytime highs were generally held to the 70s. The reprieve did not last however, as record high temperatures returned in mid and late October.

The arrival of two polar air masses in November resulted in bringing the average monthly temperatures closer to their 30 year normal. Despite Atlanta still being above average by 1.2 degrees, Athens, Columbus, and Macon had moderated considerably. Additionally, monthly rainfall rebounded nicely with the help of a daily record rainfall in Atlanta, Athens, and Columbus on the 30th. 2010 seemed to go from one extreme to another, and December was no exception. A series of arctic blasts in early, mid and late December brought record breaking cold temperatures and measurable snow as well.

		J	F	M	A	M	J	J	A	S	O	N	D	Yearly
Atlanta	2010	5.38	4.17	4.24	2.56	6.87	5.21	4.37	3.32	1.60	3.33	5.48	1.62	**48.15**
1981-2010	30 yr avg	4.20	4.67	4.81	3.36	3.66	3.95	5.27	3.90	4.47	3.41	4.10	3.90	49.68
Athens	2010	6.20	4.21	2.33	1.86	5.89	4.55	1.40	7.62	5.35	1.42	4.91	1.92	**47.66**
1981-2010	30 yr avg	4.05	4.48	4.42	3.15	3.03	4.18	4.47	3.52	3.94	3.55	3.82	3.73	46.66
Macon	2010	5.50	3.07	3.49	1.36	4.31	5.73	6.97	3.57	5.41	0.95	2.61	1.08	**44.05**
1981-2010	30 yr avg	4.23	4.35	4.55	2.96	2.72	4.06	4.95	4.10	3.58	2.79	3.32	4.04	45.98
Columbus	2010	5.34	3.56	3.83	1.61	5.83	2.45	2.16	2.45	3.17	1.48	3.82	1.56	**37.26**
1981-2010	30 yr avg	3.85	4.44	5.45	3.55	3.03	3.72	4.76	3.77	3.06	2.58	4.10	4.27	46.74

(Data compiled by National Weather Service Office in Peachtree City)

Table 17.4: Comparison of Monthly Rainfall Amounts for 2010 and the 30 Year Average for Select Cities in Georgia

17.1.3 2011

According to the National Weather Service office in Peachtree City, Georgia, 2011 was a year of extremes for North and Central Georgia. The NWS reports[1] that the year began on a mild note, but quickly shifted to an arctic airmass on the 8th, followed by a record-setting winter storm on the 9th-10th. An upper level disturbance tracked across the northern Gulf of Mexico dumping 8.8 inches of snow on Athens; while Atlanta received a snow and sleet mix totaling 4.4 inches. This was the most snow from a single storm in Athens on record, and the greatest storm total in Atlanta since January 2nd-3rd, 2002. Colder than normal temperatures lingered through much of the month until unseasonably mild conditions arrived for the final four days. The abundance of dry, cool air masses for much of the month led to precipitation deficits in all four cities. Departures from normal ranged from -1.37 inches in Athens to -2.40 inches in Atlanta.

Colder than normal temperatures returned on February 2nd-3rd, then persisted into mid-month. However, the second half of February experienced a remarkable rebound in temperature as daily averages climbed to as much as 14-18 degrees above normal. This was in response to a strong southwesterly low-level flow, which pushed high temperatures into the middle and upper

[1] http://www.srh.noaa.gov/ffc/?n=clisum2011

70s, and to as high as 80°F on the 19th. Unseasonably mild conditions persisted through the remainder of February pushing monthly averages well above normal. Departures from normal were +3.3°F in Atlanta, +2.6°F in both Athens and Columbus, and +2.2°F in Macon. With regard to precipitation, only Atlanta posted a rainfall deficit for the month, registering a departure from normal of -0.43 inches. On the 4th, a stalled front across Georgia, combined with a surge of moisture ahead of a second system over southeast Texas, produced daily rainfall totals of 1.38 inches, 1.55 inches, 2.09 inches, and 2.54 inches in Atlanta, Athens, Columbus, and Macon, respectively. These set new records for both Columbus and Macon, breaking the previous mark of 1.76 inches and 2.21 inches from 1959.

Columbus and Macon fell short of their average rainfall in March by 0.45 inches and 0.87 inches, respectively. Monthly totals of 9.06 inches and 6.65 inches in Atlanta and Athens, respectively, were 3.68 inches and 1.66 inches above their averages. The mild temperatures also persisted with Atlanta failing to record a freezing temperature during the entire month. This was the first March since 1989 in which Atlanta did not record a temperature of 32°F or below. Monthly departures from normal ranged from +1.2°F in Athens to +2.7°F in Columbus. In addition, Macon tied a record high on the 19th from 1963 when the mercury reached 88°F.

In April, a fading tropical Pacific La Nina episode contributed to conditions remaining mild and dry. The increased warmth produced record and near record high temperatures on the 9th and 10th. This excessive warmth helped fuel three severe weather events occurring on the 4-5th, 15-16th, and 27-28th. All three produced tornadoes in Georgia with the 27-28th April outbreak being of historic proportion. In fact, this 13 state outbreak produced well over 200 tornadoes and was the most extensive since the “Super Outbreak” of April 3-4, 1974. In Georgia, fifteen tornadoes occurred, with the strongest, rated as an EF-4, producing devastating damage in Catoosa County before tracking into Tennessee (Figure 17.7).

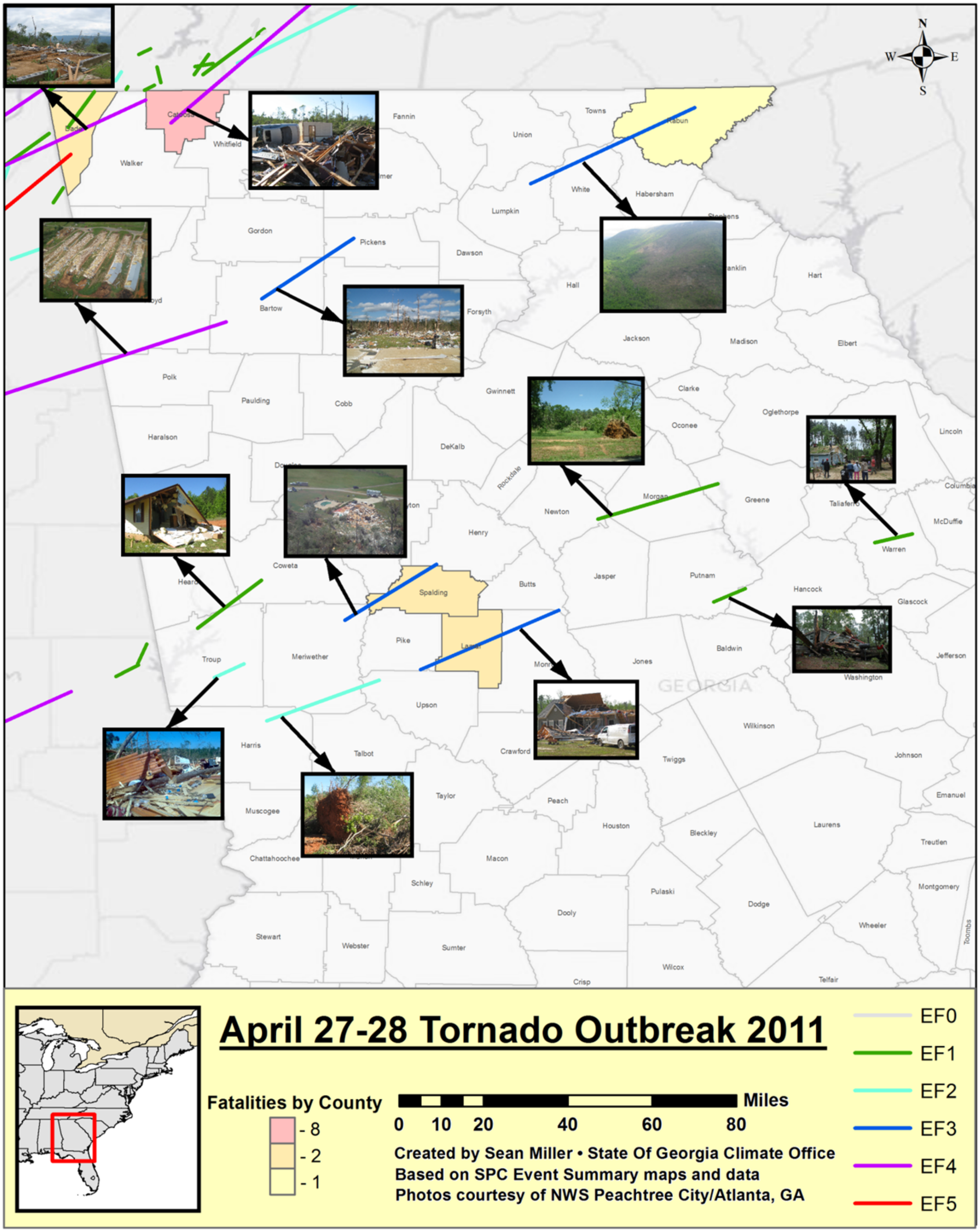
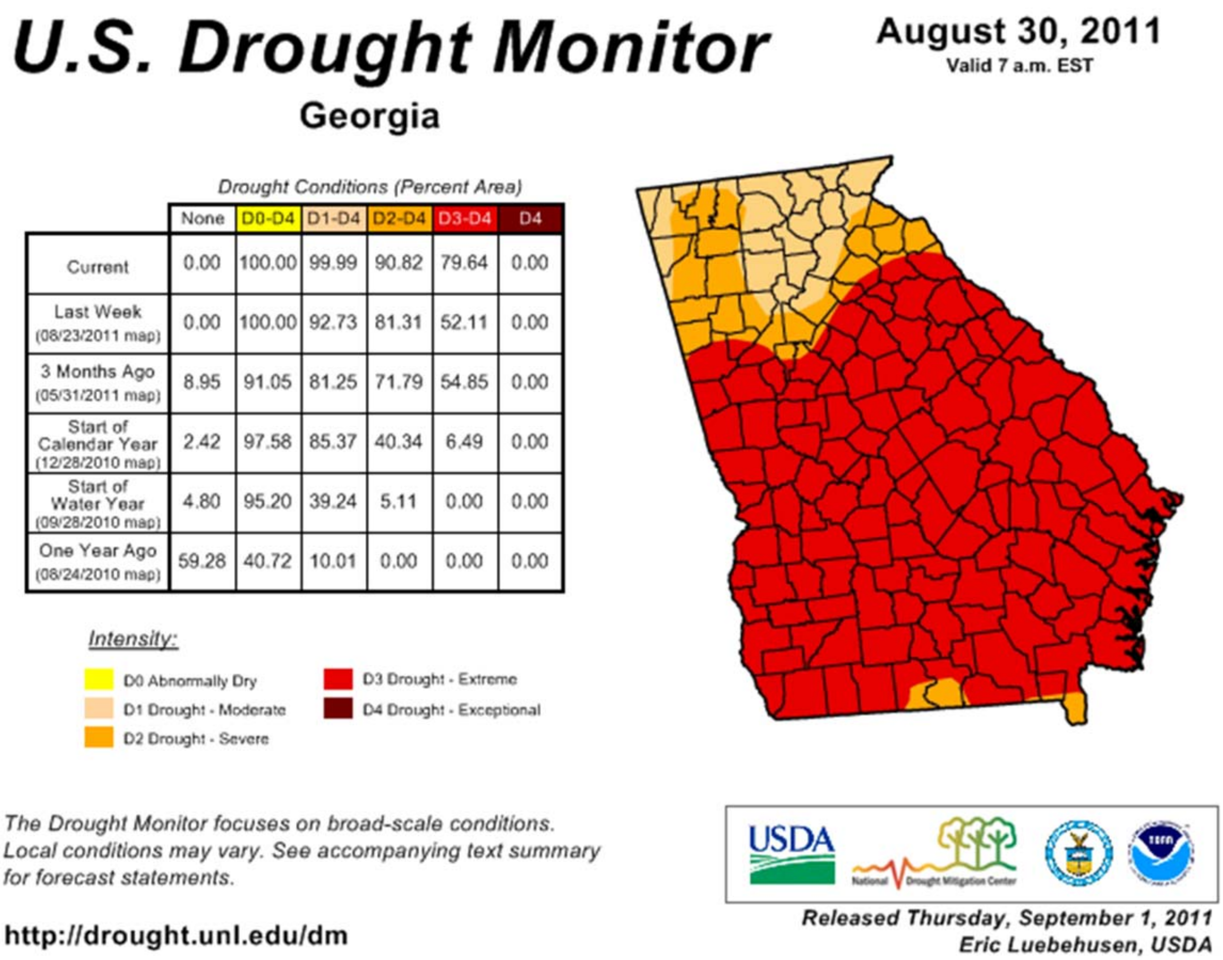


Figure 17.7: Tornado Outbreak, April 27-28, 2011

However, the additional warmth and severe weather was not accompanied by sufficient enough precipitation to offset a drier than average month in all four locations. Rainfall deficits ranged from -0.56 inches in Atlanta to -2.17 inches in Columbus. Consequently, by the end of April, moderate drought conditions were creeping northward and into northern Georgia. The drought intensified in May, as Athens, Columbus, and Macon all received less than an inch of rainfall. Monthly totals were 0.82 inches, 0.65 inches, and 0.66 inches, respectively.

Conversely, temperatures during the month of May experienced two swings between much below and much above average readings. For example, high temperatures ranged between the mid 60s and low 70s in the middle of the month to the lower and upper 90s by the end of the month. The 90°F plus high temperatures along with little or no rainfall brought the return of severe to extreme drought conditions to much of Georgia by the 1st of June. A large persistent upper level ridge of high pressure became entrenched over the south-central U.S. for June, July and August, resulting in the 2nd hottest summer on record for Georgia. Unlike the heat, rainfall was in short supply for June. All four cities recorded deficits ranging between 1.50 inches in Athens and 0.78 inches in Macon. July and August too, posted rainfall deficits seven out of eight times in the four cities, and generally on a larger scale. Only Columbus, with 5.05 inches of precipitation in August received a surplus (+1.28 inches) in these two months. By the end of August most of Georgia was under a severe to extreme drought.



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	99.99	90.82	79.64	0.00
Last Week (08/23/2011 map)	0.00	100.00	92.73	81.31	52.11	0.00
3 Months Ago (05/31/2011 map)	8.95	91.05	81.25	71.79	54.85	0.00
Start of Calendar Year (12/28/2010 map)	2.42	97.58	85.37	40.34	6.49	0.00
Start of Water Year (09/28/2010 map)	4.80	95.20	39.24	5.11	0.00	0.00
One Year Ago (08/24/2010 map)	59.28	40.72	10.01	0.00	0.00	0.00

Figure 17.8: Drought Conditions as of August 30, 2011

Highs in the middle to upper 90s persisted into the first three days of September, followed by welcomed relief. A series of early polar fronts sweeping through on the 4th and 15th cooled daytime highs to the upper 60s and 70s, while providing overnight lows in middle and upper 50s to low 60s. The fronts, while stalling across South Georgia, did help to provide above average monthly rainfall for Columbus (+0.50 inches) and Macon (+0.37 inches). However, the beneficial rain occurred mostly to the south of Atlanta and Athens, as both cities again recorded substantial deficits.

By the onset of September, La Nina conditions had re-emerged in the tropical Pacific. Characteristically, this resulted in an overall warmer and drier October through December period. However, the onslaught of cool air masses persisted through October providing another rare month with a below average temperature. Departures from normal were all below average in Atlanta (-1.2°F), Athens (-2.7°F), Columbus (-2.5°F), and Macon (-3.6°F). In line with La Nina, a record high of 85°F was set in the capital city on the 18th, breaking the old record from 1920 of 84°F. Record warmth was also achieved in November as two more records fell in Atlanta. November ended with monthly averages at or near normal in Macon (0.0°F) and Athens (+0.1°F) and 1.7°F and 1.3°F above in Atlanta and Columbus, respectively. The warmth though was mostly accompanied by drier than average conditions, as the four cities once again recorded monthly deficits. Departures from normal ranged from -1.61 inches in Atlanta to -0.19 inches in Macon. In December, a moderate strength La Nina lived up to its expectations, as milder than normal conditions prevailed throughout the month.

17.1.4 2012

According to the National Weather Service office in Peachtree City, Georgia, 2012 was a year of warmer than average temperatures and below average precipitation. The month of January was characterized by above normal temperatures and precipitation totals varying from north to south across the state. Several cities averaged temperatures several degrees above normal, including Atlanta (+5.8), Athens (+3.6), Columbus (+4.7), Macon (+3.6) and Brunswick (+4.1). Precipitation ranged from slightly above average in the north, to well below average in the south. The sharp contrast between northern drought-free areas and southern Exceptional drought areas intensified in January, according to the U.S. Drought Monitor. By the end of the month, over 50% of Georgia remained in D3 (Extreme) drought conditions, while approximately 16% were in D4 (Exceptional). There was a sharp drought gradient across the state, with south Georgia experiencing the worst conditions and areas of northwest Georgia not within a drought at all. Central to north Georgia ranged from abnormally dry to severe drought. A National Weather Service Assessment Team determined that an EF0 tornado occurred in northern Dooly County on January 21st. EF-1 tornadoes touched down in Macon County and in south central Coweta County on the 21st as well. There were also reports of golf-ball sized hail and straight-line wind damage. Flash flooding was observed with this event, as well, near and west of downtown Atlanta.

February saw a continuation of above average temperatures with several records set across the state. St. Simons Island reached a high temperature of 84° on the 24th, breaking the old record of 82° set in 1962. Athens tied a record high of 79° on the 23rd, which is the 7th highest maximum temperature recorded there since 1893. Augusta reached 82° on the 23rd, breaking a previous record of 81°. Precipitation remained well below normal for areas of the state. A few active weeks in early to mid-February brought some improvement to the area as several pulses of moisture crossed the state.

March proved to be a very memorable month with a severe weather event, elevated pollen counts, and record-setting temperatures. The month began with an intense, spring-like storm system that moved across the southeast producing widespread severe weather. A supercell thunderstorm produced two tornadoes in Georgia during this event, including an EF-3 in Paulding and Harrison Counties and an EF-1 in Cobb County. The La Nina pattern of warm temperatures seen throughout the winter, continued into March with near summer-like temperatures occurring before the official start of spring. March 2012 recorded the warmest average temperature on record at several official climate sites, including Atlanta, Athens, and Columbus. Several cities also set new March records for consecutive days at or above 80 degrees. The unusually high temperatures in the southeast during March could be partly attributed to a persistent blocking high-pressure system in the Atlantic Ocean. This blocking pattern during March kept the polar jet stream bulged well to the north. The mild winter also played a role in setting new record high pollen counts in March. The previous record for Atlanta-Sandy Springs-Roswell MSA, set in 1999, of 6,103 particles per cubic meter was broken on March 19^{th} with a total of 8,164 particles per cubic meter. The pollen count reached even higher on the 20^{th} at 9,369 particles per cubic meter.

The overall pattern of above normal temperatures and below normal precipitation persisted state-wide throughout the month of April. Despite a cold snap on April 12^{th}, leading to numerous at or below freezing low temperatures across the north, numerous cities still set new high temperature records during April. This includes Atlanta (87° on 3^{rd}), Columbus (90° on 29^{th} and 94° on 30^{th}), Brunswick (89° on 2^{nd}), and Macon (92° on 29^{th} and 93° on 30^{th}). Observed rainfall for the month reflected larger amounts in the far northeast corner of the state, with smaller amounts recorded in areas that could benefit the most from it.

May provided welcome rainfall in southern and eastern parts of the state from Tropical Storm Beryl, while other areas still remained below normal. Areas of coastal Georgia received well over 5 inches of rain in a short period of time as the storm system moved northeast along the coast on the 29^{th} and 30^{th} (Figure 17.9). The preseason tropical activity had little effect, however, on other rainfall deficits across the state, as the storm system did not move far enough inland to provide long-term drought relief. Climate stations such as Macon, Atlanta, and Athens reflected slightly below normal rainfall during May (-0.61, -0.26, -0.33, respectively).

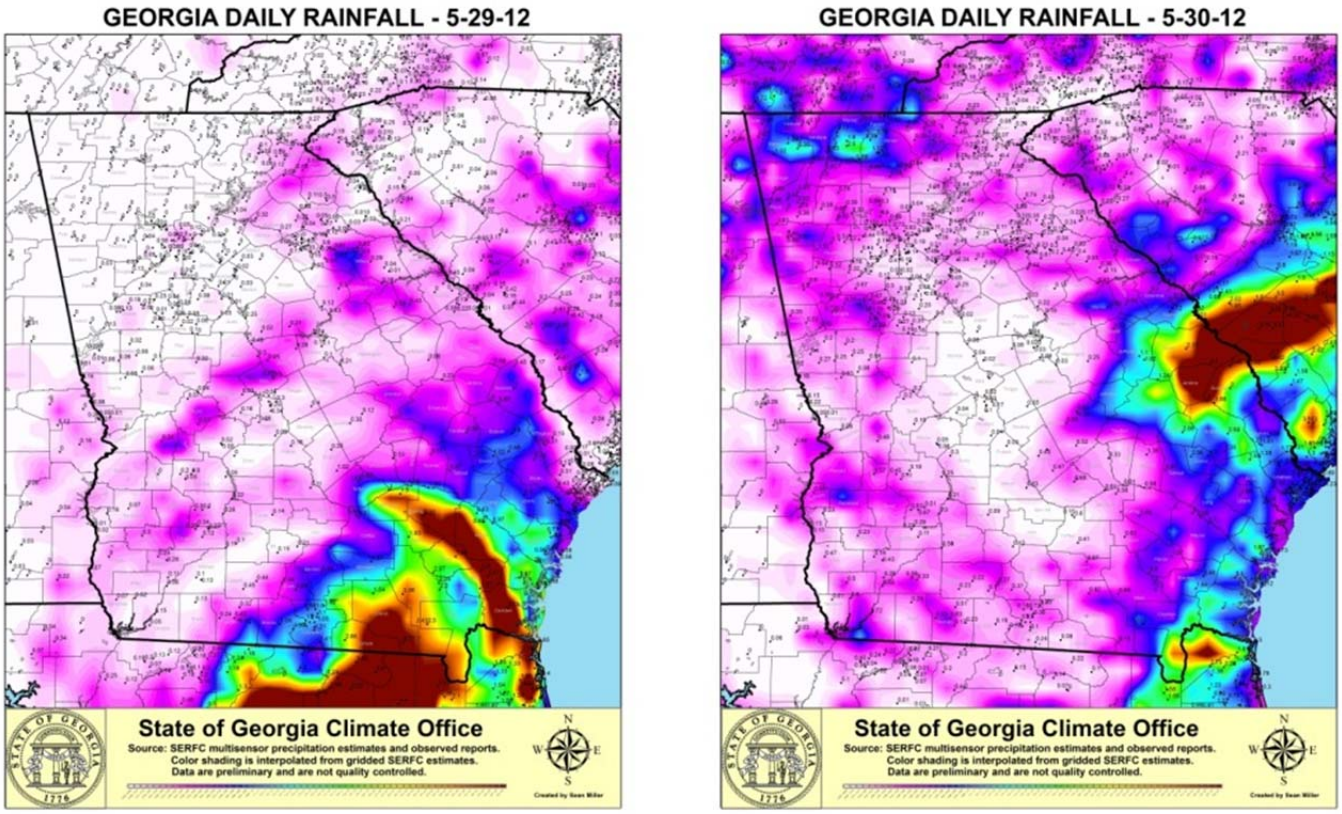


Figure 17.9: Rainfall from Tropical Storm Beryl

June was characterized by abundant rainfall from Tropical Storm Debby across south Georgia and Florida, as well as record-breaking heat across much of the U.S. Debby engulfed Florida with flooding rains beginning June 23rd and continued the deluge into parts of extreme southern and southeast Georgia through the 27th. The National Weather Service (NWS) climate station at St. Simons Island recorded 5.99 inches of rainfall during the period of the 23rd-27th, with a record daily maximum amount set on the 26th. The record daily rainfall of 2.9 inches on the 26th broke the old record of 2.77 inches set in 1963. The Community Collaborative Rain, Hail Snow Network (CoCoRaHS) rainfall reports topped 10 inches in many areas, with readings such as 12.96 inches in Kingsland and 10.05 inches at Kings Bay. The heaviest rainfall totals for the 7-day period of 21st through 27th were confined to extreme southern and southeast Georgia, similar to Tropical Storm Beryl (Figure 17.10).

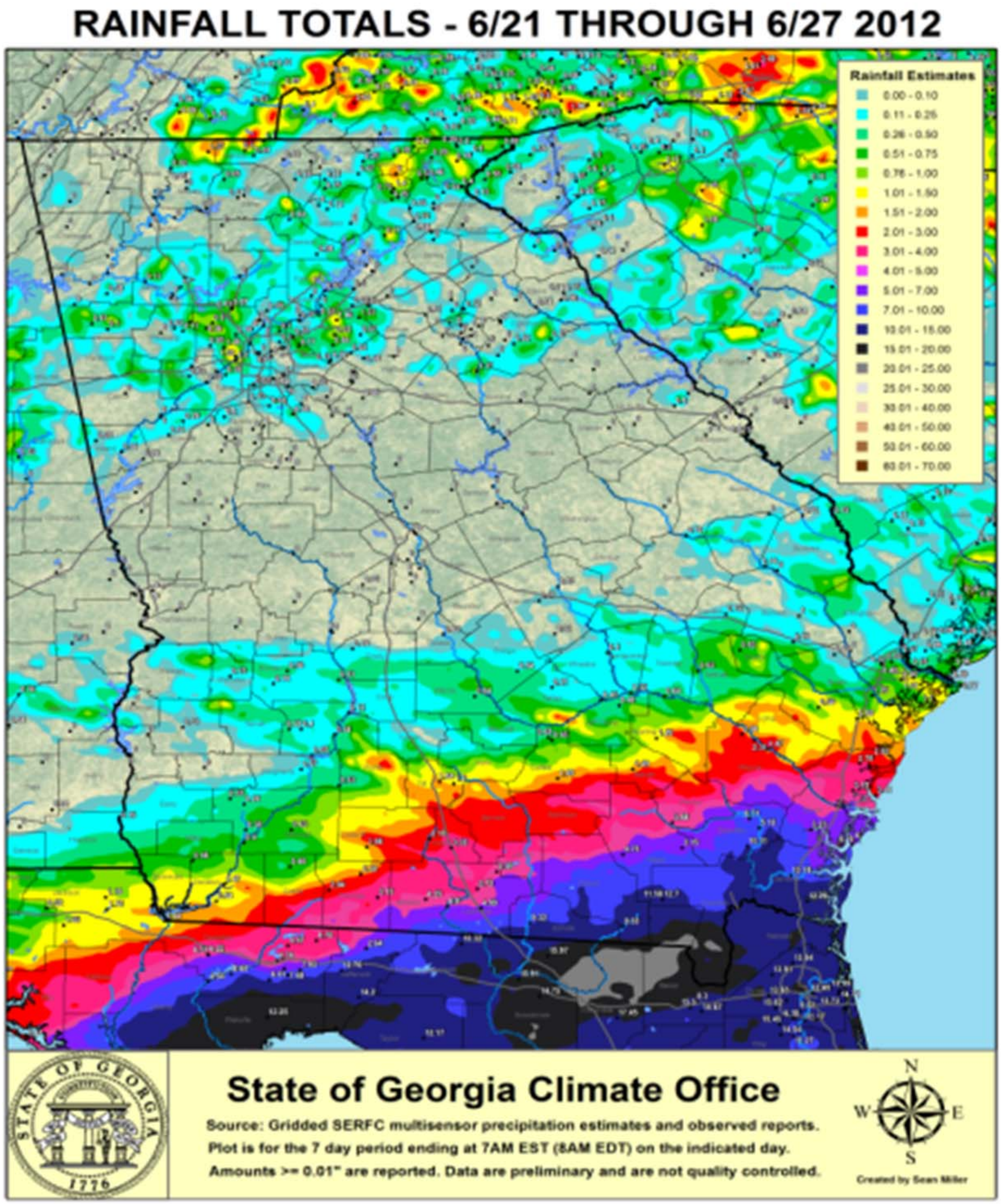


Figure 17.10: Rainfall from Tropical Storm Debby

Rainfall totals decreased further north, as drier air filtered in from a strong high pressure system in the wake of Debby. Alma, Georgia only reported 1.49 inches of rainfall for the event. Although Tropical Storm Debby provided drought relief across Florida and southeast Georgia (as registered by the Drought Monitor), it did not reach the heart of the drought-stricken areas in southwestern and central Georgia, including the central Savannah River valley (Figure 17.11).

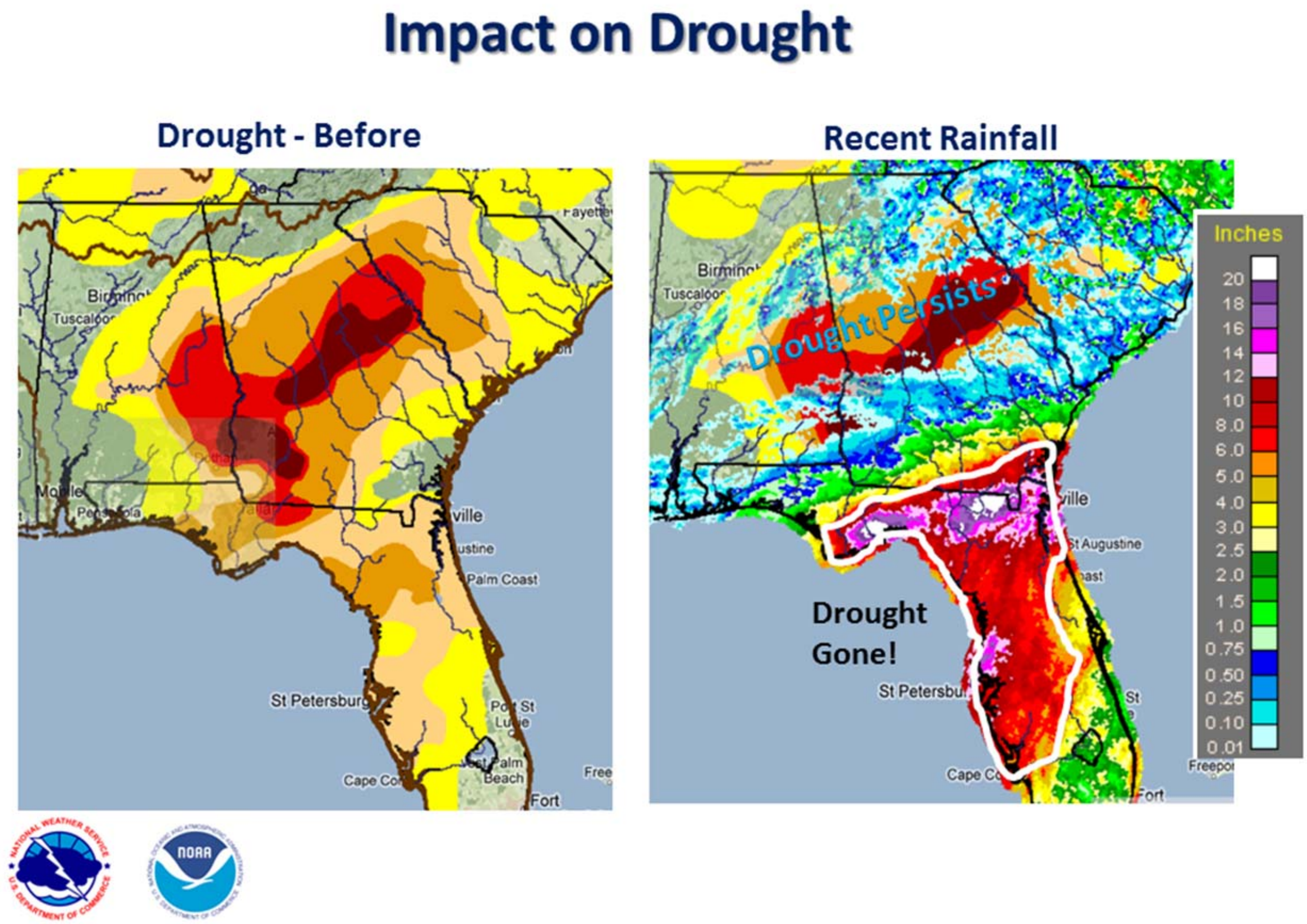


Figure 17.11: Drought Impacts from Tropical Storm Debby

The official start of summer was followed by a remarkable heat wave event, from June 29 through July 1, as a strong upper level ridge dominated across the southeast. Numerous temperature records were set, not only in Georgia, but across the U.S as well. During the three-day period, many locations reported temperatures well above 100°F. Several high temperature records were tied or broken during this event. Columbus and Atlanta set new all-time record highs of 106°F on the 30th, while Athens set a new record of 109°F on the 29th. Macon tied a record of 108°F, which was last observed in 1980. Figure 17.12 below details the highest recorded temperatures for the month of June, most of which occurred during the extreme heat event. These record high temperatures, along with dry, highly stable atmospheric conditions provided stagnant conditions for north Georgia at the end June, which allowed for very poor air quality to occur as well. The Atlanta-Sandy Springs-Roswell MSA recorded a rare Code Purple at the McDonough site on the 29th, which is considered Very Unhealthy under EPA's Air Quality Standards for ozone. The concentration reached an 8-hr average of 122 parts per billion by volume (ppbv). The last Code Purple the Atlanta-Sandy Springs-Roswell MSA experienced was on Aug 15th, 2007. The GA EPD site at Conyers, GA reached 109 ppbv on the 29th, which is a high Code Red ("Unhealthy").

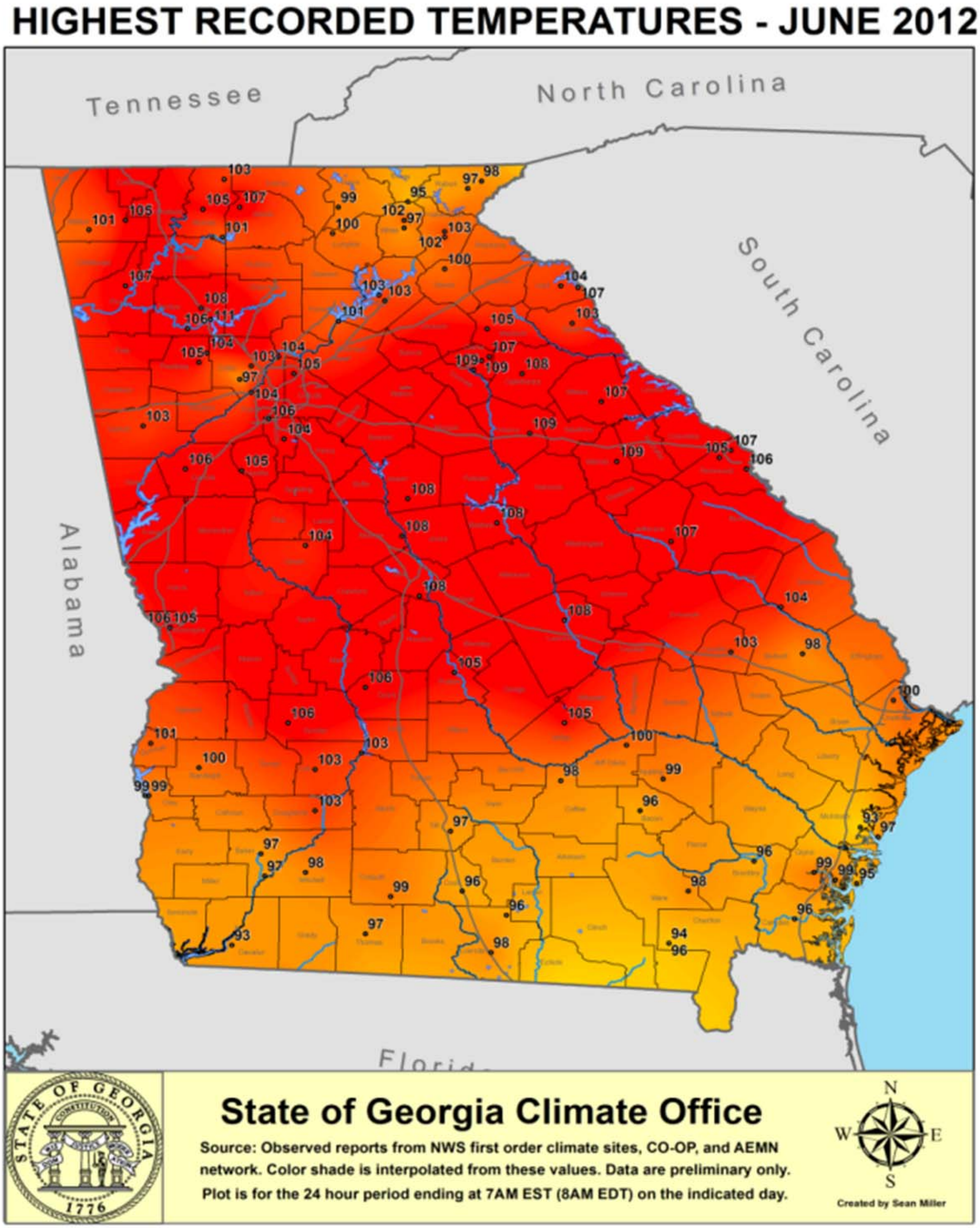


Figure 17.12: Highest Recorded Temperatures for the Month of June

The month of July was characterized by a typical summertime pattern of scattered afternoon and evening thunderstorms due to daytime heating. A Bermuda High Pressure system in the Atlantic Ocean extended across the region, slightly suppressing convection and allowing rainfall totals to remain below normal for the month. A persistent upper level trough pattern over the eastern U.S. brought beneficial rainfall to many areas of the state during the month of August. Augusta recorded its fifth wettest month of all time and the second wettest August on record, with rainfall totals of 12.28 inches recorded at Bush Field. Augusta also set a new maximum daily rainfall record on the 11th of 4.68 inches as thunderstorms passed through. Southern areas of the state received additional rainfall from the outer bands of Hurricane Isaac during the latter part of the month. The track of Isaac remained west of the state, but contributed significant precipitation to some areas of Georgia.

A persistent trough of low pressure over the northeast continued to be the dominant synoptic feature through much of September. Temperatures remained near normal across most of the state. Periods of moderate rainfall allowed portions of the extreme northwest and all of the southwest to receive over two inches of above normal rainfall for the month. Areas within the core of the drought saw brief periods of beneficial rainfall, allowing the spatial coverage of the severe to exceptional drought to decrease in parts of the north and central Georgia. As is typical, the month of October was relatively quiet across the state with temperatures averaging near normal throughout the month. Dry conditions continued across much of the drought-stricken region. Below normal rainfall of over two inches was recorded across many areas of the state. Both Alma and Macon recorded rainfall deficits over 2.5 inches for the entire month. Among first order climate sites and select cooperative observing stations, the average precipitation departure was -9.61 inches, with Plains, GA having its driest year-to-date.

The month of October ended on a significant note as former hurricane turned post-tropical cyclone Sandy tracked northeast up the Atlantic coast (Figure 17.13). The storm moved parallel to the South Carolina coast on the 27th and 28th, with winds increasing across coastal Georgia the 29th as the pressure gradient tightened. This produced breezy conditions across the state from the 29th through the 31st, which prompted the issuance of wind advisories for portions of north Georgia. Peak gusts of over 40 mph were also recorded at several NWS sites during the period.

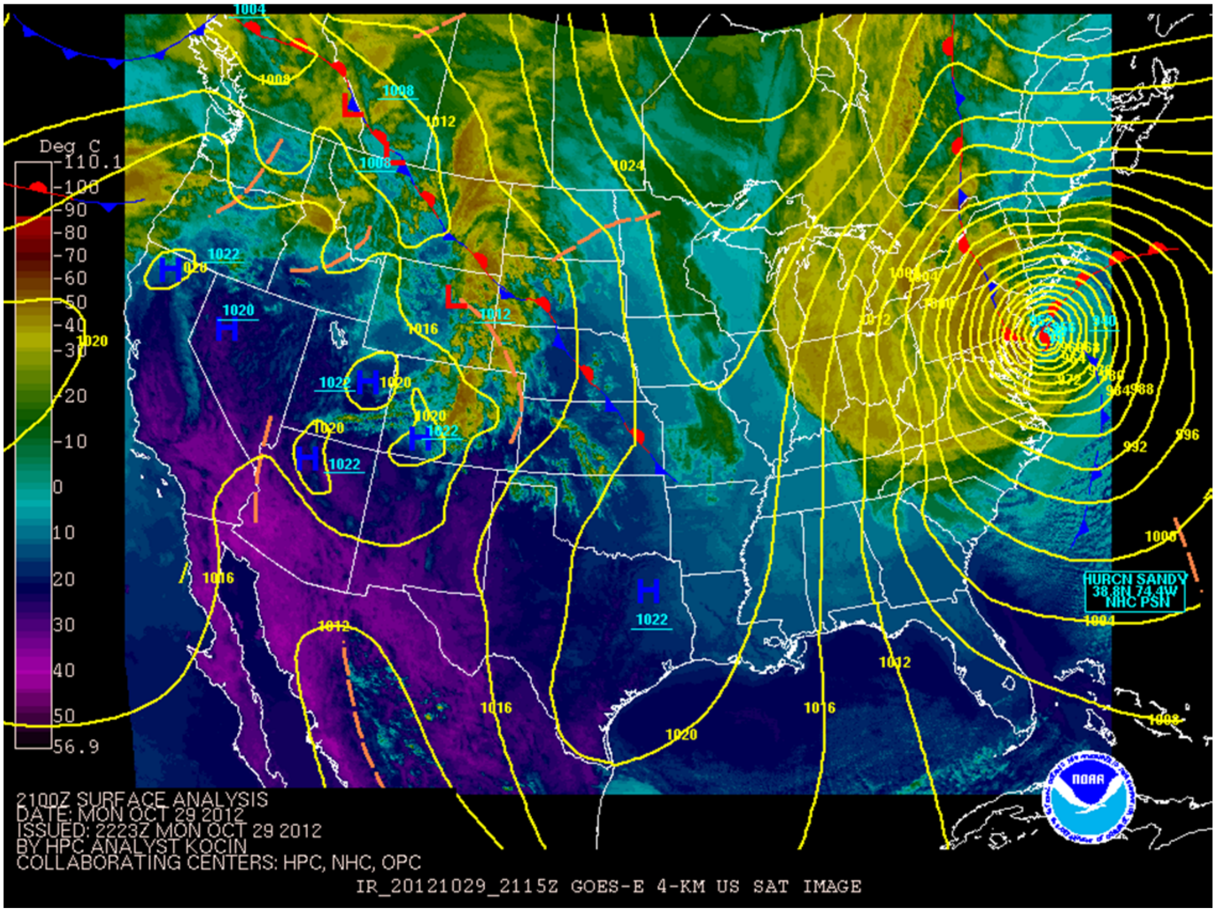


Figure 17.13: Post-tropical Cyclone Sandy Tracking Northeastward

Temperatures stayed below the record-setting warmth of November 2011 for Atlanta and Athens. The drought continued to expand across already-stricken areas of Georgia due to a lack of sufficient rainfall during the month. The four major climate sites in northern and central Georgia received an inch and a half to nearly three inches below normal precipitation for the month. White County reported a mean year-to-date rainfall deficit of 12 inches, receiving 80.3% of its normal year-to-date totals. A brief period of rainfall brought minor relief to some areas, with Atlanta setting a record daily maximum rainfall of 1.25 inches on November 6th. This broke the old record of 1.10 inches set in 1995. November 30th marked a rather quiet close to a busy Atlantic hurricane season. The 2012 season produced 19 named storms, of which 10 became hurricanes and one became a major hurricane. The number of named storms topped the average of 12, while the number of hurricanes also surpassed the average of 6. Although NOAA has classified the season as above-normal, due to the combined number, intensity, and duration of all the tropical storms and hurricanes, it is still not considered an exceptional season.

December was a mild month with temperatures averaging above normal for much of the state, as the neutral El Nino Southern Oscillation (ENSO) pattern continued in the Pacific. Atlanta set a record high temperature of 74°F on December 3rd, which tied the old record set in 1982. The 90-day rainfall departure for the state at this time (Figure 17.14) shows some improvement in of north and central Georgia, while drier than average conditions prevailed over the extreme southeast and parts of the southwest. St. Simons Island was nearly an inch below the monthly normal of 2.64 inches as drought conditions persisted and intensified across the region.

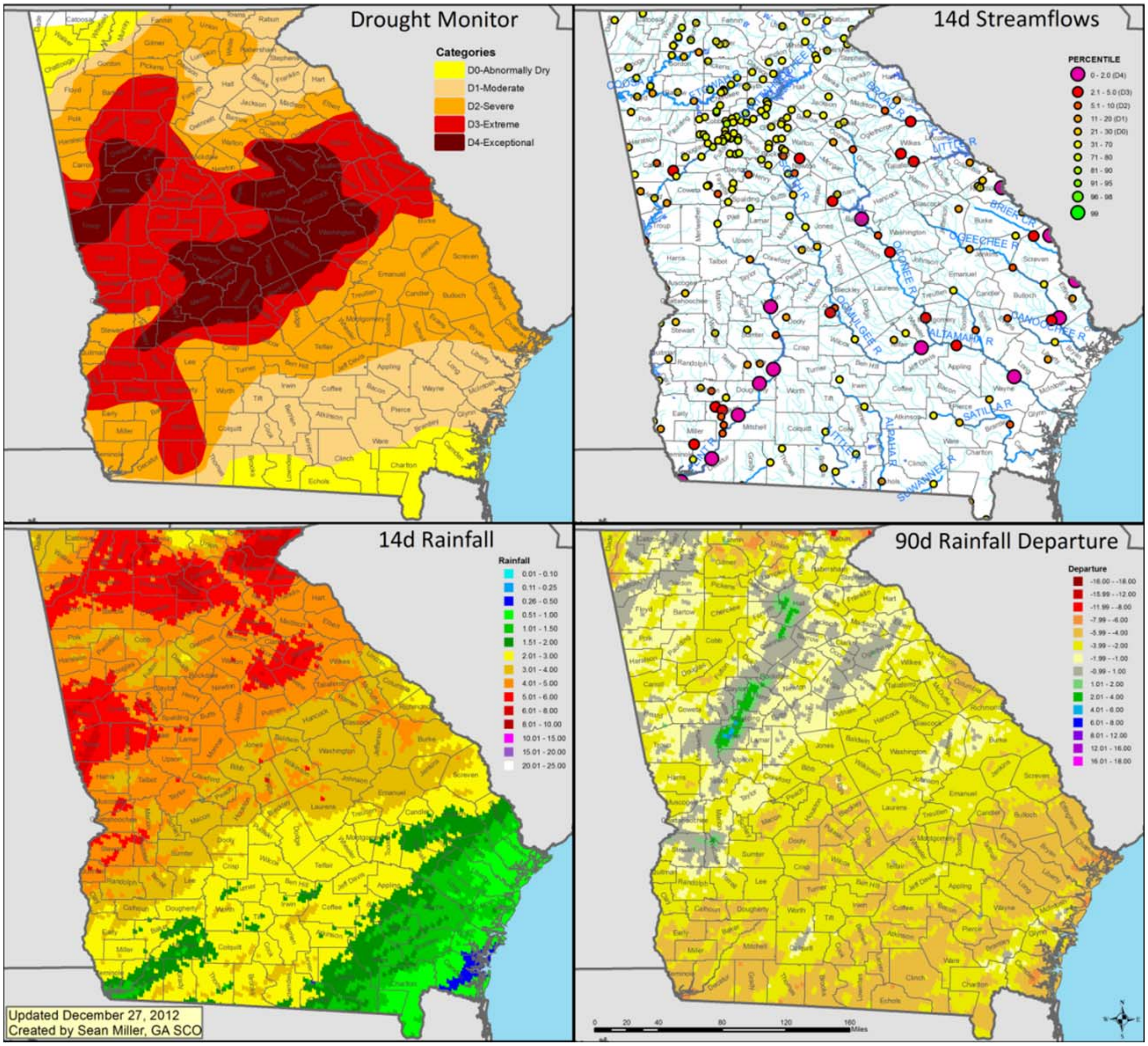


Figure 17.14: Drought Conditions across the State with Rainfall Departures and Streamflows

17.1.5 2013

The beginning months of 2013 consisted of a very "active" upper level pattern, which included fairly significant swings in temperature and precipitation across the Southeast. The positioning of the subtropical jet allowed ample amounts of Gulf of Mexico moisture to stream across the area, which aided in continuous periods of heavy rainfall occurring over the same locations for an extended period of time. Also on occasions, a dip in the jet allowed for brief intrusions of colder air into the state. Intrusions like this were evident on such days as January 25th, where the National Weather Service (NWS - Peachtree City) reported ice accumulations in areas of North Georgia. January struck a warm note as areas across the state observed above normal mean temperatures for the month. Atlanta set a record high temperature of 76°F on January 12th, breaking the old record of 75°F set in 1890. Macon also set a record high temperature on the 12th of 78°F, beating the old record of 77°F set in 1916. Columbus set several high temperature records during the period of the 12th–14th of January, reaching a maximum of 78°F on the 14th. The January temperature records continued across the state with Augusta also reaching several record highs. Augusta Regional Bush Field topped out at 81°F on the 12th, surpassing the previous record of 78°F set in 1916.

A large portion of the state received below normal rainfall during the month of January. A record low rainfall for the month was set at Augusta Regional Bush Field at 0.60 inches. This beat the old record of 0.75 inches last reached in 1981. The precipitation gradient across the state ranged from a deficit of 2-4 inches for much of Central and Southern Georgia to a surplus of 6-8 inches in parts of North Georgia. A slow moving cold front combined with significant moisture from both the Pacific and the Gulf of Mexico to create a heavy rainfall event mainly across Northwest GA during the week of January 14-18th.

The month of January ended on a stormy note as a supercell thunderstorm moved across northwest Bartow and central Gordon counties on the 30th. The NWS in Peachtree City determined an EF3 tornado, beginning southwest of Adairsville, GA and tracking 22 miles northeast, caused significant damage in Bartow and Gordon counties. The image below from the NWS shows the track of the tornado.

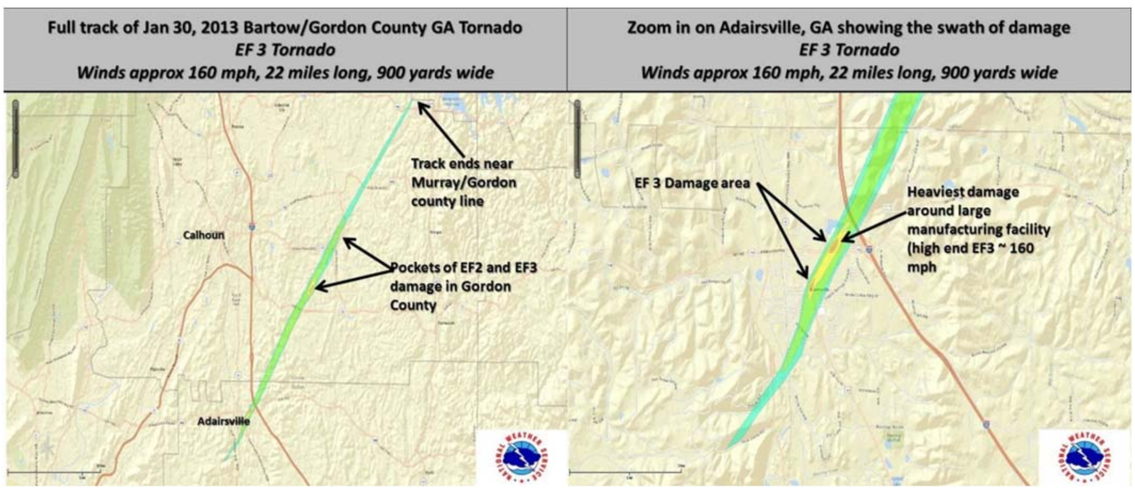


Figure 17.15: Path of Tornado in Bartow and Gordon Counties, January 30, 2013

February was characterized by periods of heavy rainfall from storm systems moving through in the progressive upper level pattern. Continuous heavy rainfall for extended periods allowed for areas like Savannah to have its wettest February on record out of 143 years of data, with 9.75 inches. This was +6.83 inches for the month. Macon and Columbus also saw their wettest February on record, while Augusta was 4th wettest and Atlanta was 15th. Alma, in Southeast GA, recorded 9.54 inches of rainfall during the month which broke the old monthly record of 9.27 inches set in 1986. Several daily maximum records were also set across the state on February 11th as a heavy band of precipitation moved through. The beneficial rainfall in February resulted in major drought improvement across Georgia. For the first time since August 2010, according to the Drought Monitor, the region was free of extreme drought.

The beginning of spring across the state was characterized by a colder than average March and continual improvement in long-term drought conditions. March was colder than the average winter temperature in some locations, as was the case in Atlanta. The average monthly temperature of 49.1°F for March in Atlanta was slightly lower than the average temperature of 49.2°F for the months of December to February of this year. March of 2013 was also 15.4°F colder in Atlanta than March of 2012, which averaged 64.5°F. Similar conditions occurred across much of the state, with temperatures near several coastal areas of Southeast Georgia averaging 5-7°F below normal. Record low temperatures of 27°F and 30°F were set on the 28th of the month in Athens and Macon, respectively. A record low of 38°F was also set in Brunswick on the 26th of the month, breaking the old record of 39°F, set in 1979. One primary cause of the cool temperatures was the Arctic Oscillation which had been extremely negative. Precipitation was slightly below-to-near normal across the state in March. Several frontal systems and associated rainfall brought some relief to the drought-stricken areas of North and Central Georgia. A cold front that pushed through on March 5th also brought with it nickel-sized hail in Fannin County and an EF-1 tornado in Glascock County, according to the NWS.

April reflected more near normal temperatures, with the continuing wet pattern allowing for removal of D1 and D0 drought areas in central and eastern sections of the state at the beginning of the month. More locally heavy rainfall eased moderate drought and long-term dryness across the state by the end of the month.

The month of May was characterized by cooler than normal temperatures and above normal rainfall in north, central and southeast parts of the state. Abnormally dry conditions remained in Southwest Georgia throughout the month. An ample supply of Gulf of Mexico and Atlantic moisture and a low pressure system led to a widespread rain event at the beginning of the month from the 4th to the 6th, with flooding across areas of north and central Georgia. Atlanta experienced a record daily maximum rainfall of 1.85 inches on the 4th, breaking the old record of 1.79 inches set in 1917. Alma and Brunswick received record daily maximum rainfall of 1.46 and 2.24 inches on the 5th, respectively, associated with the same low pressure system. According to the NWS, approximately 40 stream gage locations across north and central Georgia exceeded flood stage during that rain event, as the ground was already well saturated beforehand. Another round of strong convection moved through on the 19th and 20th of the month. Rainfall estimates showed 4 to 5 inches were received on the 19th in parts of Northeast Georgia.

May also experienced a cool trend with an average temperature of 68.6°F for the entire state, which was 2.6°F below normal. This was the 12th coldest May out of 119 years of data. Macon had its 4th coolest average temperature on record at 68.4°F, -3.5°F below the normal monthly temperature of 71.9°F. Atlanta and Columbus both reached low maximum temperature records on the 6th of the month, while Macon and Augusta tied and reached low temperature records on the 14th at 42°F and 40°F, respectively. Macon also set a record low of 49°F on the 25th.

The mean weather pattern for June featured a high pressure ridge over the western states with troughing prevailing for the east. An active storm track, centered north of Georgia, brought a series of disturbances through the state keeping June rather wet and unsettled. This pattern allowed for several days of moderate to heavy rainfall with many climate sites recording their wettest or near wettest June on record. Mean temperatures were generally near normal at most locations, with maximum temperatures slightly below average due to frequent cloud cover and rainfall. A notable severe weather episode affected portions of the north on the 13th producing widespread damaging wind along with two relatively uncommon June tornadoes. Climate impacts were wide-reaching, with saturated soils leading to crop damage and downed trees in many areas.

Above normal rainfall was experienced in nearly all portions of the state, with the exception of the extreme northwest, southwest, and along the coast. Particularly wet areas included portions of the east-central and southeast where many locations received well over 12 inches for the month of June. The greatest monthly totals observed included 18.5 inches at the co-operative observing site 4 miles northeast of Waycross and 18.36 inches in Kite. In contrast, relatively drier locations included Ringgold and LaGrange with 3.52 inches. A heavy thunderstorm in the Atlanta area dropped 4.14 inches at Hartsfield-Jackson International Airport on the 5th, setting both daily and monthly records for the greatest rainfall total for the 5th and for any single day in June. Augusta and Macon had their wettest June on record with 10.78 inches and 12.23 inches respectively. Temperatures across the state did not vary drastically from normal during June with mean temperatures at or above normal across portions of the northwest and south and at or below normal for the remainder of the state. With wet and cloudy conditions prevailing, many climate sites recorded slightly below average maximum temperatures and slightly above average minimum temperatures. This produced means that were near normal for the month. One exception was at Savannah, where the mean was +2.8°F above normal for the month.

A noteworthy severe weather event affected portions of North Georgia on the 13th of June, producing widespread damaging winds and two tornadoes. Particularly hard hit were portions of Cherokee, eastern Cobb, northern Fulton, and northern DeKalb counties. Two tornadoes, producing damage consistent with an EF-1 rating, were documented in Cherokee, Cobb, and northern Fulton counties.

July was marked by much wetter than normal rainfall conditions which led to slightly cooler than average temperatures across much of Georgia. A persistent Bermuda High pressure over the Atlantic, coupled with weak low pressure systems in the Gulf of Mexico, pulled moist air from the Gulf northward across Georgia. Heavy rainfall characterized the beginning of the month with the abundance of Gulf and tropical moisture. A stationary front to the west during the first week of July allowed significant moisture to be funneled into Alabama, Georgia and Tennessee. Rainfall totals across areas of Northeast Georgia were substantial, as was flooding in many areas from this event. One such flash flooding event occurred near and south of Gainesville, GA on the 8th, with radar-derived totals showing rainfall amounts exceeding 3-4 inches in approximately one hour. Local storm reports in Franklin County reported a mudslide and debris flow across portions of Highway 29 in Royston. The major climate sites of Atlanta, Athens, Columbus, and Macon observed above average precipitation totals of 8.48 inches, 9.19 inches, 8.81 inches and 6.99 inches, respectively, for the month of July. The average precipitation for the entire state during July was 9.10 inches, +3.53 inches above normal. The troughness and rainfall also provided cooler temperatures with a mean temperature for the entire state of 78.2°F. It was the coldest July since 1994 and ranked 11th coldest overall out of 119 years of record. Even during a relatively cool month, Metro Atlanta recorded one of few ozone exceedances this summer on July 30th, reaching Code Red.

The mean August weather pattern featured a mid-level high pressure ridge over the central states and anomalously strong troughness over New England. An active storm track, centered north of the state, kept Georgia's weather rather unsettled during the month. This wet and frequently cool pattern resulted in below normal temperatures and above normal precipitation for most areas. Heavy rainfall in the southwest and north central portions of the state allowed several cooperative observing sites to record their wettest August on record. Below normal temperatures were experienced in nearly all areas with the exception of the extreme southeast. Monthly means ranged from 3-4°F below normal for the north and east central to 1-2°F above normal in the Southeast. A warm spell occurred from the 9th-13th with daily maximum temperatures rising into the mid to upper 90s in central and southern areas. The month's warmest reading of 99°F occurred twice during this period at Valdosta and on the 15th at the cooperative observing site in Rocky Ford. Much cooler weather prevailed from the 15th-18th with many areas experiencing daily maximum temperatures of 10-20°F below normal. New daily low maximum temperature records were set during this period at Athens, Atlanta, Augusta, and Macon. Record low temperatures were also set or tied at Athens, Atlanta, and Columbus. After a slight warm up during the 21st-23rd, a dry continental air mass brought much cooler daily minimum temperatures from the 25th-27th. The month's coldest reading of 53°F occurred at the cooperative observing site near Clayton on the 26th.

Most areas saw above normal rainfall during the month of August, with the exception of a few isolated locations. Surpluses ranged from over 6-8 inches in the southwest and north central to 2 inches in the extreme southeast. Isolated deficits of up to 4 inches were noted southeast of Waycross. A particularly wet period occurred from the 14th-19th in association with a stationary front. On the 14th Columbus set new records for maximum daily rainfall both for the 14th and for any day in August with 5.73 inches. This was also the second highest total for any calendar day, falling just short of the record 5.74 inches set on April 1, 1984. Alma also set a new record daily maximum on the 16th with 2.20 inches; breaking a record of 1.94 inches set in 1971. Macon recorded its second wettest August on record with 10.20 inches, while Columbus observed its fourth wettest August with 8.63 inches. A tornado occurred in Heard County on the 18th, producing damage consistent with an EF-1 rating. This tornado traveled four tenths of a mile and caused roof damage to one mobile home. Numerous trees were snapped along its path. Many areas experienced localized flash flooding during the month. Gilmer County was particularly hard hit, with swift water rescues and infrastructure damage occurring on the 1st. Another round of heavy rain brought additional flooding and damage to the county on the 7th.

Many areas saw below normal rainfall during the month of September, with the exception of portions of the northwest and south central. Surpluses in these areas ranged from 1 to 1.5 inches, with isolated 2 inch amounts. Deficits across the remainder of the state averaged 1 to 2 inches, with isolated 3 to 4 inch areas. Among the drier locations were the Northeast Georgia Mountains, the fall line region, and along the coast. The month started on a wet note across the north, with scattered thunderstorms on the 1st, followed by heavier and more widespread rainfall on the 2nd and 3rd. A daily rainfall total of 3.36 inches was observed near Villa Rica during this event on the 2nd, with this being the second greatest 24-hour total reported in the state during September. The focus for heavier rainfall gradually shifted into South Georgia through the 8th as a cold front drifted southward. After a relatively dry period from the 9th through 12th, a cold front brought renewed convection and rainfall to the north on the 13th, with generally lighter amounts across the central and south through the 16th. Isolated heavier rainfall amounts were reported in Wilcox (17th) and Camden (18th) counties before the front finally exited the state on the 19th. A notable wet period affected portions of the state from the 21st through the 26th as an initially progressive front became stationary across the south. The month closed on a quiet note, with generally dry conditions from the 27th through the 30th.

Average temperatures were near normal across much of the state for September, with slightly above normal temps in cities such as Atlanta and Columbus. The average temperature in Atlanta was 74.4°F (0.9°F above normal). The average in Columbus was a bit warmer at 77.9°F (1.3°F above normal). The Augusta area began the month with warmer temperatures before settling into a cooler pattern by the end of the month. The average temperature at Augusta Regional Bush Field was 74.5°F or 0.1°F below the normal of 74.6°F. The highest maximum temperatures across the state were in Valdosta and Waycross, which reached 99°F and 97°F, respectively.

October was characterized by warmer than normal temperatures and below normal rainfall. Climatologically, the fall season is one of the driest periods for the region. Atlanta, Columbus, Macon and Athens were among major climate sites that recorded -0.84, -2.13, -2.17, and -2.28 inches below normal rainfall, respectively. The total precipitation at Augusta Regional Bush Field was 0.36 inches or 2.91 inches below the normal of 3.27 inches. It was the 16th driest October on record at Augusta. The Warrenton Cooperative Observing site had no rainfall for the entire month, which set a record for its driest month on record. A brief heavy rainfall event occurred at the beginning of the month, as a cold front moved across the region on the 7th and 8th. Radar estimated that over 4 inches of rain fell along the McIntosh/Liberty county line on the 7th. Nearby CoCoRaHS observers reported one to nearly two inches of rain during the same period. Abnormally dry conditions spread across portions of eastern and southeast Georgia towards the end of the month, earning a designation of D0 by the U.S. Drought Monitor. This designation typically indicates short-term dryness, slowing planting, and growth of crops or pastures.

Temperatures across the state in October were near to slightly above normal for most areas, and departures ranged from two degrees above normal across portions of the west central to one degree below normal over portions of the southeast and north central. A warm spell occurred from the 4th through the 7th with temperatures in central and southern sections reaching well into the 80s and lower 90s. The Valdosta Regional Airport recorded a maximum temperature of 92°F on the 4th, which was the warmest daily maximum observed in the state during the month. Slightly cooler conditions prevailed from the 8th through the 11th following a frontal passage, with moderating temperatures through the 13th. A series of cold fronts brought colder conditions from the 17th through the 27th, with freezes observed at several locations in the north and central areas. The season's first freeze was reported on the 20th at the Blairsville Cooperative Observing site, while the month's coldest daily minimum of 25°F occurred at LaFayette (on the 25th) and Toccoa (26th). Temperatures following this cold spell began a slow moderating trend which continued for the remainder of the month.

The mean weather pattern for November featured a high pressure ridge over the eastern Pacific with troughing prevailing over eastern Canada and New England. An active upper level flow pattern brought a series of weather disturbances through the state keeping the month rather cool and unsettled. Mean temperatures were below normal statewide, with the coldest readings in the north. Cold-air outbreaks on the 13th and 28th brought record low temperatures to some locations. Mean temperatures across the state were below normal, with departures ranging from less than one degree below normal in the southeast to over five degrees below normal in the northwest. Temperature departures at the first order climate sites ranged from -4.0°F at Athens to -0.5°F at Savannah.

The month of November began on a mild note temperature-wise, with mean temperatures from the 1st through 7th in the lower 50s (north) to lower 60s (far southeast). Slight cooling occurred on the 8th after the passage of a weak cold front, with temperatures moderating through the 11th. A strong cold front impacted the area on the 12th, with cold temperatures statewide on the 13th and 14th. Several cooperative observing sites in northern Georgia recorded daily minimum temperatures in the teens during this period. Among the coldest readings were 13°F at LaFayette (on the 14th), and 14°F at Blairsville (13th). This is the earliest date on which LaFayette has recorded a temperature this low (the previous earliest date was 11/15/40 with 11°F and 11/15/69 with 13°F). Atlanta's Hartsfield-Jackson International Airport also recorded its first freeze of the season on the 13th with 28°. This date coincides with the historical average first freeze date for Atlanta.

After a brief warm spell on the 17th and 18th of November, temperatures again cooled following the passage of a cold front on the 19th. Further cooling continued through the 25th as a modified area of arctic high pressure settled into the region. Following the passage of a strong upper level trough and associated surface wave on the 26th and 27th, high pressure again built into the region with good radiational cooling allowing for record cold temperatures at a few climate sites. Augusta and Macon set new record low temperatures on the 28th with 21°F, breaking their existing low temperature records of 22°F, set in 1903 (Macon) and 1938 (Augusta). The Elberton cooperative observing site also recorded a low of 13°F on the 29th.

November continued the pattern of below normal rainfall across much of the state. Rainfall ranged between 1 to 3 inches in a large swath of western and central Georgia, which is 25-50% of normal. Atlanta and Columbus both fell over 2 inches below normal for the month, receiving 1.87 inches and 1.79 inches, respectively. Rainfall totals across southeast Georgia were generally above normal for the month, primarily due to a storm system that moved through on the 26th-27th. Alma set a daily rainfall record of 2.60 inches on the 26th, which also was the maximum daily precipitation total for the month. St. Simons Island also set a daily rainfall record of 1.19 inches on the 26th, which broke the old record of 0.70 inches set in 1976. The greatest daily rainfall total for the entire state was 4.63 inches at the Pearson CoCoRaHS site on the 27th. The highest monthly rainfall total of 9.73 inches was recorded at the Elijay site in North Georgia. By the end of November, Elijay was a little over an inch shy of breaking its wettest year on record, which was 1967, when 84.69 inches of precipitation fell that year. White County in northern Georgia was also well above average for year-to-date rainfall with 85.47 inches by the end of November. That total was +23.58 inches above normal and +44.15 inches above rainfall amounts this same time last year.

The mean circulation pattern in December featured pronounced ridging over the eastern north Pacific and western North America, with troughing prevalent from eastern Canada into the central United States. An active storm track combined with an absence of cold-air intrusions kept the state relatively warm and wet throughout the month. Monthly average temperatures were above normal statewide, with the greatest departures found along the upper coast. Savannah had a mean temperature of 57.3°F, which is 5.6°F above normal for December. Several daily temperature records were set during warm spells on the 5th-6th and 21st-22nd, with monthly maximum temperature records set at Augusta and tied at Savannah with 83°F.

Precipitation was variable across the state in December. Coastal sections remained driest, with departures of around one inch below normal. Conversely, portions of the west central and north received plentiful rainfall with departures exceeding four (to locally six) inches above the mean. Athens received 7.62 inches (3.89 inches above normal), Atlanta had 7.80 inches (+3.90 inches), Augusta had 6.90 inches (+3.51 inches), Columbus had 8.87 inches (+4.60 inches), Macon had 9.04 inches (+5.00 inches), and Savannah had 2.38 inches (+0.57 inches). Noteworthy precipitation events occurred on the 23rd and 29th, resulting in widespread stream and isolated stem river flooding primarily in northern and central portions of the state.

17.2 Summary of Meteorological Measurements

A complete suite of meteorological instrumentation is used to characterize meteorological conditions around metropolitan Atlanta. The basic surface meteorological parameters measured at the Photochemical Assessment Monitoring Sites (PAMS) are shown in Table 17.5. The PAMS sites are Conyers, South DeKalb, and Yorkville. South DeKalb is considered an NCORE site as well. All PAMS sensors measure hourly-averaged scalar wind speed and vector-averaged wind direction at the 10-meter level, and hourly-averaged surface temperature, relative humidity and barometric pressure at the 2-meter level. Several sites include instruments to record hourly-averaged precipitation, global solar radiation and total ultraviolet radiation. The standard deviation of the wind direction is also computed at the NCORE site (South DeKalb). Other surface meteorological measurements were made across the state in 2013 and are also shown in Table 17.5.

PARAMETER	COMPANY	INSTRUMENT	MODEL	LOCATION																LEGEND	
				1C	1E	1G	1H	1I	1K	1U	2B	2D	2E	2F	2K	2N	2U	3D	4K	1C	Augusta
WSP/WDR	R.M. Young	Ultrasonic Anemometer	81000	X	X	X		X	X		X	X		X	X			X	X	1E	Brunswick
	R.M. Young	Ultrasonic Anemometer	85000				X						X			X	X			1G	Col Cr Lab
	R.M. Young	Wind Monitor A.Q.	05305VM							X										1H	Confed Ave
ATP10/ELEV	R.M. Young	Ultrasonic Anemometer	81000	X	X	X		X	X		X	X			X				X	1I	Conyers
ATP2/RH	R.M. Young	TEMP/RH Probe	41375VC	X		X				X		X				X	X			1K	Dawsonville
	R.M. Young	TEMP/RH SENSOR, DEG C	41382VC					X			X									1U	S DeKalb
BP	R.M. Young	Barometric Pressure Sensor	61201	X				X				X								2B	Sav Pres
	R.M. Young	Barometric Pressure Sensor	61302V			X				X	X									2D	Yorkville
PRECIP	Novalynx	Tipping Bucket Rain Gauge	260-2501	X		X		X		X		X								2E	Macon SE
S/R	Eppley Lab	Standard Precision Pyronometer	SPP					X				X								2F	Douglasville
TUVR	Eppley Lab	Total Ultraviolet Radiometer	TUVR					X				X								2K	Newnan
Data Logger	ESC	Data System Controller	8832	X	X		X	X	X	X	X	X	X	X	X	X	X		X	2N	Fort Mt
	ESC	Data System Controller	8816			X														2U	Evans
Towers	Aluma Tower Inc.	Crank-Up Tower	T-135	X	X	X	X	X		X	X	X	X	X	X			X	X	3D	NR-GAT
	Aluma Tower Inc.	Fold-Over Tower	FOT-10						X							X	X			4K	Sav L&A

Table 17.5: Meteorological Parameters at Each Monitoring Site

17.3 Ozone and $PM_{2.5}$ Forecasting and Data Analysis

Each day, a team of meteorologists from Georgia Department of Natural Resources, Environmental Protection Division (EPD) and Georgia Tech scientists meet at 1:30 EST to issue an air quality forecast for the Atlanta, Macon, and Columbus metropolitan areas. The Augusta metropolitan area is forecast by a group of scientists in South Carolina. The forecasts are determined based upon several meteorological factors, such as the synoptic regime, surface and upper air meteorology, satellite imagery, as well as the ambient concentration of pollutant. Multiple 2D and 3D forecasting models generated by Georgia Tech are utilized in addition to National Weather Service (NWS) synoptic forecasting models. These synoptic models consist of the North American Model (NAM), the Global Forecasting System (GFS), the European, and the Canadian models to name a few.

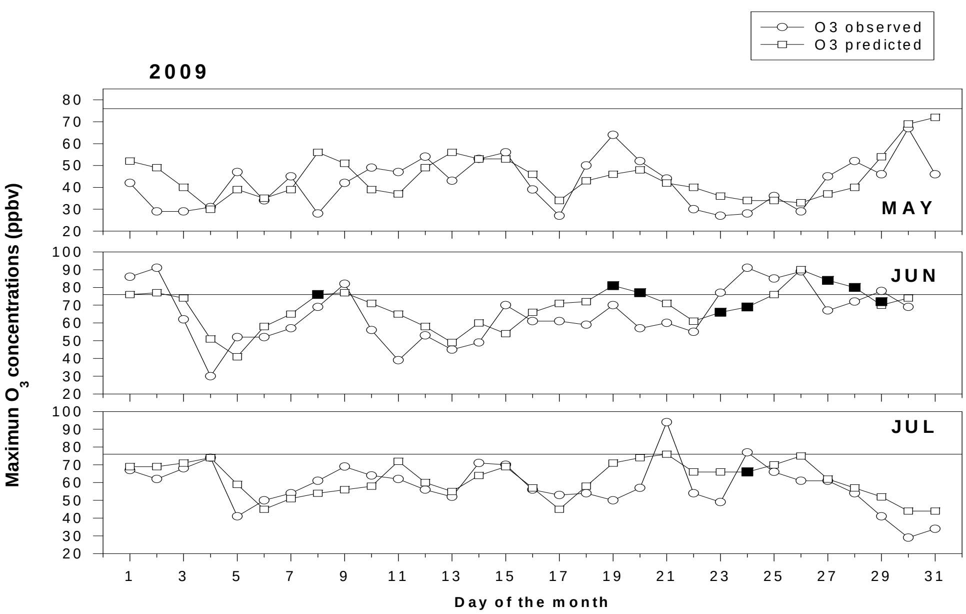
The air quality forecast is then relayed to the Clean Air Campaign and EPA, which disseminate the forecast to important national outlets, such as National Weather Service, USA Today, and The Weather Channel.

17.3.1 Ozone and $PM_{2.5}$ Data Analysis, 2009 through 2013

17.3.1.1 2009

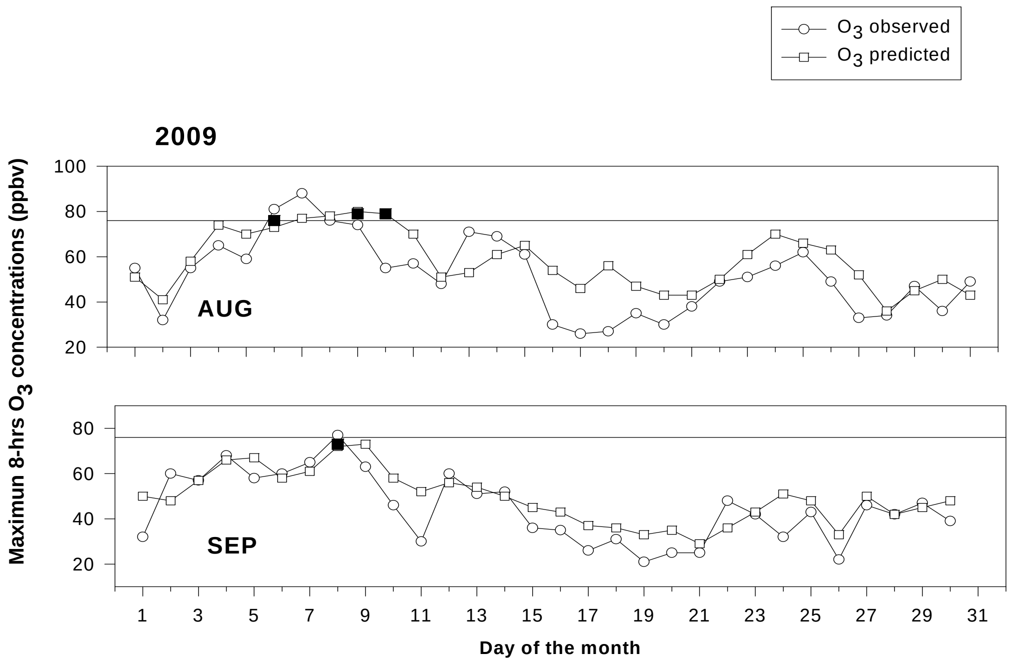
Metropolitan Atlanta had 14 ozone violations during ozone season (May through September) in 2009, while Macon had 2 ozone violations, and Augusta did not exceed the ozone standard at all. This was considered to be a below average ozone season for Metro Atlanta. Monthly time series plots of ozone predictions and observations for Metro Atlanta during the 2009 ozone season are shown in Figures 17.16 and 17.17. The dark squares shown in the figure indicate days where an ozone violation occurred, but was not forecasted, or did not occur and was forecasted. Overall forecasting performance for the team for the 2009 ozone season was 91.5% on an event to a non-event basis (binary error) and 73.9% on an AQI basis (color category). Most violations (8 out of the 14) occurred during June, with the highest concentration days occurring during a heat wave in late June. During this period, the Eastern-central part of the United States was dominated by high pressure, which provided a stable air mass with clear skies and low moisture, leading to the breakout of ozone violations. As shown in the figure, there were no major ozone episodes during May, August, or September for Metropolitan Atlanta. This could partly be attributed to the fact that return flow from the Gulf of Mexico allowed for moist, unstable conditions for much of the summer season. The synoptic regime for summer 2009 was somewhat abnormal. The Atlantic basin had only 11 named tropical systems, so tropical activity influencing the SE U.S. was not a major factor in keeping ozone levels from being elevated for extended periods. Parts of Metropolitan Atlanta did experience major flash flooding during the month of September, as reflected in the figure by the extended period of low ozone during the middle of the month, due to training of convective cells and high Gulf moisture fetch across the area.

Overall performance for $PM_{2.5}$ forecasting in 2009 for Metro Atlanta was 79.2% on an AQI basis. A total of four $PM_{2.5}$ violations were observed in Metropolitan Atlanta in 2009. Athens recorded one $PM_{2.5}$ violation, Macon had two violations, north Georgia mountains had one violation, while south central Georgia had five $PM_{2.5}$ violations in 2009. Monthly time series plots of $PM_{2.5}$ predictions and observations for Metropolitan Atlanta during 2009 (24-hour averages) are shown below in Figures 17.18 through 17.21. Some seasonal variability in $PM_{2.5}$ does exist, as shown in the figure; however, June, July and September show periods of elevated $PM_{2.5}$, relative to other seasons. This enhancement can most likely be attributed to limited early morning mixing depth, and to the moist and unstable conditions (along with isolated convection) in the tropical air mass residing over the southeast. The elevated readings shown in the winter month of February can partly be attributed to local and regional fire activity.



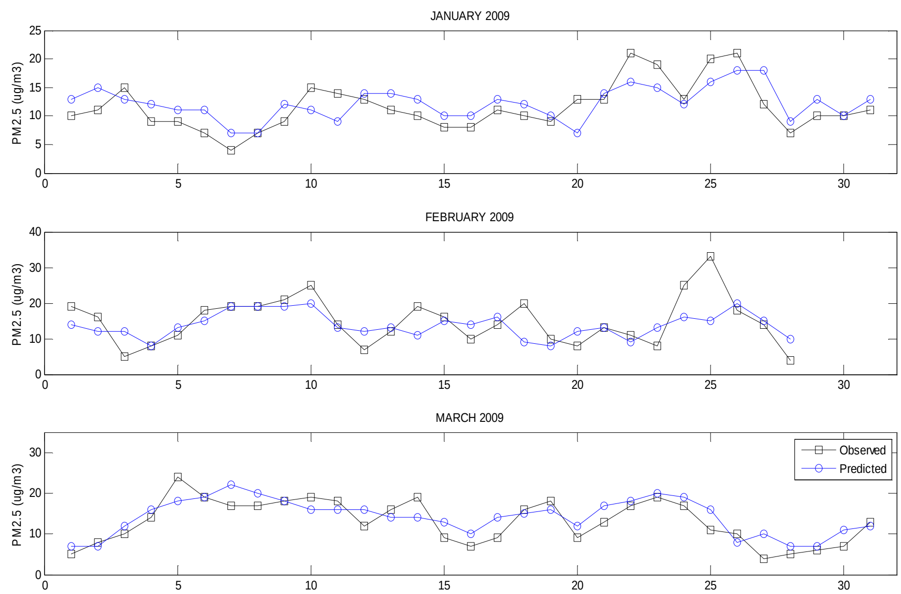
(Data compiled by Dr. Carlos Cardelino of Georgia Tech)

Figure 17.16: Monthly Time Series of Ozone Predictions and Observations for Metro Atlanta During 2009 Ozone Season (May-July)



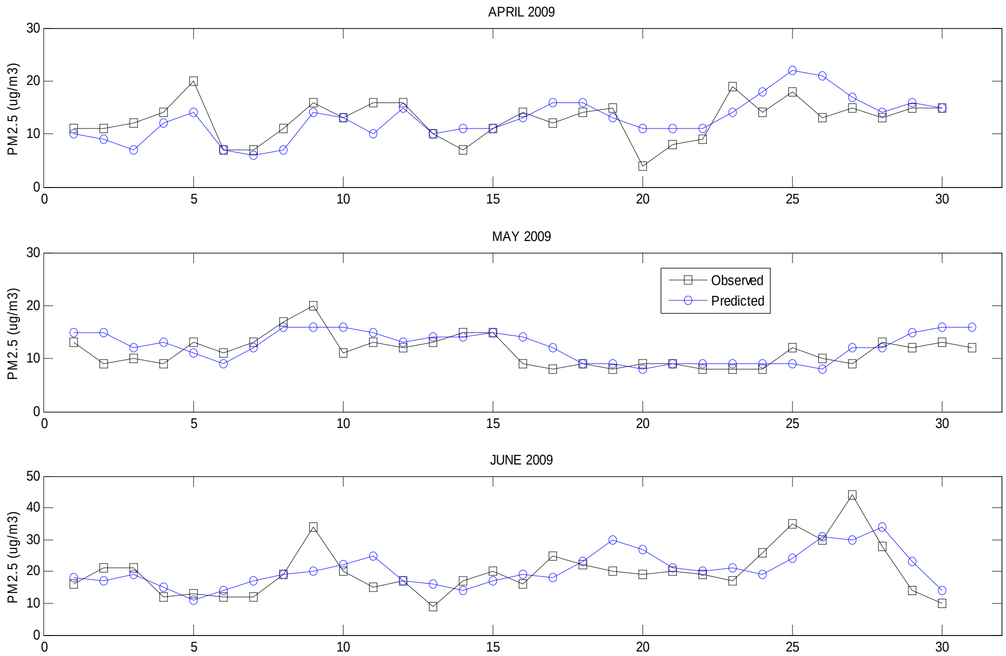
(Data compiled by Dr. Carlos Cardelino of Georgia Tech)

Figure 17.17: Monthly Time Series of Ozone Predictions and Observations for Metro Atlanta During 2009 Ozone Season (August-September)



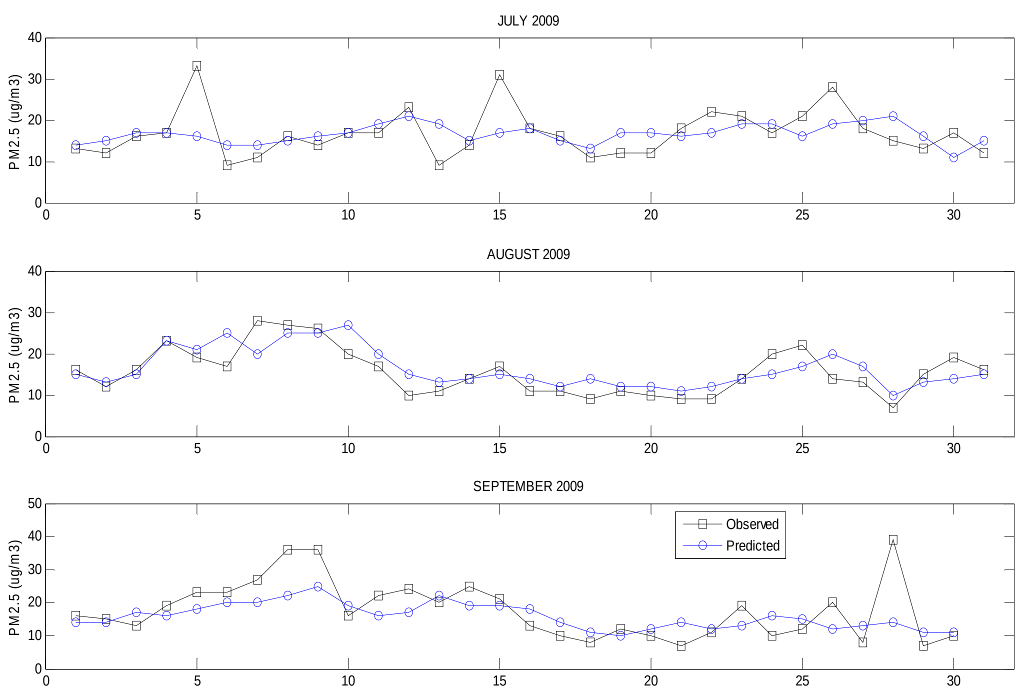
(Data compiled by Dr. Carlos Cardelino of Georgia Tech)

Figure 17.18: Monthly Times Series Plots of $PM_{2.5}$ Predictions and Observations for Metro Atlanta During 2009 (January-March)



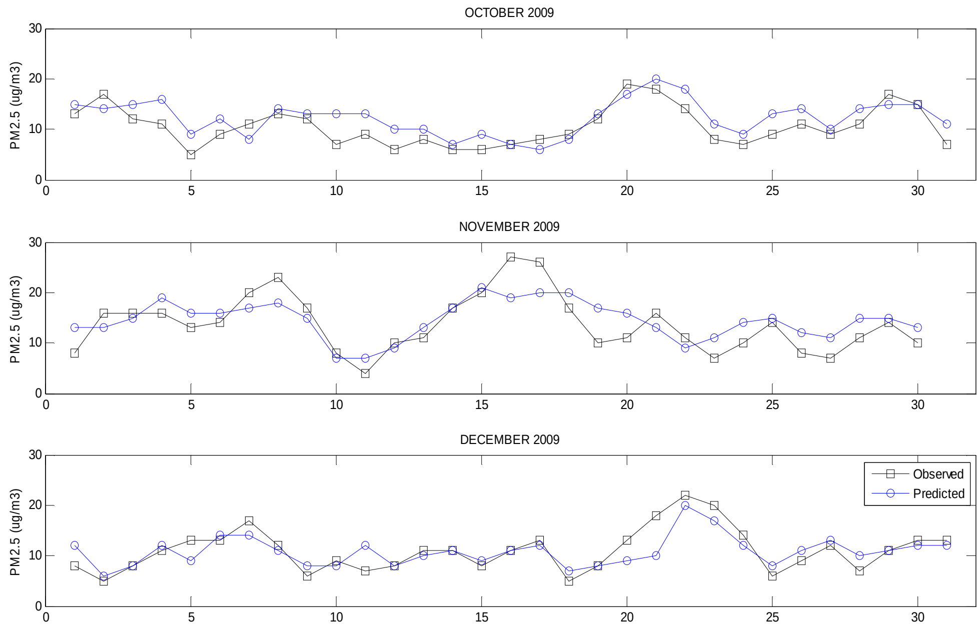
(Data compiled by Dr. Carlos Cardelino of Georgia Tech)

Figure 17.19: Monthly Times Series Plots of $PM_{2.5}$ Predictions and Observations for Metro Atlanta During 2009 (April-June)



(Data compiled by Dr. Carlos Cardelino of Georgia Tech)

Figure 17.20: Monthly Times Series Plots of $PM_{2.5}$ Predictions and Observations for Metro Atlanta During 2009 (July-September)



(Data compiled by Dr. Carlos Cardelino of Georgia Tech)

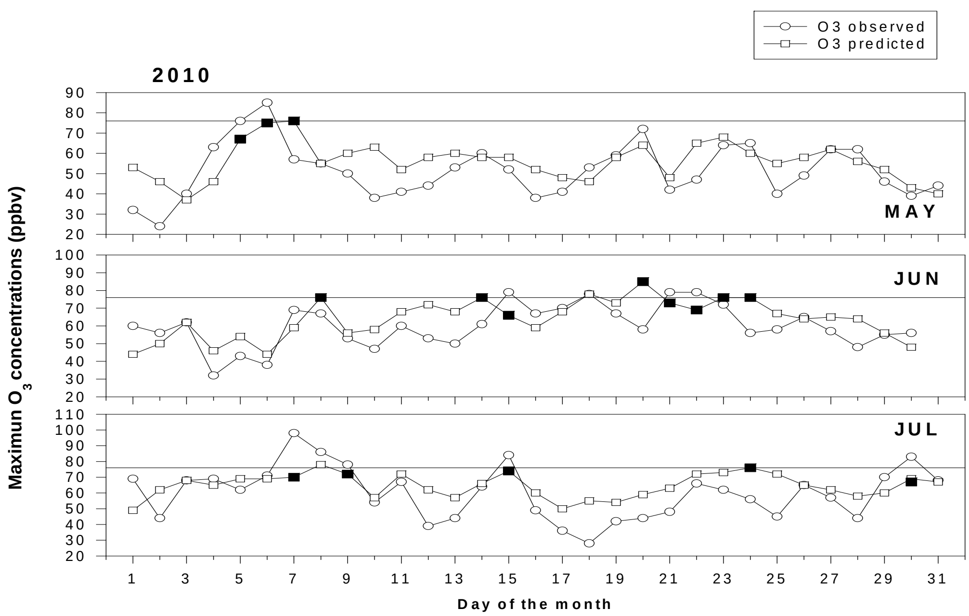
Figure 17.21: Monthly Times Series Plots of $PM_{2.5}$ Predictions and Observations for Metro Atlanta During 2009 (October-December)

17.3.1.2 2010

Metropolitan Atlanta had 24 ozone violations during ozone season (May through September) in 2010, while Macon and Augusta each had 2 ozone violations. This was considered to be a fairly typical ozone season for Metro Atlanta, with the 2009 season having only 14 ozone violations. Monthly time series plots of ozone predictions and observations for Metro Atlanta during the 2010 ozone season are shown in Figures 17.22 and 17.23. The dark squares shown in the figure indicate days where an ozone violation occurred, but was not forecasted, or did not occur and was forecasted. Overall forecasting performance for the team for the 2010 ozone season was 80% on an event to a non-event basis (binary error) and 61% on an AQI basis (color category), out of 153 days. Most violations (13 out of the 24) occurred during the summer months (June, July, and August) with the highest concentration day (98 parts per billion by volume, or ppbv) occurring on July 7th, which brought Metro Atlanta into Code Red. During this period, the Eastern-central part of the United States was dominated by a strong upper level high pressure ridge, along with a strong mid-Atlantic subtropical ridge near the surface. This synoptic regime provided strong subsidence across the Southeast United States. This highly stable air mass provided clear skies and low moisture, which led to the enhanced ozone concentration observed on July 7th. As shown in the figure, there were no major ozone episodes during May, August, or September for Metro Atlanta. Interestingly, there were 9 ozone violations during the month of September, which was a fairly abnormally high number of violations for the end of smog season. The Atlantic basin had 19 named tropical systems, however, only one (Tropical Storm Bonnie) made U.S. landfall during the month of July. Therefore, tropical activity influencing the Southeast U.S. was not a major factor in keeping ozone levels from being elevated for extended periods. During the month of September there was the presence of the lee trough extending down the spine of the Southern Appalachians, which could have played a role in the abnormal number of days with elevated ozone levels, as well as the persistence of the Atlantic (Bermuda) subtropical ridge positioned over the Southeast U.S.

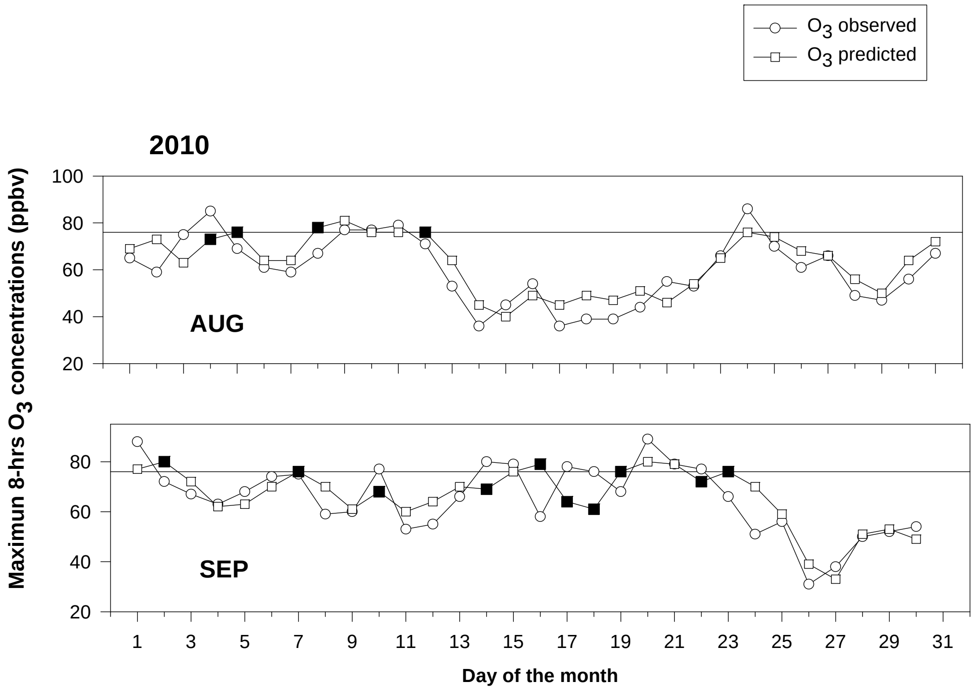
Overall performance for $PM_{2.5}$ forecasting in 2010 for Metro Atlanta was 78.9% on an AQI basis. There were no $PM_{2.5}$ violations observed in Metro Atlanta in 2010, however, Augusta and Macon each recorded one violation, the North Georgia mountains had three violations, while Savannah had two $PM_{2.5}$ violations in 2010. Monthly time series plots of $PM_{2.5}$ predictions and observations for Metropolitan Atlanta during 2010 (24-hour averages) are shown below in Figures 17.24 through 17.27. Some seasonal variability in $PM_{2.5}$ does exist, as shown in the figure; however, December and January show periods of elevated $PM_{2.5}$, relative to other seasons. This enhancement can partly be attributed to local and regional fire activity.

Two interesting exceptional events were observed during the months of April and November. On April 1st and 2nd a possible Saharan Dust transport event occurred over North Georgia. Further meteorological and trajectory analysis showed there could have been a possible contribution from regional fire activity to the west and southwest of North Georgia. This portion of the smoke plume could have gotten wrapped up in westerly flow around a high pressure ridge across the Southeast. The second major exceptional event was observed on November 12th through November 15th across South Georgia. This enhancement of particle pollution was attributed to the Arabia Fire activity in Clinch County in South Georgia.



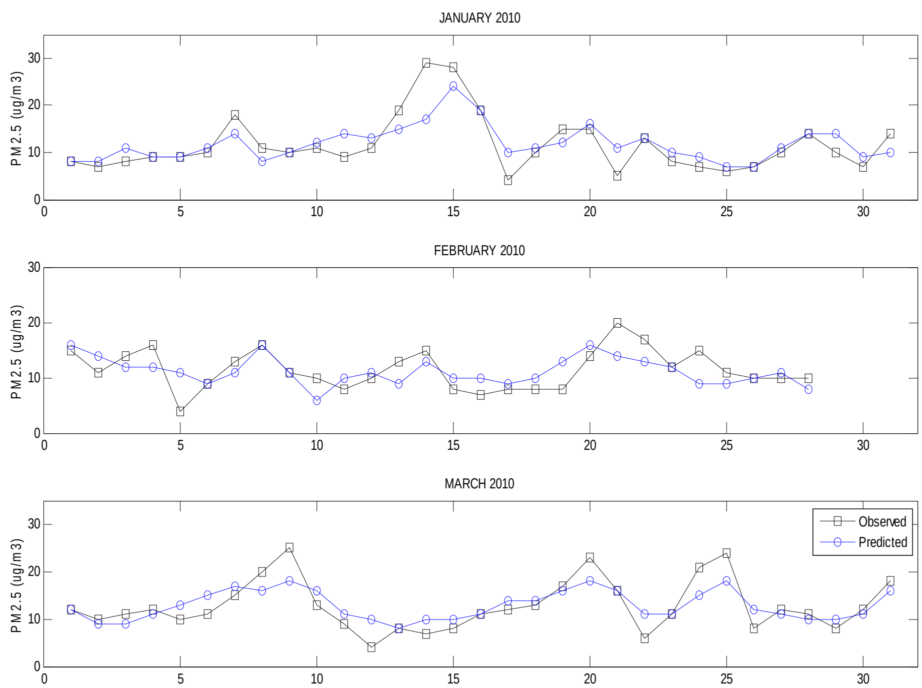
(Data compiled by Dr. Carlos Cardelino of Georgia Tech)

Figure 17.22: Monthly Time Series of Ozone Predictions and Observations for Metro Atlanta During 2010 Ozone Season (May-July)



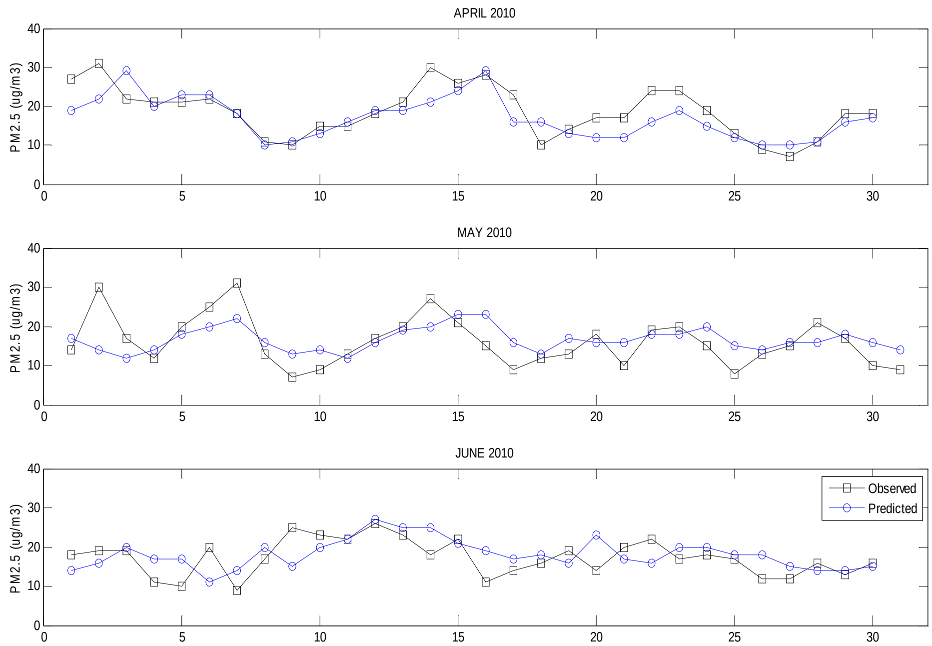
(Data compiled by Dr. Carlos Cardelino of Georgia Tech)

Figure 17.23: Monthly Time Series of Ozone Predictions and Observations for Metro Atlanta During 2010 Ozone Season (August-September)



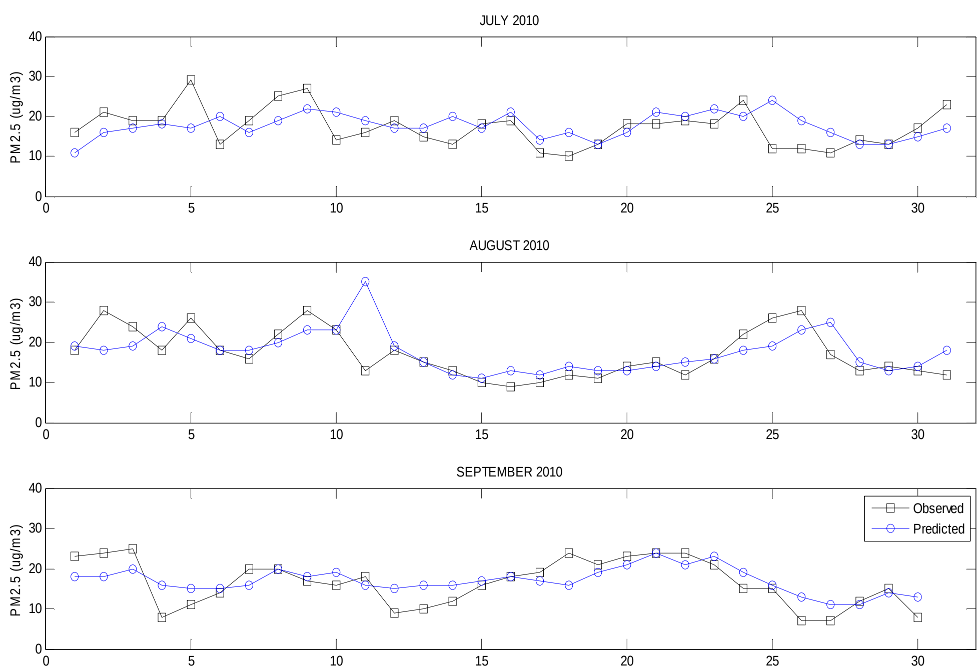
(Data compiled by Dr. Carlos Cardelino of Georgia Tech)

Figure 17.24: Monthly Times Series Plots of $PM_{2.5}$ Predictions and Observations for Metro Atlanta During 2010 (January-March)



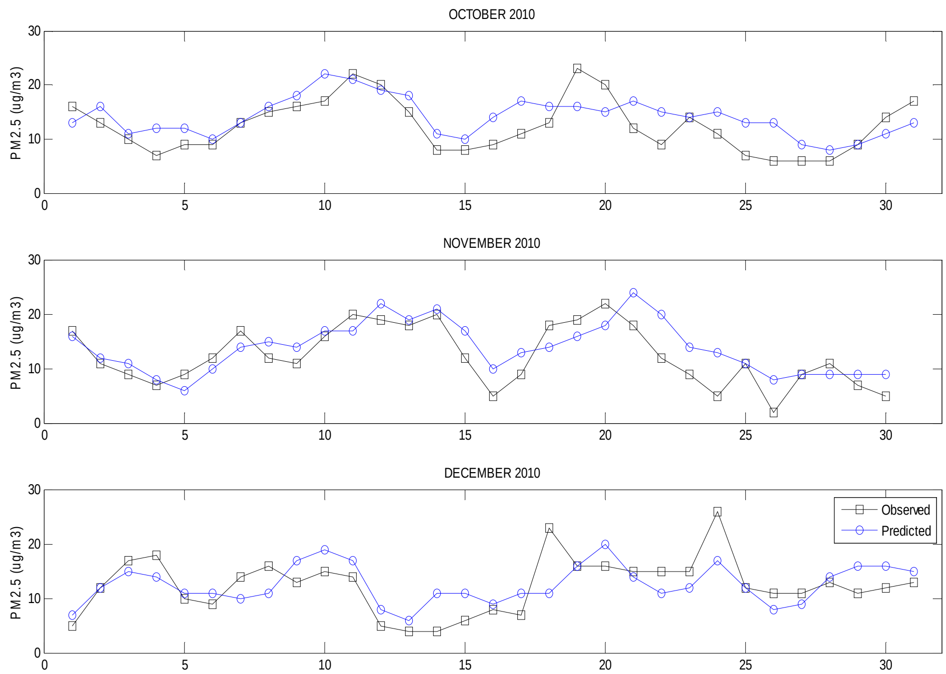
(Data compiled by Dr. Carlos Cardelino of Georgia Tech)

Figure 17.25: Monthly Times Series Plots of $PM_{2.5}$ Predictions and Observations for Metro Atlanta During 2010 (April-June)



(Data compiled by Dr. Carlos Cardelino of Georgia Tech)

Figure 17.26: Monthly Times Series Plots of $PM_{2.5}$ Predictions and Observations for Metro Atlanta During 2010 (July-September)



(Data compiled by Dr. Carlos Cardelino of Georgia Tech)

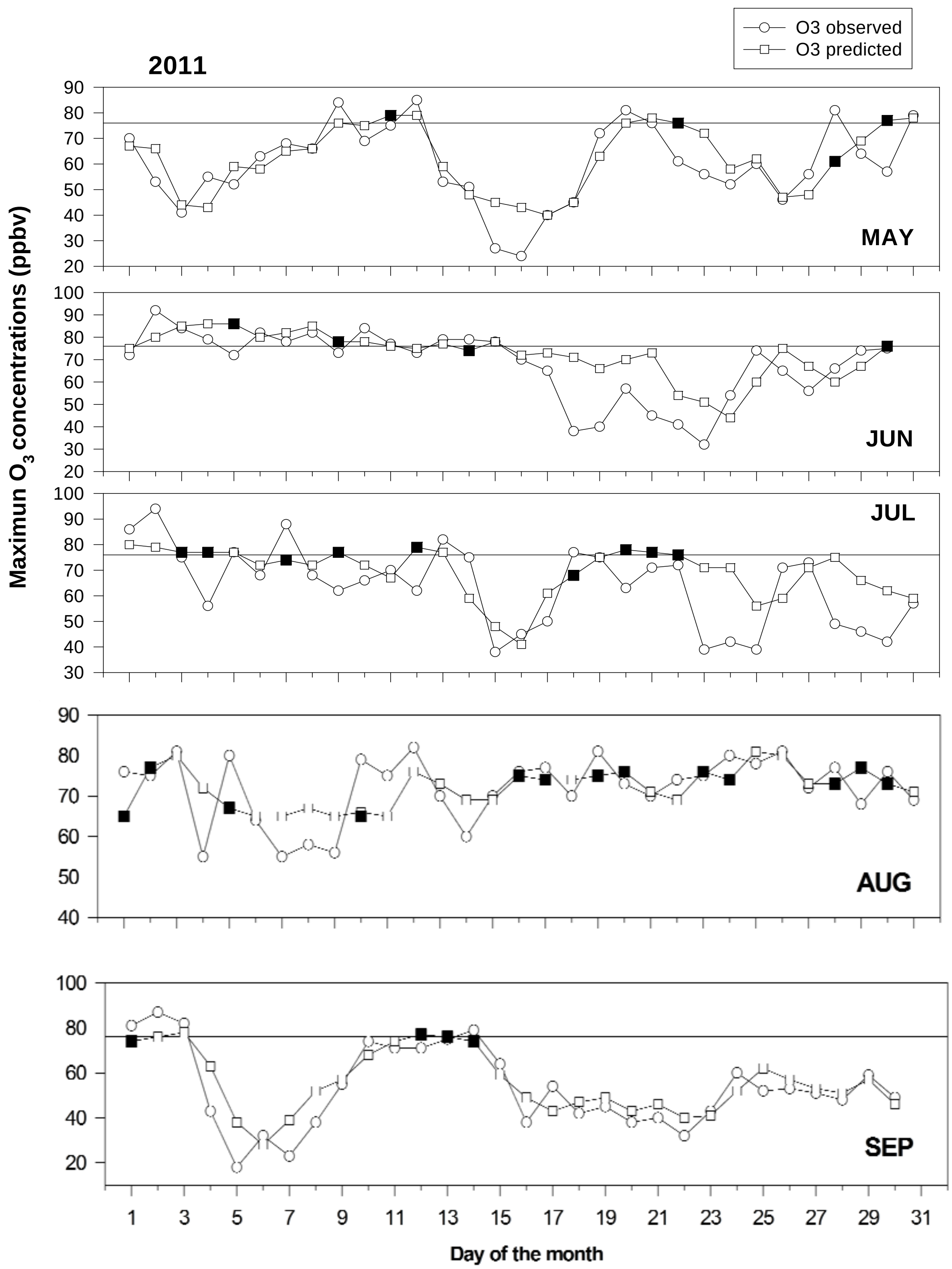
Figure 17.27: Monthly Times Series Plots of $PM_{2.5}$ Predictions and Observations for Metro Atlanta During 2010 (October-December)

17.3.1.3 2011

Metropolitan Atlanta had forty ozone violations during ozone season in 2011, while Macon had six ozone violations and Augusta had three. Athens experienced two ozone violations, while the north Georgia Mountains had two. This was considered to be a typical to slightly above average ozone season for Metro Atlanta. Monthly time series plots of ozone predictions and observations for Metro Atlanta during the 2011 ozone season are shown in Figure 17.28, below.

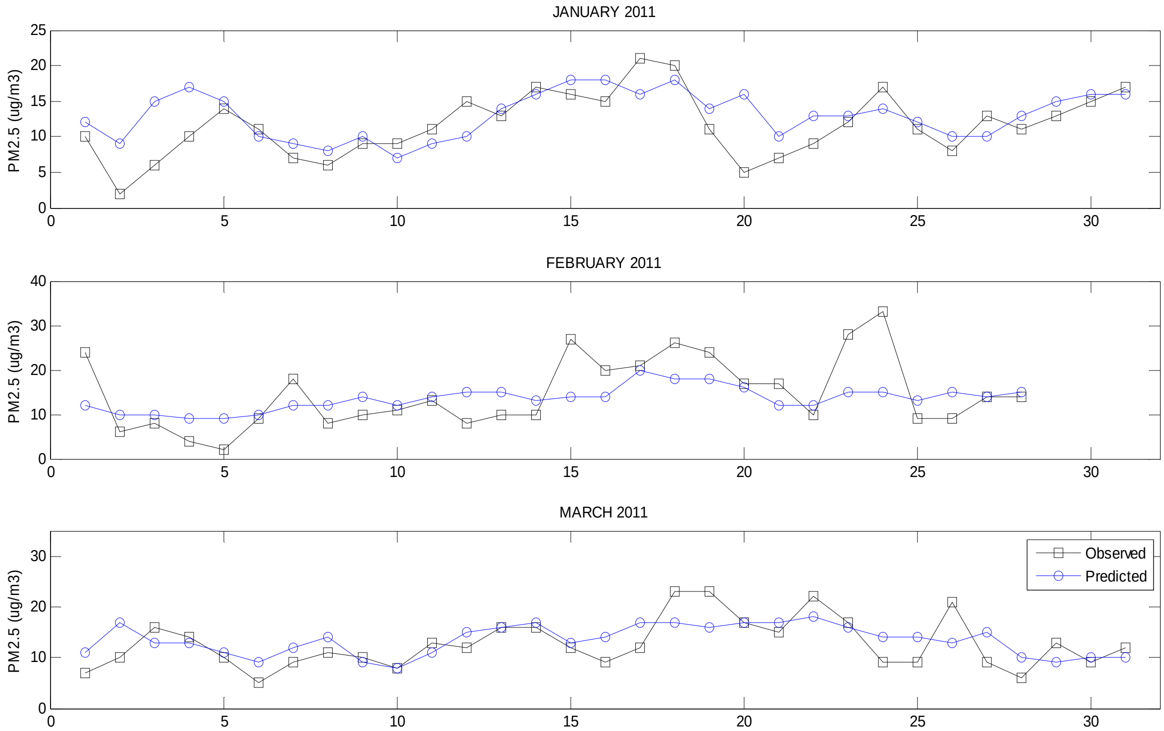
The dark squares shown in the figure indicate days where an ozone violation occurred, but was not forecasted, or did not occur and was forecasted. Most violations occurred during the months of June and August, with the highest concentration day occurring on July 2nd (94 parts per billion by volume, ppbv). Interestingly, there were no code red (unhealthy) days detected during 2011, with August having the most number of code orange days. During a violation on July 2nd, the eastern-central part of the United States was dominated by a strong high-pressure system that put north Georgia on the eastern flank of the ridge with light downslope flow conditions. This provided a stable air mass with clear skies and low moisture, leading to the breakout of ozone violations. As shown in Figure 17.28, there were six ozone violations in May, eleven in June, six in July, thirteen in August, and four in September. On a day-of-the-week basis, the greatest number of violations occurred from the middle to the end of the week. The most number of violations (nine) occurred on Friday. Some of this could possibly be attributed to the buildup of traffic around the Metro area as the weekend approaches. Overall forecasting performance for the team for the 2011 ozone season was 77.8% on an event to a non-event basis (binary error) and 62.1% on an AQI basis (color category).

There were three particle pollution ($PM_{2.5}$) violations in Metro Atlanta in 2011, whereas South Georgia had twelve violations and Savannah had five. Monthly time series plots of aerosol predictions and observations for Metro Atlanta during 2011 are shown in Figures 17.28 through 17.32. Many of these violations could be attributed to wildfire activity across South Georgia. For example, aerosol optical depth imagery from GOES East Aerosol Smoke Product (GASP) indicated elevated $PM_{2.5}$ levels in Savannah associated with two smoke episodes from wildfire activity in South Georgia on June 17th and July 5th-7th. The Honey Prairie wildfire in the Okefenokee Swamp in southeast Georgia and several other fires in Florida and Georgia were ongoing during both of these particle pollution episodes in June and July.



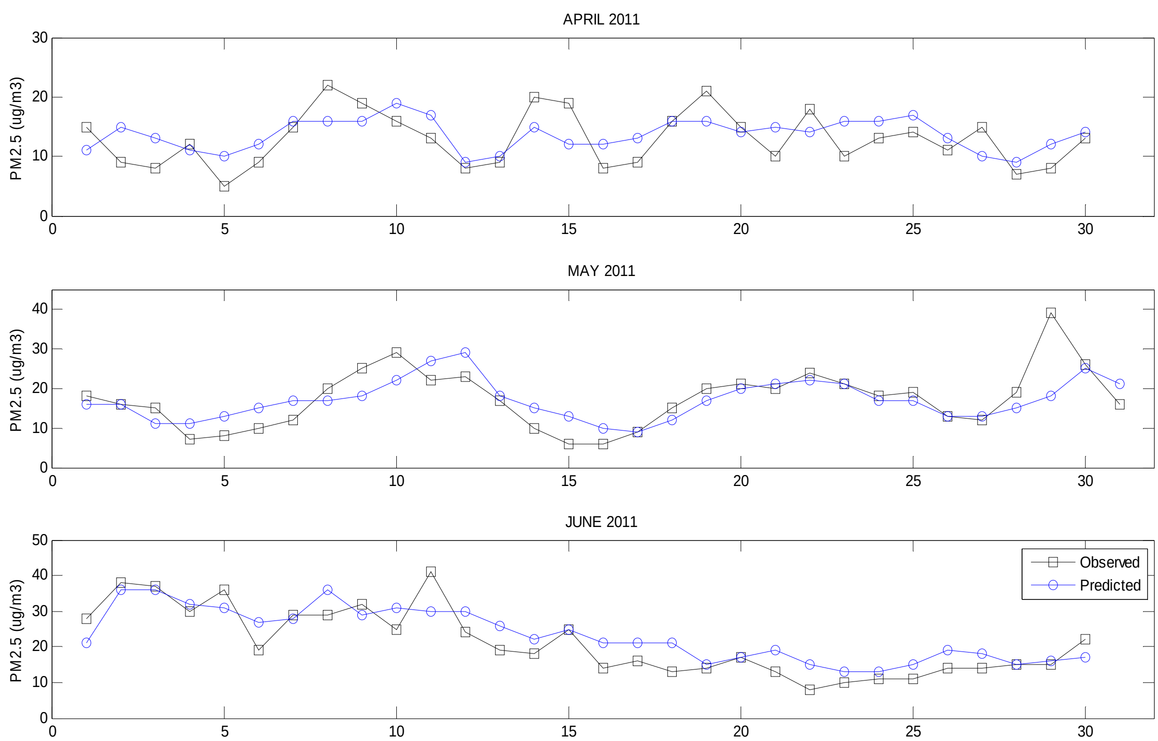
(Data compiled by Dr. Carlos Cardelino of Georgia Tech)

Figure 17.28: Monthly Time Series of Ozone Predictions and Observations for Metro Atlanta During 2011 Ozone Season (May-September)



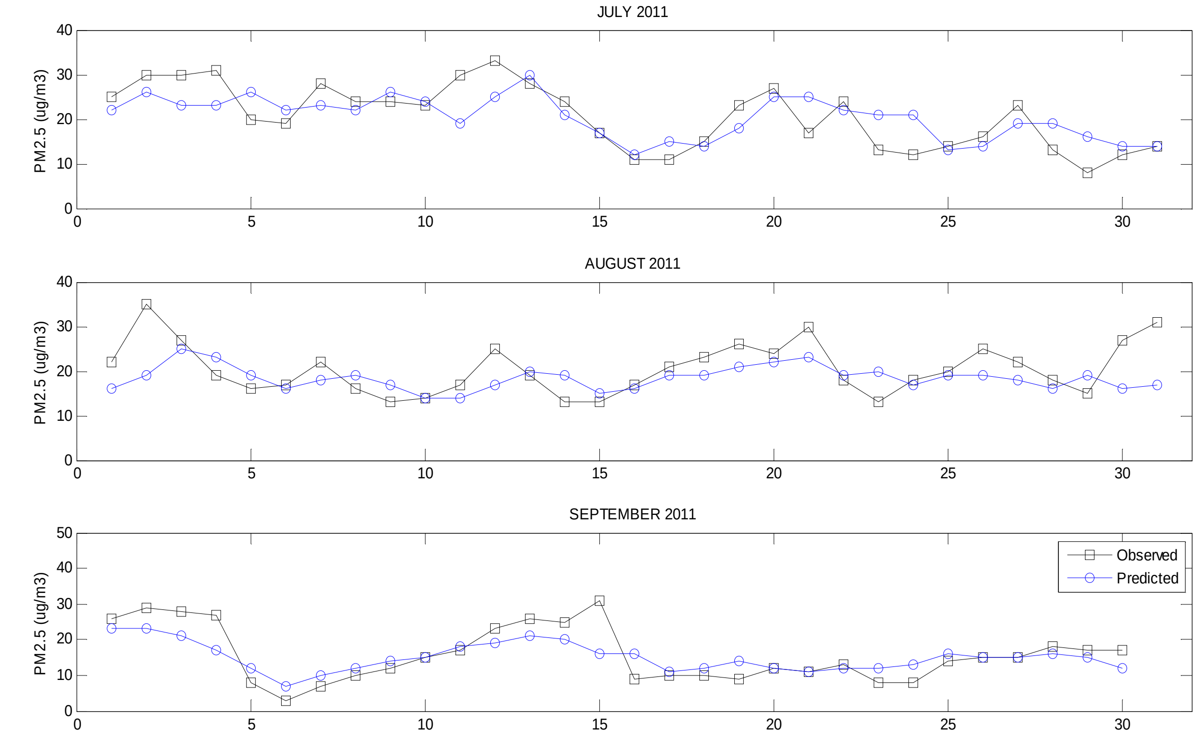
(Data compiled by Dr. Carlos Cardelino of Georgia Tech)

Figure 17.29: Monthly Time Series of $PM_{2.5}$ Predictions and Observations for Metro Atlanta During 2011 (January-March)



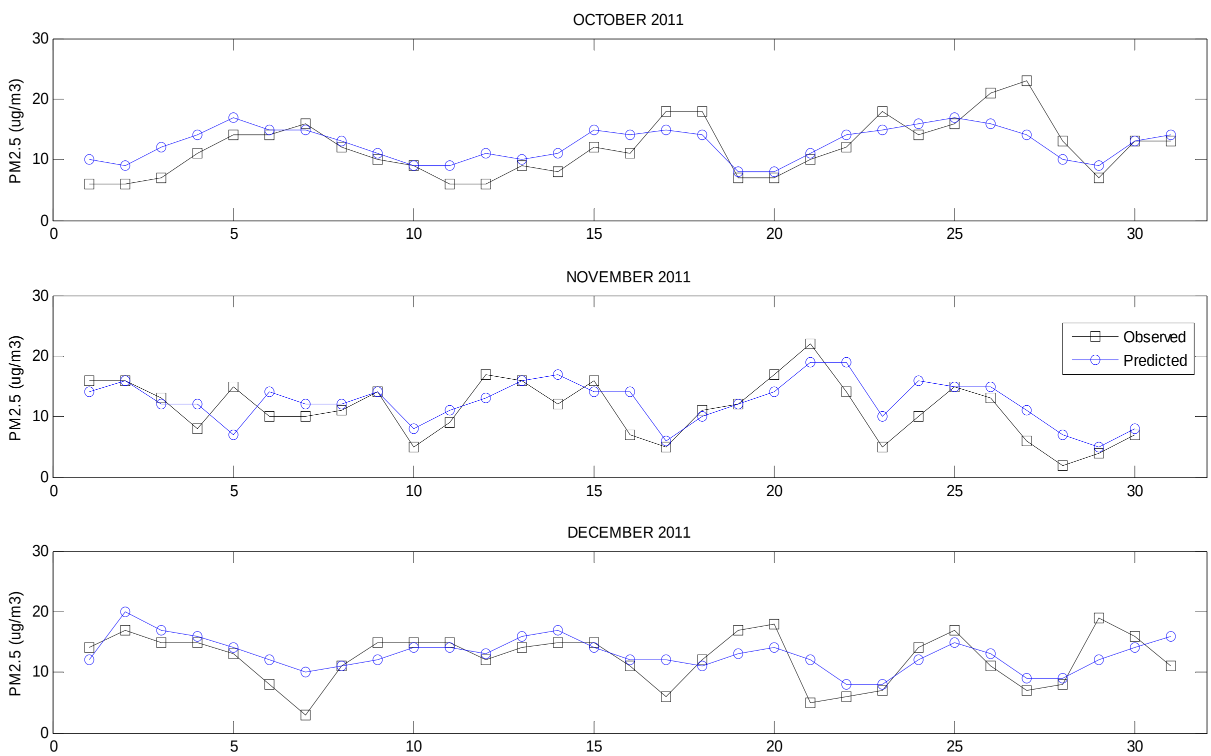
(Data compiled by Dr. Carlos Cardelino of Georgia Tech)

Figure 17.30: Monthly Time Series of $PM_{2.5}$ Predictions and Observations for Metro Atlanta During 2011 (April-June)



(Data compiled by Dr. Carlos Cardelino of Georgia Tech)

Figure 17.31: Monthly Time Series of $PM_{2.5}$ Predictions and Observations for Metro Atlanta During 2011 (July-September)



(Data compiled by Dr. Carlos Cardelino of Georgia Tech)

Figure 17.32: Monthly Time Series of $PM_{2.5}$ Predictions and Observations for Metro Atlanta During 2011 (October-December)

17.3.1.4 2012

During the 2012 ozone season (March through October), Metropolitan Atlanta had 17 ozone violations. Augusta and Athens each experienced 3 ozone violations. Macon had 2 ozone violations, while the north Georgia mountains had no violations. This was considered to be a typical to slightly below average ozone season for the Atlanta-Sandy Springs-Roswell MSA. Monthly time series plots of ozone predictions and observations for the Atlanta-Sandy Springs-Roswell MSA during the 2012 ozone season are shown in Figure 17.33.

The dark squares shown in Figure 17.33 indicate days where an ozone violation occurred, but was not forecasted, or did not occur and was forecasted. Most violations occurred during the months of June and July, with the highest concentration day, a rare Code Purple occurring on June 29th (122 parts per billion by volume, ppbv). This violation occurred at EPD's McDonough monitoring site southeast of the city under light northwest flow conditions during a record-setting heat wave event (June 29th through July 1st). During this violation, the eastern two thirds of the continental United States was dominated by a very strong high-pressure system, placing north Georgia on the eastern flank of the ridge with light downsloping flow from the Appalachians. This provided a highly stable air mass with clear skies and stagnant conditions, leading to the Code Purple ozone violation. As shown in Figure 17.33, there were only two ozone violations during August and only one in September for the Atlanta-Sandy Springs-Roswell MSA. There were 2 ozone violations in May, 6 in June, and 6 in July. On a day-of-the-week basis, the greatest number of violations occurred from the middle to the end of the week, with the most number of violations (5) occurring on both Thursday and Friday. Some of this could possibly be attributed to the buildup of traffic around the Atlanta-Sandy Springs-Roswell MSA as the weekend approaches. Overall forecasting performance for the team for the 2012 ozone season was 90.2% on an event to a non-event basis (binary error) and 68% on an AQI basis (color category). The team called 17 events, with 10 hits and 7 misses. Of the 17 ozone events, the team had 8 misses. In terms of AQI color code, there were 76 green days, 59 yellow days, 15 orange days, 1 red day, and 1 purple day.

With the continuous $PM_{2.5}$ samplers used for forecasting, there were eight $PM_{2.5}$ values above the standard in 2012. Three of these higher particle pollution values occurred in the Atlanta-Sandy Springs-Roswell MSA, 2 in the Augusta-Richmond County GA, SC MSA, 2 in south Georgia, and 1 in the Macon MSA. Monthly time series plots of $PM_{2.5}$ predictions and observation for the Atlanta-Sandy Springs-Roswell MSA during 2012 are shown in Figure 17.34.

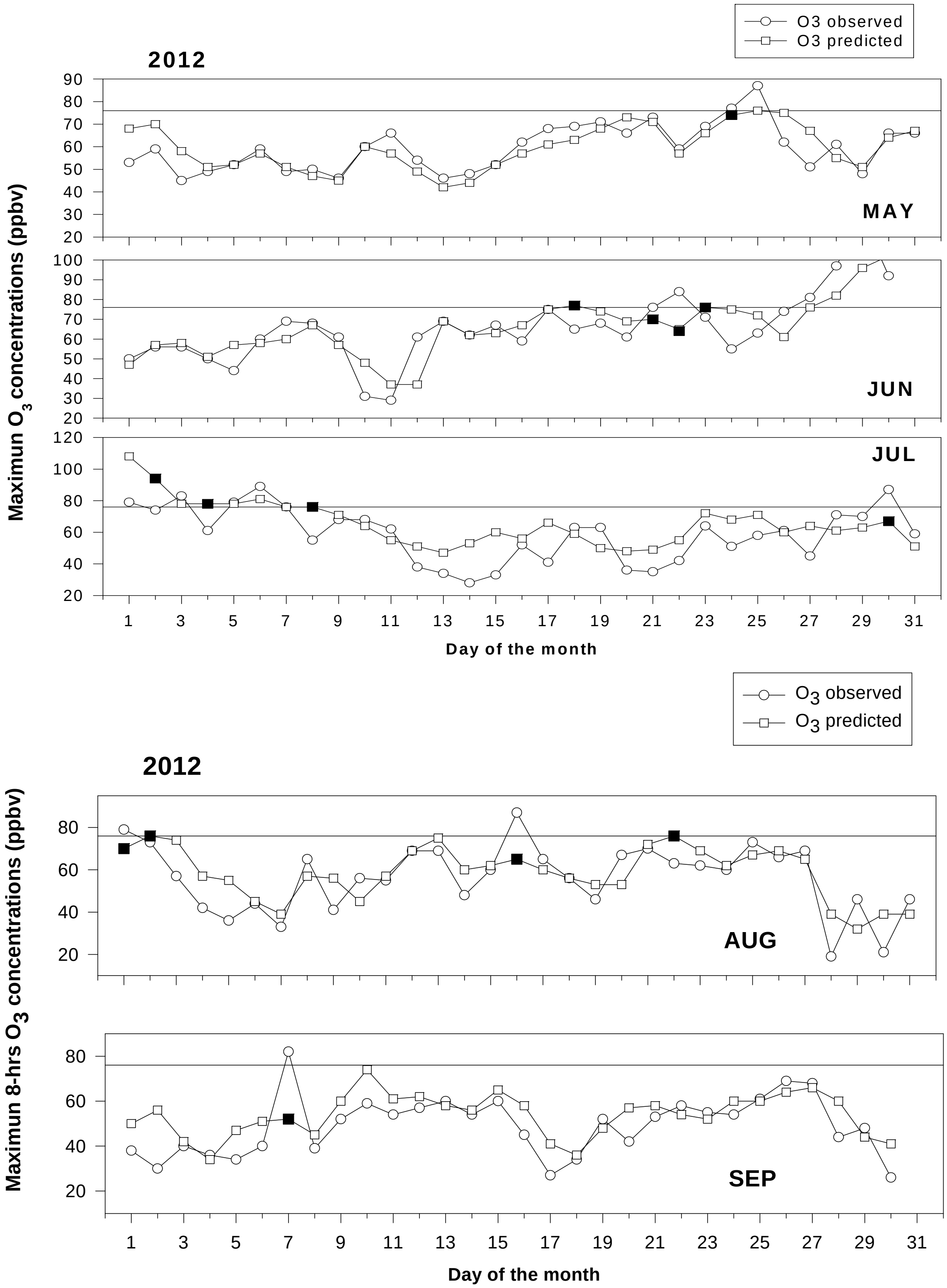


Figure 17.33: Ozone Predictions and Observations for the Atlanta-Sandy Springs-Roswell MSA During the 2012 Ozone Season

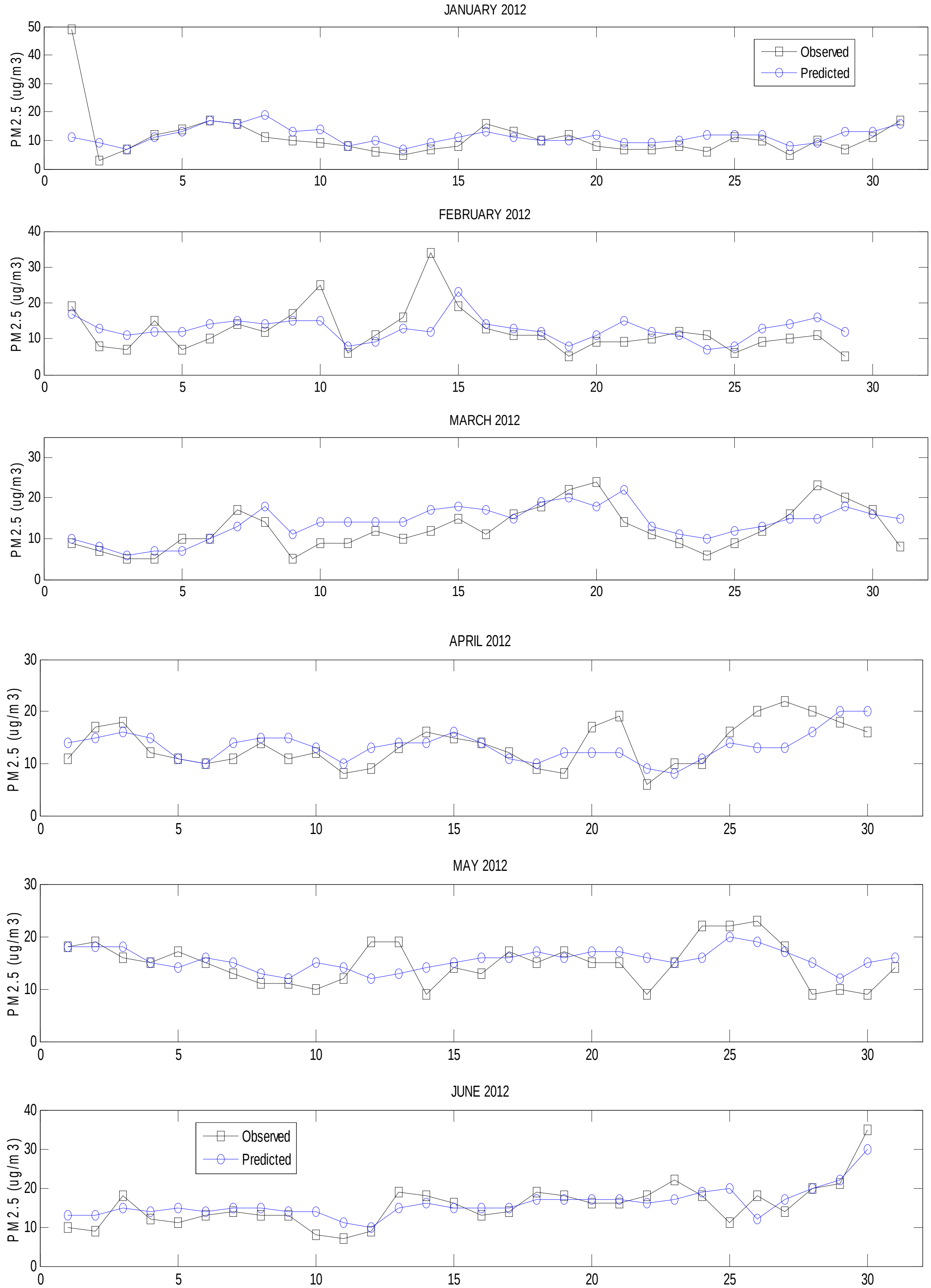
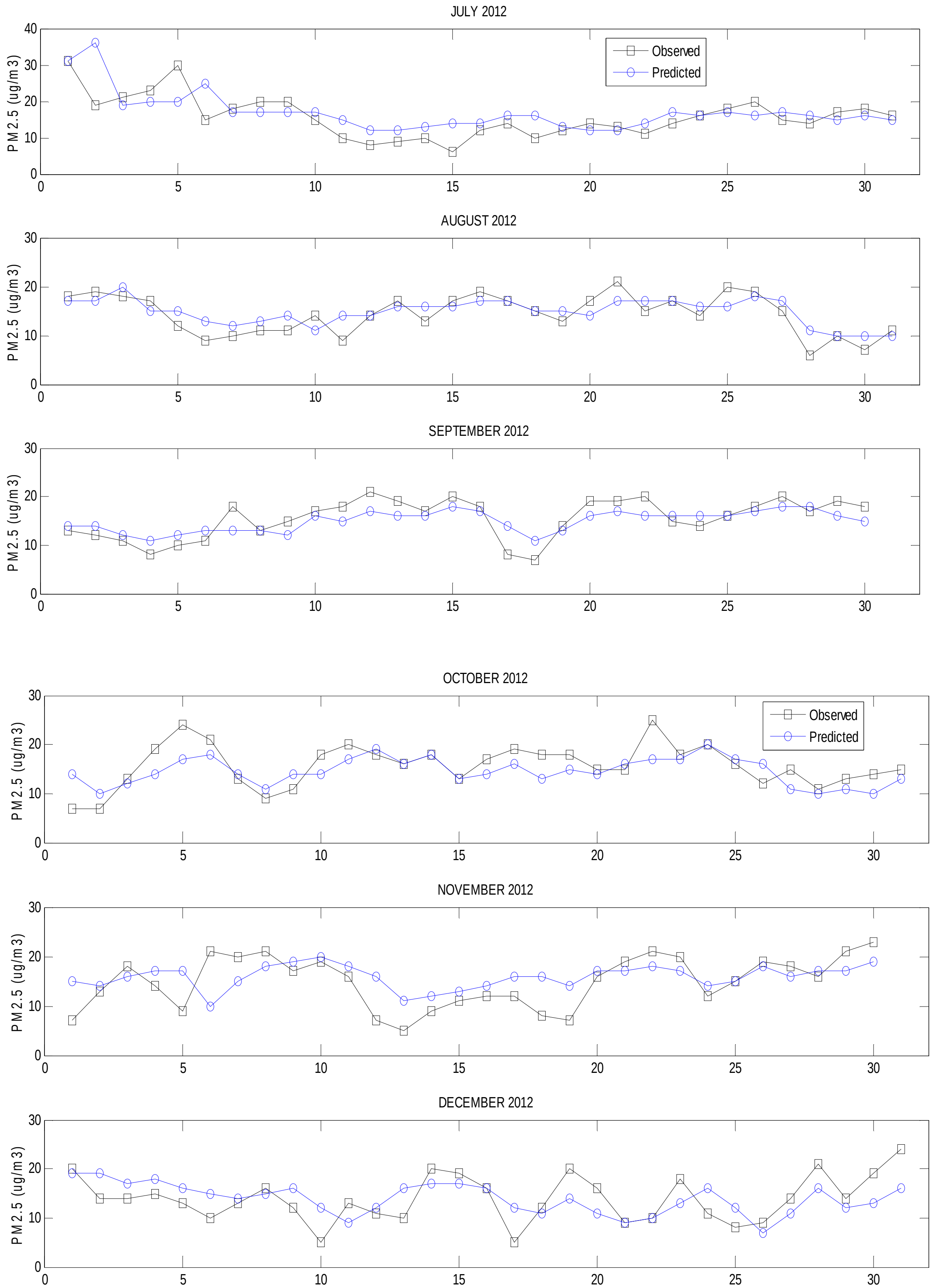


Figure 17.34a: $PM_{2.5}$ Predictions and Observations for the Atlanta-Sandy Springs-Roswell MSA During 2012



(Data compiled by Dr. Carlos Cardelino of Georgia Tech)

Figure 17.34b: $PM_{2.5}$ Predictions and Observations for the Atlanta-Sandy Springs-Roswell MSA During 2012

17.3.1.5 2013

In 2013 there were three ozone violations in the Metropolitan Atlanta area (see Figures 17.35 through 17.37 below). During much of the summer of 2013, Georgia experienced extensive troughness. The Bermuda/Azores High pressure system was positioned over the Atlantic as such that most of the state was positioned on the western flank of the ridge. This kept good return flow from the Gulf of Mexico in place with moist and unstable conditions, typical of El Nino-Southern Oscillation (ENSO) neutral conditions. There were very few days during the summer where the mid-level and surface ridge axes were directly positioned over North GA. Thus, moist and unstable conditions persisted with somewhat elevated dew points from Gulf moisture advection on several days. The first ozone violation occurred on June 14th (78 parts per billion by volume for 8-hour average) at EPA's Pike County site monitor. This violation was primarily due to dry downslope flow from the northwest, following a frontal passage earlier during the day (see Figures 17.38a through 17.40f below). Post-frontal conditions such as these during the summer typically can cause sites south and southeast of Metro Atlanta to have elevated levels of ozone, as long as wind speeds are not too high. The second violation did not occur until much later in the season on July 30th.

The violation that occurred on July 30th was mainly due to a ridge of high pressure that set up across North GA as a weak stationary front gradually stalled across South GA. Surface winds were light and variable with some possible local recirculation around the Metro Atlanta area. There was a small dry stable pocket that developed across North GA around the Metro Atlanta area due to subsidence from the ridge of high pressure. That violation seemed to be a good example of local production because it occurred around the Metro Atlanta area at the Confederate Avenue and South DeKalb sites.

The ozone violation that occurred at Confederate Avenue on September 5th was mainly due to brief ridging and a ridge axis across the area with a weak decaying front positioned just south of Metro Atlanta. The presence of an upper level ridge building to the west, combined with the exit of an upper level east coast trough, helped promote subsidence over the area. This could be verified by Peachtree City rawinsonde data and good dry downslope flow across North Georgia. Also evident from the 12Z September 5th sounding was a strong surface inversion, indicative of limited vertical mixing.

Statistical characteristics of daily team forecasting during the 2013 air quality forecasting season are given below for the cities of Atlanta, Columbus and Macon. The statistics are based on team daily predicted and final daily observed continuous ozone and $PM_{2.5}$ data (daily peak 8-hr average and daily 24-hr average, respectively).

		Observed # of days in AQI category			
Metro Area and Pollutant	**Total # of days in record**	**Good**	**Moderate**	**Unhealthy for Sensitive Groups**	**Unhealthy**
Atlanta Ozone	214	179	32	2	1
Macon Ozone	204	197	7	0	0
Atlanta $PM_{2.5}$	335	174	161	0	0
Columbus $PM_{2.5}$	299	237	62	0	0

Figure 17.35: Observed Air Quality Index for 2013

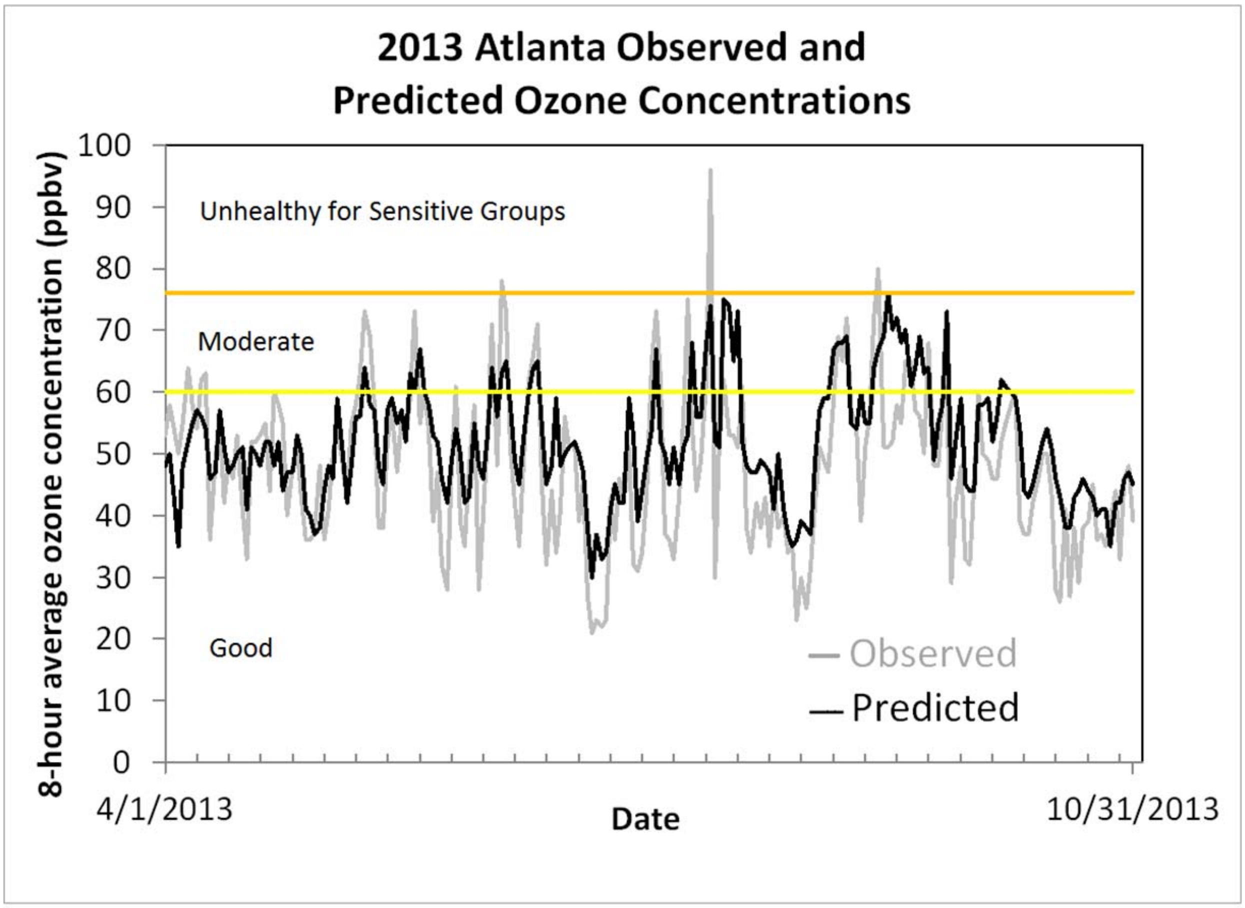


Figure 17.36a: Observed and Predicted Ozone Air Quality for Atlanta

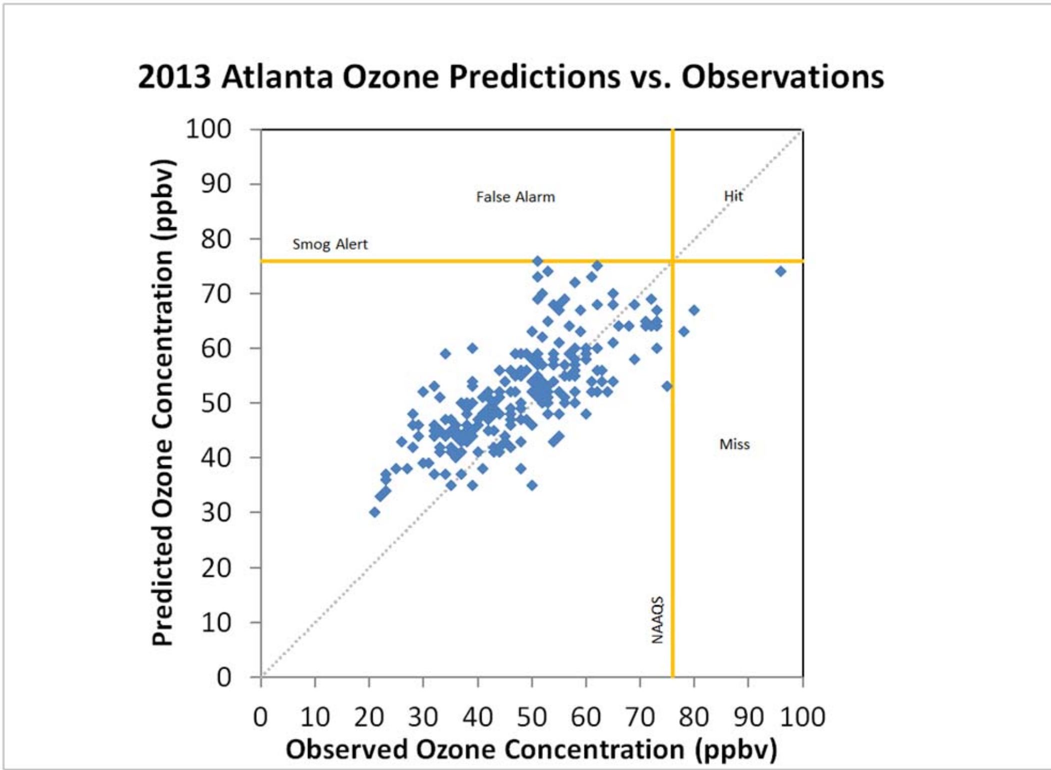


Figure 17.36b: Observed and Predicted Correlation of Ozone Air Quality for Atlanta

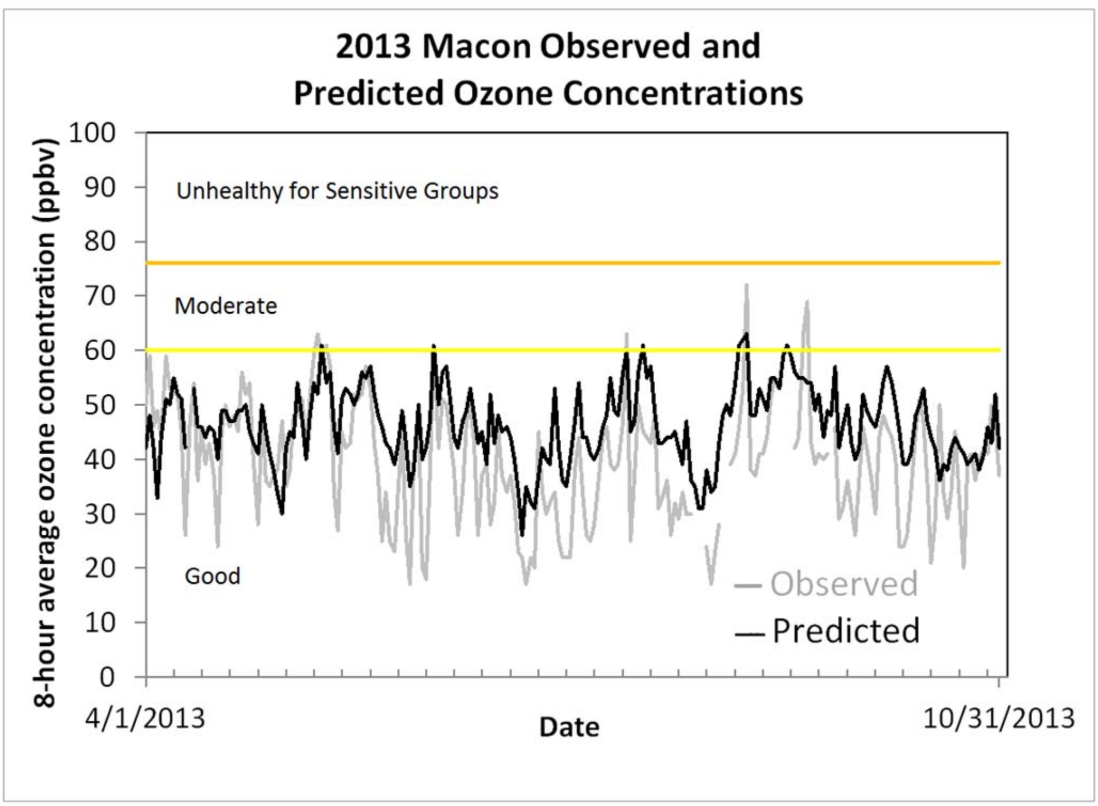


Figure 17.36c: Observed and Predicted Ozone Air Quality for Macon

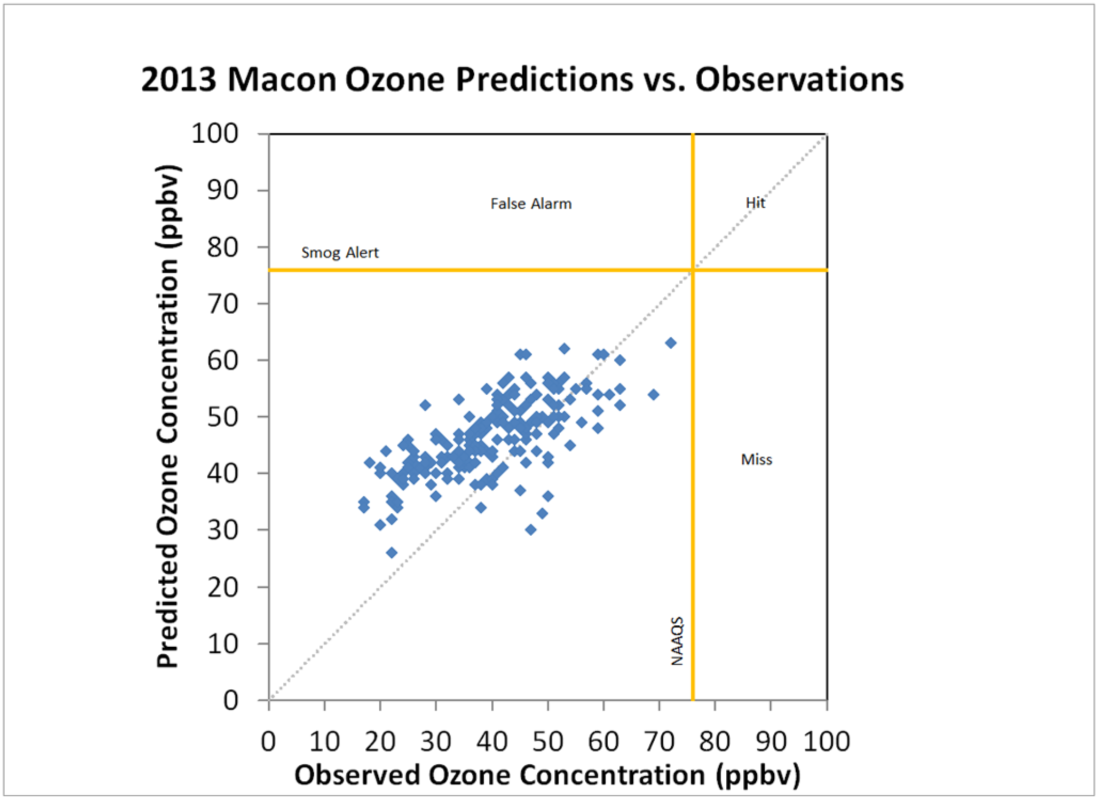


Figure 17.36d: Observed and Predicted Correlation of Ozone Air Quality for Macon

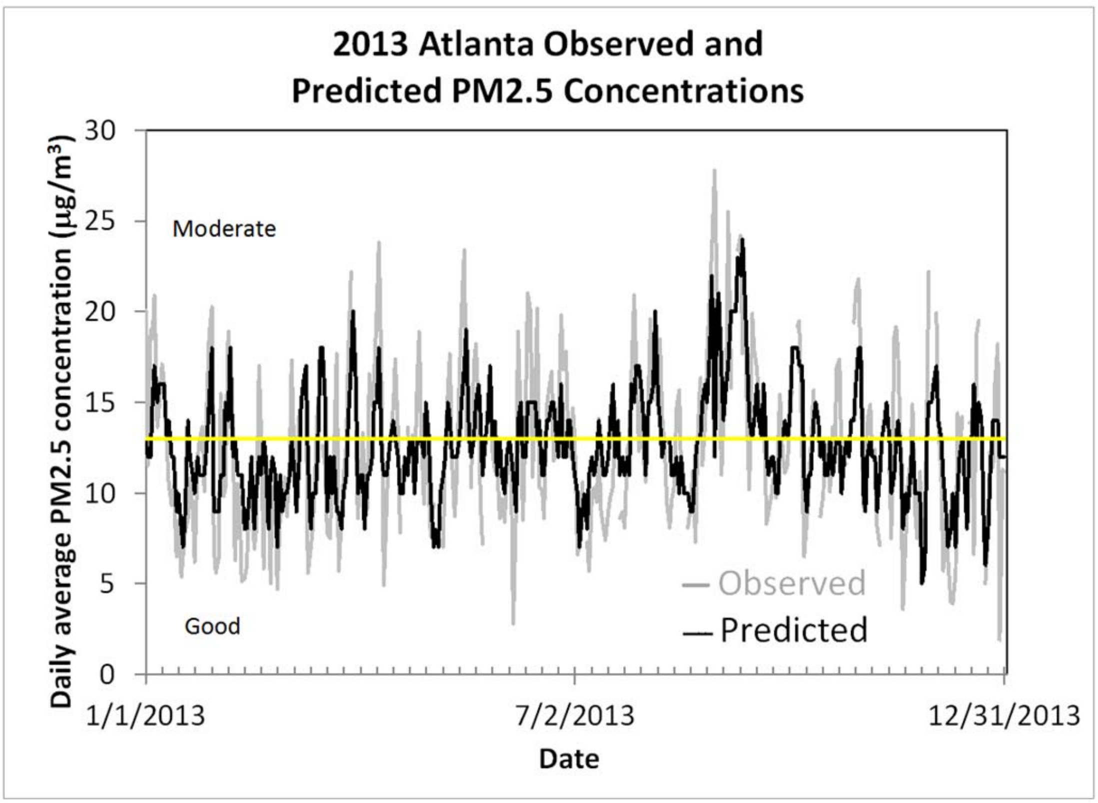


Figure 17.36e: Observed and Predicted $PM_{2.5}$ Air Quality for Atlanta

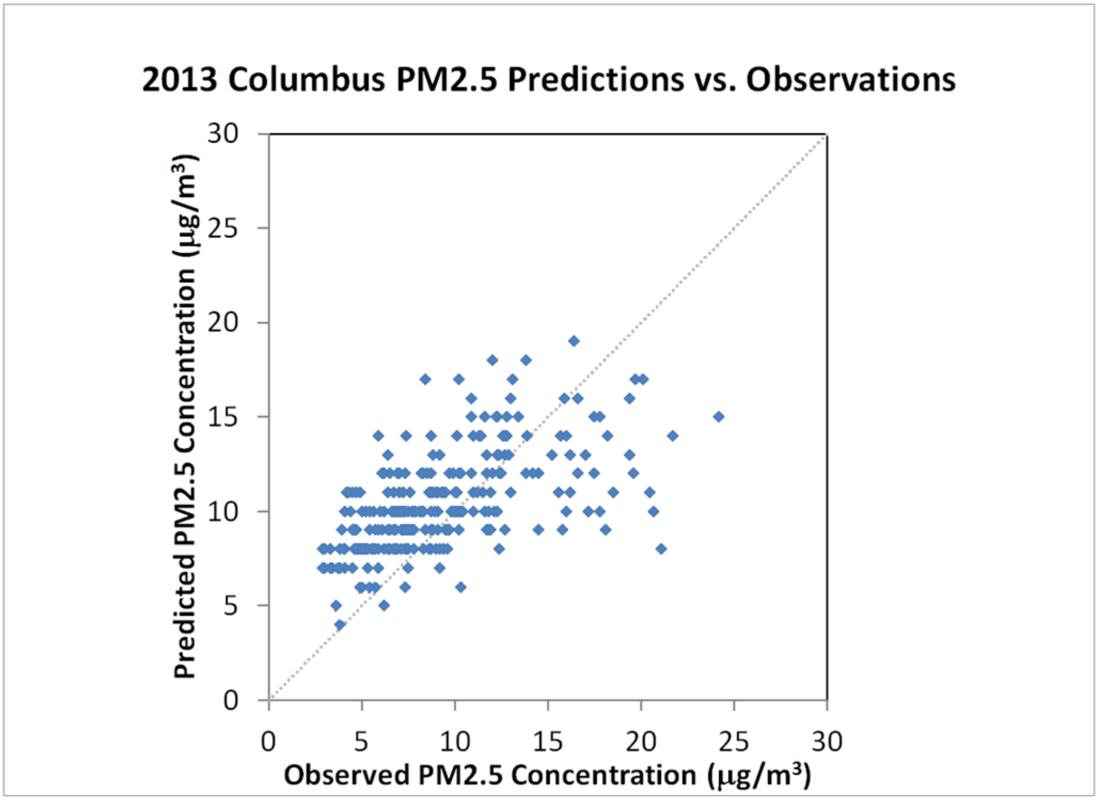


Figure 17.36f: Observed and Predicted Correlation of $PM_{2.5}$ Air Quality for Columbus

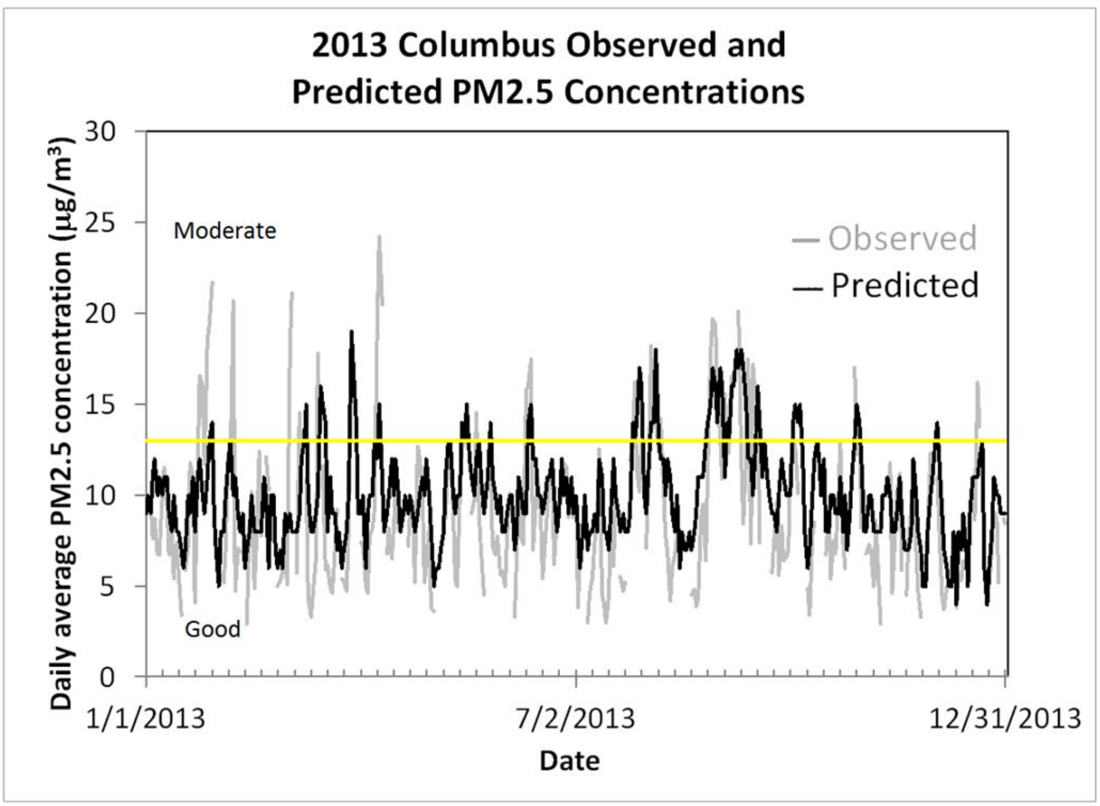
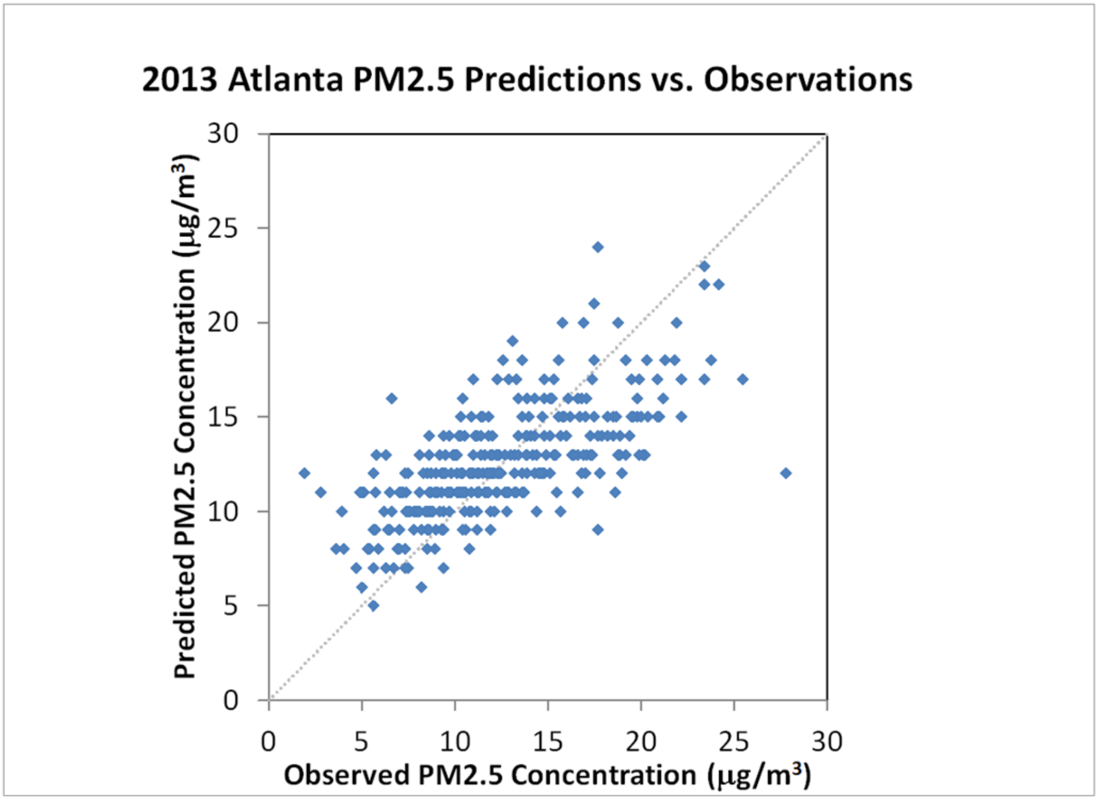


Figure 17.36g: Observed and Predicted $PM_{2.5}$ Air Quality for Columbus



(Data compiled by Dr. Michael Chang of Georgia Tech)

Figure 17.36h: Observed and Predicted Correlation of $PM_{2.5}$ Air Quality for Atlanta

	Hits	Misses	False Alarms	Bias	Gross Error	Correlation (-1 to +1)	% Accurate 2 categories	% Accurate 5 categories
Atlanta Ozone	0	3	1	4.1 ppbv	7.4 ppbv	0.74	98	86
Macon Ozone	0	0	0	6.9 ppbv	9.7 ppbv	0.55	100	86
Atlanta $PM_{2.5}$	0	0	0	0.2 µg/m³	2.6 µg/m³	0.68	100	80
Columbus $PM_{2.5}$	0	0	0	1.1 µg/m³	3.5 µg/m³	0.51	100	90

Figure 17.37: Predicted Air Quality

<u>Statistics Clarification</u>

- Hits are the number of days on which an observed exceedance of the daily NAAQS was correctly predicted.
- Misses are the number of days on which an observed exceedance of the daily NAAQS was not predicted
- False Alarms are the number of days on which an exceedance of the daily NAAQS was predicted, but was not later observed.

- Bias is the average tendency to over-predict (positive bias) or under-predict (negative bias) the observed pollutant concentration.
- Gross Error is the average absolute error of the predictions relative to the observations.
- Correlation is a measure of the ability to predict the relative change in observed concentrations. Higher positive correlation implies that the predictions are accurately anticipating changes in the observed concentrations.
- % Accurate 2 categories is the percentage of days when the forecast prediction correctly matched the observation for the “no smog alert” / “smog alert” condition (i.e. 2 categories)
- % Accurate 5 categories is the percentage of days when the forecast prediction correctly matched the observation for five categories of the Air Quality Index (Good, Moderate, Unhealthy for Sensitive Groups, Unhealthy, and Very Unhealthy).

June 14, 2013 violation

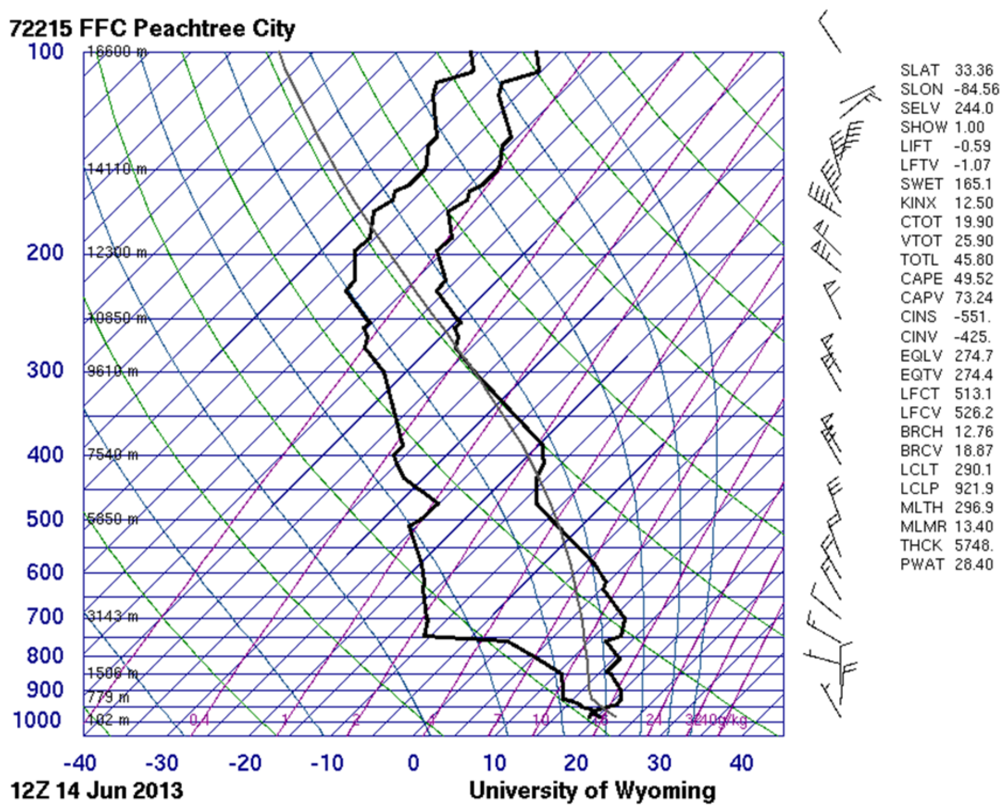


Figure 17.38a: 12z Rawsinode from Peachtree City (FFC), June 14, 2013

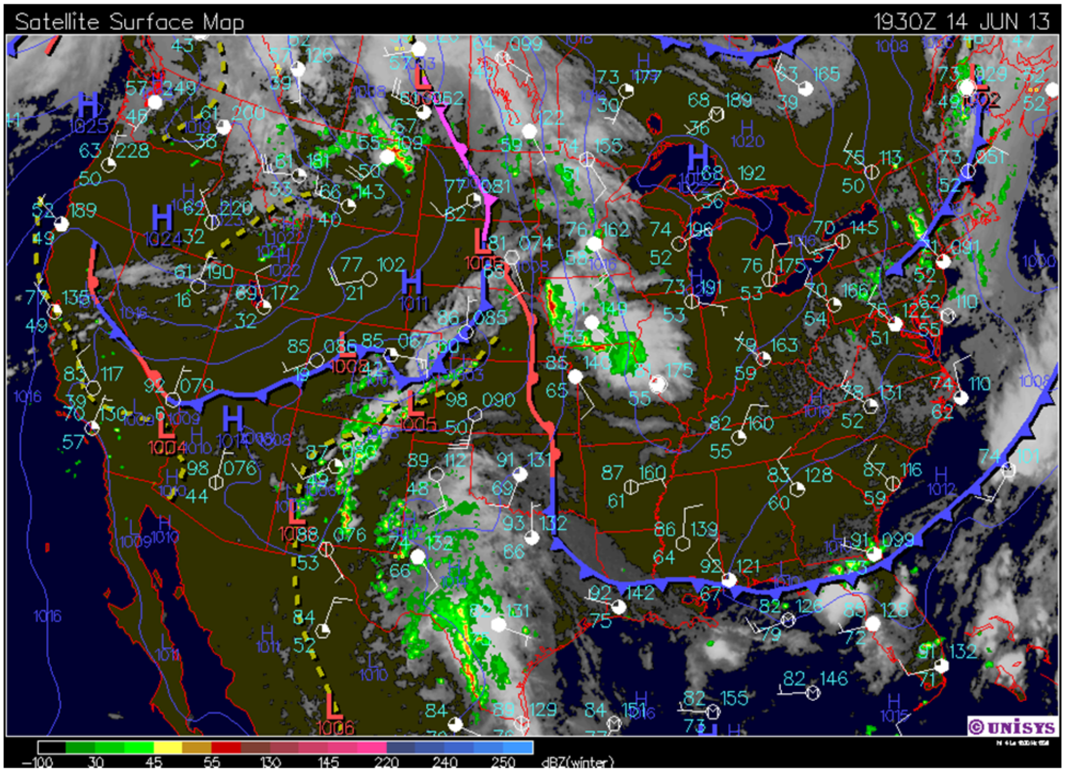


Figure 17.38b: Satellite Surface Map at 1930z, June 14, 2013

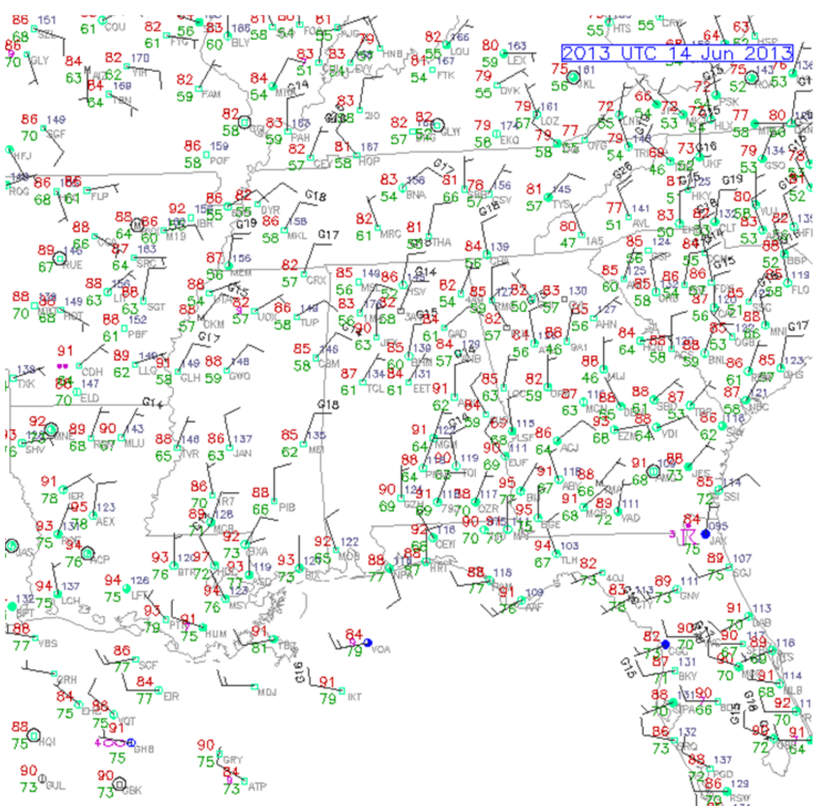


Figure 17.38c: Land-based Surface Observations across Southeast at 2013 UTC, June 14, 2013

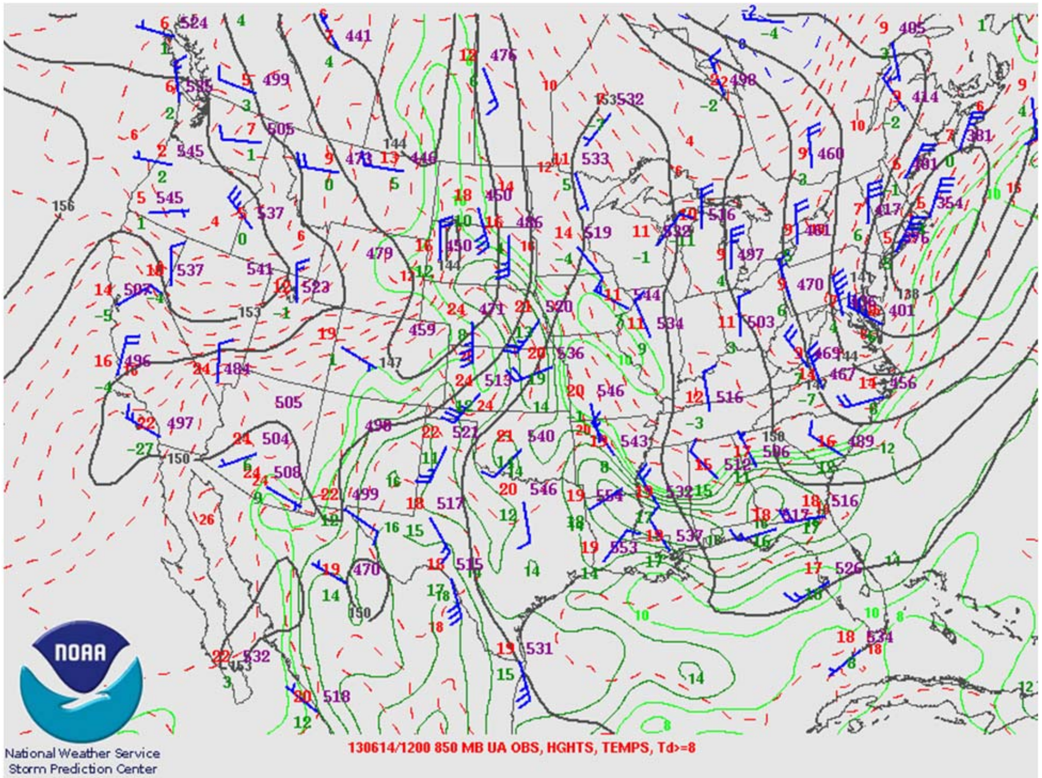


Figure 17.38d: 850mb Chart for 1200 UTC, June 14, 2013

July 30, 2013 violation:

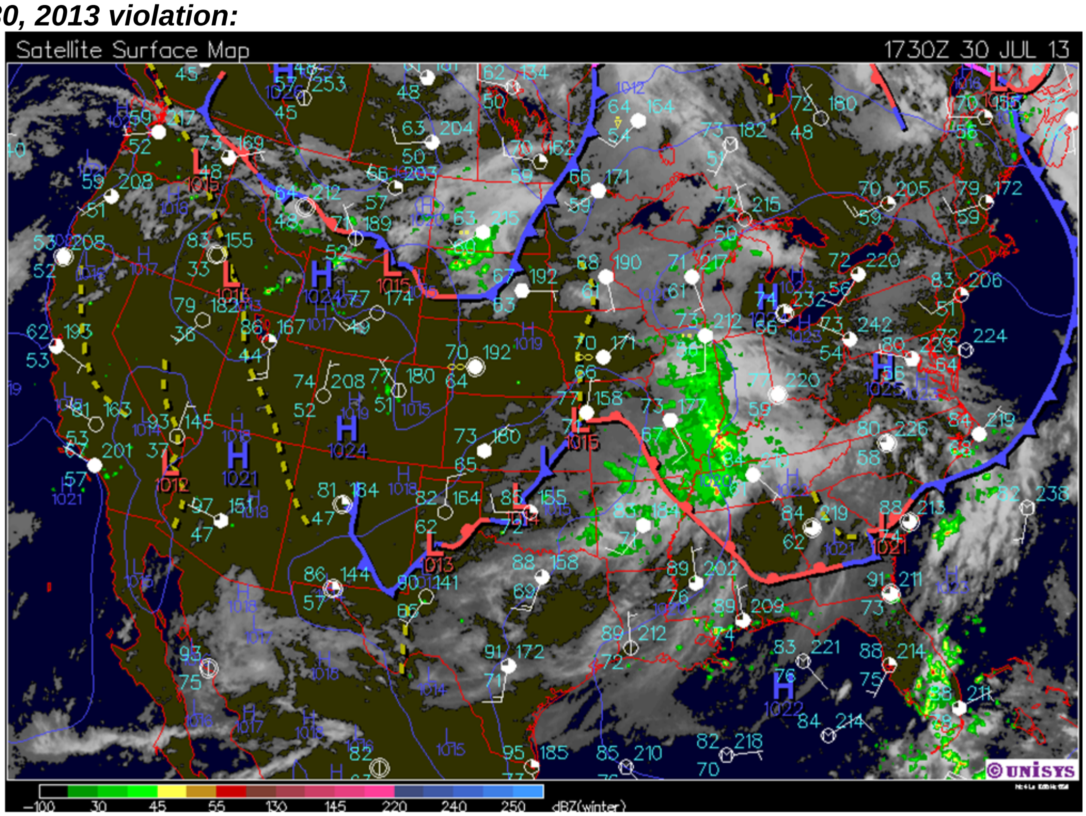


Figure 17.39a: Satellite Surface Map for July 30, 2013 at 1730z

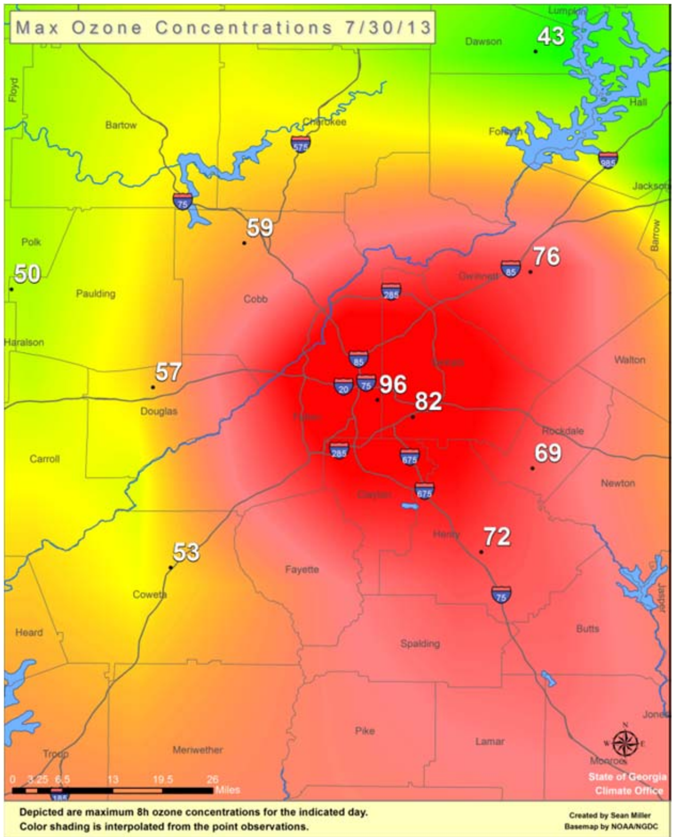


Figure 17.39b: Maximum 8-hr Ozone Concentrations for July 30, 2013 across Central Georgia

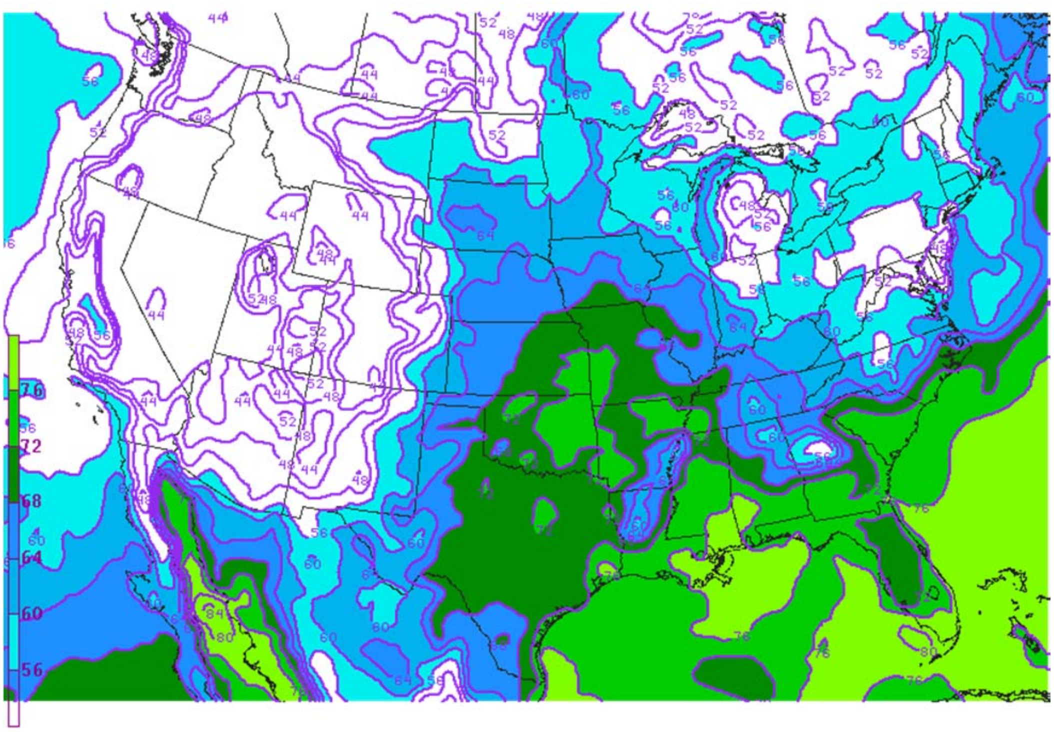


Figure 17.39c: Storm Prediction Center (SPC) IR/RAP/OBS Composite Map valid on July 30, 2013

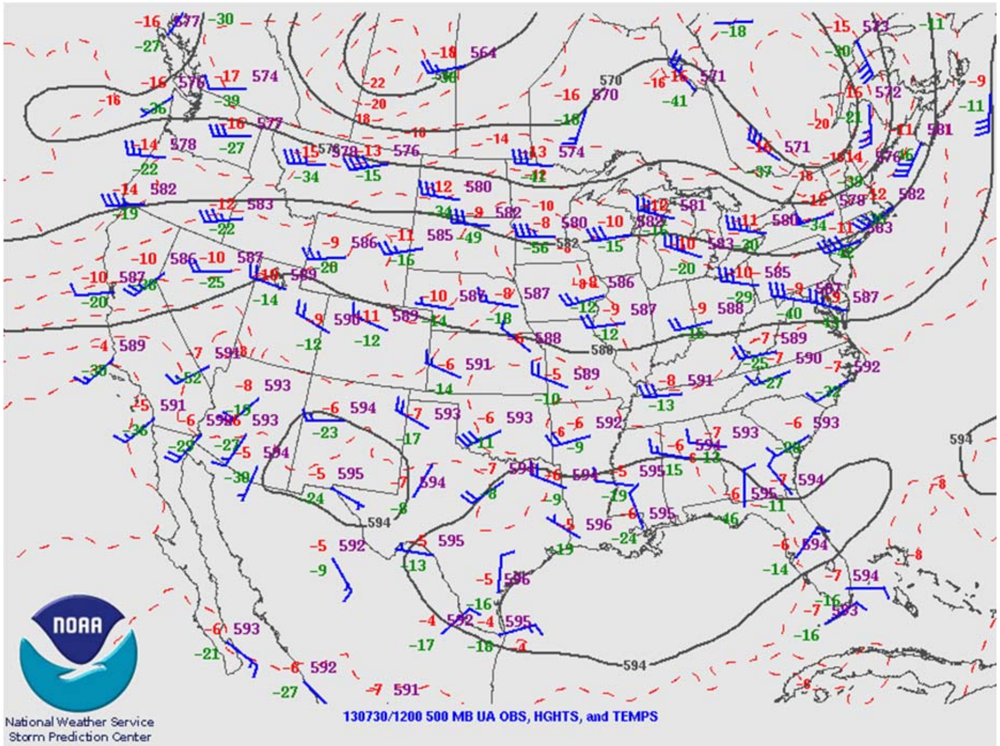


Figure 17.39d: 500mb Chart for 1200UTC on July 30, 2013

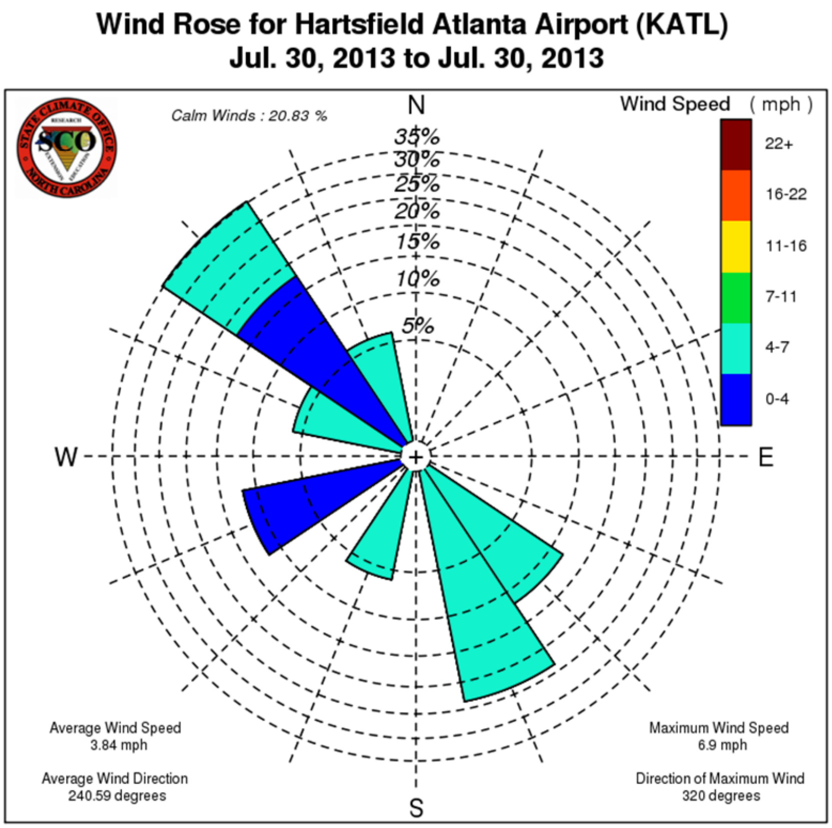


Figure 17.39e: Wind Rose for Hartsfield Atlanta Airport on July 30, 2013

September 5, 2013 violation:

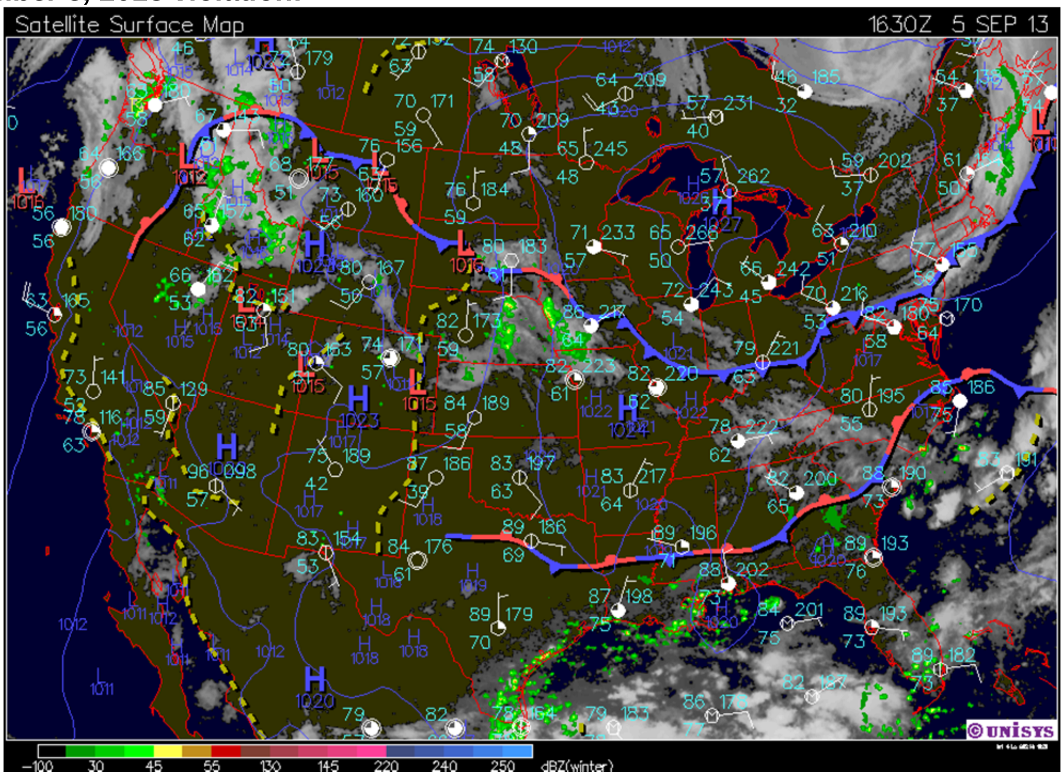


Figure 17.40a: Satellite Surface Map for September 5, 2013 at 1630z

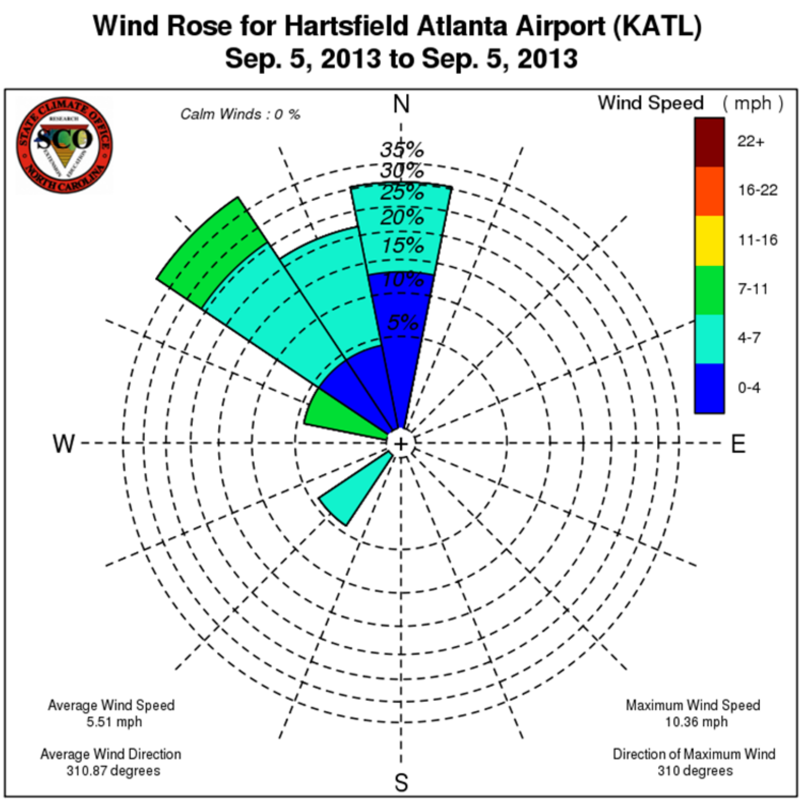


Figure 17.40b: Wind Rose for Hartsfield Atlanta Airport on September 5, 2013

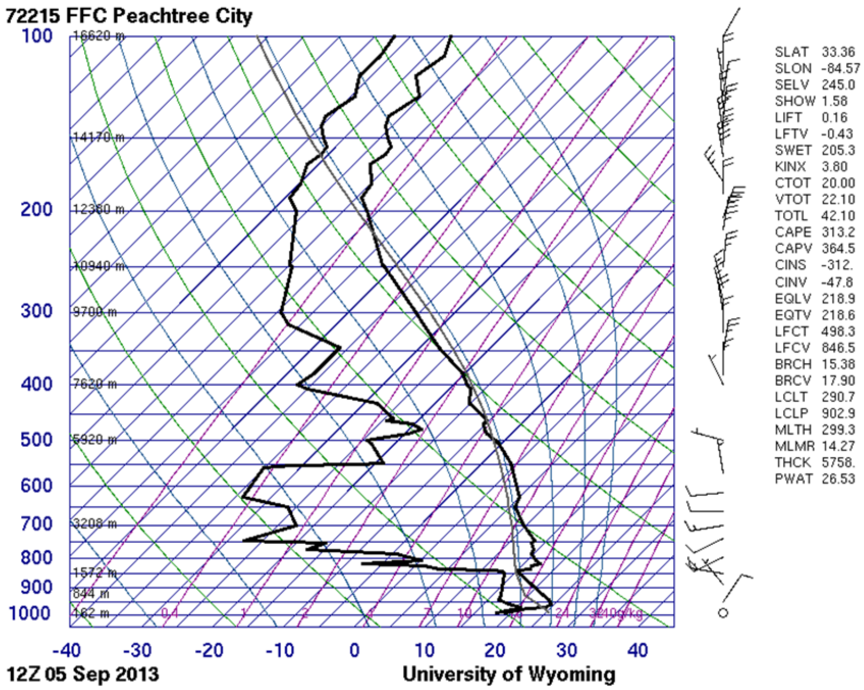


Figure 17.40c: 12z rawinsonde from Peachtree City (FFC) on September 5, 2013

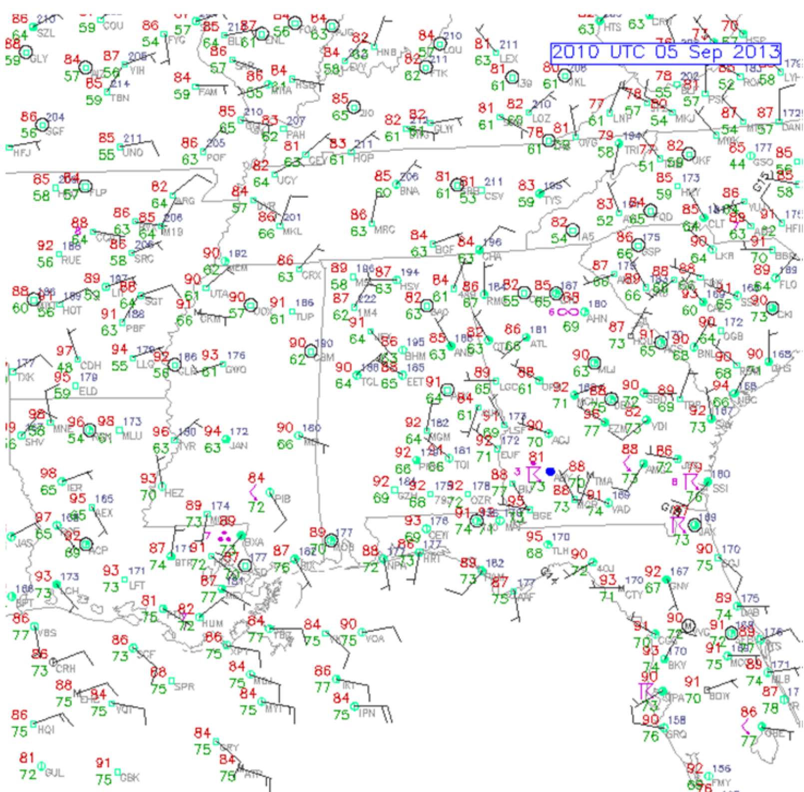


Figure 17.40d: Land-based Surface Observations across Southeast at 2010UTC on September 5, 2013

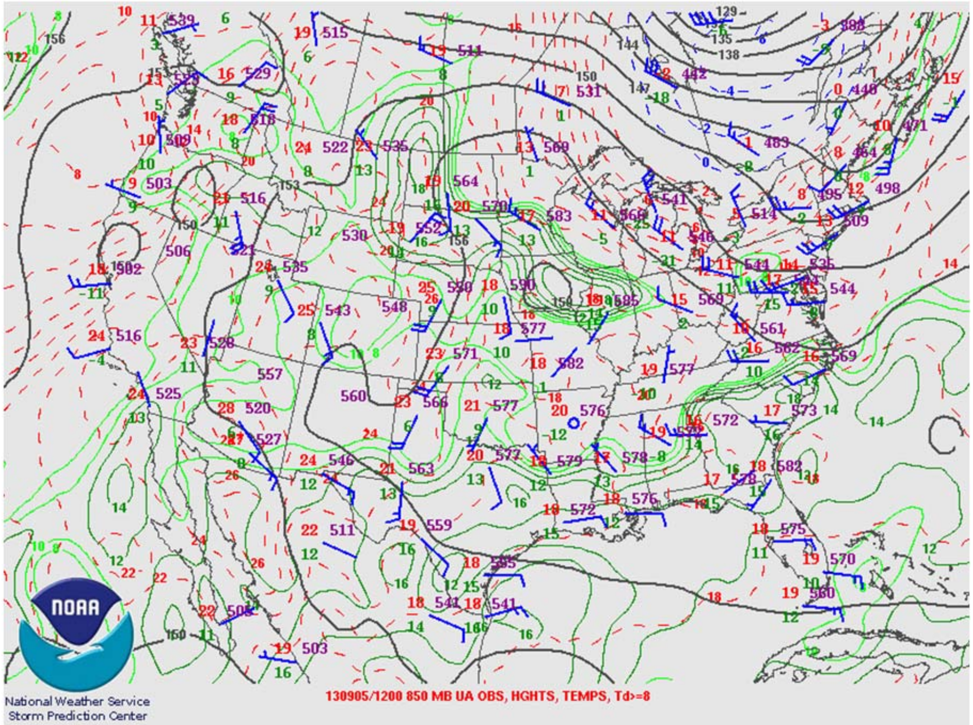


Figure 17.40e: 850mb Chart for 1200UTC on September 5, 2013

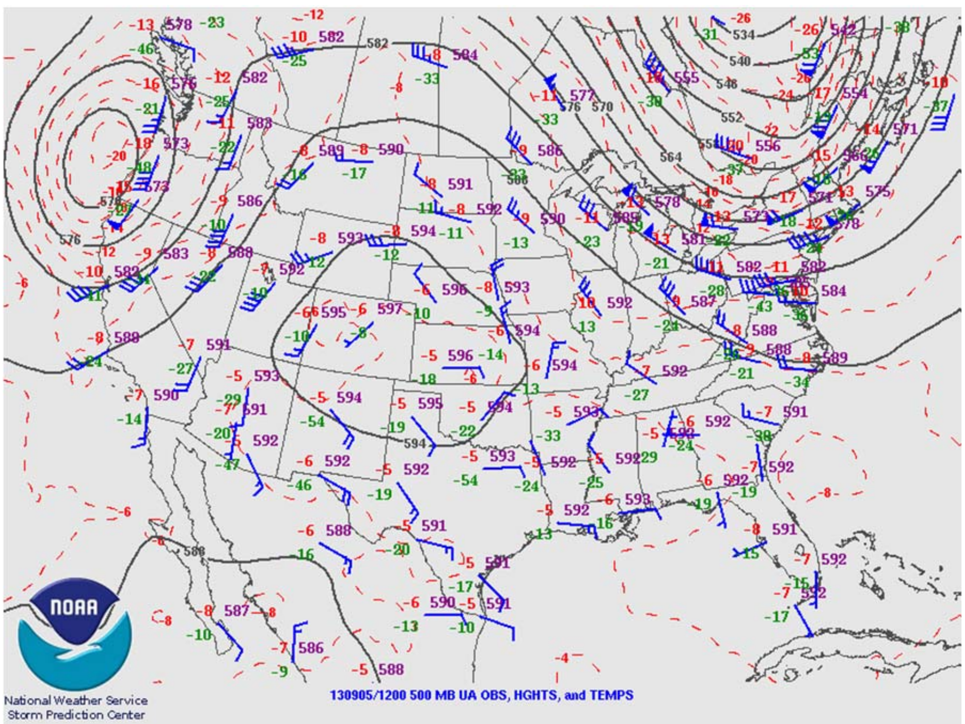


Figure 17.40f: 500mb Chart for 1200UTC on September 5, 2013

17.4 Select Meteorological and Air Quality Case Studies for 2009-2012

The following select case studies are included to show the meteorological review of the data from 2009 through 2012.

17.4.1 Case Study for 2009

Several smoke/fire events affected the southeast in 2009, elevating the $PM_{2.5}$ around the Atlanta area. One such event took place on June 10th with visible satellite imagery (Figure 17.41) showing an area of haze over the southeast, also highlighted by a Google satellite overlay image (Figure 17.42). Elevated $PM_{2.5}$ readings were recorded around the metro area, with hourly values at the Confederate Avenue site reaching as high as 41.1 $\mu g/m^3$. Widespread fire activity was also observed across the Midwest (Figure 17.43) on April 24th, 2009, with trajectories showing upper level transport of smoke into the southeast (Figure 17.44).

There were other parameters that were also in place to cause elevated ozone values across the region. On July 21st, 2009 Atlanta experienced a Code Orange day for ozone, with the South DeKalb air monitoring station reading a maximum 8-hour average concentration of 84 ppb at 7:00 pm that day. On both July 20th and July 22nd maximum 8-hour average concentrations were only in the green category, with South DeKalb reading 51 ppb on July 20th and 53 ppb on July 22nd. The July 21st event was dependent on two specific contributing factors: relative humidity and recirculation.

Humidity levels have a large effect on ozone concentrations, and how much moisture is in the air can sometimes be the difference between a good air quality day and a Code Orange ozone event. On July 20th, a stationary front was strung across southern Georgia, even as a dry pocket of air began to move in from the northwest. However, due to the sea breeze circulation along the coast, the stationary front pushed back into central Georgia in the afternoon, and the humidity rose for the latter half of the day. The temperature reached 81 degrees F, and the dewpoint reached 51 degrees, giving a relative humidity of 35%. The winds for the 20th were steady from the north, at between 5 and 10 knots. On the 21st, the stationary front had broken down and the dry pocket of air had moved overtop of north and central Georgia. The temperature that day went up to 85 degrees F, while the dewpoint again reached 51 degrees, giving a relative humidity of 31%. In addition, by mid-morning the winds had shifted, swinging around to blow from the east and southeast, then around from the west a few hours later, before going stagnant for the rest of the day. This caused a recirculation of pollution and ozone precursors back onto Atlanta, which coupled with the lower humidity, caused ozone levels to climb very quickly into the orange category. Values maxed out at the 8-hour average of 84 ppb. The next day, on the 22nd, the dry pocket of air had been pushed off to the southeast by an approaching cold front. The maximum temperature reached 83 degrees F, with a dewpoint of 53 degrees, bringing the relative humidity back up to 35%, and the winds had become fairly steady from the south and southwest, between 5 and 10 knots.

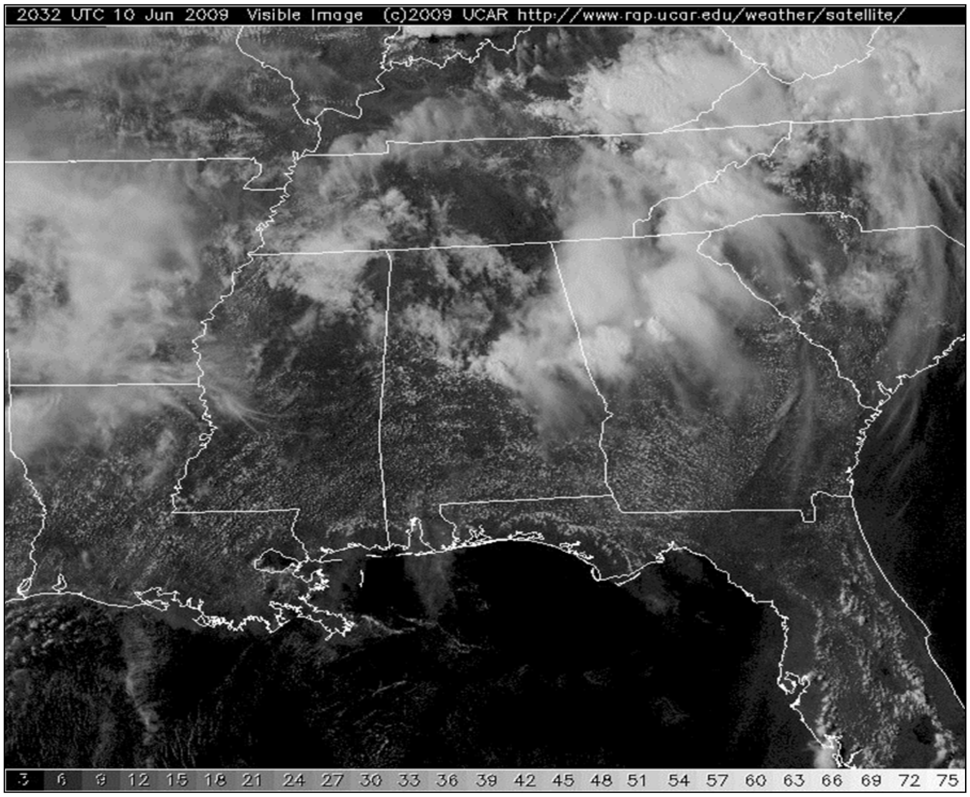


Figure 17.41: Visible Satellite Imagery of the Southeast U.S. on June 10, 2009

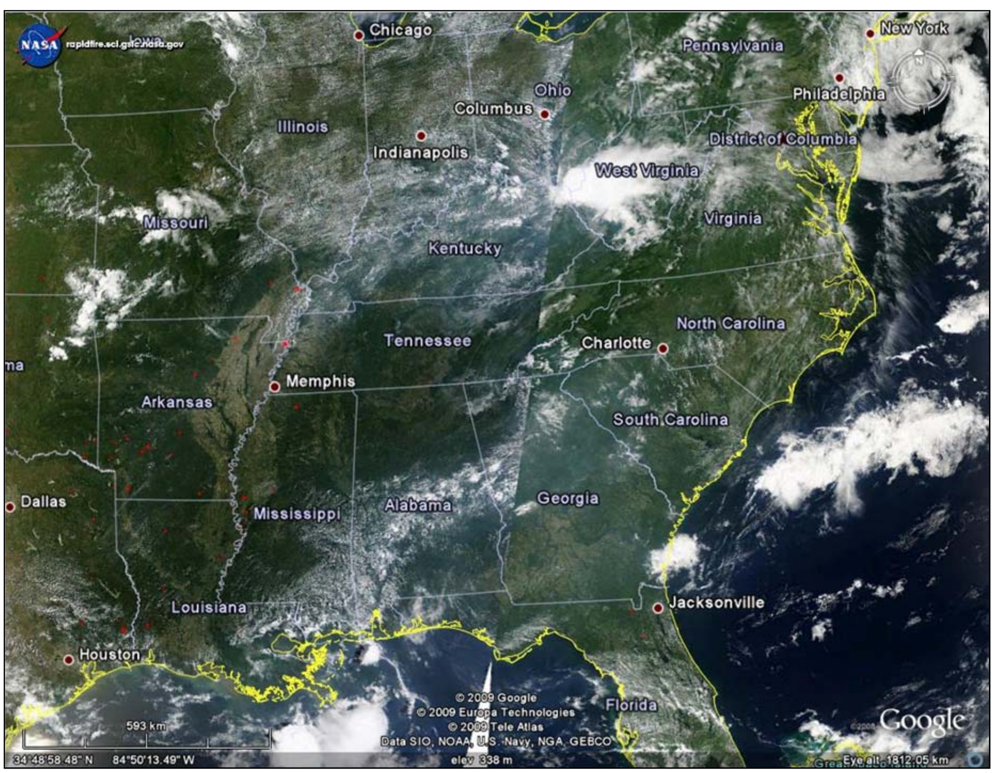


Figure 17.42: NASA Satellite Imagery Overlaid on Google Application for June 10, 2009

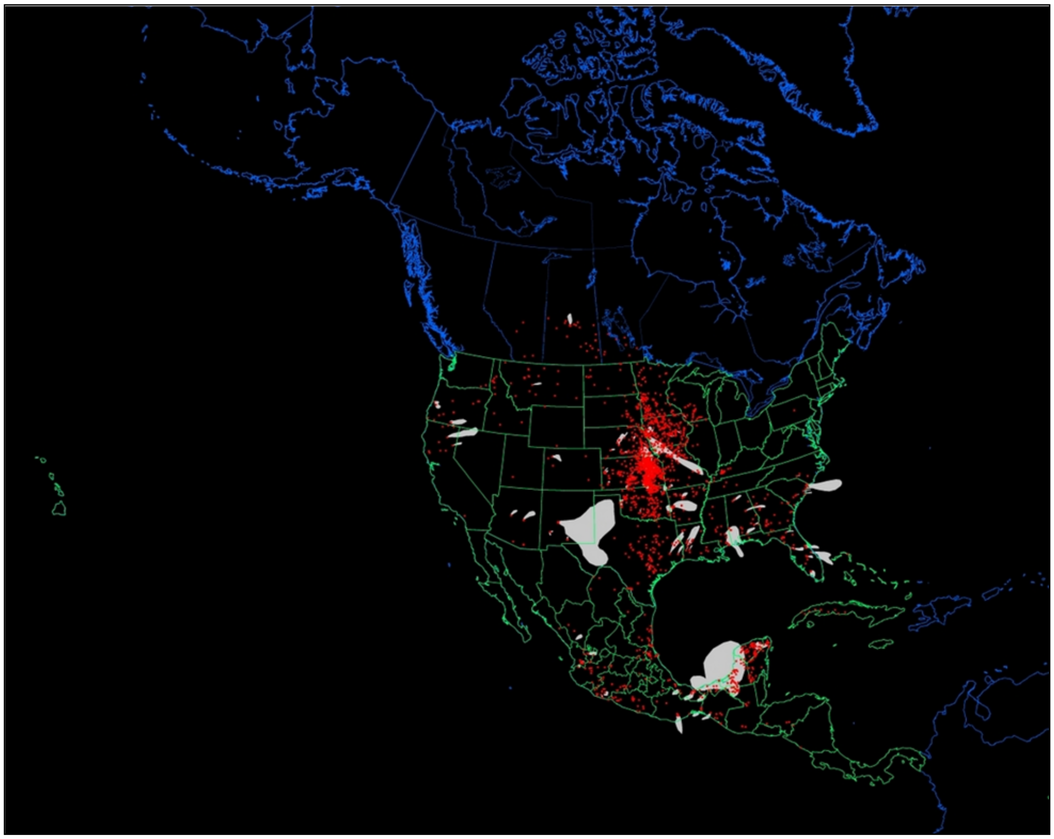


Figure 17.43: Hazard Mapping System Fire and Smoke Product for April 24, 2009

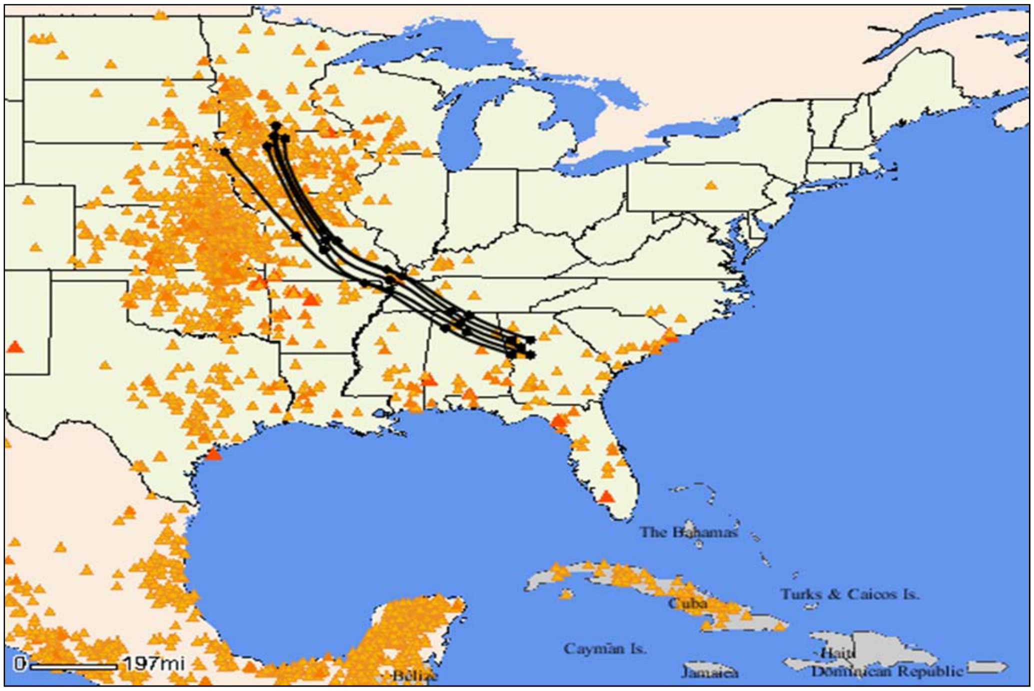


Figure 17.44: Smartfire Smoke Upper Level Trajectory and Fire Information for April 24, 2009

17.4.2 Case Study for 2010

BRIEF CLIMATOLOGICAL COMPARISON OF 2000 VS. 2010 OZONE SEASONS

There is a noticeable distinction in the recorded number of 8-hr ozone violations for the 2010 ozone season, in comparison with the 2000 ozone season. There were 46 ozone violations recorded in 2000, with only 24 violations noted for the 2010 ozone season (Tables 17.6 and 17.7). This noticeable disparity raises the question of what (if any) meteorological differences were in place during these two years that would cause ozone production to show such a contrast.

1.	Apr-30-2000	8hrO3 (.085)
2.	May-31-2000	8hrO3 (.095)
3.	Jun-01-2000	8hrO3 (.122)
4.	Jun-02-2000	8hrO3 (.103)
5.	Jun-03-2000	8hrO3 (.090)
6.	Jun-08-2000	8hrO3 (.093)
7.	Jun-09-2000	8hrO3 (.109)
8.	Jun-10-2000	8hrO3 (.107)
9.	Jun-11-2000	8hrO3 (.105)
10.	Jun-12-2000	8hrO3 (.088)
11.	Jun-23-2000	8hrO3 (.096)
12.	Jun-24-2000	8hrO3 (.097)
13.	Jun-30-2000	8hrO3 (.100)
14.	Jul-01-2000	8hrO3 (.112)
15.	Jul-02-2000	8hrO3 (.099)
16.	Jul-03-2000	8hrO3 (.103)
17.	Jul-04-2000	8hrO3 (.087)
18.	Jul-06-2000	8hrO3 (.091)
19.	Jul-07-2000	8hrO3 (.099)
20.	Jul-08-2000	8hrO3 (.085)
21.	Jul-13-2000	8hrO3 (.111)
22.	Jul-14-2000	8hrO3 (.094)
23.	Jul-16-2000	8hrO3 (.086)
24.	Jul-17-2000	8hrO3 (.093)
25.	Jul-18-2000	8hrO3 (.123)
26.	Jul-19-2000	8hrO3 (.086)
27.	Jul-21-2000	8hrO3 (.092)
28.	Jul-22-2000	8hrO3 (.091)
29.	Jul-27-2000	8hrO3 (.110)
30.	Jul-28-2000	8hrO3 (.113)
31.	Aug-05-2000	8hrO3 (.090)
32.	Aug-06-2000	8hrO3 (.091)
33.	Aug-10-2000	8hrO3 (.120)
34.	Aug-13-2000	8hrO3 (.086)
35.	Aug-14-2000	8hrO3 (.102)
36.	Aug-15-2000	8hrO3 (.104)

37.	Aug-16-2000	8hrO3 (.138)
38.	Aug-17-2000	8hrO3 (.139)
39.	Aug-18-2000	8hrO3 (.096)
40.	Aug-19-2000	8hrO3 (.115)
41.	Aug-22-2000	8hrO3 (.089)
42.	Aug-23-2000	8hrO3 (.090)
43.	Aug-24-2000	8hrO3 (.095)
44.	Aug-26-2000	8hrO3 (.099)
45.	Aug-28-2000	8hrO3 (.092)
46.	Aug-29-2000	8hrO3 (.096)

Table 17.6: Exceedances of Federal Air Quality Standards in Georgia (2000)

1.	May-05-2010	8hrO3 (.076)
2.	May-06-2010	8hrO3 (.085)
3.	Jun-15-2010	8hrO3 (.079)
4.	Jun-18-2010	8hrO3 (.078)
5.	Jun-21-2010	8hrO3 (.079)
6.	Jun-22-2010	8hrO3 (.079)
7.	Jul-07-2010	8hrO3 (.098)
8.	Jul-08-2010	8hrO3 (.086)
9.	Jul-09-2010	8hrO3 (.078)
10.	Jul-15-2010	8hrO3 (.084)
11.	Jul-30-2010	8hrO3 (.083)
12.	Aug-04-2010	8hrO3 (.085)
13.	Aug-10-2010	8hrO3 (.077)
14.	Aug-11-2010	8hrO3 (.079)
15.	Aug-24-2010	8hrO3 (.086)

Table 17.7: Exceedances of Federal Air Quality Standards in Georgia (2010)

A brief comparison of the ozone season months of May, June, July August for 2000 and 2010 is provided below.

***May*-** Substantial differences were noted between monthly climatological means and daily meteorological conditions for May 2000 and 2010. Case studies involving two ozone events during the month of May 2000 (May 31) and May 2010 (May 5-7) highlight the meteorological conditions surrounding elevated ozone levels for those dates:

Ozone Event – May 31, 2000

Meteorological conditions were particularly favorable for elevated ozone concentrations on May 31st as broad anticyclonic circulation dominated much of the Southeastern U.S. in association with a mid/upper high along the central Gulf States. Surface ridging was also building southwestward along the eastern slopes of the Appalachians in the wake of a departing shortwave trough/closed upper low moving into the western Atlantic. Very dry mean layer humidity of only 10-20% suggests plentiful insolation was providing favorable conditions for photochemical ozone production across the Atlanta metropolitan region (Figure 17.45).

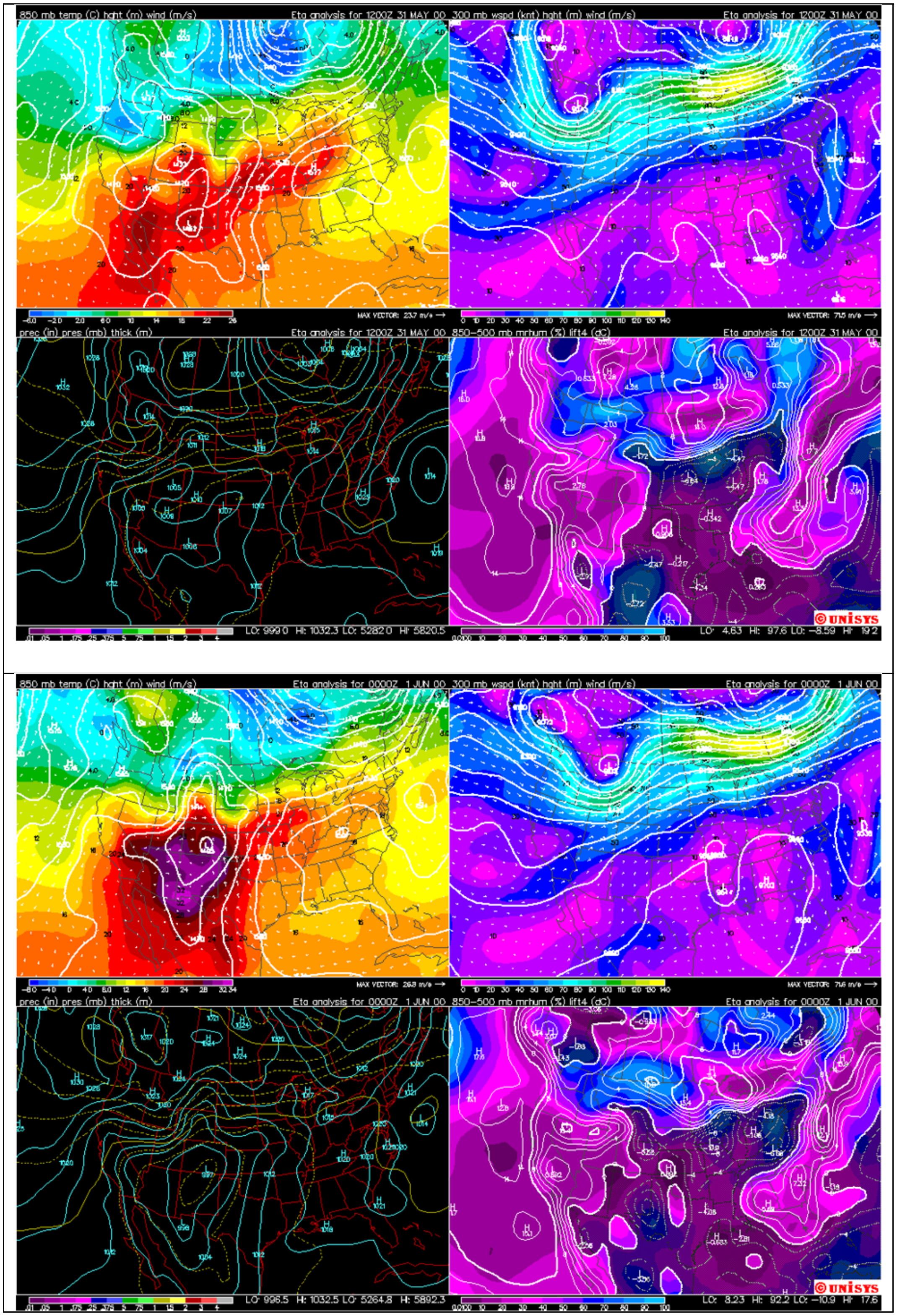
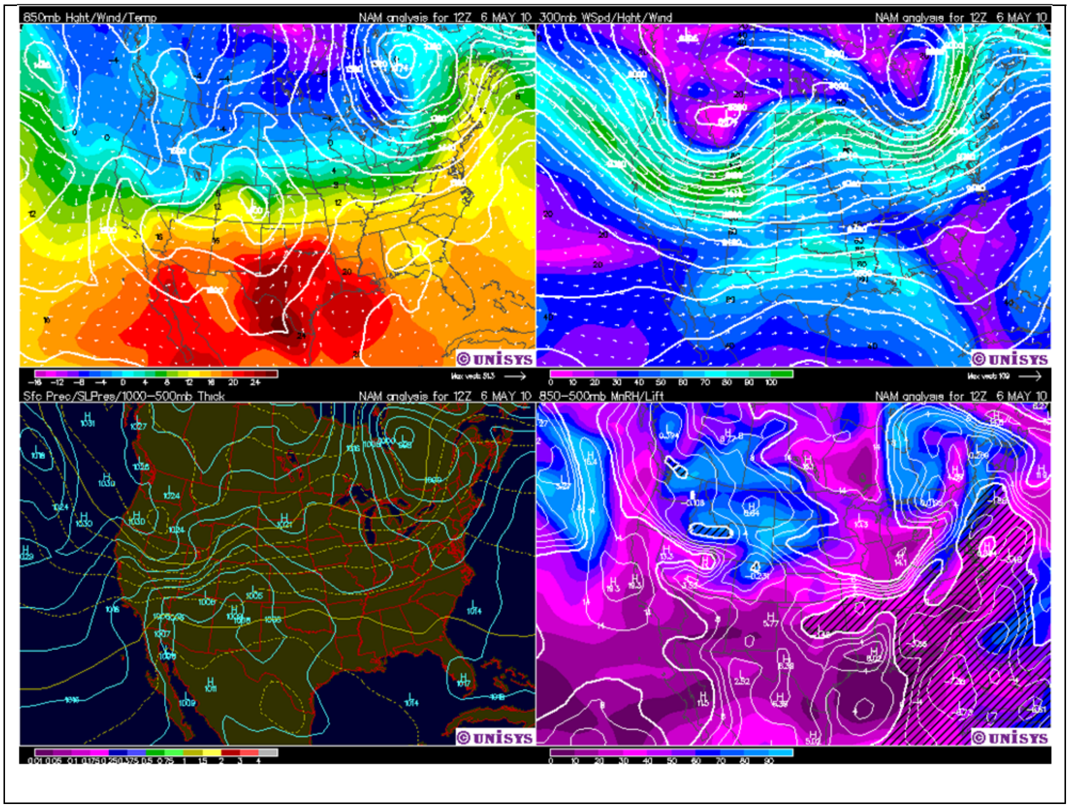


Figure 17.45: Objective Analysis from the NAM-40 Initial Fields Valid at (a) 12z on May 31, 2000, and (b) 00z on June 1, 2000

Ozone event – May 5-6, 2010

A split-flow upper regime was in place for North America during May 5th-6th with mid latitude cyclones favoring an easterly track along the polar jet branch through northern portions of the continental U.S. However, moisture associated with a weak southern branch disturbance was contributing to moderately unstable conditions over western portions of the region, while subsidence was noted across the Eastern Atlanta metro area. Although not a clear-cut situation for high ozone readings, sufficient insolation and subsidence provided by northwesterly flow aloft likely aided in elevating concentrations during this period (Figure 17.46).



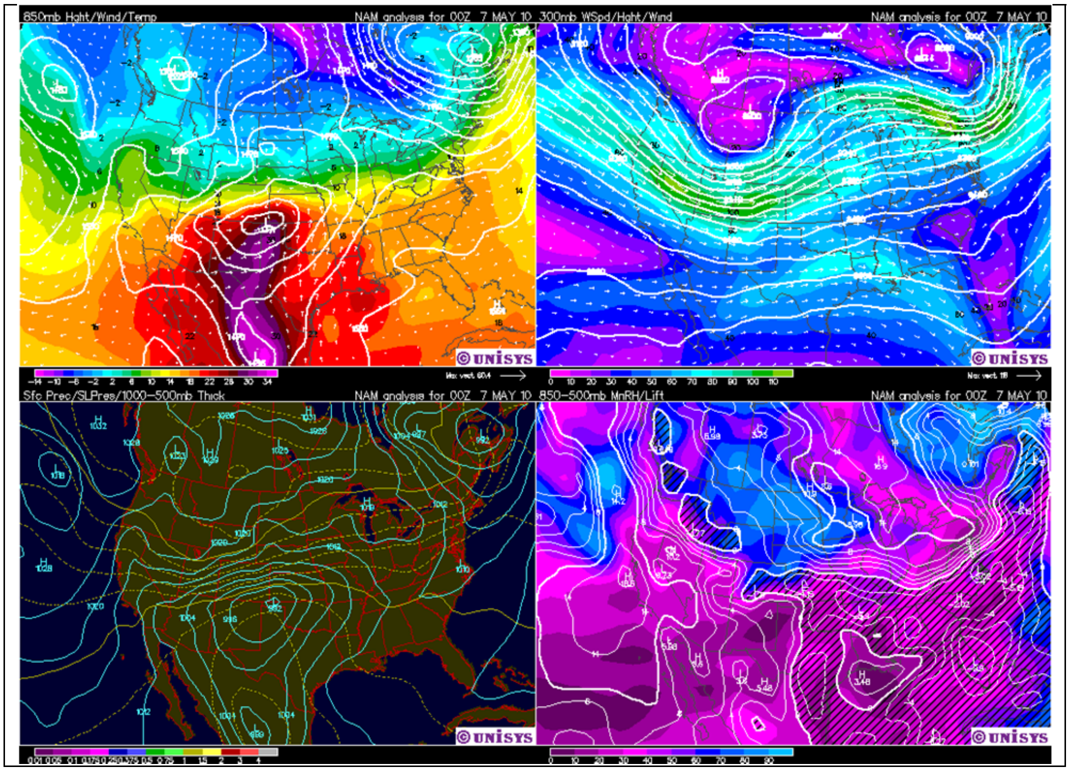


Figure 17.46: Objective Analysis from the NAM-40 Initial Fields Valid at (a) 12z on May 6, 2000, and (b) 00z on May 7, 2000

***June*- ** June 2000 had an average maximum daily temperature of 88 degrees, with the highest temperature measured at 95 degrees on June 24th, and temperatures above 90 degrees for 16 days out of the month. A total of 1.11 inches of rainfall was reported for the month. June 2010 had an average maximum daily temperature of 90 degrees, with the highest temperatures measured at 95 degrees on June 14th and 15th, and temperatures above 90 degrees for 19 days out of the month. A total of 5.41 inches of rainfall was reported for the month. So, although June 2000 was overall a cooler month than June 2010, June 2010 recorded higher humidity, and more rainfall. With ozone and fine particulate matter depending greatly on photochemistry, the higher humidity and greater rainfall amounts would have a large impact on levels of these pollutants.

***July*- ** Temperatures across the state in July 2010 were above normal, although both record highs and record lows were recorded during the month. Rainfall was spotty at best, with most of the state receiving below normal rainfall. The conditions in July 2000, however, continued with a summer drought that climatologists labeled as one of "historic proportions" (Figure 17.47). Rainfall totals 7 or more inches below normal for a 3-month summer period were reported from central Georgia westward into central and Eastern Alabama. The U.S. Geological Survey indicated on July 18, 2000 that in five southeastern states (SC, GA, AL, MS, and FL), new daily record low streamflows were recorded due to the minimal rainfall that year.

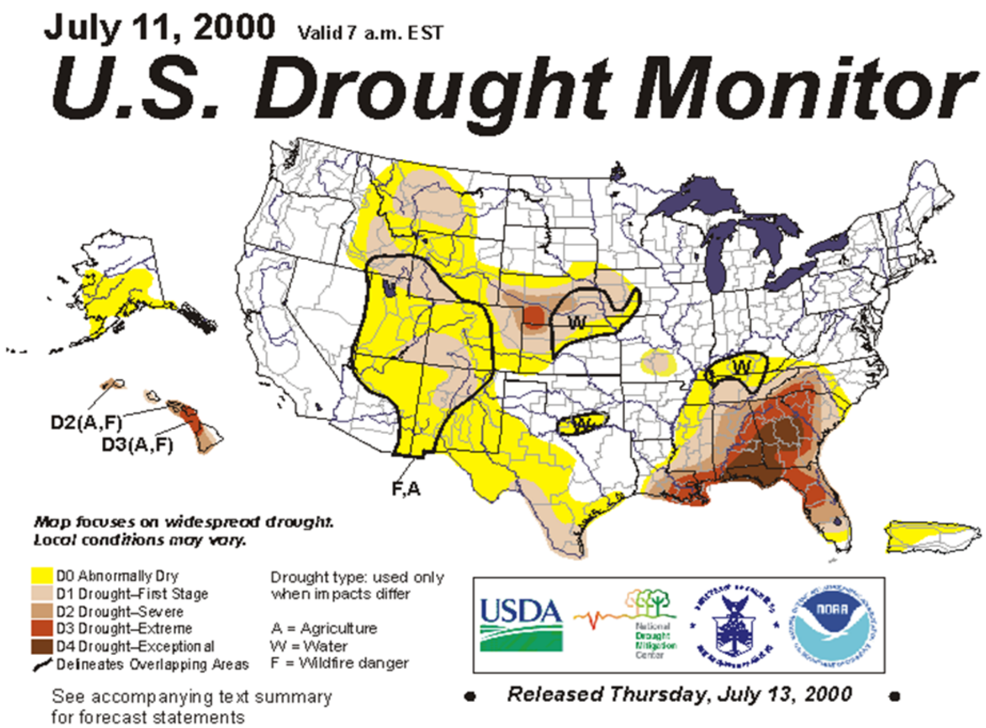
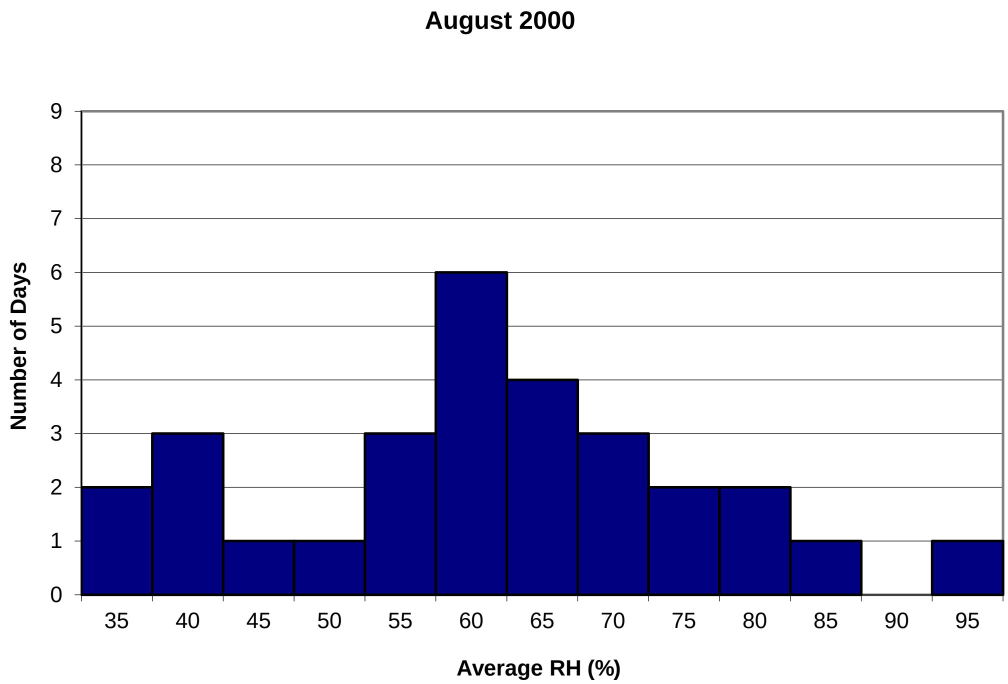


Figure 17.47: Drought Conditions Recorded by the U.S. Drought Monitor for Mid-July 2000

August **-** Ozone concentrations exceeded federal air quality standards 16 days during August 2000, compared to four days (up to August 25, 2010) during August 2010. The high number of exceedances during 2000 relative to 2010 can be partly attributed to meteorological conditions consisting of lower relative humidity and a blocked flow from the Gulf of Mexico. During a period from August 13-19, 2000, seven of those exceedances occurred. Throughout this period, the Southeast was dominated by a surface and upper level ridge, completely cutting off the flow of moisture from the Gulf of Mexico. Subsequently, the average relative humidity (RH) for Atlanta during this period was 43% with very sunny and stable conditions, allowing ozone concentrations to spike. This relatively low relative humidity was reflected throughout much of August 2000 compared to August 2010, as shown by the RH data in Figure 17.48. Most days in August 2010 had a daily average (daily averages taken from 7 AM to 5 PM) relative humidity between 60 and 75%, with a peak at 70%. August 2000 had a wide RH range between 35% and 95%, with a peak at about 60%.



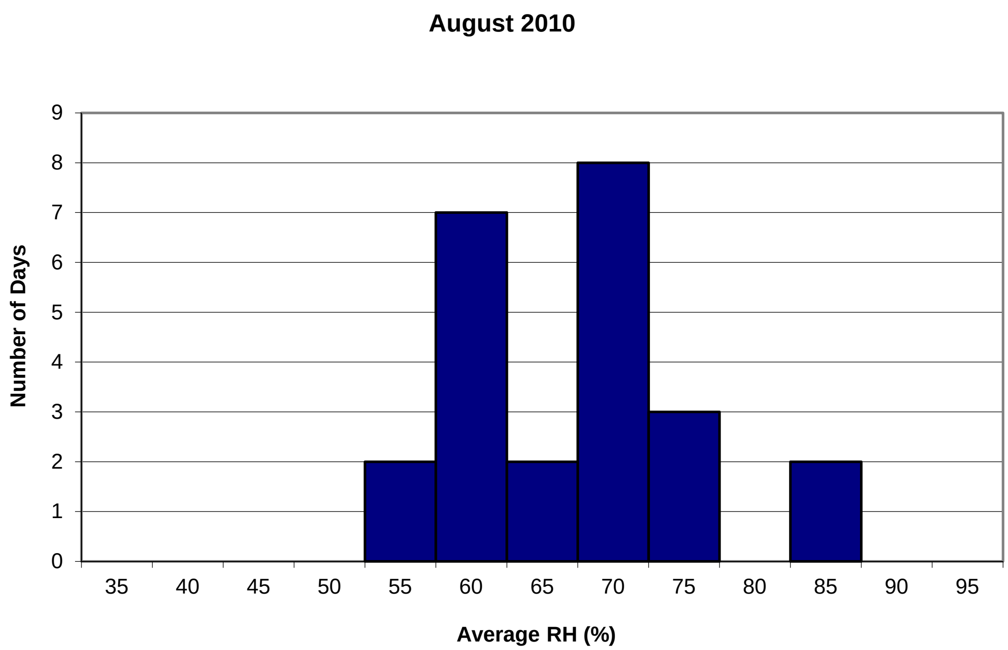


Figure 17.48: Average Daily Relative Humidity for August 2000 and 2010 (Averages taken from 7am to 5pm. August 2010 Data Include Daily Averages up to August 25, 2010.)

Summary

It would be difficult (without further analysis) to quantify the exact parameters that contributed to the low number of ozone violations in 2010, verses large number of exceedances in 2000. However, based on the preliminary analysis conducted, it is a safe assumption that moisture played a significant role in each ozone season. The U.S. Drought Monitor labeled the summer drought of 2000 as one of “historic proportions.” The drought intensity was categorized as an exceptional drought for a large part of Georgia, extreme Southeastern Alabama, and parts of Northwestern Florida for a large majority of the summer. These hot and dry conditions most likely contributed to the elevated number of ozone violations recorded during that ozone season. In contrast, a persistently moist airmass across the Southeast in the summer of 2010, due in large part to an open Gulf of Mexico and the more favorable climatological position of the Atlantic subtropical high, played a significant role in the low number of ozone violations recorded during these summer months.

17.4.3 Case Study for June 16-17, 2011

A distinct increase in particle pollution at the Savannah Lathrop-Augusta (L&A) monitoring site was observed on June 16th and 17th. This increase occurred under south-southwesterly flow conditions and is shown for June 17th in Figure 17.49. Back-trajectory analysis further verifies the transport of smoke from the wildfire areas into the Savannah area, as given by Figure 17.50. The approximate locations of the active wildfires are given by MODIS hotspot areas depicted in Figure 17.51. Enhancement of aerosol optical depth was evident from MODIS AOD Terra imagery and is shown across much of extreme South Georgia in Figure 17.52. Also overlaid are the AQI readings from EPA AIRNOW site, which show elevated $PM_{2.5}$ readings around the Valdosta area as well. This indicates that much of extreme south Georgia region was under the same smoke plume from Honey Prairie wildfire activity in southeast Georgia. Interesting visible satellite imagery, as shown in Figure 17.53, showed the development of pyro-cumulus during the afternoon convective hours on the 16th of June. This analysis showed that this increase in particle pollution around the Savannah area was attributed to transport of smoke from wildfire activity across extreme South Georgia and possibly northern Florida.

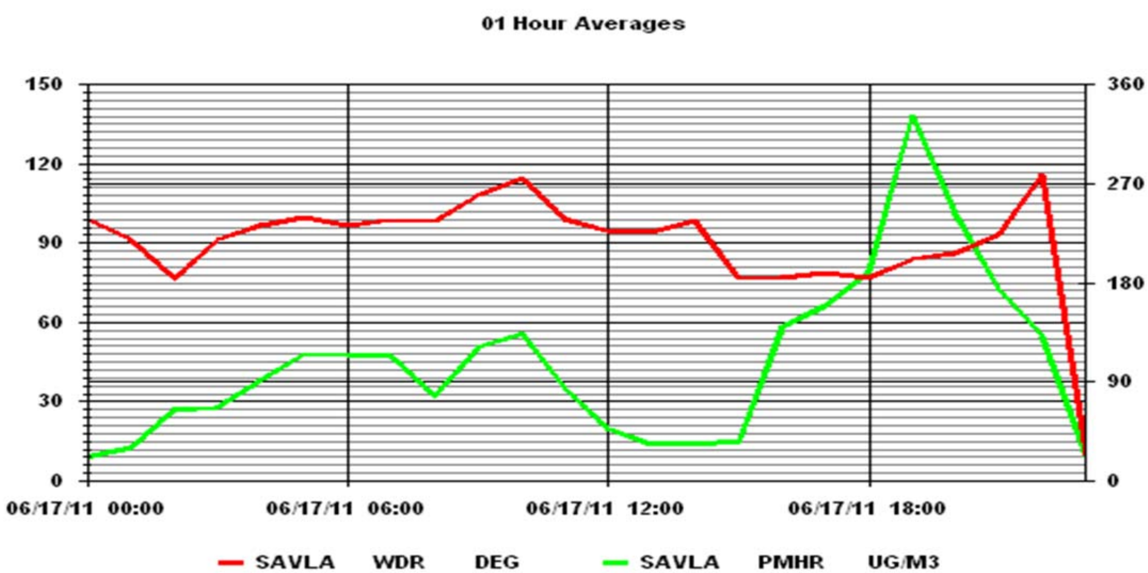


Figure 17.49: Wind Direction and Continuous $PM_{2.5}$ at Savannah L&A Site on June 17, 2011

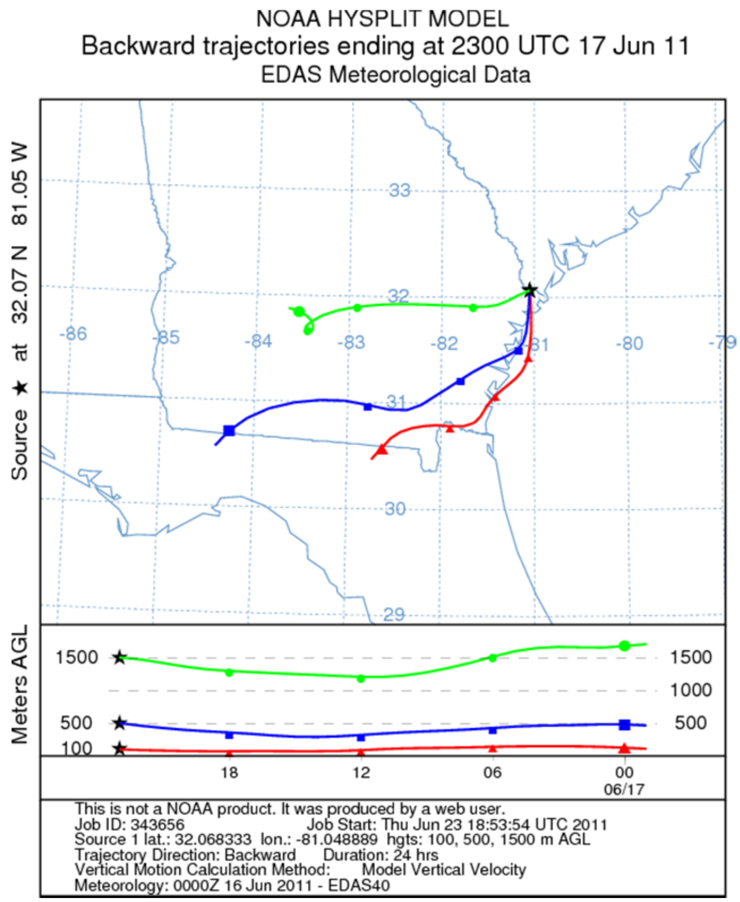


Figure 17.50: Backward Trajectory of Smoke to Savannah L&A Site on June 17, 2011

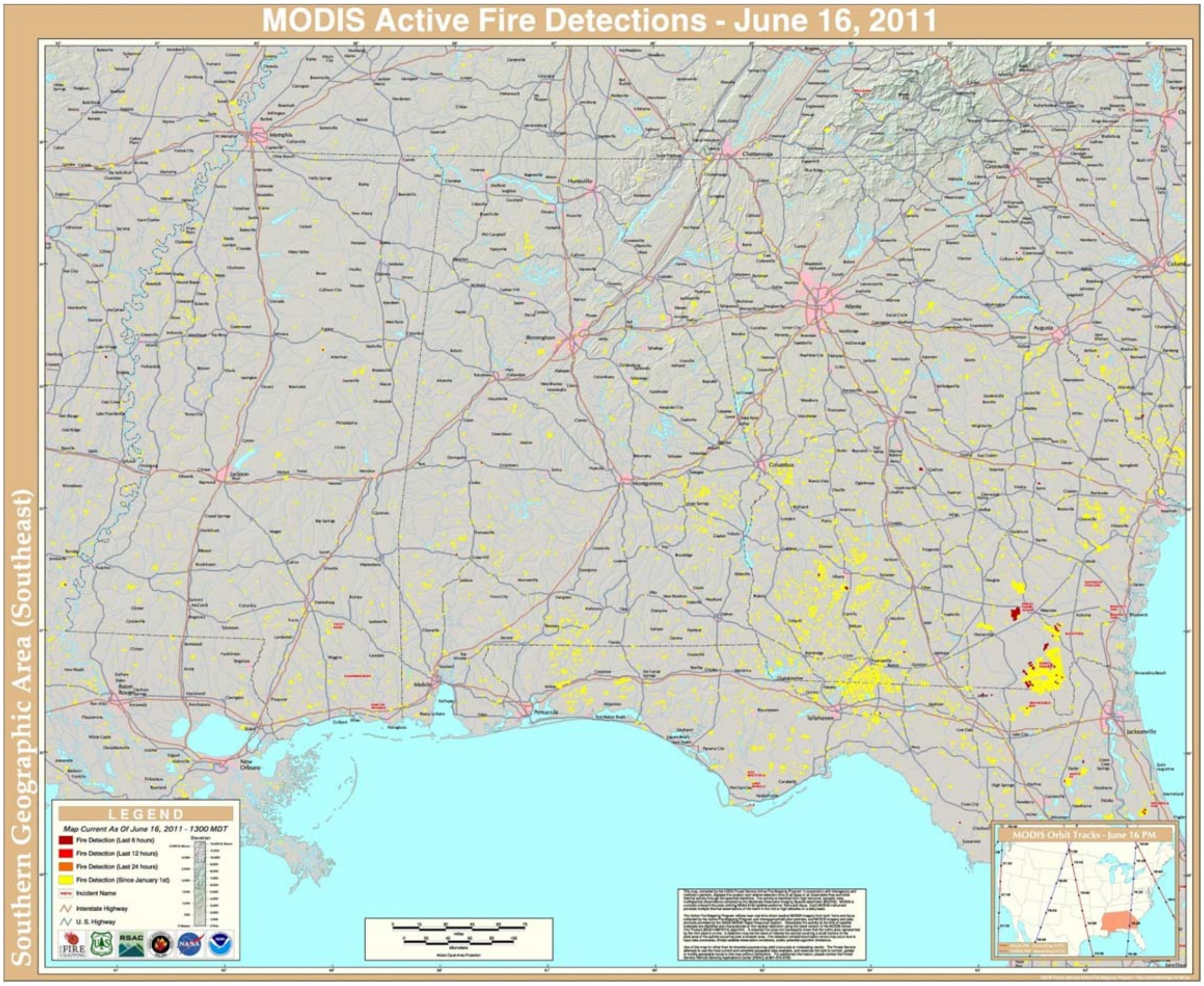


Figure 17.51: MODIS Locations of Fires on June 16, 2011

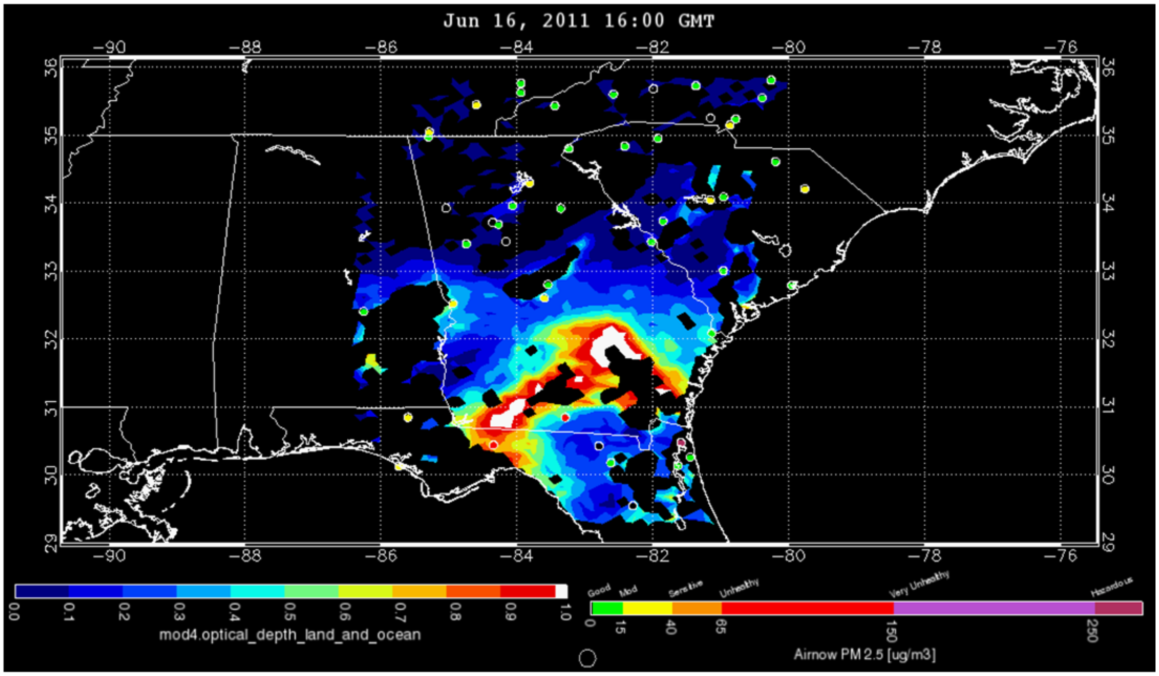


Figure 17.52: Aerosol Optical Depth with MODIS AOD Terra Imagery, June 16, 2011

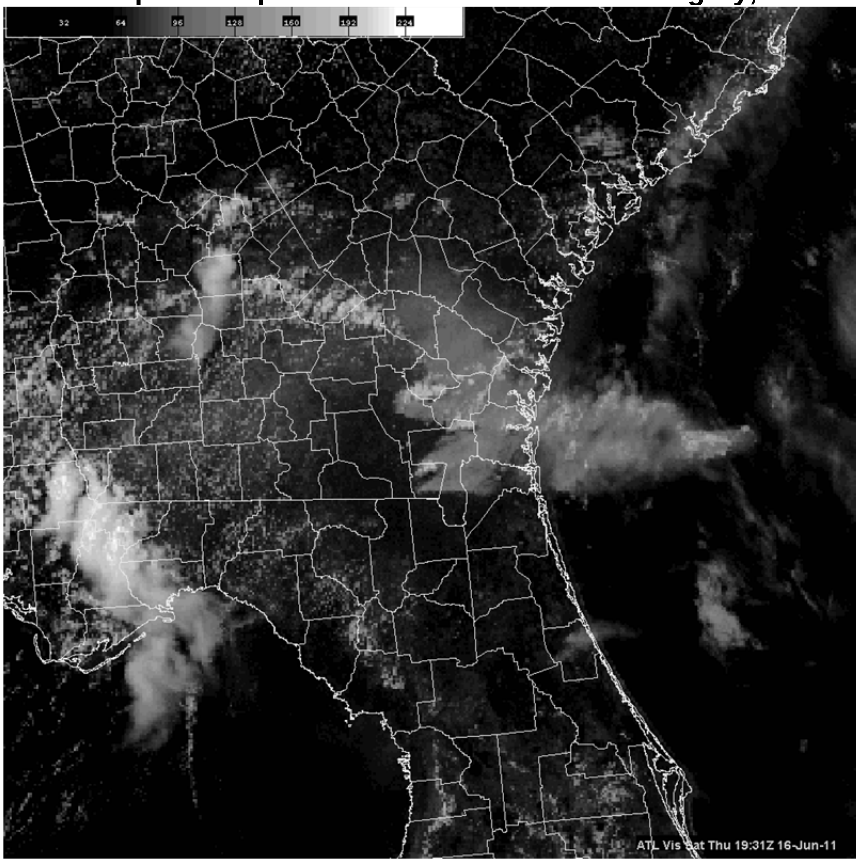


Figure 17.53: Satellite Imagery Showing the Development of Pyro-Cumulus on June 16, 2011

A similar increase in particle pollution occurred in early July around the Savannah area under south-southwesterly flow conditions on July 5th and 6th. Figure 17.54 shows this increase in $PM_{2.5}$ levels for the Savannah L&A monitoring site on July 5th. Elevated aerosol optical depth imagery from GOES East Aerosol Smoke Product occurred in concert with the particle pollution increase. Further surface and upper air meteorological analysis, although not shown, verified transport of smoke pollution from the same wildfire activity as described above. Both of the above cases indicate that transport from wildfire activity can play a major role in elevated particle pollution events across South Georgia and northern Florida.

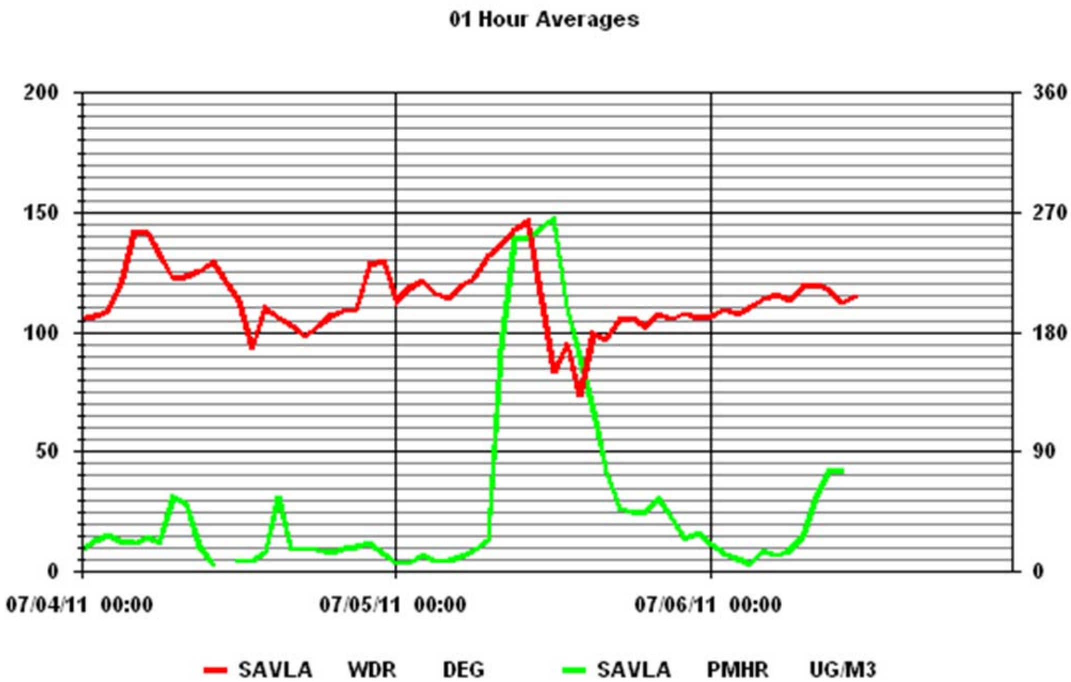


Figure 17.54: Wind Direction and Continuous $PM_{2.5}$ at Savannah L&A Site on July 5, 2011

17.4.4 Case Study for January 1, 2012

One interesting $PM_{2.5}$ episode, a possible exceptional event, occurred at the beginning of the year due to New Year's Eve local fireworks. Figure 17.55 shows the increase in $PM_{2.5}$ levels occurring between midnight and noon on New Year's Day. This increase could have been further enhanced by prefrontal pooling ahead of an approaching strong wintertime cold front. The 12Z rawinsonde from Peachtree City (Figure 17.56) shows strong winds aloft due to an increasing polar jet along with a surge of cold air advection. GASP aerosol optical imagery (Figure 17.57) shows some enhancement of aerosol optical depth (AOD) around the Atlanta-Sandy Springs-Roswell MSA, possibly due to smoke from fireworks. However, there is also increasing cloudiness associated with the frontal passage during the pass, which makes it somewhat difficult to separate the cloud optical thickness from the smoke AOD.

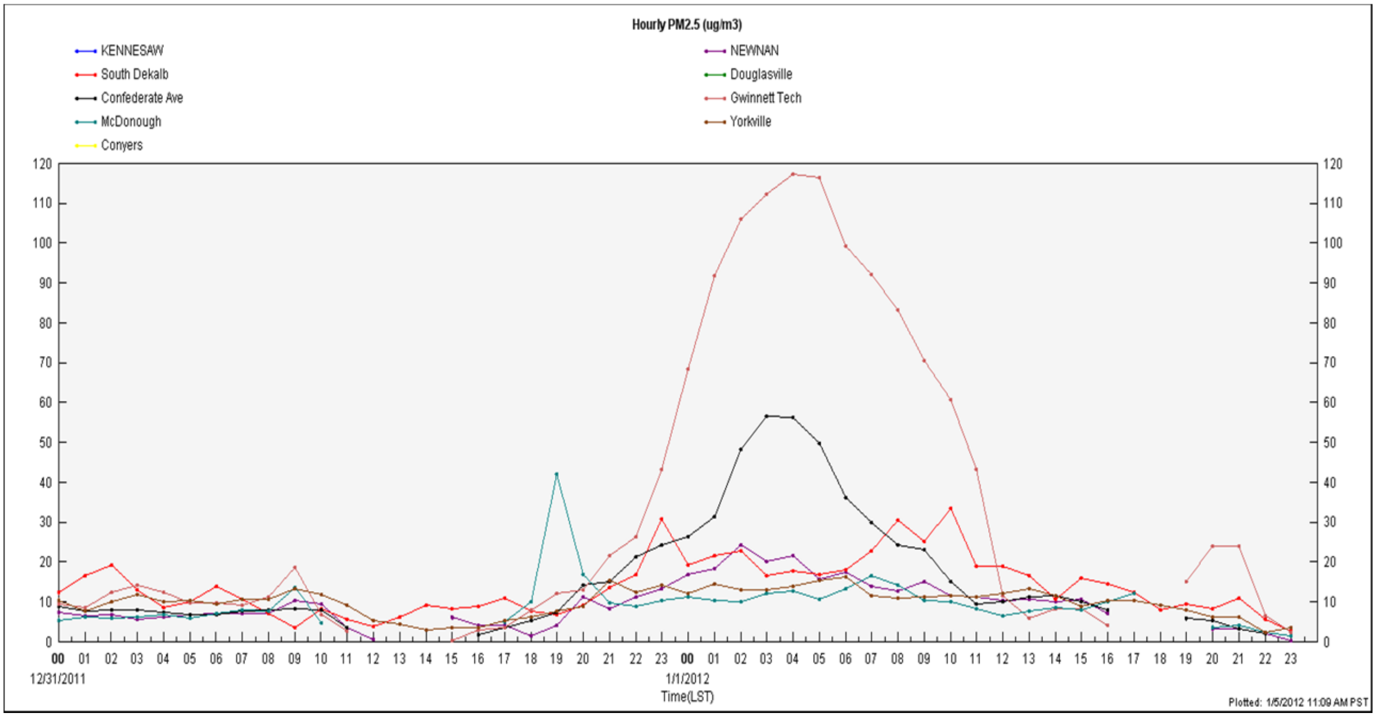


Figure 17.55: Time Series of Hourly $PM_{2.5}$

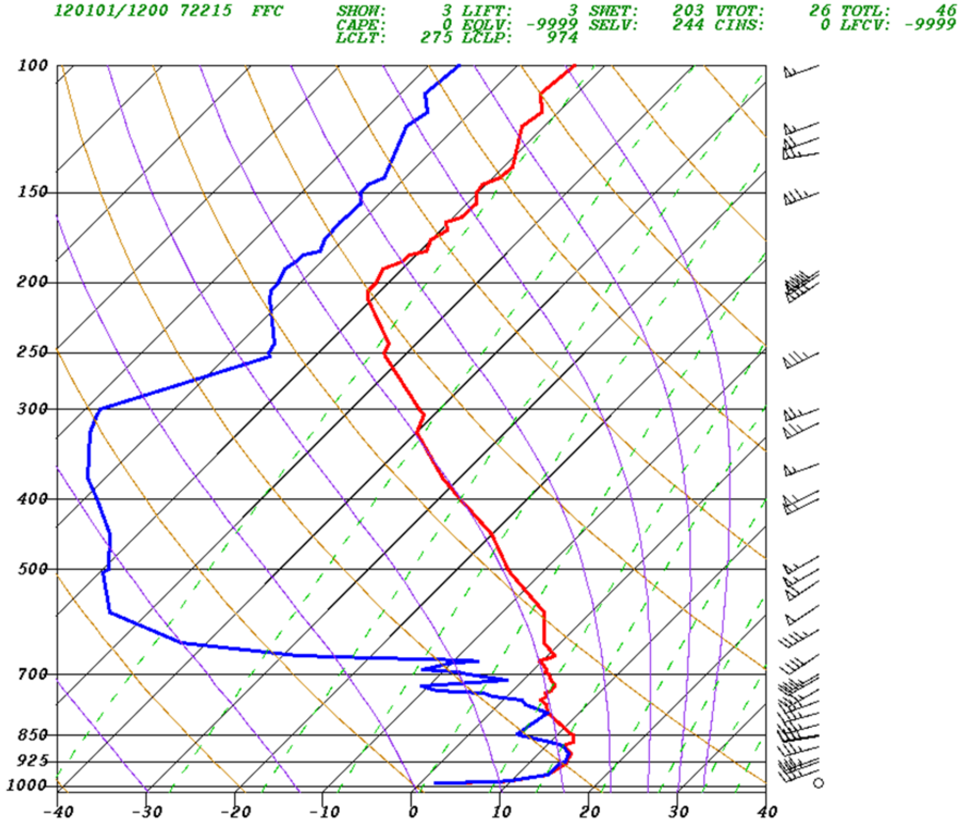


Figure 17.56: 12Z Rawinsonde from Peachtree City, GA

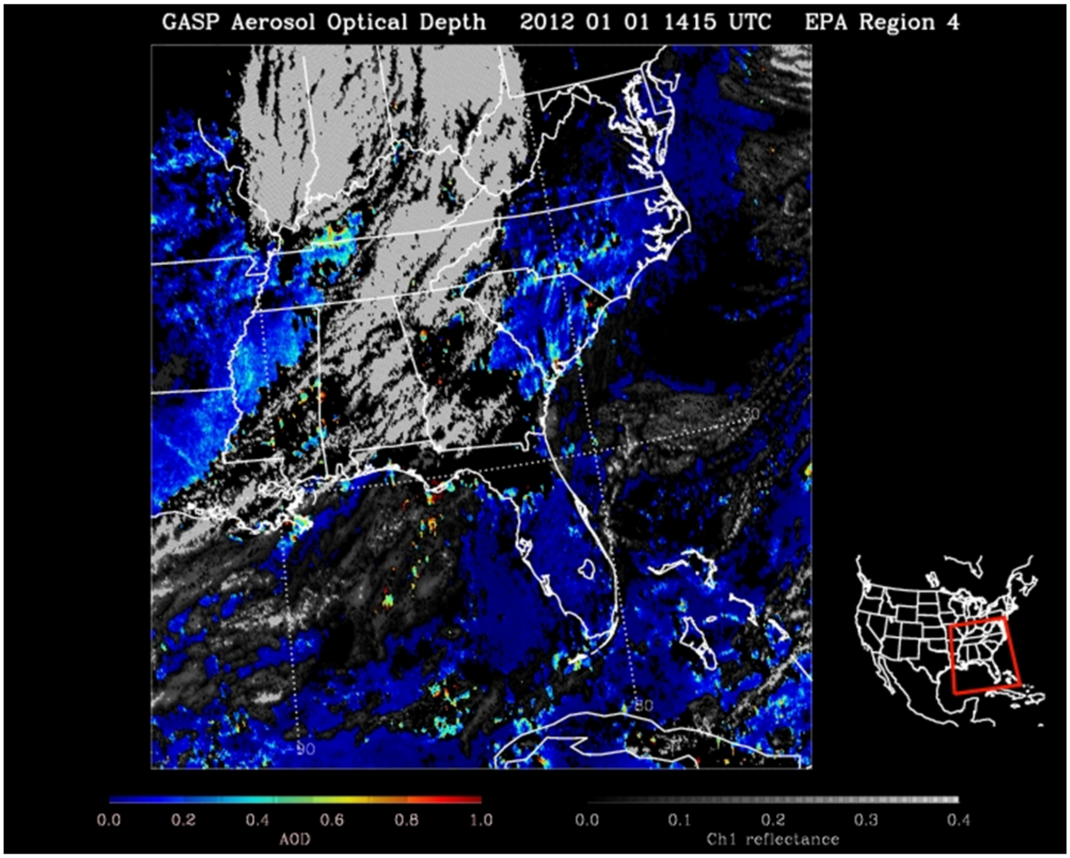


Figure 17.57: GASP Aerosol Optical Imagery

17.5 Wind and Pollution Roses

The meteorological group produced quarterly and annual wind roses, as well as PM2.5 and ozone pollution wind roses where available, for 2009 through 2013. These figures can be found in Appendix C: Wind and Pollution Roses, 2011-2013. When compared to historical climatological data, dating back to 1942 in some cases, some differences were seen in the data sets. For instance, the historical wind roses for the Columbus area show the predominant wind direction to be ENE and secondary wind direction from the NW. This data is representative of an annual average of 1967 through 1971 and 1970 through 1999. For the annual and quarterly averages from 2011 through 2013, the predominant wind direction in the Columbus area appears to be from the North, with secondary winds from NNE and ENE. Another example of the differences in the two data sets is with the Savannah area data. The historical data from 1951 through 1960 shows the predominant annual wind direction from the NE. With the 2011 through 2013 data, the predominant annual wind direction is from the WNW, while the quarterly data showed the predominant wind direction from the WSW. The differences in the data sets could be attributed to the averaging time involved. The historical data averaged a longer timeframe, while the more recent work averaged shorter timeframes. The historical data averaged several years, while the 2011-2013 data sets examined an average of one year or one quarter. In addition, the historical data was based on National Weather Service data, and the more recent averages are based on GA EPD data.

18.0 Photochemical Assessment Monitoring Stations (PAMS) Assessment

18.1 General Information

Ozone is the most prevalent photochemical oxidant and an important contributor to photochemical pollutants. The understanding of the chemical processes in ozone formation and the specific understanding of the atmospheric mixture in nonattainment areas nationwide are essential. To better understand the chemical processes and develop a strategy for solving those problems, EPA revised the ambient air quality surveillance regulations. In February 1993, Title 40, Part 58 of the Code of Federal Regulations (40 CFR Part 58) was developed to include provisions for enhanced monitoring of ozone, oxides of nitrogen, volatile organic compounds (VOCs), select carbonyl compounds, and the monitoring of meteorological parameters. These parameters would be monitored at Photochemical Assessment Monitoring Stations (PAMS). Stated in Title 40, Part 58 of the Code of Federal Regulation (40 CFR Part 58), the increased monitoring of ozone and its precursor concentrations allows for the characterization of precursor emissions within the area, transport of ozone and its precursors, and the photochemical processes leading to nonattainment. By expanding on the study of ozone formation, PAMS monitoring sites better serve as a means to study trends and spatial and diurnal variability.

PAMS measurements are performed to support the regulatory, analytical, and public health purposes of the program. By performing these measurements, GA EPD can better serve two major goals. First, by studying local atmospheric chemistry, it improves the ability to control the formation of secondary pollutants like ozone and particulate matter. Second, GA EPD is monitoring the concentration of pollutants (aside from the defined criteria air pollutants) expected to be harmful to human health, but do not have standards. By making such data available, scientists who study human health as it relates to air quality can study how these pollutants may affect human health. When this understanding is further refined, their data can serve to guide policymakers toward making decisions that protect public health.

According to EPA, PAMS monitoring was to be implemented in cities that were classified as serious, severe, or extreme for ozone nonattainment. The classifications were based on the number of exceedances of the ozone standard, and the severity of those exceedances. Nineteen areas nationwide were required to implement a PAMS network. In the Atlanta metropolitan area, a network of four sites was established beginning in 1993 (Yorkville (13-223-0003), South DeKalb (13-089-0002), Tucker (13-089-3001), and Conyers (13-247-0001)). The monitoring sites were selected depending on the pollutants monitored in relation to the prevailing winds in the area. Until the end of 2006, this was the setup of the PAMS network. At the end of 2006, the Tucker site was shut down. From that point, South DeKalb has served as the urban core-type site.

The Yorkville site is a Type 1 site. This is a rural background site that characterizes the upwind background, transported ozone, and precursor concentrations entering the Atlanta Metropolitan area. The site is located in the predominant morning upwind direction approximately 40 miles from the Atlanta urban fringe area in Paulding County, and should not be influenced by local VOC and NO_x emissions. The site provides urban scale measurements. Data from the Yorkville site is used for the future development and evaluation of control strategies, identification of incoming pollutants, corroboration of NO_x and VOC emission inventories, establishment of boundary conditions for future photochemical grid modeling and mid-course control strategy changes, development of incoming pollutant trends, and determination of attainment with NAAQS for O_3, $PM_{2.5}$, CO, and NO_2.

The South DeKalb site is a Type 2 site. The South DeKalb site is the primary wind direction, respectively, for an urban core-type site. This site is expected to measure the highest precursor concentrations of NO_x and VOCs in the Atlanta area. The South DeKalb site monitors the magnitude and type of precursor emissions and are located immediately downwind of the area of maximum precursor emissions receiving the predominant morning downwind wind. This site is located in DeKalb County in order to provide neighborhood scale measurements in the area that the precursors have the greatest impact. The data measurements generated at South DeKalb site are used principally for development and evaluation of imminent and future control strategies, corroboration of NO_x and VOC emission inventories, augmentation of RFP tracking, verification of photochemical grid model performance, characterization of ozone and toxics air pollutant exposures, development of pollutant trends (particularly toxic air pollutants and annual ambient speciated VOC trends) to compare with trends in annual VOC emission estimates, and determination of attainment with NAAQS for O_3, $PM_{2.5}$, CO, and NO_2.

The Conyers site acts as the Type 3 site. The Conyers site is the downwind site where titration of the precursors has occurred and the ozone concentrations should be at their highest. This site monitors the maximum ozone concentrations occurring downwind from the area of maximum precursor emissions, in Rockdale County. The site is an urban scale location based on the afternoon winds occurring between 1:00 PM and 4:00 PM, when titration of the precursors has occurred and the ozone is at its highest concentration. The data measurements are used in determination of attainment with the NAAQS for O_3 and NO_2, evaluation of future photochemical grid modeling applications, future development and evaluation of control strategies, development of pollutant trends, and characterization of ozone pollutant exposures.

The current PAMS network is shown in Figure 18.1.

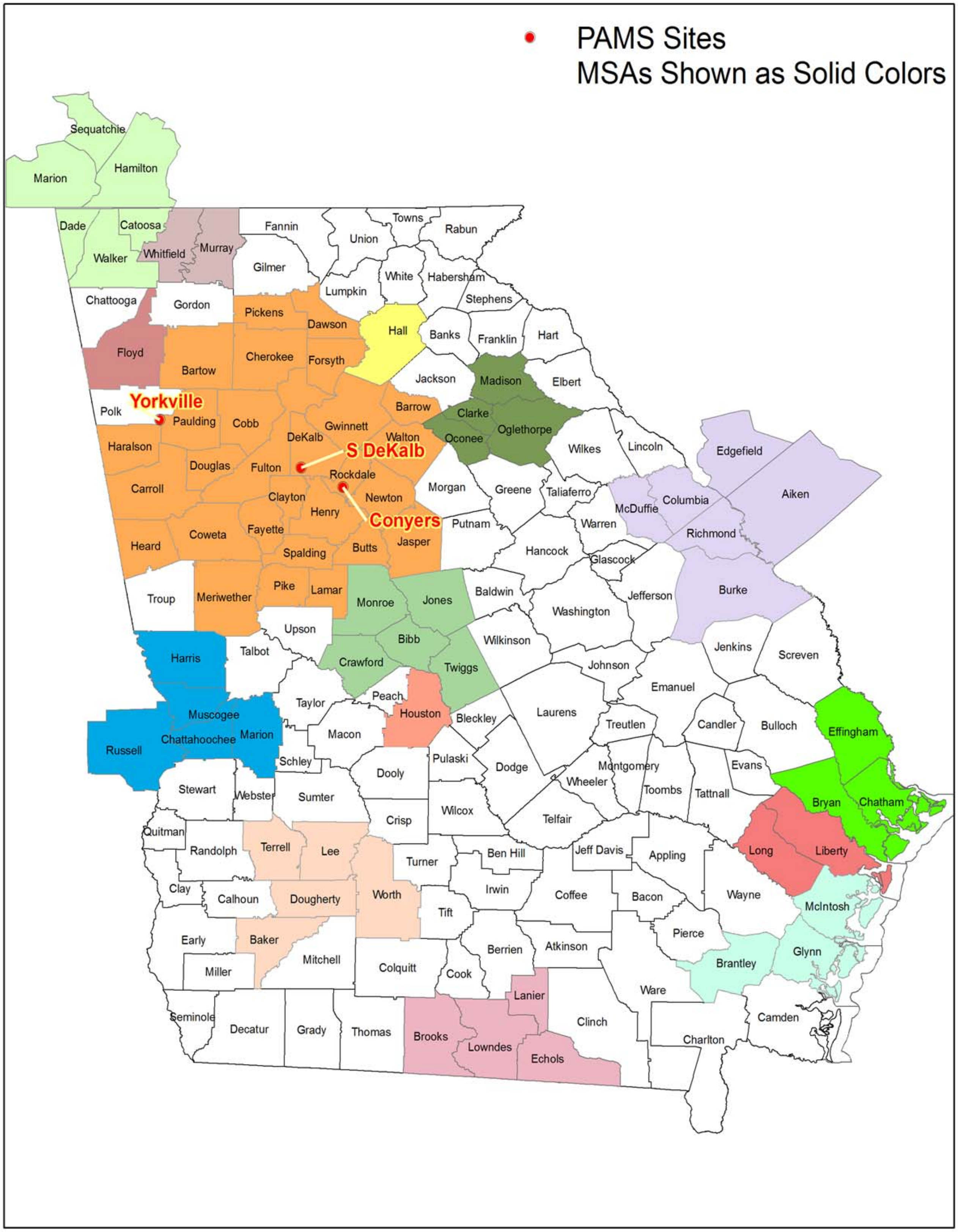


Figure 18.1: Georgia PAMS Monitoring Sites, MSAs Shown as Solid Colors

Using the EPA's 'Designing a Network Assessment for an Ambient Air Monitoring Program' document as guidance, the following PAMS assessment was performed to: 1) address whether ozone exceedances are NO_x or VOCs limited; 2) show how the PAMS data relates to State Implementation Plans (SIPs); 3) identify target emission pollutants in the SIPs; 4) identify pollutants targeted for emission reduction; 5) identify PAMS data used to assess progress in control programs; 6) assess air pollution being transported into PAMS areas; 7) assess if PAMS station are still properly sited; 8) assess if the PAMS network still meets the network design requirements; 9) discuss how the requirements for upper air measurements are being met.

18.1.1 Ozone

Ozone is a colorless gas; however, when mixed with particles and other pollutants, such as NO_2, the atmospheric reaction forms a brownish, pungent mixture. Ground level ozone formation occurs through a complex series of photochemical reactions that take place in the presence of strong sunlight. Since the reactions must take place in the presence of sunlight, ozone concentrations have a strong diurnal pattern (occurring daily and in daylight hours). Figure 18.2 shows this typical diurnal pattern of ozone concentration throughout the day.

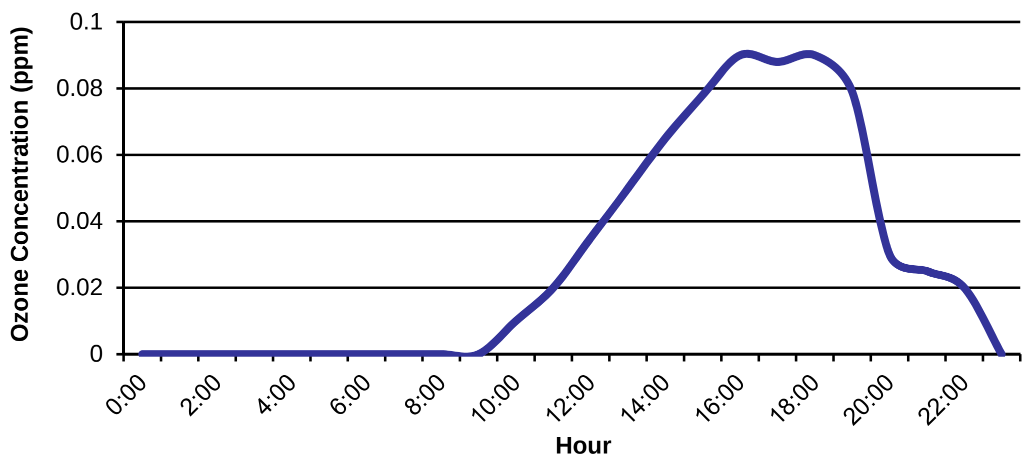
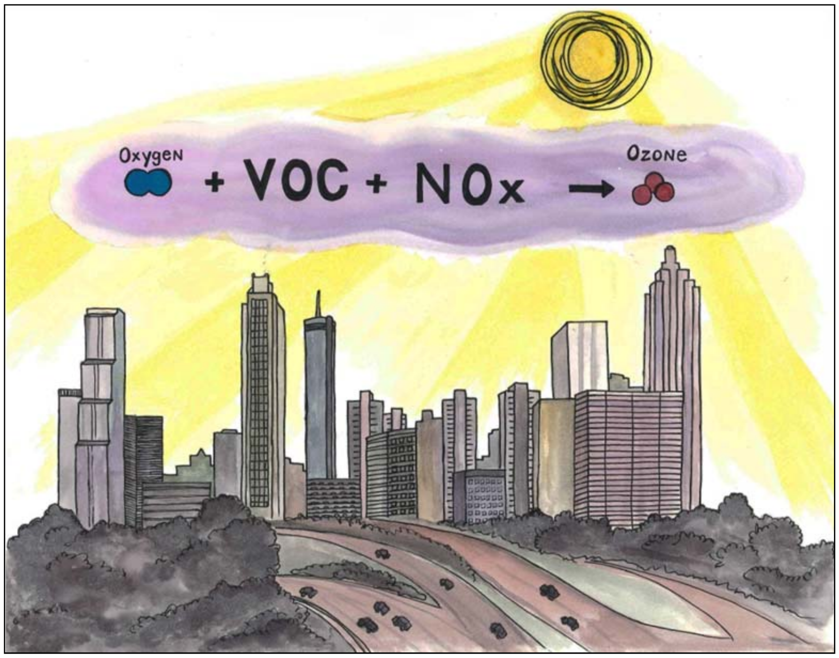


Figure 18.2: Typical Urban 1-hour Ozone Diurnal Pattern

For these photochemical reactions to take place, certain components, or precursors, must be available. The precursors to ozone are oxides of nitrogen (NO_x) and photochemically reactive volatile organic compounds (VOCs) (Figure 18.3). Common sources of NO_x include combustion processes from vehicles and industrial processes. Examples of the reactive VOCs that contribute to ozone formation are: hydrocarbons found in automobile exhaust (benzene, propane, toluene); vapors from cleaning solvents (toluene); and biogenic emissions from plants (isoprene).



(Courtesy of Jamie Smith)

Figure 18.3: Ozone Formation Process

18.1.2 Volatile Organic Compounds

Sources of volatile organic compounds (VOCs) in Georgia are shown in Figure 18.4 followed by a spatial view of VOC emissions across the state in Figure 18.5. In Georgia, biogenic emissions are the most common source of volatile organic compounds. These figures are taken from the latest emissions report from EPA, based on 2011 data.

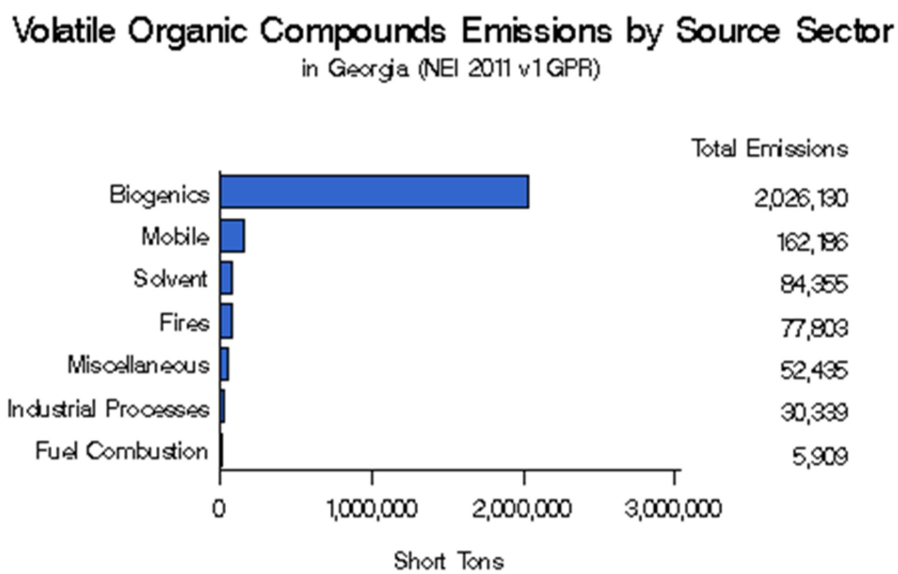


Figure 18.4: Common Sources of VOCs in Georgia in 2011

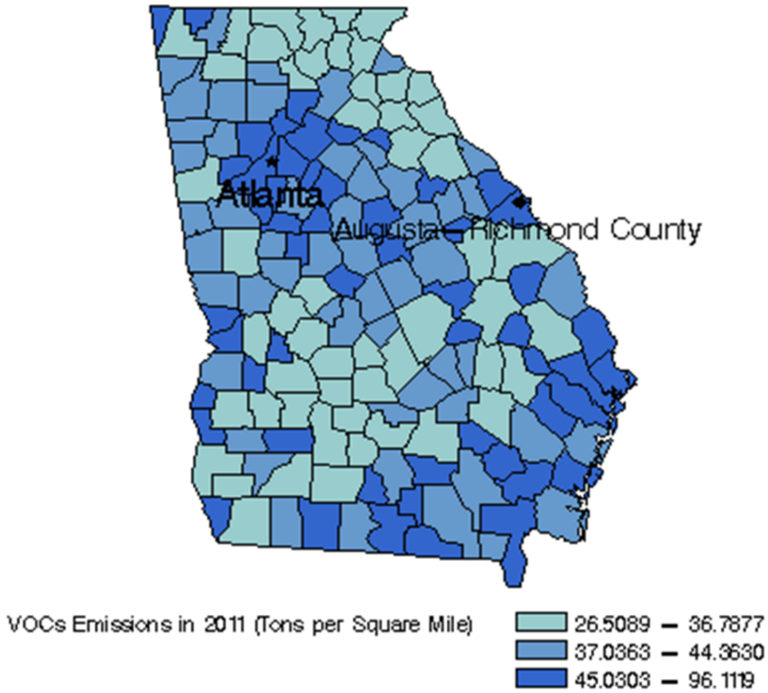


Figure 18.5: Spatial View of VOCs Emissions in Georgia

Figure 18.6 shows the seasonal occurrence of isoprene, the tracer for VOCs emissions from vegetation, from 2003 to 2013. Isoprene is a 5 carbon organic compound naturally released on a seasonal basis in large quantities by conifer trees native to Georgia. This figure represents a combination of the 6-day, 24-hour data shown as monthly averages over the eleven years from the three PAMS sites, and concentrations are given in parts per billion carbon (ppbC). Evidence of isoprene's natural seasonal origin is shown in this figure, where the ambient concentration is essentially non-existent from November to May.

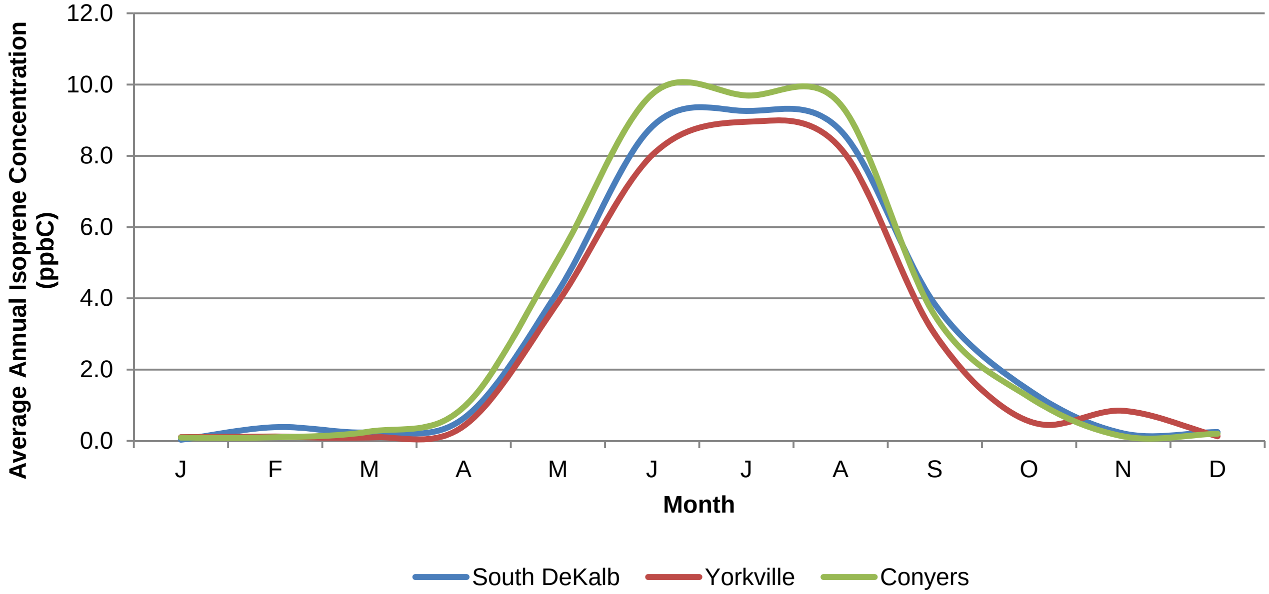


Figure 18.6: Average Yearly Profile of Isoprene, 2003-2013

The anthropogenic VOCs compounds detected at all sites with the highest ozone formation potential are toluene, m/p xylene, propylene, ethylene, and isopentane. The sources for these five compounds are varied. All five compounds are emitted by mobile sources, with ethylene being an important tracer for vehicle emissions. Toluene (generally the most abundant species in urban air), m/p xylene, and isopentane are also emitted by solvent use and refinery activities. Toluene reaches the air from a variety of sources such as combustion of fossil fuels and evaporative emissions. This hydrocarbon is in motor vehicle fuel and is also used as a common solvent in many products such as paint. It has a substituted benzene ring possessing modest atmospheric reactivity. Figure 18.7 compares the seasonal occurrence of toluene with monthly averaged data from 2003 through 2013. Again, this figure is a combination of the 6-day, 24-hour data from the three PAMS sites, and concentrations are given in parts per billion carbon (ppbC).

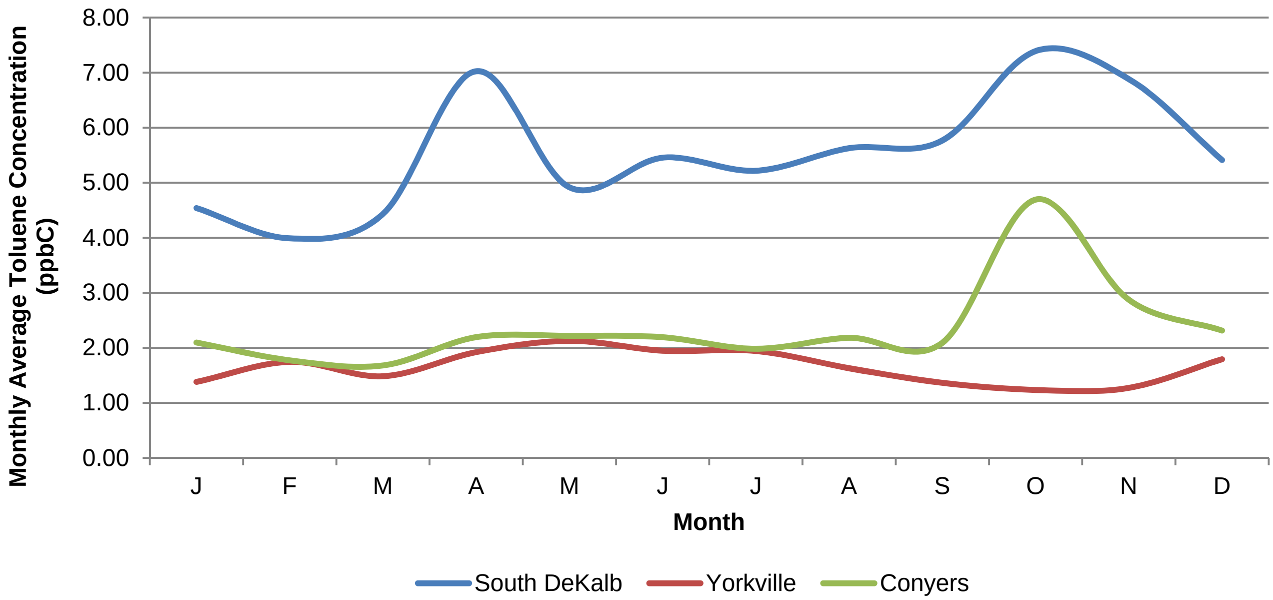


Figure 18.7: Toluene Average Annual Occurrence, 2003-2013

As shown in Figure 18.7, the atmospheric levels of toluene are relatively constant throughout the year, suggesting a steady level of emissions year-round. Over the past eleven years, an occasional spike in concentration has occurred without evidence of a pattern. Overall, the PAMS site that is situated in the urban area (South DeKalb) has slightly higher levels of toluene, while the sites located on the outskirts of the Atlanta metropolitan area (Yorkville and Conyers) show lower levels of toluene.

As stated previously, ozone is formed when its precursors come together in the presence of strong sunlight. The reaction only occurs when both precursors are present, and the reaction itself consumes the precursors as it produces ozone. The amount of ozone produced, assuming sufficient sunlight, is controlled by what is known as the "limiting reactant." Ozone production can only occur until the process has consumed all of any one of the required ingredients. As an example, natural background hydrocarbon levels are quite low in Los Angeles. Therefore, hydrocarbons are typically the reactant that limits how much ozone can be produced there. The control measures that involved reducing hydrocarbon emissions proved most effective in reducing smog in the Los Angeles area.

At the start of air quality control implementation in Georgia, the assumption was that Georgia was also hydrocarbon limited. However, the initial control measures seemed ineffective in actually reducing ozone levels. In time, researchers discovered that native vegetation naturally emits large quantities of hydrocarbons. Isoprene, the tracer for VOCs emissions from vegetation, is by far the largest contributor to ozone formation at all monitoring sites. Isoprene is a 5 carbon organic compound naturally released in large quantities by conifer trees. These trees are very abundant in the Southeastern United States, contributing a significant portion to the overall carbon loading of the atmosphere in this region. Isoprene's chemical structure makes it a highly reactive substance with a short atmospheric lifetime and large ozone forming potential. The solution to ozone control in Georgia, then, would have to focus on a different limiting reactant. Since there will always be strong sunshine in the summer, and there will always be oxygen, the only effective way left to control ozone production is to reduce emissions of oxides of nitrogen.

18.1.3 Oxides of Nitrogen

Oxides of nitrogen exist in various forms in the atmosphere (Table 18.1). The most common is nitric oxide (NO), but other forms such as nitrogen dioxide (NO_2), nitric acid (HNO_3) and dinitrogen pentoxide (N_2O_5) are also present. The bulk of these compounds in the atmosphere are produced from high temperature combustion and lightning. Nitrogen is a very stable molecule and is essentially inert unless subjected to extreme conditions. The oxides of nitrogen are less stable, however, and are key participants in atmospheric chemistry, converting back and forth between numerous states under different conditions. Many of these reactions involve the conversion of oxygen atoms between their atomic (O_2) and ozone (O_3) forms. As such, oxides of nitrogen are studied as precursors of (and alternately by-products of) ozone formation. With the many forms of oxides of nitrogen in the atmosphere, they are sometimes referred to using the generic terms NO_x or NO_y. Nitric acid (HNO_3) is the most oxidized form of nitrogen in the atmosphere. This species is water-soluble and is removed from the atmosphere in the form of acidic raindrops.

NO is changed to NO_2 in very rapid atmospheric reactions. During daylight hours, ultraviolet (UV) radiation from the sun breaks apart NO_2 into NO and free oxygen (O). The free oxygen atom (O) will attach itself to molecular oxygen (O_2) creating an ozone (O_3) molecule. This is the origin of the majority of ground level ozone. With the UV radiation breaking apart the NO_2 and N_2O_5, daytime levels are low. Then the concentrations rise rapidly overnight with the lack of UV radiation. When the sun rises again in the morning, the compounds are converted back to NO and ozone. Figure 18.8 is a representation of the typical diurnal pattern of $NO_{2.}$

Abbreviation	Full Name	Creation Processes	Elimination Processes
NO	Nitrous Oxide	Result of ozone photochemistry High-temperature combustion	Reacts with ozone to form NO_2 and oxygen
NO_2	Nitrogen Dioxide	High-temperature combustion Reaction of NO and ozone	Reacts with oxygen in strong sun to form ozone plus NO "washes out" in rain
HNO_3	Nitric Acid	$NO_2 + H_2O$	"washes out" in rain
PAN	Peroxyacetyl Nitrate	Oxidation of hydrocarbons in sunlight	Slow devolution to NO_2
NO_x	Name for NO + NO_2		
NO_y	Name for all atmospheric oxides of nitrogen- mostly NO, $NO_{2,}$ $HNO_{3,}$ N_2O_5, and PAN		

Table 18.1: Common Oxides of Nitrogen Species and Terms

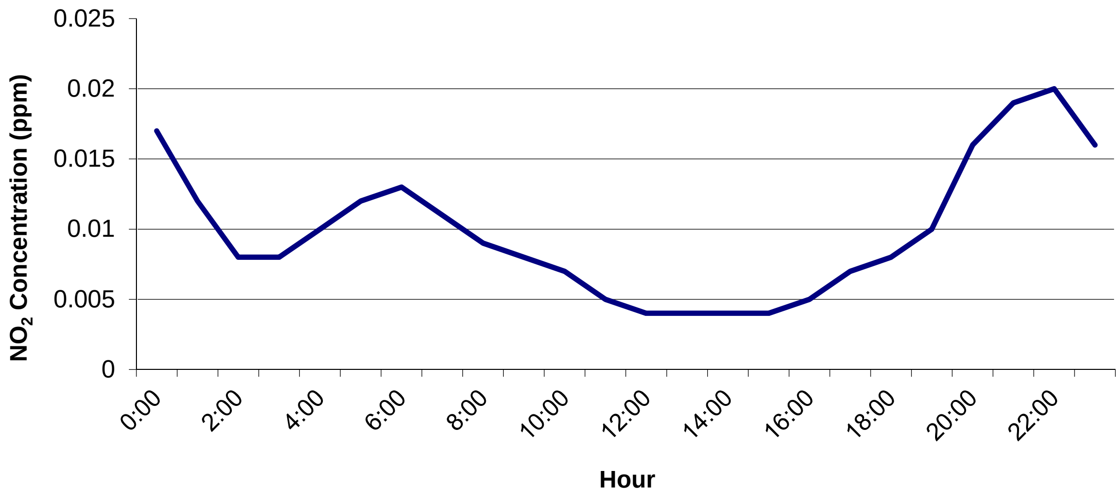


Figure 18.8: Typical Diurnal Pattern of Nitrogen Dioxide

Nitrogen dioxide (NO_2) is one of the important oxides of nitrogen. It is a light brown gas, and can be an important component of urban haze, depending upon local sources. Nitrogen oxides usually enter the air as the result of high-temperature combustion processes, such as those occurring in automobiles and industries (Figure 18.9). Home heaters, gas stoves, and non-road equipment also produce substantial amounts of NO_2. NO_2 is formed from the oxidation of nitric oxide (NO), which has a pungent odor at high concentrations and a bleach smell at lower concentrations. NO_2 is a precursor to ozone formation and can be oxidized to form nitric acid (HNO_3), one of the compounds that contribute to acid rain. Nitrate particles and NO_2 can block the transmission of light, reducing visibility.

Figure 18.10 shows a spatial view of the varying concentrations of nitrogen oxides by county in Georgia during 2011. Figures 18.9 and 18.10 are taken from the latest emissions report from EPA, based on 2011 data.

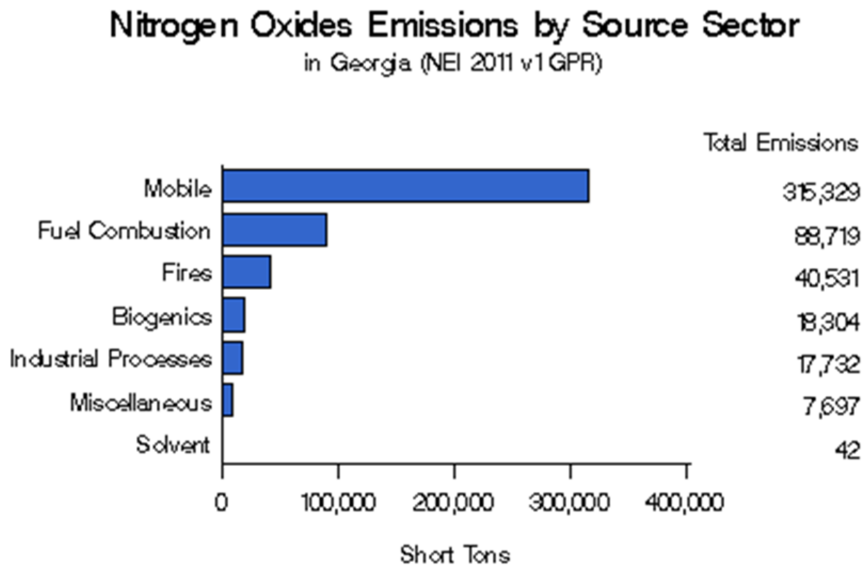


Figure 18.9: Common Sources of Nitrogen Oxides in Georgia

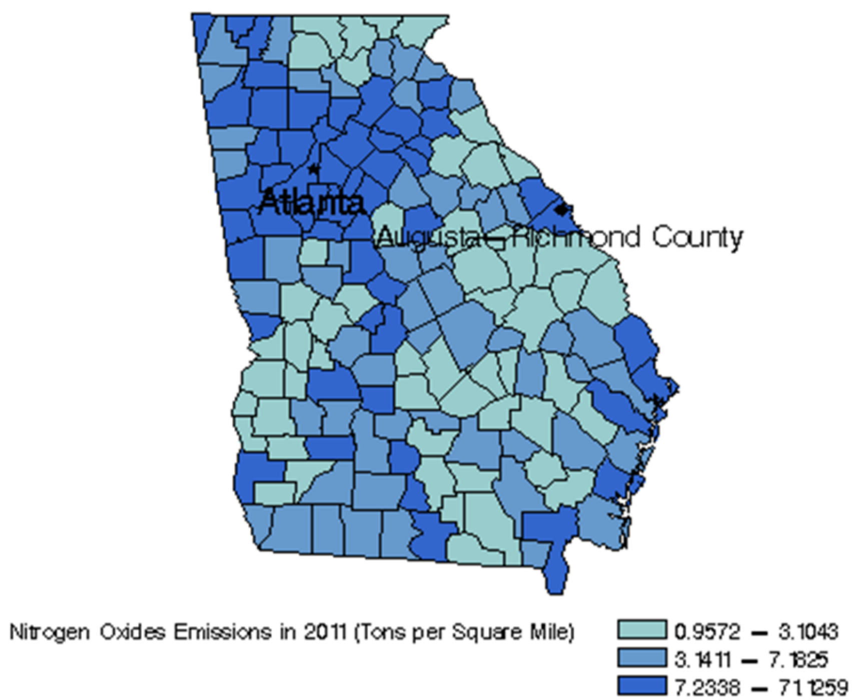


Figure 18.10: Spatial View of Nitrogen Oxides Emissions in Georgia

Efforts are being taken to reduce the emissions of harmful nitrogen oxides. School bus retrofitting, truck stop electrification, and locomotive conversions are three alternative methods that are being used to reduce emissions. School bus retrofitting focuses on older school buses that are being fitted with an emission control device to reduce emitted NO_x. A specific type of retrofit known as selective catalytic reduction (SCR) reduces output by converting nitrogen oxides to molecular nitrogen and oxygen-rich exhaust streams. SCR systems are enhanced by using a low sulfur fuel. The amount of sulfur in diesel was recently reduced by 97 percent, creating low sulfur fuel. As sulfur tends to hamper exhaust-control devices, the introduction of low sulfur fuel has allowed retrofitting to be an effective means of reducing emissions.

Truck stop electrification (TRE) reduces idling by diesel powered commercial trucks. Truck drivers are typically required to rest 8 hours for every 10 hours of travel time. During this resting period, diesel engines are idled as a means to power their air conditioning and heating systems. TRE eliminates this diesel dependence by providing an electrical system that charges battery-powered appliances including air conditioning, heating, and other electronic devices. In addition, cool or warm air is pumped into the trucks via a hose hookup at the truck stops as another method of cutting down on idling and emissions. All of this reduces oxides of nitrogen that would be produced by unnecessary idling.

Locomotive conversions reduce emissions by replacing old single diesel engines used by switch locomotives with smaller, more efficient modular diesel engines. Switch locomotives, or switchers, assemble and disassemble trains at rail yards. When they are not in action, they idle on the rails until another train comes along. The new engines, known as “genset” and eventually Tier 4 engines, utilize two or more smaller engines that can combine to equal the strength of the older engines to pull the maximum load. They can function individually, or with less horsepower, to handle less demanding loads, while cutting down on the fuel needed to perform the task. These lower-emitting off-road diesel engines also feature an automatic engine start/stop technology to reduce idling when not in use.

18.2 State Implementation Plan

To address whether ozone exceedances are NO_x or VOC limited and how PAMS data relates to Georgia’s State Implementation Plan (SIP), a SEMAP modeling study “*Emissions and Air Quality Modeling for SEMAP*” is discussed. This modeling study is referenced in the Georgia SIP “*DRAFT Revision to the Georgia State Implementation Plan for the Removal of Georgia Rules for Consumer and Commercial Products and for Gasoline Marketing, and for the Revision of the Georgia Rule for NOx Emissions from Stationary Gas Turbines and Stationary Engines used to Generate Electricity”* dated December 22, 2014. This study shows that NO_x controls are more effective at ozone reduction. The SIP targets both NO_x and VOCs emission pollutants for reduction, which are both part of local and national controls. In addition, a case study of monitoring data at the South DeKalb site was performed to determine whether ozone formation is NO_x or VOC limited.

The following excerpt is taken from Appendix C of the SIP “*DRAFT Revision to the Georgia State Implementation Plan for the Removal of Georgia Rules for Consumer and Commercial Products and for Gasoline Marketing, and for the Revision of the Georgia Rule for NOx Emissions from Stationary Gas Turbines and Stationary Engines used to Generate Electricity”* dated December 22, 2014:

‘APPENDIX C - SENSITIVITY OF OZONE IN ATLANTA TO NOx AND VOC EMISSIONS

As part of the ***S****outh****E****astern* ***M****odeling,* ***A****nalysis, and* ***P****lanning (SEMAP) project, Georgia Tech performed an analysis of the sensitivity of ozone concentrations in the Eastern U.S. to reductions in emissions of both nitrogen oxides (NOx) and volatile organic compounds (VOCs). This analysis was based off of the 2007 and 2018 SEMAP modeling which used CMAQ version*

5.01 with updates to the vertical mixing coefficients and land-water interface. The entire "ozone season" was modeled (May 1 – September 30) using a 12-km modeling grid that covered the Eastern U.S. Details of the modeling platform set-up and the detailed modeling results can be found in Appendix E.

Sensitivities were modeled relative to 2018 emissions to evaluate the impact of NOx and VOC reductions on daily 8-hour maximum ozone concentrations. Each emission sensitivity run reduced the 2018 anthropogenic NOx or VOC emissions (point, area, mobile, NONROAD, marine/aircraft/rail) within a specific geographic region by 30%. The 14 geographic regions included Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, West Virginia, Maryland, MANE-VU (minus MD), LADCO, and CENRAP. This resulted in a total of 28 model runs (2 precursors x 14 regions). The NOx and VOC sensitivities were evaluated at every ozone monitor in the domain.

GA EPD used the SEMAP NOx and VOC sensitivity modeling to examine the normalized sensitivities of NOx and VOC emissions on 8-hour daily maximum ozone concentrations (part per billion ozone/ton per day, ppb/TPD) at 10 ozone monitors in Atlanta. This analysis started with the day-by-day NOx and VOC emission sensitivities (ppb) for May 1 – September 30. Not all modeled days were used in the calculations. The criteria for selecting days to include in the calculation generally follows the approach used by EPA to select days to include in the relative response factor (RRF) calculation as described in EPA's "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze". For our analysis, the following criteria were used to select the days that would be included in the average sensitivity calculation to address the 2008 ozone NAAQS:

- *An initial threshold value of 75 ppb was used.*
- *If the 2018 modeled 8-hour daily maximum ozone concentration was at or above the threshold, then those days were included in the calculation.*
- *If at least 10 modeled days were at or above the initial threshold, then an average sensitivity was calculated based on those days.*
- *If fewer than 10 days were available, the threshold was dropped until 10 days were available or the minimum allowable threshold value of 70 ppb was reached.*
- *If there were fewer than four days available when the minimum allowable threshold value was reached, the minimum allowable threshold was lowered until at least four days were available to include in the average sensitivity calculation.*

The average absolute sensitivity was calculated for NOx and VOCs at each Atlanta ozone monitor location (Table 1). The average absolute NOx sensitivity across Atlanta is 6.396 ppb for a 30% reduction in NOx emissions across Georgia and the average absolute VOC sensitivity across Atlanta is 0.293 ppb for a 30% reduction in VOC emissions across Georgia.

Next, the average absolute sensitivity at each monitor was normalized by the emission reduction to give the normalized sensitivity (ppb/TPD). The SEMAP 30% emission reductions were statewide, but the ozone impacts at the Atlanta monitors will mostly results from the local NOx and VOC emission reductions in the nearby 15 ozone nonattainment counties. Therefore, it was not appropriate to normalize the local NOx and VOC sensitivity results by the statewide emission reduction. Instead, a conservative approach would be to assume the ozone impacts at the 10 Atlanta monitors resulted solely from the local NOx and VOC emission reductions in the nearby 15 ozone nonattainment counties. Therefore, the average absolute sensitivity was normalized by the emission reductions from NOx and VOC reductions in the nearby 15 ozone *nonattainment counties. The anthropogenic NOx emissions in the 15 ozone nonattainment counties are 281.5 TPD, so a 30% reduction is 84.5 TPD. The anthropogenic VOC emissions in the 15 ozone nonattainment counties are 280.0 TPD, so a 30% reduction is 84.0 TPD. The normalized sensitivity was calculated for NOx and VOCs at each Atlanta ozone monitor location (Table 2). The average normalized NOx sensitivity across Atlanta is 0.0757 ppb/TPD and the average normalized VOC sensitivity across Atlanta is 0.0035 ppb/TPD.*

Table 1. Absolute NOx and VOC sensitivity at 10 Atlanta ozone monitors.

AIRS ID	County	Site Name	30% NOx w/ 75 ppb threshold (ppb)	30% VOC w/ 75 ppb threshold (ppb)
13-067-0003	Cobb, GA	Kennesaw	-6.272	-0.380
13-077-0002	Coweta, GA	Newnan	-6.807	-0.148
13-085-0001	Dawson, GA	Dawsonville	-5.252	-0.059
13-089-0002	DeKalb, GA	South DeKalb	-6.515	-0.487
13-097-0004	Douglas, GA	Douglasville	-6.732	-0.350
13-121-0055	Fulton, GA	Confederate Ave.	-5.167	-0.644
13-135-0002	Gwinnett, GA	Gwinnett	-6.440	-0.222
13-151-0002	Henry, GA	McDonough	-7.341	-0.282
13-223-0003	Paulding, GA	Dallas /Yorkville	-5.849	-0.096
13-247-0001	Rockdale, GA	Conyers	-7.580	-0.262
		AVERAGE (ppb)	**-6.396**	**-0.293**

Table 2. Normalized NOx and VOC sensitivity at 10 Atlanta ozone monitors.

AIRS ID	County	Site Name	30% NOx w/ 75 ppb threshold (ppb/TPD)	30% VOC w/ 75 ppb threshold (ppb/TPD)
13-067-0003	Cobb, GA	Kennesaw	-0.0743	-0.0045
13-077-0002	Coweta, GA	Newnan	-0.0806	-0.0018
13-085-0001	Dawson, GA	Dawsonville	-0.0622	-0.0007
13-089-0002	DeKalb, GA	South DeKalb	-0.0771	-0.0058
13-097-0004	Douglas, GA	Douglasville	-0.0797	-0.0042
13-121-0055	Fulton, GA	Confederate Ave.	-0.0612	-0.0077
13-135-0002	Gwinnett, GA	Gwinnett	-0.0763	-0.0026
13-151-0002	Henry, GA	McDonough	-0.0869	-0.0034
13-223-0003	Paulding, GA	Dallas /Yorkville	-0.0693	-0.0011
13-247-0001	Rockdale, GA	Conyers	-0.0898	-0.0031
		AVERAGE (ppb/TPD)	**-0.0757**	**-0.0035**

These results show that NOx emission reductions are generally 15-25 times more effective than VOC emission reductions at reducing ozone concentrations. VOC emission increases can be converted into equivalent NOx emission reductions by taking the ratio of the Atlanta average normalized sensitivity to NOx emissions divided by the Atlanta average normalized sensitivity to VOC emissions:

- *(0.0757 ppb/TPD NOx)/(0.0035 ppb/TPD VOC) = 21.7 TPD VOC/TPD NOx*

In other words, a 21.7 TPD increase in VOC emissions is equivalent to a 1.0 TPD increase in NOx emissions. Hence, a 21.7 TPD increase in VOC emissions can be offset with a 1.0 TPD reduction in NOx emissions.'

Case Study: 2012 Georgia Ozone, NO_x, and VOC Correlations

An analysis of ambient air monitoring data at the South DeKalb site was performed to determine whether ozone formation is NO_x or VOCs limited. Figure 18.11 shows the daily maximum ozone (ppb), NO_x (ppb), and PAMS VOCs (ppbC) concentrations from 6/1/2012-8/31/2012 at the South DeKalb site. In addition, the daily maximum solar radiation (W/m^2), a key factor in ozone formation, is plotted on the secondary axis. The horizontal black line indicates the threshold for ozone violation (75 ppb); there were seven ozone violation days between 6/22/2012 and 7/6/2012. This graph shows that even when VOC concentrations are high (from 6/1-6/22) ozone concentrations stay relatively low. Ozone violation days seemed to occur when all three parameters (NO_x, VOC, and solar radiation) were high.

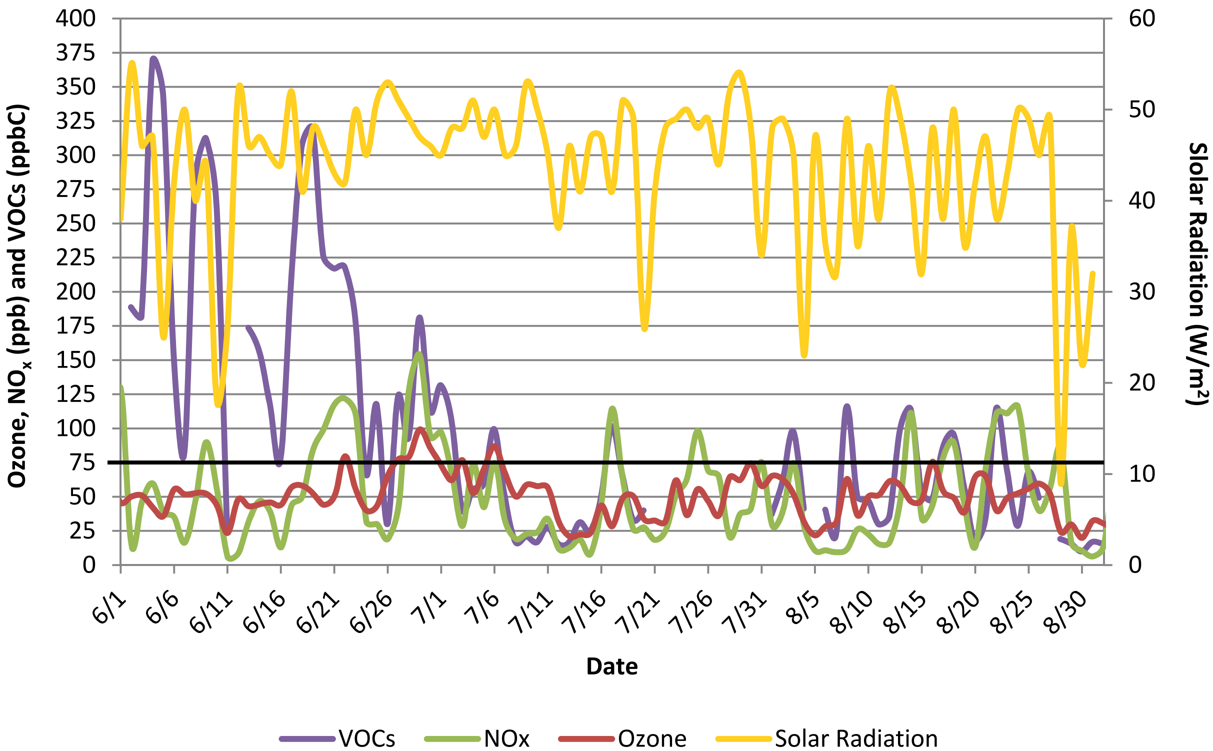


Figure 18.11: Daily Maximum Ozone, NO_x, and VOCs Concentrations and Solar Radiation at South DeKalb, 6/1/2012-8/31/2012

This data was used to create the scatter plots below (Figures 18.12 and 18.13). Daily max ozone concentrations were plotted against daily max NO_x (Figure 18.12) and VOCs concentrations (Figure 18.13) from 6/1/2012-8/31/2012. NO_x concentrations appear to be more highly correlated (r^2=0.247) to ozone than VOCs concentrations (r^2=0.026).

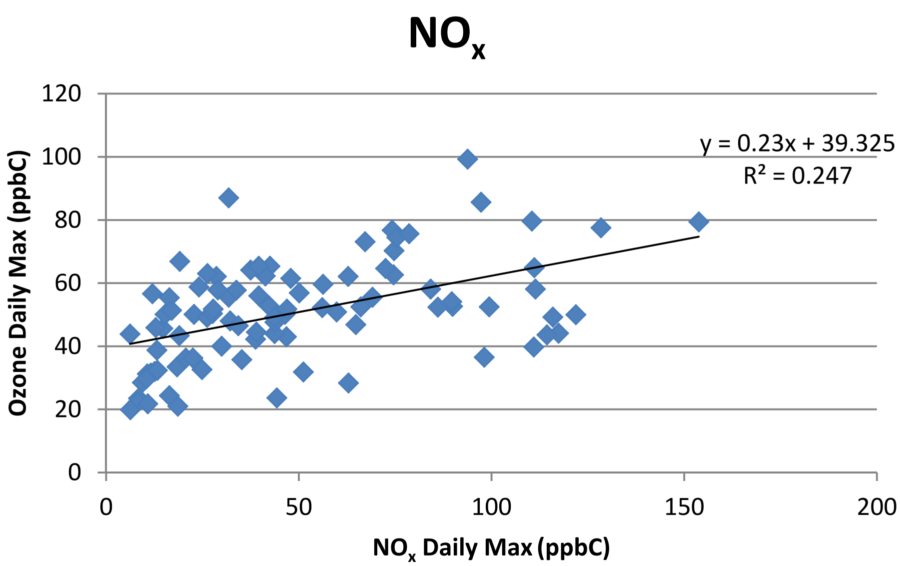
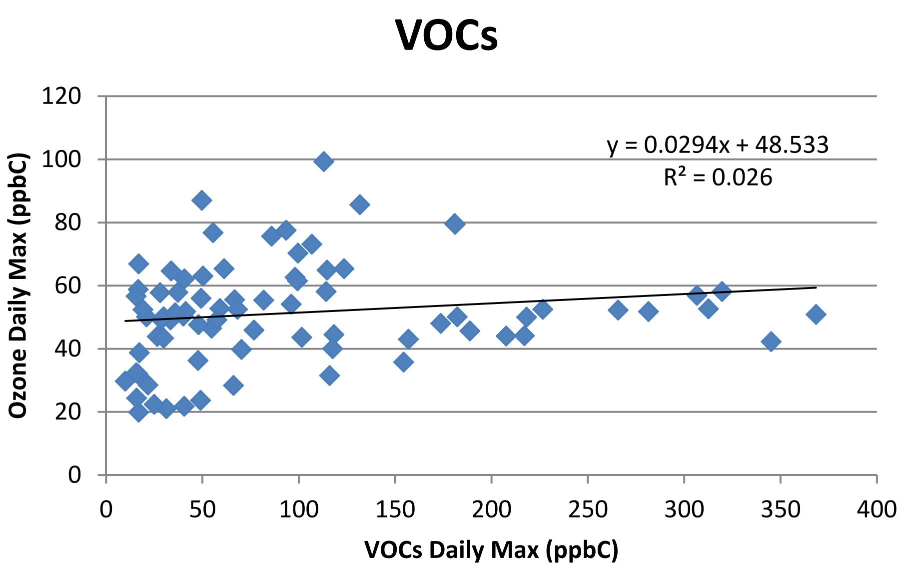


Figure 18.12: Ozone vs NO_x Daily Maximum Concentrations



Figures 18.13: Ozone vs VOCs Daily Maximum Concentrations

This data supports the results of the model previously mentioned that ozone formation is NO_x limited in Atlanta.

18.3 Assessment of Progress with Emission Control Programs

To address the PAMS data used to assess progress in the emission control programs, trends analyses were performed. Figure 18.14 shows the average annual 1-hour ozone concentrations for the three PAMS sites. The Conyers site seems to show the highest ozone concentrations for most years.

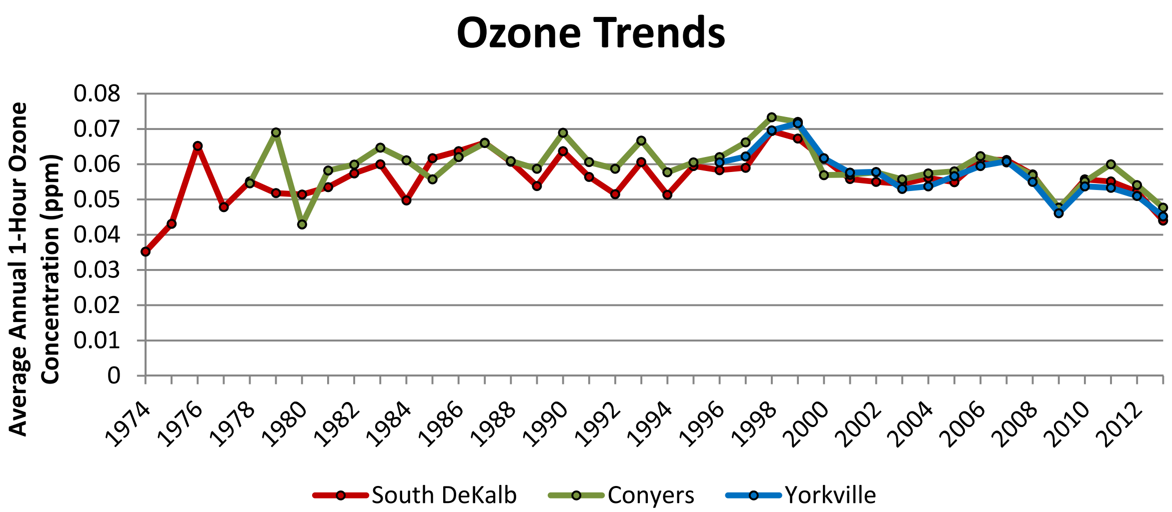


Figure 18.14: Average Annual 1-Hour Ozone Concentrations for South DeKalb, Conyers, and Yorkville 1974-2013

Figure 18.15 shows the annual average VOCs concentrations (ppbC) for hourly data (collected June 1 – August 31) at the three PAMS sites (South DeKalb, Conyers, and Yorkville). With the exception of 2012, VOCs concentrations remain higher at South DeKalb than the other sites and lowest at Yorkville. There is a general decreasing trend in VOCS concentrations at South DeKalb while at Conyers and Yorkville VOCs concentrations have a slight increasing trend until around 2011.

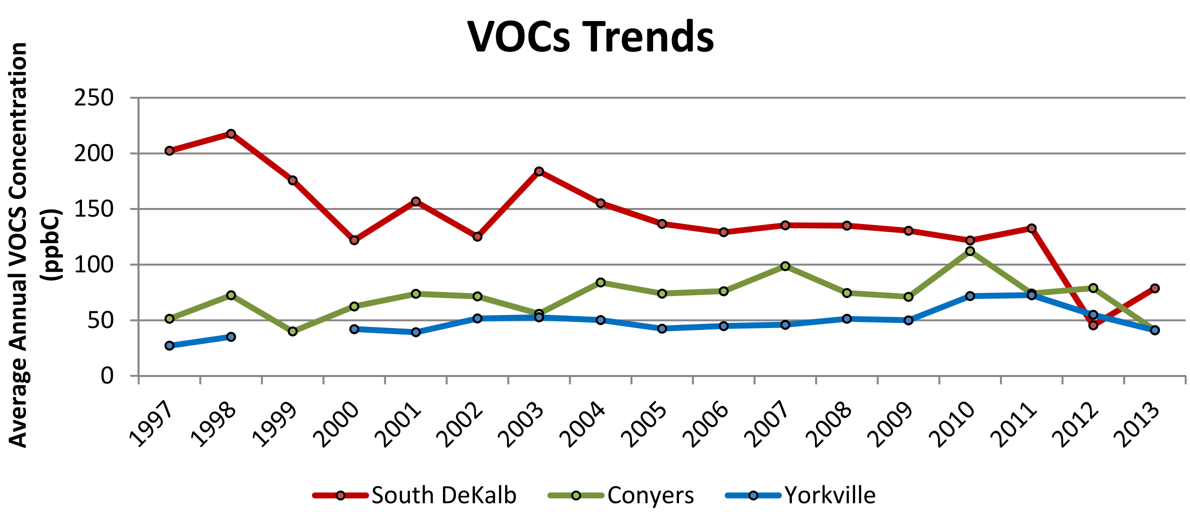


Figure 18.15: VOCs Average Annual Concentration for South DeKalb, Conyers, and Yorkville 1997-2013

Figure 18.16 shows the annual average NO_x from 1996-2013 at the PAMS sites. NO_x at South DeKalb are consistently 2-5 times higher than at Yorkville or Conyers, with Yorkville having the lowest concentrations for all years. All sites show a decreasing trend in concentrations, with reductions at South DeKalb being the most prominent.

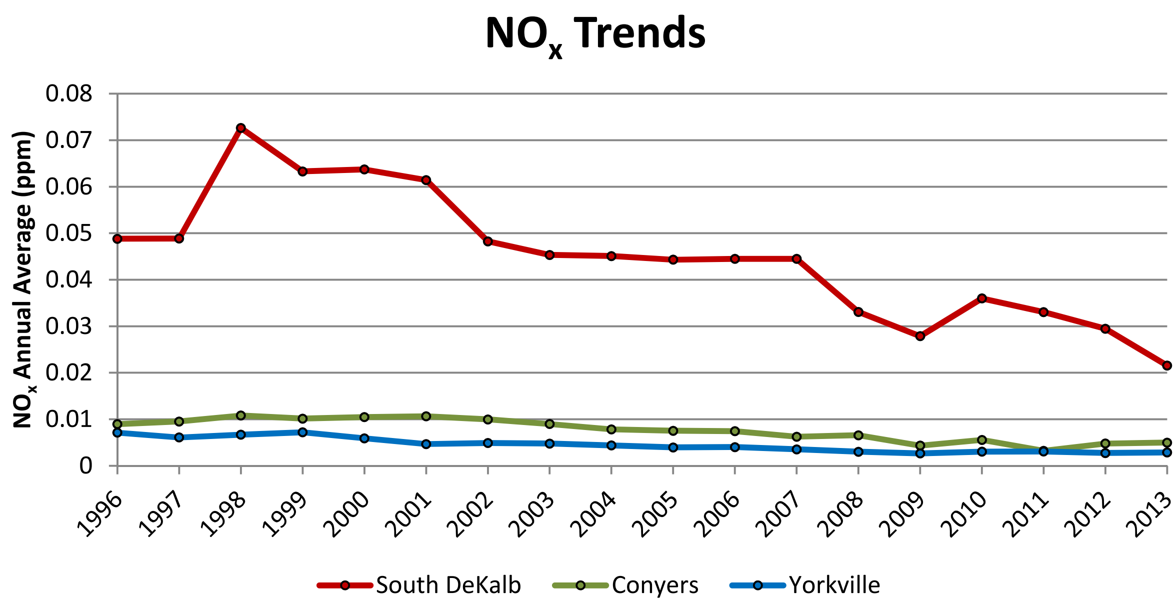


Figure 18.16: NO_x Average Annual Concentration for South DeKalb, Conyers, and Yorkville, 1996-2013

Figure 18.17 shows Georgia's annual average NO_2 concentrations from 2000 to 2013. Annual average concentrations are well below the standard of 53 ppb and show a slight decreasing trend.

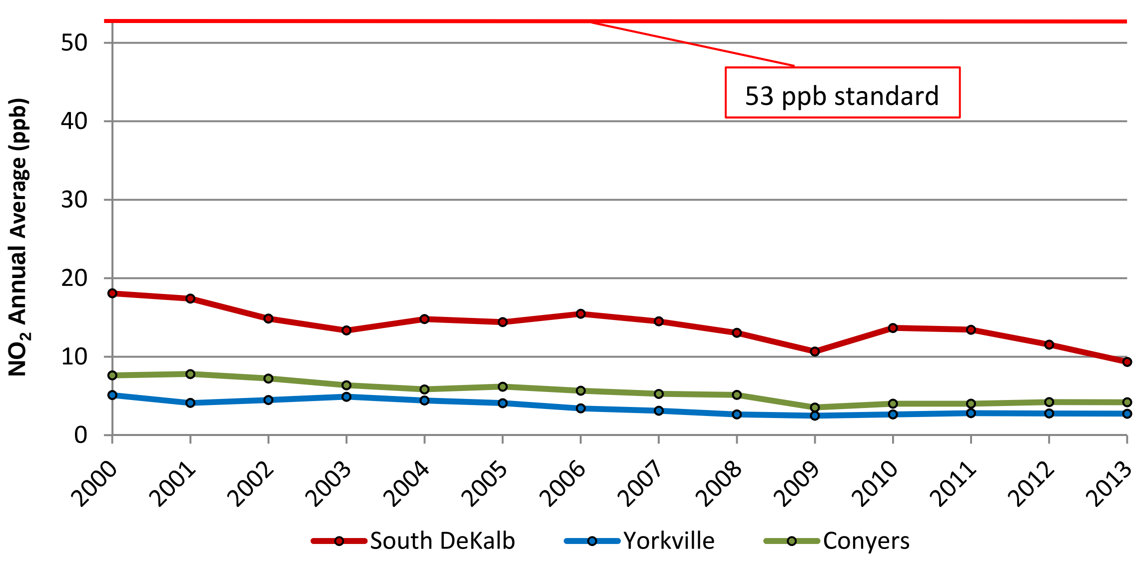


Figure 18.17 Nitrogen Dioxide Annual Averages Compared to the Annual Standard

Figure 18.18 displays the three-year averages of the 98th% of annual daily maximum 1-hour averages (1-hour design values), as available from 2000 to 2013. The 1-hour design values are well below the 100 ppb standard, and have consistently dropped since the 2000-2002 averages.

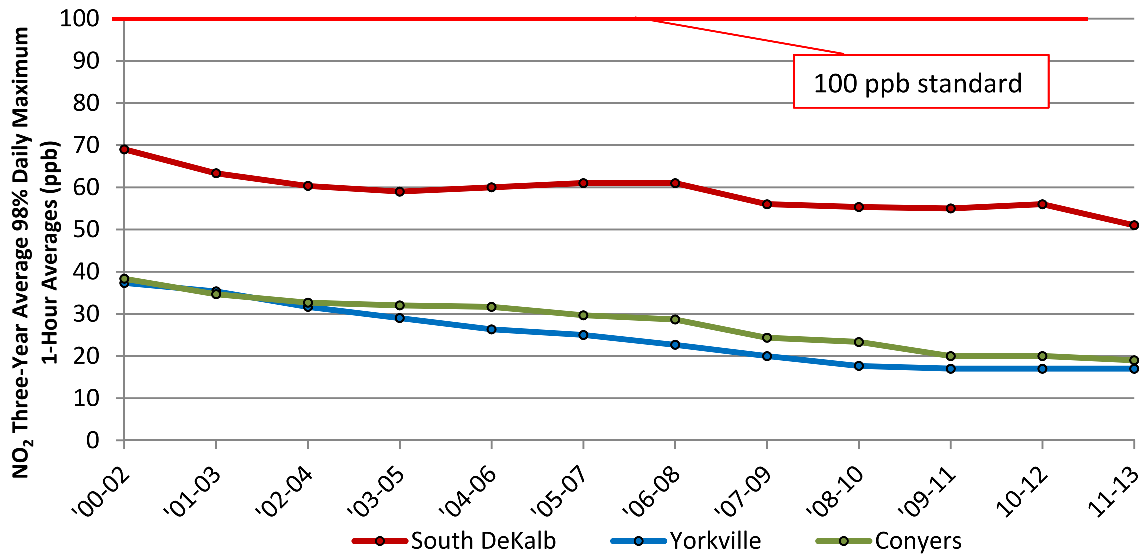


Figure 18.18: Nitrogen Dioxide 1-hour Design Values Compared to the 1-hour Standard

As part of the PAMS network, the South DeKalb site collects 3-hour samples of carbonyls during the summer months (June - August). Samples are collected at hours 6:00, 9:00, 12:00, and 15:00, every three days. The average concentrations of all the 3-hour samples of carbonyls collected during those months for 2005 through 2013 have been combined for a given hour and are shown in Figure 18.19. Acetaldehyde, acetone, and formaldehyde continue to be the biggest contributors, and for the past three years the other three compounds (benzaldehyde, propionaldehyde, and butyraldehyde) have had no detections. There appears to be an overall decreasing trend for all carbonyl concentrations, especially in 2012 and 2013.

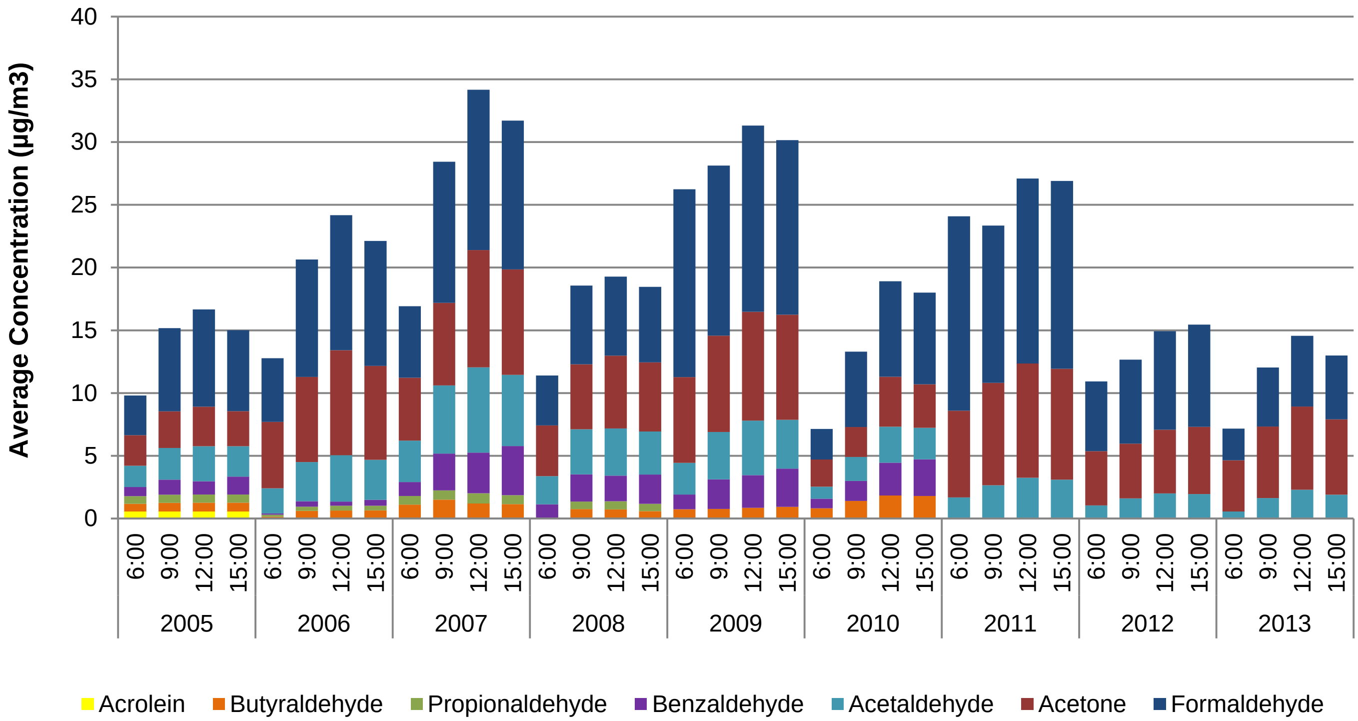


Figure 18.19: Stacked Column Chart Showing the Average Concentration for Each of the Seven Carbonyls at South DeKalb from June-August, 2005-2013

18.4 Transport of Air Pollution

A part of the SEMAP study referenced in Appendix D of the Georgia SIP "*DRAFT Revision to the Georgia State Implementation Plan for the Removal of Georgia Rules for Consumer and Commercial Products and for Gasoline Marketing, and for the Revision of the Georgia Rule for NOx Emissions from Stationary Gas Turbines and Stationary Engines used to Generate Electricity"* discusses the major contributions to Atlanta's ozone.

Figures 18.20 and 18.21 show how the fourteen geographic regions (ten SEMAP states plus Maryland, NE-MD, LADCO, and CENRAP) included in the model contributed to the changes in Georgia ozone via reductions in NO_x (Figure 18.20) or VOCs (Figure 18.21). It was found that Georgia had the largest impact on its own monitors with neighboring states having the next largest impact.

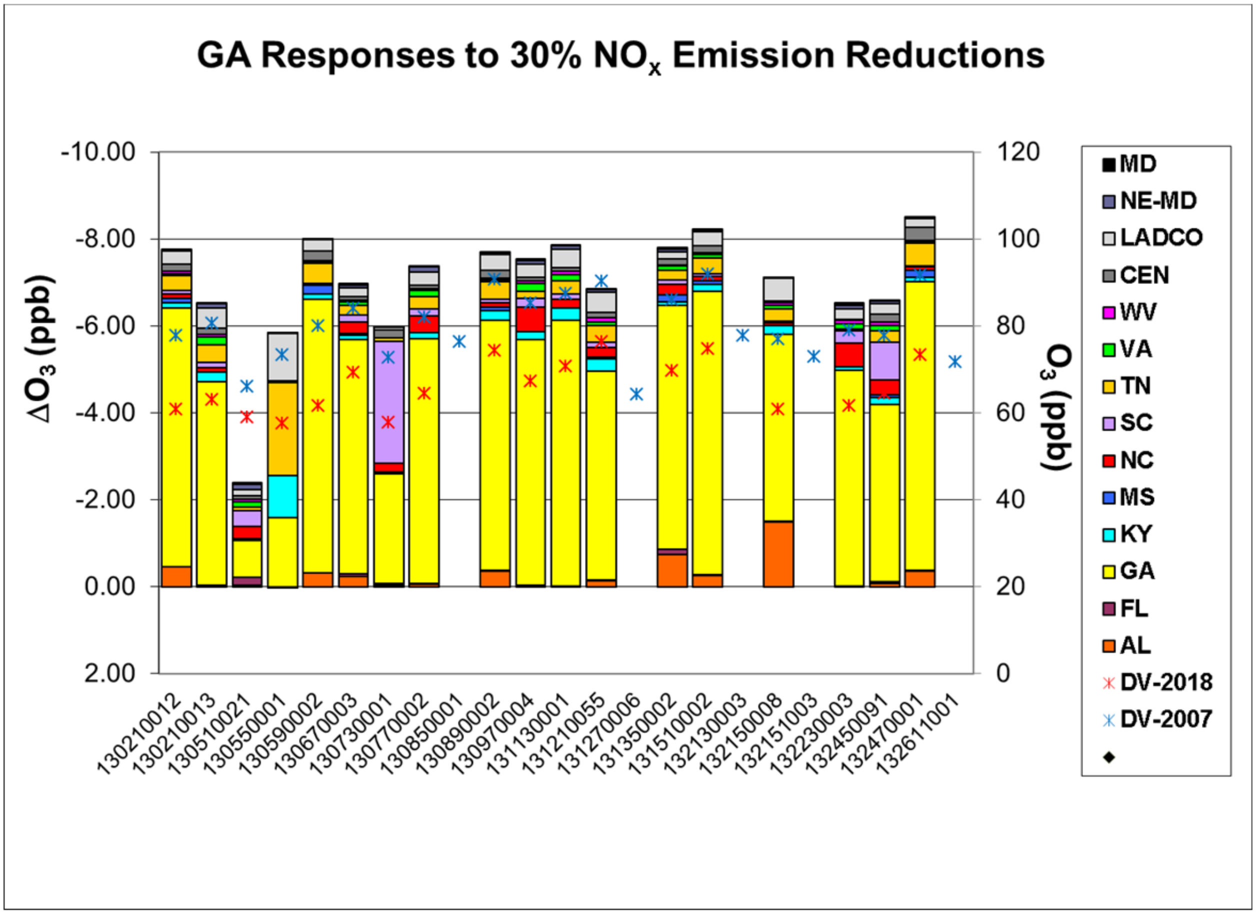


Figure 18.20: Modeled Changes in Ozone Concentrations at Georgia Monitors in Response to 30% NO_x Emissions Reductions

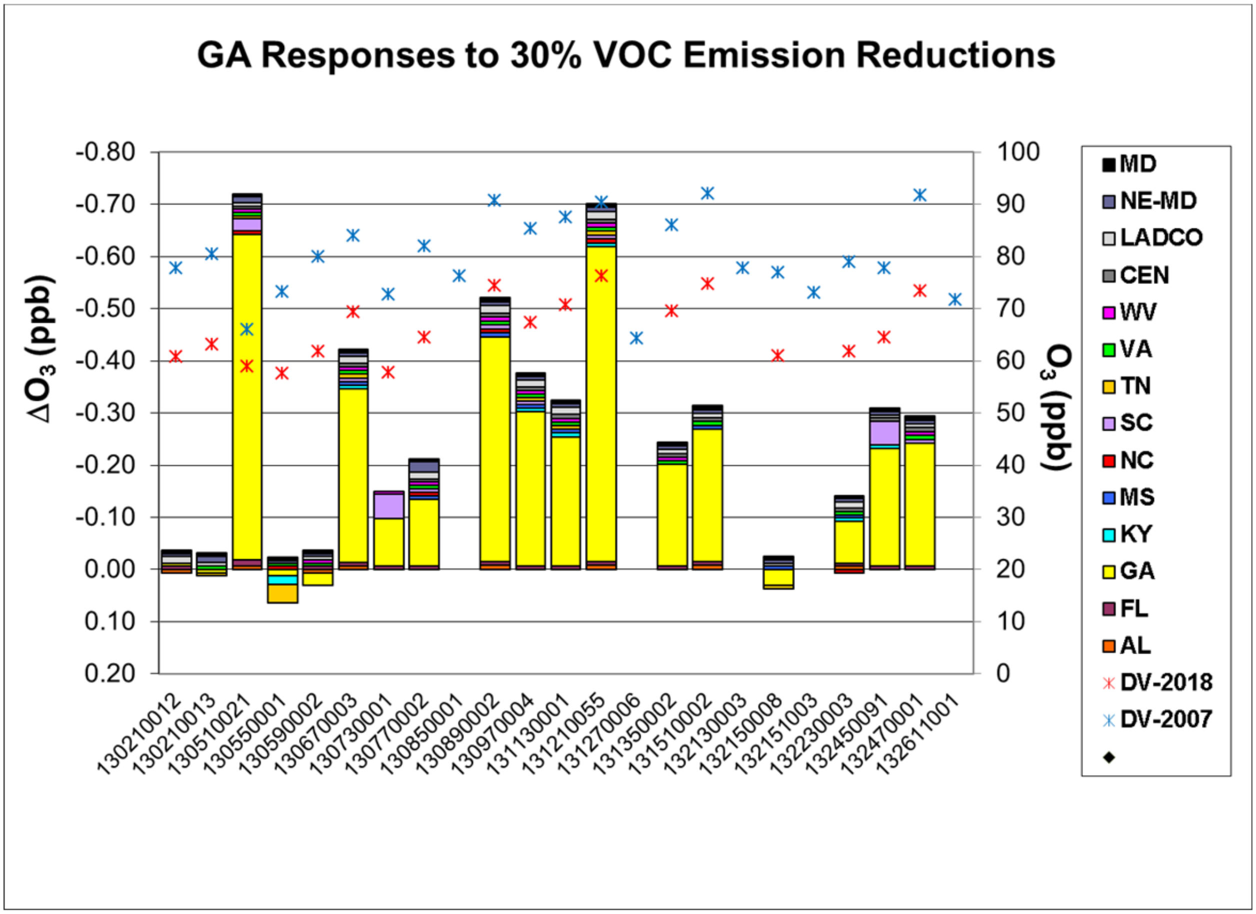


Figure 18.21: Modeled Changes in Ozone Concentrations at Georgia Monitors in Response to 30% VOCs Emissions Reductions

18.4 Assessing the Siting of Georgia's PAMS Stations

The Yorkville site is a type 1 site and serves as a rural background site. This site characterizes the upwind background, transported ozone, and precursor concentrations entering the Atlanta Metropolitan area. From the Trends Assessment (Section 7), the Yorkville site consistently has had an ozone average in the middle range of all of Georgia's sites since it started sampling in 1996. The Yorkville site has consistently had the lowest CO and NO_2 concentrations. With the Measured Concentration Assessment (Section 8), the fourth maximum ozone concentration also shows in the middle range for all of Georgia's sites, but lowest of all the PAMS sites. The Deviation from the NAAQS Assessment (Section 9) also shows the Yorkville site in the lower to middle range of sites for all of Georgia's 2009 to 2013 design values, with the exception of $PM_{2.5}$, and lowest of all the PAMS sites. In addition, the 2008 design values for CO and NO_2 at the Yorkville site showed to be the lowest of all sites sampling CO and NO_2. Of the PAMS sites, the Yorkville site has the lowest annual average concentrations of VOCs for all years, except 2012 (Figure 18.15), the lowest annual average concentrations of NO_x and NO_2, and lowest 1-hour design values compared to South DeKalb and Conyers (Figures 18.16 through Figure 18.18). This confirms that the Yorkville site is properly located to represent a rural background site.

The South DeKalb site is a Type 2 site which monitors the magnitude and type of precursor emissions and is located immediately downwind of the area of maximum precursor emissions receiving the predominant morning downwind wind. This site is located in DeKalb County in order to provide neighborhood scale measurements in the area that the precursors have the greatest impact. The wind roses for 2011 through 2013 (Appendix C) continue to show the predominant wind direction to be coming from WNW, which is the direction of downtown Atlanta. As shown in the Trends Assessment (Section 7), where CO is monitored with the PAMS sites and same method, the South DeKalb site has consistently had a higher concentration than the Yorkville site (Type 1 site). Also, the Deviation from the NAAQS Assessment (Section 9) shows the South DeKalb site to have the highest design values of CO from 2010-2013. For the NO_2 measurements, the South DeKalb site had the highest 2009-2013 design values of all the PAMS sites. Figure 18.15 shows that, of the PAMS sites, the South DeKalb site has the highest average annual concentrations of VOCs for all years, except 2012. The South DeKalb site also has the highest average annual NO_x concentrations (Figure 18.16). In addition, Figures 18.17 and 18.18 show that the South DeKalb site consistently had the highest annual average NO_2 concentrations and the highest 1-hour design values compared to Conyers and Yorkville. This is representative of Type 2 siting criteria, capturing the maximum precursor emissions.

The Conyers site acts as the Type 3 site and is the downwind site where titration of the precursors has occurred and the ozone concentrations should be at their highest. This site monitors the maximum ozone concentrations occurring downwind from the area of maximum precursor emissions, in Rockdale County. The wind roses and ozone wind roses for 2011 through 2013 (Appendix C) continue to show the predominant wind direction to be coming from NW and WNW, which is the direction of downtown Atlanta and the South DeKalb site. As can be seen in the Trends Assessment (Section 7) and in Figure 18.17, the Conyers site has consistently had one of the highest ozone concentrations since its inception in 1978. This confirms that the Conyers site is properly located to collect the highest downwind ozone concentrations.

18.5 Upper Air Measurements

For upper air measurement, GA EPD uses a SODAR PA5-LR system in conjunction with balloon rawinsonde data collected from NWS at Peachtree City. This upper air system proves especially useful for monitoring low-level winds during smoke transport events.

19.0 Exceedance Probability Assessment

As part of the 5-year assessment, GA EPD examines different aspects of whether or not new monitors are needed in certain areas, or if monitors are placed in close proximity and redundant and not needed in certain areas. One aspect to consider is the probability that an area could have exceedances of the standards set by EPA, and whether or not GA EPD has monitors in place to detect those exceedances. Lake Michigan Air Directors Consortium (LADCO) in Region 5 created an online tool, NetAssess available at http://ladco.github.io/NetAssessApp/index.html, to assess the probability of exceedances with a spatial distribution of the highest daily values. Ozone and $PM_{2.5}$ are examined below, as Georgia has had exceedances of these two pollutants and has had areas that are nonattainment of these two pollutants. The methods used to create this tool are summarized below:

"The surface probability maps were created by using EPA/CDC downscaler data. Downscaler data are daily estimates of ground level ozone and $PM_{2.5}$ for every census tract in the continental US. These are statistical estimates from "fusing" photochemical modeling data and ambient monitoring data using Bayesian space-time methods. For more details on how the data were generated, see the meta data document on the EPA website. Daily downscaler estimates for 8-hour maximum ozone and 24-hour mean $PM_{2.5}$ for the years 2007 and 2008 were obtained from the EPA website. Years 2009-2011 were obtained from the CDC's Environmental Public Health Tracking Program.

An extreme value distribution was fit for each census tract centroid in the continental United States. That is, for each census tract, yearly maxima were obtained and a distribution of those maxima was estimated. In the simplest case, an extreme value distribution would be fit using just one maximum value for each year. For example, daily precipitation values from a rain gauge over 100 years would provide about 36,500 daily values. The maximum precipitation level for each year over a span of 100 years would give 100 values (each a maximum for a year), and an extreme value distribution could be estimated using those 100 values. That distribution could be used to find the probability of an extreme flood event.

A generalized extreme value distribution, using just the maximum value for each year, has the following distribution function:

$$F(x) = exp\left\{-\left[1+\xi\left(\frac{x^{(r)}-\mu}{\sigma}\right)\right]^{\frac{-1}{\xi}}\right\}$$

where μ is the location parameter, σ is the scale parameter, and ξ is the shape parameter. However, downscaler data for the entire country was only available for 5 years (2007-2011), which would not be enough data to estimate a probability distribution. For that reason, the top r values per year were used. For 8-hour maximum ozone, the top 4 values per year were used to characterize the extreme values for each census tract (r=4), and for 24-hour mean $PM_{2.5}$ the top 7 values were used (r=7). Specifically, a joint probability distribution function for the r largest yearly values was estimated:

$$F\left(x^{(1)},\ldots,x^{(r)}\right) = exp\left\{-\left[1+\xi\left(\frac{x^{(r)}-\mu}{\sigma}\right)\right]^{\frac{-1}{\xi}}\right\} \times \prod_{k=1}^{r}\sigma^{-1}\left[1+\xi\left(\frac{x^{(k)}-\mu}{\sigma}\right)\right]^{-\frac{1}{\xi}-1}$$

where

$-\infty < \mu < \infty$ and $-\infty < \xi < \infty$; $x^{(r)} \leq z^{\cdots(r-1)} \leq \cdots \leq z^{(1)}$; and $x^{(k)} : 1 + \xi \left(x^{(k)} - \mu \right) / \sigma > 0$ for $k = 1, \ldots, r$

(see Coles 2001, 66–72).

These distributions were then used to find the probability of an extreme value above a certain threshold for each census tract. If the threshold was 70 ppb for 8-hour maximum ozone, then the probability for each census tract is

$$P(X > 70ppb) = 1 - F\left(x^{(1)}, \ldots, x^{(4)}\right).$$

Again, this is the probability that there would be at least one day in a year with an 8-hour maximum ozone value above 70 ppb (not the probability that the fourth highest value would be above the threshold). "

19.1 Ozone

Since EPA has proposed to lower the ozone standard in the range of 65-70 ppb (79FR75233), the following three figures show areas with the probability of ozone concentraions exceeding a threshold of 75 ppb, 70 ppb, and 65 ppb, respectively, based on the spatial distribution of historical highest daily values. The darker red color represents the higher probability of ozone concentrations exceeding the threshold. Red circles represent ozone monitoring sites.

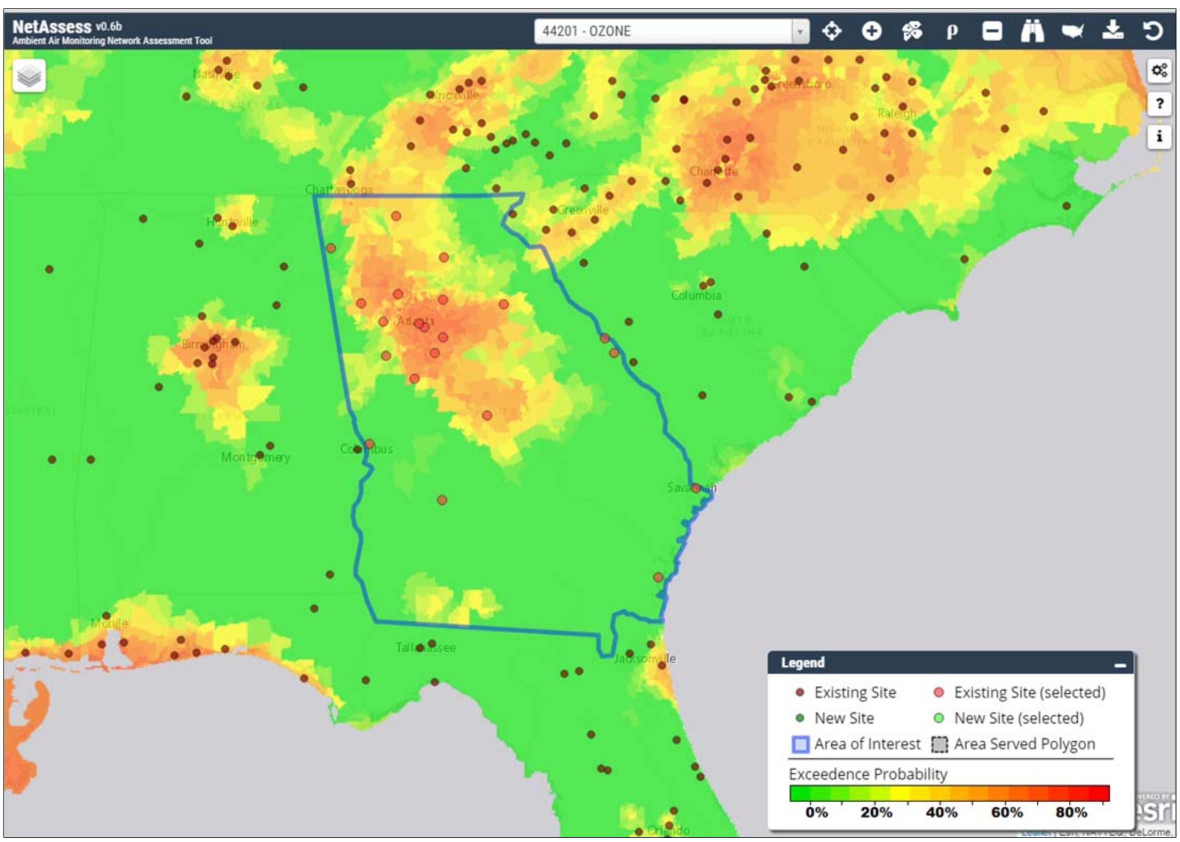


Figure 19.1: Ozone Probability of Exceedance at 75 ppb for Georgia

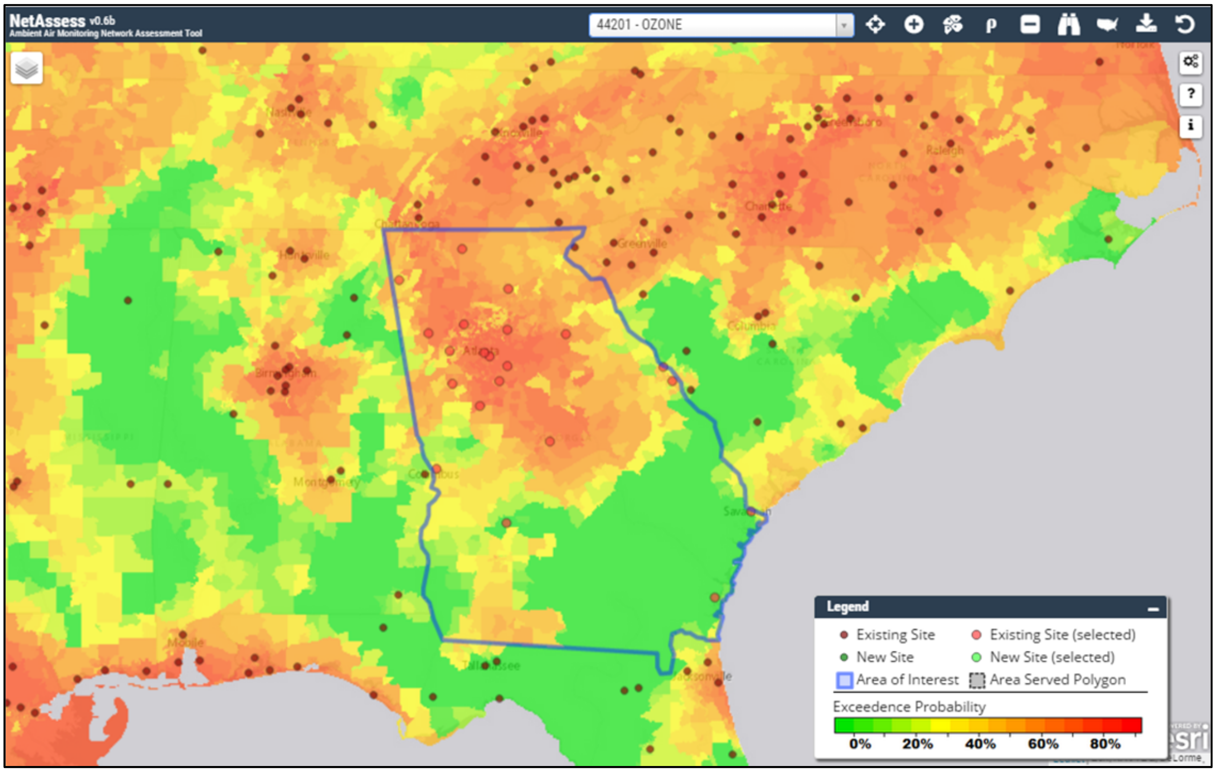


Figure 19.2: Ozone Probability of Exceedance at 70 ppb for Georgia

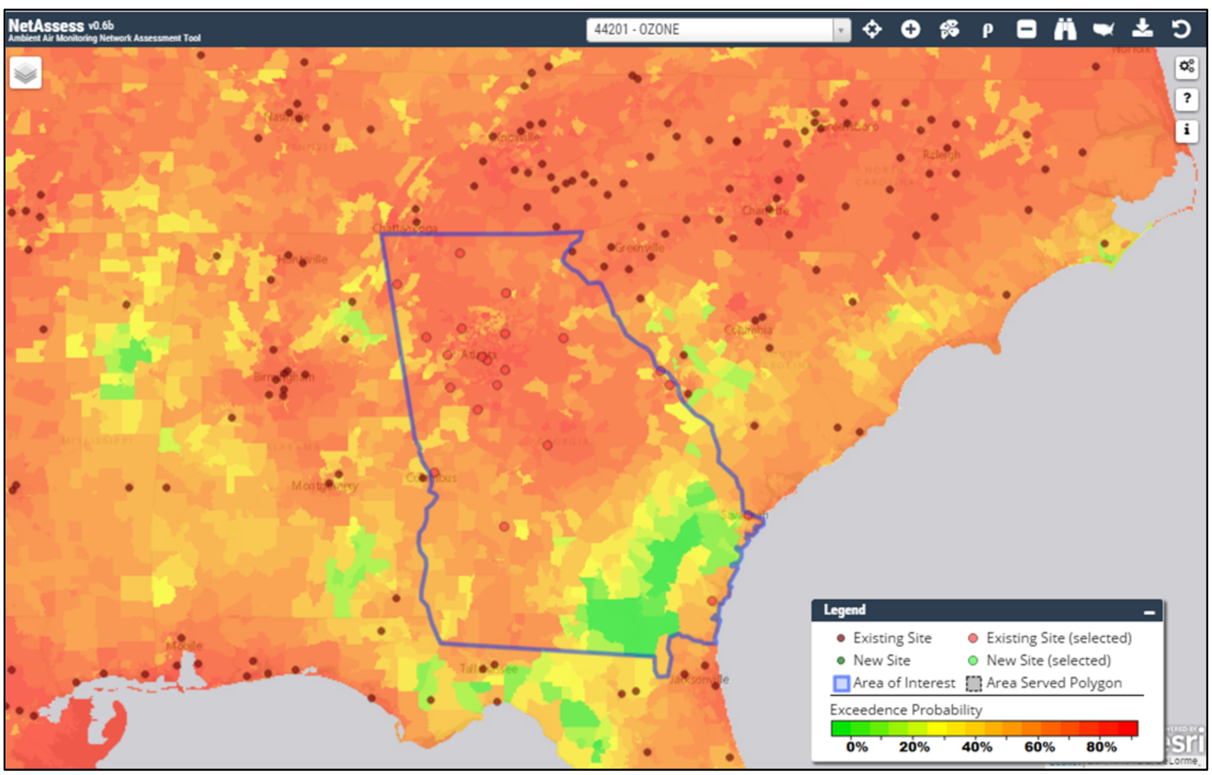


Figure 19.3: Ozone Probability of Exceedance at 65 ppb for Georgia

According to the above figures, the areas with the highest probability of exceedances for ozone concentrations at 75 ppb threshold are located in the Atlanta-Sandy Springs-Roswell, Macon, Dalton, and Chattanooga TN-GA MSAs. As the threshold level is lowered in Figure 19.2 and Figure 19.3, it appears that the Atlanta-Sandy Springs-Roswell MSA may be sufficiently covered for monitoring ozone; however, the rest of the state (northern part, middle section, and southwestern section) would need to be evaluated for placement of additional ozone monitors.

19.2 $PM_{2.5}$

Figures 19.4 through 19.7 show areas where the probability of $PM_{2.5}$ exceeding a threshold of 35 µg/m^3 is most likely in Georgia based on the spatial distribution of historical highest daily values. The darker red color represents the higher probability of ozone concentrations exceeding the threshold. Red circles represent $PM_{2.5}$ monitoring sites.

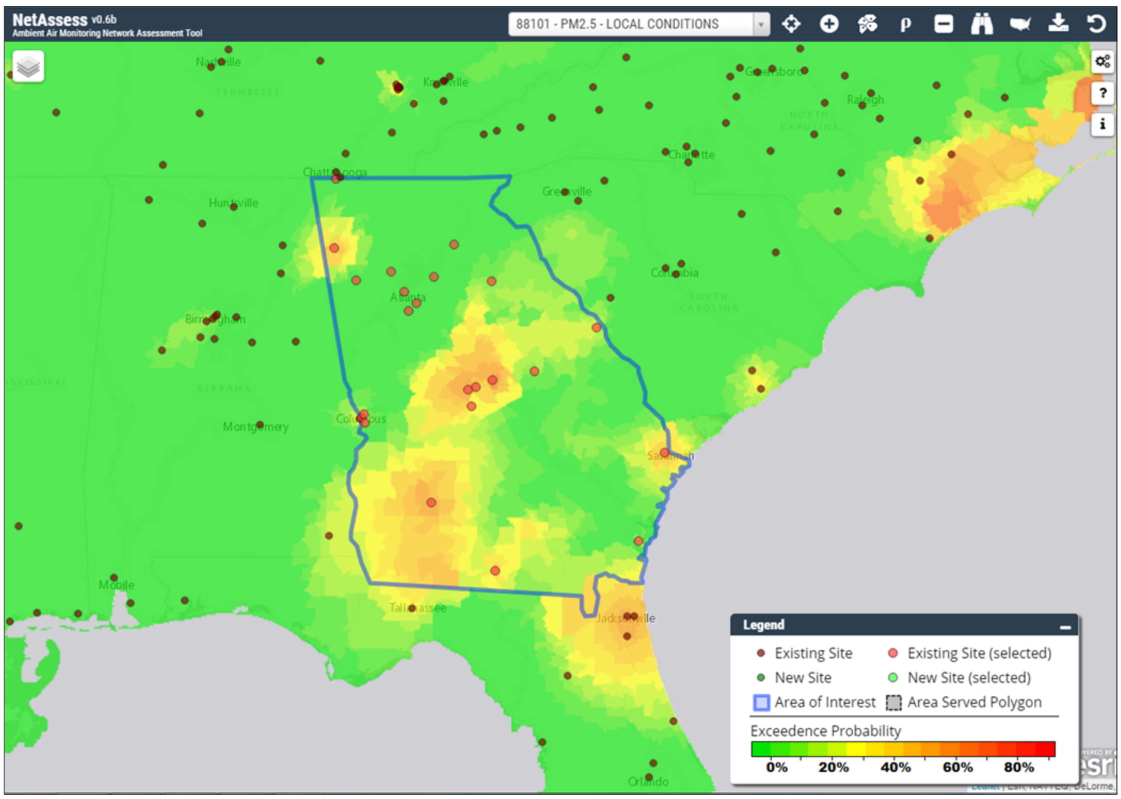


Figure 19.4: $PM_{2.5}$ Probability of Exceedance for Georgia

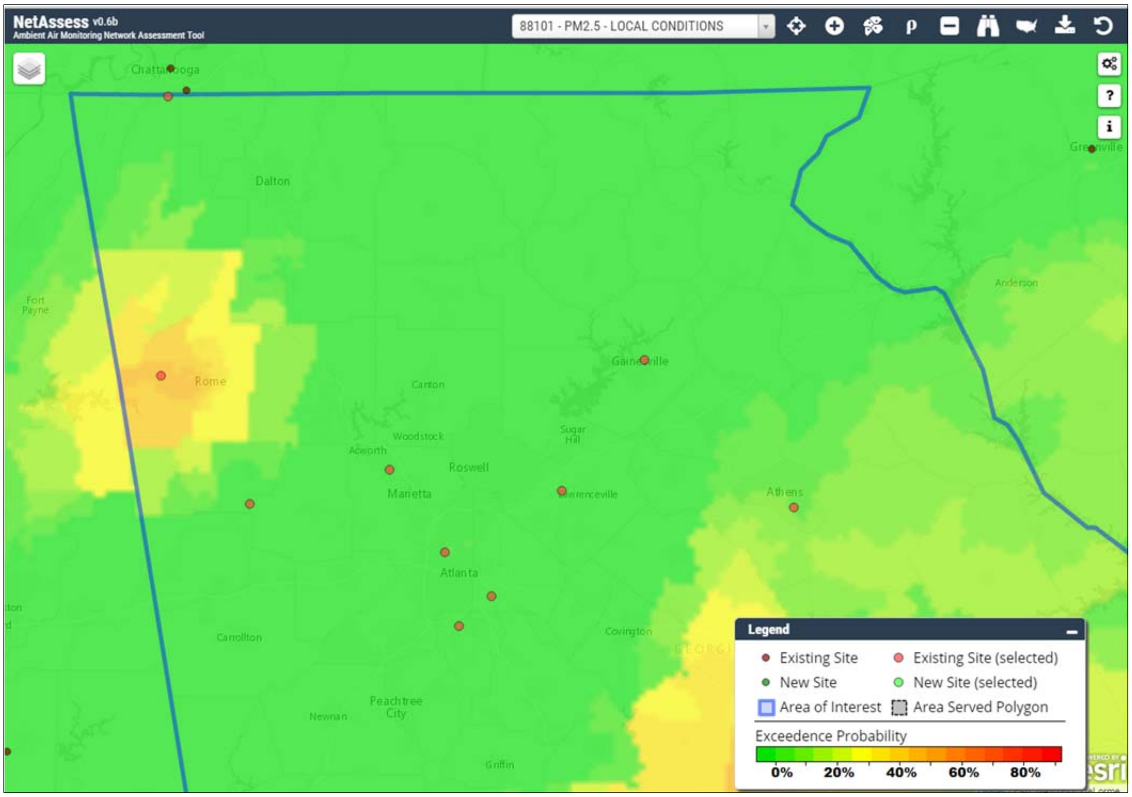


Figure 19.5: $PM_{2.5}$ Probability of Exceedance for North Georgia

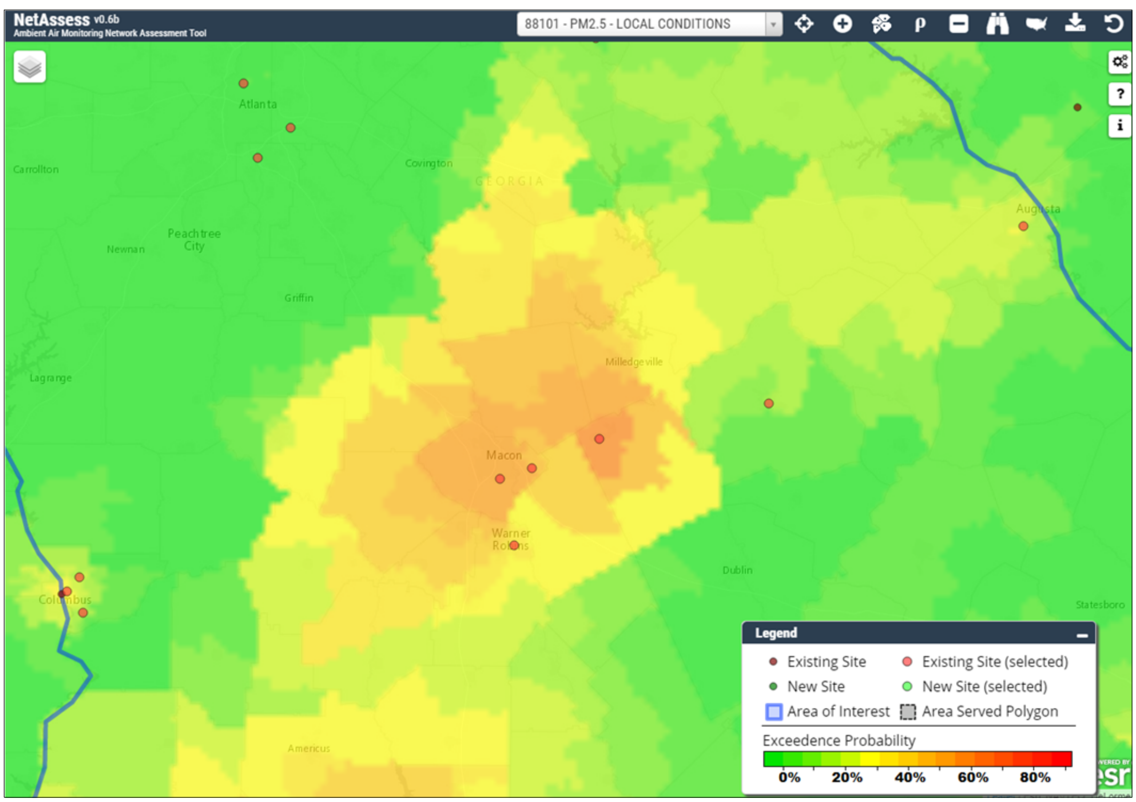


Figure 19.6: $PM_{2.5}$ Probability of Exceedance for Middle Georgia

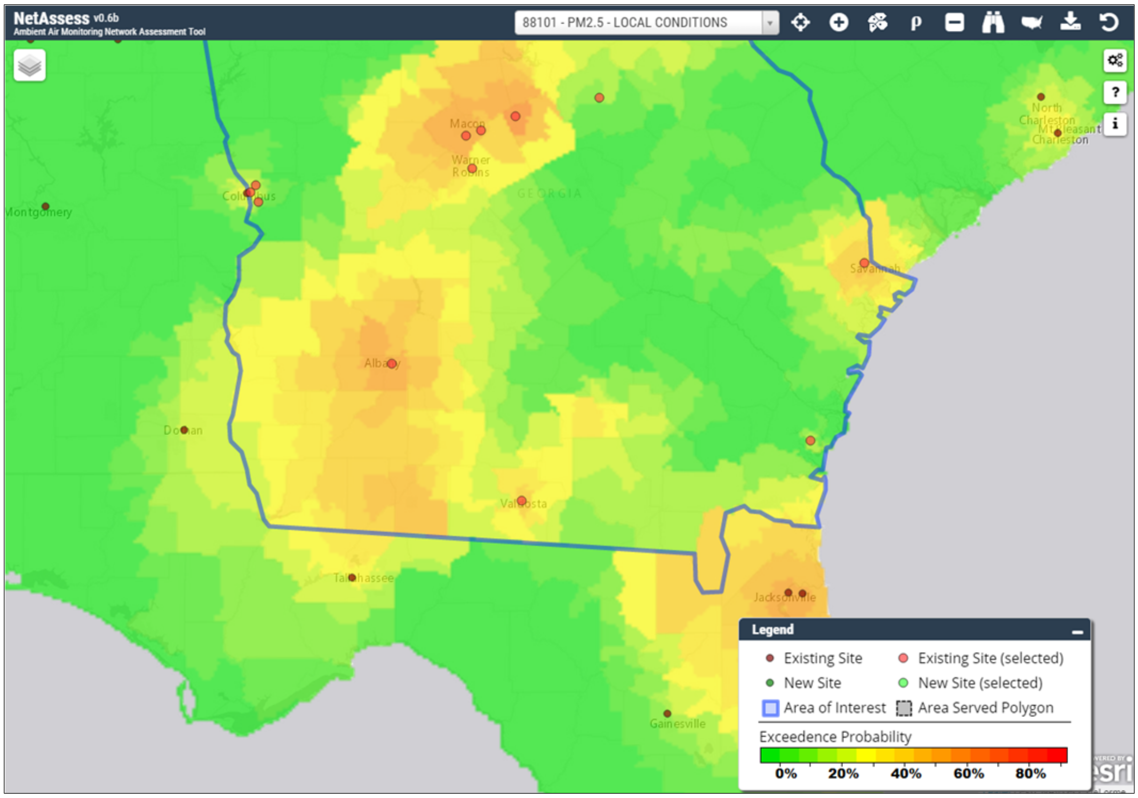


Figure 19.7: $PM_{2.5}$ Probability of Exceedance for South Georgia

According to Figures 19.4 through 19.7, the areas with the highest probability of exceedances for $PM_{2.5}$ are located in the Macon, Rome, Savannah, Albany, and Valdosta MSAs. It appears that there are several $PM_{2.5}$ monitors in the Atlanta-Sandy Springs-Roswell MSA and in the Chattanooga, TN-GA MSA where the $PM_{2.5}$ exceedance probability is much lower (green background). According to this assessment, some of these $PM_{2.5}$ monitors would not be needed. On the other hand, the area northeast of the Macon MSA and the most southwestern part of the state may need additional $PM_{2.5}$ monitors according to this assessment.

20.0 Conclusion

As part of the requirements for the Environmental Protection Agency's (EPA) amended ambient air monitoring regulations established on October 17, 2006, GA EPD has performed a Five-Year Assessment. The assessment addresses GA EPD Ambient Air Monitoring Program's efforts to meet EPA's regulations for monitoring air quality in the state of Georgia. The purposes of the Five-Year Network Assessment include: 1) ensuring that Georgia's Ambient Air Monitoring Program meets the monitoring objectives defined in Appendix D of 40CFR58, 2) evaluating the network's existing sites efficiency in meeting objectives and relative costs, 3) determining if new sites are needed or if existing sites are no longer needed and can be terminated, 4) determining whether discontinuing ambient air monitors would adversely impact data users and health studies, 5) determining if new technologies are appropriate for the network, 6) determining whether the existing and proposed sites support air quality characterization in areas with high populations of susceptible individuals (such as children and Environmental Justice areas), 7) determining whether changes need to be made to the $PM_{2.5}$ population-oriented network, 8) developing recommendations for network improvements.

This document provides a comprehensive look at Georgia's ambient air monitoring network. To fulfill the purposes of the Five-Year Assessment listed above, several different analyses were performed on different aspects involving Georgia's ambient air monitoring networks. These assessments included: Trends Impacts; Measured Concentrations; Deviation from the NAAQS; Number of Parameters Monitored; Monitor-to-Monitor Correlations; Population Requirements, Changes, Sensitive sub-populations; Air Quality Index Assessment; Health Assessment; Area Served; Emission Inventory Assessment with modeling of emissions data; Meteorological Assessment; Exceedance Probability; and PAMS network Assessment. The Five-Year Network Assessment outlines the established sites across the state of Georgia, as well as the proposal to maintain and discontinue sites in the state's ambient air quality surveillance system. In addition, Appendix A serves as a directory of existing sites with detailed site information, aerial photo, spatial scale map for each site, list of parameters monitored at each site, monitoring objectives, sampling schedules, probe inlet height, spatial scale, start date of each monitor, and recommendations for that site. Each Metropolitan Statistical Area (MSA) is mapped with existing sites shown within each MSA, as well. Appendix B is a list of Georgia's current ambient air monitoring inventory. Appendix C shows wind roses, as well as $PM_{2.5}$ and ozone pollutions wind roses, across the state for 2011 through 2013, where applicable.

If an assessment did not produce quantifiable results, the assessment included discussion within that section that outlined where sites were needed and where sites were not needed according to that assessment. These assessments included parts of the Population Assessment where ambient air monitoring in areas of sensitive sub-populations (children and environmental justice) were examined. Also, the Emissions Inventory assessment, Health Assessment, Meteorological Summary, PAMS Assessment, and Exceedance Probability Assessment did not have quantifiable results to be calculated and tallied with the other assessments. Each of these sections included the areas where monitors needed to be moved to have sufficient coverage, and areas where monitors could possibly be unnecessary or redundant and removed according to that assessment.

Each assessment that produced quantifiable results for the sites examined was ranked with one of two ranking methods. The proportionality ranking method was used when the weight of each ranking seemed to lend itself to be compared to a proportion of the highest and lowest ranking. The formula used for the proportionality ranking was (Value-Min)/(Max-Min).

The binning ranking method was used when each site's ranking had a certain limit with which that the site could be compared. For example, with the Deviation from the NAAQS assessment, the binning method was used such that if the absolute value of the pollutant's average was ≥NAAQS=1, ≥85% NAAQS=0.5, <85% NAAQS=0.

Table 20.1 was developed for assessments that produced quantifiable results. Both the ranking methods and the following table were adapted from Kevin Cavendar's (EPA/OAQPS/AQAD) example presented at the 2009 National Ambient Air Monitoring Conference. These quantifiable assessments included Trends Impacts, Measured Concentrations, Deviation from the NAAQS, Number of Parameters Monitored, Monitor-to-Monitor Correlations, Population Change, Area Served, and Number of Days with an AQI > 100. Depending on the assessment, there may be a different number of sites examined. The focus was on the criteria pollutants, and in some assessments, $PM_{2.5}$ and ozone specifically. $PM_{2.5}$ and ozone have been a focus for GA EPD due to areas of Georgia being in nonattainment for these two pollutants. Table 20.1 shows a summary of the ranks of each monitor for each assessment with quantifiable results. The site ranks and individual values for each assessment are shown within their respective sections. The total score was calculated for each monitor by adding the quantifiable scores for all the assessments in which that monitoring site was included. If the site was not involved in a particular assessment, there is a blank space in that column. A weighted average was used to determine total rank to prevent bias. The weighted averages were calculated by dividing the total rank of each site by the number of assessments in which the site was included. Sites with the highest weighted averages were given the highest ranks.

It should be noted that due to the timeliness of drafting this 5-Year Assessment document, GA EPD performed extensive evaluation on data collected through 2013. GA EPD did not include a specific evaluation of two near-road sites that were recently added to the network in 2014 and 2015.

AQS ID	Site	Trends	Measured Concentrations	Deviation from the NAAQS	Number of Parameters Monitored	Monitor-to-Monitor Correlations	Population Change	Area Served	# Days with AQI > 100	Total Score	Weighted Average	Total Rank
130890002	South DeKalb	0.691	1.66	3.5	1.00	6	0.441	0.004	0.05	**13.346**	**1.668**	**1**
132230003	Yorkville	0.291	0.74	2.5	0.64	6.5	0.441	0.485	0.19	**11.787**	**1.473**	**2**
130670003	Kennesaw	0.236	1.59	3.0	0.04	5.5	0.441	0.232	0.33	**11.369**	**1.421**	**3**
130850001	Dawsonville	0.491	0.32	1.5	0.18	8	0.441	0.213	0.00	**11.145**	**1.393**	**4**
131350002	Gwinnett Tech	0.309	1.51	3.5	0.07	4.5	0.441	0.300	0.38	**11.010**	**1.376**	**5**
130970004	Douglasville	0.273	0.63	2.0	0.04	6.5	0.441	0.041	0.19	**10.115**	**1.264**	**6**
131510002	McDonough	0.236	0.95	2.0	0.04	4	0.441	0.069	0.62	**8.356**	**1.045**	**7**
132150008	Columbus-Airport	0.545	1.37	3.0	0.07	2	0.181	0.488	0.05	**7.704**	**0.963**	**8**
132470001	Conyers	0.618	0.84	2.0	0.39	2.5	0.441	0.083	0.52	**7.392**	**0.924**	**9**
131210055	Confederate Ave.	0.382	1.00	2.0	0.11	2.5	0.441	0.020	0.86	**7.313**	**0.914**	**10**
132450091	Augusta	0.655	1.54	3.5	0.36	0	0.237	0.688	0.33	**7.310**	**0.914**	**11**
130770002	Newnan	0.236	0.16	1.0	0.07	5	0.441	0.204	0.00	**7.111**	**0.889**	**12**
132150001	Columbus-Health Dept.	1.000	1.24	2.5	0.00	2	0.181	0.129	0.00	**7.050**	**0.881**	**13**
130950007	Albany	0.382	1.70	2.5	0.07		0.020	0.688	0.62	**5.980**	**0.854**	**14**
130590002	Athens	0.182	1.07	3.0	0.11		0.281	0.836	0.29	**5.769**	**0.824**	**15**
131150003	Rome	0.691	1.02	3.0	0.11		0.085	0.151	0.52	**5.577**	**0.797**	**16**
131210039	Fire Station 8	0.709	1.37	1.5	0.04	2	0.441	0.015	0.00	**6.075**	**0.759**	**17**
130510021	Savannah-E. Pres. St.	0.309	0.16	3.0	0.32		0.366	0.919	0.21	**5.284**	**0.755**	**18**
130510091	Savannah-Mercer	0.655	1.09	2.0	0.00		0.366	1.000	0.17	**5.281**	**0.754**	**19**
130630091	Forest Park	0.618	1.09	2.5	0.00	1	0.441	0.275	0.00	**5.924**	**0.741**	**20**

AQS ID	Site	Trends	Measured Concentrations	Deviation from the NAAQS	Number of Parameters Monitored	Monitor-to-Monitor Correlations	Population Change	Area Served	# Days with AQI > 100	Total Score	Weighted Average	Total Rank
130511002	Savannah-L&A	0.727		1.5	0.07		0.366		0.79	**3.453**	**0.691**	**21**
132150011	Columbus-Cusseta	0.382	1.45	1.5	0.07	1.5	0.181	0.164	0.14	**5.387**	**0.673**	**22**
130210012	Macon-Forestry	0.273	1.05	2.5	0.25	0	0.059	0.945	0.28	**5.357**	**0.670**	**23**
133190001	Gordon	0.236	1.35	2.0	0.00		0.113	0.306	0.03	**4.035**	**0.576**	**24**
131850003	Valdosta	0.236	0.41	1.5	0.04		0.287	0.949	0.52	**3.942**	**0.563**	**25**
133030001	Sandersville	0.691	1.06	1.5	0.00		0.035	0.458	0.03	**3.774**	**0.539**	**26**
130210007	Macon-Allied	0.691	1.68	1.5	0.07	0	0.059	0.164	0.00	**4.164**	**0.521**	**27**
131270006	Brunswick	0.455	0.19	0.5	0.07		0.328	1.920	0.03	**3.493**	**0.499**	**28**
132130003	Fort Mountain	0.236	0.47	1.5	0.11		0.271	0.240	0.14	**2.967**	**0.424**	**29**
131530001	Warner Robins	0.218	0.66	0.5	0.04		1.000	0.340	0.03	**2.788**	**0.398**	**30**
132611001	Leslie	0.564	0.21	1.0	0.00		0.020	0.864	0.00	**2.658**	**0.380**	**31**
130550001	Summerville	0.400	0.26	1.5	0.00		0.019	0.264	0.00	**2.443**	**0.349**	**32**
131390003	Gainesville	0.236	0.31	1.0	0.04		0.511	0.323	0.00	**2.420**	**0.346**	**33**
132950002	Rossville	0.818	0.58	0.5	0.07		0.201	0.164	0.03	**2.363**	**0.338**	**34**
130730001	Evans	0.127	0.37	1.5	0.11	0	0.237	0.222	0.10	**2.666**	**0.333**	**35**
132151003	Columbus-Crime Lab	0.582			0.14		0.181			**0.903**	**0.301**	**36**
132150010	Columbus-Ft. Benning	0.018		1	0.00		0.181			**1.199**	**0.300**	**37**
130890003	DMRC	0.473		0.0	0.00		0.441			**0.914**	**0.229**	**38**
132150009	Columbus-UPS	0.000		0.5	0.00		0.181			**0.681**	**0.170**	**39**
130690002	General Coffee	0.218			0.11		0.059			**0.387**	**0.129**	**40**

Table 20.1: Combined Ranking Table

There were 40 ambient air monitoring sites across the state of Georgia as of 2013. Although ranks were assigned to each monitor in the table above, these are used only as guidelines; various regulations need to be considered in regards to elimination of a particular site. This table is limited in that it does not show where new sites are needed; however, gaps in monitoring areas are discussed within each non-quantifiable assessment.

Throughout this assessment, emphasis was given to sites that monitor criteria pollutants and in some assessments, $PM_{2.5}$ and ozone specifically. The quantifiable assessments that were performed focused on sites that contain these monitors. The five lowest ranking sites are the only sites, besides Savannah L&A, that do not monitor ozone or $PM_{2.5}$. The Measured Concentrations and Monitor-to-Monitor Correlations only assessed sites with ozone and $PM_{2.5}$ monitors. When all of the criteria pollutants were examined, as with Deviation from the NAAQS, the sites that monitor ozone and $PM_{2.5}$ show higher values and were ultimately ranked higher. In addition, the Area Served Assessment only assessed the sites that monitor ozone and $PM_{2.5}$. The Savannah L&A site is an exception; it monitors neither ozone nor $PM_{2.5}$, however is ranked 21 out of 40 sites. The Savannah L&A site ranks this high because it has the greatest number of days with an AQI>100 and has the third longest monitoring history.

As can be seen in the above table, the General Coffee site ranks the lowest of all the ambient monitoring sites. The General Coffee site monitors both Air Toxics and $PM_{2.5}$ speciation; however, it is located in an area with minimal population growth and has a relatively short monitoring history, so it is ranked lowest among the sites. The General Coffee site, however, serves a critical purpose as a background site for GA EPD's Air Toxics Network and $PM_{2.5}$ specation network.

Sites that monitor only a few parameters typically have lower rankings. For example, for the period of time addressed by this assessment, the Columbus-UPS and DMRC sites only monitor lead, while the Columbus-Crime Lab site only collects meteorology data. Other factors that contribute to a monitoring site having a lower ranking include sites that do not monitor criteria pollutants or sites that represent a smaller monitoring area around that monitor. The lowest ranking sites would be candidates for removal or consolidation with other nearby sites. Combining sites within the same MSA may eliminate redundancy and also ensure that regulations are met. For example, the Columbus-Crime Lab site may be a good candidate for consolidation with another site within the Columbus, GA-AL MSA.

MSAs that have multiple sites monitoring the same parameter within that MSA could have sites combined to have a sufficient number to cover the requirements. According to the population requirements (Section 12.0) for ozone and $PM_{2.5}$, several MSAs have more than the required number of monitors. In particular, the Atlanta-Sandy Springs-Roswell MSA, the Columbus GA-AL MSA, and the Macon MSA have multiples of the same monitor and more monitors than are required for the population and design values (Table 12.2). Sites within these MSAs could be consolidated to eliminate redundancy.

With the Emissions Assessment (Section 16.0), some areas of the state had models that showed higher emissions where there are currently not monitors of that particular pollutant. The Columbus GA-AL MSA modeled higher for PM_{10}, CO, and VOCs emissions. The Savannah MSA modeled higher for PM_{10}, CO, and NO_2 emissions. The Brunswick MSA modeled higher for PM_{10}.The Augusta-Richmond County, GA-SC MSA modeled higher for NO_2 and VOCs. The Hinesville MSA modeled higher for PM_{10}, $PM_{2.5}$, CO, and VOCs emissions. Therefore, according to the Emissions Assessment, additional monitors may be useful in these MSAs for collecting and characterizing potential emissions data.

For the Area Served Assessment, the ozone and $PM_{2.5}$ networks were examined. For the ozone network, there are sections of southeast GA where the polygons representing an area are very large, covering thousands of square miles. According to this assessment, ozone monitors may be needed in southeast GA to sufficiently represent this part of the state. The addition of an ozone monitor in the Valdosta MSA may be helpful to cover the southeastern portion of the state. Similarly, with the $PM_{2.5}$ Area Served Assessment, the southeastern portion of the state seems to be inadequately represented. It may be beneficial to place a $PM_{2.5}$ monitor at the General Coffee site to cover this area of the state.

As of 2013, there were 13 ambient air monitoring sites within the Atlanta-Sandy Springs-Roswell MSA. According to the population and design value requirements (Table 12.2), 3 ozone, 3 $PM_{2.5}$, and at least 2 PM_{10} monitors are required. Currently, there are 10 ozone samplers, 6 $PM_{2.5}$ samplers and 2 PM_{10} samplers, far exceeding these requirements. As shown in the Monitor-to-Monitor Correlations Section (Section 11.0), the $PM_{2.5}$ and ozone monitors within Atlanta-Sandy Springs-Roswell MSA show that this data is highly correlated. To increase efficiency within the networks, sites collecting $PM_{2.5}$ and ozone data in close proximity within this MSA could be consolidated.

With a few types of assessments, the Hinesville MSA was an area of potential concern. This is one area that GA EPD currently does not have ambient air monitors. A mentioned above, in the Emissions Assessment, the Hinesville MSA showed some of the highest predicted levels for PM_{10}, $PM_{2.5}$, CO, and VOCs emissions (Section 16.0). In addition, with the last official census, the Hinesville MSA had a population of 77,917. For the estimated 2013 census, the population had increased to 80,698, with a +16% change in the population (Section 12.1). With the MSA's population above 50,000, criteria pollutant standards could apply to this MSA. In addition, the Census Bureau's website (http://factfinder.census.gov), showed this MSA to have a higher population of children compared to other areas of the state (Section 12.2.1). All of this could potentially lead to adding ambient air monitors in the Hinesville MSA.

The highest ranking sites are the South DeKalb, Yorkville, Kennesaw, Dawsonville, and Gwinnett Tech sites. A combination of the quantifiable assessments lead to these sites being ranked the highest. All of these sites monitor either ozone or $PM_{2.5}$, as well as other pollutants. The South DeKalb site monitors the most pollutants, has been established several years, measures some of the highest concentrations, had concentrations of criteria pollutants that ranked higher for deviating from the NAAQS, and was located in one of the areas with more population growth.

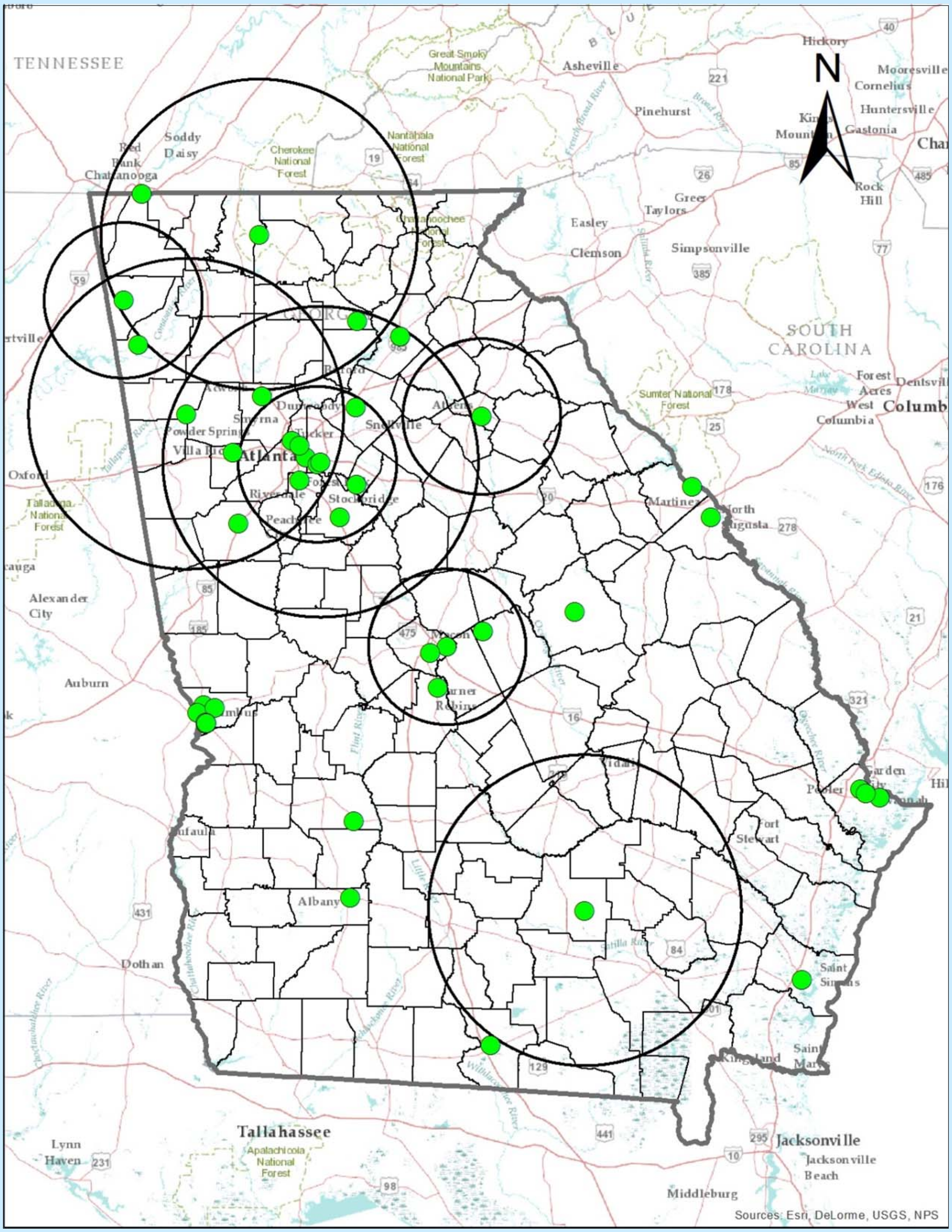
Since GA EPD conducted the previous edition of the 5-Year Assessment in 2010, several changes have been made to the ambient monitoring networks, as stated earlier. Several sites have been consolidated within the same MSA, sites have been added, and sites have been shut down. Efforts have been made to eliminate redundancies where possible, and sites have been added to ensure federal regulations are met. Therefore, the Rome, Brunswick, Savannah, and Augusta-Richmond County, GA-SC MSAs have all had sites that were consolidated since the last 5-Year Assessment.

While GA EPD has made an effort to review the ambient air monitoring network across the state, these findings and their resulting discussions form the basis for further considerations and planning. Several factors, such as available personnel and budgetary concerns, will play a large part in adding or shifting monitors around the state of Georgia. GA EPD will make every effort to place monitors where needed, especially as mandated by the federal regulations. As changes are made to the regulations, GA EPD may need to shift or consolidate monitoring locations in order to accommodate those particular changes and have sufficient coverage.

Appendix A:
Individual Site Information
Grouped by Metropolitan Statistical Area
(Smallest to Largest)

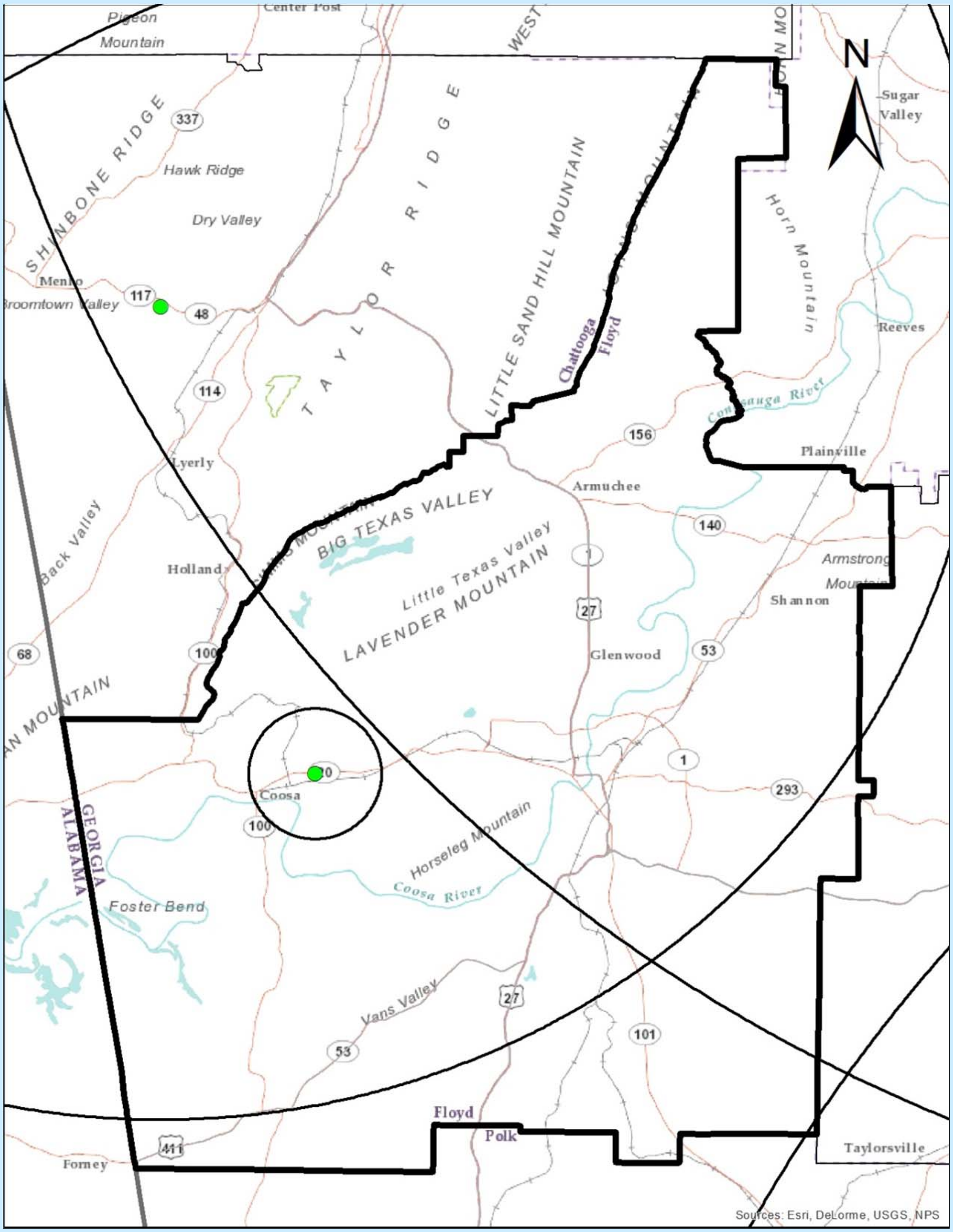
Georgia Department of Natural Resources
Environmental Protection Division

Spatial Scales of GA EPD's Ambient Air Monitors



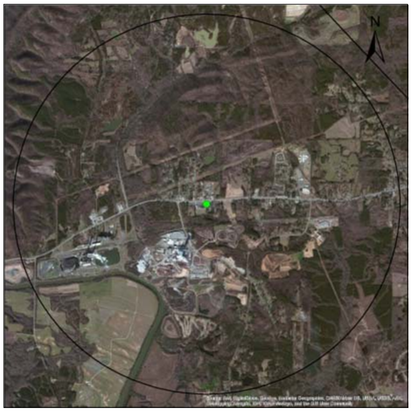
Micro Scale: up to 100m
Middle Scale: up to 0.5km
Neighborhood Scale: up to 4.0km
Urban Scale: up to 50km
Regional Scale: up to 100s of km (100km shown)

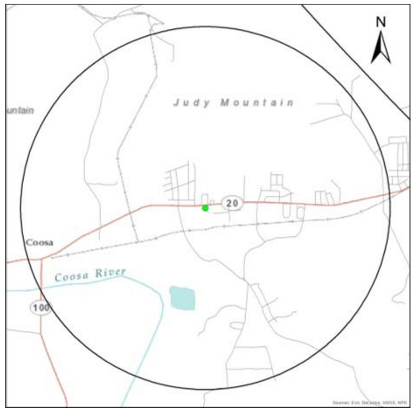
Rome MSA



N
Pigeon Mountain
Center Post
SHINBONE RIDGE
Hawk Ridge
Dry Valley
TAYLOR RIDGE
LITTLE SAND HILL MOUNTAIN
Chattooga
Floyd
Horn Mountain
Sugar Valley
Reeves
Menlo
Broomtown Valley
Lyerly
Back Valley
Holland
BIG TEXAS VALLEY
Little Texas Valley
LAVENDER MOUNTAIN
Armuchee
Plainville
Armstrong
Shannon
Glenwood
Coosa
GEORGIA
ALABAMA
Foster Bend
Horseleg Mountain
Coosa River
Vans Valley
Floyd
Polk
Forney
Taylorsville
337
117
48
114
156
140
27
53
68
100
1
293
101
411
Sources: Esri, DeLorme, USGS, NPS

Rome- Coosa Elementary





AQS ID: 131150003
Address: Coosa Elementary School, Highway 20, Rome, Floyd County, Georgia 30165
Site Established: 1/1/74
Latitude/Longitude: N34.26051/W-85.32328
Elevation: 186 meters
Area Represented: Rome MSA
Site History: Established as SO_2 site

North

South

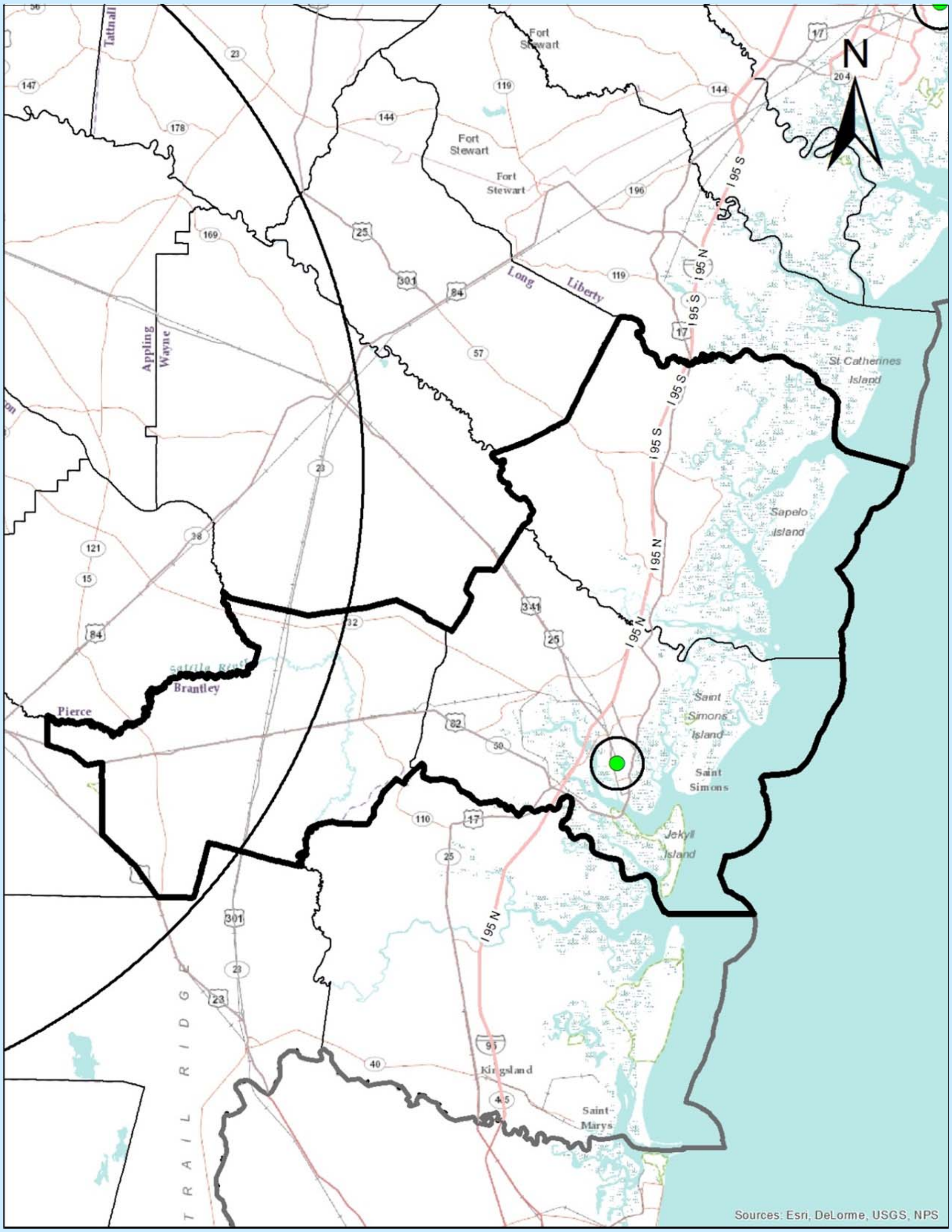
East

West

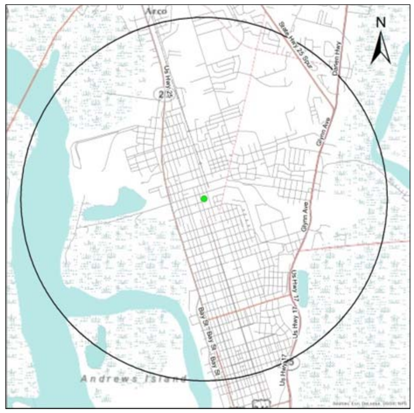
Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$	Population Exposure	Daily	2 m	Neighborhood	1/18/99
$PM_{2.5}$	Population Exposure	Continuous	3 m	Neighborhood	1/1/08
$PM_{2.5}$ Speciation	Population Exposure	Every 6 days	2 m	Neighborhood	3/1/02
SO_2	Population Exposure	Continuous	4 m	Neighborhood	1/1/75
SO_2 5-Minute Maximum	Population Exposure	Continuous	4 m	Neighborhood	8/1/10

Recommendations: Relocating site, as site property was purchased. Plan to relocate to same vicinity (212 Eagle Dr. NW, Rome GA 30165). EPA has preliminarily approved the relocation of the samplers at the site, and GA EPD is awaiting approval of the school board. Continuous $PM_{2.5}$ sampler changing from BAM to TEOM in summer 2015.

Brunswick MSA



Brunswick- Risley Middle School



AQS ID: 131270006

Address: Risley Middle School, 2900 Albany Street, Brunswick, Glynn County, Georgia 31520

Site Established: 1/1/87

Latitude/Longitude: N31.169530/W-81.496046

Elevation: 2 meters

Area Represented: Brunswick MSA

Site History: Established as SO_2 site

North

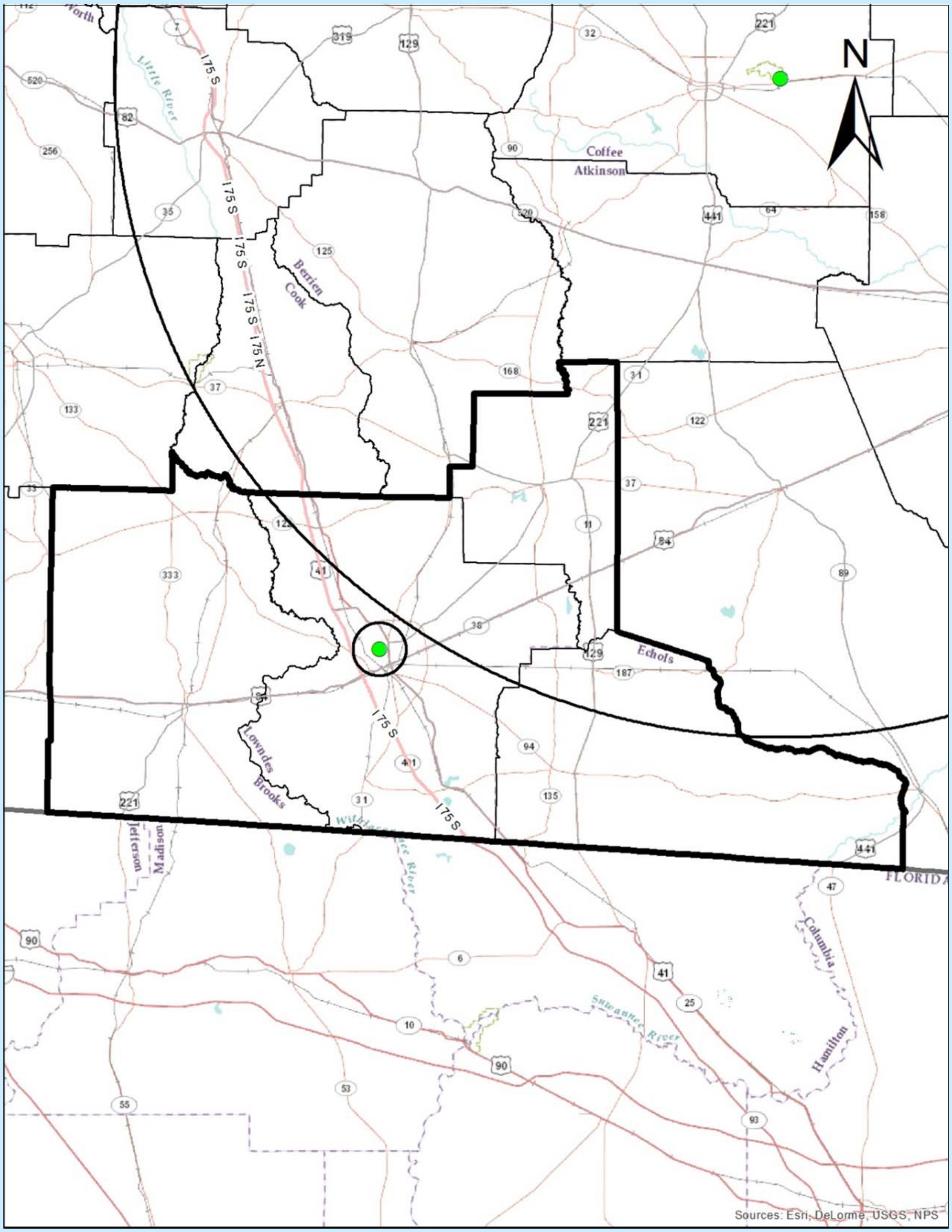
South

West

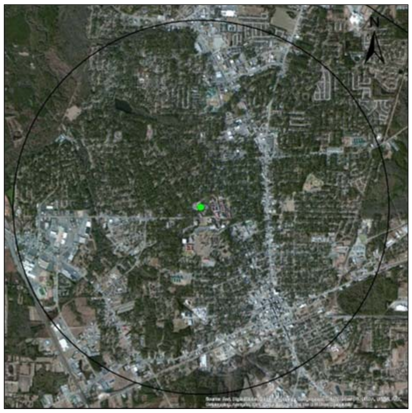
Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$	Population Exposure	Every 6 days	5 m	Neighborhood	8/31/95
O_3	Population Exposure	Continuous (Mar-Oct)	8 m	Neighborhood	3/1/95
Wind Speed	General/ Background	Continuous	10 m	Neighborhood	1/1/04
Wind Direction	General/ Background	Continuous	10 m	Neighborhood	1/1/04

Recommendations: Continue monitoring

Valdosta MSA



Valdosta- Mason Elementary



AQS ID: 131850003

Address: S.L. Mason Elementary School, 821 West Gordon Street, Valdosta, Lowndes County, Georgia 31601

Site Established: 12/17/99

Latitude/Longitude: N30.848056/W-83.294444

Elevation: 58 meters

Area Represented: Valdosta MSA

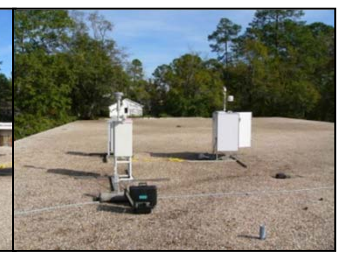
Site History: Established as $PM_{2.5}$ site

North

South

East

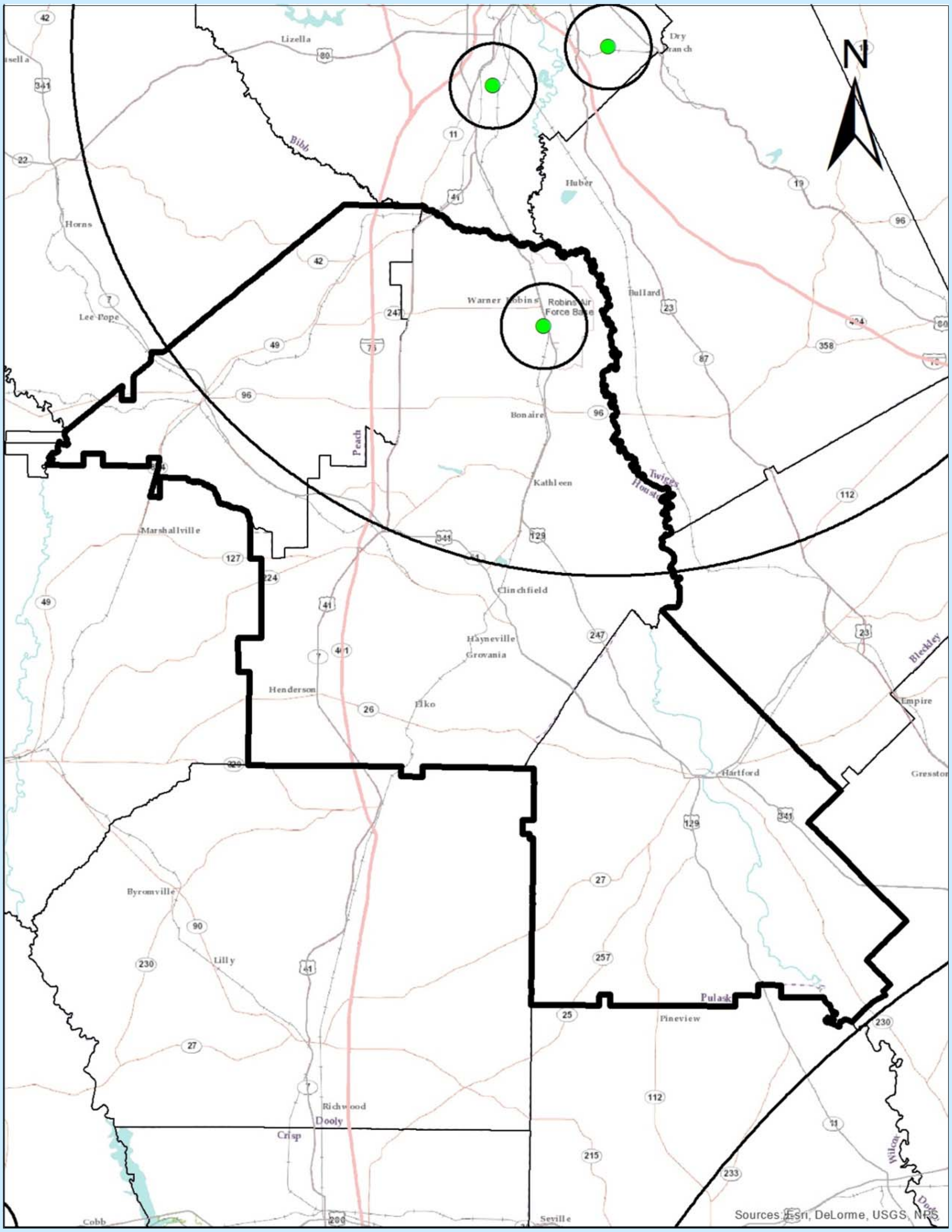
West



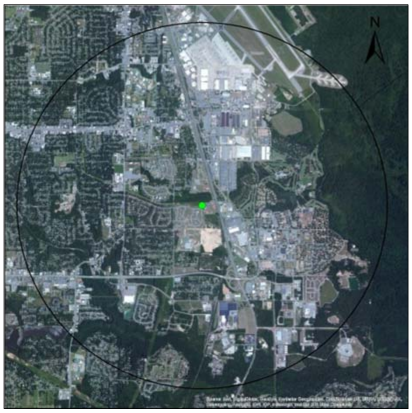
Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$	Population Exposure	Every 3 days	8 m	Neighborhood	1/1/00
$PM_{2.5}$	Population Exposure	Continuous	8 m	Neighborhood	1/1/08

Recommendations: Continue monitoring

Warner Robins MSA



Warner Robins- Air Force Base



AQS ID: 131530001

Address: Warner Robins Air Force Base, Memorial Park, 800 South 1st Street, Warner Robins, Houston County, Georgia 31088

Site Established: 6/15/00

Latitude/Longitude: N32.605600/W-83.597907

Elevation: 113 meters

Area Represented: Warner Robins MSA

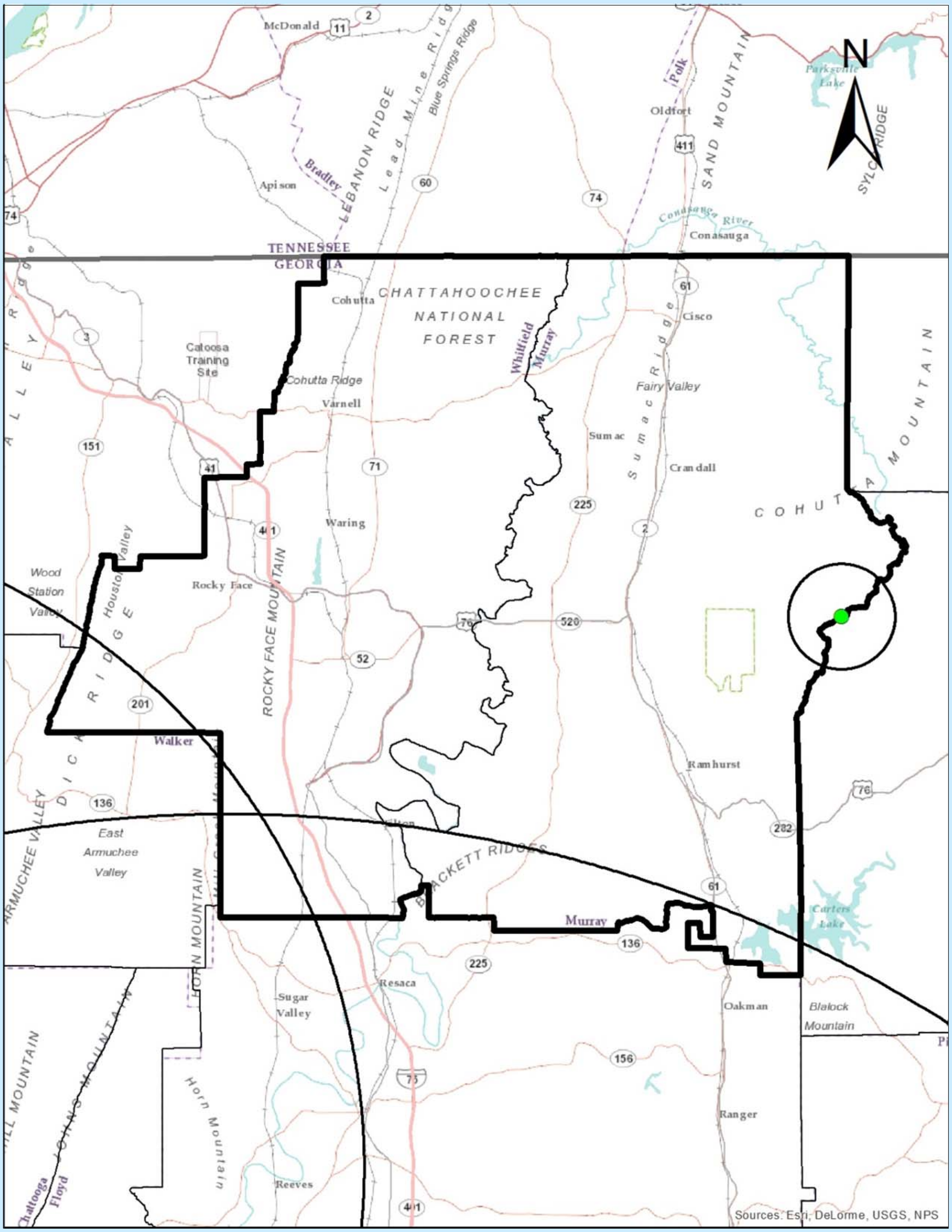
Site History: Established as $PM_{2.5}$ site

North South East West

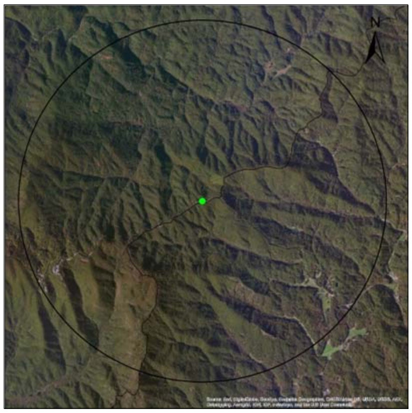
Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$	Population Exposure	Every 3 days	2 m	Neighborhood	7/5/00
$PM_{2.5}$	Population Exposure	Continuous	2 m	Neighborhood	1/1/08

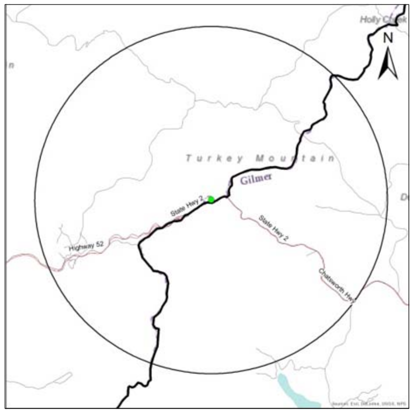
Recommendations: Continue monitoring

Dalton MSA


N
TENNESSEE
GEORGIA
CHATTAHOOCHEE
NATIONAL
FOREST
McDonald
Apison
Oldfort
Conasauga
Cohutta
Catoosa
Training
Site
Cohutta Ridge
Varnell
Cisco
Fairy Valley
Sumac
Crandall
Waring
Rocky Face
ROCKY FACE MOUNTAIN
COHUTTA MOUNTAIN
Wood
Station
Valley
Walker
Whitfield
Murray
East
Armuchee
Valley
BEAVER RIDGE
Ramhurst
Murray
Resaca
Sugar
Valley
Oakman
Blalock
Mountain
Carters
Lake
Parksville
Lake
Ranger
Reeves
Horn Mountain
Chattooga
Floyd
Polk
Bradley
Conasauga River
LEBANON RIDGE
Blue Springs Ridge
SAND MOUNTAIN
Sources: Esri, DeLorme, USGS, NPS

Chatsworth- Fort Mountain





AQS ID: 132130003

Address: Fort Mountain, State Highway 52, Cohutta Overlook, Chatsworth, Murray County, Georgia 30705

Site Established: 3/23/99

Latitude/Longitude: N34.785078/W-84.626499

Elevation: 980 meters

Area Represented: Dalton MSA

Site History: Established as O_3 site

North

South

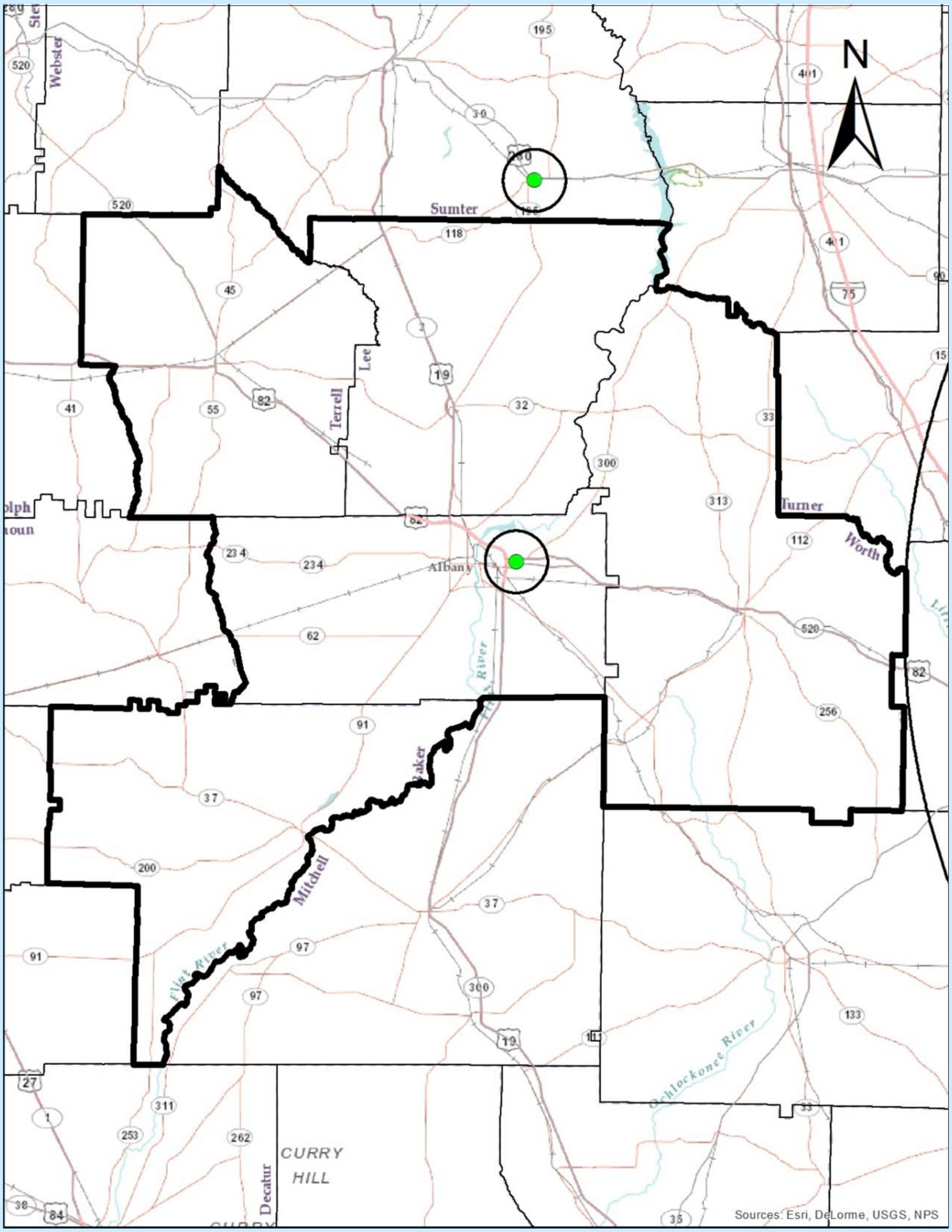
East

West

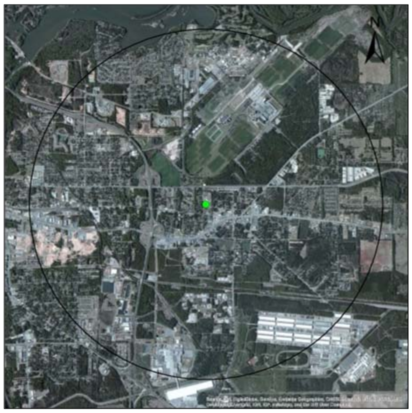
Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Population Exposure	Continuous (Mar-Oct)	4 m	Regional	3/1/00
Wind Speed	General/ Background	Continuous	10 m	Neighborhood	2/7/02
Wind Direction	General/ Background	Continuous	10 m	Neighborhood	2/7/02
Temperature	General/ Background	Continuous	2 m	Neighborhood	2/7/02
Relative Humidity	General/ Background	Continuous	2 m	Neighborhood	2/7/02

Recommendations: Continue monitoring

Albany MSA


N
Sumter
Lee
Terrell
Turner
Worth
Albany
Mitchell
Baker
Flint River
Ochlockonee River
Webster
Decatur
CURRY
HILL
Sources: Esri, DeLorme, USGS, NPS

Albany- Turner Elementary



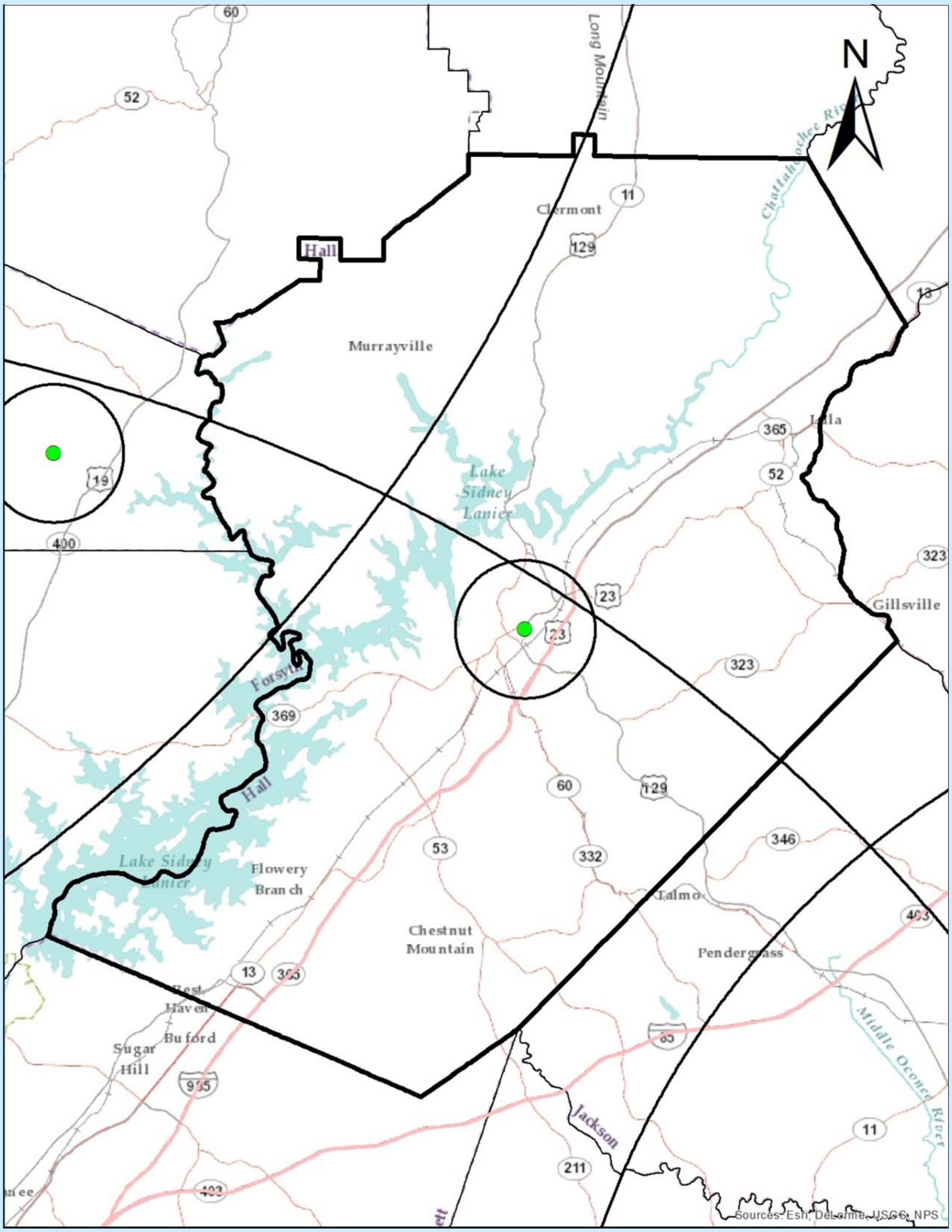
AQS ID: 130950007
Address: Turner Elementary School, 2001 Leonard Avenue, Albany, Dougherty County, Georgia 31705
Site Established: 7/31/91
Latitude/Longitude: N31.576917/W-84.100194
Elevation: 61 meters
Area Represented: Albany MSA
Site History: Established as TSP site

North South East West

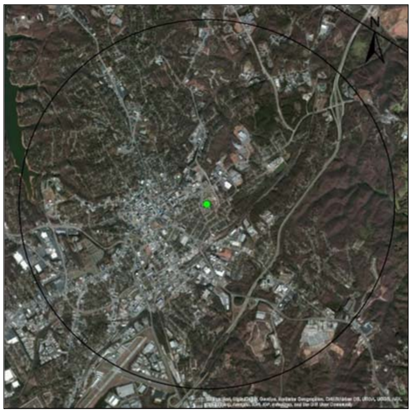
Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$	Population Exposure	Daily	6 m	Neighborhood	2/2/99
$PM_{2.5}$	Quality Assurance	Daily	6 m	Neighborhood	1/10/13
$PM_{2.5}$	Population Exposure	Continuous	6 m	Neighborhood	5/11/08

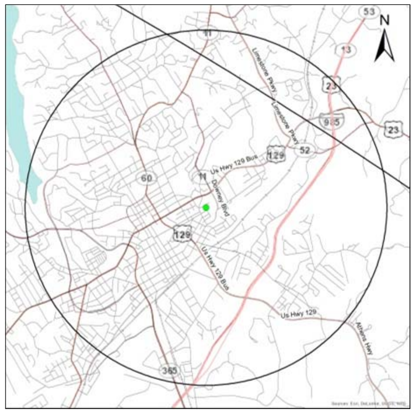
Recommendations: Continue monitoring; Running continuous monitor as FEM as of 1/10/13

Gainesville MSA



Gainesville- Boys and Girls Club





AQS ID: 131390003

Address: Boys and Girls Club, 1 Positive Place, Gainesville, Hall County, Georgia 30501

Site Established: 1/1/97

Latitude/Longitude: N34.30008/W-83.81217

Elevation: 353 meters

Area Represented: Gainesville MSA

Site History: Established as $PM_{2.5}$ site

North

South

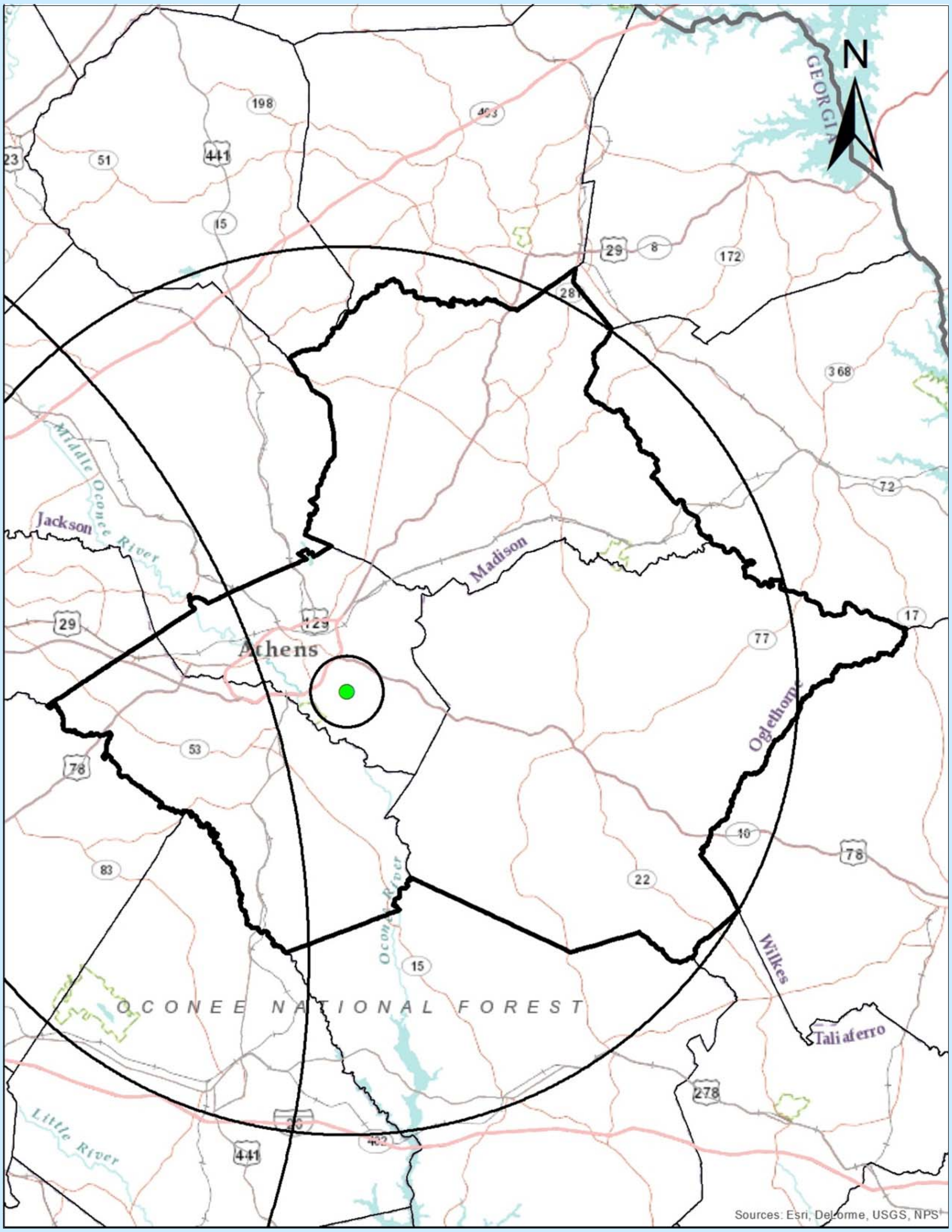
East

West

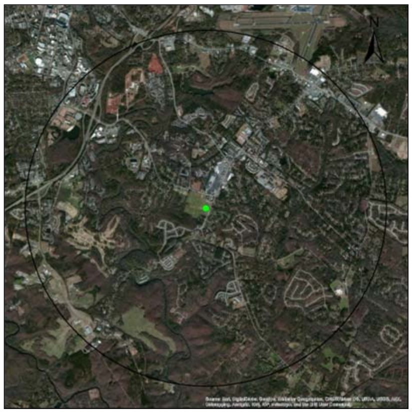
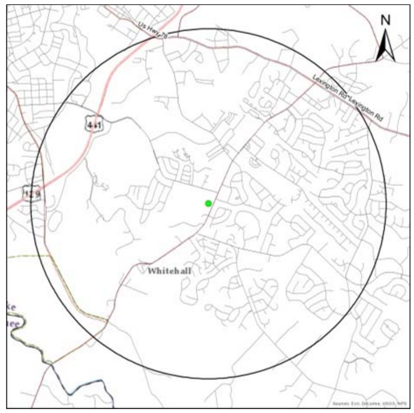
Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$	Population Exposure	Every 3 days	5 m	Neighborhood	2/14/99
$PM_{2.5}$	Population Exposure	Continuous	5 m	Neighborhood	1/1/08

Recommendations: Continue monitoring

Athens-Clark County MSA



Athens- College Station Road

AQS ID: 130590002

Address: Fire Station #7, 2350 Barnett Shoals Road, Athens, Clarke County, Georgia 30603

Site Established: 3/1/02

Latitude/Longitude: N33.91793/-W83.34461

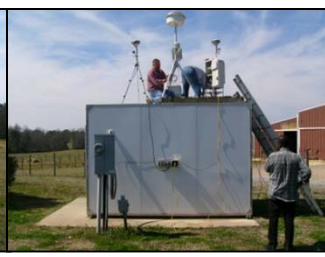
Elevation: 233 meters

Area Represented: Athens-Clarke County MSA

Site History: Established as O_3 and PM site

North

South

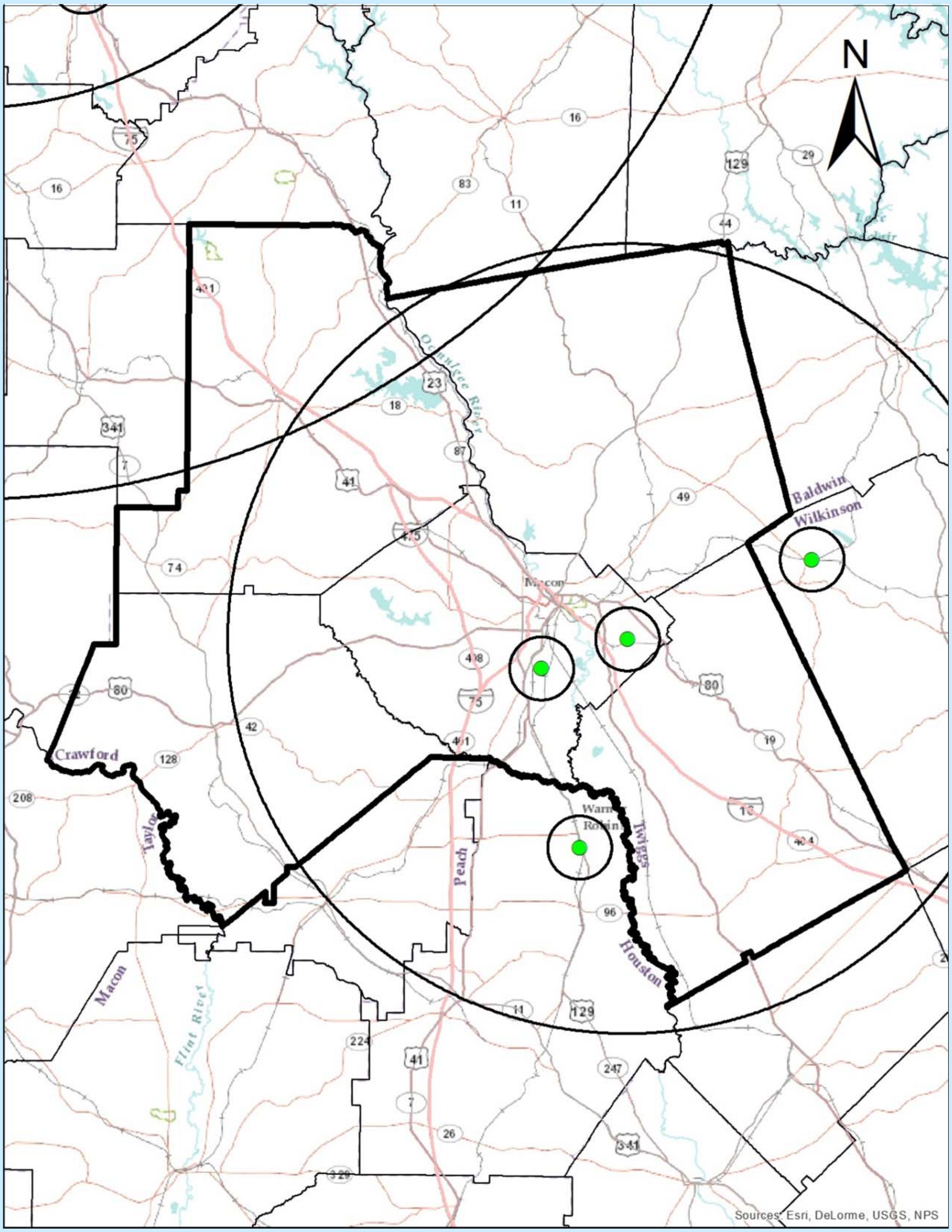


West

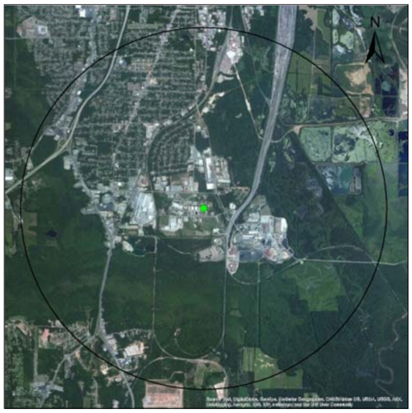
Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Population Exposure	Continuous (Mar-Oct)	6.80 m	Urban	5/1/02
$PM_{2.5}$	Population Exposure	Every 3 days	4 m	Neighborhood	2/12/05
$PM_{2.5}$	Population Exposure	Continuous	4 m	Neighborhood	8/1/04

Recommendations: Continue monitoring; considering configuring continuous $PM_{2.5}$ TEOM sampler as an FEM, which would be compared to the NAAQS

Macon MSA


N
Crawford
Taylor
Peach
Houston
Twiggs
Baldwin
Wilkinson
Macon
Flint River
Ocmulgee River
Sources: Esri, DeLorme, USGS, NPS

Macon- Allied Chemical



AQS ID: 130210007
Address: Allied Chemical, 600 Guy Paine Road, Macon, Bibb County, Georgia 31206
Site Established: 1/1/74
Latitude/Longitude: N32.77729/W-83.64120
Elevation: 106 meters
Area Represented: Macon MSA
Site History: Established as TSP site

North


South

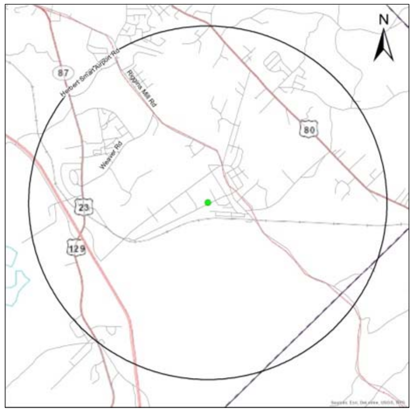

East


West


Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$ Speciation	Population Exposure	Every 6 days	4 m	Neighborhood	3/1/02
$PM_{2.5}$	Population Exposure	Daily	4 m	Neighborhood	2/2/99
$PM_{2.5}$	Quality Assurance	Every 12 days	4 m	Neighborhood	2/2/99

Recommendations: Continue monitoring

Macon- GA Forestry Commission

AQS ID: 130210012

Address: Georgia Forestry Commission, 5645 Riggins Mill Road, Dry Branch, Bibb County, Georgia 31020

Site Established: 5/7/97

Latitude/Longitude: N32.805244/W-83.543628

Elevation: 103 meters

Area Represented: Macon MSA

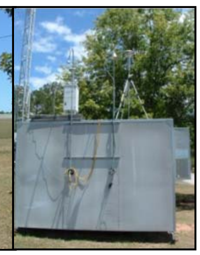
Site History: Established as O_3 and SO_2 site

North

South

East

West

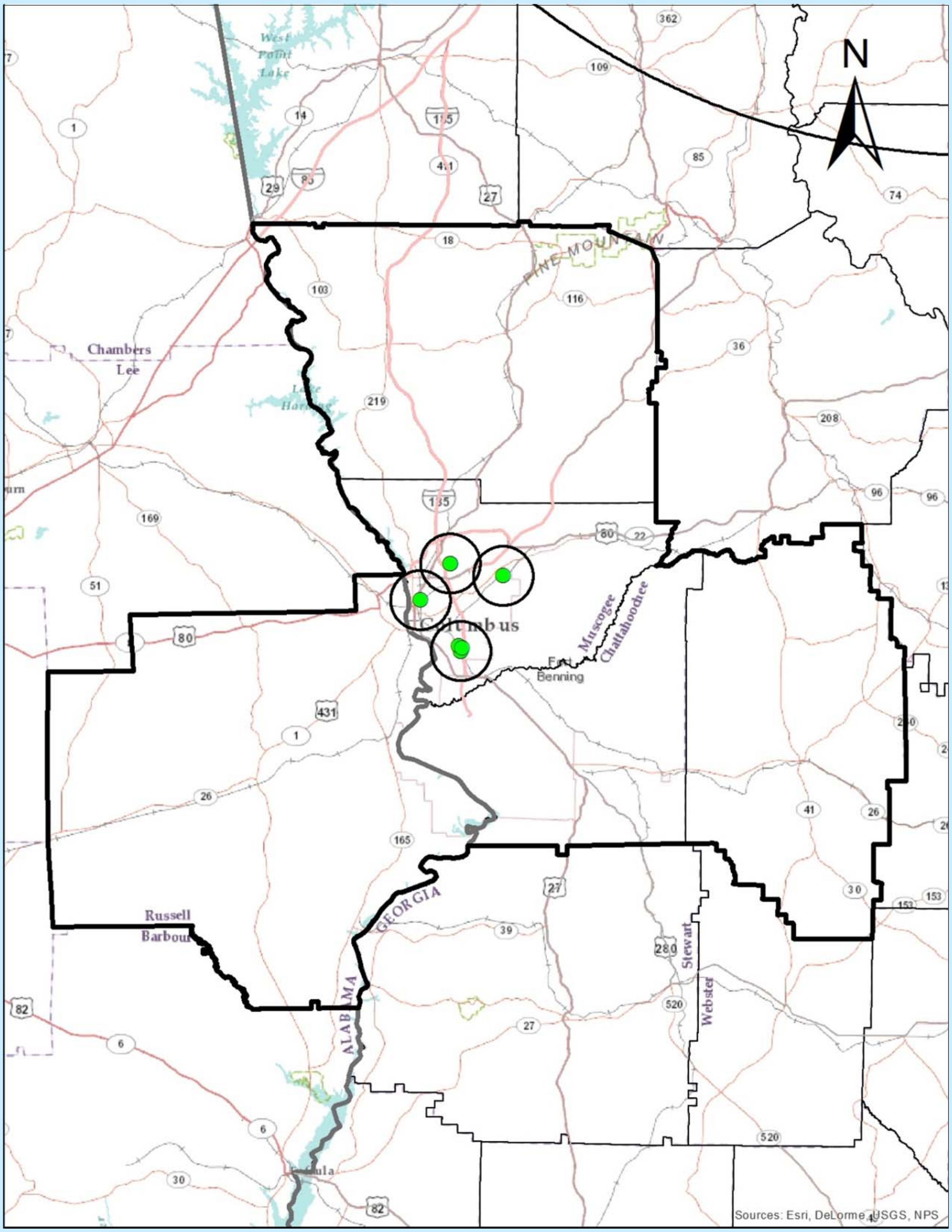


Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$	Population Exposure	Every 3 days	4 m	Neighborhood	2/1/99
$PM_{2.5}$	Population Exposure	Continuous	4 m	Neighborhood	5/5/03
Wind Direction	General/ Background	Continuous	10 m	Neighborhood	1/1/04
Wind Speed	General/ Background	Continuous	10 m	Neighborhood	1/1/04
O_3	Population Exposure	Continuous (Mar-Oct)	4 m	Neighborhood	5/7/97
SO_2	Population Exposure	Continuous	4 m	Urban	5/7/97
SO_2 5-Minute Maximum	Population Exposure	Continuous	4 m	Neighborhood	8/1/10
Toxics	Population Exposure	Every 12 days	2 m	Neighborhood	1/1/99

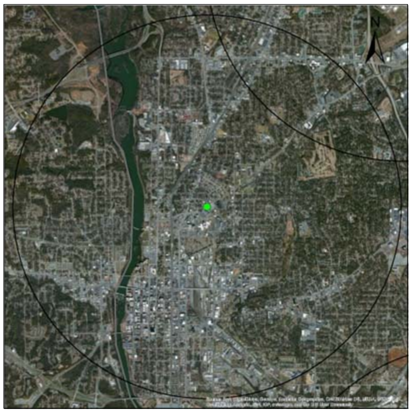
Macon- GA Forestry Commission (continued)

Recommendations: Continue monitoring; considering configuring continuous $PM_{2.5}$ TEOM sampler as an FEM, which would be compared to the NAAQS

Columbus Georgia-Alabama MSA



Columbus- Health Department



AQS ID: 132150001

Address: Muscogee City Health Department, 1958 8th Avenue, Columbus, Muscogee County, Georgia 31904

Site Established: 1/1/57

Latitude/Longitude: N32.484226/W-84.978925

Elevation: 101 meters

Area Represented: Columbus Georgia-Alabama MSA

Site History: Established as TSP site

North

South

East

West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$	Population Exposure	Every 3 days	7 m	Neighborhood	3/4/99

Recommendations: Continue monitoring

Columbus- Airport


AQS ID: 132150008

Address: Columbus Airport, 3100 Thruway Drive, Columbus, Muscogee County, Georgia 31909

Site Established: 7/1/82

Latitude/Longitude: N32.52113/W-84.94486

Elevation: 135 meters

Area Represented: Columbus Georgia-Alabama MSA

Site History: Established as O_3 site

North

South

East

West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Population Exposure	Continuous (Mar-Oct)	4 m	Neighborhood	7/1/82
$PM_{2.5}$	Population Exposure	Every 3 days	4 m	Neighborhood	6/2/03
$PM_{2.5}$	Population Exposure	Continuous	4 m	Neighborhood	6/1/03

Recommendations: Continue monitoring

Columbus- UPS

AQS ID: 132150009
Address: 4365 Allied Drive, Columbus, Muscogee County, Georgia 31906
Site Established: 9/1/90
Latitude/Longitude: N32.434809/W-84.929326
Elevation: 83 meters
Area Represented: Columbus Georgia-Alabama MSA
Site History: Established as lead site

North South East West

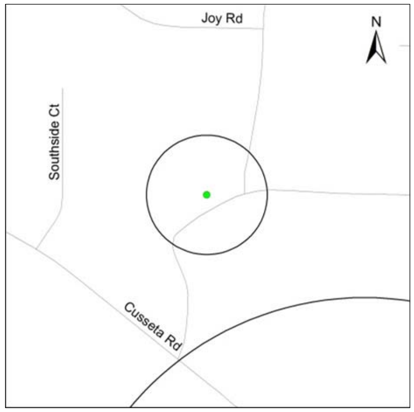



Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
Lead	Source Oriented	Every 6 days	2 m	Micro	9/1/90*

* Sampler inactive from 3/31/04 until reopened on 2/3/12

Recommendations: Lead monitoring being conducted along with Columbus-Fort Benning and Columbus-Cusseta Road sites to determine which sampler is best located to perform source monitoring

Columbus- Fort Benning



AQS ID: 132150010
Address: Ft. Benning Junction, 975 Joy Road, Columbus, Muscogee County, Georgia 31906
Site Established: 3/1/91
Latitude/Longitude: 32.43628/-84.934155
Elevation: 83 meters
Area Represented: Columbus Georgia-Alabama MSA
Site History: Established as lead site

North

South

East

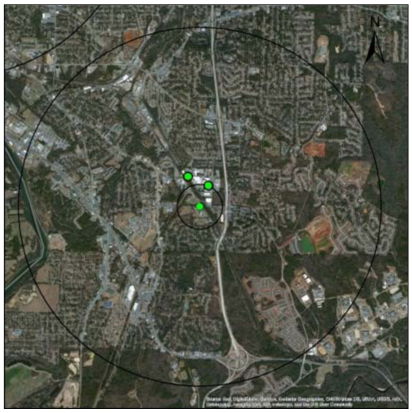
West

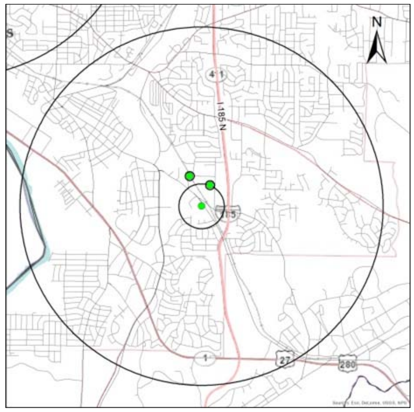
Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
Lead	Source Oriented	Every 6 days	2 m	Micro	3/1/91*
Lead	Source Oriented	Every 6 days	2 m	Micro	4/10/13

* Sampler inactive from 3/31/04 until reopened on 12/27/11

Recommendations: Lead monitoring being conducted along with Columbus-UPS and Columbus-Cusseta Road sites to determine which sampler is best located to perform source monitoring

Columbus- Cusseta Road Elementary





AQS ID: 132150011

Address: Cusseta Road Elementary School, 4150 Cusseta Road, Columbus, Muscogee County, Georgia 31903

Site Established: 9/4/91

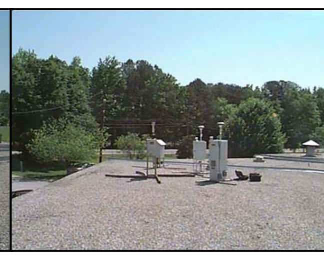
Latitude/Longitude: N32.42905/W-84.93160

Elevation: 88 meters

Area Represented: Columbus Georgia-Alabama MSA

Site History: Established as lead site

North South East West



Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
Lead	Population Exposure	Every 6 days	5 m	Middle	9/4/91
$PM_{2.5}$	Population Exposure	Every 3 days	5 m	Neighborhood	1/21/99
$PM_{2.5}$ Speciation	Population Exposure	Every 6 days	5 m	Neighborhood	5/1/02

Recommendations: Continue monitoring; Lead monitoring being conducted along with Columbus-Fort Benning and Columbus-UPS sites to determine which sampler is best located to perform source monitoring

Columbus- Crime Lab

AQS ID: 132151003

Address: Columbus Crime Lab, 8695 Beaver Run Road, Midland, Muscogee County, Georgia 31820

Site Established: 6/30/80

Latitude/Longitude: N32.50854/W-84.88037

Elevation: 122 meters

Area Represented: Columbus Georgia-Alabama MSA

Site History: Established as O_3 site

North

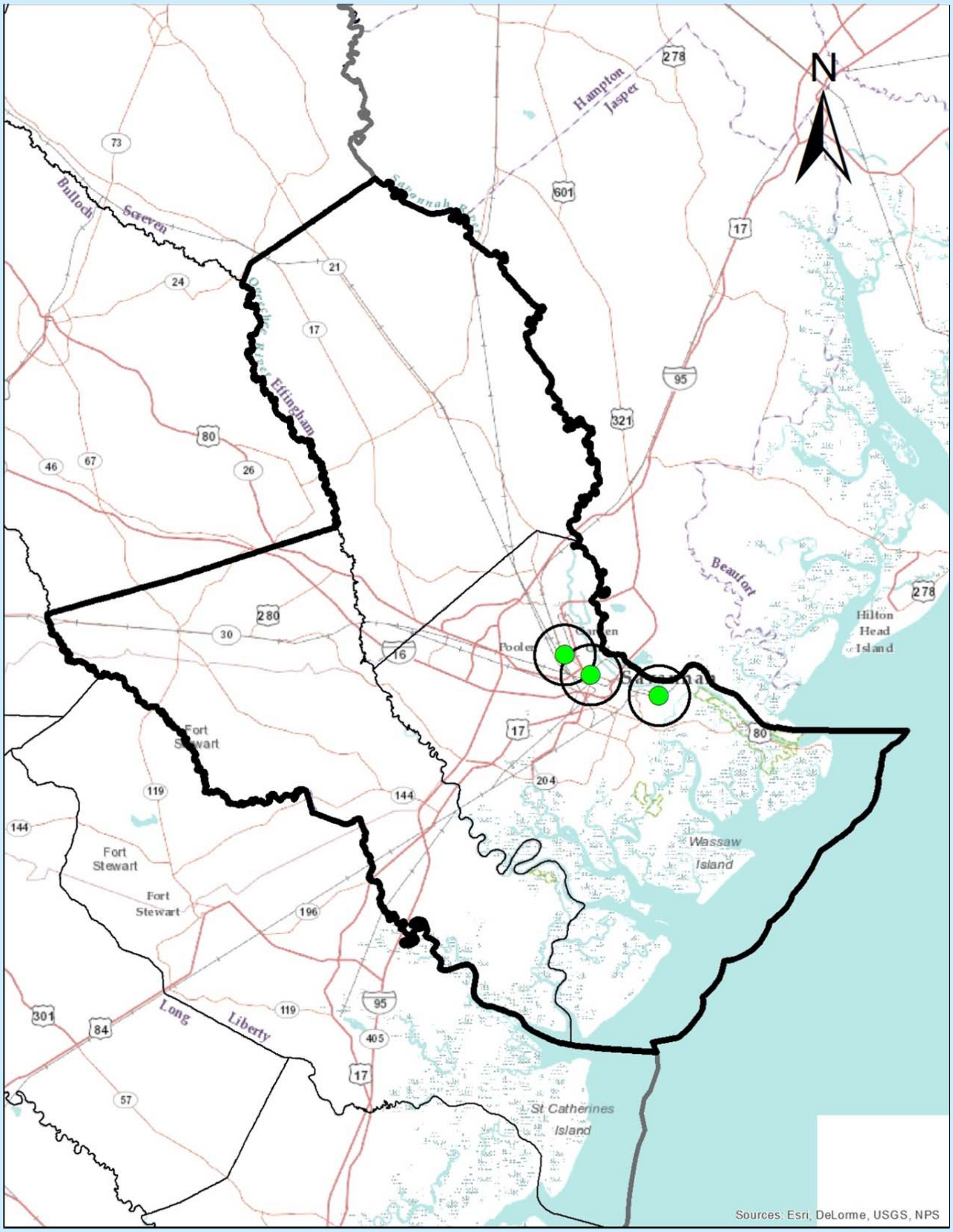
South

West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
Wind Speed	General/ Background	Continuous	10 m	Neighborhood	1/5/06
Wind Direction	General/ Background	Continuous	10 m	Neighborhood	1/5/06
Temperature	General/ Background	Continuous	2 m	Neighborhood	1/5/06
Relative Humidity	General/ Background	Continuous	2 m	Neighborhood	1/5/06
Precipitation	General/ Background	Continuous	3 m	Neighborhood	1/5/06
Barometric Pressure	General/ Background	Continuous	2 m	Neighborhood	1/5/06

Recommendations: Continue monitoring

Savannah MSA



Savannah- E. President Street

AQS ID: 130510021

Address: American Red Cross, 2500 E. President Street, Bd-A, Savannah, Chatham County, Georgia 31404

Site Established: 2/1/95

Latitude/Longitude: N32.069050/W-81.048949

Elevation: 2 meters

Area Represented: Savannah MSA

Site History: Established as SO_2 and H_2S site

North

South

East

West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Population Exposure	Continuous (Mar-Oct)	4 m	Neighborhood	4/19/95
SO_2	Source Oriented	Continuous	4 m	Neighborhood	3/29/95
SO_2 5-Minute Maximum	Population Exposure	Continuous	4 m	Neighborhood	8/1/10
Wind Direction	General/ Background	Continuous	10 m	Neighborhood	1/1/04
Wind Speed	General/ Background	Continuous	10 m	Neighborhood	1/1//04
Toxics	Population Exposure	Every 12 days	2 m	Neighborhood	9/18/96
Carbonyls	Population Exposure	Every 12 days	4 m	Neighborhood	1/1/99

Recommendations: Continue monitoring

Savannah- Mercer School

AQS ID: 130510091
Address: Mercer Middle School, 201 Rommel Avenue, Savannah, Chatham County, Georgia 31408
Site Established: 7/7/76
Latitude/Longitude: N32.110580/W-81.162024
Elevation: 4 meters
Area Represented: Savannah MSA
Site History: Established as TSP site

North

South

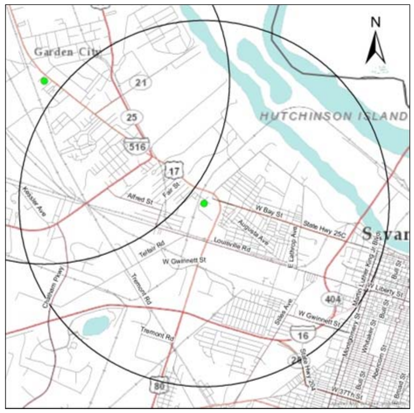
East

West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$	Population Exposure	Every 3 days	5 m	Neighborhood	1/1/99

Recommendations: Continue monitoring

Savannah- Lathrop and Augusta



AQS ID: 130511002

Address: Pumping Station at Intersection of West Lathrop and Augusta Avenue, Savannah, Chatham County, Georgia 31415

Site Established: 1/1/72

Latitude/Longitude: N32.090278/W-81.130556

Elevation: 4 meters

Area Represented: Savannah MSA

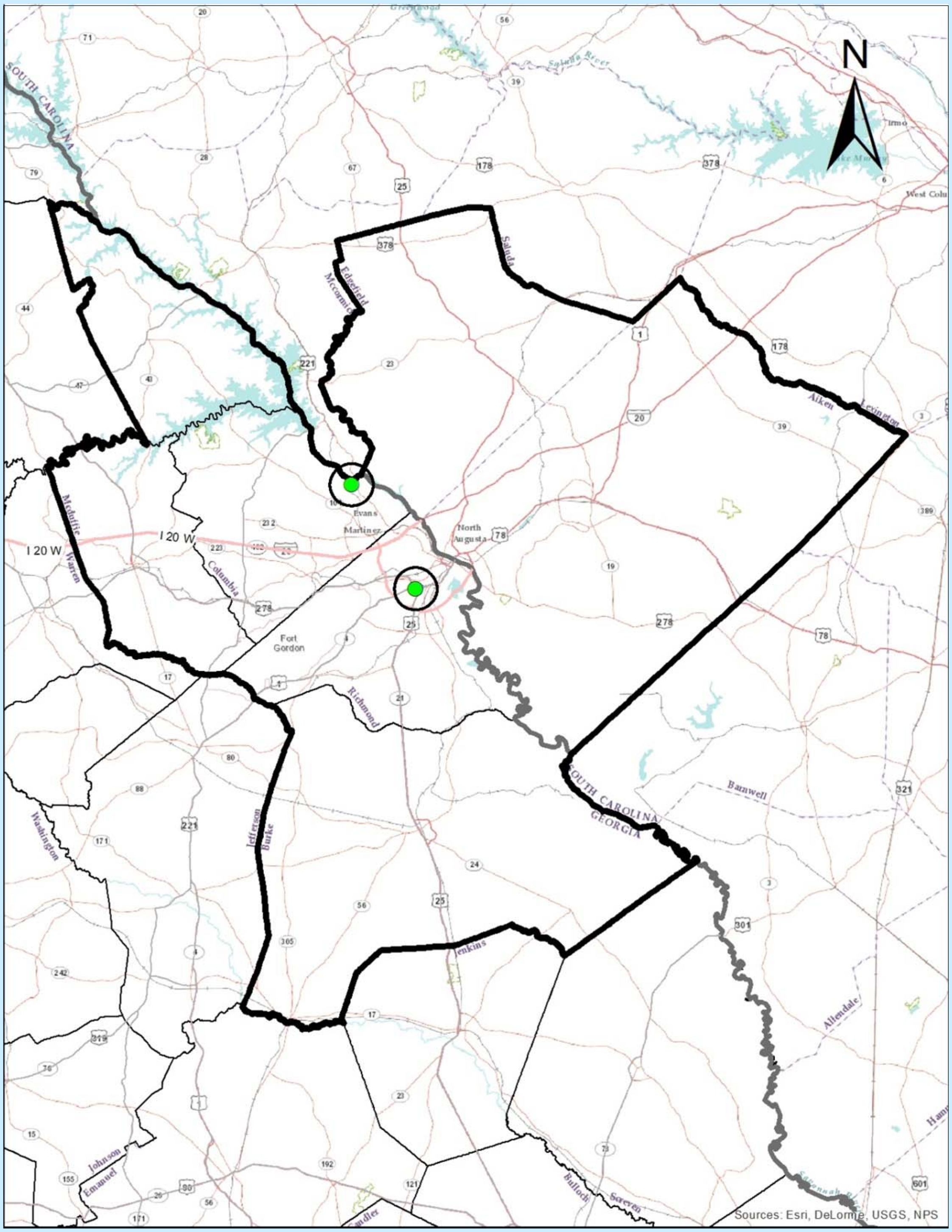
Site History: Established as TSP site

Northeast Southwest

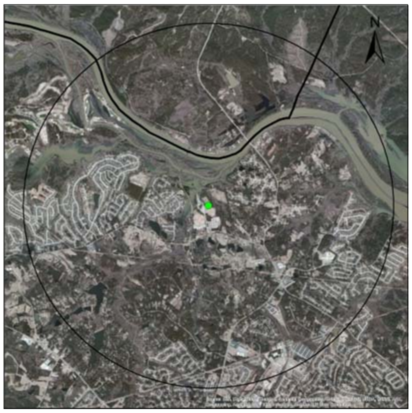
Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
SO_2	Population Exposure	Continuous	4 m	Neighborhood	1/1/98
SO_2 5-Minute Maximum	Population Exposure	Continuous	4 m	Neighborhood	8/1/10
Wind Direction	General/ Background	Continuous	10 m	Neighborhood	1/1/79
Wind Speed	General/ Background	Continuous	10 m	Neighborhood	1/1/79
$PM_{2.5}$	Population Exposure	Continuous	5 m	Neighborhood	10/1/03

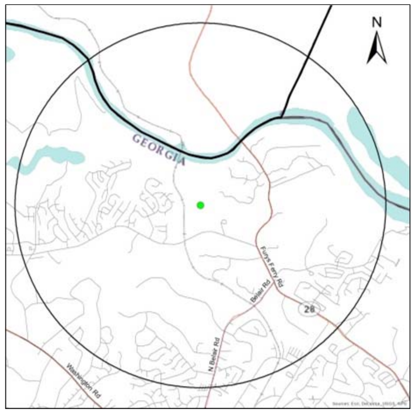
Recommendations: Continue monitoring; propose to add an ozone monitor when initiated by EPA

Augusta-Richmond County, Georgia-South Carolina MSA



Evans- Riverside Park





AQS ID: 130730001

Address: Riverside Park, 4431 Hardy McManus Road, Evans, Columbia County, Georgia 30809

Site Established: 2/17/05

Latitude/Longitude: N33.582000/W-82.131340

Elevation: 74 meters

Area Represented: Augusta-Richmond County, Georgia-South Carolina MSA

Site History: Established as O_3 and NO_Y site

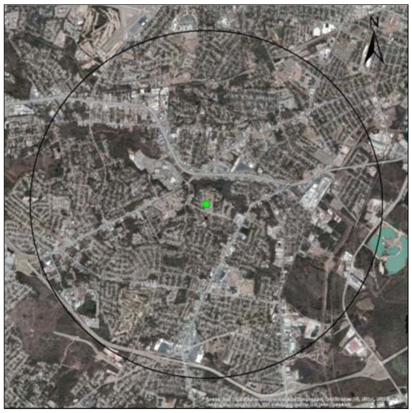
North Southeast East



Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Population Exposure	Continuous (Mar-Oct)	5 m	Neighborhood	3/1/05
Wind Speed	General/ Background	Continuous	10 m	Neighborhood	2/17/05
Wind Direction	General/ Background	Continuous	10 m	Neighborhood	2/17/05
Temperature	General/ Background	Continuous	2 m	Neighborhood	2/17/05
Relative Humidity	General/ Background	Continuous	2 m	Neighborhood	2/17/05

Recommendations: Continue monitoring

Augusta- Bungalow Road Elementary



AQS ID: 132450091

Address: Bungalow Road Elementary School, 2216 Bungalow Rd, Augusta, Richmond County, Georgia 30906

Site Established: 1/1/76

Latitude/Longitude: N33.433349/W-82.022217

Elevation: 46 meters

Area Represented: Augusta-Richmond County, Georgia-South Carolina MSA

Site History: Established as TSP site

North

South

East

West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Population Exposure	Continuous (Mar-Oct)	5 m	Neighborhood	4/27/89
PM_{10}	Population Exposure	Every 6 days	6 m	Neighborhood	4/9/96
PM_{10}	Quality Assurance	Every 12 days	6 m	Neighborhood	1/10/13
$PM_{2.5}$ Speciation	Population Exposure	Every 6 days	6 m	Neighborhood	3/2/02
$PM_{2.5}$	Population Exposure	Every 3 days	6 m	Neighborhood	2/8/99
$PM_{2.5}$	Population Exposure	Continuous	6 m	Neighborhood	10/1/03
SO_2	Population Exposure	Continuous	6 m	Neighborhood	1/14/13
SO_2 5-Minute Maximum	Population Exposure	Continuous	6 m	Neighborhood	1/14/13

Augusta- Bungalow Road Elementary (continued)

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
Wind Speed	General/ Background	Continuous	10 m	Neighborhood	10/2/03
Wind Direction	General/ Background	Continuous	10 m	Neighborhood	10/2/03
Temperature	General/ Background	Continuous	2 m	Neighborhood	10/2/03
Relative Humidity	General/ Background	Continuous	2 m	Neighborhood	10/2/03
Precipitation	General/ Background	Continuous	4 m	Neighborhood	10/2/03
Barometric Pressure	General/ Background	Continuous	2 m	Neighborhood	10/2/03

Recommendations: Continue monitoring

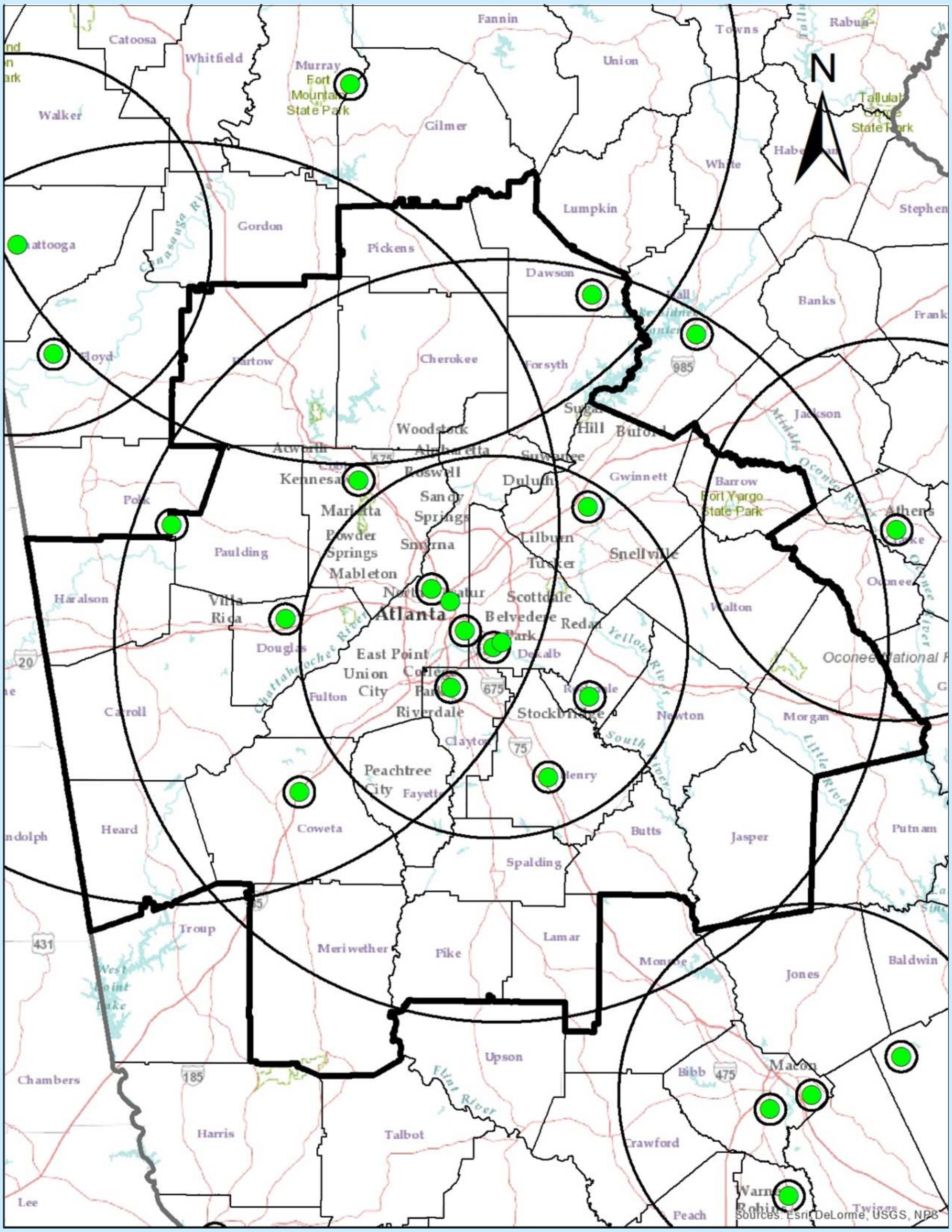
Augusta- Near-Road Monitoring Site

AQS ID: To be determined
Address: Augusta, Richmond County, Georgia (Specifics to be determined)
Site Established: To be determined
Latitude/Longitude: To be determined
Elevation: To be determined
Area Represented: Augusta-Richmond County, Georgia-South Carolina MSA

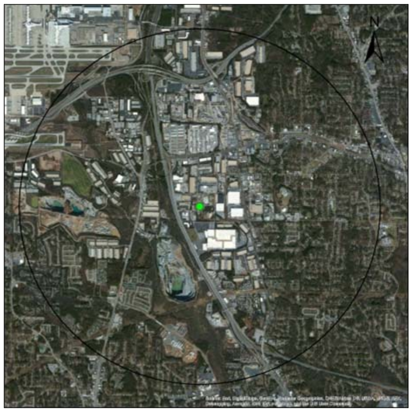
Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
NO_2	Highest Concentration	Continuous	TBD	Micro	TBD

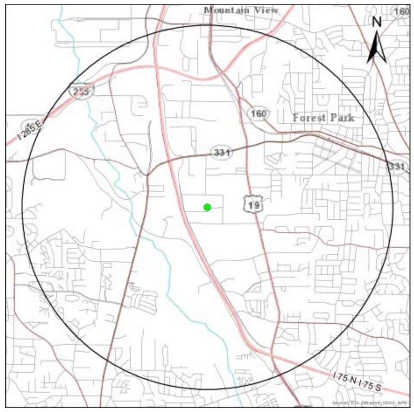
Due to changes in establishment schedule by EPA, site should be set up by January 1, 2017 (see Section 3.3 of Introduction for details)

Atlanta-Sandy Springs-Marietta



Forest Park- Georgia DOT





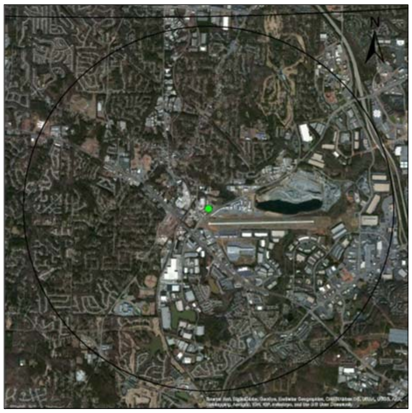
AQS ID: 130630091
Address: 25 Kennedy Drive, Forest Park, Clayton County, Georgia 30297
Site Established: 1/1/78
Latitude/Longitude: N33.609722/W-84.391111
Elevation: 288 meters
Area Represented: Atlanta-Sandy Springs-Marietta MSA
Site History: Established as TSP site

North South East West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$	Population Exposure	Every 3 days	5 m	Neighborhood	1/9/99

Recommendations: Continue monitoring

Kennesaw- National Guard



AQS ID: 130670003

Address: Georgia National Guard, 1901 McCollum Parkway, Kennesaw, Cobb County, Georgia, 30144

Site Established: 2/7/99

Latitude/Longitude: N34.015346/W-84.607484

Elevation: 317 meters

Area Represented: Atlanta-Sandy Springs-Marietta MSA

Site History: Established as $PM_{2.5}$ site

North South East West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Population Exposure	Continuous (Mar-Oct)	4 m	Neighborhood	9/1/99
$PM_{2.5}$	Population Exposure	Daily	4 m	Neighborhood	2/7/99

Recommendations: Continue monitoring

Newnan- University of West Georgia

AQS ID: 130770002

Address: Univ. of West GA, Newnan Campus, 7 Solar Circle, Newnan, Coweta County, Georgia 30265

Site Established: 5/5/99

Latitude/Longitude: N33.40389/W-84.74606

Elevation: 271 meters

Area Represented: Atlanta-Sandy Springs-Marietta MSA

Site History: Established as O_3 site

North

South

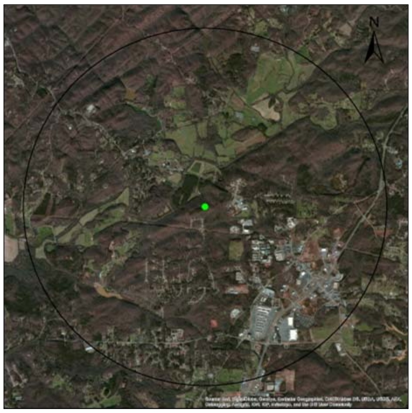
East

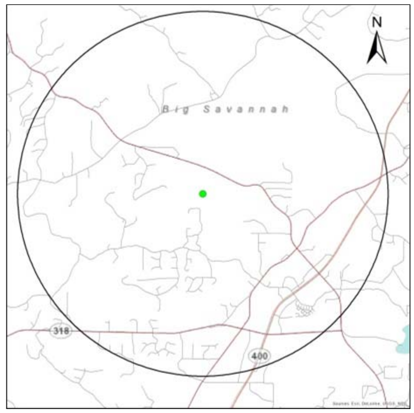
West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Population Exposure	Continuous (Mar-Oct)	4 m	Neighborhood	5/5/99
$PM_{2.5}$	Population Exposure	Continuous	4 m	Neighborhood	9/1/03
Wind Direction	General/ Background	Continuous	10 m	Neighborhood	1/1/04
Wind Speed	General/ Background	Continuous	10 m	Neighborhood	1/1/04

Recommendations: Continue monitoring

Dawsonville- GA Forestry Commission





AQS ID: 130850001

Address: Georgia Forestry Commission, 4500 Georgia Highway 53 East, Dawsonville, Dawson County, Georgia 30534

Site Established: 1/1/85

Latitude/Longitude: N34.37619/W-84.05986

Elevation: 372 meters

Area Represented: Atlanta-Sandy Springs-Marietta MSA

Site History: Established as O_3 site

North

South

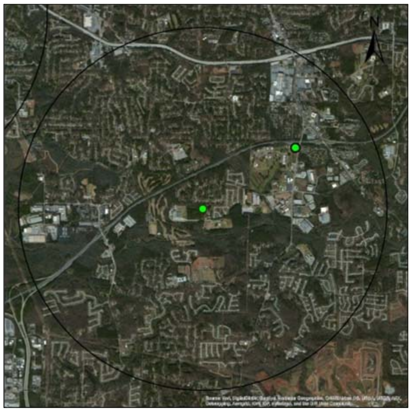
East

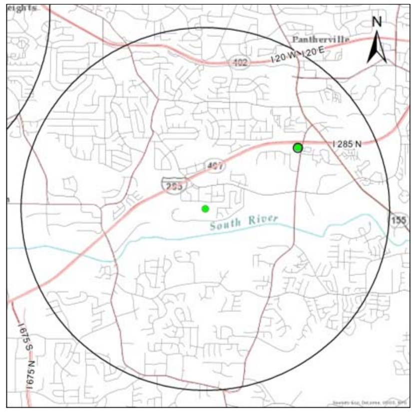
West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Population Exposure	Continuous (Mar-Oct)	4 m	Neighborhood	1/1/85
Toxics	General/ Background	Every 12 days	2 m	Neighborhood	12/11/96
Carbonyls	General/ Background	Every 12 days	4 m	Neighborhood	1/1/99
Wind Speed	General/ Background	Continuous	10 m	Neighborhood	1/1/05
Wind Direction	General/ Background	Continuous	10 m	Neighborhood	1/1/05

Recommendations: Continue monitoring

Decatur- South DeKalb





AQS ID: 130890002

Address: 2390-B Wildcat Road, Decatur, DeKalb County, Georgia 30034

Site Established: 1/1/74

Latitude/Longitude: N33.68797/-84.29048

Elevation: 308 meters

Area Represented: Atlanta-Sandy Springs-Marietta MSA

Site History: Established as O_3 site

North

South

East

West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$	Population Exposure	Daily	2.7 m	Neighborhood	1/22/99
$PM_{2.5}$	Quality Assurance	Every 12 days	2.7 m	Neighborhood	12/20/08
$PM_{2.5}$	Population Exposure	Continuous	4 m	Neighborhood	5/1/03
$PM_{2.5}$ Speciation	Population Exposure	Every 3 days	2.6 m	Neighborhood	10/1/00
SO_2	Population Exposure	Continuous	4 m	Neighborhood	10/1/10
SO_2 5-Minute Maximum	Population Exposure	Continuous	4 m	Neighborhood	10/1/10
O_3	Highest Concentration	Continuous	4 m	Neighborhood/ Urban	1/1/74

Decatur- South DeKalb (continued)

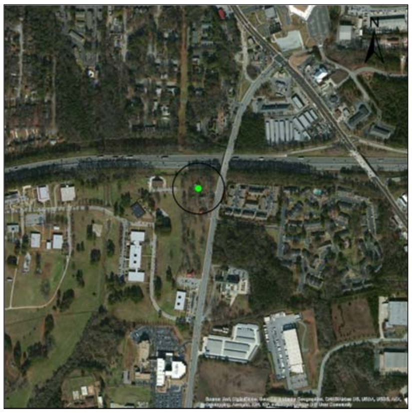
Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
CO	Population Exposure	Continuous	4 m	Neighborhood	5/19/03
NOy	Population Exposure	Continuous	10 m	Neighborhood/ Urban	1/1/98
NO	Population Exposure	Continuous	4 m	Neighborhood/ Urban	4/1/94
NOx	Population Exposure	Continuous	4 m	Neighborhood/ Urban	4/1/94
NO_2	Population Exposure	Continuous	5 m	Neighborhood/ Urban	7/21/78
Carbonyls (PAMS)	Max Precursor Emissions	3-hour Samples in Summer	4 m	Neighborhood	6/1/93
Carbonyls (PAMS/Toxics)	Max Precursor Emissions/ Population Exposure	Every 6 days	4 m	Neighborhood	6/1/93
Carbonyls	Quality Assurance	Every 12 days	4 m	Neighborhood	1/1/06
PM_{10} Select Metals (Toxics)	Population Exposure	Every 6 days	2 m	Neighborhood	1/1/00
PM_{10} Select Metals (Toxics)	Quality Assurance	Every 12 days	2.3 m	Neighborhood	1/1/05
PM_{10} Continuous	Population Exposure	Continuous	4 m	Neighborhood	1/1/11
PM_{coarse} Continuous	Population Exposure	Continuous	4 m	Neighborhood	1/1/11
VOCs (PAMS)	Max Precursor Emissions	Continuous in Summer	4 m	Neighborhood	6/1/93
VOCs (PAMS/Toxics)	Max Precursor Emissions/ Population Exposure	Every 6 days	4 m	Neighborhood	6/1/93
VOCs (Toxics)	Quality Assurance	Every 12 days	4 m	Neighborhood	1/1/05
Elemental Carbon (Aethalometer)	Population Exposure	Continuous	4 m	Neighborhood	6/12/03

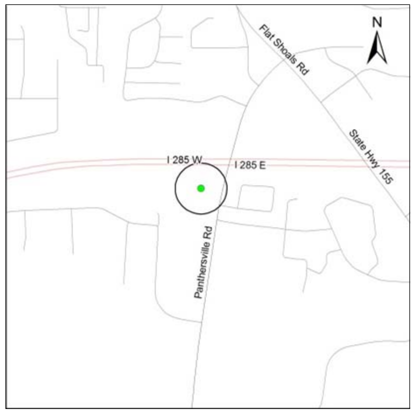
Decatur- South DeKalb (continued)

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
Semi-VOCs	Population Exposure	Every 6 days	1.6 m	Neighborhood	4/30/07
Semi-VOCs	Quality Assurance	Every 12 days	2 m	Neighborhood	4/30/07
Outdoor Temperature	General/ Background	Continuous	2 m	Neighborhood	6/1/93
Rain/Melt Precipitation	General/ Background	Continuous	3 m	Neighborhood	1/1/97
Barometric Pressure	General/ Background	Continuous	2 m	Neighborhood	6/1/93
Wind Direction	General/ Background	Continuous	10 m	Neighborhood	6/1/93
Wind Speed	General/ Background	Continuous	10 m	Neighborhood	6/1/93
Sigma Theta	General/ Background	Continuous	10 m	Neighborhood	1/1/02
Relative Humidity	General/ Background	Continuous	2 m	Neighborhood	6/1/93

Recommendations: Continue monitoring; NCore site (see Appendix C of 2014 Ambient Air Monitoring Plan for full description and approval)

Decatur- DMRC Near-Road





AQS ID: 130890003

Address: D.M.R.C., 3073 Panthersville Road, Decatur, DeKalb County, Georgia 30034

Site Established: 7/1/86

Latitude/Longitude: N33.698468/W-84.272694

Elevation: 238 meters

Area Represented: Atlanta-Sandy Springs-Marietta MSA

Site History: Established as lead site

North

South

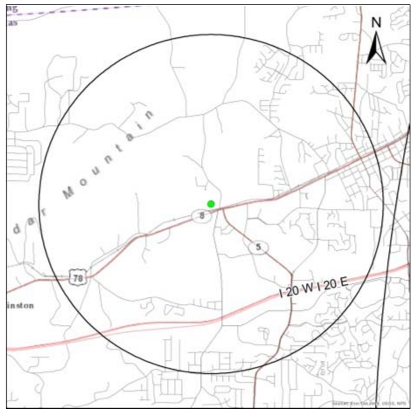
East

West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
Lead	Regional Transport	Every 6 days	2 m	Regional	7/1/86
Lead	Quality Assurance	Every 12 days	2 m	Regional	8/5/09
NO_2	Population Exposure	Continuous	4 m	Micro	1/1/15
NO	Population Exposure	Continuous	4 m	Micro	1/1/15
NOx	Population Exposure	Continuous	4 m	Micro	1/1/15
VOCs	Population Exposure	Every 6 days	2 m	Micro	3/31/15
Black Carbon	Population Exposure	Continuous	4 m	Micro	TBD

Recommendations: Continue monitoring; Lead monitor for NCore Station at South DeKalb site (see Appendix C of '2014 Ambient Monitoring Plan' for full description); Near-road site as of 1/1/15 (see 'Addedum to 2014 Ambient Monitoring Plan' for full description; GA EPD anticipates starting the black carbon sampler in near future

Douglasville- W. Strickland Street



AQS ID: 130970004

Address: Douglas County Water Authority, 7725 W. Strickland St., Douglasville, Douglas County, Georgia 30134

Site Established: 8/15/97

Latitude/Longitude: N33.743514/W-84.779263

Elevation: 368 meters

Area Represented: Atlanta-Sandy Springs-Marietta MSA

Site History: Established as O_3 site

North

South

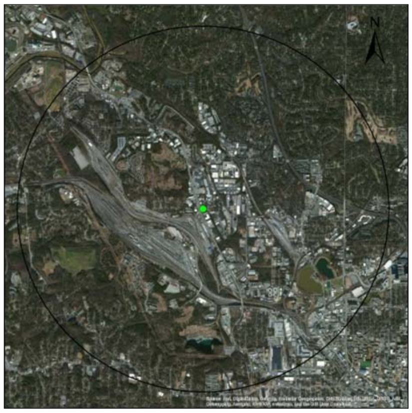
East

West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Population Exposure	Continuous (Mar-Oct)	4 m	Neighborhood	8/15/97
Wind Direction	General/ Background	Continuous	10 m	Neighborhood	8/15/97
Wind Speed	General/ Background	Continuous	10 m	Neighborhood	8/15/97

Recommendations: Continue monitoring

Atlanta- Fire Station #8



AQS ID: 131210039

Address: Fire Station #8, 1711 Marietta Blvd., Atlanta, Fulton County, Georgia 30318

Site Established: 1/1/73

Latitude/Longitude: N33.802189/W-84.435658

Elevation: 265 meters

Area Represented: Atlanta-Sandy Springs-Marietta MSA

Site History: Established as TSP site

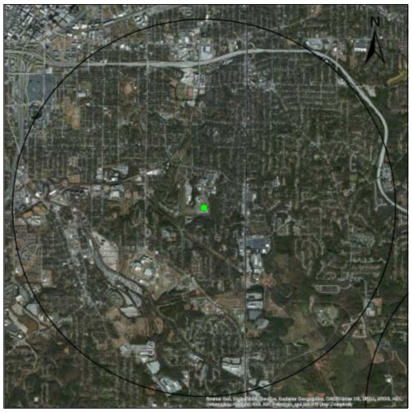
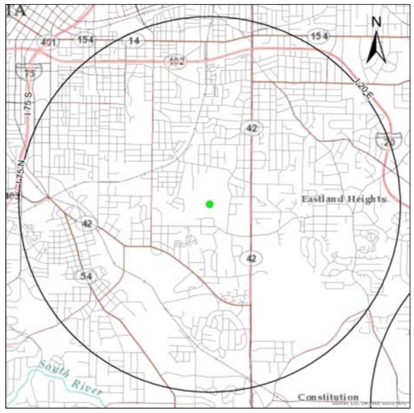
North South East West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$	Population Exposure	Every 3 days	4 m	Neighborhood	1/21/99*
PM_{10}	Population Exposure	Every 6 days	4 m	Neighborhood	10/18/87**

* Sampler inactive from 9/30/06 to 12/1/08, **Sampler inactive from 9/26/06 to 1/3/13

<u>Recommendations:</u> Continue monitoring

Atlanta- Confederate Avenue

AQS ID: 131210055

Address: 935 East Confederate Avenue, Atlanta, Fulton County, Georgia 30316

Site Established: 10/1/91

Latitude/Longitude: N33.72005/W-84.35714

Elevation: 292 meters

Area Represented: Atlanta-Sandy Springs-Marietta MSA

Site History: Established as O_3 and SO_2 site

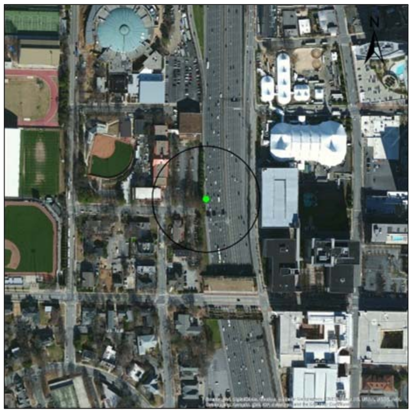
North South East West

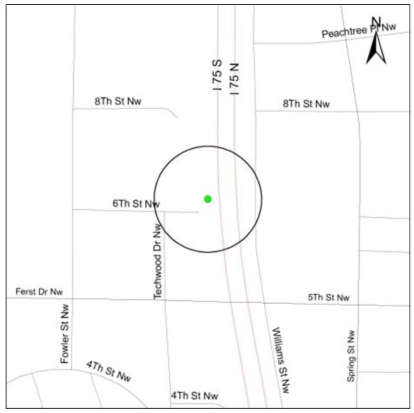



Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
SO_2	Population Exposure	Continuous	4 m	Neighborhood	10/1/91
SO_2 5-Minute Maximum	Population Exposure	Continuous	4 m	Neighborhood	8/1/10
O_3	Population Exposure	Continuous (Mar-Oct)	4 m	Neighborhood	10/1/91
$PM_{2.5}$	Population Exposure	Continuous	4.80 m	Neighborhood	7/1/05
Wind Direction	General/ Background	Continuous	10 m	Neighborhood	1/1/04
Wind Speed	General/ Background	Continuous	10 m	Neighborhood	1/1/04

Recommendations: Continue monitoring

Atlanta-Georgia Tech Near-Road





AQS ID: 131210056

Address: Georgia Institute of Technology, 6th Street, Atlanta, Fulton County, Georgia, 30313

Site Established: 6/15/14

Latitude/Longitude: N33.778315/W-84.391418

Elevation: 286 meters

Area Represented: Atlanta-Sandy Springs-Marietta MSA

Site History: Established as near-road site

Northeast

Southeast

East

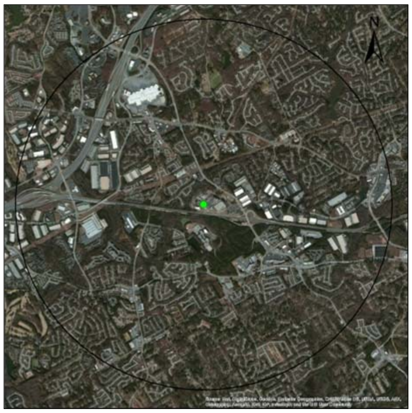
Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
NO_2	Source Oriented	Continuous	4 m	Micro	6/15/14
NO	Source Oriented	Continuous	4 m	Micro	6/15/14
NOx	Source Oriented	Continuous	4 m	Micro	6/15/14
CO	Source Oriented	Continuous	4 m	Micro	6/15/14
$PM_{2.5}$	Source Oriented	Continuous	5 m	Micro	1/1/15
Black Carbon	Source Oriented	Continuous	TBD	Micro	TBD
Wind Speed	Source Oriented	Continuous	7 m	Micro	8/20/14

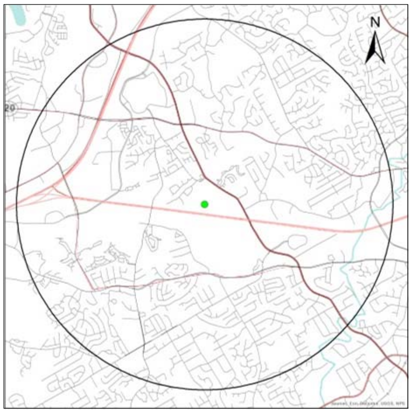
Atlanta-Georgia Tech Near-Road (continued)

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
Wind Direction	Source Oriented	Continuous	7 m	Micro	8/20/14

Recommendations: GA EPD anticipates the black carbon sampler will be running in near future. See Appendix E of '2014 Ambient Monitoring Plan' for near-road site details.

Lawrenceville- Gwinnett Tech





AQS ID: 131350002

Address: Gwinnett Tech, 5150 Sugarloaf Parkway, Lawrenceville, Gwinnett County, Georgia 30043

Site Established: 3/17/95

Latitude/Longitude: N33.96127/W-84.06901

Elevation: 290 meters

Area Represented: Atlanta-Sandy Springs-Marietta MSA

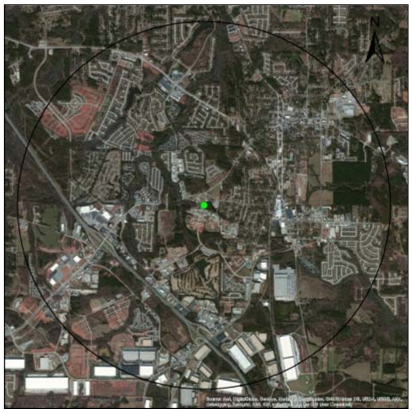
Site History: Established as O_3 site

North South East West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Highest Concentration	Continuous (Mar-Oct)	5 m	Neighborhood	5/17/95
$PM_{2.5}$	Population Exposure	Every 3 days	5 m	Neighborhood	1/1/00
$PM_{2.5}$	Population Exposure	Continuous	5 m	Neighborhood	9/1/03

Recommendations: Continue monitoring

McDonough- County Extension Office



AQS ID: 131510002

Address: Henry County Extension Office, 86 Work Camp Rd, McDonough, Henry County, Georgia 30253

Site Established: 6/7/99

Latitude/Longitude: N33.433426/W-84.161797

Elevation: 249 meters

Area Represented: Atlanta-Sandy Springs-Marietta MSA

Site History: Established as O_3 site

North

South

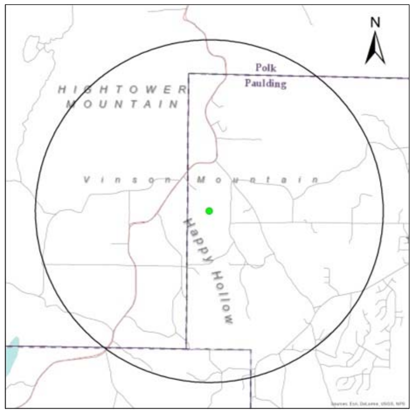
East

West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Population Exposure	Continuous (Mar-Oct)	4 m	Neighborhood	6/7/99
$PM_{2.5}$	Population Exposure	Continuous	4 m	Neighborhood	9/1/03

Recommendations: Continue monitoring

Yorkville- King Farm



AQS ID: 132230003

Address: King Farm, 160 Ralph King Path, Rockmart, Paulding County, Georgia, 30153

Site Established: 1/1/96

Latitude/Longitude: N33.92850/W-85.04534

Elevation: 379 meters

Area Represented: Atlanta-Sandy Springs-Marietta MSA

Site History: Established as PAMS site

North

South

East

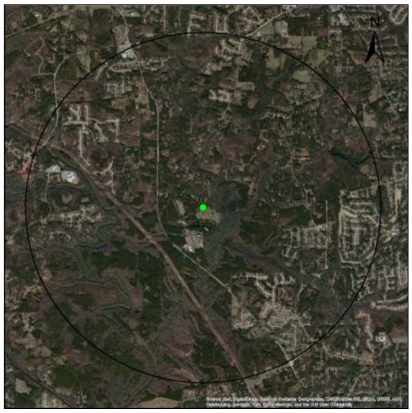
Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Population Exposure/ Upwind Background	Continuous (Mar-Oct)	4 m	Regional	1/1/96
CO	Population Exposure/ Upwind Background	Continuous	4 m	Regional	7/16/02
NO	Population Exposure/ Upwind Background	Continuous	4 m	Regional	1/1/96
NO_2	Population Exposure/ Upwind Background	Continuous	4 m	Regional	1/1/96

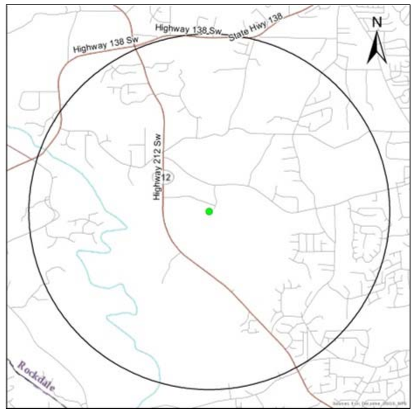
Yorkville- King Farm (continued)

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
NOx	Population Exposure/ Upwind Background	Continuous	4 m	Regional	1/1/96
Toxics	Regional Transport	Every 12 days	2 m	Neighborhood	1/1/00
VOCs (PAMS)	Upwind Background	Continuous in Summer	4 m	Regional	1/1/96
VOCs (PAMS)	Upwind Background	Every 6 days	4 m	Regional	1/1/96
VOCs (Toxics)	Regional Transport	Every 12 days	4 m	Neighborhood	1/1/96
$PM_{2.5}$	Upwind Background	Continuous	4 m	Regional	3/1/03
$PM_{2.5}$	Upwind Background/ Regional Transport	Every 3 days	5 m	Regional	1/24/99
Solar Radiation	General/ Background	Continuous	1.50 m	Regional	1/1/96
Ultraviolet Radiation	General/ Background	Continuous	1.50 m	Regional	1/1/97
Barometric Pressure	General/ Background	Continuous	2 m	Regional	1/1/96
Rain/Melt Precipitation	General/ Background	Continuous	3 m	Regional	1/1/97
Wind Direction	General/ Background	Continuous	10 m	Regional	1/1/96
Wind Speed	General/ Background	Continuous	10 m	Regional	1/1/96
Outdoor Temperature	Regional Transport	Continuous	2 m	Regional	1/1/96
Relative Humidity	General/ Background	Continuous	2 m	Regional	1/1/96

Recommendations: Continue monitoring

Conyers- Monastery





AQS ID: 132470001

Address: Monastery of the Holy Spirit, 2625 Georgia Highway 212, Conyers, Rockdale County, Georgia 30094

Site Established: 7/26/78

Latitude/Longitude: N33.590932/W-84.065386

Elevation: 219 meters

Area Represented: Atlanta-Sandy Springs-Marietta MSA

Site History: Established as O_3 site

North

South

East

West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Maximum Concentration	Continuous (Mar-Oct)	5 m	Neighborhood	7/26/78
NOx	Max Precursor Emissions Impact	Continuous	5 m	Neighborhood	4/1/94
NO_2	Max Precursor Emissions Impact	Continuous	5 m	Neighborhood	4/1/94
NO	Max Precursor Emissions Impact	Continuous	5 m	Neighborhood	4/1/94

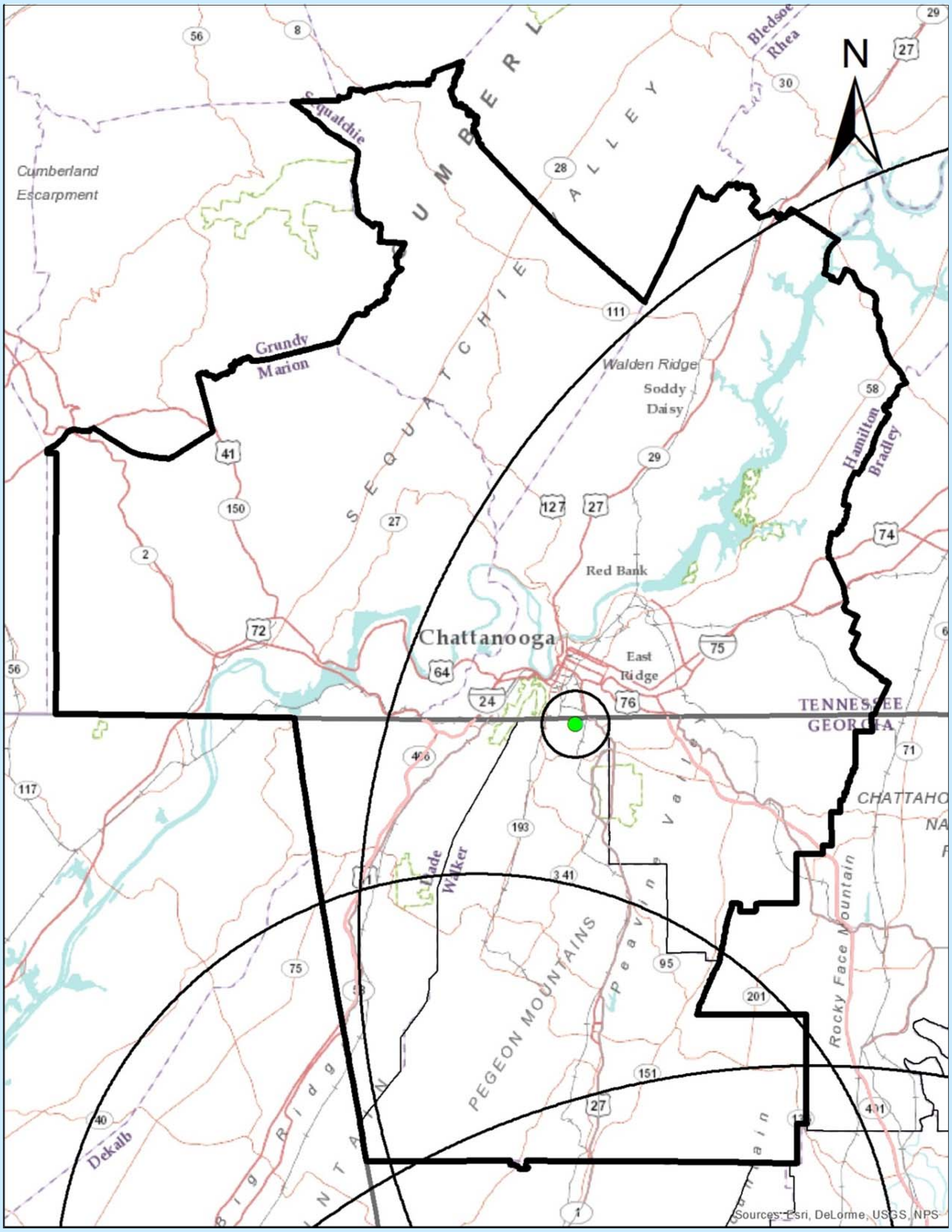
Conyers- Monastery (continued)

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
VOCs (PAMS)	Max Precursor Emissions Impact	Every 6 days	5 m	Neighborhood	1/1/94
Relative Humidity	General/ Background	Continuous	2 m	Neighborhood	6/1/94
Barometric Pressure	General/ Background	Continuous	2 m	Neighborhood	6/1/94
Ultraviolet Radiation	General/ Background	Continuous	1.50 m	Neighborhood	1/1/97
Outdoor Temperature	General/ Background	Continuous	2 m	Neighborhood	6/1/94
Solar Radiation	General/ Background	Continuous	1.50 m	Neighborhood	6/1/94
Wind Direction	General/ Background	Continuous	10 m	Neighborhood	6/1/94
Wind Speed	General/ Background	Continuous	10 m	Neighborhood	6/1/94
Rain/Melt Precipitation	General/ Background	Continuous	3 m	Neighborhood	7/1/03

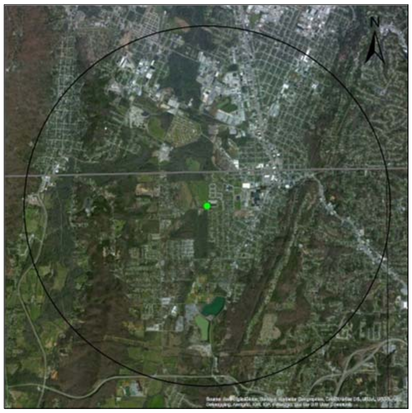
Recommendations: Continue monitoring

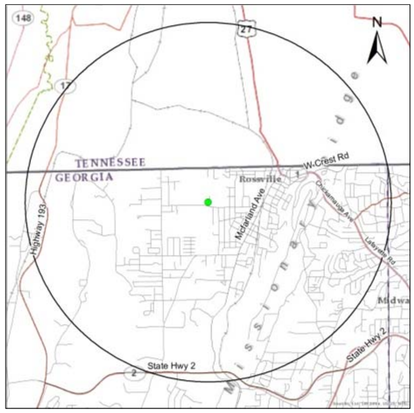
Chattanooga Tennessee-Georgia

MSA



Rossville- Maple Street





AQS ID: 132950002

Address: 601 Maple Street, Lot #6, Rossville, Walker County, Georgia, 30741

Site Established: 1/1/67

Latitude/Longitude: N34.97889/W-85.30098

Elevation: 200 meters

Area Represented: Chattanooga Tennessee-Georgia MSA

Site History: Established as TSP and SO_2/NO_2 site

North

South

East

West

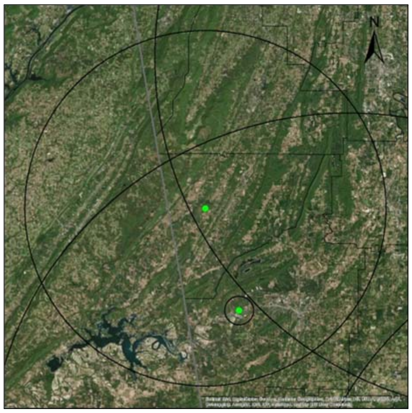
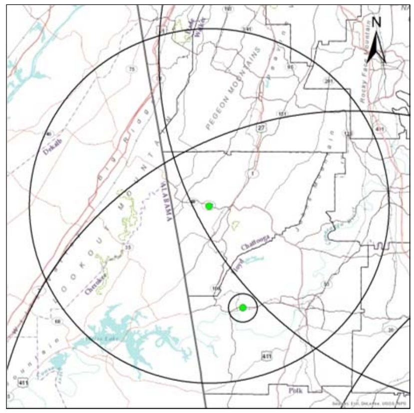
Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$	Population Exposure/ Regional Transport	Continuous	6 m	Neighborhood	1/24/07
$PM_{2.5}$	Population Exposure	Every 3 days	6 m	Neighborhood	1/1/00
$PM_{2.5}$ Speciation	Population Exposure	Every 6 days	6 m	Neighborhood	3/23/05

<u>Recommendations:</u> Continue monitoring

Sites Not in an MSA

(Listed in AQS ID Order)

Summerville- DNR Fish Hatchery

AQS ID: 130550001

Address: DNR Fish Hatchery, 231 Fish Hatchery Road, Summerville,
Chattooga County, Georgia 30747

Site Established: 1985

Latitude/Longitude: N34.474167/W-85.408056

Elevation: 276 meters

Area Represented: Not in an MSA, Summerville Micropolitan Statistical Area

Site History: Established as Acid Rain site

North

South

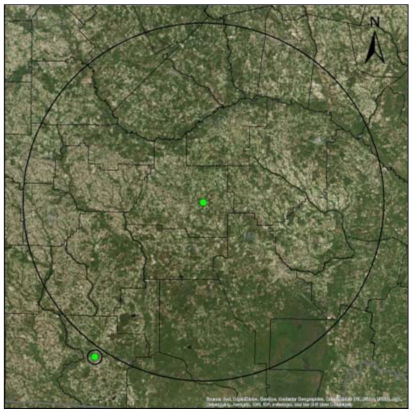
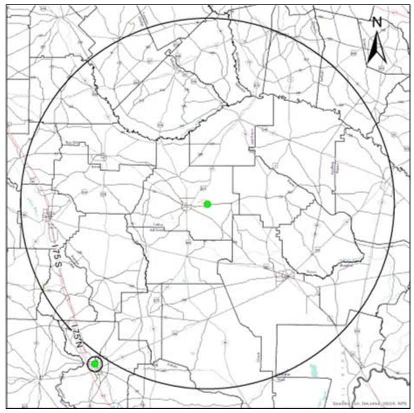
East

West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Regional Transport	Continuous (Mar-Oct)	5 m	Urban	3/1/04

Recommendations: Continue monitoring

Douglas- General Coffee State Park

AQS ID: 130690002

Address: General Coffee State Park, 6635 State Highway 32, Nicholls, Coffee County, Georgia 31554

Site Established: 1/1/99

Latitude/Longitude: N31.51309/W-82.75027

Elevation: 49 meters

Area Represented: Not in an MSA, Douglas Micropolitan Statistical Area

Site History: Established as Air Toxics site

Northwest


South

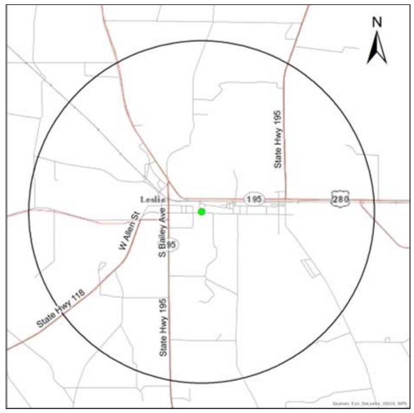

Southeast


West


Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$ Speciation	General Background	Every 6 days	3 m	Regional	3/1/02
Toxics	General Background	Every 12 days	2 m	Regional	1/1/99

Recommendations: Continue monitoring

Leslie- Union High School



AQS ID: 132611001

Address: Leslie Community Center, N Bass St/E Allen St, Leslie, Sumter County, Georgia 31764

Site Established: 1/1/81

Latitude/Longitude: N31.954112/W-84.081149

Elevation: 100 meters

Area Represented: Not in an MSA, Americus Micropolitan Statistical Area

Site History: Established as O_3 site

Northwest

Southeast

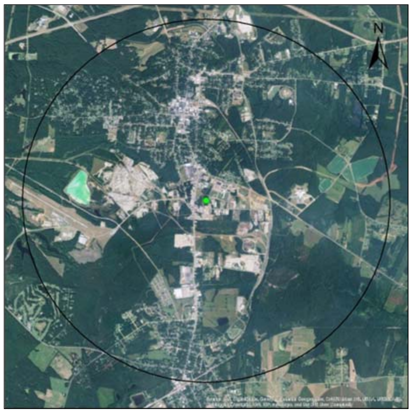
East

West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	General/ Background	Continuous (Mar-Oct)	1 m	Neighborhood	1/1/81

<u>Recommendations:</u> Continue monitoring

Sandersville- Health Department



AQS ID: 133030001

Address: Oconee Center Washington County Service Center, 824 Golden Hawk Drive, Sandersville, Washington County, Georgia 31082

Site Established: 1/1/74

Latitude/Longitude: N32.967251/W-82.806780

Elevation: 140 meters

Area Represented: Not in an MSA, Washington County

Site History: Established as TSP site

North

South

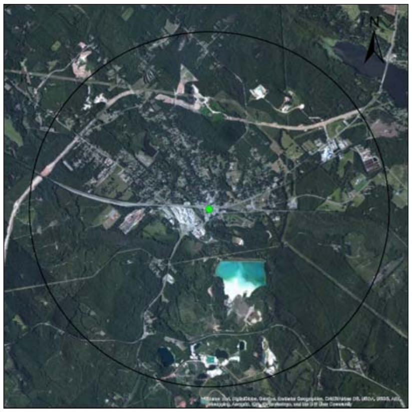
East

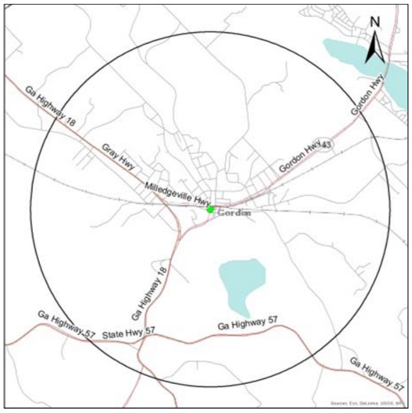
West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$	Population Exposure	Every 3 days	3 m	Neighborhood	1/30/99

Recommendations: Building being renovated, site being moved approximately 0.5 mile away

Gordon- Police Department





AQS ID: 133190001

Address: Police Department, 105 Railroad Street, Gordon, Wilkinson County, Georgia 31031

Site Established: 1/1/99

Latitude/Longitude: N32.881667/W-83.333889

Elevation: 103 meters

Area Represented: Not in an MSA, Wilkinson County

Site History: Established as $PM_{2.5}$ site

North

South

East

West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$	Population Exposure	Every 3 days	5 m	Neighborhood	1/1/99

Recommendations: Continue monitoring

Appendix B:
Inventory of Ambient Monitoring Equipment

Georgia Department of Natural Resources
Environmental Protection Division

SITE NAME	EQUIPMENT NAME	EQUIPMENT DESCRIPTION	COND./ AGE
Rome MSA			
Rome - Coosa Elementary	ESC DAS	Datalogger 8832	good/ >2
	Thermo SO2 Analyzer	43C	good/ >5
	Thermo SO2 Calibrator	146C	good/ >2
	Gast Zero Air System	M1006X	good/ >5
	Thermo 2025	PM2.5 Sampler	good/new
	Met-One SASS	Speciated PM2.5 Sampler	good/ >2
	Met-One BAM Monitor	1020 Continuous PM2.5 Sampler	good/ >2
Brunswick MSA			
Brunswick - Risley Middle School	ESC DAS	Datalogger 8832	good/ >2
	Thermo O3 Analyzer	49C	good/ >5
	Thermo O3 Calibrator	49C-PS	good/ >5
	Thermo 2025	PM2.5 Sampler	good/ >5
	Thermal Oxidizer	CDN-101	good/ >5
	Sonic Anemometer	81000	good/ >2
Valdosta MSA			
Valdosta - Mason Elementary	Thermo 2025	PM2.5 Sampler	good/1
	Met-One BAM Monitor	1020 Continuous PM2.5 Sampler	good/ <2
	ESC DAS	Datalogger 8832	good/ >2
Warner Robins MSA			
Warner Robins - Air Force Base	Thermo 2025	PM2.5 Sampler	good/1
	Met-One BAM Monitor	1020 Continuous PM2.5 Sampler	good/ <2
	ESC DAS	Datalogger 8832	good/ >2
Dalton MSA			
Chatsworth - Fort Mountain	ESC DAS	Datalogger 8832	good/ >2
	Thermo O3 Analyzer	49C	good/ >5
	Thermo O3 Calibrator	49C-PS	good/ >5
	RM Young Wind Instrument	05305vm (AQ)	good/ >8
	RM Young Temp/Relative Humidity	41375VC	good/ >2
Gainesville MSA			
Gainesville - Girls & Boys Club	Thermo 2025	PM2.5 Sampler	good/ <2
	Met-One BAM Monitor	1020 Continuous PM2.5 Sampler	fair/>3
	ESC DAS	Datalogger 8832	good/ >2
Albany MSA			
Albany - Turner Elementary	Thermo 2025	PM2.5 Sampler	good/new
	Thermo 2025	PM2.5 Sampler Co-locate	good/ <2
	Met-One BAM Monitor	Continuous PM2.5 Sampler	good/ >2
	ESC DAS	Datalogger 8832	good/ >2
Athens-Clarke County MSA			
Athens - College Station Road	Thermo O3 Analyzer	49C	good/ >5
	Thermo O3 Calibrator	49C-PS	good/ >5
	Thermo 2025	PM2.5 Sampler	good/new
	Speciated PM2.5 Sampler	MetOne	good/ <3
	Speciated PM2.5 Sampler	URG	good/new
	R&P PM2.5 Sampler	1400 A series TEOM	good/ >6
	ESC DAS	Datalogger 8832	good/ >2
Macon MSA			
Macon - Allied Chemical	Thermo 2025	PM2.5 Sampler	good/ <2
	Thermo 2025	PM2.5 Sampler Co-locate	good/ <2
	Met-One SASS	Speciated PM2.5 Sampler	good/ >8
	URG Sequential Sampler	Speciation Particulate 3000N MOD C	good/ >8
Macon - GA Forestry Commission	ESC DAS	Datalogger 8832	good/ >2
	Thermo O3 Analyzer	49-103	good/ >8
	Thermo O3 Calibrator	49C-PS	good/ >8
	Thermo SO2 Analyzer	43i	good/ >5

SITE NAME	EQUIPMENT NAME	EQUIPMENT DESCRIPTION	COND./ AGE
Macon - GA Forestry Commission (cont'd)	Thermo SO2 Calibrator	146T	good/ >8
	PermaPure Zero Air Supply	ZA-750-12	good/ >8
	Thermo 2025	PM2.5 Sampler	good/new
	Graseby PUF Sampler	GPS1-11	good/ >8
	Graseby HIVOL Sampler (metals)	2000H	good/ >8
	Andersen VOC Sampler	97-323	good/ >8
	RM Young Wind Instrument	05305vm (AQ)	good/ >8
Columbus Georgia-Alabama MSA			
Columbus - Health Department	Thermo 2025	PM2.5 Sampler	good/new
Columbus - Airport	ESC DAS	Datalogger 8832	good/ >2
	Thermo O3 Analyzer	49C	good/ >8
	Thermo O3 Calibrator	49C-PS	good/ >3
	Thermo 2025	PM2.5 Sampler	good/new
	R&P PM2.5 Sampler	TEOM 1400 A	good/ >5
	R&P	Sample Equil System	good/ >8
Columbus - UPS	General Metal Hi-Volume	HIVOL Sampler (lead) 2000H	good/ >8
Columbus - Fort Benning	General Metal Hi-Volume	HIVOL Sampler (lead) 2000H	good/ >8
Columbus - Cusseta Elementary	Thermo 2025	PM2.5 Sampler	good/new
	Met-One SASS	Speciation Control Box	good/ >3
	URG Sequential Sampler	Speciation Particulate 3000N MOD C	good/ <2
	General Metal Hi-Volume	HIVOL Sampler (lead) 2000H	good/ >8
Columbus - Crime Lab	Sonic Anemometer	81000	good/ >3
	RM Young BP Sensor	Barometric Pressure	good/ >2
	Nova Lynx	Tipping Bucket	good/ >2
	RM Young Temp/Relative Humidity	41375VC	good/ >2
	ESC DAS	Datalogger 8832	good/ >2
Savannah MSA			
Savannah - E. President Street	ESC DAS	Datalogger 8832	good/ >2
	Thermo O3 Analyzer	49	good/ >5
	Thermo O3 Calibrator	49C-PS	good/ >5
	Thermo SO2 Analyzer	43C	good/ >5
	Thermo SO2 Calibrator	146C	good/ >5
	Dayton Zero Air System	2Z866 Ozone	good/ >5
	Brey Zero Air System	50376 TRS and SO2	good/ >5
	GRASEBY/GMW PUF Sampler	GSP1	good/ >5
	Andersen HIVOL Sampler	GBM2000HBL Metals Sampler	good/ >5
	ATEC Carbonyl Sampler	100	good/ >5
	PermaPure Zero Air Supply	ZA-750-12	good/ >5
	Sonic Anemometer	81000	good/ <2
Savannah - Mercer School	Thermo 2025	PM2.5 Sampler	good/new
Savannah - Lathrop & Augusta Ave.	ESC DAS	Datalogger 8832	good/ >3
	Thermo SO2 Analyzer	43C	good/ >5
	Thermo SO2 Calibrator	146C	good/ >5
	Thermo 2025	PM2.5 Sampler	good/new
	R&P PM2.5 Sampler	TEOM 1400 A Series Continuous	good/ >5
	Sonic Anemometer	81000	good/ <2
Augusta-Richmond County, Georgia-South Carolina MSA			
Evans - Riverside Park	Thermo O3 Analyzer	Thermo 49C	good/ >3
	Thermo O3 Calibrator	Thermo 49C-PS	good/ >3
	RM Young Wind Instrument	05305vm (AQ)	good/ >8
	Tower	Fold Over	good/ >3
	ESC DAS	Datalogger 8832	good/ >2
	RM Young Temp/Relative Humidity	41375VC	good/ <2
Augusta - Bungalow Road Elem.	Thermo O3 Analyzer	49C	good/ >5

SITE NAME	EQUIPMENT NAME	EQUIPMENT DESCRIPTION	COND./ AGE
Augusta - Bungalow Road Elem. (cont'd)	Thermo O3 Calibrator	49C-PS	good/ >5
	Thermo SO2 Analyzer	43C	good/ >5
	Thermo SO2 Calibrator	146C	good/ >5
	R&P PM2.5 Sampler	TEOM 1400 A Series Continuous	good/ >5
	Thermo 2025	PM2.5 Sampler	good/ new
	Partisol PM10 Sampler	Model 2000-H	good/ >5
	Met-One SASS	Speciated PM2.5 Sampler	good/ <3
	URG 3000N	Speciated PM2.5 Sampler	good/ <2
	Sonic Anemometer	81000	good/ >3
	ESC DAS	Datalogger 8832	good/ >2
	Nova Lynx	Tipping Bucket	good/ >2
	RM Young Temp/Relative Humidity	41375VC	good/ >2
	RM Young BP Sensor	Barometric Pressure	good/ >2
Atlanta-Sandy Springs-Marietta MSA			
Forest Park - GA DOT	Thermo 2025	PM2.5 Sampler	good/ <2
Kennesaw - National Guard	ESC DAS	Datalogger 8832	good/ >2
	Thermo O3 Analyzer	49C	good/ >5
	Thermo O3 Calibrator	49C-PS	good/ >5
	PermaPure Zero Air System	ZA-750-12	good/ >5
	Thermo 2025	PM2.5 Sampler	good/ <2
Newnan - Univ. of West Georgia	ESC DAS	Datalogger 8832	good/ >3
	Thermo O3 Analyzer	49C	good/ >5
	Thermo O3 Calibrator	49C-PS	good/ >5
	PermaPure Zero Air System	ZA-750-12	good/ >5
	R&P PM2.5 Sampler	TEOM 1400 A Series Continuous	good/ >5
	Sonic Anemometer	81000	good/ >3
Dawsonville - GA Forestry	ESC DAS	Datalogger 8832	good/ >2
	Thermo O3 Analyzer	49C	good/ >5
	Thermo O3 Calibrator	49C-PS	good/ >5
	PermaPure Zero Air Supply	ZA-750-12	good/ >5
	Andersen PUF Sampler		good/ >5
	Graseby HIVOL Sampler (metals)	2000H	good/ >5
	ATEC VOC Sampler	2200	good/ >5
	ATEC Carbonyl Sampler	100	good/ >5
	RM Young Wind Instrument	05305vm (AQ)	good/ >8
Decatur - South DeKalb	ESC DAS	Datalogger 8832	good/ >3
	Thermo O3 Analyzer	49I	good/ <3
	Thermo O3 Calibrator	49I-PS	good/ <1
	Thermo Dynamic Gas Calibrator	146C Gas Dilution Calibrator	good/ >5
	Thermo Gas Calibrator	146I Gas Dilution Calibrator	good/ <1
	Thermo NOy Analyzer	42C	good/ >5
	Thermo NOx Analyzer	42C	good/ >5
	Thermo CO Analyzer	48C Trace Level Analyzer	good/ >5
	Thermo SO2 Analyzer	43i-TLE	good/new
	Thermo 2025	PM2.5 Sampler	good/ <2
	Thermo 2025	PM2.5 Sampler Co-locate	good/ <2
	Met-One	BAM 1020 PM10	good/new
	Met-One	BAM 1020 PM2.5	good/new
	Met-One SASS	Speciated PM2.5 Sampler	good/ <3
	URG 3000N	Speciated PM2.5 Sampler	good/ <2
	Thermo Zero Air Supply	111 Ozone	good/ >5
	Perkin Elmer Autosystem XL GC	Gas Chromatograph	good/ >8
	Perkin Elmer Turbomatrix TD	Thermal Desorber	good/ <3
	Perkin Elmer Nelson Interface	NCI 900 Interface	good/ >8

SITE NAME	EQUIPMENT NAME	EQUIPMENT DESCRIPTION	COND./ AGE
Decatur - South DeKalb (cont'd)	Parker Balston TOC	Zero Air Gas Generator	good/ >8
	Parker Balston TOC	Zero Air Gas Generator	good/ >8
	Perkin Elmer Clarus 500	Gas Chromatograph	good/ <3
	Perkin Elmer Turbomatrix TD 300	Thermal Desorber	good/ <2
	Magee Scientific	Aethalometer	good/ <5
	ATEC Carbonyl Sampler	Model 8000	good/new
	ATEC Carbonyl Sampler	Model 8000	good/new
	Shawnee Instruments	PM10 Sampler	good/ >5
	Shawnee Instruments	PM10 Sampler Co-locate	good/ >5
	PUF	Semi-VOCs Sampler	good/ >3
	PUF	Semi-VOCs Sampler Co-locate	good/ >3
	ATEC 2200	VOCs Sampler	good/ >5
	ATEC 2200	VOCs Sampler Co-locate	good/ >5
	RM Young Wind Instrument	05305vm (AQ)	good/ >8
	RM Young Temp/Relative Humidity	41375VC	good/ >2
	Nova Lynx	Tipping Bucket	good/ >2
	RM Young BP Sensor	Barometric Pressure	good/ >2
Decatur - DMRC	Graseby HIVOL Sampler (metals)	2000H	fair/ >8
	Graseby HIVOL Sampler (metals)	2000H Co-locate	fair/ >8
Douglasville - W. Strickland Street	Thermo O3 Analyzer	49C	good/ >5
	Thermo O3 Calibrator	49C-PS	good/ >5
	RM Young Wind Instrument	05605VM	good/ >2
	ESC DAS	Datalogger 8832	good/ >2
Atlanta - Fire Station #8	Thermo 2025	PM2.5 Sampler	good/<2
	Partisol PM10 Sampler	Model 2000-H	good/ <2
Atlanta - Confederate Avenue	ESC DAS	Datalogger 8832	good/ >3
	Thermo O3 Analyzer	49I	good/ <1
	Thermo O3 Calibrator	49I-PS	good/ <1
	Thermo SO2 Analyzer	43C	good/ >3
	Thermo SO2 Calibrator	146I	good/ <1
	R&P PM2.5 Sampler	TEOM 1400 A Series Continuous	good/ >3
	RM Young Wind Instrument	05305vm (AQ)	good/ >2
Atlanta- Near-road	ESC DAS	Datalogger 8832	good/ >2
	Thermo NO2 Analyzer	42I	good/new
	Thermo CO Analyzer	48C	good/ >5
Lawrenceville - Gwinnett Tech.	ESC DAS	Datalogger 8832	good/ >2
	Thermo O3 Analyzer	49C	good/ >5
	Thermo O3 Calibrator	49C-PS	good/ >5
	Gast Zero Air System	4Z024 pump and cannisters	good/ >8
	Thermo 2025	PM2.5 Sampler	good/ <2
	R&P PM2.5 Sampler	TEOM 1400 A Series Continuous	good/ >5
McDonough - County Extension	ESC DAS	Datalogger 8832	good/ >3
	Thermo O3 Analyzer	49C	good/ >5
	Thermo O3 Calibrator	49C-PS	good/ >5
	PermaPure Zero Air System	ZA-750-12	good/ >5
	R&P PM2.5 Sampler	TEOM 1400 A Series Continuous	good/ >5
Yorkville - King Farm	Thermo O3 Analyzer	49C	good/ >5
	Thermo O3 Calibrator	49C-PS	good/ >5
	Thermo NOx Analyzer	42C	good/ >5
	Thermo CO Analyzer	48C	good/ >5
	Thermo Dynamic Gas Calibrator	146C Gas Dilution Calibrator	good/ >5
	Thermo 2025	PM2.5 Sampler	good/ <3
	R&P PM2.5 Sampler	TEOM 1400 A Series Continuous	good/ >5
	Graseby PUF Sampler	BMPS1-11	good/ >15

SITE NAME	EQUIPMENT NAME	EQUIPMENT DESCRIPTION	COND./ AGE
Yorkville - King Farm (cont'd)	General Metal Hi-Volume	HIVOL Sampler 2000H	good/ >15
	ATEC VOCs Sampler	2200	good/ >5
	Tekran Vapor Analyzer	2537A Mercury Vapor Analyzer	poor/ >15
	Perkin Elmer Autosystem XL GC	Gas Chromatograph	good/ >15
	Perkin Elmer Turbomatrix TD	Thermal Desorber	good/ >15
	Perkin Elmer Nelson Interface	NCI 900 Interface	good/ >8
	Parker Balston TOC	Zero Air Gas Generator	good/ >8
	Tylan RO-32	Flow Regulator	good/ >15
	RM Young Wind Instrument	05305VM (AQ)	good/ >8
	PSP	Solar Radiation Instrument	good/ >5
	TUVR	Ultraviolet Radiation Instrument	good/ >8
	ESC DAS	Datalogger 8832	good/ >2
	Nova Lynx	Tipping Bucket	good/ >2
	RM Young Temp/Relative Humidity	41375VC	good/ >2
	RM Young BP Sensor	Barometric Pressure	good/ >2
Conyers - Monastery	ESC DAS	Datalogger 8832	good/ >3
	Thermo O3 Analyzer	49C	good/ >5
	Thermo O3 Calibrator	49C-PS	good/ >5
	Thermo NOx Analyzer	42C	good/ >5
	Thermo NOx Calibrator	146C	good/ >5
	Thermo Zero Air Supply	111 Ozone	good/ >5
	Perkin Elmer Autosystem XL GC	Gas Chromatograph	good/ >8
	Perkin Elmer Turbomatrix TD	Thermal Desorber	good/ >4
	Perkin Elmer Nelson Interface	NCI 900 Interface	good/ >5
	Parker Balston TOC	Zero Air Gas Generator	good/ >10
	RM Young Wind Instrument	05305vm (AQ)	good/ <2
	PSP	Solar Radiation Instrument	good/ >5
	TUVR	Ultraviolet Radiation Instrument	good/ >5
	Nova Lynx	Tipping Bucket	good/ >2
	RM Young Temp/Relative Humidity	41375VC	good/ >2
	RM Young BP Sensor	Barometric Pressure	good/ >2
Chattanooga Tennessee-Georgia MSA			
Rossville - Maple Street	ESC DAS	Datalogger 8832	good/ >2
	Thermo 2025	PM2.5 Sampler	good/new
	Met-One SASS	Speciated PM2.5 Sampler	good/ <2
	URG 3000N	Speciated PM2.5 Sampler	good/ <2
	Met-One BAM Monitor	1020 Continuous PM2.5 Sampler	good/ <2
Sites Not in an MSA			
Summerville - DNR Fish Hatchery	ESC DAS	Datalogger 8832	good/ >2
	Thermo O3 Analyzer	49C	good/ >5
	Thermo O3 Calibrator	49C-PS	good/ >5
Douglas - General Coffee SP	Met-One SASS	Speciated PM2.5 Sampler	good/ <2
	URG 3000N	Speciated PM2.5 Sampler	good/ <2
	Andersen PUF Sampler		good/ >5
	Graseby HIVOL Sampler (metals)	2000H	good/ >8
	ATEC VOC Sampler	2200	good/ >3
Leslie - Union High School	ESC DAS	Datalogger 8832	good/ >2
	Thermo O3 Analyzer	49C	good/ >8
	Thermo O3 Calibrator	49C-PS	good/ >8
	PermaPure Zero Air Supply	ZA-750-12	good/ >8
Sandersville - Health Department	Thermo 2025	PM2.5 Sampler	good/ >5
Gordon - Police Department	Thermo 2025	PM2.5 Sampler	good/new
Georgia EPD Air Branch			
Quality Assurance Unit	TriCal (2)	Flow Standard	good/ >3

SITE NAME	EQUIPMENT NAME	EQUIPMENT DESCRIPTION	COND./ AGE
Quality Assurance Unit (cont'd)	General Metal Works	Hi-Volume Orifice	good/ >3
	Graseby GMW	PUF Orifice	good/ >3
	DC-Lite DCL-H	Flow Standard	good/ >3
	DC-Lite DCL-L	Flow Standard	good/ >3
	DC-2	DryCal Flow Standard Base	good/ >3
	DC-HC-1	DryCal High Flow Cell	good/ >3
	DC--LC-1	DryCal Low Flow Cell	good/ >3
	DC-MC-1	DryCal Medium Flow Cell	good/ >3
	49PS	Ozone Standard	good/ >3
	DeltaCal	Flow Standard	good/ >3
	Gilibrator Flow Cell (6)	Flow Standard	good/ >3
	VRC	Variable HiVol orifice	good/ >3
	Thermo 146I (2)	Multi-gas Calibrator	good/ >3
	Thermo 146T	Multi-gas Calibrator	good/ >3
	Thermo 49PS	Ozone Standard	good/ >3
	DeltaCal	Flow Standard	good/ >3
Meteorology Unit Workshop	RM Young Wind Instrument (14)	05305vm (AQ)	good/ >7
	RM Young Wind Instrument (8)	05103 coastal	good/ >8
	Sonic Anemometer (2)	81000	good/ <2
	Sonic Anemometer (4)	85000	good/ <5
	PSP (4)	Solar Radiation Instrument	good/ >8
	PSP	Solar Radiation Instrument	poor/ <2
	TUVR (3)	Ultraviolet Radiation Instrument	good/ >8
	TUVR (2)	Ultraviolet Radiation Instrument	good/ >3
	TUVR	Ultraviolet Radiation Instrument	good/ <2
Warehouse/Storage	HIVOL Sampler (9)	Metals Sampler	Varies
	PUF (9)	Semi-VOCs Sampler	Varies
	VOCs (9)	VOCs Sampler	Varies
	PM10 Sampler (12)	PM10	Varies
	ATEC Carbonyl Sampler	100	good/ >3
	ESC DAS (11)	Datalogger 8816	good/ >5
	Gast Zero Air System	M1006X	good/ >8
	Met-One BAM 1020 Monitor	Continuous PM10 Sampler	good/ <3
	R&P PM2.5 Sampler (2)	TEOM 1400 A Series Continuous	good/ >5
	Thermo 2025 (6)	PM2.5 Sampler	Varies
	Thermo NOx/NOy Analyzer (3)	42C	good/ >5
	Thermo NOy Calibrator (2)	146C	good/ >4
	Thermo O3 Analyzer	49C	good/ >5
	Thermo O3 Calibrator	49C-PS	good/ >5
	Thermo SO2 Analyzer (2)	43C	good/ >4
	Thermo SO2 Calibrator	146I	good/ <2
	Thermo SO2 Calibrator	146	good/ >5
	Thermo SO2/NOx Calibrator	146I	good/ <1
	Thermo Zero Air Supply (2)	111 Ozone	good/ >5
	Thermo Zero Air System	111 Ozone	good/ >5

Appendix C:
Wind and Pollution Roses, 2011-2013

Georgia Department of Natural Resources
Environmental Protection Division

2011-2013 Quarterly Wind Roses

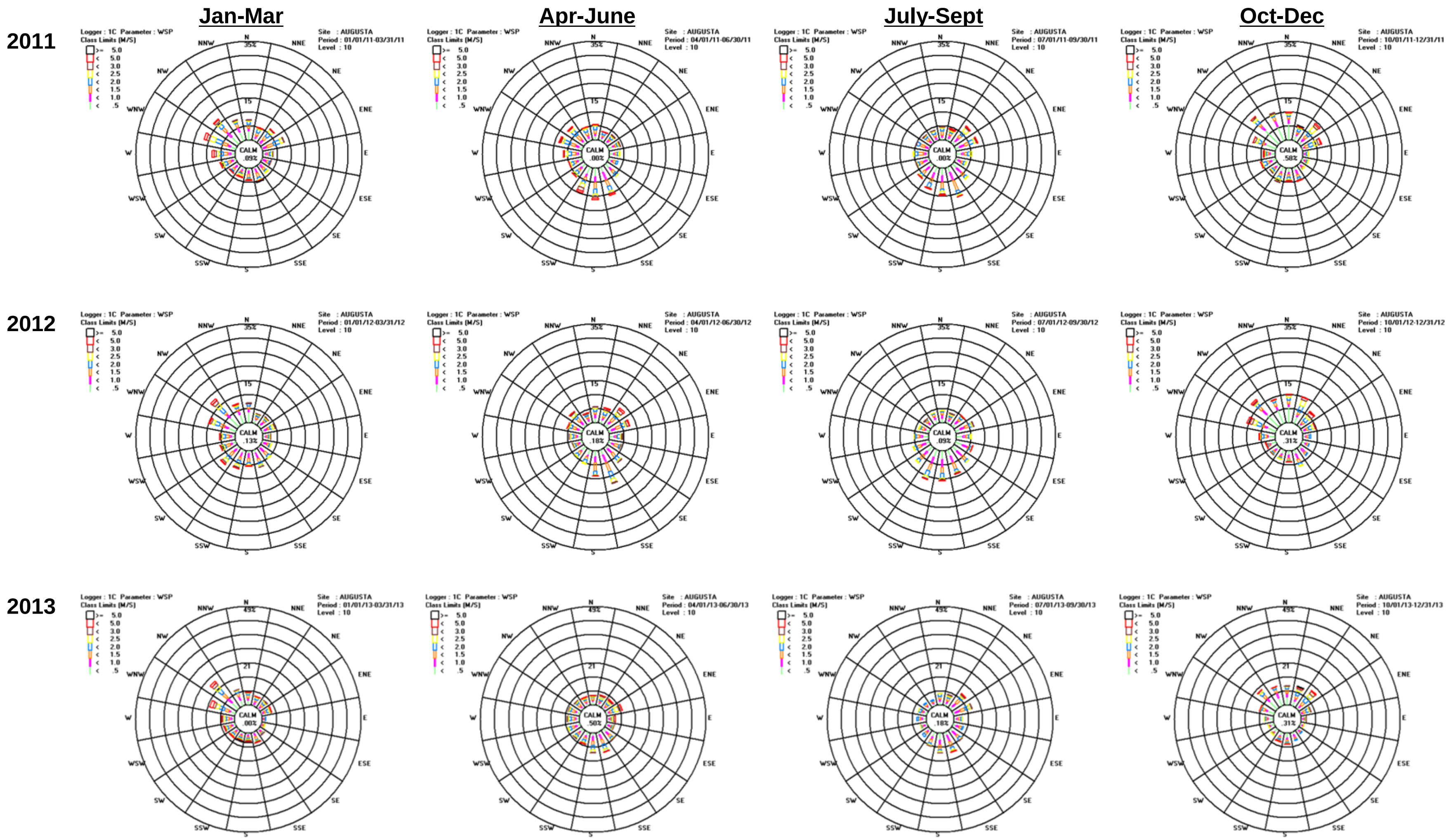


Figure C.1: Augusta Wind Rose for Each Quarter, 2011-2013

2011-2013 Quarterly Wind Roses

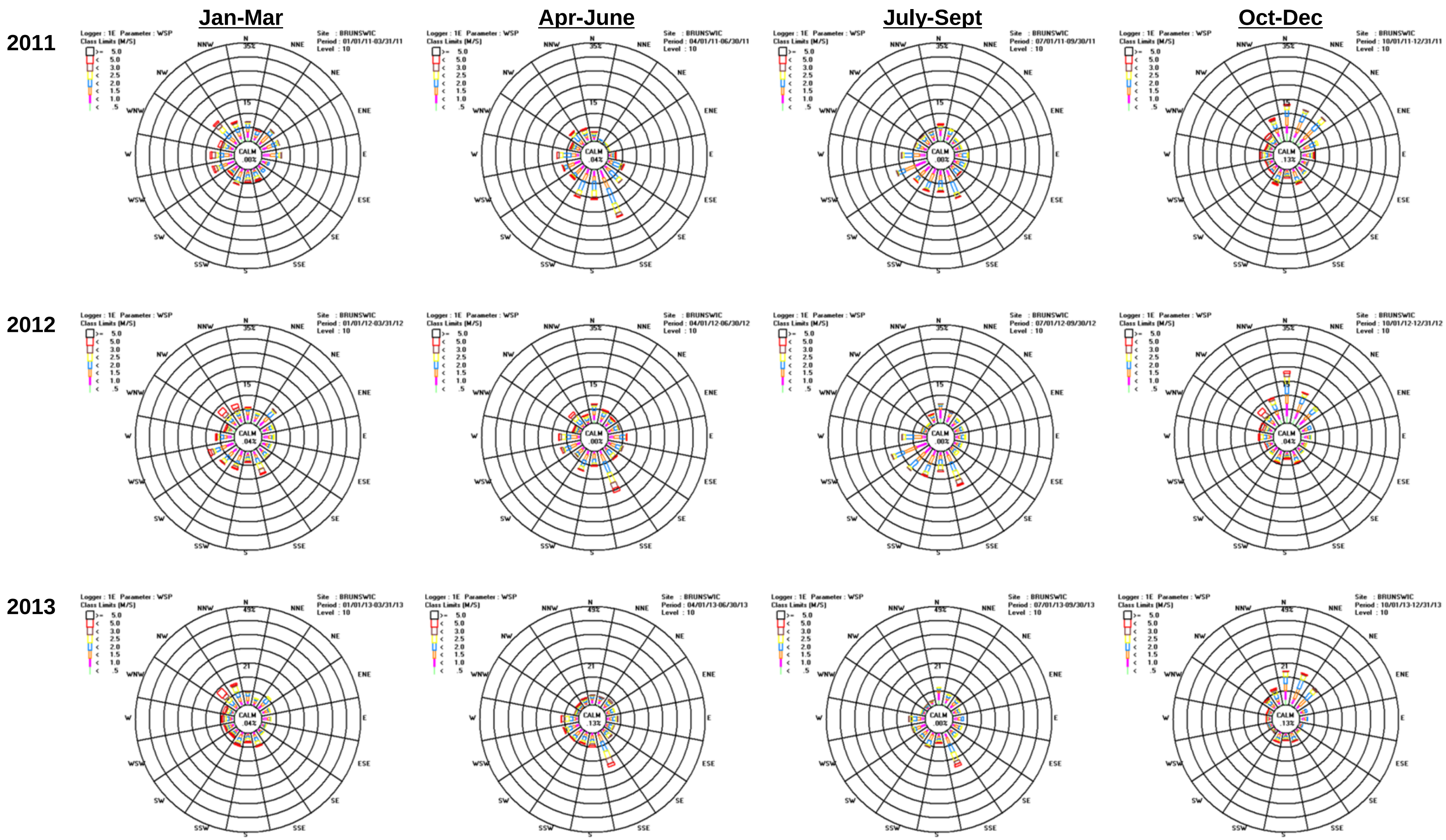


Figure C.2: Brunswick Wind Rose for Each Quarter, 2011-2013

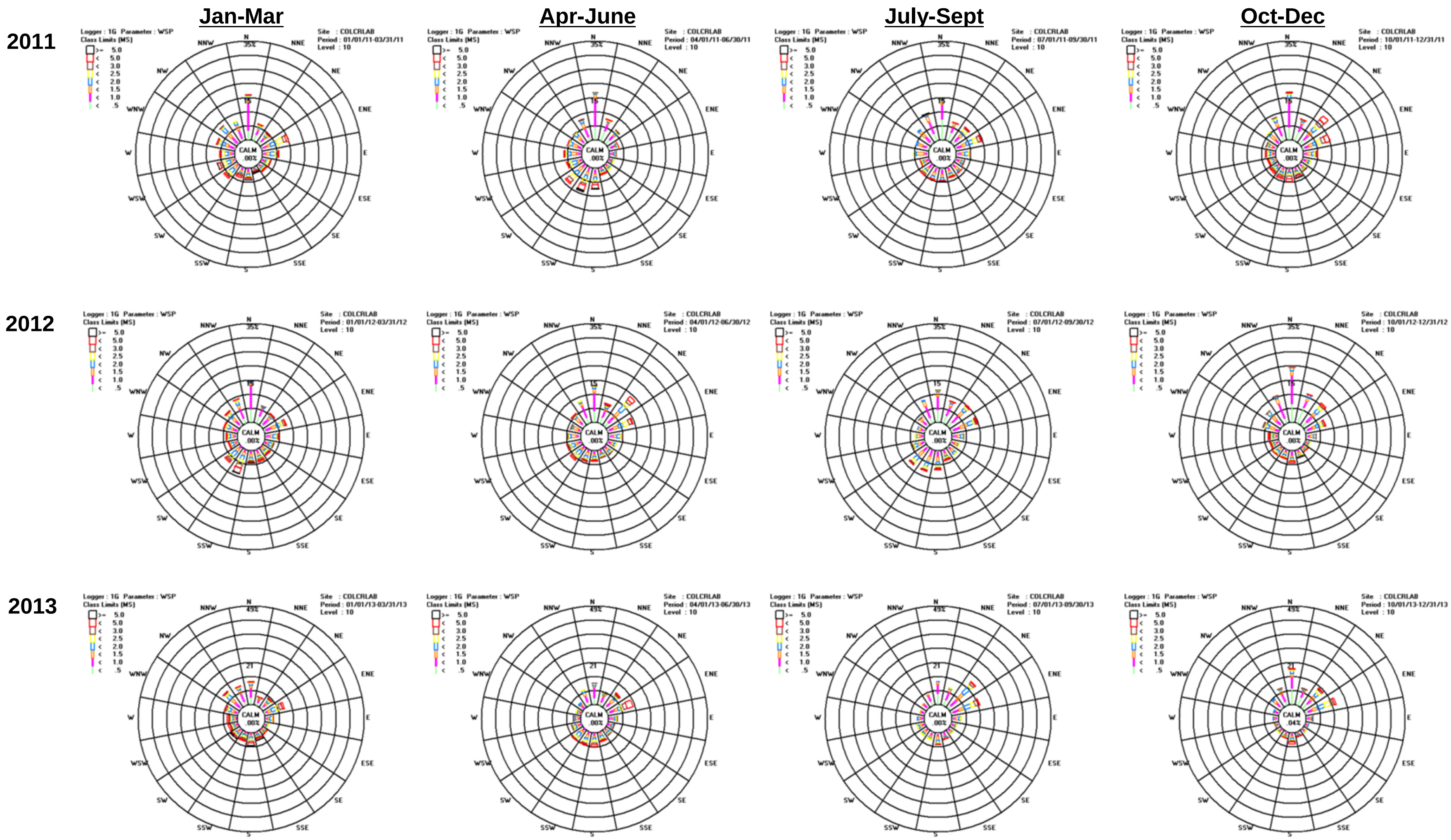


Figure C.3: Columbus Wind Rose for Each Quarter, 2011-2013

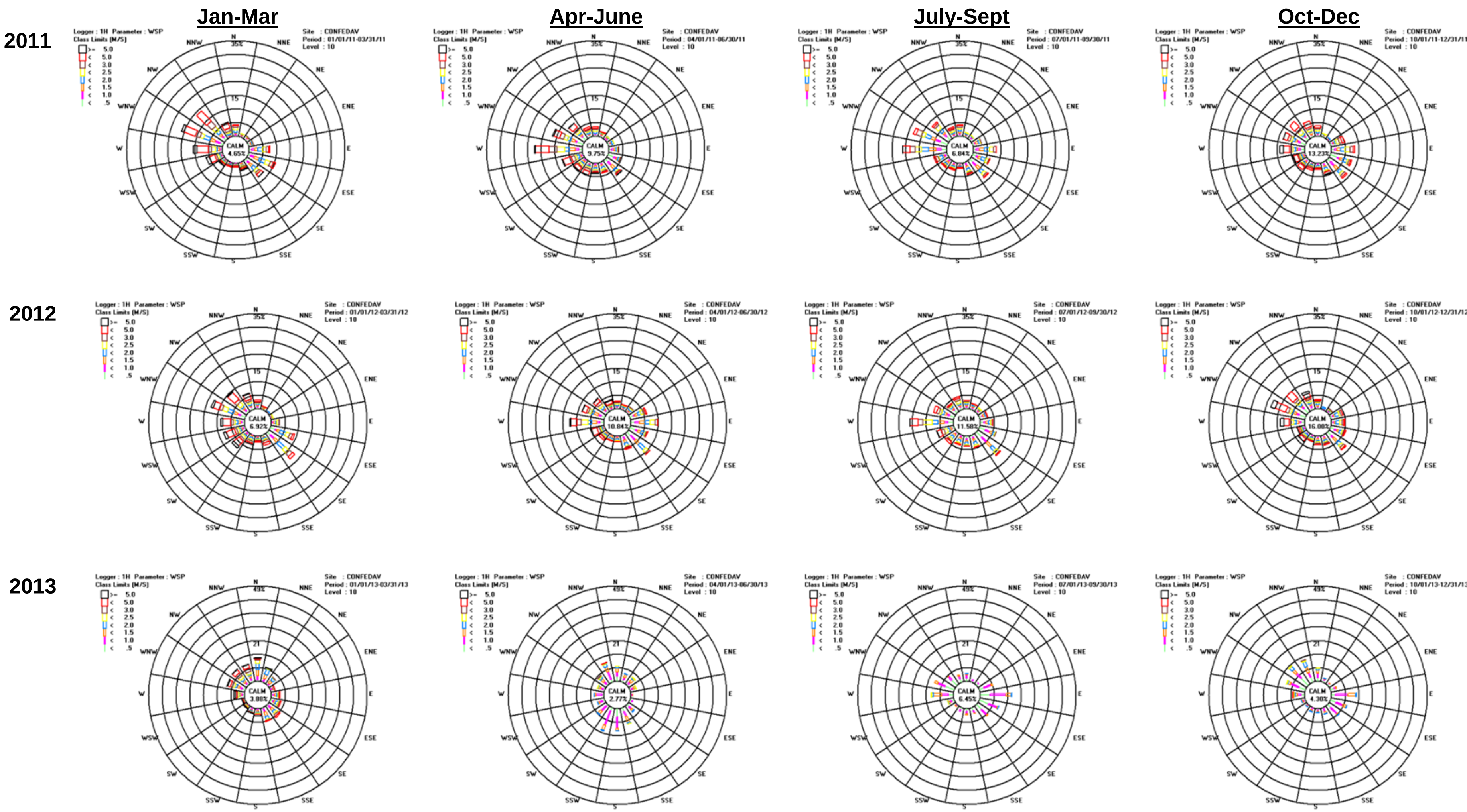


Figure C.4: Confederate Avenue Wind Rose for Each Quarter, 2011-2013

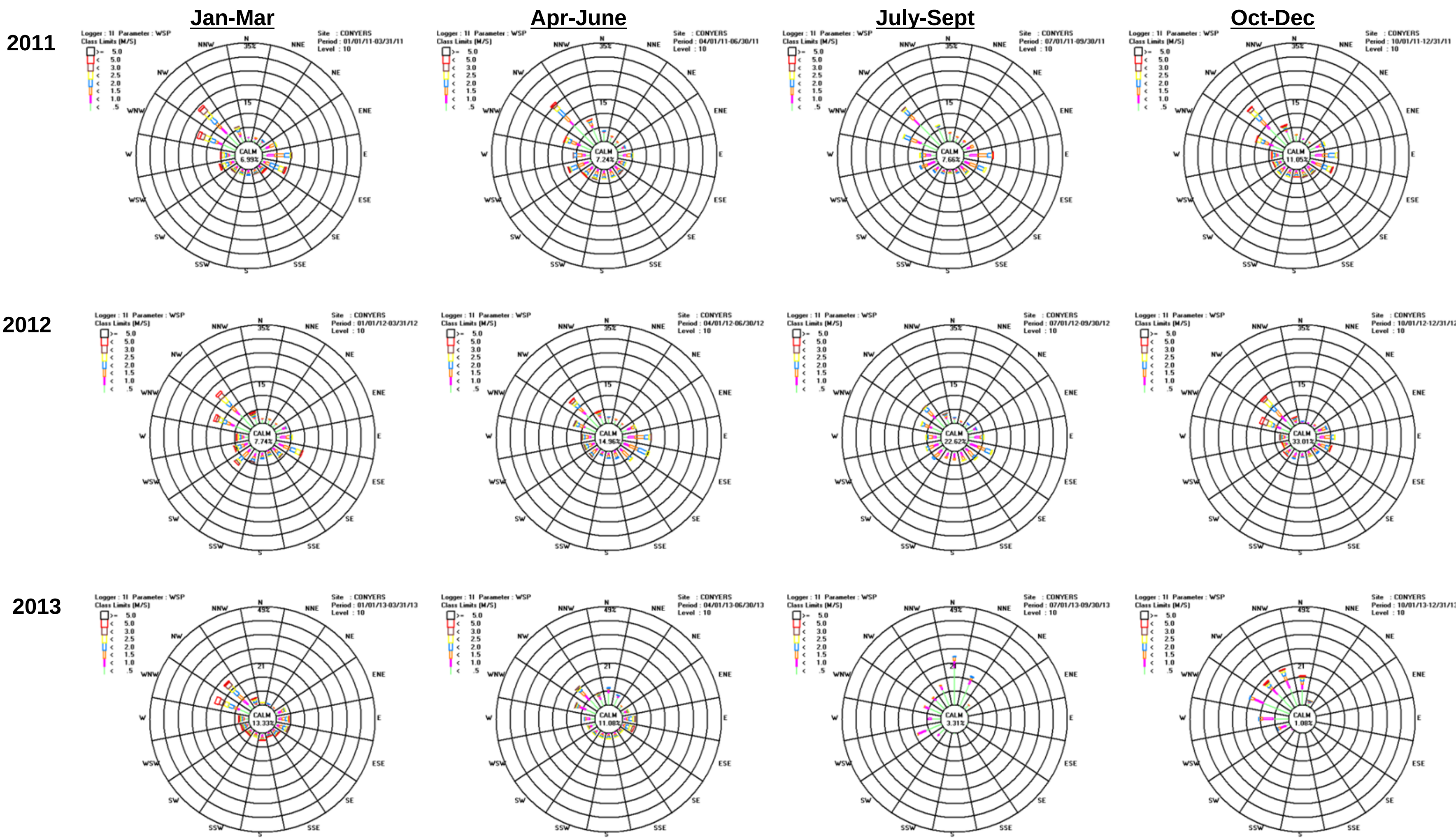


Figure C.5: Conyers Wind Rose for Each Quarter, 2011-2013

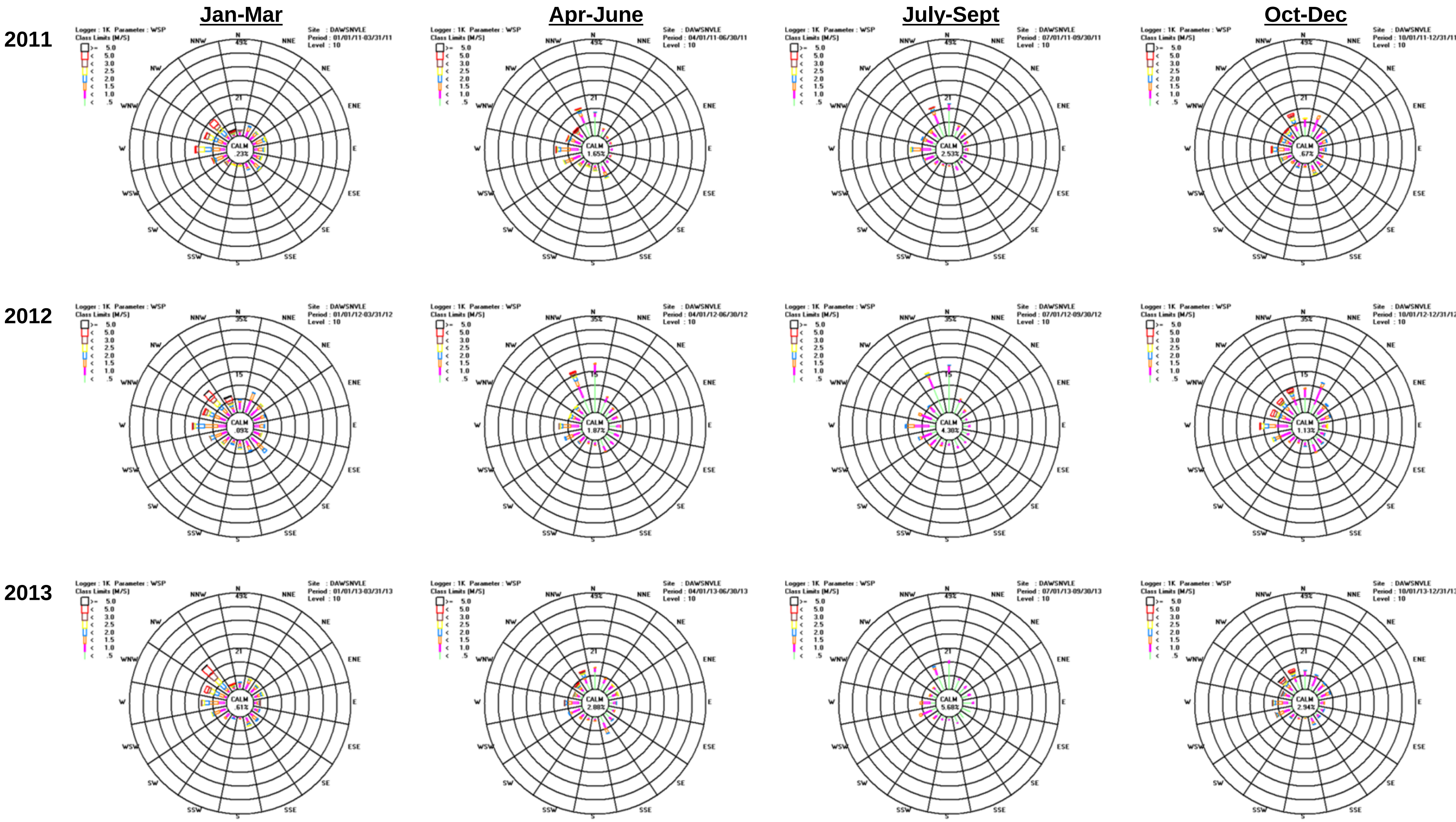


Figure C.6: Dawsonville Wind Rose for Each Quarter, 2011-2013

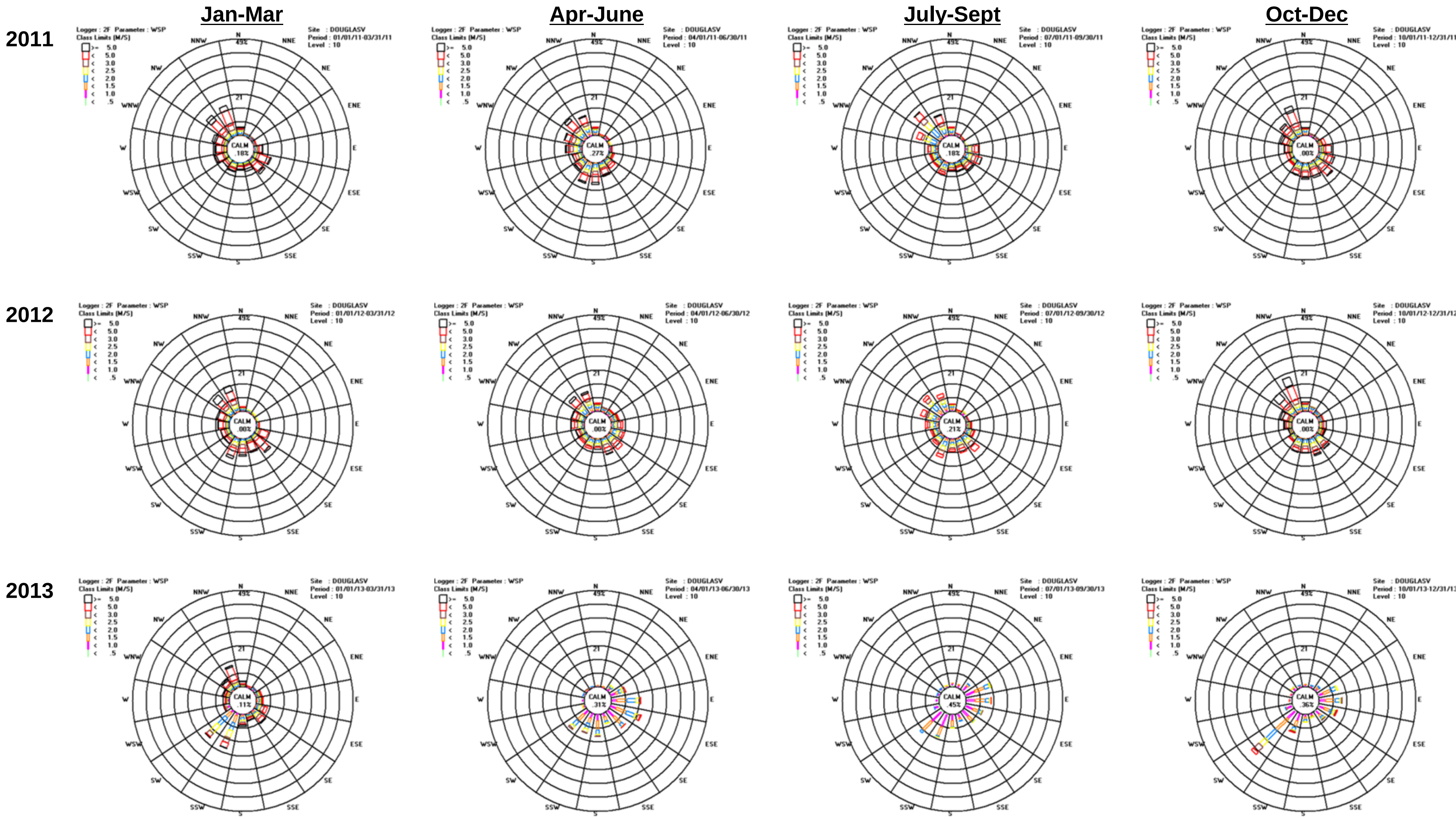


Figure C.7: Douglasville Wind Rose for Each Quarter, 2011-2013

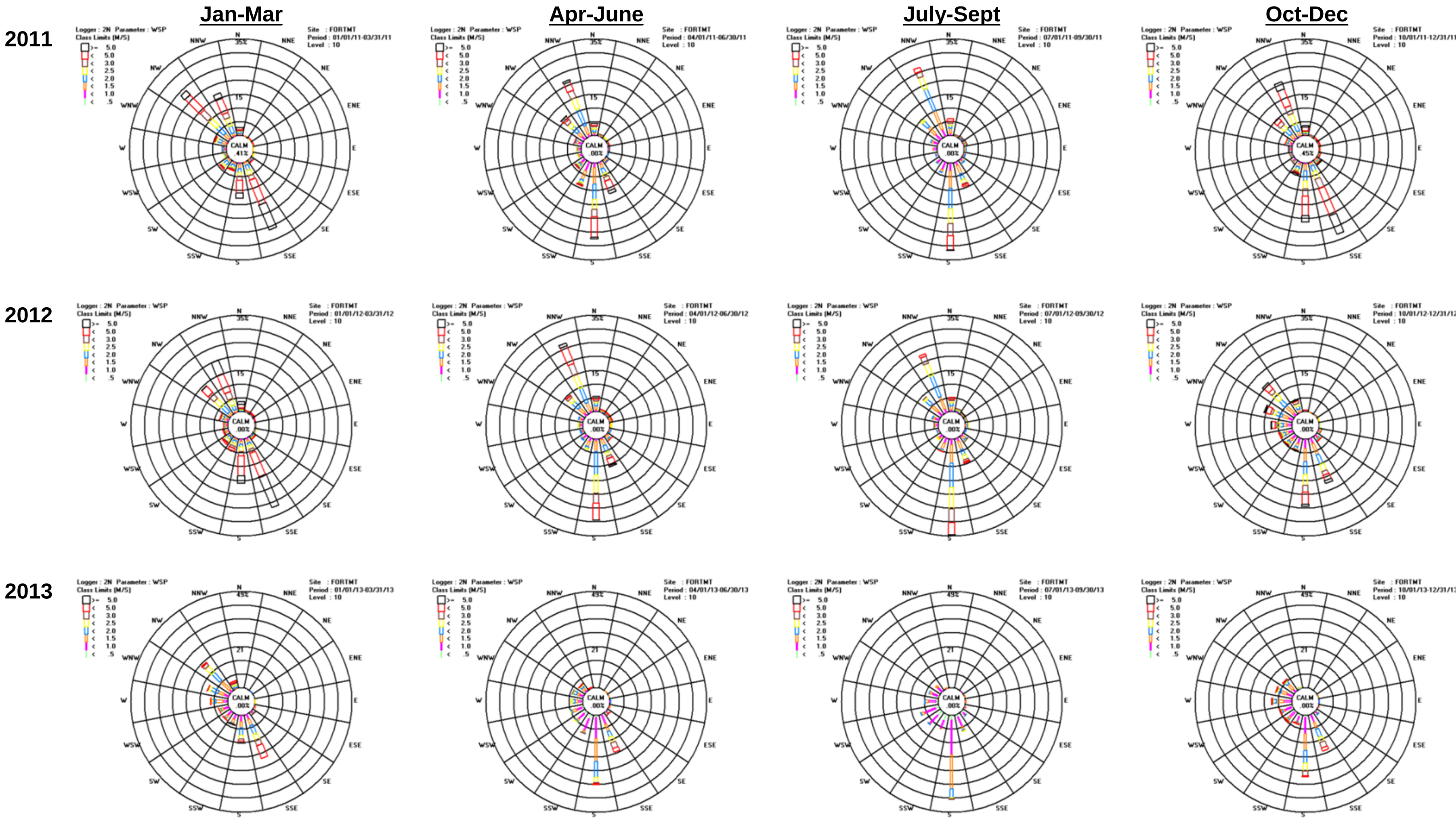


Figure C.8: Fort Mountain Wind Rose for Each Quarter, 2011-2013

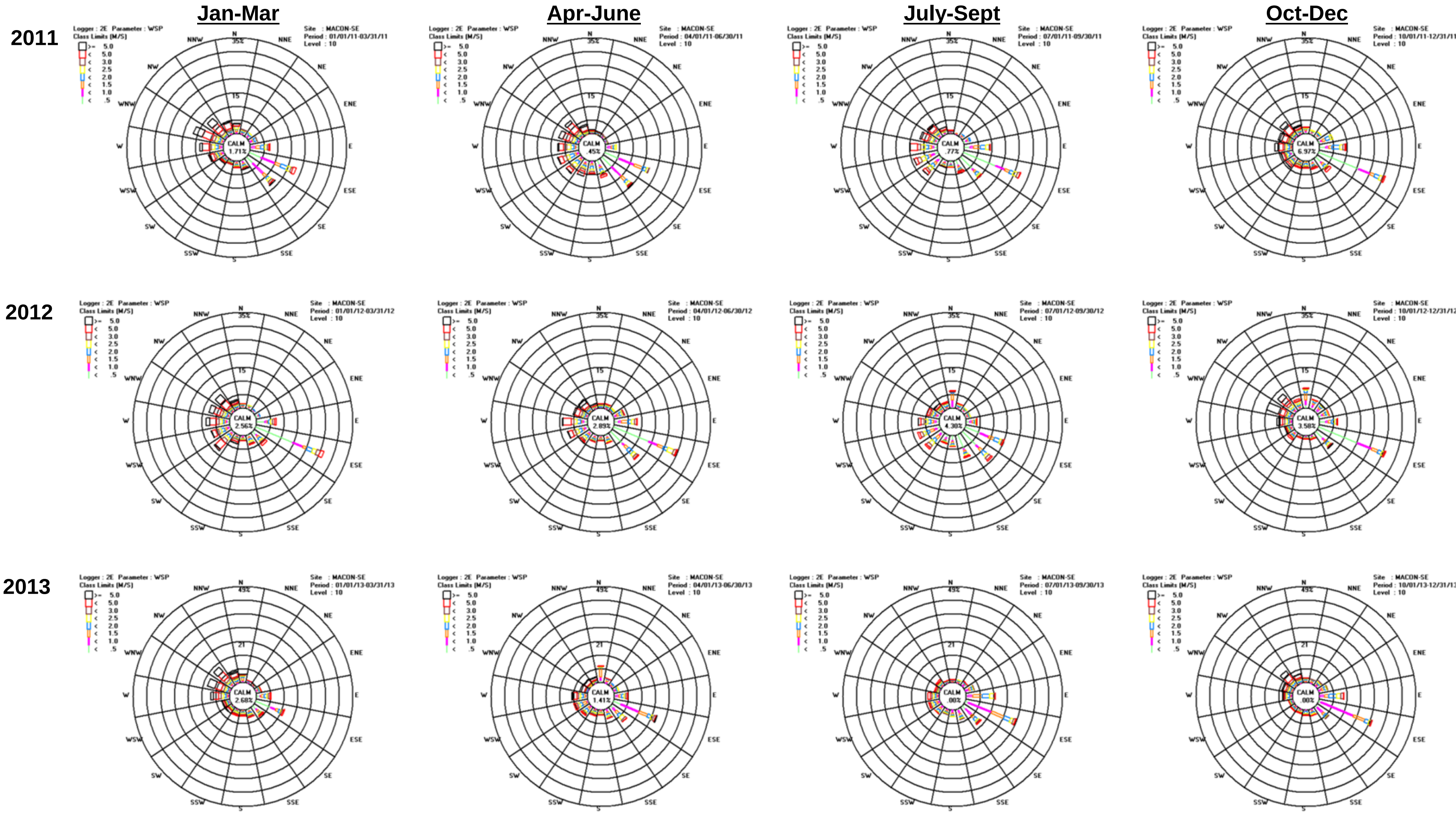


Figure C.9: Macon-SE Wind Rose for Each Quarter, 2011-2013

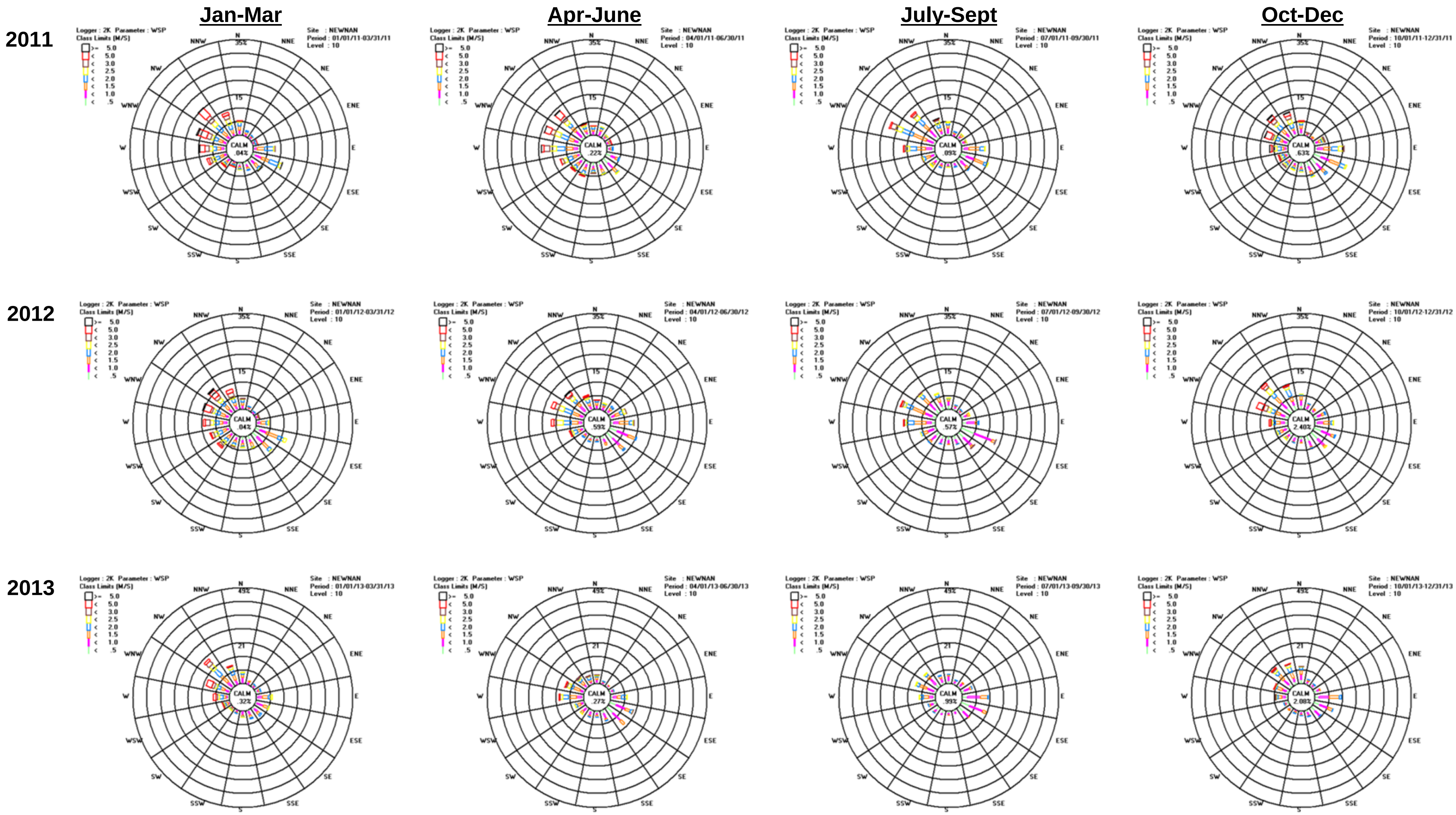


Figure C.10: Newnan Wind Rose for Each Quarter, 2011-2013

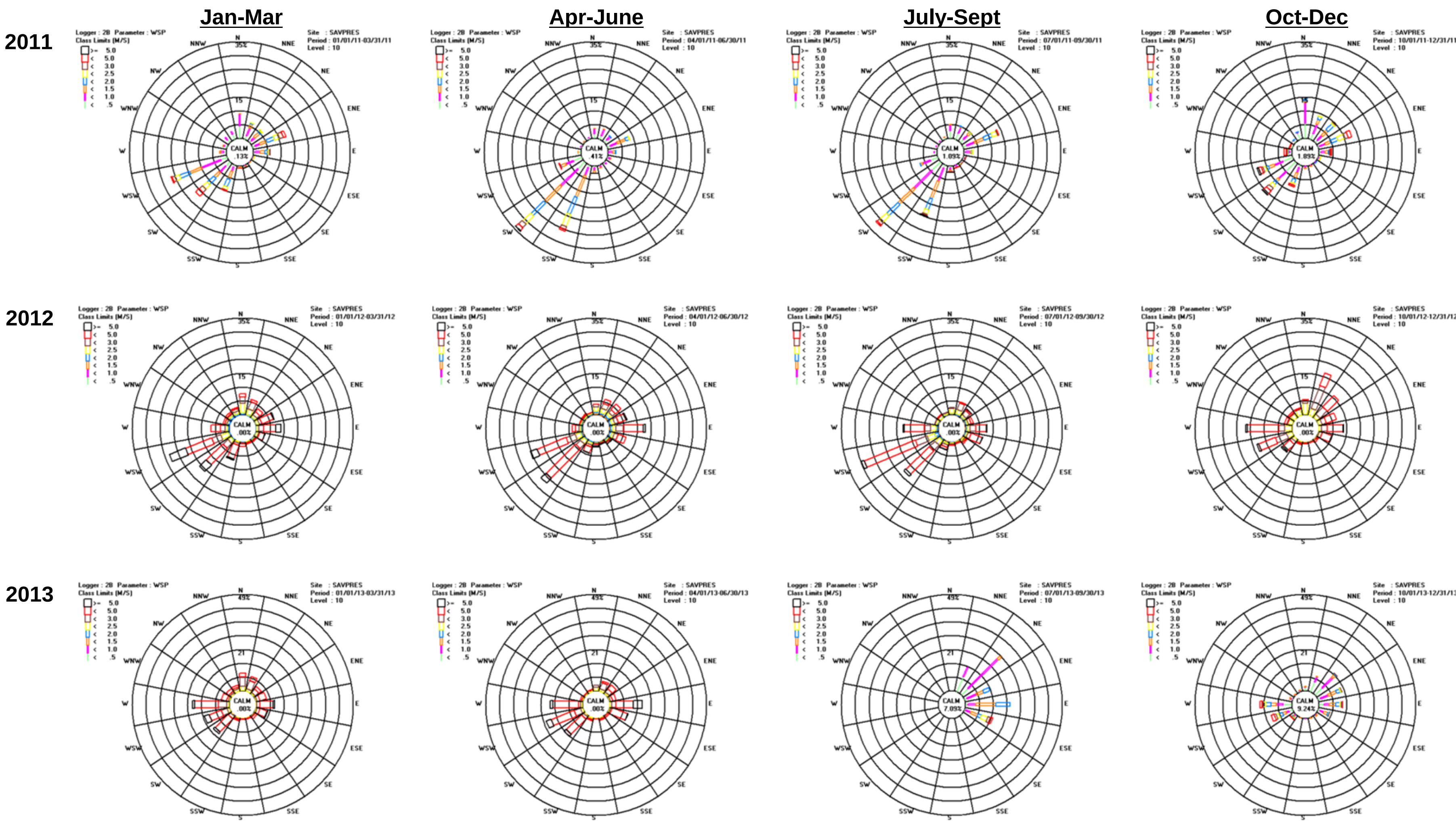


Figure C.11: Savannah-E Pres St Wind Rose for Each Quarter, 2011-2013

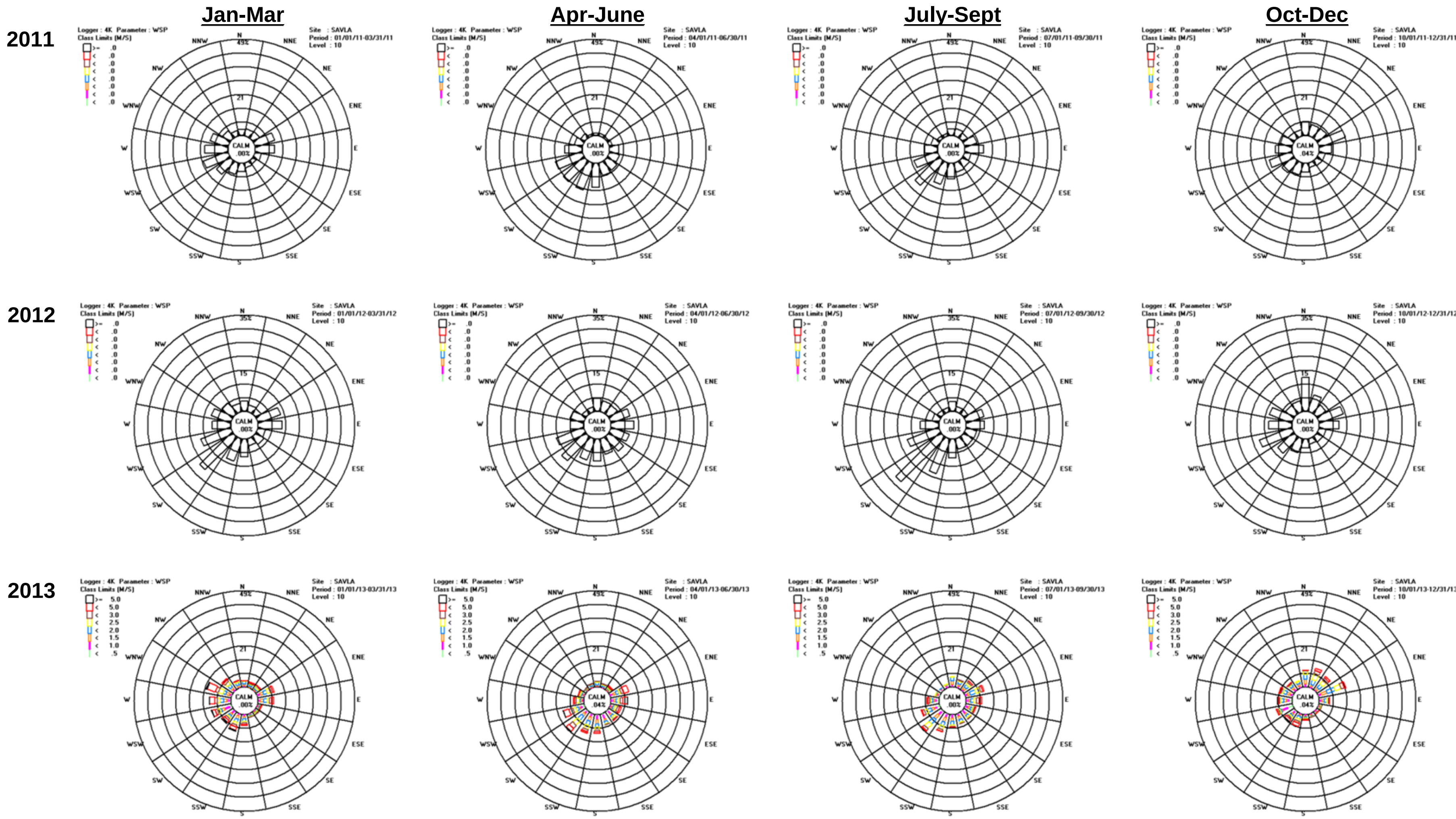


Figure C.12: Savannah-L&A Wind Rose for Each Quarter, 2011-2013

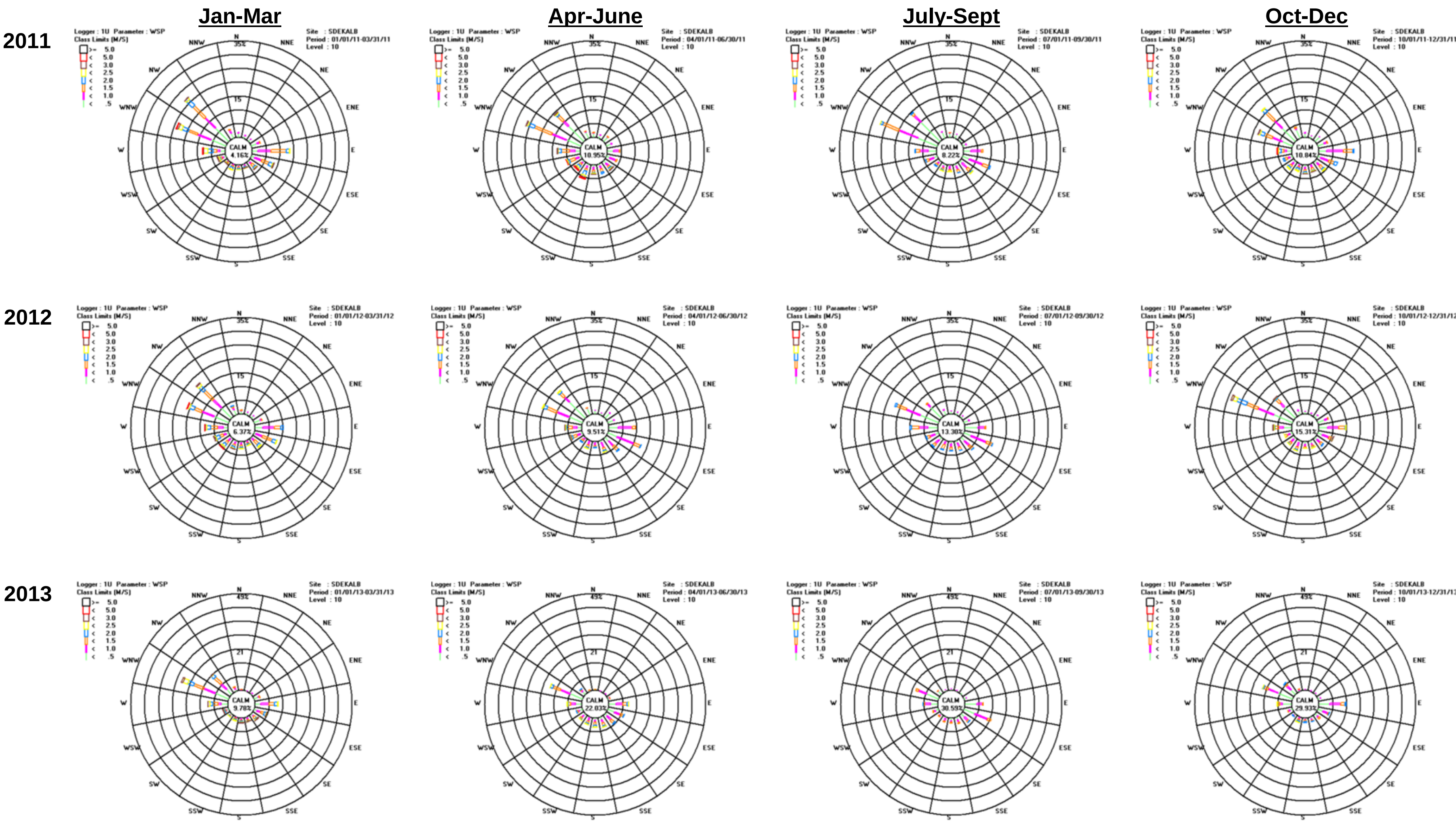


Figure C.13: South DeKalb Wind Rose for Each Quarter, 2011-2013

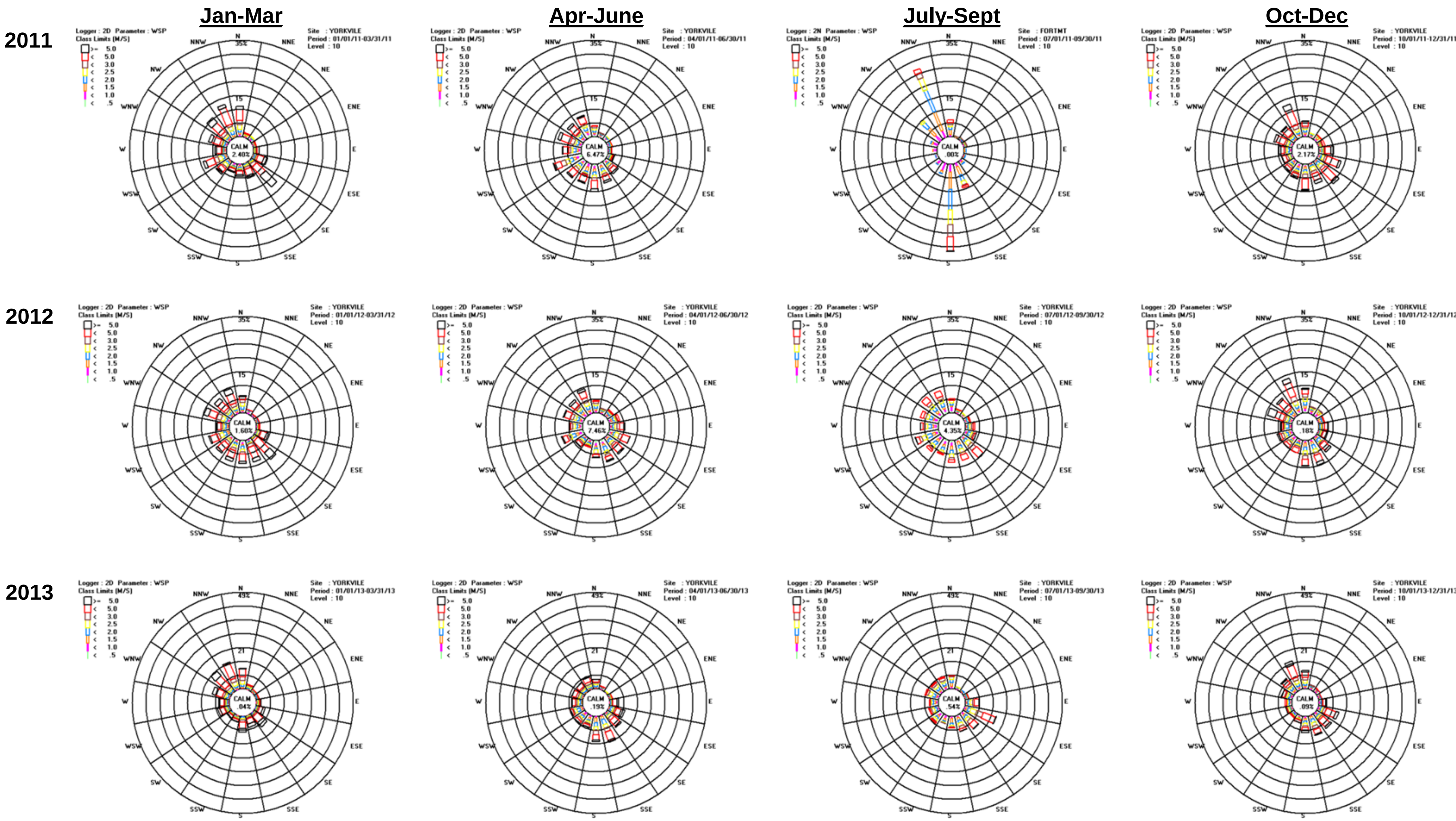
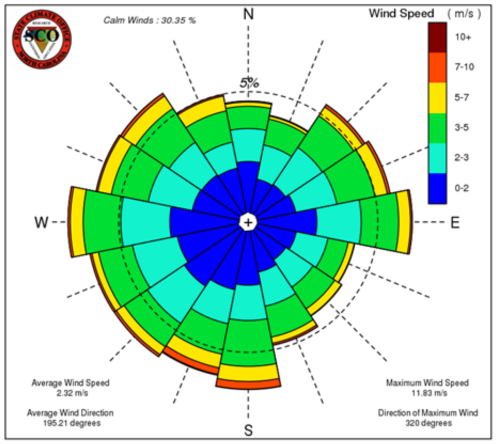


Figure C.14: Yorkville Wind Rose for Each Quarter, 2011-2013

2011-2013 Annual Wind Roses

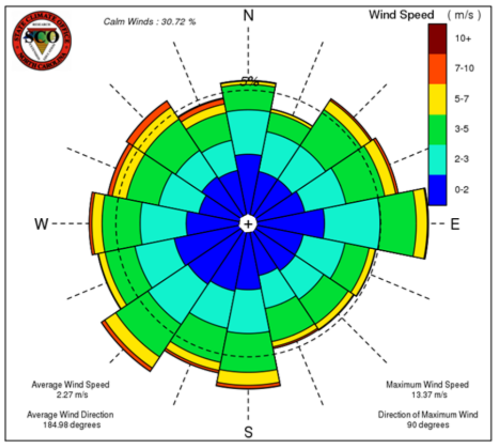
2011

Wind Rose for Albany Sw Ga Rgnl Ap (KABY)
Jan. 1, 2011 to Dec. 31, 2011



2012

Wind Rose for Albany Sw Ga Rgnl Ap (KABY)
Jan. 1, 2012 to Dec. 31, 2012



2013

Wind Rose for Albany Sw Ga Rgnl Ap (KABY)
Jan. 1, 2013 to Dec. 31, 2013

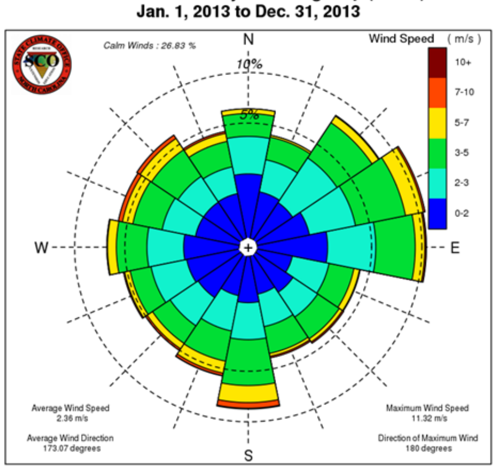
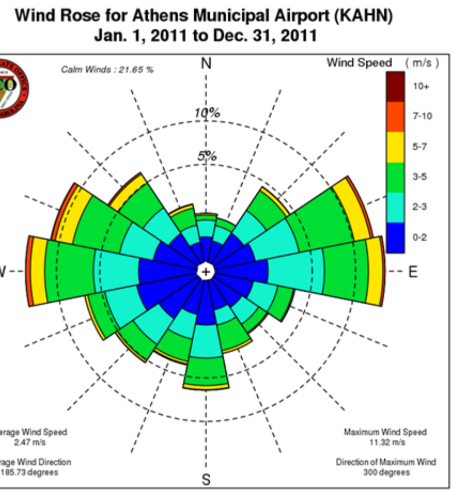
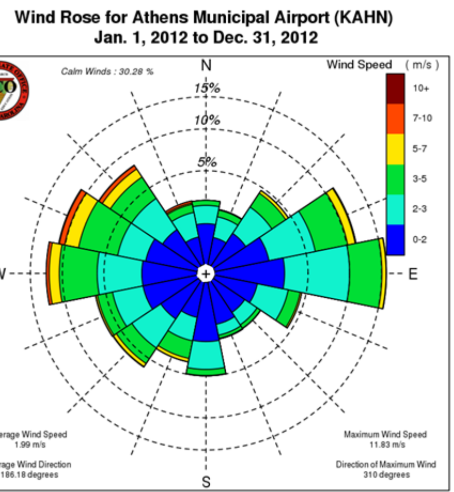


Figure C.15: Albany Wind Direction and Speed Joint Frequency Distribution for Each Year, 2011-2013

2011



2012



2013

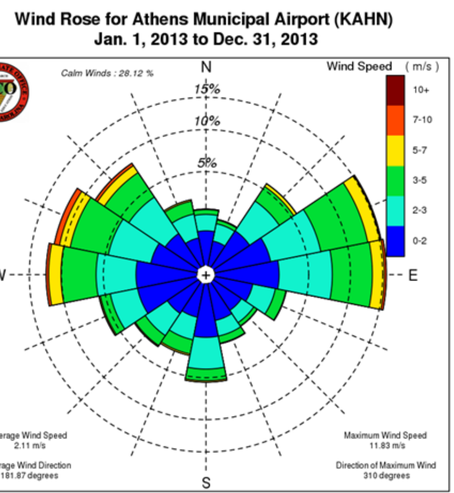
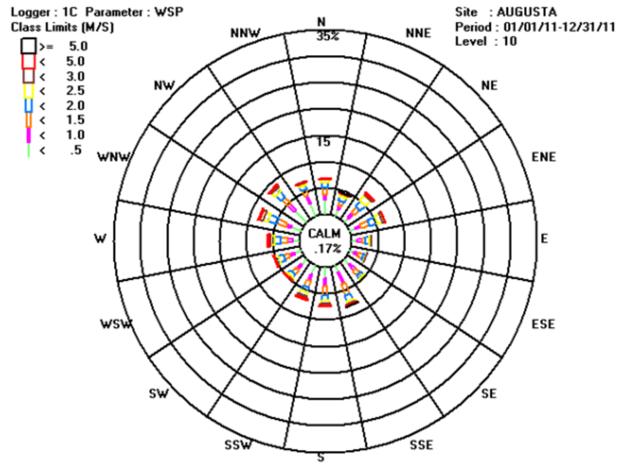
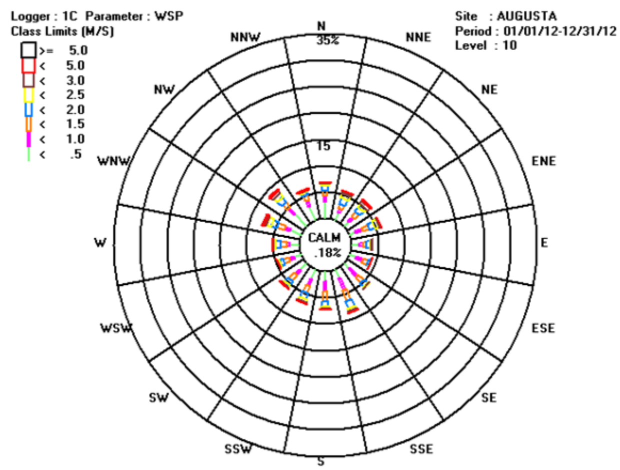


Figure C.15: Athens Wind Direction and Speed Joint Frequency Distribution for Each Year, 2011-2013

2011



2012



2013

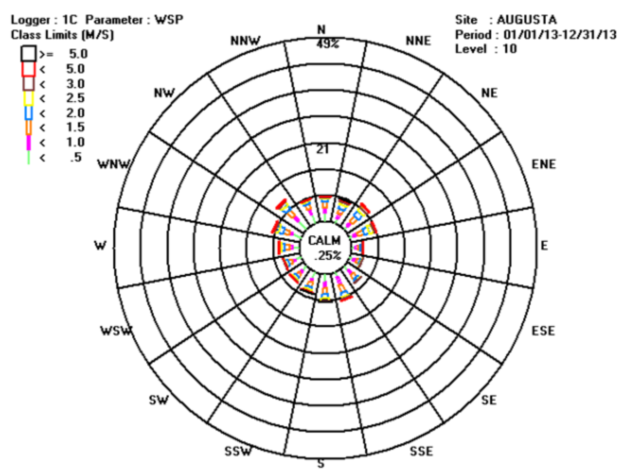
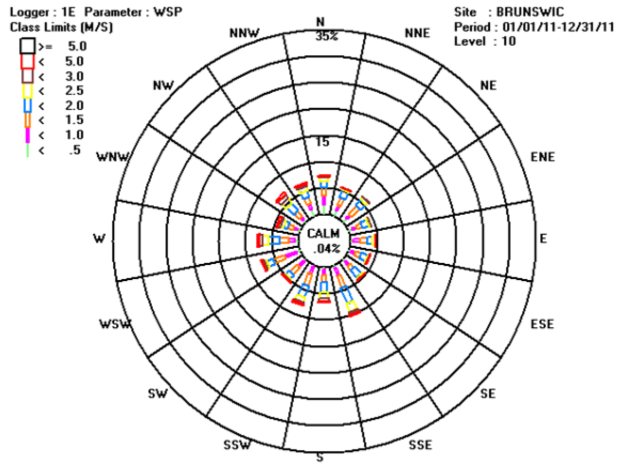
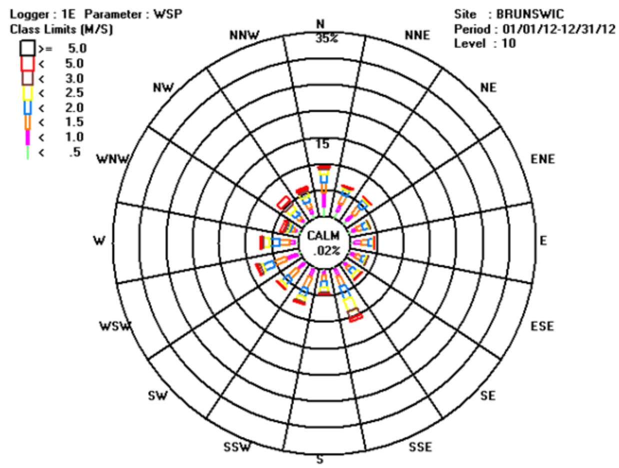


Figure C.15: Augusta Wind Direction and Speed Joint Frequency Distribution for Each Year, 2011-2013

2011



2012



2013

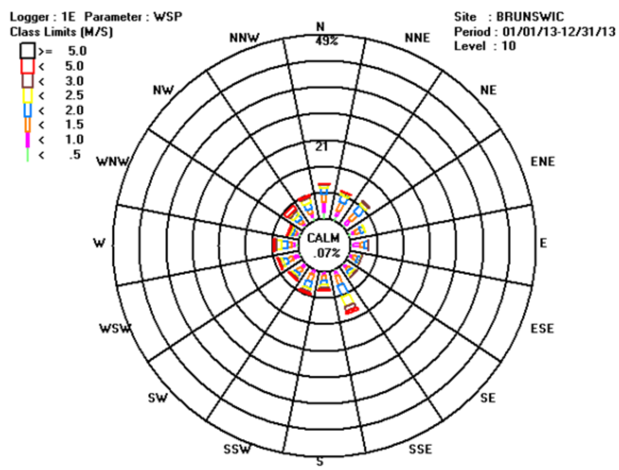


Figure C.16: Brunswick Wind Direction and Speed Joint Frequency Distribution for Each Year, 2011-2013

2011

2012

2013

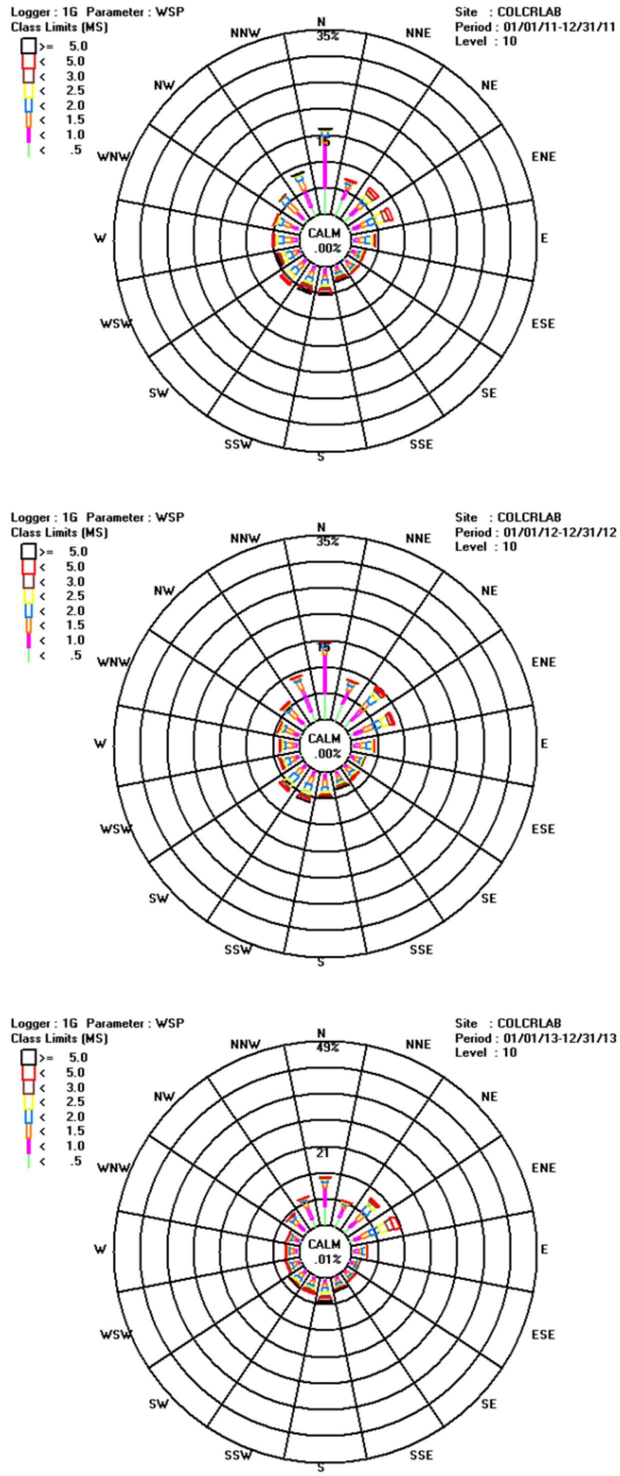


Figure C.17: Columbus Wind Direction and Speed Joint Frequency Distribution for Each Year, 2011-2013

2011

2012

2013

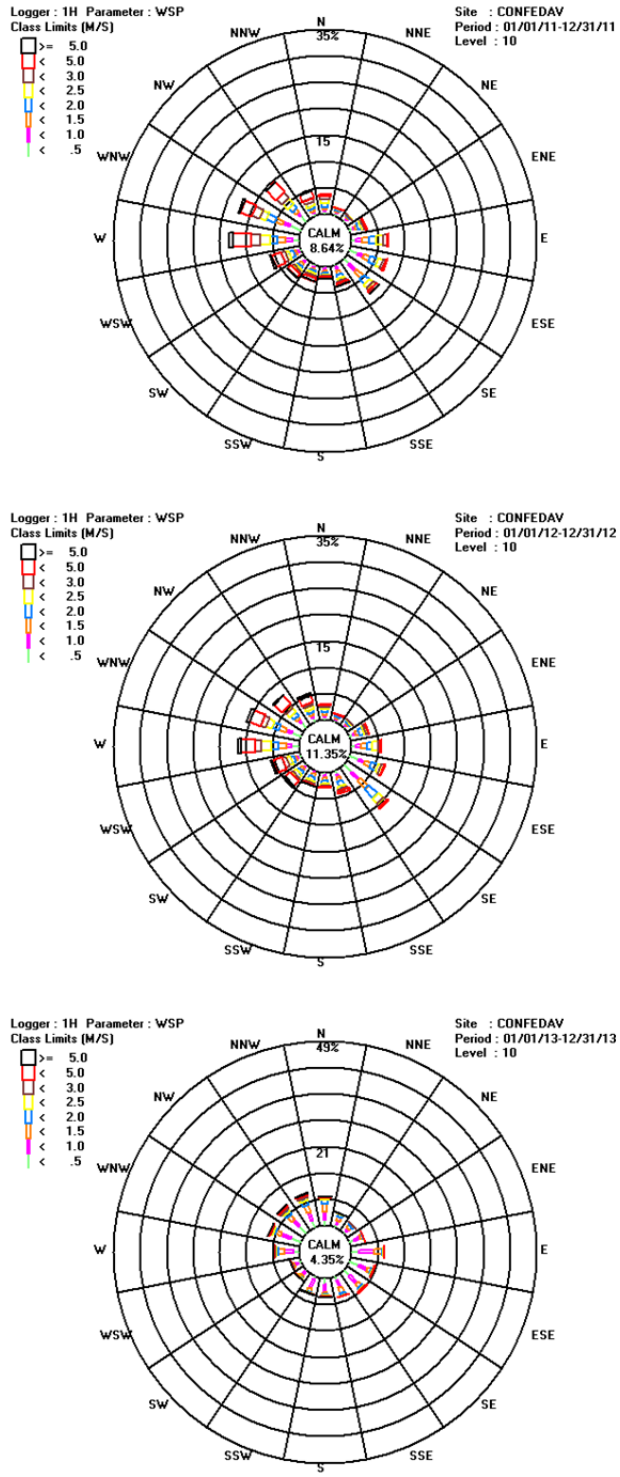
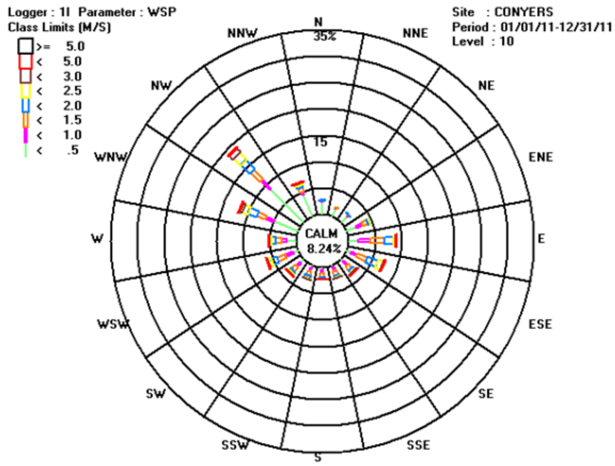
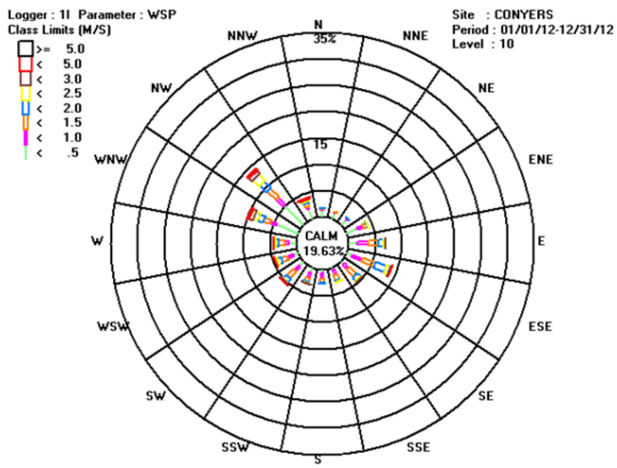


Figure C.18: Confederate Avenue Wind Direction and Speed Joint Frequency Distribution for Each Year, 2011-2013

2011



2012



2013

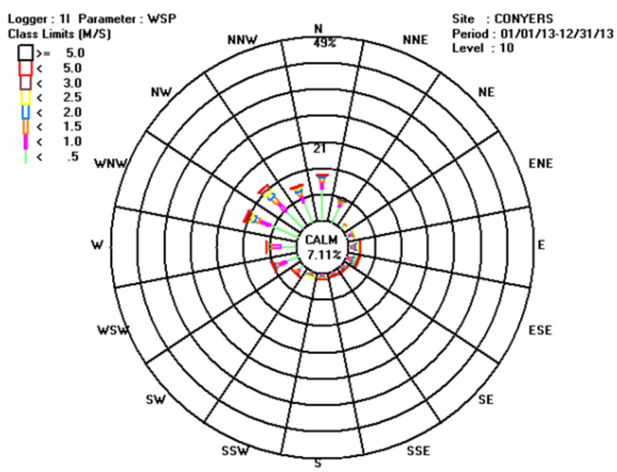
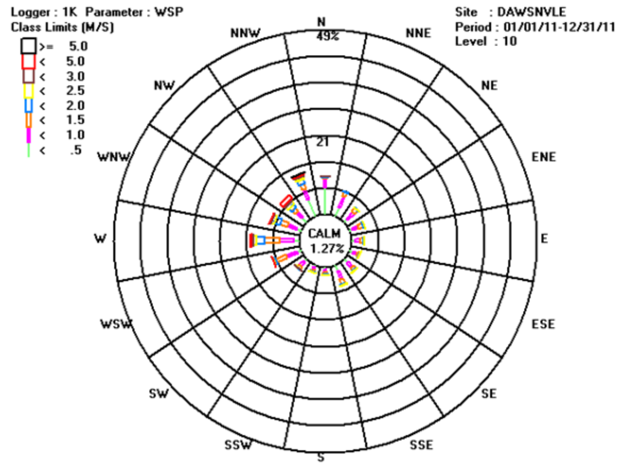
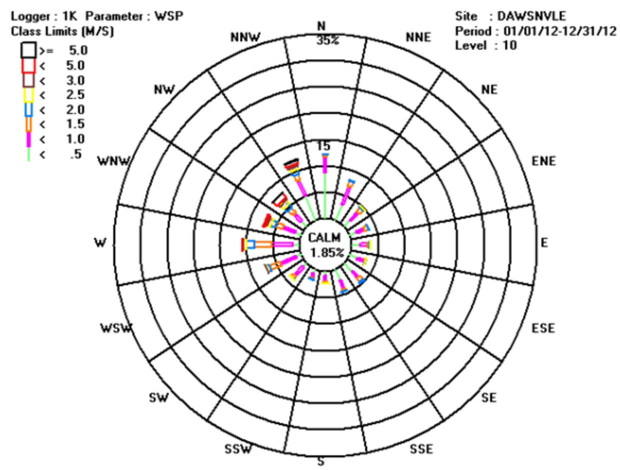


Figure C.19: Conyers Wind Direction and Speed Joint Frequency Distribution for Each Year, 2011-2013

2011



2012



2013

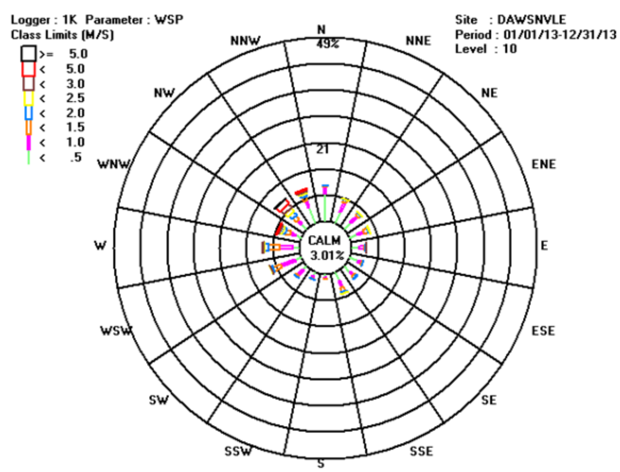
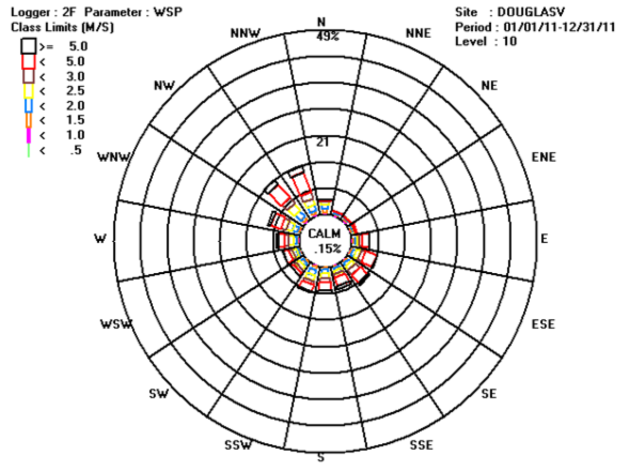
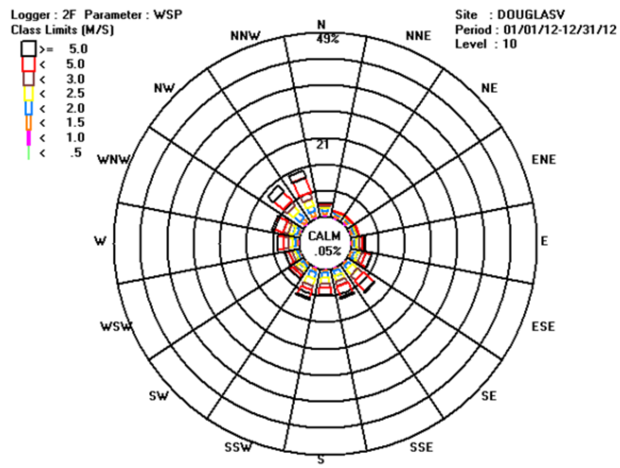


Figure C.20: Dawsonville Wind Direction and Speed Joint Frequency Distribution for Each Year, 2011-2013

2011



2012



2013

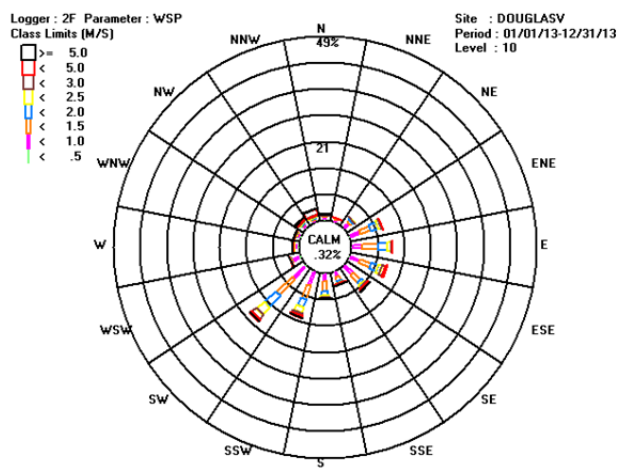


Figure C.21: Douglasville Wind Direction and Speed Joint Frequency Distribution for Each Year, 2011-2013

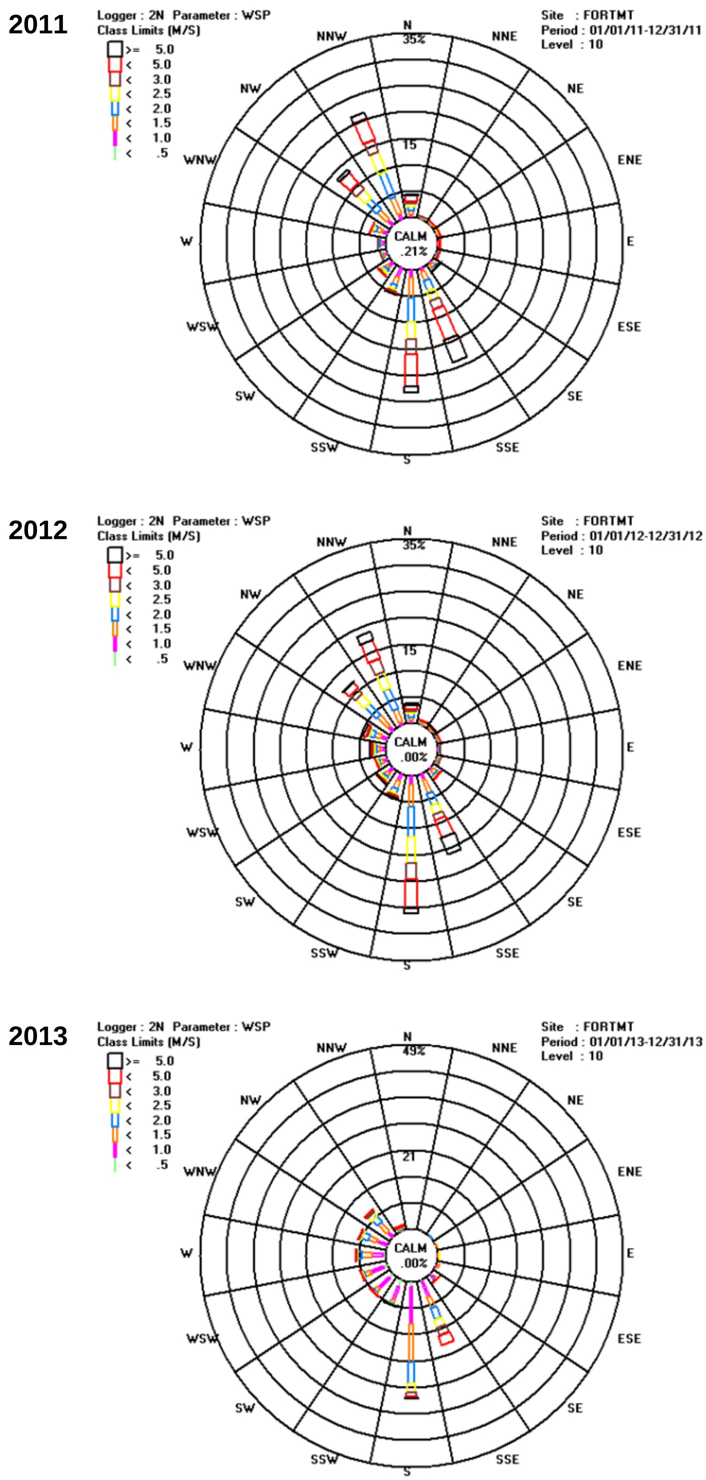
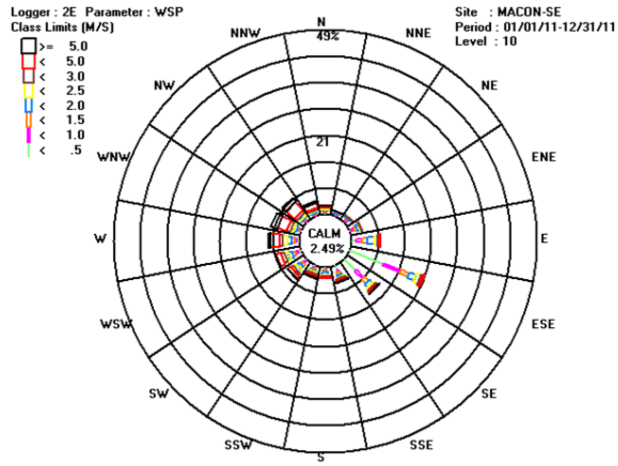
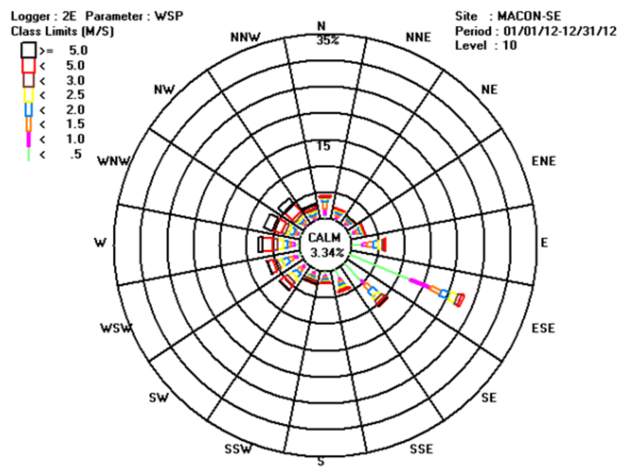


Figure C.22: Fort Mountain Wind Direction and Speed Joint Frequency Distribution for Each Year, 2011-2013

2011



2012



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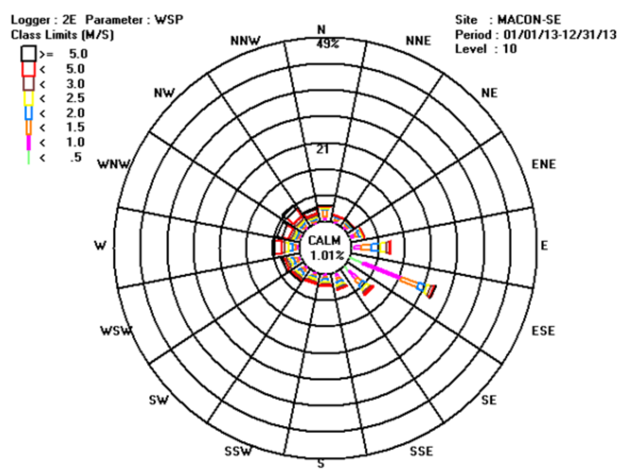
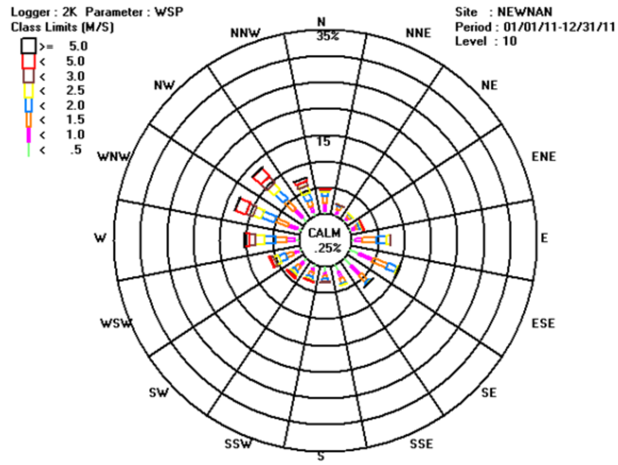
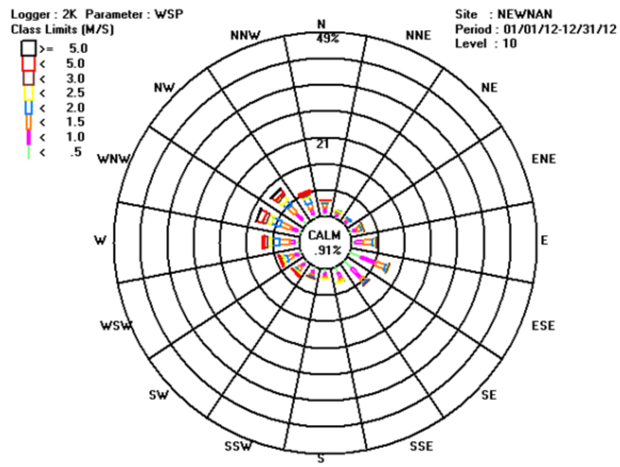


Figure C.23: Macon Wind Direction and Speed Joint Frequency Distribution for Each Year, 2011-2013

2011



2012



2013

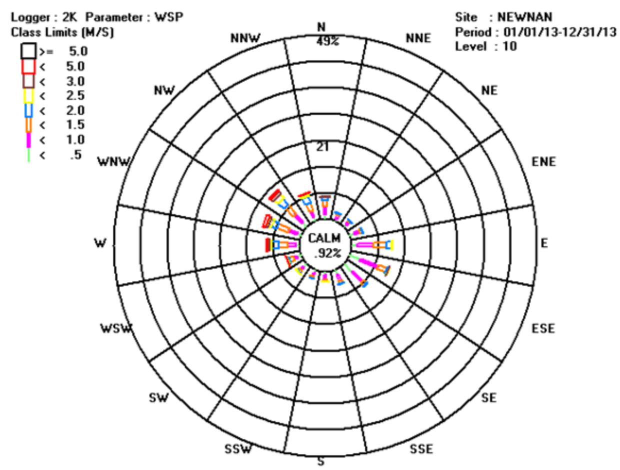
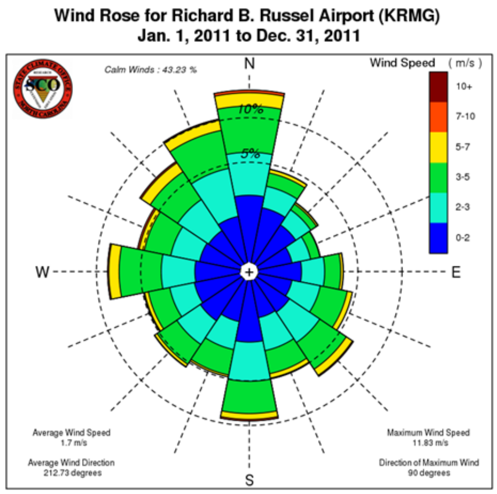
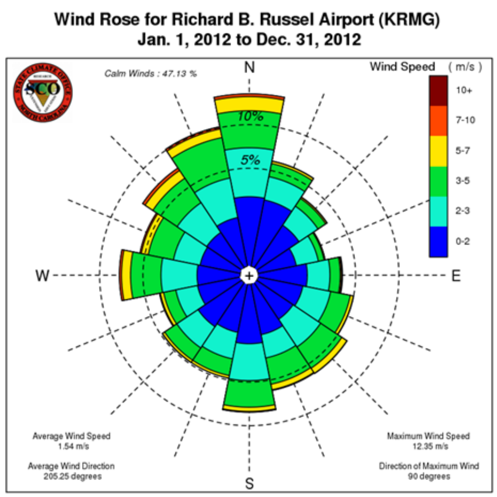


Figure C.24: Newnan Wind Direction and Speed Joint Frequency Distribution for Each Year, 2011-2013

2011



2012



2013

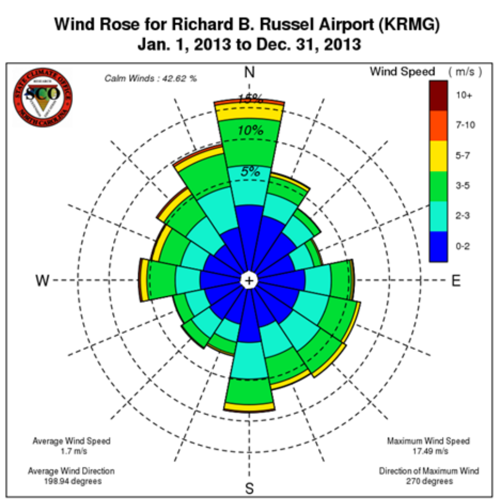
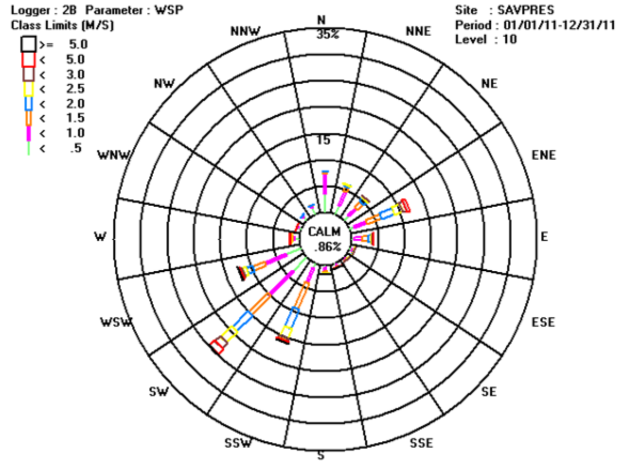
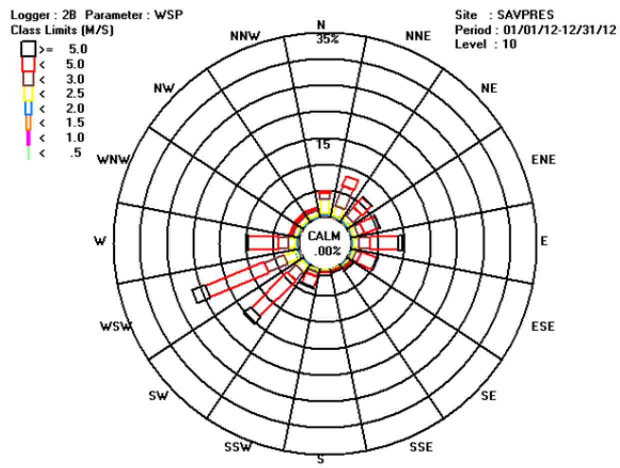


Figure C.15: Rome Wind Direction and Speed Joint Frequency Distribution for Each Year, 2011-2013

2011



2012



2013

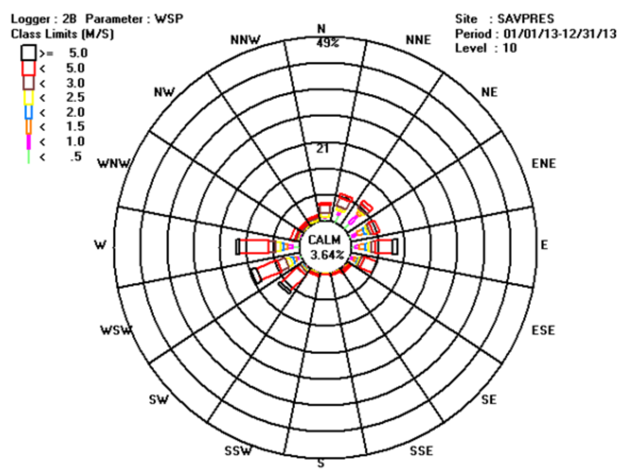
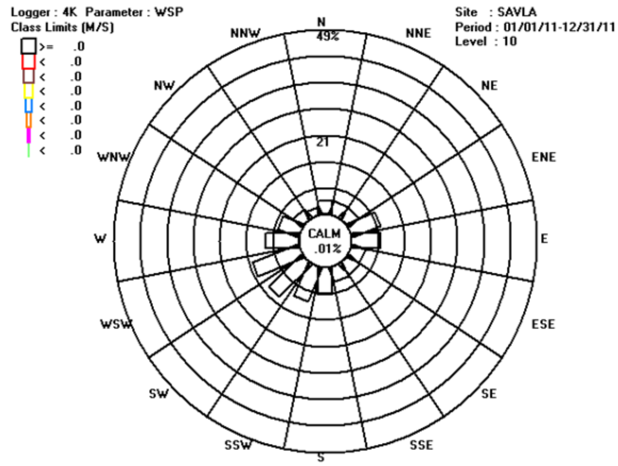
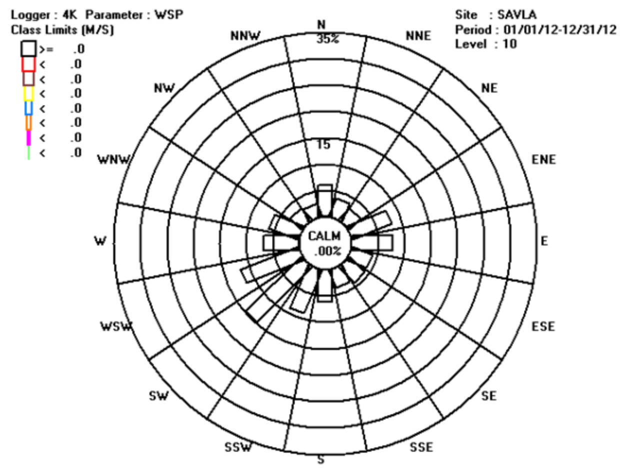


Figure C.25: Savannah-E Pres Wind Direction and Speed Joint Frequency Distribution for Each Year, 2011-2013

2011



2012



2013

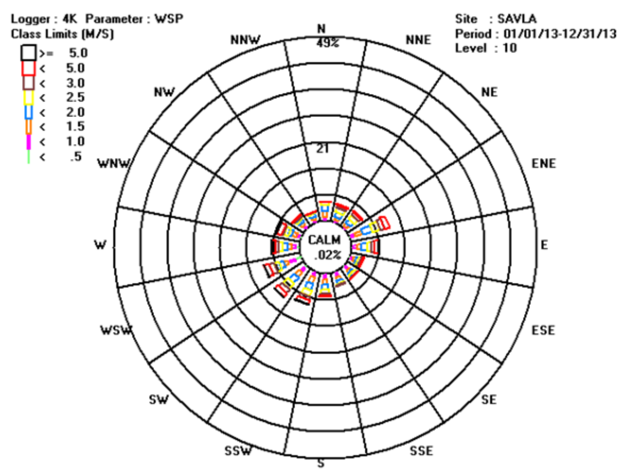
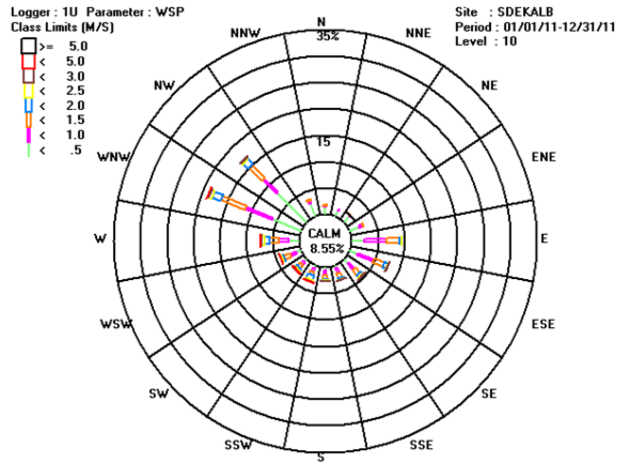
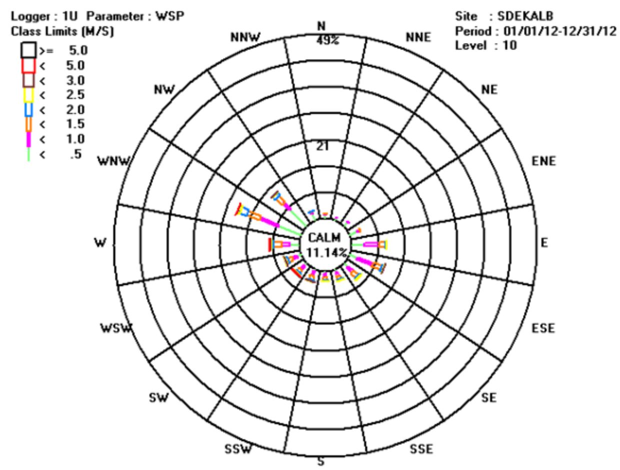


Figure C.26: Savannah-L&A Wind Direction and Speed Joint Frequency Distribution for Each Year, 2011-2013

2011



2012



2013

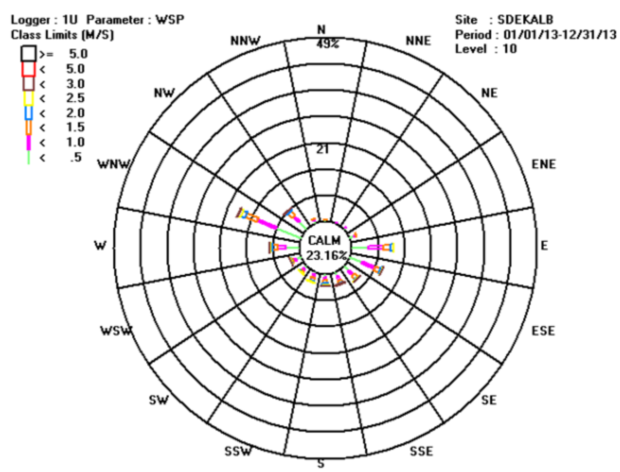
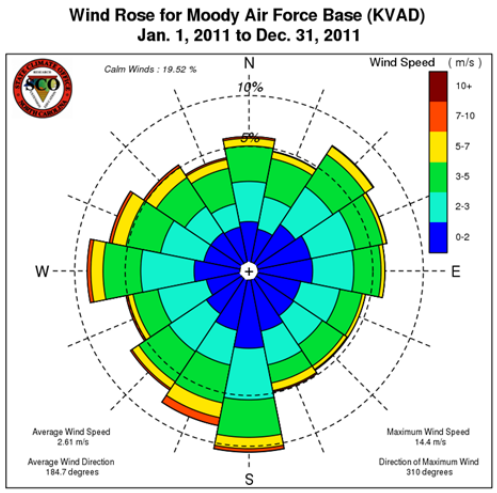
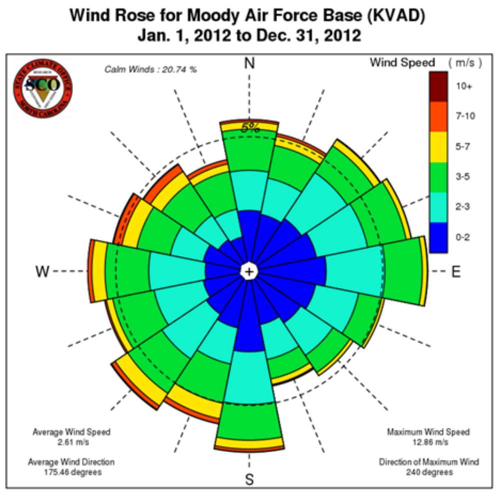


Figure C.27: South DeKalb Wind Direction and Speed Joint Frequency Distribution for Each Year, 2011-2013

2011



2012



2013

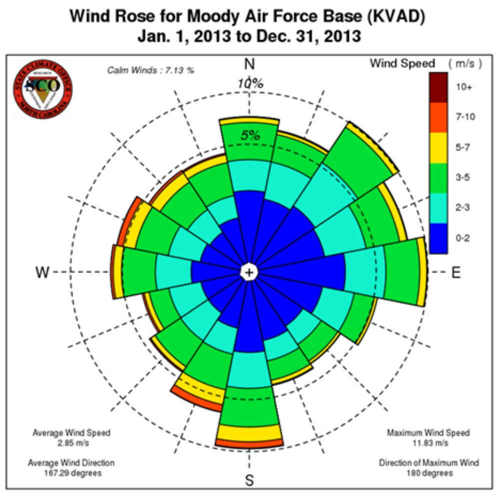


Figure C.27: Valdosta Wind Direction and Speed Joint Frequency Distribution for Each Year, 2011-2013

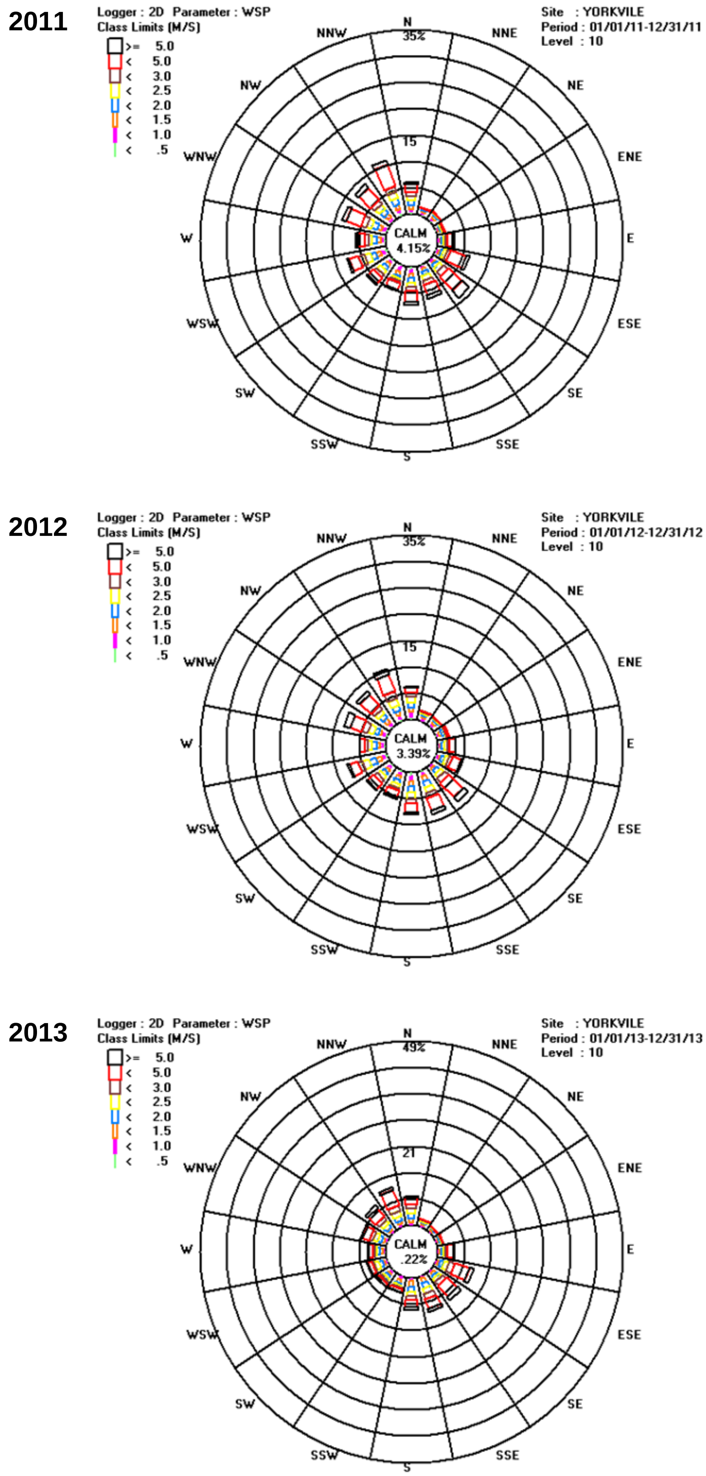


Figure C.28: Yorkville Wind Direction and Speed Joint Frequency Distribution for Each Year, 2011-2013

Ozone Wind Roses 2011-2013

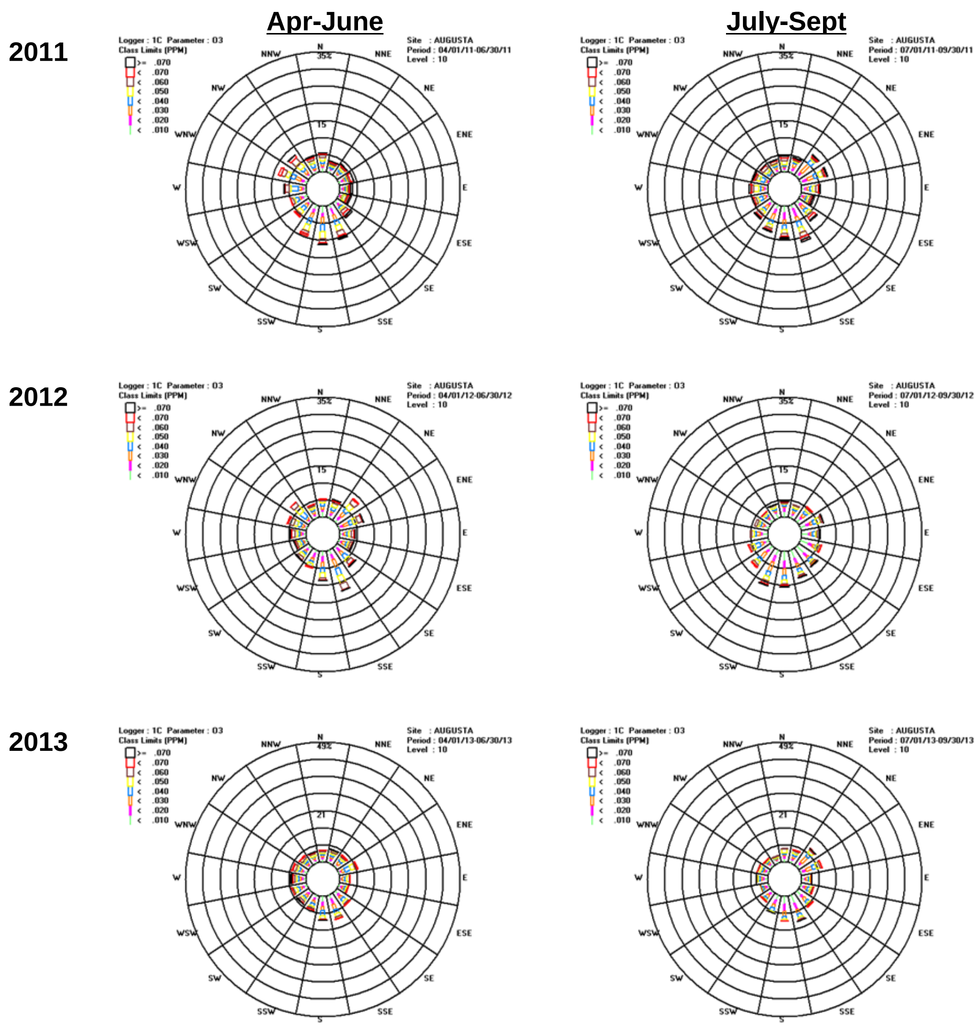


Figure C.29: Augusta Ozone and Wind Direction and Speed Joint Frequency Distribution for Each Quarter, 2011-2013

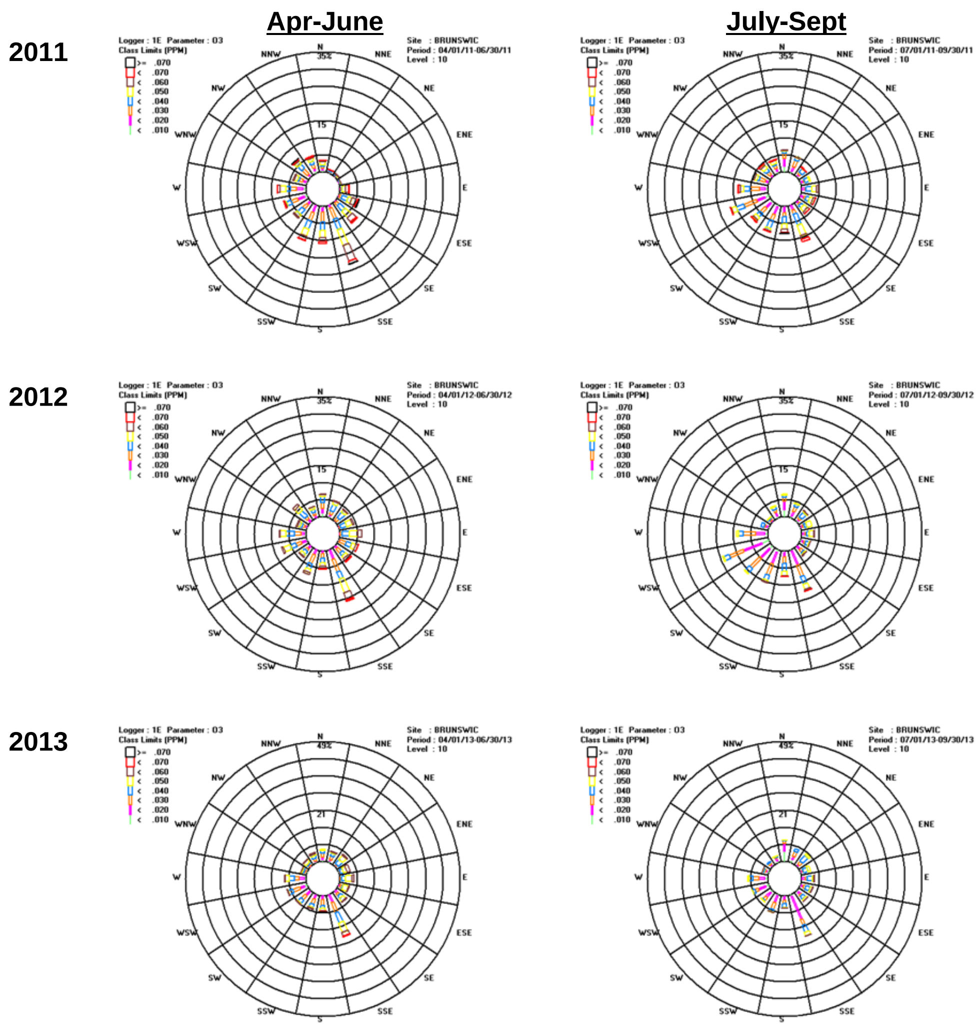


Figure C.30: Brunswick Ozone and Wind Direction and Speed Joint Frequency Distribution for Each Quarter, 2011-2013

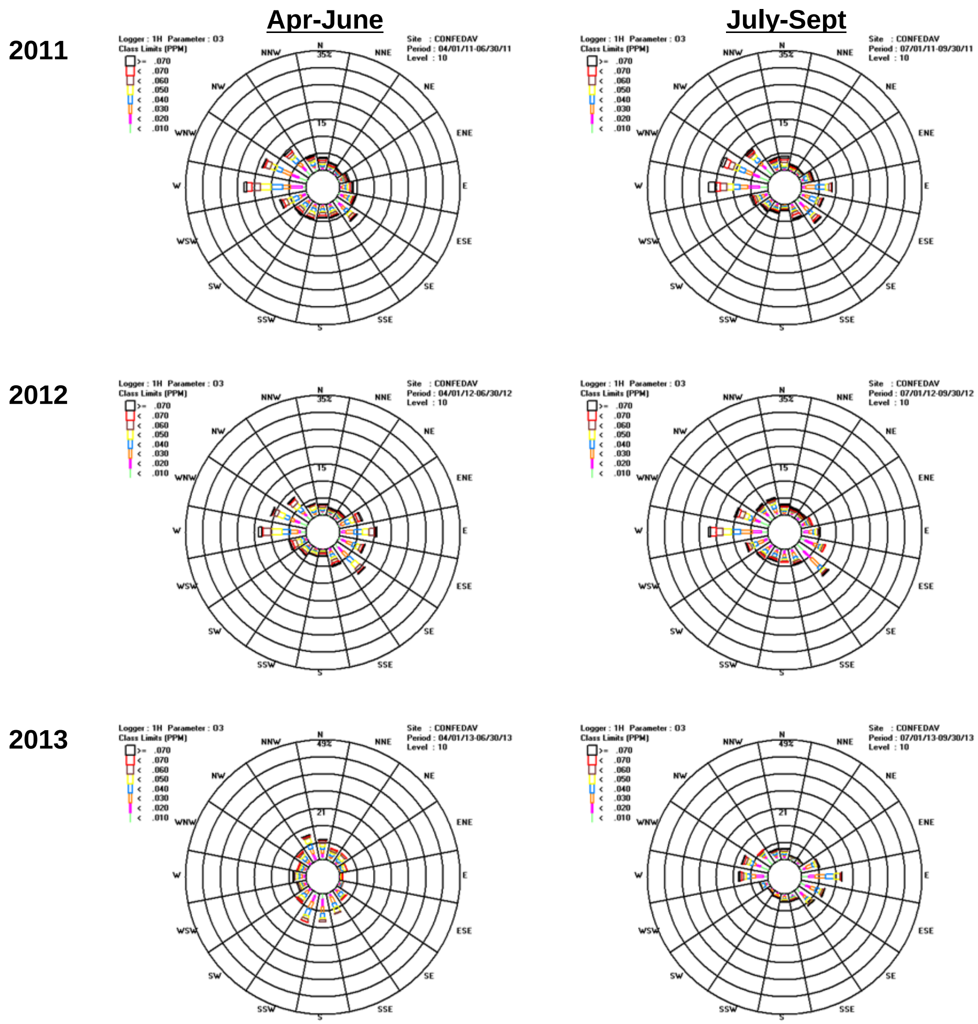


Figure C.31: Confederate Avenue Ozone and Wind Direction and Speed Joint Frequency Distribution for Each Quarter, 2011-2013

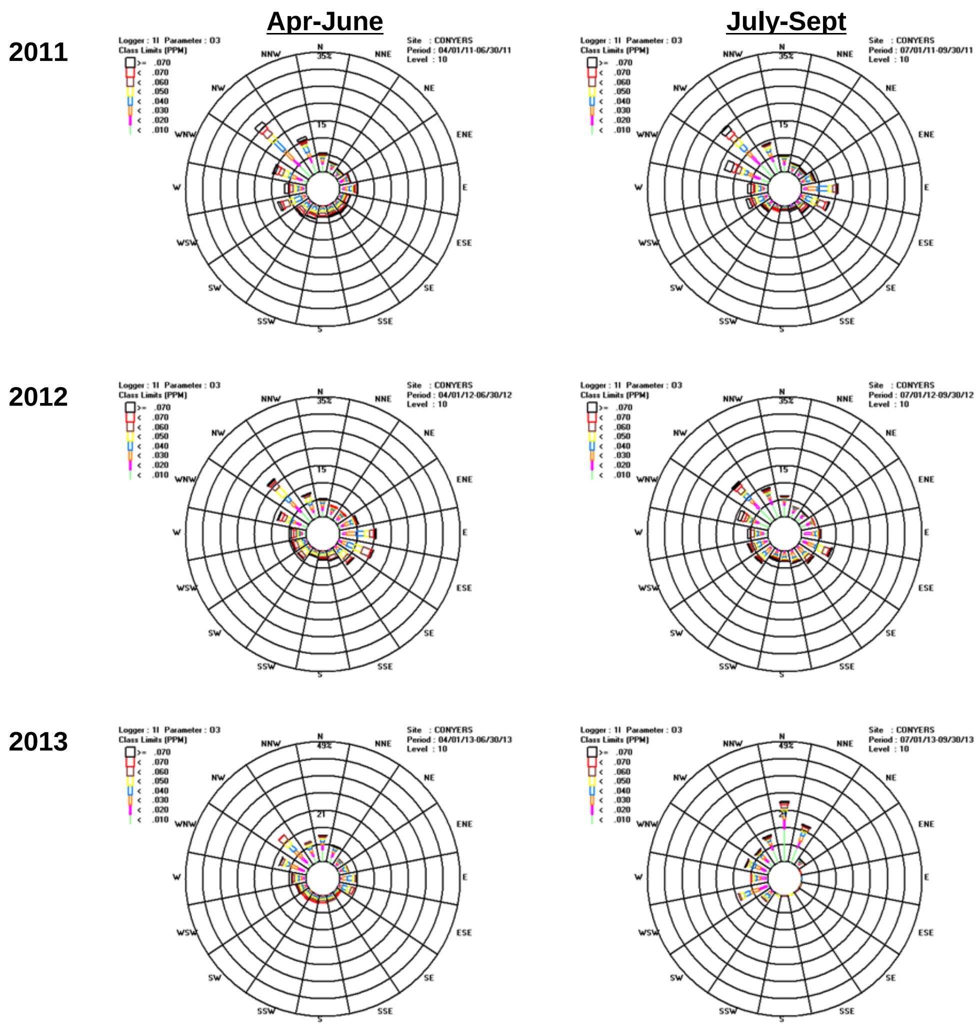


Figure C.32: Conyers Ozone and Wind Direction and Speed Joint Frequency Distribution for Each Quarter, 2011-2013

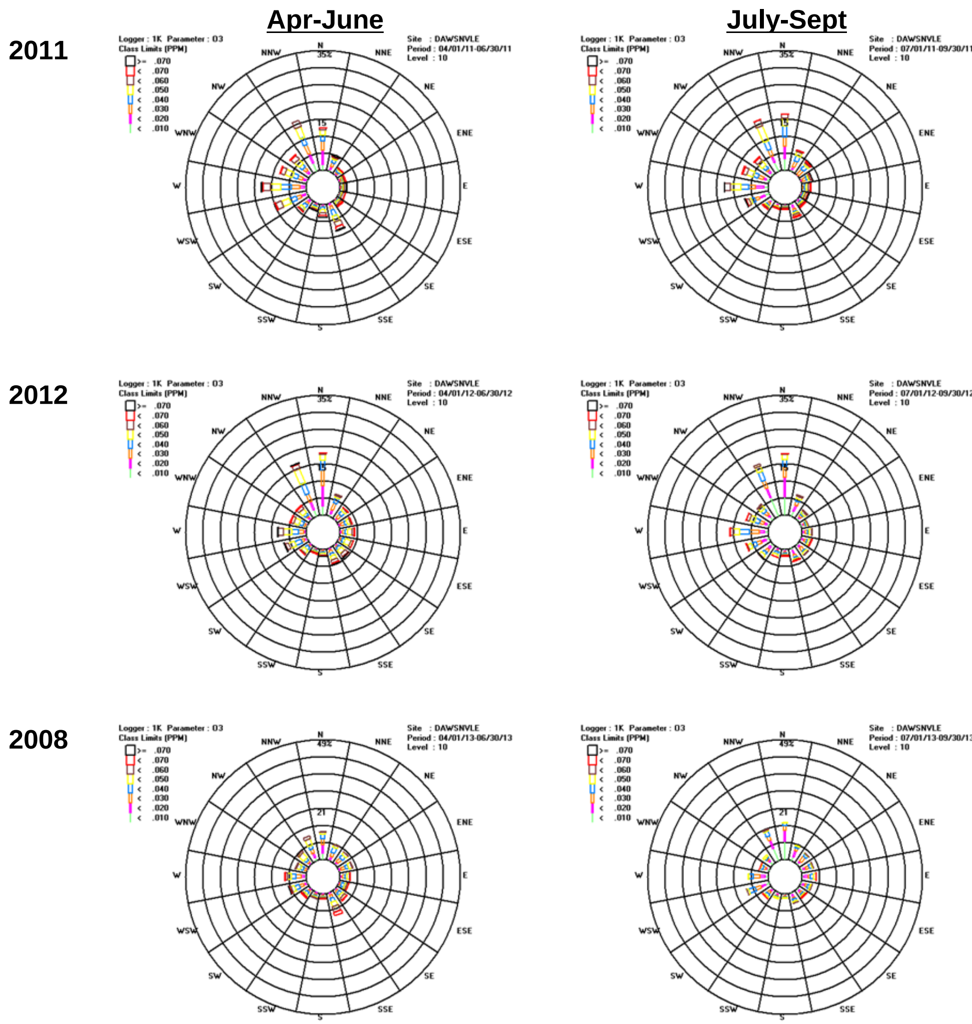


Figure C.33: Dawsonville Ozone and Wind Direction and Speed Joint Frequency Distribution for Each Quarter, 2011-2013

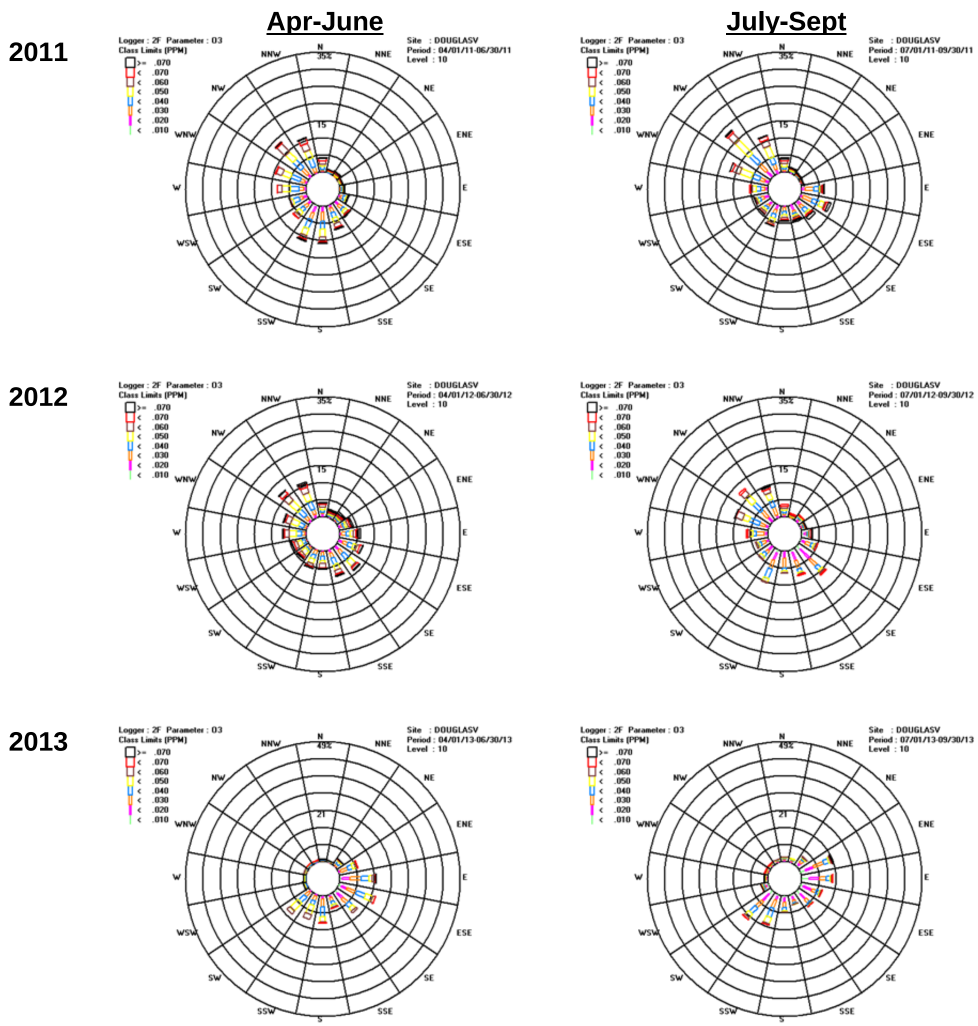


Figure C.34: Douglasville Ozone and Wind Direction and Speed Joint Frequency Distribution for Each Quarter, 2011-2013

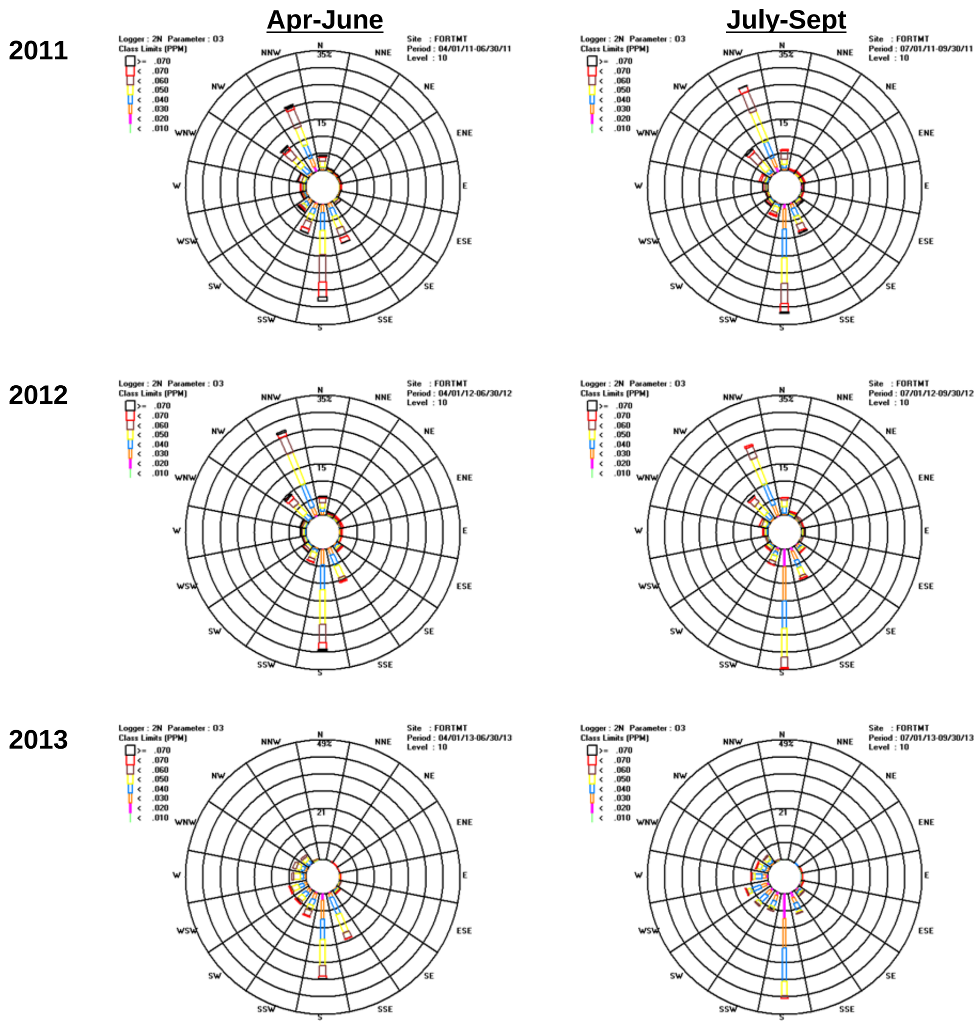


Figure C.35: Fort Mountain Ozone and Wind Direction and Speed Joint Frequency Distribution for Each Quarter, 2011-2013

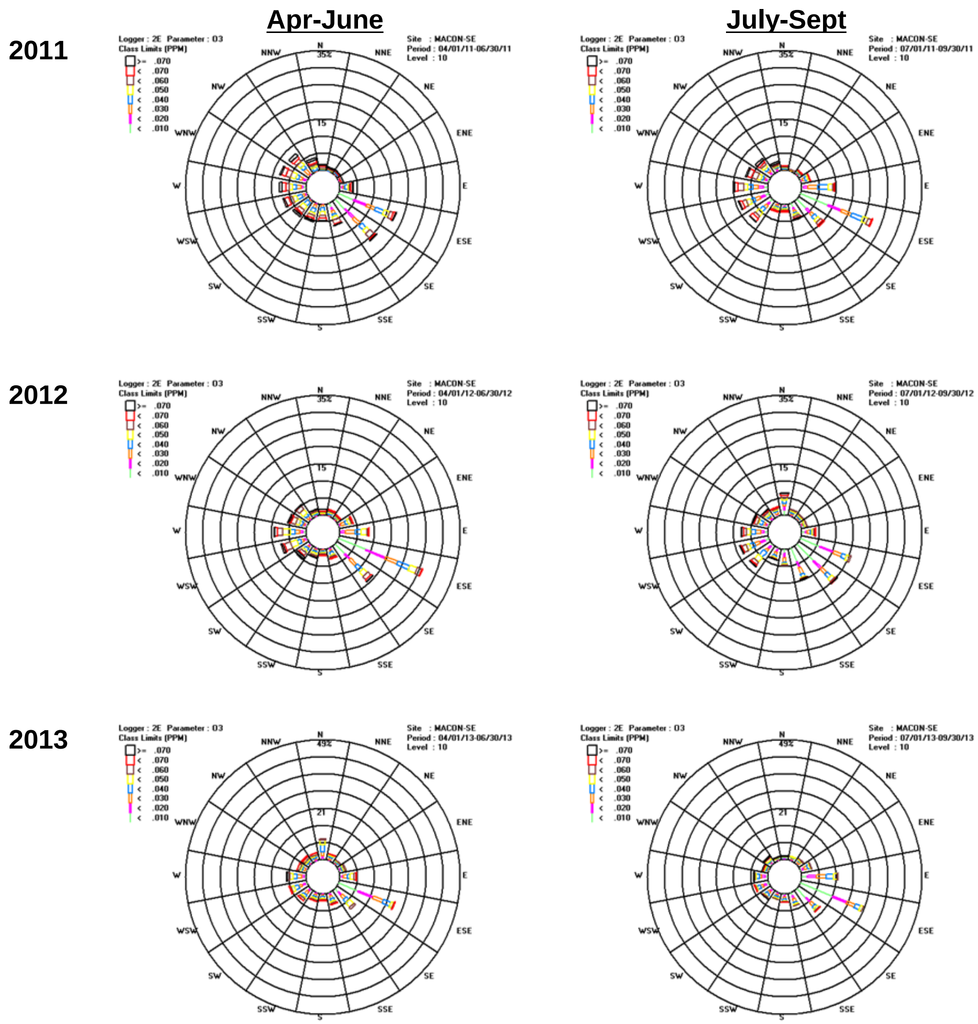


Figure C.36: Macon Ozone and Wind Direction and Speed Joint Frequency Distribution for Each Quarter, 2011-2013

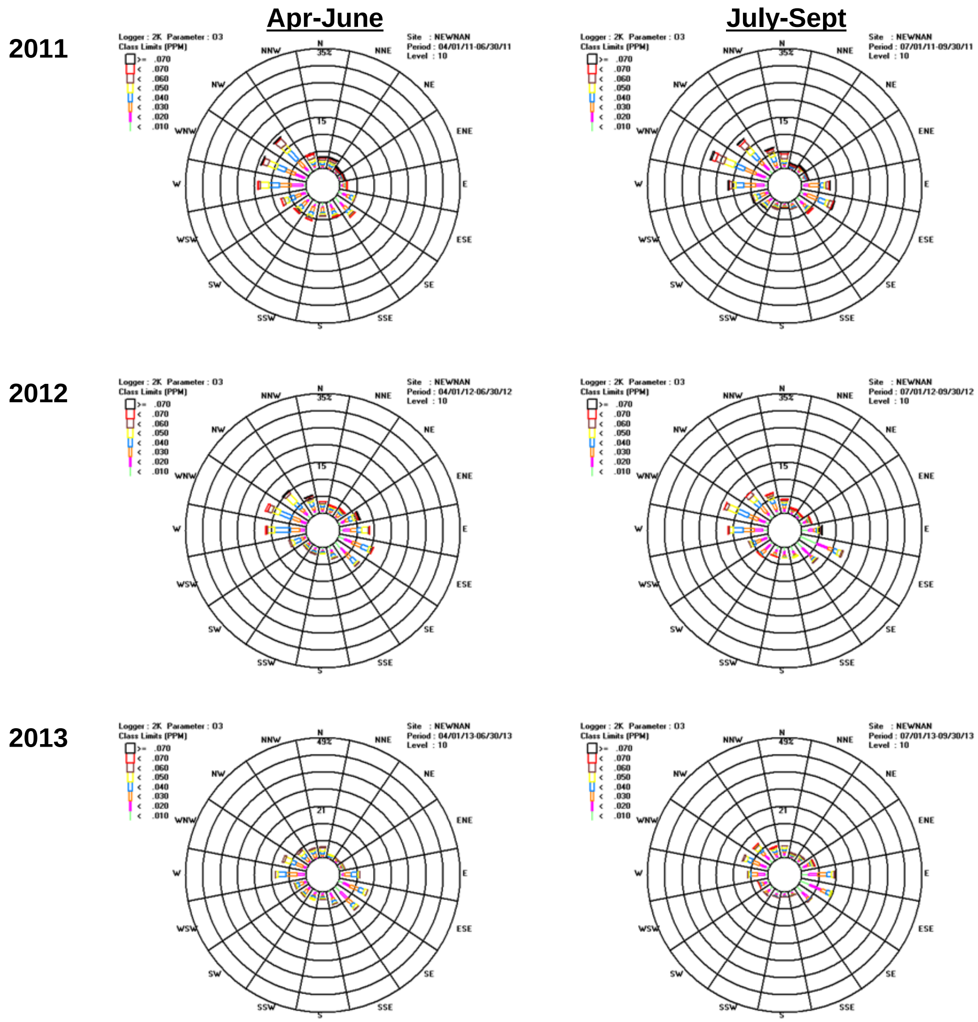


Figure C.37: Newnan Ozone and Wind Direction and Speed Joint Frequency Distribution for Each Quarter, 2011-2013

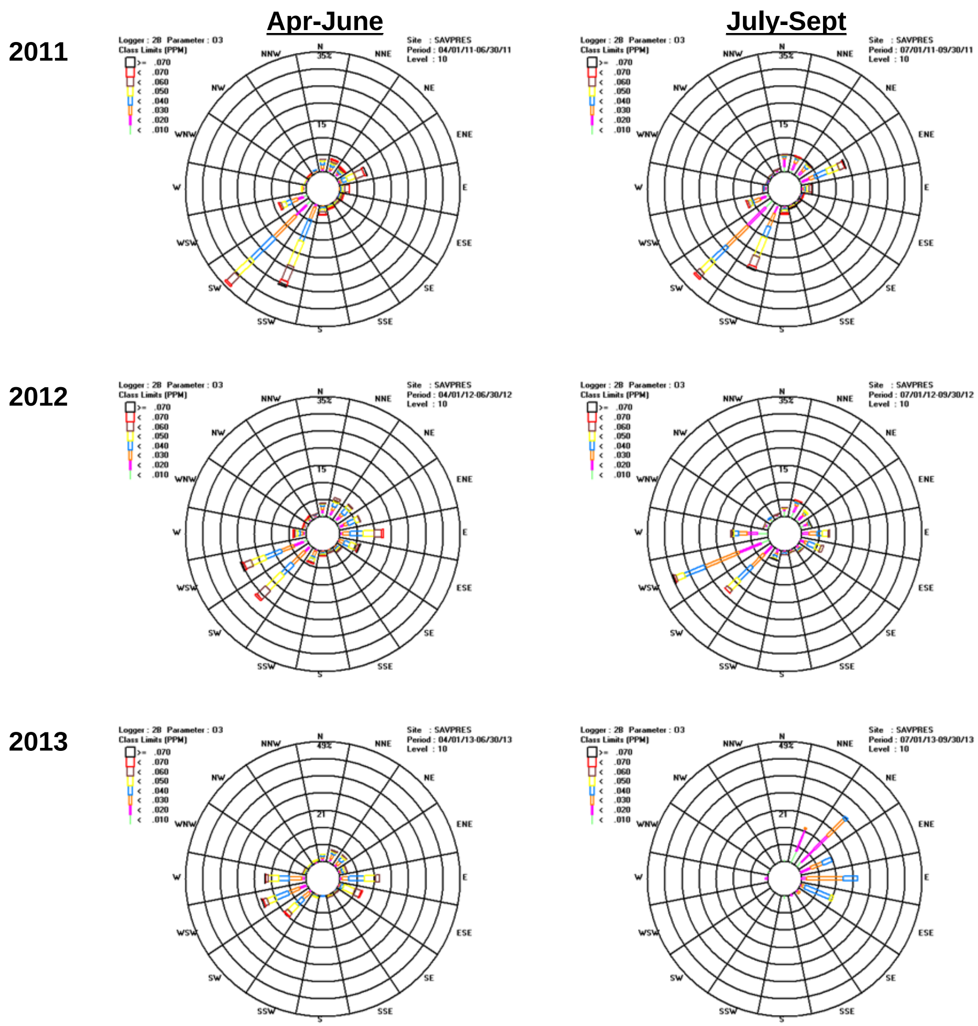


Figure C.38: Savannah Ozone and Wind Direction and Speed Joint Frequency Distribution for Each Quarter, 2011-2013

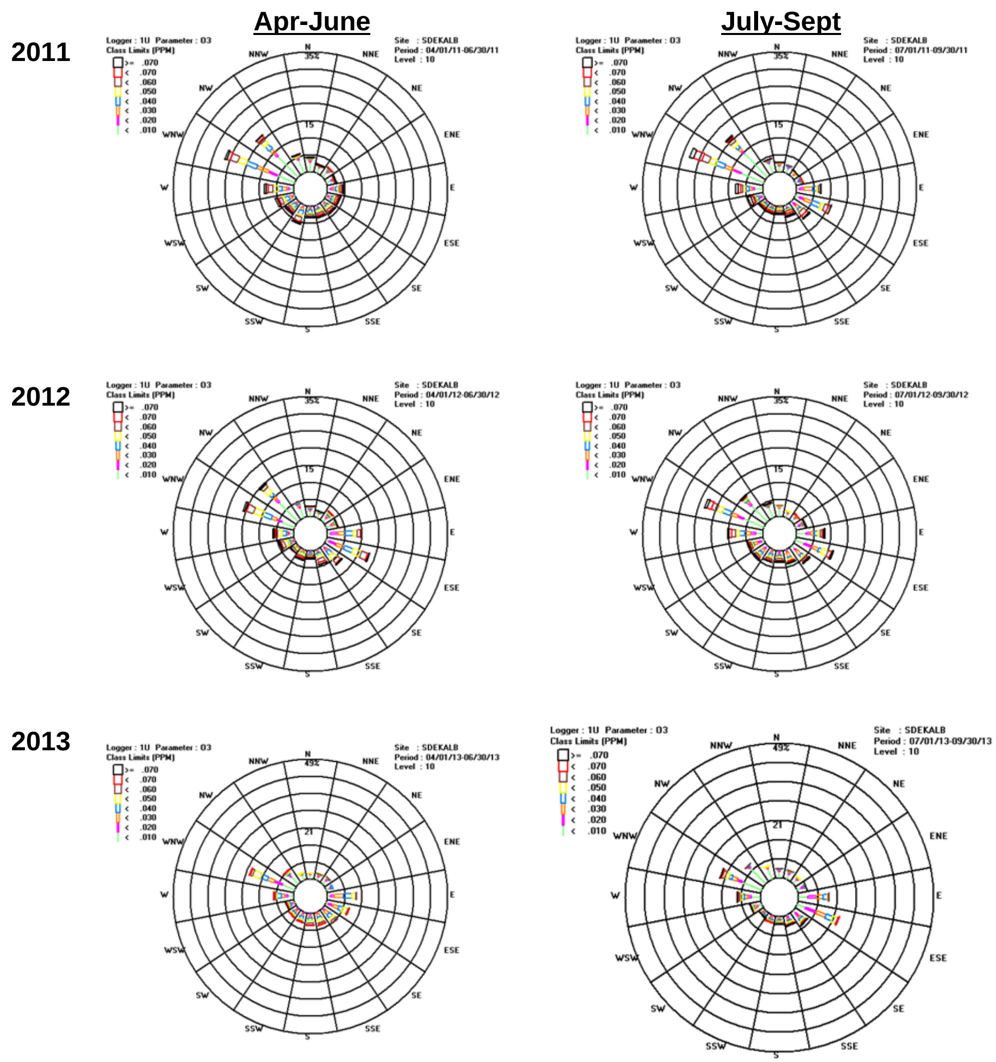


Figure C.39: South DeKalb Ozone and Wind Direction and Speed Joint Frequency Distribution for Each Quarter, 2011-2013

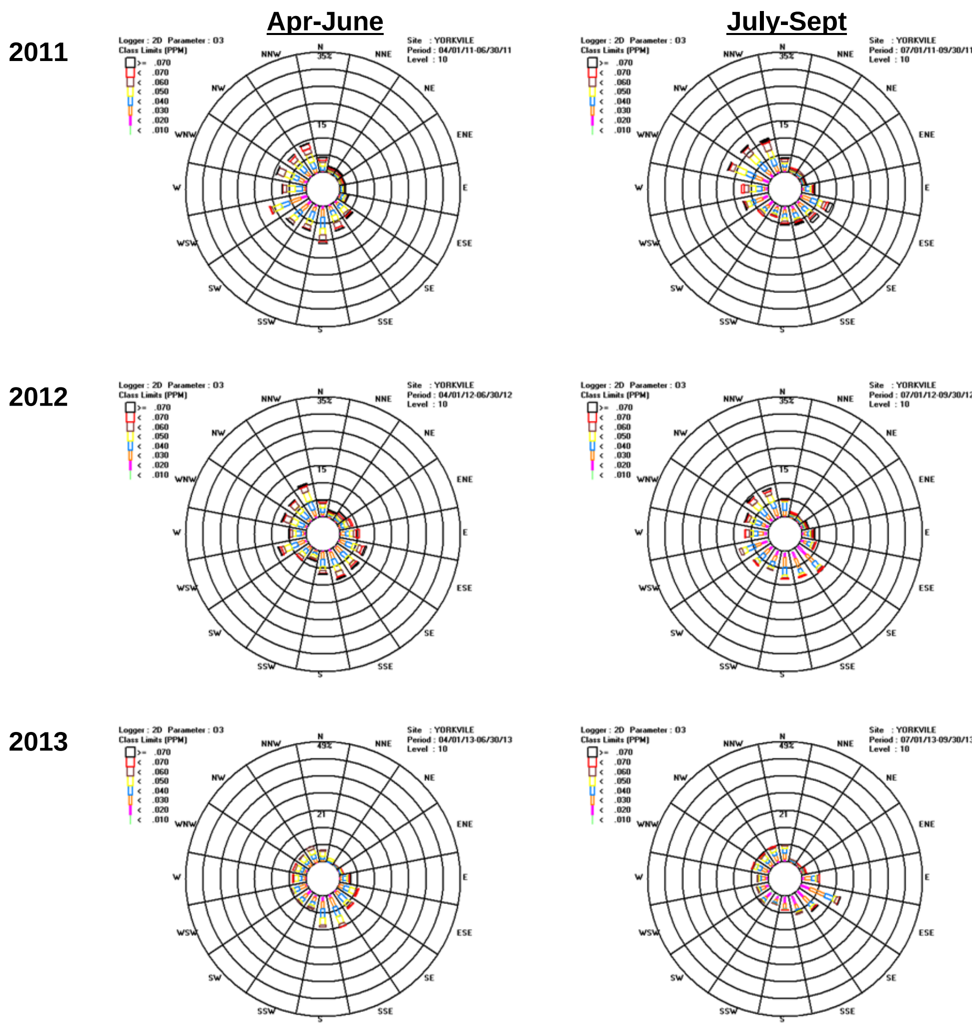


Figure C.40: Yorkville Ozone and Wind Direction and Speed Joint Frequency Distribution for Each Quarter, 2011-2013

$PM_{2.5}$ Quarterly Wind Roses 2011-2013

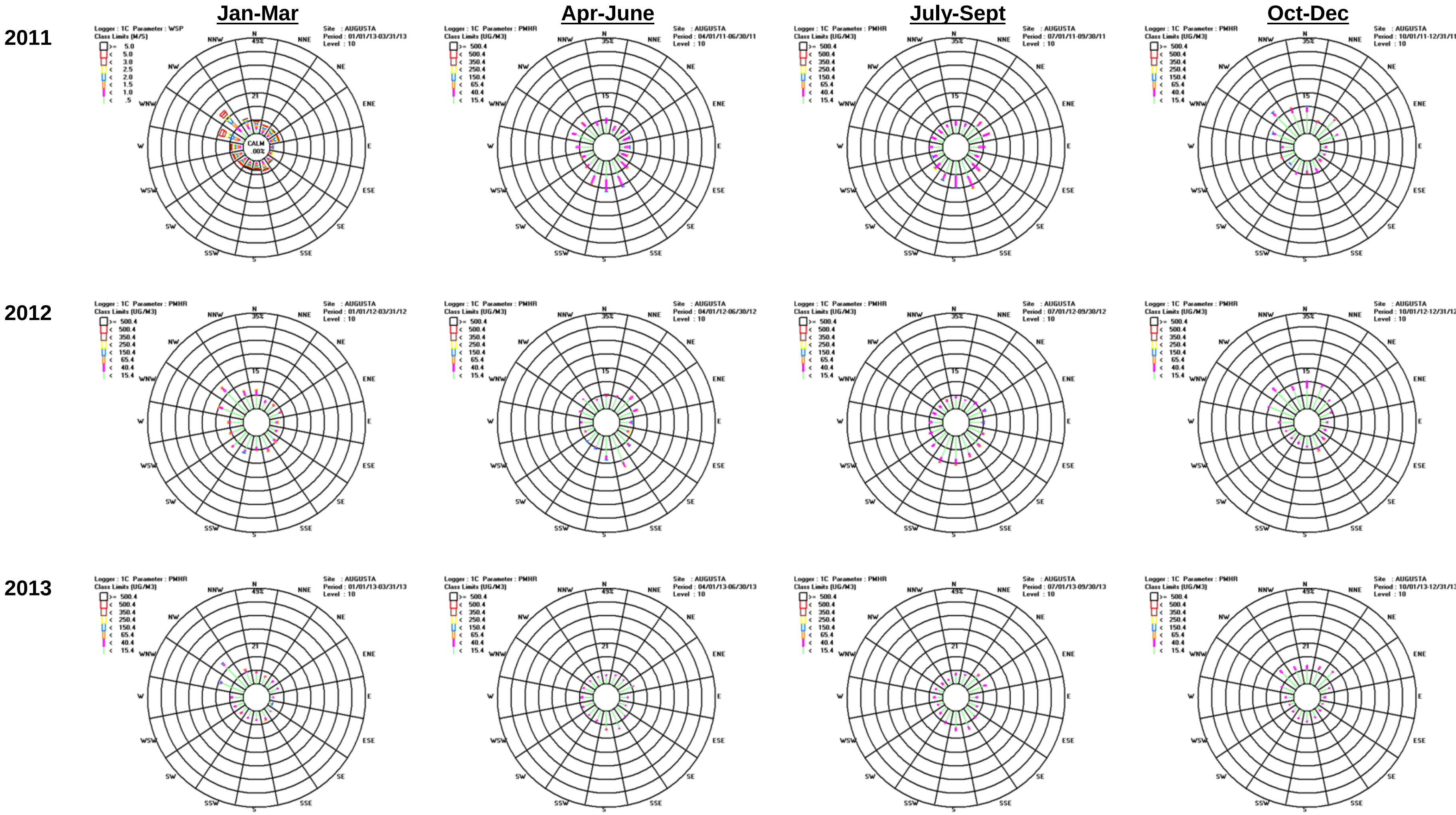


Figure C.41: Augusta $PM_{2.5}$ and Wind Direction and Speed Joint Frequency Distribution for Each Quarter, 2011-2013

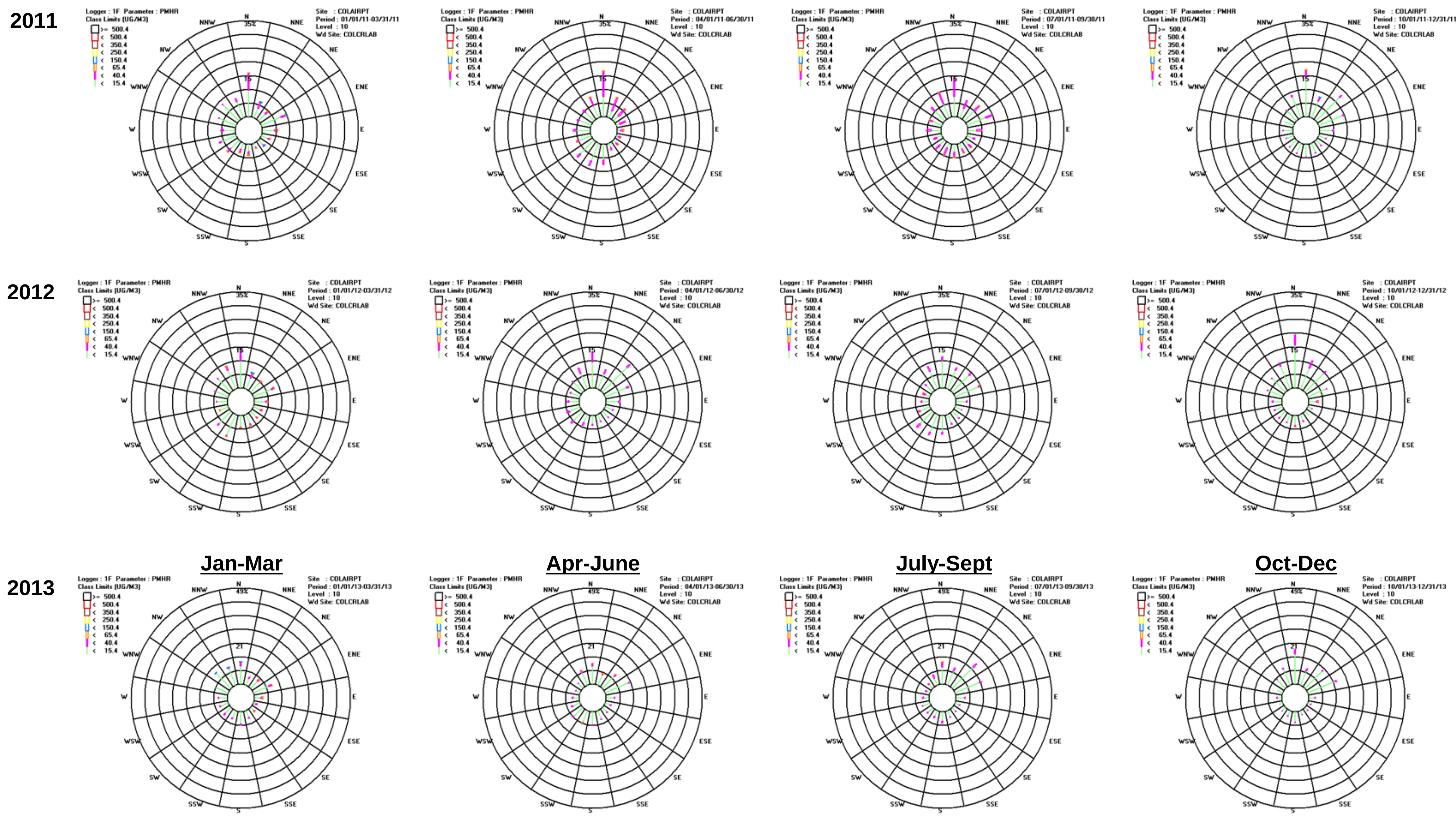


Figure C.42: Columbus $PM_{2.5}$ and Wind Direction and Speed Joint Frequency Distribution for Each Quarter, 2011-2013

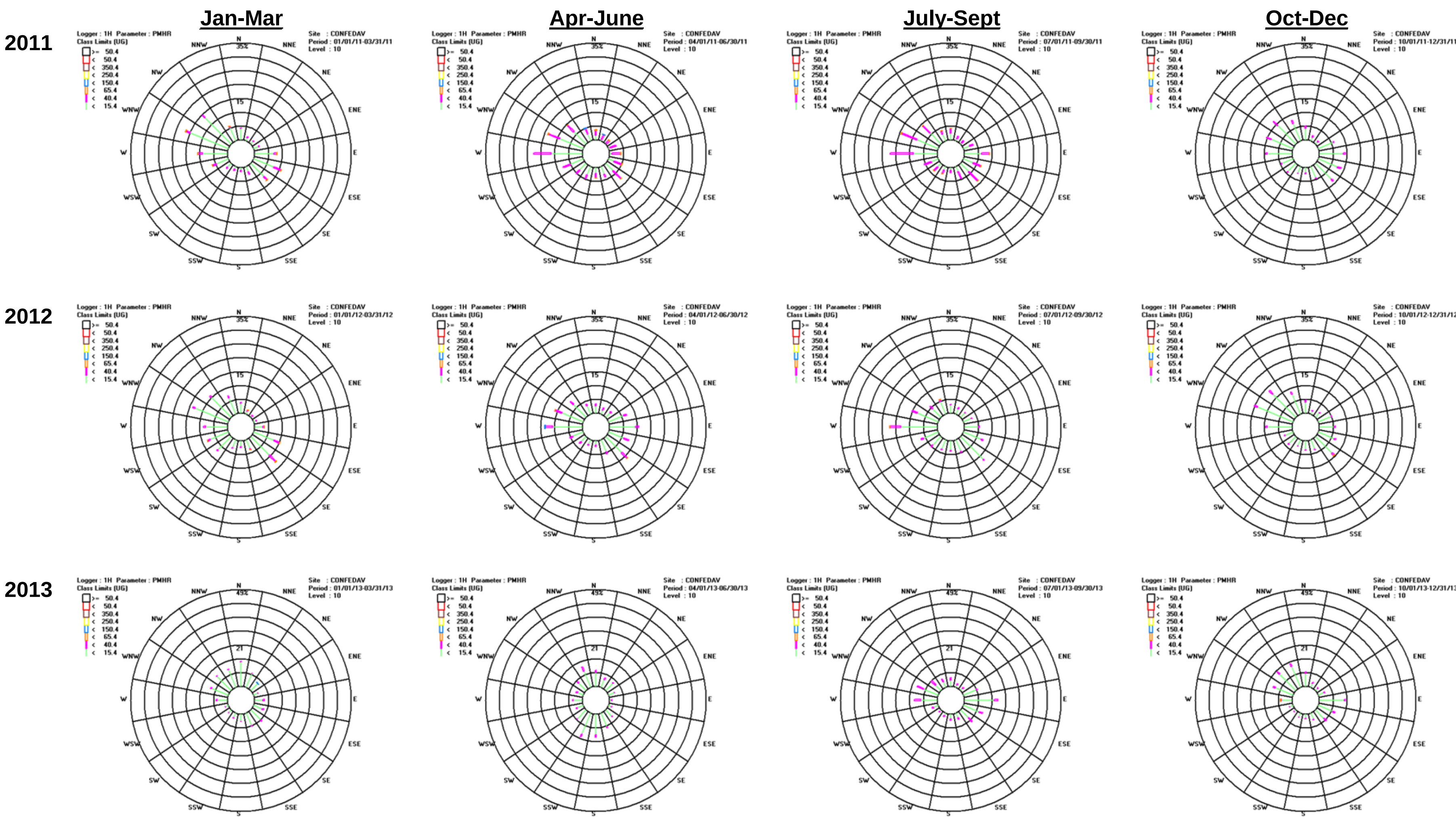


Figure C.43: Confederate Ave $PM_{2.5}$ and Wind Direction and Speed Joint Frequency Distribution for Each Quarter, 2011-2013

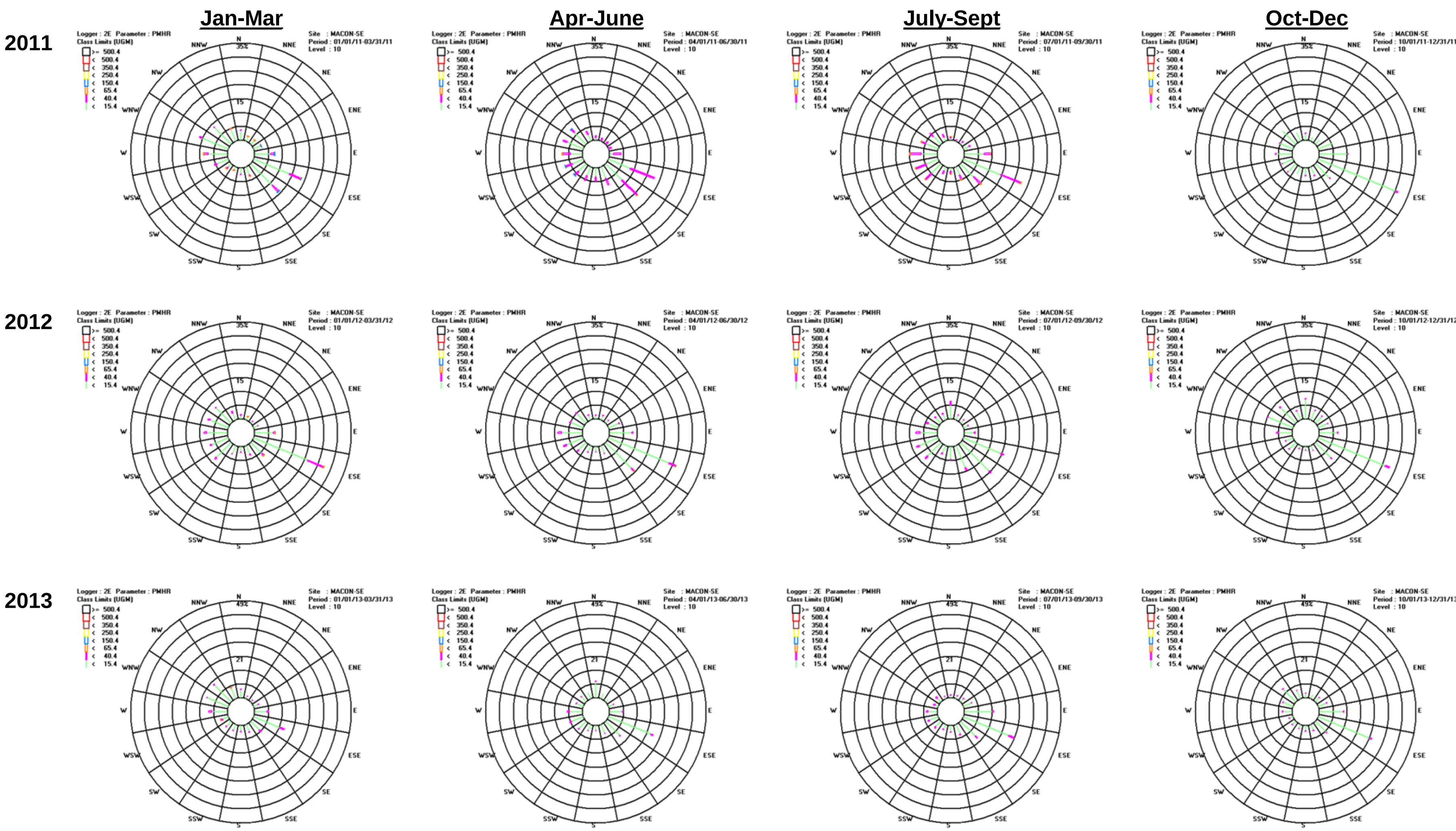


Figure C.44: Macon SE $PM_{2.5}$ and Wind Direction and Speed Joint Frequency Distribution for Each Quarter, 2011-2013

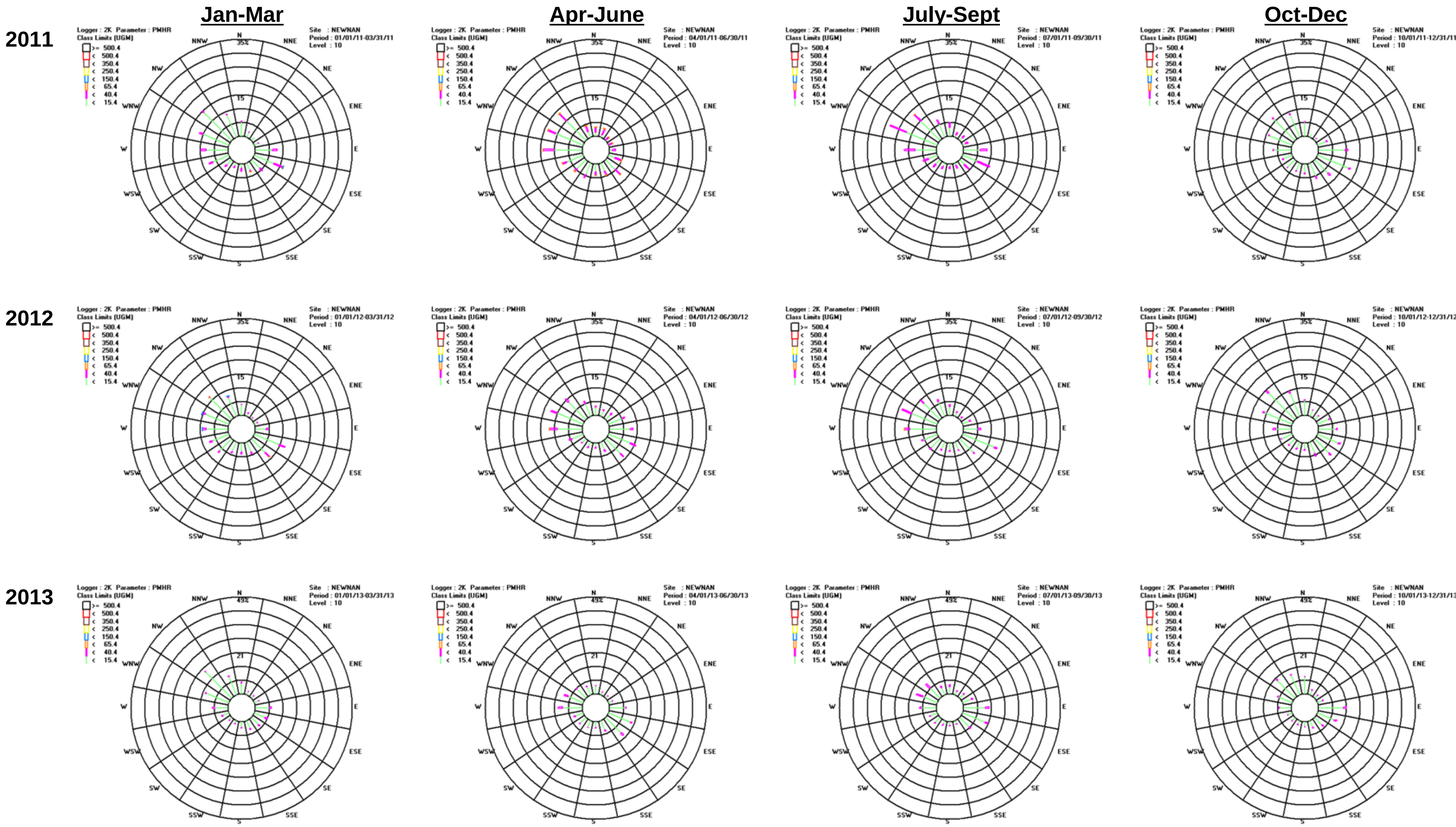


Figure C.45: Newnan $PM_{2.5}$ and Wind Direction and Speed Joint Frequency Distribution for Each Quarter, 2011-2013

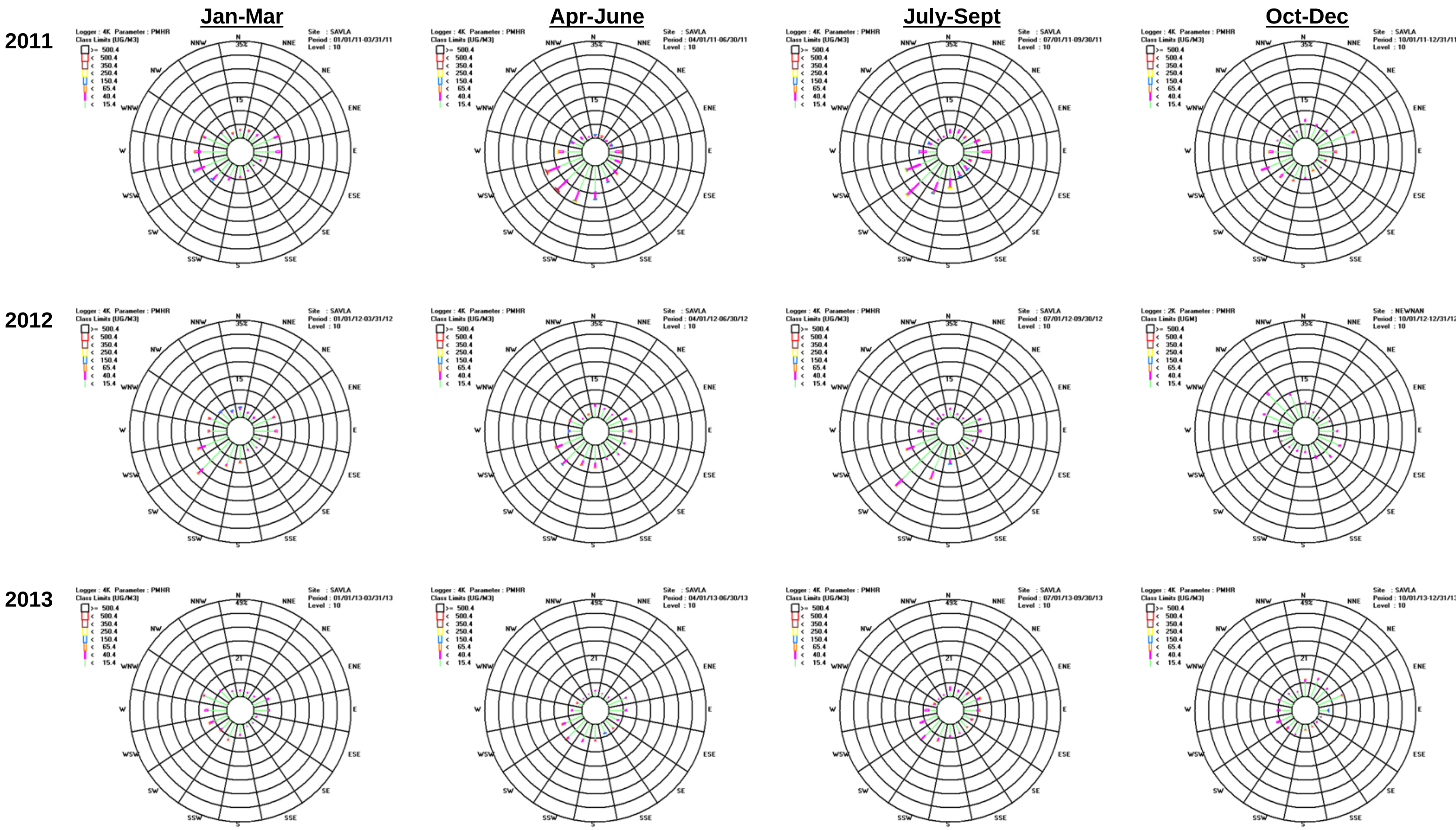


Figure C.46: Savannah L&A $PM_{2.5}$ and Wind Direction and Speed Joint Frequency Distribution for Each Quarter, 2011-2013

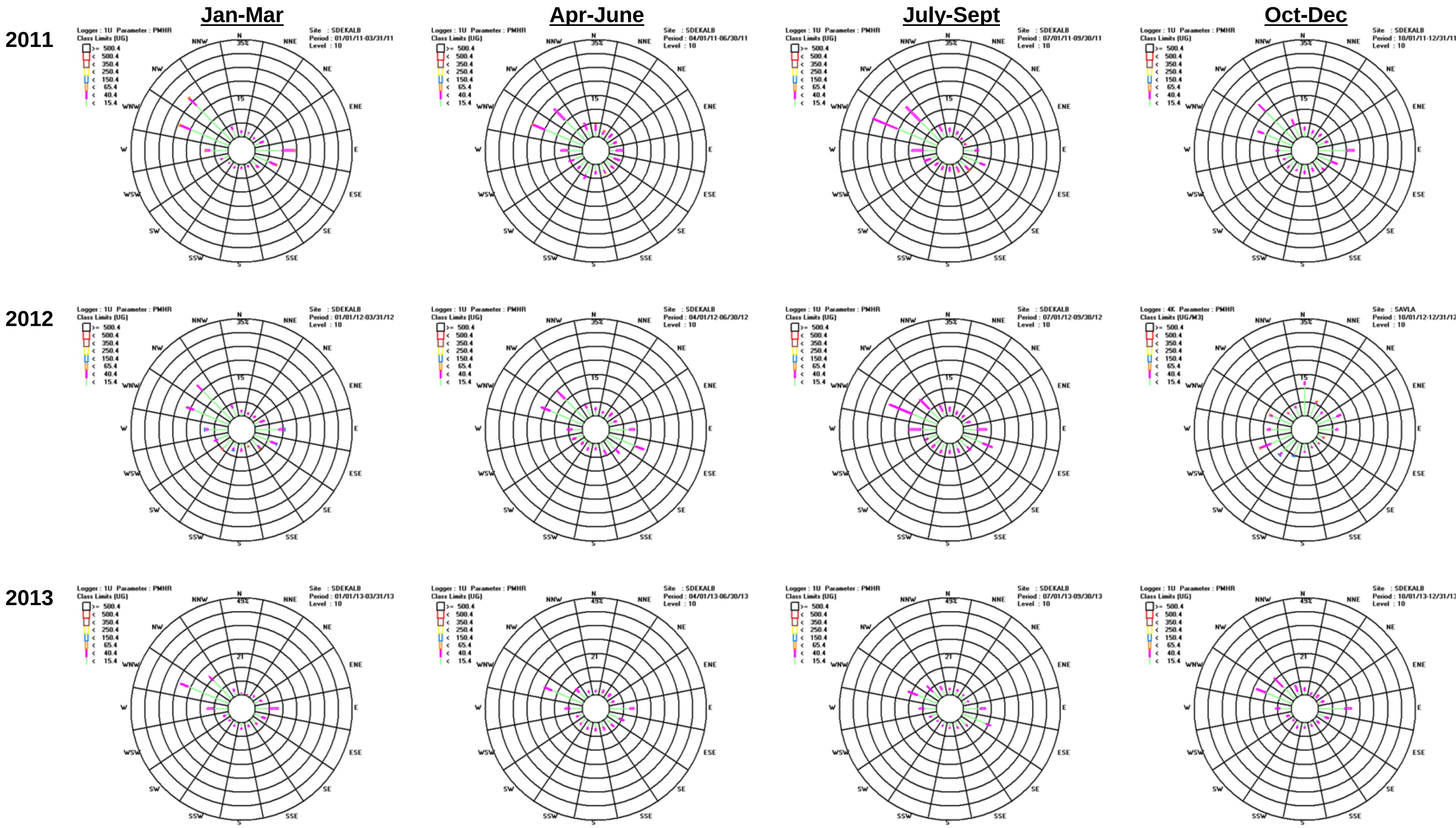


Figure C.47: South DeKalb $PM_{2.5}$ and Wind Direction and Speed Joint Frequency Distribution for Each Quarter, 2011-2013

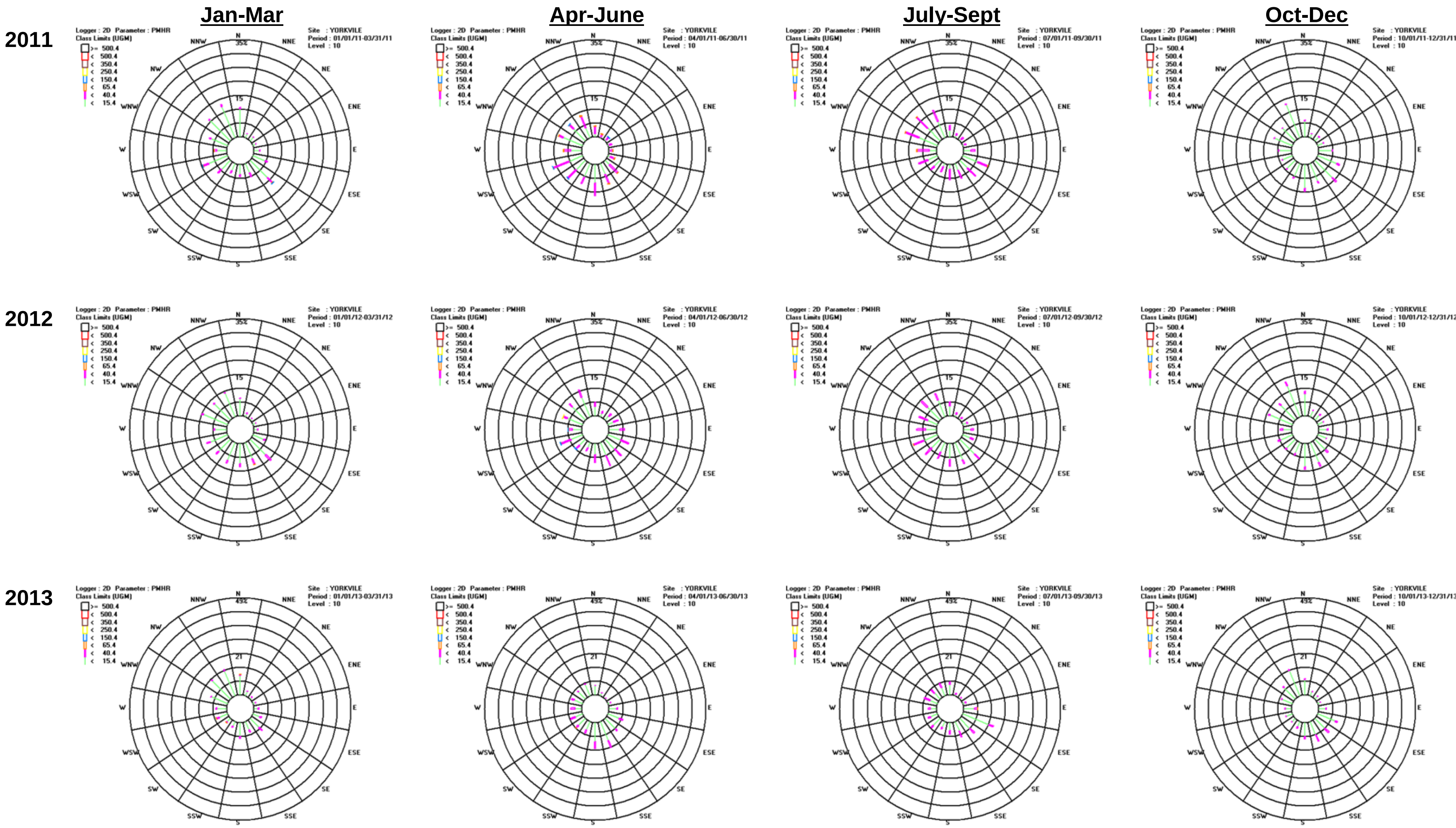


Figure C.48: Yorkville $PM_{2.5}$ and Wind Direction and Speed Joint Frequency Distribution for Each Quarter, 2011-2013

Appendix D:
List of Closed Ambient Monitors
(in order of shut down date)

Georgia Department of Natural Resources
Environmental Protection Division

Site ID	Site Name	Sampler	Date Shut Down	Last Published in Annual Plan
131210039	Fire Station#8	PM_{10}	9/26/06	N/A
130893001	Tucker	Ozone	10/31/06	N/A
130090001	Milledgeville-Airport	SO_2	12/31/06	2009
130893001	Tucker	PAMS VOCs, NO/NOx/NOy/NO_2	1/7/07	N/A
131110091	McCaysville	SO_2	10/2/07	2007
131210001	Fulton Co Health Dept	PM_{10}	9/1/08	2008
130970003	Douglasville-Beulah Pump Station	PM_{10}	9/1/08	2008
132550002	Griffin-Spalding County	PM_{10}	9/1/08	2008
132151003	Columbus-Crime Lab	Ozone	10/31/08	2008
130090001	Milledgeville-Airport	Air Toxics	10/31/08	2011
131150004	Rome-Co. Health Dept	Air Toxics	10/31/08	2011
131210020	Utoy Creek	Air Toxics	10/31/08	2011
131273001	Brunswick-Brunswick Coll	Air Toxics/Carbonyls	10/31/08	2011
131390003	Gainesville-Fair St Elem	Air Toxics	10/31/08	2011
131530001	Warner Robins-AFB	Air Toxics	10/31/08	2011
131850003	Valdosta-Mason Elem	Air Toxics	10/31/08	2011
132155000	Columbus-Columbus State	Air Toxics	10/31/08	2011
132450092	Augusta-Clara Jenkins	Air Toxics	10/31/08	2011
130550001	Summerville-Fish Hatchery	Acid Rain	10/31/08	2011
130850001	Dawsonville-GA Forestry	Acid Rain	10/31/08	2011
131890001	McDuffie-Fish Hatchery	Acid Rain	10/31/08	2011
132410002	Hiawassee-Lake Burton	Acid Rain	10/31/08	2011
132970001	Social Circle-Fish Hatchery	Continuous $PM_{2.5}$	10/31/08	2011
131130001	Fayetteville-GA DOT	Ozone, Wind Speed, Wind Direction	10/31/08	2013
131270006	Brunswick-Risley Middle	Total Reduced Sulfur	10/31/08	2013
131210048	Georgia Tech	$PM_{2.5}$	12/1/08	2008
131150005	Rome-Coosa High School	$PM_{2.5}$, PM_{10}, $PM_{2.5}$ speciation	Consolidated with 131150003 3/09	2008
131210048	Georgia Tech	SO_2, NO, NO_2, NOx	4/30/09	2011
130150003	Cartersville	Wind Speed, Wind Dir	12/31/11	2011
130730001	Evans –Riverside Park	NO_y	7/28/2008	2012
130210013	Macon-Lake Tobesofkee	NO_y, O_3	10/31/2008	2012
131270006	Brunswick-Risley Middle	SO_2	12/31/12	2012
132150008	Columbus -Airport	SO_2	12/31/12	2012
130510017	Savannah-Market St.	$PM_{2.5}$	12/31/12	2012
132450005	Augusta-Medical College	$PM_{2.5}$	12/31/12	2012
131210032	Atlanta-E. Rivers School	$PM_{2.5}$, PM_{10}	12/31/12	2012
130892001	Doraville Health Center	$PM_{2.5}$	12/31/12	2012
130670004	Powder Springs-Macland	$PM_{2.5}$	12/31/12	2012

	Aquatic Ctr.			
130210007	Macon-Allied Chemical	PM_{10}	12/31/12	2012
130510014	Savannah-Shuman Middle	PM_{10}	12/31/12	2012
130550001	Summerville-Fish Hatchery	PM_{10}	12/31/12	2012
130892001	Doraville Health Center	PM_{10}	12/31/12	2012
130950007	Albany-Turner Elementary	PM_{10}	12/31/12	2012
131150003	Rome-Coosa Elementary	PM_{10}	12/31/12	2012
131210048	Atlanta-Georgia Tech	PM_{10}	12/31/12	2012
131270004	Brunswick-Arco Pump Station	PM_{10}	12/31/12	2012
132150011	Columbus-Cusseta Road	PM_{10}	12/31/12	2012
133030001	Sandersville-Health Dept	PM_{10}	12/31/12	2012
130893001	Tucker-Idlewood Road	Wind Speed, Wind Direction, Temp, RH, Solar Radiation, UV Radiation, BP, Precip	5/31/13	2013
130890002	Decatur-South DeKalb	Hexavalent chromium	7/15/13	2013
132470001	Conyers-Monastery	Continuous Gas Chromatograph	8/31/13	2013
130150003	Cartersville	Lead	2/22/14	2013
131210099	Roswell Road	CO	3/5/14	2013
130590002	Athens	$PM_{2.5}$ Speciation	1/24/15	2014