GEORGIA
DEPARTMENT OF NATURAL RESOURCES

ENVIRONMENTAL PROTECTION DIVISION

2020 Five-Year Network Assessment
Air Protection Branch
Ambient Monitoring Program

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Executive Summary

The Ambient Monitoring Program of the Air Protection Branch of the Environmental Protection Division (GA AAMP) 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 AAMP'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 *2020 Ambient Air Monitoring Plan* to fulfill these requirements.

All monitoring networks operated by the GA AAMP 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; and the PAMS network.

Each pollutant that GA AAMP monitors is discussed with summary of the 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.

GA AAMP meets or exceeds current ambient air monitoring requirements. There are adequate ambient air monitoring stations in populated areas, including where sensitive subgroups reside. Monitoring needs continue to evolve. This may require the consolidation of sites for one of more pollutants if GA AAMP determines additional monitoring is required for another pollutant.

Georgia AAMP's Ambient Air Monitoring Networks

GA AAMP's budget is made up of a combination of three sources: state funds, federal funds, and fee funds. In recent years, GA AAMP has had budget constraints, and since the last Five-Year Assessment there has been some fluctuation in the number of ambient air monitoring samplers across the state. There was total reduction of approximately 7.6% 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. Four state funded Georgia Air Toxics sites were discontinued. Although these Air Toxics samplers did not collect criteria pollutant data, the data collected at these sites was included in the annual risk assessment for the state. In addition, one meteorological site, two lead monitors, one PAMS site, two ozone monitors, and four $PM_{2.5}$ 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.

The objectives of Georgia AAMP's 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 AAMP's website. On this website (https://airgeorgia.org/), hourly air quality measurements from all continuous monitoring samplers are electronically transmitted and posted, including ozone and $PM_{2.5}$ data. In addition, summary data from the non-continuous samplers is also posted on the GA AAMP website.

- Support compliance with ambient air quality standards and emissions strategy development. Data from GA AAMP'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 AAMP'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 according to EPA guidance. Eight of these produced quantifiable results which were used to determine the relative importance of each monitor within the GA AAMP 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. The highest-ranking sites are the Gwinnett Tech, Kennesaw, Dawsonville, and South DeKalb sites and are considered the most important sites in the monitoring network according to the assessments performed. The five lowest ranking sites are the Rome, Columbus-Crime Lab, NR-285, Columbus-Allied, and Kraftsman sites, according to these assessments. Several factors, such as available personnel and budgetary concerns, would play a large part in adding or shifting monitors around the state of Georgia. The GA AAMP will make every effort to place monitors where needed, especially as mandated by the federal regulations.

Acronyms and Glossary

AADT	Annual Average Daily Traffic
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
ARM	Approved Regional Method
BAM	Beta Attenuation Monitor
CAA	Clean Air Act
CBSA	Core Based Statistical Area
CFR	Code of Federal Regulations
CO	Carbon Monoxide
CSA	Combined Statistical Area
CV	Coefficient of Variation
DNPH	Dinitrophenylhydrazine
EPA	United States Environmental Protection Agency
FEM	Federal Equivalent Method
FRM	Federal Reference Method- the official measurement technique for a given pollutant
GA AAMP	Georgia Ambient Air Monitoring Program
GA EPD	Georgia Environmental Protection Division
GEO MEAN	Geometric Mean
HAP	Hazardous Air Pollutant
HPLC	High Performance Liquid Chromatography
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
NATTS	National Air Toxics Trends Station
NCore	National Core Multipollutant Monitoring Network
NDV	Normalized Design Value
NMHC	Non-Methane Hydrocarbons
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
NO_y	Reactive oxides of Nitrogen
NWS	National Weather Service
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

ppb	Parts per Billion
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 Stations
SO_2	Sulfur Dioxide
SPMS	Special Purpose Monitoring Stations
STN	Speciation Trends Network
TBD	To Be Determined
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
ZPS	Zero/Precision/Span

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, on the GA AAMP's website (https://airgeorgia.org/).

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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 Ambient Air Monitoring Program's (GA AAMP) assessment to meet EPA's regulations for monitoring air quality in the state of Georgia. The purposes of the Five-Year Network Assessment include:

- ensuring that Georgia's Ambient Air Monitoring Program meets the monitoring objectives defined Appendix D of 40CFR58
- evaluation of the network's existing sites efficiency in meeting objectives and relative costs
- determining if new sites are needed or if existing sites are no longer needed and can be terminated
- determine whether discontinuing ambient air monitors would adversely impact data users and health studies
- determine if new technologies are appropriate for the network
- 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)
- determine whether changes need to be made to the $PM_{2.5}$ population-oriented network
- develop recommendations for network improvements.

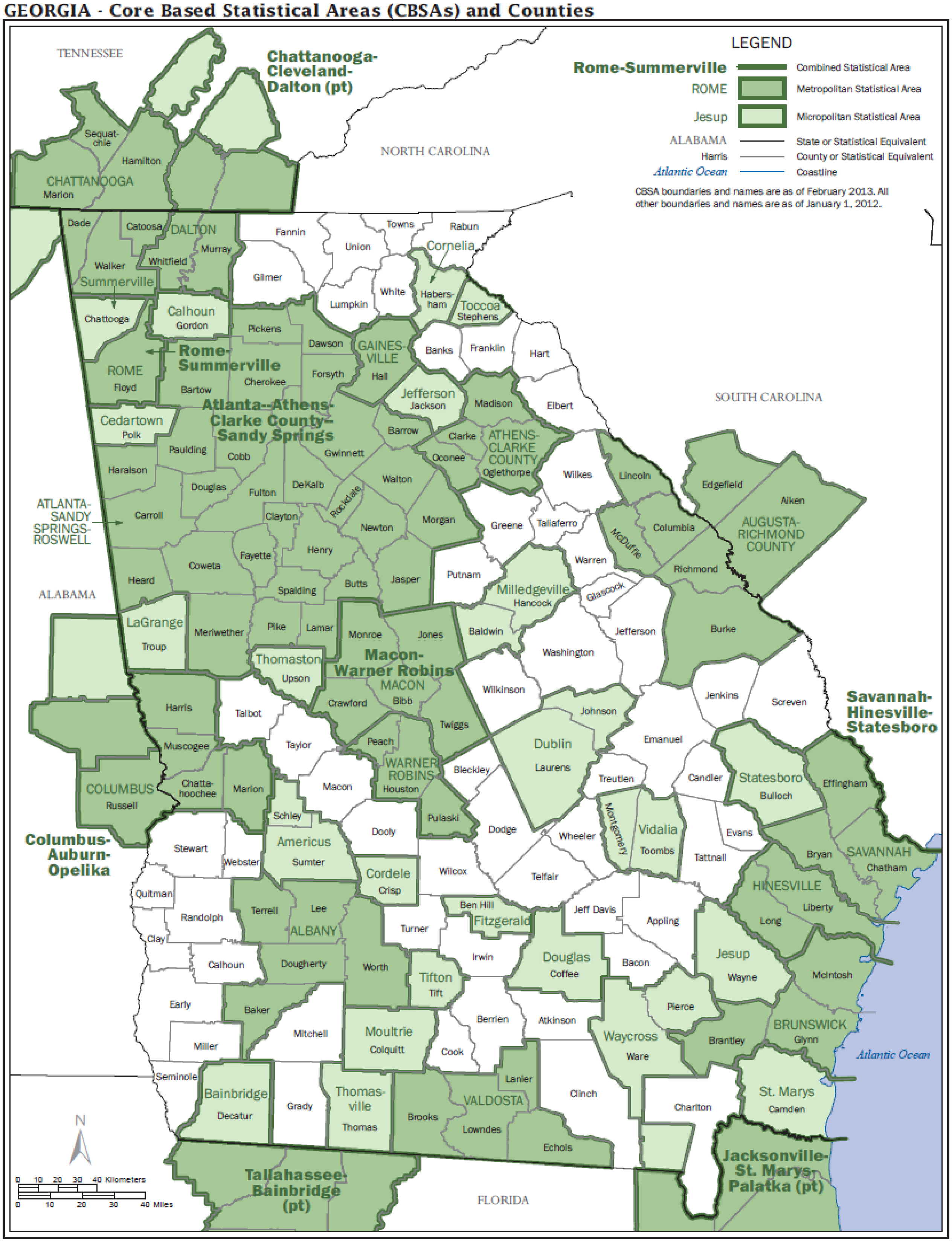
This document will provide a comprehensive look at Georgia's ambient air monitoring network. Multiple assessments were performed on Georgia's network including: Trends Impacts; Measured Concentrations; Deviation from the NAAQS; Number of Parameters Monitored; Monitor-to-Monitor Correlations; Air Quality 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 Georgia. In the early 1970's, the GA AAMP took over the responsibility of ambient air monitoring to better identify and control air pollutants in Georgia. The GA AAMP currently relies on a sampling network of 38 stations to:

- determine whether air quality standards are being met
- track air quality improvements
- measure the impact of industrial expansion
- provide air pollution information to the public
- assist in enforcement actions

Within this document, the GA AAMP has included the metropolitan statistical area (MSA) represented by each site, which was derived from the following map (Figure 1). The U.S. Census Bureau defines an MSA as a geographic entity containing a core urban area of 50,000 or more population and consists of one or more counties containing the core urban area, as well as adjacent counties that have a high degree of social and economic integration with the urban core (http://www.census.gov/population/metro/).

GEORGIA - Core Based Statistical Areas (CBSAs) and Counties



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

Figure 1: Map of Statistical Areas in Georgia

Section 2.0 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 3.0 describes the monitoring objectives and spatial scales. Section 4.0 gives a description of the networks. Section 5.0 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 describes the pollutants, analysis methods, and quality assurance schedules. 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. The Appendix E displays 2016-2018 wind roses and pollution roses from across the state (historical climatological wind roses are also available upon request). The Appendix F includes the full memorandum of agreements (MOAs) documentation, where applicable in the state.

1.1 Mandate

This document is produced in response to duties mandated to ambient air monitoring agencies in 40CFR58.10:

> ***40 CFR PART 58.10: Annual monitoring network plan and periodic network assessment.***
>
> *(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. 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 assessments are due every five years beginning July 1, 2010.*

1.2 Procedures for Making Changes to the Monitoring Network

In some circumstances, monitors must be shut down or moved. While the Ambient Monitoring Program of GA AAMP makes every effort to maintain continued operation of all required monitors, it operates as a guest or leaseholder at all monitoring sites. The GA AAMP does not hold ownership rights to the land at any of its ambient air monitoring sites. If the GA AAMP loses its lease or is otherwise forced to leave a given site, the monitors at that site may be moved to a nearby location or discontinued [40CFR58.14(c)(6)].

1.3 Memorandum of Agreement

The GA AAMP has memorandum of agreements with the Chattanooga-Hamilton County Air Pollution Control Bureau and the South Carolina Department of Health and Environmental Control for air monitoring activities in MSAs that cross state lines.

As stated in the Memorandum of Agreement dated December 28, 2017, "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 40CFR58 Appendix D, Section 2, (e) (March 28, 2016)." For full MOA documentation, see Appendix F of this document.

The Memorandum of Agreement dated January 2017 states, "The purpose of the Memorandum of Agreement (MOA) is to renew 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 EPD (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 40CFR58 Appendix D, Section 2, (e)." For full MOA documentation, see Appendix F of this document.

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

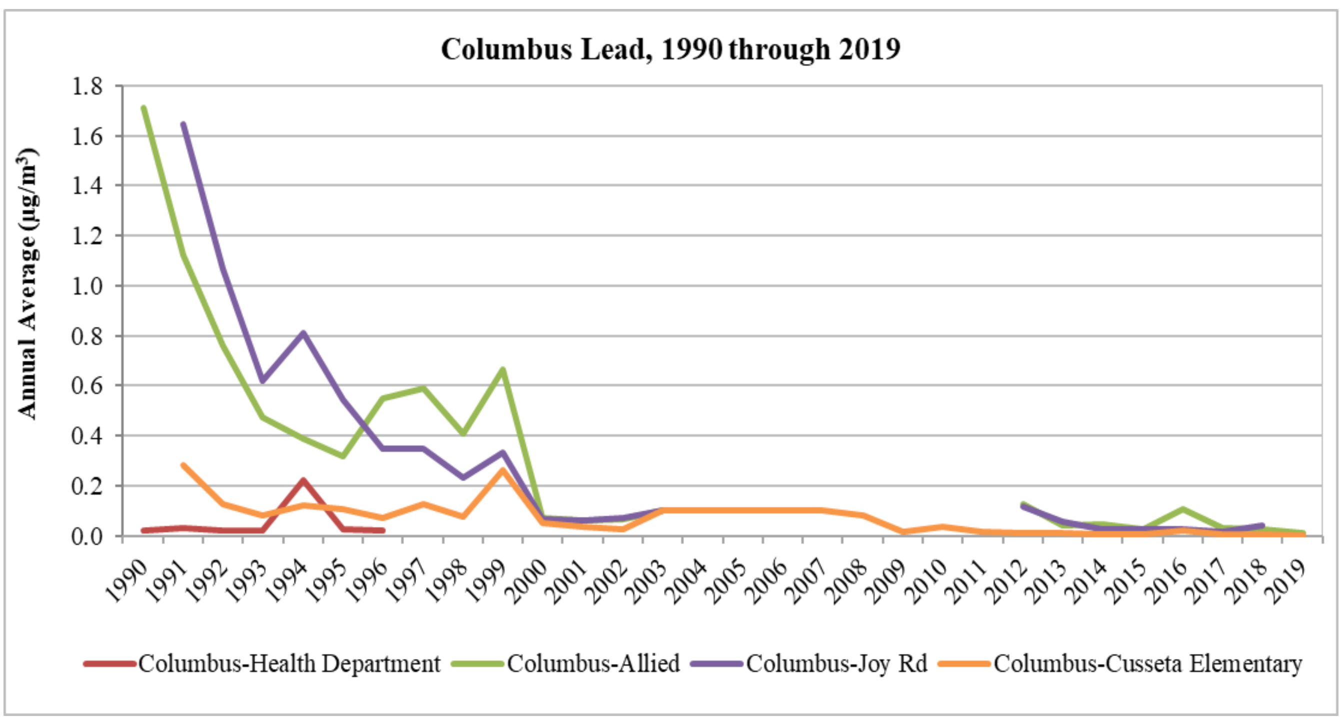
1.4 Request for Waiver/Discontinuance

Renewal of Solar and TUVR Radiation at Conyers Site:
The GA AAMP is requesting a waiver to continue monitoring the solar radiation and total ultraviolet radiation at the Conyers site (13-247-0001) for the South DeKalb (13-089-0002) PAMS site. The South DeKalb monitoring site does not fit the necessary guidelines for measurement of solar radiation, due to the topography of the site location. Solar radiation measurements from the total global solar radiation sensor must be made from a location that is

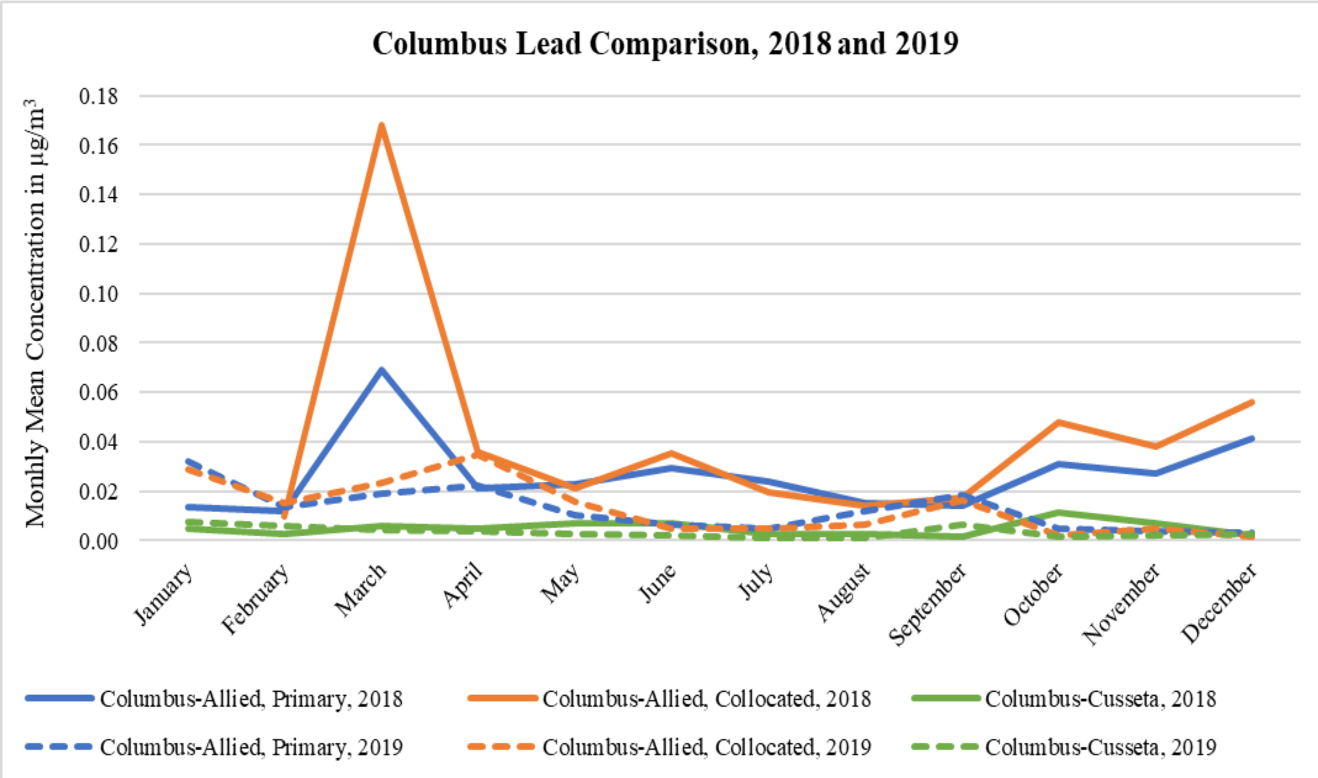
free from any obstruction which may cause a shadowing effect. In addition, the pyranometer must be located away from highly reflective surfaces, which may cause enhanced optical scattering and overestimate the incoming total solar radiation. The required total ultraviolet radiation and solar radiation measurements are collected at the Conyers monitoring site, which meets necessary criteria.

Renewal of Lead Monitoring Waiver:
As part of GA AAMP's *2013 Ambient Air Monitoring Plan*, GA AAMP 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. As part of the requirements of 40CFR58, Appendix D, Section 4.5, GA AAMP has included this request every year since the approval, and requests to renew the waiver for this site. Based on the 2017 Toxic Release Inventory, the amount of lead emitted is now 0.4 tons per year.

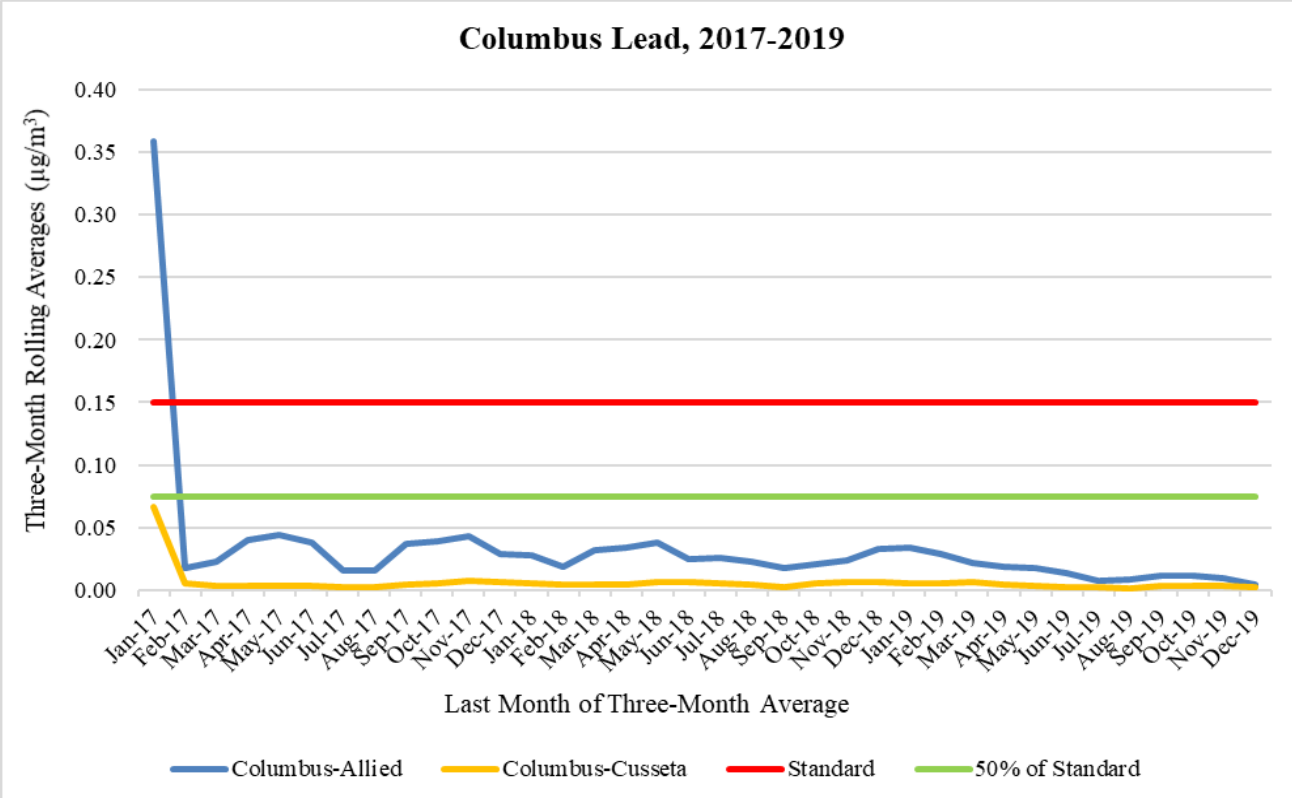
Request to Discontinue Columbus, GA-AL MSA Lead Monitors:
The GA AAMP has monitored lead in the Columbus, GA-AL MSA since 1990, and in 2012, had reopened two of the lead monitors that had been shut down since 2004. The monitors were set up as source-oriented monitors for the sources in the area that had lead emissions greater than 0.5 tons per year. According to the Toxic Release Inventory, the source released only 211.01 pounds in 2018. As of March 2019, the source that had been emitting lead ceased the lead operations, and since that time, the lead monitors in the Columbus, GA-AL MSA have been collecting very low concentrations of lead in the ambient air. The following graph shows the decrease in lead concentrations from 1990 through 2019.



As of 2018, GA AAMP has operated two lead monitors in the Columbus, GA-AL MSA. The next graph is a comparison of the 2018 and 2019 monthly averages, showing the difference between when the emission source was in operation (solid lines) to when it was shut down (dotted lines).



EPA has stated that the Regional Administrator may waive the requirement to monitor near lead sources if the monitoring agency can demonstrate that the source will not contribute more than 50% of the standard (40CFR58, Appendix D, 4.5ii). The following graph shows this comparison. The red line represents the lead standard of 0.15 µg/m^3 and the green line represents 50% of the standard at 0.075 µg/m^3. Both the Columbus lead monitors collect data well below this 50% threshold.



With the source no longer producing lead, and the lead data well below 50% of the standard, the GA AAMP is requesting to discontinue monitoring for lead in the Columbus, GA-AL MSA as of December 31, 2020. The GA AAMP will keep the lead monitors in place in case there is an increase in emissions from the source, and the need arises to monitor lead in the Columbus, GA-AL MSA in the future.

Request to Discontinue Rome MSA SO_2 Monitor:
The GA AAMP is requesting to discontinue monitoring for SO_2 in the Rome MSA. The Rome-Kraftsman site, which is located in Floyd County, began monitoring SO_2 in January 2017 as part of the EPA Data Requirements Rule (DRR). The EPA states in 40CFR, Section 51.1203, paragraph (c)(3) of the Federal Register that if the SO_2 monitor "is not located in an area designated as nonattainment as the 2010 SO_2 NAAQS is not also being used to satisfy other ambient SO_2 minimum monitoring requirements listed in 40 CFR part 58, appendix D, section 4.4; and is not otherwise required as part of a SIP, permit, attainment plan or maintenance plan, may be eligible for shut down upon EPA approval if it produces a design value no greater than 50 percent of the 2010 SO_2 NAAQS from data collected in either its first or second 3-year period of operation." The SO_2 NAAQS is 75 ppb, and the 2017-2019 design value for the Rome SO_2 monitor is 20 ppb, which is much lower than the 37.5 ppb value (50% of the NAAQS). The monitor is not in an area designated as nonattainment of the SO_2 NAAQS and is not used for GA EPD's State Implementation Plan. In addition, the population weighted emissions index (PWEI) is well below the threshold that requires a monitor in the area. The PWEI for Floyd County is 135.84, using the 2018 National Emissions Inventory and the 2018 estimated population provided by the U.S. Census Bureau, and the threshold is 5,000. Therefore, the GA AAMP is requesting to cease monitoring SO_2 in the Rome MSA as of December 31, 2020.

1.5 Air Quality Index (AQI)

The Air Quality Index (AQI) is a method of reporting daily air quality that converts concentration levels of pollution to a simple color-coded number scale of 0-500. Colored categories on the AQI scale are related to potential health effects from exposure to measured concentrations of a major pollutant. Certain monitoring stations in the GA AAMP's SLAMS network provide data used in daily AQI reporting.

Figure 2 shows how the monitored concentrations correspond to the AQI values, descriptors and health advisories. AQI 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, GA-SC MSA; the Savannah MSA; and the Chattanooga TN-GA MSA. The GA AAMP provides daily AQI reporting to the general public in Georgia through the Ambient Monitoring Program website (https://airgeorgia.org/). The Chattanooga, Tennessee-Georgia MSA AQI reporting is covered by the GA AAMP and the Chattanooga-Hamilton County Air Pollution Control Bureau per the MOA, as discussed above. The Augusta-Richmond County, GA-SC MSA AQI is covered by the GA AAMP and the South Carolina Department of Health and Environmental Control per the MOA.

Maximum Pollutant Concentration									
$PM_{2.5}$	PM_{10}	SO_2	O_3	O_3	CO	NO_2			
(24hr) µg/m^3	(24hr) µg/m^3	(1hr)* ppb	(8hr)^ ppm	(1hr) ppm	(8hr) ppm	(1hr) ppb	**AQI Value**	**Descriptor**	**EPA Health Advisory**
0.0–12.0	0– 54	0– 35	0.000–0.054	None	0.0–4.4	0– 53	0 to 50	**Good (green)**	Air quality is considered satisfactory, and air pollution poses little or no risk.
12.1–35.4	55–154	36–75	0.055–0.070	None	4.5–9.4	54-100	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.
35.5–55.4	155 – 254	76 – 185	0.071 – 0.085	0.125 – 0.164	9.5–12.4	101-360	101 to 150	**Unhealthy for Sensitive Groups**	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	186–304*	0.086–0.105	0.165–0.204	12.5–15.4	361-649	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	305–604*	0.106–0.200	0.205–0.404	15.5–30.4	650-1249	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.
250.5–350.4	425–504	605–804*	0.201-(^)	0.405 – 0.504	30.5–40.4	1250-1649	301 to 400	**Hazardous (maroon)**	AQI values over 300 trigger health warnings of emergency conditions. The entire population is more likely to be affected.
350.5–500.4	505–604	805–1004*	None^	0.505–0.604	40.5–50.4	1650-2049	401 to 500		

*Values of 200 or greater are calculated with 24-hr SO_2 concentrations; ^Values of 301 or greater are calculated with 1-hr O_3 concentrations

Figure 2: Detailed AQI Values by Pollutant

1.6 QAPP and QMP

As part of the requirements for EPA (40CFR58 Appendix A), the GA AAMP 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.

QAPP Title	Submittal	Approval
Quality Assurance Project Plan of the Georgia Ambient Air Quality Monitoring Project for $PM_{2.5}$	3/19/2019	5/7/2019
Quality Assurance Project Plan of the Georgia Ambient Air Quality Monitoring Project for the Criteria Air Pollutants (Including Data Requirement Rule) and National Core Multi-Pollutant Station	5/24/2019	7/15/2019
Quality Assurance Project Plan of the Georgia Ambient Air Quality Monitoring Project for the Photochemical Assessment Monitoring Stations State of Georgia	4/29/2020	
Quality Assurance Project Plan of the Georgia Ambient Air Quality Monitoring Project for the Near Road Monitoring Network	5/24/2019	7/19/2019
Quality Assurance Project Plan for the Georgia National Air Toxics Trends Project	5/24/2019	6/5/2019
Quality Assurance Project Plan for the Georgia Ambient Monitoring Program Ethylene Oxide	9/24/2019	4/20/2020
Quality Management Plan for the Air Protection Branch	3/2/2020	

Table 1: List of Georgia AAMP's QAPPs

1.7 Public Notice and Comment Procedures

Future changes to the monitoring network listed in the Annual Ambient Air Monitoring Plan are subject to a required public notice and comment process each year 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 proposed changes and documentation are required to submit their comments, in writing, to the GA AAMP at the following address:

Air Protection Branch
Attn: Annual Ambient Air Monitoring Plan Comments
4244 International Parkway, Suite 120
Atlanta, Georgia 30354

In addition, public comments can be submitted in writing to DeAnna Oser, Program Manager of the Ambient Monitoring Program, at DeAnna.Oser@dnr.ga.gov.

The deadline for submitting comments to the GA AAMP is no later than 30 days after the date on which the document is published on https://airgeorgia.org/. Should the comment period end on a weekend or holiday, comments will be accepted up until the next working day. The GA AAMP, in soliciting comments for the final draft before submittal to EPA as required by 40CFR58.10(a)(1), will address, as appropriate, any comments received before the deadline.

The GA AAMP's responses to comments and any other relevant information will be included in the final document published on https://airgeorgia.org/.

1.8 Use of Data

GA AAMP 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 1.5 and in Section 13.0), the GA AAMP website (https://airgeorgia.org/) 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 AAMP routinely has requests of the ambient air monitoring data from other states, various universities, research institutes, public health and federal agencies such as the 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 AAMP 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 AAMP 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 AAMP's ambient monitoring network, as well as GA AAMP'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.

1.9 New Technologies

At a few sites across the state, GA AAMP is planning to add new monitoring equipment in which new technologies will be put to use. The GA AAMP has started using the TISCH Environmental TE-WILBUR FRM PM Sampler as a PM_{10} monitor at the Fire Station #8 site. The Teledyne T640 Advanced Pollution Instrumentation PM Mass Monitors are being used throughout Georgia, for both $PM_{2.5}$, PM_{10}, and PM_{coarse} sampling. The GA AAMP plans to use the Thermo 49iQPS Ozone Calibrators later this year. The GA AAMP also plans to use a direct NO_2 analyzer that uses Cavity Attenuated Phase Shift (CAPS) Spectroscopy to measure True NO_2, NO_X, and NO gases.

1.10 Georgia AAMP Budget

GA AAMP's budget is made up of a combination of three sources: state funds, federal funds, and fee funds. In recent years, GA AAMP has had budget constraints, and since the last Five-Year Assessment there has been some fluctuation in the number of ambient air monitoring samplers across the state. There was total reduction of approximately 7.6% 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. Four state funded Georgia Air Toxics sites were discontinued. Although these Air Toxics samplers did not collect criteria pollutant data, the data collected at these sites was included in the annual risk assessment for the state. In addition, one meteorological site, two lead monitors, one PAMS site, two ozone monitors, and four $PM_{2.5}$ 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.

1.11 Inventory of Ambient Monitoring Equipment

As part of the requirements for the *Ambient Air Monitoring Plan*, the GA AAMP has included a list and evaluation of the current ambient monitoring equipment. See attached Appendix B of this document 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	Black Carbon	Metals
Rome MSA																						
131150003	Rome	Floyd				S	X															
131150006	Kraftsman*	Floyd										S								NR		
Brunswick MSA																						
131270006	Brunswick	Glynn	S		S															NR		
Valdosta MSA																						
131850003	Valdosta	Lowndes			S	S																
Warner Robins MSA																						
131530001	Warner Robins	Houston			S	S																
Dalton MSA																						
132130003	Fort Mountain	Murray	S																	NR		
Albany MSA																						
130950007	Albany	Dougherty			S	S																
Gainesville MSA																						
131390003	Gainesville	Hall				S																
Athens-Clarke County MSA																						
130590002	Athens	Clarke	S			S																
Macon MSA																						
130210007	Macon-Allied	Bibb			S		X															
130210012	Macon-Forestry	Bibb	S		S	S						S								NR		
Columbus Georgia- Alabama MSA																						
132150001	Columbus-Health Dept.	Muscogee			S																	
132150008	Columbus-Airport	Muscogee	S		S	S																
132150009	Columbus-Allied	Muscogee											S*									
132150011	Columbus-Cusseta	Muscogee			S		X						S*									
132151003	Columbus-Crime Lab	Muscogee																		NR		
Savannah MSA																						
130510021	Savannah-E. President	Chatham	S									S								NR		
130511002	Savannah- L&A	Chatham				S						S								NR		
Augusta-Richmond County, Georgia-South Carolina MSA																						
130730001	Evans	Columbia	S																	NR		
132450091	Augusta	Richmond	S			S	X					S			S					NR		

Table 2: 2020 Georgia Ambient Air Monitoring Network

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	Black Carbon	Metals
Atlanta-Sandy Springs-Marietta MSA																						
130630091	Forest Park	Clayton			S																	
130670003	Kennesaw	Cobb	S		S																	
130850001	Dawsonville	Dawson	S																	NR		
130890002	South DeKalb	DeKalb	S/P/C	S/P/C	S/C	S/C	T/C	S	S/P	S/P	S/P/C	C			C	P	N	N	P/N	P/C		N
130890003	NR-285	DeKalb							R	R							R				R	
130970004	Douglasville	Douglas	S																	NR		
131210039	Fire Station #8	Fulton			S									S								
131210055	United Ave.	Fulton	S			S						S								NR		
131210056	NR-GA Tech	Fulton		R	R	R				R										R	R	
131350002	Gwinnett Tech	Gwinnett	S			S																
131510002	McDonough	Henry	S			S																
132319991	EPA CASTNET	Pike	A																			
132470001	Conyers	Rockdale	S																	NR/P		
Chattanooga Tennessee-Georgia MSA																						
132950002	Rossville	Walker			S	S	X															
Not in an MSA																						
130550001	Summerville	Chattooga	S																			
130690002	General Coffee	Coffee			S		X															
132611001	Leslie	Sumter	S																			
133030001	Sandersville	Washington				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; A=CASTNET
**requesting to shut down*

Table 2: 2020 Georgia Ambient Air Monitoring Network (continued)

2.0 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 EPA 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[1]. 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. An exceedance does not always imply that a violation of the standard took place. For each pollutant, there are specific rules for a given time period before a pattern of exceedances is considered a violation of the NAAQS. If a violation occurs, it may result in regulatory actions to further clean up the air in the area where the violation occurred. 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.

3.0 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.

[1] For a list of the most current standards, please refer to EPA's website https://www.epa.gov/criteria-air-pollutants/naaqs-table.

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 40CFR58, Table D-1, and summarized in Table 3 below.

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

Table 3: Monitoring Objective and Spatial Scale

4.0 Description of Networks

4.1 NCore

The State of Georgia is required to have one National Core (NCore) Multipollutant Monitoring station, and the GA AAMP complies with this requirement at the South DeKalb site (13-089-0002) in DeKalb County. The NCore site monitoring equipment includes: $PM_{2.5}$ FRM, $PM_{2.5}$ continuous, $PM_{2.5}$ speciation, ozone (collecting data year-round), trace level carbon monoxide (CO), trace level sulfur dioxide (SO_2), trace level nitrogen oxide (NO), total reactive nitrogen (NOy), wind direction, wind speed, temperature, and relative humidity. The site has operated since January 1, 2011, and site establishment and details were included in the GA AAMP's *2011 Ambient Air Monitoring Plan, Appendix C, Ambient Air Monitoring Plan for National Core (NCore) Multipollutant Monitoring Station*. NCore monitoring network sites have 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

4.2 Sulfur Dioxide

EPA lowered the sulfur dioxide (SO_2) NAAQS standard to a 1-hour primary standard of 75 ppb, and added new SO_2 ambient monitoring requirements in 2010 (75FR119, 06/22/10) and retained in 2019 (84FR9866, 3/18/19). The rule combines air quality modeling and monitoring. The rule requires 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 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 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. Based on these requirements, the GA AAMP is required to have one monitor in the Atlanta-Sandy Springs-Marietta MSA. Currently, GA AAMP monitors SO_2 at the United Avenue (13-121-0055) and South DeKalb (13-089-0002) sites in the Atlanta-Sandy Springs-Marietta MSA, the Augusta (13-245-0091) site in the Augusta-Richmond County, GA-SC MSA, the Savannah-L&A (13-051-1002) and Savannah-E. President Street (13-051-0021) sites in the Savannah MSA, the Macon-Forestry (13-021-0012) site in the Macon MSA, and the Kraftsman (13-115-0006) site in the Rome MSA.

In accordance with the EPA Data Requirements Rule for sulfur dioxide (Federal Register: Vol. 80, No. 162, 08/21/15), the GA AAMP modeled SO_2 concentrations in 2016 in order to select the most appropriate location for the Rome SO_2 monitor that would capture the maximum SO_2 emissions from the nearby facilities. As of January 1, 2017, the Rome SO_2 monitor was moved from the Coosa location (13-115-0003) to the Kraftsman Road location (13-115-0006) to meet this requirement. For site details, see Appendix A. For more information regarding location selection and modeling, see the GA AAMP's *2016 Ambient Air Monitoring Plan, Appendix D-International Paper-Rome Modeling Report* at https://airgeorgia.org/networkplans.html. Since that time, the GA AAMP has shown that this monitor is not needed for this requirement and is applying to discontinue monitoring for SO_2 at the Kraftsman site as of December 31, 2020. Refer to Section 1.4 for details about this request to discontinue this monitor.

As an NCore site, the South DeKalb site (13-089-0002) also began monitoring trace level sulfur dioxide as of October 1, 2010. The GA AAMP collects and reports 5-minute maximum data with all the SO_2 monitors in the state.

4.3 Nitrogen Dioxide

EPA's last revision of the nitrogen dioxide (NO_2) National Ambient Air Quality Standard and monitoring requirements was January 22, 2010. Near-road NO_2 monitors were 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) (Federal Register, Vol. 75, No. 26, 02/09/10). The GA AAMP meets this requirement with two monitors in the Atlanta-Sandy Springs-Marietta MSA. The first near-road NO_2 monitor was set up at the near-road site on the Georgia Institute of Technology campus (NR-GA Tech, 13-121-0056) on June 15, 2014. NO_2/NO/NOx, CO, $PM_{2.5}$, black carbon, wind speed and wind direction are monitored at this site. 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* at https://airgeorgia.org/networkplans.html. The second near-road monitoring site was set up in the Atlanta-Sandy Springs-Marietta MSA on January 1, 2015 at the established monitoring site near interstate 285 (NR-285, 13-089-0003) (formerly DMRC). At the NR-285 site, NO_2/NO/NOx, volatile organic compounds, and black carbon are monitored for the near-road network. For details regarding the establishment of the second near-road site, refer to the GA AAMP's Addendum to the *2015 Ambient Air Monitoring Plan* at https://airgeorgia.org/networkplans.html.

In addition to the near-road NO_2 requirements, the GA AAMP is required to operate at least 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 (40CFR58, Appendix D, Section 4.3.3). The South DeKalb site (13-089-0002) is the GA AAMP's PAMS site (discussed below), and collects area-wide NO_2 data for the Atlanta-Sandy Springs-Marietta MSA. 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.

4.4 Carbon Monoxide

EPA's last revision to the monitoring requirements for the carbon monoxide (CO) monitoring network was in 2011. EPA requires 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 this monitoring requirement, the State of Georgia is required to have one CO monitor located in the Atlanta-Sandy Springs-Marietta MSA, collocated with an NO_2 near-road monitor. The GA AAMP meets this monitoring requirement with a CO monitor that began monitoring at the NR-GA Tech site (13-121-0056) on June 15, 2014. In addition, the South DeKalb site (13-089-0002) is the GA AAMP's NCore site and collects CO data as part of that network (discussed above).

4.5 Lead

EPA's last review on the requirements for measuring lead in the ambient air was in 2016. The emission threshold for placing lead monitors near industrial facilities remains at 0.5 tpy (Federal Register: Vol. 81, No. 201, Page 71932, 10/18/16). The GA AAMP has met this requirement with lead monitors located in the Columbus, GA-AL MSA in Muscogee County near a source of lead emissions. There is one lead monitor located at the Cusseta Elementary School (13-215-0011) site, and the Columbus-Allied (13-215-0009) site has two collocated lead monitors. However, with the latest EPA Toxic Release Inventory in 2018, the source was emitting only 211.01 pounds per year. The GA AAMP is requesting to discontinue monitoring for lead in this area, and to close the lead monitors in the Columbus, GA-AL MSA as of December 31, 2020. Refer to Section 1.4 for more detail about this request for discontinuing these monitors.

4.6 $PM_{2.5}$ Speciation Trends Network (STN)

The Speciation Trends Network (STN) (40CFR58, Appendix D, Section 4.7.4) characterizes the make-up of the $PM_{2.5}$ samples collected. With this speciation information, air quality modeling can be improved to help implement the NAAQS standards; health studies can be interpreted by knowing the constituents of the $PM_{2.5}$ sample, and the understanding of the constituents in regional haze is also improved. There are 52 Speciation Trends sites across the United States. The GA AAMP meets this requirement with the South DeKalb site (13-089-0002). The South DeKalb Speciation Trends site began monitoring on October 1, 2000, and samples are collected every three days. Additionally, there are six more $PM_{2.5}$ speciation monitors that the GA AAMP has chosen to operate. These sites are 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 General Coffee (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.

4.7 Photochemical Assessment Monitoring Stations (PAMS)

On October 26, 2015, EPA made revisions to the ozone standard, and with those changes, also revised the regulations for the supporting PAMS stations (Federal Register, Vol.80, No. 206, page 65467). EPA is requiring that PAMS measurements be collected at NCore sites only. The GA AAMP meets this requirement with the South DeKalb (13-089-0002) site, which is the GA AAMP's NCore site. Therefore, for the PAMS requirements, the GA AAMP will continue hourly collection of speciated volatile organic compounds in June, July, and August; three 8-hour samples of carbonyls collected every third day during June, July and August; hourly ozone, NO, direct NO_2, NOy, temperature, wind direction, wind speed, barometric pressure, relative humidity, precipitation, and sigma theta at the South DeKalb site. As discussed in Section 1.4, solar radiation and ultraviolet radiation are monitored at the Conyers (13-247-0001) site due to siting conditions.

The South DeKalb site is located in DeKalb County to provide neighborhood scale measurements in the area that the chemicals that form ozone have the greatest impact. The data measurements generated at the South DeKalb site are used principally for development and evaluation of imminent and future control strategies, corroboration of NOx and VOC emission inventories, 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, $PM_{2.5}$, PM_{10}, CO, SO_2, and NO_2. On January 8, 2020 (85 FR 834, page 834) EPA delayed the start of the revised PAMS monitoring network to June 1, 2021. GA AAMP will continue preparing to implement the program as funding and personnel resources allow with the goal of full implementation on or before June 1, 2021.

4.8 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 pollutants. The NATTS network was established to produce data that is consistent and of standardized quality to be able to perform comparisons of air toxics data nationwide. There are 24 NATTS locations nationwide, with both urban sites to address the range of population exposure in urban areas, and rural sites to characterize population exposure in non-urban areas, establish background concentrations, and better assess environmental impacts of emissions of air toxic pollutants. The GA AAMP meets the requirement with the location of the NATTS station at the South DeKalb site (13-089-0002). As part of the NATTS network, the GA AAMP samples metals with a PM_{10} sampler, semi-volatile organic compounds, volatile organic compounds, and carbonyls. Samples are collected from midnight to midnight for a 24-hour sample, every 6 days. In addition, an 8-hour carbonyls sample is collected three times a day, every third day through June, July, and

August. Also at the South DeKalb site, GA AAMP began sampling ethylene oxide as of January 2020.

4.9 Ozone

Ozone monitoring has been in place in the Atlanta area since the 1970's. Currently the Atlanta-Sandy Springs-Roswell MSA ozone network includes nine monitors located in nine counties. Across Georgia, there are 19 ozone monitors in the network, which exceeds the EPA requirement (40CR58, Appendix D, Section 4.1). The standard is an 8-hour averaging time, fourth maximum value, averaged over three years. On October 1, 2015, EPA lowered the ozone standard to 0.070 ppm. For this 2015 standard, and with the 2014-2016 data, the Atlanta area was redesignated to include only a 7-county area for the non-attainment area (Federal Register, Vol. 83, No. 107, page 25776).

As part of the Clean Air Status and Trends Network (CASTNET), EPA established a monitoring site in Pike County, 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 95 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. https://www.epa.gov/castnet. With the exception of the South DeKalb and CASTNET sites, ozone in Georgia, unlike other pollutants previously discussed, is monitored March through October, complying with federal monitoring regulations (in 40CFR Part 58).

4.10 Particulate Matter

Particulate pollution may be categorized by size since there are different health impacts associated with the different sizes of particulate matter. GA AAMP currently monitors for three sizes of particles: PM_{10} (up to 10 microns in diameter), $PM_{2.5}$ (up to 2.5 microns in diameter) and PMcoarse (PM_{10} minus $PM_{2.5}$). To give size relation, approximately ten PM_{10} particles can fit on a cross section of a human hair, and approximately thirty $PM_{2.5}$ particles would fit on a cross section of a hair. These particles and droplets are invisible to the naked eye, and composition and sources can vary greatly by region. There are three monitoring stations with PM_{10} monitors, one station with a PMcoarse monitor, and 25 stations with continuous and/or integrated $PM_{2.5}$ monitors, which exceeds the number of samplers required according to 40CFR58, Appendix D, Section 4.7.

For an area to be in attainment of the annual ambient air $PM_{2.5}$ standard, the three-year average of the annual average concentrations has to be less than or equal to 12.0 $\mu g/m^3$. In addition, the 24-hour primary and secondary standard requires that the three-year average of the 98th percentile of the 24-hour concentrations be less than or equal to 35 $\mu g/m^3$. Currently all areas of Georgia are designated unclassifiable/attainment for the 2012 annual $PM_{2.5}$ standard because the national standards are being met. For PM_{10}, the 24-hour data is compared to 150 $\mu g/m^3$. The standard allows one exceedance per year, averaged over a 3-year period, and all three samplers collected data well below the standard. Currently, there is no standard for PMcoarse.

5.0 Site Evaluations

The GA AAMP performs site evaluations throughout the year on an annual basis for each site. The following table details when the most recent site evaluations were performed and a summary of the comments that the evaluator made about each site.

Table 4: Site Evaluations

SITE ID	COMMON NAME	COUNTY	SITE EVALUATION DATE	COMMENTS	ACTION TAKEN
Rome MSA					
131150003	Rome	Floyd	4/16/2019	Samplers meet siting criteria. The site was originally established as an SO_2 site for the purpose of monitoring the paper mill and power plant to the southwest. The SO_2 analyzer has been moved to the Kraft Paper Mill site. A TEOM sampler from the discontinued site at Yorkville has replaced the BAM 1020. 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.	No action required
131150006	Kraftsman	Floyd	4/25/2019	Samplers meet siting criteria. The site was established in Dec. of 2016 for the purpose of monitoring SO2 emissions from the paper mill off of Hwy 20. A model 43 TLE SO2 analyzer, S/N 1114048202, is located in the shelter also, but is not being used.	No action required
Brunswick MSA					
131270006	Brunswick	Glynn	11/6/2019	Samplers meet siting criteria. 2025 needs new hinge lock buttons. 2025 inlet 5m above ground, O_3 inlet 4.1m above ground, 2025 to O_3 inlet 2.4m. O_3 inlet to wall 1.9m, O_3 inlet 1.5m over shelter, 2025 inlet to wall 4.1m, 2025 2.1m inlet to shelter. O_3 inlet 20.4m to dripline, 2025 20.8m inlet to dripline.	No action required
Valdosta MSA					
131850003	Valdosta	Lowndes	12/5/2019	Samplers meet siting criteria. The overall condition appears unchanged since the last survey. Rooftop to ground 4m, BAM inlet to rooftop 2.5m, 2025 inlet to rooftop 2.1m, BAM inlet to nearest dripline 19.2m. BAM inlet 3.7m from 2025 inlet.	No action required
Warner Robins MSA					
131530001	Warner Robins	Houston	1/17/2019	Samplers meet siting criteria. T640 to dripline 14.4m, T640 inlet to ground 2m, 2025 inlet to ground 2.1m, 2025 to dripline 13.5m, T640 `inlet to 2025 inlet 3.6m. 2025 leaning slightly.	No action required.
Dalton MSA					
132130003	Fort Mountain	Murray	10/29/2019	Samplers meet siting criteria.	No action required
Albany MSA					
130950007	Albany	Dougherty	2/6/2019	Samplers meet siting criteria. Inlet heights: BAM 2.4m, Primary 2025 2.2m, co-located 2025 2.1m, Inlet separation: BAM to Primary 2025 3.1m, BAM to co-located 2025 2.5m, 2025 to 2025 2.5m. Samplers on rooftop 4.4m above ground. Air handler exhaust 2.9m from BAM. Nearest dripline 62.6m from BAM inlet.	No action required.
Gainesville MSA					
131390003	Gainesville	Hall	1/17/2019	Samplers meet siting criteria.	No action required.
Athens-Clark County MSA					
130590002	Athens	Clarke	4/4/2019	O_3 inlet 4.5m, T640 4.6m, T640 4.5m T640 inlet heights. 5.1m O_3 to dripline, 8.7m T640, T640 9m, these being to the allowed shrubbery. 1.3m between T640 inlets, 2m from O_3 to nearest T640 inlet. T640 102m to nearest lane traffic, 20m to parking lot. Deficiencies noted.	All inlets at top height of shrubbery with at least 270º of unobstructed fetch, meeting minimum requirement. Will cut shrubbery back. Addressed by publication of this document.
Macon MSA					
130210007	Macon-Allied	Bibb	9/28/2019	Samplers meet siting criteria. Nearest dripline 26.8m to SASS 27m to Primary 2025. 1.7m SASS to URG, 2.7m SASS to Primary 2025, 2.6m P 2025 to C 2025, 1.9m URG to P 2025, 3m 2025 to URG. Inlet heights: P2025 2.1m, C2025 2.1m, URG 2.1m, SASS 1.8m.	No action required
130210012	Macon-Forestry	Bibb	12/6/2019	The floor around the door is rotting out. The floor covering is cracked and has holes. There is water damage to the west wall of the shelter, where an antenna was installed. Drip lines were found to be too close. Deficiencies noted.	Growth along fence line cut back. All inlets have at least 270º of unobstructed fetch. Addressed by publication of this document.

SITE ID	COMMON NAME	COUNTY	SITE EVALUATION DATE	COMMENTS	ACTION TAKEN
Columbus, GA-AL MSA					
132150001	Columbus-Health Dept.	Muscogee	9/27/2019	Samplers meet siting criteria. Nearest objects taller than inlet: 12.9m to large air handler, 43.8m to building. Inlet 2.2m above rooftop, 11.8m above ground.	No action required.
132150008	Columbus-Airport	Muscogee	9/27/2019	Samplers meet siting criteria. Water damage to ceiling and wall around door and a/c. Soft floor. Inlet heights: O_3 3.8m TEOM 4.5m 2025 4.8m. Separation TEOM to O_3 2m TEOM to 2025 1.9m 2025 to O_3 1.4m. Distance to Dripline O_3 39.8 TEOM 40.4m 2025 34m from roof O_3 1m 2025 2.2m TEOM 2m.	No action taken.
132150009	Columbus-Allied	Muscogee	3/6/2019	Samplers meet siting criteria. Nearest drip line taller than inlet is 6 m away. Both inlets 2m above ground, 4.9m to nearest dripline, 2.1m between samplers, 7.7m to roadway, bus stop nearby.	No action taken.
132150011	Columbus-Cusseta	Muscogee	2/15/2019	Samplers meet siting criteria. Samplers on rooftop 3.8m above ground. Inlet heights above rooftop: URG 2.1m, SASS 1.9m, Lead 1.1m, 2025 2.2m. Inlet separation: 2025 to lead 3.2m, URG to lead 5m, URG to 2025 3.3m, SASS to lead 4.3m, SASS to 2025 3.7m, URG to SASS 1.5m. Partisol 2000 stored on site, not in use.	Not applicable.
132151003	Columbus-Crime Lab	Muscogee	1/16/2019	Samplers meet siting criteria. Heights above ground: Anemometer 10m, Hygrometer & Thermometer 3m, Barometer1.1m, Precipitation gauge 3m.	Not applicable.
Savannah MSA					
130510021	Savannah-E. President	Chatham	6/19/2019	Samplers meet siting criteria. Construction of apartment buildings directly West across Woodcock Street completed since last survey. Apartment complex is currently in use. Trees removed during construction. Nearest drip line to inlets is now more than thirty meters distant. Barometer inlet height 1.6m, RH inlet 2.5m, tower 9m. SO_2 inlet looked dirty and had a wasp nest in the funnel.	Not applicable.
130511002	Savannah – L&A	Chatham	5/22/2019	Floor soft around doorway. Water damage to wall near a/c. Driplines too close.SO_2 dripline 4m, height 4m. T640 nearest dripline 6.5m, to ground 4.4m, to rooftop 1.8m. Deficiencies noted.	Growth along fence line was cut back. Planning on replacing shelter and will take any needed actions to improve siting quality at the same time. Will look into having trees cut back. Addressed by publication of this document.
Augusta MSA					
130730001	Evans	Columbia	9/28/2019	Samplers meet siting criteria. Shelter exterior and floor rotting. 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. Nearest dripline 30.4m from O_3. Heights: O_3 4.4m, Anemometer 9.4m, T/RH 1.9m. T/RH 1.7 from building. O_3 1.6m above roof edge, 0.2m from tower. Could not open with expected degree of force T/RH to check anything.	Not applicable.
132450091	Augusta	Richmond	9/28/2019	Samplers meet siting criteria. PM10 samplers DNR numbered 137627 & 137574, PM2.5 sampler DNR number 135369 on site but not sampling. 153 to roadway. Heights: Anemometer 11m, O_3 4.6m, SO_2 4.6m, Barometer 1.7m, Ta/RH 2.4m, tipping bucket 3.4m, SASS 2.4m, URG 2.6m, TEOM 4.5m, T640 4.3m. Distance from roof: O_3 2m, SO_2 2m, T640 1.7m, TEOM 1.9m, tipping bucket 0.8m. Separation: TEOM to O_3 1.5m, TEOM to SO_2 1.5m, TEOM to T640 1.5m, T640 to O_3 2.5m, T640 to SO_2 2.4m, O_3 to SO_2 0.2m, SASS to URG 2m, SASS to TEOM 3m, SASS to T640 4.7m. Nearest dripline 21.4m to T640.	Not applicable.
Atlanta-Sandy Springs-Marietta MSA					
130630091	Forest Park	Clayton	7/29/2019	Samplers meet siting criteria. The site was moved April 2016, from the DOT building roof to a nearby location on the ground, 115 meters to the NE. There are not any site deficiencies that need to be addressed.	Not applicable.
130670003	Kennesaw	Cobb	1/08/2019	Samplers meet siting criteria. There were not any deficiencies observed at the site. A parking lot is 18 meters north of inlets. A small parking lot is also adjacent to the sampler trailer, south. The site is designated as Neighborhood spatial scale. 7 classroom trailers shown in the aerial photograph are no longer present at the site. 14 storage bins are located there now.	Not applicable.
130850001	Dawsonville	Dawson	11/07/2019	Samplers meet siting criteria. Met tower is inside 10x height differential with the trees to the north, east and south. A few trees to the SE of the ozone inlet are also inside of the height-distance criteria. Note: Obstructions are measured from the trunks of trees.	No action taken; Forest Service property

SITE ID	COMMON NAME	COUNTY	SITE EVALUATION DATE	COMMENTS	ACTION TAKEN
130890002	South DeKalb	DeKalb	12/19/2019	Samplers meet siting criteria. A large swath of trees to the north, east and west was cut down in Oct.2018 to extend obstacle distances to sampling inlets. All drip lines to sampler inlets exceed 20 meters. Although a few trees are still inside height-distance differential, at least 270 degrees of the monitoring path for all of the samplers is now unobstructed. Anew deck was built Nov. 2019 for the exterior samplers.	Not applicable.
130890003	NR-285	DeKalb	4/23/2019	Samplers meet siting criteria. The Near Road site began sampling Jan. 2015. A new exit lane to Flat Shoals Rd. adjacent to the site has been completed since the last survey. An ATEC 2200 VOCS sampler is being stored inside the trailer. No deficiencies were noted at the site at this time.	Not applicable.
130970004	Douglasville	Douglas	1/10/2019	Samplers meet siting criteria. The trailer is located at the Douglasville Water and Sewer Authority maintenance site. The area is a parking lot for WSA service vehicles and storage for water works equipment and pipes. The parking lot for WSA vehicles is to the north, east, and south of the trailer. The WSA building is 32 meters to the southeast. The inside trailer siding near the floor and the countertop has become slightly warped due to past water infiltration. The water appears to have gained 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. There is a small rip in the trailer floor.	No action taken.
131210039	Fire Station #8	Fulton	8/7/2019	Samplers meet siting criteria. Solar panels have been installed on the roof. There are not any deficiencies compromising sampling quality.	Not applicable.
131210055	United Ave.	Fulton	3/03/2020	Samplers meet siting criteria. The site is located at the Georgia Highway Patrol and the Georgia Army National Guard complex.	Not applicable.
131210056	NR-GA Tech	Fulton	4/9/2019	Samplers meet siting criteria. This site is designated as a NO_2 Near Road Site and sampling began June 16, 2014. There were no deficiencies observed at the site.	Not applicable.
131350002	Gwinnett Tech	Gwinnett	4/8/2019	Samplers meet siting criteria. The sampling trailer is surrounded on west (25 meters away) and northeast (22 meters away) by the college parking lot. The trailer floor has a few rips in it near the door. The trailer floor is buckling up slightly because of water infiltration on plywood support.. No deficiencies noted that would affect sampling performance. The Partisol 2025 is still present on the trailer roof but has been replaced by the TX640 for PM sampling.	Not applicable.
131510002	McDonough	Henry	9/28/2019	Samplers meet siting criteria. Cars idle near shelter while dropping off goods to thrift store. TEOM 4.4m height, 26.2m to dripline, 1.9m to shelter, 7m to adj rooftop. O_3 4m height, 29.6m to dripline, 1.4m to shelter, 7.7m to rooftop, 2.6m to TEOM.	No action taken.
132470001	Conyers	Rockdale	7/30/2019	Samplers meet siting criteria. There are no deficiencies at this site.	Not applicable.
Chattanooga Tennessee-Georgia MSA					
132950002	Rossville	Walker	6/13/2019	Samplers meet siting criteria. One board on the platform between the URG and Met One sampler is starting to deteriorate and weaken and should be replaced. The small tree/shrubs to the west of the platform have been removed.	Deck has been rebuilt since site evaluation.
Not in an MSA					
130550001	Summerville	Chattooga	2/12/2020	Samplers meet siting criteria. The site is Urban spatial scale. No deficiencies detected. Another ozone analyzer is sitting on the counter and may be a replacement for the analyzer currently plugged in.	Not applicable.
130690002	General Coffee	Coffee	10/23/2019	Samplers meet siting criteria. Drip line 13m from 2025. Drip line 10.7m from SASS, Drip line 12.5m from URG. 2025 inlet 1.8m from Xonteck, Deck 0.85m to ground. 2025 inlet 2.1m to deck, SASS 1.8m to deck, URG 2m to deck. URG to SAS inlet 2.8m, 2025 to SASS inlet 4.4m, 2025 to URG 5m.	Not applicable.
132611001	Leslie	Sumter	3/8/2019	Sampler meets siting criteria. More water damage to walls and floor than last survey, dripline is 9.8m East and 9.3m South of inlet. Unrestricted air flow.	Site has at least 270º of unobstructed fetch, meeting minimum requirements.
133030001	Sandersville	Washington	4/22/2020	Samplers meet siting criteria. T640 inlet 3.1m above ground. Ta sensor mounted on post separate from T640 1.8m above ground, recommend Ta sensor relocated closer to inlet. 20.8m to center of nearest road, 17.4m to edge of nearest road. 43.6m to nearest dripline.	Not applicable.

Introduction to Assessment Sections

To fulfill the objectives of the Five-Year Assessment, multiple 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 AAMP is meeting the above listed objectives. The Air Quality Index (AQI), including health related statistics, comprehensive meteorological data, and the PAMS 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 2018, and the sites were used as they were set up through 2018. 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 2018. 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 2018.

6.0 Trends Impact Assessment

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 GA AAMP'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, arsenic, 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 2018, 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 2018, there were 38 ambient air monitoring sites in 28 counties across the state of Georgia, including the EPA's CASTNET site. There are several sites in Georgia with a long running history. Of the 38 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 Kraftsman site in Rome, GA which began sampling in 2016.

Table 6.0: Georgia Monitoring History

Sites Arranged by Start Date				
Rank	**Site Location**	**County**	**Start Date**	**Proportionality Ranking**
1	Columbus-Health Dept.	Muscogee	1957	1.00
2	Rossville	Walker	1967	0.83
3	Savannah-L&A	Chatham	1972	0.75
4	Fire Station #8	Fulton	1973	0.73
5	Macon-Allied	Bibb	1974	0.71
5	South DeKalb	DeKalb	1974	0.71
5	Rome-Coosa	Floyd	1974	0.71
5	Sandersville	Washington	1974	0.71
9	Augusta	Richmond	1976	0.68
10	Forest Park	Clayton	1978	0.64
10	Conyers	Rockdale	1978	0.64
12	Columbus-Crime Lab	Muscogee	1980	0.61
13	Leslie	Sumter	1981	0.59
14	Columbus-Airport	Muscogee	1982	0.58
15	Dawsonville	Dawson	1985	0.53
16	NR-285	DeKalb	1986	0.51
17	Brunswick	Glynn	1987	0.49
18	Summerville	McDuffie	1990	0.44
19	Albany	Dougherty	1991	0.42
19	Columbus-Cusseta Elementary	Muscogee	1991	0.42
19	United Ave.	Fulton	1991	0.42
22	Savannah-E. President St.	Chatham	1995	0.36
22	Gwinnett Tech	Gwinnett	1995	0.36
24	Macon-Forestry	Bibb	1997	0.32
24	Douglasville	Douglas	1997	0.32
26	Kennesaw	Cobb	1999	0.29
26	Gainesville	Hall	1999	0.29
26	Fort Mountain	Murray	1999	0.29
26	McDonough	Henry	1999	0.29

Sites Arranged by Start Date				
Rank	Site Location	County	Start Date	Proportionality Ranking
26	Valdosta	Lowndes	1999	0.29
31	General Coffee	Coffee	1999	0.27
31	Warner Robins	Houston	2000	0.27
33	Athens	Clarke	2002	0.24
34	Evans	Columbia	2005	0.19
35	CASTNET	Pike	2011	0.08
36	Columbus-Allied	Muscogee	2012	0.07
37	NR-GA Tech	Fulton	2014	0.03
38	Rome-Kraftsman	Floyd	2016	0.00

6.1 Ozone

The following table examines the longevity of GA AAMP'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 2018.

Table 6.1: Ozone Monitoring History

Ozone			
Rank	Site Location	County	Start Date
1	South DeKalb	DeKalb	1974
2	Conyers	Rockdale	1978
3	Columbus-Airport	Muscogee	1983
4	Dawsonville	Dawson	1987
5	Leslie	Sumter	1988
6	Augusta	Richmond	1989
7	United Ave.	Fulton	1991
8	Brunswick	Glynn	1995
8	Savannah-E. President St.	Chatham	1995
8	Gwinnett Tech	Gwinnett	1995
11	Macon-Forestry	Bibb	1997
11	Douglasville	Douglas	1997
11	Kennesaw	Cobb	1997
14	McDonough	Henry	1999
14	Fort Mountain	Murray	1999
14	Athens	Clarke	1999
17	Summerville	Chattooga	2000
18	Evans	Columbia	2002
19	CASTNET	Pike	2011

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 Georgia site, Evans, is most susceptible to termination. The CASTNET site is part of the EPA network, and started reporting data in 2011. These sites have a shorter history and are therefore less useful when trying to determine trends.

Figure 6.1 displays the annual average 1-hour ozone concentrations for all active sites as of 2018. 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 0.070 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 been in decline. Since 2011, hourly ozone levels have remained below 0.060 ppm, with minor increases and decreases. 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).

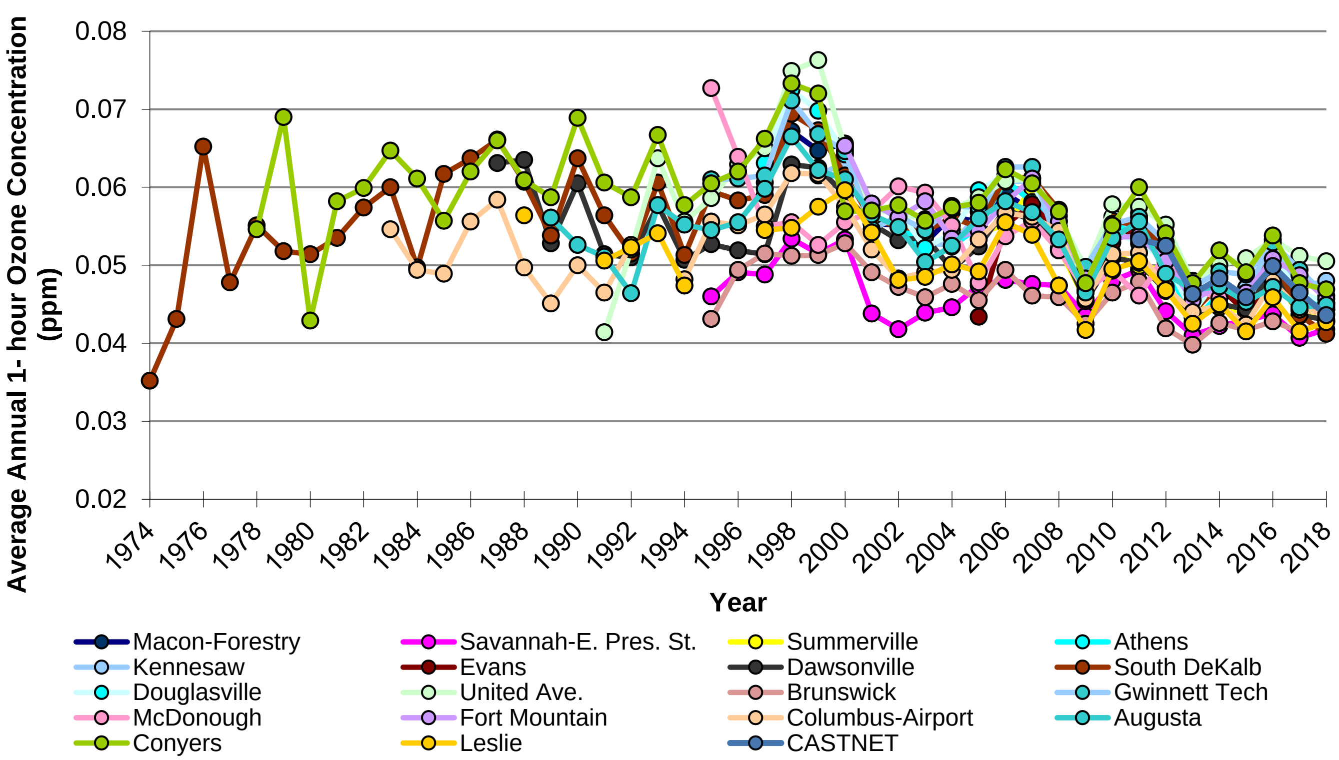


Figure 6.1: Ozone Trend in Data

6.2 Carbon Monoxide

In the following table, the longevity of GA AAMP'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 in the current network.

Table 6.2: Carbon Monoxide Monitoring History

Carbon Monoxide				
Rank	**Site Location**	**City Name**	**County**	**Start Date**
1	South DeKalb	Decatur	DeKalb	2003*
2	NR-GA Tech	Atlanta	Fulton	2014**

*sampler not working in 2009
** sampler started June 2014

Figure 6.2 shows the annual average 1-hour CO concentration for all active sites as of 2018. The South DeKalb site was added in 2003 and NR-GA Tech in 2014. South DeKalb shows a slight decreasing trend in the most recent years, with annual average remaining below 0.35 ppm. However, the NR-GA Tech site began on an increasing trend with a rapid decline from 2016 to 2017. Recently, the average annual concentrations show a steady trend.

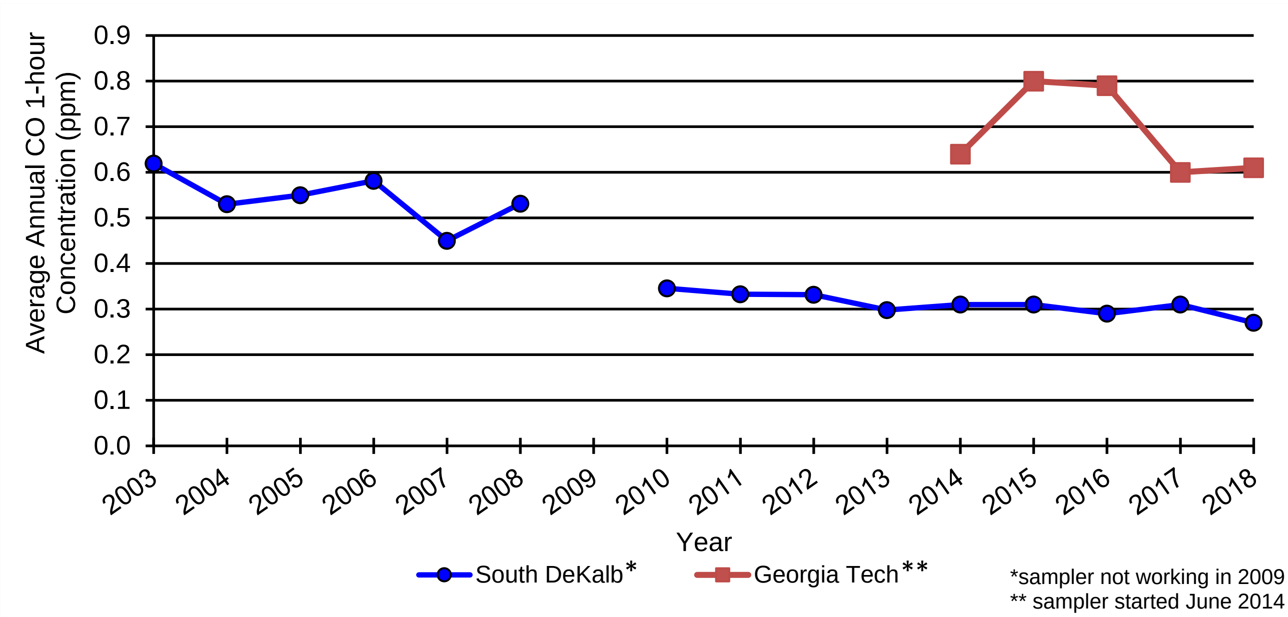


Figure 6.2: Carbon Monoxide Trend in Data

6.3 Sulfur Dioxide

The following table examines the longevity of GA AAMP's sulfur dioxide monitors. The annual averages for all sulfur dioxide monitors are plotted below the table to display the trend in sulfur dioxide data across the entire network. The analysis includes the sulfur dioxide monitors that were sampling data as of 2018.

Table 6.3: Sulfur Dioxide Monitoring History

Sulfur Dioxide			
Rank	**Site Location**	**County**	**Start Date**
1	United Ave.	Fulton	1991
2	Savannah-E. President St.	Chatham	1995
3	Macon-Forestry	Bibb	1997
4	Savannah-L&A	Chatham	1998
5	South DeKalb	DeKalb	2010
6	Augusta	Richmond	2013
7	Rome-Kraftsman	Floyd	2016

Figure 6.3 shows the annual average SO_2 concentrations for all active sites as of 2018. The site in the Rome area (Rome-Coosa) was established in 1975 and was the longest surviving SO_2 site in Georgia. In December of 2016, SO_2 monitoring was moved from the Rome-Coosa location to the Rome-Kraftsman location due to the Data Requirements Rule (DRR, see Section 4.2 for more details). There has been a consistent downward trend in the data, and all 2018 averages are below 2.0 ppb.

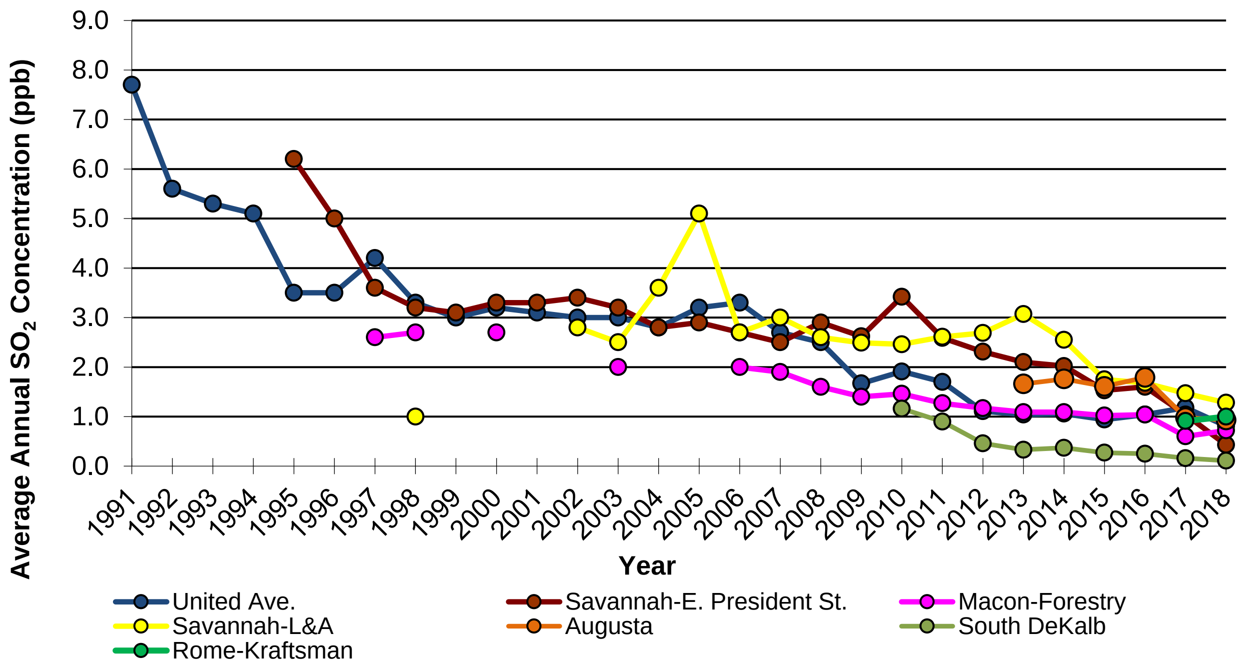


Figure 6.3: Sulfur Dioxide Trend in Data

6.4 Nitrogen Dioxide

The following table examines the longevity of GA AAMP's nitrogen dioxide monitors. The annual averages for 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 2018. NO_2 monitoring was discontinued at the Yorkville and Conyers sites in December 2015. The South DeKalb site's NO_2 monitor was established in 1982, while the NR-GA Tech and NR-285 sites were added as part of the Near-road network in 2014 and 2015, respectively.

Table 6.4: Nitrogen Dioxide Monitoring History

Nitrogen Dioxide			
Rank	**Site Location**	**County**	**Start Date**
1	South DeKalb	DeKalb	1982
2	NR-GA Tech	Fulton	2014**
3	NR-285	DeKalb	2015

** sampler started June 2014

Figure 6.4 shows the annual average 1-hour NO_2 concentrations for all sites active as of 2018. NR-GA Tech and NR-285 show higher averages of NO_2, possibly due to the sites being located near heavily traveled interstates, while the South DeKalb has been on a decreasing trend since it was established in 1982.

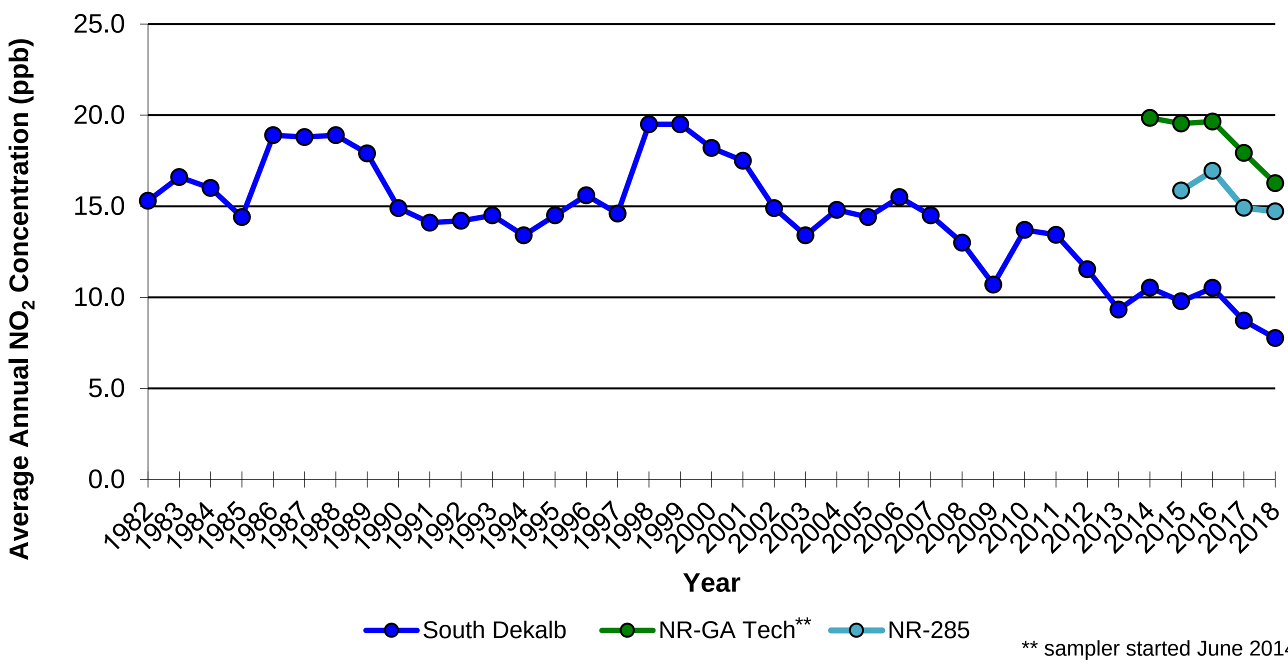


Figure 6.4: Nitrogen Dioxide Trend in Data

6.5 PM_{10}

Table 6.6 shows the start date of GA AAMP's PM_{10} (integrated and continuous) monitors. Integrated samples are collected every 6 days. Continuous samples are collected hourly. The Fire Station #8 site began operation in late 1987 and ran until 2006. Then it was shut down until it restarted in 2013.

Table 6.5: PM_{10} Monitoring History (Integrated and Continuous)

Particulate Matter$_{10}$ Integrated			
Rank	**Site Location**	**County**	**Start Date**
1	Fire Station #8	Fulton	1987*
2	Augusta	Richmond	1996
3	South DeKalb	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 2018 are plotted in Figure 6.5. Some variation in concentrations at the Augusta site is apparent from 1997 until 2007 when concentrations begin a steady decline. Then in 2017, there was a spike in the data. The PM_{10} sampler at the Augusta site was changed from an integrated sampler to a continuous sampler in October of 2017. The South DeKalb site has a relatively short record, but concentrations appear to have remained steady. The Fire Station #8 site's concentration has declined significantly since it began operation in late 1987; however, there is a lapse in the data from 2006 until 2013, but concentrations have remained stable thereafter.

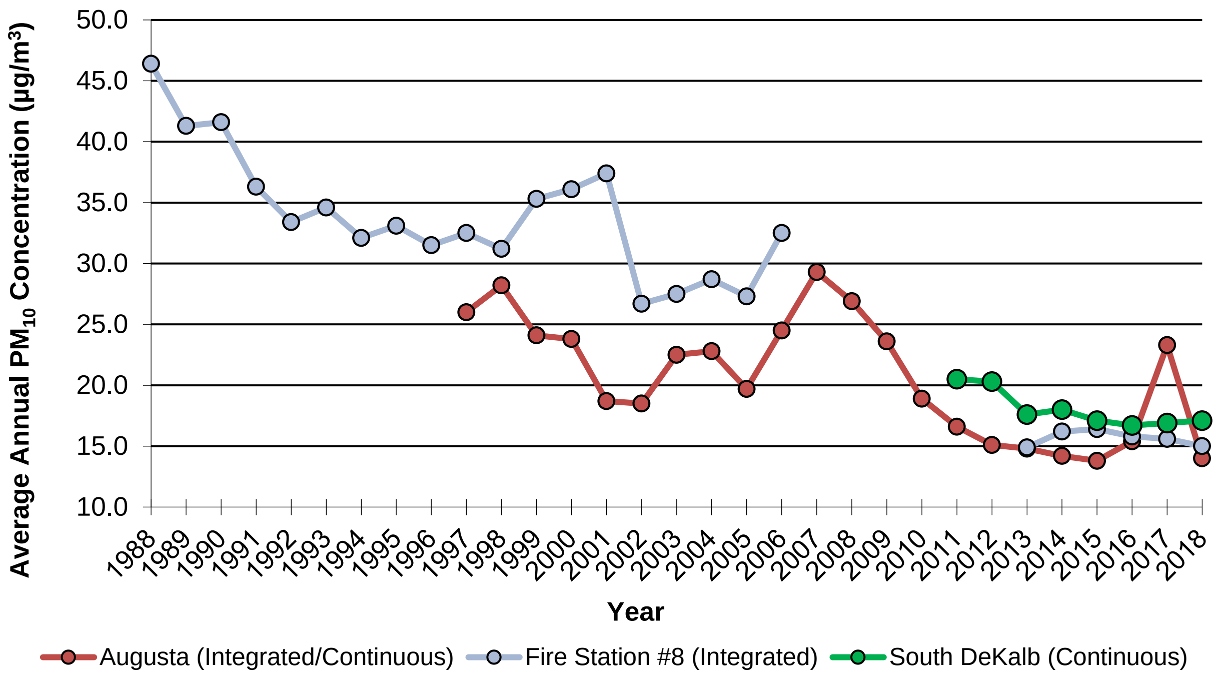


Figure 6.5: PM_{10} Trend in Data

6.6 $PM_{2.5}$ (Federal Reference Method)

The following table examines the longevity of Georgia AAMP'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 2018. The NR-GA Tech and General Coffee sites started monitoring $PM_{2.5}$ in January 2015 and 2016.

Table 6.6: $PM_{2.5}$ Monitor History

Particulate Matter$_{2.5}$ Federal Reference Method			
Rank	**Site Location**	**County**	**Start Date**
1	Macon-Allied	Bibb	1999
1	Macon-Forestry	Bibb	1999
1	Forest Park	Clayton	1999
1	Kennesaw	Cobb	1999
1	South DeKalb	DeKalb	1999
1	Albany	Dougherty	1999
1	Fire Station #8	Fulton	1999
1	Brunswick	Glynn	1999
1	Gainesville*	Hall	1999
1	Columbus-Health Dept.	Muscogee	1999
1	Columbus-Cusseta	Muscogee	1999
1	Augusta*	Richmond	1999
1	Sandersville	Washington	1999
14	Rossville	Walker	2000
14	Gwinnett Tech*	Gwinnett	2000
14	Warner Robins	Houston	2000
14	Valdosta	Lowndes	2000
18	Columbus-Airport	Muscogee	2003
19	NR-GA Tech	Fulton	2015
20	General Coffee	Coffee	2016

*As of November 2018, these FRM monitors were shut down replaced with continuous FEM monitors.

The $PM_{2.5}$ FRM monitors are used for attainment purposes and use a method of collection that is approved by EPA. As of 2018, there were a total of 18 $PM_{2.5}$ 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 6.6). 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. Since the increase in 2010, concentrations have consistently decreased, with the NR-GA Tech having the highest average (9.19 $\mu g/m^3$) in 2018.

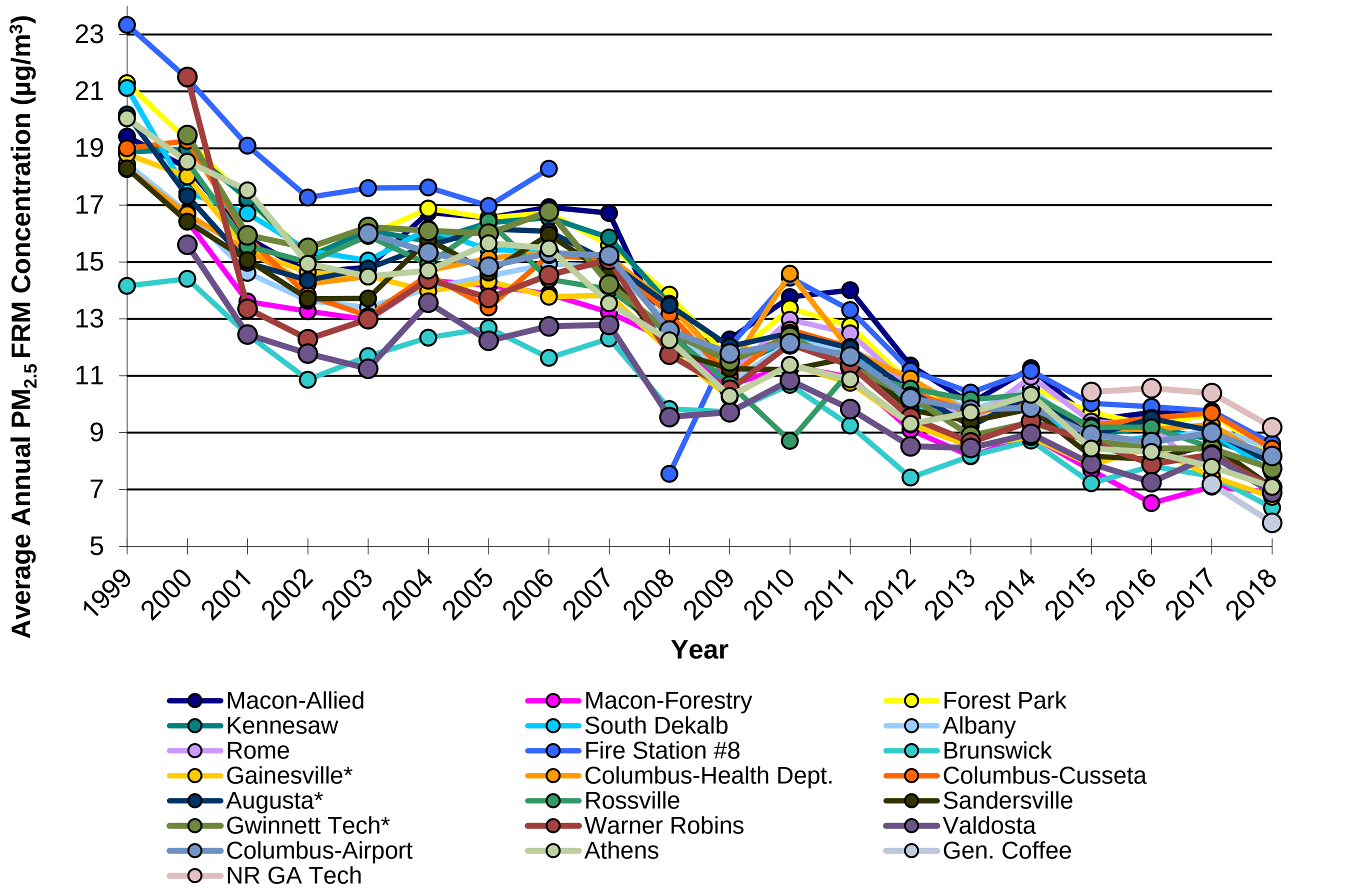


Figure 6.6: $PM_{2.5}$ FRM Trend in Data

6.7 $PM_{2.5}$ (Continuous)

In the following table, the duration of GA AAMP'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 2018.

Table 6.7: $PM_{2.5}$ Continuous Monitor History

Particulate Matter$_{2.5}$ Continuous			
Rank	**Site Location**	**County**	**Start Date**
1	South DeKalb	DeKalb	2002
2	Macon-Forestry	Bibb	2003
2	Columbus-Airport	Muscogee	2003
2	Savannah-L&A	Chatham	2003
2	Augusta	Richmond	2003
2	Gwinnett Tech	Gwinnett	2003

Particulate Matter$_{2.5}$ Continuous			
Rank	**Site Location**	**County**	**Start Date**
2	McDonough	Henry	2003
8	Athens	Clarke	2004
9	United Ave.	Fulton	2005
10	Rossville	Walker	2007
11	Albany	Dougherty	2008
11	Gainesville	Hall	2008
11	Warner Robins	Houston	2008
11	Valdosta	Lowndes	2008
15	Rome-Coosa	Floyd	2009
16	NR-GA Tech	Fulton	2016

Continuous samples provide almost instant data, allowing someone to judge the air quality the very day of its collection instead of waiting weeks for FRM data. There are two types of continuous $PM_{2.5}$ samplers: one type that is not equivalent to the federal method (non-FEM) and one type that is equivalent to the federal method (FEM). The non-FEM samplers are used for general informational purposes about the air quality in an area and for air quality forecasting. Until 2017, GA AAMP had two sites that monitored continuous $PM_{2.5}$ data with FEMs: the South DeKalb and Albany sties. The South DeKalb site began sampling with the FEM as of 2011, while the Albany FEM started in 2013. Then in the last quarter of 2017, the continuous monitors at the Gainesville, Macon-Forestry, Savannah-L&A, Augusta, Gwinnett Tech, Rossville sites were changed to FEMs. Also, in 2018, the continuous monitors at the Valdosta and Athens sites were changed to FEMs. These monitors can be used for attainment purposes along with the FRMs. The other $PM_{2.5}$ continuous monitors in the network are not being run as FEMs as of 2018, 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 6.7) resembles the $PM_{2.5}$ FRM 24-hour data (Figure 6.6). 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. Concentrations have remained in decline since 2013, with Athens having the most significant decline and lowest concentrations in both 2017 and 2018.

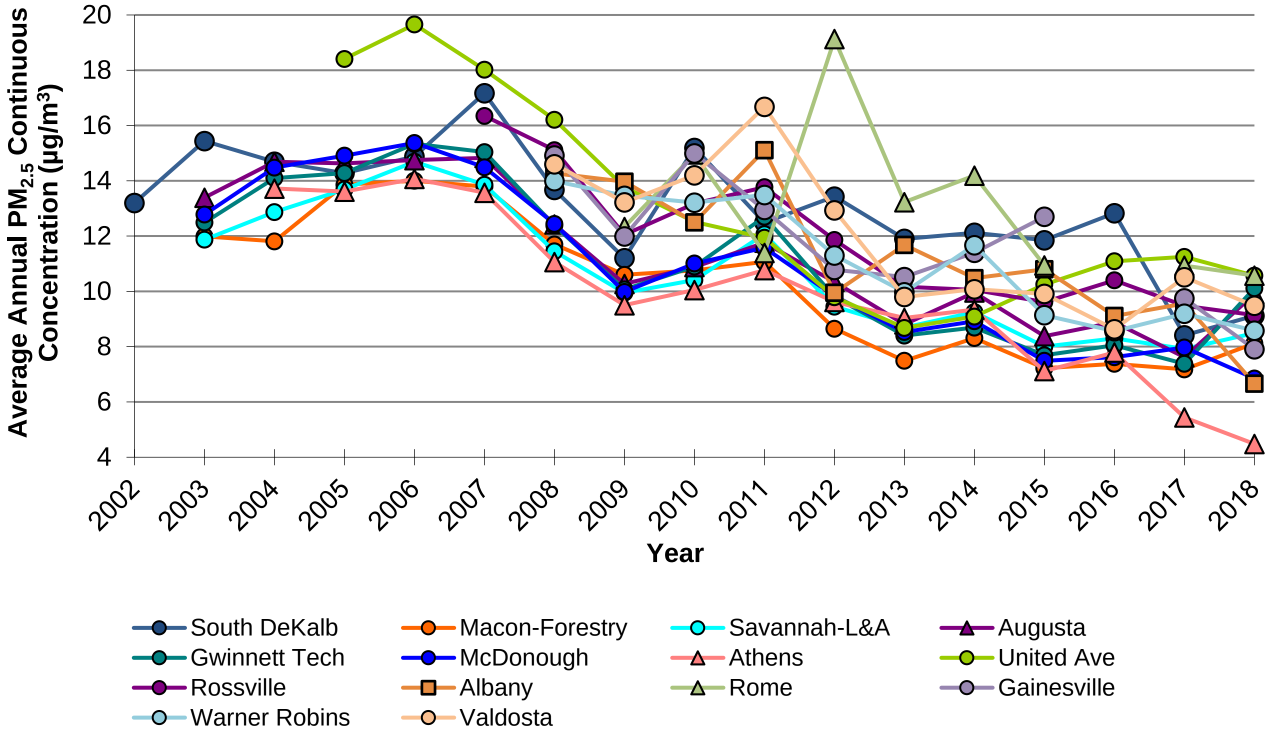


Figure 6.7: $PM_{2.5}$ Continuous Trend in Data

6.8 $PM_{2.5}$ (Speciation)

The following table examines the duration of GA AAMP'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 2018.

Table 6.8: $PM_{2.5}$ Speciation Monitor History

Particulate Matter$_{2.5}$ Speciation			
Rank	**Site Location**	**County**	**Start Date**
1	South DeKalb	DeKalb	2001
2	Athens	Clarke	2002
2	Macon-Allied	Bibb	2002
2	Columbus-Cussetta	Muscogee	2002
2	Augusta	Richmond	2002
2	General Coffee	Coffee	2002
7	Columbus-Health Dept.	Muscogee	2005
8	Rome-Coosa	Floyd	2009

The South DeKalb site was established before the other 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 average annual $PM_{2.5}$ speciation sulfate concentrations as a representation of the $PM_{2.5}$ speciation data. There is an overall decreasing trend in the data from 2001 to 2018. 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.

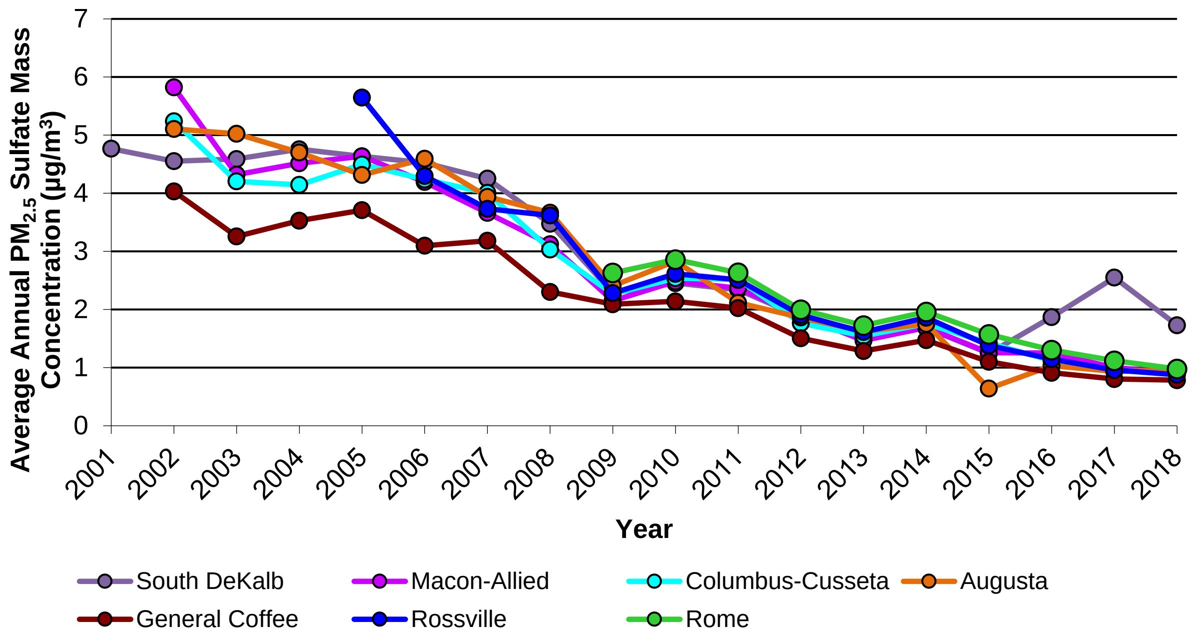


Figure 6.8: $PM_{2.5}$ Speciation Sulfate Trend in Data

6.9 Lead

The following table examines the longevity of GA AAMP's lead monitors. The annual averages for these lead monitors are plotted below the table to display the trend in lead data. The analysis includes the lead monitors that were sampling data as of 2018.

Table 6.9: Lead Monitor History

Lead			
Rank	**Site Location**	**County**	**Start Date**
1	Columbus-Cussetta	Muscogee	1991
2	Columbus-Allied	Muscogee	2012

The longest running lead site is the Columbus-Cusseta site in Muscogee County which has been collecting data since 1991. The Columbus-Allied site was added in 2012. Figure 7.10 shows that the annual lead concentrations at the Columbus-Cusseta site began high and showed a more fluctuating pattern during the 1990s. From 2003 to 2007, the laboratory detection levels changed and Columbus-Cussetta concentrations were reported at that laboratory detection limit of 0.10 $\mu g/m^3$. Then in 2009, the laboratory analysis method and detection limit changed, causing the concentrations to drop significantly. Concentrations for the Columbus-Cussetta site have remained below 0.05 $\mu g/m^3$. The concentration at the Columbus-Allied site had a sharp increase in 2016, then began to decline rapidly in 2017, and has been below 0.05 µg/m^3 since then.

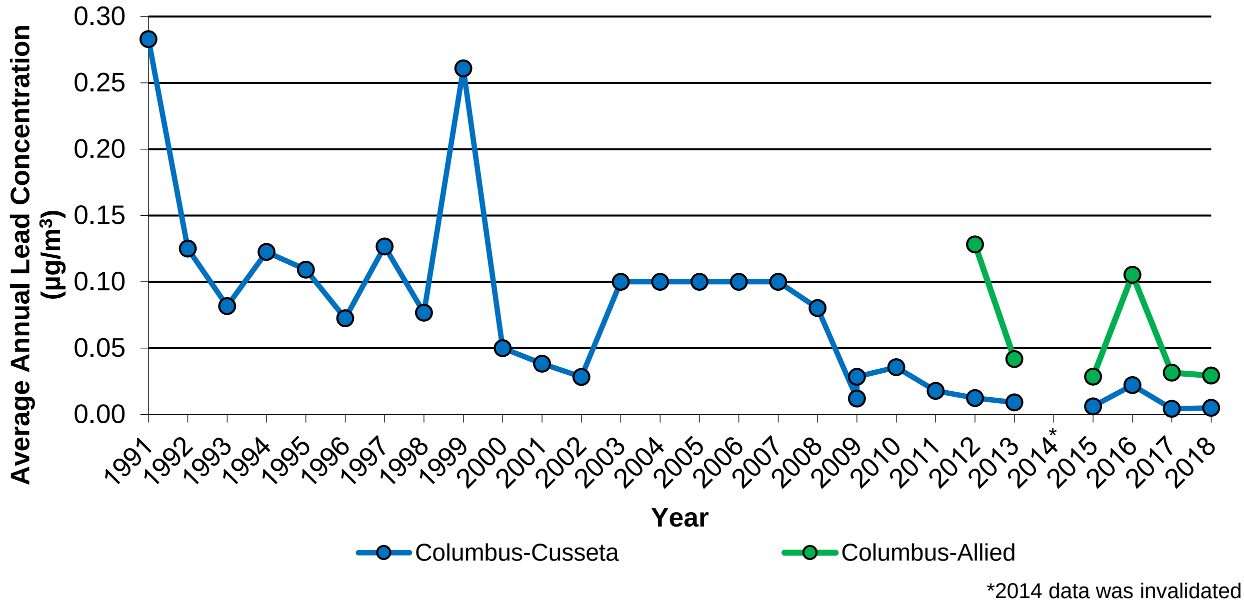


Figure 6.9: Lead Trend in Data

6.10 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 27 sites nationwide 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 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 2018.

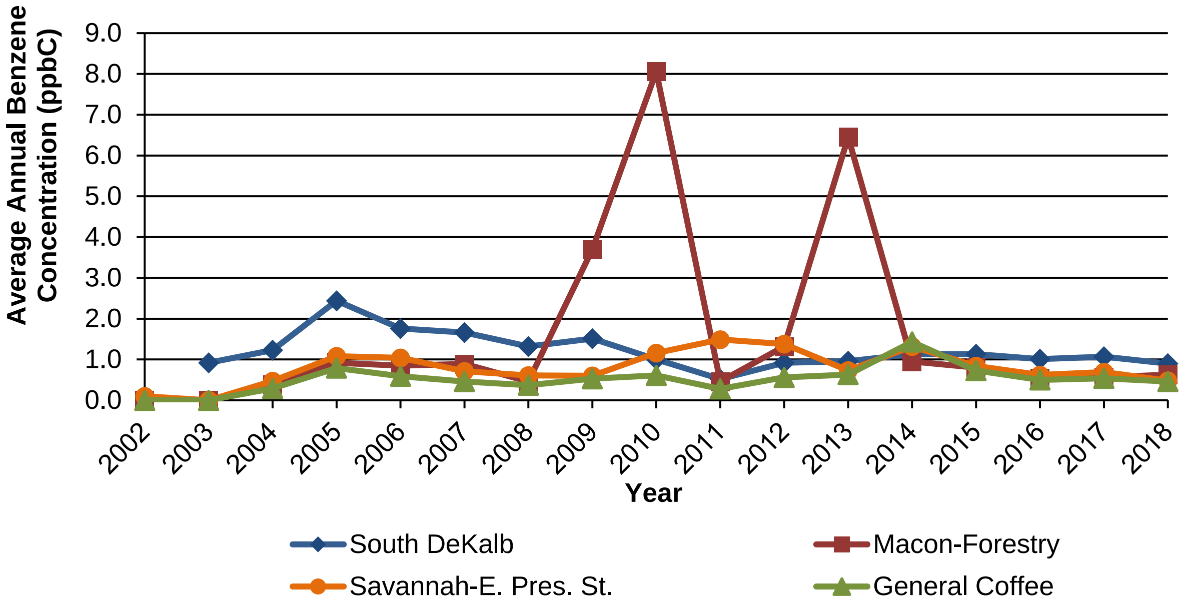


Figure 6.10: Comparison of Benzene Trend in Data

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, but had a rapid decrease in 2014, and the low values have remained. Annual concentrations at all other sites seem to follow the same trend, which shows concentrations below 2.0 ppbC through 2018.

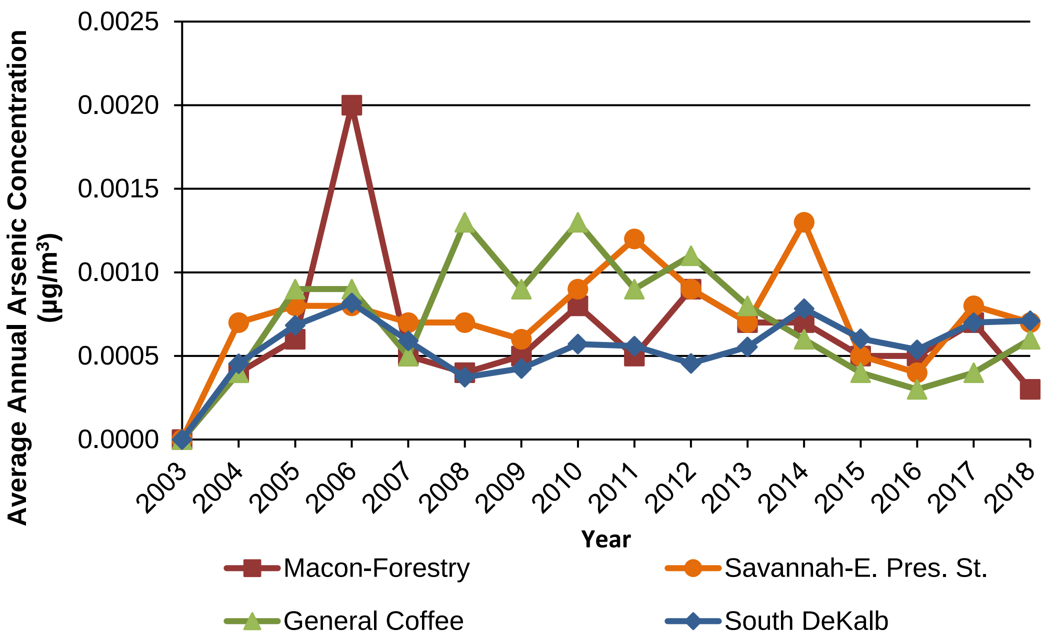


Figure 6.11 Comparison of Arsenic Trend in Data

Average annual arsenic concentrations have remained below 0.0015 µg/m^3 since 2003 with the exception of the Macon-Forestry site in 2006 (0.002 µg/m^3), which to date, has been the highest. Average annual concentrations for the past five years for all sites have ranged between 0.0003 and 0.0013 µg/m^3.

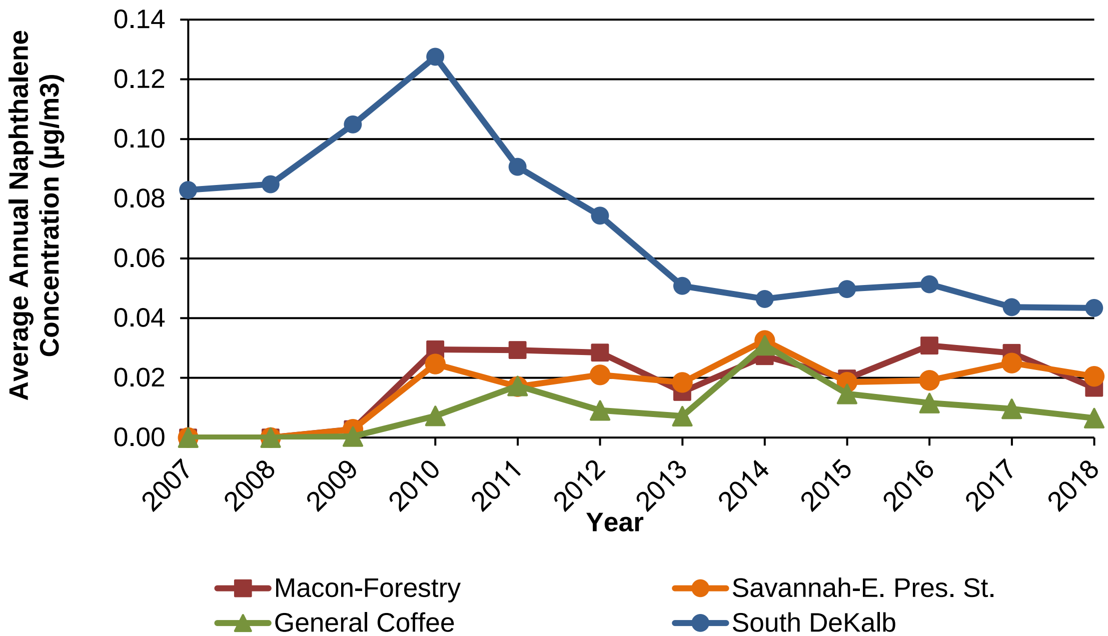


Figure 6.12 Comparison of Naphthalene Trend in Data

Average annual naphthalene concentrations remained close to 0 µg/m^3 from 2003 until 2007, when the South DeKalb site started collecting naphthalene data. At the end of 2009, the laboratory analysis method changed, and more data was detected. The South DeKalb site has consistently had much greater concentrations of naphthalene detected compared to the other Air Toxics sites. Naphthalene concentrations began to significantly decline at the South DeKalb site in 2011 and have remained below 0.06 µg/m^3 through 2018. At the other sites, there was a slight increase in 2014, but concentrations declined the following year. In 2018, concentrations remained lower for all sites, with the General Coffee site showing the lowest concentration at 0.0065 µg/m^3.

6.13 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 2018, there were 38 sites in 28 counties across the state, including the EPA's CASTNET site. There are several sites in Georgia with a long running history. Of the 38 sites, almost half the sites have collected data since the 1970's and 80'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 NR-GA Tech and Rome-Kraftsman sites, which began sampling ambient air data in 2014 and 2016, 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 2018 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.

As noted within the discussion above, the lead emissions in the Columbus, GA-AL MSA continue to decrease due to the source no longer using emitting lead, and the lead monitors in this area may no longer be required. Also, the $PM_{2.5}$ network has been evolving from the integrated FRM method to the continuous FEM method, and going forward the GA AAMP will be evaluating both $PM_{2.5}$ methods and networks.

7.0 Measured Concentrations

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 98th 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 4th daily maximum value of the 8-hour averages. For this analysis, to give a more comprehensive look at the data, five-year averages from 2014 to 2018 of the $PM_{2.5}$ 98th percentile, $PM_{2.5}$ annual means, and ozone 4th 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 7.1: $PM_{2.5}$ 24-Hour Site Rankings Measured Concentrations

Measured Concentrations $PM_{2.5}$ 98th Percentile 2014-2018			
Site ID	**Site Name**	**Average ($\mu g/m^3$)**	**Proportion Ranking**
132150011	Columbus-Cussetta	26.9	1.00
130950007	Albany	23.1	0.68
131210056	*NR-GA Tech	21.3	0.52
132450091	Augusta	21.2	0.52
131270006	Brunswick	20.4	0.45
133030001	Sandersville	20.1	0.43
130210007	Macon-Allied	19.8	0.40
130511002	*Savannah-L&A	19.7	0.39
131210039	Fire Station #8	19.1	0.34
130630091	Forest Park	19.0	0.33
132150008	Columbus-Airport	18.7	0.31
132150001	Columbus-Health Dept.	18.7	0.30
130890002	South DeKalb	18.4	0.28
132950002	Rossville	18.3	0.27
13139003	Gainesville	17.9	0.24
131530001	Warner Robins	17.9	0.24
130670003	Kennesaw	17.9	0.24
131850003	Valdosta	17.4	0.20
130590002	Athens	17.3	0.19

Measured Concentrations $PM_{2.5}$ 98th Percentile 2014-2018			
Site ID	**Site Name**	**Average ($\mu g/m^3$)**	**Proportion Ranking**
131350002	Gwinnett	17.1	0.17
130210012	Macon-Forestry	16.0	0.08
130690002	*General Coffee	15.1	0.00

***Site averages not for all 5 years**

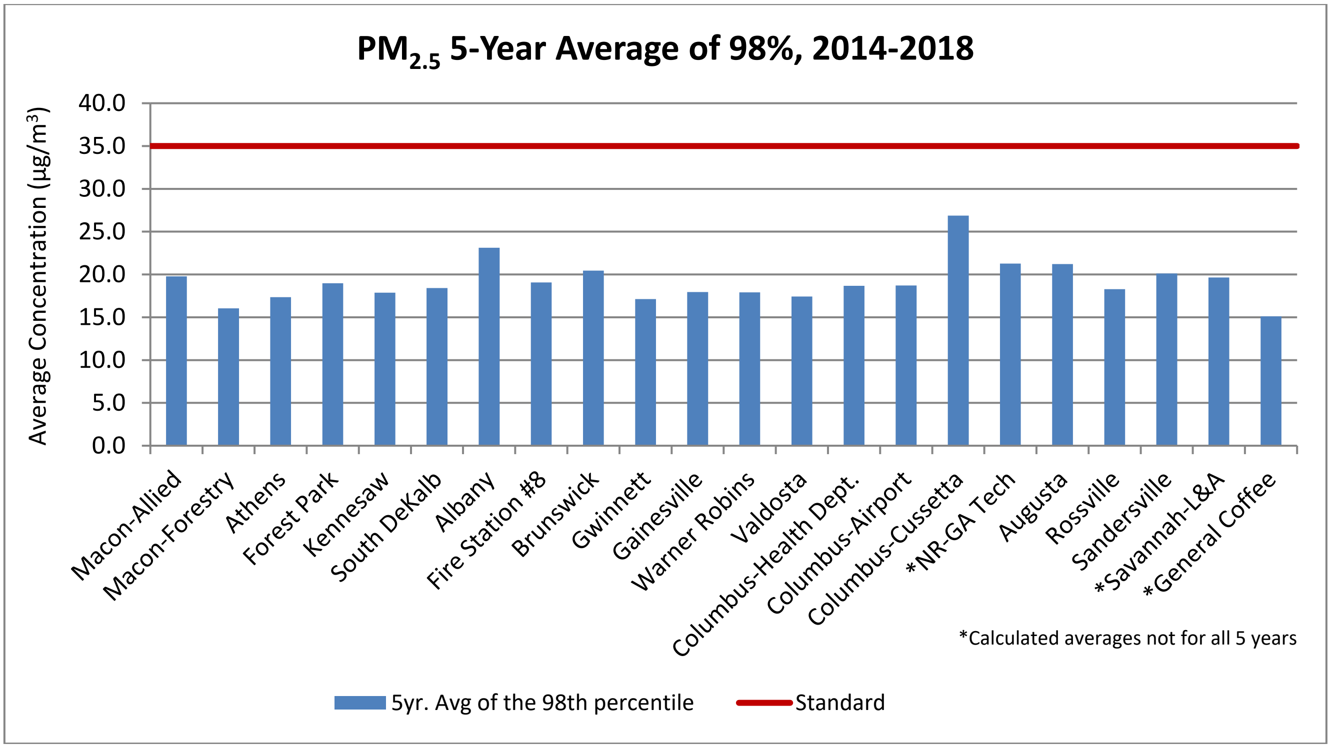


Figure 7.1: $PM_{2.5}$ 24hr 5 year 98th Average

For the 5-year averages of $PM_{2.5}$ 24-hour design values, the Columbus-Cusseta, Albany, and Augusta sites would rank the highest. The $PM_{2.5}$ values in the Columbus and Albany areas can be affected by prescribed fires and agricultural burns that take place nearby. The Macon-Forestry and Gwinnett Tech sites would rank the lowest for the $PM_{2.5}$ 24-hour values of 5-year averages. The Savannah-L&A and General Coffee sites are ranked lower, however, the averages for these sites is used with data from only 2017 to 2018.

$PM_{2.5}$ Annual Mean 2014-2018 Average of 5 Yr. Averages			
Site ID	Site Name	Average ($\mu g/m^3$)	Proportion Ranking
131210056	*NR-GA Tech	10.2	1.00
131210039	Fire Station # 8	9.9	0.92
130210007	Macon-Allied	9.7	0.86
130511002	*Savannah-L&A	9.7	0.85
130630091	Forest Park	9.5	0.80
132150011	Columbus-Cussetta	9.4	0.77
130950007	Albany	9.2	0.71
132150001	Columbus-Health Dept.	9.2	0.71
132450091	Augusta	9.1	0.70
130670003	Kennesaw	9.1	0.68
132150008	Columbus-Airport	8.9	0.65
132950002	Rossville	8.9	0.63
130890002	South DeKalb	8.8	0.61
131350002	Gwinnett	8.5	0.53
130590002	Athens	8.4	0.49
133030001	Sandersville	8.4	0.49
131530001	Warner Robins	8.3	0.46
13139003	Gainesville	7.9	0.35
131850003	Valdosta	7.8	0.34
131270006	Brunswick	7.5	0.25
130210012	Macon-Forestry	7.4	0.23
130690002	*General Coffee	6.6	0.00

*****Site averages not for all 5 years

Table 7.2: $PM_{2.5}$ Annual 5 Year Averages

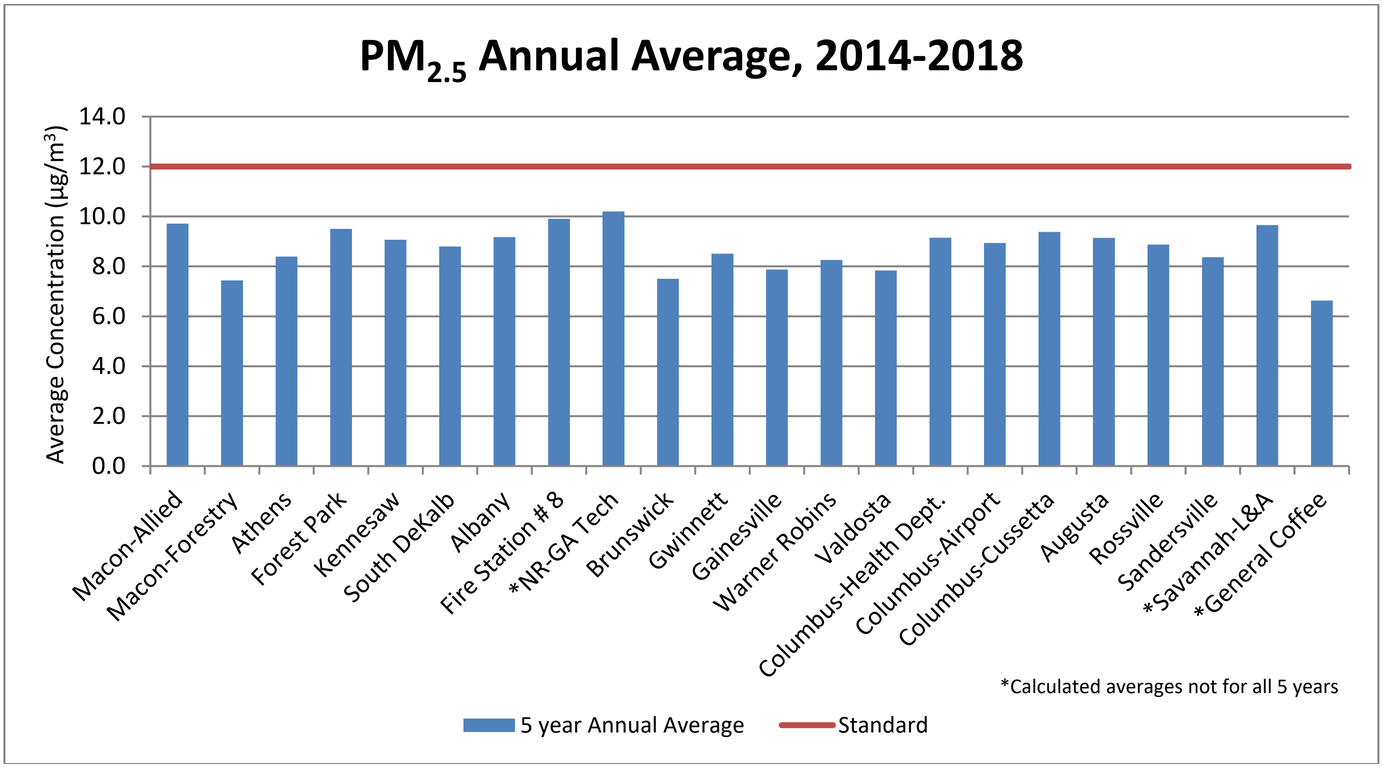


Figure 7.2: $PM_{2.5}$ Annual Measured Concentrations

For the $PM_{2.5}$ Annual design values 5-year averages, the NR-GA Tech, Macon-Allied and Fire Station # 8 sites would rank the highest, and the Macon-Forestry, Brunswick and General Coffee sites would rank the lowest. Note: the Savannah L&A, NR-GA Tech, and General Coffee sites do not have five years of data.

Table 7.3: Ozone Sites Ranked, Measured Concentrations

Five Year Average 2014-2018 of 4th Max Ozone			
Site ID	Site Name	Average (ppb)	Proportion Ranking
131210055	United Ave.	0.074	1.00
131510002	McDonough	0.071	0.88
132470001	Conyers	0.071	0.88
130890002	South DeKalb	0.070	0.84
131350002	Gwinnett Tech	0.069	0.80
130970004	Douglasville	0.067	0.72
130670003	Kennesaw	0.066	0.68
132319991	CASTNET	0.066	0.68
132130003	Fort Mtn.	0.065	0.64
130850001	Dawsonville	0.065	0.64
130210012	Macon-Forestry	0.064	0.60
130590002	Athens	0.064	0.60
132450091	Augusta	0.061	0.48
130550001	Summerville	0.061	0.48
130730001	Evans	0.060	0.44
132611001	Leslie	0.060	0.44
130510021	Savannah-E. Pres. St.	0.058	0.36
131270006	Brunswick	0.057	0.32
132150008	Columbus-Airport	0.049	0.00

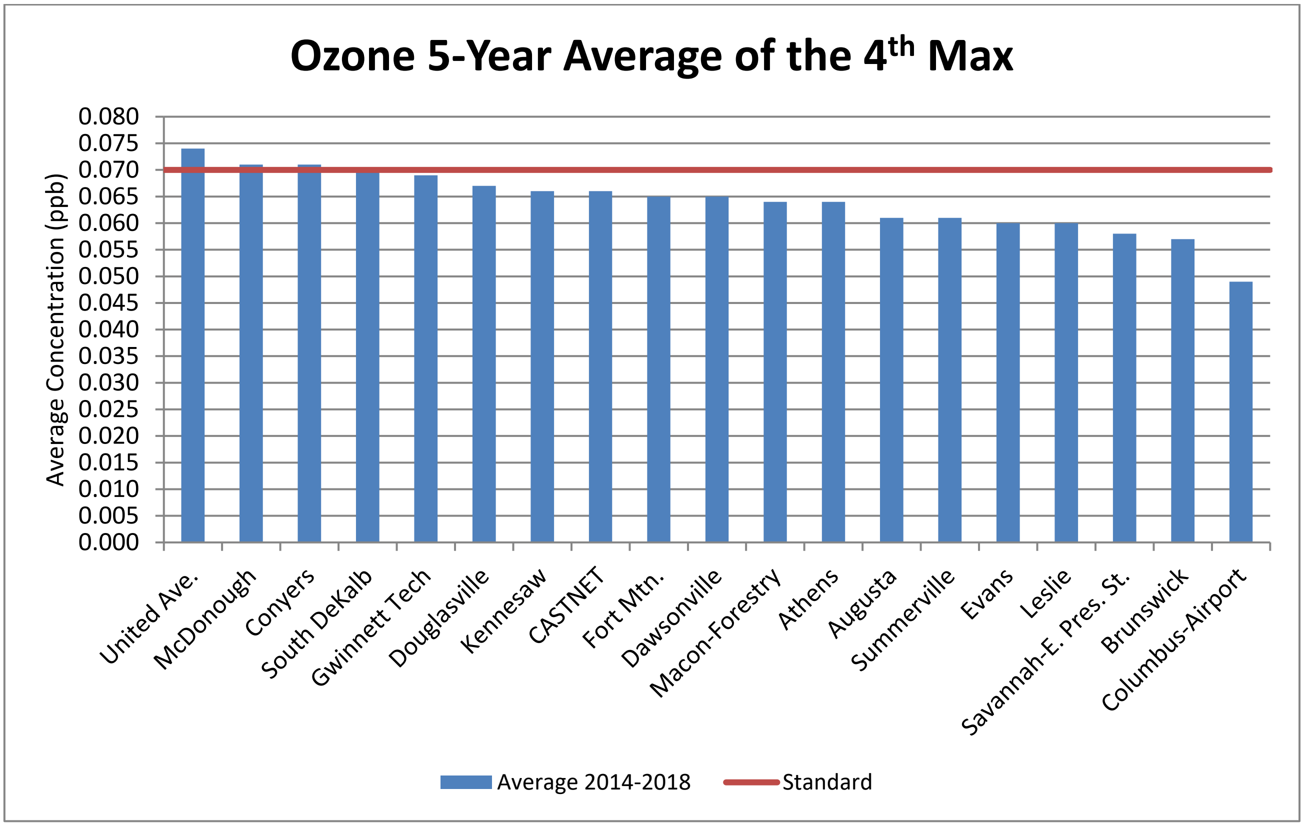


Figure 7.3: Ozone Measured Concentrations

With the ozone design values, the Savannah-E. Pres. St., Brunswick, and Columbus-Airport sites would rank the least important. The United Ave, McDonough, and Conyers sites show the highest design values across the timeframe and would rank the highest with this type of assessment.

7.1 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 2014 to 2018 data was used from AQS.

Table 7.4 gives the total score for each site. The Columbus-Cussetta site received the highest overall score while the Evans, Leslie, Savannah-E. Pres. St., and General Coffee sites ranked the lowest. Although General Coffee ranked the lowest of all, this site would not be recommended for consolidation or closure with this assessment because the data began in 2017. With this assessment, the three sites, Evans, Leslie, and Savannah-E. Pres. St., could be recommended to be shut down or consolidated.

Table 7.4: Sum of $PM_{2.5}$ 24 Hour, $PM_{2.5}$ Annual, and Ozone Ranking Scores for Each Site

Site ID	Site Name	$PM_{2.5}$ 24 Hour Score	$PM_{2.5}$ Annual Score	Ozone Score	Total Ranking Score
132150011	Columbus-Cussetta	1.00	0.77		1.77
130890002	South DeKalb	0.28	0.61	0.84	1.73
132450091	Augusta	0.52	0.70	0.48	1.70
130670003	Kennesaw	0.24	0.68	0.68	1.60
131210056	*NR-GA Tech	0.52	1.00		1.52
131350002	Gwinnett	0.17	0.53	0.80	1.50
130950007	Albany	0.68	0.71		1.39
130590002	Athens	0.19	0.49	0.60	1.28
130210007	Macon-Allied	0.40	0.86		1.26
131210039	Fire Station # 8	0.34	0.92		1.25
130511002	*Savannah-L&A	0.39	0.85		1.23
130630091	Forest Park	0.33	0.80		1.13
131270006	Brunswick	0.45	0.25	0.32	1.02
132150001	Columbus-Health Dept.	0.30	0.71		1.01
131210055	United Ave.			1.00	1.00
132150008	Columbus-Airport	0.31	0.365	0.00	0.95
133030001	Sandersville	0.43	0.49		0.91
130210012	Macon-Forestry	0.08	0.23	0.60	0.91
132950002	Rossville	0.27	0.63		0.90
131510002	McDonough			0.88	0.88
132470001	Conyers			0.88	0.88
130970004	Douglasville			0.72	0.72
131530001	Warner Robins	0.24	0.46		0.69
132319991	CASTNET			0.68	0.68
130850001	Dawsonville			0.64	0.64
132130003	Fort Mountain			0.64	0.64
131390003	Gainesville	0.24	0.35		0.59
131850003	Valdosta	0.20	0.34		0.53
130550001	Summerville			0.48	0.48
130730001	Evans			0.44	0.44
132611001	Leslie			0.44	0.44
130510021	Savannah-E. Pres. St.			0.36	0.36
130690002	*General Coffee	0.00	0.00		0.00

8.0 Deviation from the NAAQS

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 2014-2016 through 2016-2018 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 (2014 to 2018) are compared to the actual standard as indicated. The data was used through 2018 and NAAQS standards as of 2018 were used in this analysis due to the inception and deadline of the document.

8.1 Ozone

The following table displays the three-year design values for ozone from 2014 to 2018. 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 0.060 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.

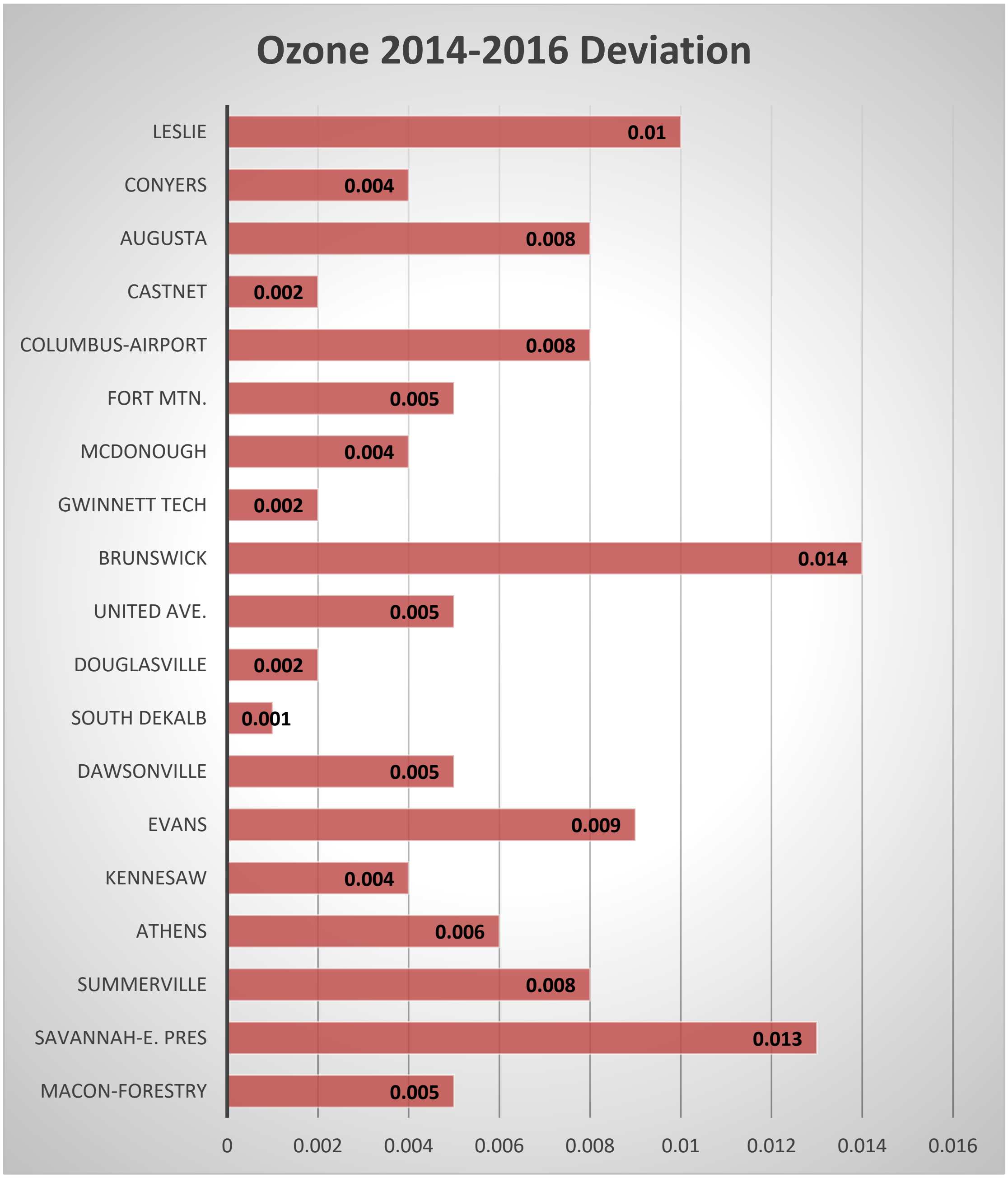
Ozone Sites	2014-2016 (ppm)	Absolute Value from NAAQS	Rank	2015-2017 (ppm)	Absolute Value from NAAQS	Rank	2016-2018 (ppm)	Absolute Value from NAAQS	Rank	Total Ranking
Macon-Forestry	0.065	0.005	**0.5**	0.065	0.005	**0.5**	0.065	0.005	**0.5**	**1.5**
Savannah-E Pres St	0.057	0.013	**0.0**	0.057	0.013	**0.0**	0.057	0.013	**0.0**	**0.0**
Summerville	0.062	0.008	**0.5**	0.061	0.009	**0.5**	0.060	0.010	**0.5**	**1.5**
Athens	0.064	0.006	**0.5**	0.064	0.006	**0.5**	0.065	0.005	**0.5**	**1.5**
Kennesaw	0.066	0.004	**0.5**	0.067	0.003	**0.5**	0.066	0.004	**0.5**	**1.5**
Evans	0.061	0.009	**0.5**	0.059	0.011	**0.0**	0.060	0.010	**0.5**	**1.0**
Dawsonville	0.065	0.005	**0.5**	0.065	0.005	**0.5**	0.065	0.005	**0.5**	**1.5**
South DeKalb	0.071	0.001	**0.5**	0.071	0.001	**0.5**	0.069	0.001	**0.5**	**1.5**
Douglasville	0.068	0.002	**0.5**	0.069	0.001	**0.5**	0.067	0.003	**0.5**	**1.5**
United Ave	0.075	0.005	**0.5**	0.075	0.005	**0.5**	0.073	0.003	**0.5**	**1.5**
Brunswick	0.056	0.014	**0.0**	0.056	0.014	**0.0**	0.057	0.013	**0.0**	**0.0**
Gwinnett Tech	0.072	0.002	**0.5**	0.071	0.001	**0.5**	0.069	0.001	**0.5**	**1.5**

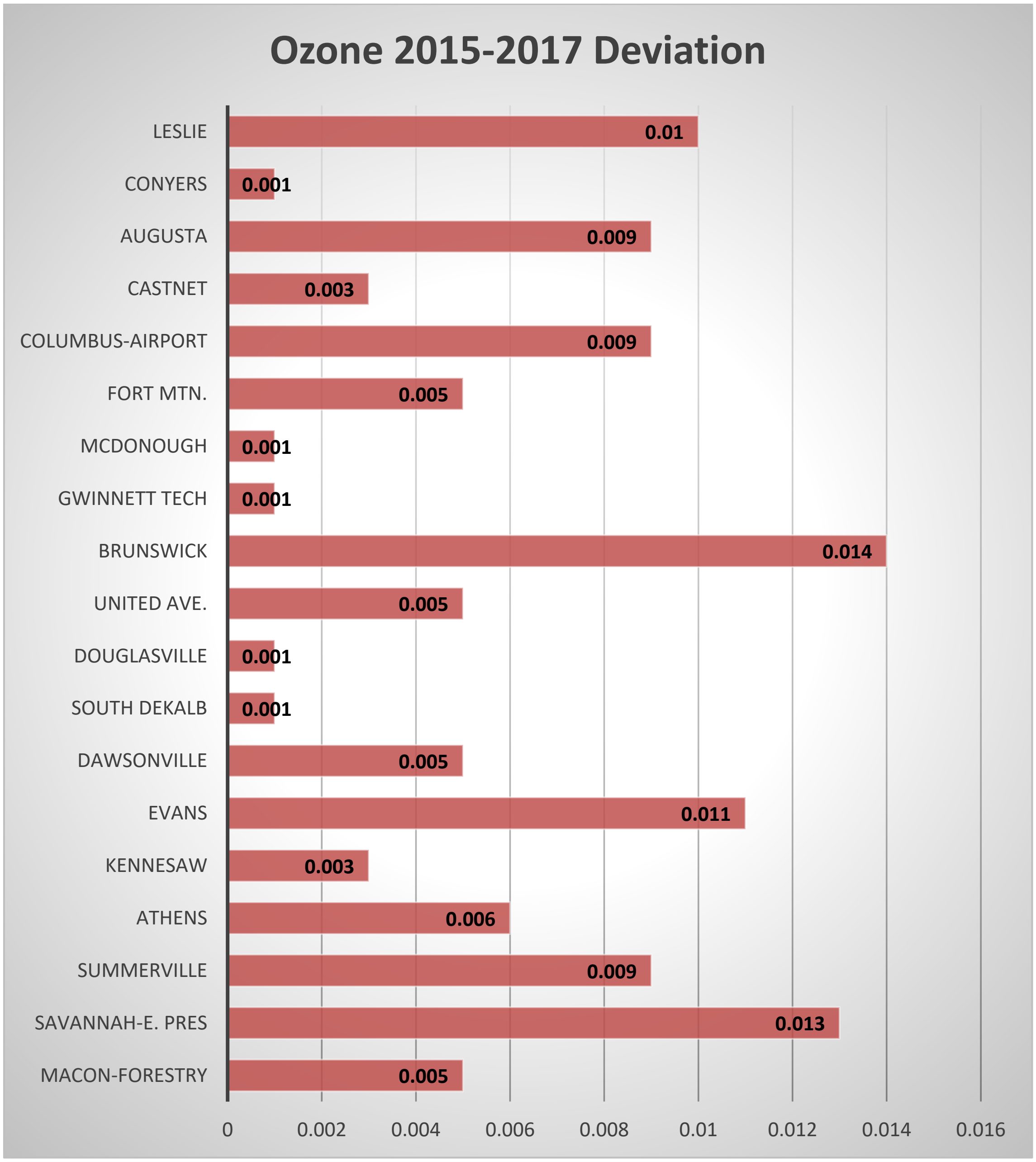
Ozone Sites	2014-2016 (ppm)	Absolute Value from NAAQS	Rank	2015-2017 (ppm)	Absolute Value from NAAQS	Rank	2016-2018 (ppm)	Absolute Value from NAAQS	Rank	Total Ranking
McDonough	0.074	0.004	**0.5**	0.071	0.001	**0.5**	0.071	0.001	**0.5**	**1.5**
Ft. Mountain	0.065	0.005	**0.5**	0.065	0.005	**0.5**	0.065	0.005	**0.5**	**1.5**
Columbus-Airport	0.062	0.008	**0.5**	0.061	0.009	**0.5**	0.060	0.010	**0.5**	**1.5**
CASTNET	0.068	0.002	**0.5**	0.067	0.003	**0.5**	0.066	0.004	**0.5**	**1.5**
Augusta	0.062	0.008	**0.5**	0.061	0.009	**0.5**	0.062	0.008	**0.5**	**1.5**
Conyers	0.074	0.004	**0.5**	0.069	0.001	**0.5**	0.070	0	**1.0**	**2.0**
Leslie	0.060	0.010	**0.5**	0.060	0.010	**0.5**	0.061	0.009	**0.5**	**1.5**

Figure 8.1: 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 site was the Conyers site, with a ranking of 2.0. The lowest ranking ozone sites were the Savannah-E. Pres. St. and 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 (0.059 ppm), 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 0.070 ppm. To aide in displaying this data graphically, the standard of 0.070 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 0.070 ppm, then it would be displayed in the graph as 0. The sites that were closest to the standard of 0.070 ppm are considered most important. The sites are shown in order of importance. The absolute value from the standard determined its 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 2014-2016 Deviation
LESLIE 0.01
CONYERS 0.004
AUGUSTA 0.008
CASTNET 0.002
COLUMBUS-AIRPORT 0.008
FORT MTN. 0.005
MCDONOUGH 0.004
GWINNETT TECH 0.002
BRUNSWICK 0.014
UNITED AVE. 0.005
DOUGLASVILLE 0.002
SOUTH DEKALB 0.001
DAWSONVILLE 0.005
EVANS 0.009
KENNESAW 0.004
ATHENS 0.006
SUMMERVILLE 0.008
SAVANNAH-E. PRES 0.013
MACON-FORESTRY 0.005
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016


Ozone 2015-2017 Deviation
LESLIE 0.01
CONYERS 0.001
AUGUSTA 0.009
CASTNET 0.003
COLUMBUS-AIRPORT 0.009
FORT MTN. 0.005
MCDONOUGH 0.001
GWINNETT TECH 0.001
BRUNSWICK 0.014
UNITED AVE. 0.005
DOUGLASVILLE 0.001
SOUTH DEKALB 0.001
DAWSONVILLE 0.005
EVANS 0.011
KENNESAW 0.003
ATHENS 0.006
SUMMERVILLE 0.009
SAVANNAH-E. PRES 0.013
MACON-FORESTRY 0.005
0 0.002 0.004 0.006 0.008 0.01 0.012 0.014 0.016

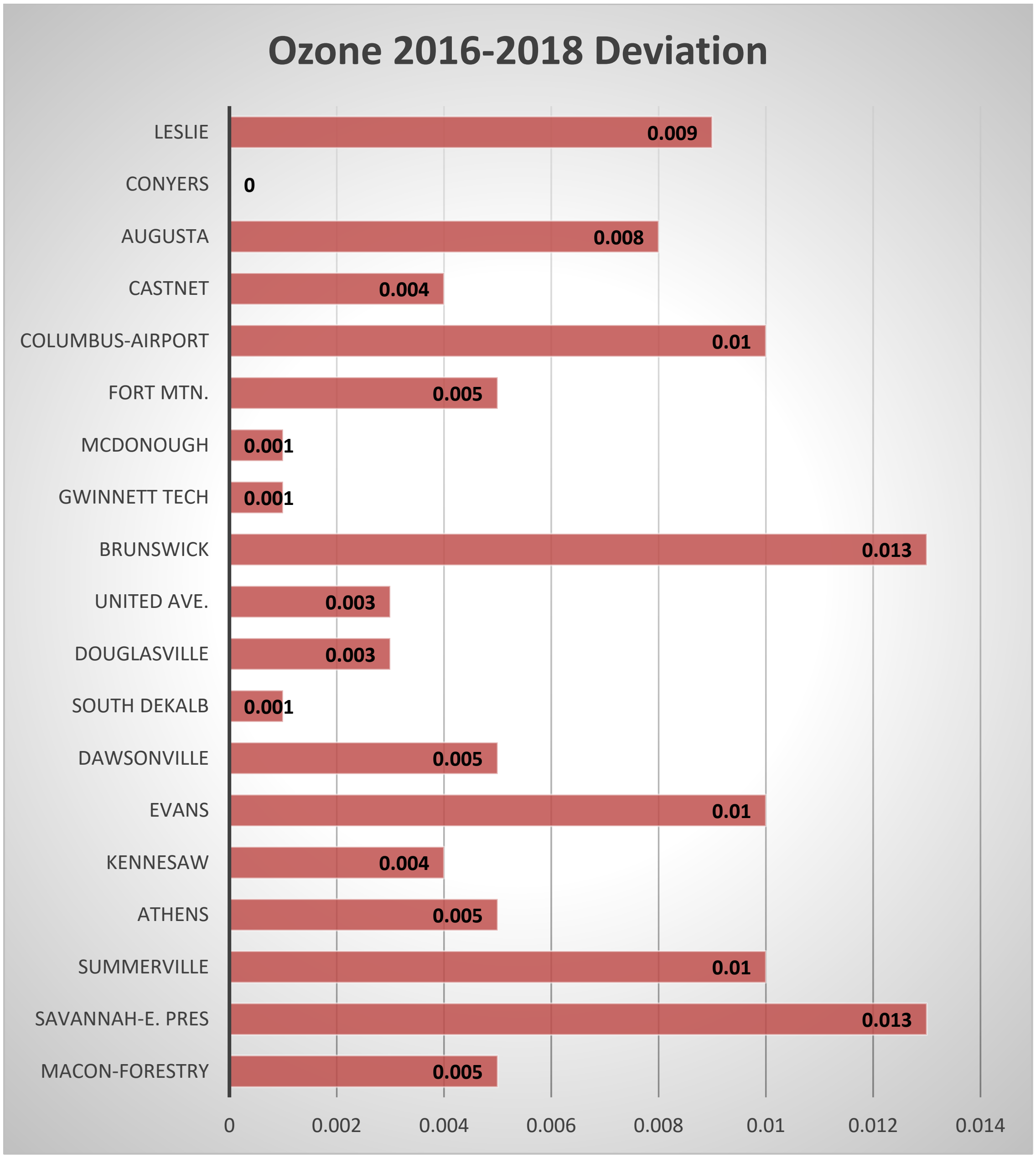


Figure 8.1: Ozone Deviation from the NAAQS (Absolute Value)

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 Tech, Conyers, McDonough, and Douglasville sites. The Brunswick and Savannah-E. Pres. sites are consistently the least important ozone sites with this type of analysis, having the largest deviation from the NAAQS.

8.2 $PM_{2.5}$ 24-Hour

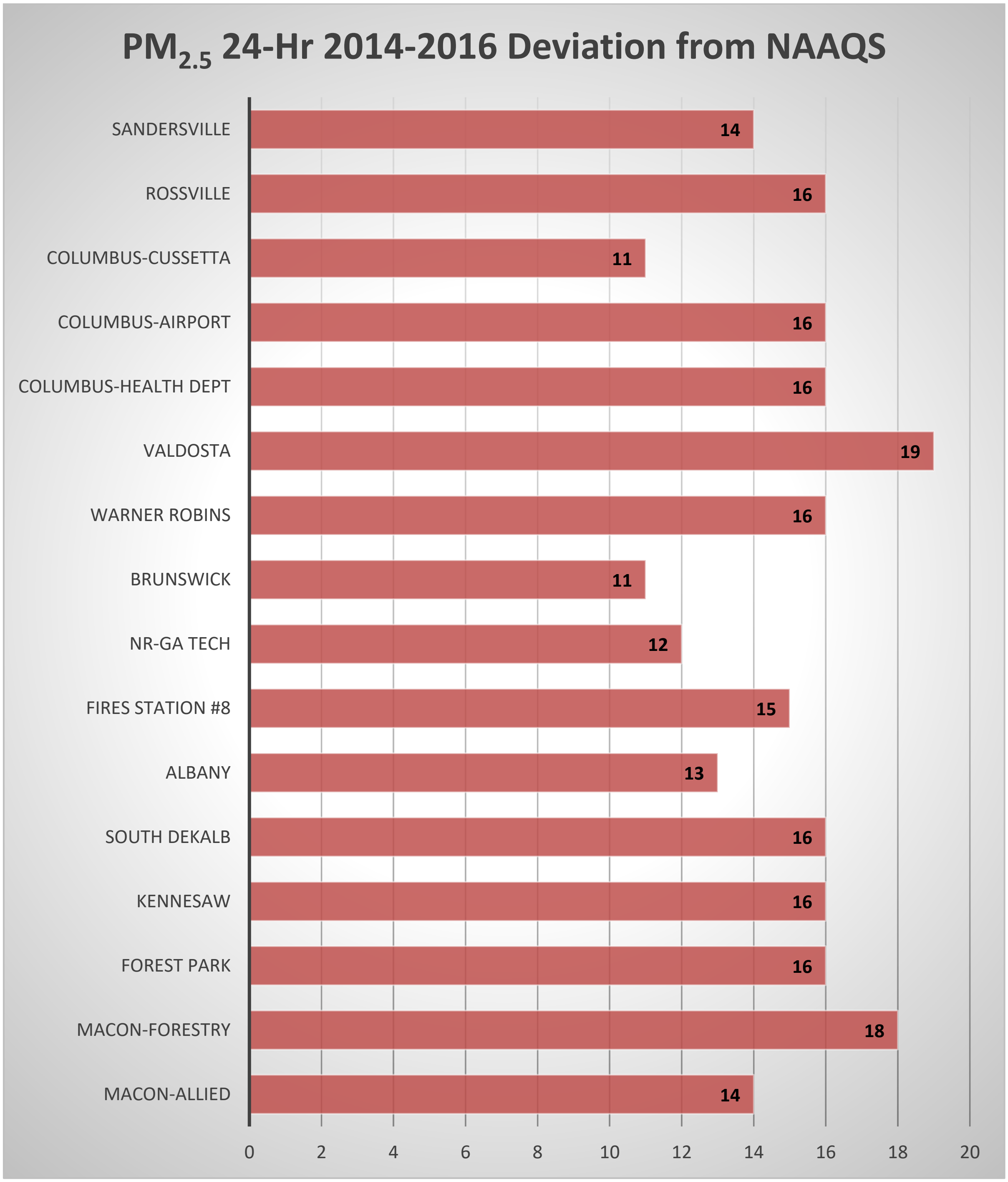
The following table displays the 2014 to 2018 24-hour $PM_{2.5}$ three-year design values in micrograms per cubic meter ($\mu g/m^3$). The National Ambient Air Quality Standard for 24-hour $PM_{2.5}$ is 35 $\mu g/m^3$. The ranking for each monitor is also displayed in the table. These rankings were determined 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.

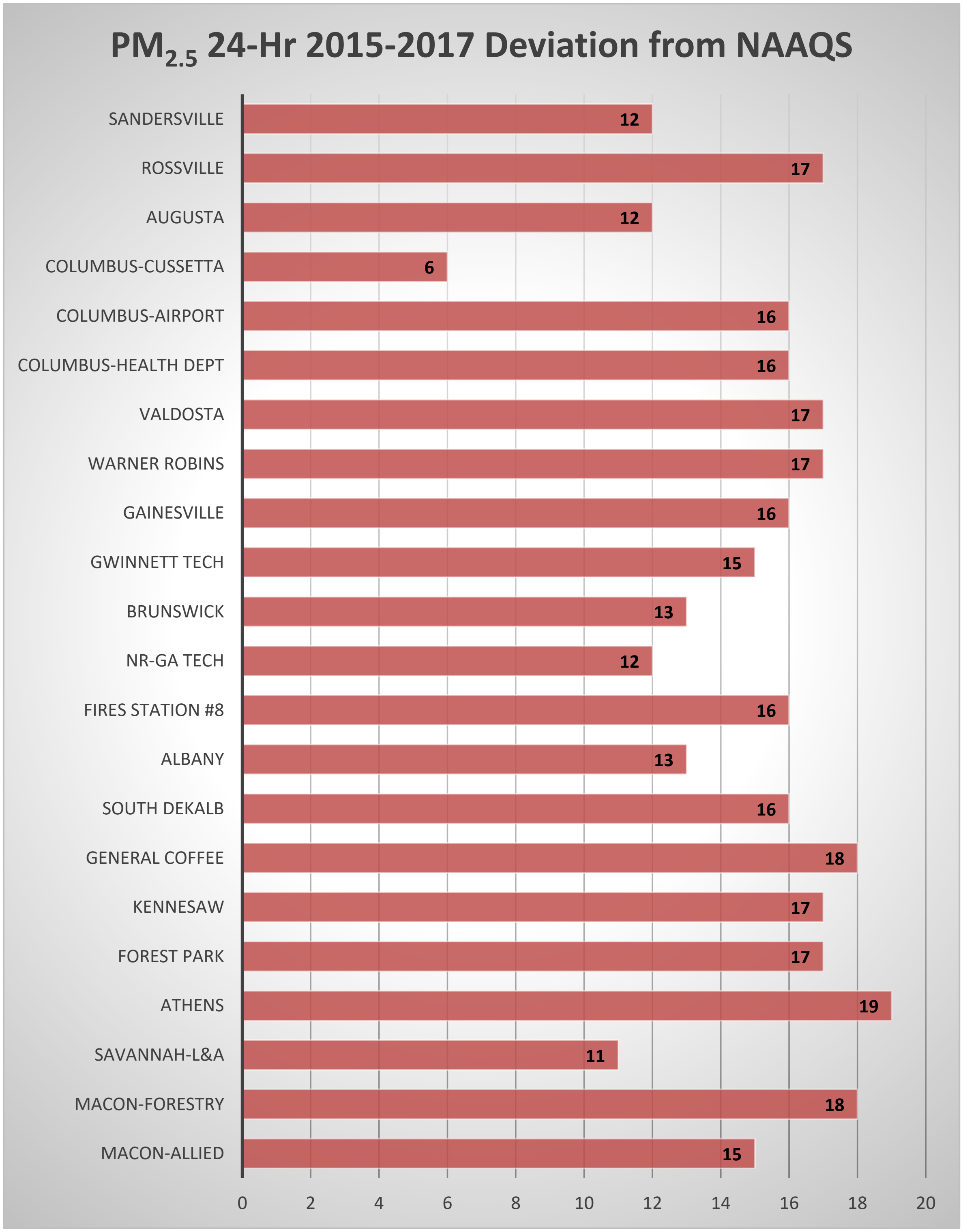
$PM_{2.5}$ 24-Hour	2014-2016	Absolute Value from NAAQS	Rank	2015-2017	Absolute Value from NAAQS	Rank	2016-2018	Absolute Value from NAAQS	Rank	Total Ranking
Macon-Allied	21	14	0	20	15	0	19	16	0	0.0
Macon-Forestry	17	18	0	17	18	0	16	19	0	0.0
Savannah-L&A	----	---	---	24	11	0	20	15	0	0.0
Athens	19	16	0	16	19	0	17	18	0	0.0
Forest Park	19	16	0	18	17	0	18	17	0	0.0
Kennesaw	19	16	0	18	17	0	17	18	0	0.0
General Coffee	---	---	---	17	18	0	15	20	0	0.0
South DeKalb	19	16	0	19	16	0	19	16	0	0.0
Albany	22	13	0	22	13	0	23	12	0	0.0
Fires Station #8	20	15	0	19	16	0	19	16	0	0.0
NR-GA Tech	23	12	0	23	12	0	21	14	0	0.0
Brunswick	24	11	0	22	13	0	22	13	0	0.0
Gwinnett Tech	18	17	0	20	15	0	21	14	0	0.0
Gainesville	20	15	0	19	16	0	19	16	0	0.0
Warner Robins	19	16	0	18	17	0	18	17	0	0.0
Valdosta	16	19	0	18	17	0	18	17	0	0.0
Columbus-Health Dept	19	16	0	19	16	0	19	16	0	0.0
Columbus-Airport	19	16	0	19	16	0	18	17	0	0.0
Columbus-Cussetta	24	11	0	29	6	0	32	3	0.5	0.5
Augusta	23	12	0	23	12	0	24	11	0	0.0
Rossville	19	16	0	18	17	0	18	17	0	0.0
Sandersville	21	14	0	23	12	0	21	14	0	0.0

Table 8.2: $PM_{2.5}$ 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 µg/m^3). The Columbus-Cussetta site was the only site that has a value close enough to the NAAQS to have a ranking 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 µg/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 µg/m^3.


PM2.5 24-Hr 2014-2016 Deviation from NAAQS
SANDERSVILLE
14
ROSSVILLE
16
COLUMBUS-CUSSETTA
11
COLUMBUS-AIRPORT
16
COLUMBUS-HEALTH DEPT
16
VALDOSTA
19
WARNER ROBINS
16
BRUNSWICK
11
NR-GA TECH
12
FIRES STATION #8
15
ALBANY
13
SOUTH DEKALB
16
KENNESAW
16
FOREST PARK
16
MACON-FORESTRY
18
MACON-ALLIED
14
0
2
4
6
8
10
12
14
16
18
20


PM2.5 24-Hr 2015-2017 Deviation from NAAQS
SANDERSVILLE 12
ROSSVILLE 17
AUGUSTA 12
COLUMBUS-CUSSETTA 6
COLUMBUS-AIRPORT 16
COLUMBUS-HEALTH DEPT 16
VALDOSTA 17
WARNER ROBINS 17
GAINESVILLE 16
GWINNETT TECH 15
BRUNSWICK 13
NR-GA TECH 12
FIRES STATION #8 16
ALBANY 13
SOUTH DEKALB 16
GENERAL COFFEE 18
KENNESAW 17
FOREST PARK 17
ATHENS 19
SAVANNAH-L&A 11
MACON-FORESTRY 18
MACON-ALLIED 15
0 2 4 6 8 10 12 14 16 18 20

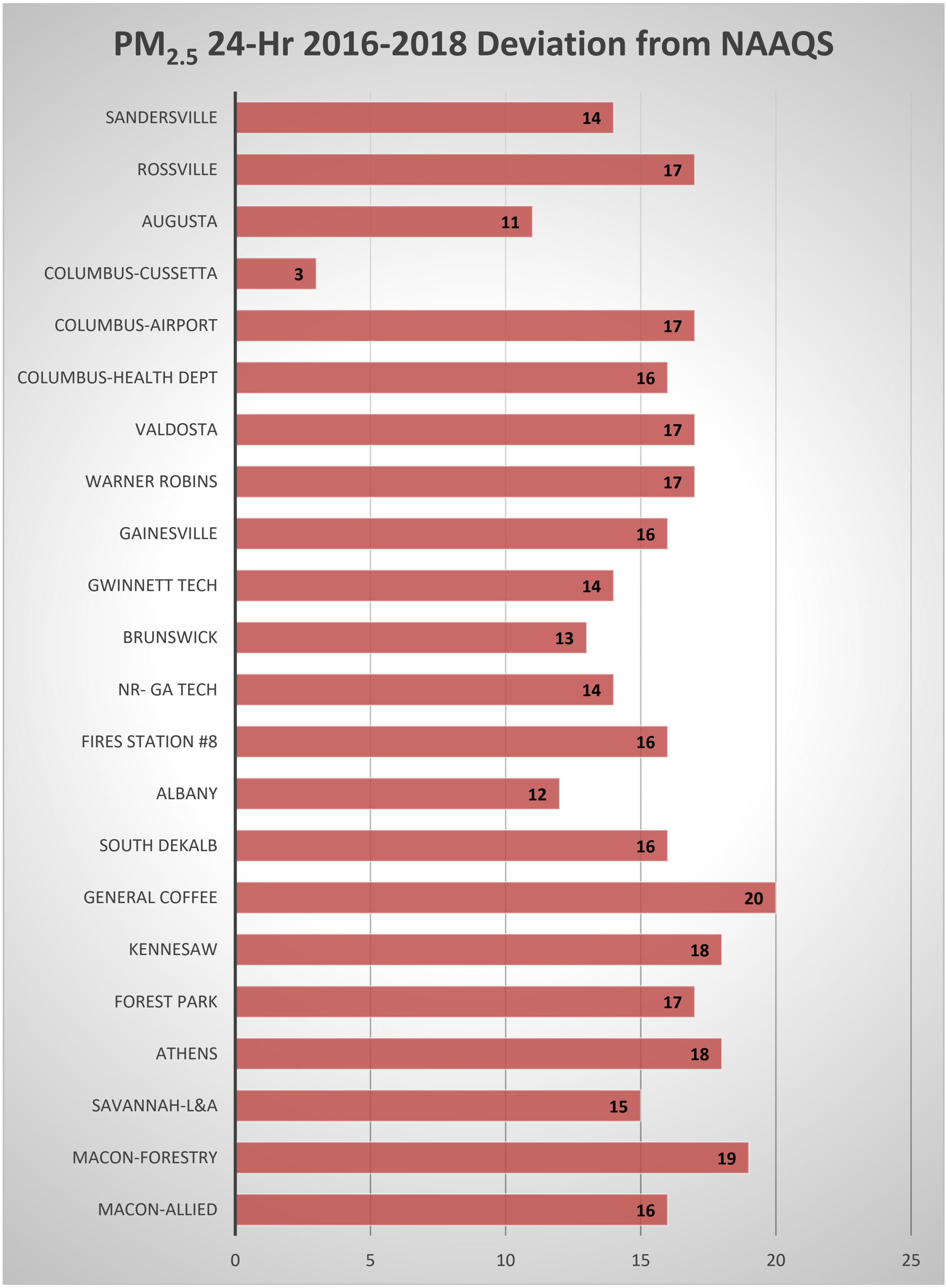


Figure 8.2: $PM_{2.5}$ 24-Hour Deviation from the NAAQS (Absolute Value)

8.3 $PM_{2.5}$ Annual

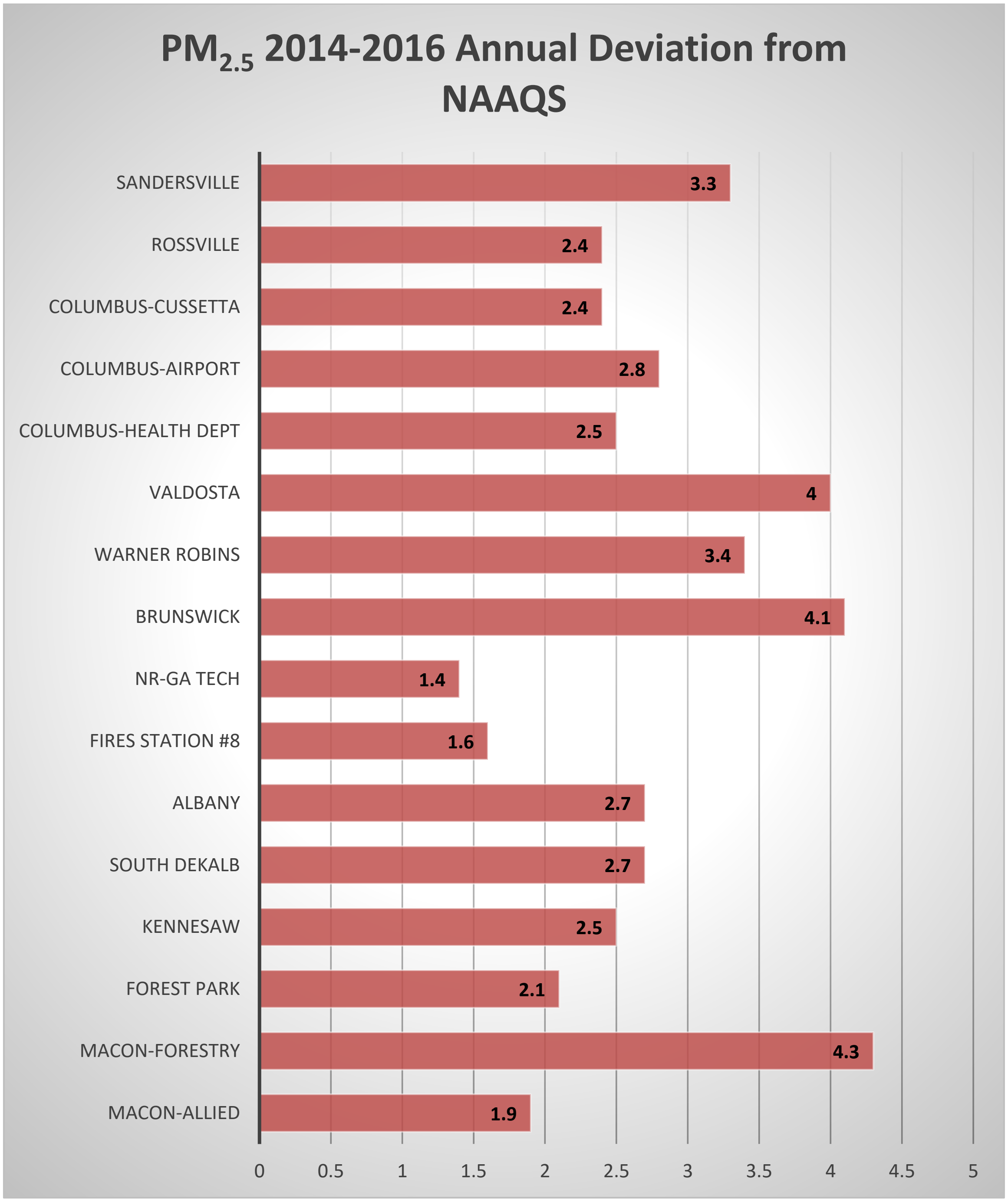
The following table displays the three-year design values for annual $PM_{2.5}$ from 2014 to 2018. Also shown in the table are the rankings for each monitor in Georgia AAMP's $PM_{2.5}$ network. These rankings were determined with a binning method as described above. Each three-year design value was 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.

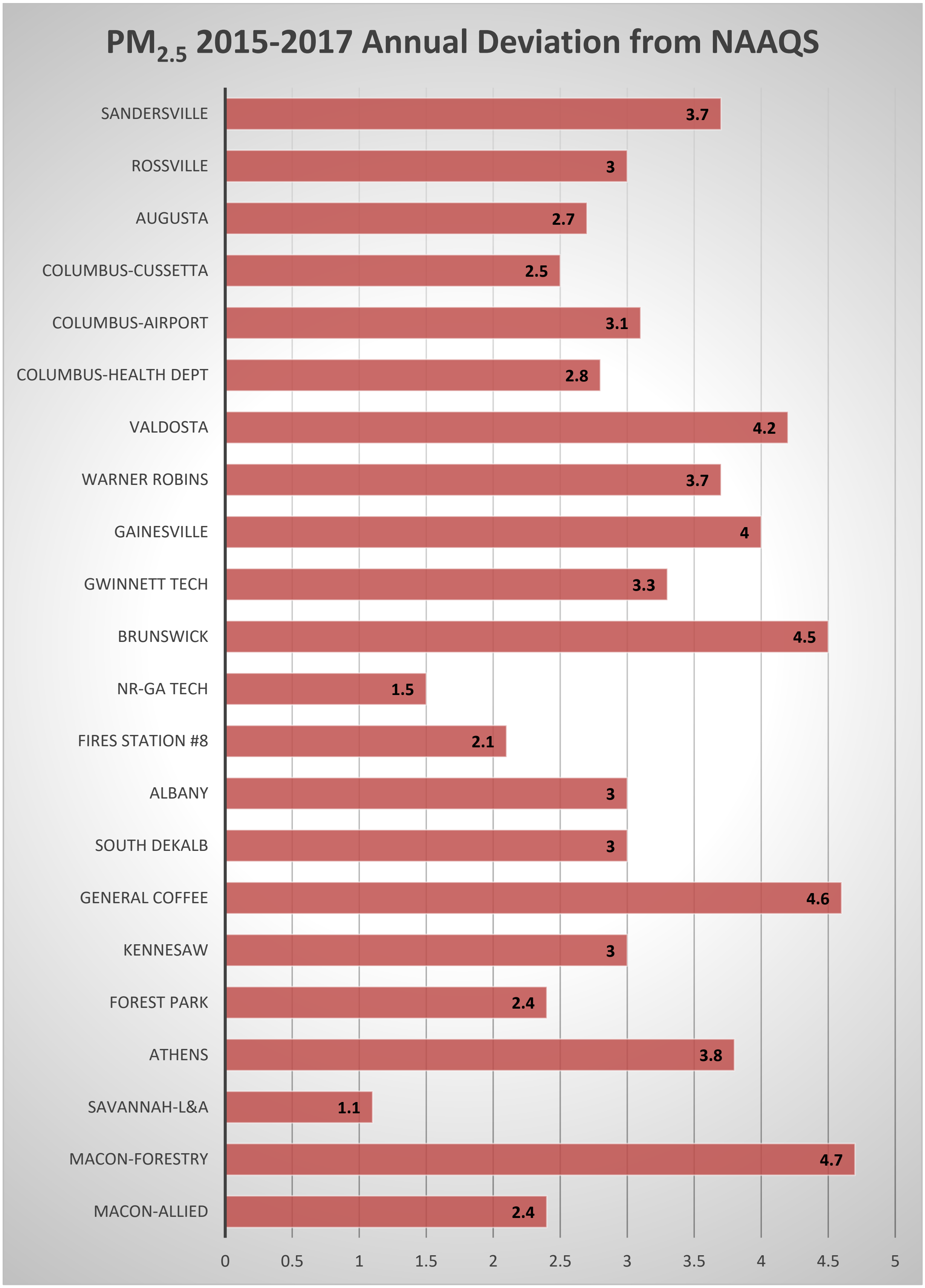
Table 8.3: $PM_{2.5}$ Annual Design Values and Ranking

$PM_{2.5}$ Annual	2014-2016 (µg/m^3)	Absolute Value from NAAQS	Rank	2015-2017 (µg/m^3)	Absolute Value from NAAQS	Rank	2016-2018 (µg/m^3)	Absolute Value from NAAQS	Rank	Total Ranking
Macon-Allied	10.1	1.9	**0.0**	9.6	2.4	**0.0**	9.3	2.7	**0.0**	**0.0**
Macon-Forestry	7.7	4.3	**0.0**	7.3	4.7	**0.0**	7.3	4.7	**0.0**	**0.0**
Savannah-L&A	----	---	**---**	10.9	1.1	**0.5**	9.6	2.4	**0.0**	**0.5**
Athens	9.0	3.0	**0.0**	8.2	3.8	**0.0**	8.1	3.9	**0.0**	**0.0**
Forest Park	9.9	2.1	**0.0**	9.6	2.4	**0.0**	9.1	2.9	**0.0**	**0.0**
Kennesaw	9.5	2.5	**0.0**	9.0	3.0	**0.0**	8.7	3.3	**0.0**	**0.0**
General Coffee	---	---	**---**	7.4	4.6	**0.0**	6.6	5.4	**0.0**	**0.0**
South DeKalb	9.3	2.7	**0.0**	9.0	3.0	**0.0**	8.6	3.4	**0.0**	**0.0**
Albany	9.3	2.7	**0.0**	9.0	3.0	**0.0**	8.8	3.2	**0.0**	**0.0**
Fires Station #8	10.4	1.6	**0.5**	9.9	2.1	**0.0**	9.4	2.6	**0.0**	**0.5**
NR-GA Tech	10.6	1.4	**0.5**	10.5	1.5	**0.5**	10.1	1.9	**0.0**	**1.0**
Brunswick	7.9	4.1	**0.0**	7.5	4.5	**0.0**	7.2	4.8	**0.0**	**0.0**
Gwinnett Tech	8.8	3.2	**0.0**	8.7	3.3	**0.0**	9.0	3.0	**0.0**	**0.0**
Gainesville	8.4	3.6	**0.0**	8.0	4.0	**0.0**	7.9	4.1	**0.0**	**0.0**
Warner Robins	8.6	3.4	**0.0**	8.3	3.7	**0.0**	8.3	3.7	**0.0**	**0.0**
Valdosta	8.0	4.0	**0.0**	7.8	4.2	**0.0**	7.4	4.6	**0.0**	**0.0**
Columbus-Health Dept	9.5	2.5	**0.0**	9.2	2.8	**0.0**	8.8	3.2	**0.0**	**0.0**
Columbus-Airport	9.2	2.8	**0.0**	8.9	3.1	**0.0**	8.6	3.4	**0.0**	**0.0**
Columbus-Cussetta	9.6	2.4	**0.0**	9.5	2.5	**0.0**	9.2	2.8	**0.0**	**0.0**
Augusta	9.6	2.4	**0.0**	9.3	2.7	**0.0**	9.5	2.5	**0.0**	**0.0**
Rossville	9.6	2.4	**0.0**	9.0	3.0	**0.0**	8.8	3.2	**0.0**	**0.0**
Sandersville	8.7	3.3	**0.0**	8.3	3.7	**0.0**	7.9	2.7	**0.0**	**0.0**

The majority of three-year averages were below 85% of the NAAQS, which is 10.2 µg/m^3, giving a ranking of 0.0 for that three-year average. Also, before the 2014-2016 averages, several sites had averages above the 85% of the NAAQS standard (10.2 µg/m^3), giving that site a ranking of 0.5. As a result, all the sites in the previous assessment had a total ranking of at least 0.5. The highest ranking site for the $PM_{2.5}$ annual standard is NR-GA Tech with a ranking of 1.0.

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/m^3.





PM2.5 2015-2017 Annual Deviation from NAAQS
SANDERSVILLE 3.7
ROSSVILLE 3
AUGUSTA 2.7
COLUMBUS-CUSSETTA 2.5
COLUMBUS-AIRPORT 3.1
COLUMBUS-HEALTH DEPT 2.8
VALDOSTA 4.2
WARNER ROBINS 3.7
GAINESVILLE 4
GWINNETT TECH 3.3
BRUNSWICK 4.5
NR-GA TECH 1.5
FIRES STATION #8 2.1
ALBANY 3
SOUTH DEKALB 3
GENERAL COFFEE 4.6
KENNESAW 3
FOREST PARK 2.4
ATHENS 3.8
SAVANNAH-L&A 1.1
MACON-FORESTRY 4.7
MACON-ALLIED 2.4
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5

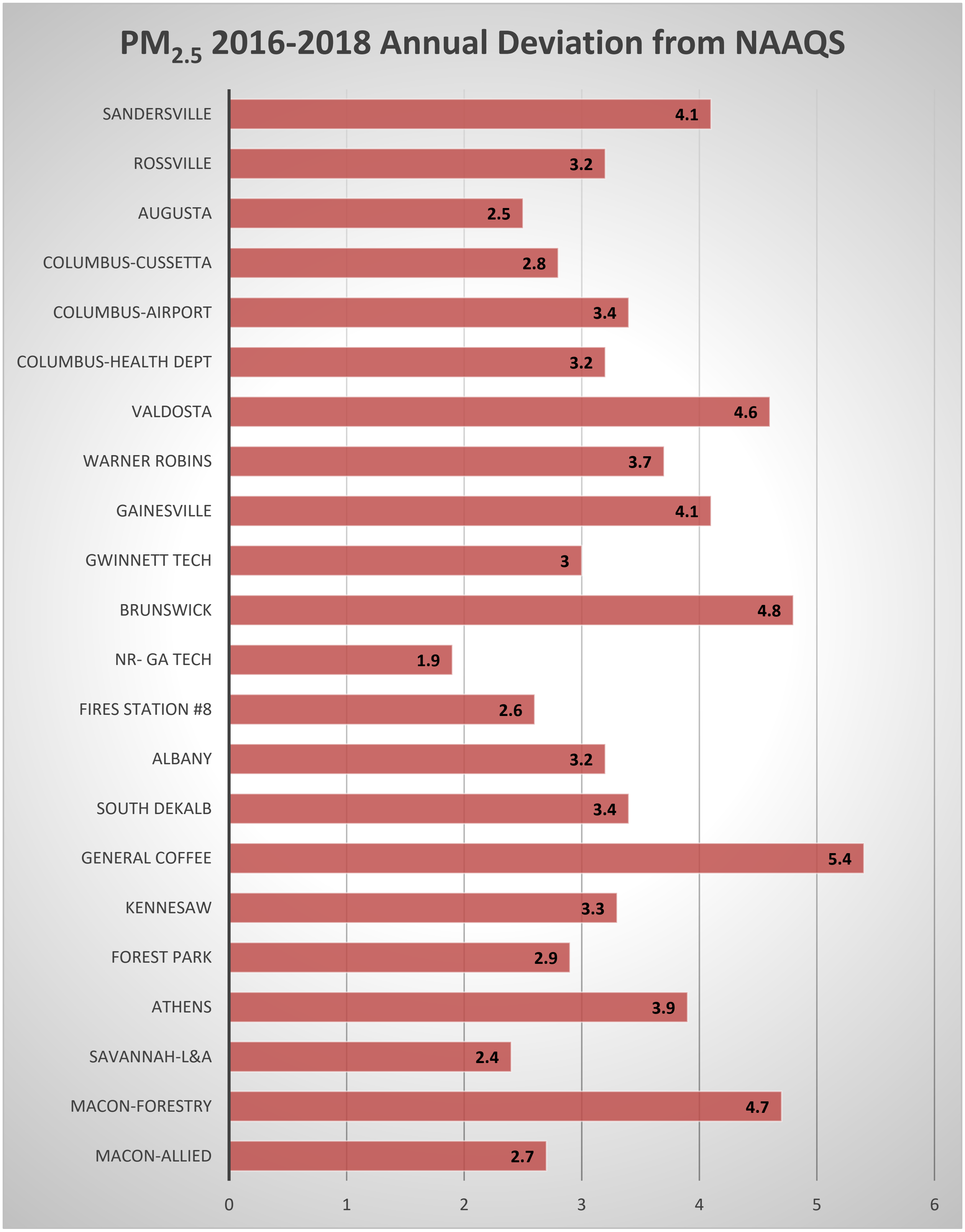


Figure 8.3: $PM_{2.5}$ Annual Deviation from the NAAQS (Absolute Value)

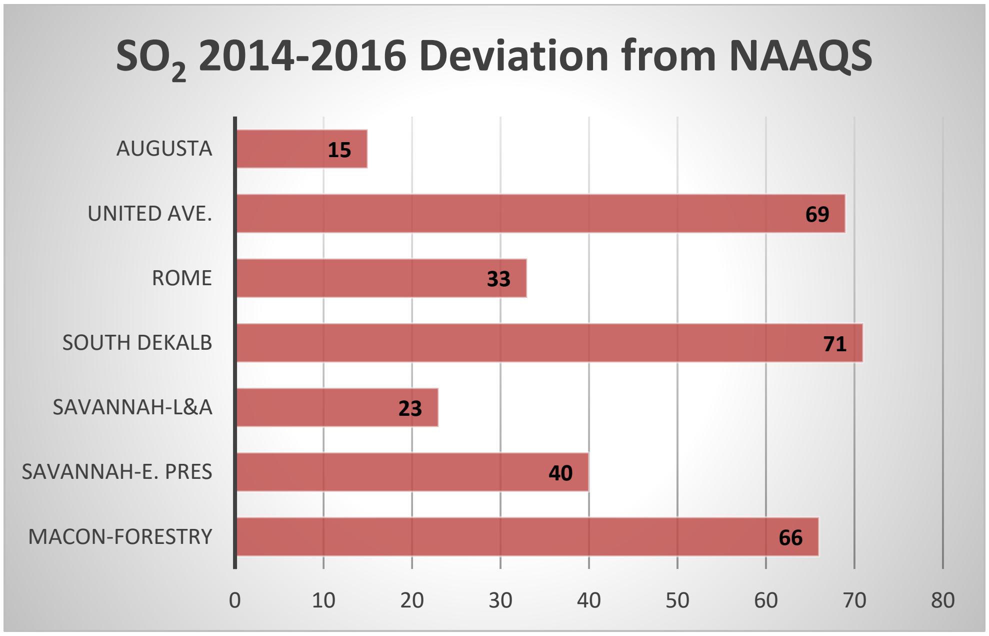
8.4 Sulfur Dioxide

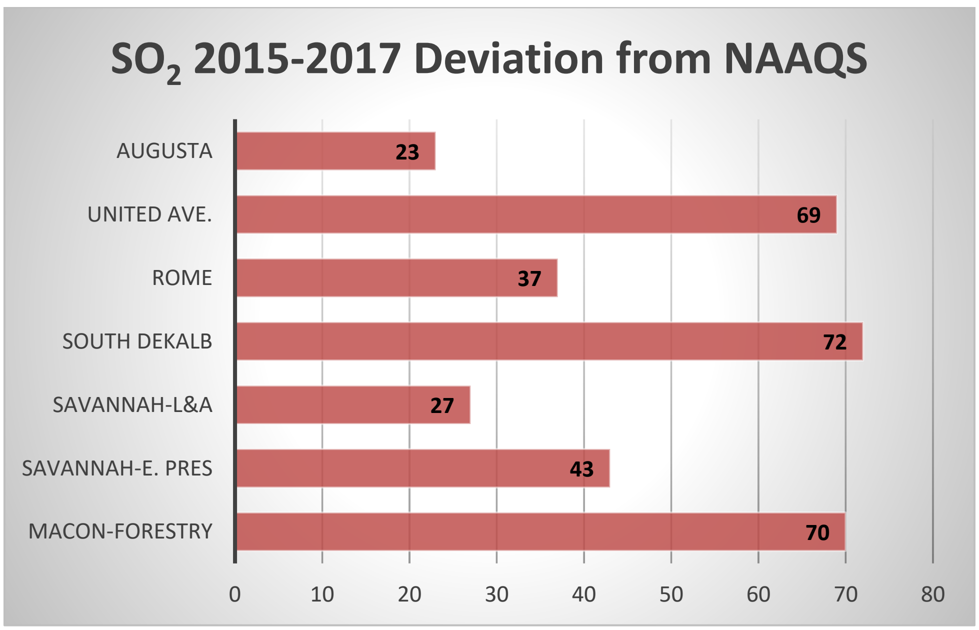
The sulfur dioxide (SO_2) National Ambient Air Quality standard compares the 99th percentile of 1-hour daily maximum concentrations, averaged for three years, compared to 75 ppb. The following table and graphs show these three-year averages from 2014-2016 to 2016-2018 compared to 75 ppb. As of 2018, there were seven SO_2 samplers collecting data in Georgia.

Table 8.4: Sulfur Dioxide Values and Ranking

SO_2 99% of daily 1-hr maxes, 75 ppb	Deviation from the NAAQS									
Site	**2014-2016**	**Absolute Value from NAAQS**	**Rank**	**2015-2017**	**Absolute Value from NAAQS**	**Rank**	**2016-2018**	**Absolute Value from NAAQS**	**Rank**	**Total Ranking**
Macon-Forestry	9	66	**0.0**	5	70	**0.0**	4	71	**0.0**	**0.0**
Savannah-E Pres.	35	40	**0.0**	32	43	**0.0**	32	43	**0.0**	**0.0**
Savannah-L&A	52	23	**0.0**	48	27	**0.0**	45	30	**0.0**	**0.0**
South DeKalb	4	71	**0.0**	3	72	**0.0**	2	73	**0.0**	**0.0**
Rome/Kraftsman	42	33	**0.0**	38	37	**0.0**	28	47	**0.0**	**0.0**
United Ave.	6	69	**0.0**	6	69	**0.0**	6	69	**0.0**	**0.0**
Augusta	60	15	**0.0**	52	23	**0.0**	52	23	**0.0**	**0.0**

For sulfur dioxide, 85% of the NAAQS is 63.75 ppb. The sulfur dioxide sites in this analysis all had a ranking of 0.0. The site with the highest three-year average of SO_2 was the Augusta site's 2014-2016 value of 60 ppb, which is 80% of the standard. All the sites have the lowest ranking of 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. All of the concentrations are well below the standard. The GA AAMP has been evaluating the need to continue monitoring SO_2 in the Rome MSA, as the SO_2 design value is below 50% of the NAAQS, and the population weighted emissions index (PWEI) is well below the threshold that requires a monitor in the area. Refer to the request to shut down the Rome SO_2 monitor as December 31, 2020 in Section 1.4 for more details.


SO_2 2014-2016 Deviation from NAAQS
AUGUSTA
UNITED AVE.
ROME
SOUTH DEKALB
SAVANNAH-L&A
SAVANNAH-E. PRES
MACON-FORESTRY
15
69
33
71
23
40
66
0
10
20
30
40
50
60
70
80


SO_2 2015-2017 Deviation from NAAQS
AUGUSTA
UNITED AVE.
ROME
SOUTH DEKALB
SAVANNAH-L&A
SAVANNAH-E. PRES
MACON-FORESTRY
23
69
37
72
27
43
70
0
10
20
30
40
50
60
70
80

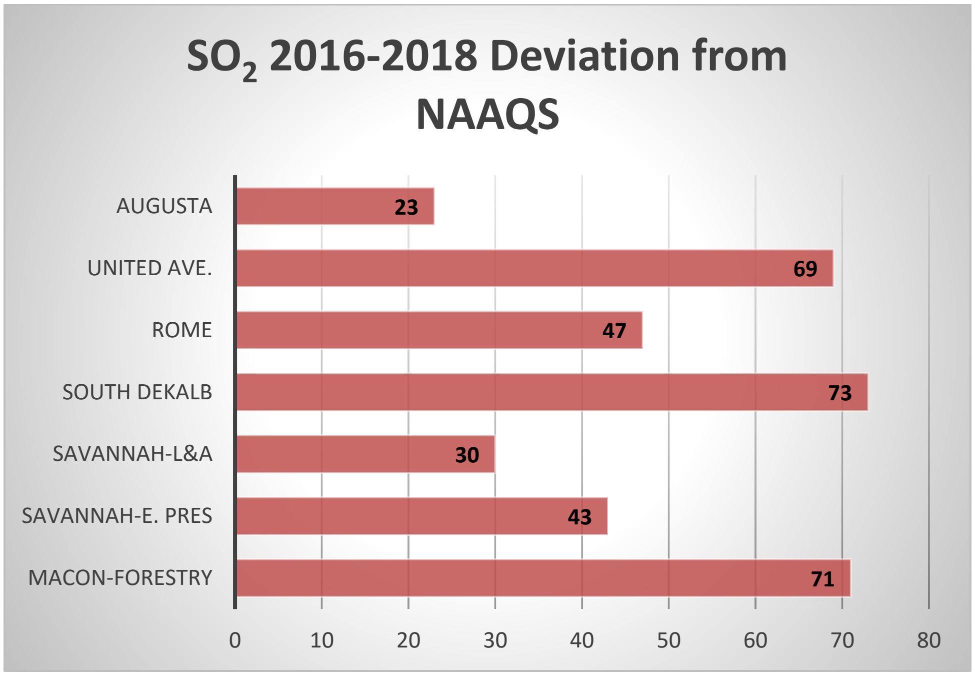


Figure 8.4: Sulfur Dioxide Deviation from the NAAQS (Absolute Value)

8.5 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 AAMP has two sites that collect criteria lead data. Both samplers are located in Muscogee County, at the Allied and Cusseta Elementary sites in Columbus. The following table displays the maximum quarterly averages for all the sites from 2014 to 2018. 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 µg/m^3 up to 0.1499 µg/m^3 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 8.5: Lead Values and Ranking

Lead 1st Max, 3-month rolling avg, 0.15 µg/m^3	**Deviation from the NAAQS**															
Site	**2014**	**Absolute Value from NAAQS**	**Rank**	**2015**	**Absolute Value from NAAQS**	**Rank**	**2016**	**Absolute Value from NAAQS**	**Rank**	**2017**	**Absolute Value from NAAQS**	**Rank**	**2018**	**Absolute Value from NAAQS**	**Rank**	**Total Ranking**
Columbus-Allied	0.0791	0.0709	**0.0**	0.0427	0.1073	**0.0**	0.3566	0.2066	**0.0**	0.3592	0.2092	**0.0**	0.0377	0.1123	**0.0**	**0.0**
Columbus-Cusseta	0.0183	0.1317	**0.0**	0.0112	0.1388	**0.0**	0.0750	0.0750	**0.0**	0.0669	0.0831	**0.0**	0.0068	0.1432	**0.0**	**0.0**

All sites had a ranking of 0.0 with the binning method since all of the concentrations were outside the ±85% threshold of the standard of 0.15 μg/m^3 (less 0.1274 μg/m^3 and greater than 0.1726 μg/m^3). The following graph displays the three-month rolling averages of the two lead sites in Columbus. The averages are compared to the standard, shown with a red line, and the actual values are shown instead of absolute values. The green line is the Columbus-Allied site, showing how this site had three-month averages above the standard at the end of 2016 and the beginning of 2017. In November 2016, there was a violation of the lead standard in Columbus due to a malfunction on a silo control and is reflected in the graph below. The lead concentrations in Columbus have decreased significantly.

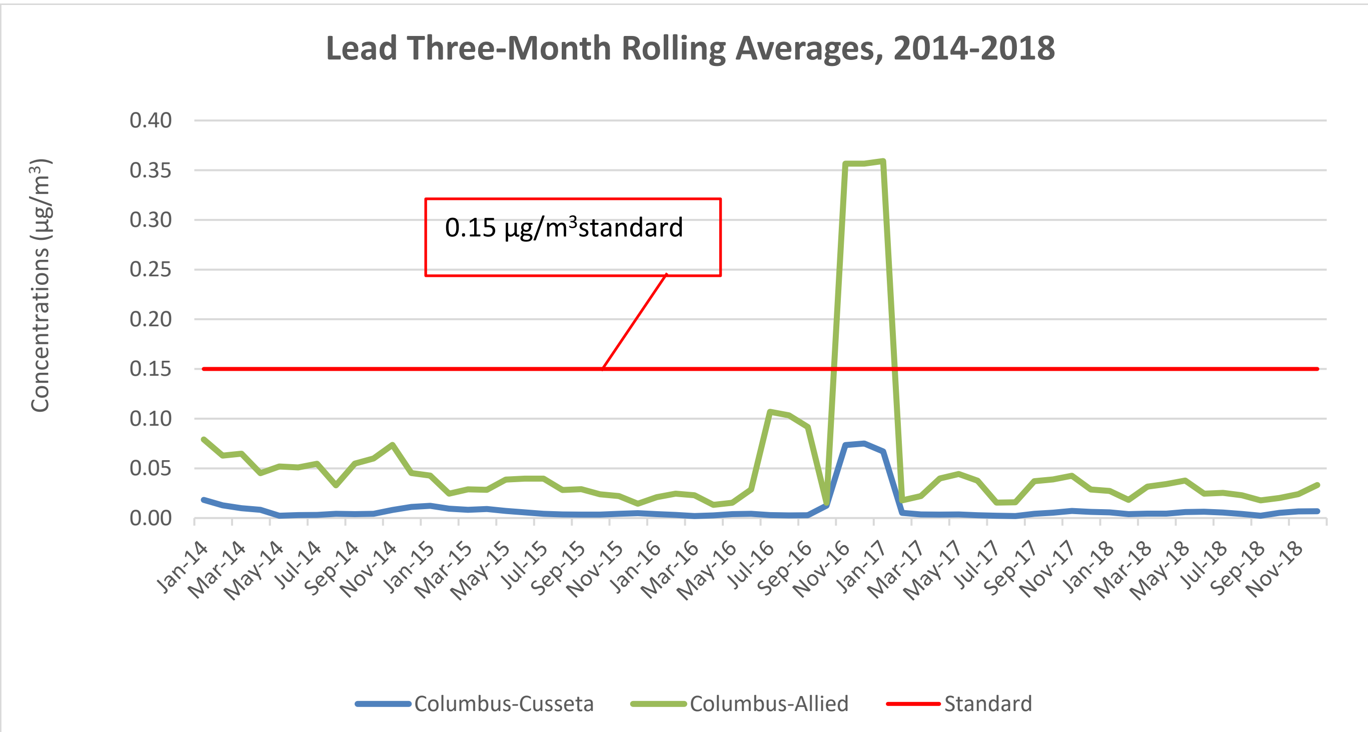


Figure 8.5: Lead Deviation from the NAAQS

8.6 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 2018, GA AAMP operates three PM_{10} monitors, located at the South DeKalb, Fires Station #8, and Augusta sites. 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 or above 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 8.6: PM_{10} Values and Ranking

PM_{10} 1st Max, 150 µg/m³	Deviation from the NAAQS										
Site	**2014**	**Rank**	**2015**	**Rank**	**2016**	**Rank**	**2017**	**Rank**	**2018**	**Rank**	**Total Rank**
South DeKalb	80	**0.0**	81	**0.0**	60	**0.0**	26	**0.0**	46	**0.0**	**0**
Fire Station #8	32	**0.0**	78	**0.0**	68	**0.0**	33	**0.0**	33	**0.0**	**0**
Augusta	50	**0.0**	33	**0.0**	43	**0.0**	475	**0.0**	27	**0.0**	**0**

The following graph displays the first maximum PM_{10} data shown in the table above for the three sites from 2014 to 2018. On average, all three sites have yearly maximum concentrations at least 70 µg/m³ below the standard. In January 2017, the Augusta PM_{10} integrated sampler experienced an anomaly that caused an unexplainably high value above the NAAQS. Therefore, on October 1, 2017, GA AAMP replaced the integrated sampler, which collected data every 6 days, with a continuous regulatory FEM to monitor hourly PM_{10} sampler as a proactive solution to collect data more frequently, and PM_{10} data is now available on a daily basis. If high values occur in the future that are at levels approaching or above the National Ambient Air Quality Standard, the number of PM_{10} monitors in the Augusta-Richmond County, GA-SC MSA may need to be reconsidered.

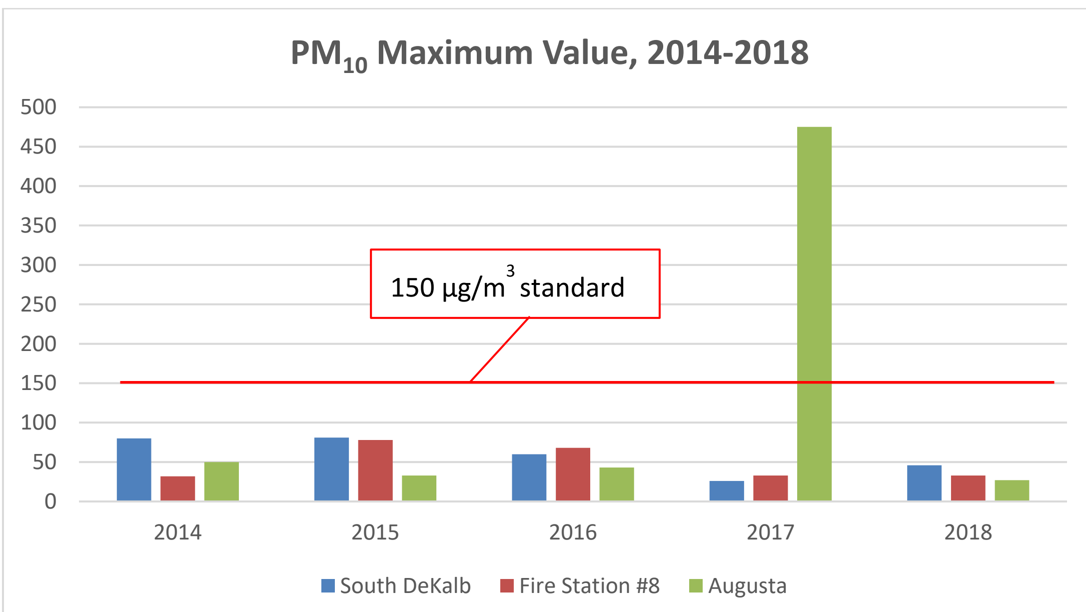


Figure 8.6: PM_{10} Deviation from the NAAQS

8.7 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 2018 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 8.7.1: Nitrogen Dioxide 1-Hr Design Values and Ranking

NO_2 98th Percentile of daily 1-hr maxes, 100 ppb	Deviation from the NAAQS						
Site	**2014-2016**	**Rank**	**2015-2017**	**Rank**	**2016-2018**	**Rank**	**Total Ranking**
South DeKalb	50	**0**	48	**0**	45	**0**	**0**
NR-285	58	**0**	56	**0**	53	**0**	**0**
NR-GA Tech	51	**0**	50	**0**	47	**0**	**0**

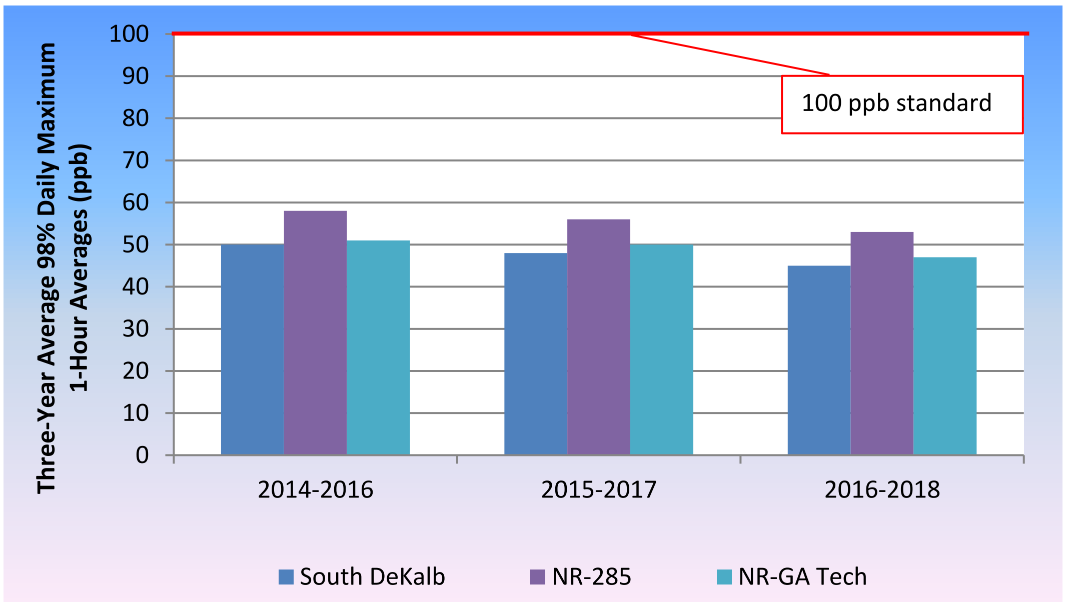


Figure 8.7.1: Nitrogen Dioxide Deviation from the NAAQS for 1-Hour Standard

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 8.7.2: Nitrogen Dioxide Annual Design Values and Ranking

NO_2 Annual, 53 ppb	Deviation from the NAAQS										
Site	2014	Rank	2015	Rank	2016	Rank	2017	Rank	2018	Rank	Total Ranking
South DeKalb	10.53	**0**	9.78	**0**	10.52	**0**	8.72	**0**	7.76	**0**	**0**
NR-285	---	**---**	15.86	**0**	16.94	**0**	14.91	**0**	14.72	**0**	**0**
NR-GA Tech	19.85	**0**	19.54	**0**	19.65	**0**	17.93	**0**	16.27	**0**	**0**

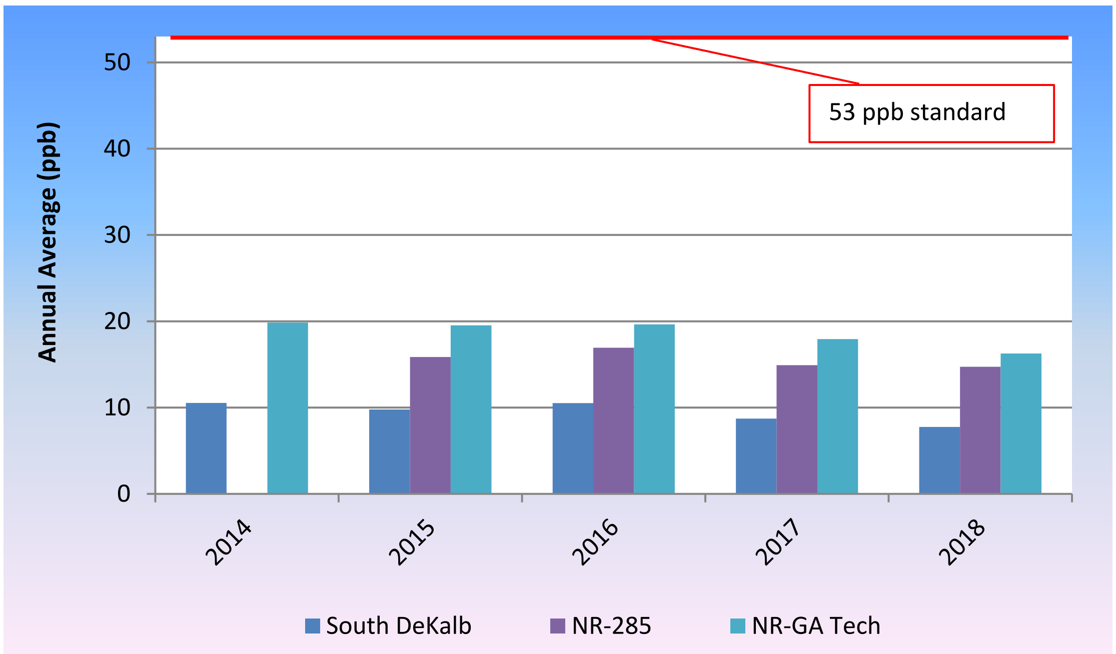


Figure 8.7.2: Nitrogen Dioxide Deviation from the NAAQS for Annual Standard

8.8 Carbon Monoxide

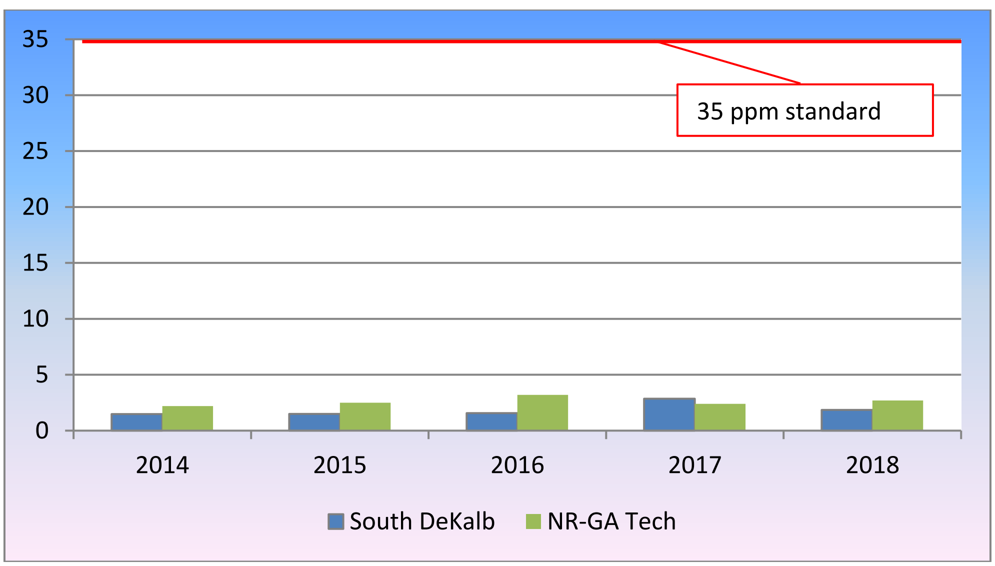
For the carbon monoxide (CO) data analysis, both sites that were sampling carbon monoxide data through 2018 were examined. The two sites collecting carbon monoxide data are the South DeKalb site in DeKalb County, and the NR-GA Tech site in Fulton County. The carbon monoxide data collected for several years has been consistently below the standard. The following tables display the first maximum values for the 1-hour and 8-hour readings for 2014 through 2018. 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 8.8: Carbon Monoxide Values and Rankings

CO 1-hour, 35 ppm	Deviation from the NAAQS										
Site	2014	Rank	2015	Rank	2016	Rank	2017	Rank	2018	Rank	Total Ranking
South DeKalb	1.475	0	1.494	0	1.569	0	2.853	0	1.848	0	0
NR-GA Tech	2.2	0	2.5	0	3.2	0	2.4	0	2.7	0	0

CO 8-hour, 9 ppm	Deviation from the NAAQS										
Site	2014	Rank	2015	Rank	2016	Rank	2017	Rank	2018	Rank	Total Ranking
South DeKalb	1.4	0	1.3	0	1.4	0	1.4	0	1.3	0	0
NR-GA Tech	1.8	0	2	0	2.3	0	2.1	0	2.0	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.



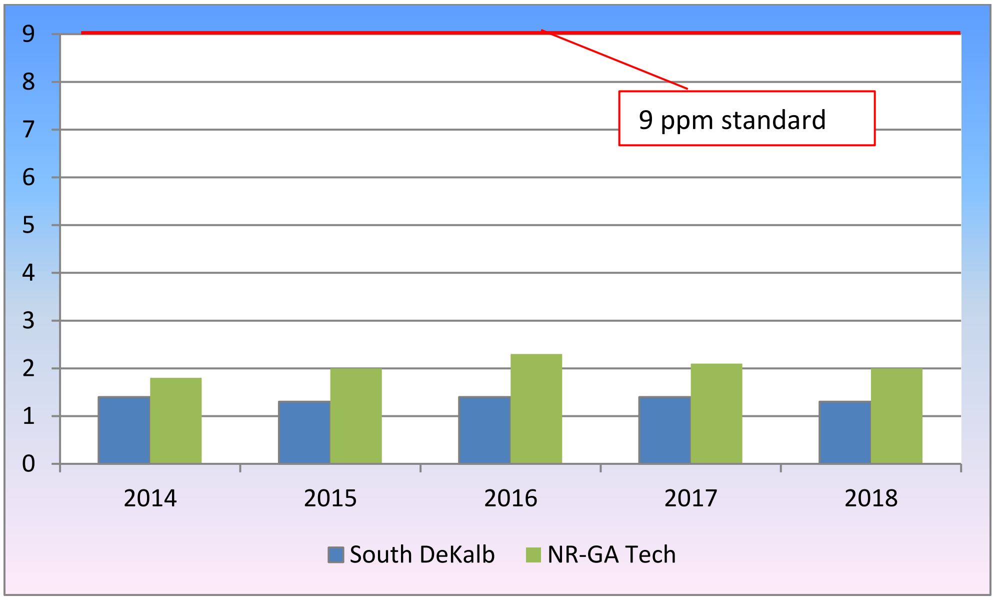


Figure 8.8: Carbon Monoxide Deviation from the NAAQS

For carbon monoxide, both the South DeKalb and NR-GA Tech sites have averages significantly lower than the standards.

8.9 Concluding Points

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 and $PM_{2.5}$ show the most value. Although sites that monitor SO_2, PM_{10}, lead, CO and NO_2 are required by EPA, these sites would have less value when comparing to the NAAQS. Therefore, those sites with concentrations far below the NAAQS for several years could be recommended for elimination. Table 8.9 sums the ranks of each pollutant monitored for each site. The Conyers site has the highest total rank (2.0) while there are 16 sites with the lowest rank (0.0). According to this analysis, there are many sites that could be recommended for elimination as they have had concentrations consistently below the NAAQS for several years (2014-2018).

Table 8.9: 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	0.0	0.0	1.5	0.0		0.0	0.0	0.0	0.0	0.0	1.5
Gwinnett Tech	0.0	0.0	1.5								1.5
Augusta	0.0	0.0	1.5	0.0		0.0					1.5
CASTNET			1.5								1.5
Savannah-E Pres St			0.0	0.0							0.0
Athens	0.0	0.0	1.5								1.5

	$PM_{2.5}$ 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
Columbus-Airport	0.0	0.0	1.5								1.5
Kennesaw	0.0	0.0	1.5								1.5
Macon-Forestry	0.0	0.0	1.5	0.0							1.5
Forest Park	0.0	0.0									0.0
Albany	0.0	0.0									0.0
Rome-Kraftsman				0.0							0.0
Columbus-Health Dept	0.0	0.0									0.0
Douglasville			1.5								1.5
United Ave			1.5	0.0							1.5
McDonough			1.5								1.5
Conyers			2.0								2.0
Macon-Allied	0.0	0.0									0.0
Savannah-L&A	0.5	0.0		0.0							0.5
Summerville			1.5								1.5
Fire Station #8	0.5	0.0				0.0					0.5
Valdosta	0.0	0.0									0.0
Columbus-Cusseta	0.0	0.5			0.0						0.5
Sandersville	0.0	0.0									0.0
Evans			1.0								1.0
Dawsonville			1.5								1.5
Fort Mountain			1.5								1.5
Gainesville	0.0	0.0									0.0
Leslie			1.5								1.5
Brunswick	0.0	0.0	0.0								0.0
Warner Robins	0.0	0.0									0.0
Rossville	0.0	0.0									0.0
Columbus-Allied					0.0						0.0
General Coffee	0.0	0.0									0.0
Conyers											0.0
NR-GA Tech	1.0	0.0					0.0	0.0	0.0	0.0	1.0
NR-285							0.0	0.0			0.0

9.0 Number of Parameters Monitored

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 AAMP'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.

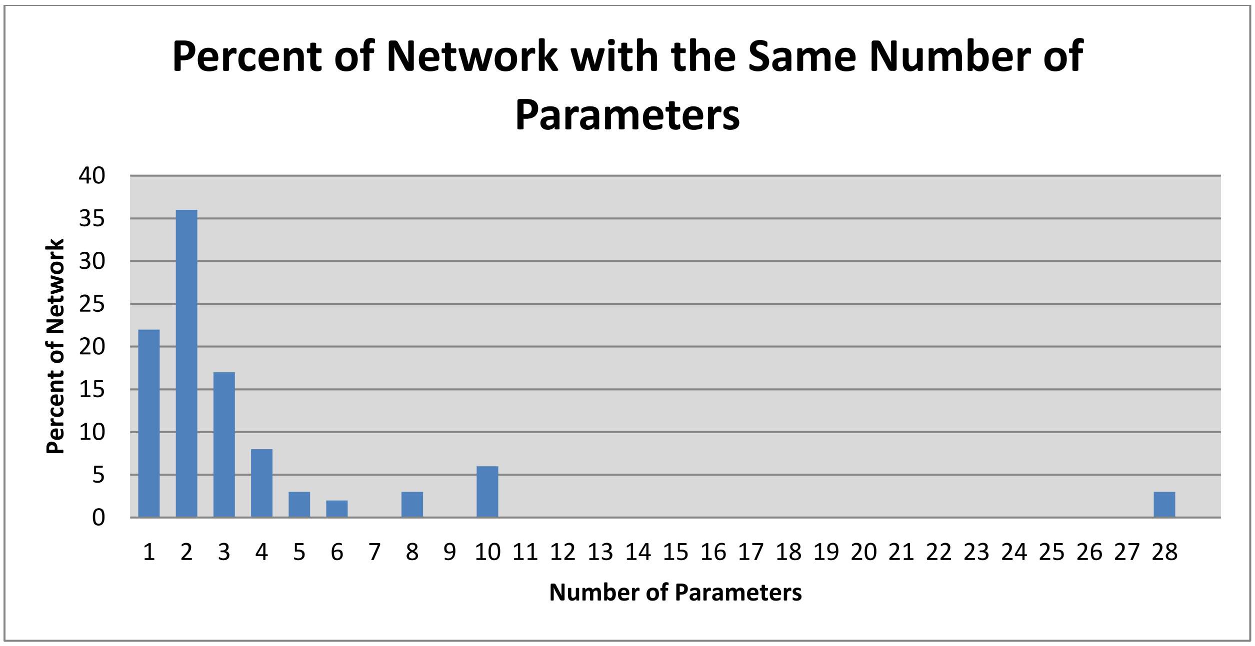


Figure 9.1: Percent of Network with Same Number of Parameters

From a percentage standpoint, most of Georgia's ambient air monitoring network monitors for less than three parameters. Twenty-two percent of the ambient air monitoring sites monitor for one parameter. Two parameters are measured by thirty-six percent of the monitoring network's sites. Seventeen 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.

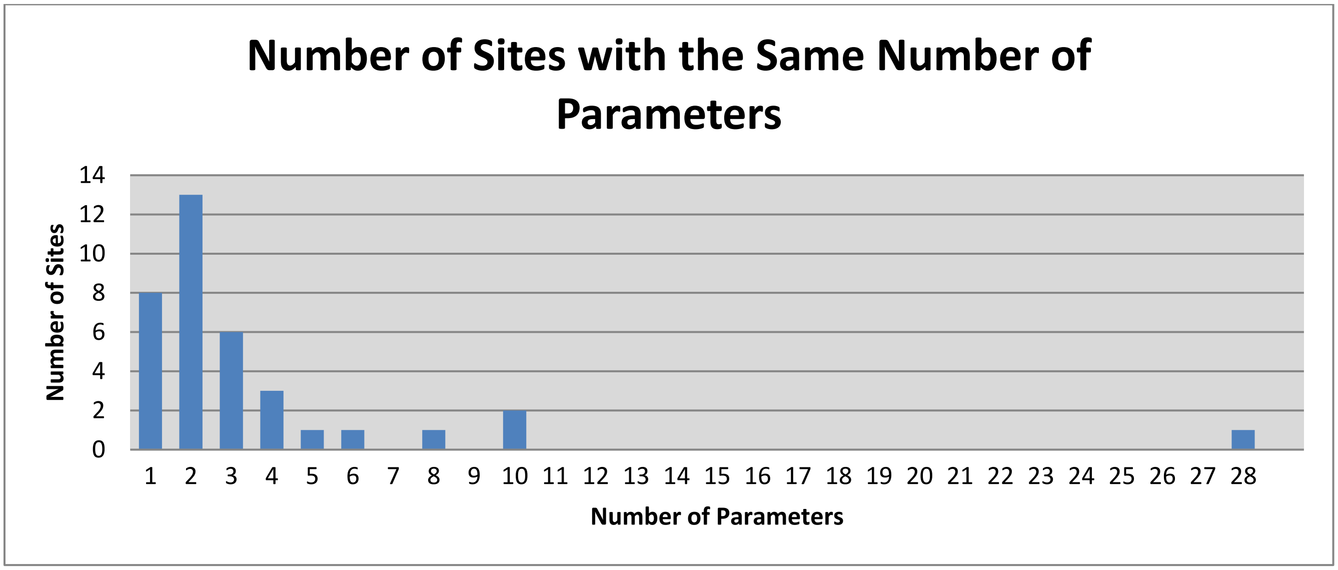


Figure 9.2: Number of Sites with the Same Number of Parameters

The above graph shows the same information as shown in Figure 9.1, 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 eight sites that monitor only one parameter. There are ten sites that monitor two parameters. Four sites monitor three parameters. There is one site that measures twenty-eight parameters. The following graph shows each site and how many parameters are measured at that site.

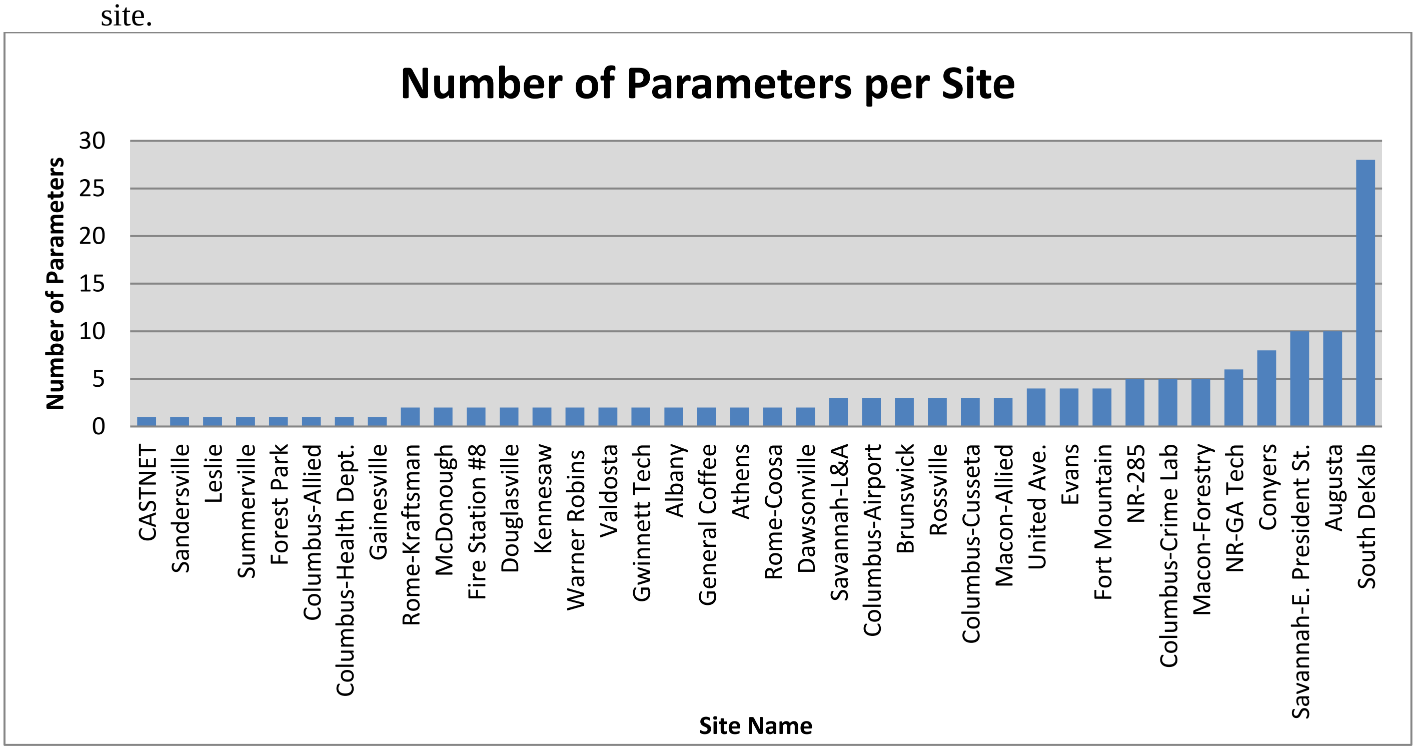


Figure 9.3: Number of Parameters per Site

Figure 9.3 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, Augusta, and Savannah-E. President Street sites. The South DeKalb site monitors 28 parameters. The Augusta and Savannah-E. President Street sites both measure 10 parameters. In addition, the number of parameters monitored at the Conyers, NR-GA Tech, Macon-Forestry, Columbus-Crime Lab and NR-285 Lab sites range from 8 to 5 parameters. All of the other 30 sites monitor four or less parameters. The above information is shown in the following table with the appropriate ranking.

	Number of Parameters	Proportionate Ranking
South DeKalb	28	1.00
Augusta	10	0.33
Savannah-E. President St.	10	0.33
Conyers	8	0.26
NR-GA Tech	6	0.19
Macon-Forestry	5	0.15
Columbus-Crime Lab	5	0.15
NR-285	5	0.15
Fort Mountain	4	0.11
Evans	4	0.11
United Ave.	4	0.11
Macon-Allied	3	0.07
Columbus-Cusseta	3	0.07
Rossville	3	0.07
Brunswick	3	0.07
Columbus-Airport	3	0.07
Savannah-L&A	3	0.07
Dawsonville	2	0.04
Rome-Coosa	2	0.04
Athens	2	0.04
General Coffee	2	0.04
Albany	2	0.04
Gwinnett Tech	2	0.04
Valdosta	2	0.04
Warner Robins	2	0.04
Kennesaw	2	0.04
Douglasville	2	0.04
Fire Station #8	2	0.04
McDonough	2	0.04
Rome-Kraftsman	2	0.04
Gainesville	1	0
Columbus-Health Dept.	1	0

	Number of Parameters	Proportionate Ranking
Columbus-Allied	1	0
Forest Park	1	0
Summerville	1	0
Leslie	1	0
Sandersville	1	0
CASTNET	1	0

Table 9.1: Number of Parameters Monitored per Site and Rankings

9.1 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 9.1. A large portion of sites across the state of Georgia monitor fewer than five parameters per site. One reason to perform 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, Augusta, Savannah-E. President Street, and Conyers 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 eight 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.

10.0 Monitor-to- Monitor Correlations

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.

10.1 $PM_{2.5}$

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 2014 through 2018 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 10.1 through 10.3 show site pairs for each MSA, the distance between the sites, the r^2 value and the rank. Figures 10.1, 10.3, and 10.5 show the $PM_{2.5}$ correlation matrix for each MSA. Figures 10.2 and 10.4 plot the r^2 and distance between for each site pair for each MSA (with greater than two sites).

Table 10.1 displays the Atlanta MSA. Kennesaw/Fire Station #8 pair shows the highest correlation (r^2=0.94) 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 10.1 gives a visual representation of the r^2 values in Table 10.1. Figure 10.2 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**
130630091	Forest Park	130670003	Kennesaw	30	0.92	0
130630091	Forest Park	130890002	South DeKalb	8	0.86	0
130630091	Forest Park	131210039	Fire Station #8	14	0.94	0
130630091	Forest Park	131210056	NR-GA Tech	12	0.90	0
130630091	Forest Park	131350002	Gwinnett Tech	30	0.87	0
130670003	Kennesaw	130890002	South DeKalb	29	0.78	0
130670003	Kennesaw	131210039	Fire Station #8	17	0.94	0
130670003	Kennesaw	131210056	NR-GA Tech	21	0.91	0
130670003	Kennesaw	131350002	Gwinnett Tech	31	0.89	0
130890002	South DeKalb	131210039	Fire Station #8	11	0.86	0
130890002	South DeKalb	131210056	NR-GA Tech	9	0.79	0
130890002	South DeKalb	131350002	Gwinnett Tech	23	0.81	0
131210039	Fire Station #8	131210056	NR-GA Tech	3	0.92	0
131210039	Fire Station #8	131350002	Gwinnett Tech	24	0.88	0
131210056	NR-GA Tech	131350002	Gwinnett Tech	22	0.86	0

Table 10.1: Atlanta MSA $PM_{2.5}$ Correlations and Rankings

	South DeKalb	*Fire Station #8*	*Gwinnett Tech*	*NR-GA Tech*	*Forest Park*	*Kennesaw*
South DeKalb	1.00					
Fire Station #8	0.86	1.00				
Gwinnett Tech	0.81	0.88	1.00			
NR-GA Tech	0.79	0.92	0.86	1.00		
Forest Park	0.86	0.94	0.87	0.90	1.00	
Kennesaw	0.78	0.94	0.89	0.91	0.92	1.00

Figure 10.1 Correlation Matrix of Atlanta MSA $PM_{2.5}$

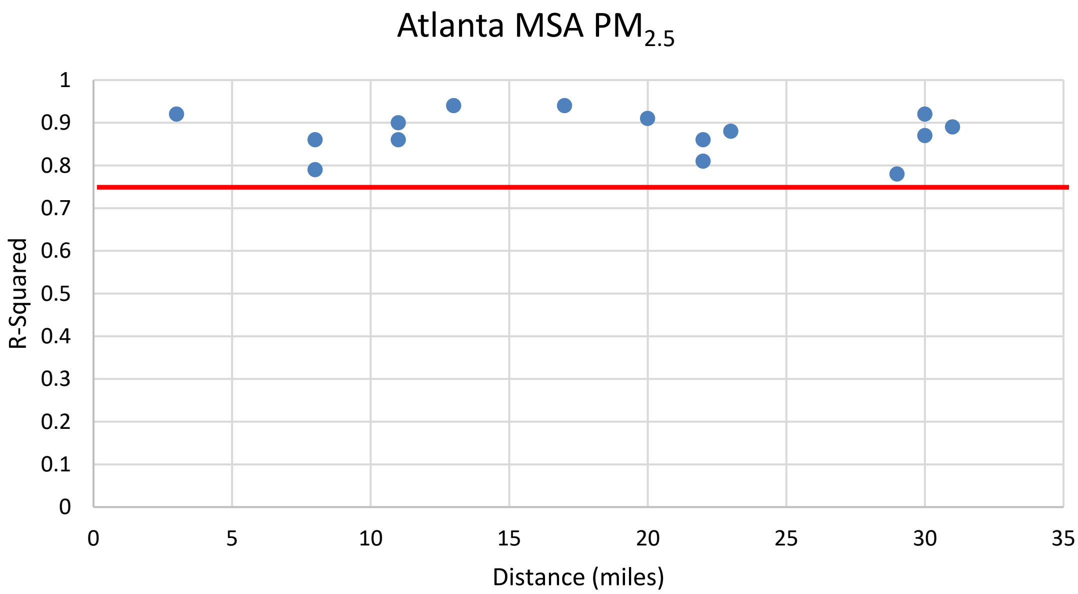


Figure 10.2: Atlanta MSA $PM_{2.5}$ Correlations

In Table 10.2, 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 0.81 or more, indicating high correlation between sites in this MSA. Figure 10.3 gives a visual representation of the r^2 values from Table 10.2. Figure 10.4 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**
011130003	Alabama	132150001	Columbus-Health Dept	4	0.87	0
011130003	Alabama	132150008	Columbus-Airport	7	0.84	0
011130003	Alabama	132150011	Columbus-Cussetta	4	0.81	0
132150001	Columbus-Health Dept.	132150008	Columbus-Airport	3	0.92	0
132150001	Columbus-Health Dept.	132150011	Columbus-Cussetta	5	0.85	0
132150008	Columbus-Airport	132150011	Columbus-Cussetta	6	0.84	0

Table 10.2: Columbus MSA $PM_{2.5}$ Correlations and Rankings

	Columbus-Health Dept.	Columbus-Airport	Columbus-Cussetta	Alabama
Columbus-Health Dept.	1.00			
Columbus-Airport	0.92	1.00		
Columbus-Cussetta	0.85	0.84	1.00	
Alabama	0.87	0.84	0.81	1.00

Figure 10.3: Columbus MSA $PM_{2.5}$ Correlation Matrix

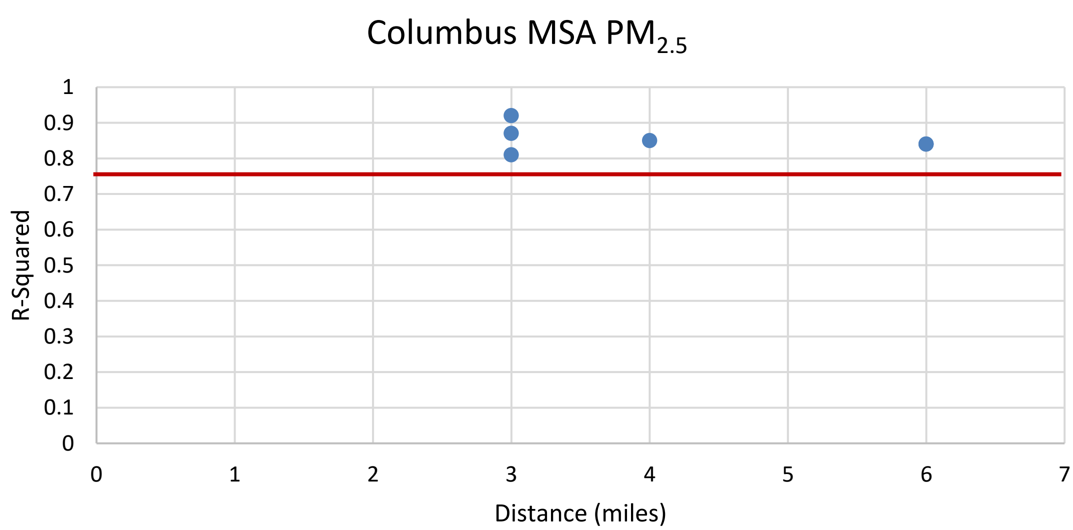


Figure 10.4: Columbus MSA $PM_{2.5}$ Correlations

Table 10.3 shows the r^2 values for the $PM_{2.5}$ samplers in the Macon MSA. The r^2 between these two monitors is 0.77 with a rank of 0. Figure 10.5 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	0.77	0

Table 10.3: Macon MSA $PM_{2.5}$ Correlations and Rankings

	Macon-Allied	*Macon-Forestry*
Macon-Allied	1.00	
Macon-Forestry	0.77	1.00

Figure 10.5: Columbus MSA $PM_{2.5}$ Correlation Matrix

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.

10.2 Ozone

Correlations between paired ozone sites were calculated using hourly data from 2014 through 2018. 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 10.4 through 10.6 show site pairs for each MSA, the distance between the sites, the r^2 value and the rank. Figures 10.6, 10.8, and 10.9 show the ozone correlation matrix for each MSA. Figure 10.7 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 10.4 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/United Ave. pair show the highest correlations (r^2=0.97) 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 10.3 gives a visual representation of the data from Table 10.4. 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	0.76	1
130670003	Kennesaw	130890002	South DeKalb	29	0.83	1
130670003	Kennesaw	130970004	Douglasville	21	0.89	0.5
130670003	Kennesaw	131210055	United Ave	25	0.86	1
130670003	Kennesaw	131350002	Gwinnett Tech	31	0.79	1
130670003	Kennesaw	131510002	McDonough	47	0.78	1
130670003	Kennesaw	132319991	CASTNET	59	0.77	1
130670003	Kennesaw	132470001	Conyers	43	0.77	1
130850001	Dawsonville	130890002	South DeKalb	49	0.73	1
130850001	Dawsonville	130970004	Douglasville	60	0.74	1
130850001	Dawsonville	131210055	United Ave	48	0.70	1
130850001	Dawsonville	131350002	Gwinnett Tech	29	0.74	1
130850001	Dawsonville	131510002	McDonough	65	0.69	1
130850001	Dawsonville	132319991	CASTNET	85	0.75	1
130850001	Dawsonville	132470001	Conyers	54	0.73	1
130890002	South DeKalb	130970004	Douglasville	28	0.79	1
130890002	South DeKalb	131210055	United Ave	4	0.97	0
130890002	South DeKalb	131350002	Gwinnett Tech	23	0.87	1
130890002	South DeKalb	131510002	McDonough	19	0.90	0.5
130890002	South DeKalb	132319991	CASTNET	35	0.84	1
130890002	South DeKalb	132470001	Conyers	14	0.91	0.5
130970004	Douglasville	131210055	United Ave	24	0.82	1
130970004	Douglasville	131350002	Gwinnett Tech	43	0.74	1
130970004	Douglasville	131510002	McDonough	41	0.75	1
130970004	Douglasville	132319991	CASTNET	44	0.82	1
130970004	Douglasville	132470001	Conyers	42	0.75	1
131210055	United Ave	131350002	Gwinnett Tech	24	0.87	1
131210055	United Ave	131510002	McDonough	23	0.89	0.5
131210055	United Ave	132319991	CASTNET	37	0.81	1
131210055	United Ave	132470001	Conyers	19	0.88	0.5
131350002	Gwinnett Tech	131510002	McDonough	37	0.78	1
131350002	Gwinnett Tech	132319991	CASTNET	57	0.72	1
131350002	Gwinnett Tech	132470001	Conyers	26	0.82	1
131510002	McDonough	132319991	CASTNET	22	0.89	0.5
131510002	McDonough	132470001	Conyers	12	0.94	0.5
132319991	CASTNET	132470001	Conyers	34	0.84	1

Table 10.4: 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	*Dawsonville*	*South DeKalb*	*Douglasville*	*United Ave*	*Gwinnett Tech*	*CASTNET*	*McDonough*	*Conyers*
Kennesaw	1.00								
Dawsonville	0.76	1.00							
South DeKalb	0.83	0.73	1.00						
Douglasville	0.89	0.74	0.79	1.00					
United Ave	0.86	0.70	0.97	0.82	1.00				
Gwinnett Tech	0.79	0.75	0.87	0.74	0.87	1.00			
CASTNET	0.77	0.75	0.84	0.82	0.81	0.72	1.00		
McDonough	0.78	0.69	0.90	0.75	0.89	0.78	0.89	1.00	
Conyers	0.77	0.73	0.91	0.75	0.88	0.82	0.84	0.94	1.00

Figure 10.6: Atlanta MSA Ozone Correlation Matrix

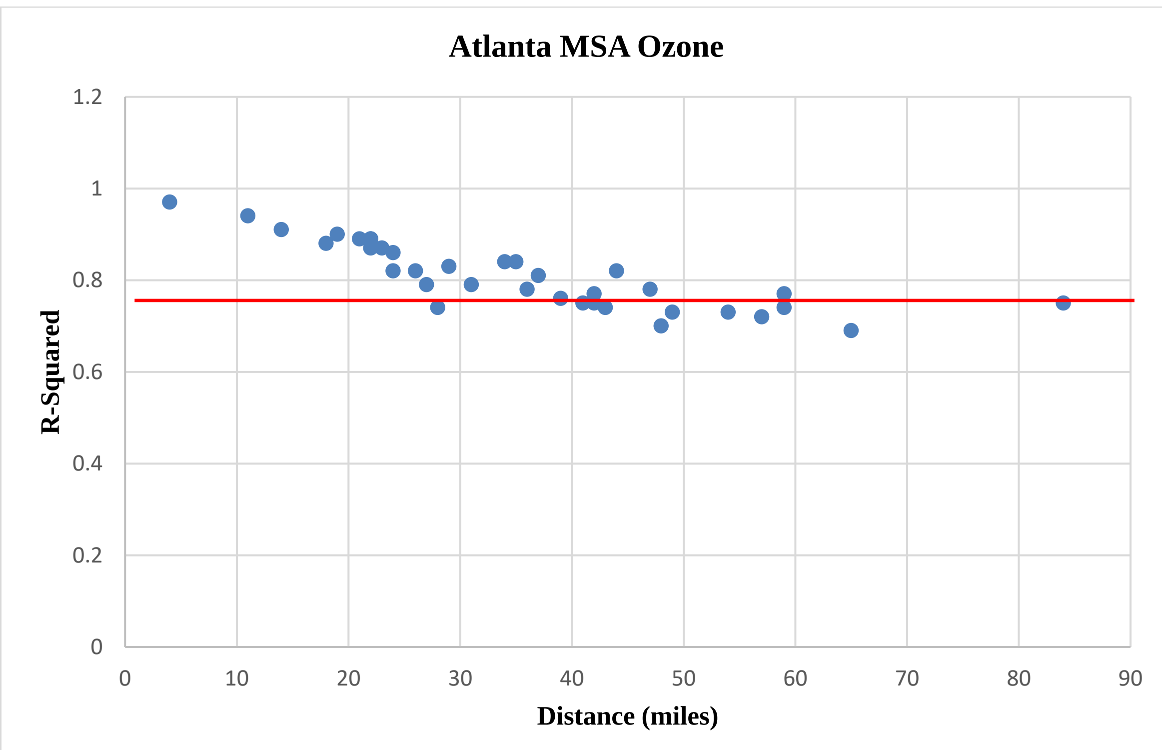


Figure 10.7: Atlanta MSA Ozone Correlations

In Table 10.5, 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 (0.97) 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	7	0.97	1

Table 10.5: Columbus MSA Ozone Correlations and Rankings

	Columbus-Airport	*Alabama*
Columbus-Airport	1.00	
Alabama	0.97	1.00

Figure 10.8: Columbus MSA Ozone Correlation Matrix

Table 10.6 shows the r^2 value for the ozone samplers in the Augusta MSA. There is a high correlation between the Evans/South Carolina-Trenton and Augusta/South Carolina-Jackson pairs (0.93) indicating that 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	0.90	0.5
130730001	Evans	450030003	South Carolina - Jackson	25	0.88	0.5
130730001	Evans	450370001	South Carolina -Trenton	19	0.93	0.5
132450091	Augusta	450030003	South Carolina - Jackson	15	0.93	0.5
132450091	Augusta	450370001	South Carolina -Trenton	23	0.91	0.5
450030003	South Carolina - Jackson	450370001	South Carolina -Trenton	27	0.88	0.5

Table 10.6: Augusta Ozone Correlations and Rankings

	Evans	Augusta	South Carolina - Jackson	South Carolina - Trenton
Evans	1.00			
Augusta	0.90	1.00		
South Carolina - Jackson	0.88	0.93	1.00	
South Carolina - Trenton	0.93	0.91	0.88	1.00

Figure 10.9: Augusta MSA Ozone Correlation Matrix

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, several of the sites with ozone monitors have higher r-square values (>0.75), 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 higher correlations.

10.3 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. Table 10.7 shows the sum of the $PM_{2.5}$ and Ozone ranks for each site. Dawsonville had the highest overall rank while NR-GA Tech, Fire Station #8, Columbus-Health Dept, Columbus-Cussetta, Forest Park, Macon-Forestry, and Macon-Allied 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
130970004	Douglasville		7.5	7.5
130890002	South DeKalb	0	6	6
131210056	NR-GA Tech	0		0
130670003	Kennesaw	0	7.5	7.5
131350002	Gwinnett Tech	0	8	8
131510002	McDonough		6	6
131210055	United Ave.		6	6
132470001	Conyers		6.5	6.5
131210039	Fire Station #8	0		0
132150001	Columbus-Health Dept.	0		0
132150008	Columbus-Airport	0	1	1
132150011	Columbus-Cussetta	0		0
130630091	Forest Park	0		0
130210012	Macon-Forestry	0		0
130210007	Macon-Allied	0		0
130730001	Evans		1.5	1.5
132450091	Augusta		1.5	1.5
132319991	CASTNET		7.5	7.5

Figure 10.7: Total of Ozone and $PM_{2.5}$ Ranks for Each Site

11.0 Area Served Assessment

For the Area Served Assessment, the EPA NetAssess2020 v1.1 tool (https://sti-r-shiny.shinyapps.io/EPA_Network_Assessment/) was used. This is an updated version of the NetAssess tool developed by Lake Michigan Air Directors Consortium (LADCO) for the 2015 network assessment, which was adapted from the 'Network Assessment Analyses and Tools' developed by EPA for the 2010 network assessment. The explanation for this tool is found in the NetAssess Documentation Site (http://ladco.github.io/NetAssessApp/tools.html#areaserved). This documentation 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. All points within a polygon are closer to the monitor in that polygon than to any other monitor. Once the polygons are calculated, data from the [2018 census] are used to determine which census tract centroids were within each polygon. The population represented by the polygon is calculated by summing the populations of these census tracts."*

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, 2018 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 red dots indicate the location of each monitor and the polygon drawn in white indicates the area served by that monitor.

11.1 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, red circles indicate Georgia ozone monitors while the white 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.

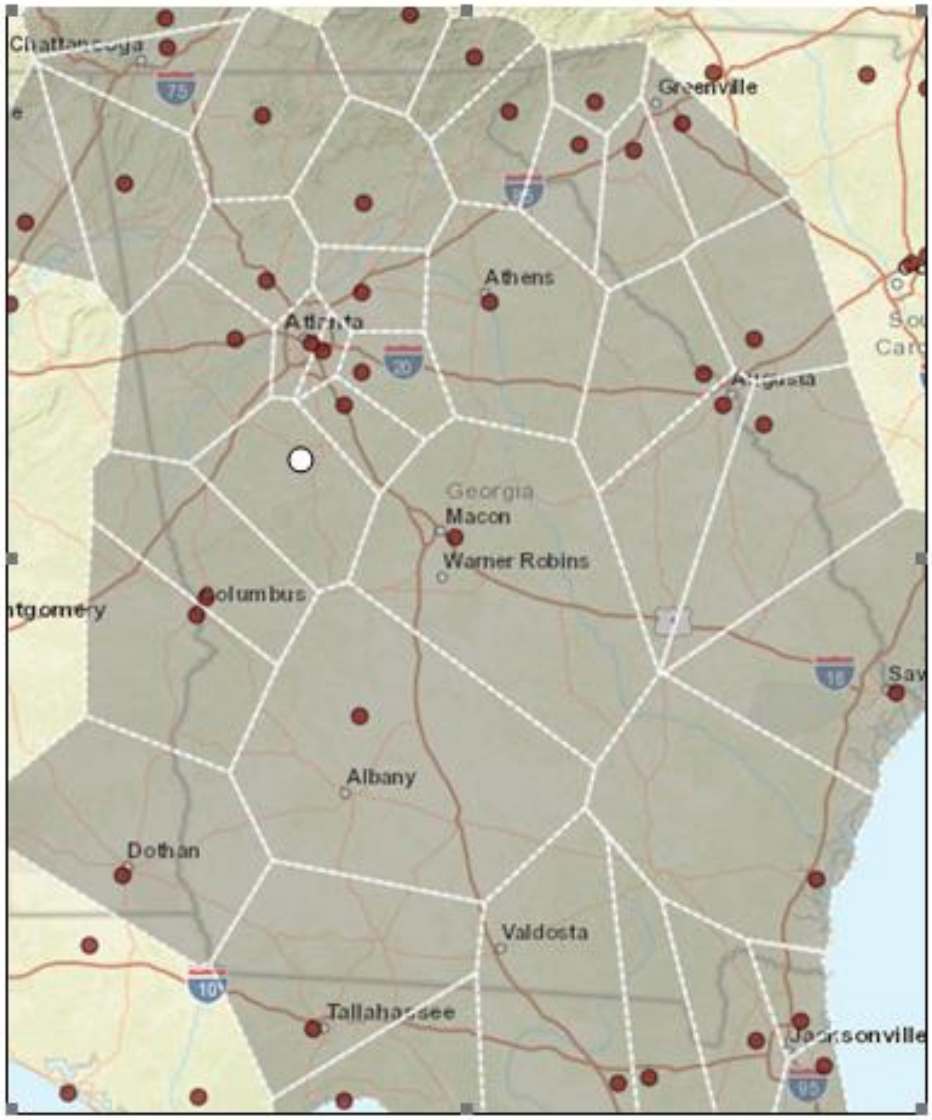


Figure 11.1: Ozone Area Served with Monitors Sampling in 2018, All of Georgia

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	Site Name	2018 Population	Area (sq mi)	Latitude	Longitude	Rank
010499991	Sand Mtn AL Ag Exp Stn	179737	1833.60	34.28900	-85.970065	
010690004	161 Buford Lane	282478	4339.40	31.18893	-85.423094	
011130003	Phenix City	279894	3114.30	32.43703	-84.999653	
120030002	Hwy 90 Olustee Forest Service Office	57574	1411.59	30.20111	-82.441111	
120230002	751 SE Sycamore Terrace	327788	6328.21	30.17806	-82.619167	

Monitor	Site Name	2018 Population	Area (sq mi)	Latitude	Longitude	Rank
120310077	13333 Lanier Road	274763	595.76	30.47773	-81.587339	
120310100	13600 William Davis Pkwy	554465	677.99	30.26028	-81.453611	
120310106	4770 Cisco Dr	478081	2018.16	30.37822	-81.8409	
120730012	110 Century Park Cr W	481147	4425.50	30.43972	-84.346389	
121290001	County Rd 59	57340	2027.04	30.0925	-84.161111	
132611001	Leslie	461083	7868.76	31.95429	-84.08100965	1
130210012	Macon- Forestry	634499	7106.60	32.80526	-83.54349278	0.900504
131270006	Brunswick	285702	4946.36	31.16980	-81.49503478	0.618498
130510021	Savannah- E. Pres. St	696672	4749.44	32.06848	-81.04942006	0.592792
130590002	Athens	376700	3505.42	33.91814	-83.34438540	0.430393
130970004	Douglasville	611079	2360.63	33.74124	-84.77642878	0.280948
132150008	Columbus- Airport	287890	2346.34	32.52127	-84.94463476	0.279083
130550001	Summerville	227436	2247.89	34.47453	-85.40884739	0.266230
130730001	Evans	190896	2192.29	33.58204	-82.13124941	0.258972
132130003	Fort Mountain	256443	2188.43	34.78522	-84.62642331	0.258468
132450091	Augusta	296605	2162.17	33.43390	-82.02240000	0.255040
132319991	CASTNET	259916	2105.03	33.17870	-84.40520000	0.247581
130850001	Dawsonville	397506	1705.80	34.37623	-84.05950647	0.195464
130670003	Kennesaw	994400	1178.77	34.01544	-84.60742344	0.126663
131350002	Gwinnett Tech	1278721	908.88	33.96320	-84.06910000	0.091431
132470001	Conyers	308259	753.67	33.58855	-84.06960764	0.071169
131510002	McDonough	241916	618.54	33.43395	-84.16181057	0.053528
131210055	United Ave	979432	412.74	33.72074	-84.35731616	0.026663
130890002	South DeKalb	485550	208.50	33.68780	-84.29050000	0
370750001	Forest Road 423 Spur	62546	1106.96	35.2578	-83.7955	
371139991	USDA Southern Res Stn	54363	976.45	35.0608	-83.4306	
450030003	Jackson	183208	3372.99	33.34223	-81.788731	
450370001	Trenton	164002	1853.29	33.73996	-81.853635	
450730001	Round Mountain Tower Rd	109435	1173.36	34.80526	-83.2377	
450770002	106 Hopewell Rd	146604	810.81	34.65361	-82.838659	
450070005	215 McAlister Road	215836	1176.45	34.62324	-82.53205924	
450450016	510 Garrison Rd	484213	1309.27	34.75185	-82.25670125	
450770003	901 Allgood Bridge Road	92655	622.40	34.85154	-82.744576	
470651011	Soddy Daisy	212823	2339.39	35.23348	-85.181581	
470654003	Reservoir Rd	474864	913.13	35.10264	-85.162194	

Table 11.1: List of Ozone Monitors with Area Served in Square Miles

With the Area Served Assessment for ozone sites, the Leslie monitor (13-261-1001) ranks the highest with 7868.76 square miles covered by this ozone site. The South DeKalb site (13-089-0002) ranks the lowest with 208.50 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 at the Valdosta site (13-185-0003), or at the General Coffee site (13-069-0002) in Douglas County, may be helpful to cover the southeastern part of the state.

11.2 $PM_{2.5}$ Area Served

In the following section, the Georgia's $PM_{2.5}$ sites and the area covered by each monitor are examined. The red dots indicate the existing $PM_{2.5}$ sites, and the white 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. It should be noted that when the NetAssess tool was used to pull the $PM_{2.5}$ data, the Sandersville site did not show on the map. Therefore, the site was added to the map and the NetAssess tool created a polygon representing area served for this site. In addition, the Savannah MSA should have only one site collecting $PM_{2.5}$ data, instead of the two sites represented for this MSA. To adjust for this, and since sites were unable to be removed from the map, both the polygons for the Savannah MSA were added together for the total square miles of area served for this MSA.

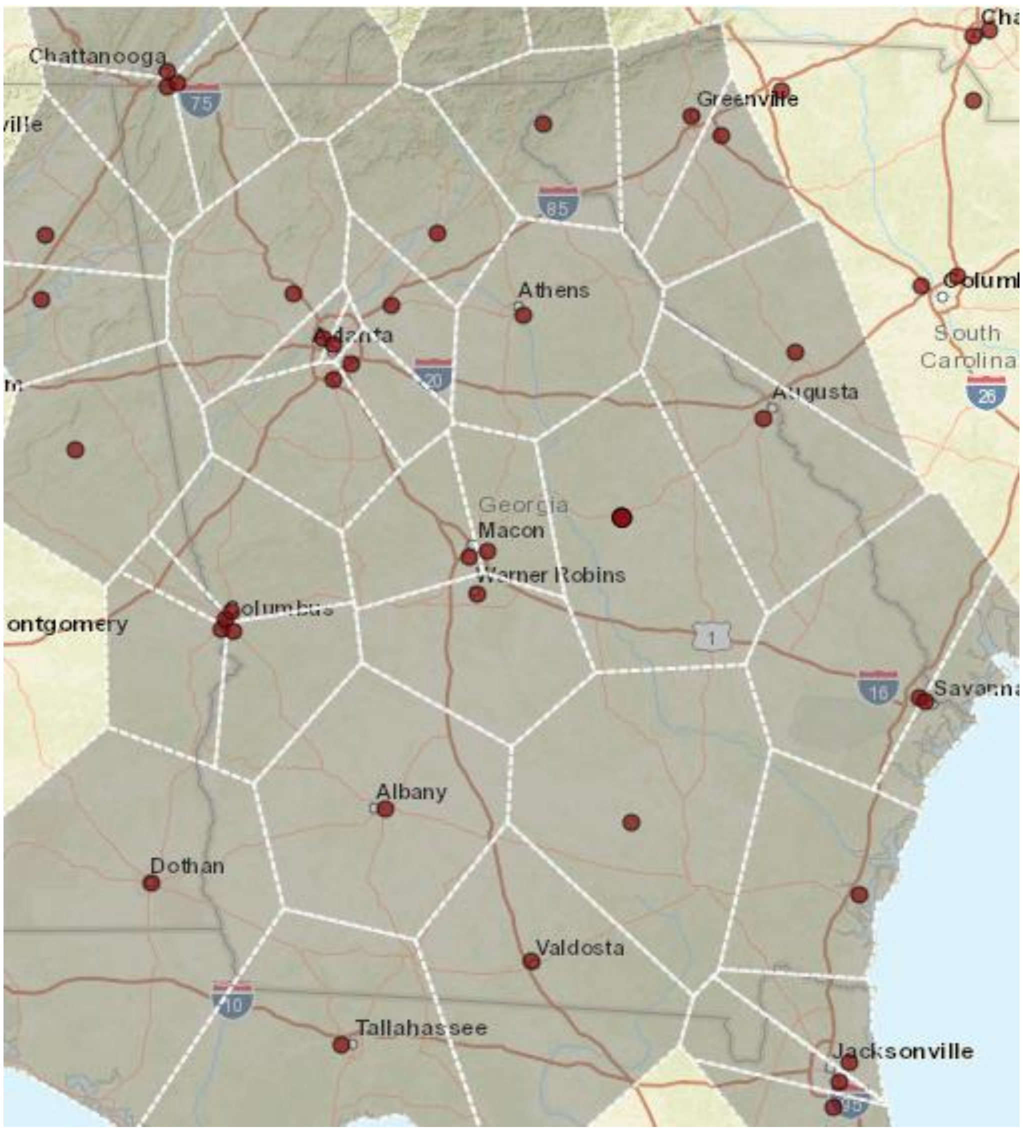


Figure 11.6: $PM_{2.5}$ Area Served with Monitors Sampling in 2018, All of Georgia

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	Site Name	2018 Population	Area (sq mi)	Latitude	Longitude	Rank
010270001	Ashland Airport	199438	3527.429	33.28493	-85.803608	
010491003	13112 Hwy 68	201461	2141.709	34.28857	-85.969858	
010550010	1001 Wallace Dr	222116	1913.136	33.99149	-85.992647	
010690003	126 North St. Andrews St	718448	9422.051	31.22478	-85.390789	
011130003	Phenix City	548925	1917.769	30.1358	-81.6339807	
120310098	14932 Mandarin Rd	455331	2224.721	30.35472	-81.547778	
120310099	9429 Merrill Road	388051	875.6797	30.26278	-81.606833	
120310108	5895 Pepsi Place	496416	737.8412	30.43972	-84.346389	
120730012	110 Century Park Cr W	208844	5888.058	32.77746	-83.6409957	
131850003	Valdosta	106235	6943.66122	32.48420	-84.97890	1.0000
130690002	General Coffee	348433	6017.01604	33.91814	-83.34439	0.8643
130950007	Albany	559572	5077.243385	33.80224	-84.43562	0.7267
130511002	Savannah L&A	1217999	4961.79884	32.09078	-81.13022	0.7098
133030001	Sandersville	158067	4450.599582	32.96720	-82.80700	0.6349
132450091	Augusta	165939	3486.888594	34.97880	-85.30090	0.4938
130590002	Athens	124545	3437.85362	35.46677	-83.27793	0.4866
131270006	Brunswick	1302264	3293.837515	33.96320	-84.06910	0.4655
130670003	Kennesaw	723026	3179.165174	33.68780	-84.29050	0.4487
131530001	Warner Robins	341683	2722.40632	30.84860	-83.29330	0.3818
131390003	Gainesville	258765	2354.837065	32.60560	-83.59780	0.3280
132150011	Columbus- Cusseta	481147	2066.032651	33.43390	-82.02240	0.2857
130630091	Forest Park	1350570	2056.380097	34.01544	-84.60742	0.2843
132150008	Columbus- Airport	102200	1841.707296	32.42970	-84.93160	0.2528
130210012	Macon- Forestry	348925	1458.693955	32.11068	-81.16182	0.1967
130210007	Macon- Allied	119014	1373.365378	32.80526	-83.54349	0.1842
132950002	Rossville	256557	1358.307394	31.51310	-82.74997	0.1820
131350002	Gwinnett Tech	441824	1123.557282	34.29930	-83.81340	0.1476
130890002	South DeKalb	320667	721.6249344	31.57760	-84.09980	0.0888
132150001	Columbus- Health Dept	236355	347.8780449	32.52127	-84.94463	0.0340
131210039	Fire Station #8	461842	345.5614319	33.77840	-84.39140	0.0337
131210056	NR- GA Tech	203871	115.4445454	31.16980	-81.49503	0.0000
370990006	US RT 19 North	67945	1298.075	35.43477	-83.442133	
371730002	30 Recreation Park Drive	212967	1199.233	33.73996	-81.853635	
450370001	Trenton	213430	2678.005	34.80526	-83.2377	
450730001	Round Mtn Tower Rd	555542	2304.644	34.8439	-82.4145845	

Monitor	Site Name	2018 Population	Area (sq mi)	Latitude	Longitude	Rank
450450015	133 Perry Avenue	346919	1668.734	34.75185	-82.2567013	
450450016	510 Garrison Road	404970	1717.382	34.99438	-85.24293	
470650031	Tombras Ave	257461	1345.952	35.05092	-85.293019	
470654002	Siskin Dr	221515	2143.253	35.45012	-84.596195	
471071002	Saint Mark AME Zion Church	153893	2353.293	32.43703	-84.999653	

Table 11.2: List of $PM_{2.5}$ Monitors and Area Served

With the Area Served Assessment for the $PM_{2.5}$ network, the Valdosta site (13-185-0003) ranks the highest with 6943.66 square mile coverage. The NR-GA Tech site (13-121-0056) ranks the lowest with this assessment, with a 115.44 square mile coverage. For the $PM_{2.5}$ network, the southeast area of the state in between the Macon/Warner Robins area and the Savannah area has a larger section where the polygons intersect that is not represented by a $PM_{2.5}$ monitor. According to the Area Served assessment, this area of the state could benefit from an additional $PM_{2.5}$ monitor if resources allow.

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 O_3, $PM_{2.5}$, and PM_{10} networks, each metropolitan statistical area (MSA) above a certain population, and each monitor above a certain percentage of the National Ambient Air Quality Standards (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 AAMP is meeting population-oriented requirements for monitoring ambient air. In addition, it is GA AAMP'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 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_3 NAAQS[3]	Most recent 3-year design value concentrations <85% of any O_3 NAAQS[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 PM_{10} data show ambient concentrations exceeding the PM_{10} NAAQS by 20 percent or more.
[3]Medium concentration areas are those for which ambient PM_{10} data show ambient concentrations exceeding 80 percent of the PM_{10} NAAQS.
[4]Low concentration areas are those for which ambient PM_{10} 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 AAMP 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 2017 (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 2010 to 2017, 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 2014-2016, 2015-2017, and 2016-2018 design values for the O_3, $PM_{2.5}$, and PM_{10} monitors across the GA AAMP 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 actual number of monitors GA AAMP has in place, as well as neighboring states that share that 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 (2010 Census)	Pop (2017 Estimate)	Percent Change in Pop from 2010 to 2017 (%)	Rank by Pop Change	$PM_{2.5}$					$PM_{2.5}$					O_3					PM_{10}				
					Table D-5					**Table D-5**					**Table D-2**					**Table D-4**				
					98th Percentile, 3yrs (µg/m^3)					Annual Average, 3yrs (µg/m^3)					4th Max Average, 3yrs (ppm)					1st Max, 3yrs (µg/m^3)				
					85% = 29.75					85% = 10.2					85% = 0.595					80% = 120; 120% = 180				
					2014 - 2016	**2015 - 2017**	**2016 - 2018**	**Req**	**Act**	**2014 - 2016**	**2015 - 2017**	**2016 - 2018**	**Req**	**Act**	**2014 - 2016**	**2015 - 2017**	**2016 - 2018**	**Req**	**Act**	**2014 - 2016**	**2015 - 2017**	**2016 - 2018**	**Req**	**Act**
Rome MSA	96,317	97,471	0.16%	0.034	20	16	14	**0**	**1**	9.9	8.7	8.3+	**0**	**1**										
Brunswick MSA	112,370	115,939	3.18%	0.091	24	22	11	**0**	**1**	7.9	7.5	7.2	**0**	**1**	0.056	0.056	0.057	**0**	**1**					
Valdosta MSA	139,588	143,969	3.14%	0.090	16	18	18	**0**	**1**	8.0	7.8	7.4	**0**	**1**										
Warner Robins MSA	139,900	188,764	34.93%	1.000	19	18	18	**0**	**1**	8.6	8.3	8.3	**0**	**1**										
Dalton MSA	142,227	143,407	0.83%	0.024											0.065	0.065	0.065	**1**	**1**					
Albany MSA	157,308	153,776	-2.25%	0.064	22	22	23	**0**	**1**	9.3	9.0	8.8	**0**	**1**										
Gainesville MSA	179,684	192,865	7.34%	0.210	20	19	19	**0**	**1**	8.4	8.0	7.9	**0**	**1**										
Athens-Clark County MSA	192,541	209,780	5.32%	0.256	19	16	17	**0**	**1**	9.0	8.2	8.1	**0**	**1**	0.064	0.064	0.065	**1**	**1**					
Macon MSA	232,293	229,966	-1.00%	0.029				**0**	**2**				**0**	**2**				**1**	**1**					
Allied					21	20	19			10.1	9.6	9.3												
Forestry					17	17	16			7.7	7.3	7.3			0.065	0.065	0.065							
Columbus GA-AL MSA	294,865	309,979	5.13%	0.147				**1**	**3GA, 1AL**				**0**	**3GA,1 AL**				**1**	**1GA, 1AL**					
Health Dept.					19	19	19			9.5	9.2	8.8												
Airport					19	19	18			9.2	8.9	8.6			0.062	0.061	0.060							
Cusseta					24	29	32			9.6	9.5	9.2												
Savannah MSA	347,611	377,476	8.59%	0.246				**0**	**1**				**1**	**1**				**1**	**1**					
E. President															0.057	0.057	0.057							
L&A						24	20				10.9	9.7												
Augusta GA-SC MSA	556,877	589,519	5.86%	0.168				**1***	**1GA, 1SC**				**1***	**1GA,1 SC**				**2***	**2GA, 2SC**				**1-2**	**1**
Evans															0.061	0.059	0.060							
Augusta					23	23	24			9.6	9.3	9.5			0.062	0.061	0.062			50	475	475		

	Pop (2010 Census)	Pop (2017 Estimate)	Percent Change in Pop from 2010 to 2017 (%)	Rank by Pop Change	$PM_{2.5}$ Table D-5 98th Percentile, 3yrs (µg/m^3) 85% = 29.75					$PM_{2.5}$ Table D-5 Annual Average, 3yrs (µg/m^3) 85% = 10.2					O_3 Table D-2 4th Max Average, 3yrs (ppm) 85% = 0.595					PM_{10} Table D-4 1st Max, 3yrs (µg/m^3) 80% = 120; 120% = 180				
					2014 - 2016	**2015 - 2017**	**2016 - 2018**	**Req**	**Act**	**2014 - 2016**	**2015 - 2017**	**2016 - 2018**	**Req**	**Act**	**2014 - 2016**	**2015 - 2017**	**2016 - 2018**	**Req**	**Act**	**2014 - 2016**	**2015 - 2017**	**2016 - 2018**	**Req**	**Act**
Atlanta MSA	5,268,860	5,700,990	8.20%	0.235				**2**	**6**				**3**	**6**				**3**	**9**				**2-4**	**2**
Forest Park					19	18	18			9.9	9.6	9.1												
Kennesaw					19	18	17			9.5	9.0	8.7			0.066	0.067	0.066							
Dawsonville															0.065	0.065	0.065							
South DeKalb					19	19	19			9.3	9.0	8.6			0.071	0.071	0.069			81	81	60		
NR-285																								
Douglasville															0.068	0.069	0.067							
Fire Station #8					20	19	19			10.4	9.9	9.4								78	78	68		
NR-GA Tech					23	23	21			10.6	10.5	10.1												
United Avenue															0.075	0.075	0.073							
Gwinnett Tech					18	20	21			8.8	8.7	9.0			0.072	0.071	0.069							
McDonough															0.074	0.071	0.071							
CASTNET															0.068	0.067	0.066							
Conyers															0.074	0.069	0.070							
Chattanooga TN-GA MSA Regional Transport site	528,143	548,359	3.83%	0.110	19	18	18	**1****	**1GA, 3TN**	9.6	9.0	8.8	**1****	**1GA,3 TN**				**2****	**2TN**					
Not in an MSA																								
Summerville	26,015	24,880	-4.36%	0.125											0.062	0.061	0.060	**1**	**1**					
General Coffee (Douglas Micro) Background site	50,731	43,048	-15.14%	0.434		17	15	**0**	**1**		7.4	6.6	**0**	**1**										
Leslie (Americus Micro)	37,829	35,855	-5.22%	0.149											0.060	0.060	0.061	**1**	**1**					
Sandersville (Washington Co)	21,187	20,506	-3.21%	0.092	21	23	21	**0**	**1**	8.7	8.3	7.9	**0**	**1**										
Totals								**5**	**28**				**6**	**28**				**14**	**24**				**3-6**	**3**

*Covered by Memorandum of Agreement with South Carolina Department of Health and Environmental Control
**Covered by Memorandum of Agreement with Chattanooga-Hamilton County-Walker Metropolitan Statistical Area Criteria Pollutant Air Quality Agreement
+Not 3 years of data; monitor was shut down at the end of 2017

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

The population during the official 2010 census, the 2017 estimate, and the percent change in population of the remaining micropolitan statistical areas in which GA AAMP does not have monitors are shown in Table 12.3.

Micropolitan Statistical Areas without monitors	Population (2010 Census)	Population (2017 Estimate)	Percent Change in Population
Bainbridge	27,842	27,023	-2.94%
Calhoun	55,186	56,424	2.24%
Cedartown	41,475	41,444	-0.07%
Cordele	23,439	23,005	-1.85%
Cornelia	43,041	43,878	1.94%
Dublin	58,414	57,251	-1.99%
Fitzgerald	27,172	17,272	-36.43%
Hinesville-Ft Stewart	77,917	79,977	2.64%
Jesup	30,099	29,833	-0.88%
LaGrange	67,044	69,433	3.56%
Moultrie	45,498	45,890	0.86%
St Marys	50,513	52,252	3.44%
Statesboro	70,217	73,742	5.02%
Thomaston	27,153	26,241	-3.36%
Thomasville	44,720	44,909	0.42%
Tifton	40,118	40,531	1.03%
Toccoa	26,175	25,625	-2.10%
Vidalia	36,346	36,122	-0.62%
Waycross	55,070	54,829	-0.44%

Table 12.3: Population Change in Micropolitan Statistical Areas without Monitors

In Table 12.2, one can see that GA AAMP 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 O_3 and $PM_{2.5}$ 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 AAMP does not currently have a PM_{10} or O_3 monitor in the Chattanooga TN-GA MSA; however, Georgia has an agreement with Tennessee to use the data from their PM_{10} and O_3 monitors. According to 40CFR58, Appendix D, GA AAMP would be required to have 14 O_3 monitors for its population by area and the percentage of each pollutant compared to the NAAQS. Currently, the network consists of 24 O_3 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 AAMP would be required to have 4 $PM_{2.5}$ monitors for the daily standard and 6 for the annual standard. GA AAMP 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, three PM_{10} monitors would be required and GA AAMP's network which currently has three monitors.

Table 12.2 shows that most of Georgia's MSAs experienced population growth from the 2010 census to the estimated 2017 population. The Warner Robins MSA saw the biggest increase, with 34.93%. Therefore, the Warner Robins MSA ranked the highest according to this assessment. The next biggest areas to have an increase in population were the Savannah and Atlanta-Sandy Springs-Roswell MSAs with 8.59% and 8.20% increases, respectively. The only two MSAs to experience a decrease in percent population from 2010 to 2017 were Albany (-2.25%) and Macon (-1.00%). In addition, all of the areas with monitors that are 'Not in an MSA' had a decrease in population with General Coffee having the largest decrease in population (-15.14%) and lowest rank.

On October 1, 2015, EPA passed a new rule to revise both the primary and secondary ozone standards. The 8-hour primary ozone standard, designed to protect public health, was revised to 0.070 parts per million (ppm). The secondary standard, designed to protect sensitive vegetation and ecosystems, including forests, parks, wildlife refuges and wilderness areas, was also revised to 0.070 ppm (Federal Register, Vol. 80, No. 206, page 65292). This rule went into effect on December 28, 2015. The Atlanta area was redesignated to include only a 7-county non-attainment area. No network adjustments were necessary after the new rule was passed, as all the monitoring requirements in 40 CFR 58 Appendix D were still met.

12.1 Population Change

In order to assess population change, the 2010 census and the American Community Survey 5-year estimated population for 2017 were compared. Figure 12.1 shows the 2017 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 an orange triangle. The darker the color green, the higher the estimated population for that census tract. Completely white census tracts denote missing census data.

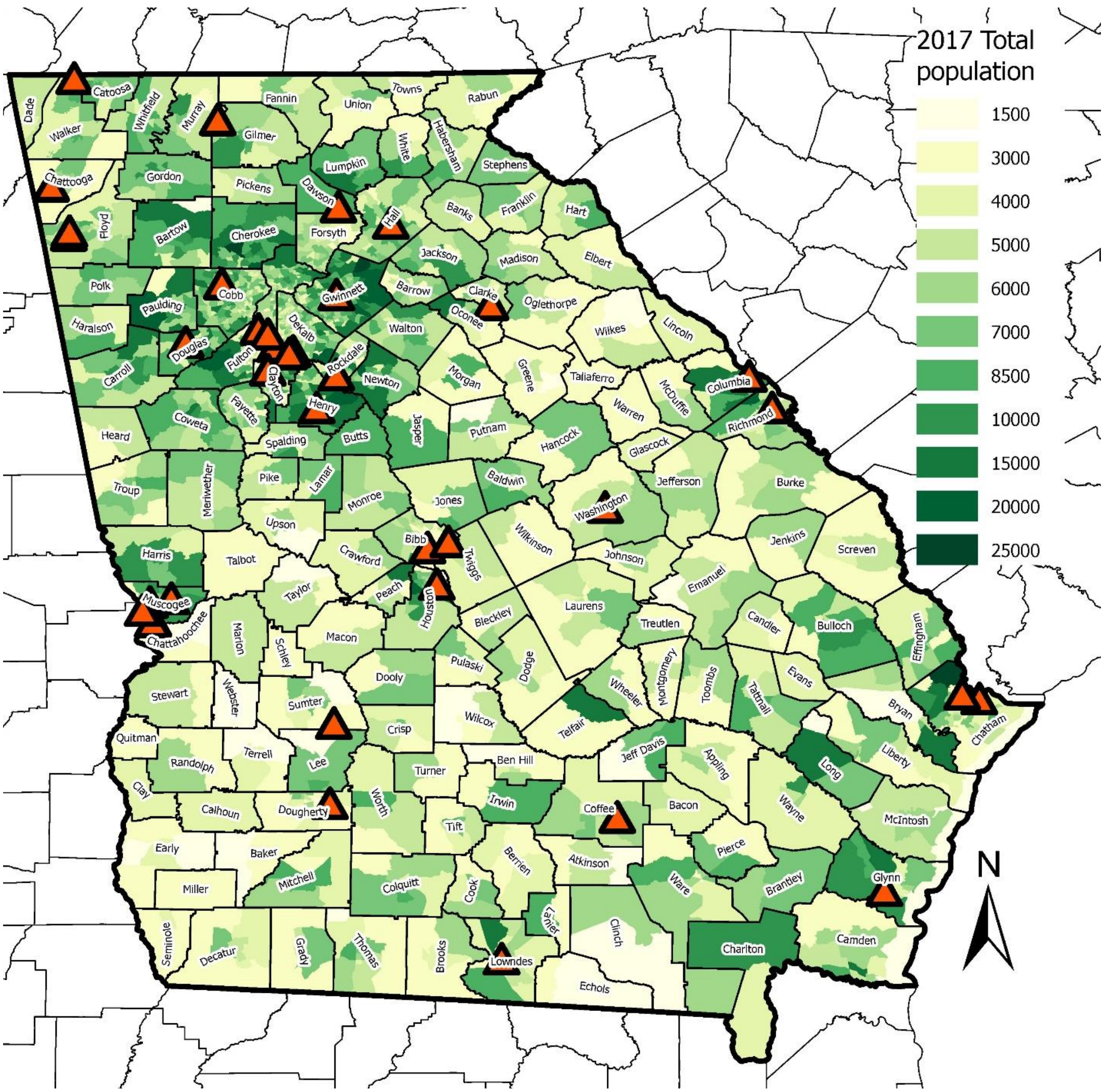


Figure 12.1: 2017 Georgia Total Estimated Population by Census Tract

Figure 12.2 shows the percent change in population for each census tract between 2010 and 2017. The darker blue colors represent a negative percent change in population, while the darker red and orange represent a positive percent change in population. The total population of Georgia increased about 5.3% from 2010 to 2017, with a total estimated population of 10,201,635 in 2017. Overall changes in population were calculated for each county using the 2010 census data and the American Community Survey 5-year estimated population for 2017. Long County had the highest overall increase in population (+23.4%) and Quitman County had the greatest overall decrease in population (-14.8%) between 2010 and 2017.

Figure 12.2 and 12.5 both indicate a census tract in Chattahoochee County with a population change of approximately 260%, while the County as a whole has a decrease in population by -1.5%. This population change differs between the census tract and the County significantly because of the size of the population in that census tract versus the other census tracts which are used to calculate the County's overall change. This census tract in 2010 had a population of approximately 204, which increased to 709 in 2017. Comparatively, the other census tracts in Chattahoochee County had populations of approximately 1141 to 4042 in 2010, with the 2017 populations ranging from 1902 to 3473. As a result, the change in the outlier census tract only counted for a small portion of the overall population change in the County.

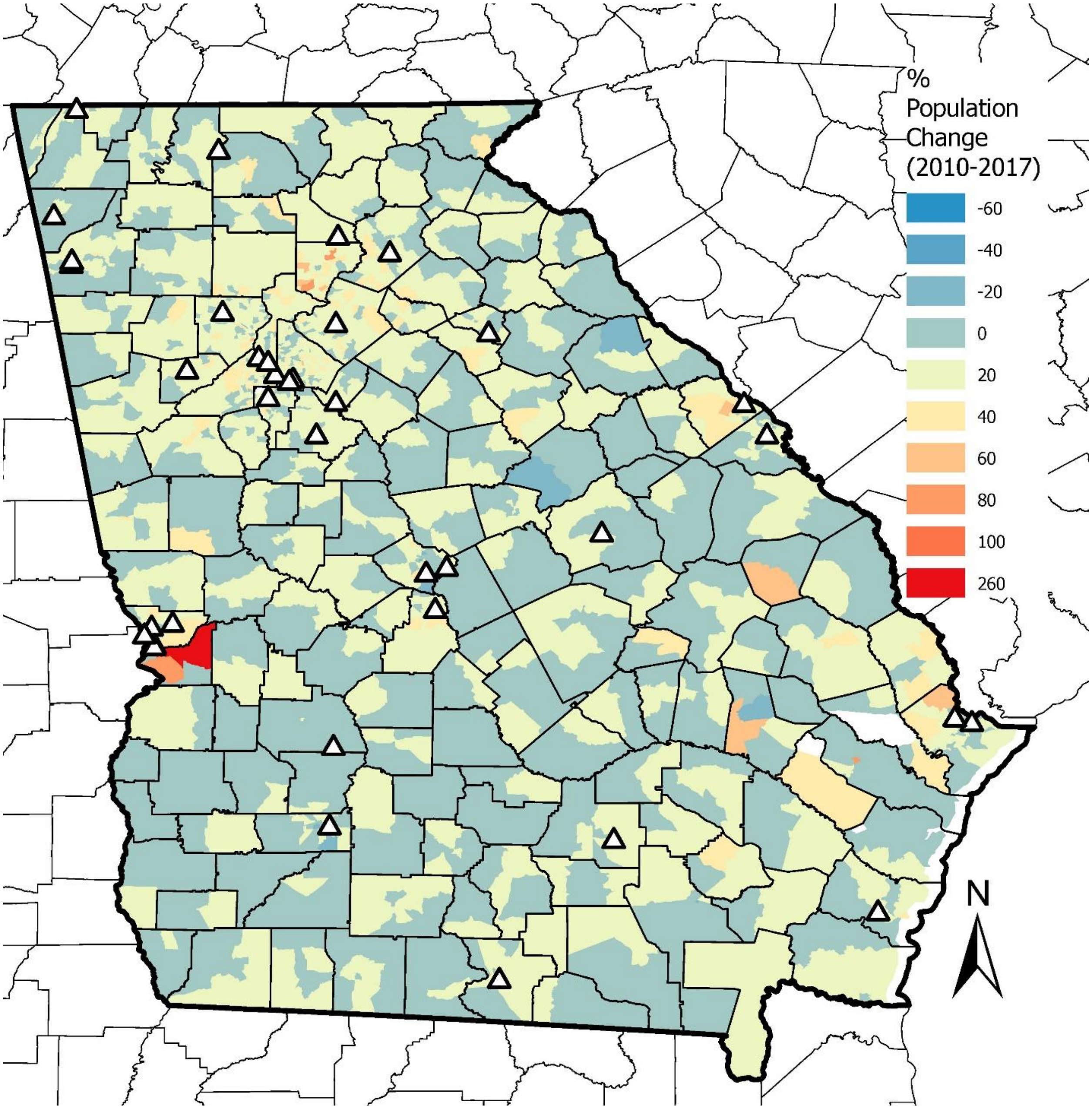


Figure 12.2: Georgia Percent Population Change by Census Tract from 2010 to 2017

Figures 12.3 through 12.7 show a closer view of the percent change in population from 2010 to 2017 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.

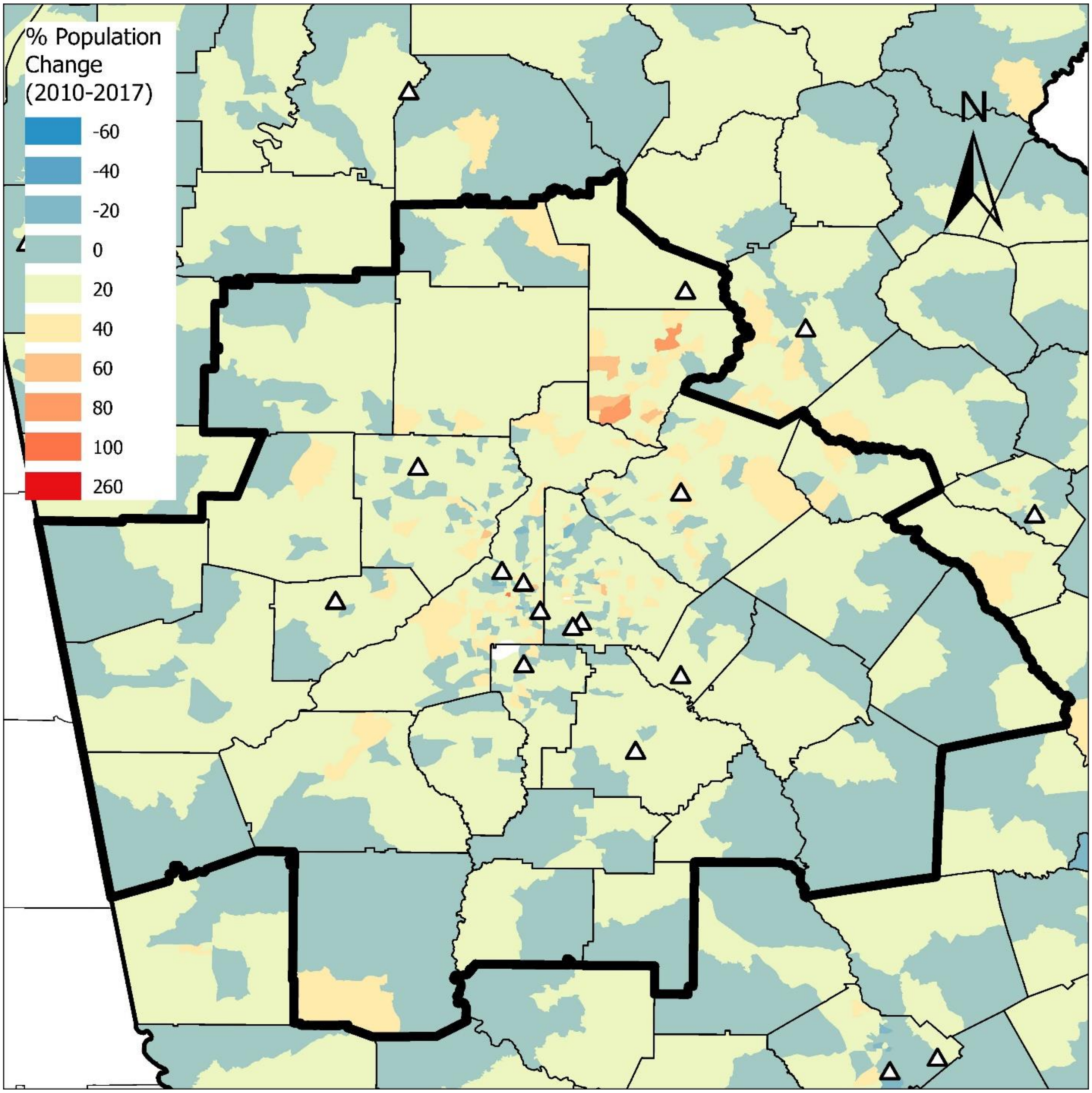


Figure 12.3: Atlanta-Sandy Springs-Roswell MSA Percent Population Change by Census Tract from 2010 to 2017

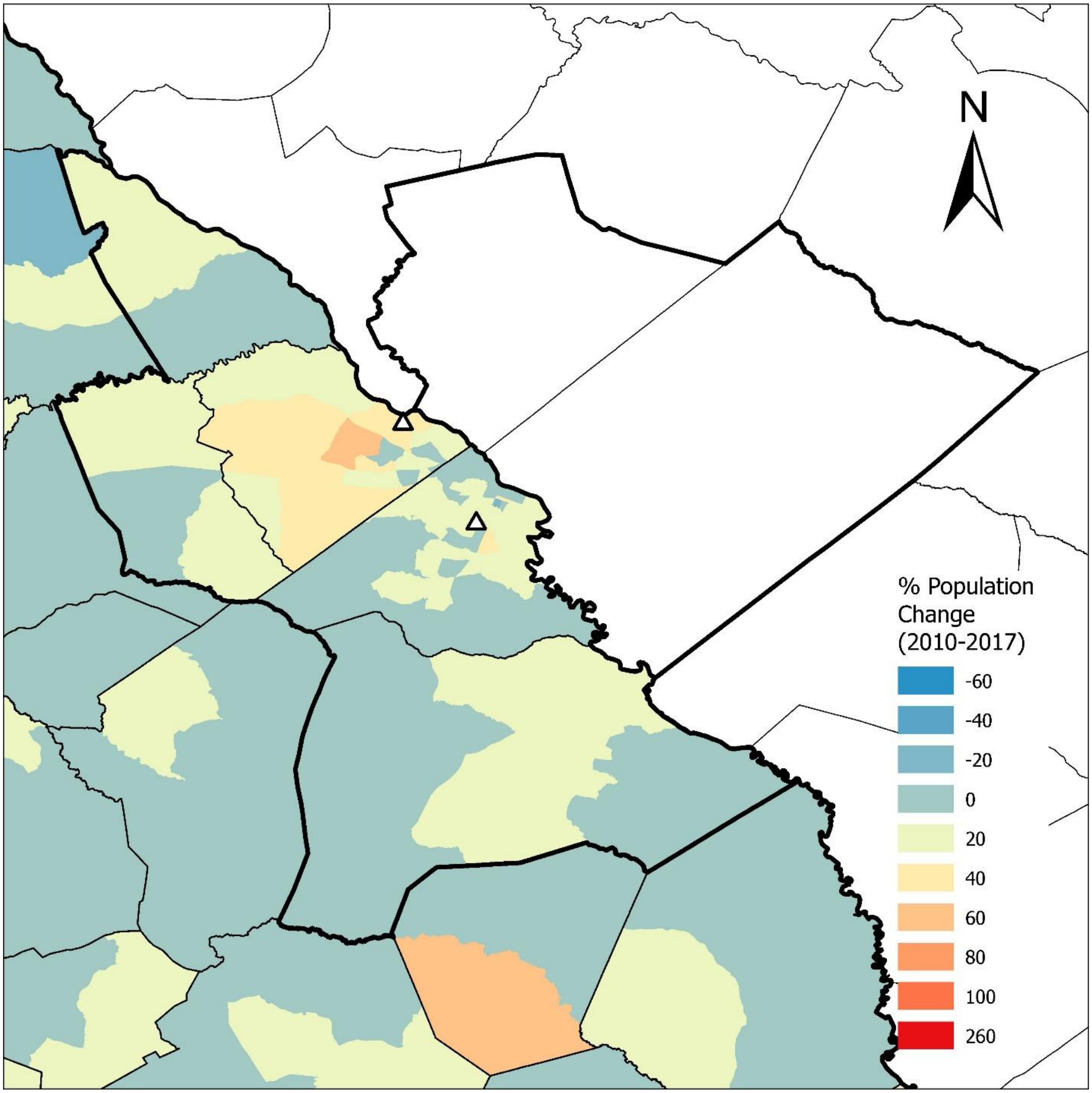


Figure 12.4: Augusta-Richmond County, GA-SC MSA Percent Population Change by Census Tract from 2010 to 2017

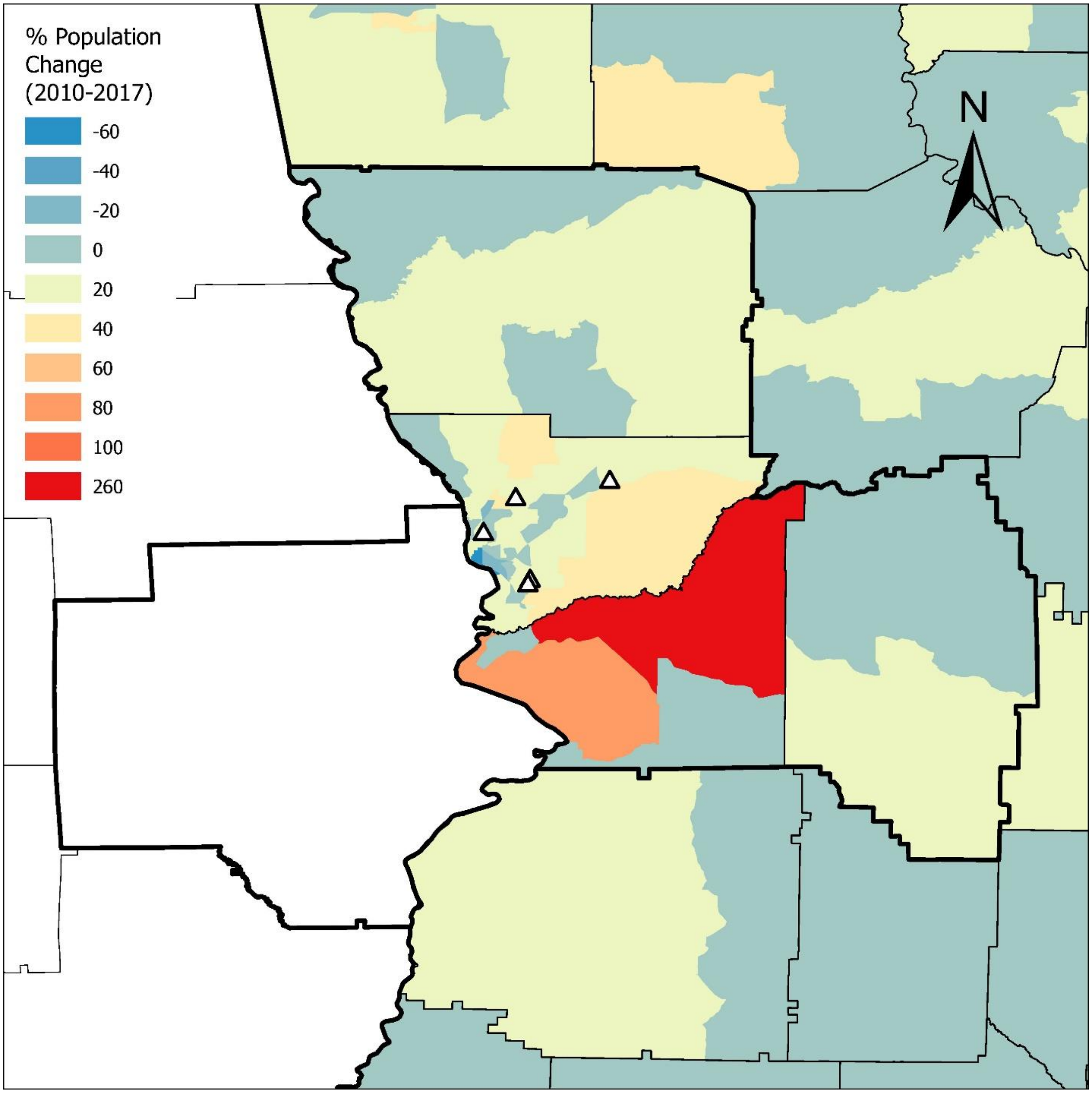


Figure 12.5: Columbus GA-AL MSA Percent Population Change by Census Tract from 2010 to 2017

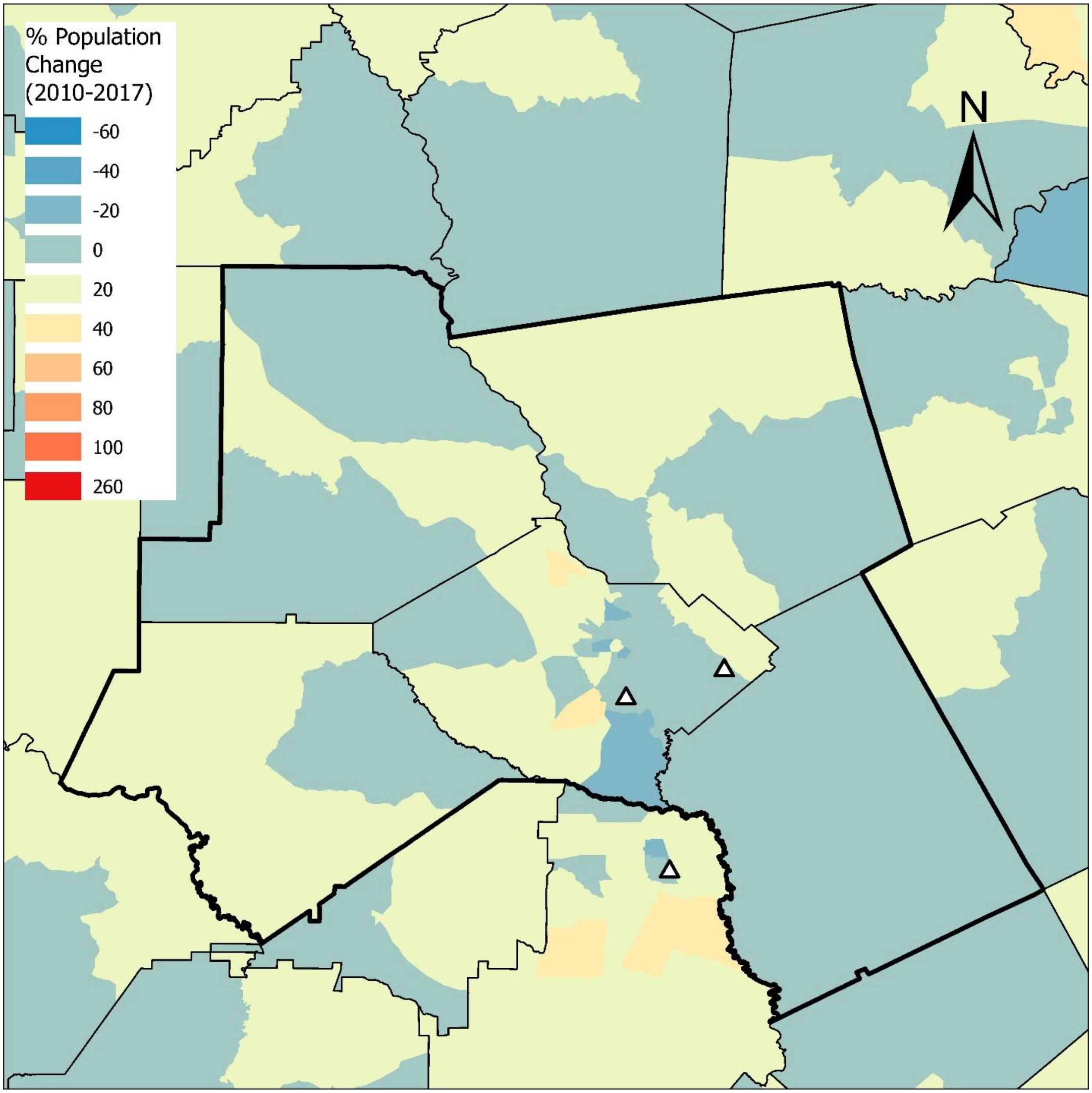


Figure 12.6: Macon MSA Percent Population Change by Census Tract from 2010 to 2017

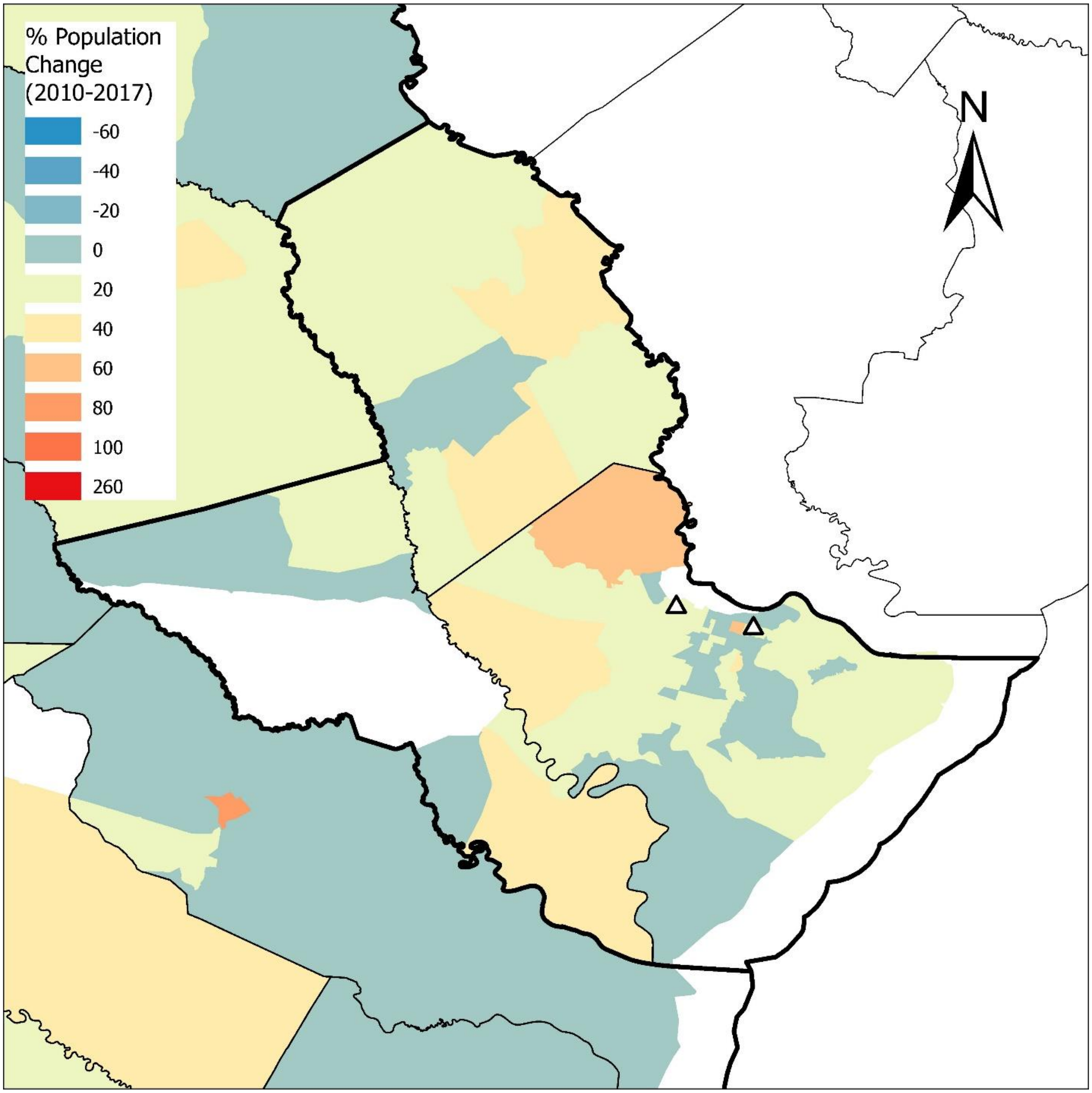


Figure 12.7: Savannah MSA Percent Population Change by Census Tract from 2010 to 2017

12.2 Sensitive Sub-Populations

To meet the requirements set forth by EPA, GA AAMP 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 ArcGIS Pro and show the 2017 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 26.5 percent. Most of the census tracts are in the range of 4-9%. The census tracts with the highest percent populations under 5 years of age are located in Fulton County, Liberty County and Muscogee County.

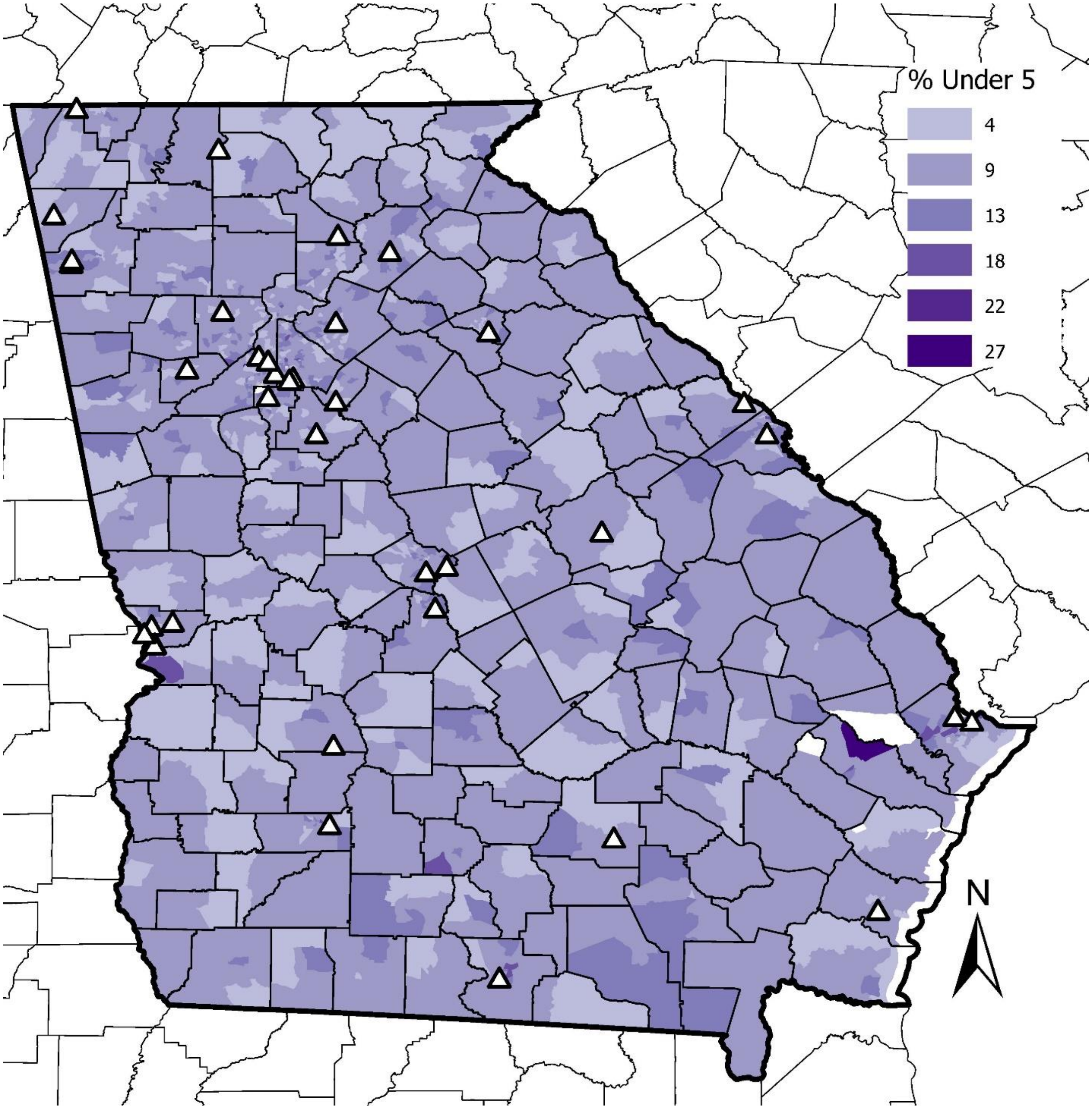


Figure 12.8: Percent of Georgia's Population under 5 Years of Age

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 20-30% range with a total range of 0-60%. The majority of Georgia's ambient air monitors are located in tracts with 20-30% 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 Gainsesville site is at Fair Street Elementary School, the Valdosta site is at Mason Elementary, the Albany site is at Turner Elementary, the South DeKalb site is located next to Cedar Grove Middle School and Georgia State University Perimeter College, and the Brunswick site is at Risley Early College Academy. In addition, two sites are located on a college campuses: the Gwinnett Tech site is at Gwinnett Technical College and the NR-GA Tech site is at Georgia Institute of Technology. The census tracts with the highest percent population under 18 years of age are located in Fulton County (60%), Chatham County (49.2%), and Liberty County (47.7%).

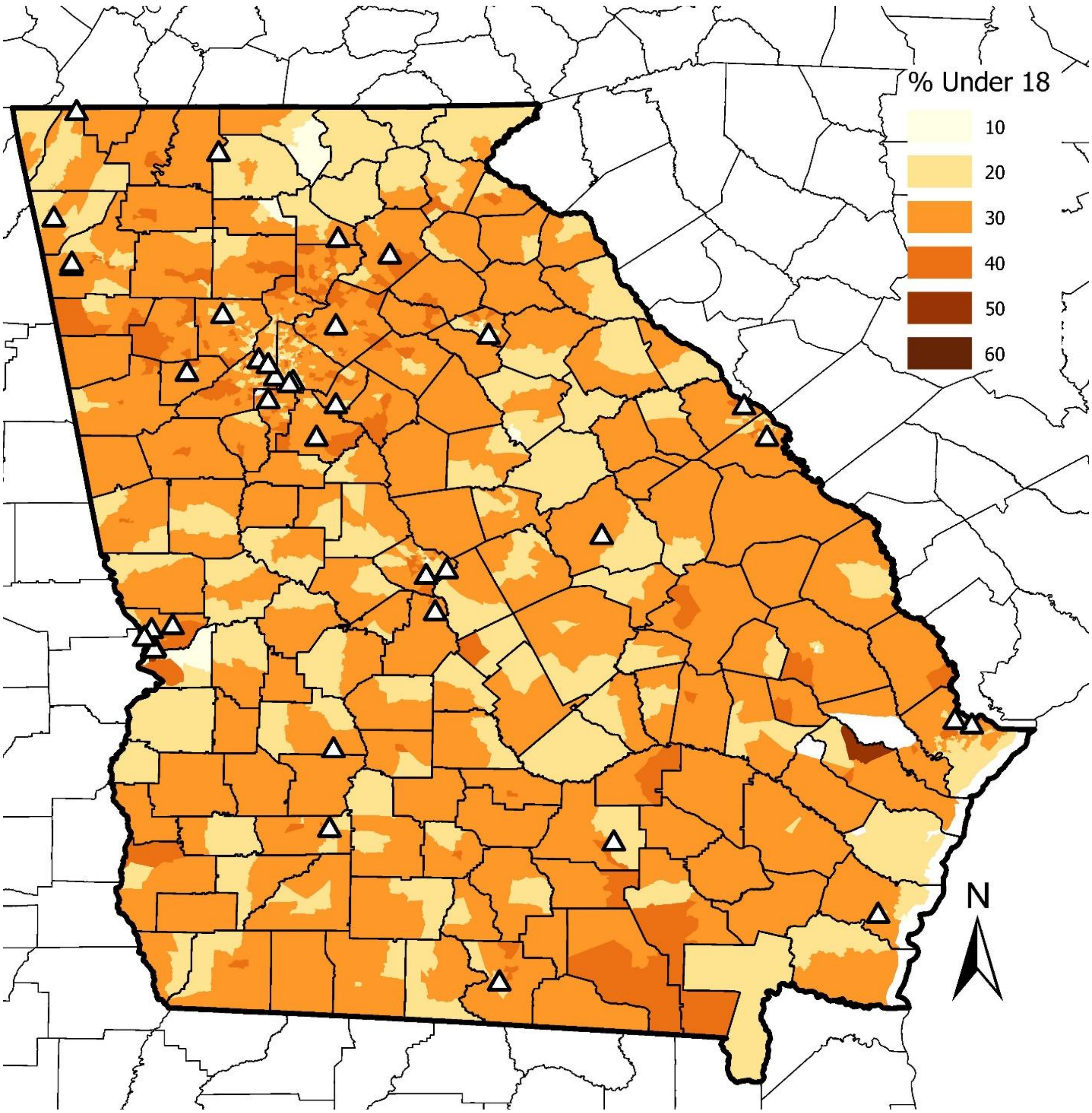


Figure 12.9: Percent of Population Under 18 Years of Age in Georgia

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 10-15% range with a total range of 0-47.7%. The majority of Georgia's ambient air monitors are located in census tracts in the 10-15% range. The two census tracts with the highest percentages of persons over the age of 65 are located in Chatham County (47.7% and 46.1%, respectively), and GA AAMP has ambient air monitors in this County. Several counties in the Northeastern part of the state also have higher percentages of persons over the age of 65. More air monitors could be added in the Northeastern part of the state and in Greene County to monitor where a higher percentage of the population is elderly.

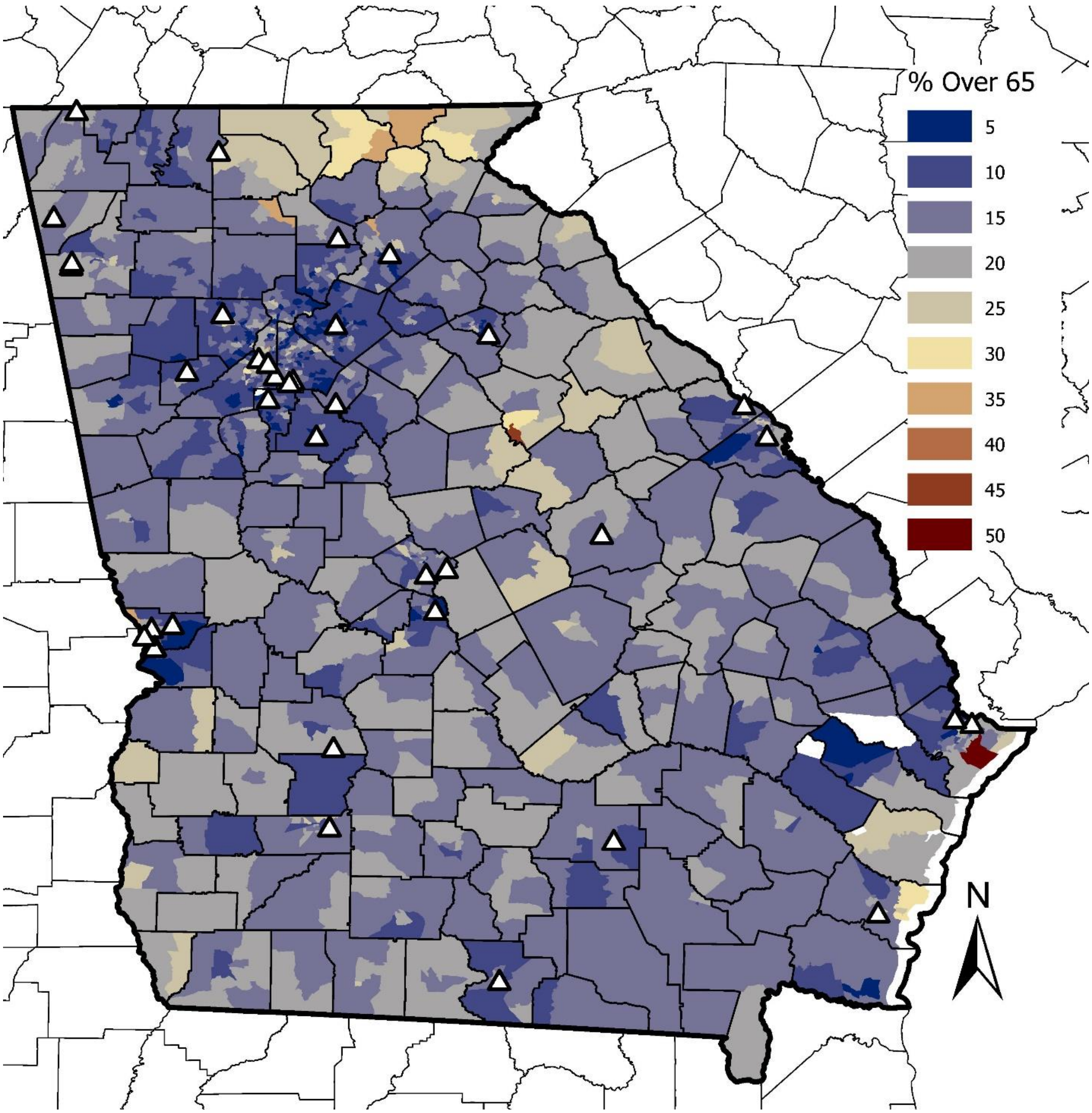


Figure 12.10: Percent of Georgia's Population over 65 Years of Age

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.

The majority of the ambient air monitors in the Atlanta-Sandy Springs-Roswell MSA are located within census tracts where 4-9% 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).

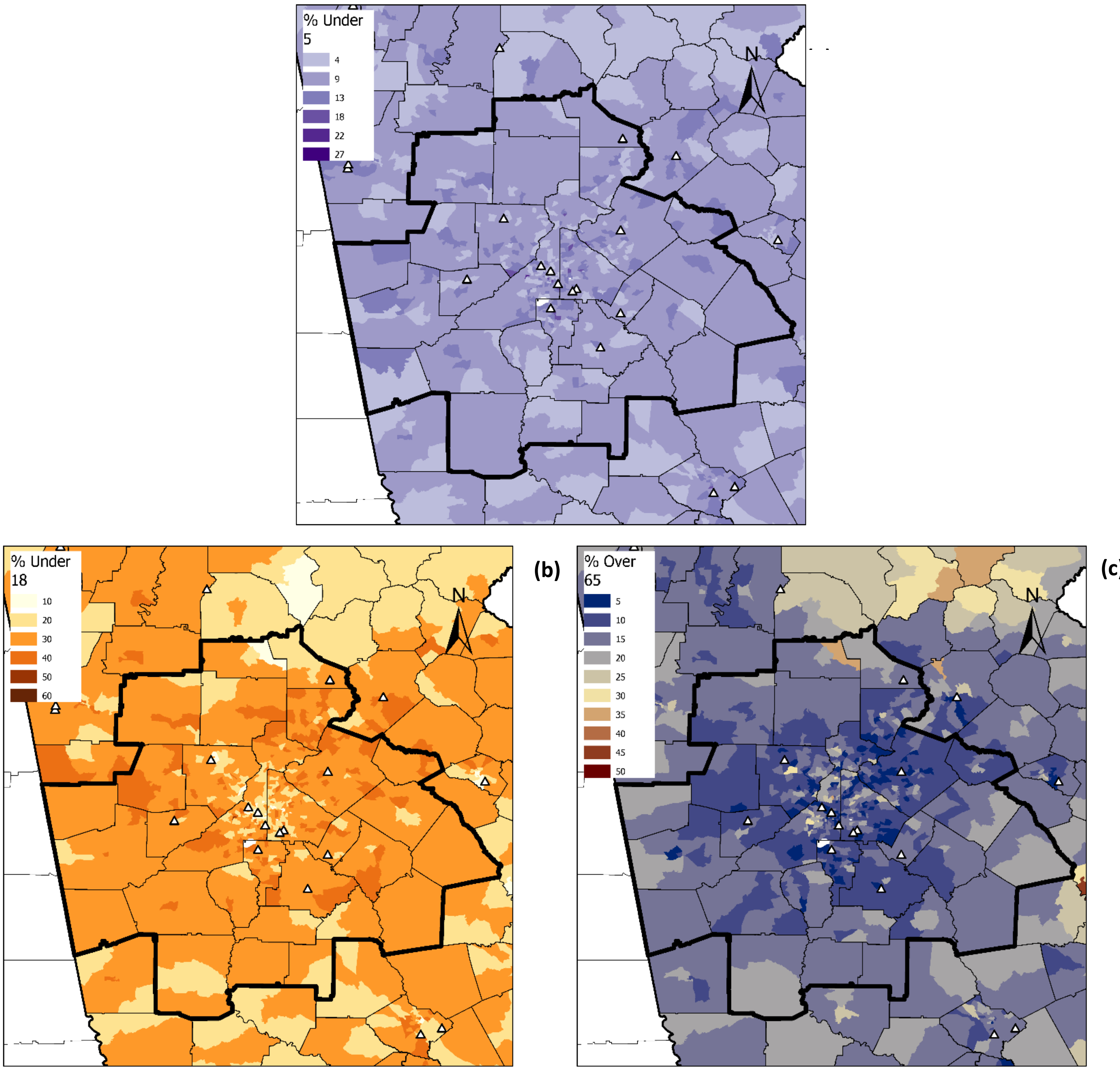


Figure 12.11: Percent of the Population in the Atlanta-Sandy Springs-Roswell MSA (a) under 5 Years, (b) under 18 Years, and (c) over 65 Years

Both ambient air monitors in the Augusta-Richmond County, GA-SC MSA are located within census tracts with 4-9% of the population under 5 years (Figure 12.12a). For percent of the population under 18 years, both monitors are 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).

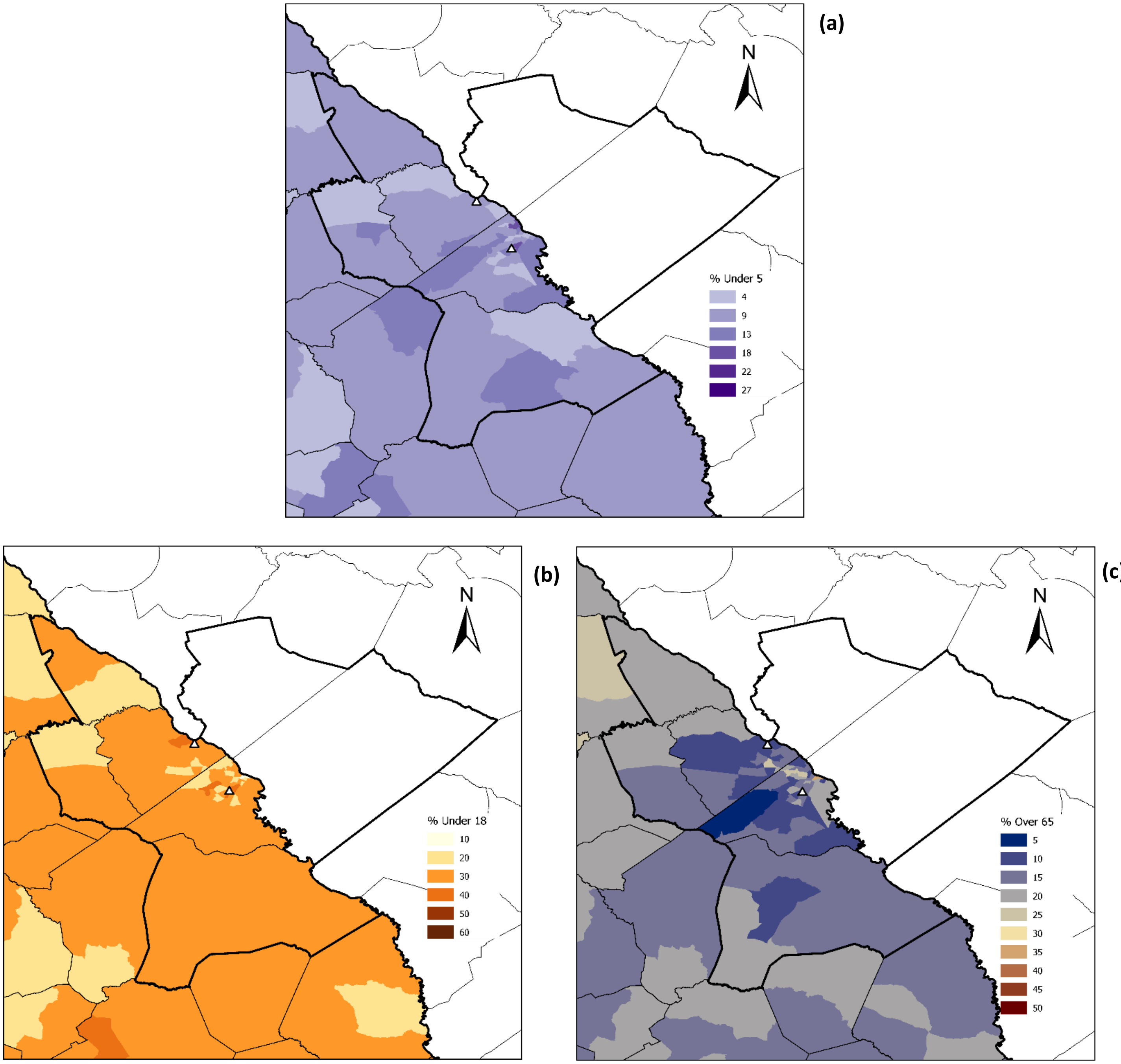


Figure 12.12: Percent of the Population in the Augusta-Richmond County, GA-SC MSA (a) under 5 Years, (b) under 18 Years, and (c) over 65 Years

The majority of ambient air monitors in the Columbus, GA-AL MSA are in the 0-4% and 9-13% ranges 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).

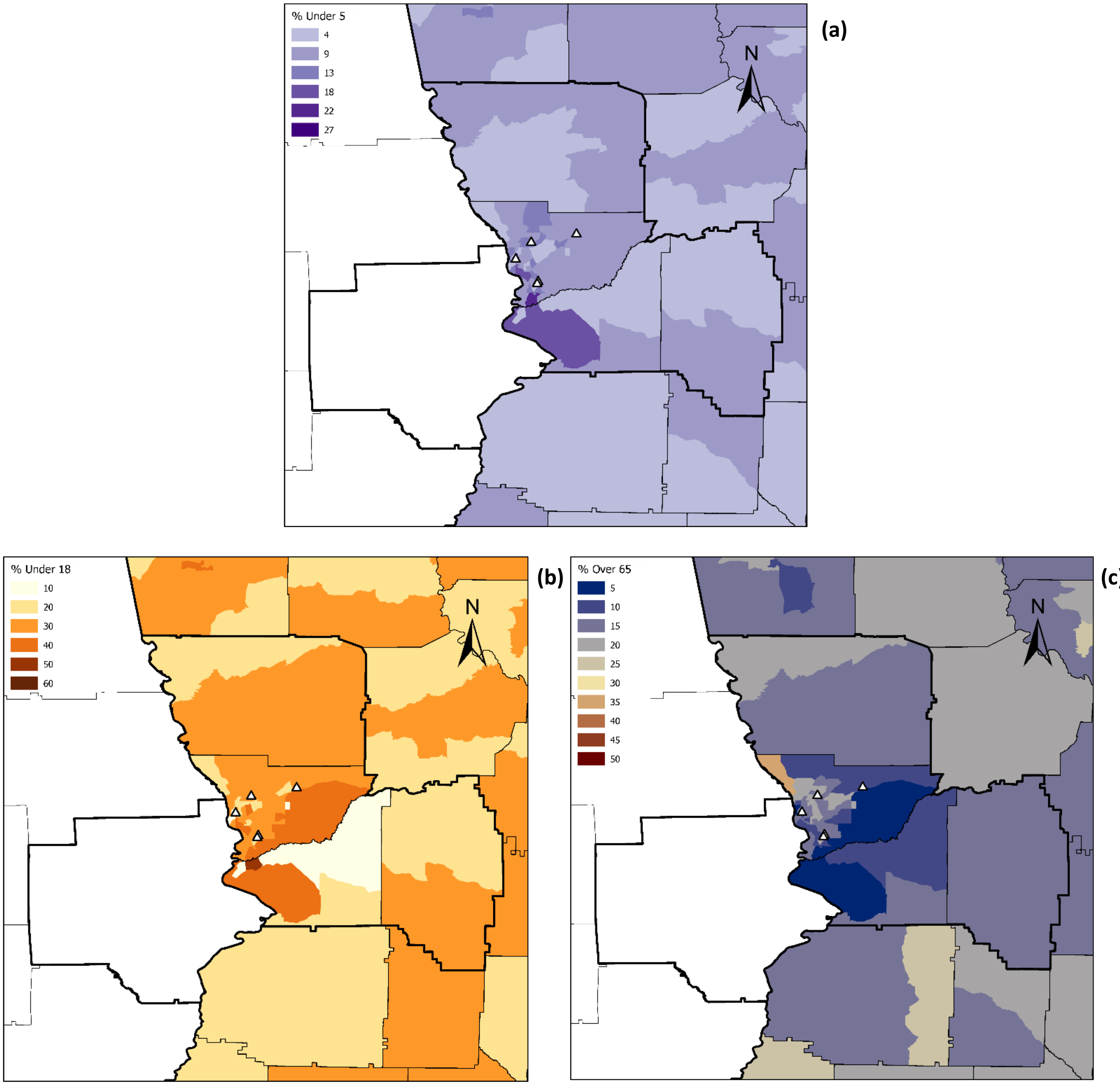


Figure 12.13: Percent of the Population in the Columbus, GA-AL MSA (a) under 5 Years, (b) under 18 Years, and (c) over 65 Years

Both monitors in the Macon MSA are located in census tracts with 4-9% of the population under 5 years of age (Figure 12.14a), with 10-20% of the population under 18 years (Figure 12.14b), and with 10-15% of the population over 65 years (Figure 12.14c)

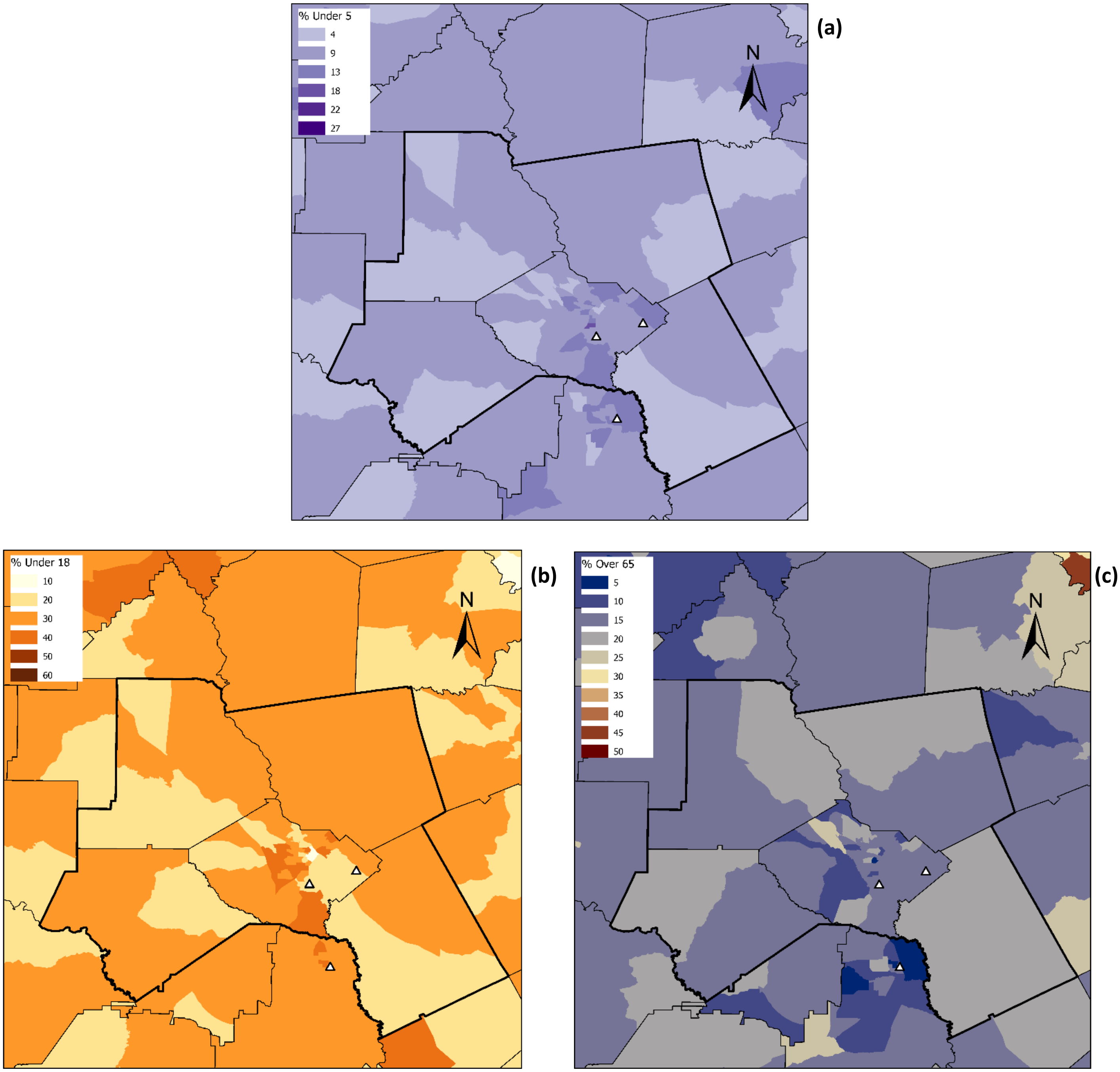


Figure 12.14: Percent of the Population in the Macon MSA (a) under 5 Years, (b) under 18 Years, and (c) over 65 Years

In the Savannah MSA, one monitor is located in a tract with 9-13% of the population under 5 years, and the other monitor is located in an area with 13-18% of the population under 5 years (Figure 12.15a). For percent of the population under 18 years, both monitors are in an area with 30-40% of the population under 18 years (Figure 12.15b). For percent of the population over 65 years, one monitor is 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).

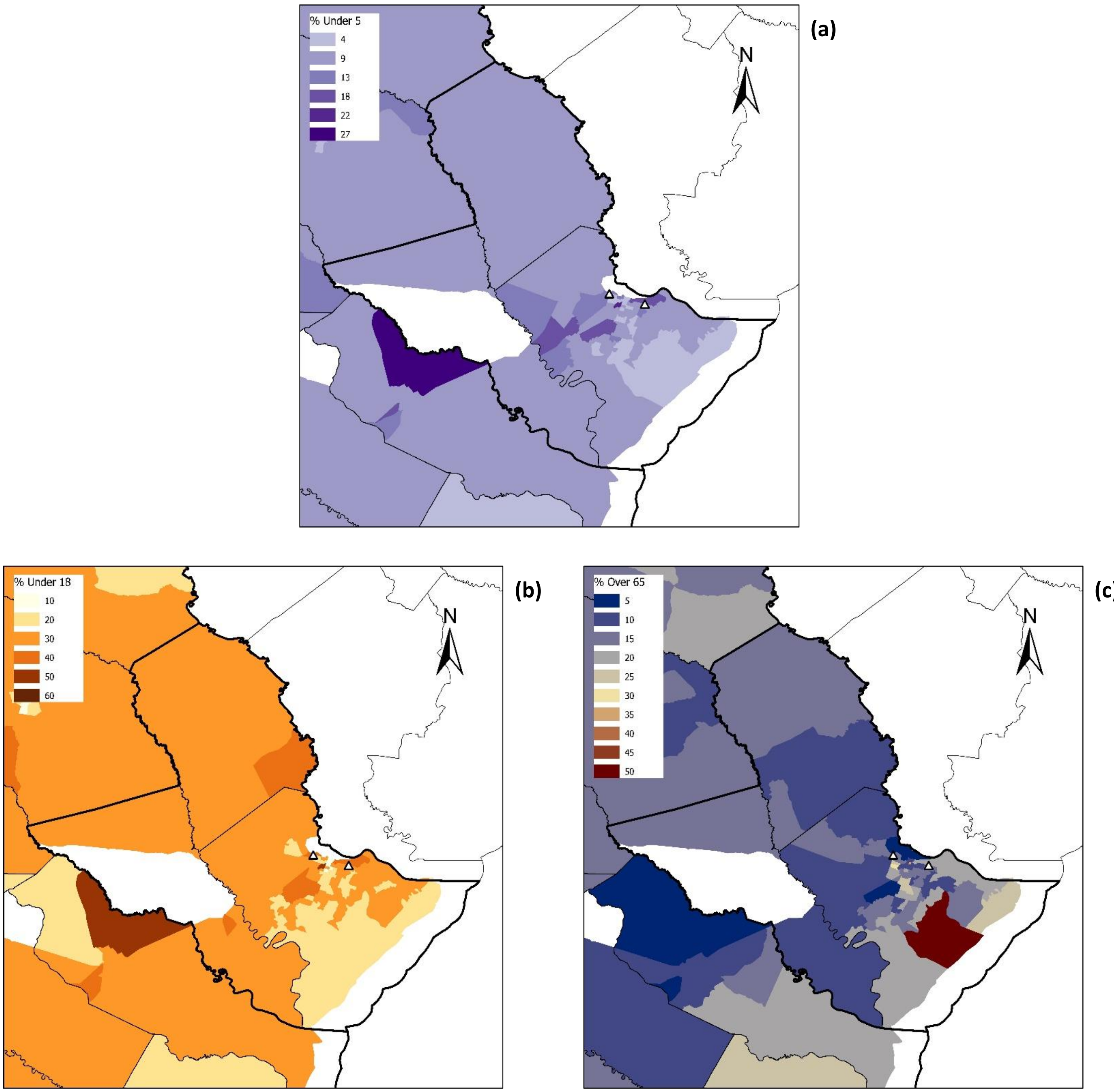


Figure 12.15: Percent of the Population in the Savannah MSA (a) under 5 Years, (b) under 18 Years, and (c) over 65 Years

This assessment considered GA AAMP'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 AAMP considered in this assessment involves areas with low-income populations and minorities. GA AAMP 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 (https://www.cdc.gov/asthma/brfss/2017/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 (percent)	95% CI* (percent)	Prevalence (number)	95% CI* (number)
GA	White NH	3,420	8.3	0.63	(7.1-9.6)	351,499	(297,984-402,014)
GA	Black NH	1,564	10.1	0.98	(8.1-12.0)	235,721	(188,872-282,571)
GA	Other NH	218	3.5	1.45	(0.6-6.4)	12,954	(2,223-23,685)
GA	Multirace NH	98	17.3	4.8	(7.8-26.9)	17,574	(6,973-28,176)
GA	Hispanic	534	3.1	0.79	(1.6-4.7)	20,227	(10,102-30,352)

*CI denotes confidence interval
https://www.cdc.gov/asthma/brfss/2017/default.htm

Table 12.4: Adult Self-Reported Current Asthma Prevalence Rate (Percent) and Prevalence (Number) by Race/Ethnicity and State or Territory: BRFSS 2017

State	Race/Ethnicity	Sample Size	Prevalence (percent)	Standard Error (percent)	95% CI* (percent)	Prevalence (number)	95% CI* (number)
GA	White NH	3,429	13.2	0.77	(11.7-14.7)	558,812	(491,137-626,488)
GA	Black NH	1,569	13.8	1.11	(11.6-15.9)	323,654	(269,499-377,860)
GA	Other NH	219	6.1	1.94	(2.3-9.9)	22,616	(8,150-37,082)
GA	Multirace NH	100	24.3	5.19	(14.0-34.6)	25,140	(13,147-37,134)
GA	Hispanic	535	5.3	1.02	(3.3-7.3)	34,459	(21,236-47,682)

*CI denotes confidence interval
https://www.cdc.gov/asthma/brfss/2017/default.htm

Table 12.5: Adult Self-Reported Lifetime Asthma Prevalence Rate (Percent) and Prevalence (Number) by Race/Ethnicity and State or Territory: BRFSS 2017

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 (17.3% and 24.3%, 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 (percent)	95% CI* (percent)	Prevalence (number)	95% CI* (number)
GA	18-24	393	10.5	1.80	(7.0-14.1)	109,504	(70,607-148,401)
GA	25-34	741	6.8	1.12	(4.6-9.0)	95,171	(63,580-126,761)
GA	35-44	721	9.4	1.28	(6.9-11.9)	126,132	(90,876-161,387)
GA	45-54	859	8.3	1.15	(6.1-10.6)	112,870	(80,942-144,798)
GA	55-64	1,208	9.3	0.98	(7.3-11.2)	116,675	(91,401-141,949)
GA	65+	2,023	6.8	0.68	(5.5-8.2)	96,921	(77,592-116,249)

*CI denotes confidence interval
https://www.cdc.gov/asthma/brfss/2017/default.htm

Table 12.6: Adult Self-Reported Current Asthma Prevalence Rate (Percent) and Prevalence (Number) by Age and State or Territory: BRFSS 2017

State	Age Group	Sample Size	Prevalence (percent)	Standard Error (percent)	95% CI* (percent)	Prevalence (number)	95% CI* (number)
GA	18-24	393	16.9	2.14	(12.7-21.1)	175,628	(128,137-223,120)
GA	25-34	745	12.6	1.41	(9.8-15.4)	176,207	(135,192-217,222)
GA	35-44	723	13.4	1.53	(10.3-16.4)	180,408	(136,877-223,938)
GA	45-54	860	10.7	1.24	(8.2-13.1)	144,343	(109,786-178,901)
GA	55-64	1,210	13.8	1.20	(11.4-16.1)	174,052	(142,446-205,658)
GA	65+	2,032	9.9	0.82	(8.3-11.5)	140,981	(117,284-164,679)

*CI denotes confidence interval
https://www.cdc.gov/asthma/brfss/2017/default.htm

Table 12.7: Adult Self-Reported Lifetime Asthma Prevalence Rate (Percent) and Prevalence (Number) by Age and State or Territory: BRFSS 2017

For the asthma prevalence rate in Georgia, the age group of 18-24 years had the highest rate for both the current and lifetime asthma prevalence rate at 10.5% and 16.9%, respectively.

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 (percent)	95% CI* (percent)	Prevalence (number)	95% CI* (number)
GA	< $15000	568	14.3	1.91	(10.6-18.1)	97,212	(69,789-124,635)
GA	$15-$24999	1,019	10.7	1.24	(8.3-13.1)	140,743	(107,278-174,209)
GA	$25-$49999	1,143	8.3	1.07	(6.2-10.4)	126,979	(93,588-160,370)
GA	$50-$74999	675	7.4	1.33	(4.7-10.0)	67,716	(42,710-92,722)
GA	>=$75000	1,399	5.7	0.83	(4.1-7.3)	110,358	(77,898-142,819)

*CI denotes confidence interval
https://www.cdc.gov/asthma/brfss/2017/default.htm

Table 12.8: Adult Self-Reported Current Asthma Prevalence Rate (Percent) and Prevalence (Number) by Income and State or Territory: BRFSS 2017

State	Income	Sample Size	Prevalence (percent)	Standard Error (percent)	95% CI* (percent)	Prevalence (number)	95% CI* (number)
GA	< $15000	570	18.6	2.15	(14.4-22.8)	126,719	(94,799-158,640)
GA	$15-$24999	1,022	15.1	1.45	(12.2-17.9)	198,707	(158,516-238,897)
GA	$25-$49999	1,145	12.4	1.28	(9.9-14.9)	190,441	(149,696-231,186)
GA	$50-$74999	677	11.9	1.70	(8.6-15.3)	110,681	(77,521-143,840)
GA	>=$75000	1,402	10.0	1.02	(8.0-12.0)	195,211	(154,591-235,831)

*CI denotes confidence interval
https://www.cdc.gov/asthma/brfss/2017/default.htm

Table 12.9: Adult Self-Reported Lifetime Asthma Prevalence Rate (Percent) and Prevalence (Number) by Income and State or Territory: BRFSS 2017

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 14.3%, and with the lifetime rates, the prevalence was 18.6%

12.2.3.2 Census Tracts Demographics

Figures 12.16 through 12.22 (below) were created using ArcGIS Pro and show the 2017 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. The majority of Georgia's ambient air monitors are located in census tracts in the 10-20% range, with a total range of 0-88.6%. The census tracts with the highest percentages of persons below poverty are located in Clarke and Chatham counties (88.6% and 87.6%, respectively).

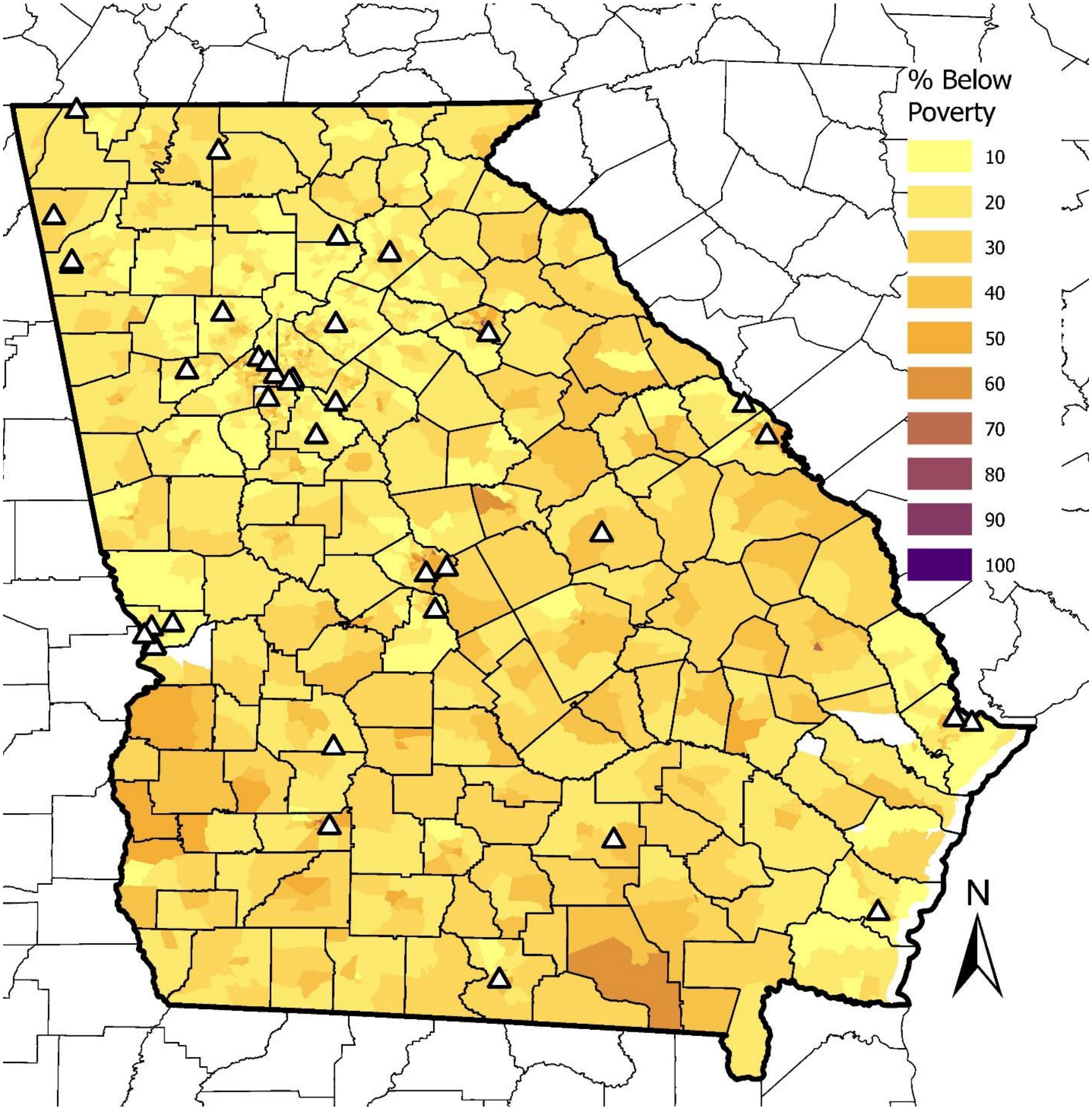


Figure 12.16: Georgia Map Indicating Percent of Population below Poverty for Each Census Tract

Figure 12.17 shows the percent minority 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 the 40-50% and 50-60% ranges. The tracts with the highest percentages of minorities are located in Fulton and Chatham counties, each with 100%.

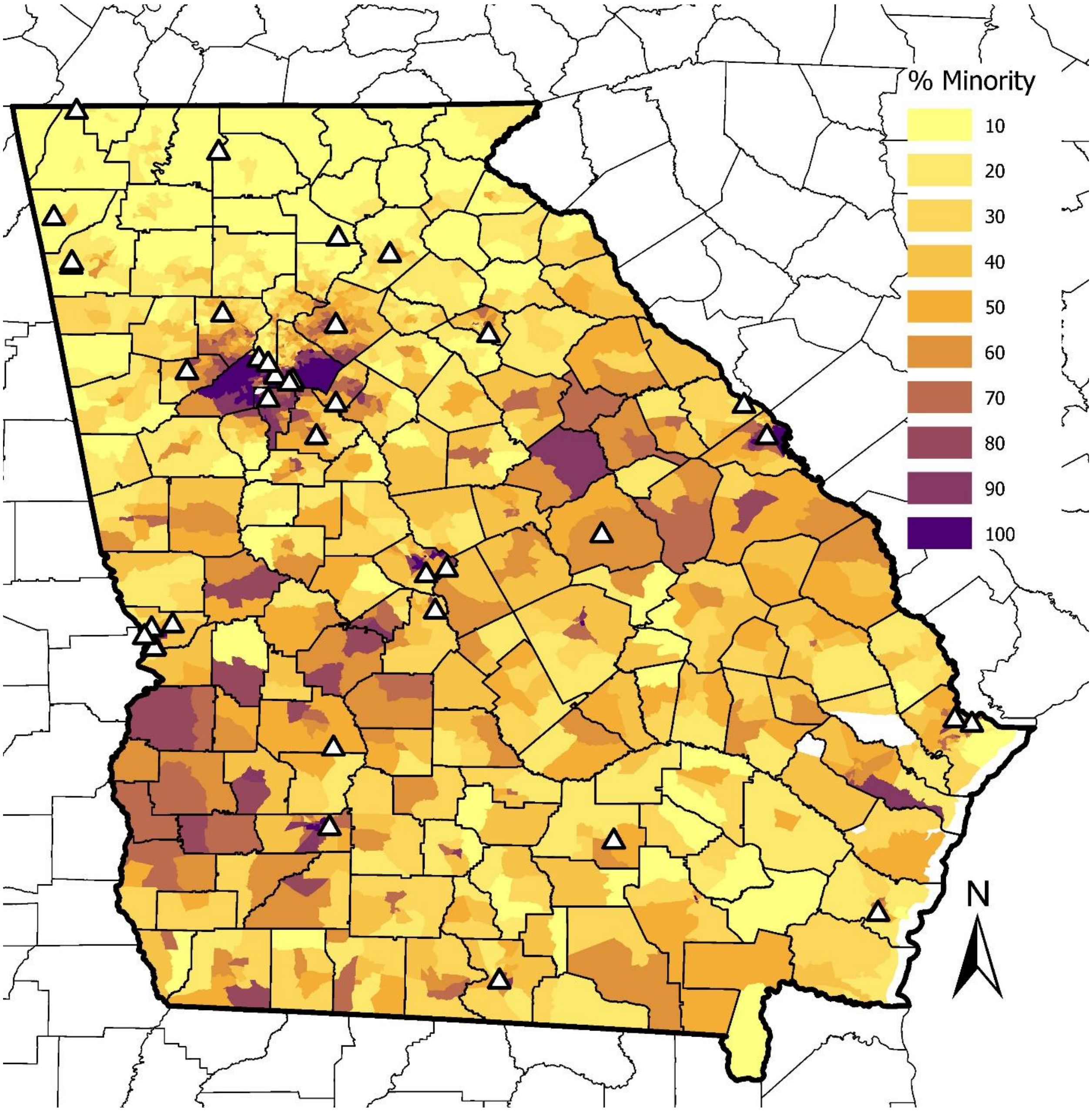


Figure 12.17: Percent Minority by Census Tract in Georgia

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

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

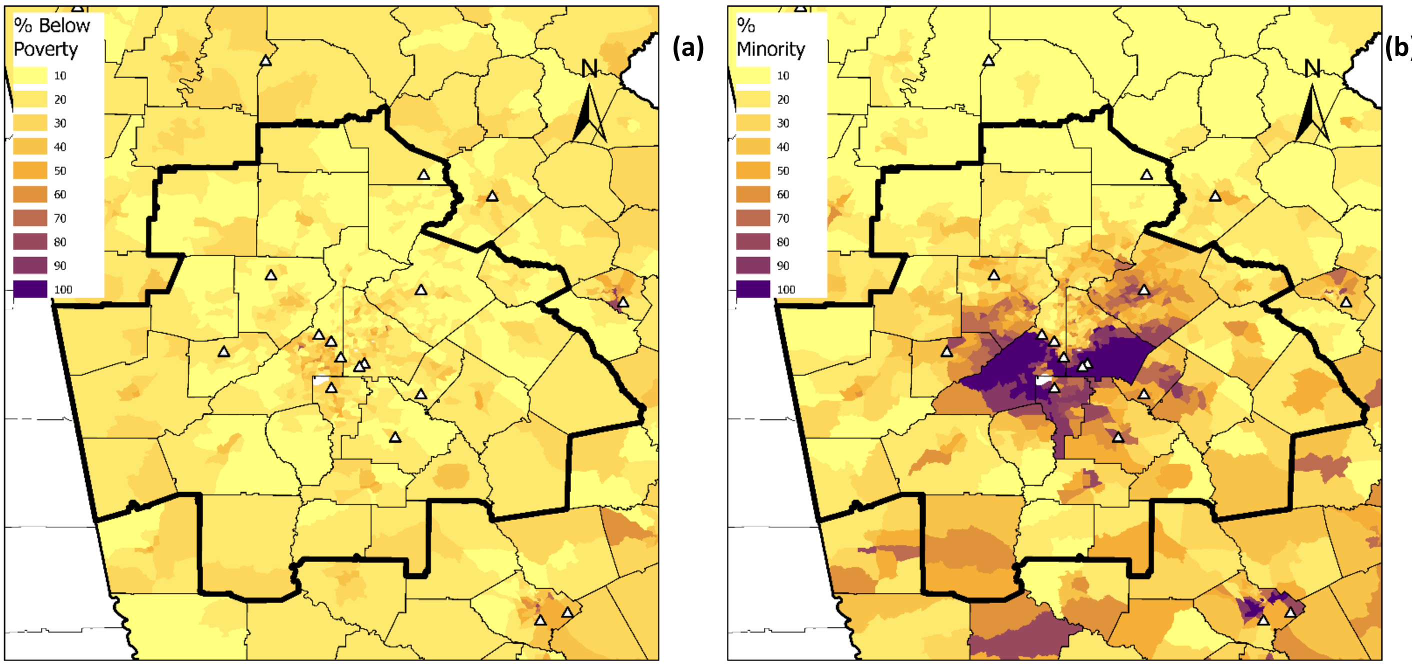


Figure 12.18: Percent of the Population in the Atlanta-Sandy Springs-Roswell MSA (a) below Poverty and (b) Minority

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 10-20% range and the other is located in the 60-70% range.

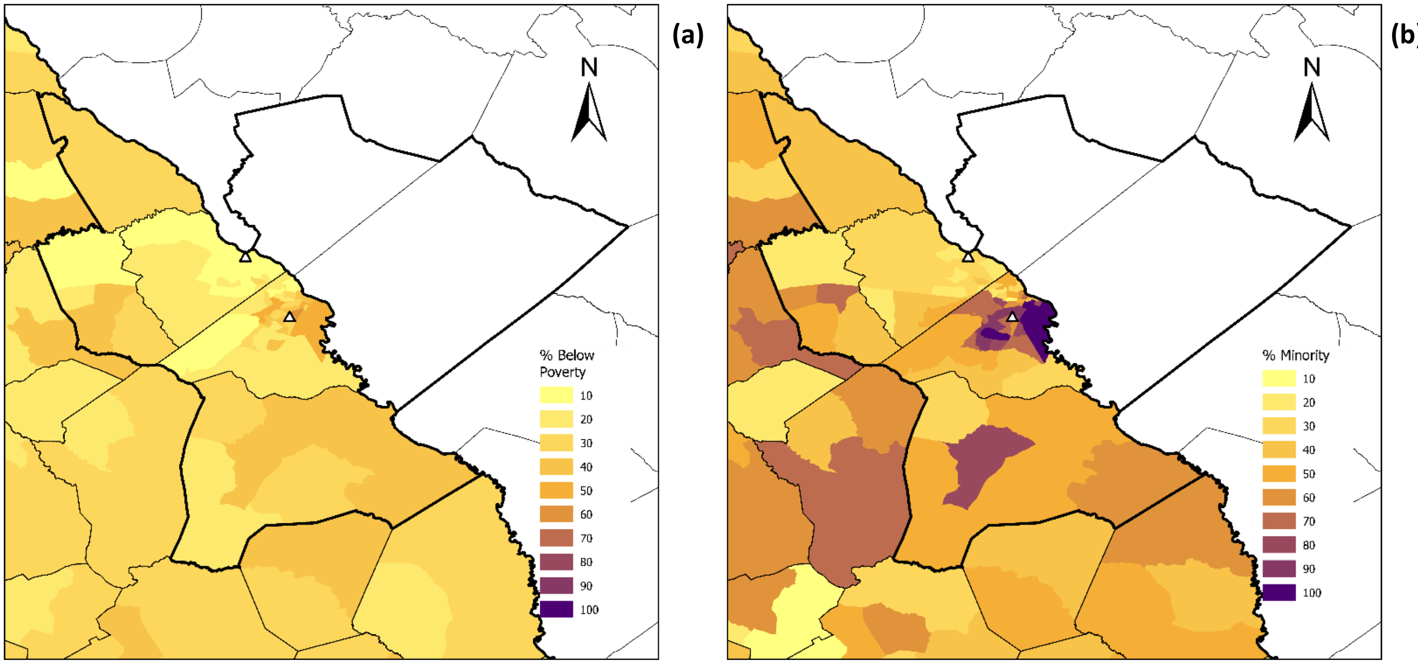


Figure 12.19: Percent of the Population in the Augusta-Richmond County GA-SC MSA (a) below Poverty and (b) Minority

In the Columbus GA-AL MSA, two monitors are in the 0-10%, one is in the 10-20%, and three are in the 30-40% range for percent of population below poverty (Figure 12.20a). For percent minority (Figure 12.20b), one monitor is in the 20-30%, two are in the 40-50%, one is in the 80-90%, and one is in the 90-100% range for percent minority population.

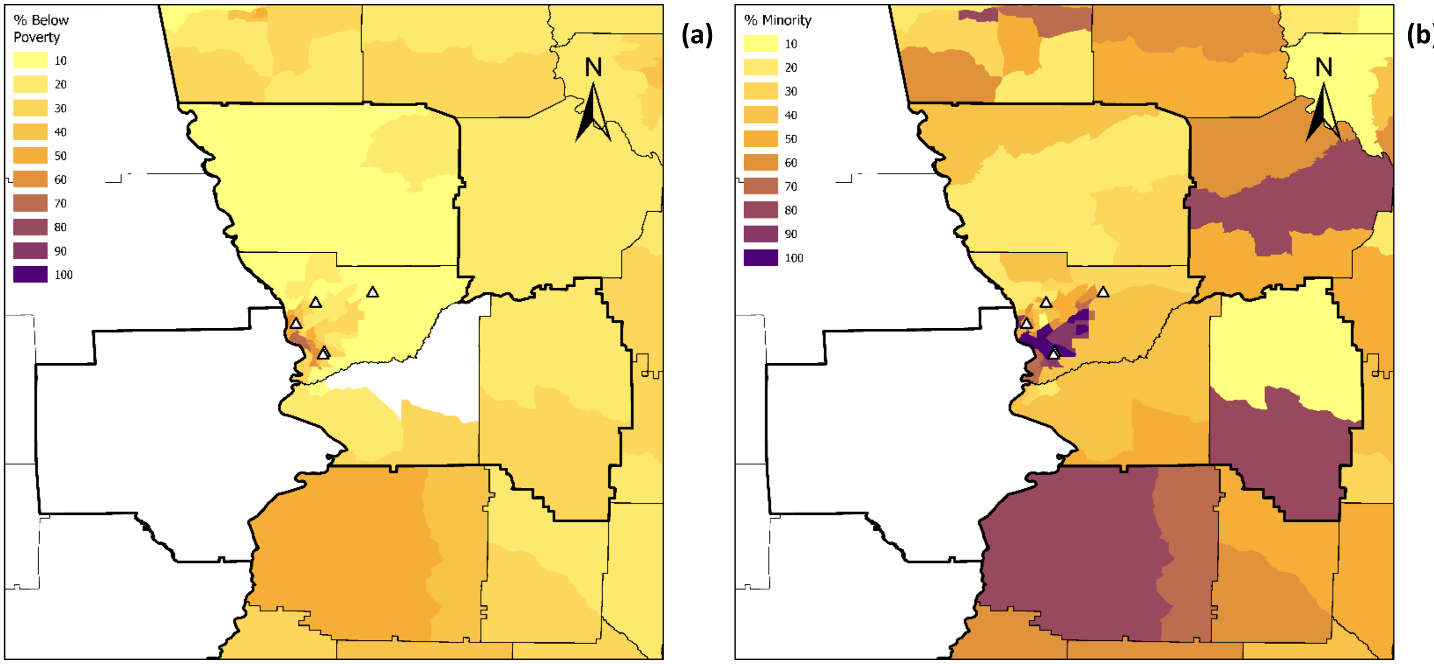


Figure 12.20: Percent of the Population in the Columbus, GA-AL MSA (a) below Poverty and (b) Minority

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

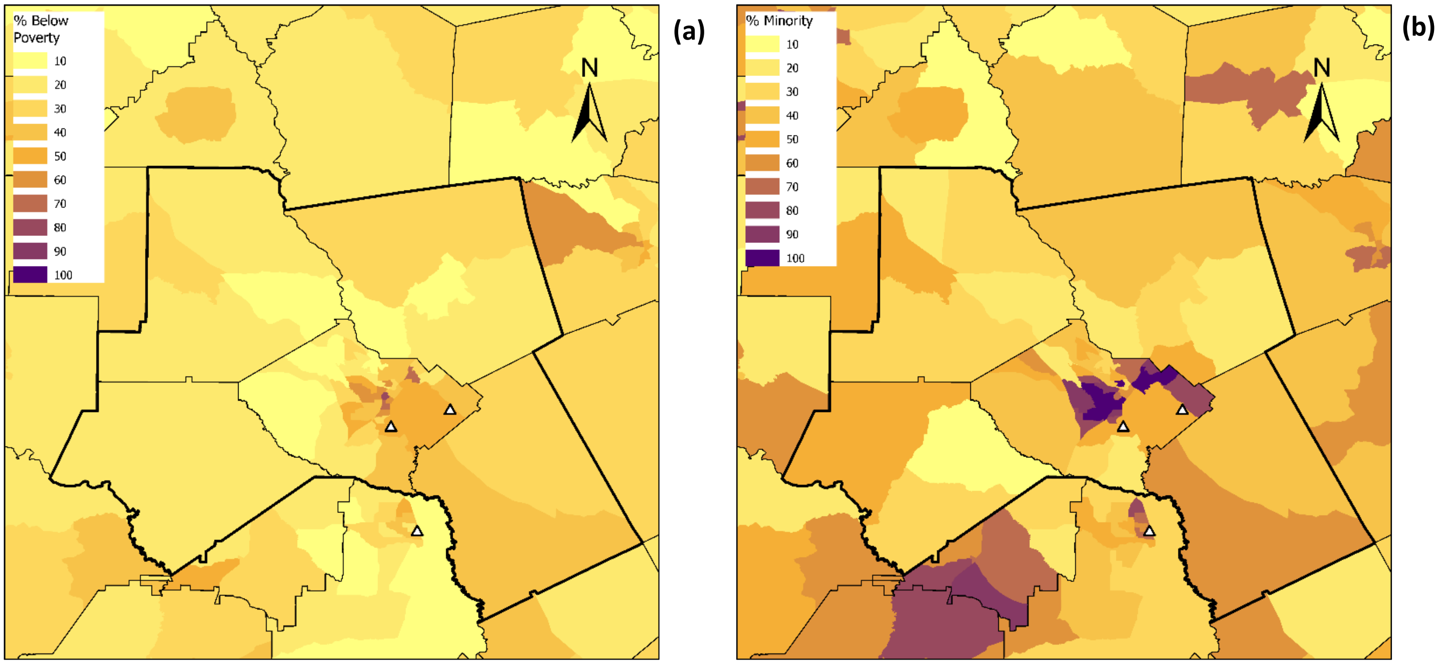


Figure 12.21: Percent of the Population in the Macon MSA (a) below Poverty and (b) Minority

One of the ambient air monitors in the Savannah MSA is located in an area with 20-30% population below poverty and the other is in an area with 40-50% population below poverty (Figure 12.22a). One ambient air monitor is located in an area with 60-70% minority population, and the second with 90-100% minority population (Figure 12.22b).

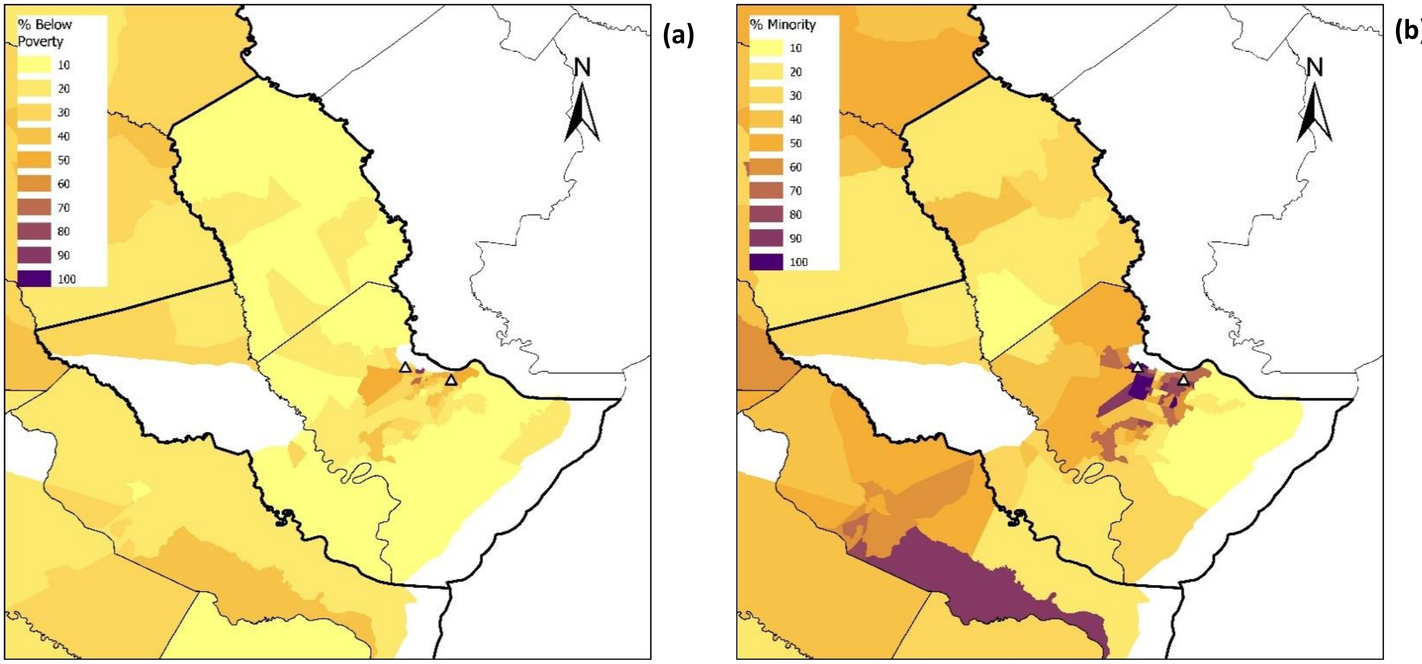


Figure 12.22: Percent of the Population in the Savannah MSA (a) below Poverty and (b) Minority

With this assessment of the location of GA AAMP'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 AAMP 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 ArcGIS Pro 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 AQI Assessment

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 (https://www.epa.gov/criteria-air-pollutants/naaqs-table).

Table 13.1: National Ambient Air Quality Standards

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 [81 FR 71906, Oct 18, 2016]		primary and secondary	Rolling 3-month average	0.15 $\mu g/m^3$ (1)	Not to be exceeded
Nitrogen Dioxide [77 FR 20218, Apr 3, 2012] [75 FR 6474, Feb 9, 2010]		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 [80 FR 65292 Oct 26, 2015]		primary and secondary	8-hour	0.070 ppm (3)	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particle Pollution[78 FR 3085 Jan 15, 2013]	$PM_{2.5}$	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 [84 FR 9866, March 18, 2019] [77 FR 20218, Apr 3, 2012]		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 October 1, 2015, and effective December 28, 2015. The previous (2008) standards additionally remain in effect in some areas. Revocation of the previous (2008) O_3 standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.
(4) The previous SO_s standards (0.14 ppm 24-hour and 0.03 ppm annual) will additionally remain in effect in certain areas: (1) any area for which it is not yet 1 year since the effective date of designation under the current (2010) standards, and (2) any area for which an implementation plan providing for attainment of the current (2010) standard has not been submitted and approved and which is designation nonattainment under the previous SO_2 standards or is not meeting the requirements of a SIP under the previous SO_2 standards (40 CFE 50.4(3)). A SIP call is an EPA action requiring a state to resubmit all or part of its State Implementation Plan to demonstrate attainment of the required NAAQS.
https://www.epa.gov/criteria-air-pollutants/naaqs-table

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 2018 Georgia Air Sampling Network collected data at 38 locations in 28 counties, including all sites monitored during segmented sections of the year and the EPA CASTNET site. 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 AAMP determines the index number on a daily basis for each of the pollutants and reports the number to AirNow (https://airnow.gov/). The highest of the figures and corresponding pollutant are reported for each major metropolitan area in Georgia.

Maximum Pollutant Concentration										
$PM_{2.5}$	PM_{10}	SO_2	SO_2	O_3	O_3	CO	NO_2			
(24hr) µg/m^3	(24hr) µg/m^3	(1hr) ppm	(24hr) ppm	(1hr) ppm	(8hr) ppm	(8hr) ppm	(1hr) ppm	**AQI Value**	**Descriptor**	**EPA Health Advisory**
0 – 12.0	0 – 54	0 – 0.035	None	None	0 – 0.054	0 – 4.4	0 – 0.053	0 to 50	**Good (green)**	Air quality is considered satisfactory, and air pollution poses little or no risk.
12.1 – 35.4	55 – 154	0.036 – 0.075	None	None	0.055 – 0.070	4.5 – 9.4	0.054 – 0.100	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.
35.5 – 55.4	155 – 254	0.076 – 0.185	None	0.125 – 0.164	0.071 – 0.085	9.5 – 12.4	0.101 – 0.360	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	0.186 – 0.304	None	0.165 – 0.204	0.086 – 0.105	12.5 – 15.4	0.361 – 0.649	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	None	0.305 – 0.604	0.205 – 0.404	0.106 – 0.200	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	> 425	None	> 0.605	> 0.404	> 0.200	30.5 – 50.4	>1.25	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, the GA AAMP uses a few 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 oftentimes 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-Roswell MSA, the Augusta-Richmond County Georgia-South Carolina MSA, the Savannah MSA, and the Chattanooga Tennessee-Georgia MSA. As an added service to the public, the GA AAMP reports the highest AQI values and corresponding pollutants for each major metropolitan area in Georgia. 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 number 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-Roswell MSA consistently has the highest number of days above 100. There has been a seemingly cyclical pattern, with an overall downward trend.

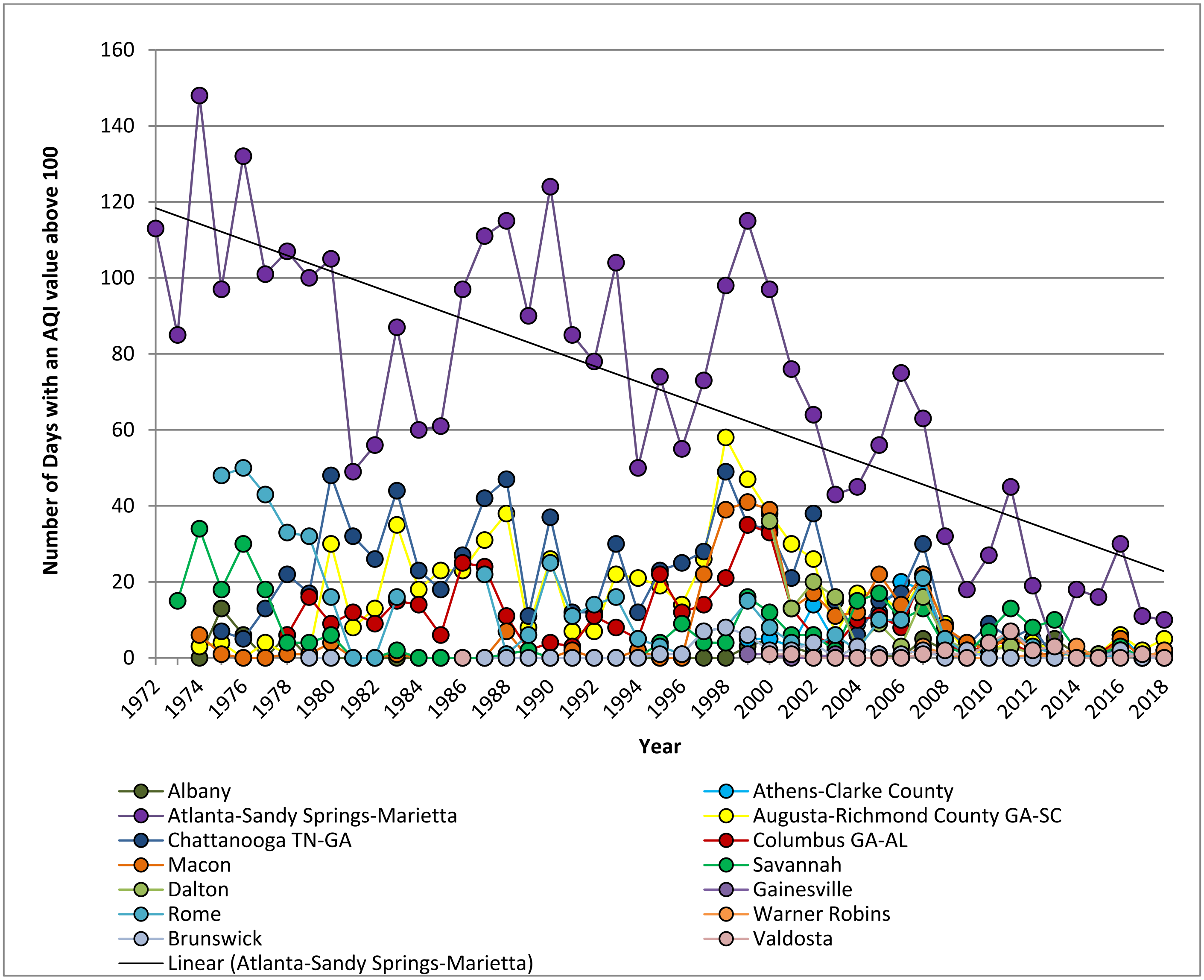
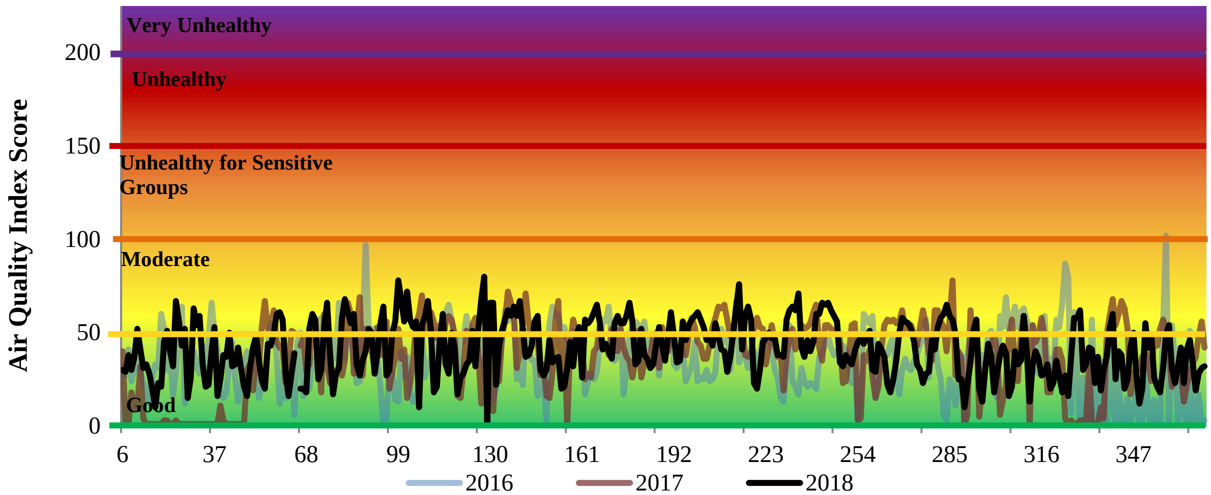


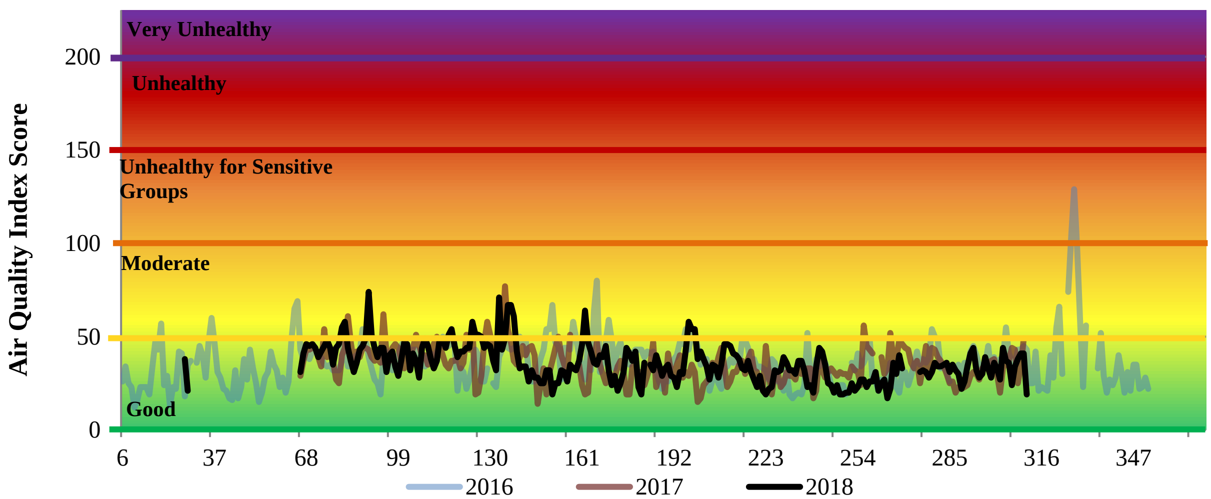
Figure 13.1: Number of Days with an AQI value above 100 across Georgia from 1972 to 2018

The following charts additionally show the trends of the AQI in each of the Metropolitan Statistical Areas (MSAs) from 2016 through 2018. The darkest years line is the most recent year, 2018. Additionally, the 2016 information shows a spike in November at many of the MSAs. Many of these are due to large wildfires in the state at that time. Additionally, only one MSA shows even semblance of a trend – the Atlanta-Sandy Springs-Roswell MSA, which hints at seasonal variation in the AQI. This seasonal variation would be consistent with the higher ozone values which occur in the MSA during the summer months.

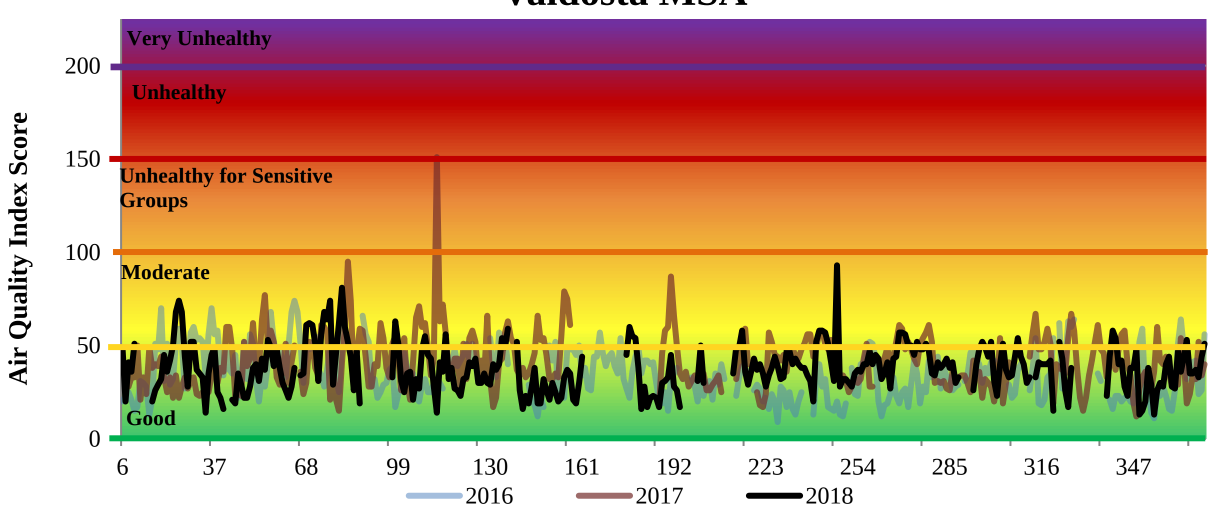
Rome MSA



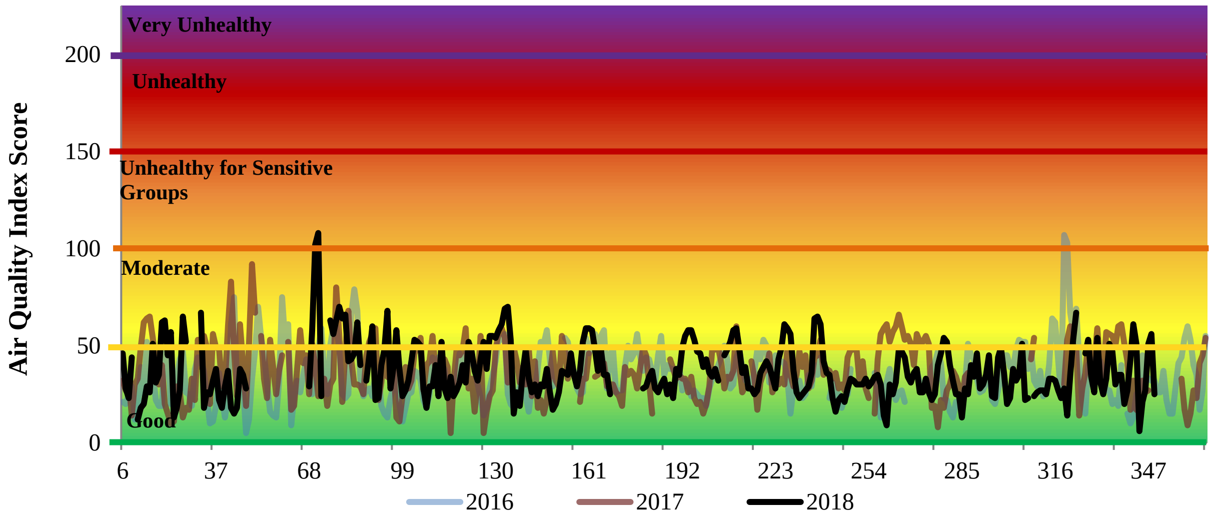
Brunswick MSA



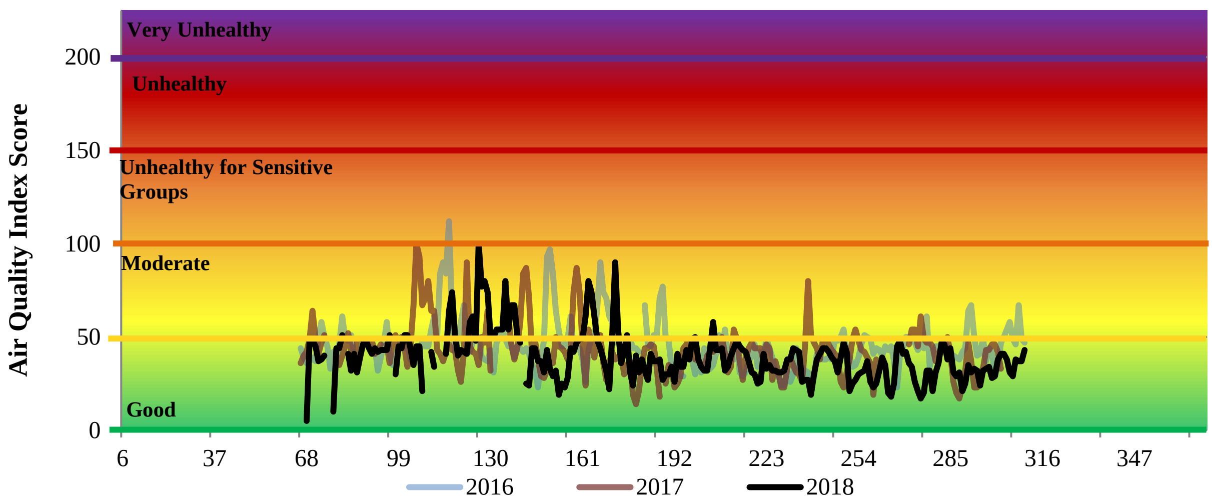
Valdosta MSA



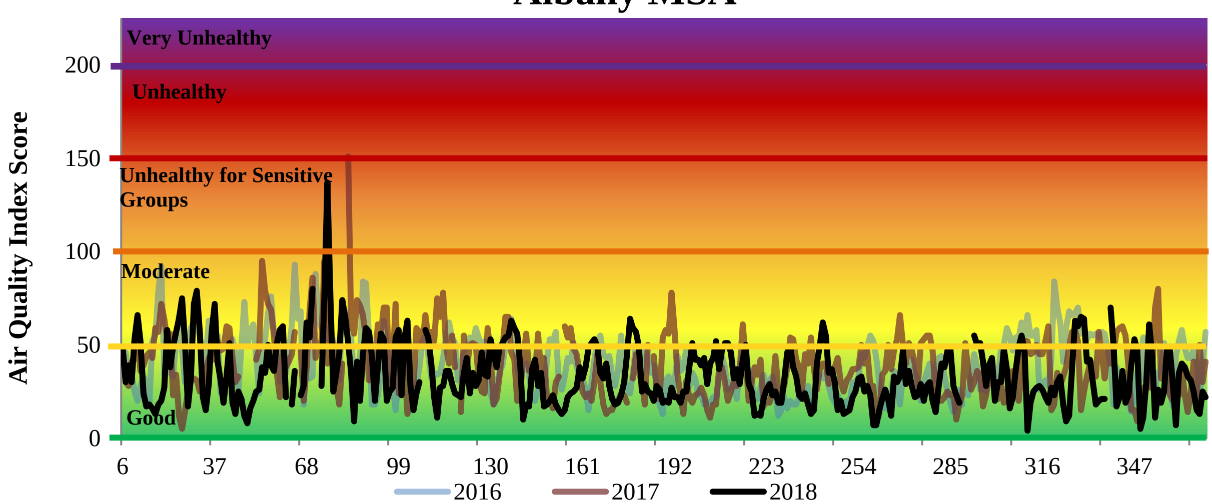
Warner Robins MSA



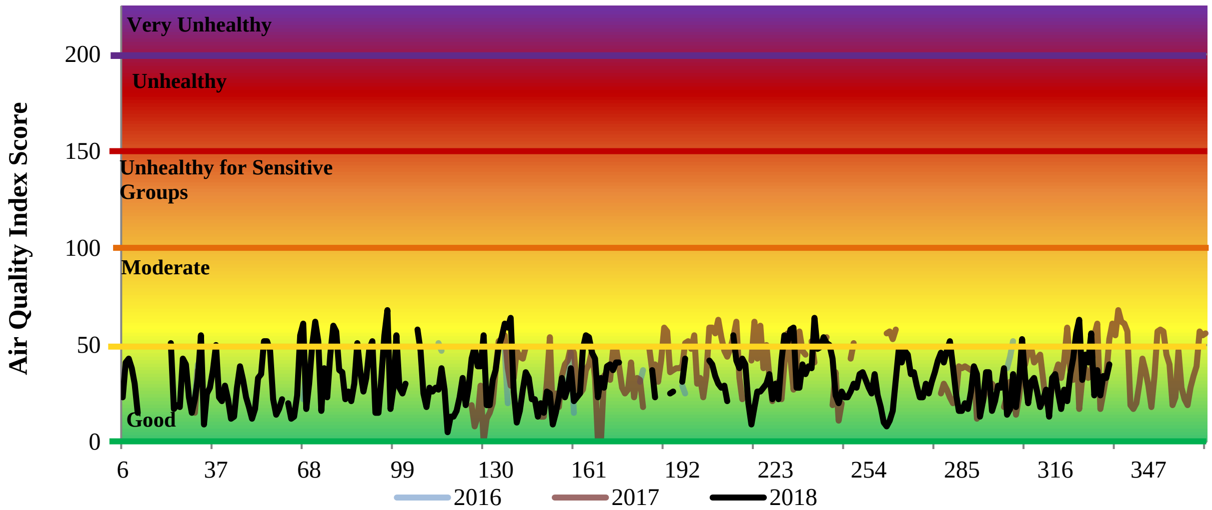
Dalton MSA



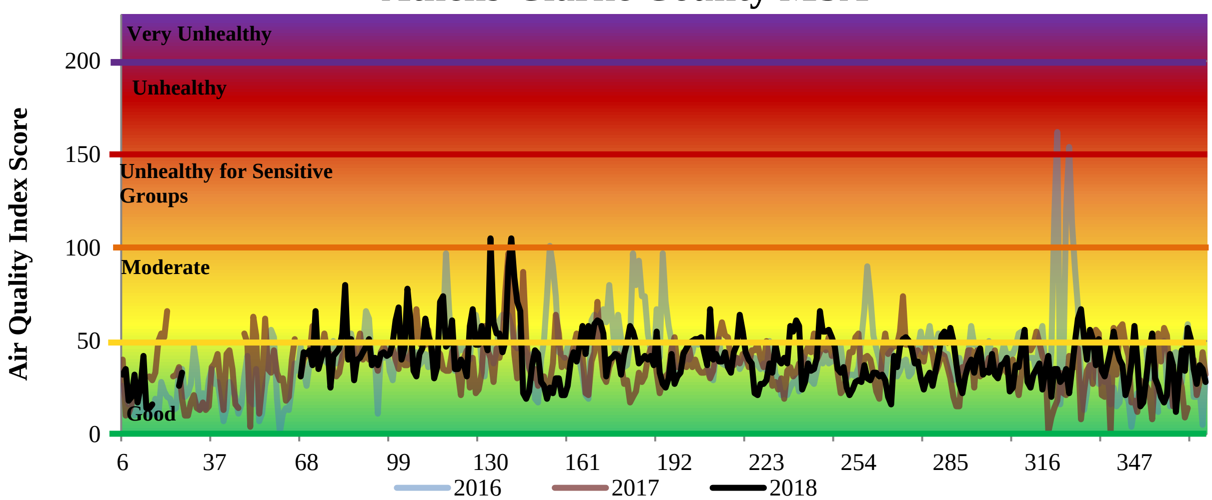
Albany MSA



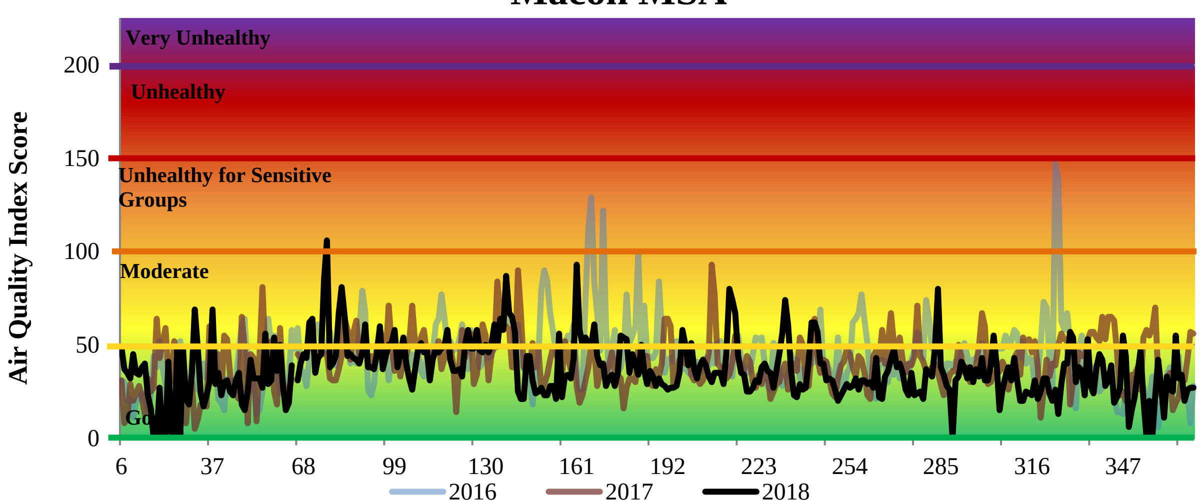
Gainesville MSA

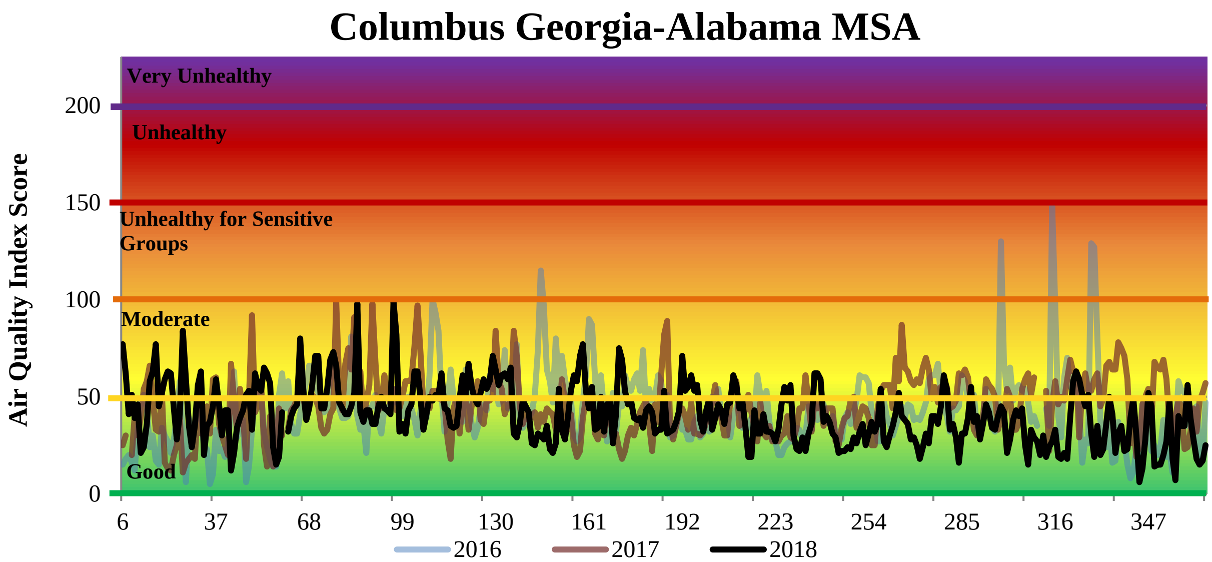


Athens-Clarke County MSA



Macon MSA




Columbus Georgia-Alabama MSA
Very Unhealthy
Unhealthy
Unhealthy for Sensitive Groups
Moderate
Good
Air Quality Index Score
0
50
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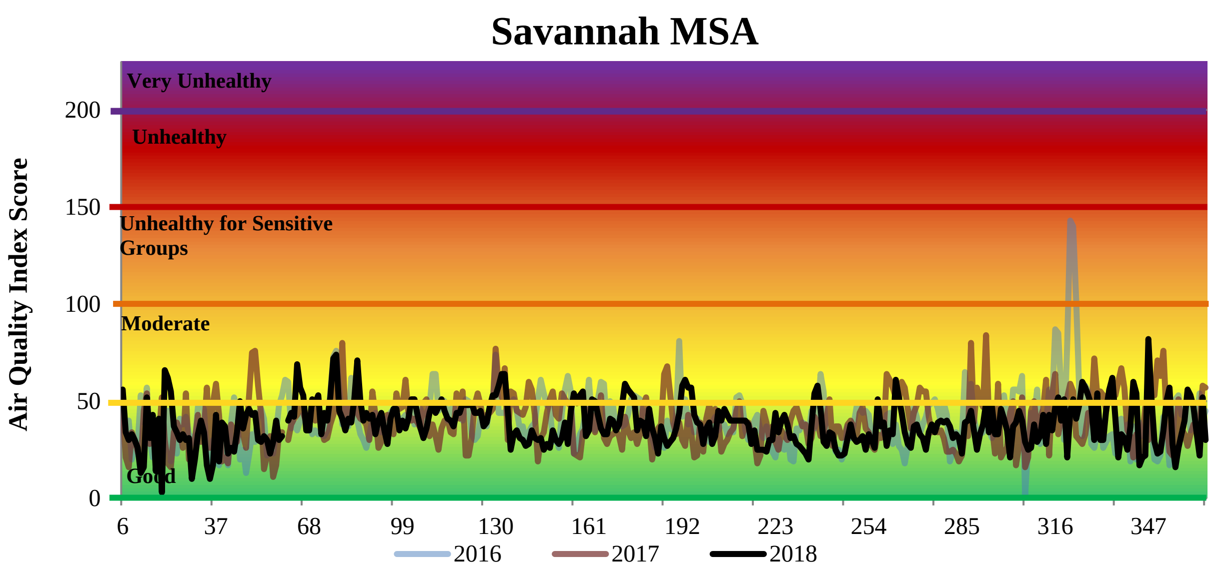
2016
2017
2018


Savannah MSA
Very Unhealthy
Unhealthy
Unhealthy for Sensitive Groups
Moderate
Good
Air Quality Index Score
0
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2016
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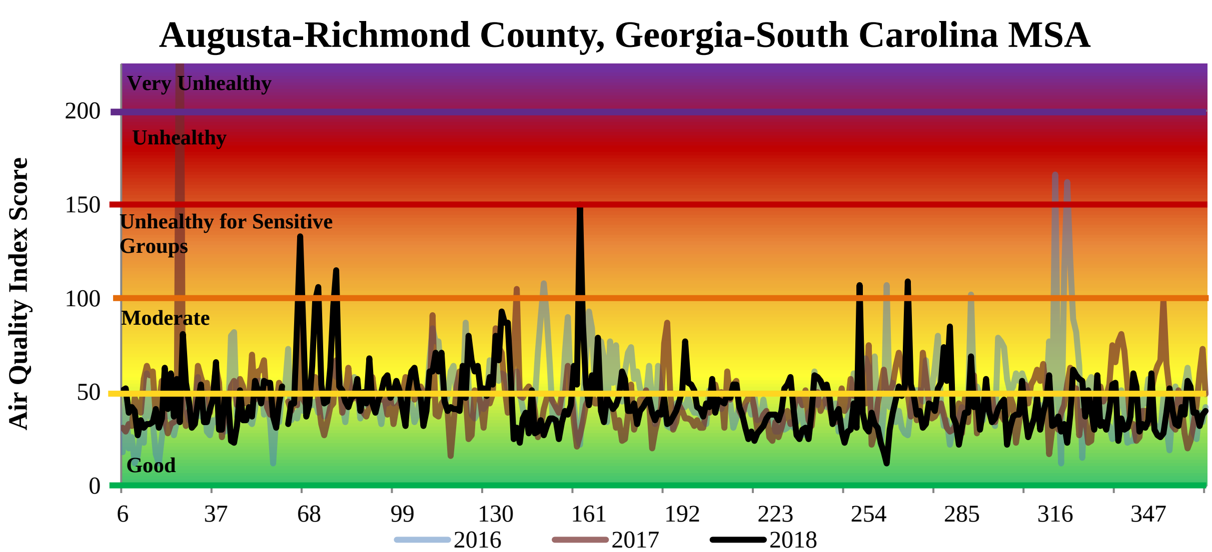
2018


Augusta-Richmond County, Georgia-South Carolina MSA
Very Unhealthy
Unhealthy
Unhealthy for Sensitive Groups
Moderate
Good
Air Quality Index Score
0
50
100
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6
37
68
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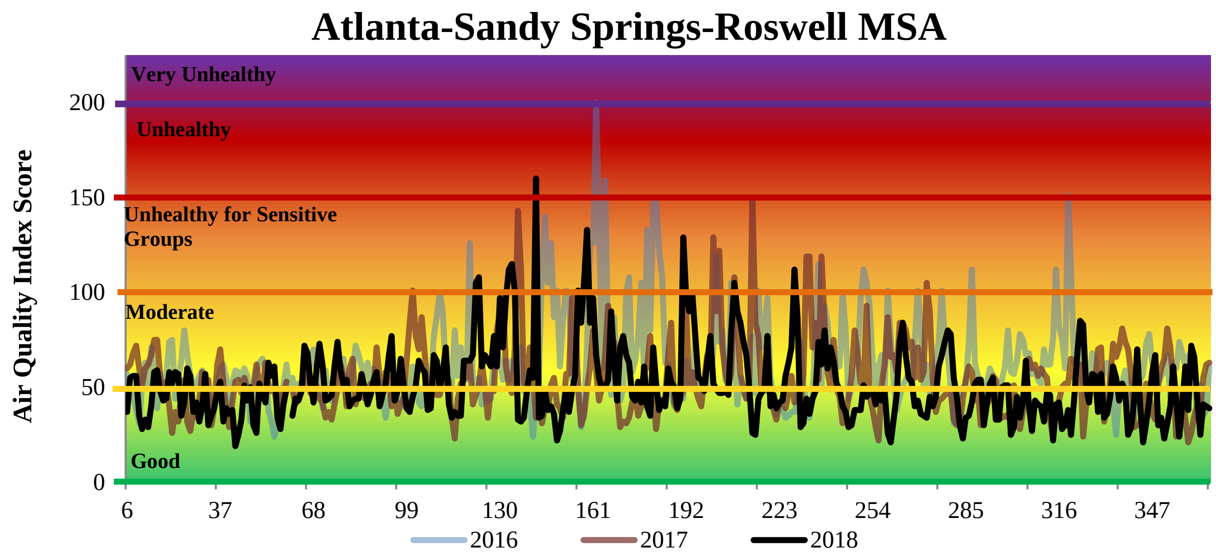


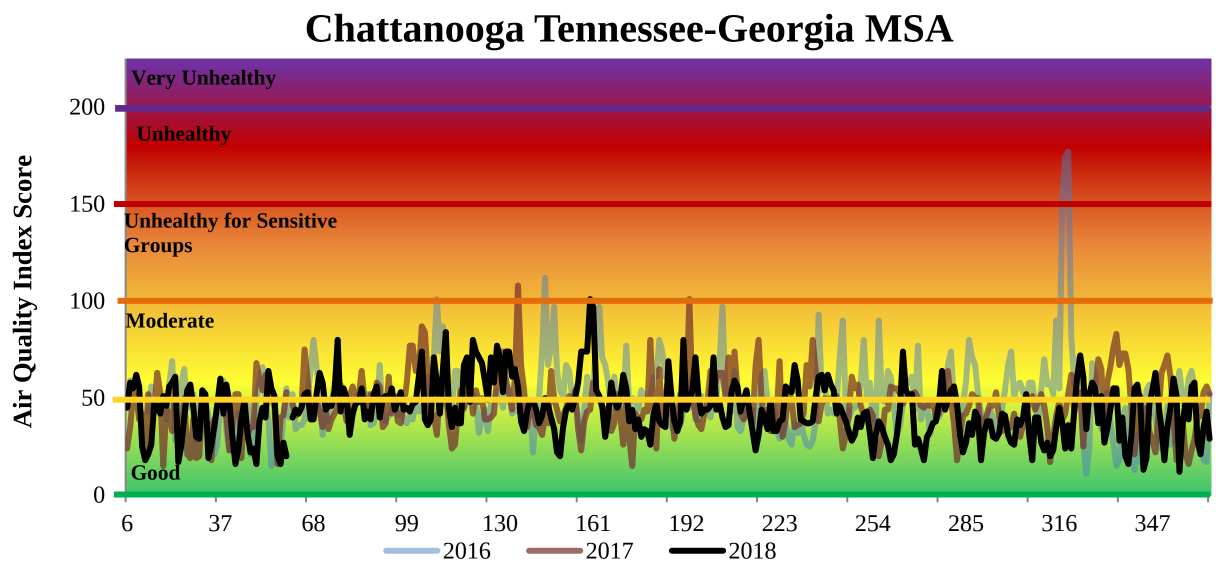


Figure 13.2: Color Charted MSA AQI Trend Lines from 2016-2018

The following table outlines each metropolitan statistical area (MSA) as defined by the U.S. Census Bureau, in which GA AAMP 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 2020, 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. It should be noted that there can be exceedances of the NAAQS within an

MSA, and AQI values over 100, but not have a violation of the NAAQS due to how the NAAQS are calculated.

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 2016 through 2018. A three-year average is a better representation of air quality since year to year weather systems can be variable, affecting the air quality. The AQS AQI index provides the daily maximum for each MSA. The number of 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 E 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 a map of the areas listed below, refer to Figure 13.3.

Table 13.3: Criteria Pollutants Current Status of the NAAQS and the 2016-2018 Average AQI

(as of January 2020)

(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	0.33	Potentially Dalton and Chattanooga TN-AL MSAs
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	0.67	Potentially Savannah and Valdosta MSAs
$PM_{2.5}$-Annual	Attainment	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	0.33	Potentially Brunswick and Albany MSAs
$PM_{2.5}$-Annual	Attainment	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	0.67	Potentially Macon and Atlanta-Sandy Springs-Roswell MSAs
$PM_{2.5}$-Annual	Attainment	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	N/A	0.33	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	0.67	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	0.67	Potentially Atlanta-Sandy Springs-Roswell and Athens-Clarke County MSAs
$PM_{2.5}$-Annual	Attainment	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	1.00	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	1.67	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	1.00	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	0.67	Potentially Sandersville
$PM_{2.5}$-Annual	Attainment	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	1.33	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	0.00	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		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	0.67	Potentially South Carolina
CO	Attainment	N/A	N/A	N/A
SO_2	Attainment	N/A	1.33	Potentially South Carolina
NO_2	Attainment	N/A	N/A	N/A
$PM_{2.5}$-24-Hour	Attainment/Unclassifiable	N/A	2.33	Potentially South Carolina
$PM_{2.5}$-Annual	Attainment	N/A		
PM_{10}	Attainment	N/A	0.33	N/A
Pb	Attainment	N/A	N/A	N/A

Atlanta-Sandy Spring-Roswell 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	Henry, Gwinnett, Fulton, DeKalb, Cobb, Clayton and Bartow	17.00	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	1.00	Potentially Gainesville, Macon, Athens-Clarke County MSAs
$PM_{2.5}$-Annual	Attainment	N/A		
PM_{10}	Attainment	N/A	0.00	N/A
Pb	Attainment	N/A	0.00	N/A

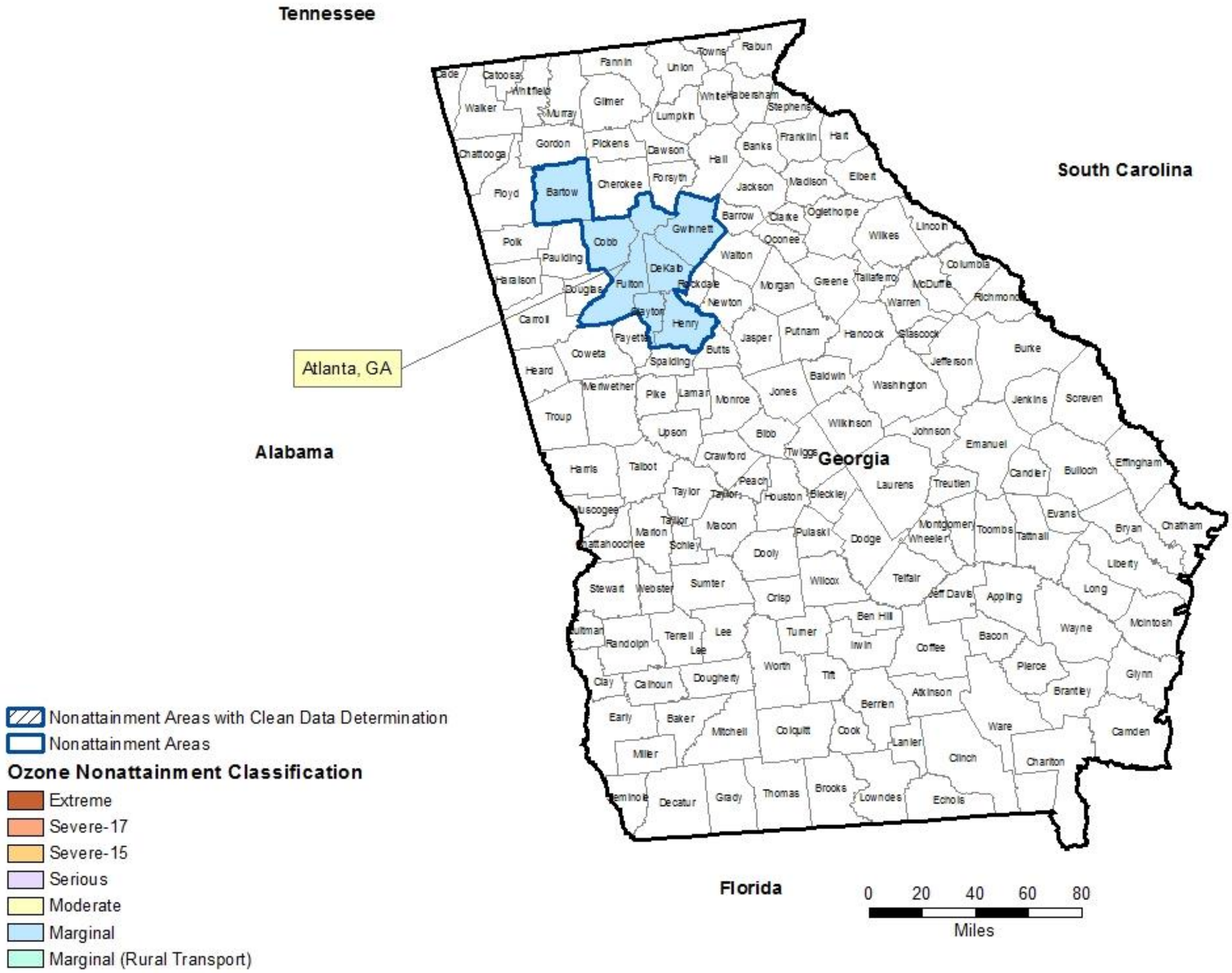
Chattanooga Tennessee-Georgia MSA

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	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	1.00	Potentially Rome and Dalton MSAs
$PM_{2.5}$-Annual	Attainment	N/A		
PM_{10}	Attainment	N/A	N/A	N/A
Pb	Attainment	N/A	N/A	N/A

For the ozone and $PM_{2.5}$ standards, Georgia has had areas of attainment/unclassifiable, nonattainment, and areas redesignated to attainment. 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. For maps of these previous designations, refer to EPA's website: https://www.epa.gov/green-book.

For an area to be in attainment of the annual ambient air $PM_{2.5}$ standard, the three-year average of the annual average concentrations has to be less than or equal to 12.0 $\mu g/m^3$. In addition, the 24-hour primary and secondary standard requires that the three-year average of the 98th percentile of the 24-hour concentrations be less than or equal to 35 $\mu g/m^3$ (Federal Register Vol. 78, No. 10, page 3086, January 15, 2013). Currently all areas of Georgia are designated unclassifiable/attainment for the 2012 annual $PM_{2.5}$ standard because they are meeting the national standard.

For an area to be in attainment of the ozone standard, the annual fourth-highest daily maximum 8-hour concentration, averaged over three years has to be less than or equal to 0.070 ppm (Federal Register Vol. 80, No. 206, page 65292, October 26, 2015). Currently for the 2015 ozone standard, Georgia has a 7-county nonattainment area within the Atlanta MSA, as shown in Figure 13.3.



(https://www3.epa.gov/airquality/greenbook/ga8_2015.html)

Figure 13.3: Georgia's 8-Hour Ozone Nonattainment Area Map (2015 Standard)

In summary, $PM_{2.5}$ and ozone are important pollutants affecting the air quality of the state of Georgia. These pollutants are the primary cause of AQI values above 100 in Georgia. In addition, the Atlanta-Sandy Springs-Roswell MSA is the only area of Georgia that is in nonattainment because of ozone. Due to the nonattainment status of this area and its higher AQI values, the Atlanta MSA is continually under surveillance for comparisons to the ozone standard.

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 PM10 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

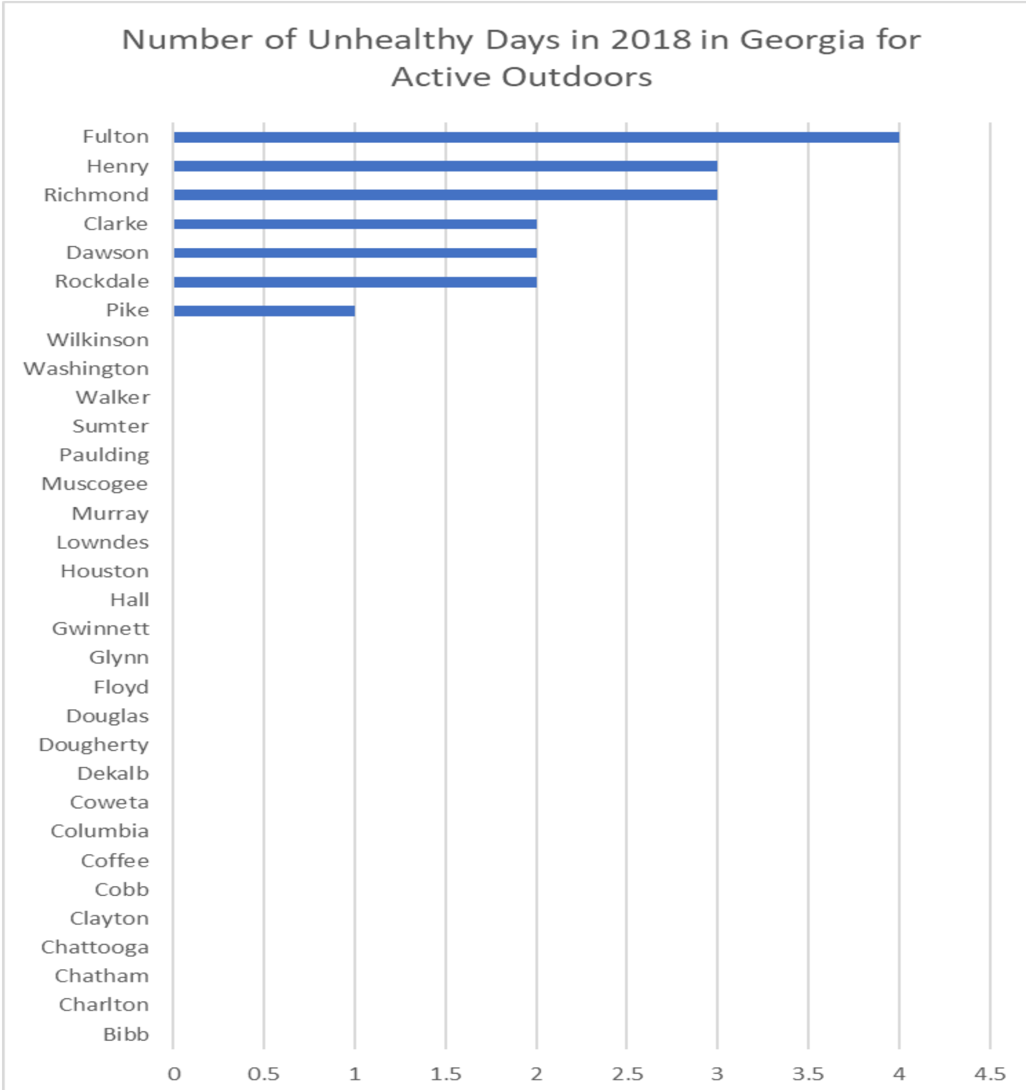
Source: https://www3.epa.gov/aircompare/

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 affected 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 2018, the number of unhealthy days for the general population did not exceed 150. 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 affect the general population if the AQI value were above 150, or Code Red.

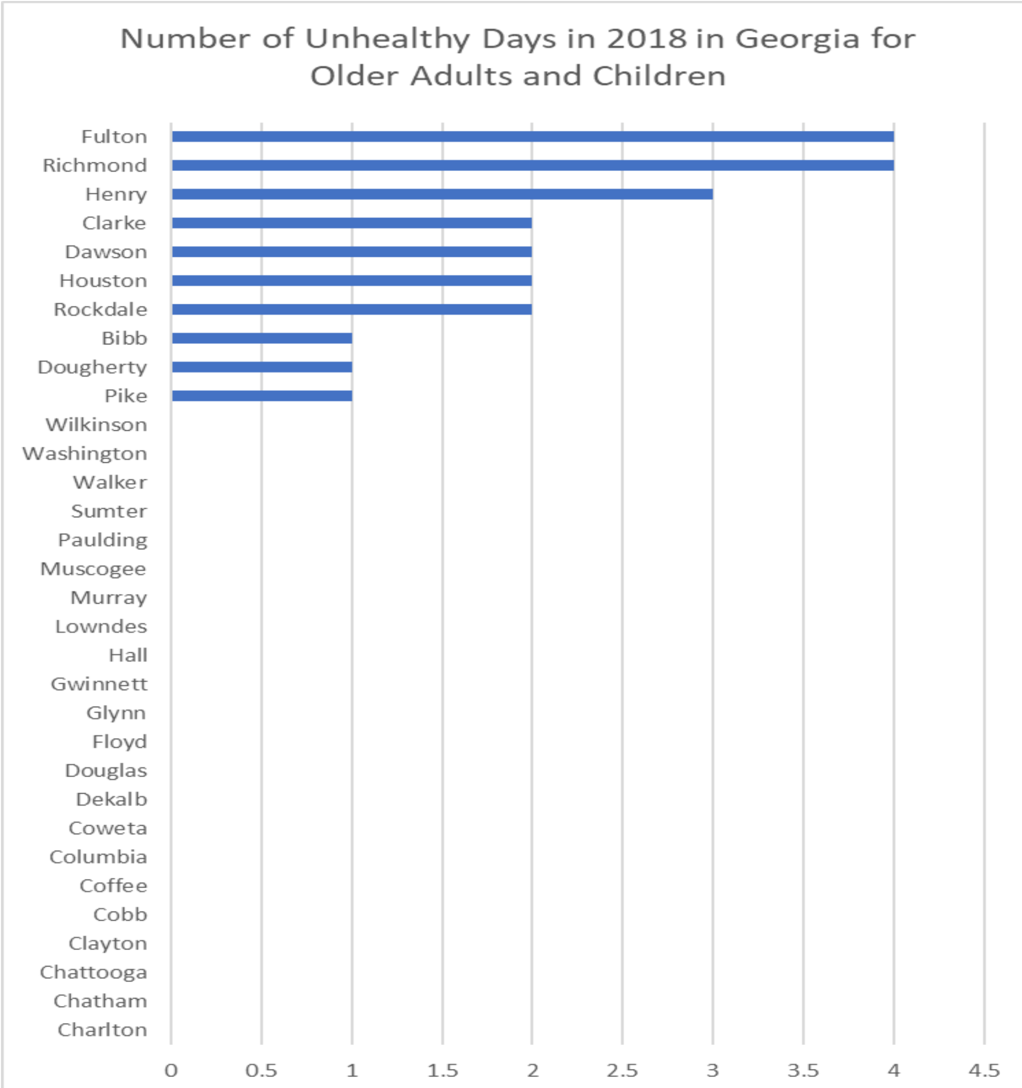
Figure 14.2 shows the number of unhealthy days in Georgia in 2018 for the population who participates in outdoor activity. An AQI value between 101 and 150 affects this population, with ozone and sulfur dioxide being the primary pollutants that contribute to unhealthy days (Figure 14.1). Seven counties had at least one unhealthy day, with Fulton County reporting the highest number (4 days).



Source: https://www3.epa.gov/aircompare/

Figure 14.2: Number of Unhealthy Days in 2018 for Active Outdoors

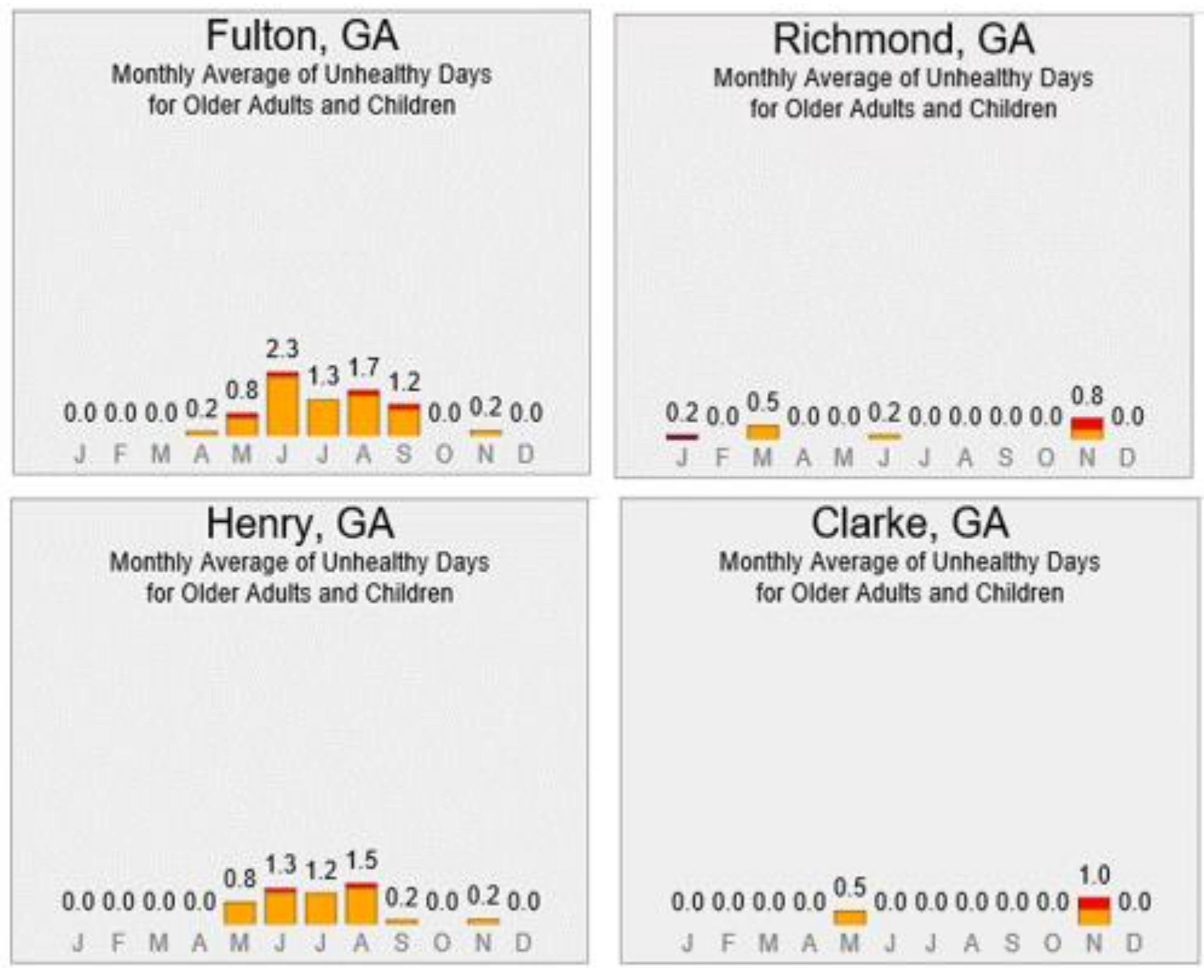
In the following figure, the number of unhealthy days in Georgia in 2018 for older adults and children is shown. An AQI value between 101 and 150 affects this population, with ozone and particle pollution being the primary contributors to unhealthy days (Figure 14.1). There were ten counties that had at least one unhealthy day in 2018. Fulton and Richmond County showed the highest number of unhealthy days (4 days).



Source: https://www3.epa.gov/aircompare/

Figure 14.3: Number of Unhealthy Days in 2018 for Older Adults and Children

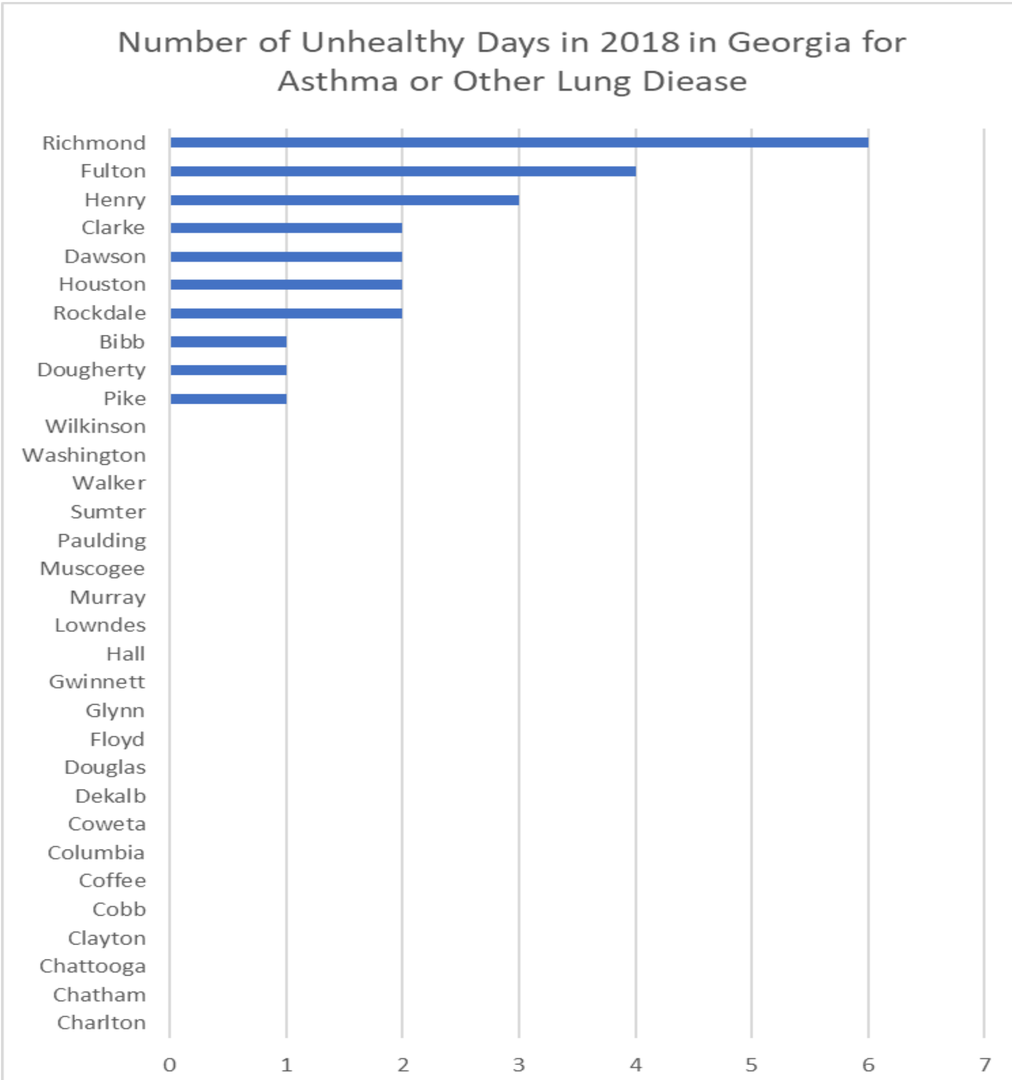
The following figure shows the monthly averages for the highest four counties for the past five years in each county according to unhealthy for sensitive groups (shown in orange), unhealthy air (shown in red), and very unhealthy air (shown in purple) by month. Each bar shows the total number of unhealthy 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 Fulton and Henry Counties. The effect is almost evenly distributed across the year for Richmond and Clarke Counties.



Source: https://www3.epa.gov/aircompare/

Figure 14.4: Monthly Averages for Top Four Counties with Unhealthy Days for Older Adults and Children, 2014-2018

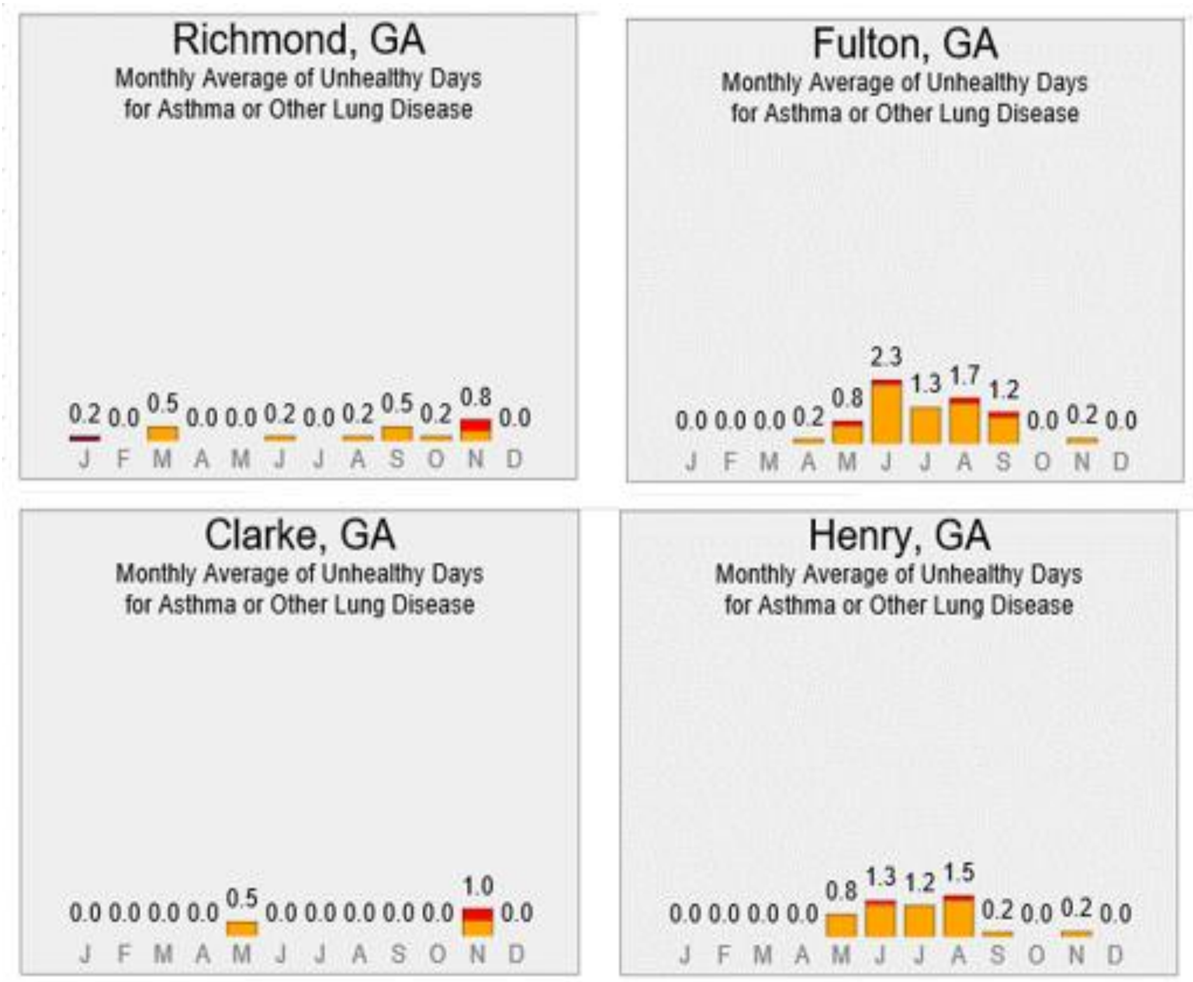
The following figure shows the number of unhealthy days in 2018 in Georgia for people who suffer from asthma and other lung diseases. People who suffer from asthma and other lung diseases can be affected by ozone, particle pollution, and sulfur dioxide, with the AQI value between 101 and 150 (Figure 14.1). Ten counties had at least one unhealthy day for asthma and other lung disease sufferers. The maximum number of unhealthy days occurred in Richmond County (6 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.



Source: https://www3.epa.gov/aircompare/

Figure 14.5: Number of Unhealthy Days in 2018 for People with Asthma and Other Lung Disease

The following figure shows the top four counties with the highest number of unhealthy days for people with asthma or other lung diseases (Richmond, Fulton, Clarke, and Henry 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 2.3 days in Fulton County, occurring in June. The other five year averages ranged from 0.0 to 1.7 days per month.



Source: https://www3.epa.gov/aircompare/

Figure 14.6: Monthly Averages for Top Four Counties with Unhealthy Days for People with Asthma and Other Lung Disease, 2014-2018

The Georgia Department of Public Health reports that in 2017, 13.5% of Georgia's children, age 0 to 17 years had asthma (https://www.cdc.gov/asthma/brfss/2017/child/tableL1.htm). In addition, about 13.9% of children in Georgia had been told at some point that they had asthma. In 2017, the adult asthma prevalence rate in Georgia was 12.6%, corresponding to the sample size of 6,034 people (https://www.cdc.gov/asthma/brfss/2017/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 2017 for current and lifetime asthma prevalence (Tables 14.1 and 14.2, respectively) (https://www.cdc.gov/asthma/brfss/2017/tableC3.htm).

Age Group	Sample Size	Prevalence (percent)	Standard Error	95% CI* (percent)	Prevalence (number)	95% CI* (number)
18-24	393	10.5	1.80	(7.0 - 14.1)	109,504	(70,607 - 148,401)
25-34	741	6.8	1.12	(4.6 - 9.0)	95,171	(63,580 - 126,761)
35-44	721	9.4	1.28	(6.9 - 11.9)	126,132	(90,876 - 161,387)
45-54	853	8.3	1.15	(6.1 - 10.6)	112,870	(80,942 - 144,798)
55-64	1,208	9.3	0.98	(7.3 - 11.2)	116,675	(91,401 - 141,949)
65+	2,023	6.8	0.68	(5.5 - 8.2)	96,921	(77,592 - 116,249)

* CI denotes confidence interval

Source: https://www.cdc.gov/asthma/brfss/2017/tableC3.htm

Table 14.1: Adult Self-Reported Current Asthma Prevalence Rate (Percent) and Prevalence (Number) by Age: BRFSS 2017

The age group with the highest current asthma prevalence in Georgia was 18-24 with 10.5% prevalence.

Age Group	Sample Size	Prevalence (percent)	Standard Error	95% CI* (percent)	Prevalence (number)	95% CI* (number)
18-24	393	16.9	2.14	(12.7 - 21.1)	175,628	(128,137 – 223,120)
25-34	745	12.6	1.41	(9.8 - 15.4)	176,027	(135,192 - 217,222)
35-44	723	13.4	1.53	(10.3 - 16.4)	180,408	(136,877 – 223,938)
45-54	860	10.7	1.24	(8.2 - 13.1)	144,343	(109,786 - 178,901)
55-64	1,210	13.8	1.20	(11.4 - 16.1)	174,052	(142,446 – 205,658)
65+	2,032	9.9	0.82	(8.3 - 11.5)	140,981	(117,284 – 164,679)

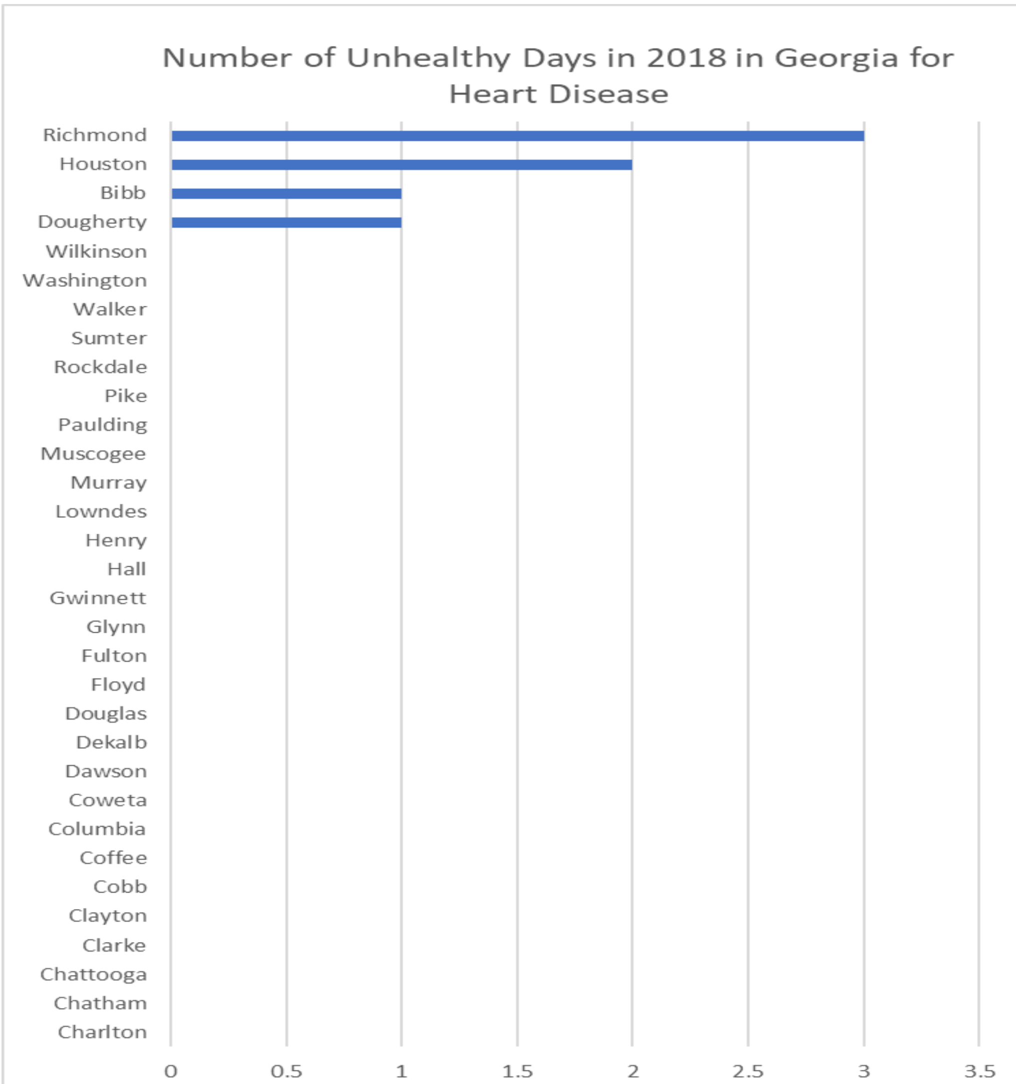
* CI denotes confidence interval

Source: https://www.cdc.gov/asthma/brfss/2017/tableL3.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 16.9%.

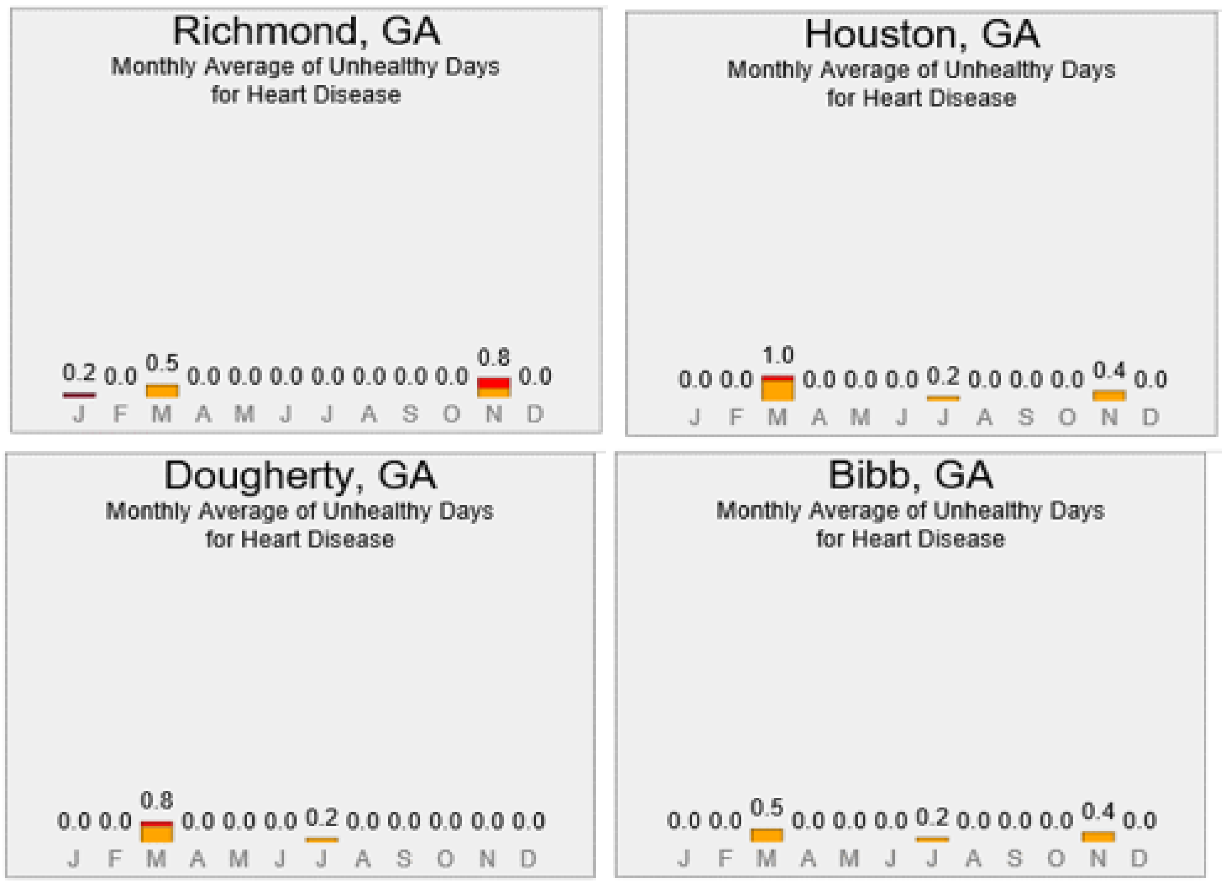
Figure 14.7 shows the number of unhealthy days in 2018 in Georgia for people who suffer from heart disease. For this group, particle pollution and carbon monoxide are the pollutants of concern. In general, the AQI value would be between 101 and 150 for this group to be affected (Figure 14.1). However, more sensitive individuals could be affected with lower AQI values. There were four counties that experienced unhealthy days for people with heart disease, with Richmond County having the maximum days (3 days).



Source: https://www3.epa.gov/aircompare/

Figure 14.7: Number of Unhealthy Days in 2018 for People with Heart Disease

The following figure shows the top four counties with the highest number of unhealthy days for people with heart disease (Richmond, Houston, Dougherty, and Bibb Counties). The highest five-year average occurred in March (1.0 days) in Houston County. The other five-year averages range from 0.0 to 0.8 days per month to potentially affect people with heart disease.



Source: https://www3.epa.gov/aircompare/

Figure 14.8: Monthly Averages of Top Four Counties with Unhealthy Days for People with Heart Disease, 2014-2018

Several counties across the state had at least one day in 2018 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 6 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 AAMP, this information is provided to the public, as well as to researchers for health effects studies.

15.0 Exceedance Probability Assessment

As part of the 5-year assessment, GA AAMP 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 AAMP has monitors in place to detect those exceedances. Lake Michigan Air Directors Consortium (LADCO) in Region 5 created an online tool, NetAssess (https://ladco.shinyapps.io/NetAssessApp/) which was updated for the 2020 Five-Year Assessment and available at https://sti-r-shiny.shinyapps.io/EPA_Network_Assessment/, 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 from http://ladco.github.io/NetAssessApp/tools.html#exprob, with the years of data updated:

"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 [2014-2016] were obtained from the EPA website. Years [2014-2016] 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 [limited number of years], 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).”

15.1 Ozone

Since the EPA has lowered the ozone standard to 70 ppb, the following three figures show areas with the probability of ozone concentraions exceeding a threshold of 70 ppb, based on the spatial distribution of historical highest daily values. The darker orange color represents the higher probability of ozone concentrations exceeding the threshold. Red circles represent ozone monitoring sites.

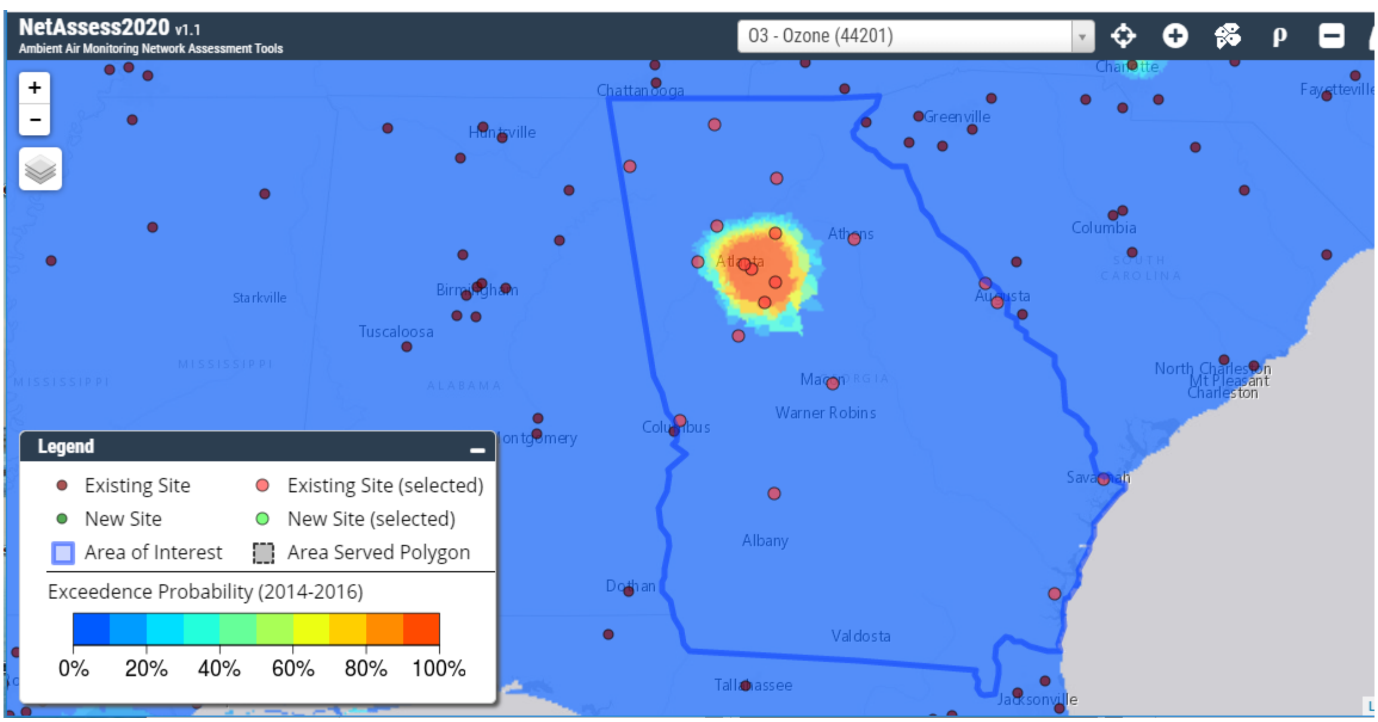


Figure 15.1: Ozone Probability of Exceedance at 70 ppb for Georgia

According to the above figure, the area with the highest probability of exceedances for ozone concentrations is located within the Atlanta-Sandy Springs-Roswell, MSA. It appears that the Atlanta-Sandy Springs-Roswell MSA has more than enough ozone monitors to cover that area if there are exceedances of the ozone NAAQS. In addition, there are a few monitors that are within the MSA that have 0% or very low percentage of exceeding the NAAQS. These monitors are at the Douglasville, Kennesaw, Dawsonville, and CASTNET sites. The rest of Georgia shows no probability of exceeding the ozone NAAQS of 70 ppb. According to this assessment, any of these four monitors on the outskirts of the MSA, or across the state, may not be needed to represent ozone data for Georgia.

15.2 $PM_{2.5}$

Figure 15.2 shows 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.

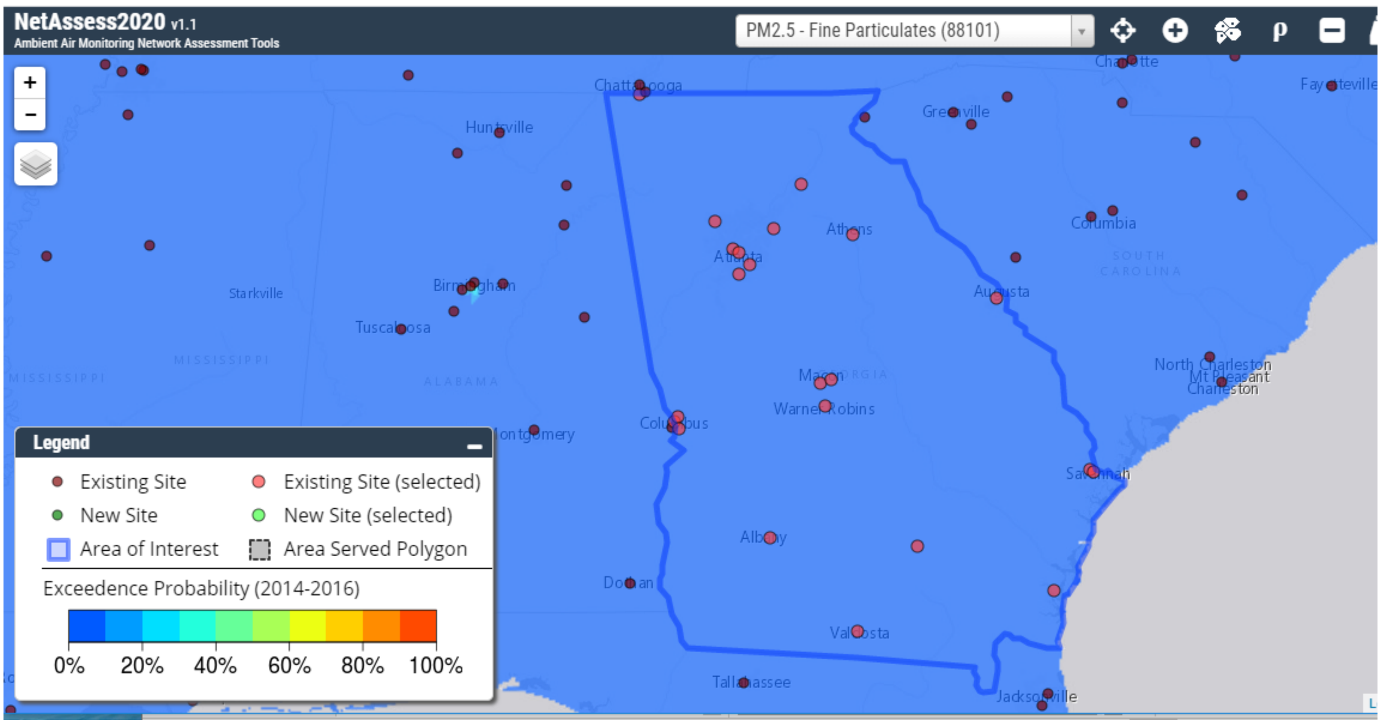


Figure 15.2: $PM_{2.5}$ Probability of Exceedance for Georgia

According to Figure 15.2, there is no probability of exceedances for the daily $PM_{2.5}$ NAAQS of 35 µg/m^3. According to this assessment, Georgia has more $PM_{2.5}$ monitors than needed for coverage of the state, and all of these monitors may not be needed to compare to the $PM_{2.5}$ NAAQS for the state.

16.0 Emissions Assessment

In order to determine if GA AAMP'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, https://gispub.epa.gov/neireport/2014/, 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 500 tons/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 2016 and 2028 typical anthropogenic emissions of CO, PM_{10}, SO_2, $PM_{2.5}$, VOCs, and NO_x were compared for each county in Georgia along with the difference and percent change between 2016 and 2028. 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 2028.

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 for EPA's Regional Haze (RH) modeling project to address future visibility levels at Class I areas (EPA, 2019a).

Air quality models use emission inventory data and meteorological data to estimate ambient air concentrations. For the purpose of regulatory modeling, air quality models are typically run for a "base year" and a "future year". For the EPA RH modeling project, 2016 was the "base year" and 2028 was the "future year". The base year meteorology was used for both the base year and future year air quality modeling. For the 2028 RH modeling project, EPA used a modeling platform developed through the National Emissions Inventory Collaborative process (NEIC, 2019).

Emission inventories typically contain annual emissions with units of tons-per-year (TPY). EPA's Regional Haze (RH) emission inventory consists of air pollutants and their precursors emitted from several source sectors. DMU re-classified EPA's source sector emission summaries into seven (7) source categories: Electric Generation Units (EGU) point, non-EGU point, Nonroad, Onroad, Marine-Airport-Rail (MAR), Fire, and Area. EGU point sources are fossil fuel power plants. Non-EGU point sources refer to point sources (e.g., oil & gas and manufacturing facilities) that are not EGUs (EPA, 2019). The Nonroad sources are nonroad mobile equipment. Onroad sources consist of mobile gasoline and diesel vehicles that drive on roads. Emissions from both Nonroad and Onroad sources were calculated using the Motor Vehicle Emissions Simulator (MOVES) model (EPA, 2015). The MAR sources consist of Category 1-3 commercial marine vessels, airports, and rail locomotives. The fire sources cover emissions from fires related to agricultural, wildfires, and prescribed burning activities. The area sources consist of all other emissions from small point sources (e.g. < 25 TPY NOx) that are not covered by the previous six categories and other non-point sources (e.g., non-point area fugitive dust and non-point oil and gas sources). Once the annual emission inventories were developed, EPA ran the Sparse Matrix Operator Kernel Emissions (SMOKE) model (version 4.5) to generate hourly, gridded, speciated emission data for the air quality model (EPA, 2019a). The Weather Research and Forecasting

(WRF) model (version 3.8) was used to generate meteorological fields for the air quality model (EPA, 2019a). The 2028 projection inventories were prepared for all sectors except for biogenic emission and fire emissions, which were held constant in the future (EPA, 2019a).

EPA conducted air quality modeling for the base year (2016) and the future year (2028) with the Comprehensive Air Quality Model with Extensions (CAMx) version 7.0 beta (EPA, 2019a). Figure 16.1 shows the 36-km modeling domain which covers most of North America, and the 12-km modeling domain which covers the entire continental U.S. CAMx produces hourly pollutant 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 EPA 2016 and 2028 emission inventories and CAMx modeling results to produce data to create GIS maps and emission charts for this report.

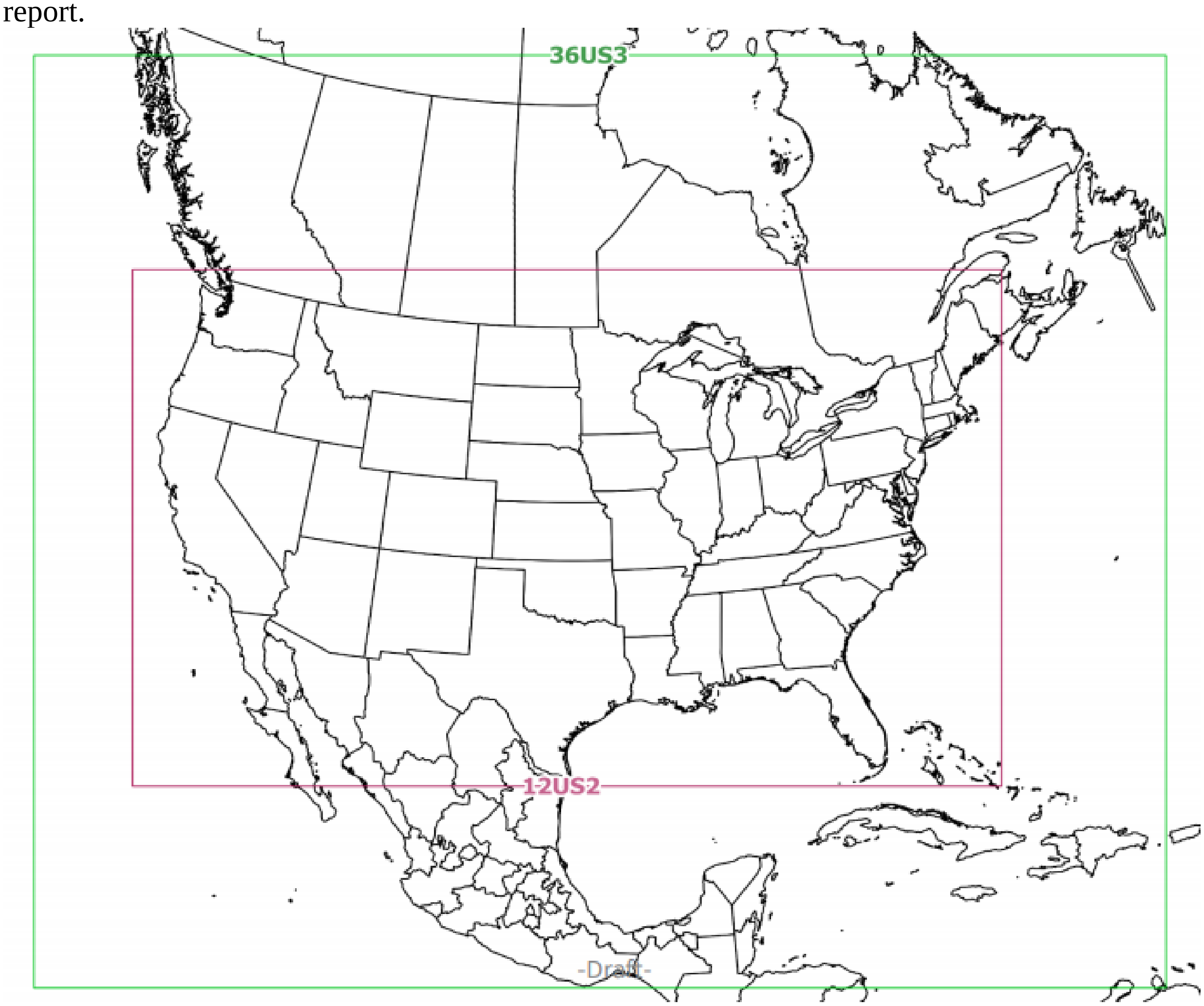


Figure 16.1: 36-km (green box) and 12-km (magenta box) modeling domain

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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 airports, breweries, distilleries and wineries, brick, structural clay or clay ceramics plants, chemical plants, electricity generation via combustion, food products processing plants, glass plants, cement manufacturing plants, sugar mills, and other industrial sources.

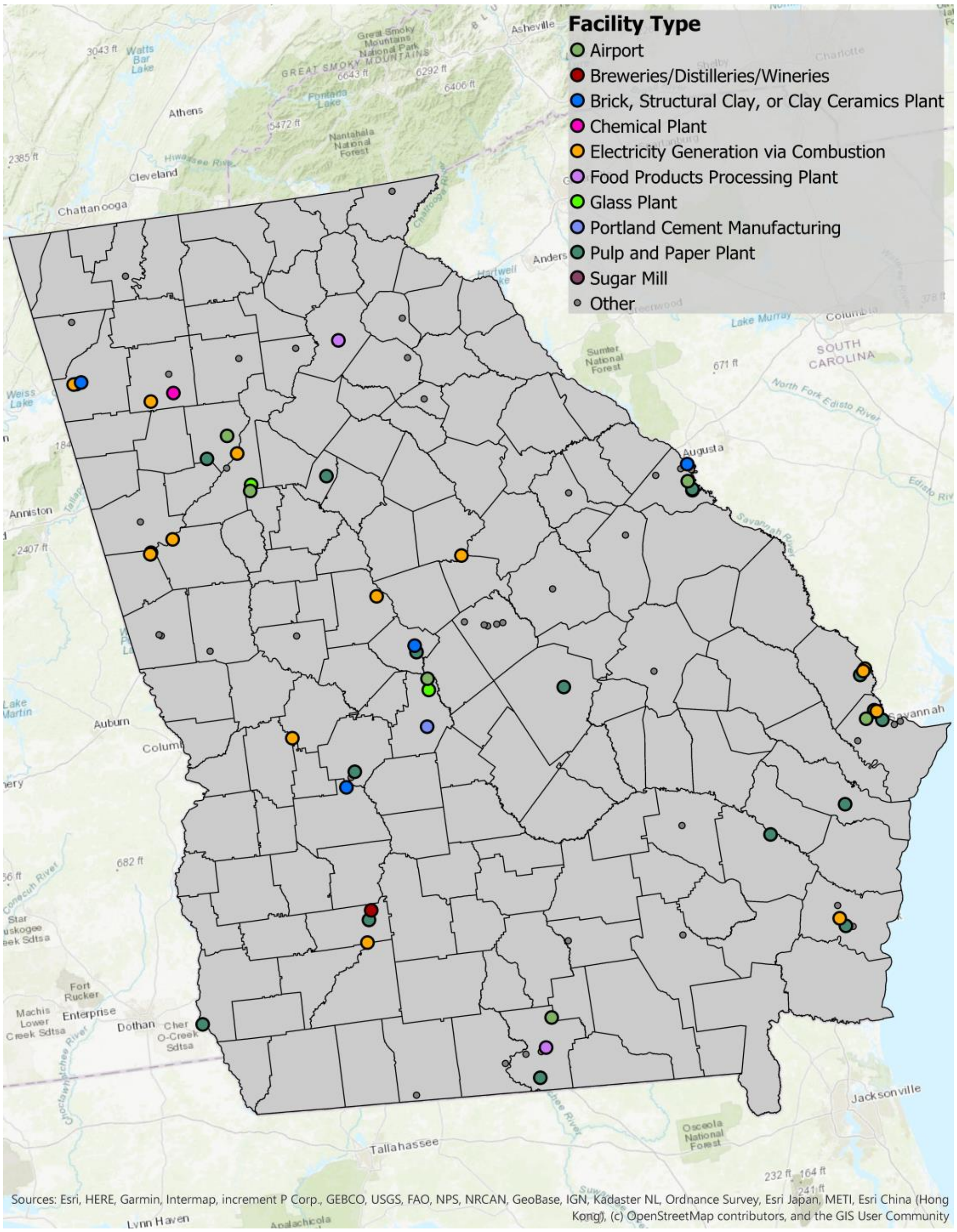


Figure 16.2: SO_2 Emitting Facilities in Georgia

In the following figure, the total modeled anthropogenic sulfur dioxide typical emissions are shown for 2016 and 2028. 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 2016 and 2028 emissions is shown using the formula 2028 emissions – 2016 emissions. The percent change in emissions between 2016 and 2028 is shown using the formula (2028/2016-1) X 100.

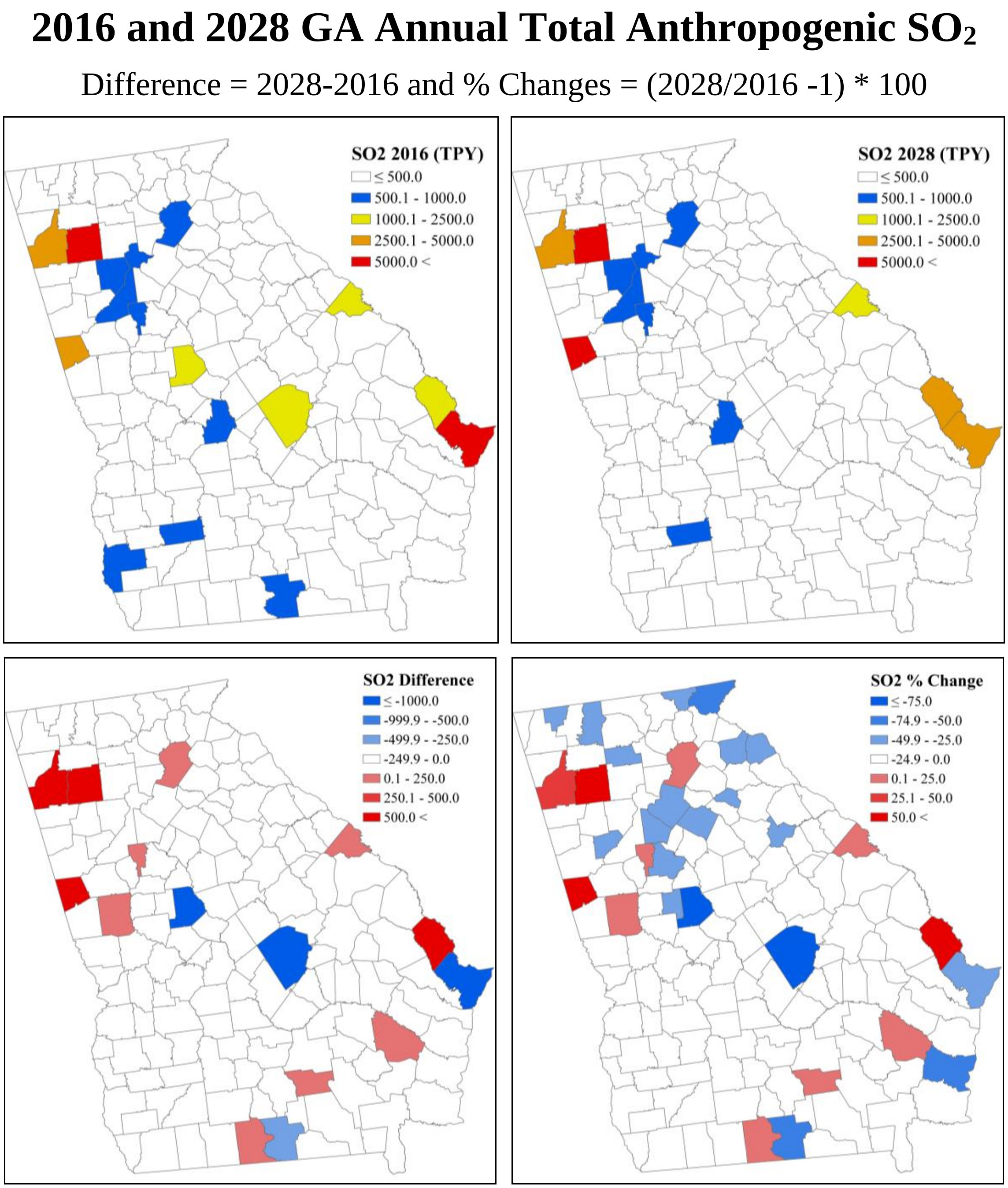


Figure 16.3: Sulfur Dioxide 2016 and 2028 Typical Emissions

The areas with the highest levels of emissions seem to be in the Rome MSA, Savannah MSA, and the outskirts of the Atlanta-Sandy Springs-Roswell MSA. With the modeled 2016 data, the counties with the highest levels were Bartow, Chatham (Red), Heard, and Floyd (Orange). In the modeled 2028 data, there were several changes. There were increases in emissions in the Savannah MSA, specifically in Chatham County and in the outskirts of the Atlanta-Sandy Springs-Roswell MSA in Heard County. Decreases were seen throughout the rest of the state, specifically in Monroe County in the Macon MSA, Lowndes County in the Valdosta MSA, Early County and Laurens County.

The following model output shows projected annual average concentrations of sulfur dioxide based on 2016 data. The concentrations are shown in parts per billion, and the hotter colors represent higher levels of concentration (orange and red). These models take into account meteorological conditions based on 2016 data. The current locations of GA AAMP's ambient air monitors are shown with white triangles.

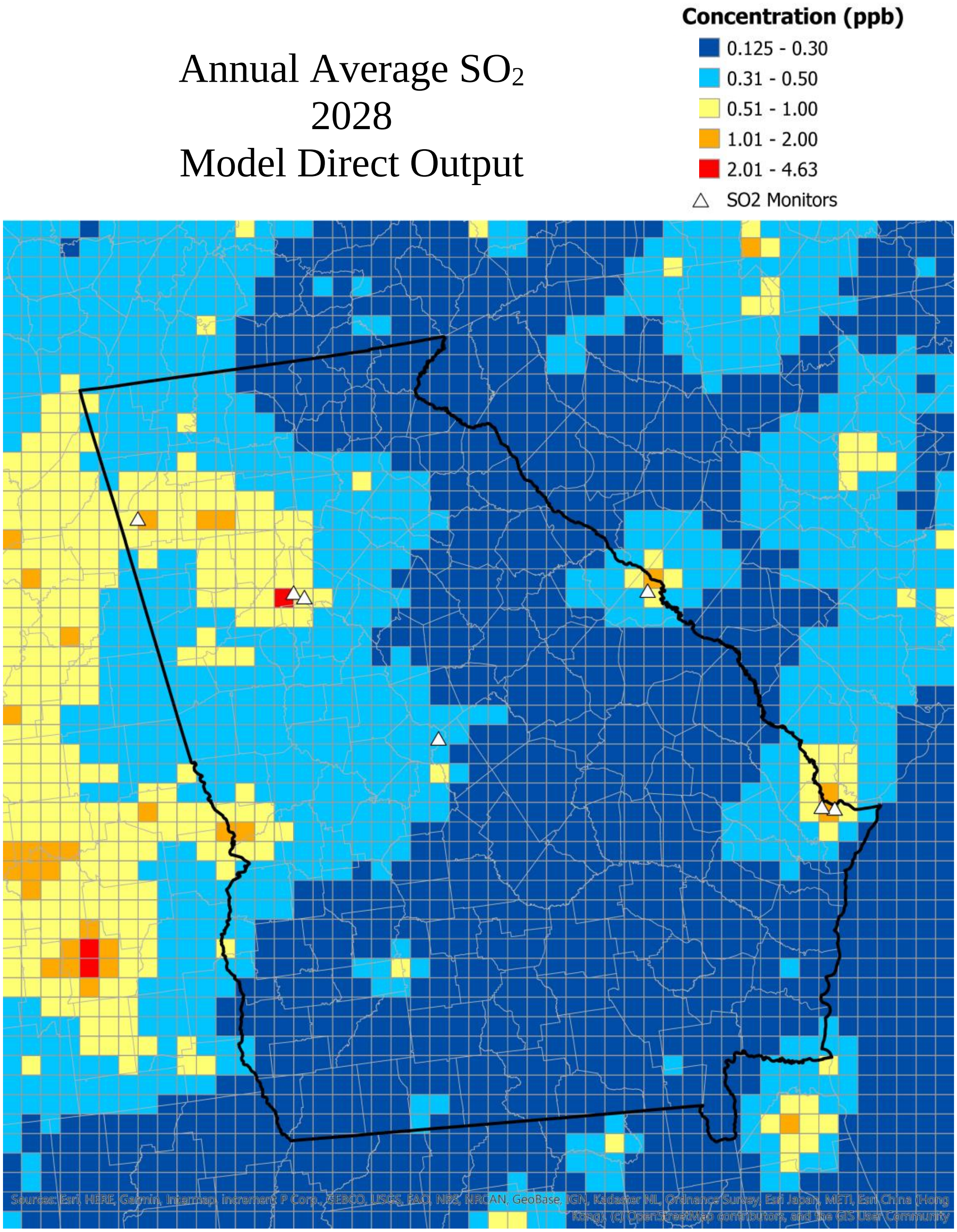


Figure 16.4: Sulfur Dioxide, Modeled 2028, Annual Average

With the above model, the annual average concentrations of sulfur dioxide emissions for 2028 are predicted to be highest in the Atlanta-Sandy Springs-Roswell MSA, with secondary high values in the Rome MSA, Columbus, GA-AL MSA, Augusta-Richmond County, GA-SC MSA and the Savannah MSA. GA AAMP has strategically placed SO_2 monitors in areas with the highest predicted 2028 SO_2 emissions (Atlanta-Sandy Springs-Roswell MSA, Augusta-Richmond County, GA-SC MSA, and the Savannah MSA). According to this model, it appears the Macon MSA may not need an SO_2 monitor, with annual averages predicted at 0.31-0.50 ppb. It should be noted that the values represented on this map are especially low values, with the highest category (red) ranging from 2.01 to 4.63 ppb. 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.

16.2 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 brick, structural clay or clay ceramics plants, electricity generation via combustion, lumber or sawmills, pulp and paper plants, and other industrial sources.

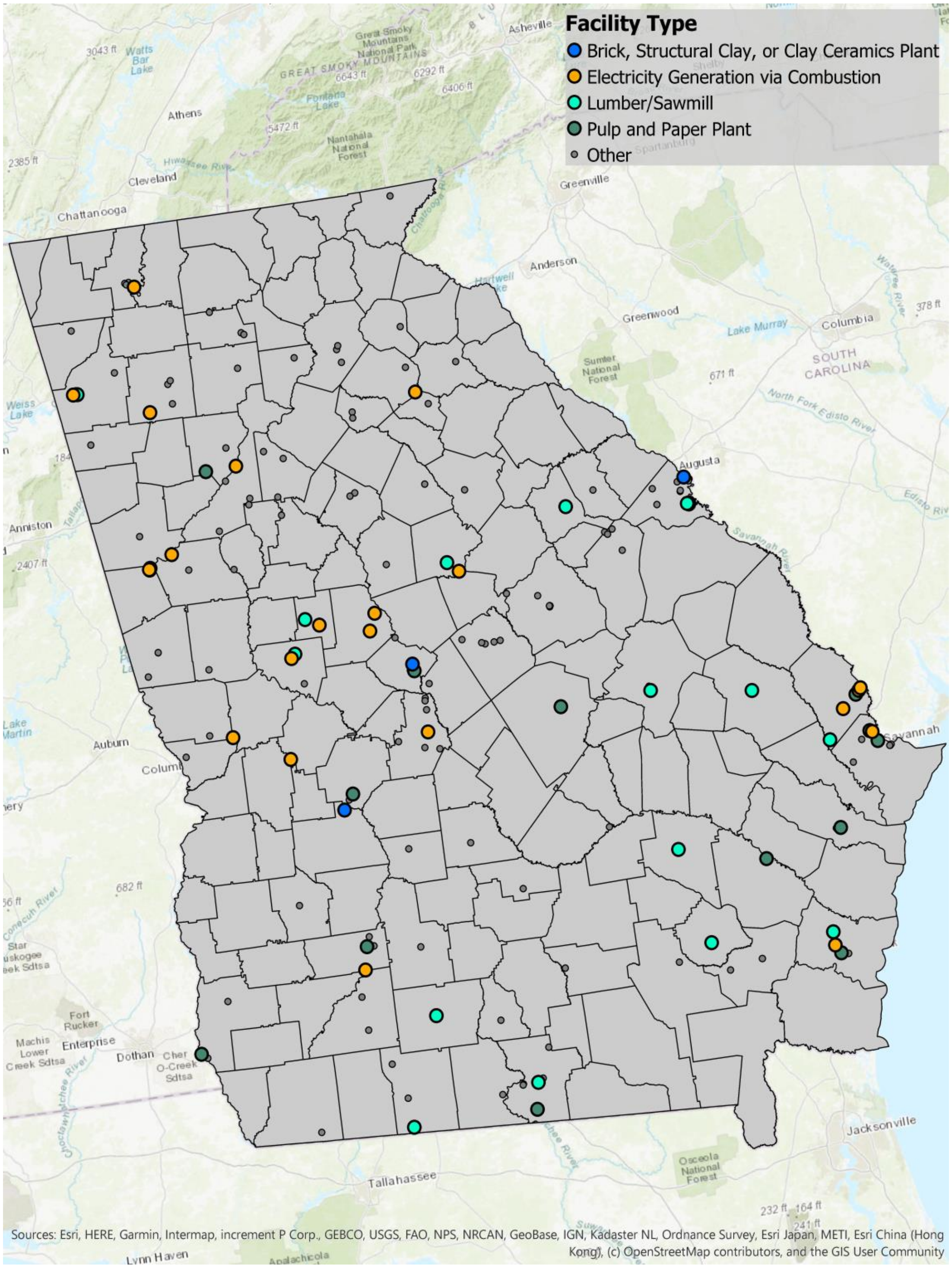


Figure 16.5: PM_{10} Emitting Facilities in Georgia

The following figure shows the total primary anthropogenic PM_{10} typical emissions for 2016 and 2028. 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 2016 and 2028 emissions is shown using the formula 2028 emissions - 2016 emissions. The percent change in emissions from 2016-2028 is shown using the formula (2028/2016-1) X 100.

2016 and 2028 GA Annual Total Anthropogenic PM_{10}

Difference = 2028-2016 and % Changes = (2028/2016 -1) * 100

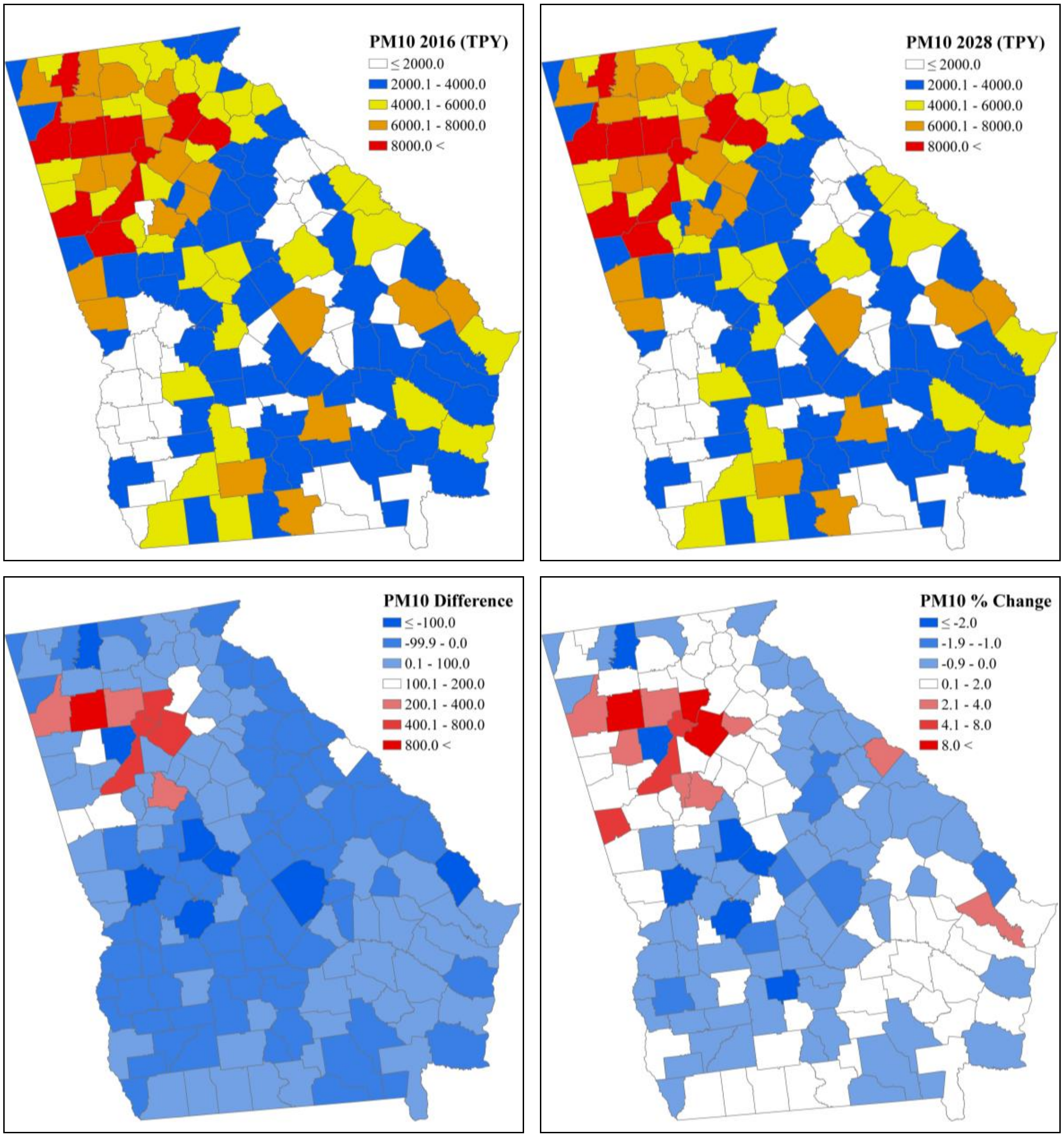


Figure 16.6: PM_{10} 2016 and 2028 Typical Emissions

According to the 2016 and 2028 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, the Dalton MSA, the Gainesville MSA, the Rome MSA, and Jackson County. These areas are shown in red in the top two maps and represent greater than 8,000 TPY of emissions. There does not appear to be much projected change in the PM_{10} emissions levels from 2016 to 2028.

The following model outputs show projected average annual concentrations of PM_{10} based on 2016 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 2016 data. The current locations of GA AAMP's ambient air monitors are shown with white triangles.

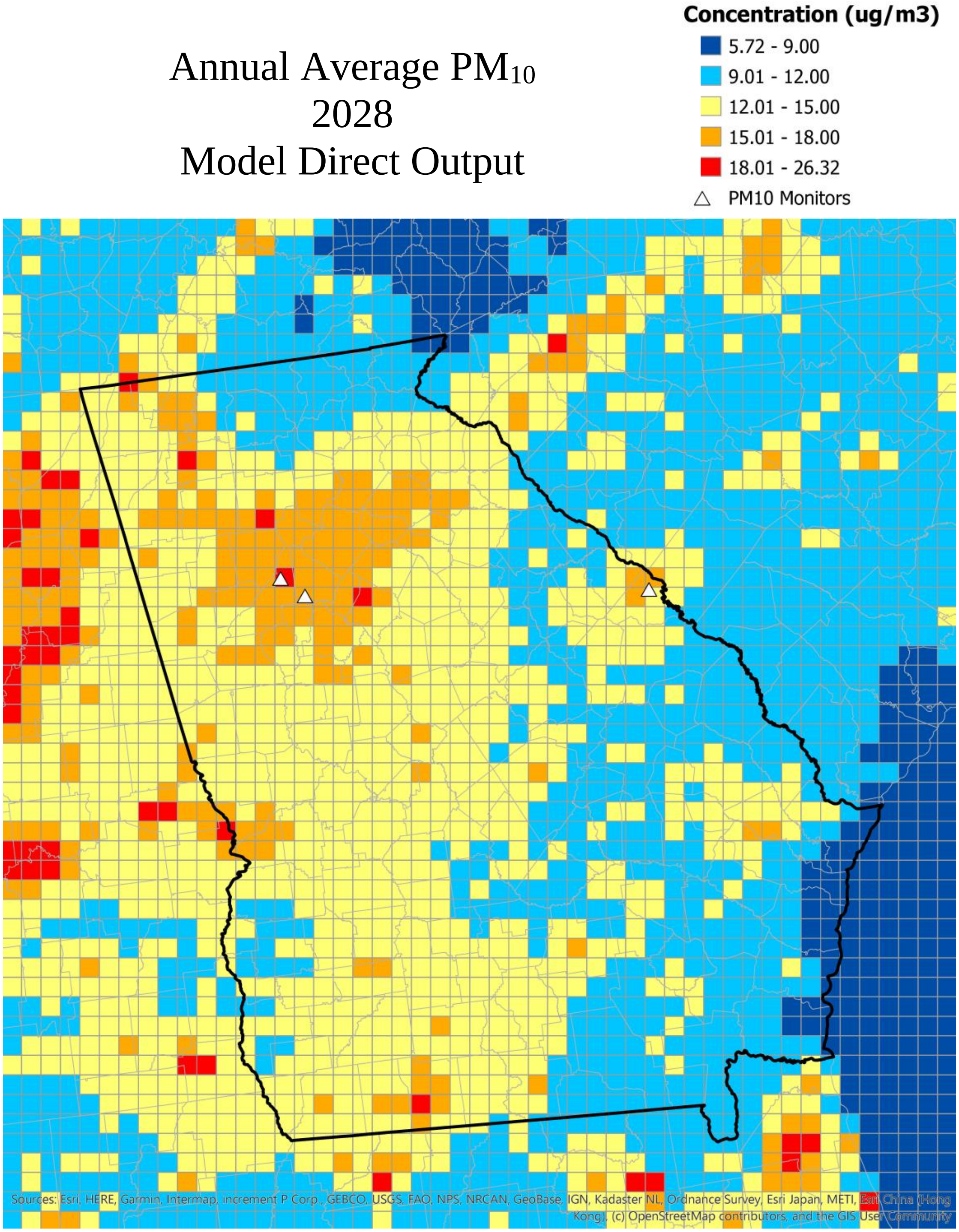


Figure 16.7: PM_{10}, Modeled 2028, Annual Average

In 2016, the state of Georgia had a particularly extreme wildfire event that occurred in north Georgia. Since this model is using 2016 as a base year, it is possible that some of the high PM_{10} values seen in the above map are due these wildfires. A second map is shown below which has excluded PM_{10} 24-hour average values greater than 50 μg/m^3 to account for possible wildfire influence.

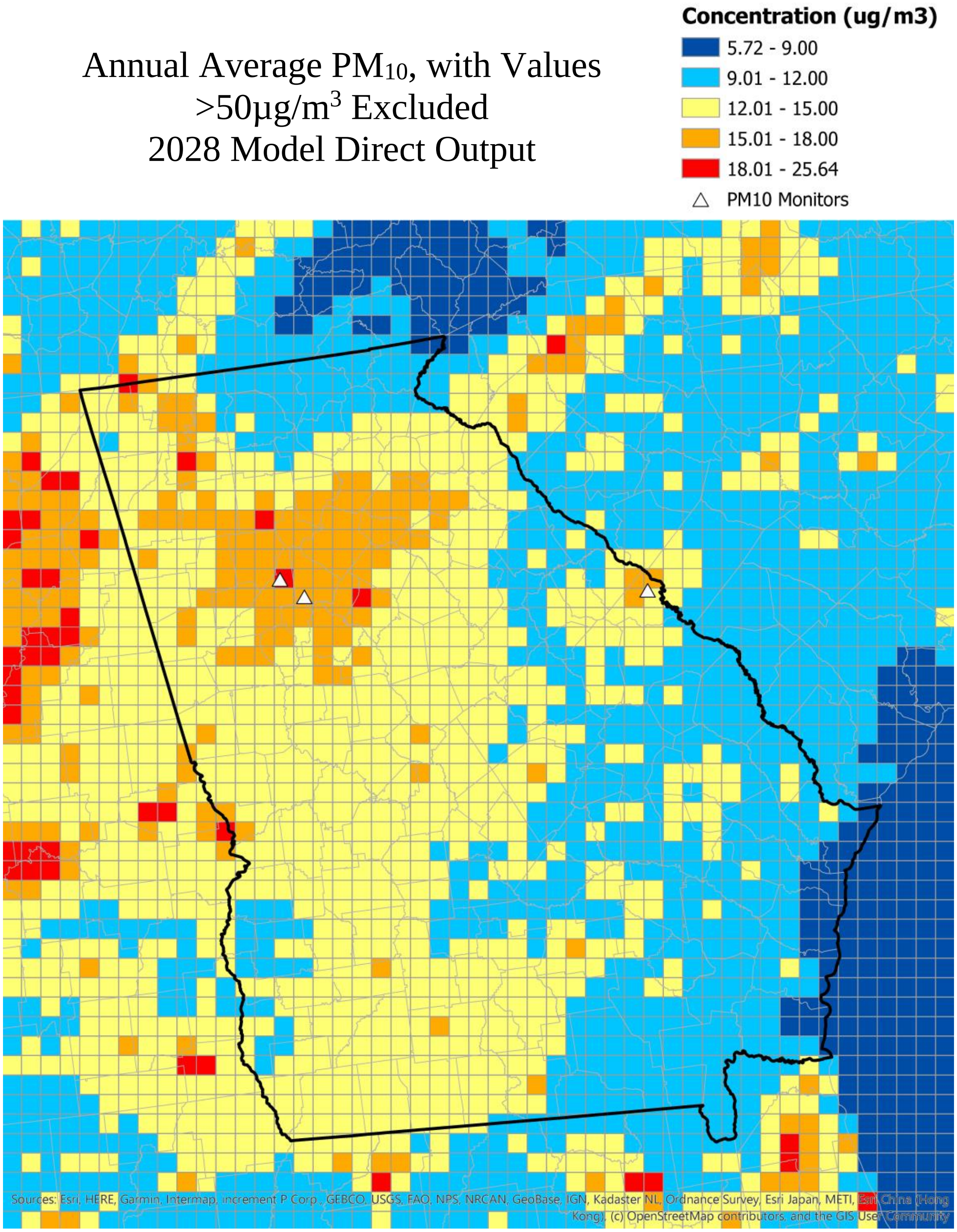


Figure 16.8: PM_{10}, Modeled 2028, Annual Average, with Values Greater than 50 µg/m^3 Excluded

According to the modeled 2028 annual average with values greater than 50 µg/m^3 excluded, the areas with the highest PM_{10} emissions are primarily in the Atlanta-Sandy Springs-Roswell MSA, the Columbus, GA-AL MSA, and the Chattanooga, TN-GA MSA, with secondary high values in the Augusta-Richmond County, GA-SC MSA. The NAAQS for PM_{10} comparison is 150 µg/m^3, so it should be noted that these are very low values reflected in the map. GA AAMP has PM_{10} monitors located in the Atlanta-Sandy Springs-Roswell MSA and Augusta-Richmond County, GA-SC MSA which are located in MSAs with higher populations, according to the Federal Register (40CFR58). 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.

16.3 $PM_{2.5}$

The following map shows the location of the source types that as a whole emit over 500 tons/year of $PM_{2.5}$ in Georgia. The source types displayed include electricity generation via combustion, lumber and sawmills, plywood and engineered wood product plants, pulp and paper plants, and other industrial sources.

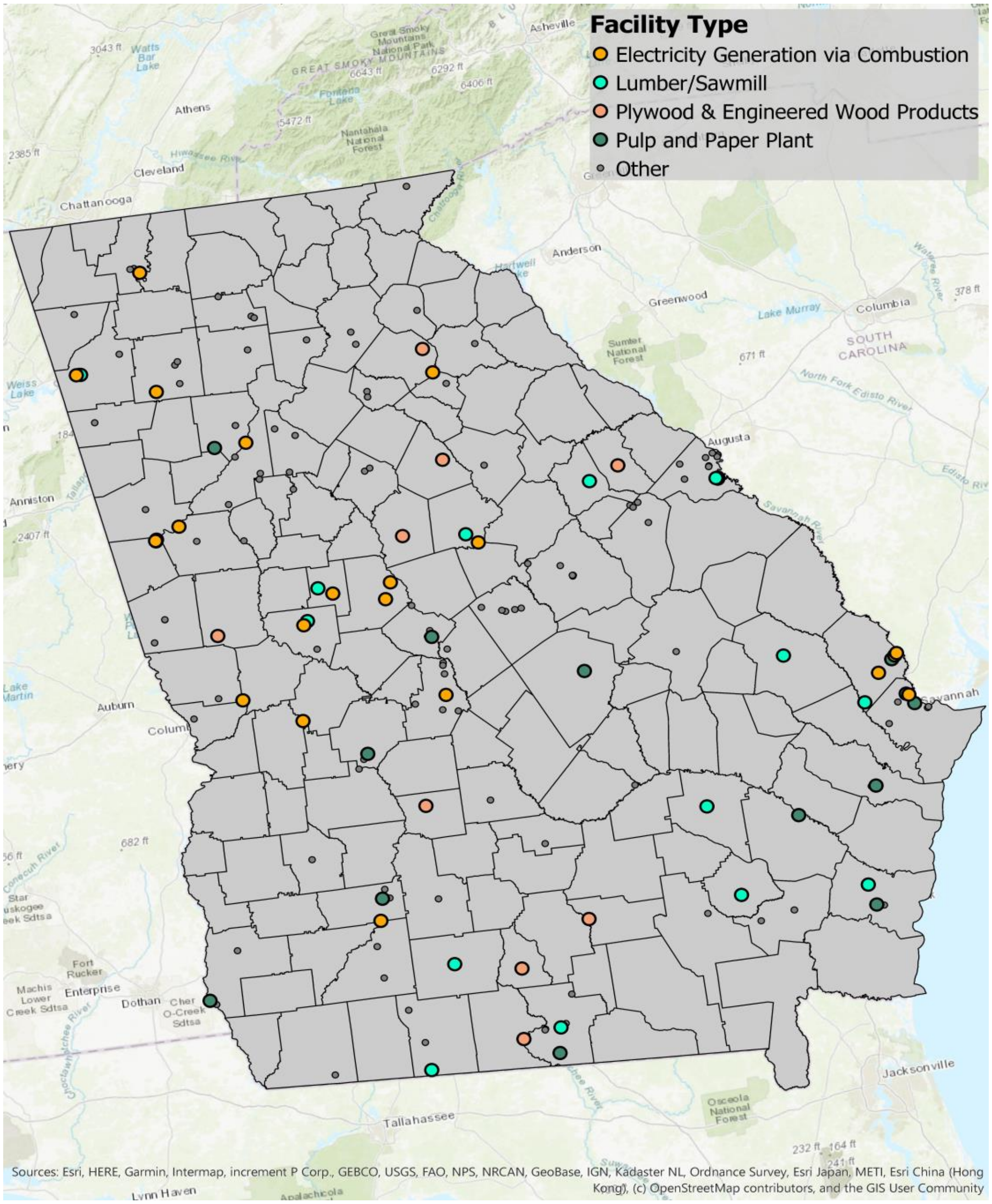


Figure 16.9: $PM_{2.5}$ Emitting Facilities in Georgia

In the following figure, the total anthropogenic $PM_{2.5}$ typical emissions are shown for 2016 and 2028. 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 2016 and 2028 emissions is shown using the formula 2028 emissions - 2016 emissions. A percent change in emissions is shown using the formula (2028/2016-1) X 100.

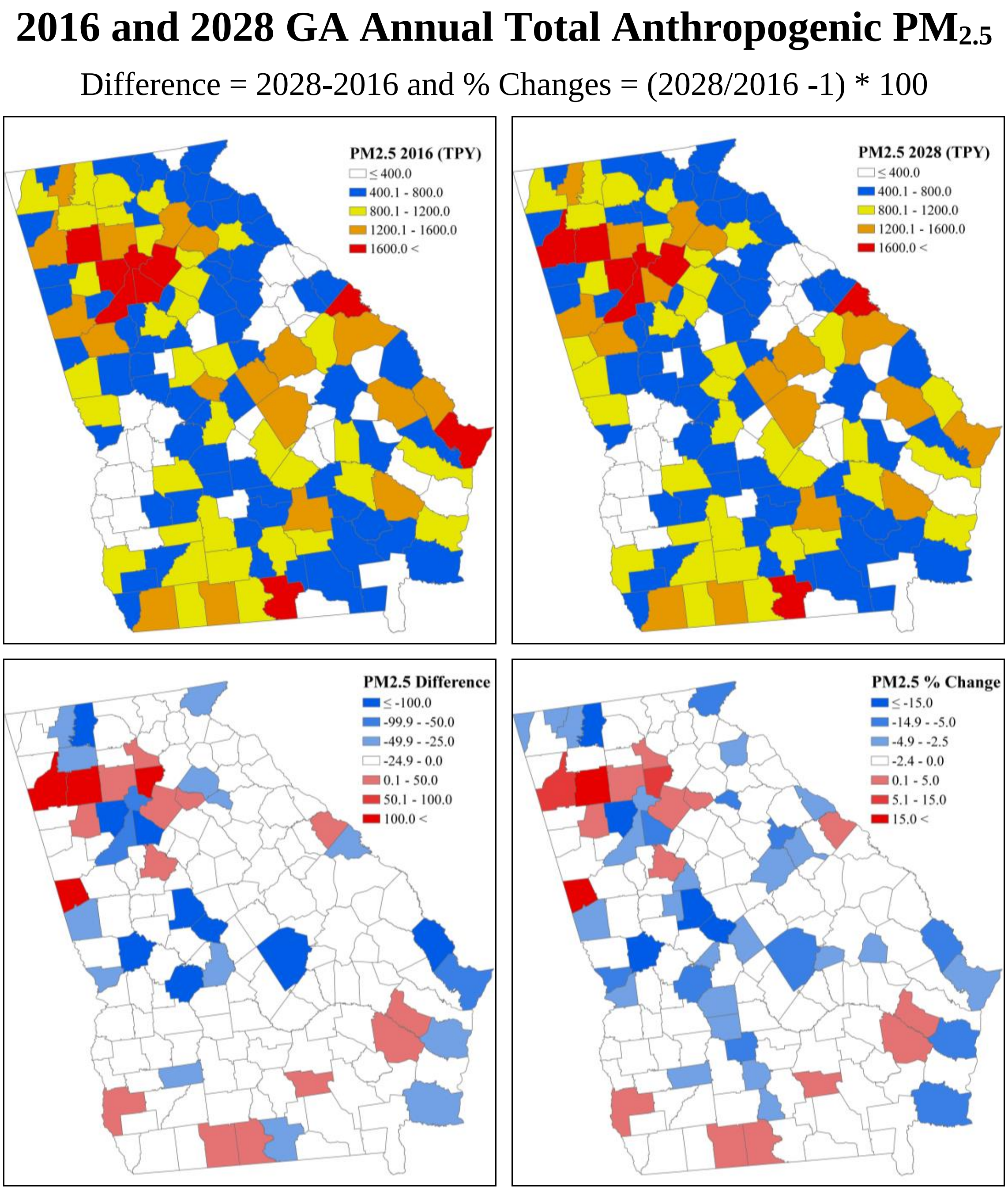


Figure 16.10: $PM_{2.5}$ 2016 and 2028 Typical Emissions

According to the 2016 typical anthropogenic primary $PM_{2.5}$ emissions maps shown above, the areas with the highest typical anthropogenic $PM_{2.5}$ emissions are Bartow, Cobb, DeKalb, Gwinnett and Fulton Counties in the Atlanta-Sandy Springs-Roswell MSA, Lowndes County in the Valdosta MSA, Richmond County in the Augusta-Richmond County, GA-SC MSA, and Chatham County in the Savannah MSA (all are shown in red). Bartow, Cobb, Gwinnett, Fulton, Lowndes, and Richmond Counties have over 1,600 TPY of typical $PM_{2.5}$ emissions in 2016 and projected for 2028 as well. DeKalb and Chatham Counties show a projected decrease of $PM_{2.5}$

emissions from 2016 to 2028 (shown in orange in 2028). The other areas of the state show little change from 2016 to 2028.

The following model outputs show projected concentrations of the $PM_{2.5}$ annual average based on 2016 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 2016 data. The current locations of GA AAMP's ambient air monitors are shown with white triangles.

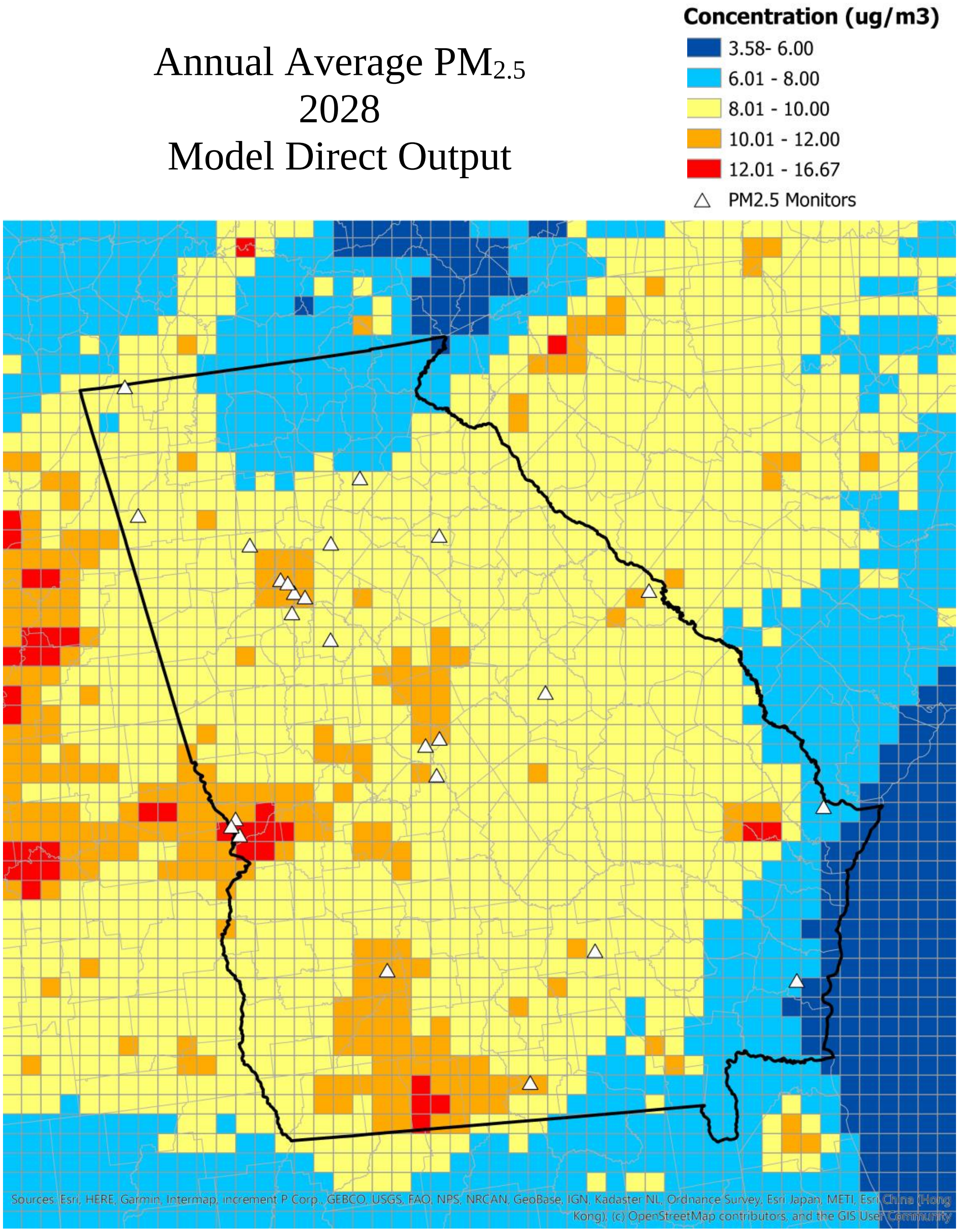


Figure 16.11: $PM_{2.5}$, Modeled 2028, Annual Average

In 2016, the state of Georgia had a particularly extreme wildfire event that occurred in north Georgia. Since this model is using 2016 as a base year, it is possible that some of the high $PM_{2.5}$ values seen in the above map are due to these wildfires. A second map is shown below which has excluded $PM_{2.5}$ 24-hour daily averages greater than 35 µg/m^3.

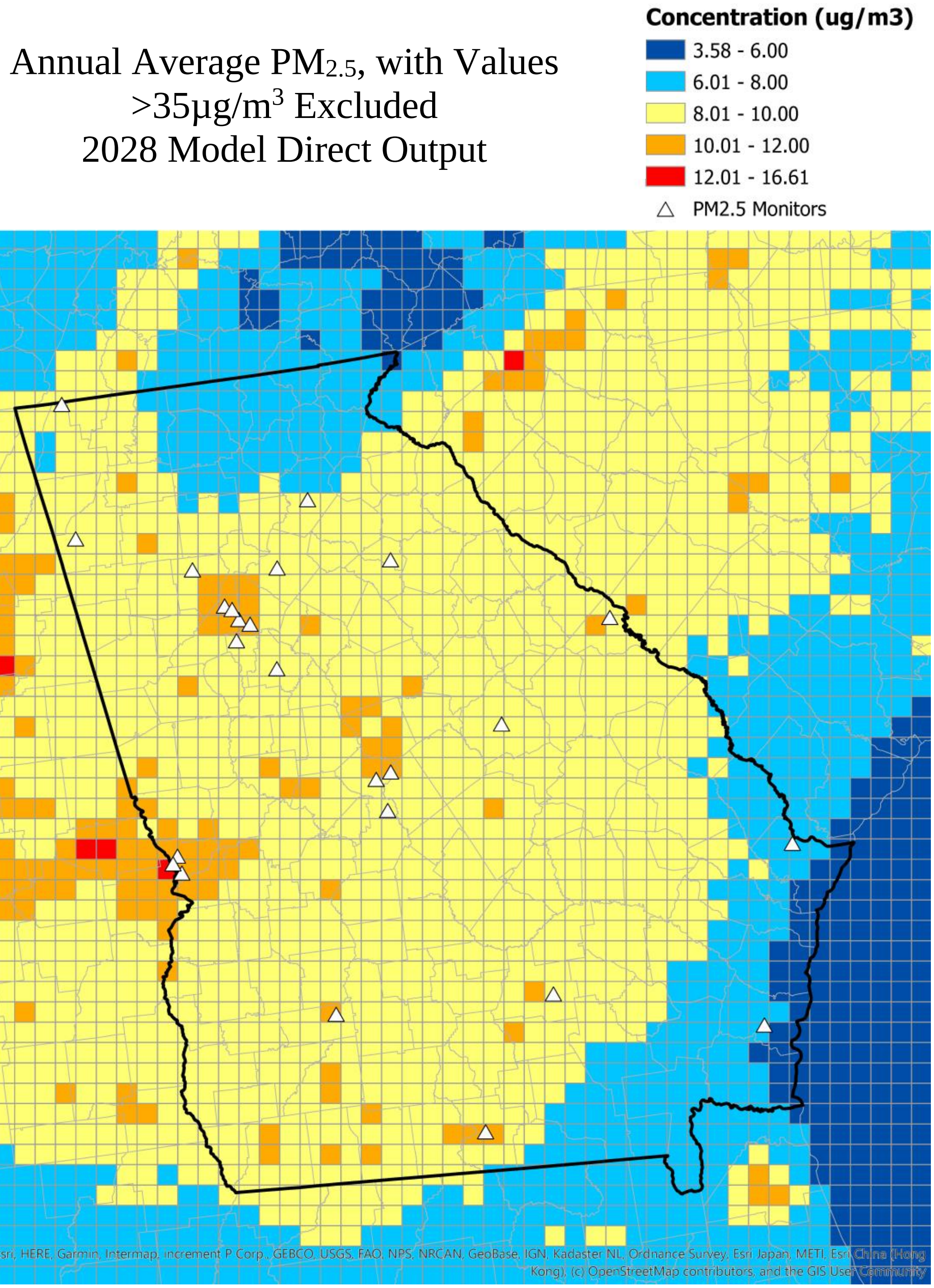


Figure 16.12: $PM_{2.5}$, Modeled 2028, Annual Average, with Values Greater than 35 µg/m^3 Excluded

According to the modeled 2028 annual average with 24-hour daily averages greater than 35 µg/m^3 excluded, the areas with the highest $PM_{2.5}$ emissions are primarily in the Columbus, GA-AL MSA. The areas with the lowest $PM_{2.5}$ emissions are in the Savannah MSA and the Brunswick MSA. As stated above with the PM_{10} Emission Assessment, GA AAMP 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 over 500 tons/year of CO in Georgia. The source types displayed include airports, brick, structural clay, or clay ceramics plants, compressor stations, electricity generation via combustion, fabricated metal products plants, fertilizer plants, food products processing plants, landfills, lumber or sawmills, plywood and engineered wood products plants, cement manufacturing plants, pulp and paper plants, and other industrial sources.

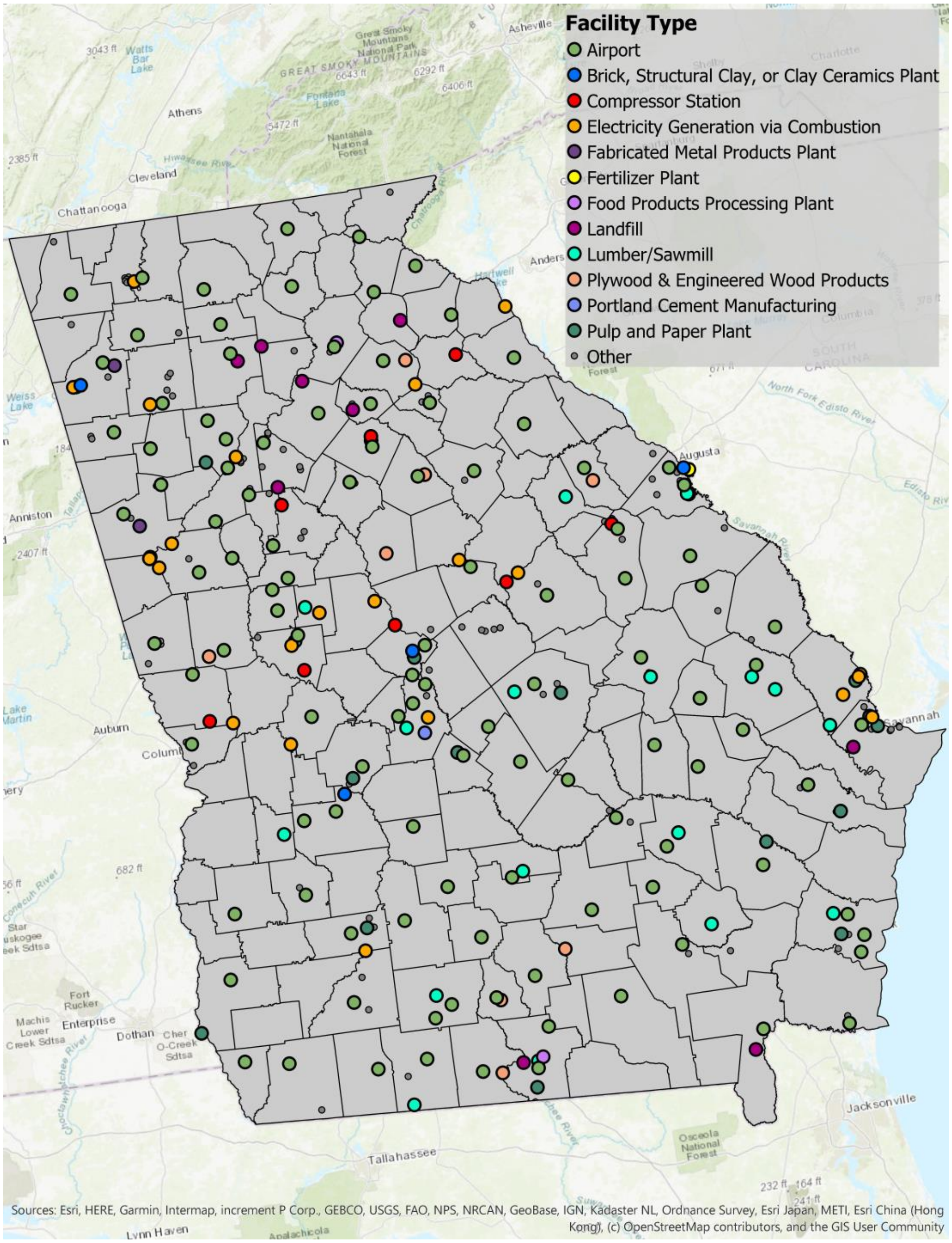


Figure 16.13: CO Emitting Facilities in Georgia

In the following maps, the total anthropogenic carbon monoxide typical emissions are shown for 2016 and 2028. 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 2016 and 2028 emissions is shown using the formula 2028 emissions - 2016 emissions. A percent change in emissions is shown using the formula (2028/2016-1) X 100.

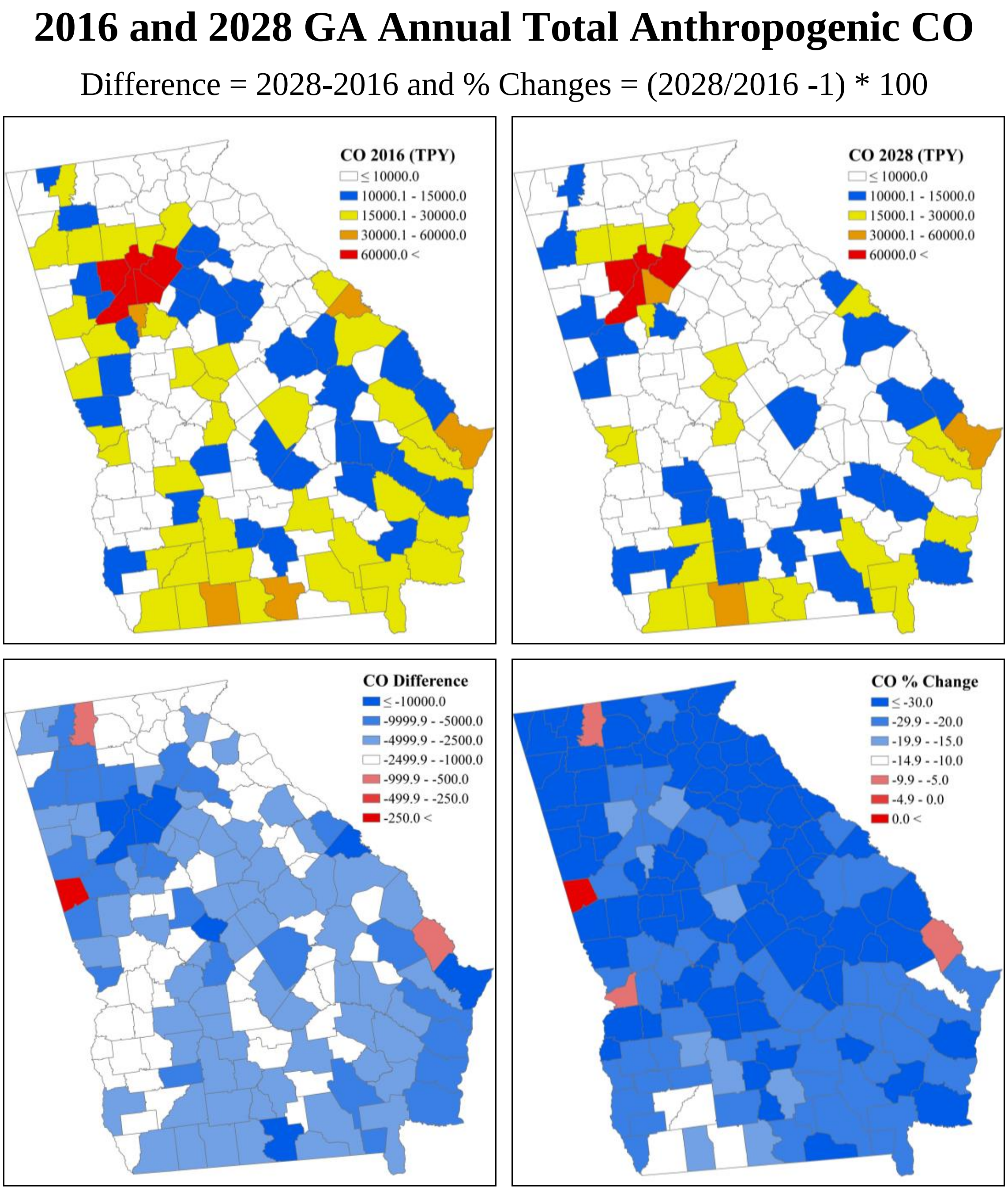


Figure 16.14: CO 2016 and 2028 Typical Emissions

For the CO emissions in Georgia, the Atlanta-Sandy Springs-Roswell MSA (shown in red) has the highest level of emissions for 2016. In 2028, the predicted CO emissions for most parts of the Atlanta-Sandy Springs-Roswell decrease with the notable exception of Fulton, Cobb and Gwinnett Counties. Several other areas of the state also have a predicted decrease of CO emissions in 2028.

In the following model outputs, projected annual average concentrations of CO based on 2016 data are shown. The concentrations are shown in parts per million, higher concentration levels are shown in red. These models take into account meteorological conditions based on 2016 data. The current locations of GA AAMP's ambient air monitors are shown with white triangles.

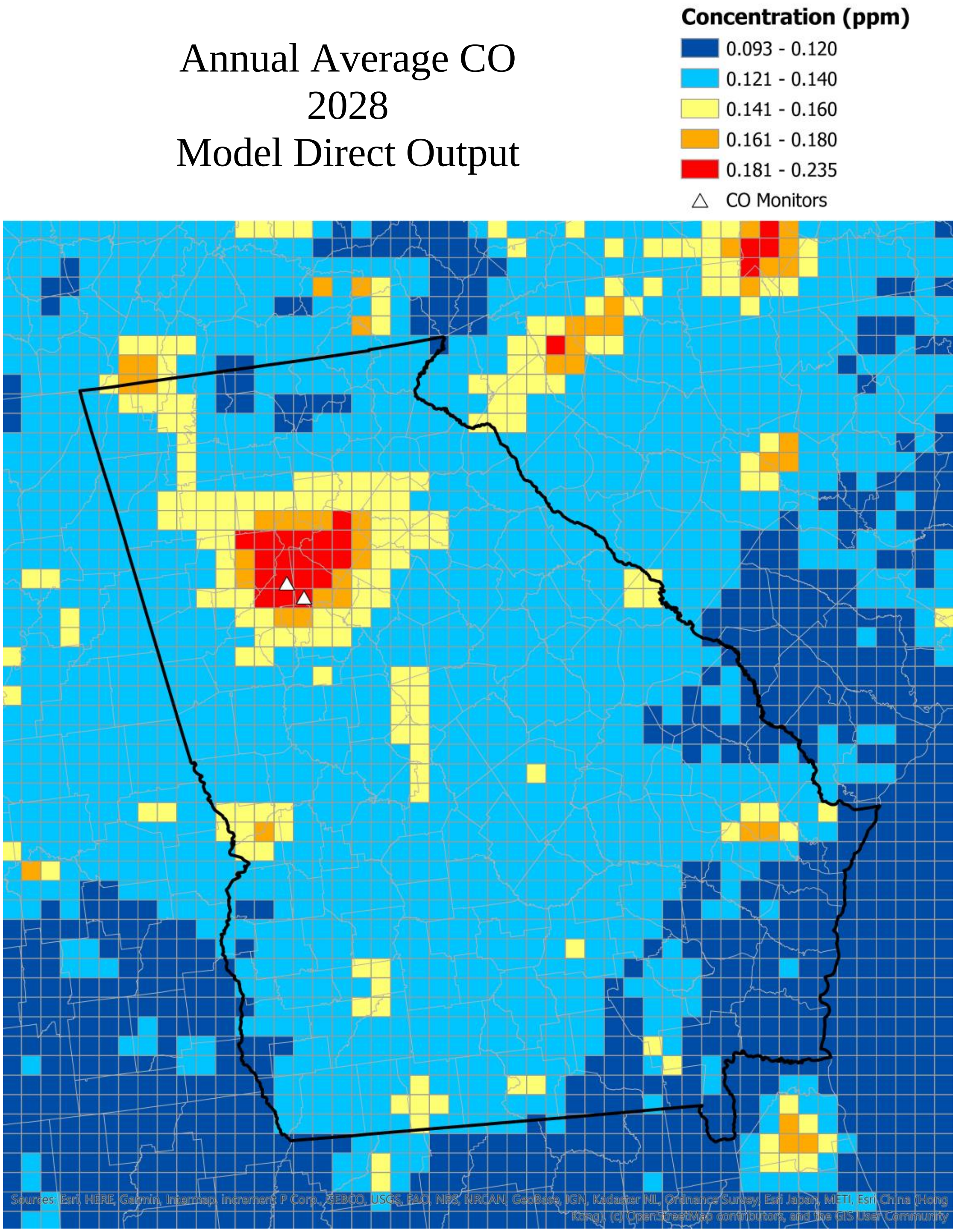


Figure 16.15: CO, Modeled 2028, Annual Average

With the above map, the annual average concentrations of carbon monoxide are predicted. For the annual averages, the Atlanta-Sandy Springs-Roswell MSA has the highest level of emissions (shown in red). GA AAMP has CO monitors located in the Atlanta-Sandy Springs-Roswell

MSA, with higher population and areas of high vehicle traffic, according to the Federal Register (40CFR58).

16.5 Ozone

The following model outputs show predicted concentrations of ozone at the fourth highest daily 8-hour maximum based on 2016 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 2016 data. The current locations of GA AAMP's ambient air monitors are shown with white triangles.

It should be noted that ozone is a secondary pollutant, and not directly emitted from sources; therefore, models were not conducted of emissions data for ozone. NOx and VOCs are major contributors to the formation of ozone, and this emission information was modeled, with the results discussed in the sections below.

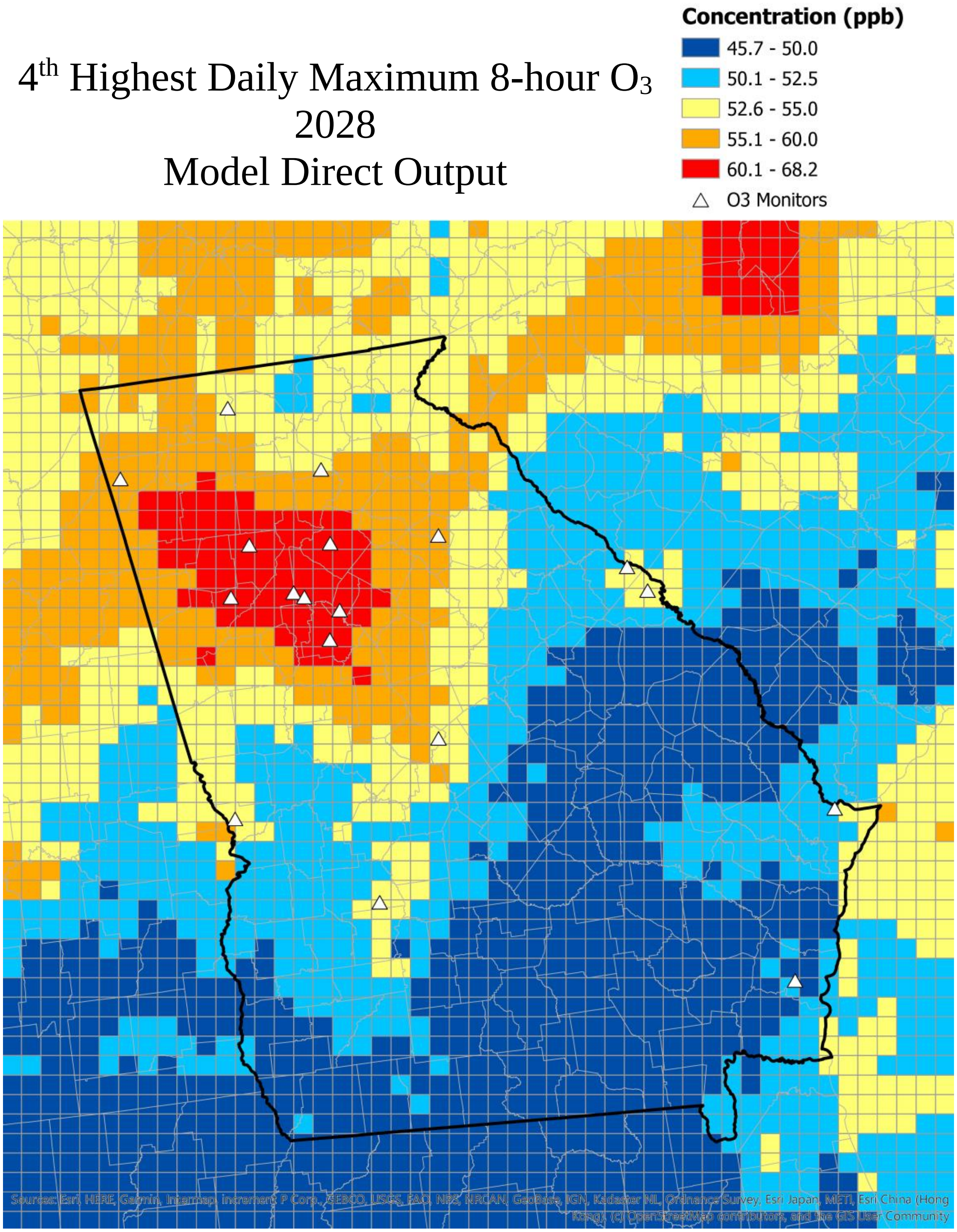


Figure 16.16: Ozone, Modeled 2028, 4th Highest Daily Maximum

It appears that GA AAMP has ozone monitors in most of the areas of the state where the highest levels of 4th highest daily maximum of the 8-hour O_3 values are predicted to be in 2028. Several ozone monitors are located in areas with lower predicted ozone values and may not be needed, according to this assessment. There are two monitors (United 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 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.

On October 1, 2015 EPA changed the 8-hour primary and secondary ozone standards, designed to protect public health, to 70 parts per billion (ppb) (80FR65292). At this time, even with the strengthening of the standard, no adjustments have been needed to fulfill the network requirements in 40 CFR 58 Appendix D.

16.6 NO_X

The following map shows the location of the source types that emit over 500 tons/year of oxides of nitrogen in Georgia. The source types displayed include airports, brick, structural clay, or clay ceramics plants, chemical plants, compressor stations, electricity generation via combustion, fertilizer plan, glass plant, lumber or sawmills, plywood and engineered wood products plants, cement manufacturing plants, pulp and paper plants, rail yards, sugar mills, and other industrial facilities.

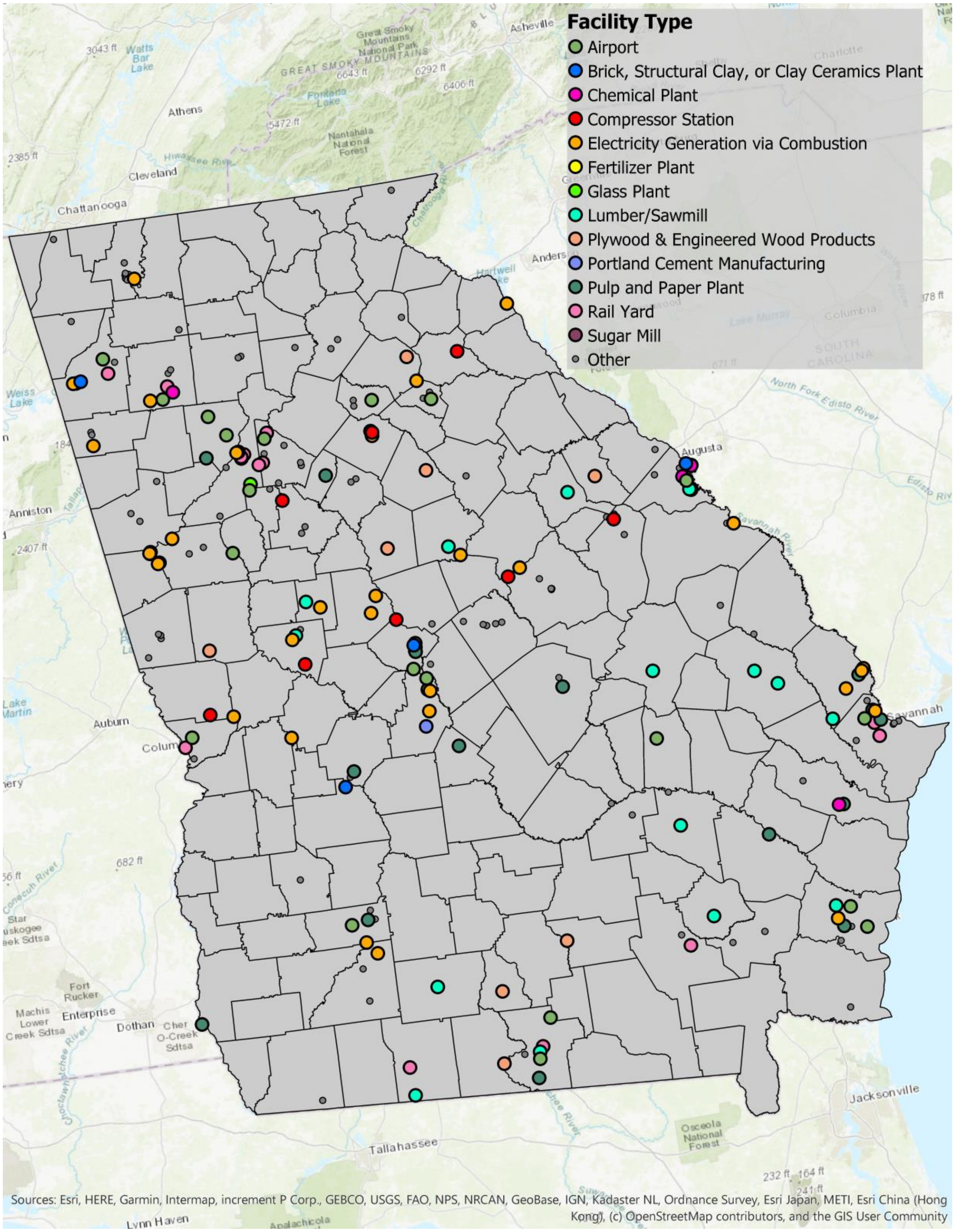


Figure 16.17: NO_X Emitting Facilities in Georgia

In the following maps, the total anthropogenic oxides of nitrogen typical emissions are shown for 2016 and 2028. 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 2016 and 2028 emissions is shown using the formula 2028 emissions - 2016 emissions. A percent change in emissions is shown using the formula (2028/2016-1) X 100.

2016 and 2028 GA Annual Total Anthropogenic NO_X

Difference = 2028-2016 and % Changes = (2028/2016 -1) *100

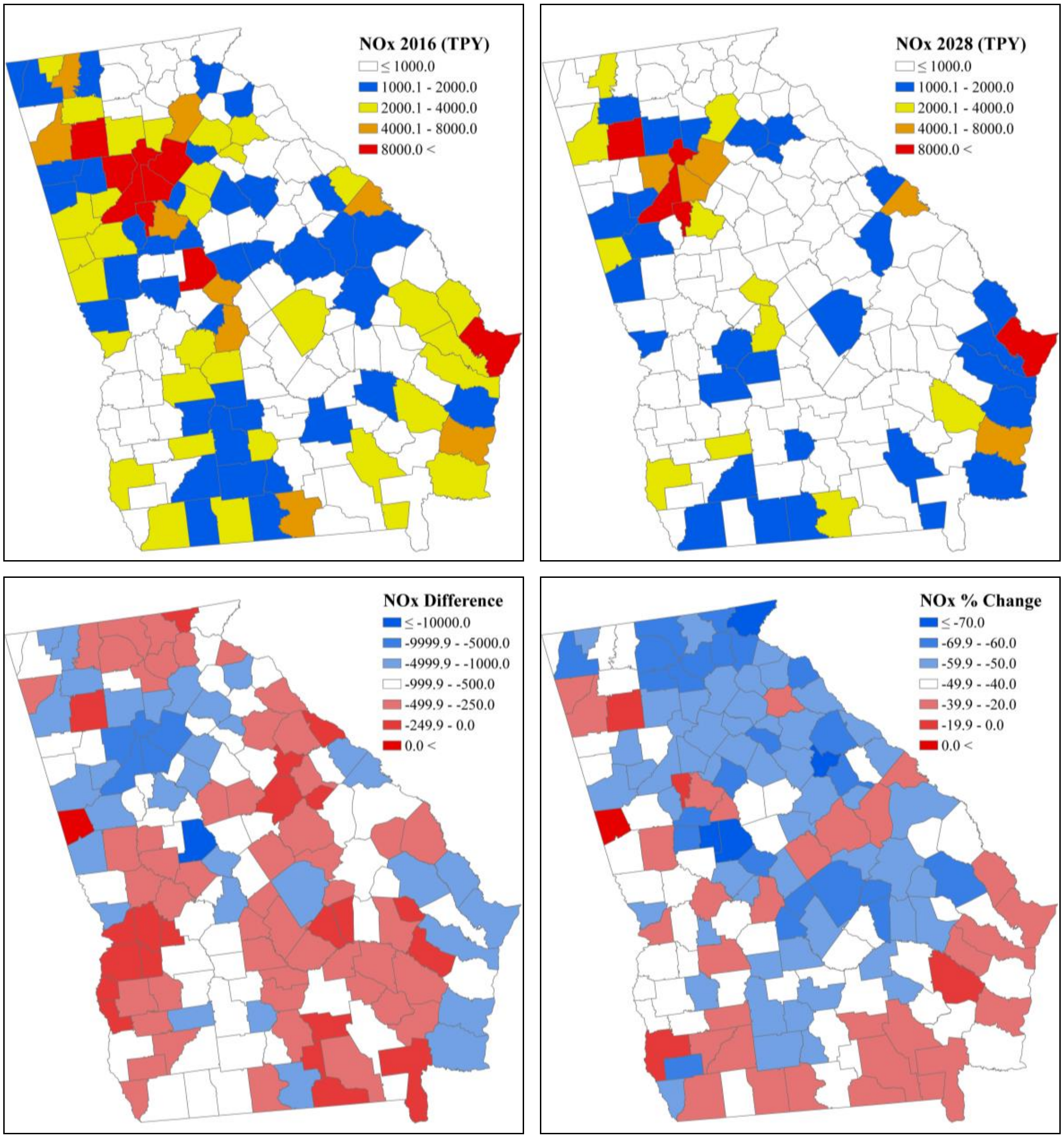


Figure 16.18: NO_X 2016 and 2028 Typical Emissions

The NOx emissions models show that part of the Atlanta-Sandy Springs-Roswell MSA, part of the Savannah MSA, and part of the Macon MSA, have over 8,000 TPY of typical predicted emissions in 2016 (shown in red). In 2028, the predicted NOx emissions levels in most of these areas have significant decreases, with levels dropping to none or half the 2016 level with the exception of Chatham County in the Savannah MSA and Bartow, Fulton and Clayton Counties in the Atlanta-Sandy Springs-Roswell MSA.

The following model outputs show projected annual average concentrations of nitrogen dioxide based on 2016 data. The concentrations are shown in parts per billion, and the hotter colors (red and orange) represent higher levels of concentration. These models take into account meteorological conditions based on 2016 data. The current locations of GA AAMP's ambient air monitors are shown with white triangles.

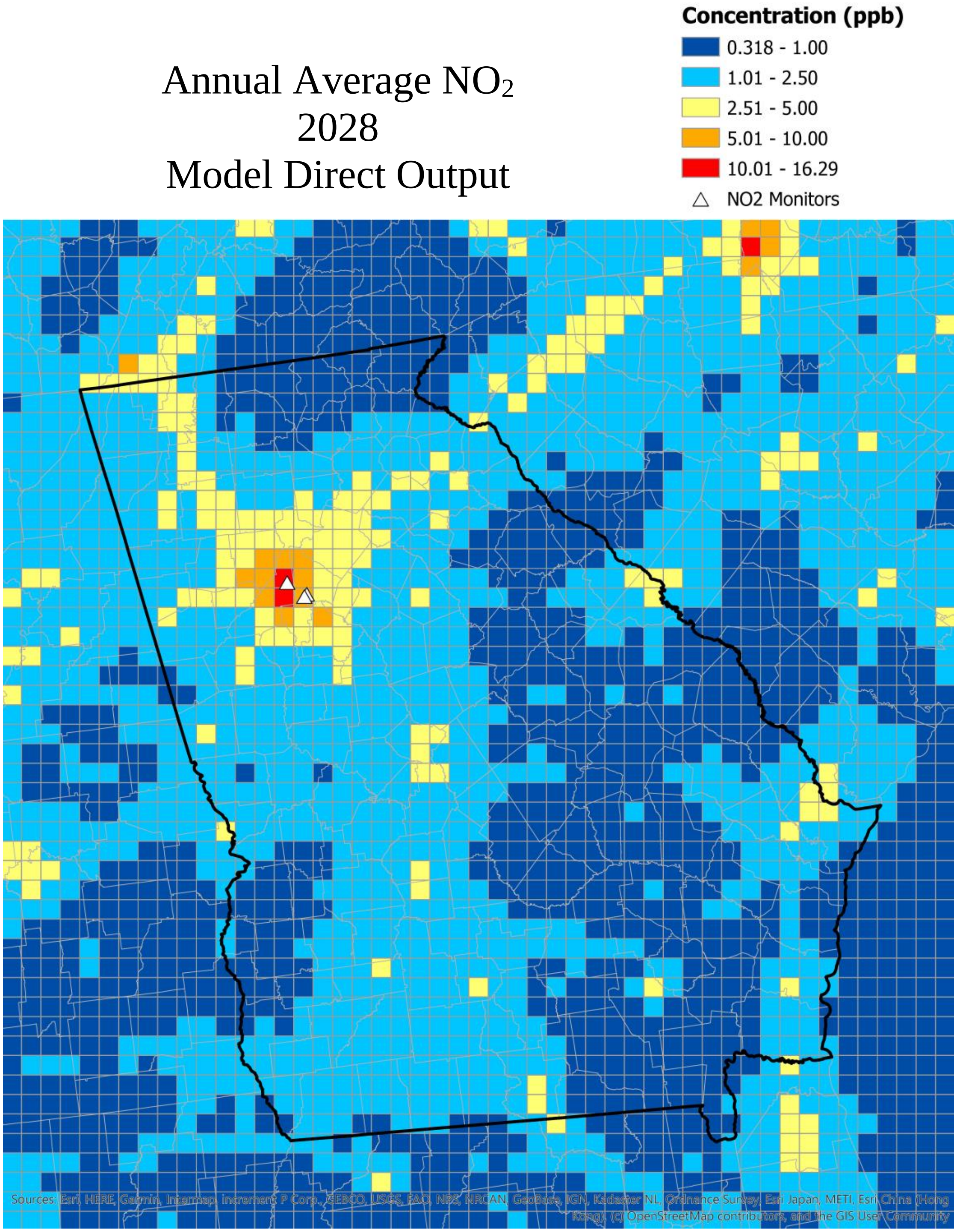


Figure 16.19: NO_2, Modeled 2028, Annual Average

In the above map, the areas with the highest annual average of NO_2 are predicted. The Atlanta-Sandy Springs-Roswell MSA has the highest predicted level, 10.01-16.29 ppb. The Atlanta-Sandy Springs-Roswell MSA has a monitor that is part of the PAMS network, and two monitors that are part of the Near-road network with areas of higher population and high vehicle traffic, according to the Federal Register (40CFR58).

16.7 Volatile Organic Compounds

In the following map, the source types that emit over 500 tons/year of 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.

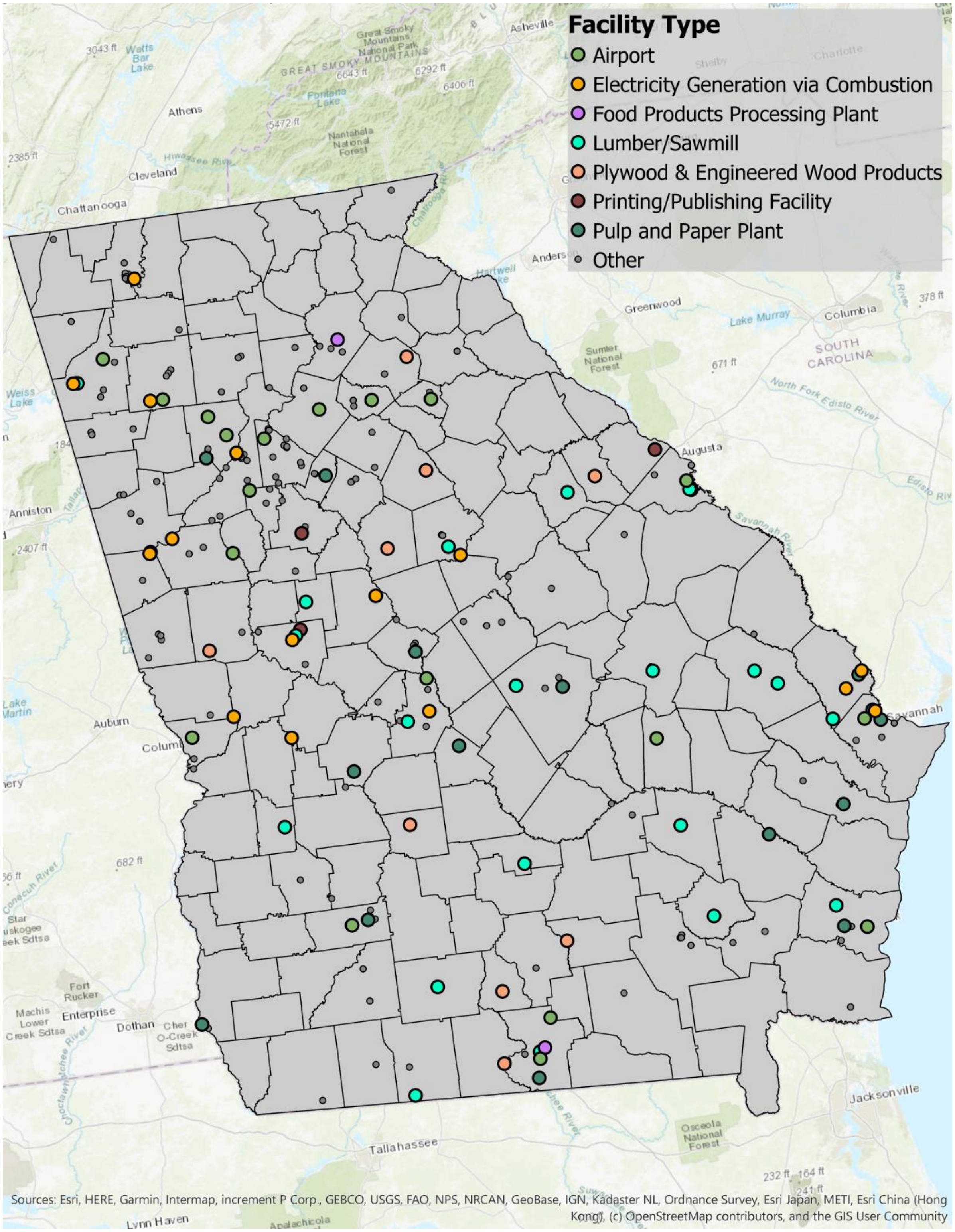


Figure 16.20: VOCs Emitting Facilities in Georgia

The following maps show the total anthropogenic VOCs for typical emissions for 2016 and 2028. 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 2016 and 2028 emissions is shown using the formula 2028 emissions - 2016 emissions. A percent change in emissions is shown using the formula (2028/2016-1) X 100.

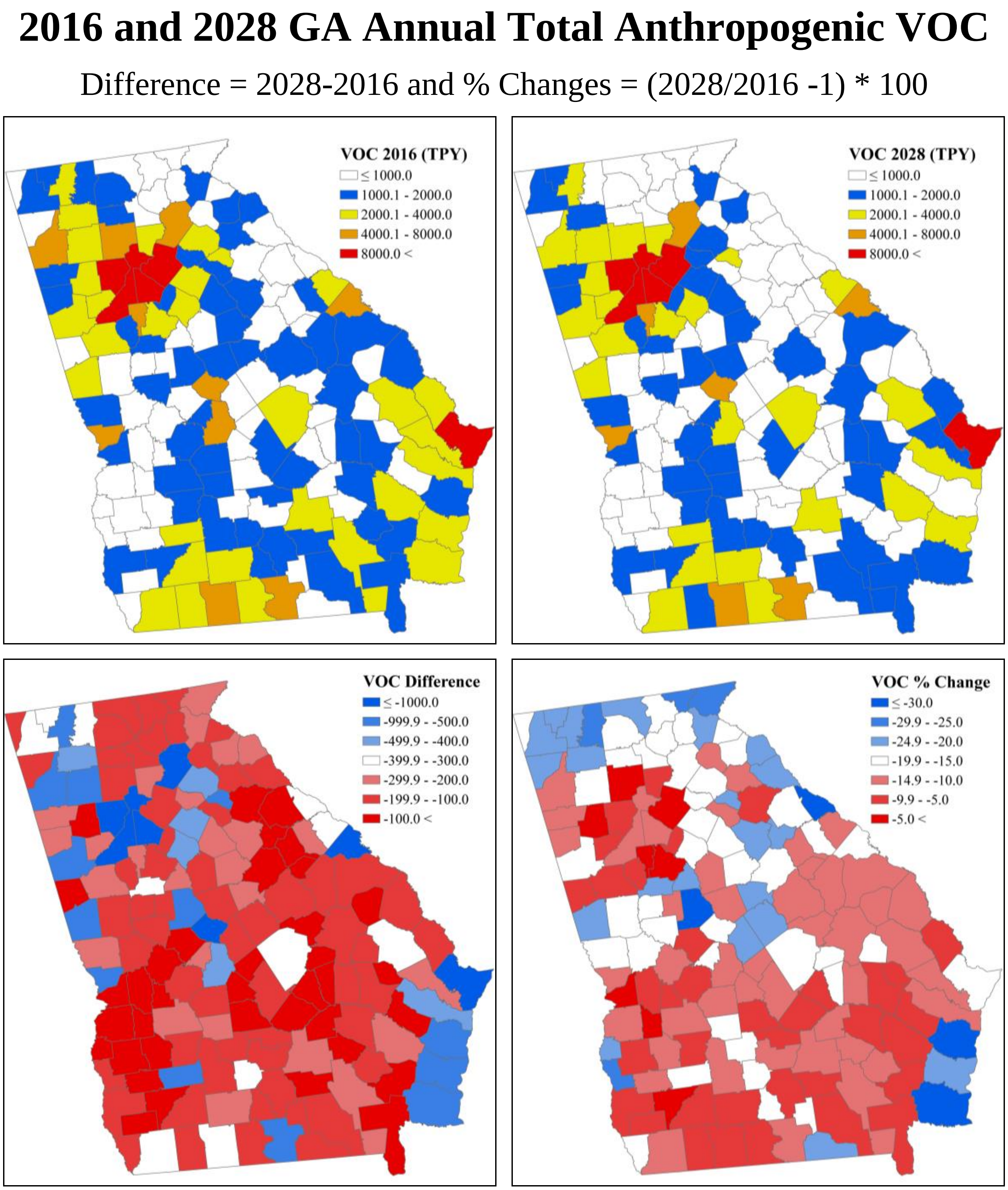


Figure 16.21: VOCs 2016 and 2028 Typical Emissions

According to the 2016 and 2028 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 and the Savannah MSA. The total emissions per county are >8,000 TPY, shown in red. There is a predicted overall decrease in VOCs emissions across the state in 2028. It should be noted that biogenic (natural) sources in Georgia are more important in regards to VOCs emissions than anthropogenic (man-made) sources.

The two following model outputs show predicted 2028 concentrations of the annual average VOCs and the average VOCs during ozone season (March 1-Ocotber 31) based on 2016 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 hotter colors (red and orange) represents higher levels of concentration. These models take into account meteorological conditions based on 2016 data. The current locations of GA AAMP's ambient air monitors are shown with white triangles.

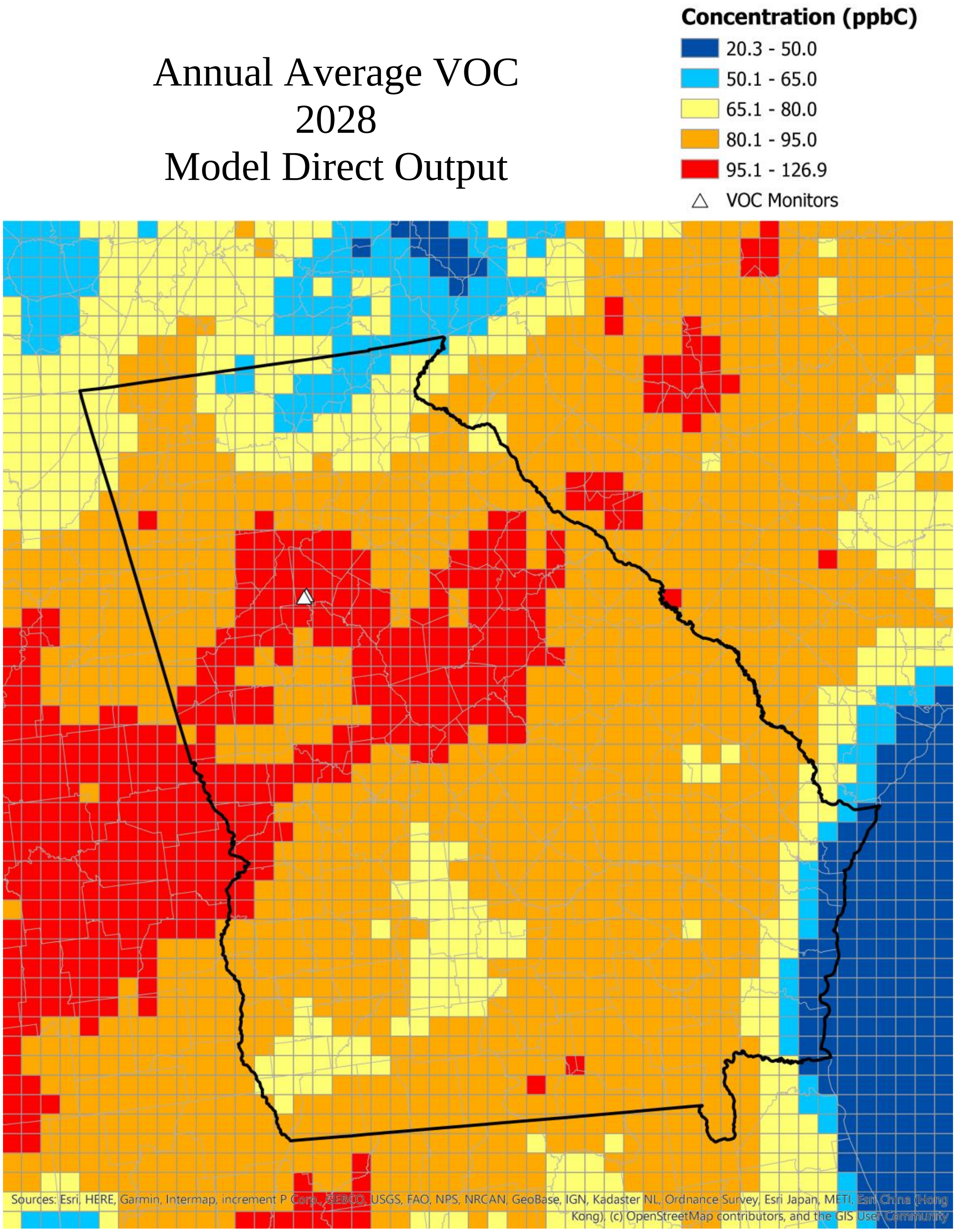


Figure 16.22: VOCs, Modeled 2028 Annual Average

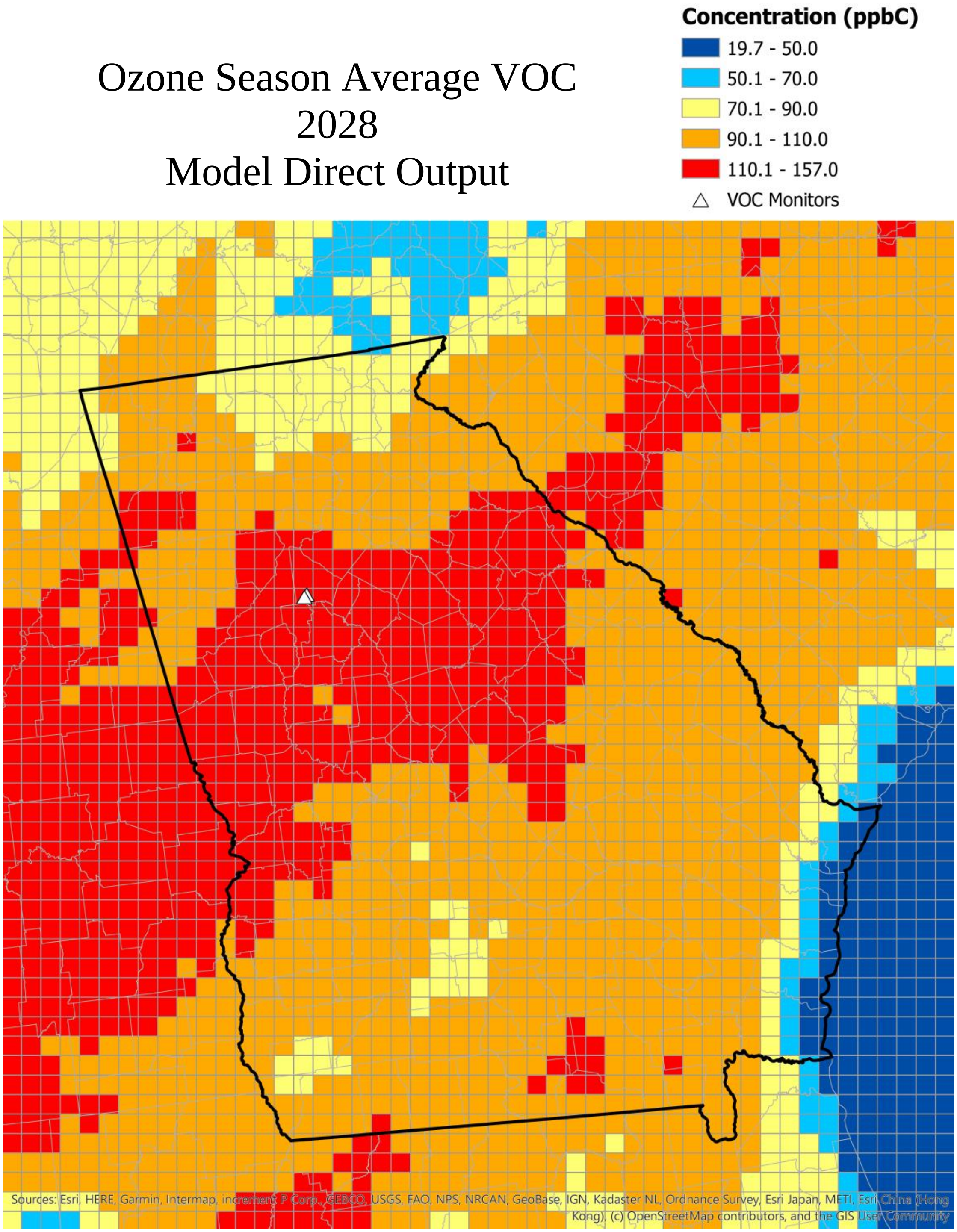


Figure 16.23: VOCs, Modeled 2028 Ozone Season Average

In the above maps, almost the entire state has at least the second highest level of 2028 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 AAMP may need to add VOCs samplers to sufficiently monitor VOCs concentrations. The Emissions Assessment is one of many assessments being considered to determine if monitors need to be added, removed, or moved within Georgia.

In summary, based on the above modeling results, most of the pollutants have very low predicted values for 2028. The GA AAMP may consider discontinuing the SO_2 monitor in the Macon MSA and the $PM_{2.5}$ monitors where the predicted emissions are very low (especially along the coast). The GA AAMP may consider adding VOCs monitors across the northern half of the state. However, there are many factors that are considered when placing, discontinuing, or moving monitors, such as population, sources, traffic, etc. 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.

16.8 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, Marine-Airport-Railroad (MAR), and Fires.

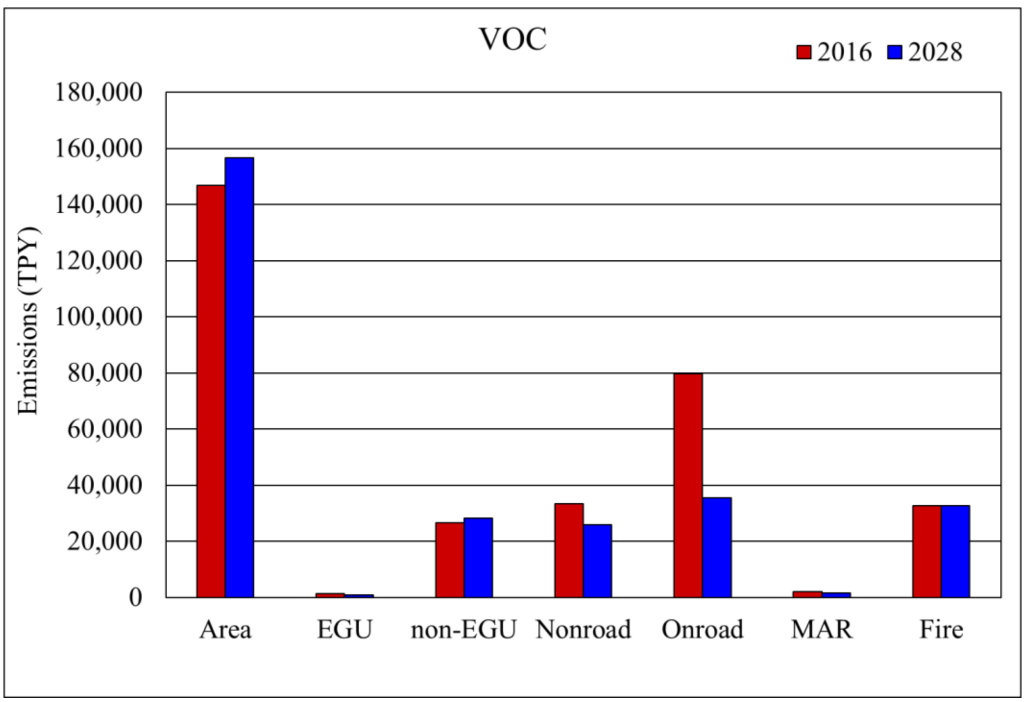


Figure 16.24: VOCs Emissions Trends in Georgia, 2016-2028

The largest sources of VOCs emissions in 2016 were Area Sources and Onroad Sources. In 2016, the Onroad emissions were at approximately 80,000 TPY. There is expected to be a significant decrease in the Onroad emissions, and by the year 2028 the level could be less than half the level they were in 2016. The fire emissions levels seem to remain from 2016 to 2028 (approximately 32,000 TPY).

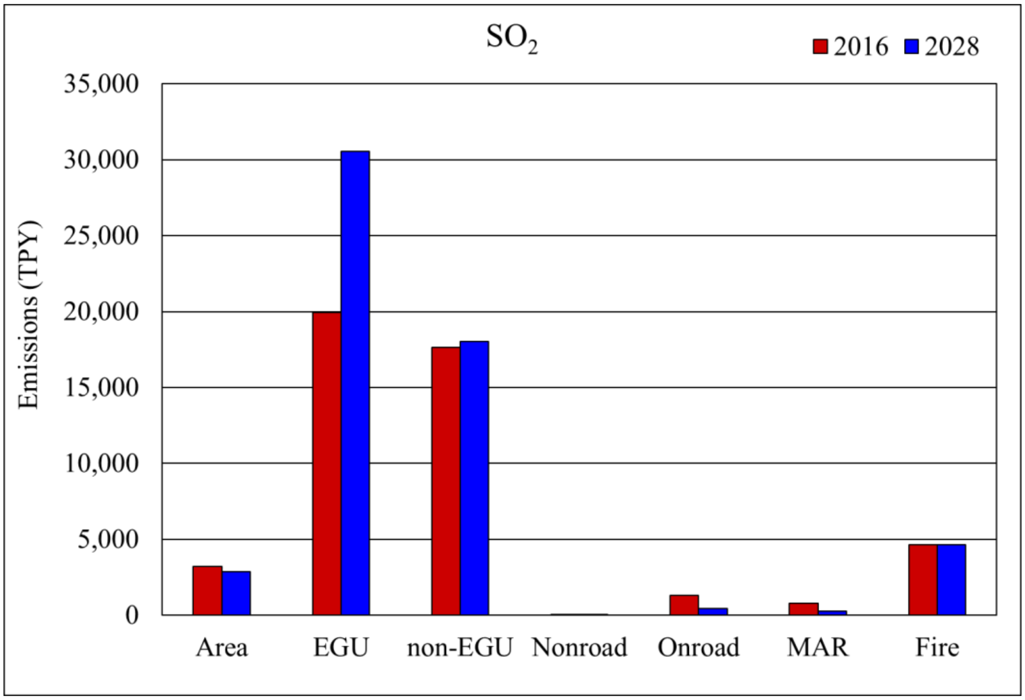


Figure 16.25: SO_2 Emissions Trends in Georgia, 2016-2028

SO_2 emissions are almost entirely attributed to EGUs and Non-EGUs. From 2016 to 2028, EGUs are expected to have an increase from over just at 20,000 to about 30,000 TPY. The other contributors remain at approximately the same level from 2016 to 2028.

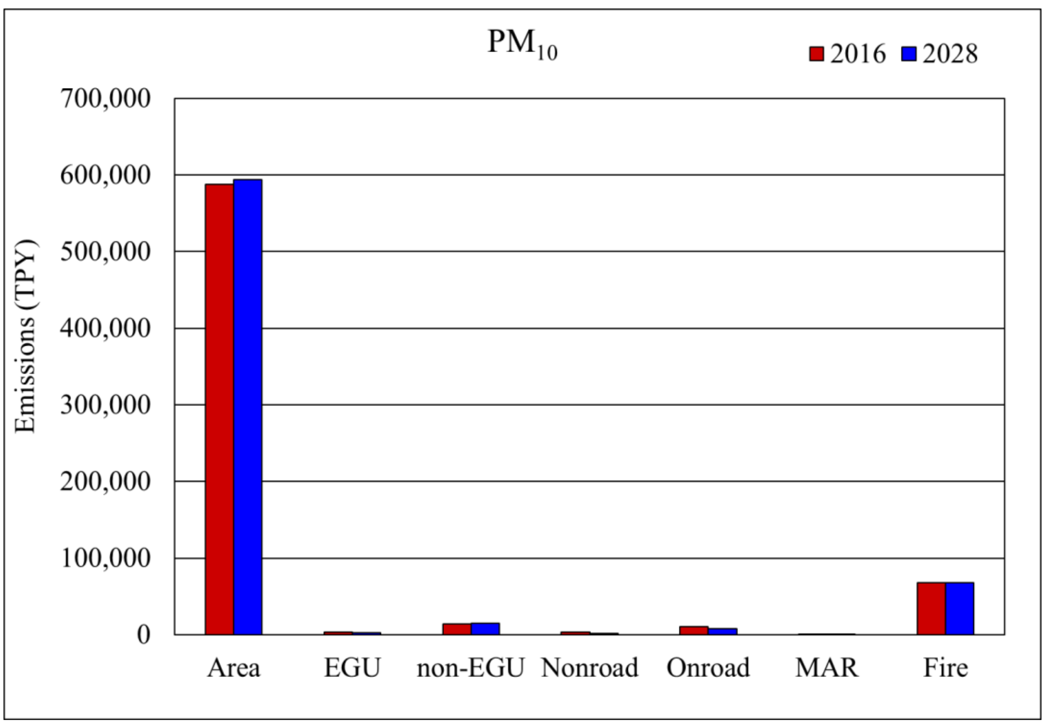


Figure 16.26: PM_{10} Emissions Trends in Georgia, 2016-2028

For the PM_{10} emissions, Area Sources are the highest contributing sources. Levels of emissions are expected to remain about the same level from 2016 to 2028, around 590,000 TPY.

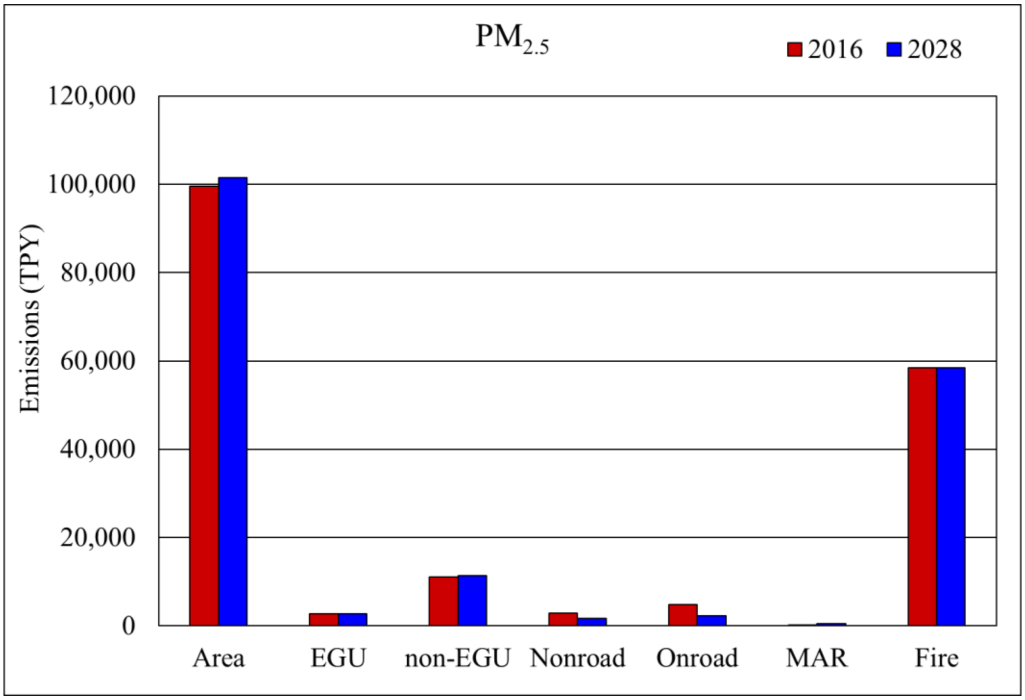


Figure 16.27: $PM_{2.5}$ Emissions Trends in Georgia, 2016-2028

The majority of the $PM_{2.5}$ emissions are from Area Sources and Fires. Both sources are significantly higher than the other sources, with emission levels at about 100,000 and 60,000 TPY, respectively. $PM_{2.5}$ emission levels from all source types are expected to remain about the same from 2016 to 2028.

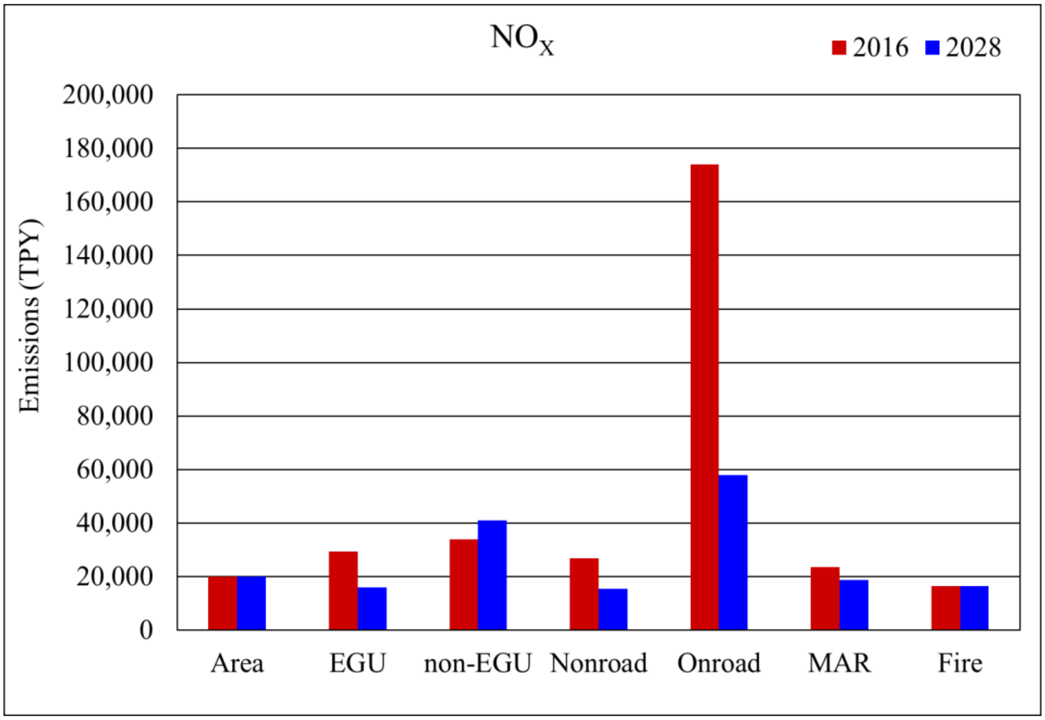


Figure 16.28: NOx Emissions Trends in Georgia, 2016-2028

Onroad emissions are the largest contributors to NO_X pollution in Georgia. There is an expected dramatic decrease of almost two-thirds, from about 175,000 to 60,000 TPY, from 2016 to 2028.

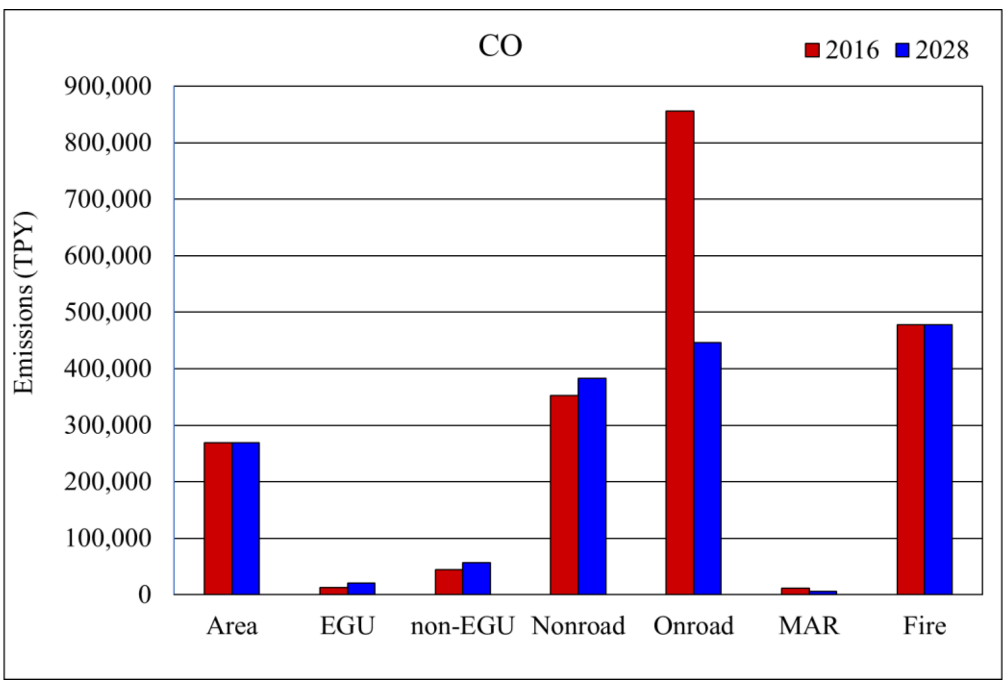


Figure 16.29: CO Emissions Trends in Georgia, 2016-2028

As can be seen in the above graph, the largest levels of CO emission in Georgia are from Onroad emissions, with about 855,000 TPY in 2016. However, those Onroad emission levels are expected to show a decrease of about half that level by 2028, and drop to about 450,000 TPY.

17.0 Meteorological Assessment

17.1 State Climatology and Meteorological Summary for 2014 through 2018

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 2014

Meteorological Summary – 2014

The climate across North and Central Georgia varies based on a variety of factors, the most prominent of which is terrain. The typical climatology of North Georgia, excluding the Northeast Georgia Mountains, includes warm and humid summer months, and mild winters with interspersed cold spells. Central Georgia has a similar climatology, with summer high temperatures in the lower 90's and winter lows averaging in the middle 30's. Average rainfall ranges from 45-75 inches in the state, with March generally being the wettest month and September and October averaging as the driest months. The average temperature across the entire state for 2014 was 63°F, only -0.4 degrees cooler than average, but the coolest year since 2010. Rainfall amounts were 1.27" (inches) above normal for the state.

The year began on a cold note when an arctic blast broke decades of previous temperature records. Statewide, the monthly mean temperature was 40.1°F, which was 6.8°F below the average of 46.9°F. It ranked as the 6th coldest January for the state since records began in 1895. January was characterized by colder and drier than normal conditions, frequent cold-air outbreaks, and a few wintry precipitation events. Monthly average temperatures were well below normal statewide, with the greatest departures found across the north and west. Temperatures dropped to record lows on the 6th and 7th of the month, in association with an upper level longwave trough that pushed a strong arctic front into the Southeastern U.S. This front was also accompanied by gusty winds, some up to 30 miles per hour (mph), which caused wind chill indices to reach close to zero over parts of north and central Georgia. Daily minimums on the 7th ranged from near -5°F in the northern mountains to near 20°F along the immediate coast. Several daily minimum temperature records were established on the 7th. Many climate locations also established new daily low maximum records on the 7th as well. After a brief mid-month warm-up, cold temperatures returned on the 21st and continued for the remainder of the month. Macon established a new record low of 13°F on the 25th (breaking the old record of 16°F set in 1963).

Precipitation was typically below average across the state in January, with the exception of the southeast coast where departures were two to three inches above normal. Accumulating snowfall occurred in the far northern portions of the state on the 5th and 6th and again on the 21st and 22nd. Trace amounts were reported as far south as Atlanta in both cases.

Location	January Precipitation (in.)	Departure from Norm
Athens	4.68	+0.63
Atlanta	3.35	-1.01
Augusta	2.48	-1.43
Macon	3.23	-1.01
Savannah	2.41	-1.28

Figure 17.1. Precipitation in January 2014

A significant winter storm affected much of the state on the 28th and 29th with accumulating snow and freezing rain. An advancing arctic front moved into the area on the 27th, with freezing temperatures being recorded across much of the state by the evening of the 28th. A shortwave then began spreading moisture into the area, resulting in a mixture of snow, freezing rain, and sleet. Snow totals of up to 3-4" throughout the state and ice accumulations of up to 0.4-0.5" were reported south of Atlanta by the 29th. The combination of very cold temperatures, accumulating snowfall, and workday-hours onset resulted in abysmal travel conditions in and around Atlanta.

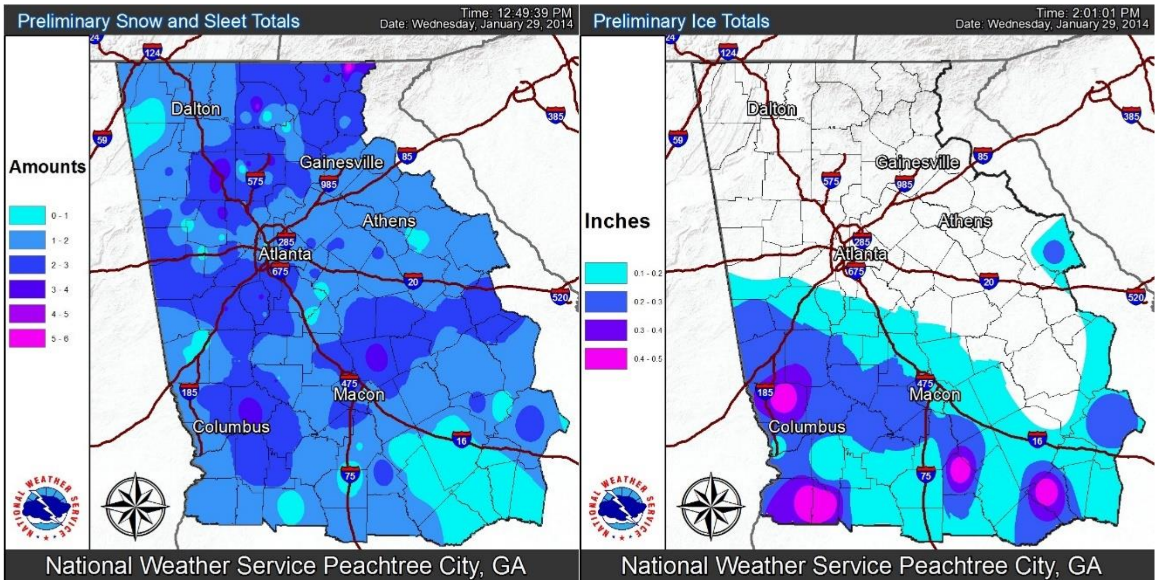


Figure 17.2. Snowfall January 2014

The month of February proved to be relatively mild with regard to precipitation and temperature across the state. The average statewide temperature of 49.8°F was 1.2°F above the 20th century average of 48.6°F, making it the warmest February since 2012. Most major climate sites across the state saw near-normal average temperatures. Athens recorded 47°F (-0.2), Macon's average temperature was 49.4°F (-0.6), Columbus recorded 50.8°F (-0.3), and Savannah's average temperature was 55.2°F (+2.2). Several record high temperatures were set throughout the month, including a record high of 74°F in Atlanta on February 2nd (breaking the old record of 73 set in 1986). A record high of 82°F was also set on the 2nd at Augusta, which tied the old record of 82°F set in 1991. Rainfall amounts were, on average, below normal across much of the state. The statewide average precipitation was 4.04", -0.47 below the 20th century average of 4.51". Areas in the Northeast and Southeast experienced the most dryness, with Brunswick and Alma in Southeast Georgia falling almost 2" below normal rainfall.

Two significant weather events occurred at the beginning and end of the month. A powerful storm brought heavy snow and record levels of ice to north and central Georgia on February 11-13th. Then, a cold front moved through the state on the 21st, spawning severe weather with that system. The National Weather Service (NWS) in Peachtree City (FFC) confirmed an EF-2 tornado with maximum winds of 125 mph struck Laurens and Johnson counties.

March crept in with cooler and drier-than-average conditions. The average statewide temperature for the month was 52.9°F, which was -2.5°F below the average of 55.4°F. Precipitation totals were only -0.64" below the average of 5.06" statewide. April began on a much more active note with a strong storm system moving through north and central Georgia on the 6th and 7th. Over a 48-hr period, widespread 2-4 inches of rain fell across North Georgia and parts of West Central Georgia. The higher rainfall amounts caused many rivers to reach flood stage, according to the NWS at FFC. In addition to the flooding, an EF-1 tornado was confirmed in Spalding County on the 7th. Another severe weather event later in the month spawned an EF-2 tornado in Troup and Heard counties on the 28th. The NWS also confirmed an EF-1 tornado in Whitfield County with that system on the 28th, with a peak wind of 97 mph.

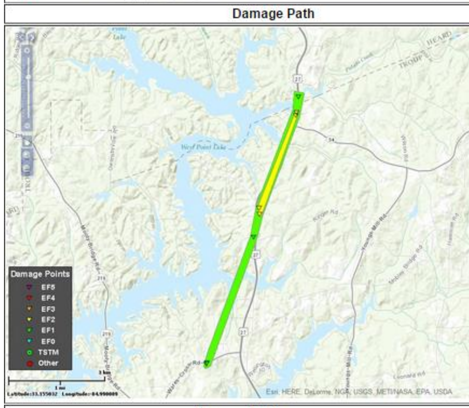
Damage Path

County	Rating	# of Injuries	KML
Spalding	EF-1	3	

Rating: EF-1
Peak Wind: 95 MPH
Path Length: 0.94 MILES
Path Width: 150 YARDS
Fatalities: 0
Injuries: 3

Start Date: APRIL 7 2014
Start Time: 9:50 PM EDT
Start Location: 8 MILES NW OF GRIFFIN
Start Lat/Lon: 33.3025/-84.3850

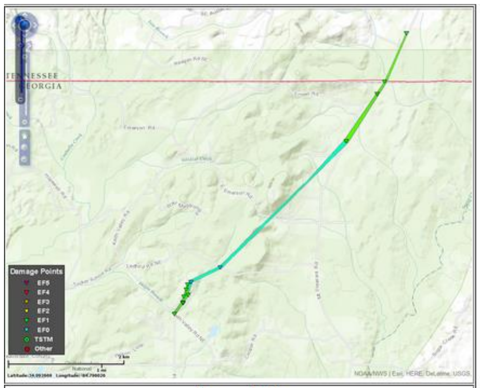
End Date: APRIL 7 2014
End Time: 9:52 PM EDT
End Location: 4 MILES SSE OF WOOLSEY
End Lat/Lon: 33.3086/-84.3705



Damage Path

County	Rating	# of Injuries	KML
Troup/Heard	EF-2	0	

Rating: EF-2
Peak Wind: 120 MPH
Path Length: 5.5 MILES
Path Width: 150 YARDS
Fatalities: 0
Injuries: 0
Start Date: APRIL 28, 2014
Start Time: 7:00 PM EDT
Start Location: 2 MI NE WARES CROSSROADS
Start Lat/Lon: 33.1220/-85.0556
End Date: APRIL 28, 2014
End Time: 7:10 PM EDT
End Location: 3 MI NE HARRISONVILLE
End Lat/Lon: 33.2000/-85.0247



Damage Path

County	Rating	# of Injuries	KML
Whitfield	EF-1	0	

Rating:	EF-1
Peak Wind:	97 MPH
Path Length:	3.4 MILES
Path Width:	100 YARDS
Fatalities:	0
Injuries:	0
Start Date:	APRIL 28, 2014
Start Time:	11:05 PM EDT
Start Location:	5 Miles E of Cohutta
Start Lat/Lon:	34.9510/-84.8718
End Date:	APRIL 28, 2014
End Time:	11:10 PM EDT
End Location:	4 Miles WNW of Gregory
End Lat/Lon:	34.9876/-84.8321

Figure 17.3. Tornado Pathways, April 2014

The month of May saw near normal, to slightly above normal, precipitation across the majority of the state. Areas of North Georgia and western parts of the state fell slightly below average in rainfall. Temperatures averaged one to three degrees above average in areas of North and Central Georgia, with below average temperatures in the southwest. Another round of severe weather caused an EF0 tornado to touch down in Dodge County on the 14th of the month, and an EF-1 in Banks County on the 15th. No injuries or deaths occurred as a result of either tornado.

The summer months proved to be slightly cooler than normal and two to four inches drier than normal across the majority of locations, according to the NWS at FFC. June was warmer than normal, with July and August averaging cooler than normal temperatures. August also averaged drier than normal, with Macon and Columbus experiencing the 2nd and 6th driest months on record, respectively. Climatologically, the Fall season is one of the driest periods for the region. September experienced mostly above normal temperatures and below normal precipitation across North and Central Georgia. Interestingly, a NWS survey team determined that downburst winds estimated between 70 and 80mph caused damage at Henry County Airport on the 7th. Several planes were destroyed and others damaged as a result of those winds.

October was characterized by warmer than normal temperatures and below normal rainfall across eastern parts of the state, with above normal rainfall in the north and west. The month began with severe weather and subsequently cooler temperatures. A strong shortwave and associated cold front moved across the state, causing Atlanta, Athens, and Macon to set record low daily maximum temperature records of 65°, 66° and 69°F on the 4th, respectively. Record low temperatures continued as Athens set a record low of 38°F and Macon 37°F on the 5th. Alma tied a record low of 45°F on the 6th. A persistent longwave trough remained across the eastern U.S. with disturbances in the flow setting off a round of severe weather on the 6th. The NWS at FFC recorded an EF-1 tornado just north of Ringgold at approximately 7:40 P.M. EDT on the 6th. A warm spell occurred from the 9th through the 13th with temperatures in central and southern areas reaching into the 80's and lower 90's. Numerous record high temperatures were set across the state. A persistent ridge of high pressure at the end of the month propelled temperatures to record warmth once again.

November proved to be relatively cool on average across the state. The average statewide temperature of 49.8°F was -4.4° below the 20th century average of 54.2°F, making it the 4th coolest November on record and the coolest November since 1976. Macon experienced its coldest average November minimum temperature on record of 34.5°F, which was -8.5° below the average. Athens and Columbus both experienced their 4th coolest November on record. The month began on a cool note as wraparound moisture and freezing temperatures behind a strong upper level low allowed areas of North Georgia to receive their first snow of the season on November 1st. Macon and Brunswick then set record low temperatures on the 2nd with 29°F and 38°F, respectively. The record low temperatures continued through the month as Athens, Columbus, and Macon were among sites that set record low temperatures on the 19th with 20°, 21°, and 17°F, respectively. Augusta also dipped to 15°F on the 19th, which broke the existing record of 22°F set in 2008.

November Avg. Temperature (°F) and Rankings – ***Courtesy of NWS at***

Site	Avg. Temp. and Current Ranking	Normal	Dep. from Normal	Previous Records
Athens	48.1 (4th Coolest)	53.8	-5.7	46.4 (1951)
Atlanta	49.0 (16th Coolest)	54.0	-5.0	44.2 (1976)
Columbus	50.8 (4th Coolest)	57.3	-6.5	48.7 (1976)
Macon	49.2 (#1 Coolest)	55.9	-6.7	49.3 (1901)
Cartersville	45.6	51.3	-5.7	
DeKalb Peachtree Arpt	46.6	52.7	-6.1	
Fulton Co. Arpt	47.0	53.0	-6.0	
Gainesville	47.3	52.6	-5.3	
Peachtree City	47.2	52.7	-5.5	
Rome	45.7	50.9	-5.2	

Figure 17.4. November 2014 Average Temperatures

Average precipitation statewide was 4.37", a departure of +1.50 above the average. Periods of severe weather spawned several tornadoes across the state. A NWS survey determined an EF-1 tornado touched down in Twiggs County on November 17th. Another round of several weather associated with a strong storm system on the 23rd produced four tornadoes and a straight line wind event over Troup County, according to the NWS in Peachtree City. The year ended with a warmer and wetter than average December across many climate sites.

17.1.2 2015

<u>Meteorological Summary – 2015</u>

The climate across North and Central Georgia varies based on a variety of factors, the most prominent of which is terrain. The Gulf of Mexico and the Atlantic Ocean are the two nearby maritime bodies that exert an important influence on the North Georgia climate, acting as major sources of moisture support. The typical climatology of North Georgia, excluding the Northeast Georgia Mountains, includes warm and humid summer months, and mild winters with interspersed cold spells. Central Georgia has a similar climatology, with summer high temperatures in the lower 90's and winter lows averaging in the middle 30's. Average rainfall ranges from 45-75" (inches) in the state, with March generally being the wettest month and September and October averaging as the driest months. The average temperature across the entire state for 2015 was 65.3°F, which ranked 3rd warmest on record behind a tie for 1st and 2nd warmest. Rainfall amounts were 5.66" above normal for the state.

The year began on a relatively quiet note during the month of January with near normal temperatures and below normal precipitation across much of the state. The average statewide temperature of 45.1°F was -1.0°F below the 20^{th} century average of 46.1°. Temperatures averaged below normal for many of the major climate sites, including Atlanta, Athens, Columbus and Macon which fell -0.2°, -1.6°, -1.4°, and -2.2° below normal, respectively. Rainfall amounts varied across the state. Savannah reported a daily rainfall record of 1.89” on the 12^{th}. An area of low pressure moved across the southern portion of the state during the latter half of the month, leading to 24-hour rain totals of over an inch and a half across Columbus and Macon during the period of the 22^{nd} – 23^{rd}.

Several tornadoes and scattered wind damage were reported ahead of a strong cold front that pushed through the state on January 4^{th}. Two EF-1 tornadoes in Tift County, one EF-1 tornado in Dodge County, and one EF-1 tornado in Chatham County were reported. Due to severe damage to mobile homes, two injuries were associated with an EF-1 tornado reported in Bacon County east of the city of Alma. Pulaski County reported two EF-0 tornadoes as well.

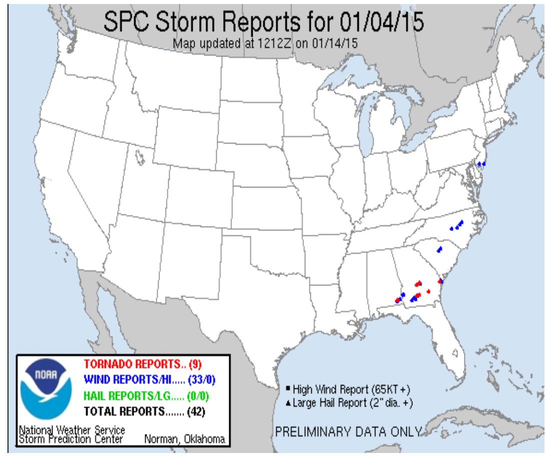


Figure 17.5. Storm Reports, January 4, 2015

The month of February was characterized by below-average temperatures and variable precipitation. Most locations received relatively normal precipitation amounts. A low pressure system moved through on February 16^{th} spreading precipitation throughout the state. This combined with a wedge of cold air to cause a significant ice storm in parts of northeast Metro Atlanta and points to the north and east. Ice totals reached up to 0.5” in some areas, and by the morning of February 17^{th}, more than 200,000 people were without power. Extensive damage to trees and power lines was reported as well. An Arctic air mass pushed into the state and caused record-breaking cold temperatures at many locations on February 20^{th}. Following this cold outbreak, sufficient moisture surged into north Georgia to cause snow, sleet, freezing rain, and hazardous road conditions on the night of February 20^{th} and the morning of the 21^{st}. The precipitation impacted Metro Atlanta and further north, with totals up to 2” in extreme northwest Georgia. On February 25^{th}, Georgia saw more winter weather impacts in the northern portion of the state. A strong system brought plentiful moisture to the area, resulting in a heavy snowfall event in north Georgia, a heavy and wet mix of snow, sleet, and freezing to northern Metro Atlanta, and cold, heavy rain in the southern portion of the state. Areas in the north received 7” to 10” of snow.

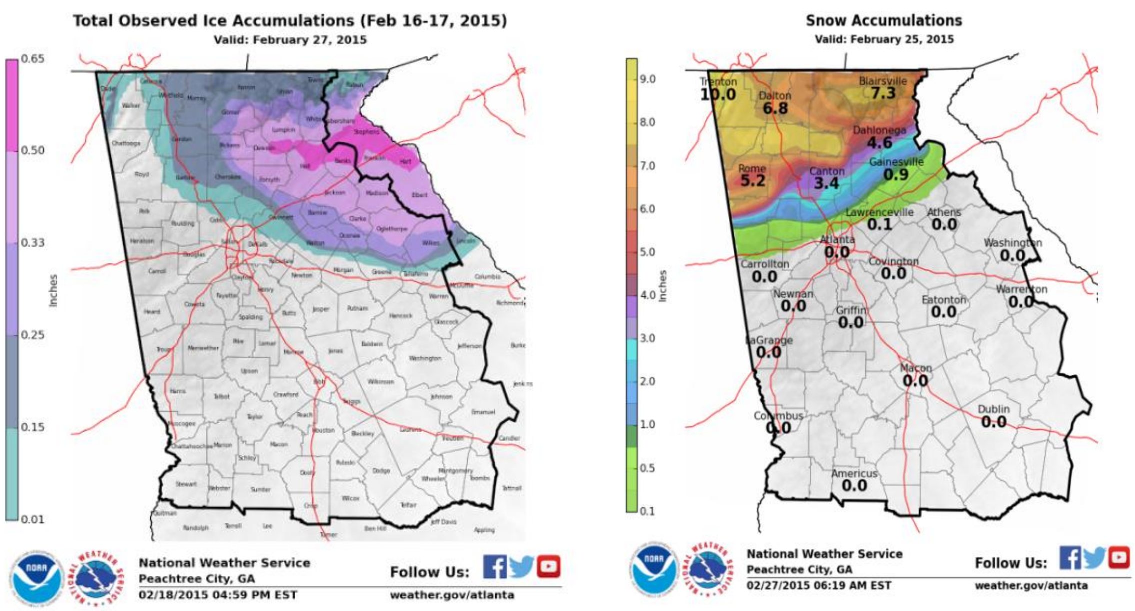


Figure 17.6. Ice and snow accumulations, February 2015

Georgia experienced above average temperatures and below average precipitation for March. The month was characterized by large temperature swings and an active long-wave pattern as the state transitioned into the Spring season. The average temperature for Georgia during the month of March is typically 55.4°, though the majority of the state exceeded that average. Atlanta's average temperature of 57.6°F was 3.3° above normal. At 56.8°, the average temperature in Athens was 2.5° above normal. Athens also recorded a record high temperature of 87° on March 16th, breaking the previous record of 85° set in 2012. Most locations in Georgia recorded below average precipitation; however, no precipitation records were broken for the month. The month of March was abnormally quiet in terms of severe weather, with a few cold air damming events. In fact, it was the first time on record that no tornadoes were reported for the month of March.

April was characterized by warmer than normal temperatures and wetter than normal conditions throughout Georgia. The month was more active than March in terms of severe weather, with two different significant events causing damaging wind, hail, and a few tornadoes. On April 3rd, an EF-1 tornado associated with strong convection ahead of a fast-moving cold front was reported in Dade County, causing limbs and trees to fall. April 19th and 20th were both active severe weather days across north and central Georgia. A weak shortwave moved through on the morning of the 19th and caused one EF-2 tornado (Burke County), three EF-1 tornadoes (Chattahoochee, Sumter, and Laurens Counties), one EF-0 tornado (Coffee County), and widespread wind damage across northwest and central Georgia. On the 20th, a cold front pushed through the state. Wind damage and widespread hail were reported across the northern Metro Atlanta area.

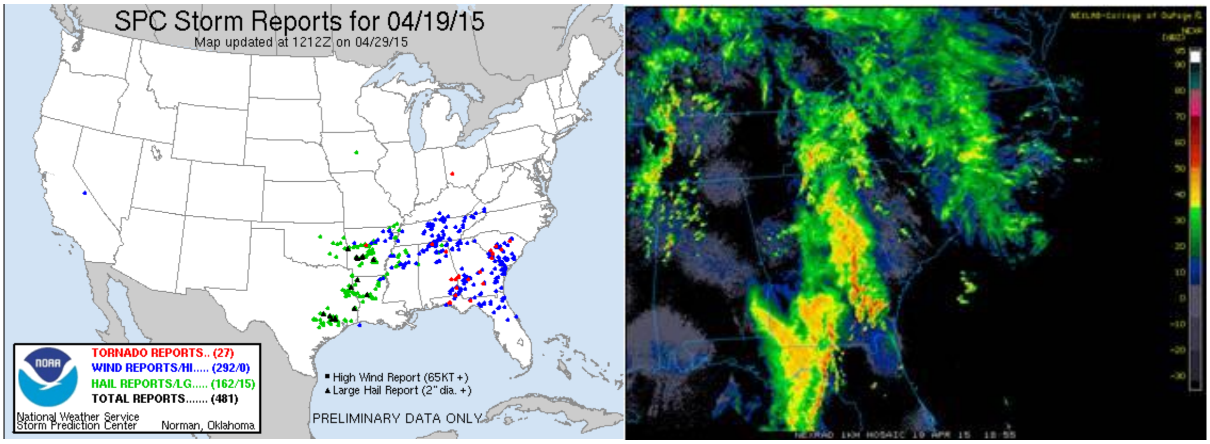


Figure 17.7. Wind and tornado reports, April 2015

The month of May began drier than normal, and many locations in Georgia only recorded trace amounts of rainfall in the first half of the month. By the end, most major climate sites recorded below normal precipitation except for Atlanta and areas along the Georgia-Alabama border. Temperatures were above normal for the majority of the state. The summer months were relatively quiet with a typical summertime pattern of hot temperatures and near normal precipitation for many areas. A prevailing high pressure ridge settled over the southeast for much of the month of June, allowing for above average temperatures and near normal precipitation across the state.

While most of the state experienced above normal temperatures in July, Central Georgia was notably drier and hotter with well above normal temperatures and below normal precipitation. Atlanta's average temperature was 81.3°F (+1.1°) and Athens recorded 82.0° (+1.4°), making them both the 13th warmest July on record for those sites. Macon's average temperature was 83.8° (+2.0°), making it the 7th warmest July on record. Macon also tied its record high temperature on July 14th with 101°; the previous record was set in 1977. Dominant high pressure and abundant tropical moisture led to variable temperatures and precipitation during the month of August. Temperatures were very close to normal, and areas that received above normal rainfall generally had slightly cooler than normal temperatures.

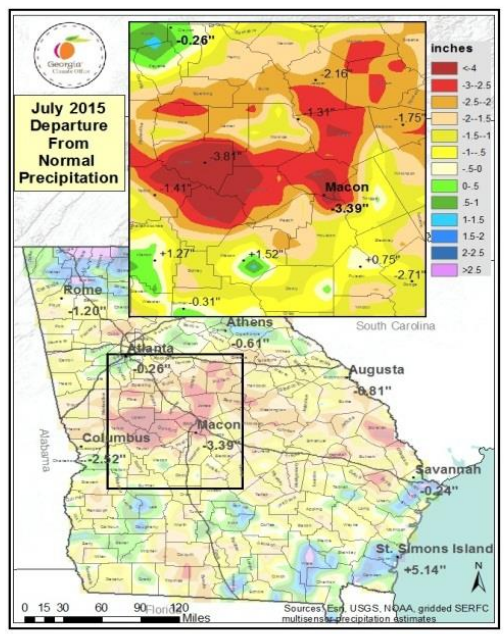


Figure 17.8. Departure from normal precipitation, July 2015

Georgia's cooler than normal temperatures during September, compared to the rest of the country, were a welcome sign of climatological fall. September was characterized by abundant tropical moisture, hybrid cold air damming events, and cold frontal passages, all of which brought cloudy conditions that helped moderate temperatures. Precipitation was variable throughout the state, although the major climate sites generally recorded below normal monthly rainfall totals with the exception of extreme southeast Georgia.

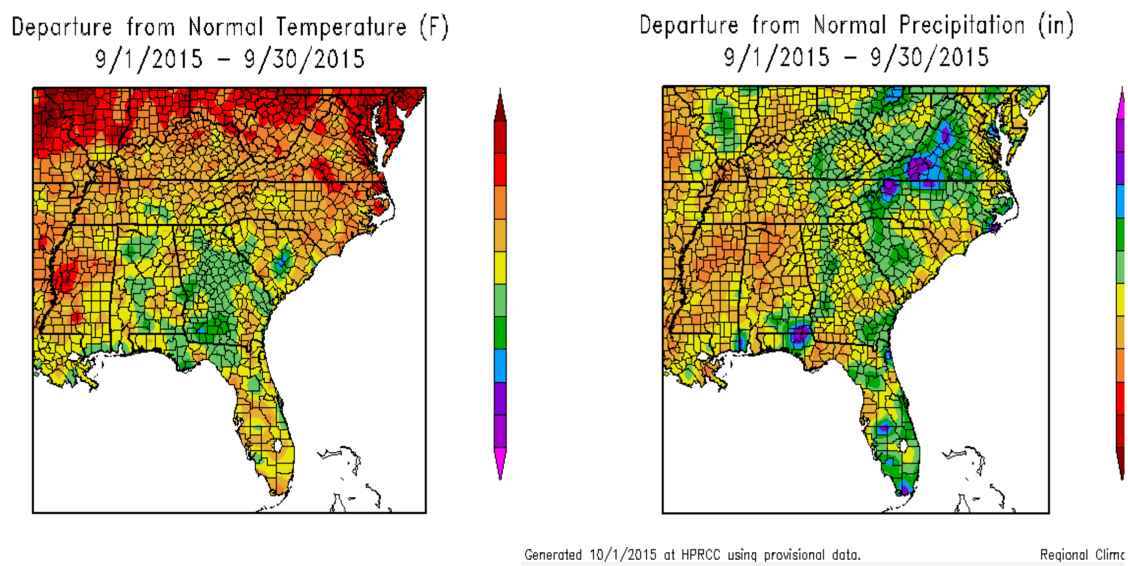
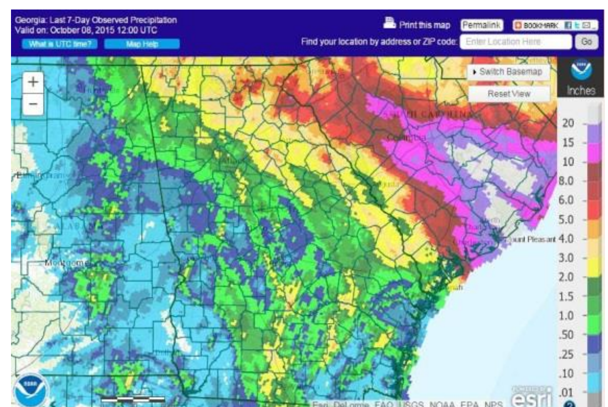


Figure 17.9. Departure from normal precipitation, September 2015

The month of October began on a wet note when a heavy rainfall event linked to Hurricane Joaquin off the Atlantic coast allowed for abundant rainfall in the state, particularly in the northeast. The rest of the month was characterized by cold frontal passages associated with low pressure systems, mild high pressure days, cold air damming events, and another surge of moisture from the Gulf of Mexico at the end of the month. October's mean monthly temperatures throughout Georgia were close to normal. North and northeast Georgia generally received above normal precipitation, while areas in the south and along the coast saw below normal precipitation. Areas that saw more rainfall generally had cooler than normal monthly temperatures due to increased cloud cover; areas receiving less rainfall, and thus less cloud cover, mostly had warmer than normal temperatures this month.



7-day observed rainfall associated with moisture from Hurricane Joaquin.

Figure 17.10. Precipitation from Hurricane Joaquin

November in Georgia was remarkably warmer and wetter than normal. Seven climate sites were ranked in the top ten for warmest average November temperature and six climate sites were ranked in the top ten for total monthly precipitation. A few severe weather outbreaks occurred when low pressure systems brought cold frontal passages and surging moisture plumes to the state. The associated rainfall caused several flooding issues along rivers and in urban cities. Although bouts of high pressure built in behind these weather systems, cloudiness and little radiational cooling kept nighttime temperatures warmer than normal throughout the entire state. According to the Storm Prediction Center, there were three days of severe weather during the month. On the first two days of November, Gulf moisture combined with instability in southern Georgia resulting in strong winds and two brief EF-0 tornadoes in Grady and Colquitt Counties. On the 18th, a strong upper low pressure system and associated surface front brought a squall line of storms across the area. Three tornadoes formed in the bowing segment of the squall line, one in Coweta County (EF-1), Fulton County (EF-1), and DeKalb County (EF-0). Strong winds and heavy rain were reported throughout the Atlanta Metro area.

The year ended on a warm note as a strong polar vortex kept cold air from penetrating southward, allowing most climate sites to experience their warmest December on record. Atlanta, Athens, Macon, Columbus, Augusta, St. Simons Island, Savannah, Valdosta, Alma, and Gainesville all had their warmest Decembers on record with 57.6° (+12.3°), 56.4° (+11.0°), 58.6° (+10.6°), 59.1° (+10.0°), 59.3° (+12.1°), 64.6° (+10.5°), 64.2° (+12.5°), 64.5° (+11.4°), 63.4° (+10.8°), and 55.0° (+11.3°), respectively. Several sites also had their wettest December on record, including Athens with 12.37” (+8.64”), Macon with 12.62” (+8.58”), and Columbus with an incredible 17.38” (+13.11”). Atlanta had its second wettest December on record with 12.51” (+8.61”).

17.1.3 2016

<u>Meteorological Summary – 2016</u>

The majority of locations in North and Central Georgia were much warmer than normal and drier than normal during 2016. A winter weather event impacted much of North Georgia from January 22nd through January 23rd, with light snow accumulations as far as south central Georgia. Several locations experienced record, or near-record, seasonal summer temperatures. Atlanta also experienced the 1st warmest Fall on record.

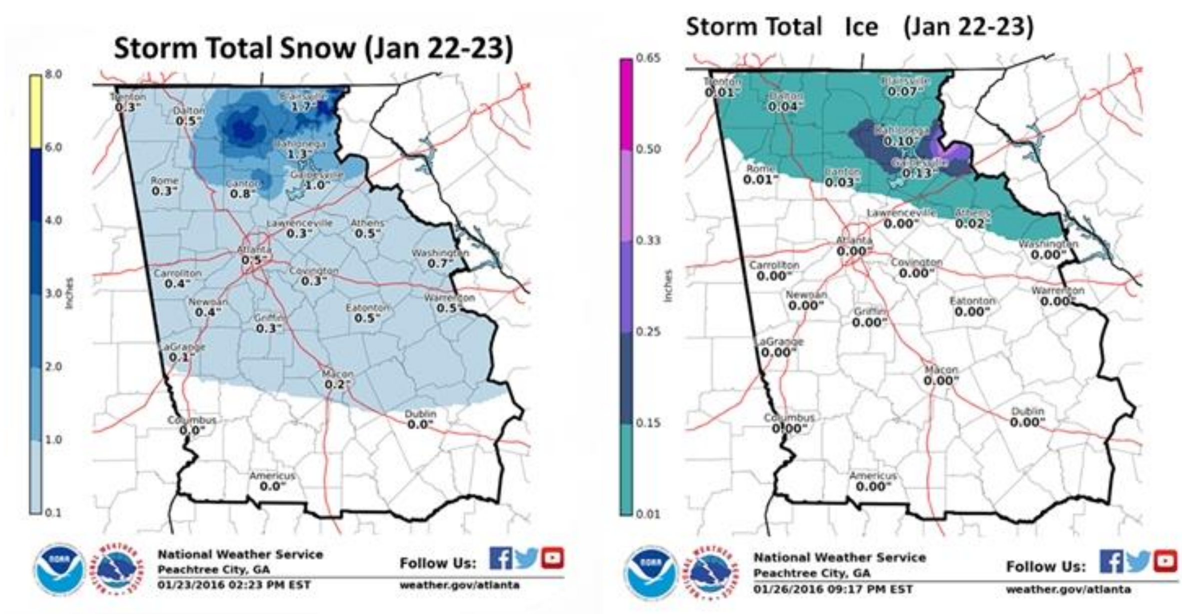


Figure 17.11 Total Snow and Ice, January 22-23, 2016

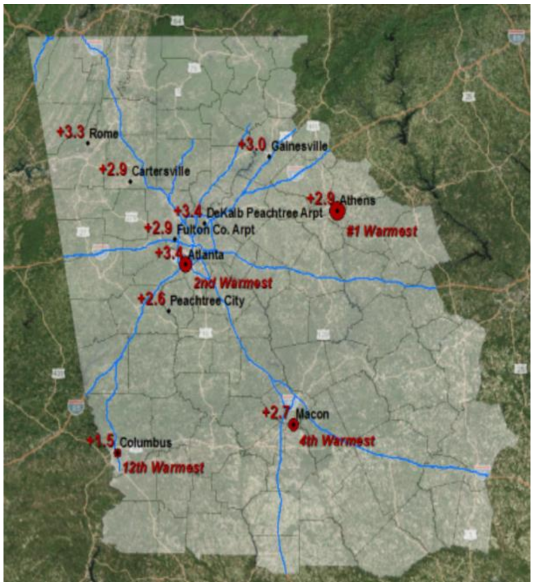


Figure 17.12. Seasonal Avg. Temperature (°F) and Rankings for Jun-Aug *(National Weather Service at Peachtree City)*

Site	Avg. Temp. and Current Ranking	Normal	Dep. from Normal	Previous Records
Athens	67.4 (2nd Warmest)	63.4	+4.0	69.4 (1931)
Atlanta	69.1 (#1 Warmest)	63.6	+5.5	67.8 (1931)
Columbus	70.3 (5th Warmest)	66.8	+3.5	72.1 (1919)
Macon	68.6 (4th Warmest)	65.3	+3.3	69.4 (1985)
Cartersville	65.9	61.1	+4.8	
DeKalb Peachtree Arpt	66.8	62.5	+4.3	
Fulton Co. Arpt	66.6	62.8	+3.8	
Gainesville	66.7	62.0	+4.7	
Peachtree City	65.9	62.1	+3.5	
Rome	66.6	61.3	+5.3	

Figure 17.13. Seasonal Avg. Temperature (°F) and Rankings for Sept. – Nov. *(National Weather Service at Peachtree City)*

<u>Drought Summary</u>

The Northeast Alabama, Northwest Georgia, and Southern Tennessee core drought area started showing noticeable rainfall deficits in March 2016. East central Georgia saw rapidly degrading conditions in early summer 2016. Newer core emerged south of Macon area that began in early fall 2016, and expanded towards south Georgia along I-75, and along the Alabama/Georgia border. Drought led to North Georgia wildfire activity and air quality issues in mid-November 2016.

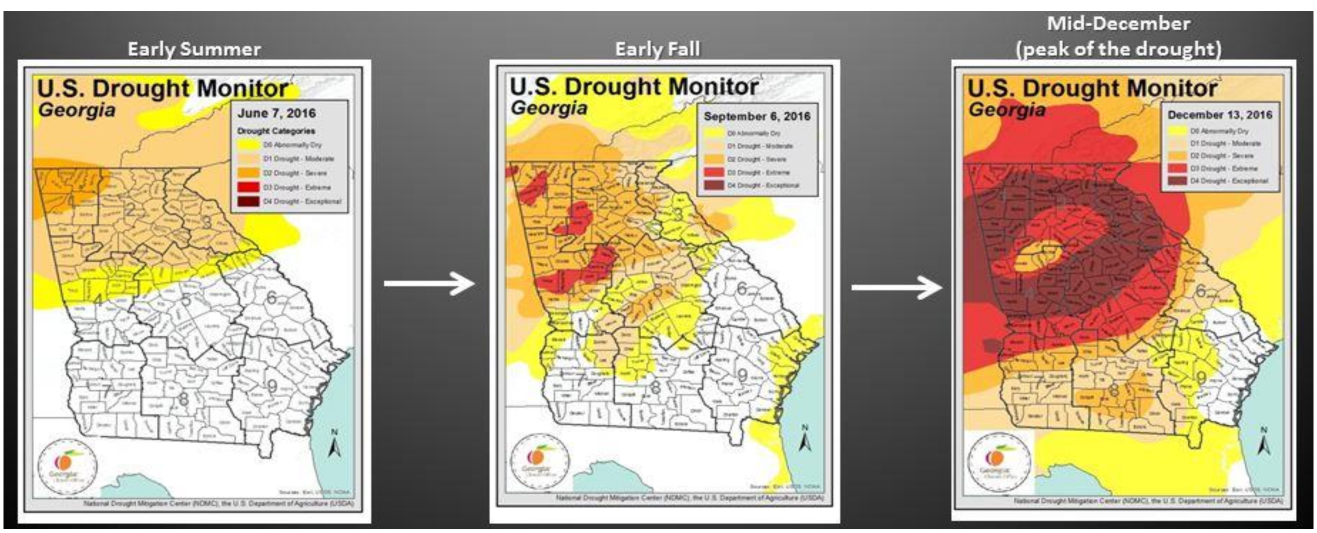


Figure 17.14. Drought Monitor, June through December, 2016

Agricultural Impacts

Agricultural impacts were widespread and devastating to farmers, who described extremely dry pastures, bringing in hay from out of state with no second cutting, losing their entire corn crop and feeding it to livestock, noticing ribs showing on lactating cows, and inability to plant winter grazing.

Figure 17.15. Drought Conditions, 2016

Meteorological Instruments

A complete suite of meteorological instrumentation is used to characterize meteorological conditions around Metro Atlanta. A ceilometer currently runs at the South DeKalb site to monitor the evolution of the morning mixing height and the thickness of the atmospheric boundary layer. A map of the EPD meteorological network, as well sample pictures of various meteorological instruments, is detailed below. Please note that the Confederate Ave. site name was changed to United Ave. Also, the Newnan site was shut down at the end of 2017.

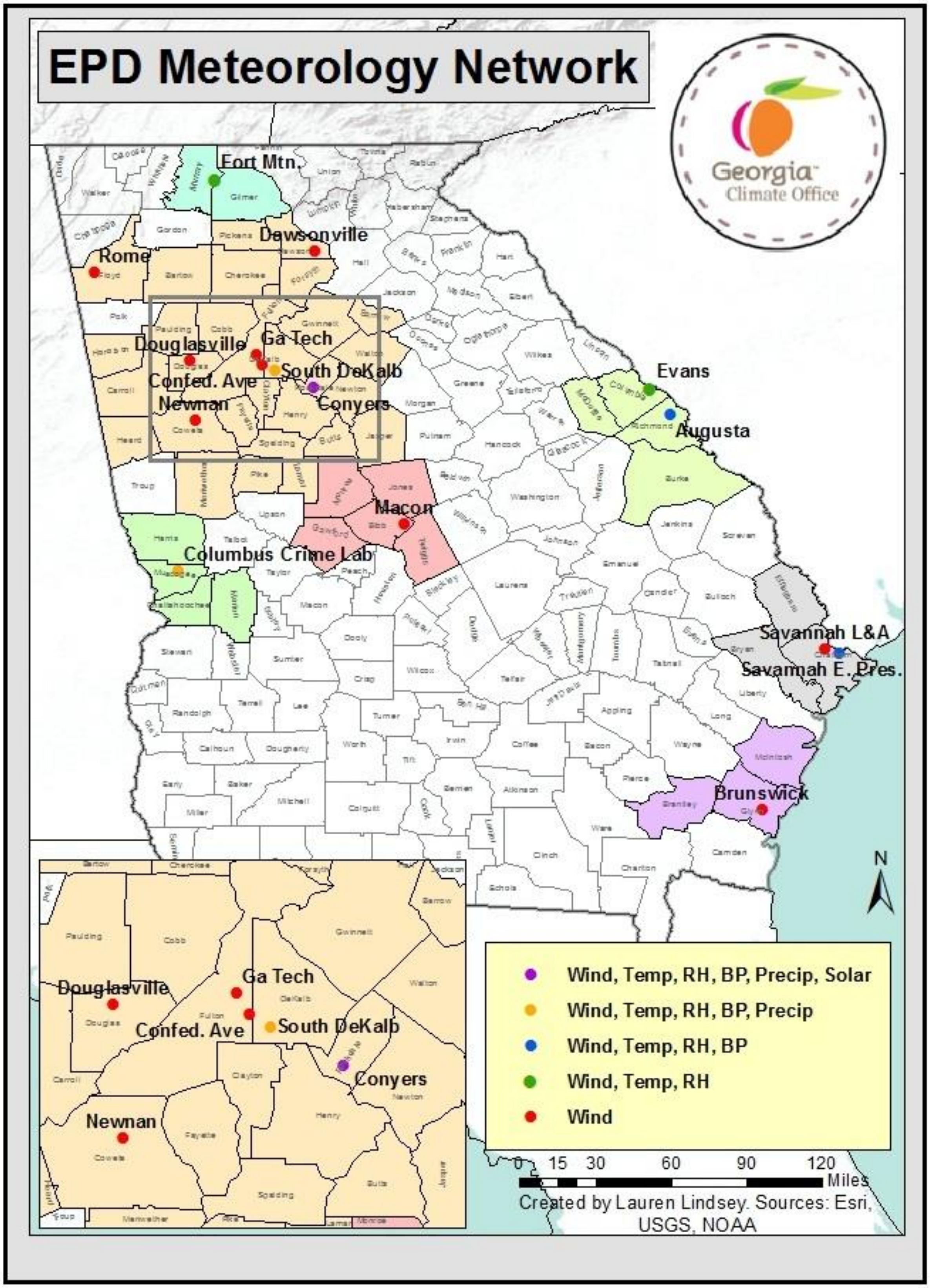


Figure 17.16. Meteorological Stations, 2016

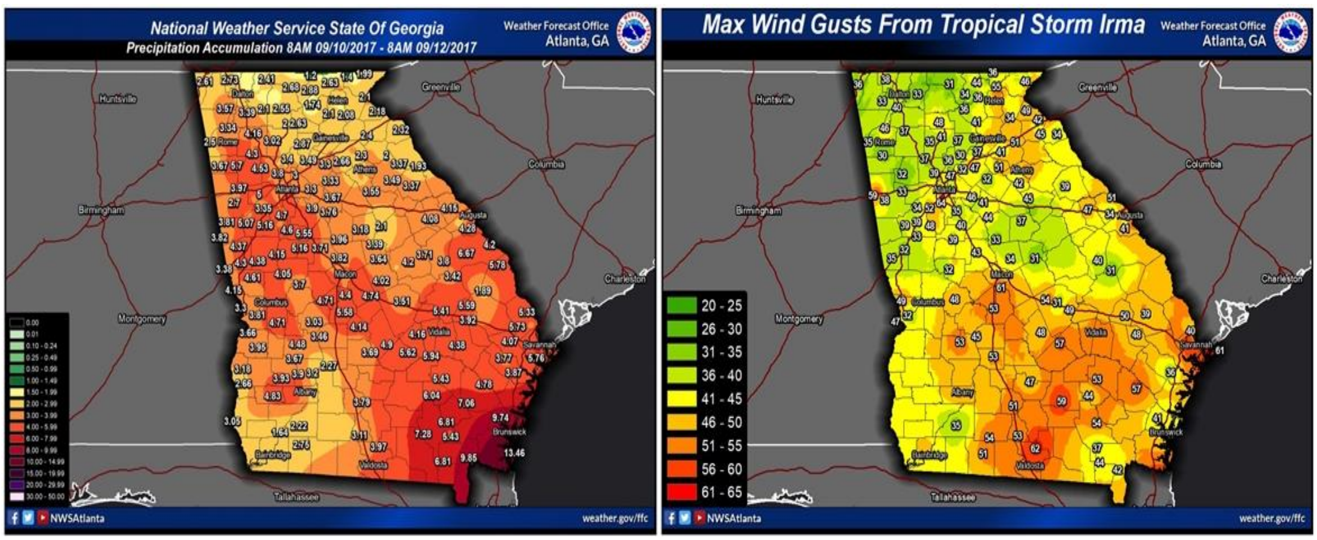
17.1.4 2017

<u>Meteorological Summary – 2017</u>

<u>2017 Climate Highlights</u>

<u>Hurricane Irma</u>

Hurricane Irma made landfall in southwest Florida on September 10, 2017. By the morning of Monday, September 11th, then-Tropical Storm Irma moved into Georgia with a very large wind field containing at least tropical storm force wind gusts (39+mph). The heaviest rainfall totals were confined to far southeast Georgia. Widespread sustained winds of 30-45 mph with gusts in the 50-65 mph range downed numerous trees and power lines across the area.

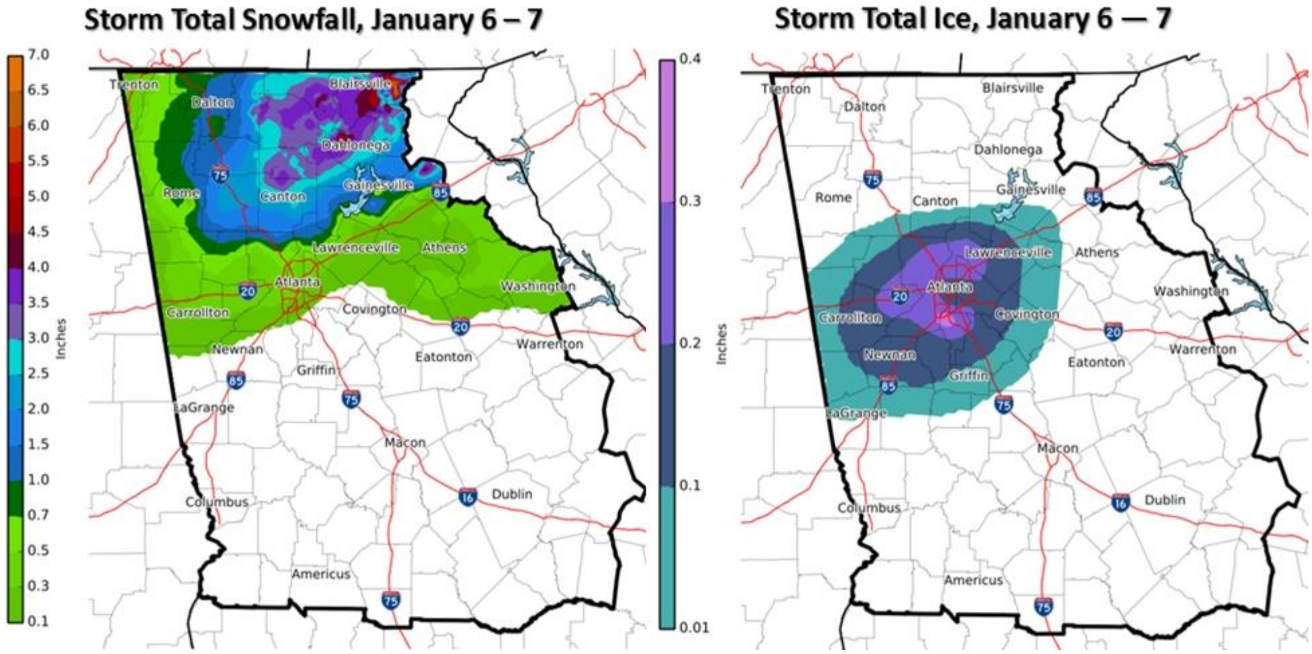


(images and information courtesy of National Weather Service – Peachtree City)

Figure 17.17. Precipitation and Wind Gusts from Tropical Storm Irma, 2017

<u>North Georgia Winter Storm</u>

A winter weather event unfolded across most of north Georgia beginning the evening of Friday, January 6, 2017 and lasted through the morning hours on Saturday, January 7, 2017. The result was several inches of snow across much of north Georgia, with significant freezing rain accumulations up to a quarter of an inch across much of the Atlanta metropolitan area.



(images and information courtesy of National Weather Service – Peachtree City)

Figure 17.18. Total Snowfall and Ice, January 6-7, 2017

Solar Eclipse

A total solar eclipse of the sun was visible within a narrow pathway across the U.S. on August 21st. Parts of North Georgia were within the path of the shadow. There was a noticeable decrease in photochemically-produced ozone detected during the eclipse, as seen in hourly ozone and solar radiation data below.

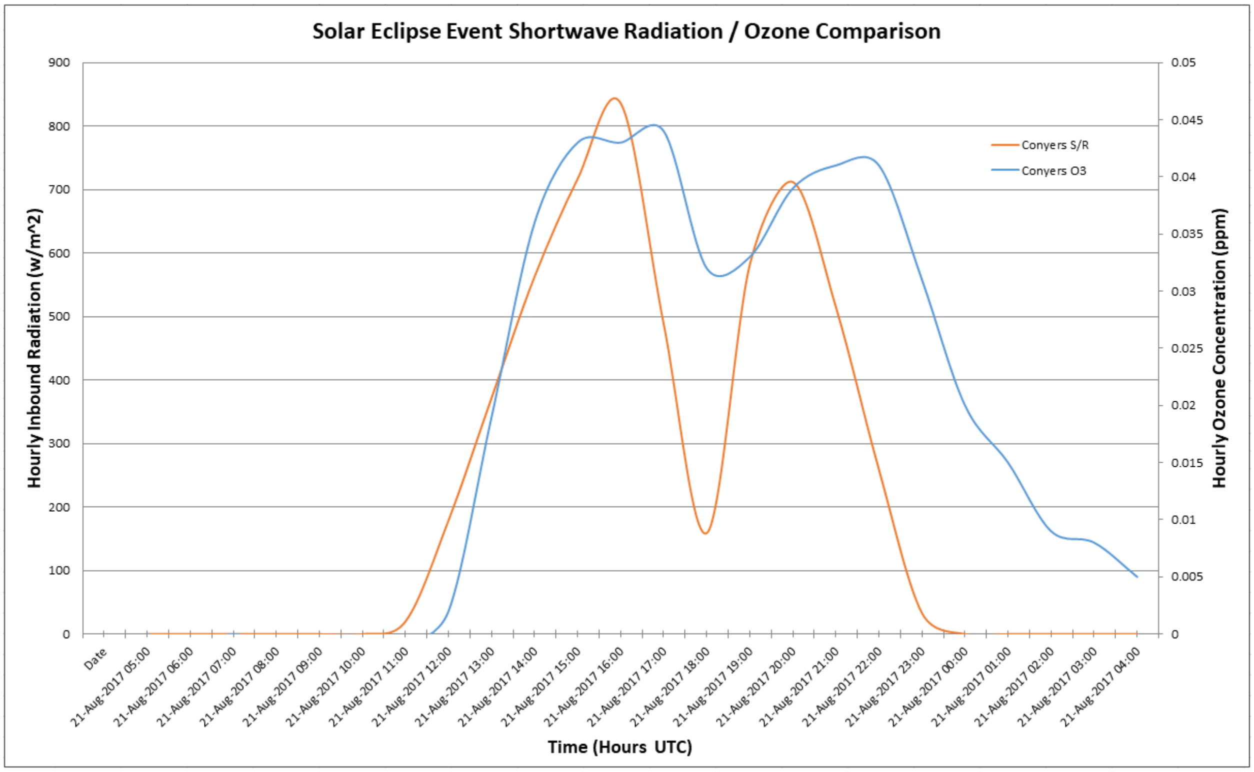


Figure 17.19. Solar Eclipse Radiation and Ozone Comparison, 2017

2017 Drought Conditions in Georgia

From January through March, drought conditions were mostly confined to north Georgia with D3 drought conditions present in north Georgia. Drought conditions migrated southward through mid-June with D3 conditions observed in south Georgia. All drought conditions were eliminated by July 25th . By mid-November, much of south Georgia, and the Atlanta metro area either showed D0 or D1 drought conditions. D1 conditions across south Georgia continued to expand through the end of the year.

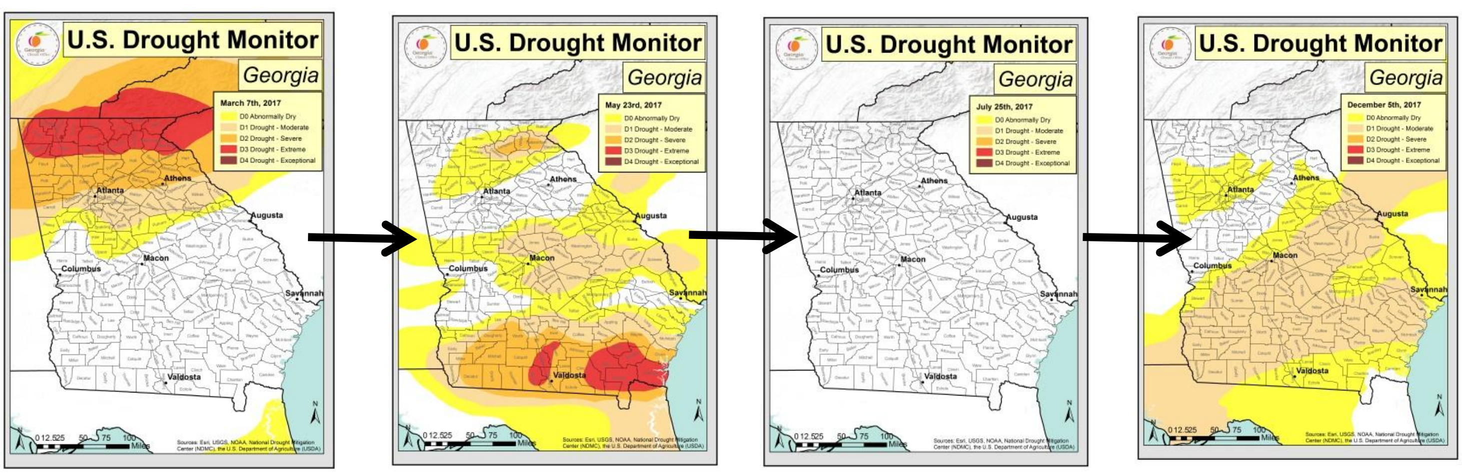


Figure 17.20. Drought Monitor, 2017

Agricultural Impacts

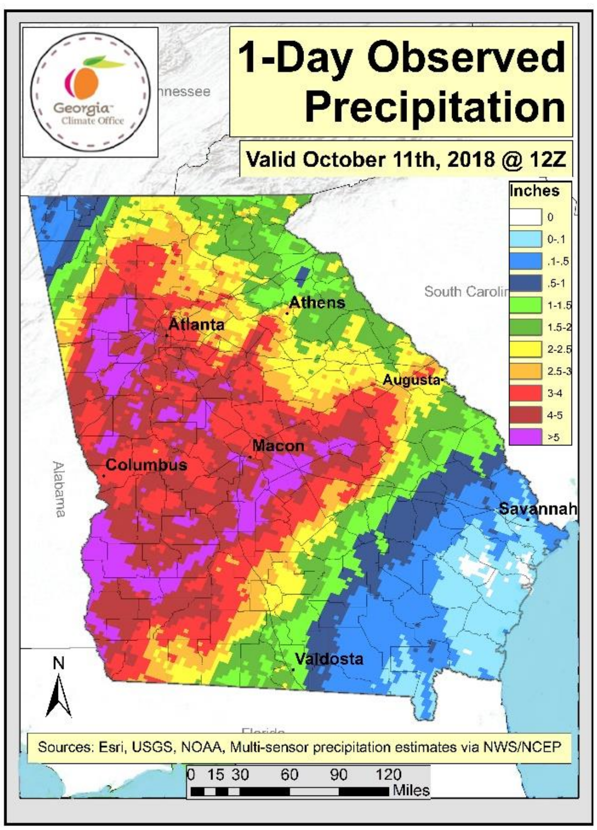
Most of the agricultural impacts were felt in northeast and far south Georgia where drought conditions were most extreme. Much of the peach crop (around 80%) was devastated by a combinations of the warm winter, a late frost, and lingering stress from the La Nina 2016 drought. Critical hay shortage during peak drought conditions – with no hay to harvest, farmers had to import scarce, smaller, and more expensive hay with poorer quality. Numerous reports of reduced amounts of beef and milk produced by livestock, ponds and creeks that were dried up completely, and brush fires.

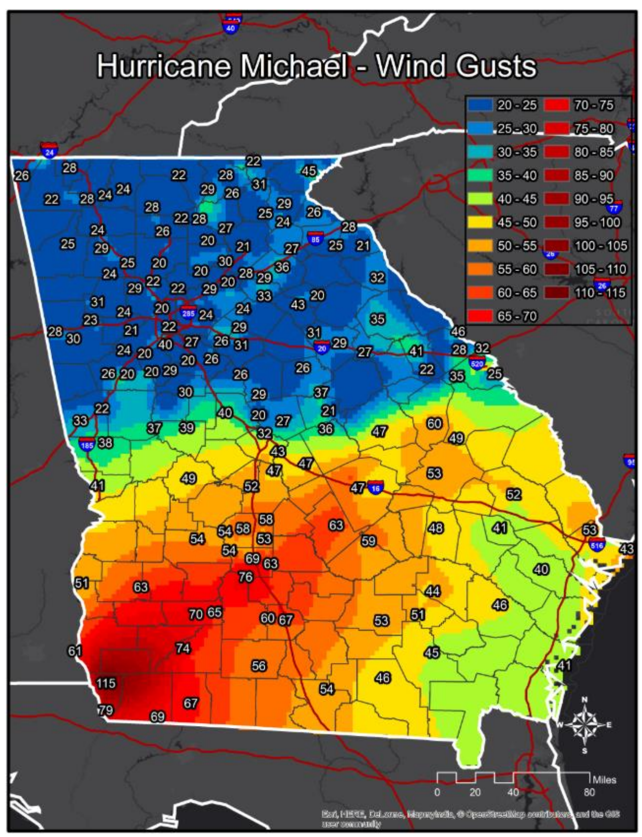
17.1.5 2018

Meteorological Summary – 2018

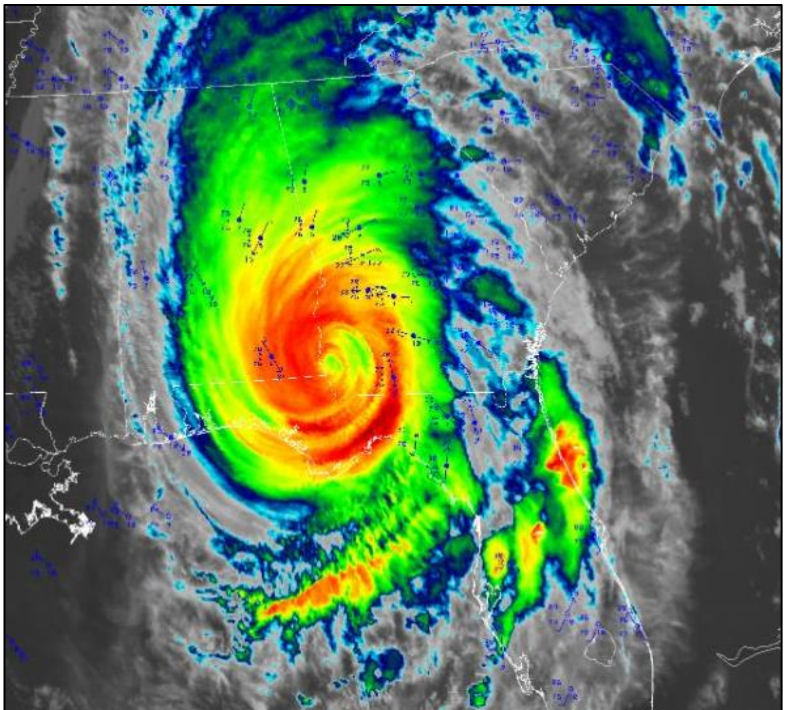
Hurricane Michael

Michael made landfall near Panama City on October 10th as a category 5 hurricane, making it the strongest hurricane to make landfall along the Florida panhandle on record. As Michael weakened to category 3 strength and moved into southwest Georgia, it became the first major hurricane to directly impact the state since the 1890s. The highest wind gust in Georgia was 115 miles per hour recorded in Donalsonville. Michael's outer bands produced 1 EF-1 and 2 EF-0 tornadoes and widespread wind damage causing power outages and crop damage. Rainfall totals reached in excess of 5" in some locations leading to isolated instances of flooding, including a few roads that were washed out.





Maximum Observed Wind Gusts		
Georgia Environmental Protection Division Meteorological Network		
Site Name	County	Wind gust (mph)
Savannah-L&A	Chatham	48.54
Dawsonville	Dawson	42.95
Evans	Columbia	40.04
Douglasville	Douglas	34.40
Columbus-Crime Lab	Muscogee	28.18
NR-GA Tech	Fulton	22.81



This infrared satellite image was taken as Hurricane Michael entered southwest Georgia as it maintained a Category 3 intensity on the evening of October 10, 2018.

Location	Rainfall Total (in.)
7 NE Dallas	5.84
The Rock	5.35
4 NE Newnan	5.07
1 N Carrollton	4.83
1 ESE Sandersville	4.28
3 SW Americus	4.17
Jonesboro	4.15
1 NNE Dublin	3.98
3 S Peachtree City	3.92
3 S Rutland	3.76
Woodbury	3.71
1 N Cartersville	3.52
4 NNE Columbus	3.34
2 NNE Doraville	3.23
2 NNE Cumming	2.75
2 WSW Gainesville	2.50

Rainfall totals associated with Hurricane Michael.

Figure 17.21. Precipitation and Wind Gusts from Hurricane Michael, October 2018

Conditions in Georgia

The year began with D0 (abnormally dry) conditions present in almost 89% of the state, D1 (moderate drought) conditions in the northeast and south, and D2 (severe drought) conditions in far southwest Georgia. D2 conditions expanded northward and a new area of D2 was briefly introduced into northeast Georgia until mid-February when conditions began to improve for all north Georgia. D1 and D2 conditions existed in southeast Georgia until late May. For nearly three months, from June 5th through September 4th, there were no drought conditions present. Small areas of D0 and D1 were then introduced in north, central, and southeast Georgia and conditions and fluctuated but showed overall improvement by the end of the year.

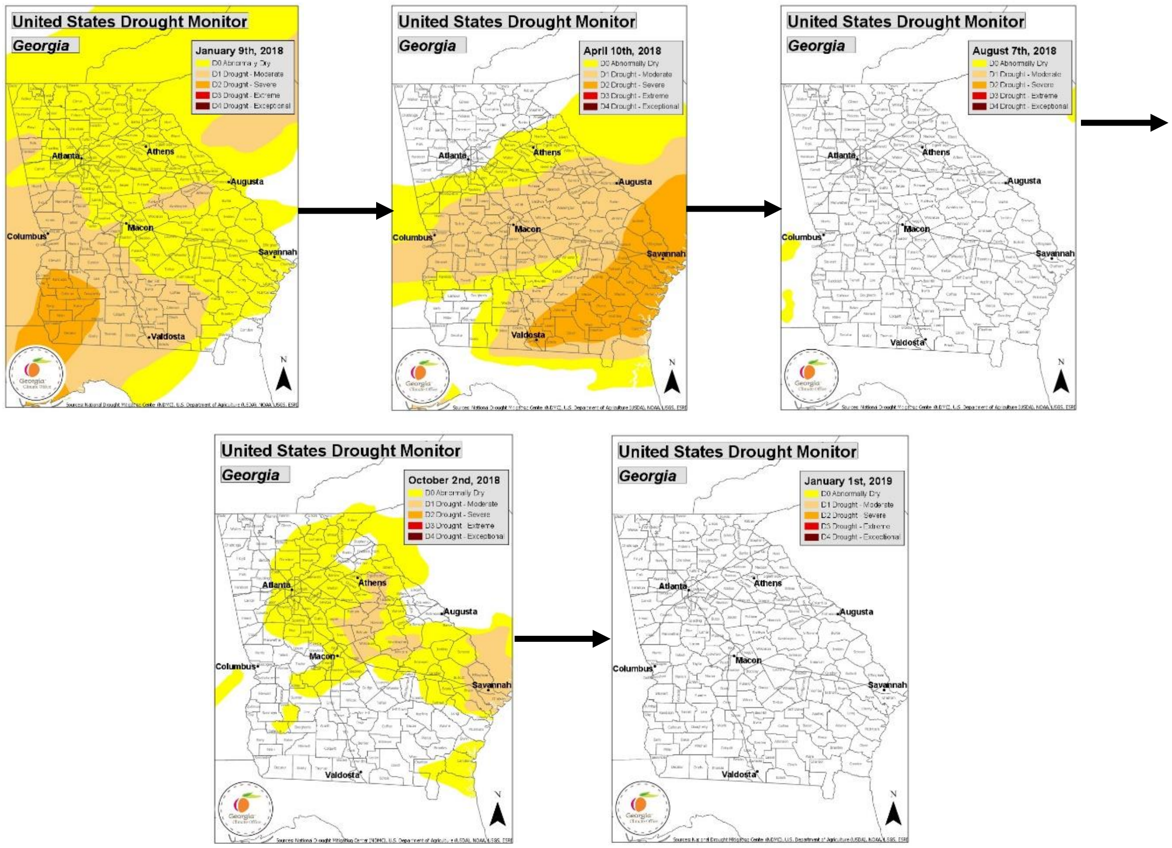


Figure 17.22. Drought Monitor, 2018

<u>Agricultural Impacts</u>

Late season freezes in March slowed pasture growth, pasture green-up and corn growth and caused freeze damage on grains. Abundant rain in May stalled cutting of hay, slowed peanut and cotton planting, and created issues for pesticide applications. The lack of rain that began in September worsened pasture conditions and feed for livestock, and dry soils made for difficult peanut harvest conditions. Hurricane Michael moved through southwest Georgia as a category 3 storm on October 10^{th} causing widespread damage to farms from winds and flooding. Compared to 2017, corn production increased while cotton, peanut, soybean, and tobacco production decreased during 2018.

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 site is South DeKalb. The South DeKalb site is considered an NCORE site as well. The PAMS site measures 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. The Conyers site collects global solar radiation and total ultraviolet radiation for the PAMS network. The Augusta, Columbus, Conyers and South DeKalb sites also have instruments to record hourly-averaged precipitation. 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 2018 and are also shown in Table 17.5.

PARAMETER	COMPANY	INSTRUMENT	MODEL	LOCATION													
				Augusta	Brunswick	Col Cr Lab	United Ave.	Conyers	Dawsonville	S. DeKalb	Sav. E. Pres	Macon Forestry	Douglasville	Ft. Mtn	Evans	NR-GT	Sav L&A
Wind Speed/Wind Direction	R.M. Young	Ultrasonic Anemometer	81000	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ambient Temperature/ Relative Humidity	R.M. Young	TEMP/RH SENSOR, DEG C	41382VC	X		X		X		X	X			X	X		
Barometric Pressure	R.M. Young	Barometric Pressure Sensor	61302V	X		X		X		X	X						
Precipitation	Novalynx	Tipping Bucket Rain Gauge	260-2501	X		X		X		X							
Solar Radiation	Eppley Lab	Standard Precision Pyronometer	PSP/SPP 38380F3					X									
Total Ultraviolet Radiation	Eppley Lab	Total Ultraviolet Radiometer	TUVR 38020					X									
Data Logger	ESC	Data System Controller	8832	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Towers	Aluma Tower Inc.	Crank-Up Tower	T-135	X	X	X	X	X		X	X	X	X			X	X
	Aluma Tower Inc.	Fold-Over Tower	FOT-10						X					X	X		

Table 17.1: 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, 2014 through 2018

17.3.1.1 2014 Ozone and $PM_{2.5}$ Data Analysis

In 2014, there were eight ozone violations in the Atlanta Metropolitan area. During much of the summer of 2014, Georgia experienced periods of weak troughness, which kept moist and unstable conditions across North Georgia for much of the summer. Overall, the longwave pattern was fairly progressive, so long-lived, persistent, strong Omega block high pressure systems were fairly infrequent over Georgia. The Bermuda/Azores high pressure system was positioned over the Atlantic Ocean as such that most of the state was positioned on the western flank of the ridge. This setup 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, or slight El Nino conditions. There were very few days during the summer where the mid-level and surface ridge axes were directly positioned over North Georgia. There were also several days during the summer where Georgia remained under the eastern periphery of a strong anticyclone which allowed upper level shortwaves to skirt across the area (“ridge–riders”). Thus, moist and unstable conditions persisted with somewhat elevated dew points from Gulf of Mexico moisture advection on several days.

The first ozone violations occurred at Conyers and South Dekalb monitoring stations on June 16th. The ozone violation at Conyers climbed to 0.081 parts per million by volume (ppmv), while the ozone at South Dekalb climbed to 0.076 ppmv. The violation was primarily due to the presence of a weak ridge of high pressure centered over the Southeast. Upper level radiosonde data from the 12Z rawinsonde from Peachtree City showed the presence of a shallow moist layer near 700 millibars (mb), although a dry pocket was evident near 850 mb and aloft at 500mb. Light and variable winds persisted for most of day with some north-northwest (NNW) flow at the Conyers site. The violation was primarily due to local production with some dry, downslope flow from the northwest (NW). There was also afternoon convection that fired up along a weak lee trough down the southern spine of the Appalachian Mountains, which is a common feature during the summertime.

On July 17th, a much more complicated meteorological setup allowed the Douglasville site to reach an ozone violation of 0.078 ppmv. This was due to passage of a weak shear axis during the day and a surface trough that gave a few hours of southeast (SE) flow, followed by NW flow. Forward and backward trajectory analysis showed that there could have been transport from the Metropolitan area as well. Peachtree City rawinsonde upper air data also showed southeast (SE) flow just above the surface. Interestingly, the Newnan monitoring site experienced elevated ozone levels on the 17th, with an associated wind shift from SE to NW as well, which put this site downwind of the Douglasville plume. The overall synoptic meteorological setup showed a weak ridge of high pressure over North Georgia with a stationary front to the south draped along the Georgia coast. This synoptic setup allowed more transport from the Metropolitan area towards Douglasville as winds swung through SE. It is fairly typical to get elevated ozone at Douglasville under east-southeast (ESE) flow, as long as winds are weak enough. This meso-synoptic flow pattern can allow southern sites, such as Newnan, to get hit with elevated ozone if the surface flow shifts to a more NNW flow (downwind of Douglasville).

An 8-hr ozone violation of 0.077 ppmv was recorded on August 6th at the Conyers monitoring station. This was followed by ozone violations on Aug. 7th of 0.085 ppmv and 0.083 ppmv at the Conyers and McDonough monitoring sites, respectively. An ozone violation of 0.078 ppmv was also observed at the Confederate Avenue site on August 7th. The violation was likely due to local production, followed by transport of the plume downwind towards the Conyers/McDonough sites. On August 5th, satellite imagery and surface dew point analysis (Figure A) showed development of a dry stable pocket of air over the Metropolitan area.

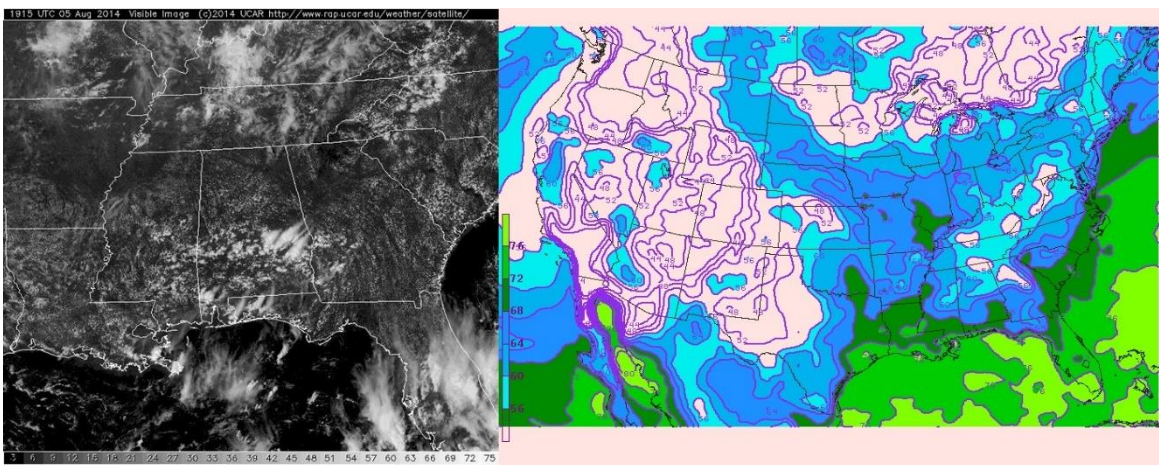


Figure 17.23. August 5th, 2014 – Infrared Satellite Imagery and 19z

Surface analysis shows high pressure dominant across the Southeast during the period, giving light downslope flow conditions, with a back-door cold front dipping into North Georgia by the 7th. The cold front allowed for scattered convective activity to develop across North and Central Georgia by late afternoon of the 7th. Peachtree City 12z radiosonde data showed relatively dry, stable conditions and light NNW flow within the boundary layer. The sounding data also showed dry air aloft near 500 mb, which is indicative of subsidence over an area. Interestingly, there was elevated residual ozone observed at the high elevation Fort Mountain site late on August 4th and 5th, which could have contributed to the event as well during evolution of the morning mixing height on the 6th and 7th (Figures B and C). These dry, stable, meteorological conditions, during light NNW flow, are typical for producing elevated ozone concentrations during the summertime, assuming other precursors are in place.

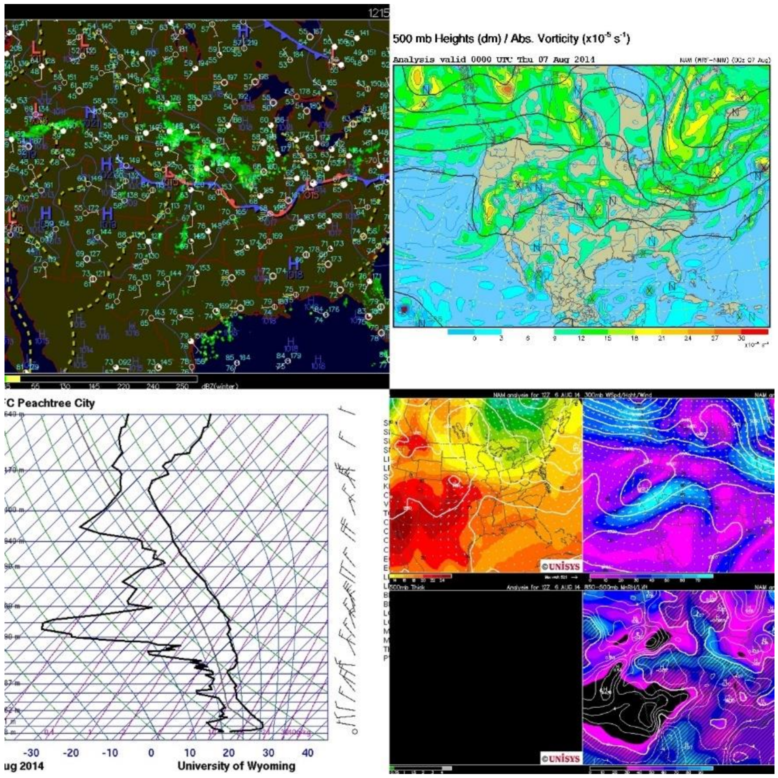


Figure 17.24. Meteorological analyses for August 6th ozone violation (including surface, vorticity, radiosonde, 850mb, and relative humidity analysis)

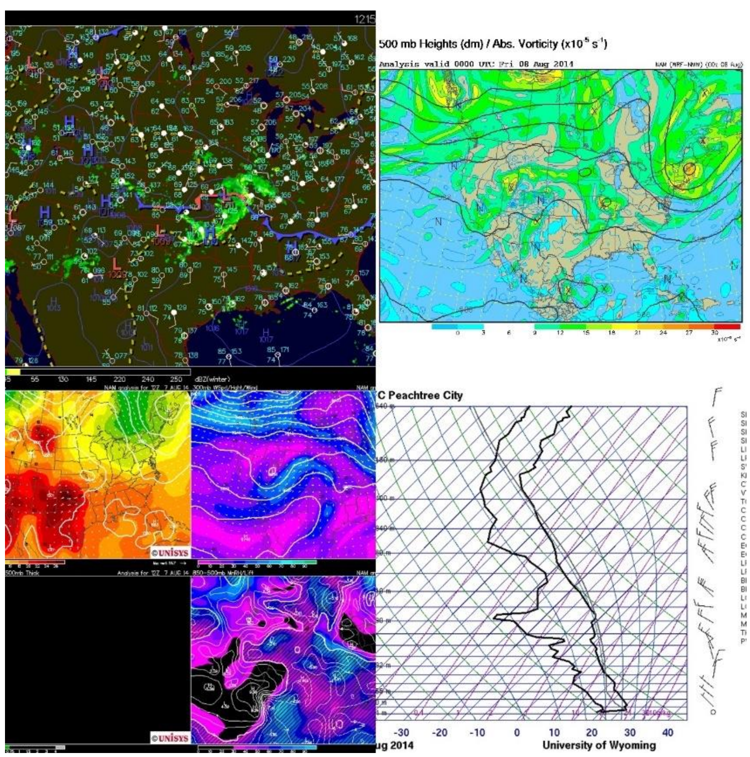


Figure 17.25. Meteorological analyses for August 7th ozone violation (including surface, vorticity, radiosonde, 850mb, and relative humidity analysis)

A more classical ozone violation occurred on August 15th, when the McDonough site recorded an ozone violation of 0.089 ppmv. The synoptic situation showed good surface ridging across North Georgia during the event with very dry and highly stable conditions in place. There were light and variable winds below 850 mb, as verified by FFC 12Z radiosonde data (Figure D). Good subsidence along with light and variable wind conditions indicated the surface ridge axis was positioned not far from Atlanta, along with the enhanced dry air aloft above 800mb. There were light and variable surface wind conditions along with weak NW flow reported at many of the sites for much of the morning hours. Very light, downslope flow is typical for pushing a plume southeast of the city towards the Conyers/McDonough area. It is also possible that local recirculation could have contributed to the build-up of ozone, as boundary layer flow swung from NNW through SE and then back to NNW. There was also an upper level trough passage at 500 mb during the day on the 15th, which helped usher in drier, stable air, while a surface ridge aided in good subsidence around the area. North Georgia was sandwiched between two frontal systems, one to the north and another to the south.

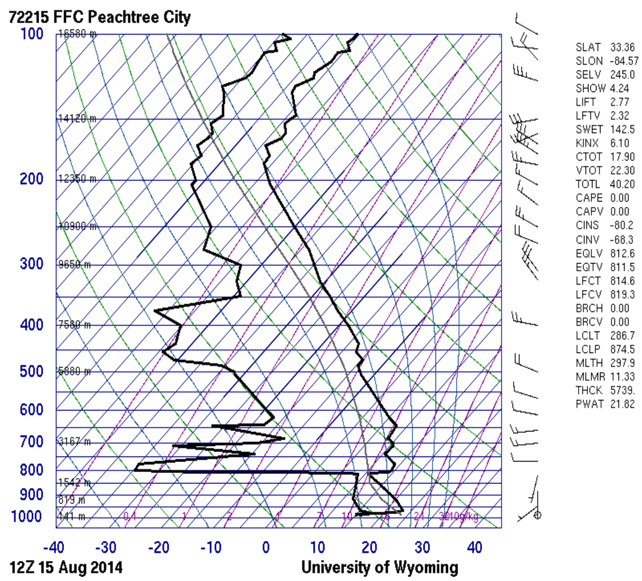


Figure 17.26. 12z FFC radiosonde data for August 15th

Air Quality Forecasting Statistics

Statistical characteristics of daily team forecasting for ozone and particulate matter (PM) during the 2014 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 (daily peak 8-hour average, AQS parameter code 44201) and preliminary and final PM (daily 24-hour average, AQS parameter codes 88101 and 88502) data. Observed data were retrieved from the US EPA AirNow Tech database (www.airnowtech.org) on 9/30/2015.

Observed Air Quality:

Metro Area and Pollutant	Total # of days in record	Observed # of days in AQI category			
		Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy
Atlanta Ozone	214	164	42	8	0
Macon Ozone	200	190	10	0	0
Atlanta PM2.5	359	178	180	1	0
Columbus PM2.5	293	219	74	0	0

Predicted Air Quality:

	Hits	Misses	False Alarms	Bias	Gross Error	Correlation (-1 to +1)	% Accurate 2 categories	% Accurate 5 categories
Atlanta Ozone	5	3	7	4.2 ppbv	7.8 ppbv	0.67	95	75
Macon Ozone	0	0	0	7.3 ppbv	9.3 ppbv	0.64	100	88
Atlanta PM2.5	0	1	0	0.1 $\mu g/m^3$	3.0 $\mu g/m^3$	0.57	99.7	73
Columbus PM2.5	0	0	0	0.8 $\mu g/m^3$	3.1 $\mu g/m^3$	0.55	100	79

Notes:

- 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).

Observed and Predicted Air Quality:

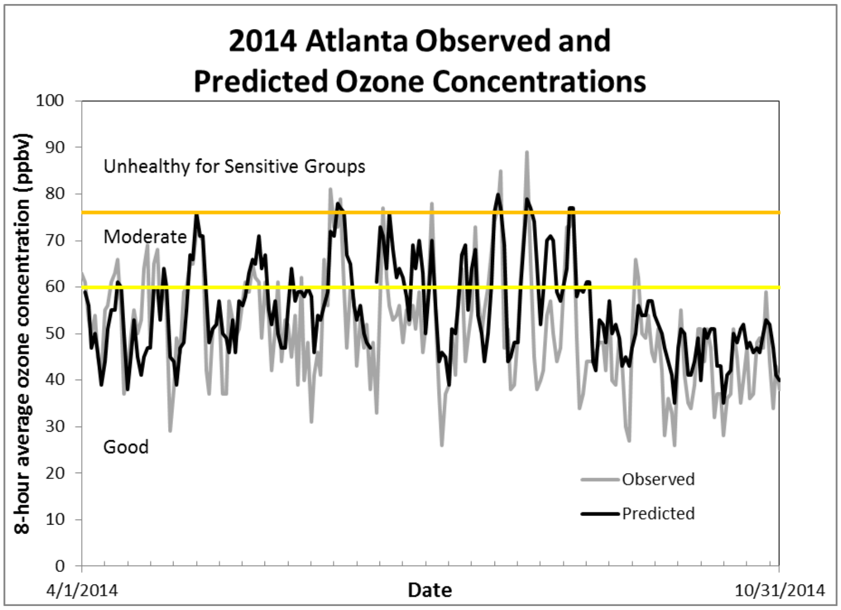


Figure 17.27. Atlanta observed and predicted ozone, 2014

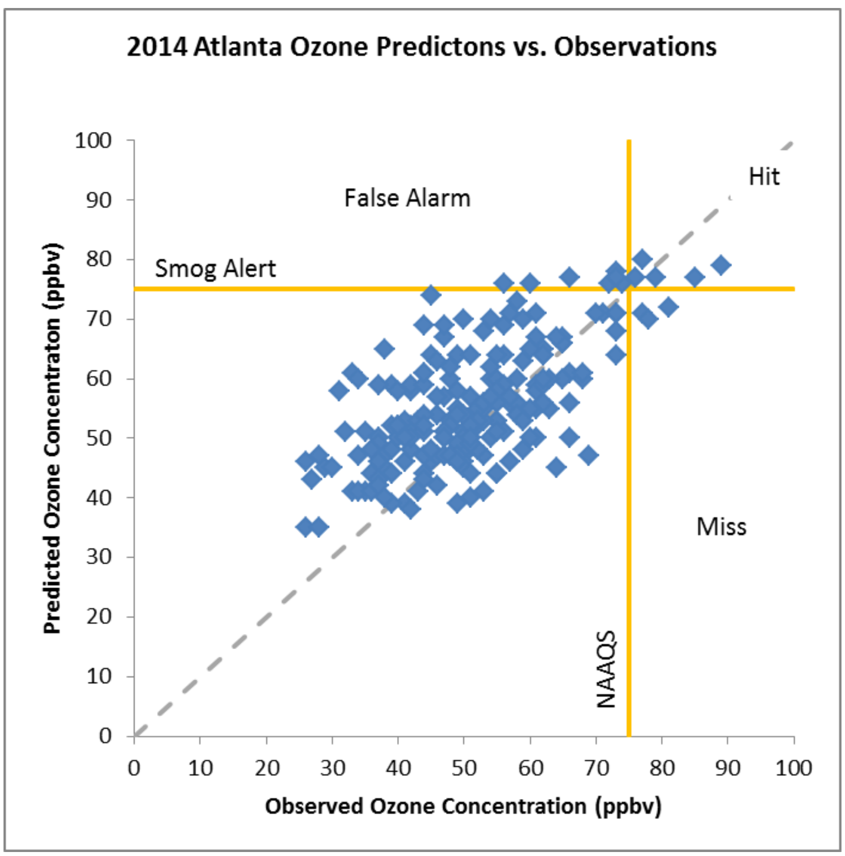


Figure 17.28. Atlanta observed vs. predicted ozone, 2014

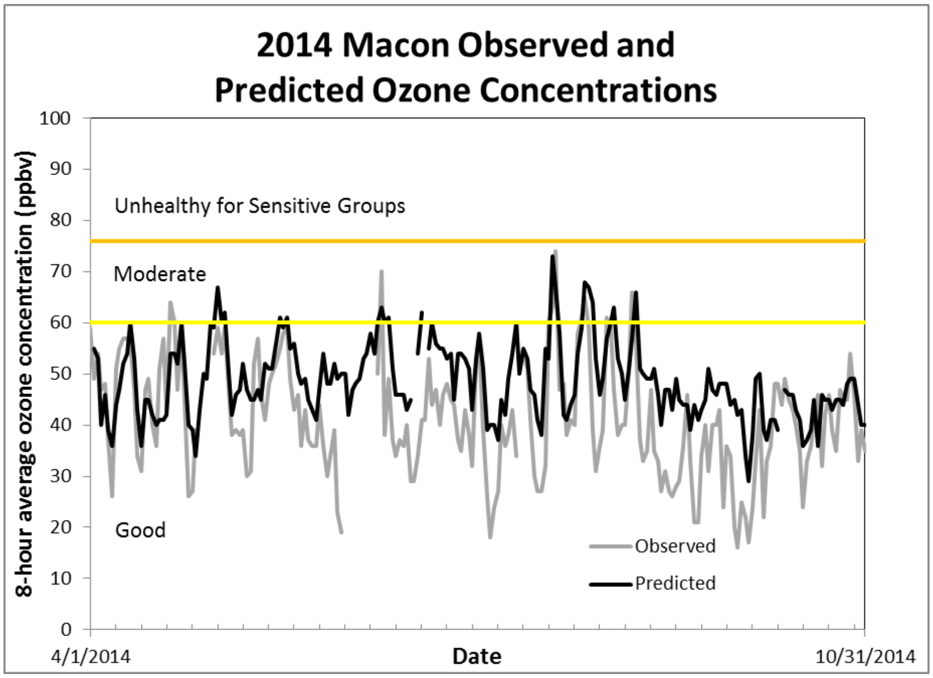


Figure 17.29. Macon observed and predicted ozone, 2014

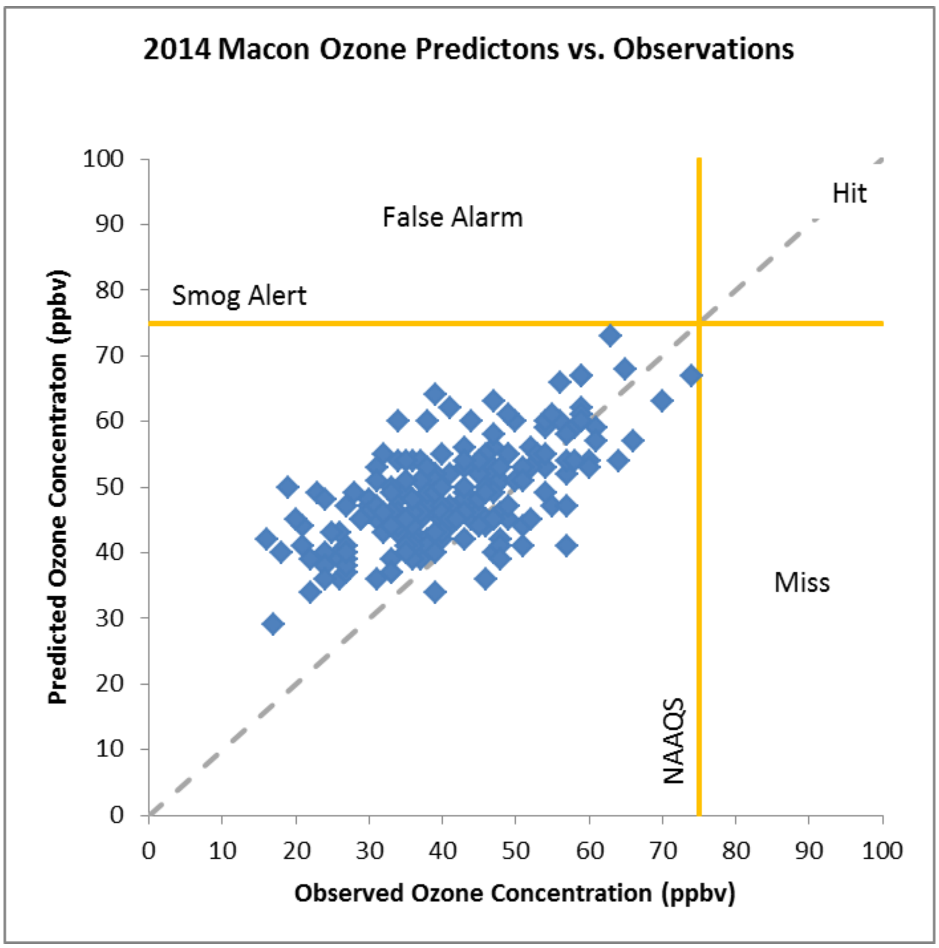


Figure 17.30. Macon observed vs. predicted ozone, 2014

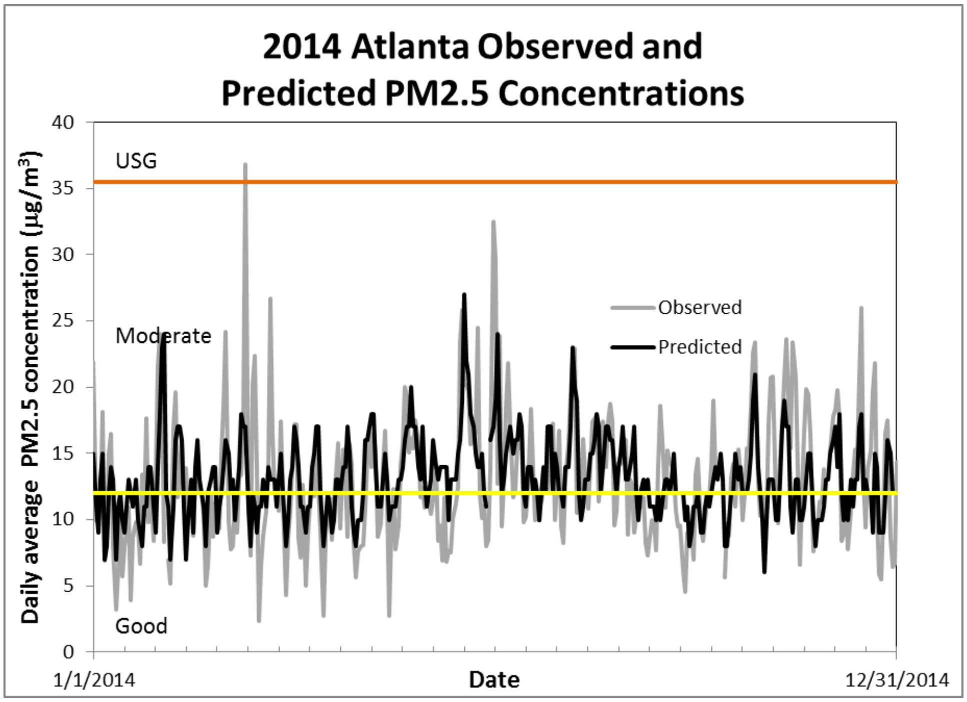


Figure 17.31. Atlanta observed and predicted $PM_{2.5}$, 2014

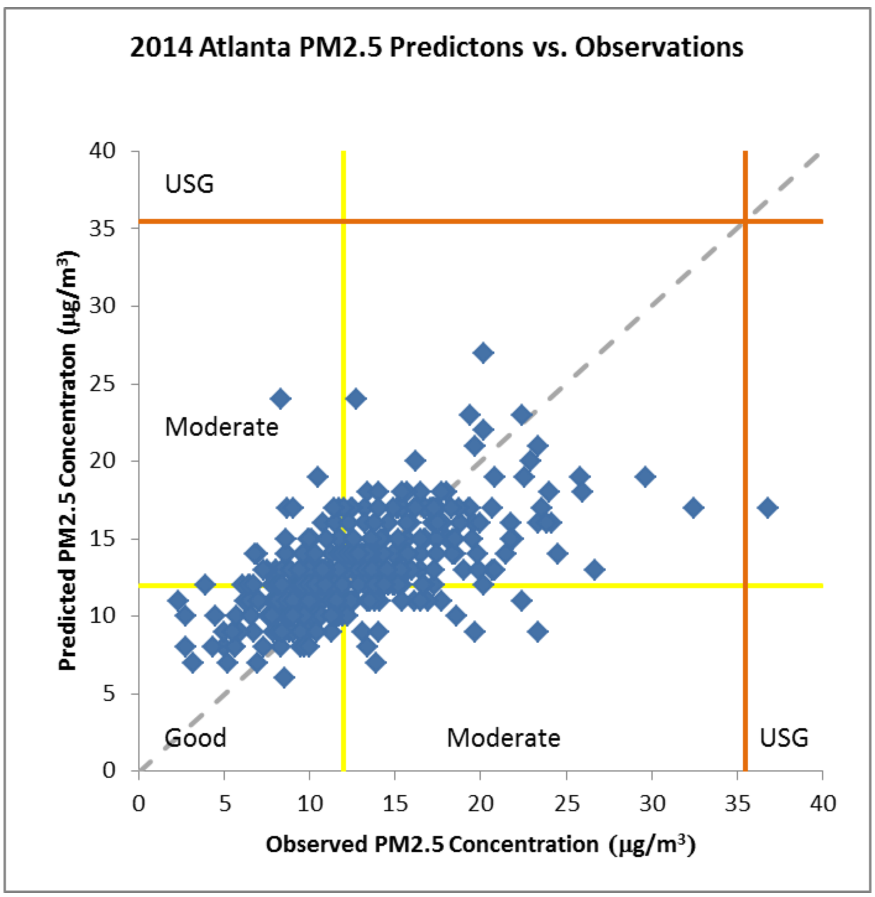


Figure 17.32. Atlanta observed vs. predicted $PM_{2.5}$, 2014

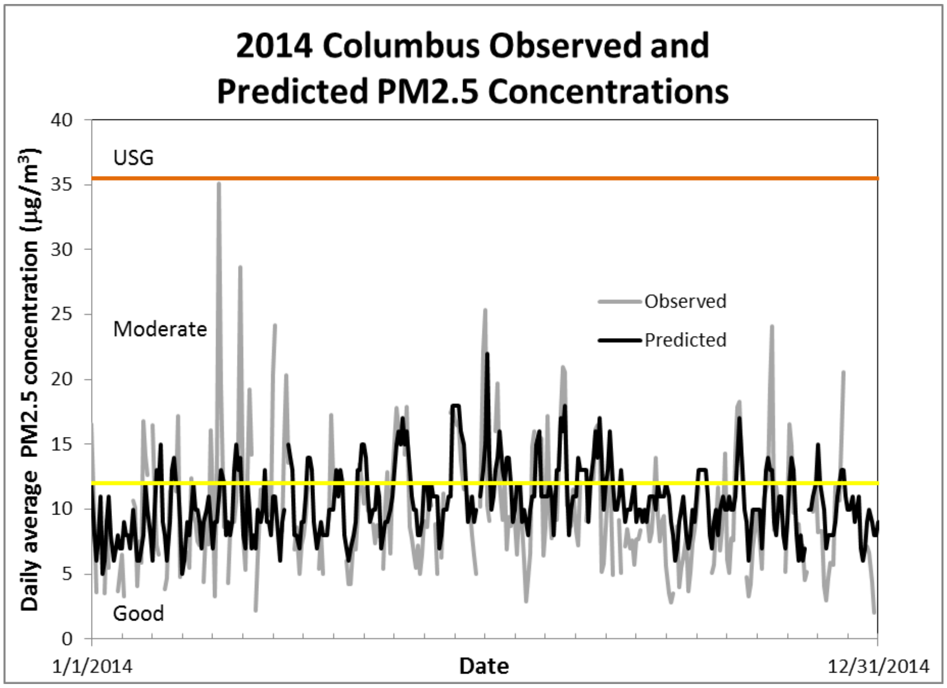
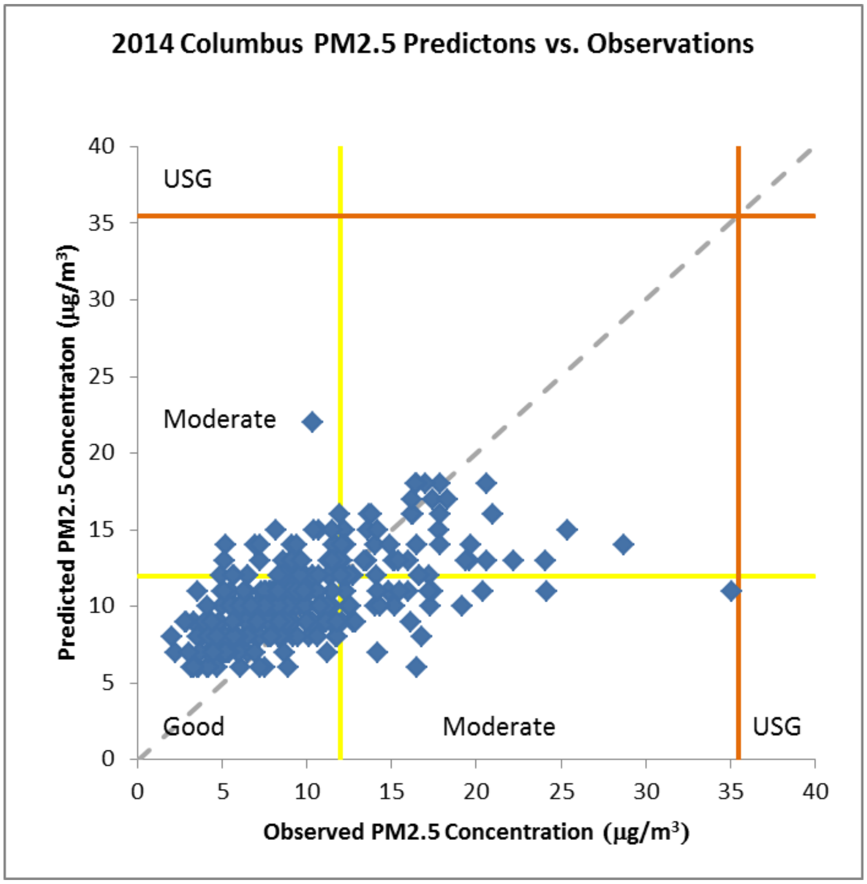


Figure 17.33. Columbus observed and predicted $PM_{2.5}$, 2014



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

Figure 17.34. Columbus observed vs. predicted $PM_{2.5}$, 2014

17.3.1.2 2015 Ozone and $PM_{2.5}$ Data Analysis

In 2015, there were seven ozone violations in the Atlanta Metropolitan area. The first ozone violation occurred at the Confederate Avenue and Newnan monitoring stations on May 8th[th]. The violation was primarily due to the presence of a tropical system off to the east, providing good subsidence across the region. Most of north Georgia was on the western subsidence side of the system, with dry, stable conditions over Metro Atlanta. Prime conditions for local production of ozone around the area, plus the dry, stable, light and variable wind conditions contributed to the ozone violation. The winds had a northeasterly component in the morning and southwesterly in the afternoon, showing that local recirculation likely played a role as well. The Newnan monitoring site had very light winds from the NNW-NNE-N for much of the day, indicating light downslope flow from the NNW, which may have put Bledsoe site downwind from the main plume that had formed from urban production.

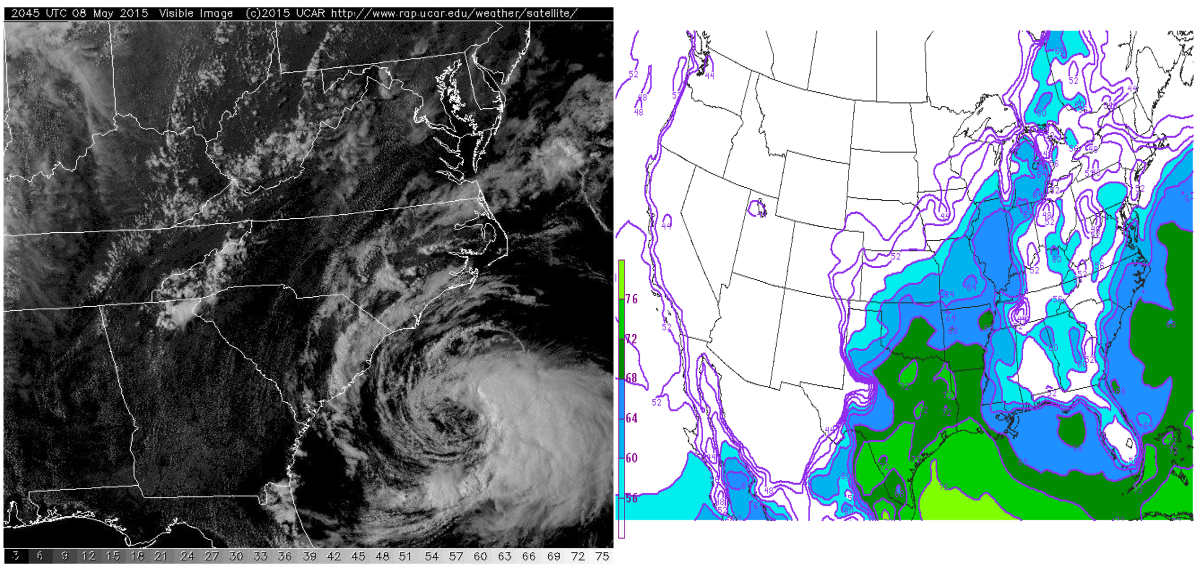


Figure 17.35. Tropical system off coast of Georgia, May 2015

A more classical setup for an ozone violation occurred on May 13[th] at the Conyers and McDonough monitoring sites. A surface front that moved through, followed by good downslope northwesterly flow, placed these monitoring sites directly downwind of the Metro area. The 12z FFC sounding showed nice dry, stable conditions with an early morning inversion. Light northwesterly flow was also evident at the lower levels and near the surface. The satellite and surface chart show the position of the surface front just south of Atlanta by 6:00a.m. So postfrontal conditions, and light northwesterly flow behind the front played important roles in this event. Fort Mountain monitoring site was elevated, so additional ozone from residual ozone aloft could have been attributed to the violation as well.

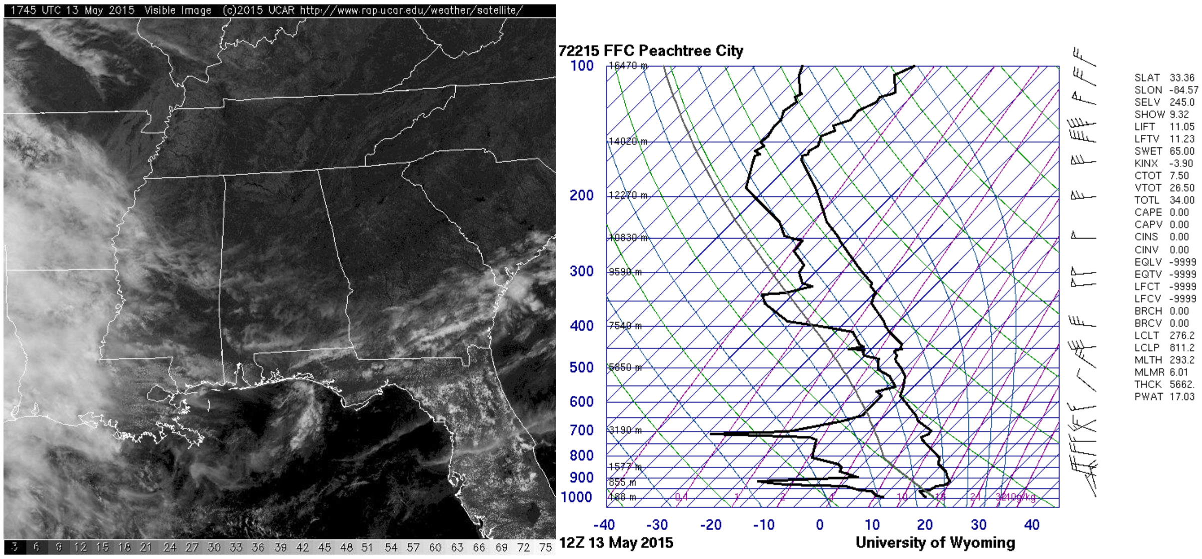


Figure 17.36. Wind Conditions, May 2015

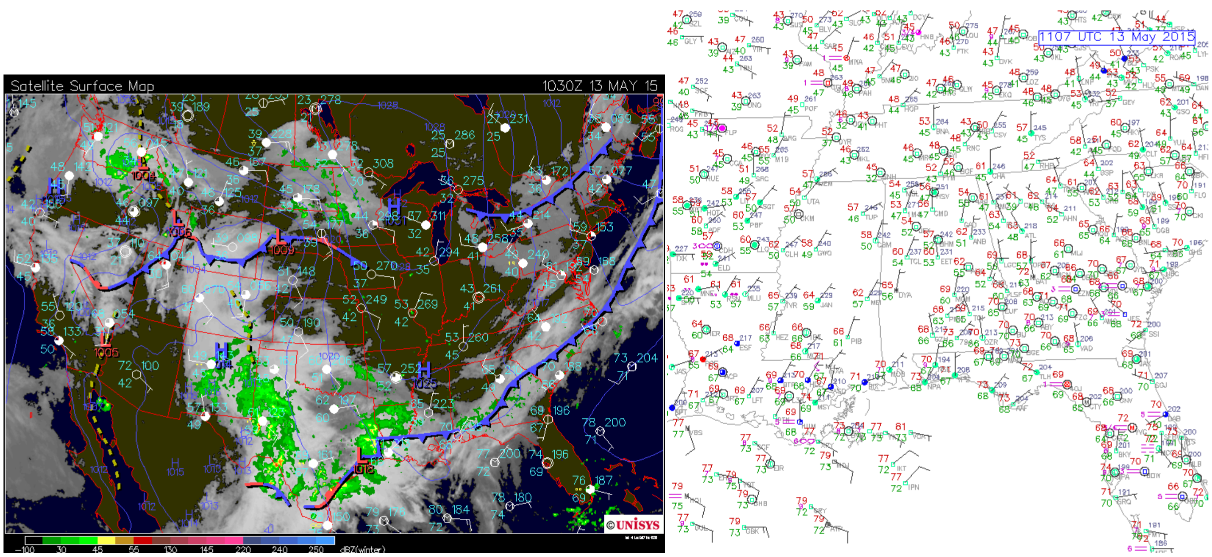


Figure 17.37. Wind Conditions, May 2015

The Confederate Avenue ambient monitoring site experienced an ozone exceedance on July 17th and again on July 18th, 2015. The 8-hr ozone values reached 0.076 ppm and 0.077 ppm, respectively. Meteorological conditions at the time consisted of an upper level ridge centered over the lower Mississippi valley, which allowed very light winds and dry conditions to aid in ozone production and accumulation. There was also a lee surface trough axis across central Georgia, as shown on the July 17th satellite surface composite. The 12z KFFC sounding on the 17th showed fairly dry and somewhat stable conditions with light and variable winds at the lower levels and near the surface, with an early morning inversion, which limited vertical mixing. There was a pronounced dry layer between 850mb and 700mb, another dry layer between 500mb and 200mb, and a moister layer just below 850mb. The violation at Confederate Avenue on the 17th was likely attributed to local production, aided by typical Friday traffic emissions, stagnant meteorological conditions with light and variable winds, and perhaps some local recirculation around the Metro area.

On the 18th, the upper level ridge continued to dominate the Gulf States, providing dry, stable conditions across the area. The 12z FFC sounding for the 18th shows that somewhat drier conditions at the low and mid-levels existed, relative to the 17th KFFC sounding; however, there was also a lee trough that persisted across central Georgia, which provided a focus for afternoon convection. Ozone production occurred on the 18th before weak impulses moved along the eastern periphery of the ridge. These impulses, along with a weak surface boundary, allowed for an increase in isolated afternoon convection. This episode was interesting and much trickier to predict since there was a thunderstorm reported at the airport around 1700 local time, so any outflows generated could have contributed to pushing polluted air towards nearby monitors.

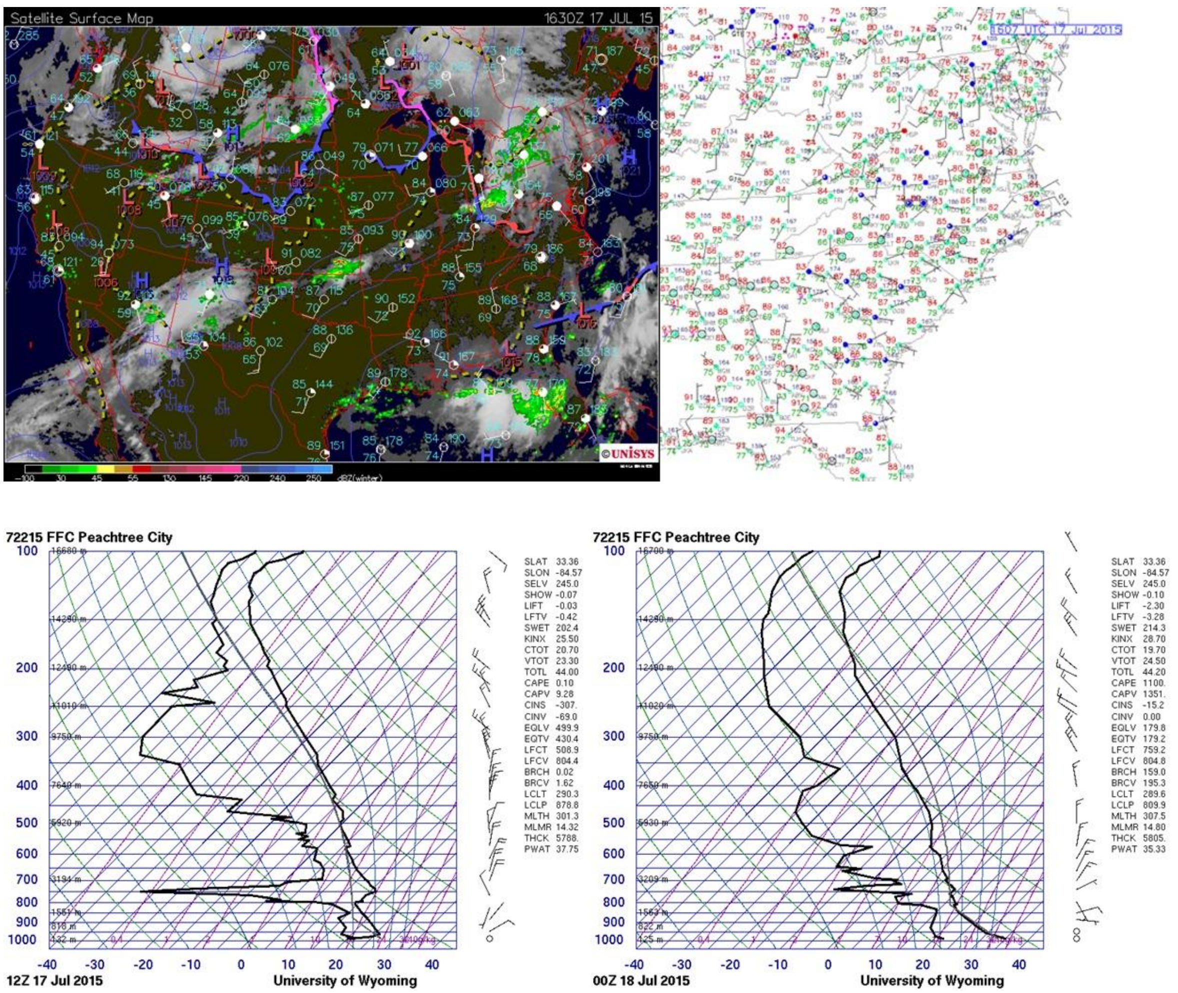


Figure 17.38. Wind conditions, July 17, 2015

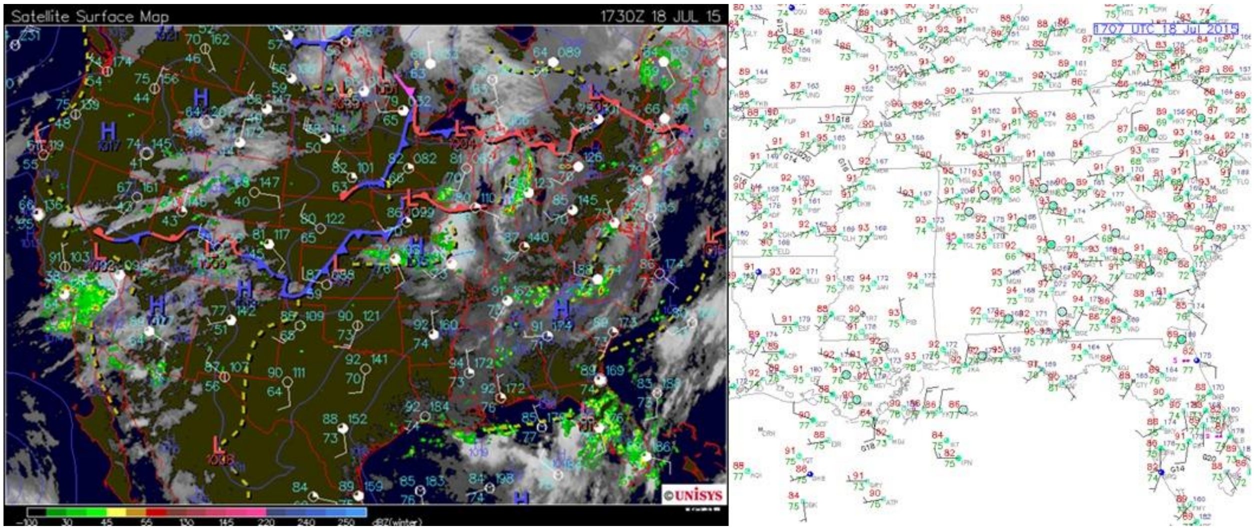


Figure 17.39. Wind conditions, July 18, 2015

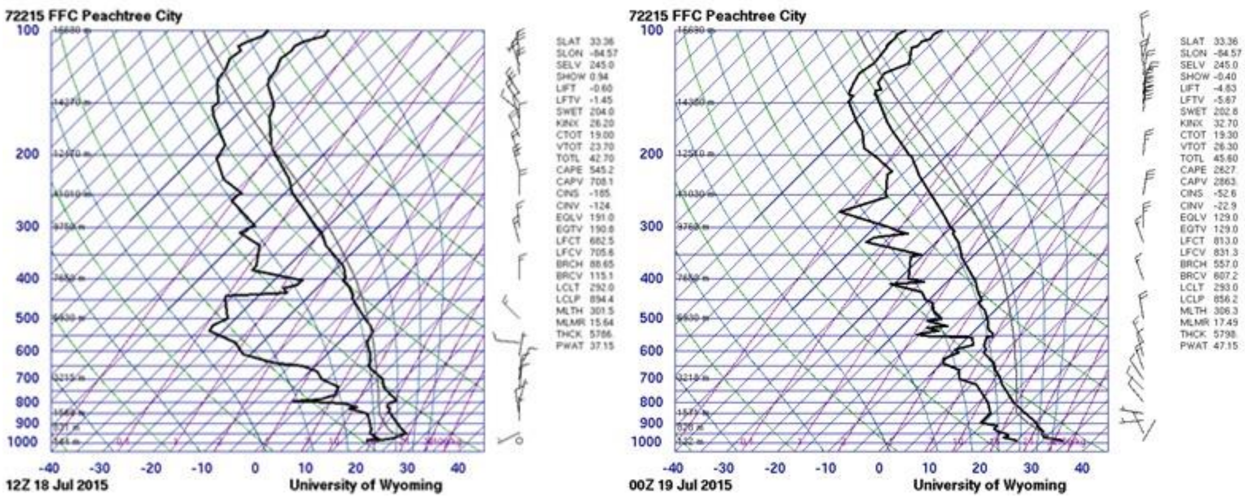


Figure 17.40. Wind conditions, July 18, 2015 (continued)

<u>Air Quality Forecasting Statistics</u>

Statistical characteristics of daily team forecasting for ozone and particulate matter (PM) during the 2015 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 (daily peak 8-hour average, AQS parameter code 44201) and preliminary and final PM (daily 24-hour average, AQS parameter codes 88101 and 88502) data. Observed data were retrieved from the US EPA AirNow Tech database (www.airnowtech.org) on 6/26/2016. Note: the following analyses include only days on which there are records for <u>both</u> observed and predicted values. In 2015, there were 365 possible days in the $PM_{2.5}$ season (January 1 – December 31), and 214 days in the ozone season (April 1 – October 31).

Observed Air Quality:

Metro Area and Pollutant	Total # of days in record	Observed # of days in AQI category			
		Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy
Atlanta Ozone	209	152	50	7	0
Macon Ozone	209	201	8	0	0
Atlanta PM2.5	347	194	153	0	0
Columbus PM2.5	285	248	36	1	0

Predicted Air Quality:

	Hits	Misses	False Alarms	Bias	Gross Error	Correlation (-1 to +1)	% Accurate 2 categories	% Accurate 5 categories
Atlanta Ozone	1	7	4	3.2 ppbv	7.9 ppbv	0.76	95	77
Macon Ozone	0	0	0	6.3 ppbv	8.5 ppbv	0.68	100	92
Atlanta PM2.5	0	0	0	0.4 $\mu g/m^3$	2.8 $\mu g/m^3$	0.67	100	73
Columbus PM2.5	0	1	0	2.2 $\mu g/m^3$	3.3 $\mu g/m^3$	0.57	99.6	82

Notes:

- 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).

Observed and Predicted Air Quality:

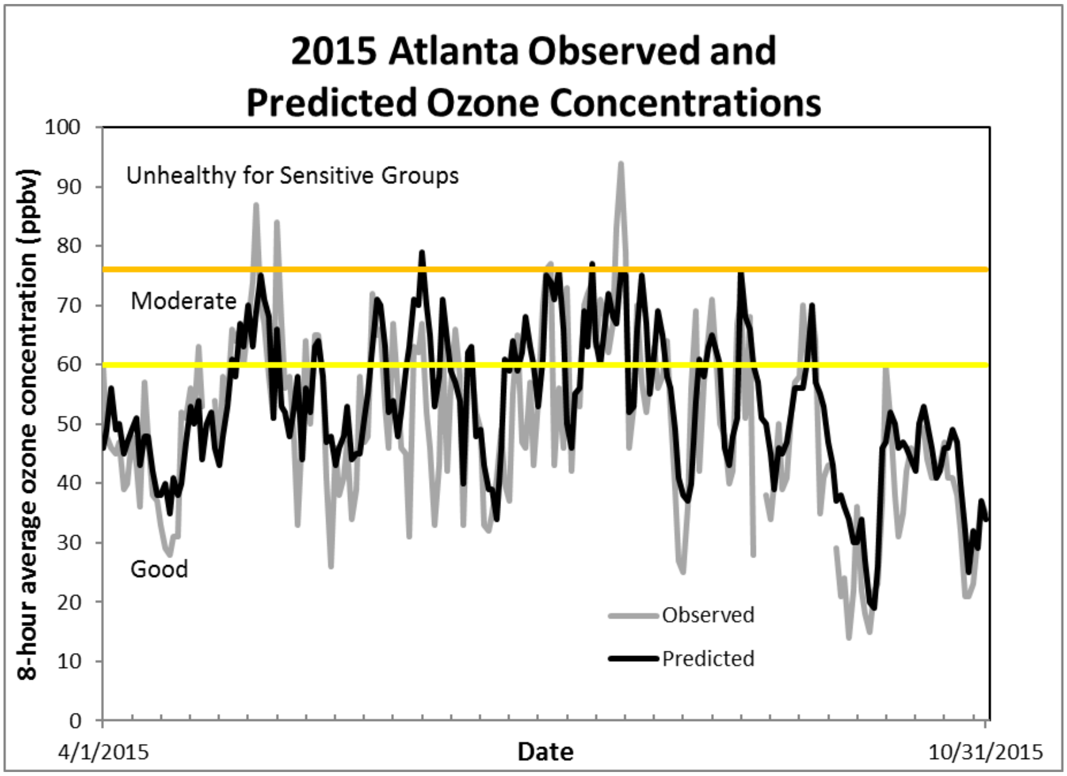


Figure 17.41. Atlanta observed and predicted ozone, 2015

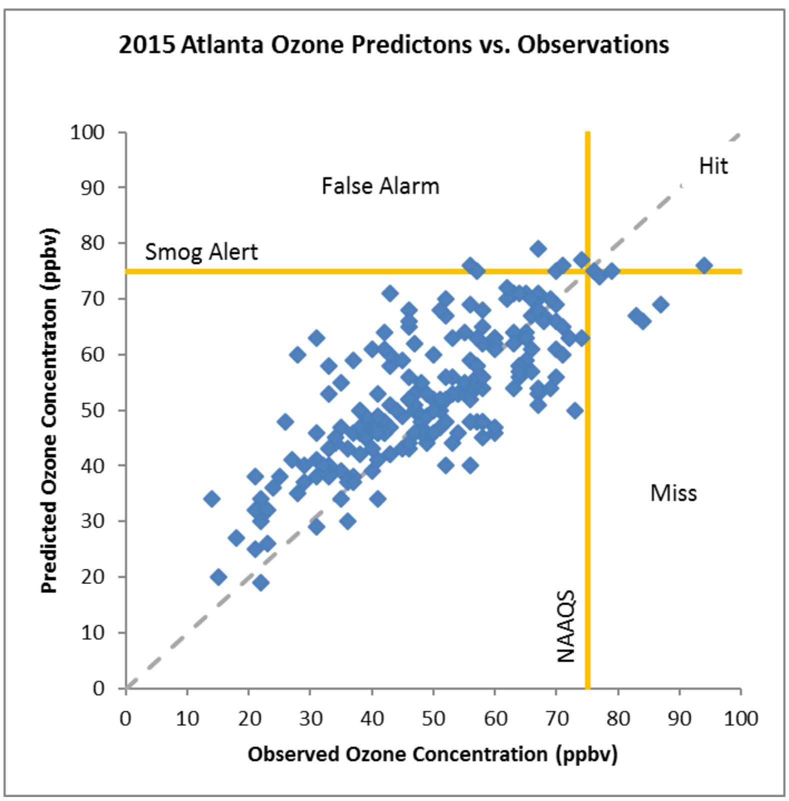


Figure 17.42. Atlanta observed vs. predicted ozone, 2015

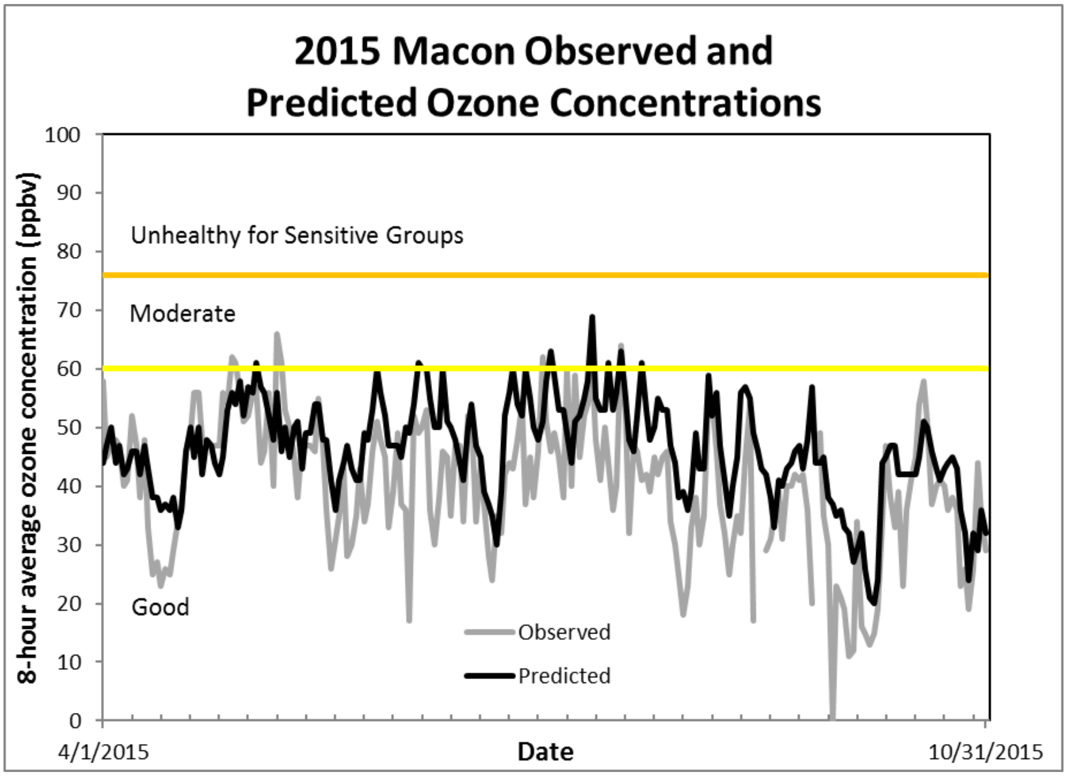


Figure 17.43. Macon observed and predicted ozone, 2015

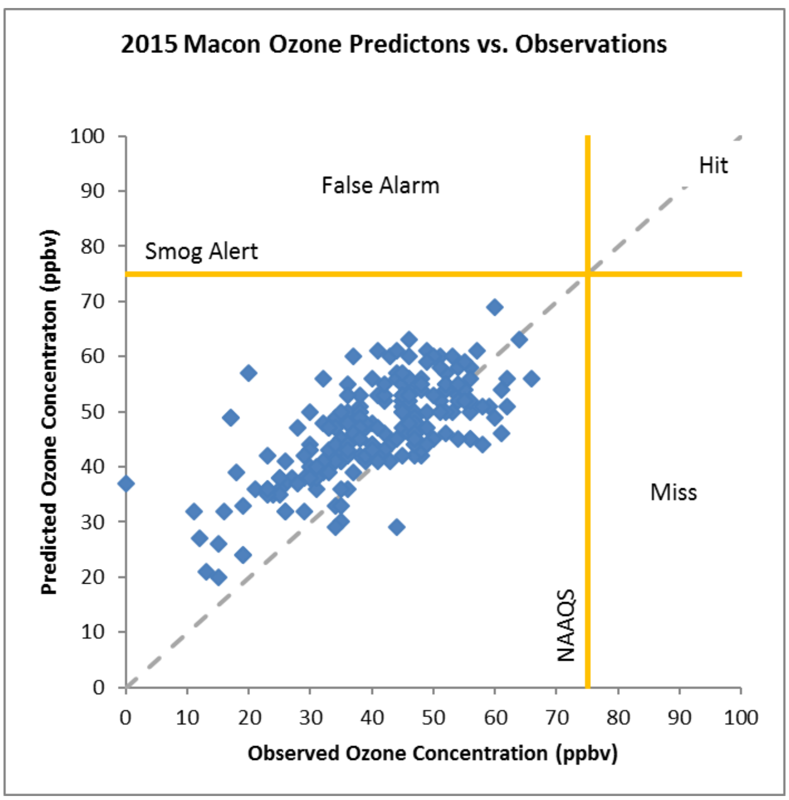


Figure 17.44. Macon ozone predictions vs. observations, 2015

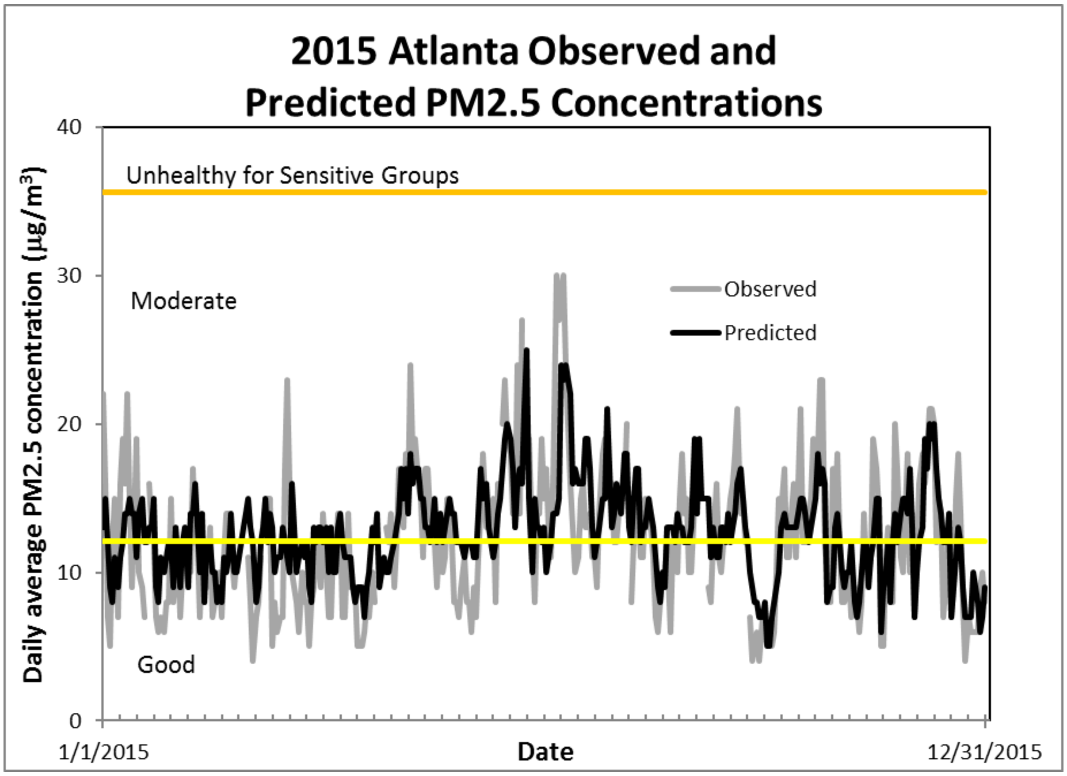


Figure 17.45. Atlanta observed and predicted $PM_{2.5}$ concentrations, 2015

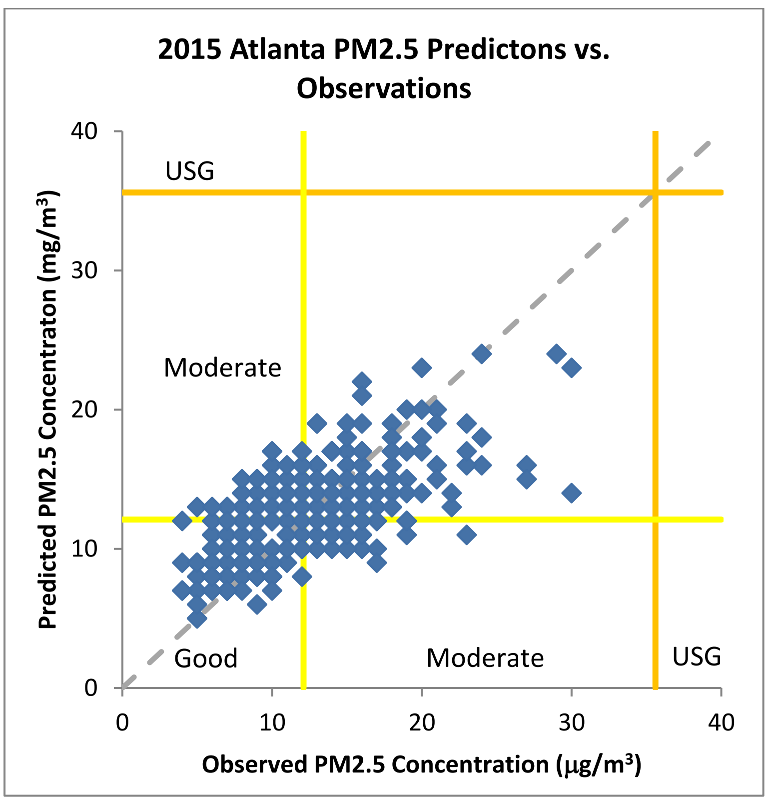


Figure 17.46. Atlanta $PM_{2.5}$ predictions vs. observations, 2015

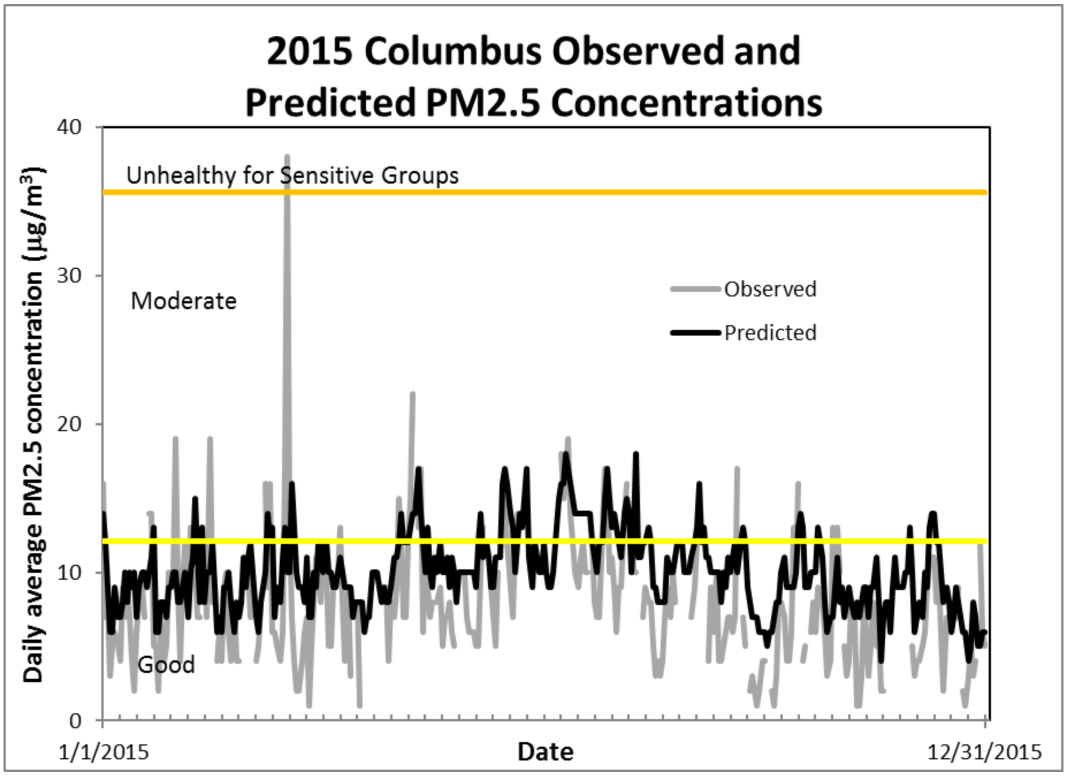
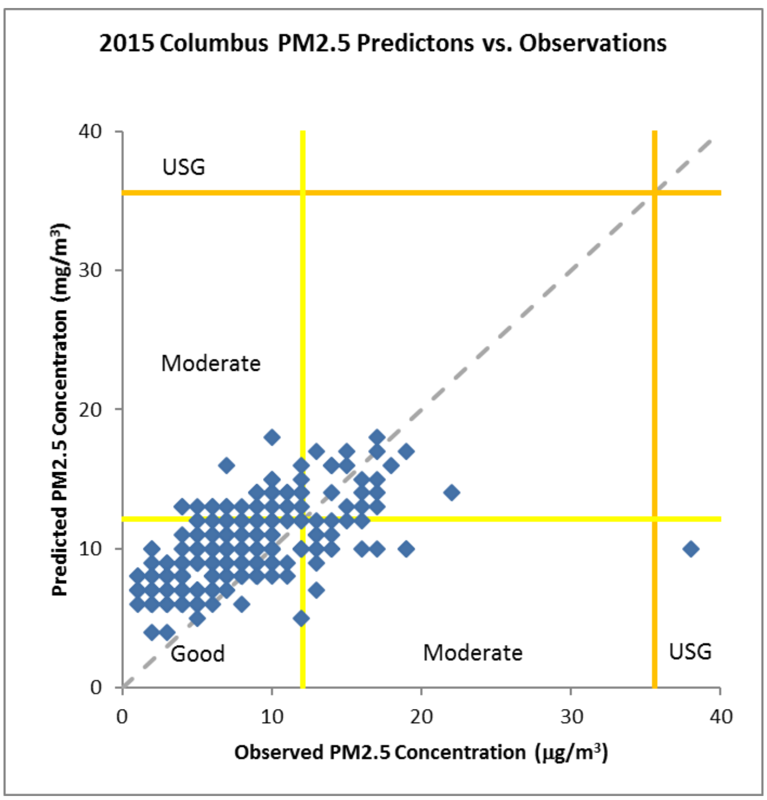


Figure 17.47. Columbus observed and predicted $PM_{2.5}$ concentrations, 2015



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

Figure 17.48. Columbus $PM_{2.5}$ predictions vs. observations, 2015

17.3.1.3 2016 Ozone and $PM_{2.5}$ Data Analysis

Characteristics of the 2016 Air Quality Forecasting Season in Atlanta, Macon, and Columbus Georgia

The table following displays statistics based on team daily predicted and final daily observed continuous ozone (daily peak 8-hour average, AQS parameter code 44201) and preliminary and final PM (daily 24-hour average, AQS parameter code 88502) data. Observed data were retrieved from the US EPA AirNow Tech database (www.airnowtech.org). Note: the following analyses include only days on which there are records for both observed and predicted values. In 2016, there were 365 possible days in the $PM_{2.5}$ season (January 1 – December 31), and 214 days in the ozone season (April 1 – October 31).

Air Quality Forecasting Statistics

Observed Air Quality:

		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	101	84	26	3
Macon Ozone	181	147	31	3	0
Atlanta PM2.5	343	169	171	3	0
Columbus PM2.5	322	278	43	1	0

Predicted Air Quality:

	Hits	Misses	False Alarms	Bias	Gross Error	Correlation (-1 to +1)	% Accurate 2 categories	% Accurate 5 categories
Atlanta Ozone	12	17	10	1.6 ppbv	7.6 ppbv	0.65	87	63
Macon Ozone	1	2	1	3.8 ppbv	7.3 ppbv	0.70	98	80
Atlanta PM2.5	1	2	1	0.2 $\mu g/m^3$	2.7 $\mu g/m^3$	0.47	99	72
Columbus PM2.5	0	1	0	1.0 $\mu g/m^3$	2.8 $\mu g/m^3$	0.48	99+	87

Observed and Predicted Air Quality:

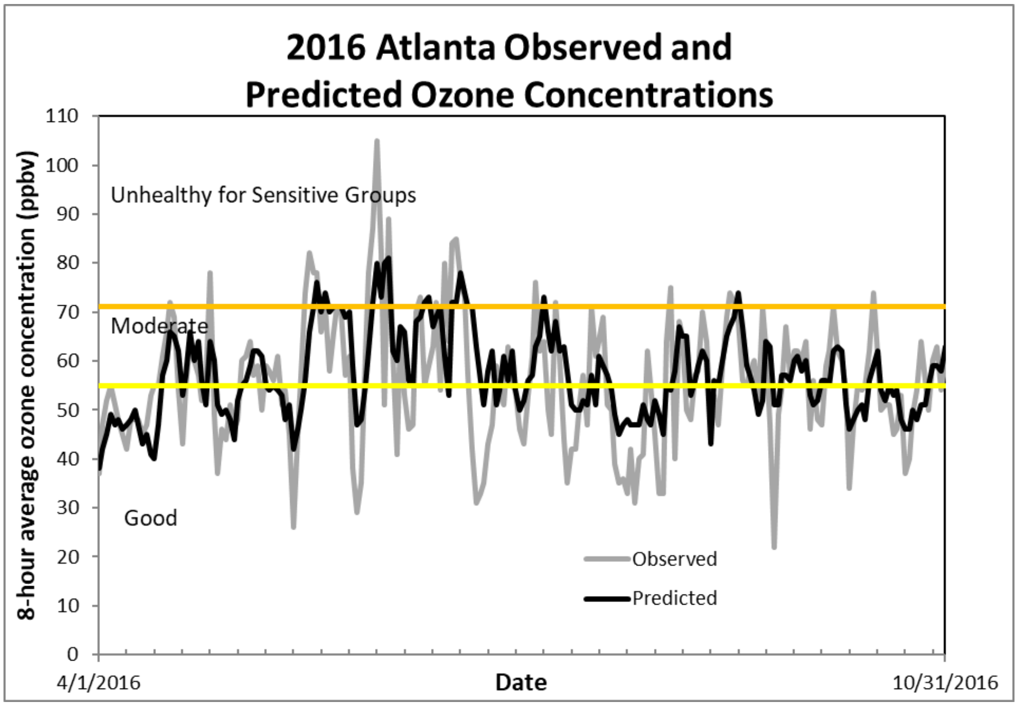


Figure 17.49. Atlanta observed and predicted ozone concentrations, 2016

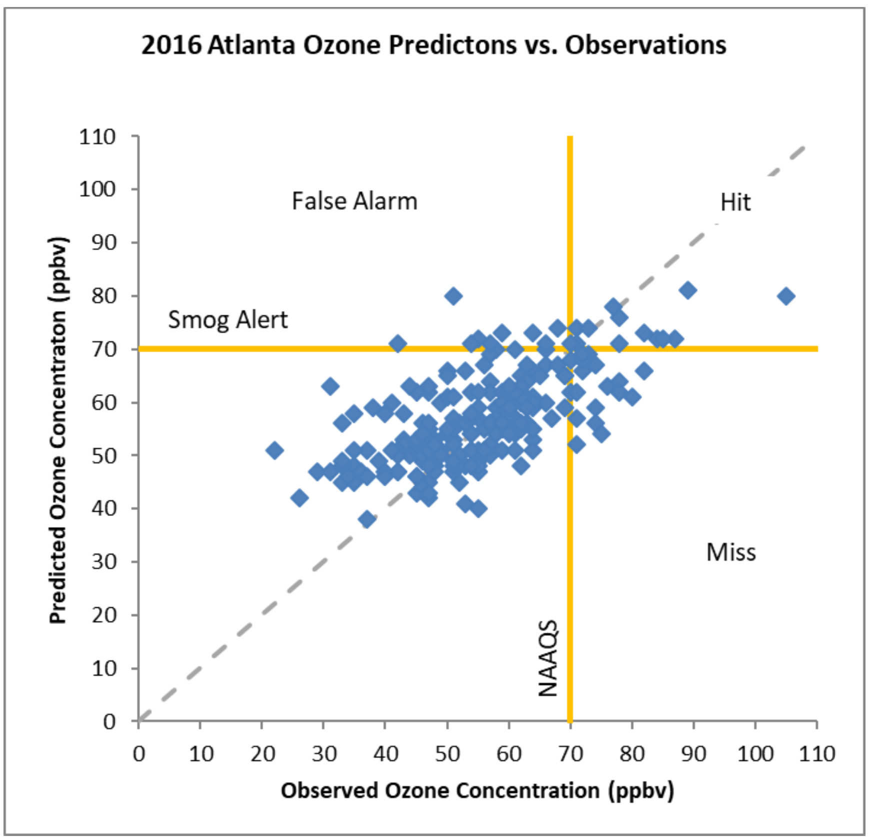


Figure 17.50. Atlanta observed vs. predicted ozone concentrations, 2016

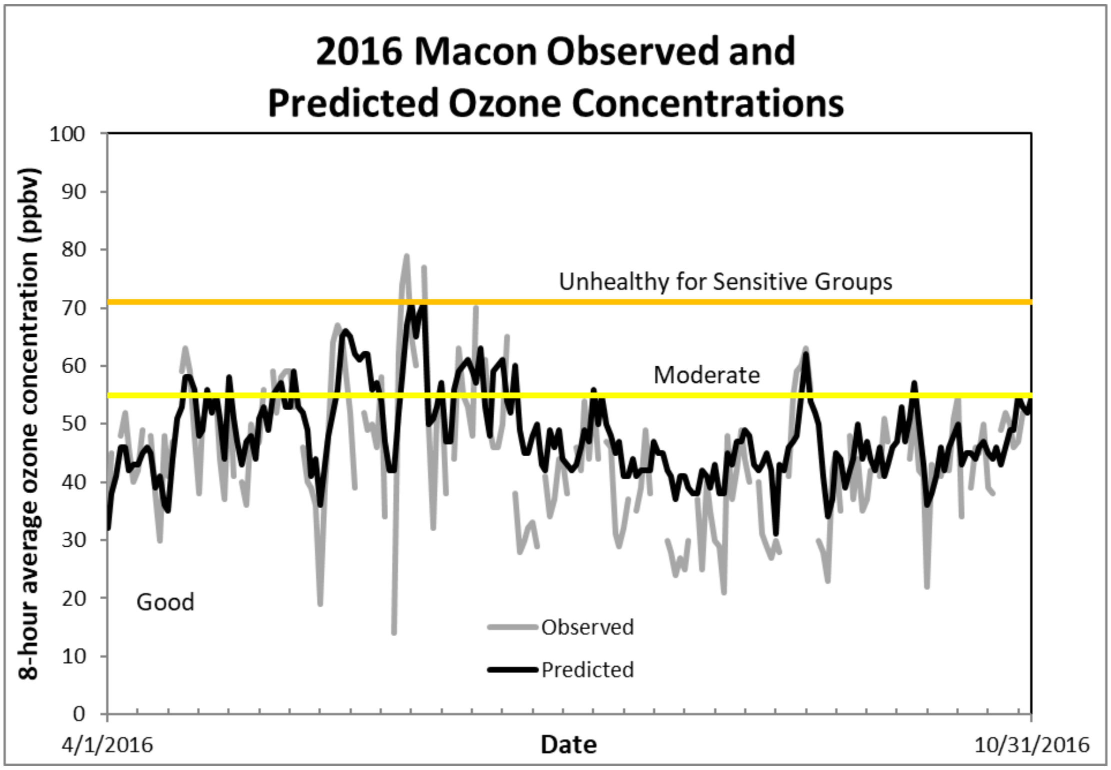


Figure 17.51. Macon observed and predicted ozone concentrations, 2016

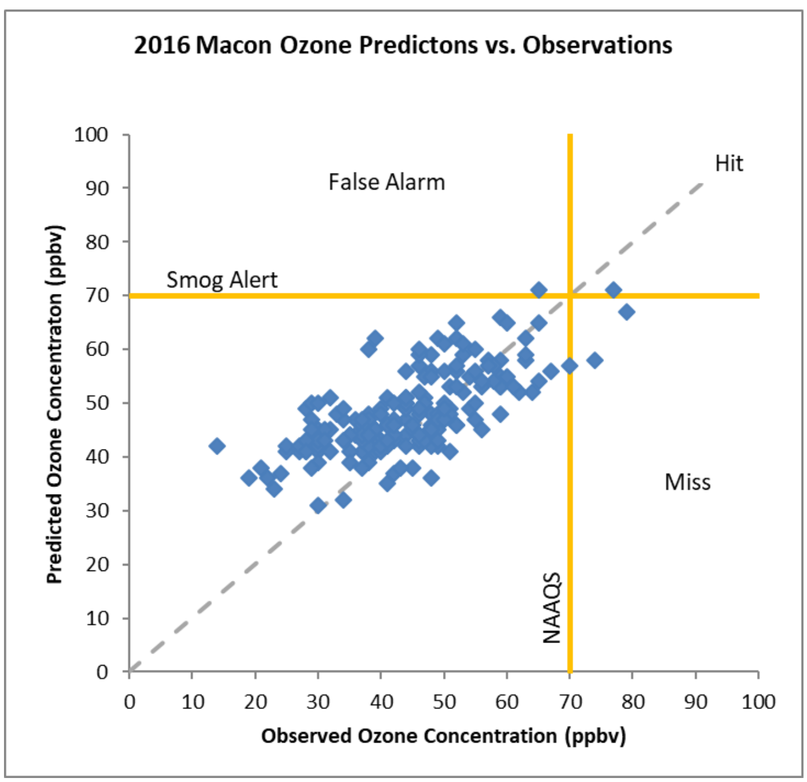


Figure 17.52. Macon observed vs. predicted $PM_{2.5}$ concentrations, 2016

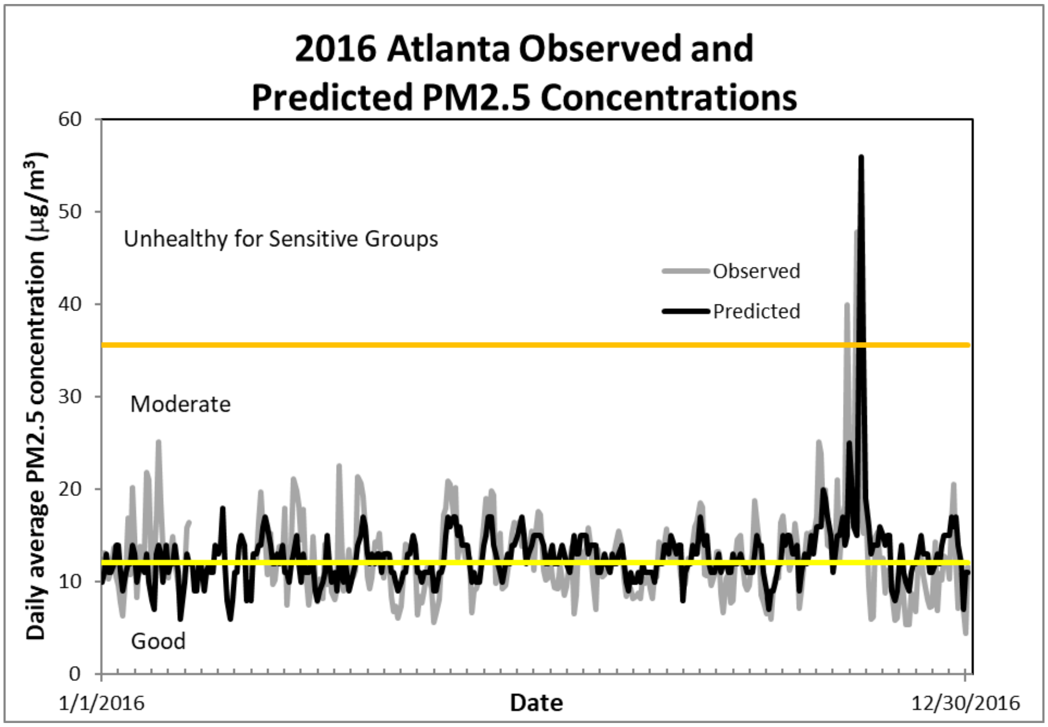


Figure 17.53. Atlanta observed and predicted $PM_{2.5}$ concentrations, 2016

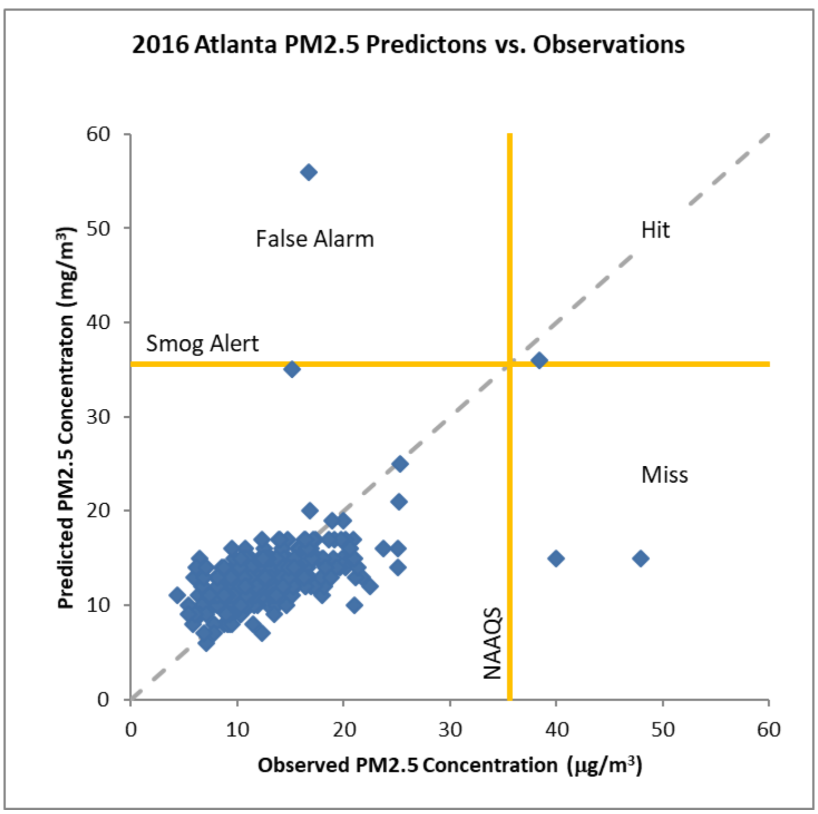


Figure 17.54. Atlanta observed vs. predicted $PM_{2.5}$ concentrations, 2016

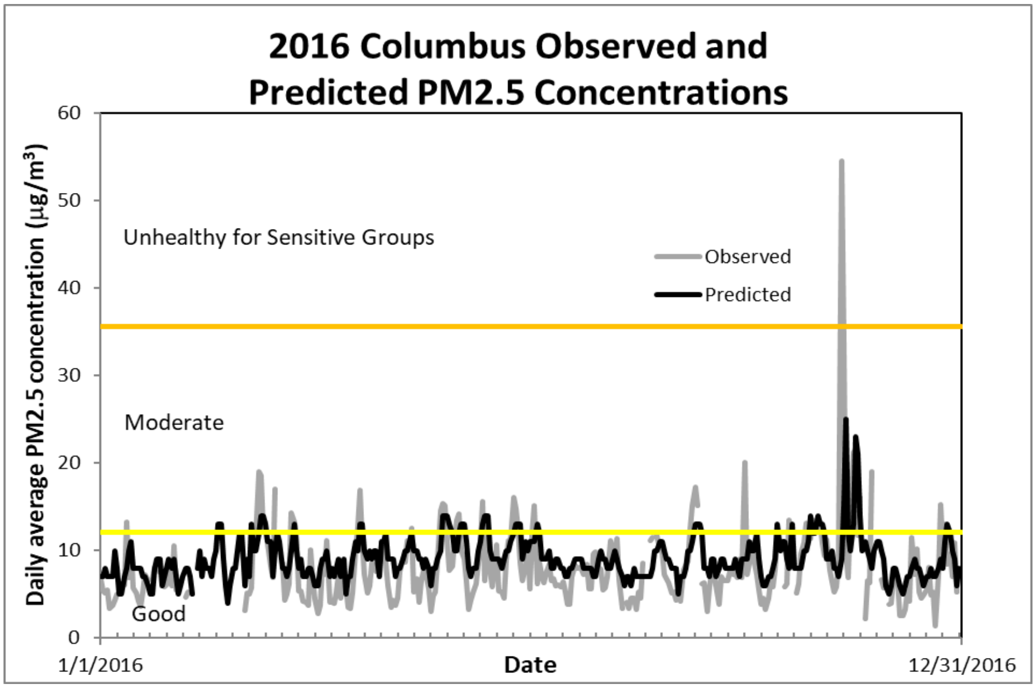
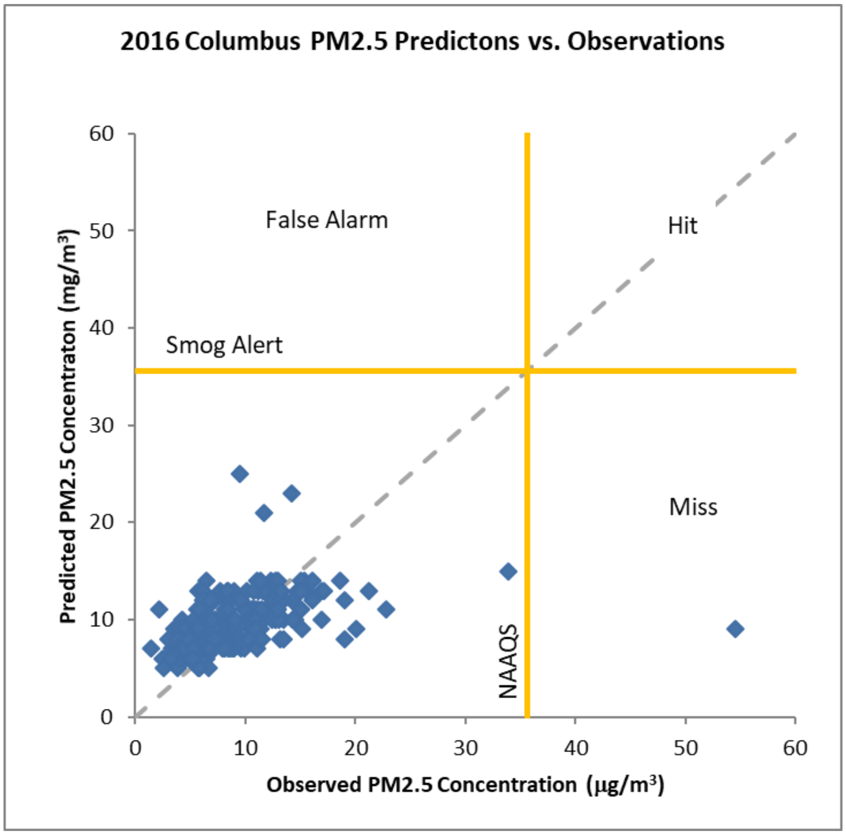


Figure 17.55. Columbus observed and predicted $PM_{2.5}$ concentrations, 2016



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

Figure 17.56. Columbus observed vs. predicted $PM_{2.5}$ concentrations, 2016

17.3.1.4 2017 Ozone and $PM_{2.5}$ Data Analysis

Characteristics of the 2017 Air Quality Forecasting Season in Atlanta, Macon, and Columbus Georgia

The table following displays statistics based on team daily predicted and final daily observed continuous ozone (daily peak 8-hour average, AQS parameter code 44201) and preliminary and final PM (daily 24-hour average, AQS parameter code 88502) data. Observed data were retrieved from the US EPA AirNow Tech database (www.airnowtech.org) on 7/26-27/2018. Note: the following analyses include only days on which there are records for both observed and predicted values. In 2017, there were 365 possible days in the $PM_{2.5}$ season (January 1 – December 31), and 214 days in the ozone season (April 1 – October 31).

Observed Air Quality:

		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	137	67	10	0
Macon Ozone	214	193	21	0	0
Atlanta PM2.5	365	217	148	0	0
Columbus PM2.5	342	286	56	0	0

Predicted Air Quality:

	Hits	**Misses**	**False Alarms**	**Bias**	**Gross Error**	**Correlation (-1 to +1)**	**% Accurate 2 categories**	**% Accurate 5 categories**
Atlanta Ozone	1	9	4	2.7 ppbv	7.2 ppbv	0.76	94	79
Macon Ozone	0	0	0	4.0 ppbv	7.3 ppbv	0.68	100	90
Atlanta PM2.5	0	0	0	0.2 $\mu g/m^3$	2.7 $\mu g/m^3$	0.65	100	78
Columbus PM2.5	0	0	0	0.5 $\mu g/m^3$	2.5 $\mu g/m^3$	0.61	100	84

Notes:

- 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).

Observed and Predicted Air Quality:

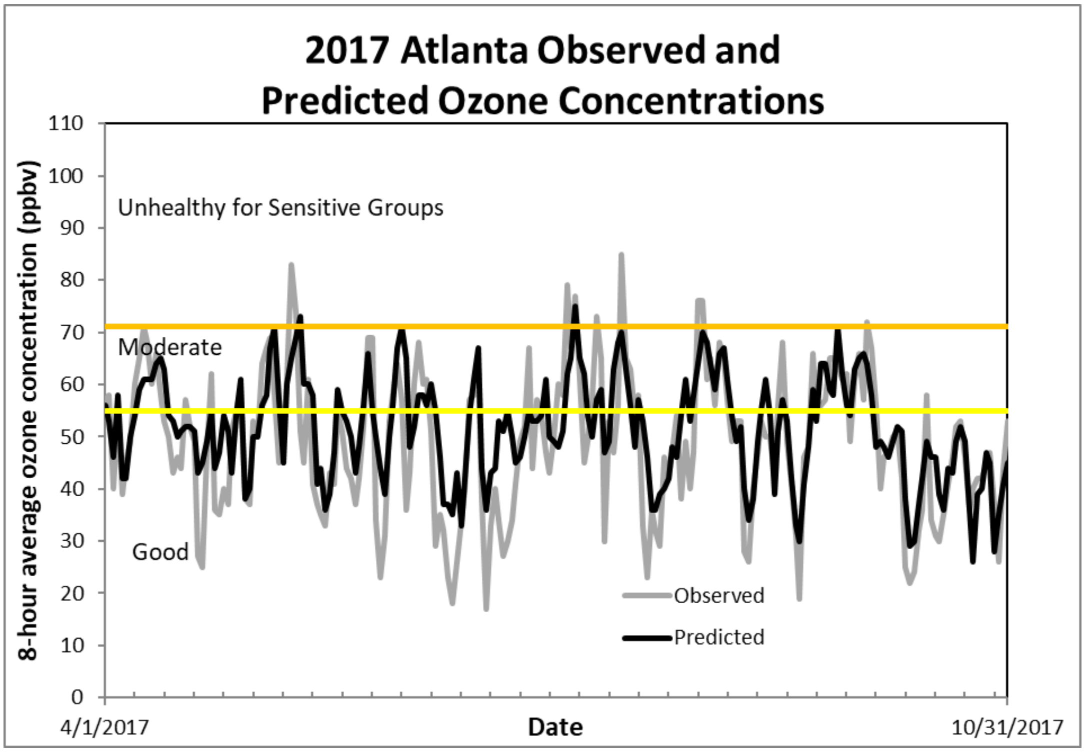


Figure 17.57. Atlanta observed and predicted ozone concentrations, 2017

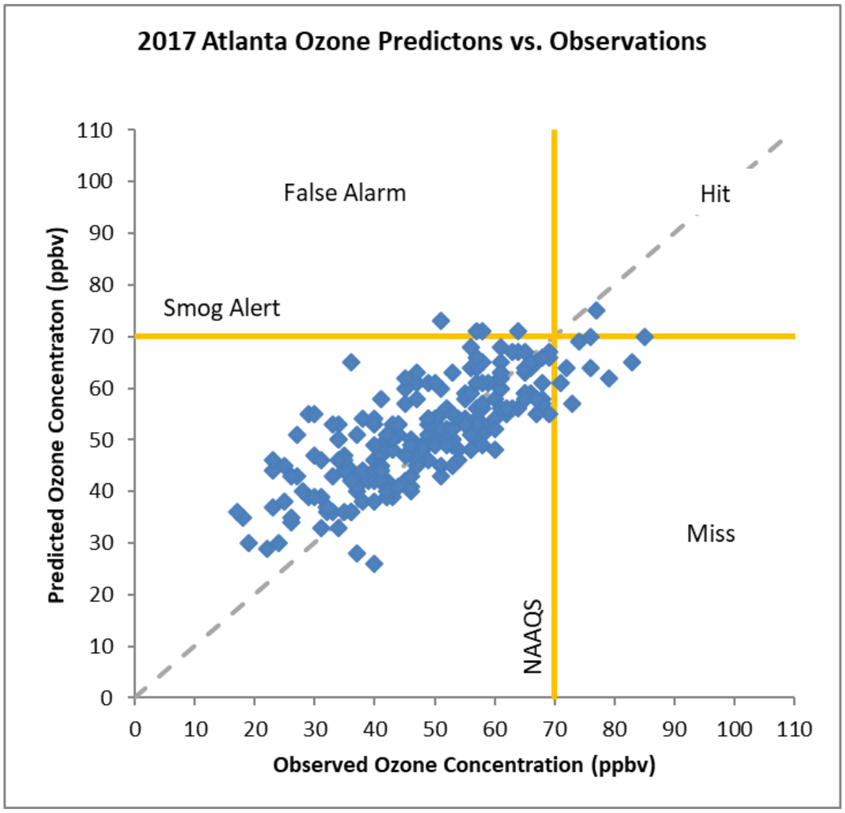


Figure 17.58. Atlanta observed vs. predicted ozone concentrations, 2017

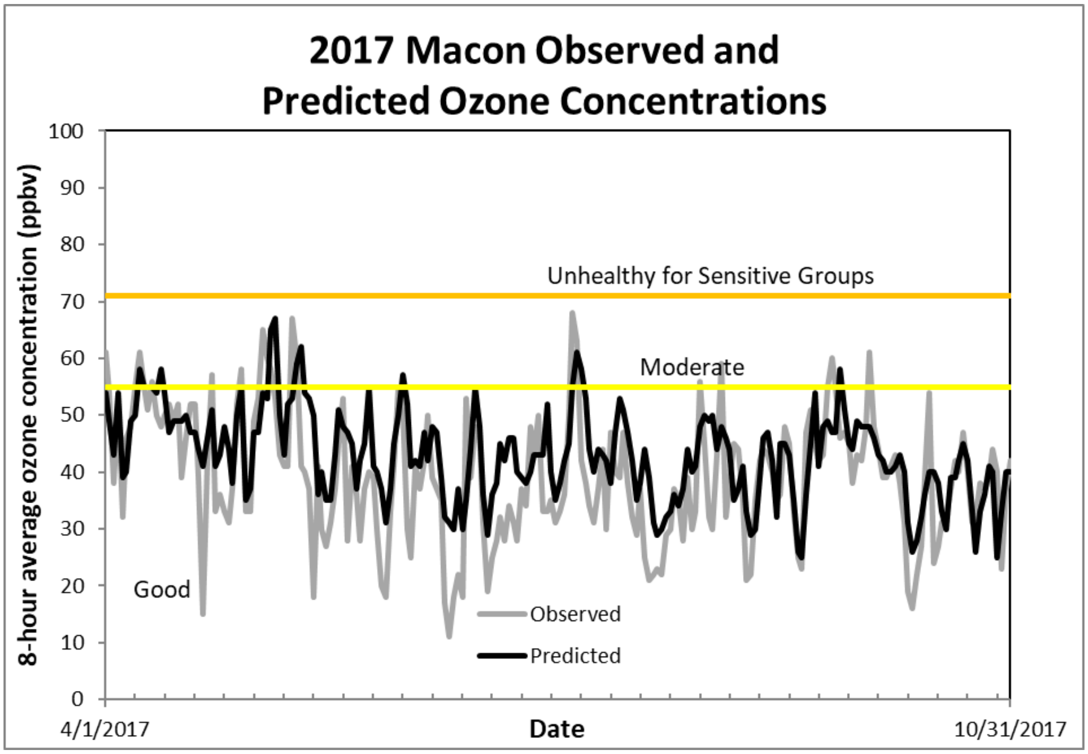


Figure 17.59. Macon observed vs. predicted ozone concentrations, 2017

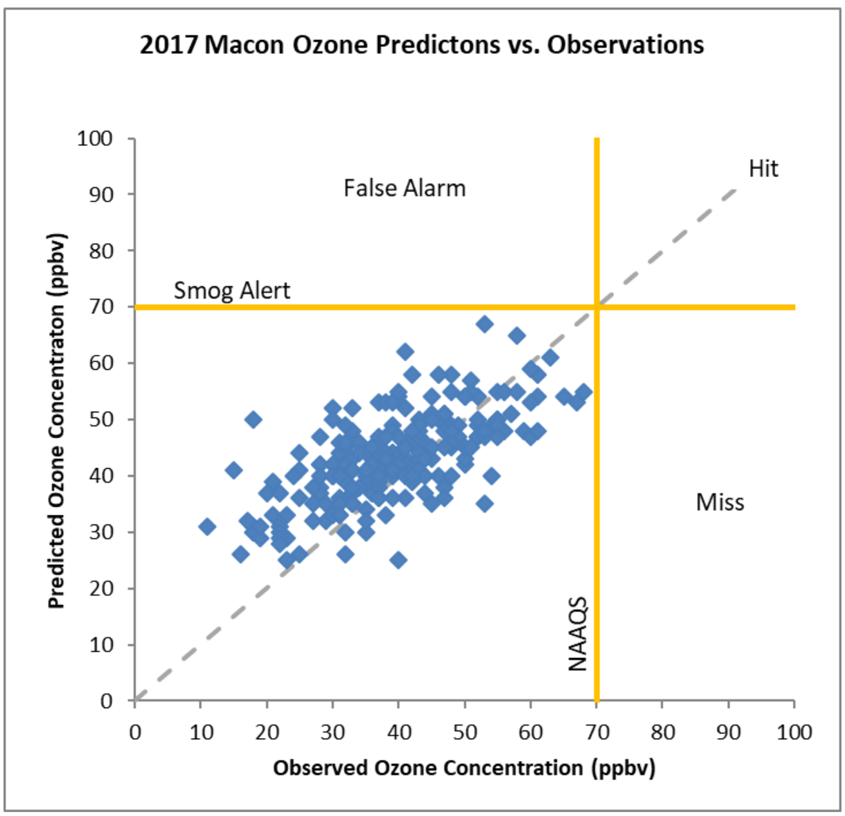


Figure 17.60. Macon observed vs. predicted ozone concentrations, 2017

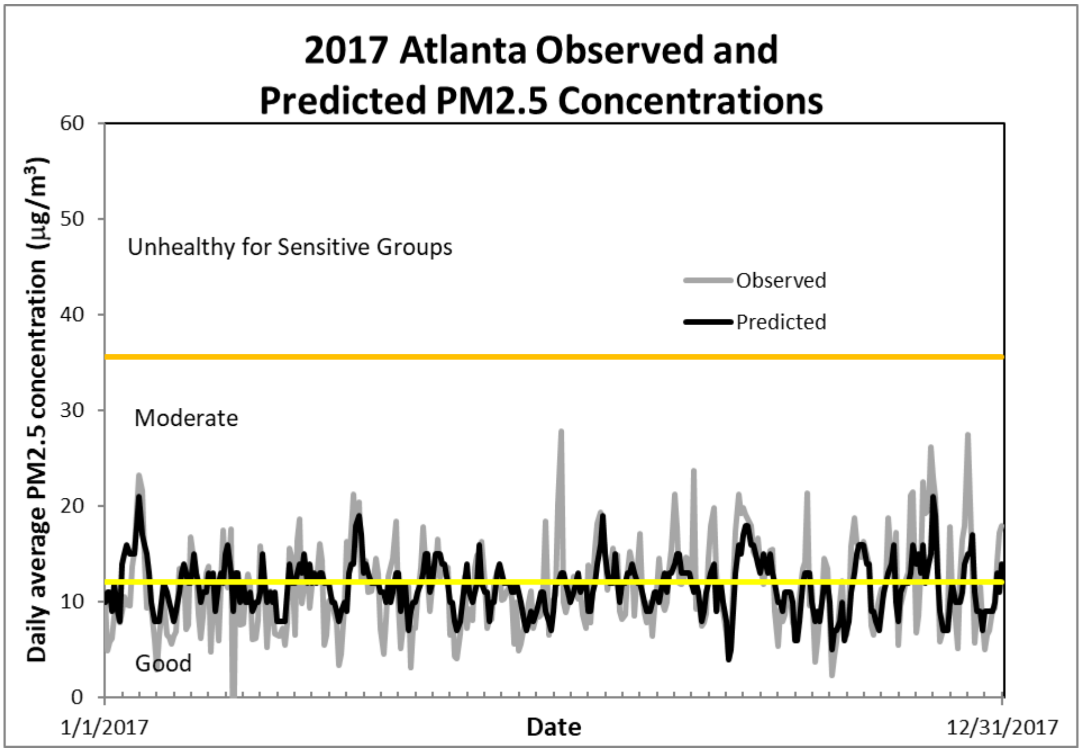


Figure 17.61. Atlanta observed and predicted $PM_{2.5}$ concentrations, 2017

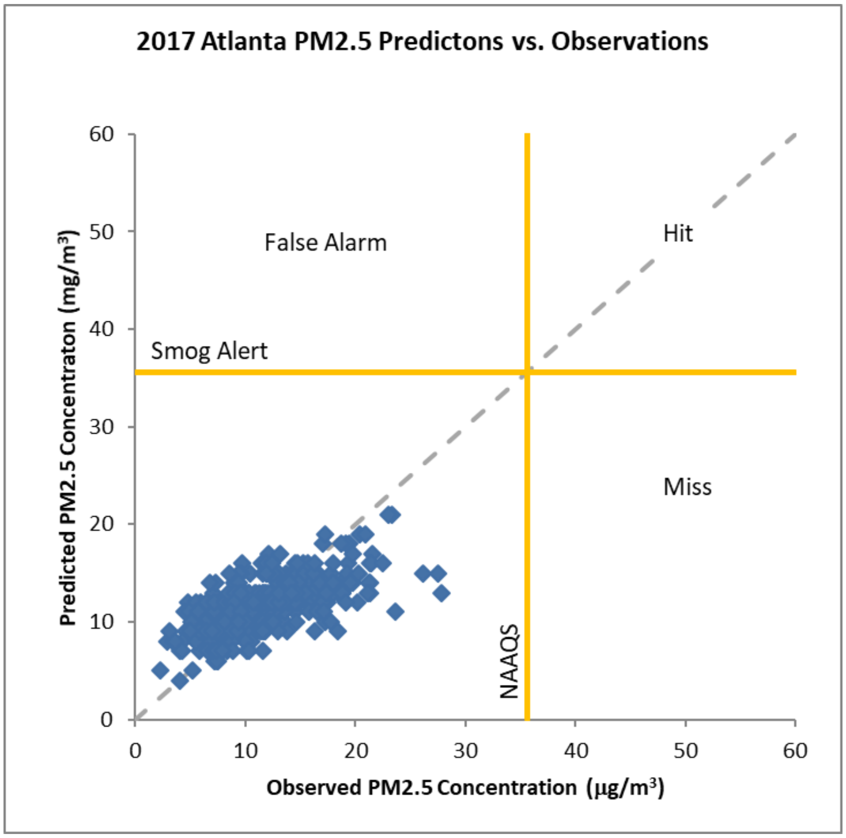


Figure 17.62. Atlanta observed vs. predicted $PM_{2.5}$ concentrations, 2017

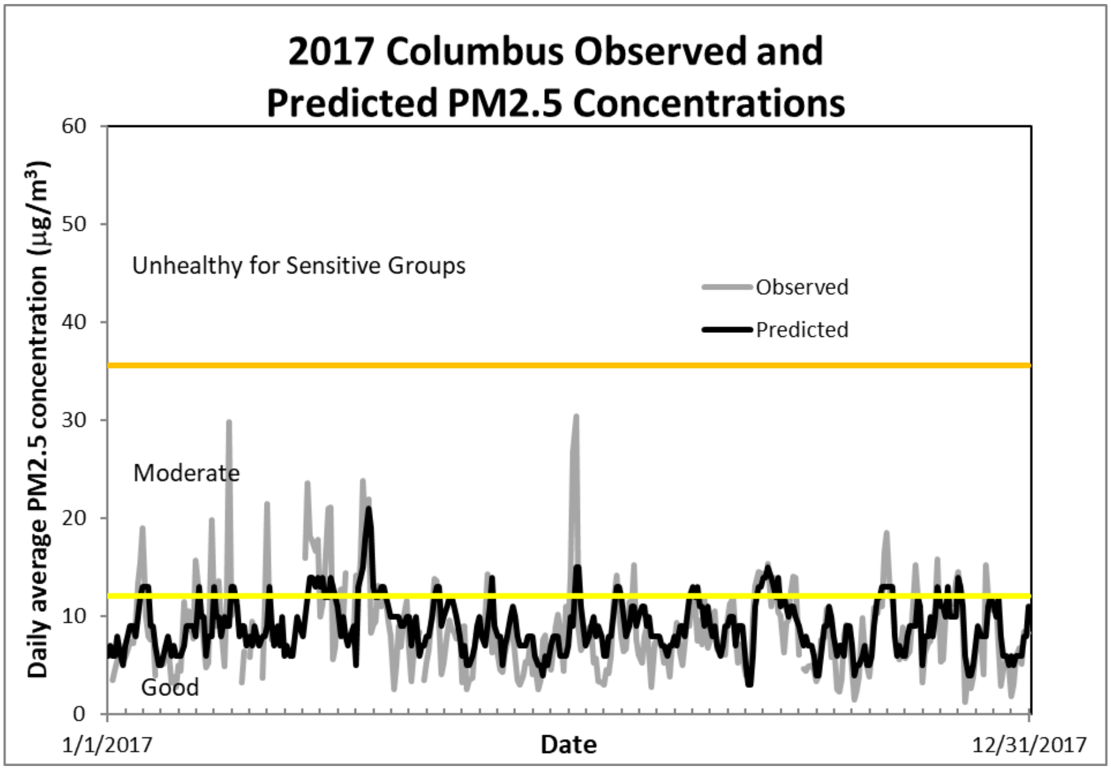
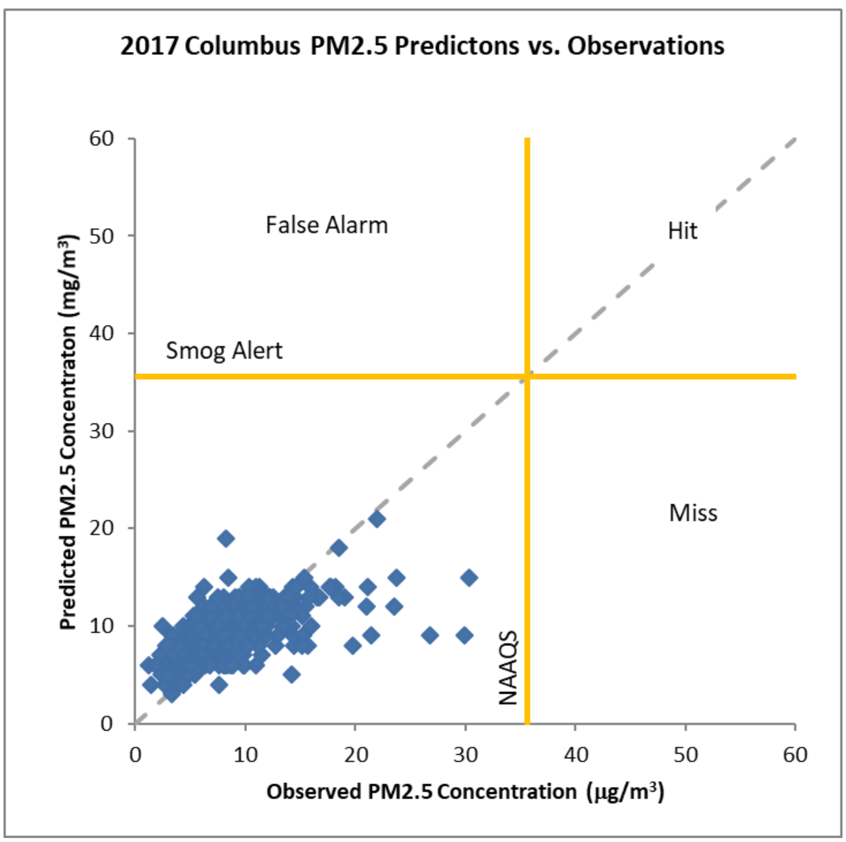


Figure 17.63. Columbus observed and predicted $PM_{2.5}$ concentrations, 2017



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

Figure 17.64. Columbus observed vs. predicted $PM_{2.5}$ concentrations, 2017

Finally, it is reasonable to consider the performance of the team and its ability to predict an impending exceedance event, particularly for ozone in Atlanta. In 2017, there were 10 exceedances of the ozone NAAQS in the Atlanta CBSA. The team only predicted one of the 10 events. If one contrasted this with performance in 2016 when the team correctly issued a smog alert on 12 of the 29 days when an exceedance occurred, one might conclude that the team's ability to forecast air quality in 2017 was poor. Other metrics, such as gross error, correlation, and the ability of the team to accurately forecast the correct Air Quality Index (AQI) 5-color code across the whole ozone season, however, suggests that the team forecasting performance in 2017 was actually better than in 2017 than in 2016. This was likely also true for the year 2015, when the team again only managed to accurately forecast one ozone NAAQS exceedance event in Atlanta.

Predicted Atlanta Ozone Air Quality:

Year	Hits	Misses	False Alarms	Bias	Gross Error	Correlation (-1 to +1)	% Accurate 2 categories	% Accurate 5 categories
2017	1	9	4	2.7 ppbv	7.2 ppbv	0.76	94	79
2016	12	17	10	1.6 ppbv	7.6 ppbv	0.65	87	63
2015	1	7	4	3.2 ppbv	7.9 ppbv	0.76	95	77
2014	5	3	7	4.2 ppbv	7.8 ppbv	0.67	95	75

These results, and other similar analyses of data dating back to 1996 (but not shown here), suggest that the team's ability to accurately forecast the next day's pollutant concentration has remained relatively consistent over time (e.g. any given ozone forecast is expected to be accurate within a range of about ±8 ppbv). In the more recent years when air quality has been notably "better" (i.e. more days with pollutant concentrations in the "good" and "moderate" AQI ranges), exceedance events, when they do occur, tend to be more modest in concentration. Rather than exceedances being characterized by multiple monitoring sites observing concentrations above the ozone NAAQS or observations of very high ozone concentrations (e.g. > 85 ppbv) at even only one site, exceedances may be observed at only a single monitoring station or may be within only a few ppbv of the 70 ppbv NAAQS threshold. It is in this context of "cleaner air" that forecasting low level exceedances is more difficult than in other "polluted air" years when exceedances are more extreme and are not subject to the ±8 ppbv limit of accuracy of the forecasting team. That is for example, an exceedance event in which the peak pollutant concentration is 88 ppbv is more likely to be predicted by the team than an event in which the peak pollutant concentration is 71 ppbv.

It should also be noted, that due to constraints in funding for the Georgia Air Quality Forecasting program, no new tools have been addressed to forecast air quality since ~2010. The team continues to rely on tools developed in earlier years when air quality in Georgia was significantly different than it is now. These tools may not be as well suited for forecasting the more "nuanced" type of exceedance events that occur today, as they were for forecasting the more "extreme" type of exceedance events that used to occur in the past. If additional funding were available in the future, it is recommended that an investment be made to develop air quality forecasting tools that are based on air quality that the state is experiencing now and is projected to experience within the next few years.

17.3.1.5 2018 Ozone and $PM_{2.5}$ Data Analysis

Characteristics of the 2018 Air Quality Forecasting Season in Atlanta, Macon, and Columbus Georgia

The table following displays statistics based on team daily predicted and final daily observed continuous ozone (daily peak 8-hour average, AQS parameter code 44201) and preliminary and final PM (daily 24-hour average, AQS parameter code 88101 and 88502) data. Observed data were retrieved from the US EPA AirNow Tech database (www.airnowtech.org) on 9/5/2019. Note: the following analyses include only days on which there are records for both observed and predicted values. In 2018, there were 365 possible days in the $PM_{2.5}$ season (January 1 – December 31), and 214 days in the ozone season (April 1 – October 31).

2018 Air Quality Forecasting Season

Observed Air Quality:

		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	140	64	10	0
Macon Ozone	209	186	23	0	0
Atlanta PM2.5	365	248	117	0	0
Columbus PM2.5	365	305	60	0	0

Predicted Air Quality:

	Hits	**Misses**	**False Alarms**	**Bias**	**Gross Error**	**Correlation (-1 to +1)**	**% Accurate 2 categories**	**% Accurate 5 categories**
Atlanta Ozone	4	6	6	1.1 ppbv	6.0 ppbv	0.81	94	82
Macon Ozone	0	0	0	1.9 ppbv	5.8 ppbv	0.78	100	90
Atlanta PM2.5	0	0	0	0.0 $\mu g/m^3$	2.2 $\mu g/m^3$	0.70	100	78
Columbus PM2.5	0	0	0	-0.5 $\mu g/m^3$	2.4 $\mu g/m^3$	0.60	100	86

Observed and Predicted Air Quality:

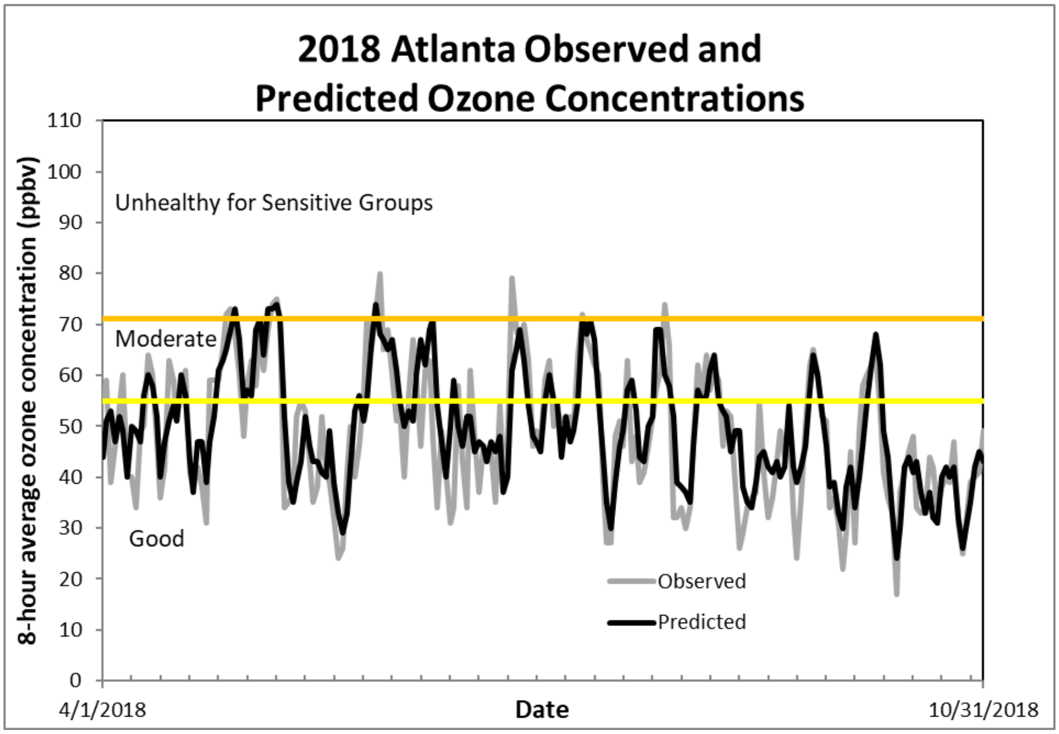


Figure 17.65. Atlanta observed and predicted ozone concentrations, 2018

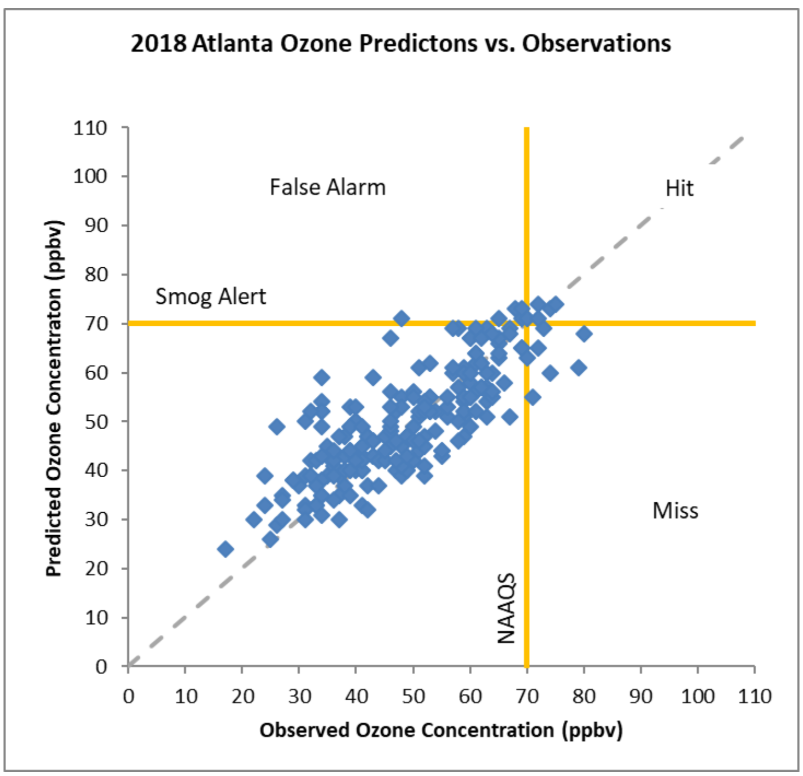


Figure 17.66. Atlanta observed vs. predicted ozone concentrations, 2018

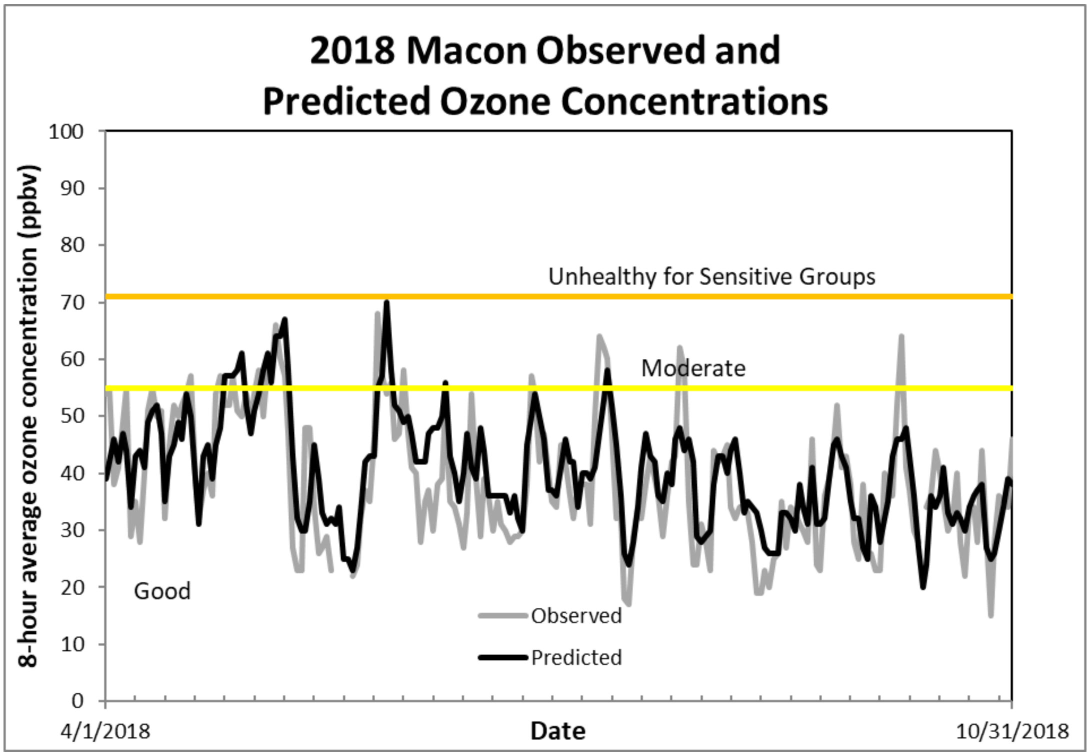


Figure 17.67. Macon observed and predicted ozone concentrations, 2018

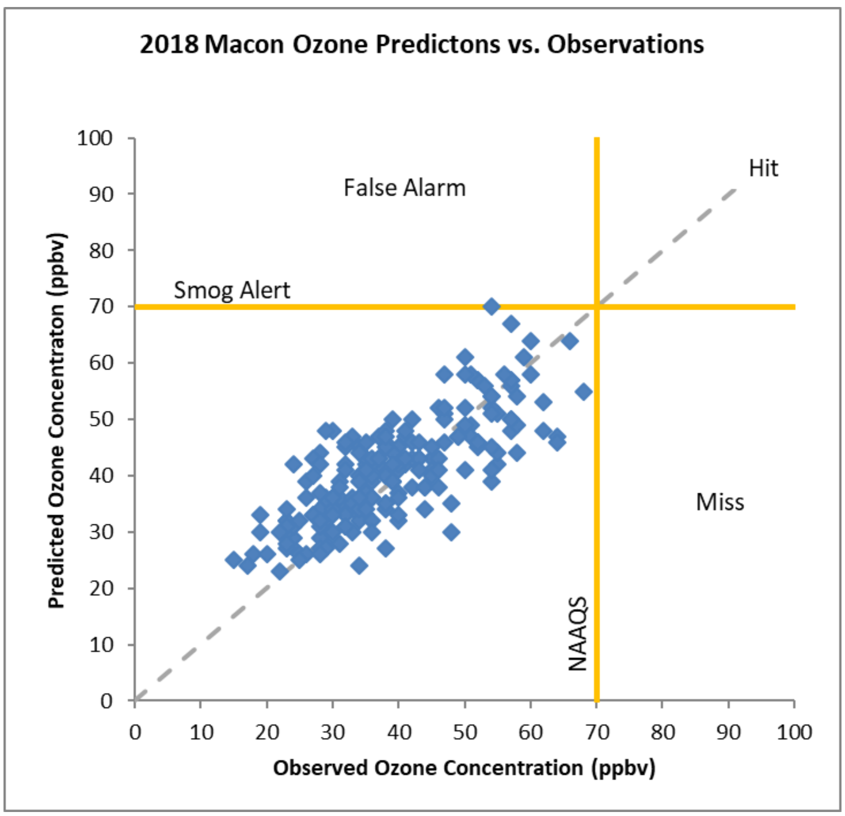


Figure 17.68. Macon observed vs. predicted ozone concentrations, 2018

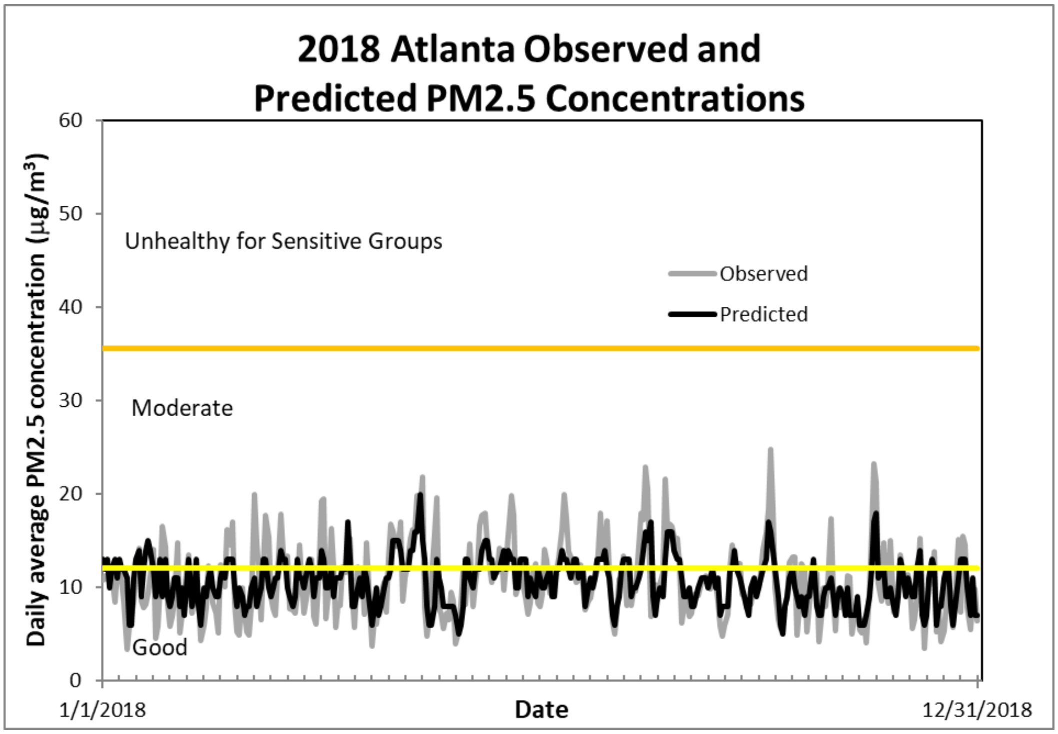


Figure 17.69. Atlanta observed and predicted $PM_{2.5}$ concentrations, 2018

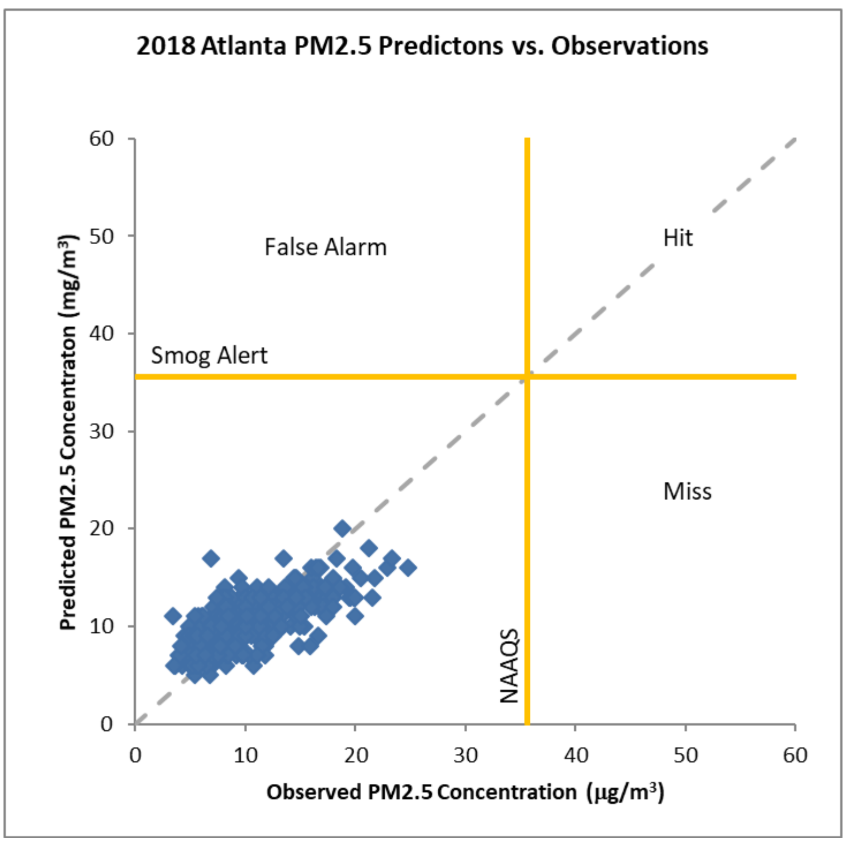


Figure 17.70. Atlanta observed vs. predicted $PM_{2.5}$ concentrations, 2018

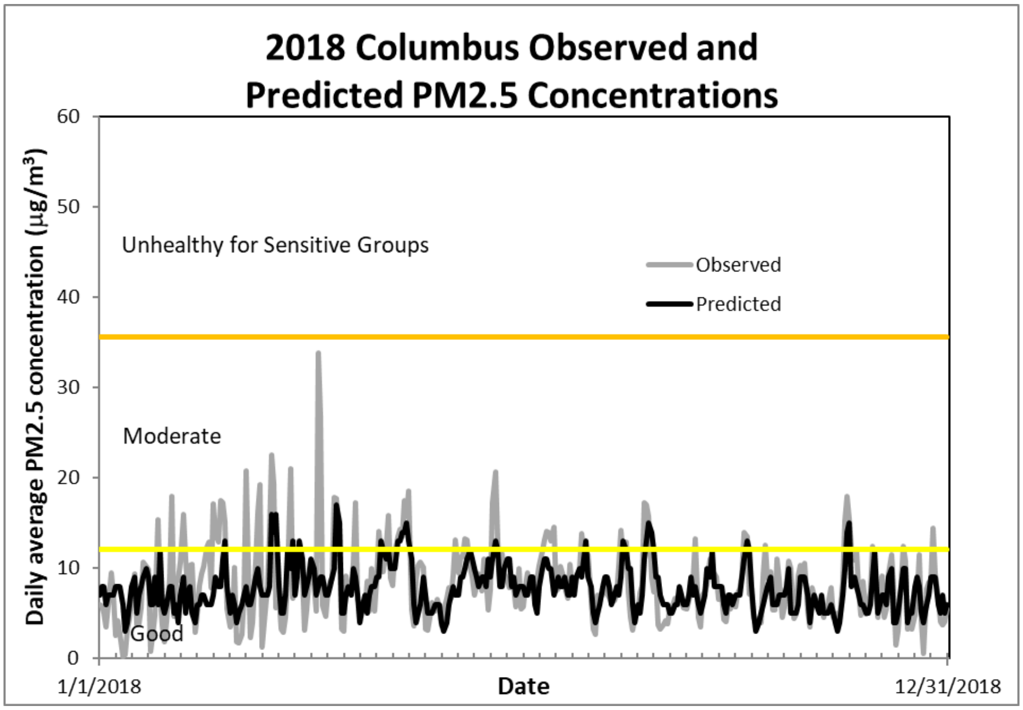
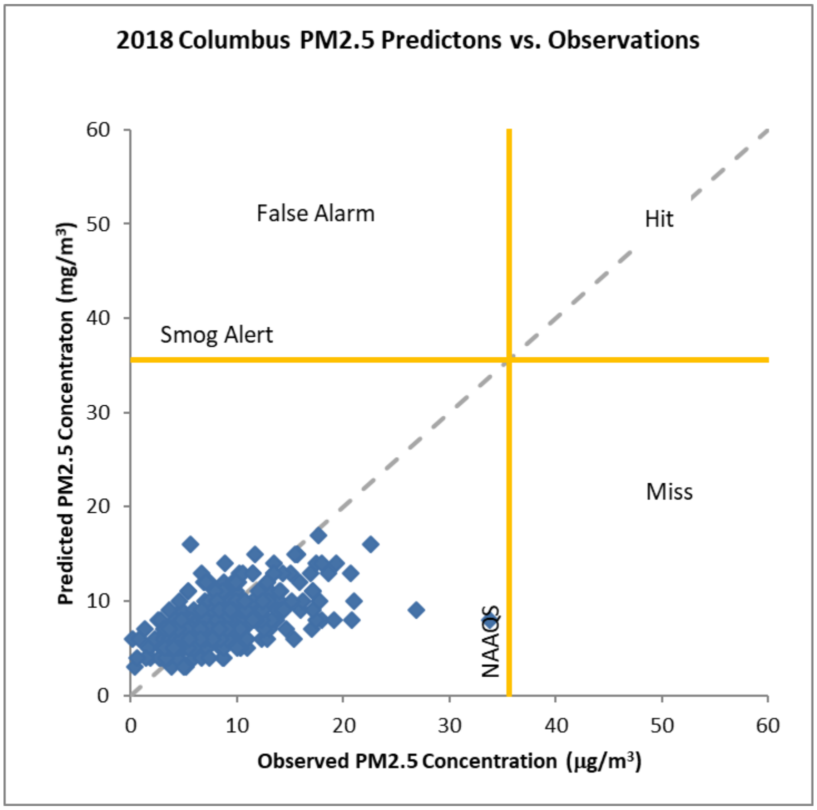


Figure 17.71. Columbus observed and predicted $PM_{2.5}$ concentrations, 2018



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

Figure 17.72. Columbus observed vs. predicted $PM_{2.5}$ concentrations, 2018

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 AAMP 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 AAMP 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. In 2013 the continuous gas chromatograph at Conyers was shut down, and in 2015, the 6-day PAMS canister and $NO/NO_2/NO_x$ monitors were shut down. Then in 2017 the Yorkville site was shut down. At this point, Conyers is only used to measure solar radiation and total ultra violet radiatoin, and South DeKalb is the only PAMS site in the GA AAMP network.

Also according to EPA, PAMS monitoring is to be implemented at sites that are part of the NCore network. For GA AAMP, the South DeKalb site serves as the NCore site; therefore, the GA AAMP is meeting this requirement by monitoring for PAMS pollutants at this site.

South DeKalb is expected to measure the highest precursor concentrations of NOx 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, 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 current PAMS site is shown in Figure 18.1.

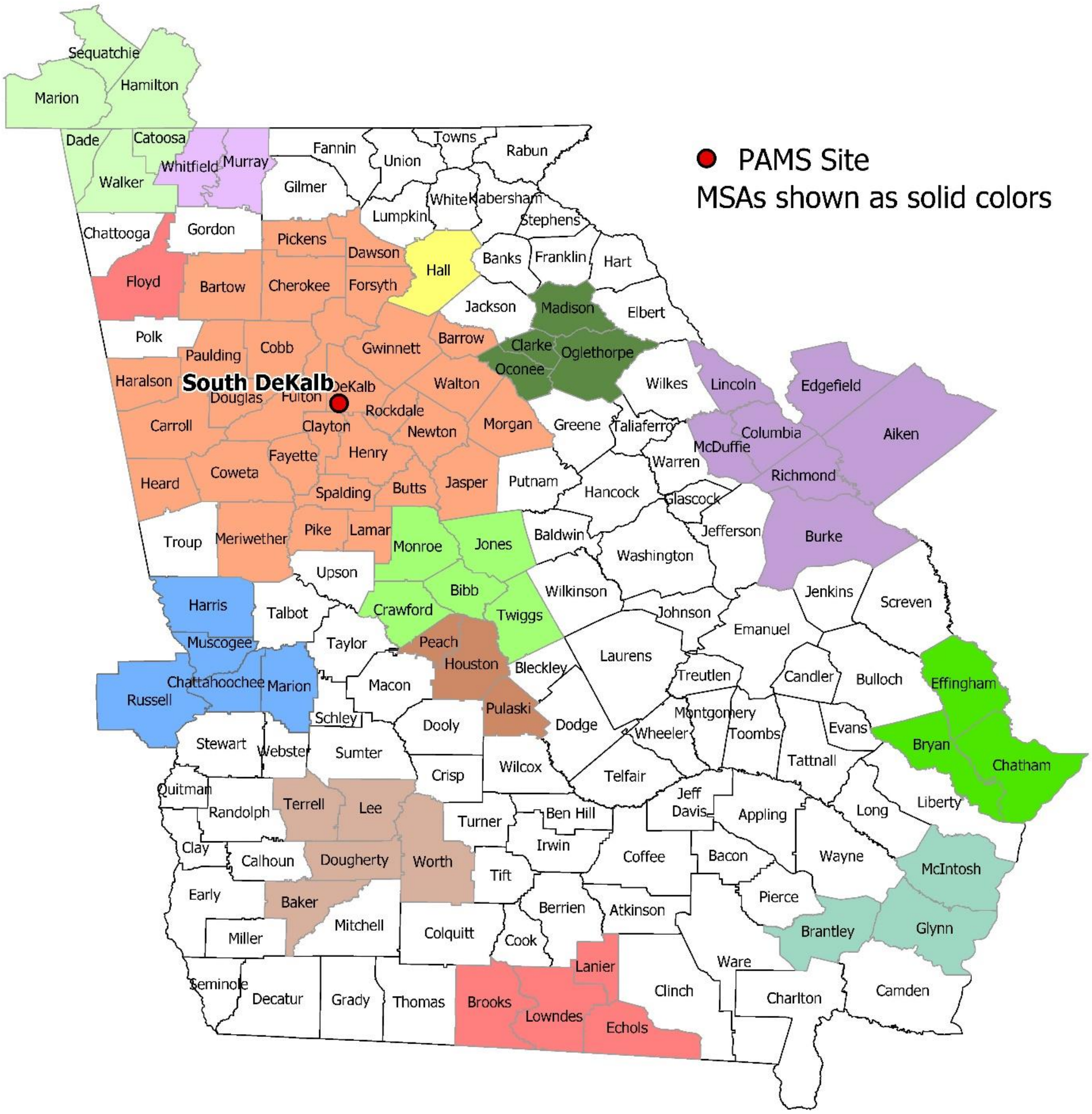


Figure 18.1: Georgia PAMS Monitoring Site, MSAs Shown as Solid Colors

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 is 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.

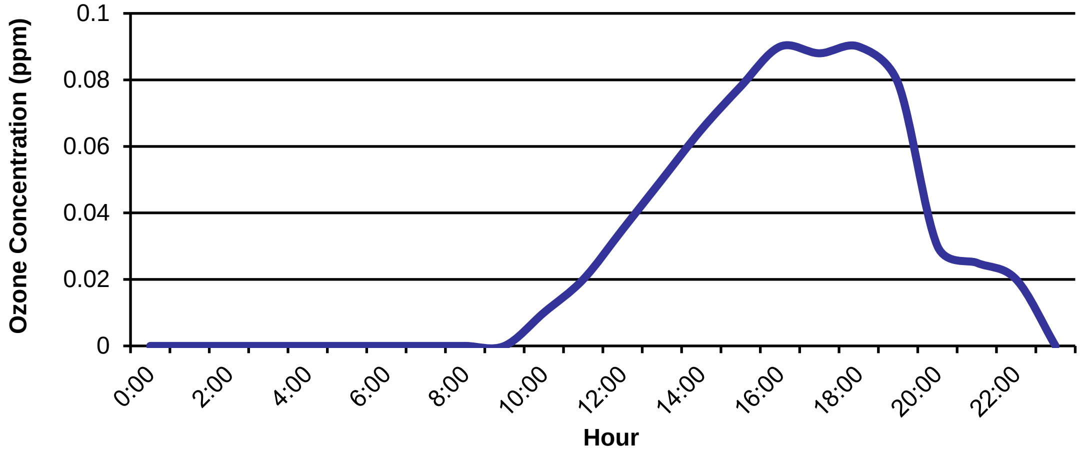
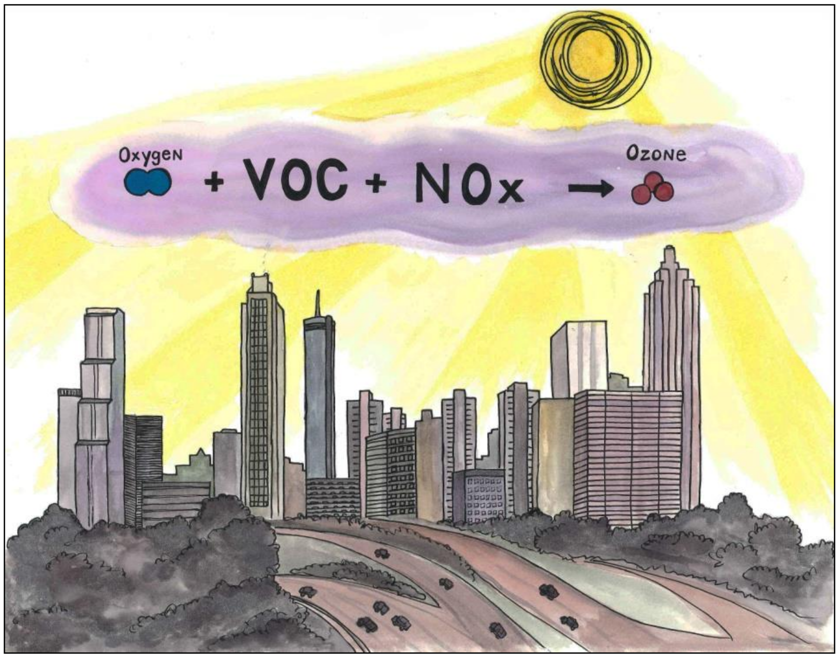


Figure 18.2: Typical Urban 1-hour Ozone Diurnal Pattern

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 2014 data.

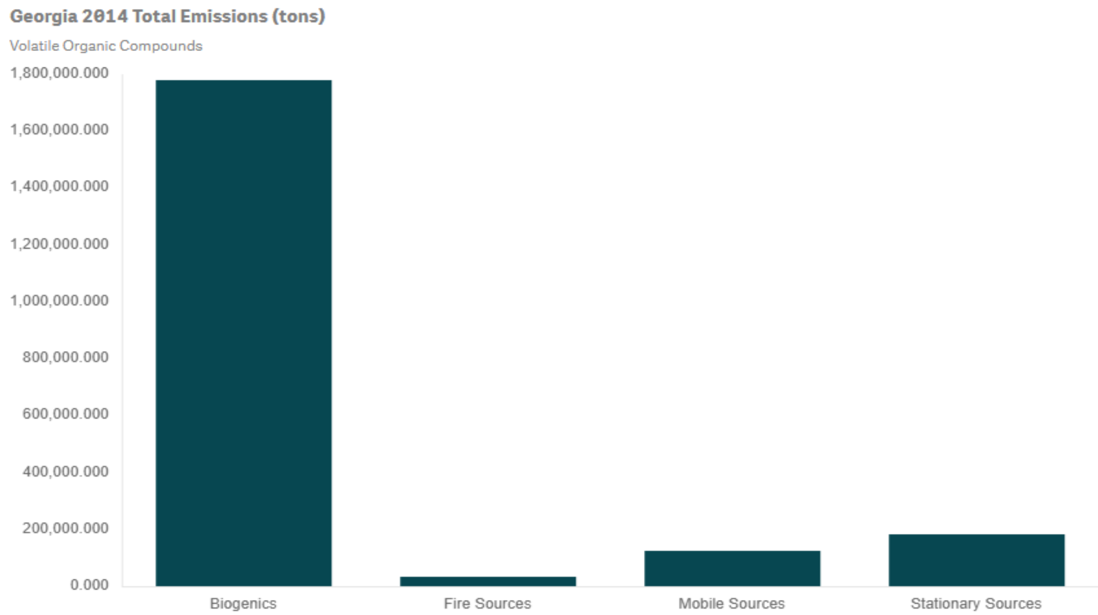


Figure 18.4: Common Sources of VOCs in Georgia in 2014

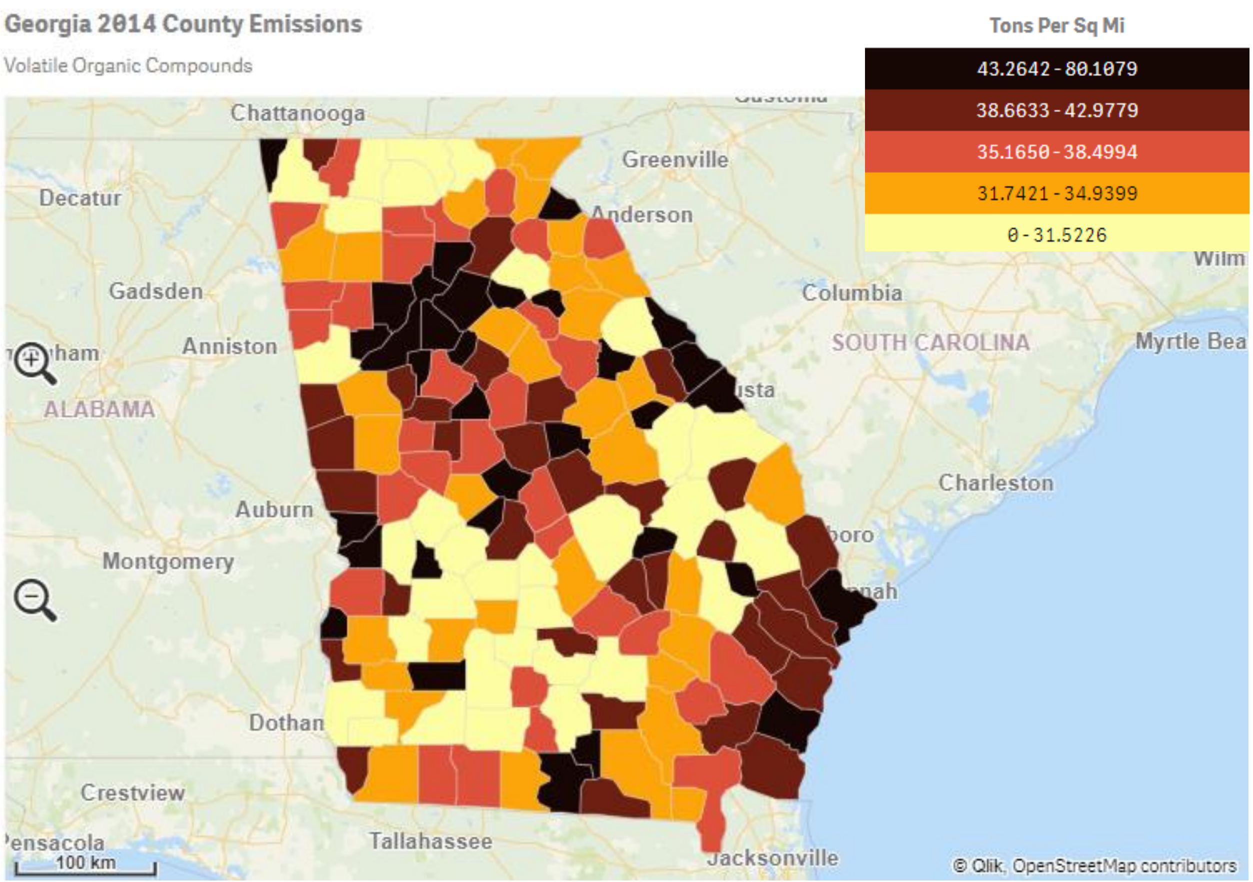


Figure 18.5: Spatial View of VOCs Emissions in Georgia

Figure 18.6 shows the seasonal occurrence of isoprene, the tracer for VOCs emissions from vegetation. Isoprene is a 5 carbon organic compound naturally released on a seasonal basis in large quantities by conifer trees native to Georgia. Evidence of isoprene's natural seasonal origin is shown in this figure, where the ambient concentration is essentially non-existent from November to May.

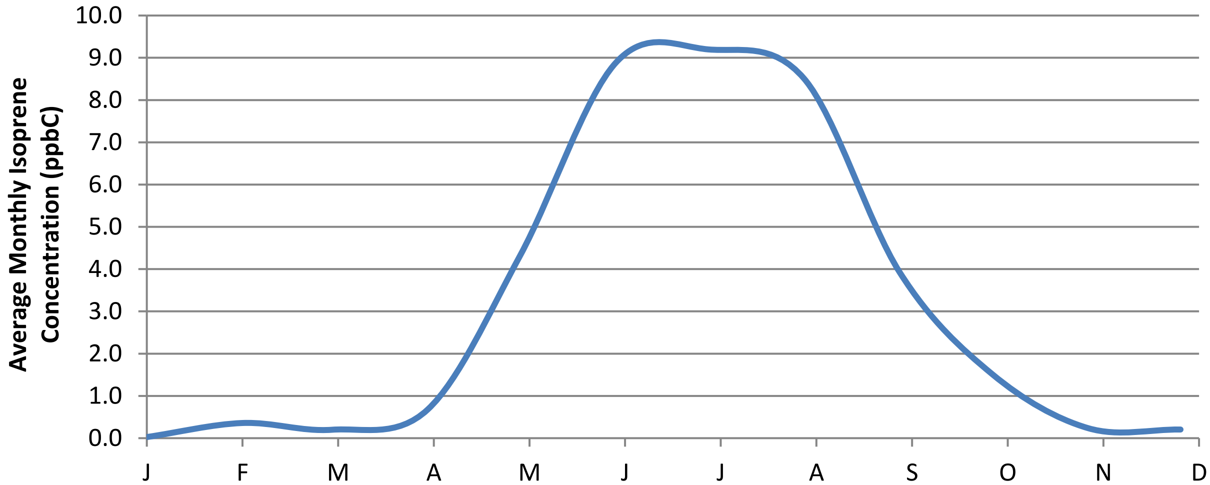


Figure 18.6: Average Yearly Profile of Isoprene

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.

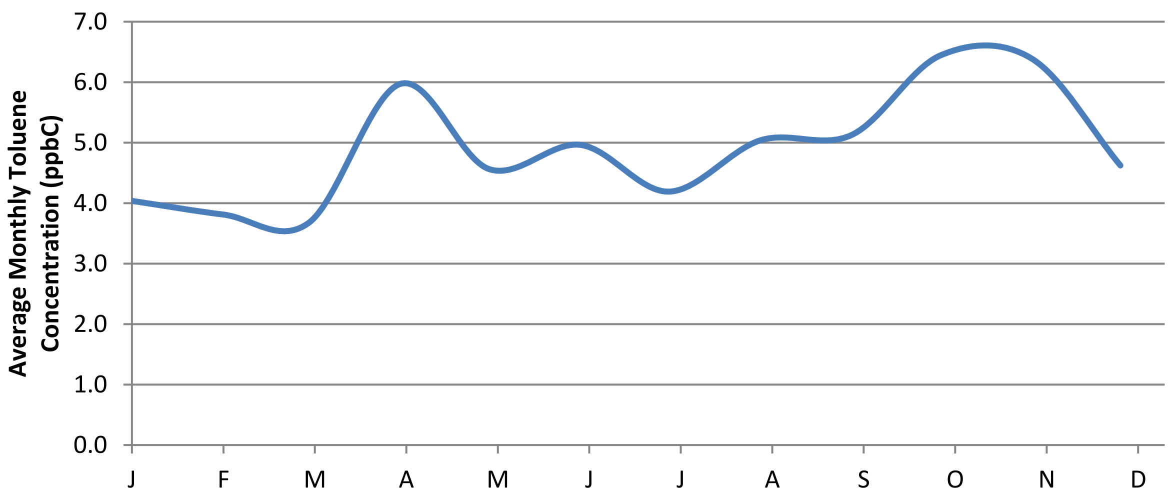


Figure 18.7: Toluene Average Annual Occurrence

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.

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

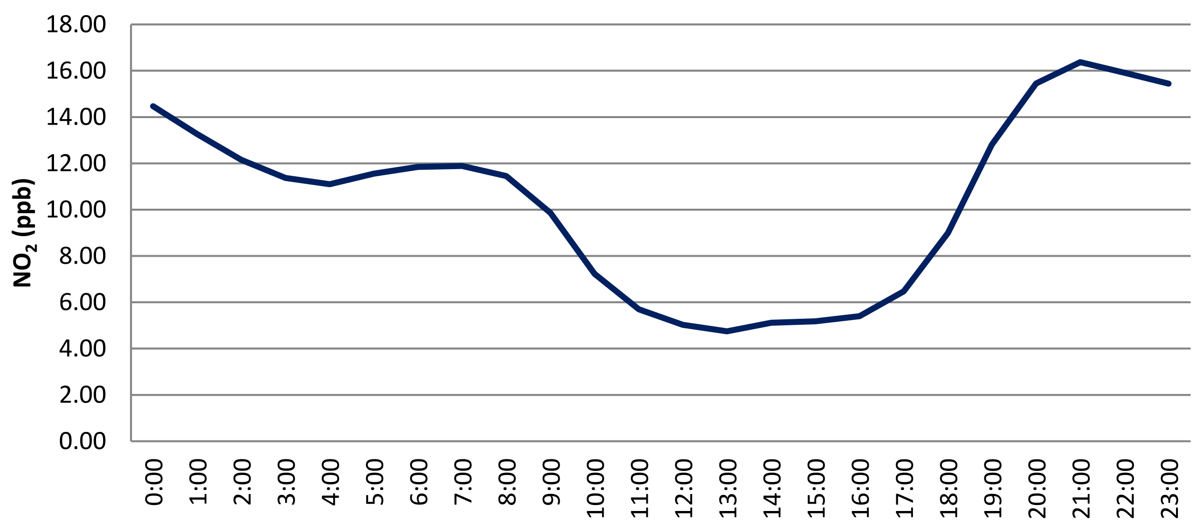


Figure 18.8: Typical Diurnal Pattern of Nitrogen Dioxide

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 2014. Figures 18.9 and 18.10 are taken from the latest emissions report from EPA, based on 2014 data. Mobile sources are the biggest contributor to NO_x in Georgia.

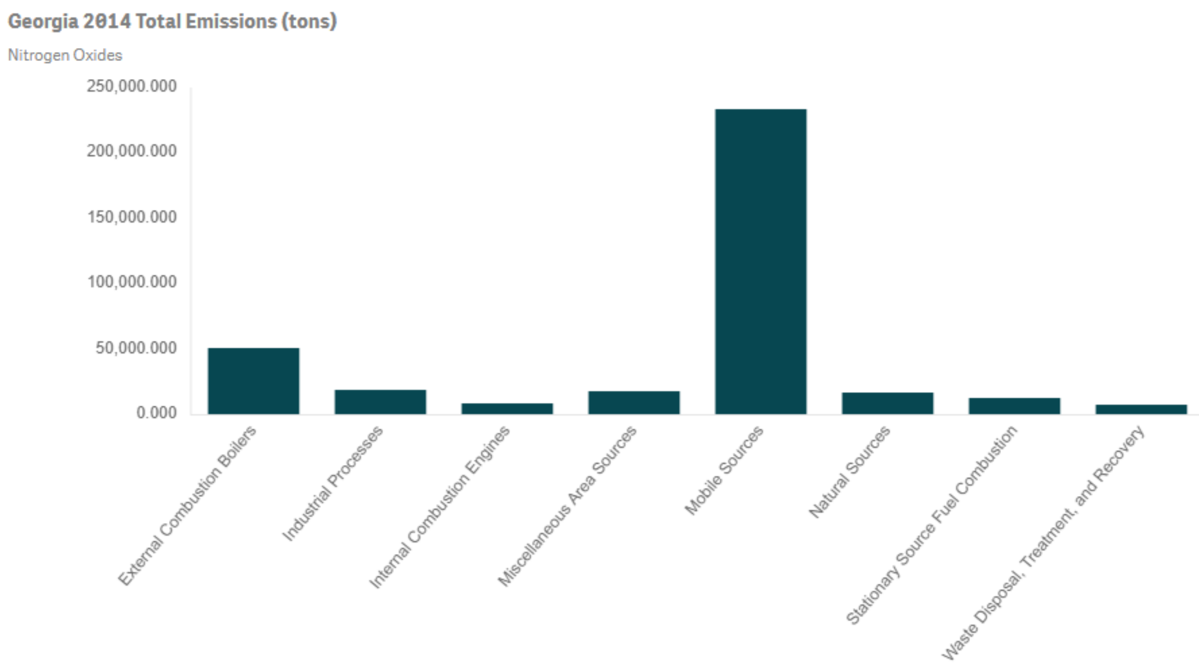


Figure 18.9: Common Sources of Nitrogen Oxides in Georgia in 2014

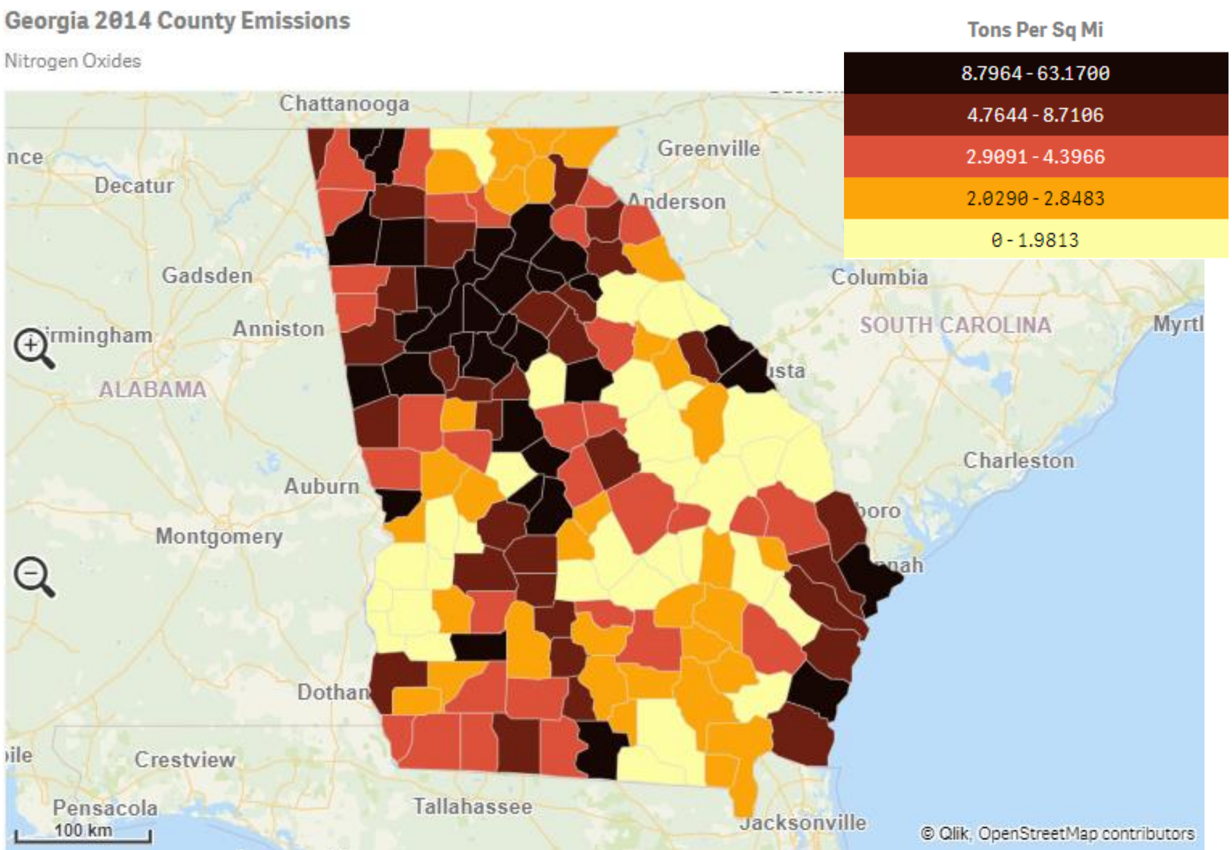


Figure 18.10: Spatial View of Nitrogen Oxides Emissions in Georgia

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 *"Clean Air Act Section 110(l) Noninterference Demonstration for the Relaxation of Summertime Reid Vapor Pressure Requirements in the Former 13-County Atlanta Designated Volatility Nonattainment Area"* dated August 15, 2018. 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 D of the SIP *"Clean Air Act Section 110(l) Noninterference Demonstration for the Relaxation of Summertime Reid Vapor Pressure Requirements in the Former 13-County Atlanta Designated Volatility Nonattainment Area"* dated August 15, 2018:

'APPENDIX D - 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 C.*

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, ppt/TPD) at 9 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 "Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze" (December 3, 2014). For our analysis, the 10 highest modeled days in 2018 were selected to be included in the average sensitivity calculation at each monitoring site to address the 2008 and 2015 ozone NAAQS.*

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 ***6.487 ppb*** *for a 30% reduction in NOx emissions across Georgia and the average absolute VOC sensitivity across Atlanta is* ***0.351 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 result 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 9 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 maintenance counties are 281.5 TPD, so a 30% reduction is 84.5 TPD. The anthropogenic VOC emissions in the 15 ozone maintenance 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 ***0.07680 ppb/TPD*** *and the average normalized VOC sensitivity across Atlanta is* ***0.00417 ppb/TPD****.*

Table 1. *Absolute NOx and VOC sensitivity at 9 Atlanta ozone monitors.*

AIRS ID	***County***	***Site Name***	***30% NOx (ppb)***	***30% VOC (ppb)***
13-067-0003	*Cobb, GA*	*Kennesaw*	*-6.260*	*-0.412*
13-077-0002	*Coweta, GA*	*Newnan*	*-6.807*	*-0.148*
13-085-0001	*Dawson, GA*	*Dawsonville*	*-4.333*	*-0.005*
13-089-0002	*DeKalb, GA*	*South DeKalb*	*-7.385*	*-0.576*
13-097-0004	*Douglas, GA*	*Douglasville*	*-6.732*	*-0.350*
13-121-0055	*Fulton, GA*	*Confederate Ave.*	*-5.428*	*-0.884*
13-135-0002	*Gwinnett, GA*	*Gwinnett*	*-6.440*	*-0.222*
13-151-0002	*Henry, GA*	*McDonough*	*-7.341*	*-0.282*
13-247-0001	*Rockdale, GA*	*Conyers*	*-7.655*	*-0.277*
		AVERAGE (ppb)	***-6.487***	***-0.351***

Table 2. *Normalized NOx and VOC sensitivity at 9 Atlanta ozone monitors.*

AIRS ID	***County***	***Site Name***	***30% NOx (ppb/TPD)***	***30% VOC (ppb/TPD)***
13-067-0003	*Cobb, GA*	*Kennesaw*	*-0.0741*	*-0.0049*
13-077-0002	*Coweta, GA*	*Newnan*	*-0.0806*	*-0.0018*
13-085-0001	*Dawson, GA*	*Dawsonville*	*-0.0513*	*-0.0001*
13-089-0002	*DeKalb, GA*	*South DeKalb*	*-0.0874*	*-0.0069*
13-097-0004	*Douglas, GA*	*Douglasville*	*-0.0797*	*-0.0042*
13-121-0055	*Fulton, GA*	*Confederate Ave.*	*-0.0643*	*-0.0105*
13-135-0002	*Gwinnett, GA*	*Gwinnett*	*-0.0763*	*-0.0026*
13-151-0002	*Henry, GA*	*McDonough*	*-0.0869*	*-0.0034*
13-247-0001	*Rockdale, GA*	*Conyers*	*-0.0906*	*-0.0033*
		AVERAGE (ppb/TPD)	***-0.07680***	***-0.00417***

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:

- *(0.07680 ppb/TPD NOx)/(0.00417 ppb/TPD VOC) =* ***18.4 TPD VOC/TPD NOx***

In other words, a 18.4 TPD increase in VOC emissions is equivalent to a 1.0 TPD increase in NOx emissions. Hence, a 18.4 TPD increase in VOC emissions can be offset with a 1.0 TPD reduction in NOx emissions.'

Case Study: 2016 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 6/1/2016-8/31/2016 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 (70 ppb); there were five ozone violation days between 6/10/2016 and 7/20/2016. In all of the violation cases, the solar radiation for the specific date was higher than the average solar radiation per days across the time period. Additionally, for 4 out of the 5 dates, the NO_X concentrations were above average. VOCs were only measured for 4 of the violation days; 3 of 4 days had VOC concentrations greater than average. This seems to suggest a pattern of ozone violation days occurring when all three parameters (NO_x, VOC, and solar radiation) have high concentrations.

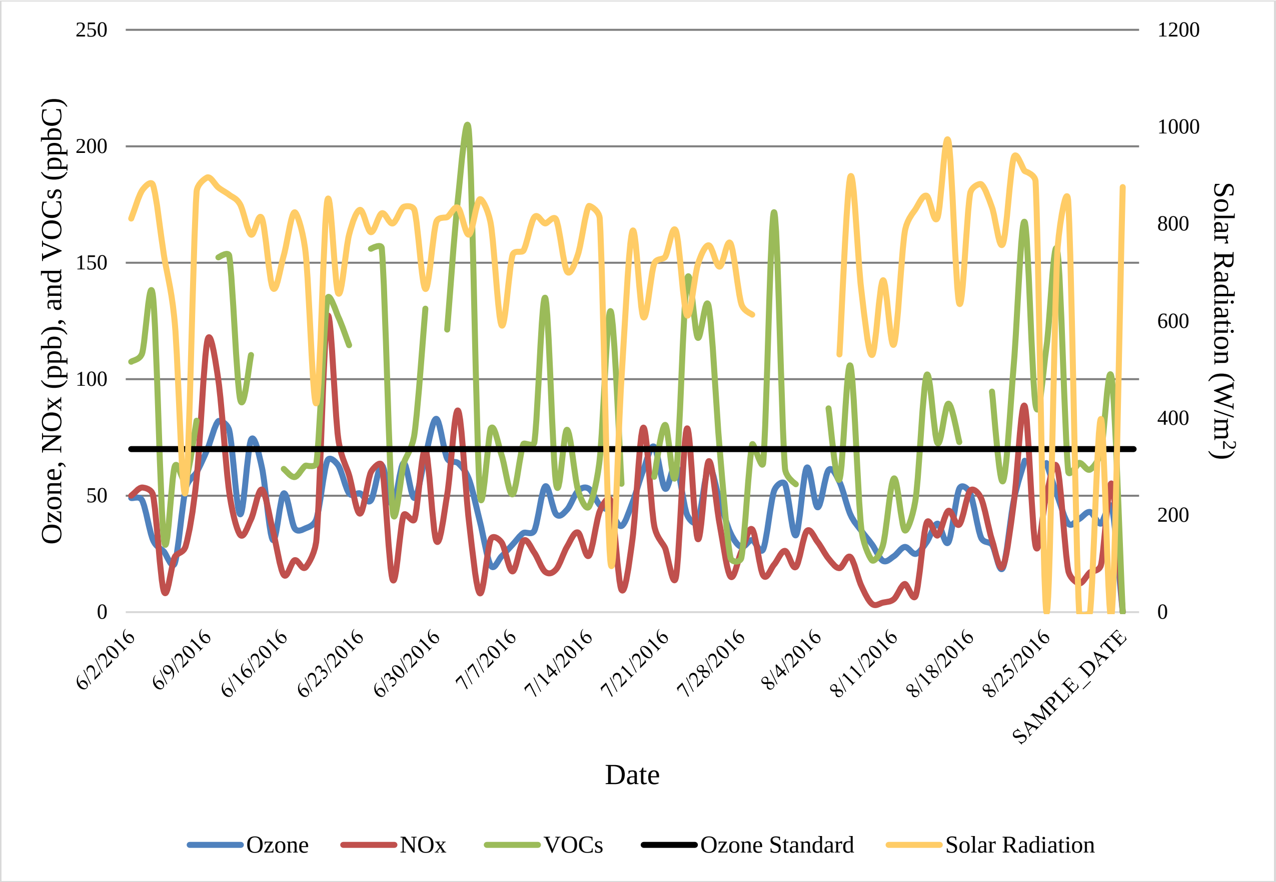


Figure 18.11: Daily Maximum Ozone, NO_x, and VOCs Concentrations and Solar Radiation at South DeKalb, 6/1/2016-8/31/2016

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 6/1/2016-8/31/2016. NO_x concentrations appear to be more highly correlated (r^2=0.3242) to ozone than VOCs concentrations (r^2=0.2931).

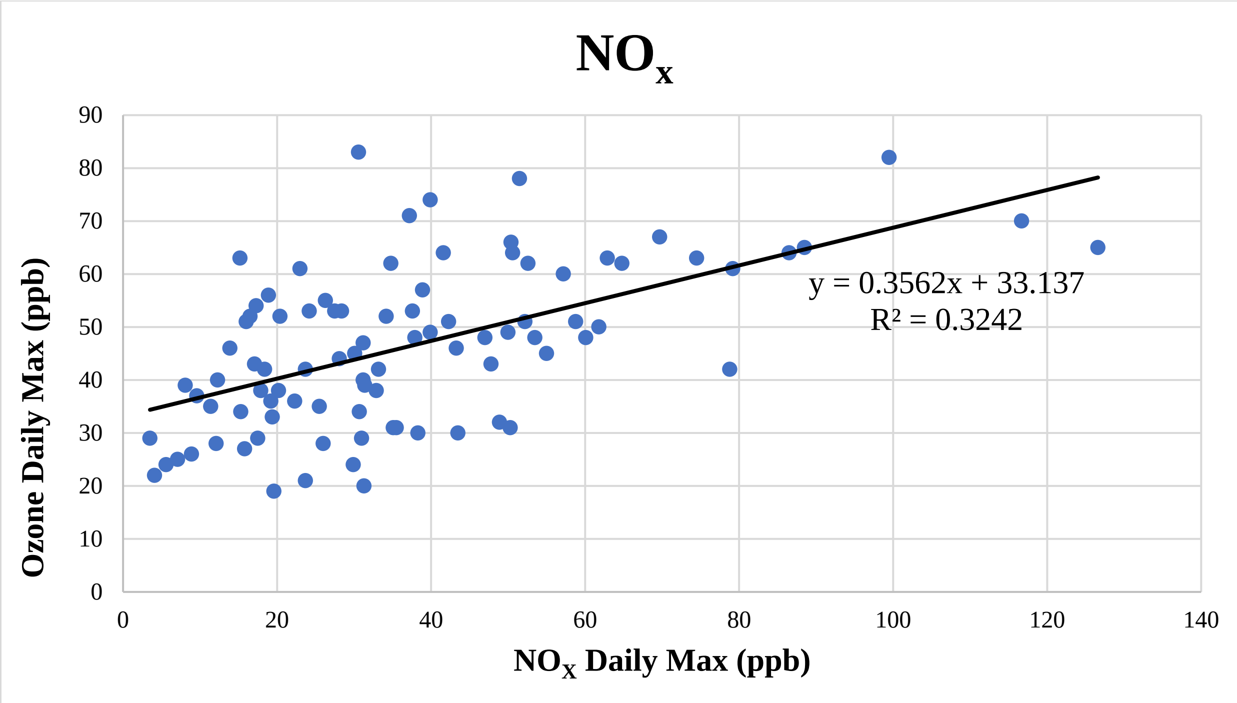
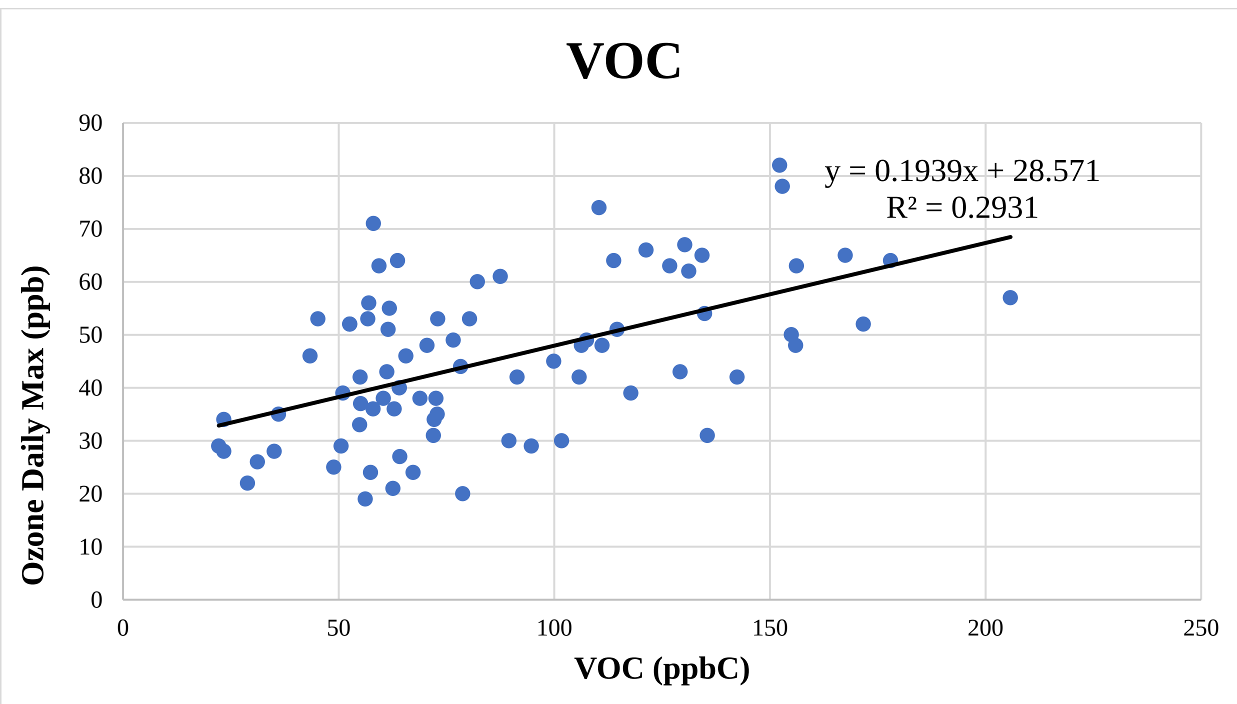


Figure 18.12: Ozone vs NO_x Daily Maximum Concentrations



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 NO_x and ozone concentrations, and the summer (June 1-August 21) 1-hour averages for the VOCs concentrations at the South DeKalb site. The graph also indicates when the Multi-Pollutant Rule was implemented. With the implantation of this rule, both ozone and NO_x concentrations show a consistent decrease in concentrations. The VOCs are not directly controlled by the Multi-Pollutant Rule, and do not show a consistent pattern, but have had an overall decrease since 1995.

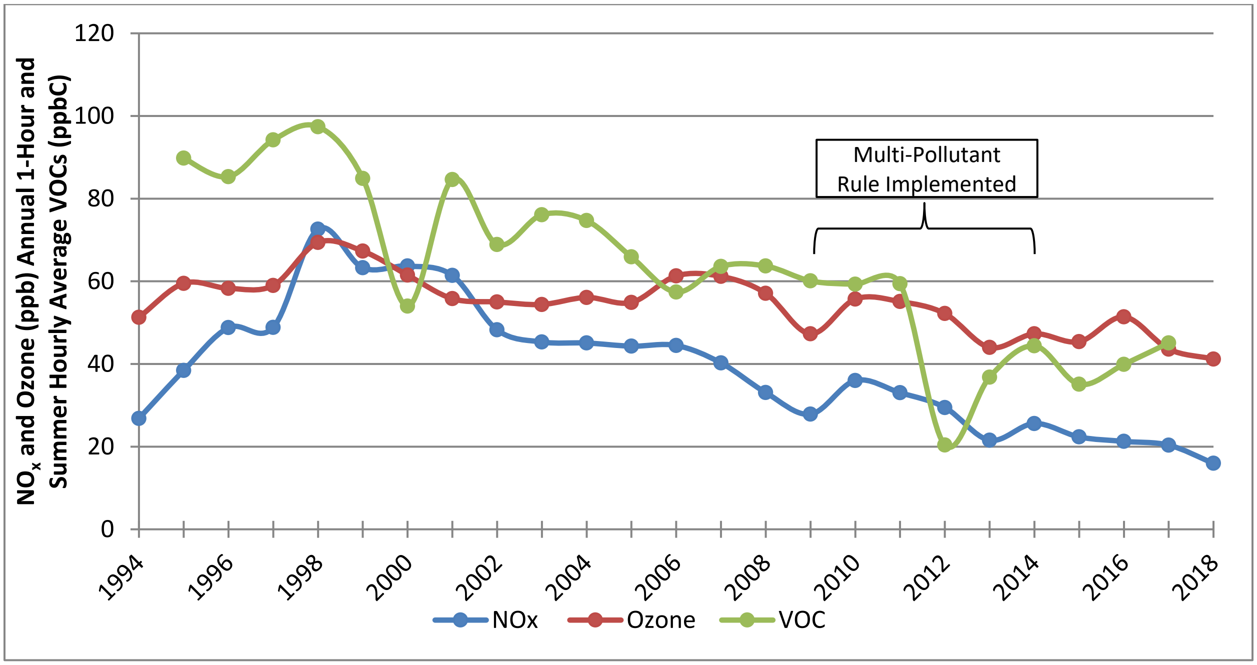


Figure 18.14: Average Annual 1-Hour NO_X and Ozone, and Summer Hourly Average VOC Concentrations for South DeKalb, 1994 - 2018

Figure 18.15 shows Georgia's annual average NO_2 concentrations from 2000 to 2018. Annual average concentrations are well below the standard of 53 ppb and show a slight decreasing trend.

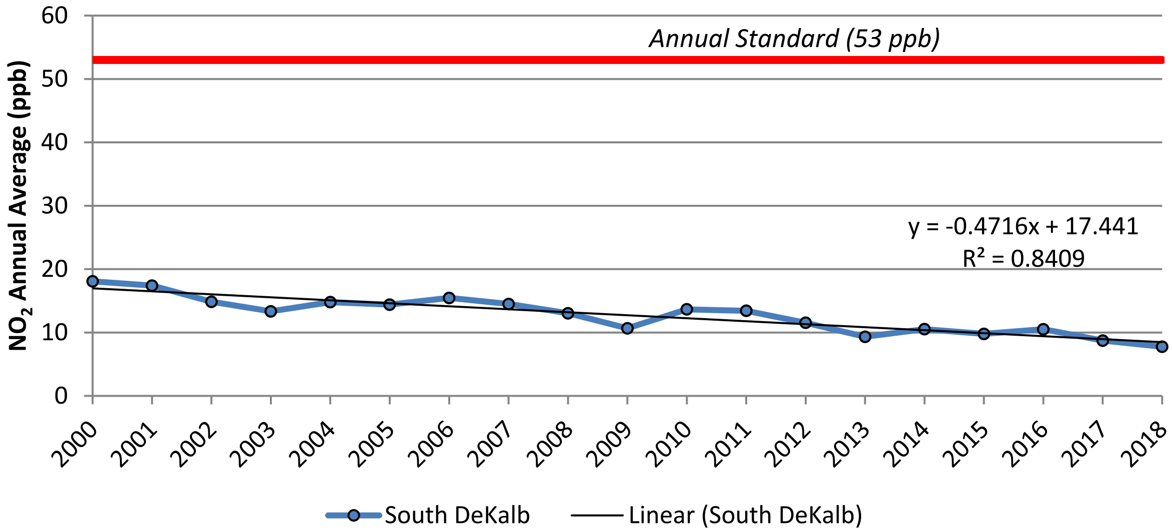


Figure 18.15 Nitrogen Dioxide Annual Averages Compared to the Annual Standard

Figure 18.16 displays the three-year averages of the 98th% of annual daily maximum 1-hour averages (1-hour design values), as available from 2000 to 2018. The 1-hour design values are well below the 100 ppb standard and have consistently dropped since the 2000-2002 averages.

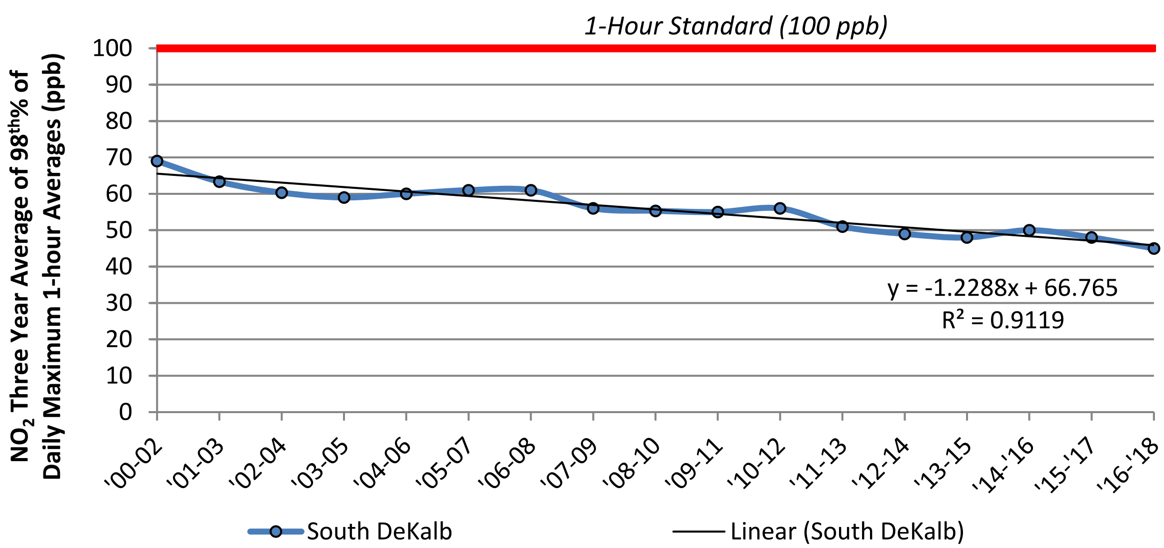


Figure 18.16: Nitrogen Dioxide 1-hour Design Values Compared to the 1-hour Standard

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.

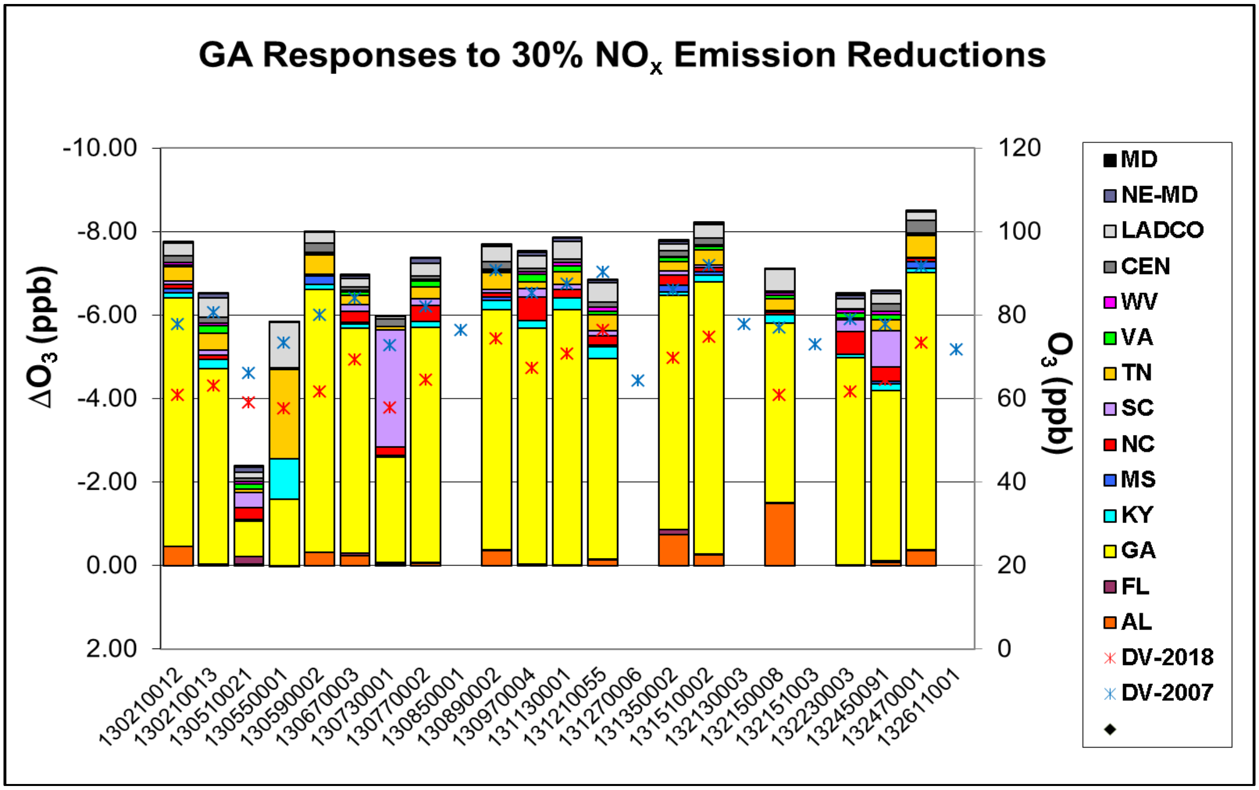


Figure 18.20: Modeled Changes in Ozone Concentrations at Georgia Monitors in Response to 30% NO_x Emissions Reductions

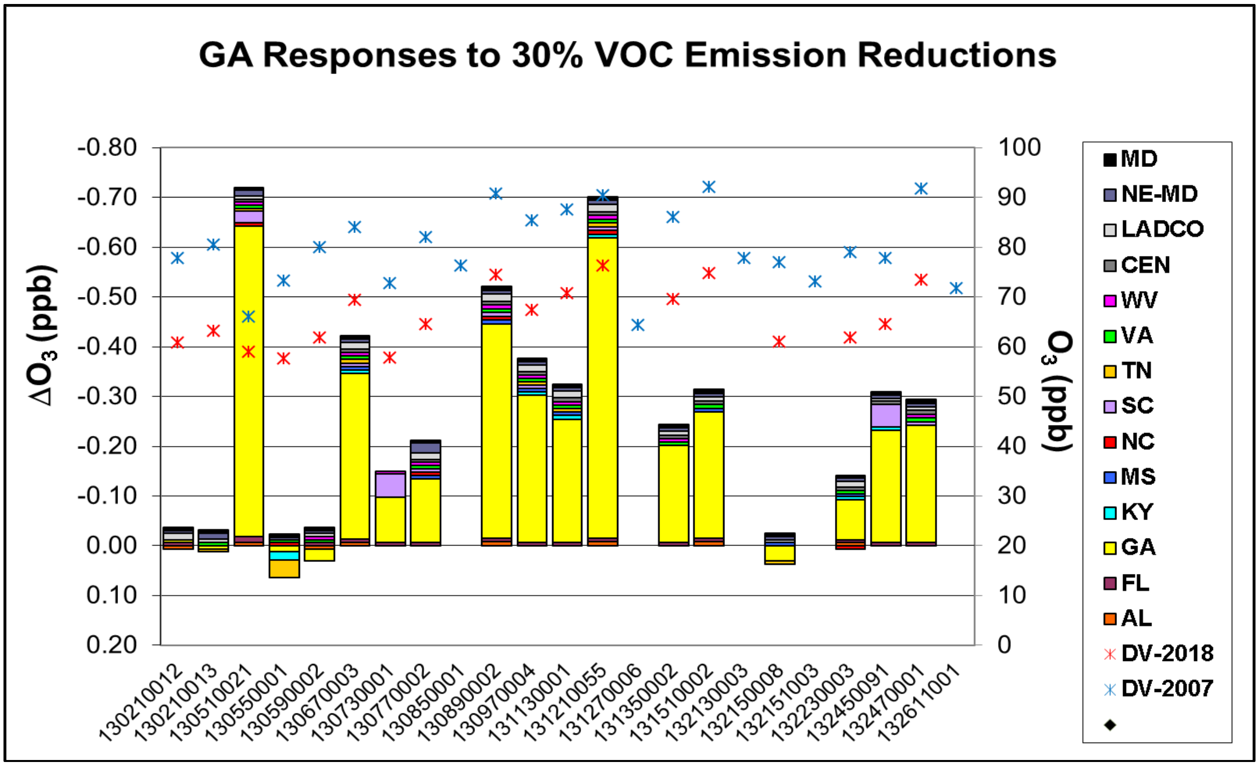


Figure 18.21: Modeled Changes in Ozone Concentrations at Georgia Monitors in Response to 30% VOCs Emissions Reductions

18.4 Assessing the Siting of Georgia's PAMS Stations

The South DeKalb 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 wind roses for 2016 through 2018 (Appendix E) 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 6.0) and Deviation from the NAAQS Assessment (Section 8.0), the South DeKalb site has lower concentrations of CO and NO_2 when compared to the other sites (NR-GA Tech and NR-285): however, the other sites are located in close proximity to monitor near-road emissions. In addition, the South DeKalb PAMS site has been collocated with the NCore network requirements since 2011.

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 Conclusion

As part of the requirements for the Environmental Protection Agency's (EPA) amended ambient air monitoring regulations established on October 17, 2006, GA AAMP has performed a Five-Year Assessment. The assessment addresses GA AAMP'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 E shows wind roses, as well as $PM_{2.5}$ and ozone pollutions wind roses, across the state for 2016 through 2018, 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 19.1 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 AAMP due to areas of Georgia being in nonattainment for these two pollutants, either currently (ozone) or in the past ($PM_{2.5}$). 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 AAMP performed extensive evaluation on data collected from 2014 through 2018.

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
131350002	Gwinnett Tech	0.36	1.50	1.5	0.04	8.0	0.235	0.239	0.36	12.234	1.529	1
130670003	Kennesaw	0.29	1.60	1.5	0.04	7.5	0.235	0.575	0.14	11.880	1.485	2
130850001	Dawsonville	0.53	0.64	1.5	0.04	8.0	0.235	0.195	0.43	11.570	1.446	3
130890002	South DeKalb	0.71	1.73	1.5	1.00	6.0	0.235	0.089	0.21	11.474	1.434	4
132470001	Conyers	0.64	0.88	2.0	0.26	6.5	0.235	0.071	0.43	11.016	1.377	5
130970004	Douglasville	0.32	0.72	1.5	0.04	7.5	0.235	0.281	0.29	10.886	1.361	6
132319991	CASTNET	0.08	0.68	1.5	0.00	7.5	0.235	0.248	0.21	10.453	1.307	7
131210055	United Ave.	0.42	1.00	1.5	0.11	6.0	0.235	0.027	1.00	10.292	1.287	8
131510002	McDonough	0.29	0.88	1.5	0.04	6.0	0.235	0.053	0.79	9.788	1.224	9
132450091	Augusta	0.68	1.70	1.5	0.33	1.5	0.168	0.749	0.93	7.557	0.945	10
130590002	Athens	0.24	1.28	1.5	0.04		0.256	0.917	0.57	4.803	0.686	11
132150008	Columbus-Airport	0.58	0.95	1.5	0.07	1.0	0.142	0.532	0.21	4.984	0.623	12
130210012	Macon-Forestry	0.32	0.91	1.5	0.15	0.0	0.029	1.097	0.21	4.216	0.527	13
132611001	Leslie	0.59	0.44	1.5	0.00		0.149	1.000	0.00	3.679	0.526	14
130511002	Savannah-L&A	0.75	1.23	0.5	0.07		0.246	0.710	0.00	3.506	0.501	15
130730001	Evans	0.19	0.44	1.0	0.11	1.5	0.168	0.259	0.07	3.737	0.467	16
131270006	Brunswick	0.49	1.02	0.0	0.07		0.091	1.084	0.14	2.895	0.414	17
132130003	Fort Mountain	0.29	0.64	1.5	0.11		0.024	0.258	0.07	2.892	0.413	18
132150011	Columbus-Cusseta	0.42	1.77	0.5	0.07	0.0	0.147	0.286	0.07	3.263	0.408	19
130550001	Summerville	0.44	0.48	1.5	0.00		0.125	0.266	0.00	2.811	0.402	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
130950007	Albany	0.42	1.39	0.0	0.04		0.064	0.727	0.14	2.781	0.397	21
131210056	NR-GA Tech	0.03	1.52	1.0	0.19	0.0	0.235	0.000	0.00	2.975	0.372	22
131530001	Warner Robins	0.27	0.69	0.0	0.04		1.000	0.382	0.14	2.522	0.360	23
131210039	Fire Station #8	0.73	1.25	0.5	0.04	0.0	0.235	0.034	0.00	2.789	0.349	24
133030001	Sandersville	0.71	0.91	0.0	0.00		0.092	0.635	0.00	2.347	0.335	25
132950002	Rossville	0.83	0.90	0.0	0.07		0.110	0.182	0.21	2.302	0.329	26
130510021	Savannah-E. Pres. St.	0.36	0.36	0.0	0.33		0.246	0.593	0.21	2.099	0.300	27
130210007	Macon-Allied	0.71	1.26	0.0	0.07	0.0	0.029	0.184	0.14	2.393	0.299	28
131850003	Valdosta	0.29	0.53	0.0	0.04		0.090	1.000	0.07	2.020	0.289	29
130630091	Forest Park	0.64	1.13	0.0	0.00	0.0	0.235	0.284	0.00	2.289	0.286	30
132150001	Columbus-Health Dept.	1.00	1.01	0.0	0.00	0.0	0.147	0.034	0.07	2.261	0.283	31
130690002	General Coffee	0.27	0.00	0.0	0.04		0.434	0.864	0.00	1.608	0.230	32
131390003	Gainesville	0.29	0.59	0.0	0.04		0.210	0.328	0.14	1.598	0.228	33
131150003	Rome	0.71			0.04		0.034		0.07	0.854	0.171	34
132151003	Columbus-Crime Lab	0.61			0.15		0.147	0.000	0.00	0.907	0.151	35
130890003	NR-285	0.51		0.0	0.15		0.235		0.00	0.895	0.149	36
132150009	Columbus-Allied	0.07		0.0	0.00		0.147		0.00	0.217	0.036	37
131150006	Kraftsman	0		0.0	0.04		0.034		0.00	0.074	0.015	38

Table 19.1: Combined Ranking Table

There were 38 ambient air monitoring sites across the state of Georgia as of 2018. Although ranks were assigned to each monitor in the table above, these are used only as guidelines; various regulations need to be considered in regard 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 (Rome, Columbus-Crime Lab, NR-285, Columbus-Allied, Kraftsman) are the only sites that do not monitor ozone or $PM_{2.5}$. The Measured Concentrations (Section 7.0) and Monitor-to-Monitor Correlations (Section 10.0) only assessed sites with ozone and $PM_{2.5}$ monitors. When all of the criteria pollutants were examined, as with Deviation from the NAAQS (Section 8.0), the sites that monitor ozone and $PM_{2.5}$ show higher values and were ultimately ranked higher. In addition, the Area Served Assessment (Section 11.0) only assessed the sites that monitor ozone and $PM_{2.5}$.

Sites that monitor only a few parameters typically have lower rankings. As can be seen in the above table, the Rome-Kraftsman site ranks the lowest of all the ambient monitoring sites. The Rome-Kraftsman site monitors only SO_2 as addressed by the Number of Parameters Monitored Assessment (Section 9.0). The Columbus-Allied site monitors only lead, and 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, and in particular ozone or $PM_{2.5}$, or sites that represent a smaller monitoring area around that monitor (Section 11.0). For example, the NR-285 site does not collect ozone of $PM_{2.5}$, and it is one of the lowest ranking sites. 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, there are currently six sites within the Columbus, GA-AL MSA, and the Columbus-Allied and Columbus-Crime Lab sites may be good candidates for consolidation with the other sites within the Columbus, GA-AL MSA.

For the Area Served Assessment (Section 11.0), 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 at the site in the Valdosta MSA or at the General Coffee site in Douglas County may be helpful to cover the southeastern portion of the state.

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 type of monitor and more monitors than are required for the population and design values (Table 12.2). For the Atlanta-Sandy Springs-Roswell MSA, there are six $PM_{2.5}$ monitors, while only three would be required, and there are nine ozone monitors, while only three would be required. Also, for the Columbus, GA-AL MSA, there are four $PM_{2.5}$ monitors, while only one would be required, according to the population and $PM_{2.5}$ design value. Sites within these MSAs could be consolidated to eliminate redundancy.

As of 2018, there were 13 ambient air monitoring sites within the Atlanta-Sandy Springs-Roswell MSA. As discussed above, according to the population and design value requirements (Table 12.2), three ozone, three $PM_{2.5}$, and at least two PM_{10} monitors are required. Currently, there are nine ozone samplers, six $PM_{2.5}$ samplers and two 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. The $PM_{2.5}$ r^2 values range from 0.78 to 0.94, all above the EPA's suggested limit of 0.75 indicating redundancy. The ozone values range from 0.69 to 0.97, with 29 out of 36 values above the 0.75 threshold, indicating redundancy for several ozone monitors within the MSA. To increase efficiency within the networks, sites collecting $PM_{2.5}$ and ozone data in close proximity within this MSA could be consolidated.

With the Emissions Assessment (Section 16.0), some areas of the state had models that showed lower predicted emissions where there are currently monitors for that particular pollutant. The Macon MSA modeled lower SO_2 emissions, and the coastal areas (Savannah MSA and Brunswick MSA) modeled lower $PM_{2.5}$ emissions. The GA AAMP may consider whether or not these monitors are still beneficial for the network, while still meeting federal requirements. Also with the Emissions Assessment, there were some areas that were shown that could possibly benefit from having monitors added. The area across the mid-region of the state could potentially benefit from having VOCs monitors, as this area is predicted to have higher VOCs emissions and the monitors are currently only located in the Atlanta-Sandy Springs-Roswell MSA. Therefore, according to the Emissions Assessment, additional VOCs monitors may be useful for collecting and characterizing potential emissions data.

The highest-ranking sites are the Gwinnett Tech, Kennesaw, Dawsonville, and South DeKalb sites. A combination of the quantifiable assessments lead to these sites being ranked the highest. They have all been collecting data at least 20 years (Section 6.0). They are all located within the Atlanta-Sandy Springs-Roswell MSA, which consistently measures the highest number of days above 100 for the AQI (Section 13.0), and is one of the areas with more population growth (Section 12.0). All of these sites monitor either ozone or $PM_{2.5}$, as well as other pollutants. The Gwinnett Tech and South DeKalb sites had concentrations of criteria pollutants that ranked higher in the Deviation from the NAAQS Assessment (Section 8.0) for having concentrations close to the NAAQS. The South DeKalb site monitors the most pollutants (Section 9.0) and has been established since 1974 (Section 6.0).

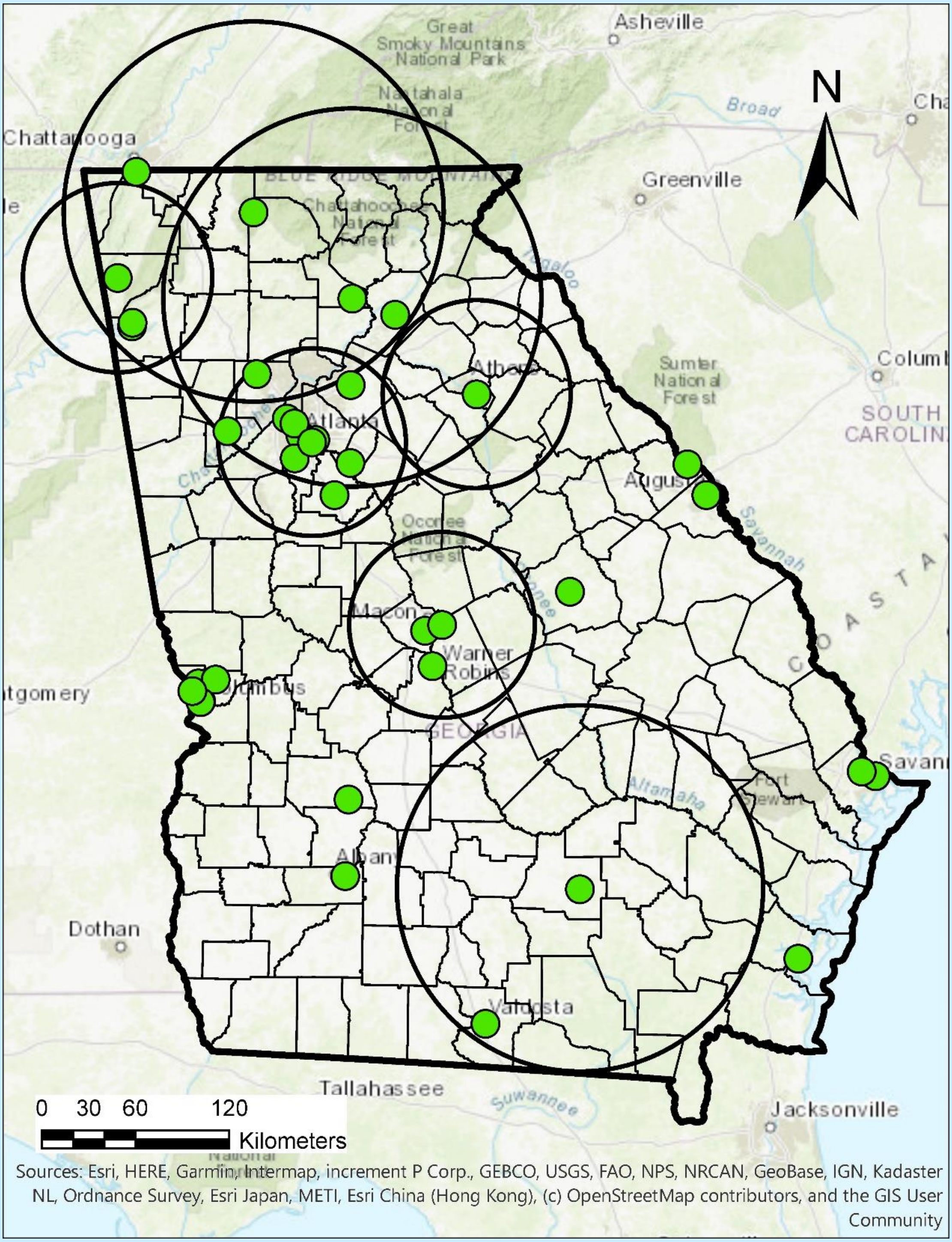
Since GA AAMP conducted the previous edition of the 5-Year Assessment in 2015, several changes have been made to the ambient monitoring networks, as stated earlier. A few sites have been consolidated within the same MSA, sites have been added, and sites have been shut down. Efforts have been made to eliminate redundancies where possible, and sites have been added to ensure federal regulations are met. One example is that the NR-285 site was leveraged with a former lead monitoring site, to now monitor for near-road pollutants. Also, when the $PM_{2.5}$ background monitor was shut down at one site, it was moved and consolidated with the General Coffee site where $PM_{2.5}$ speciation and Air Toxics data was collected. Appendix A of this document contains a full, detailed list of GA AAMP's current sites, and Appendix D lists monitors that have been shut down.

While GA AAMP 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 AAMP will make every effort to place monitors where needed, especially as mandated by the federal regulations. As changes are made to the regulations, GA AAMP 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)

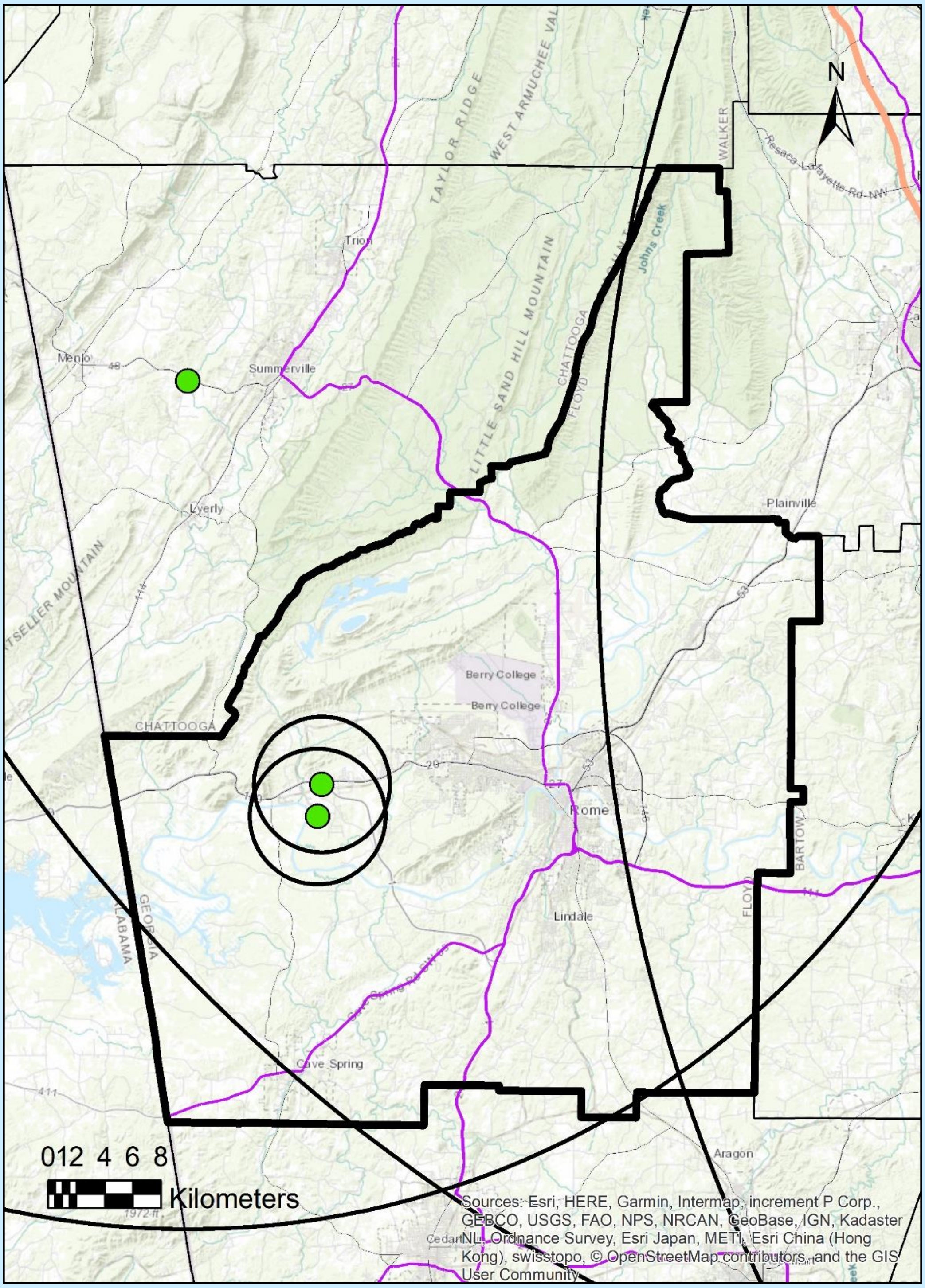
Georgia Department of Natural Resources
Environmental Protection Division

Spatial Scales of GA AAMP's Ambient Air Monitors



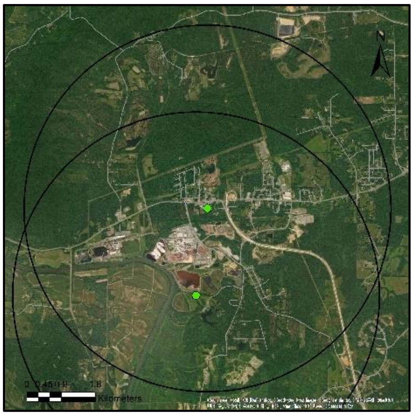
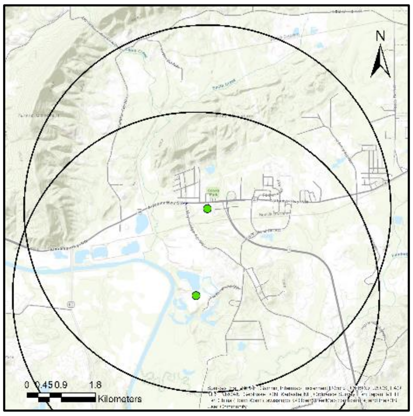
<u>Radius of Circles on Map</u>
Micro Scale: up to 100m
Middle Scale: up to 0.5km
Neighborhood Scale: up to 4.0km
Urban Scale: up to 50km
Regional Scale: up to 100s of km (100km shown)

Rome MSA



<u>Radius of Circles on Map</u>
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

AQS ID: 131150003

Address: 5041 Alabama Hwy, Rome, Floyd County, Georgia 30165

Site Established: 1/1/74

Latitude/Longitude: N34.2605/W-85.3232

Elevation: 186 meters

Area Represented: Rome MSA

Site History: Established as SO_2 site

North South East West

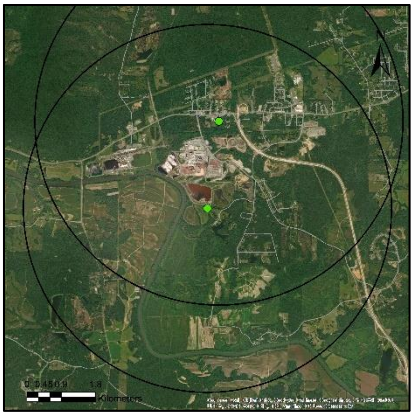


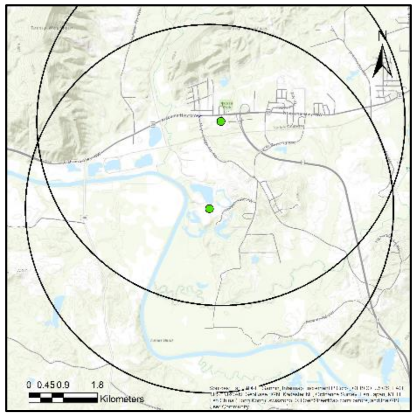

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$ Speciation	Population Exposure	Every 6 days	2.5 m	Neighborhood	3/1/02
$PM_{2.5}$ Continuous	Population Exposure	Continuous	3.5 m	Neighborhood	1/1/08*

*Sampler inactive from 1/1/15 until reopened 2/15/17

GA AAMP's plans for this site: Continue monitoring

Kraftsman





AQS ID: 131150006

Address: 238 Mays Bridge Rd. SW, Rome, Floyd County, Georgia 30165

Site Established: 1/1/17

Latitude/Longitude: N34.2434/W-85.3259

Elevation: 191 meters

Area Represented: Rome MSA

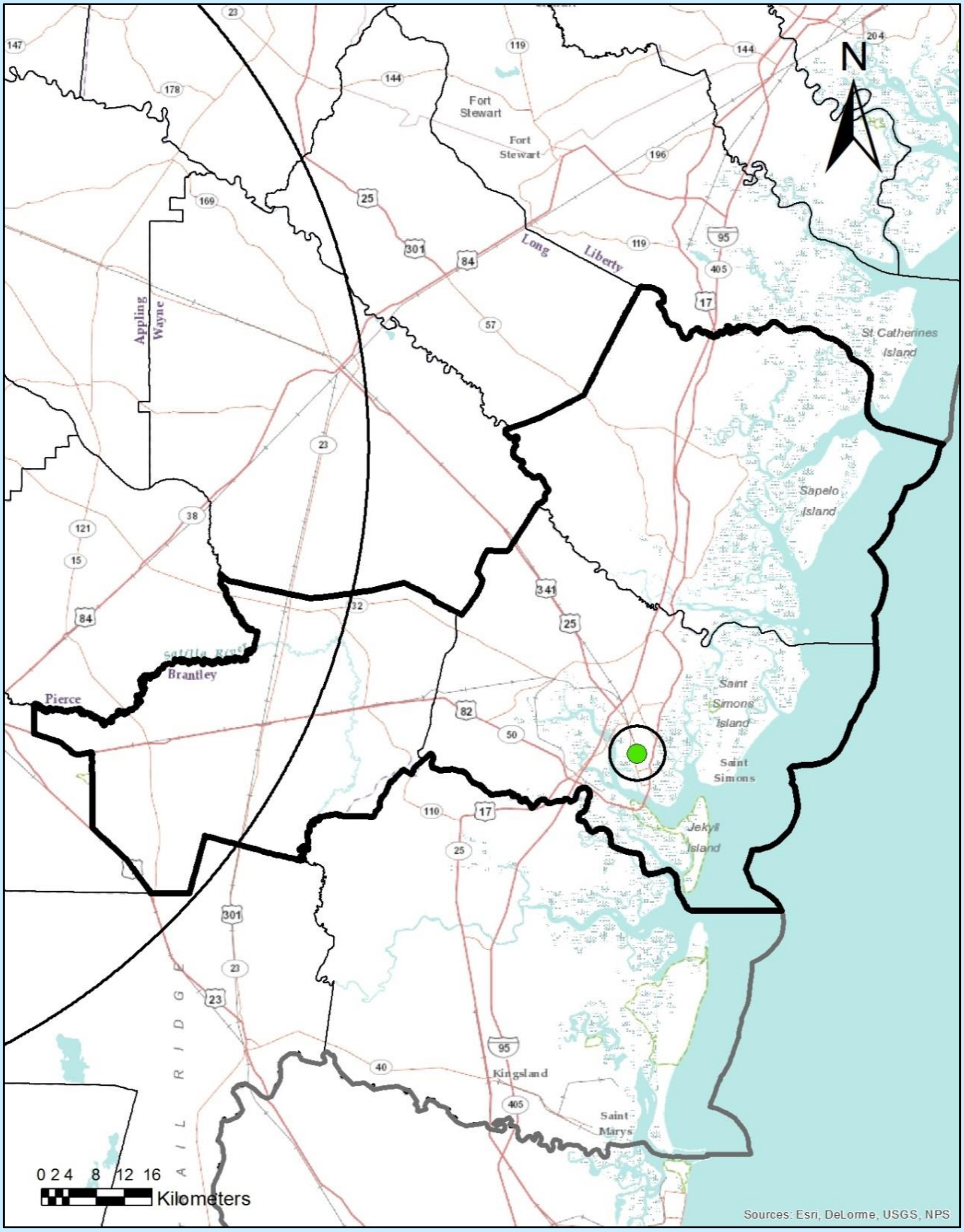
Site History: Established as SO_2 site

North South East West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
SO_2	Population Exposure	Continuous	3.8 m	Neighborhood	1/1/2017
SO_2 5-Minute Maximum	Population Exposure	Continuous	3.8 m	Neighborhood	1/1/2017
Wind Speed	Population Exposure	Continuous	10 m	Neighborhood	1/1/2017
Wind Direction	Population Exposure	Continuous	10 m	Neighborhood	1/1/2017

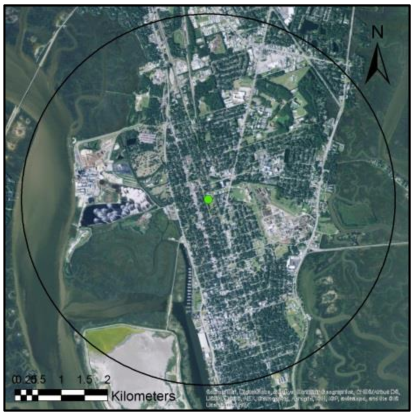
GA AAMP's plans for this site: Plan to shut down site as of December 31, 2020; please refer to Section 1.4 for more details

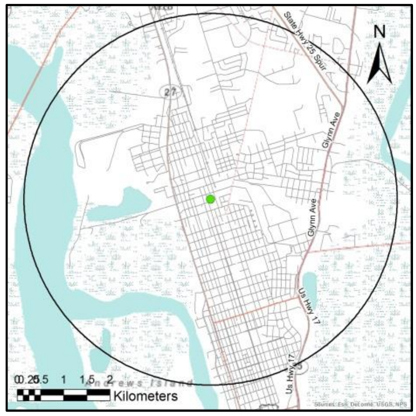
Brunswick MSA



Radius of Circles on Map
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)

Brunswick





AQS ID: 131270006

Address: Risley Early College Academy, 2900 Albany Street, Brunswick, Glynn County, Georgia 31520

Site Established: 1/1/87

Latitude/Longitude: N31.1696/W-81.4952

Elevation: 19.4 meters

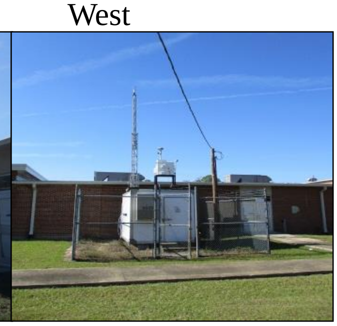
Area Represented: Brunswick MSA

Site History: Established as SO_2 site

North

South

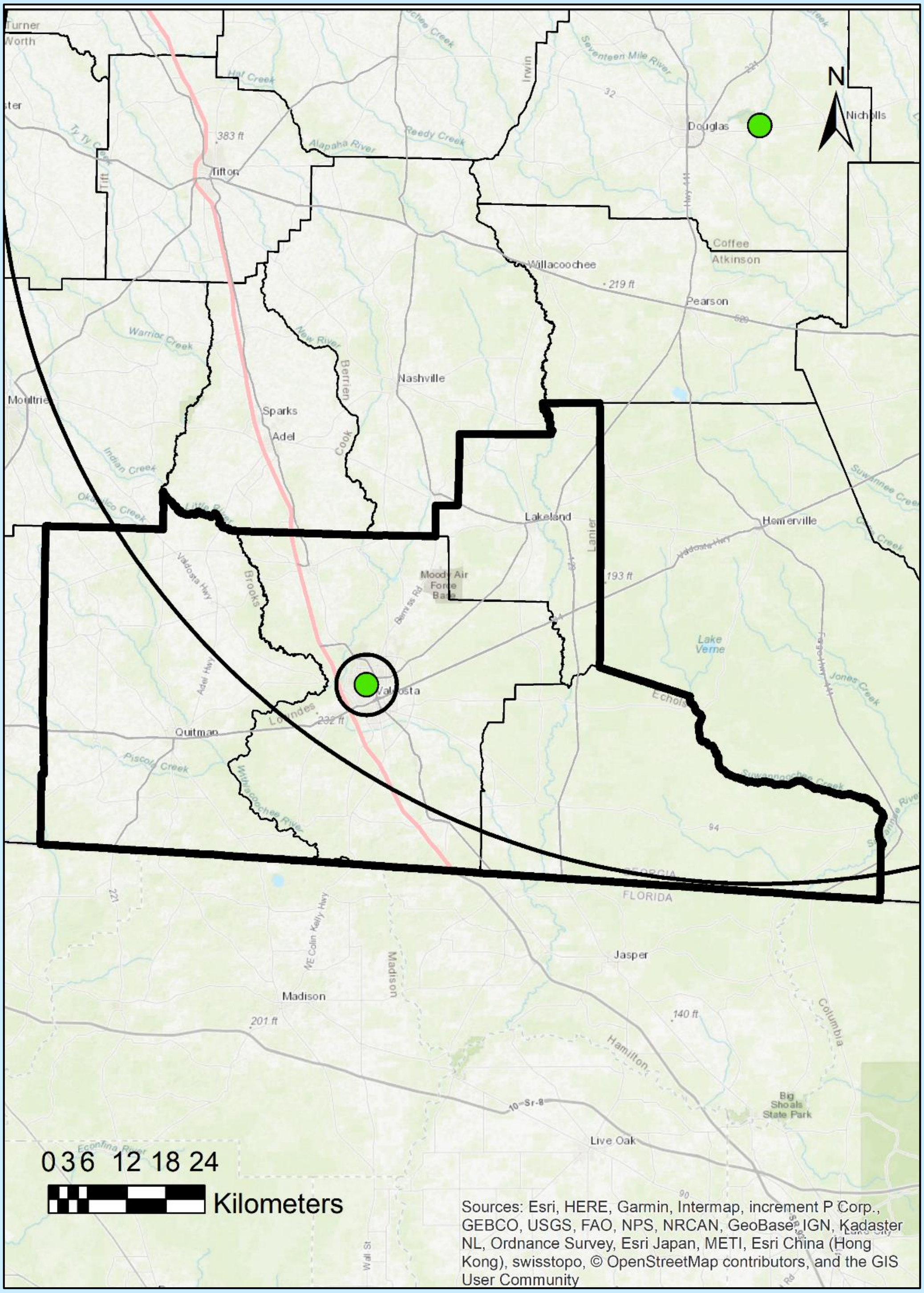
West



Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$	Population Exposure	Every 3 days	2.6 m	Neighborhood	8/31/95
O_3	Population Exposure	Continuous (Mar-Oct)	4.3 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

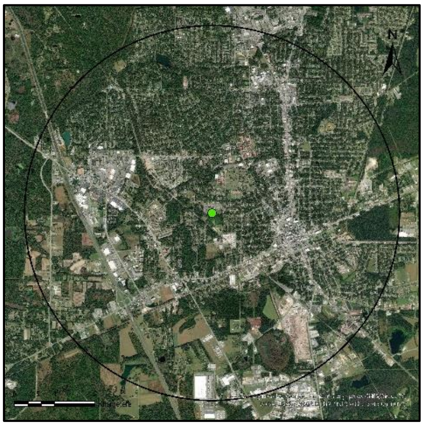
GA AAMP's plans for this site: Continue monitoring

Valdosta MSA



<u>Radius of Circles on Map</u>
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)

Valdosta




AQS ID: 131850003

Address: 821 W Gordon Street, Lowndes County, Georgia 31602

Site Established: 12/17/99

Latitude/Longitude: N30.836577/W-83.294719

Elevation: 55.0 meters

Area Represented: Valdosta MSA

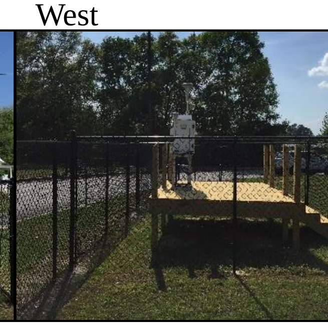
Site History: Established as $PM_{2.5}$ site

North

South

East

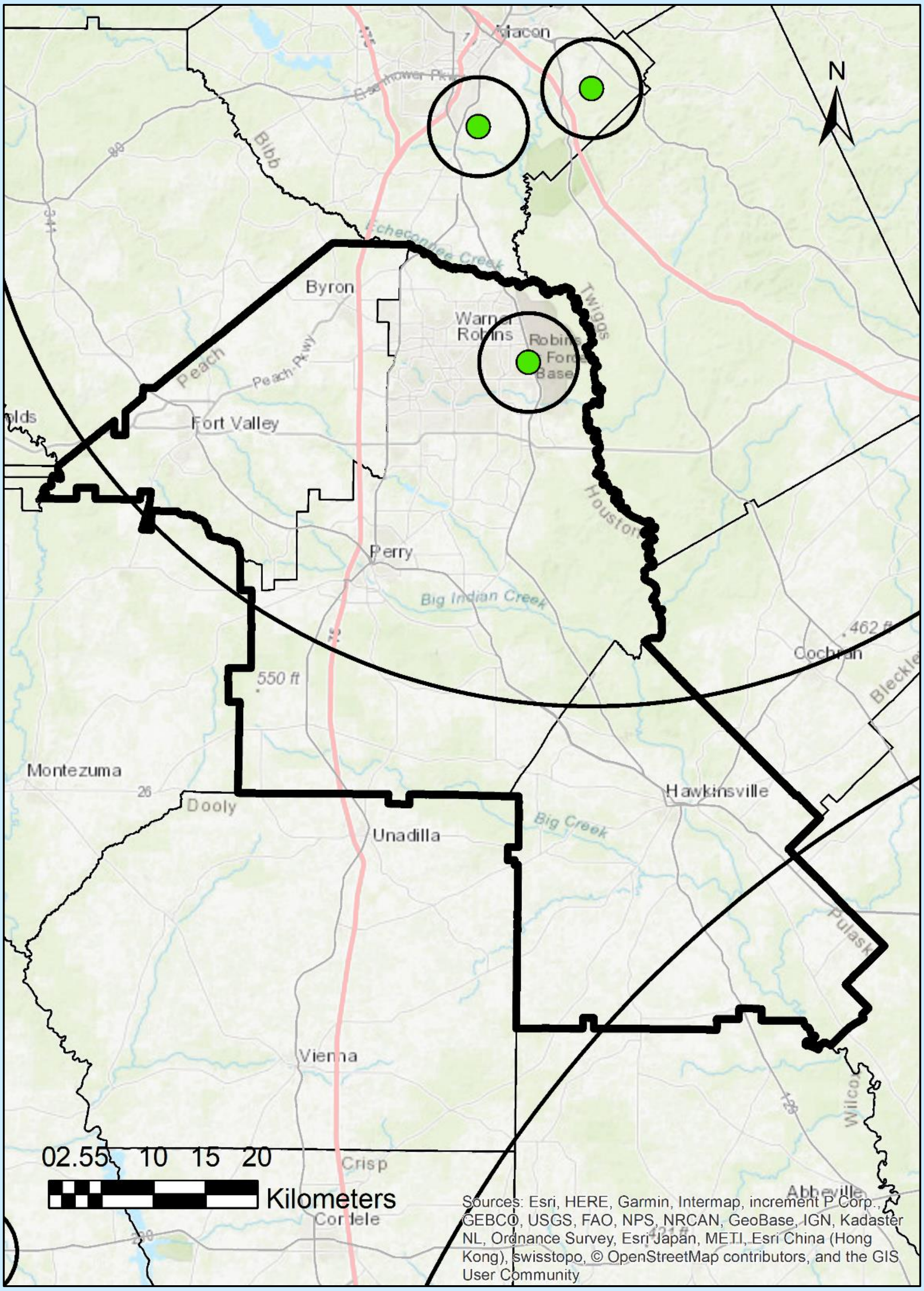
West



Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$	Population Exposure	Every 3 days	3 m	Neighborhood	1/1/00
$PM_{2.5}$	Population Exposure	Continuous	3 m	Neighborhood	1/1/08

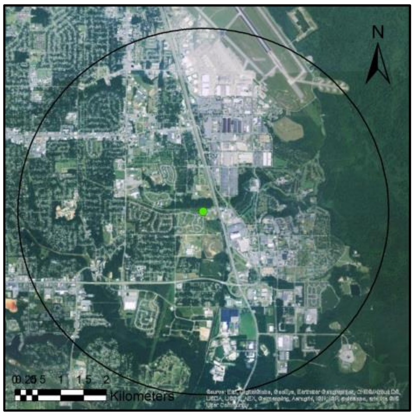
GA AAMP's plans for this site: Continue monitoring; GA AAMP moved the monitoring station to the ground due construction being done on the roof where the monitor was previously located (new site location meets siting criteria); GA AAMP shut down the non-FEM BAM Continuous $PM_{2.5}$ sampler on 3/11/20 and is in the process of replacing it with an FEM Teledyne T640 Continuous $PM_{2.5}$ sampler (plan to have in place summer 2020).

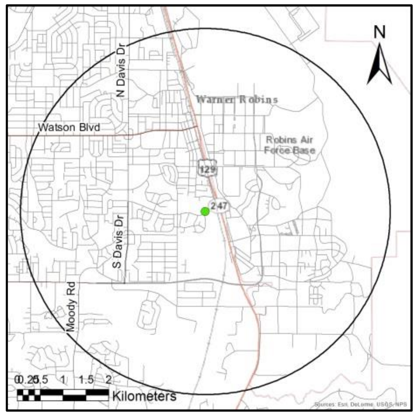
Warner Robins MSA



<u>Radius of Circles on Map</u>
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)

Warner Robins





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: N32.6056/W-83.5978

Elevation: 86.25 meters

Area Represented: Warner Robins MSA

Site History: Established as $PM_{2.5}$ site

North

South

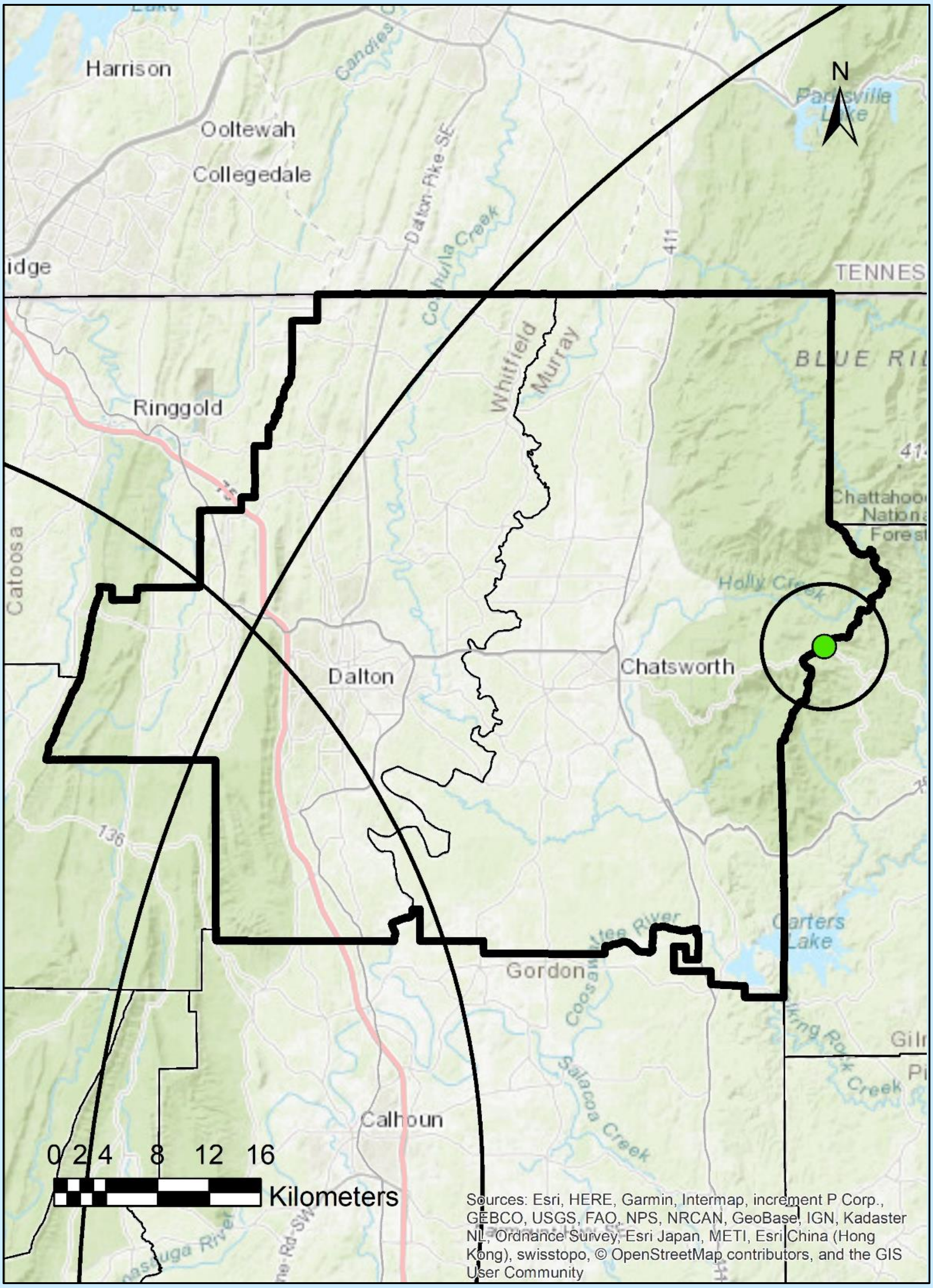
East

West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$	Population Exposure	Every 3 days	3 m	Neighborhood	7/5/00
$PM_{2.5}$	Population Exposure	Continuous	3 m	Neighborhood	1/1/08

GA AAMP's plans for this site: Continue monitoring; Running continuous monitor as FEM as of 3/7/2018

Dalton MSA



<u>Radius of Circles on Map</u>
Micro Scale: up to 100m
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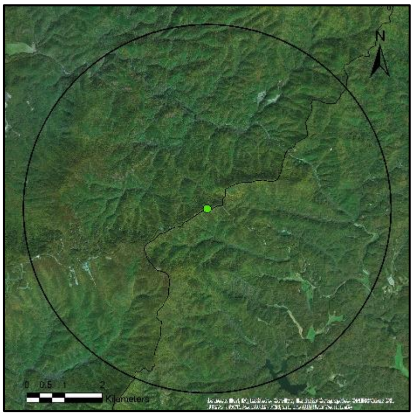
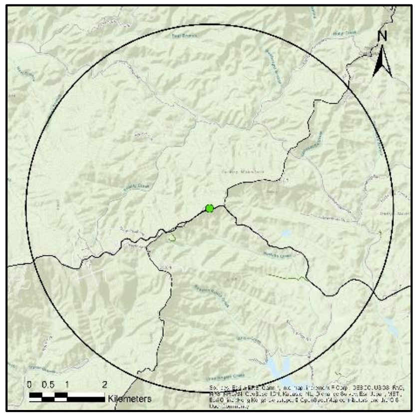
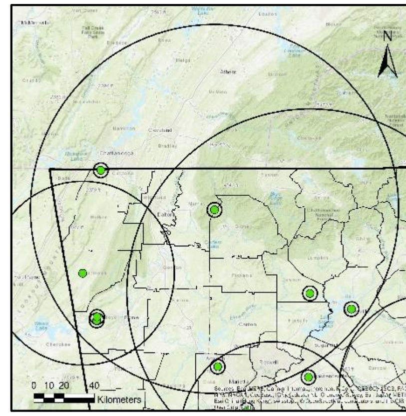
Neighborhood Scale: up to 4.0km
Urban Scale: up to 50km
Regional Scale: up to 100s of km (100km shown)

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: N34.7851/W-84.6265

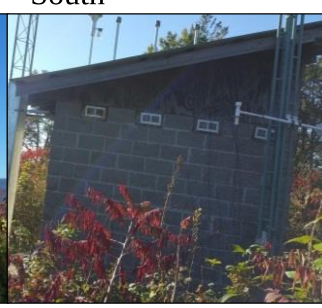
Elevation: 794 meters

Area Represented: Dalton MSA

Site History: Established as O_3 site

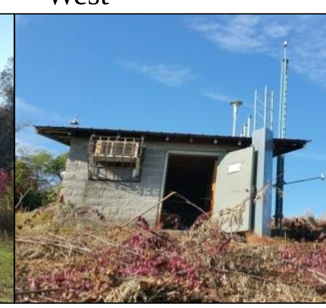
North

South



East

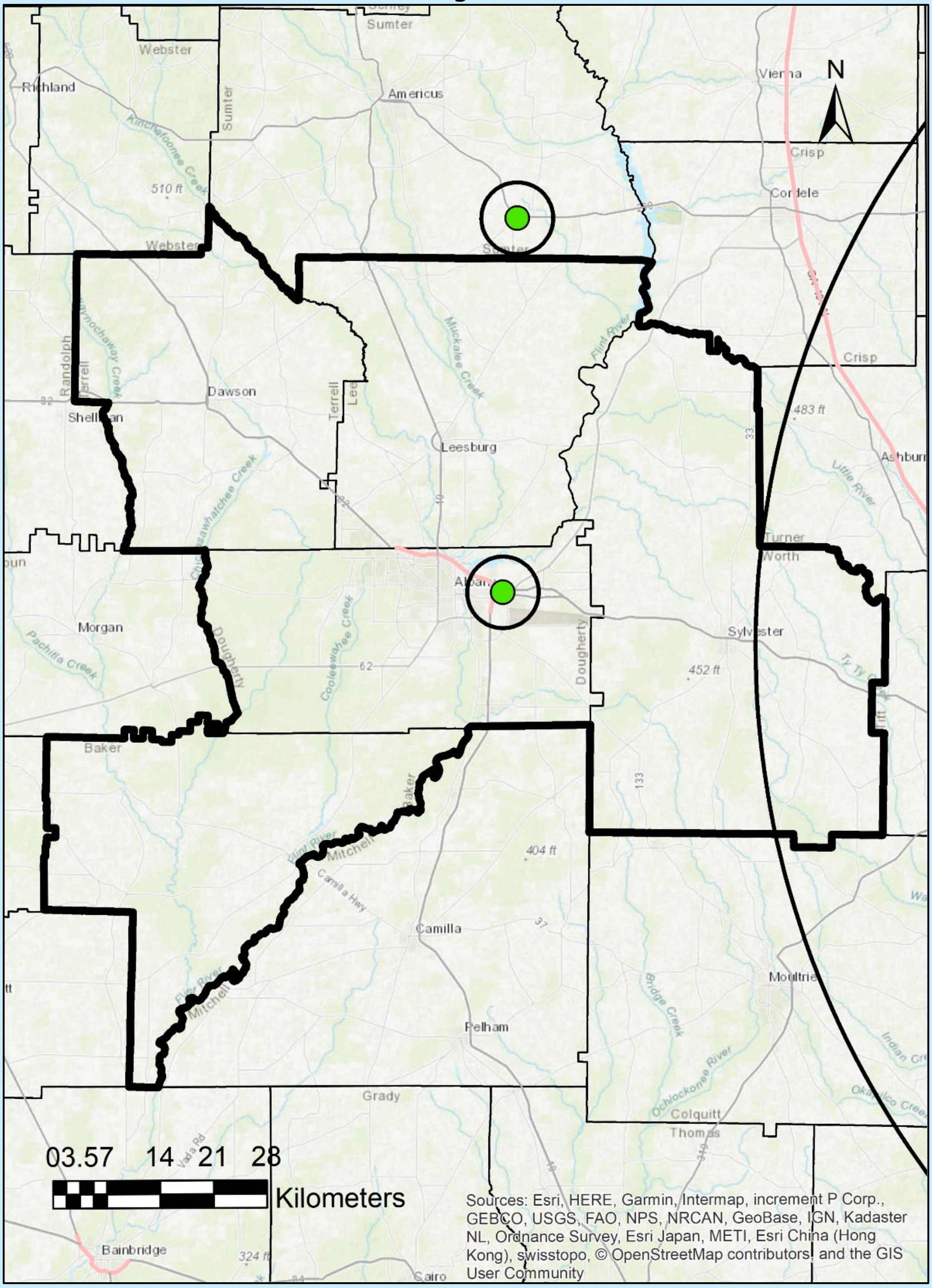
West



Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Population Exposure	Continuous (Mar-Oct)	5 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
Outdoor Temperature	General/ Background	Continuous	3 m	Neighborhood	2/7/02
Relative Humidity	General/ Background	Continuous	3 m	Neighborhood	2/7/02

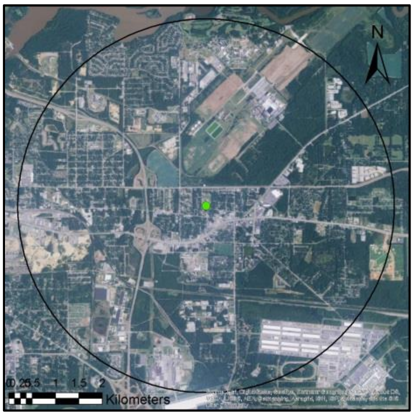
GA AAMP's plans for this site: Continue monitoring

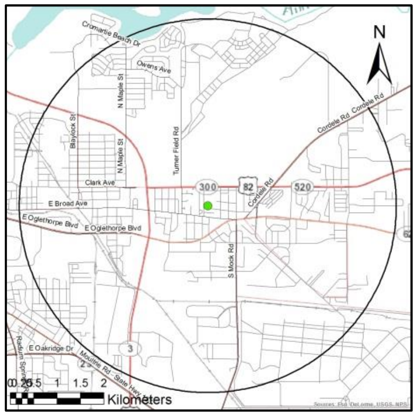
Albany MSA



<u>Radius of Circles on Map</u>
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)

Albany





AQS ID: 130950007

Address: Turner Elementary School, 2001 Leonard Avenue, Albany, Dougherty County, Georgia 31705

Site Established: 7/31/91

Latitude/Longitude: N31.5776/W-84.0998

Elevation: 67 meters

Area Represented: Albany MSA

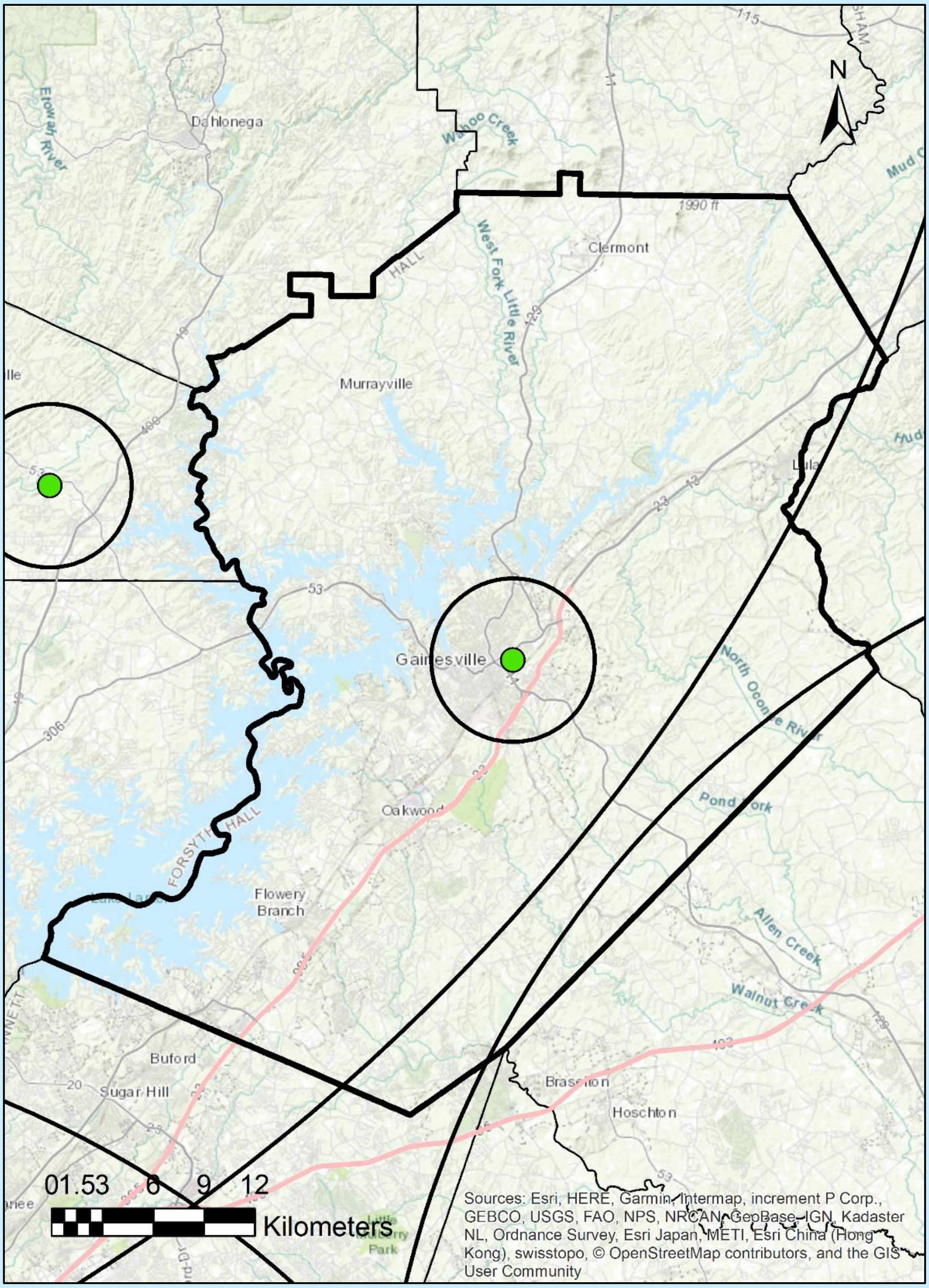
Site History: Established as TSP site

North South East West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$	Population Exposure	Every 3 days	2.1 m	Neighborhood	2/2/99
$PM_{2.5}$	Quality Assurance	Every 12 days	2.1 m	Neighborhood	1/10/13
$PM_{2.5}$	Population Exposure	Continuous	2.1 m	Neighborhood	5/11/08

GA AAMP's plans for this site: Continue monitoring; Running continuous monitor as FEM as of 1/10/13; GA AAMP replaced the FEM BAM Continuous $PM_{2.5}$ sampler with an FEM Teledyne T640 Continuous $PM_{2.5}$ sampler on 3/1/19. GA AAMP is planning to relocate this sampling station to ground level once the appropriate infrastructure is in place.

Gainesville MSA



<u>Radius of Circles on Map</u>
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)

Gainesville

AQS ID: 131390003

Address: Fair Street School, 695 Fair Street, Gainesville, GA 30501

Site Established: 1/1/97

Latitude/Longitude: N34.2993/W-83.8134

Elevation: 353 meters

Area Represented: Gainesville MSA

Site History: Established as $PM_{2.5}$ site

North

South

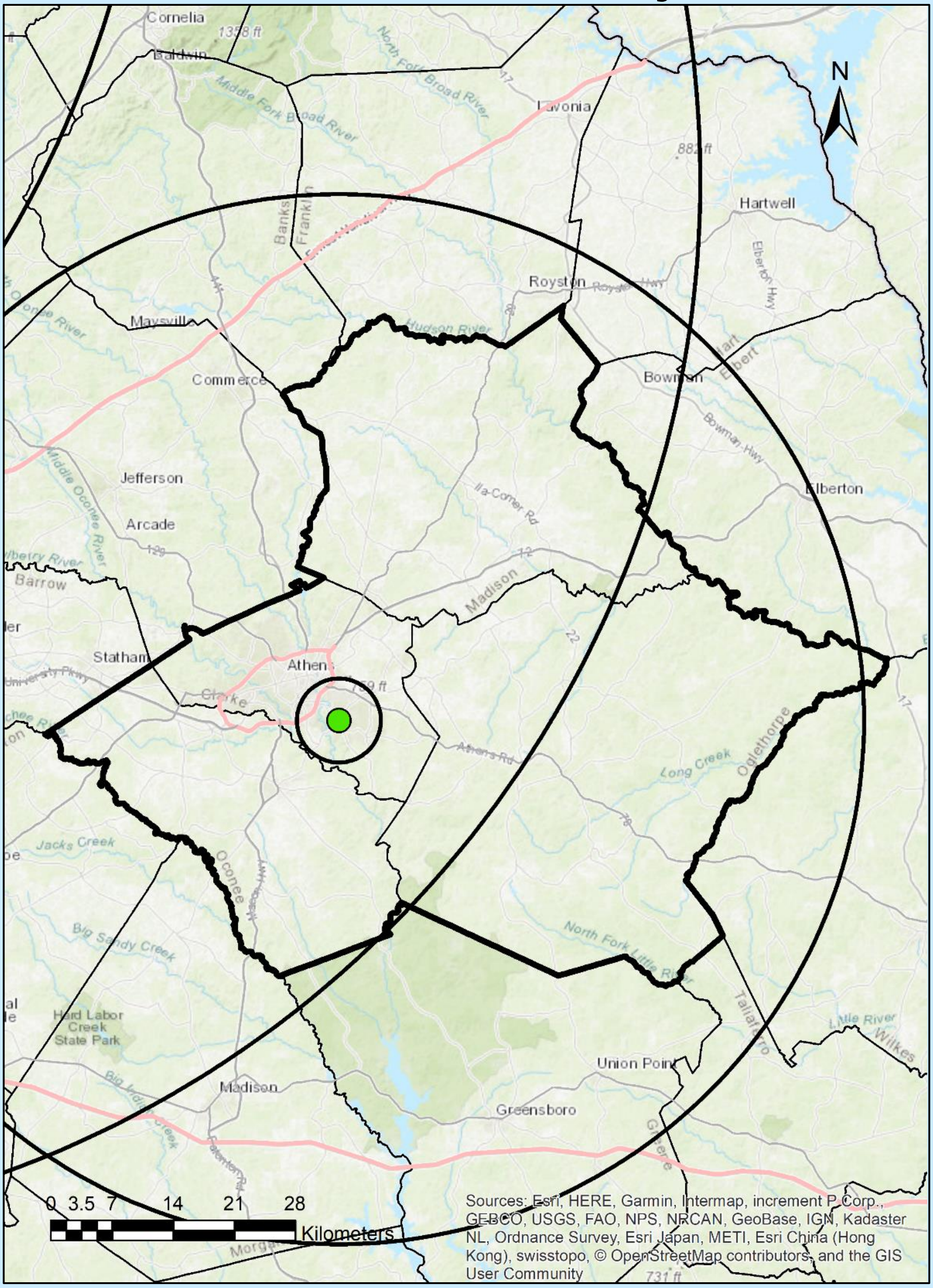
East

West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$	Population Exposure	Continuous	2.9 m	Neighborhood	1/1/08

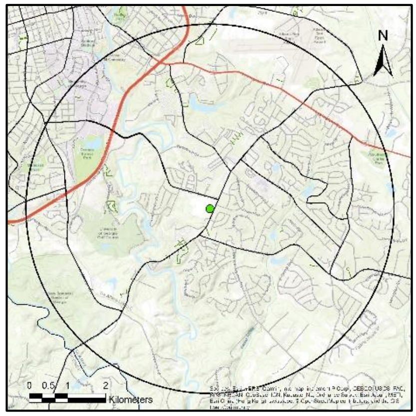
GA AAMP's plans for this site: Continue monitoring; Running continuous monitor as FEM as of 10/3/2017

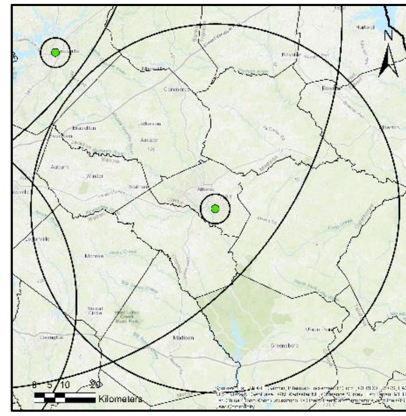
Athens-Clarke County MSA



<u>Radius of Circles on Map</u>
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)

Athens





AQS ID: 130590002

Address: 2350 Barnett Shoals Road, Athens, Clarke County, Georgia 30605

Site Established: 3/1/02

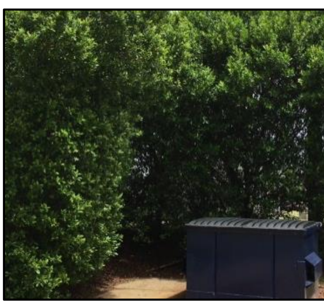
Latitude/Longitude: N33.9180/W-83.3445

Elevation: 220 meters

Area Represented: Athens-Clarke County MSA

Site History: Established as O_3 and PM site

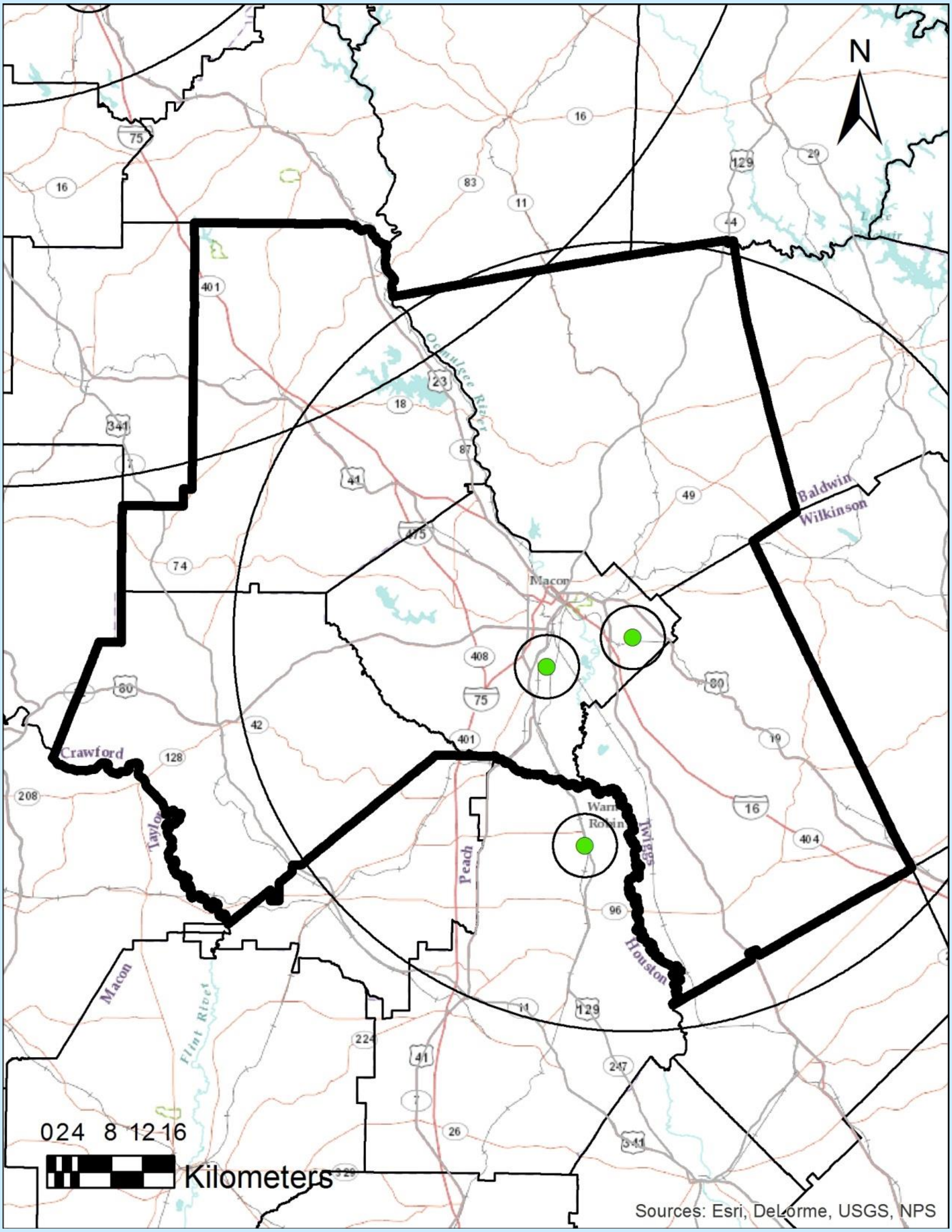
North South East West



Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Population Exposure	Continuous (Mar-Oct)	3.4 m	Urban	5/1/02
$PM_{2.5}$	Population Exposure	Continuous	4.4 m	Neighborhood	8/1/04
$PM_{2.5}$	Quality Assurance	Continuous	4.4 m	Neighborhood	2/15/19

GA AAMP's plans for this site: Continue monitoring; Running continuous $PM_{2.5}$ monitor as FEM as of 4/1/2018; On February 15, 2019, GA AAMP added a second FEM Teledyne T640 Continuous $PM_{2.5}$ sampler to satisfy collocation requirements.

Macon MSA



<u>Radius of Circles on Map</u>
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)

Macon-Allied

AQS ID: 130210007

Address: 300 Allied Industrial Blvd., Macon, Bibb County, Georgia 31206

Site Established: 1/1/74

Latitude/Longitude: N32.7773/W-83.6411

Elevation: 106 meters

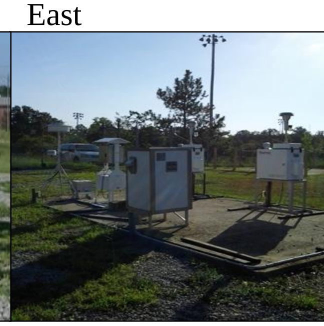
Area Represented: Macon MSA

Site History: Established as TSP site

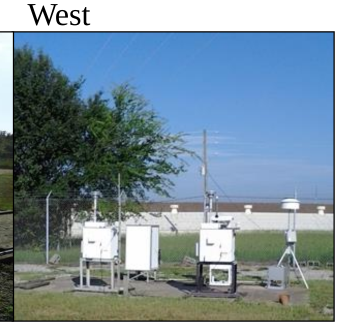
North

South

East



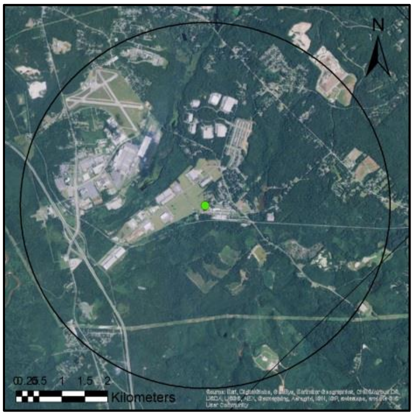
West

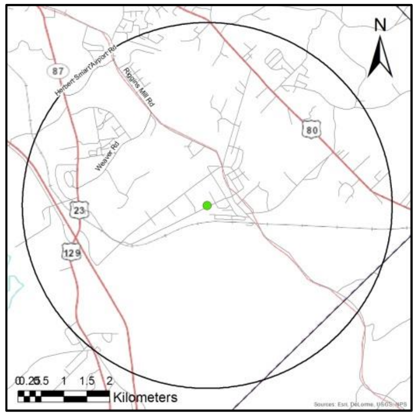


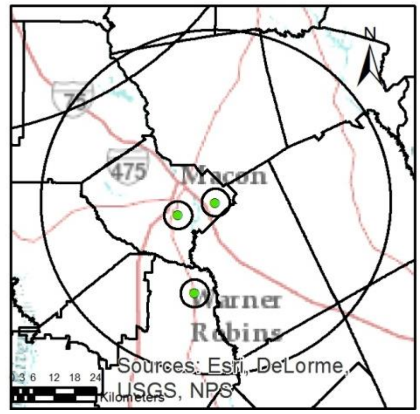
Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$ Speciation	Population Exposure	Every 6 days	2.5 m	Neighborhood	3/1/02
$PM_{2.5}$	Population Exposure	Every 3 days	2.5 m	Neighborhood	2/2/99
$PM_{2.5}$	Quality Assurance	Every 12 days	2.5 m	Neighborhood	2/2/99

GA AAMP's plans for this site: Continue monitoring

Macon-Forestry







AQS ID: 130210012

Address: Georgia Forestry Commission, 5645 Riggins Mill Road, Dry Branch, Bibb County, Georgia 31020

Site Established: 5/7/97

Latitude/Longitude: N32.8051/W-83.5436

Elevation: 120 meters

Area Represented: Macon MSA

Site History: Established as O_3 and SO_2 site

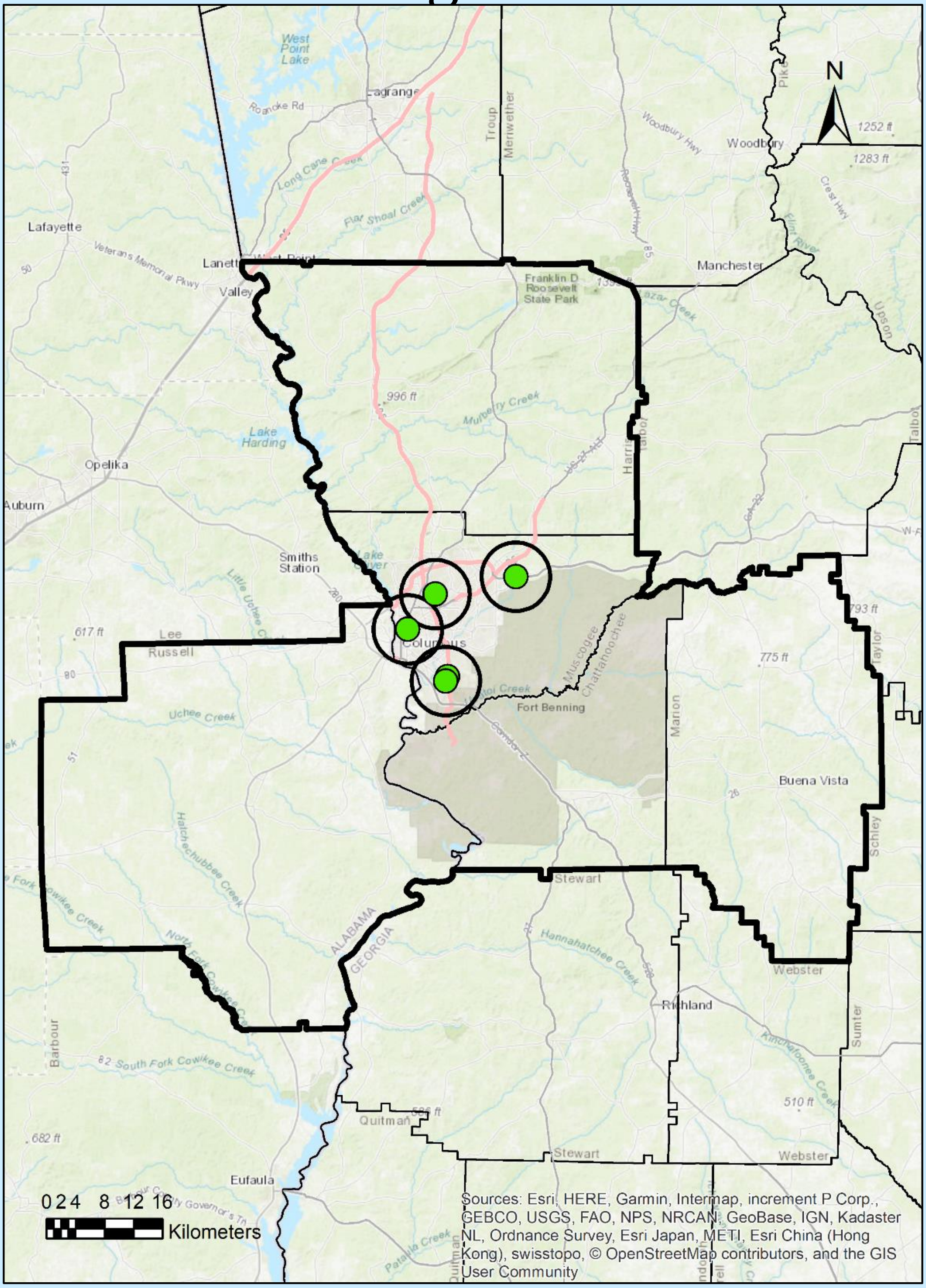
North South East West




Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$	Population Exposure	Every 3 days	3 m	Neighborhood	2/1/99
$PM_{2.5}$	Population Exposure	Continuous	3.5 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)	3.5 m	Neighborhood	5/7/97
SO_2	Population Exposure	Continuous	3.5 m	Urban	5/7/97
SO_2 5-Minute Maximum	Population Exposure	Continuous	3.5 m	Neighborhood	8/1/10

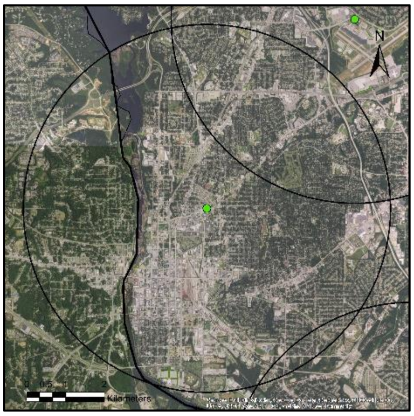
GA AAMP's plans for this site: Continue monitoring; Running continuous $PM_{2.5}$ monitor as FEM as of 10/1/2017

Columbus Georgia-Alabama MSA



<u>Radius of Circles on Map</u>
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)

Columbus-Health Department



AQS ID: 132150001

Address: Muscogee City Health Department, 2100 Comer Ave., Columbus, Muscogee County, Georgia 31901

Site Established: 1/1/57

Latitude/Longitude: N32.4842/W-84.9789

Elevation: 111 meters

Area Represented: Columbus Georgia-Alabama MSA

Site History: Established as TSP site

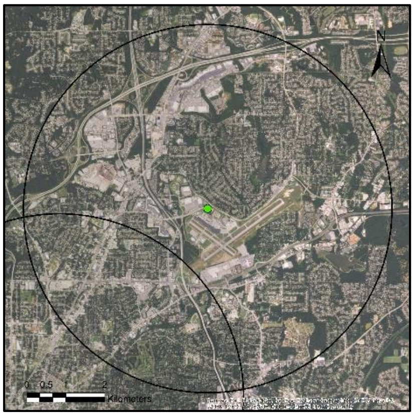
North South East West




Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$	Population Exposure	Every 3 days	1.8 m	Neighborhood	3/4/99

GA AAMP's plans for this site: Continue monitoring

Columbus-Airport




AQS ID: 132150008

Address: Columbus Airport, 3100 Airport Thruway Drive, Columbus, Muscogee County, Georgia 31909

Site Established: 7/1/82

Latitude/Longitude: N32.5211/W-84.9447

Elevation: 445 meters

Area Represented: Columbus Georgia-Alabama MSA

Site History: Established as O_3 site

North

South

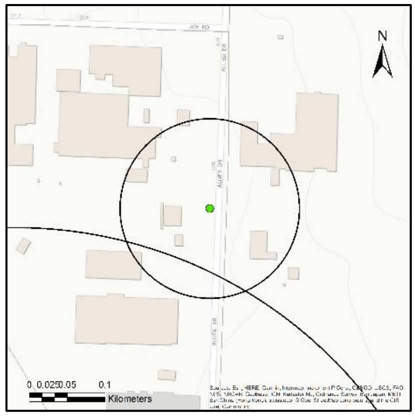
East

West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Population Exposure	Continuous (Mar-Oct)	3 m	Neighborhood	7/1/82
$PM_{2.5}$	Population Exposure	Every 3 days	4.8 m	Neighborhood	6/2/03
$PM_{2.5}$	Population Exposure	Continuous	3 m	Neighborhood	6/1/03

GA AAMP's plans for this site: Continue monitoring

Columbus-Allied



AQS ID: 132150009

Address: 4365 Allied Drive, Columbus, Muscogee County, Georgia 31906

Site Established: 9/1/90

Latitude/Longitude: N32.4344/W-84.9293

Elevation: 85 meters

Area Represented: Columbus Georgia-Alabama MSA

Site History: Established as lead site

North

South

East

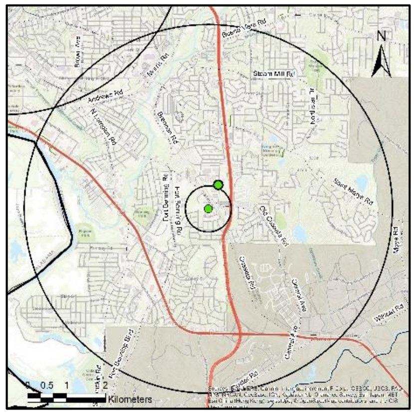
West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
Lead	Source Oriented	Every 6 days	2.3 m	Micro	9/1/90*
Lead	Quality Assurance /Source Oriented	Every 12 days	2.3 m	Micro	2/1/18

* Sampler inactive from 3/31/04 until reopened on 2/3/12

GA AAMP's plans for this site: Planning to shut down the site as of December 31, 2020; please refer to Section 1.4 for details

Columbus-Cusseta



AQS ID: 132150011

Address: Cusseta Road Elementary School, 4150 Cusseta Road, Columbus, Muscogee County, Georgia 31903

Site Established: 9/4/91

Latitude/Longitude: N32.4297/W-84.9316

Elevation: 87.1 meters

Area Represented: Columbus Georgia-Alabama MSA

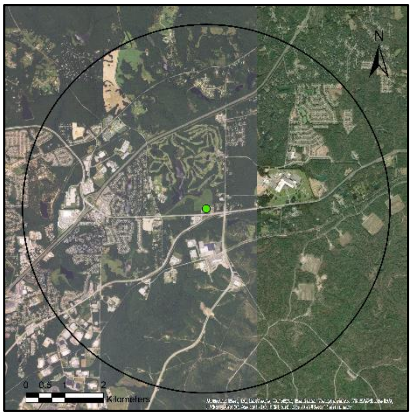
Site History: Established as lead site

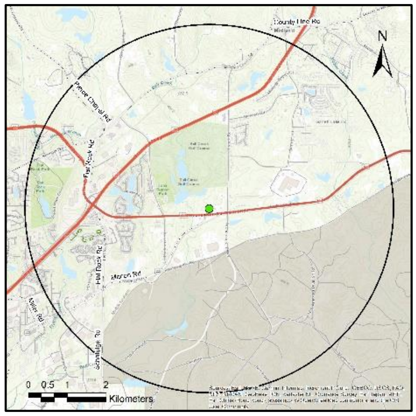
North South East West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
Lead	Population Exposure/Source Oriented	Every 6 days	1.8 m	Middle	9/4/91
$PM_{2.5}$	Population Exposure	Every 3 days	1.8 m	Neighborhood	1/21/99
$PM_{2.5}$ Speciation	Population Exposure	Every 6 days	1.8 m	Neighborhood	5/1/02

GA AAMP's plans for this site: Continue monitoring $PM_{2.5}$ and $PM_{2.5}$ speciation; planning to shut down lead monitor as of December 31, 2020; please refer to Section 1.4 for more details

Columbus-Crime Lab





AQS ID: 132151003

Address: Columbus Crime Lab, 8395 Beaver Run Road, Midland, Muscogee County, Georgia 31820

Site Established: 6/30/80

Latitude/Longitude: N32.5394/W-84.8448

Elevation: 122 meters

Area Represented: Columbus Georgia-Alabama MSA

Site History: Established as O_3 site

North

South

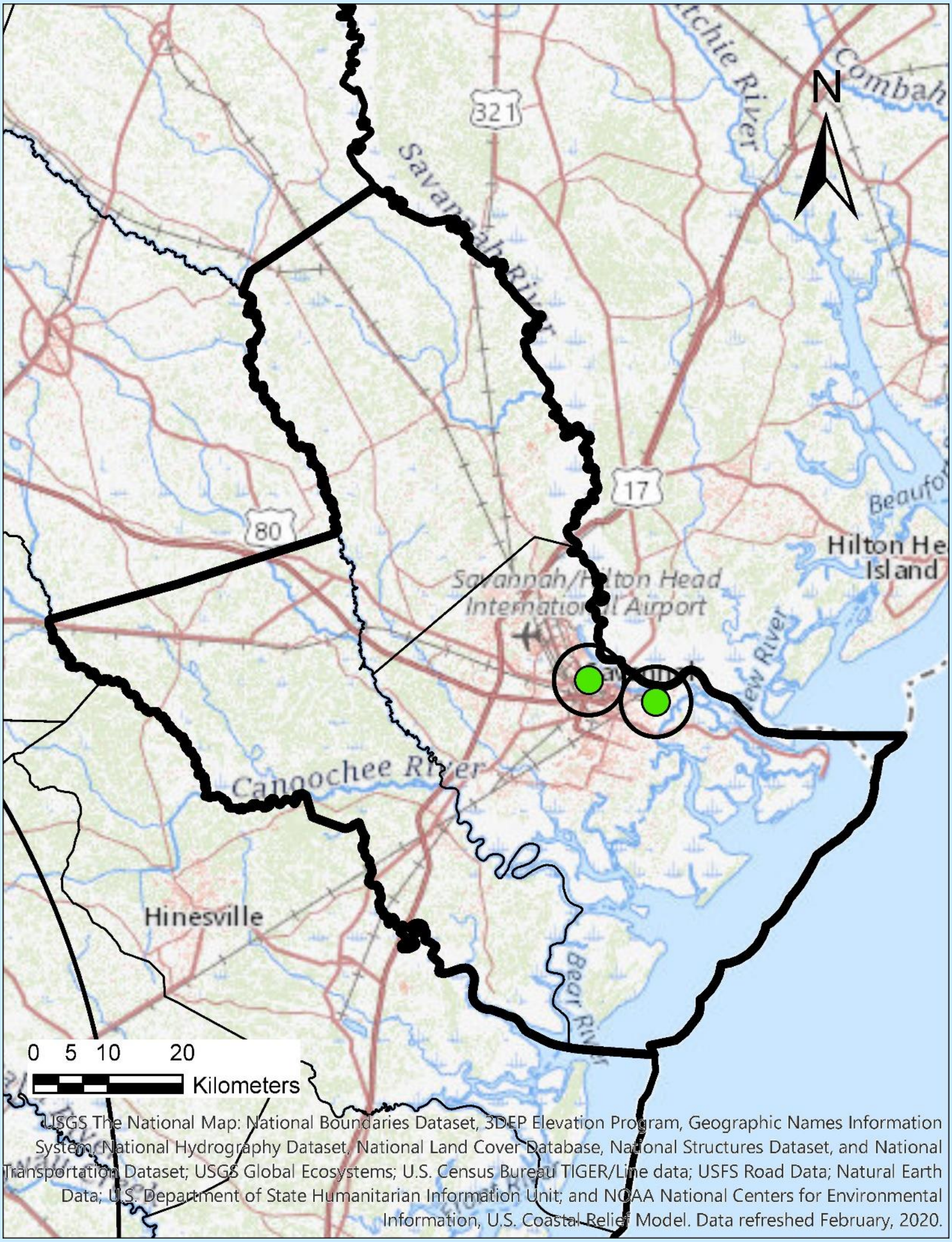
East

West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
Wind Speed	General/ Background	Continuous	10 m	Neighborhood	1/5/06
Wind Direction	General/ Background	Continuous	10 m	Neighborhood	1/5/06
Outdoor Temperature	General/ Background	Continuous	2.2 m	Neighborhood	1/5/06
Relative Humidity	General/ Background	Continuous	2.2 m	Neighborhood	1/5/06
Rain/Melt Precipitation	General/ Background	Continuous	2.6 m	Neighborhood	1/5/06
Barometric Pressure	General/ Background	Continuous	1.8 m	Neighborhood	1/5/06

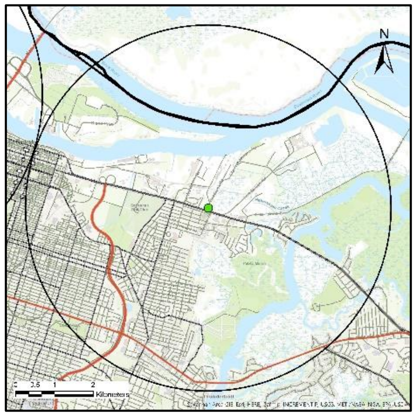
GA AAMP's plans for this site: Continue monitoring

Savannah MSA



<u>Radius of Circles on Map</u>
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)

Savannah- E. President



AQS ID: 130510021

Address: American Red Cross, 2500 E. President Street, Bd-A, Savannah, Chatham County, Georgia 31404

Site Established: 2/1/95

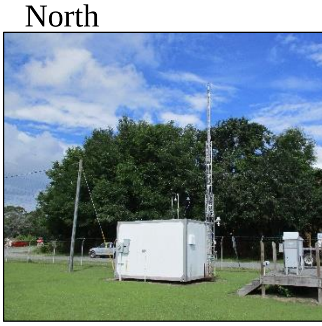
Latitude/Longitude: N32.0683/W-81.0496

Elevation: 10.4 meters

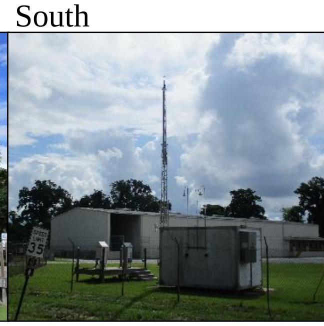
Area Represented: Savannah MSA

Site History: Established as SO_2 and H_2S site

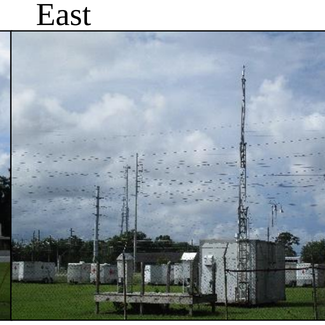
North



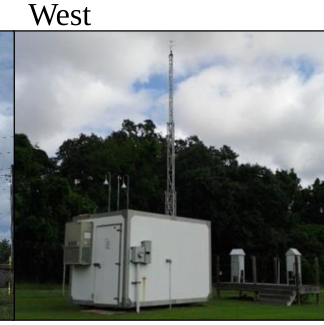
South



East



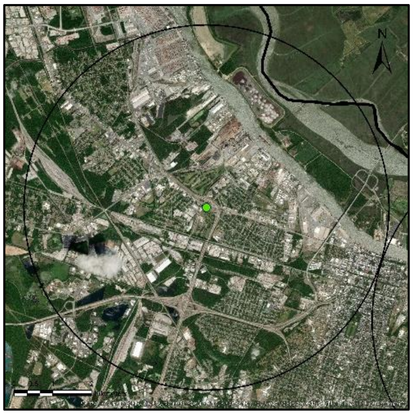
West

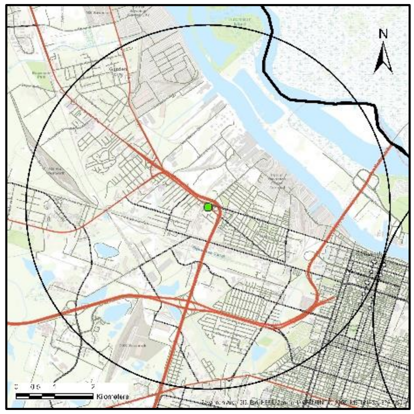


Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Population Exposure	Continuous (Mar-Oct)	3.8 m	Neighborhood	4/19/95
SO_2	Source Oriented	Continuous	3.8 m	Neighborhood	3/29/95
SO_2 5-Minute Maximum	Population Exposure	Continuous	3.8 m	Neighborhood	8/1/10
Wind Direction	General/ Background	Continuous	10 m	Neighborhood	1/1/04
Wind Speed	General/ Background	Continuous	10 m	Neighborhood	1/1//04

GA AAMP's plans for this site: Continue monitoring

Savannah- L&A





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: N32.0906/W-81.1304

Elevation: 6.11 meters

Area Represented: Savannah MSA

Site History: Established as TSP site

North

South

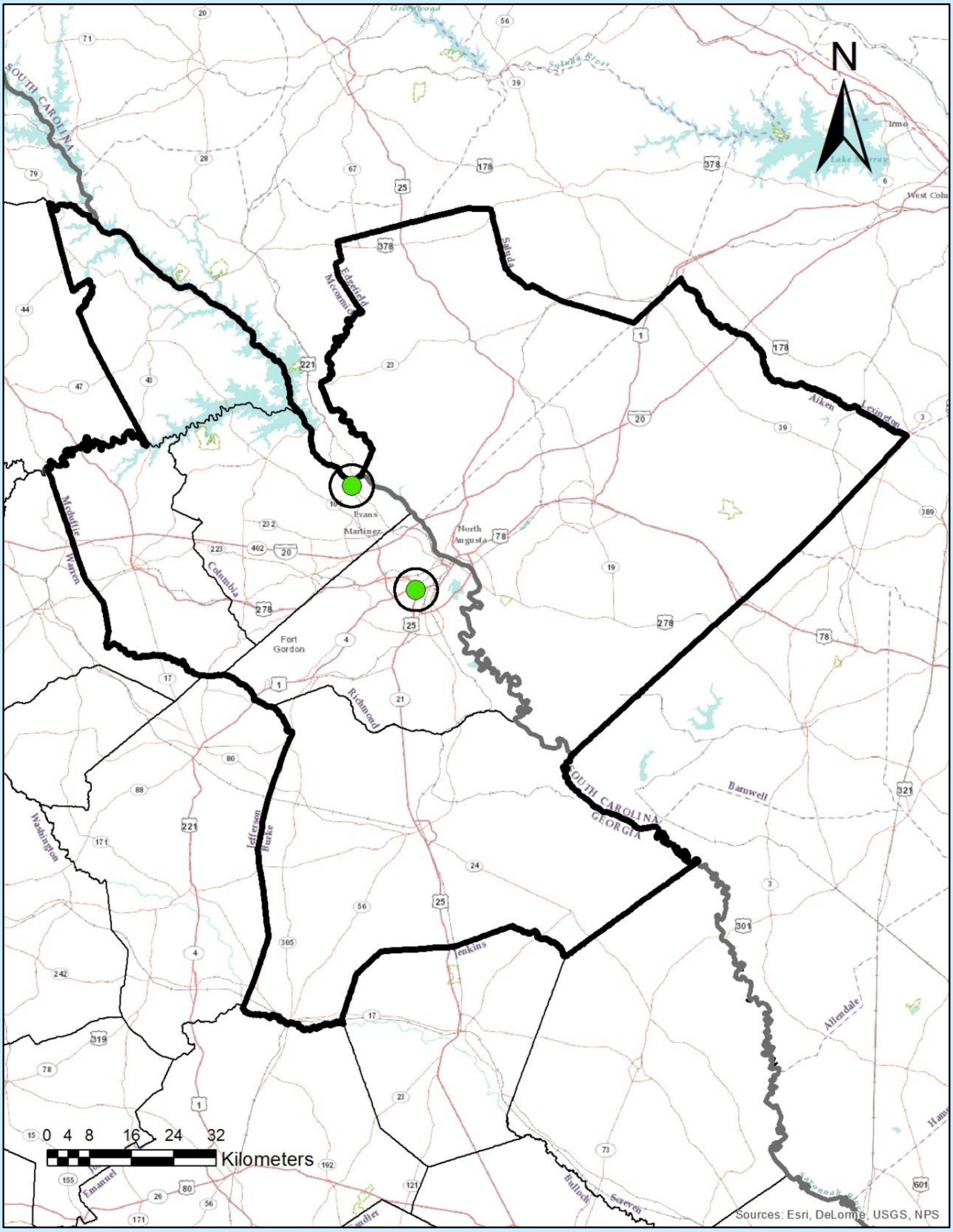
East

West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
SO_2	Population Exposure	Continuous	4.1 m	Neighborhood	1/1/98
SO_2 5-Minute Maximum	Population Exposure	Continuous	4.1 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	4.5 m	Neighborhood	10/1/03

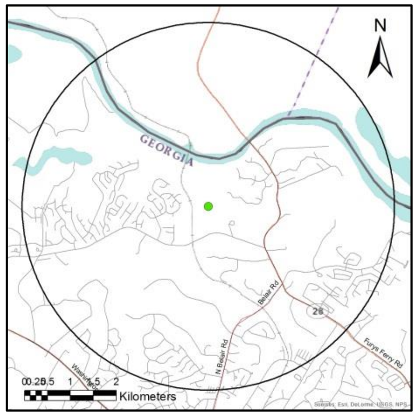
GA AAMP's plans for this site: Continue monitoring; propose to add an ozone monitor when initiated by EPA; Running continuous $PM_{2.5}$ sampler as FEM as of 11/7/2017

Augusta-Richmond County, Georgia-South Carolina MSA



<u>Radius of Circles on Map</u>
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)

Evans



AQS ID: 130730001

Address: Riverside Park, 4431 Hardy McManus Road, Evans, Columbia County, Georgia 30809

Site Established: 2/17/05

Latitude/Longitude: N33.5819/W-82.1314

Elevation: 74 meters

Area Represented: Augusta-Richmond County, Georgia-South Carolina MSA

Site History: Established as O_3 and NO_Y site

North

South

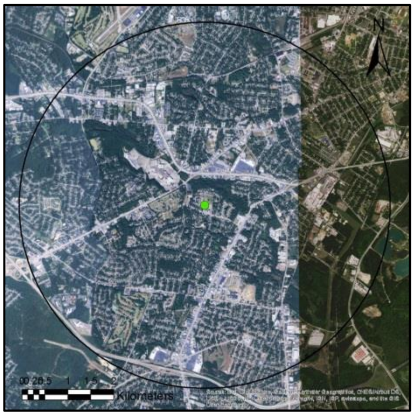
East

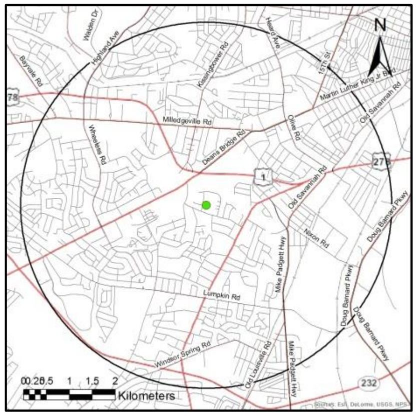
West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Population Exposure	Continuous (Mar-Oct)	5 m	Neighborhood	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
Outside Temperature	General/ Background	Continuous	2 m	Neighborhood	2/17/05
Relative Humidity	General/ Background	Continuous	2 m	Neighborhood	2/17/05

GA AAMP's plans for this site: Continue monitoring

Augusta





AQS ID: 132450091

Address: Bungalow Road Elementary School, 2216 Bungalow Rd, Augusta, Richmond County, Georgia 30906

Site Established: 1/1/76

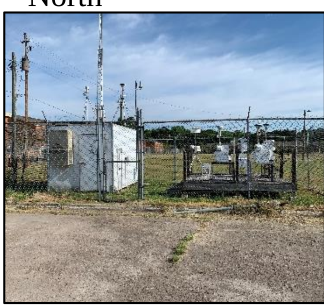
Latitude/Longitude: N33.4339/W-82.0224

Elevation: 48.77 meters

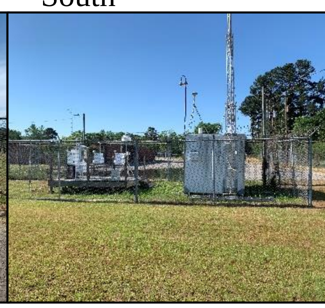
Area Represented: Augusta-Richmond County, Georgia-South Carolina MSA

Site History: Established as TSP site

North



South



East

West

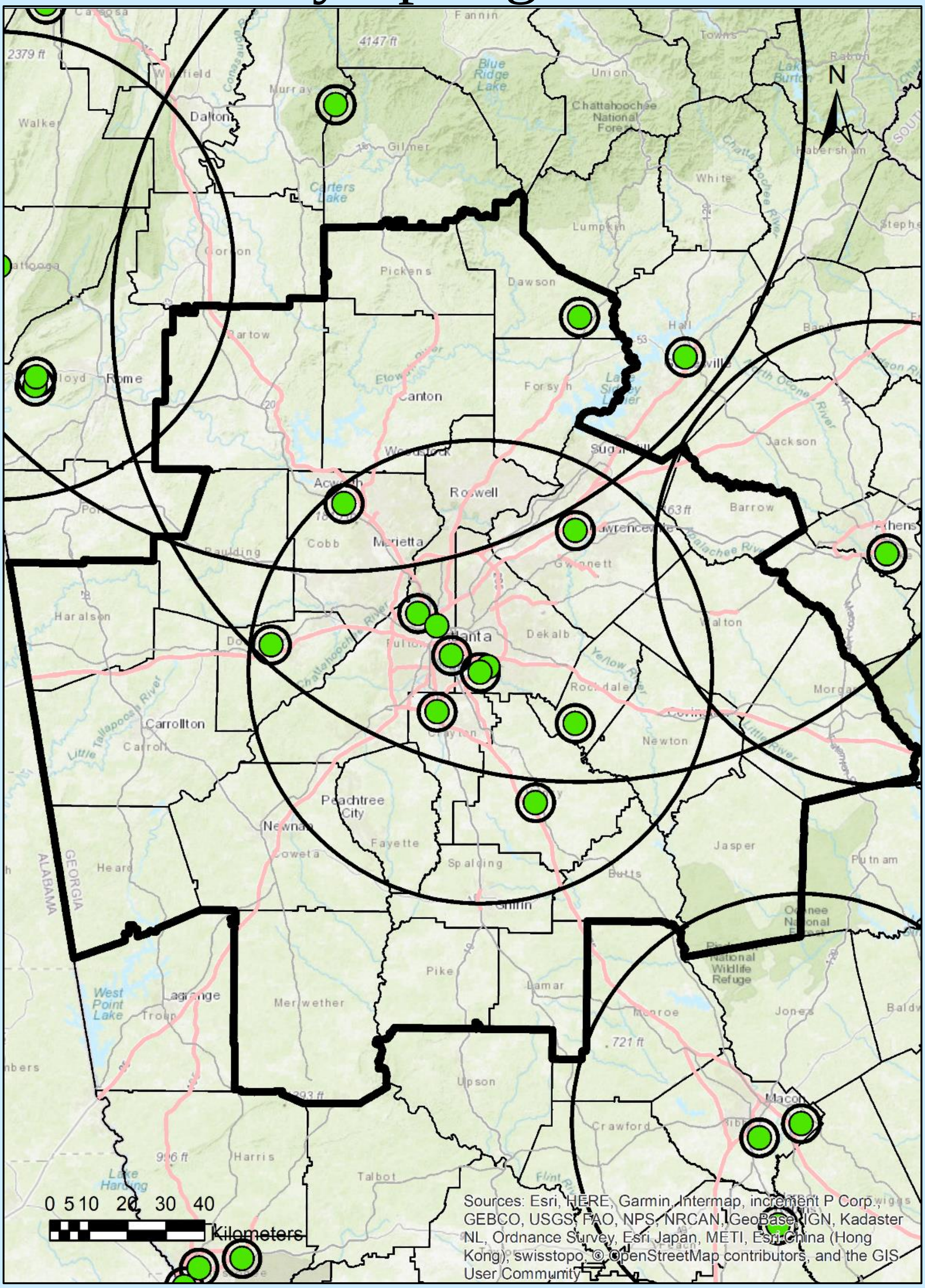
Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Population Exposure	Continuous (Mar-Oct)	4.5 m	Neighborhood	4/27/89
PM_{10}	Population Exposure	Continuous	3.5 m	Neighborhood	4/9/96
$PM_{2.5}$ Speciation	Population Exposure	Every 6 days	2.5 m	Neighborhood	3/2/02
$PM_{2.5}$	Population Exposure	Continuous	4.5 m	Neighborhood	10/1/03
SO_2	Population Exposure	Continuous	4.5 m	Neighborhood	1/14/13
SO_2 5-Minute Maximum	Population Exposure	Continuous	4.5 m	Neighborhood	1/14/13
Wind Speed	General/ Background	Continuous	10 m	Neighborhood	10/2/03

Augusta (continued)

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
Wind Direction	General/ Background	Continuous	10 m	Neighborhood	10/2/03
Outside Temperature	General/ Background	Continuous	2 m	Neighborhood	10/2/03
Relative Humidity	General/ Background	Continuous	2 m	Neighborhood	10/2/03
Rain/Melt Precipitation	General/ Background	Continuous	4 m	Neighborhood	10/2/03
Barometric Pressure	General/ Background	Continuous	2 m	Neighborhood	10/2/03

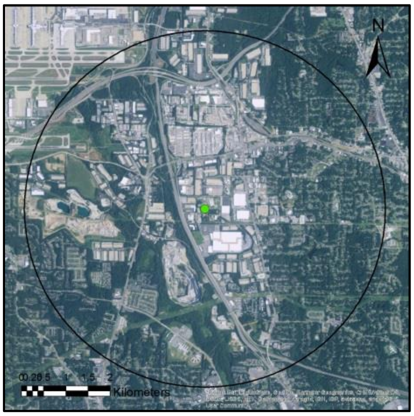
GA AAMP's plans for this site: Continue monitoring; Running continuous $PM_{2.5}$ monitor as FEM as of 10/1/2017; In January 2017, the PM_{10} integrated sampler collected an unexplainably high value. Therefore, GA AAMP replaced the integrated sampler, which collected data every 6 days, with a continuous hourly PM_{10} sampler as a proactive solution to collect data more frequently. If high values occur in the future that are at levels approaching or above the National Ambient Air Quality Standard, the number of PM_{10} monitors in the Augusta-Richmond County, GA-SC MSA may need to be reconsidered.

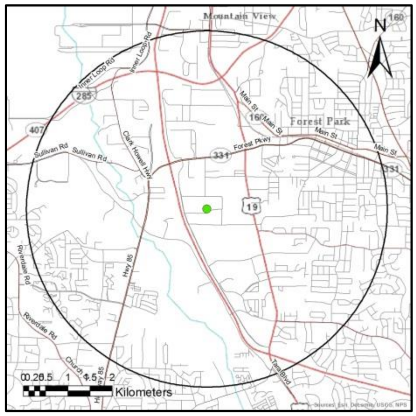
Atlanta-Sandy Springs-Marietta MSA



<u>Radius of Circles on Map</u>
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)

Forest Park





AQS ID: 130630091

Address: 25 Kennedy Drive, Forest Park, Clayton County, Georgia 30297

Site Established: 1/1/78

Latitude/Longitude: N33.6107/W-84.3908

Elevation: 288 meters

Area Represented: Atlanta-Sandy Springs-Marietta MSA

Site History: Established as TSP site

North

South

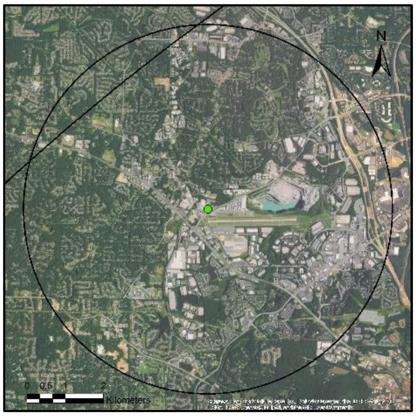
East

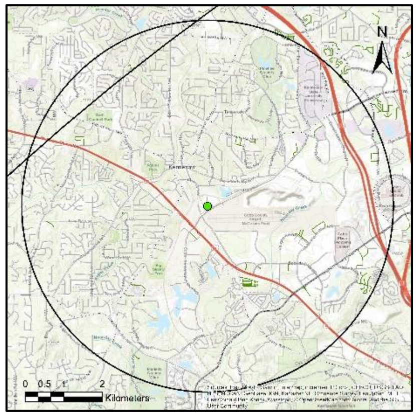
West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$	Population Exposure	Every 3 days	2.2 m	Neighborhood	1/9/99

GA AAMP's plans for this site: Continue monitoring

Kennesaw





AQS ID: 130670003

Address: Georgia National Guard, 1901 McCollum Parkway, Kennesaw, Cobb County, Georgia, 30144

Site Established: 2/7/99

Latitude/Longitude: N34.0153/W-84.6075

Elevation: 317 meters

Area Represented: Atlanta-Sandy Springs-Marietta MSA

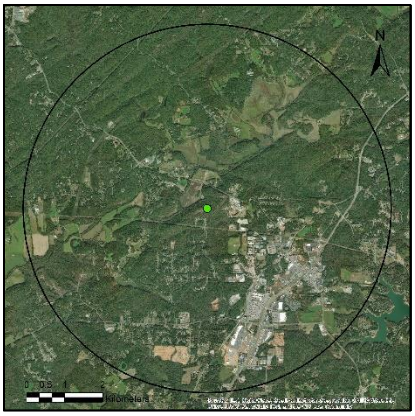
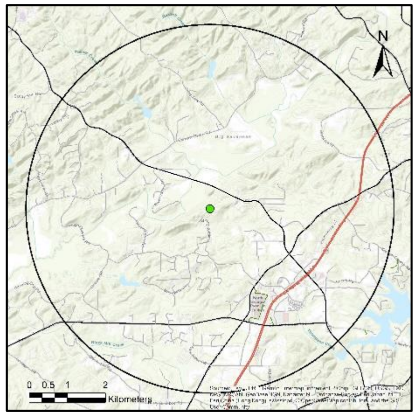
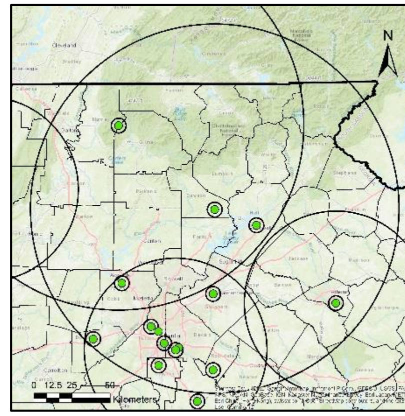
Site History: Established as $PM_{2.5}$ site

North South East West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Population Exposure	Continuous (Mar-Oct)	4.2 m	Neighborhood	9/1/99
$PM_{2.5}$	Population Exposure	Every 3 Days	4.8 m	Neighborhood	2/7/99

GA AAMP's plans for this site: Continue monitoring

Dawsonville

AQS ID: 130850001

Address: Georgia Forestry Commission, 4500 Georgia Highway 53 East, Dawsonville, Dawson County, Georgia 30534

Site Established: 1/1/85

Latitude/Longitude: N34.3761/W-84.0596

Elevation: 372 meters

Area Represented: Atlanta-Sandy Springs-Marietta MSA

Site History: Established as O_3 site

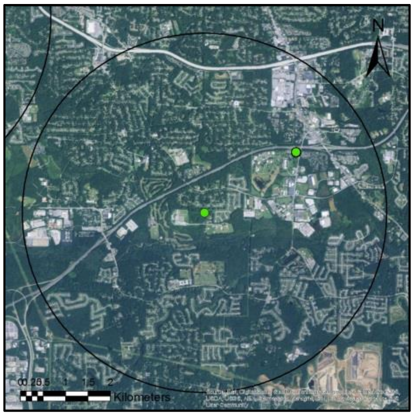
North South East West

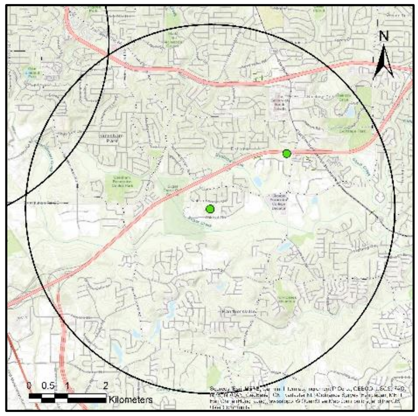


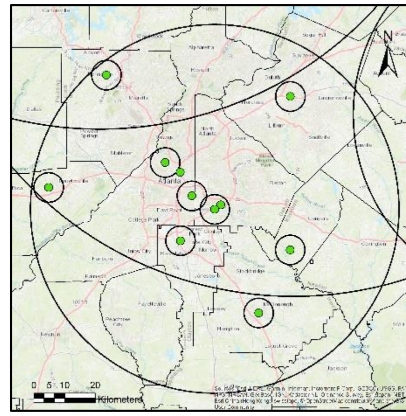

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Population Exposure	Continuous (Mar-Oct)	4 m	Neighborhood	1/1/85
Wind Speed	General/ Background	Continuous	10 m	Regional	1/1/05
Wind Direction	General/ Background	Continuous	10 m	Regional	1/1/05

GA AAMP's plans for this site: Continue monitoring

South DeKalb







AQS ID: 130890002

Address: 2390-B Wildcat Road, Decatur, DeKalb County, Georgia 30034

Site Established: 1/1/74

Latitude/Longitude: N33.6877/W-84.2905

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	Every 3 days	2.4 m	Neighborhood	1/22/99
$PM_{2.5}$	Quality Assurance	Every 3 days	2.4 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	2.2 m	Neighborhood	10/1/00
SO_2	Population Exposure	Continuous	3.8 m	Neighborhood	10/1/10
SO_2 5-Minute Maximum	Population Exposure	Continuous	3.8 m	Neighborhood	10/1/10
O_3	Population Exposure	Continuous	4 m	Neighborhood/ Urban	1/1/74
CO	Population Exposure	Continuous	4 m	Neighborhood	5/19/03

South DeKalb (continued)

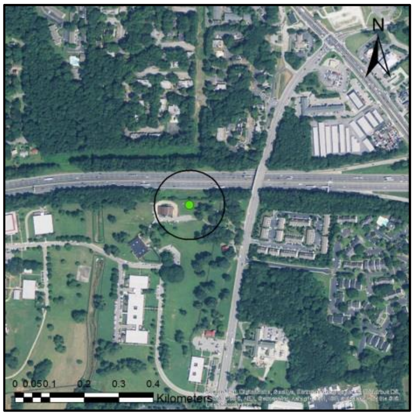
Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
NOy	Population Exposure	Continuous	10 m	Neighborhood/ Urban	1/1/98
NO	Population Exposure	Continuous	4 m	Neighborhood/ Urban	4/1/94
NOx	Population Exposure	Continuous	4 m	Neighborhood/ Urban	4/1/94
NO_2	Population Exposure	Continuous	4 m	Neighborhood/ Urban	7/21/78
Carbonyls (PAMS)	Max Precursor Emissions	Three 8-hour samples every third day in summer	3.8 m	Neighborhood	6/1/93
Carbonyls (NATTS)	Population Exposure	Every 6 days	3.8 m	Neighborhood	6/1/93
Carbonyls (NATTS)	Quality Assurance	1/month	3.8 m	Neighborhood	1/1/06
PM_{10} Select Metals (NATTS)	Population Exposure	Every 6 days	2 m	Neighborhood	1/1/00
PM_{10} Select Metals (NATTS)	Quality Assurance	1/month	2 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 (June-August)	3.8 m	Neighborhood	6/1/93
VOCs (NATTS)	Population Exposure	Every 6 days	3.8 m	Neighborhood	6/1/93
VOCs (NATTS)	Quality Assurance	1/month	3.8 m	Neighborhood	1/1/05
Semi-VOCs (NATTS)	Population Exposure	Every 6 days	2.5 m	Neighborhood	4/30/07
Semi-VOCs (NATTS)	Quality Assurance	1/month	2.5 m	Neighborhood	4/30/07
Outdoor Temperature	General/ Background	Continuous	2 m	Neighborhood	6/1/93
Rain/Melt Precipitation	General/ Background	Continuous	3.2 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

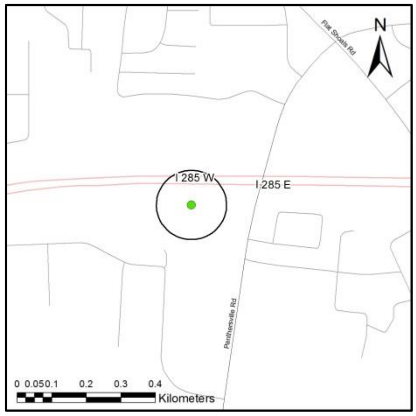
South DeKalb (continued)

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
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

GA AAMP's plans for this site: Continue monitoring. NCore site (refer to GA AAMP's *2011 Ambient Air Monitoring Plan, Appendix C, Ambient Air Monitoring Plan for National Core (NCore) Multipollutant Monitoring Station* for full description and approval). Solar radiation and ultraviolet radiation for South DeKalb PAMS are currently monitored at the Conyers site due to equipment specifications (see Section 1.4 for waiver request). GA AAMP is planning to replace both the primary and collocated NATTS high-volume PM_{10} metals samplers with low-volume PM_{10} metals samplers when the collection and analysis method are fully operational. GA AAMP installed an Agilent 7890B Gas Chromatograph to fulfill the PAMS requirement for measuring hourly VOCs that will become operational when functioning properly.

NR-285





AQS ID: 130890003

Address: 3073 Panthersville Road, Decatur, DeKalb County, Georgia 30034

Site Established: 7/1/86

Latitude/Longitude: N33.6985/W-84.2727

Elevation: 238 meters

Area Represented: Atlanta-Sandy Springs-Marietta MSA

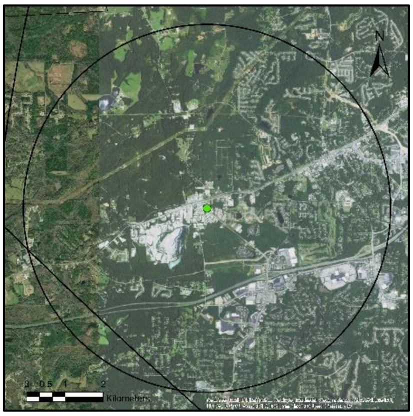
Site History: Established as lead site

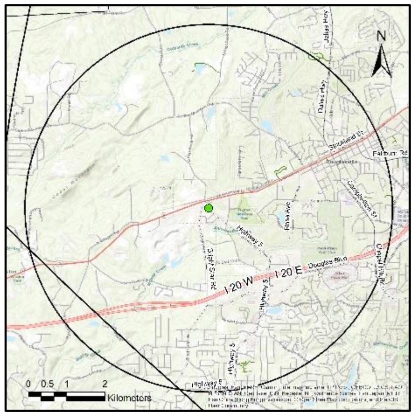
North South East West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
NO_2	Population Exposure	Continuous	3.3 m	Micro	1/1/15
NO	Population Exposure	Continuous	3.3 m	Micro	1/1/15
NOx	Population Exposure	Continuous	3.3 m	Micro	1/1/15
VOCs	Population Exposure	Every 6 days	3.3 m	Micro	3/31/15
Black Carbon	Population Exposure	Continuous	3.3 m	Micro	9/1/15

GA AAMP's plans for this site: Continue monitoring; Near-road site as of 1/1/15 (see *Addendum to 2015 Ambient Monitoring Plan* for full description).

Douglasville





AQS ID: 130970004

Address: Douglas County Water Authority, 7725 W. Strickland St., Douglasville, Douglas County, Georgia 30134

Site Established: 8/15/97

Latitude/Longitude: N33.7411/W-84.7765

Elevation: 373 meters

Area Represented: Atlanta-Sandy Springs-Marietta MSA

Site History: Established as O_3 site

North

South

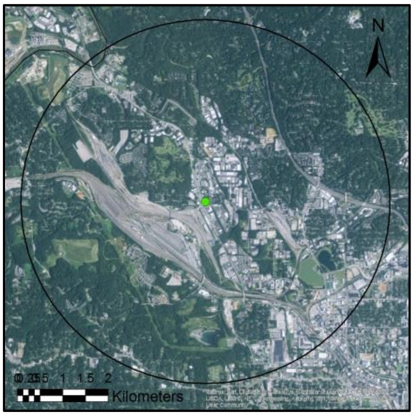
East

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

GA AAMP's plans for this site: Continue monitoring

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: N33.8021/W-84.4357

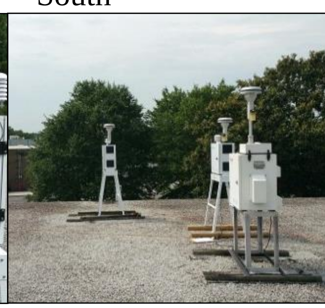
Elevation: 265 meters

Area Represented: Atlanta-Sandy Springs-Marietta MSA

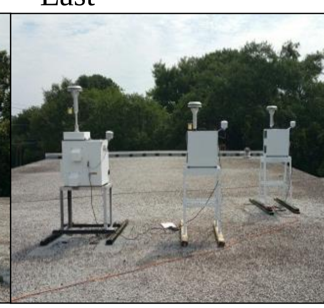
Site History: Established as TSP site

North

South



East



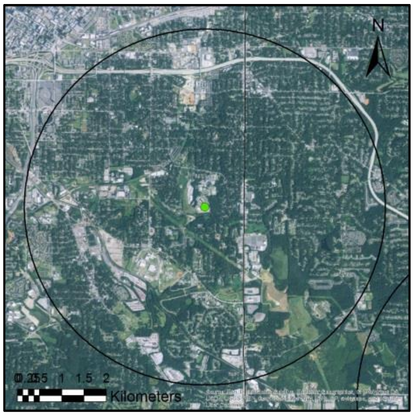
West

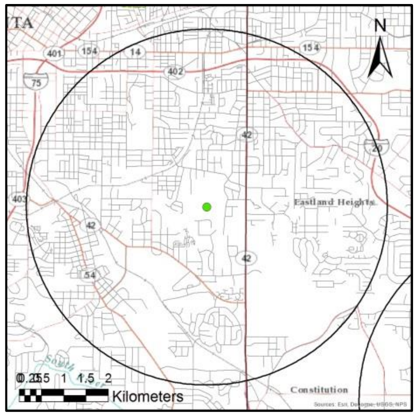
Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$	Population Exposure	Every 3 days	10 m	Neighborhood	1/21/99*
PM_{10}	Population Exposure	Every 6 days	10 m	Neighborhood	1/1/86**
PM_{10}	Population Exposure/Quality Assurance	Every 12 days	10 m	Neighborhood	2/1/86***

* Sampler inactive from 9/30/06 to 12/1/08, **Sampler inactive from 9/26/06 to 1/3/13, ***Sampler inactive from 10/12/87 to 1/1/06 and from 9/26/06 to 6/1/17

GA AAMP's plans for this site: Continue monitoring

United Avenue





AQS ID: 131210055

Address: 945 United Avenue, Atlanta, Fulton County, Georgia 30316

Site Established: 10/1/91

Latitude/Longitude: N33.7206/W-84.3574

Elevation: 288 meters

Area Represented: Atlanta-Sandy Springs-Marietta MSA

Site History: Established as O_3 and SO_2 site

North

South

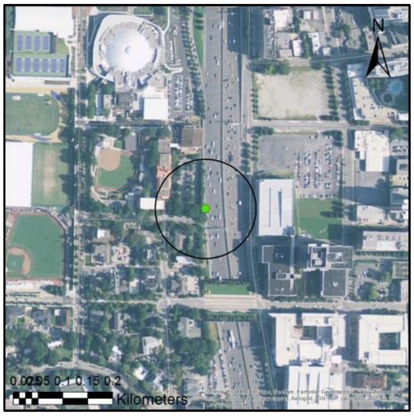
East

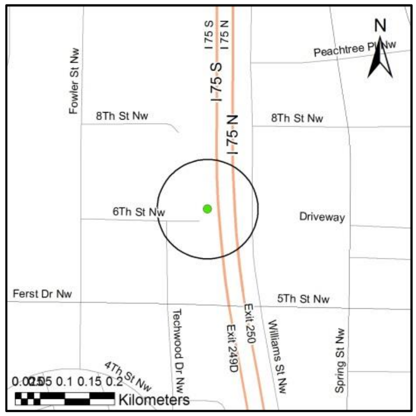
West

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	Maximum Concentration	Continuous (Mar-Oct)	4 m	Neighborhood	10/1/91
$PM_{2.5}$	Population Exposure	Continuous	4.8 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

GA AAMP's plans for this site: Continue monitoring

NR-GA Tech





AQS ID: 131210056

Address: Georgia Institute of Technology, 6th Street and I-75, Atlanta, Fulton County, Georgia, 30313

Site Established: 6/15/14

Latitude/Longitude: N33.7784/W-84.3914

Elevation: 286 meters

Area Represented: Atlanta-Sandy Springs-Marietta MSA

Site History: Established as near-road site

North South East West

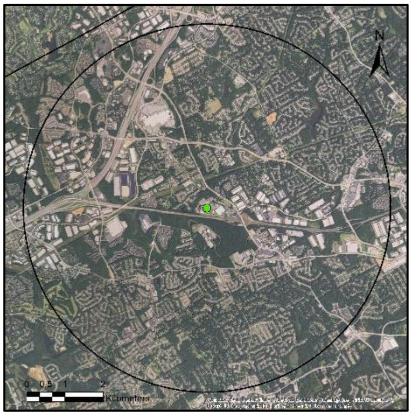
Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
NO_2	Source Oriented	Continuous	3.5 m	Micro	6/15/14
NO	Source Oriented	Continuous	3.5 m	Micro	6/15/14
NOx	Source Oriented	Continuous	3.5 m	Micro	6/15/14
CO	Source Oriented	Continuous	3.5 m	Micro	6/15/14
$PM_{2.5}$	Source Oriented	Every 3 days	4.8 m	Micro	1/1/15
Black Carbon	Source Oriented	Continuous	4.4 m	Micro	7/9/15
Wind Speed	Source Oriented	Continuous	5.5 m	Micro	8/20/14

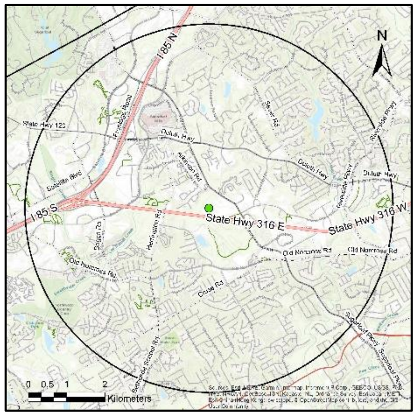
NR-GA Tech (continued)

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
Wind Direction	Source Oriented	Continuous	5.5 m	Micro	8/20/14
$PM_{2.5}$	Source Oriented	Continuous	3.5 m	Micro	3/1/18

GA AAMP's plans for this site: Continue monitoring; See Appendix E of *2014 Ambient Air Monitoring Plan* for near-road site establishment and details. On March 1, 2018 GA AAMP installed a nephelometer at this site (see Section 1.0 of Appendix C for more details).

Gwinnett Tech





AQS ID: 131350002

Address: Gwinnett Tech, 5150 Sugarloaf Parkway, Lawrenceville, Gwinnett County, Georgia 30043

Site Established: 3/17/95

Latitude/Longitude: N33.9632/W-84.0691

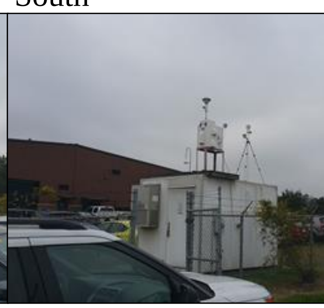
Elevation: 294 meters

Area Represented: Atlanta-Sandy Springs-Marietta MSA

Site History: Established as O_3 site

North

South



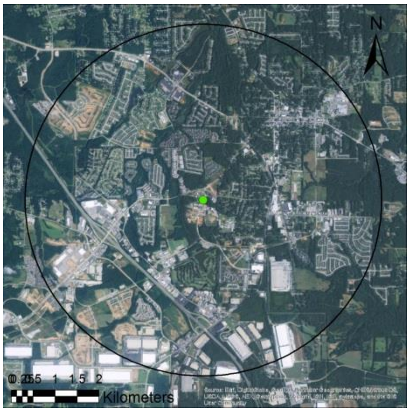
East

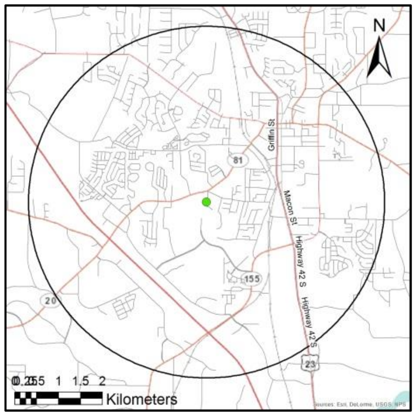
West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Population Exposure	Continuous (Mar-Oct)	3.4 m	Neighborhood	5/17/95
$PM_{2.5}$	Population Exposure	Continuous	4.4 m	Neighborhood	9/1/03

GA AAMP's plans for this site: Continue monitoring; On October 26, 2017 GA AAMP installed an FEM Teledyne T640 Continuous $PM_{2.5}$ sampler to replace the BAM $PM_{2.5}$ sampler. The $PM_{2.5}$ FRM sampler was shut down as of October 31, 2018.

McDonough





AQS ID: 131510002

Address: Blessings Thrift Store, 86 Work Camp Rd, McDonough, Henry County, Georgia 30253

Site Established: 6/7/99

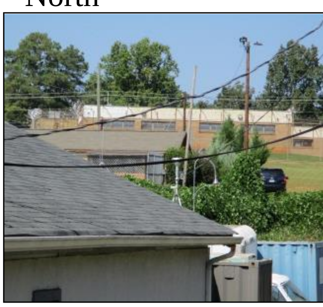
Latitude/Longitude: N33.4338/W-84.1619

Elevation: 261.35 meters

Area Represented: Atlanta-Sandy Springs-Marietta MSA

Site History: Established as O_3 site

North



South

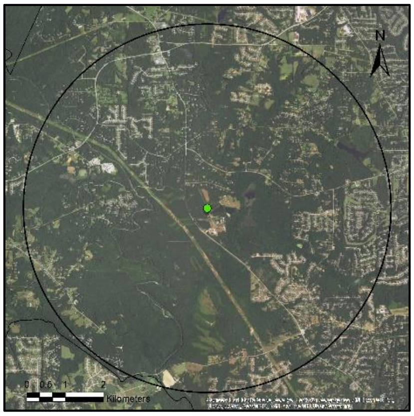
East

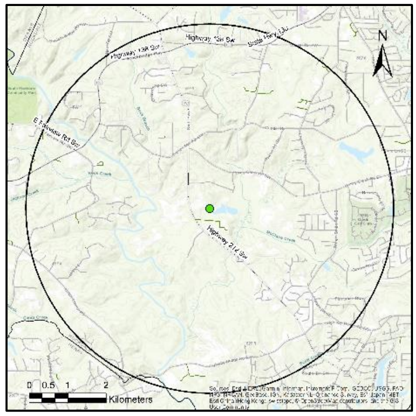
West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Maximum Concentration	Continuous (Mar-Oct)	4 m	Neighborhood	6/7/99
$PM_{2.5}$	Population Exposure	Continuous	4.2 m	Neighborhood	9/1/03

GA AAMP's plans for this site: Continue monitoring

Conyers





AQS ID: 132470001

Address: 2625 Georgia Highway 212, Conyers, Rockdale County, Georgia 30094

Site Established: 7/26/78

Latitude/Longitude: N33.5884/W-84.0697

Elevation: 219 meters

Area Represented: Atlanta-Sandy Springs-Marietta MSA

Site History: Established as O_3 site

North

South

East

West

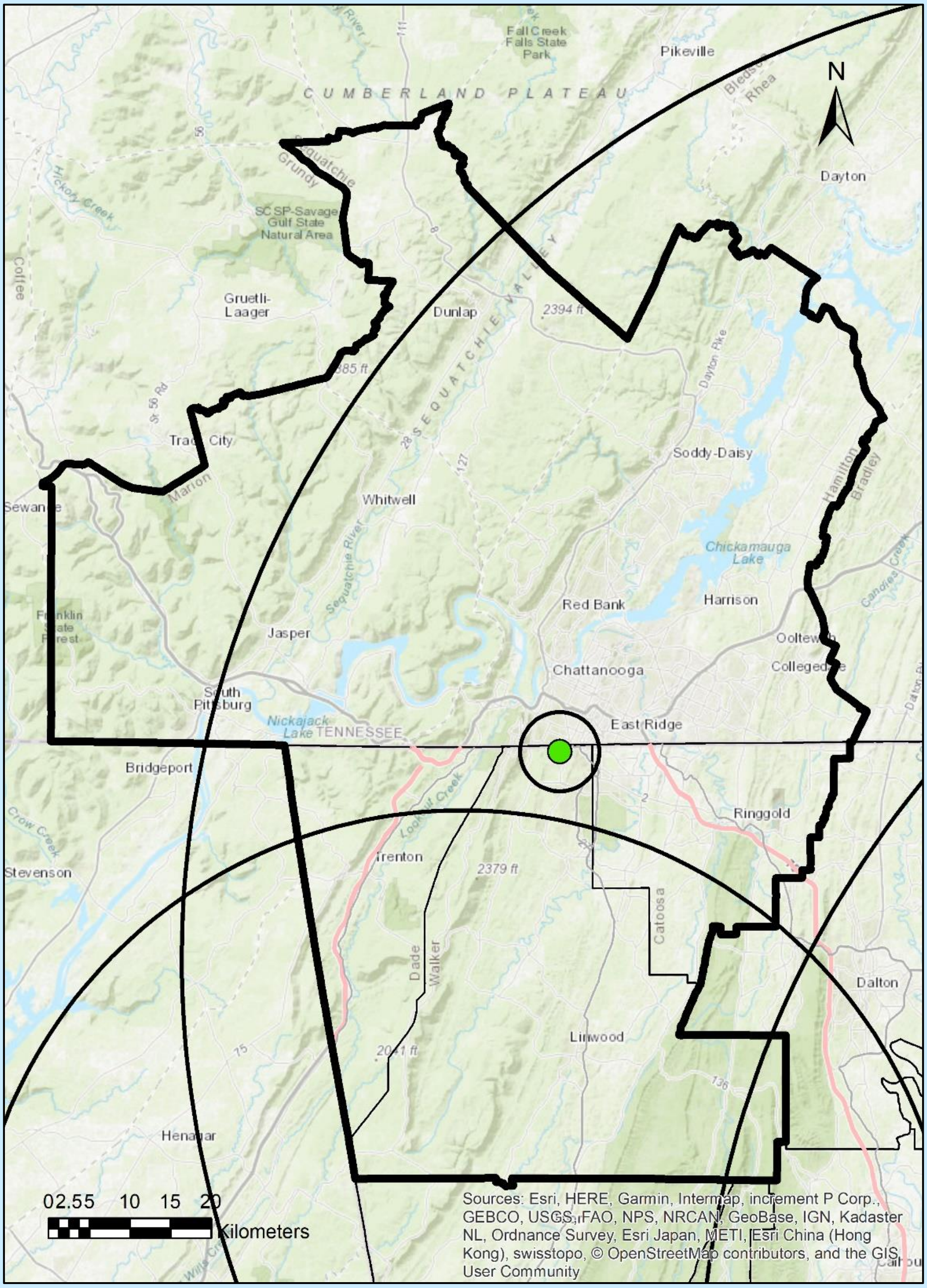
Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Maximum Concentration	Continuous (Mar-Oct)	4.4 m	Neighborhood	7/26/78
Relative Humidity	General/ Background	Continuous	2.9 m	Neighborhood	6/1/94
Barometric Pressure	General/ Background	Continuous	2.9 m	Neighborhood	6/1/94
Ultraviolet Radiation	General/ Background	Continuous	2.2 m	Neighborhood	1/1/97
Outdoor Temperature	General/ Background	Continuous	2.9 m	Neighborhood	6/1/94
Solar Radiation	General/ Background	Continuous	2.2 m	Neighborhood	6/1/94

Conyers (continued)

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
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	3.8 m	Neighborhood	7/1/03

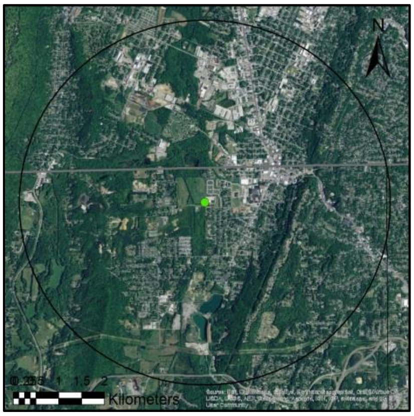
GA AAMP's plans for this site: Continue monitoring; Ultraviolet radiation and solar radiation monitored at Conyers are also used to fulfill meteorological requirements for South DeKalb PAMS (see Section 1.4 for waiver request).

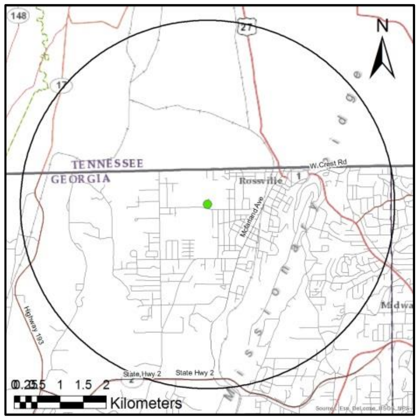
Chattanooga Tennessee-Georgia MSA



<u>Radius of Circles on Map</u>
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)

Rossville





AQS ID: 132950002

Address: 601 Maple Street, Lot #6, Rossville, Walker County, Georgia, 30741

Site Established: 1/1/67

Latitude/Longitude: N34.9788/W-85.3009

Elevation: 200 meters

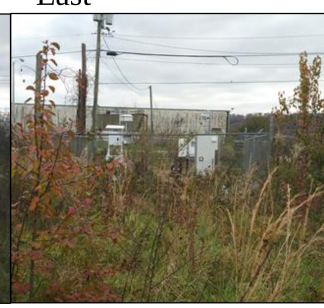
Area Represented: Chattanooga Tennessee-Georgia MSA

Site History: Established as TSP and SO_2/NO_2 site

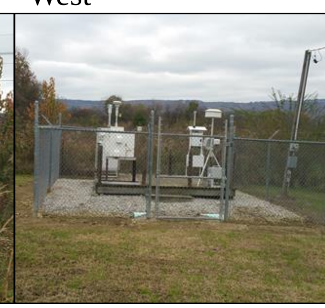
North

South

East



West



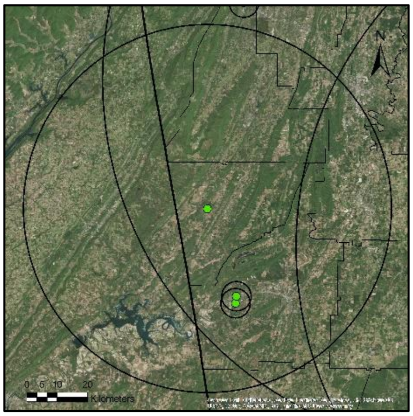
Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$	Population Exposure	Continuous	2.9 m	Neighborhood	1/24/07
$PM_{2.5}$	Population Exposure/ Regional Transport	Every 3 days	2.2 m	Neighborhood	1/1/00
$PM_{2.5}$ Speciation	Population Exposure	Every 6 days	2.2 m	Neighborhood	3/23/05

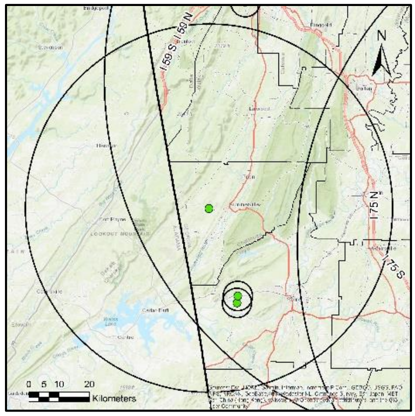
<u>GA AAMP's plans for this site:</u> Continue monitoring; On October 1, 2017 GA AAMP installed an FEM Teledyne T640 Continuous $PM_{2.5}$ sampler to replace the BAM $PM_{2.5}$ sampler.

Sites Not in an MSA

(Listed in AQS ID Order)

Summerville





AQS ID: 130550001

Address: DNR Fish Hatchery, 231 Fish Hatchery Road, Summerville, Chattooga County, Georgia 30747

Site Established: 1985

Latitude/Longitude: N34.4744/W-85.4089

Elevation: 276 meters

Area Represented: Not in an MSA, Summerville Micropolitan Statistical Area

Site History: Established as Acid Rain site

North

South

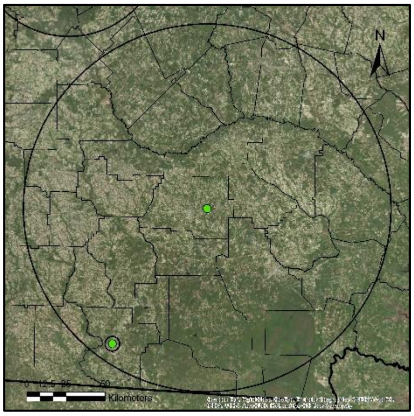
East

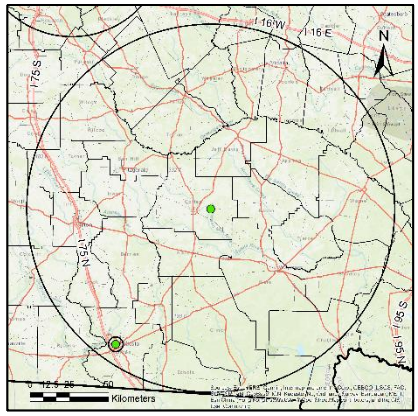
West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	Regional Transport	Continuous (Mar-Oct)	4 m	Urban	3/1/04

GA AAMP's plans for this site: Continue monitoring

General Coffee





AQS ID: 130690002

Address: 46 John Coffee Road, Nicholls, Coffee County, Georgia 31554

Site Established: 1/1/99

Latitude/Longitude: N31.5129/W-82.7501

Elevation: 49 meters

Area Represented: Not in an MSA, Douglas Micropolitan Statistical Area

Site History: Established as Air Toxics site

North

South

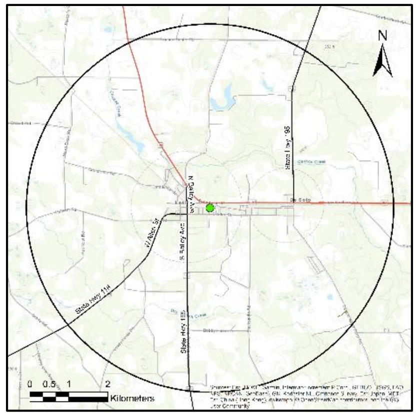
East

West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
$PM_{2.5}$ Speciation	General Background	Every 6 days	3.5 m	Regional	3/1/02
$PM_{2.5}$	General Background	Every 3 days	3 m	Regional	2/1/17
Ethylene Oxide	General Background	As needed	3 m	Regional	9/19/19

GA AAMP's plans for this site: Continue monitoring; this site is also being used as part of GA AAMP’s data study on Ethylene Oxide.

Leslie



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: N31.9541/W-84.0811

Elevation: 108 meters

Area Represented: Not in an MSA, Americus Micropolitan Statistical Area

Site History: Established as O_3 site

North

South

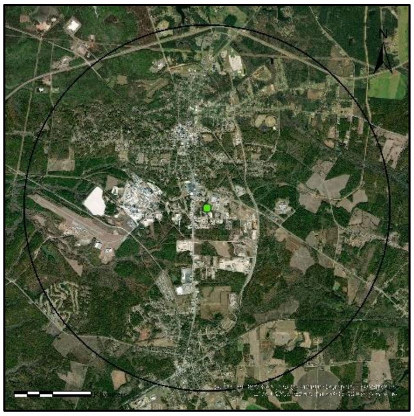
East

West

Parameter	Monitoring Objective	Sampling Schedule	Probe Inlet Height	Spatial Scale	Begin Date
O_3	General/ Background	Continuous (Mar-Oct)	3 m	Neighborhood	1/1/81

GA AAMP's plans for this site: Continue monitoring

Sandersville



AQS ID: 133030001

Address: 420 Riddleville Road, Sandersville, Washington County, Georgia 31082

Site Established: 1/1/74

Latitude/Longitude: N32.968060/W-82.805903

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	Continuous	3 m	Neighborhood	1/30/99

GA AAMP's plans for this site: Continue monitoring; On August 14, 2019 GA AAMP replaced the FRM with an FEM Teledyne T640 Continuous $PM_{2.5}$ sampler. GA AAMP has moved sampling station to ground level due to roof of building replaced (new site location meets siting criteria).

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	ESC DAS 8832	Datalogger 8832	good/ >7
	Met One SASS	PM2.5 Speciation Sampler	good/ >6
	URG 3000N	PM2.5 Speciation Sampler	good/ >10
	TEOM 1400AB	Continuous PM2.5/PM10 Sampler	good/ >6
Kraftsman	ESC DAS 8832	Datalogger	good/ >6
	Thermo 43i	SO2 Analyzer	good/ >6
	Thermo 146i	Multi-Gas Calibrator	good/ >6
	Sulfur Dioxide Cylinder	Gas Cylinder	good/ <9
	RM Young Ultrasonic Anemometer 810000	Wind Speed and Wind Direction	good/ >3
	Aluma T-135	Meteorological Crank Tower	good/ >3
	Environics 7000	Zero Air Supply	good/ >5
Brunswick MSA			
Brunswick	ESC DAS 8832	Datalogger	good/ >7
	Thermo 49 series	O3 Analyzer	good/ >9
	Thermo 49 series	O3 Analyzer	good/ >9
	Thermo Partisol-Plus 2025	Integrated PM2.5 Sampler	good/ >9
	RM Young Ultrasonic Anemometer 81000	Wind Speed and Wind Direction	good/ >6
	Aluma T-135	Meteorological Crank Tower	good/ >10
	Environics 7000	Zero Air Supply	good/ >6
Valdosta MSA			
Valdosta	Thermo Partisol-Plus 2025	Integrated PM2.5 Sampler	good/ >6
	Teledyne T640 (summer 2020)	Continuous PM2.5 Sampler	new
	ESC DAS 8832 (summer 2020)	Datalogger	good/<5
Warner Robins MSA			
Warner Robins	Thermo Partisol-Plus 2025	Integrated PM2.5 Sampler	good/ >5
	Teledyne T640	Continuous PM Sampler	good/>3
Dalton MSA			
Fort Mountain	ESC DAS 8832	Datalogger	good/ >7
	Thermo 49 series	O3 Analyzer	good/ >9
	Thermo 49 series	O3 Calibrator	good/ >9
	RM Young Ultrasonic Anemometer 81000	Wind Speed and Wind Direction	good/ >10
	RM Young Temp/RH Probe 41382VC	Ambient Temperature & Relative Humidity	good/ >6
	Aluma FOT-10	Meteorological Fold Over Tower	good/ >10
Gainesville MSA			
Gainesville	Teledyne T640	Continuous PM Sampler	good/ >3
	ESC DAS 8832	Datalogger	good/ >7
Albany MSA			
Albany	Thermo Partisol-Plus 2025	Integrated PM2.5 Sampler	good/ >5
	Thermo Partisol-Plus 2025	Collocated Integrated PM2.5 Sampler	good/ >5
	ESC DAS 8832	Datalogger	good/ >7
	Teledyne T640	Continuous PM Sampler	good/ >1
Athens-Clarke County MSA			
Athens	Thermo 49 series	O3 Analyzer	good/ >9
	Thermo 49 series	O3 Calibrator	good/ >9
	Teledyne T640	Continuous PM Sampler	good/ >2
	Teledyne T640	Collocated Continuous PM Sampler	good/ >1
	ESC DAS 8832	Datalogger	good/ >7
	Environics 7000	Zero Air Supply	good/ >5
Macon MSA			
Macon-Allied	Thermo Partisol-Plus 2025	Integrated PM2.5 Sampler	good/ >5
	Thermo Partisol-Plus 2025	Collocated Integrated PM2.5 Sampler	good/ >5
	Met One SASS	PM2.5 Speciation Sampler	good/ >10

SITE NAME	EQUIPMENT NAME	EQUIPMENT DESCRIPTION	COND./ AGE
Macon-Allied cont'd	URG 3000N	PM2.5 Speciation Sampler	good/ >10
Macon Forestry	ESC DAS 8832	Datalogger	good/ >7
	Thermo 49 series	O3 Analyzer	good/ >10
	Thermo 49 series	O3 Calibrator	good/ >10
	Thermo 43i	SO2 Analyzer	good/ >9
	Thermo 146i	Multi-Gas Calibrator	good/ >10
	Thermo Partisol-Plus 2025	Integrated PM2.5 Sampler	good/ >5
	Teledyne T640	Continuous PM Sampler	good/ >2
	Sulfur Dioxide Cylinder	Gas Cylinder	good/ >9
	Graseby PUF Sampler GPS1-11*	Semi-VOCs (PAH) Sampler	good/ >10
	Graseby High Volume 2000H*	Metals Sampler	good/ >10
	AVOCS*	VOC Sampler	good/ >10
	RM Young Ultrasonic Anemometer 81000	Wind Speed and Wind Direction	good/ >10
	Aluma T-135	Meteorological Crank Tower	good/ >10
Columbus Georgia-Alabama MSA			
Columbus - Health Department	Thermo Partisol-Plus 2025	Integrated PM2.5 Sampler	good/ >5
Columbus - Airport	ESC DAS 8832	Datalogger	good/ >7
	Thermo 49 series	O3 Analyzer	good/ >10
	Thermo 49 series	O3 Calibrator	good/ >7
	Thermo Partisol-Plus 2025	Integrated PM2.5 Sampler	good/ >5
	TEOM 1400AB	Continuous PM2.5 Sampler	good/ >9
	Environics 7000	Zero Air Supply	good/ >5
Columbus - Allied	TSP High Volume 2000H	Metals-Pb (lead) Sampler	good/ >10
	TSP High Volume 2000H	Collocated Metals-Pb (lead) Sampler	good/ >10
Columbus - Cusseta	Thermo Partisol-Plus 2025	Integrated PM2.5 Sampler	good/ >5
	Met One SASS	PM2.5 Speciation Sampler	good/ >7
	URG 3000N	PM2.5 Speciation Sampler	good/ >5
	TSP High Volume 2000H	TSP-Pb (lead) Sampler	good/ >10
Columbus - Crime Lab	RM Young Ultrasonic Anemometer 81000	Wind Speed and Wind Direction	good/ >7
	Aluma T-135	Meteorological Crank Tower	good/ >10
	RM Young Barometric Pressure Sensor 61302V	Barometric Pressure Sensor	good/ >6
	Novalynx 260-2501 Tipping Bucket	Precipitation Sensor	good/ >6
	RM Young Temp/RH Probe 41382VC	Ambient Temperature & Relative Humidity	good/ >6
	ESC DAS 8832	Datalogger	good/ >7
Savannah MSA			
Savannah - E President	ESC DAS 8832	Datalogger	good/ >7
	Thermo 49 series	O3 Analyzer	good/ >9
	Thermo 49 series	O3 Calibrator	good/ >9
	Thermo 43i	SO2 Analyzer	good/ >9
	Thermo 146i	Multi-Gas Calibrator	good/ >9
	Environics 7000	Zero Air Supply	good/ >5
	Graseby PUF Sampler GSP1*	Semi-VOCs (PAH) Sampler	good/ >9
	Andersen Hi-VL 2000 HBL*	Metals Sampler	good/ >9
	ATEC 1000*	Carbonyls Sampler	good/ >9
	Sulfur Dioxide Cylinder	Gas Cylinder	good/ >9
	RM Young Ultrasonic Anemometer 81000	Wind Speed and Wind Direction	good/ >7
	Aluma T-135	Meteorological Crank Tower	good/ >10
	RM Young Temp/RH Probe 41382VC	Ambient Temperature & Relative Humidity	good/ >6
	RM Young Barometric Pressure Sensor 61302	Barometric Pressure Sensor	good/ >6

SITE NAME	EQUIPMENT NAME	EQUIPMENT DESCRIPTION	COND./ AGE
Savannah - L&A	ESC DAS 8832	Datalogger	good/ >7
	Thermo 43i	SO2 Analyzer	good/ >9
	Thermo 146i	Multi-Gas Calibrator	good/ >9
	Teledyne T640	Continuous PM Sampler	good/ >2
	Sulfur Dioxide Cylinder	Gas Cylinder	good/ >9
	RM Young Ultrasonic Anemometer 81000	Wind Speed and Wind Direction	good/ >5
	Aluma T-135	Meteorological Crank Tower	good/ >10
	Environics 7000	Zero Air Supply	good/ >5
Augusta-Richmond County, Georgia-South Carolina MSA			
Evans	Thermo 49 series	O3 Analyzer	good/ >8
	Thermo 49 series	O3 Calibrator	good/ >7
	RM Young Ultrasonic Anemometer 81000	Wind Speed and Wind Direction	good/ >10
	Aluma FOT-10	Meteorological Fold Over Tower	good/ >7
	ESC DAS 8832	Datalogger	good/ >7
	Sabio 1001	Zero Air Supply	good/ >5
	RM Young Temp/RH Probe 41382VC	Ambient Temperature & Relative Humidity	good/ >5
Augusta	Sabio 1001	Zero Air Supply	good/ >5
	Thermo 49 series	O3 Analyzer	good/ >9
	Thermo 49 series	O3 Calibrator	good/ >9
	Thermo 43i-TLE	SO2 Analyzer	good/ >9
	Thermo 146i	Multi-Gas Calibrator	good/ >9
	TEOM 1400AB	Continuous PM10 Sampler	good/ >9
	Teledyne T640	Continuous PM2.5 Sampler	good/>3
	Met One SASS	PM2.5 Speciation Sampler	good/ >6
	URG 3000N	PM2.5 Speciation Sampler	good/ >6
	Sulfur Dioxide Cylinder	Gas Cylinder	good/ >9
	RM Young Ultrasonic Anemometer 81000	Wind Speed and Wind Direction	good/ >6
	Aluma T-135	Meteorological Crank Tower	good/ >10
	ESC DAS 8832	Datalogger	good/ >7
	Novalynx 260-2501 Tipping Bucket	Precipitation Sensor	good/ >6
	RM Young Temp/RH Probe 41382VC	Ambient Temperature & Relative Humidity	good/ >6
	PM Young Barometric Pressure Sensor 61302	Barometric Pressure Sensor	good/ >6
Atlanta-Sandy Springs-Marietta MSA			
Forest Park	Thermo Partisol-Plus 2025	Integrated PM2.5 Sampler	good/ >5
Kennesaw	ESC DAS 8832	Datalogger	good/ >6
	Thermo 49 series	O3 Analyzer	good/ >8
	Thermo 49 series	O3 Calibrator	good/ >8
	Thermo Partisol-Plus 2025	Integrated PM2.5 Sampler	good/ >4
Dawsonville	Thermo 49 series	O3 Analyzer	good/ >7
	Thermo 49 series	O3 Calibrator	good/ >7
	ESC DAS 8832	Datalogger	good/ >7
	Environics 7000	Zero Air Supply	good/ >7
	RM Young Ultrasonic Anemometer 81000	Wind Speed and Wind Direction	good/ >7
	Aluma FOT-10	Meteorological Fold Over Tower	good/ >10
South DeKalb	ESC DAS 8832	Datalogger	good/ >7
	Thermo 49 series	O3 Analyzer	good/ >4
	Thermo 49 series	O3 Calibrator	good/ >5
	Environics 6103	Multi-Gas Calibrator	good/ >5
	Environics 6103	Multi-Gas Calibrator	good/ >4
	Themo 42iY	NOy Analyer	good/ >9

SITE NAME	EQUIPMENT NAME	EQUIPMENT DESCRIPTION	COND./ AGE
South DeKalb cont'd	Thermo 42i	NOx Analyzer	good/ >9
	Thermo 48i-TLE	CO Analyzer	good/ >5
	Thermo 43i-TLE	SO2 Analyzer	good/ >5
	Thermo Partisol-Plus 2025	Integrated PM2.5 Sampler	good/ >5
	Thermo Partisol-Plus 2025	Collocated Integrated PM2.5 Sampler	good/ >5
	Teledyne T640X	Continuous PM Sampler	good/>3
	Met One SASS	PM2.5 Speciation Sampler	good/ >5
	URG 3000N	PM2.5 Speciation Sampler	good/ >9
	Sabio 1001	Zero Air Supply	good/ >4
	Sabio 1001	Zero Air Supply	good/ >4
	ATEC 8000	Carbonyls Sampler	good/ >5
	ATEC 8000	Collocated Carbonyls Sampler	good/ >5
	Tisch Environmental PUF	Semi-VOCs (PAH) Sampler	good/ >8
	Tisch Environmental PUF	Collocated Semi-VOCs (PAH) Sampler	good/ >8
	ATEC 2200	VOCs Sampler	good/ >9
	ATEC 2200	Collocated VOCs Sampler	good/ >9
	Agilent 7890-B GC	Gas Chromatograph	good/ >1
	AirGas Hydrogen Cylinder (4)	Gas Cylinder	good/ >1
	AirGas Helium Cylinder (3)	Gas Cylinder	good/ >1
	NexAir Helium Cylinder	Gas Cylinder	good/ >1
	AirGas Compressed Air (9)	Gas Cylinder	good/ >1
	AirGas Nitrogen Cylinder (2)	Gas Cylinder	good/ >1
	Carbon Monoxide Cylinder	Gas Cylinder	good/ <9
	Nitrogen Oxide Cylinder	Gas Cylinder	good/ <9
	Sulfur Dioxide Cylinder	Gas Cylinder	good/ <9
	RM Young Ultrasonic Anemometer 81000	Wind Speed and Wind Direction	good/ >6
	Aluma T-135	Meteorological Crank Tower	good/ >10
	RM Young Temp/RH Probe 41382VC	Ambient Temperature & Relative Humidity	good/ >6
	Novalynx 260-2501 Tipping Bucket	Precipitation Sensor	good/ >6
	RM Young Barometric Pressure Sensor 61302	Barometric Pressure Sensor	good/ >6
NR-285	Thermo 42i	NOx Analyzer	good/ >5
	Xonteck 910	VOC Sampler	good/ >5
	Environics 6103	Multi-gas Calibrator	good/ >5
	Nitrogen Oxide Cylinder	Gas Cylinder	good/ >9
	MAAP 5012	Black Carbon Sampler	good/ >4
Douglasville	Thermo 49 series	O3 Analyzer	good/ >9
	Thermo 49 series	O3 Calibrator	good/ >9
	RM Young Ultrasonic Anemometer 81000	Wind Speed and Wind Direction	good/ >5
	Aluma T-135	Meteorological Crank Tower	good/ >10
	Sabio 1001	Zero Air Supply	good/ >5
	ESC DAS 8832	Datalogger	good/ >6
Fire Station #8	Thermo Partisol-Plus 2025	Integrated PM2.5 Sampler	good/ >5
	Tisch TE-Wilbur Filter Based	Integrated PM10 Sampler	good/>3
	Tisch TE-Wilbur Filter Based	Collocated Integrated PM10 Sampler	good/>3
United Avenue	ESC DAS 8832	Datalogger	good/ >4
	Thermo 49 series	O3 Analyzer	good/ >7
	Thermo 49 series	O3 Calibrator	good/ >6
	Thermo 43i	SO2 Analyzer	good/ >6
	Thermo 146i	Multi-gas Calibrator	good/ >4

SITE NAME	EQUIPMENT NAME	EQUIPMENT DESCRIPTION	COND./ AGE
United Avenue cont'd	TEOM 1400AB	Continuous PM2.5 Sampler	good/ >9
	Sulfur Dioxide Cylinder	Gas Cylinder	good/ >9
	Sabio 1001	Zero Air Supply	good/ >5
	RM Young Ultrasonic Anemometer 81000	Wind Speed and Wind Direction	good/ >10
	Aluma T-135	Meteorological Crank Tower	good/ >10
NR-GA Tech	ESC DAS 8832	Datalogger	good/ >6
	Thermo 42i	NO2 Analyzer	good/ >5
	Thermo 48i-TLE	CO Analyer	good/ >9
	Thermo Partisol-Plus 2025	Integrated PM2.5 Sampler	good/ >5
	Ambilabs Dual Wavelength Nephelometer	Integrated PM2.5 Sampler	good/ >3
	Carbon Monoxide Cylinder	Gas Cylinder	good/ >9
	Nitrogen Oxide Cylinder	Gas Cylinder	good/ >9
	RM Young Ultrasonic Anemometer 81000	Wind Speed and Wind Direction	good/ >6
	Aluma T-135	Meteorological Crank Tower	good/ >6
	Environics 7000	Zero Air Supply	good/ >5
	Environics 6103	Multi-gas Calibrator	good/ >5
	Multi Angle Absorption Photometer (MAAP) 5012	Black Carbon Sampler	good/ >4
Gwinnett Tech	ESC DAS 8832	Datalogger	good/ >6
	Thermo 49 series	O3 Analyzer	good/ >9
	Thermo 49 series	O3 Calibrator	good/ >9
	Environics 7000	Zero Air Supply	good/ >4
	Teledyne T640	Continuous PM Sampler	good/ >3
McDonough	ESC DAS 8832	Datalogger	good/ >7
	Thermo 49 series	O3 Analyzer	good/ >9
	Thermo 49 series	O3 Calibrator	good/ >9
	Environics 7000	Zero Air Supply	good/ >5
	TEOM 1400AB	Continuous PM2.5 Sampler	good/ >9
Conyers	ESC DAS 8832	Datalogger	good/ >7
	Thermo 49 series	O3 Analyzer	good/ >9
	Thermo 49 series	O3 Calibrator	good/ >9
	Teledyne 701	Zero Air Supply	good/ >5
	RM Young Ultrasonic Anemometer 81000	Wind Speed and Wind Direction	good/ >6
	Aluma T-135	Meteorological Crank Tower	good/ >10
	Eppley Lab Standard Precision Pyronometer 38380F3	Solar Radiation Instrument	good/ >9
	Eppley Lab TUVR 38020	Ultraviolet Radiometer	good/ >9
	Novalynx 260-2501 Tipping Bucket	Precipitation Sensor	good/ >6
	RM Young Temp/RH Probe 41382VC	Ambient Temperature & Relative Humidity	good/ >6
	RM Young Barometric Pressure Sensor 61302	Barometric Pressure Sensor	good/ >6
Chattanooga Tennessee-Georgia MSA			
Rossville	Thermo Partisol-Plus 2025	Integrated PM2.5 Sampler	good/ >6
	Met One SASS	PM2.5 Speciation Sampler	good/ >6
	URG 3000N	PM2.5 Speciation Sampler	good/ >6
	ESC DAS 8832	Datalogger	good/ >7
	Teledyne T640	Continuous PM2.5 Sampler	good/ >2
Sites Not in an MSA			
Summerville	ESC DAS 8832	Datalogger	good/ >7
	Thermo 49 series	O3 Analyzer	good/ >9
	Thermo 49 series	O3 Calibrator	good/ >9
General Coffee	Met One SASS	PM2.5 Speciation Sampler	good/ >5
	URG 3000N	PM2.5 Speciation Sampler	good/ >9

SITE NAME	EQUIPMENT NAME	EQUIPMENT DESCRIPTION	COND./ AGE
General Coffee cont'd	Graseby High Volume 2000H*	Metals Sampler	good/ >10
	Xonteck 911^	VOC Sampler	good/ >8
	Thermo Partisol-Plus 2025	Integrated PM2.5 Sampler	good/ >10
Leslie	ESC DAS 8832	Datalogger	good/ >7
	Thermo 49 series	O3 Analyzer	good/ >10
	Thermo 49 series	O3 Calibrator	good/ >10
	Environics 7000	Zero Air Supply	good/ >5
Sandersville	Teledyne T640	Continuous PM Sampler	good/ >3
Georgia AAMP			
Quality Assurance Unit	Alicat Scientific FP-25 (2)	Flow, Temperature & Pressure Standard	good/ >6
	Andersen General Metals Works	High Volume PM10 Orifice	good/ >6
	BGI/MesaLabs DeltaCal (4)	Flow, Temperature & Pressure Standard	good/ >6
	BGI/MesaLabs TetraCal (3)	Flow, Temperature & Pressure Standard	good/ >6
	BGI VRC	Variable High Volume Orifice	good/ >6
	BIOS DC-Lite DCL-H	Flow Standard	good/ >6
	BIOS DC-Lite DCL-L	Flow Standard	good/ >6
	BIOS Definer 220 High Flow	High flow volumetric standardized gas	good/ >6
	BIOS Definer 220 Low Flow	Low flow volumetric standardized gas	good/ >6
	Chinook Engineering Streamline Pro (3)	Flow Transfer Standard	good/ >6
	Dwyer 475-1 FM	Digital Manometer	good/ >6
	Dwyer 475-2-FM	Digital Manometer	good/ >6
	Fisher Scientific 14-648-4 (5)	Stop Watch	good/ >6
	Graseby Graseby GMW	PUF Orifice	good/ >6
	Linde Spectra PAMS Gas Standard	PAMS - Gas Standard	good/ >6
	Mesa Labs Flexcal High Flow	High Flow	good/ >6
	Mesa Labs Flexcal Low Flow	Low Flow	good/ >6
	Scott-Marrin EPA UltraPure Gas Standard	PAMS - EPA UltraPure Gas Standard	good/ >6
	Sensidyne Gilibrator Flow Cell (6)	Flow Standard	good/ >6
	Sensidyne Gilibrator Flow Cell Base (2)	Flow Standard	good/ >6
	Tisch Environmental TE-5028A	High Volume PM10 Orifice	good/ >6
	Tisch Environmental TE-5040A	PUF Orifice	good/ >6
	Vaisala HM40/HM46	Temperature & Relative Humidity Probe	good/ >6
	Vaisala HMI41/HMP46	Temperature & Relative Humidity Probe	good/ >6
	Dwyer 477-1-FM (2)	Digital Manometer	good/ >6
	Dwyer 475-0-FM (3)	Digital Manometer	good/ >6
	Thermo 49i-PS (2)	O3 Standard	good/ >9
	Thermo 49-PS (2)	O3 Standard	good/ >10
	Thermo 146i (2)	Multi-Gas Calibrator	good/ >10
	Praxair/Nexair EPA Protocol Gas Standard (2)	EPA Protocol NO/CO/SO2 Gas Standard	good/ >6
	Airgas EPA Protocol Gas Standard (5)	EPA Protocol NO/NOx/CO/SO2 Gas Standard	good/ >6
	Bosch GLM 80 (2)	Laser Distance/Angle Measurer	good/ >6
	Scott-Marrin EPA Protocol Gas Standard (3)	EPA Protocol NO/CO/SO2 Gas Standard	good/ >6

SITE NAME	EQUIPMENT NAME	EQUIPMENT DESCRIPTION	COND./ AGE
Quality Assurance Unit cont'd	Scott-Marrin EPA Protocol Gas Standard	EPA Protocol NO/NOx/CO/SO2 Gas Standard	good/ >6
Meteorology Unit Workshop	RM Young Ultrasonic Anemometer 810000 (13)	Wind Speed and Wind Direction	Varies
	RM Young Meteorological Translator 26800	Datalogger	good/ >1
	Eppley Lab Standard Precision Pyronometer 38380F3 (5)	Solar Radiation Instrument	Varies
	Eppley Lab TUVR (6)	Ultraviolet Radiometer	Varies
	RM Young Wind Monitor 05305VM (2)	Wind Speed and Wind Direction	good/ >9
	Novalynx 260-2501 Tipping Bucket (8)	Precipitation Sensor	good/ >9
	RM Young Temp/RH Probe 41382VC/ 41382VC (13)	Ambient Temperature & Relative Humidity	good/ >5
	RM Young Barometric Pressure Sensor 61302 (14)	Barometric Pressure	good/ >9
	Aluma T-135 (5)	Meteorological Crank Tower	Varies
Workshop	Met One SASS (7)	PM2.5 Speciation Sampler	good/ >8
	URG 3000N (4)	PM2.5 Speciation Sampler	good/ >5
	Thermo 43i-TLE (3)	SO2 Analyzer	Various
	Thermo 146i (10)	Multi-Gas Calibrator	Various
	Thermo 42i (5)	NO, NO2, NOx Analyzer	Various
	Environics 6103 (3)	Multi-Gas Calibrator	good/ >4
	Thermo 48i-TLE (6)	CO Analyzer	Various
	Thermo 42iY	NOy Analyzer	good/ >8
	Thermo 43i (4)	SO2 Analyzer	Various
	Sabio 1001 (2)	Zero Air Supply	good/ >5
	Teledyne T701H (2)	Zero Air Supply	Various
	Environics 7000 (6)	Zero Air Supply	good/ >4
	Teledyne T640 (3)	Continuous PM Sampler	good/ >3
	Teledyne T640X	Continuous PM Sampler	good/ >3
	Met One E-SEQ-FRM (5)	Integrated PM Sampler	Various
	Thermo 42C (2)	NO/NO2/NOx Analyzer	Various
	Thermo 49i-PS (5)	O3 Calibrator	Various
	Thermo 49i (2)	O3 Analyzer	Various
	Thermo 49C-PS (5)	O3 Calibrator	Various
	Thermo 49C (2)	O3 Analyzer	Various
	Thermo Partisol-Plus 2025 (13) TEOM 1400AB (3)	Integrated PM2.5 Sampler Continuous PM2.5 Sampler	Various good/ >8
	Agilaire 8872 (2)	Datalogger	Various
	ATEC 2200-iP (6)	VOCs Sampler	good/ >8
	ATEC 2200-iC (3)	VOCs Sampler	good/ >8
	ATEC 8000 (5)	Carbonyls Sampler	Various
	Agilaire 8832 (7)	Datalogger	Various
	Thermo 49i QPS (7)	Primary O3 Standard	good/ >3
	Thermo 49i-PS, Thermo 49i	O3 Bench Calibrator and Sampler	good/ >8
	Thermo 146iQ	Multi-Gas Calibrator	good/ >2
	Xonteck 911 (2)	Canister Sampler	good/ >5
	Tisch Wilbur	PM10 Sampler	good/ >3
	Alicat Scientific FP-25 (6)	Flow, Temperature & Pressure Standard	Various
	Alicat Whisper	Flow, Temperature & Pressure Standard	Various
	BGI/MesaLabs TetraCal (17)	Flow, Temperature & Pressure Standard	Various

SITE NAME	EQUIPMENT NAME	EQUIPMENT DESCRIPTION	COND./ AGE
Workshop	BGI/MesaLabs DeltaCal (22)	Flow, Temperature & Pressure Standard	Various
cont'd	Tisch Environmental TE-5028A VRC (10)	Variable High Volume Orifice	Various
	Tisch Environmental TE-5040A (11)	PUF Orifice	Various
	Sensidyne Gilibrator Flow Cell Base (17)	Flow Standard	Various
	Sensidyne Gilibrator Flow Cell (51)	Flow Standard	Various
	AirGas Hydrogen Cylinder (2)	Gas Cylinder	good/ >1
	Carbon Monoxide Cylinder(2)	Gas Cylinder	good/ >9
	Nitrogen Oxide Cylinder	Gas Cylinder	good/ >9
	Sulfur Dioxide Cylinder (3)	Gas Cylinder	good/ >9
	Compressed Air Mix	Gas Cylinder	good/ >9

NOTE:

COND = Condition **Age = age in years**

*** = Not currently in use** **^ = Used for Data Study**

Appendix C:
Pollutant Description, Analysis Method, and Quality Assurance Schedule

Georgia Department of Natural Resources
Environmental Protection Division

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 (SOP). Field personnel visit sampling sites, replace sample media, and check the operation and calibration of monitors per the SOP.

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 GA AAMP's main office immediately. Numerous manual and automated checks are performed to ensure that only valid data are reported to EPA.

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 monitoring data.

1.0 Particulate Matter

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 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). $PM_{2.5}$ are 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. $PM_{2.5}$ is also referred to as "fine" particles. $PM_{10-2.5}$ is 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 are formed 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

GA AAMP conducts PM_{10} monitoring on an integrated basis at one site in Georgia. GA AAMP uses an EPA-approved method. The Tisch – TE Wilbur Filter Based PM_{10} Air Sampler functions to collect airborne particulate matter ≤ 10mm (PM_{10}) on a pre-weighted 47mm diameter filter over a 24 hour period, midnight to midnight. The sampler normally samples every 6 days and exposed filter are subsequently collected and sent to the InterMountain Laboratory for gravimetric analysis and measurement of PM_{10} concentration. The system monitors and records all system sensors such as flow, temperatures and barometric pressure, as well as the system pressure, filter temperature variation, and flow total which provides the operator or laboratory technician additional information on the sample if warnings or alarms occurred during the sample run. These monitors are used to determine attainment of the PM_{10} standard. These analyzers are subjected to quarterly checks and are audited by GA AAMP's Quality Assurance Unit on a semi-annual basis, within a five to seven month window.

b. Particulate Matter (PM_{10}) Continuous

GA AAMP conducts PM_{10} monitoring on a continuous basis at two sites in Georgia. GA AAMP uses EPA-approved equivalent methods. The Thermo Scientific tapered element oscillating microbalance (TEOM) is one of these methods (EQPM-1090-079), and the data is used to determine attainment of the PM_{10} NAAQS. 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 TEOM sampler draws air through a filter at a constant mass flow controller flow rate. During sampling, ambient air passes through the PM_{10} inlet first, then, if sampling for $PM_{2.5}$ through a sharp cut cyclone. Only particles equal to or less than 10 microns, or 2.5 microns in diameter, respectively are allowed to pass on into two separate flows: the 3 LPM sample stream, which is sent to the mass transducer and the 13.7 LPM exhaust stream. The 3 LPM sample stream is collected onto the Teflon™ coated filter which is weighed every 2 seconds. The difference between the filter's current weight and the initial weight gives the total mass of the collected particles in $\mu g/m^3$.

The other method used for sampling PM_{10} is the Teledyne T640/640x, which is a real-time, continuous PM mass monitor that uses scattered light spectrometry for measurement. The T640 measures $PM_{2.5}$, and the T640x Option measures $PM_{2.5}$, PM_{10}, and $PM_{10-2.5}$. The sampling head draws in the ambient air with different size particles, which are dried with the Aerosol Sample Conditioner (ASC) and moved into the optical particle sensor where scattered light intensity is measured to determine particle size diameter. The inlet used for the T640x option samples at 16.67 liters per minute (LPM) to mechanically size-cut the aerosol intake for sampling particles at 10 microns and under. The particles move separately into the T-aperture through an optically differentiated measurement volume that is homogeneously illuminated with polychromatic light. This Model T640 with 640x option PM_{10} monitor is configurable as a PM_{10} FEM (EQPM-0516-239), and the data is used to determine attainment of the PM_{10} NAAQS. This analyzer is subjected to monthly flow checks and is audited by GA AAMP's Quality Assurance Unit on a semi-annual basis.

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

At sites where GA AAMP collects $PM_{2.5}$ samples on an integrated basis, the samples are measured using very similar techniques utilized for measuring PM_{10}. The official federal reference method (FRM) 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. This data is collected using the FRM, and the data is appropriate to use for making attainment determinations relative to the $PM_{2.5}$ NAAQS. Currently, GA AAMP uses the Thermo Scientific Partisol 2025 (RFPS-0498-118 or EQPM-0202-145), and as GA AAMP replaces these Thermo 2025 filter-based $PM_{2.5}$ FRM monitors, the Met One sequential filter-based $PM_{2.5}$ FRM monitors (RFPS-0717-245) will be used as the replacement. 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 of this document and in Table 1 below. On a semi-annual basis, GA AAMP's Quality Assurance Unit audits these $PM_{2.5}$ samplers.

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

GA AAMP monitors for $PM_{2.5}$ on a continuous basis with three different methods. One method is the Teledyne T640, which is an optical aerosol spectrometer that converts optical measurements to mass measurements by determining sampled particle size via scattered light using 90° white-light scattering with polychromatic LED. The inlet used for the T640 samples at 5.0 liters per minute (LPM). The Aerosol Sample Conditioner (ASC) removes the volatile components (mainly water) of the aerosol to avoid false particle size. The internal vacuum pump is controlled by a pulse-width modulation (PWM) feedback control for consistently accurate flow to the sensor. The external vacuum pump is controlled by an ambient and pressure compensated mass flow controller in combination with a pneumatic valve for consistently accurate flow. The Teledyne T640 is officially designated as an US EPA Federal Equivalent Method (FEM) (EQPM-0516-236 and EQPM-0516-238) (81 FR 45285), and used for making attainment decisions relative to the $PM_{2.5}$ NAAQS. As of November 2018, GA AAMP began to shut down $PM_{2.5}$ FRMs (filter based) monitors where collocated with the continuous $PM_{2.5}$ FEM Teledyne T640 monitors, depending federal siting requirements.

Another $PM_{2.5}$ continuous collection method utilized by GA AAMP is the Thermo Scientific tapered element oscillating microbalance (TEOM) Series 1400/1400a monitors is used. 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. Currently, the TEOMs in the ambient air monitoring network are not configured to sample as FEMs. Therefore, data collected from the TEOM samplers cannot be used for making attainment decisions relative to the NAAQS.

The other type of continuous $PM_{2.5}$ monitor that GA AAMP uses is the Ambilabs Nephelometer, which measures ambient air for the presence of particulate matter on a continuous, real-time basis. The nephelometer determines PM concentrations by measuring the shutter count which allows the light source to stabilize, and wavelengths which shows the average diameter of the measured particle size. Measurements are updated every second. The unit includes an LCD display to provide information about the parameters and flow rate. An active heating system, which is controlled based on relative humidity (RH) levels, warms the sample air and sample cell to keep the RH below a set point to avoid particle growth with humidity. The nephelometer is equipped with an internal data logger that enables data to be stored and downloaded through the R232 port. The nephelometer is subjected to weekly zero, precision, and span (ZPS) checks, quarterly multipoint calibrations, and is audited by GA AAMP’s Quality Assurance Unit on a semi-annual basis.

All three types of continuous $PM_{2.5}$ samplers are used to support development of air quality models and forecasts, including the AQI, and to provide the public with information about pollutant concentrations in real time. All three types of analyzers are subject to monthly flow checks and are audited by GA AAMP’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 1. GA AAMP’s Quality Assurance Unit subjects these samplers to audits on a semi-annual basis.

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

As part of the NCore requirements (discussed in Section 4.1), the South DeKalb site (13-089-0002) began $PM_{10-2.5}$ sampling as of January 1, 2011. The Teledyne T640x $PM_{10-2.5}$ is the current system used to measure coarse particulate matter. The Teledyne T640/640x is a real-time, continuous PM mass monitor that uses scattered light spectrometry for measurement. The T640x Option measures $PM_{2.5}$, PM_{10}, and $PM_{10-2.5}$. The sampling head draws in the ambient air with different size particles, which are dried with the Aerosol Sample Conditioner (ASC) and moved into the optical particle sensor where scattered light intensity is measured to determine particle size diameter. The particles move separately into the T-aperture through an optically differentiated measurement volume that is homogeneously illuminated with polychromatic light. GA AAMP uses the 16.7 LPM Model T640 with 640x option $PM_{10-2.5}$ monitor: EQPM-0516-240. This analyzer is subjected to monthly flow checks and is audited by GA AAMP's Quality Assurance Unit on a semi-annual basis.

The sampling frequency of the integrated (FRM), continuous (Teledyne, TEOM, Nephelometer), and speciated $PM_{2.5}$ samplers is detailed in Table 1, and the attached Appendix A. The $PM_{2.5}$ samplers highlighted in yellow are the $PM_{2.5}$ samplers that are used for comparison to the NAAQS for attainment purposes.

Site ID	Common Name	City	County	Integrated	Continuous	Speciation
Rome MSA						
131150003	Rome	Rome	Floyd		$PM_{2.5}$	6 Day
Brunswick MSA						
131270006	Brunswick	Brunswick	Glynn	$PM_{2.5}$ (3 Day)		
Valdosta MSA						
131850003	Valdosta	Valdosta	Lowndes	$PM_{2.5}$ (3 Day)	FEM $PM_{2.5}$	
Warner Robins MSA						
131530001	Warner Robins	Warner Robins	Houston	$PM_{2.5}$ (3 Day)	FEM $PM_{2.5}$	
Albany MSA						
130950007	Albany	Albany	Dougherty	2 $PM_{2.5}$ (3 Day, 12 Day)	FEM $PM_{2.5}$	
Gainesville MSA						
131390003	Gainesville	Gainesville	Hall		FEM $PM_{2.5}$	
Athens-Clarke County MSA						
130590002	Athens	Athens	Clarke		2 FEM $PM_{2.5}$	
Macon MSA						
130210007	Macon-Allied	Macon	Bibb	2 $PM_{2.5}$ (3 Day, 12 Day)		6 Day
130210012	Macon-Forestry	Macon	Bibb	$PM_{2.5}$ (3 Day)	FEM $PM_{2.5}$	
Columbus, Georgia- Alabama MSA						
132150001	Columbus-Health Dept.	Columbus	Muscogee	$PM_{2.5}$ (3 Day)		
132150008	Columbus-Airport	Columbus	Muscogee	$PM_{2.5}$ (3 Day)	$PM_{2.5}$	
132150011	Columbus-Cusseta	Columbus	Muscogee	$PM_{2.5}$ (3 Day)		6 Day
Savannah MSA						
130511002	Savannah-L&A	Savannah	Chatham		FEM $PM_{2.5}$	
Augusta, Georgia-South Carolina MSA						

132450091	Bungalow Road	Augusta	Richmond		FEM $PM_{2.5}$	6 Day
Atlanta-Sandy Springs-Marietta MSA						
130630091	Forest Park	Forest Park	Clayton	$PM_{2.5}$ (3 Day)		
130670003	Kennesaw	Kennesaw	Cobb	$PM_{2.5}$ (3 Day)		
130890002	South DeKalb	Decatur	DeKalb	2 $PM_{2.5}$ (3 Day, 3 Day)	FEM $PM_{2.5}$	3 Day
131210039	Fire Station #8	Atlanta	Fulton	$PM_{2.5}$ (3 Day)		
131210055	United Ave.	Atlanta	Fulton		$PM_{2.5}$	
131210056	NR-Georgia Tech	Atlanta	Fulton	$PM_{2.5}$ (3 Day)	$PM_{2.5}$	
131350002	Gwinnett Tech	Lawrenceville	Gwinnett		FEM $PM_{2.5}$	
131510002	McDonough	McDonough	Henry		$PM_{2.5}$	
Chattanooga, Tennessee-Georgia MSA						
132950002	Rossville	Rossville	Walker	$PM_{2.5}$ (3 Day)	FEM $PM_{2.5}$	6 Day
Not in an MSA						
130690002	General Coffee	Douglas	Coffee	$PM_{2.5}$ (3 Day)		6 Day
133030001	Sandersville	Sandersville	Washington		FEM $PM_{2.5}$	

Highlighted samplers used for comparison to NAAQS

Table 1: $PM_{2.5}$ Sampling Frequency

2.0 Carbon Monoxide (CO)

Carbon monoxide (CO) is a colorless and poisonous gas produced by incomplete burning of fossil fuels used in vehicles, space heating, and industrial processes. Boilers and other fuel burning heating systems are also significant sources.

Breathing elevated levels of 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 nitrogen (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 GA AAMP's Quality Assurance Unit on a semi-annual basis.

3.0 Ozone (O_3)

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

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 conditions are dry and 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 may experience breathing difficulty when exposed to short-term concentrations at higher levels of ozone. 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 monitors is used to determine compliance with the NAAQS for ozone.

As required by Table D-3 of 40 CFR Part 58, Appendix D (4.1)(c)(3)(i), GA AAMP 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, as required by 40 CFR Part 58. During the monitoring season, analyzers are subjected to weekly ZPS checks and quarterly multipoint calibrations. GA AAMP's Quality Assurance Unit audits these samplers on an annual basis.

EPA established a Clean Air Status and Trends Network (CASTNET) 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. Since 2011, the CASTNET ozone monitor has met requirements for quality assurance and completeness criteria and can be used for comparison to the NAAQS [40 CFR 58, (1.1)(b)].

4.0 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 (A) 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 GA AAMP's Quality Assurance Unit on an annual basis.

5.0 Nitrogen Oxides (NOx)

Several gaseous oxides of nitrogen (NO_x) 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 immediately reacts with oxygen 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 higher NO_2 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 significant local NO_2 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. GA AAMP operates a Thermo Environmental Model 42i Chemiluminescence NO-NO_2-NO_x Analyzer (EPA Automated Equivalent Method RFNA-1289-074). 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°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 GA AAMP's Quality Assurance Unit on an annual basis.

6.0 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, GA AAMP's Quality Assurance Unit audits these samplers.

In addition to the criteria lead network sites, lead is monitored as a trace metal in the National Air Toxics Trends Station (NATTS), and with the $PM_{2.5}$ speciation samplers. 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. GA AAMP's Quality Assurance Unit audits these lead samplers on an annual basis.

7.0 Metals

A sub-group of the National Air Toxics Trends data includes the metals group, which encompass compounds such as cadmium, mercury, chromium and lead. These pollutants, also known as Hazardous Air Pollutants (HAPs), are those pollutants that are known or suspected to cause cancer or other serious health effects, such as damage to the immune system, reproductive effects or birth defects, developmental or neurological problems, or adverse environmental effects. 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. 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.

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 PM_{10} sampler used for sampling toxic metal particles less than or equal to 10 microns in diameter as part of the NATTS network 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 samplers run once every six days following a pre-established schedule that corresponds to a nationwide sampling schedule. On the sixth day the sampler runs midnight to midnight and takes a 24-hour composite sample. 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. In the summer of 2019, GA AAMP plans to replace both the primary and collocated NATTS high-volume PM_{10} metals samplers with low-volume PM_{10} metals samplers. GA AAMP will use the Met One single channel sampler set up for PM_{10}, collecting samples on 47 mm diameter Teflon™ filters, with a volumetric flow rate of 16.7 liters per minute. The NATTS PM_{10} metals samplers are subjected to quarterly checks and audited by GA AAMP's Quality Assurance Unit on a semi-annual basis.

8.0 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 and react with NO_2 in sunlight to form ground level ozone. Some VOCs are also hazardous air pollutants, which can cause serious health effects. 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 a significant source of VOCs. VOCs include chemicals such as benzene, toluene, methylene chloride and methyl chloroform. Some VOCs are naturally occurring. VOCs such as pinenes and terpenes emitted from pine trees are a significant source of VOCs in the southeastern United States.

VOCs are collected and analyzed with three different types of samplers. Two types of collection method use a passivated inert stainless steel canister: ATEC 2200 and Xonteck 910/911. The 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 samplers collect a sample for a representative 24-hour period, and the samples are analyzed using a gas chromatograph with mass spectroscopy detection (GC/MS), using EPA compendium method TO15, by the GA EPD laboratory or the Eastern Research Group (ERG), as applicable. The South DeKalb site uses the ATEC 2200 to collect VOCs as part of the National Air Toxics Trends Station. These VOCs samplers are subjected to quarterly checks and are audited by GA AAMP’s Quality Assurance Unit twice per year.

The third type of sampler used for VOCs collection and analysis is with the Photochemical Assessment Monitoring Station (PAMS) network in which VOCs are collected and analyzed on-site with a gas chromatograph/flame ionization detector (GC/FID). The South DeKalb site is the GA AAMP’s PAMS site. During June, July, and August, the PAMS VOCs samples are collected continuously on an hourly basis. The VOCs sampler in the PAMS network is subjected to checks and audited during the PAMS season (June, July and August).

9.0 Carbonyls

Carbonyl compounds are a subset of VOCs, and 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 site, during June, July, and August, three 8-hour 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 GA AAMP's Quality Assurance Unit every six months.

10.0 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. PAHs can occur in air attached to dust particles, and some can evaporate into the air from soil or surface waters. PAHs can stick tightly to particles and seep through soil to contaminate groundwater. They do not dissolve easily in water and can stick to solid particles and settle to the bottoms of lakes and rivers. Many PAHs are known or suspected carcinogens. The PUF (polyurethane foam) sampler used for sampling semi-volatile organic compounds, as part of the NATTS network, 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 the GA EPD laboratory and analyzed using gas chromatography with an electron capture detector (ECD). The semi-VOCs samplers are subjected to quarterly checks and audited by GA AAMP's Quality Assurance Unit annually.

11.0 Black Carbon

Black carbon is a particulate aerosol formed from the incomplete combustion of fossil fuels, biomass, and biofuels. Diesel engines are a large contributor of black carbon. Sampling for black carbon provides an estimate of the anthropogenic portion of carbon sources in ambient air pollution. For continuous sampling of black carbon, GA AAMP currently uses a Multiangle Absorption Photometer (MAAP) at the NR-285 (13-089-0003) and NR-Georgia Tech (13-121-0056) sites. Operating at 60 Watts/110V AC, these instruments use 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 GA AAMP's Quality Assurance Unit every six months.

12.0 Meteorological Parameters

GA AAMP has fifteen meteorological stations across the state. Surface meteorological measurements, including wind speed and wind direction, are measured at each location. In addition, as part of the Photochemical Assessment Monitoring Site (PAMS) in the metropolitan Atlanta area, a complete suite of meteorological instrumentation is used to characterize meteorological conditions. The PAMS station measures hourly-averaged vector 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 total hourly 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 GA AAMP's Quality Assurance Unit on an annual basis. For upper air measurement, GA AAMP uses a Vaisala BL-VIEW Ceilometer in conjunction with balloon rawinsonde data collected from NWS at Peachtree City. This upper air system is useful for monitoring the mixing height and low-level winds during smoke transport events.

Appendix D:
List of Closed Ambient Monitors
(in order of shut down date)

Georgia Department of Natural Resources
Environmental Protection Division

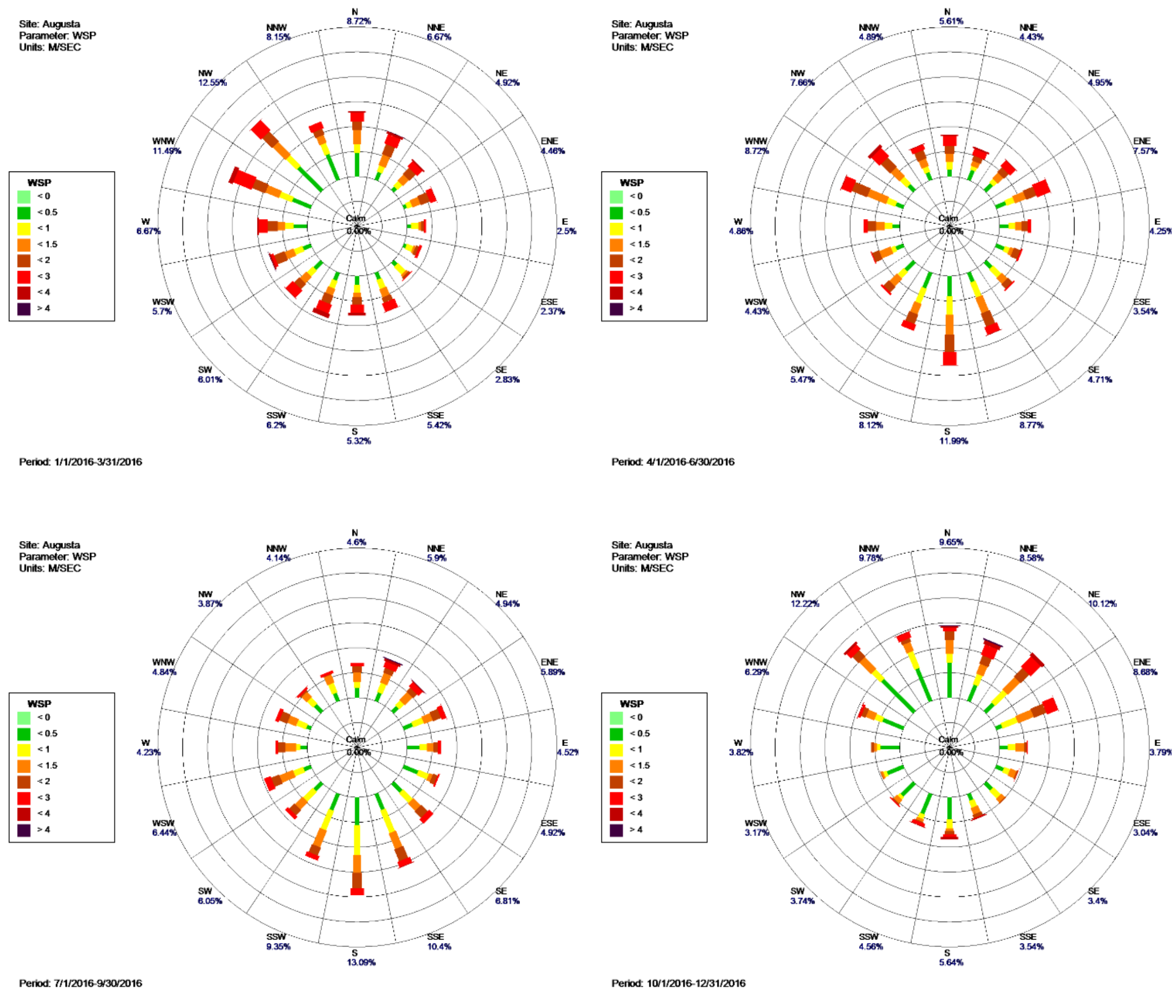
Site ID	Site Name	Sampler	Date Shut Down	Last Published in Annual Plan
131210039	Fire Station#8	PM_{10}	9/26/06	N/A
130893001	Tucker	Ozone	10/31/06	N/A
130090001	Milledgeville-Airport	SO_2	12/31/06	2009
130893001	Tucker	PAMS VOCs, NO/NOx/NOy/NO_2	1/7/07	N/A
131110091	McCaysville	SO_2	10/2/07	2007
131210001	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	Air Toxics	10/31/08	2011
131530001	Warner Robins	Air Toxics	10/31/08	2011
131850003	Valdosta	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	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	Total Reduced Sulfur	10/31/08	2013
131210048	Georgia Tech	$PM_{2.5}$	12/1/08	2008
131150005	Rome	$PM_{2.5}$ FRM, 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	NO_y	7/28/2008	2012
130210013	Macon-Lake Tobesofkee	NO_y, O_3	10/31/2008	2012
131270006	Brunswick	SO_2	12/31/12	2012
132150008	Columbus -Airport	SO_2	12/31/12	2012
130510017	Savannah-Market St.	$PM_{2.5}$ FRM	12/31/12	2012
132450005	Augusta-Medical College	$PM_{2.5}$ FRM	12/31/12	2012
131210032	Atlanta-E. Rivers School	$PM_{2.5}$ FRM, PM_{10}	12/31/12	2012
130892001	Doraville Health Center	$PM_{2.5}$ FRM	12/31/12	2012
130670004	Powder Springs-Macland Aquatic Ctr.	$PM_{2.5}$ FRM	12/31/12	2012
130210007	Allied	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	PM_{10}	12/31/12	2012
131150003	Rome	PM_{10}	12/31/12	2012
131210048	Georgia Tech	PM_{10}	12/31/12	2012
131270004	Brunswick-Arco Pump	PM_{10}	12/31/12	2012

	Station			
132150011	Columbus-Cusseta Road	PM_{10}	12/31/12	2012
133030001	Sandersville	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	South DeKalb	Hexavalent chromium	7/15/13	2013
132470001	Conyers	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
132230003	Yorkville	Continuous Gas Chromatograph	8/31/15	2015
132230003	Yorkville	6-Day PAMs, NO/NO_2/NOx, CO	12/31/15	2015
130850001	Dawsonville	Air Toxics/Carbonyls	12/31/15	2015
132470001	Conyers	6-Day PAMs, NO/NO_2/NOx	12/31/15	2015
130890003	NR-285	Lead	6/30/16	2016
130890002	South DeKalb	Black carbon	12/31/16	2016
133190001	Gordon	$PM_{2.5}$ FRM	12/31/16	2016
132230003	Yorkville	O_3	12/31/16	2016
132230003	Yorkville	$PM_{2.5}$ FRM, Continuous $PM_{2.5}$, VOCs, Semi-VOCs, Carbonyls, Metals, Wind Speed, Wind Direction, Temp, RH, Solar Radiation, UV Radiation, BP, Precip	1/31/17	2016
131150003	Rome-Coosa	SO_2	12/31/16	2017
132450091	Augusta	Integrated PM_{10}	3/31/18	2017
130770002	Newnan	O_3, $PM_{2.5}$, Wind Direction, Wind Speed	11/15/17	2018
132150010	Columbus-Joy Rd	Lead	6/30/18	2018
132450091	Augusta	$PM_{2.5}$ FRM	10/31/18	2018
131390003	Gainesville	$PM_{2.5}$ FRM	10/31/18	2018
131350002	Gwinnett Tech	$PM_{2.5}$ FRM	10/31/18	2018
130210012	Macon-Forestry	Air Toxics	12/31/18	2018
130510021	Savannah-E. President's Street	Air Toxics	12/31/18	2018
130690002	General Coffee	Air Toxics	12/31/18	2018
130590002	Athens	$PM_{2.5}$ FRM	3/31/19	2018
130510091	Savannah-Mercer	$PM_{2.5}$ FRM	6/30/19	2019
133030001	Sandersville	$PM_{2.5}$ FRM	8/15/19	2019

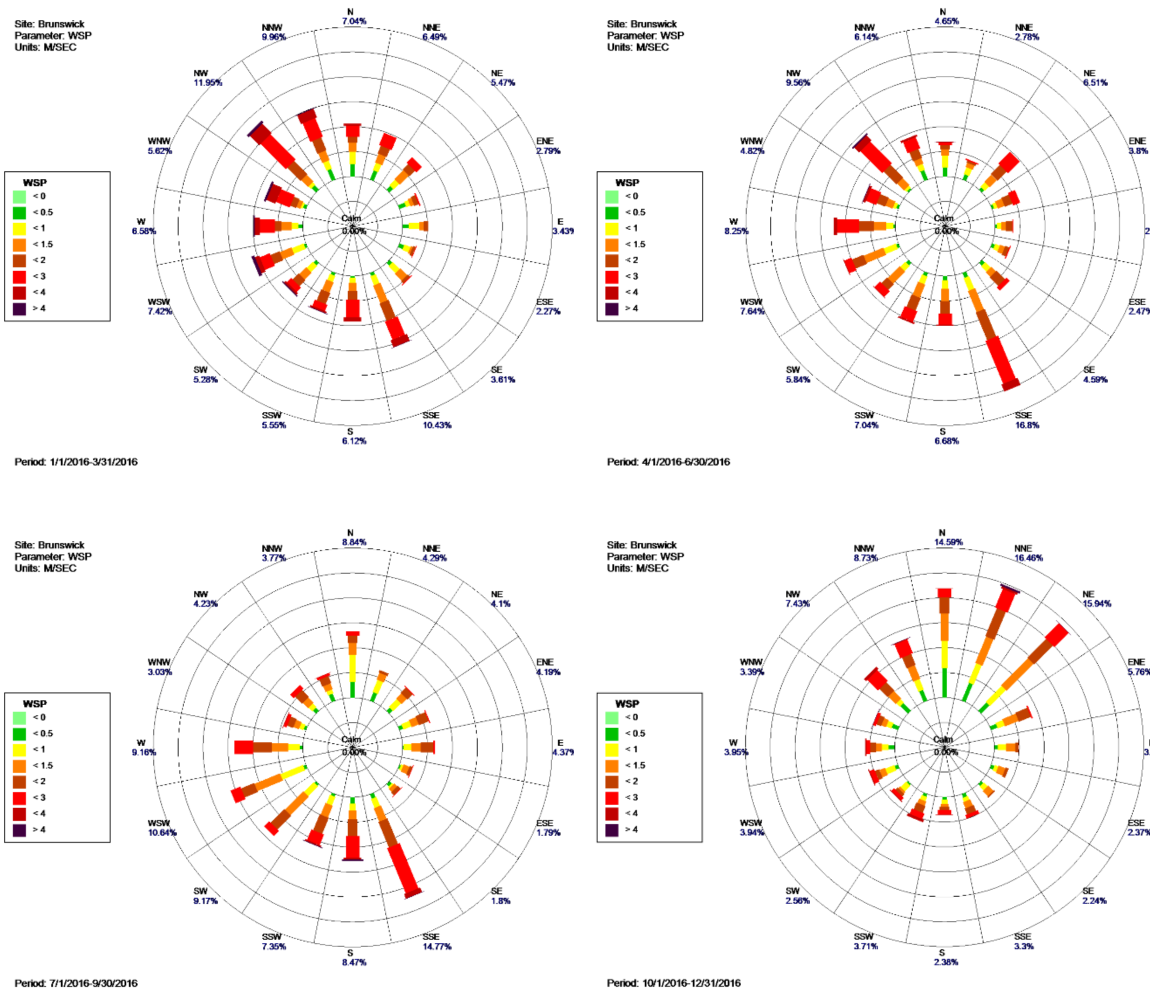
Appendix E:
Wind and Pollution Roses

Georgia Department of Natural Resources
Environmental Protection Division

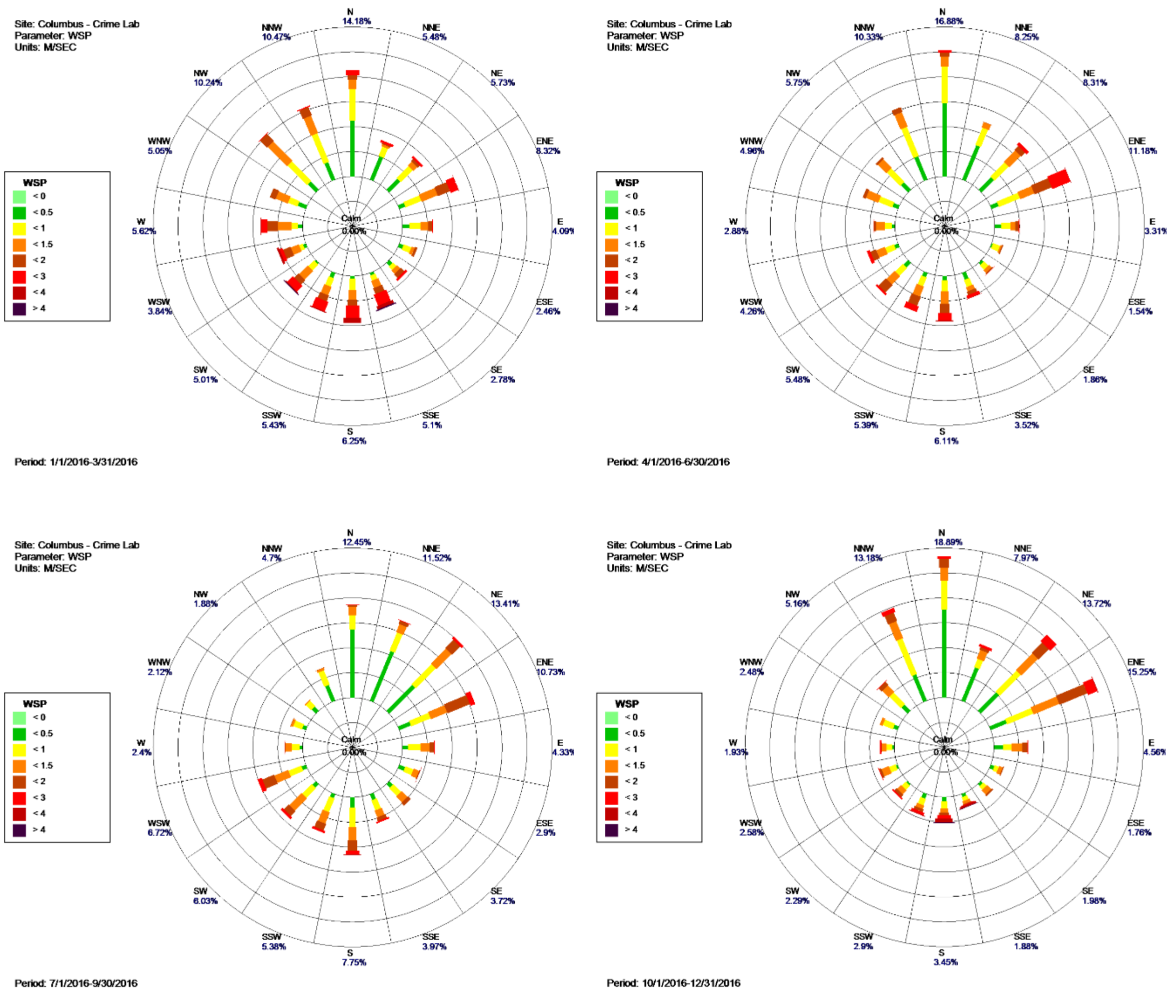
Note: In a few instances, the equipment had malfunctioned and the data was not available.



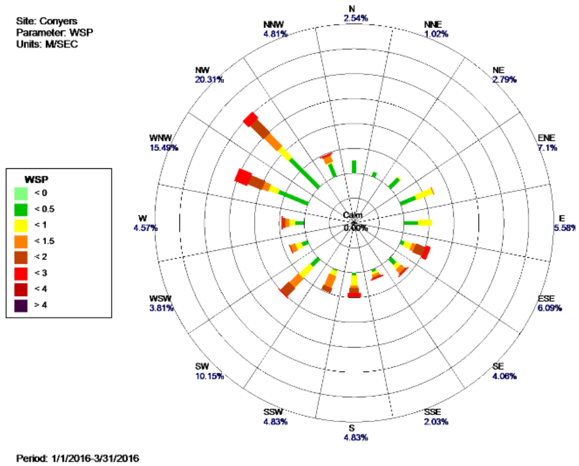
Augusta, 2016 Quarterly Winds

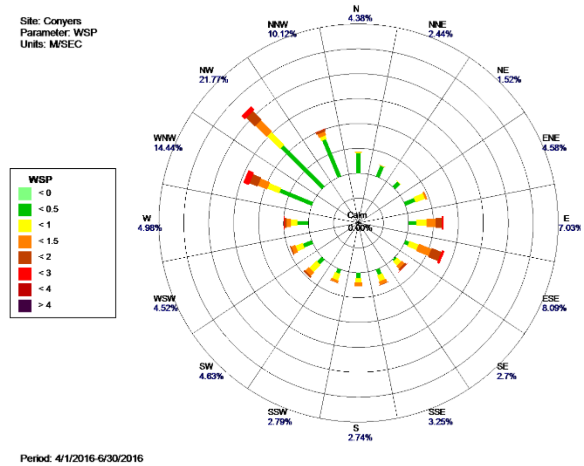


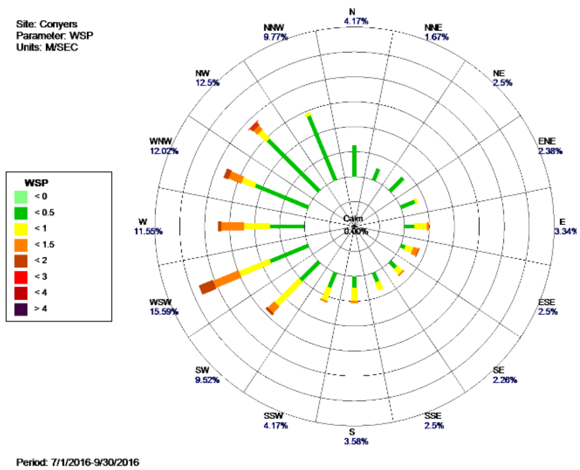
Brunswick, 2016 Quarterly Winds



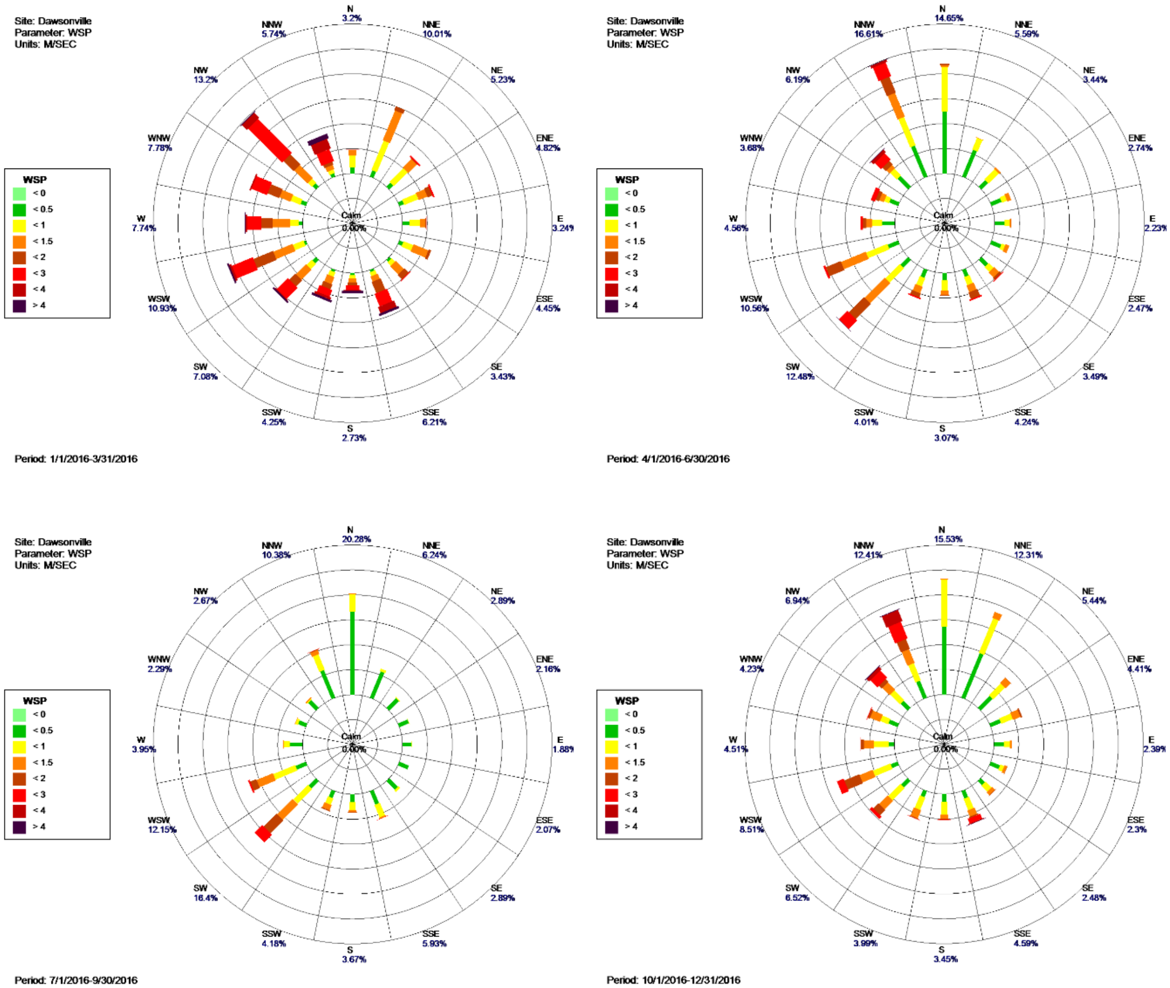
Columbus-Crime Lab, 2016 Quarterly Winds



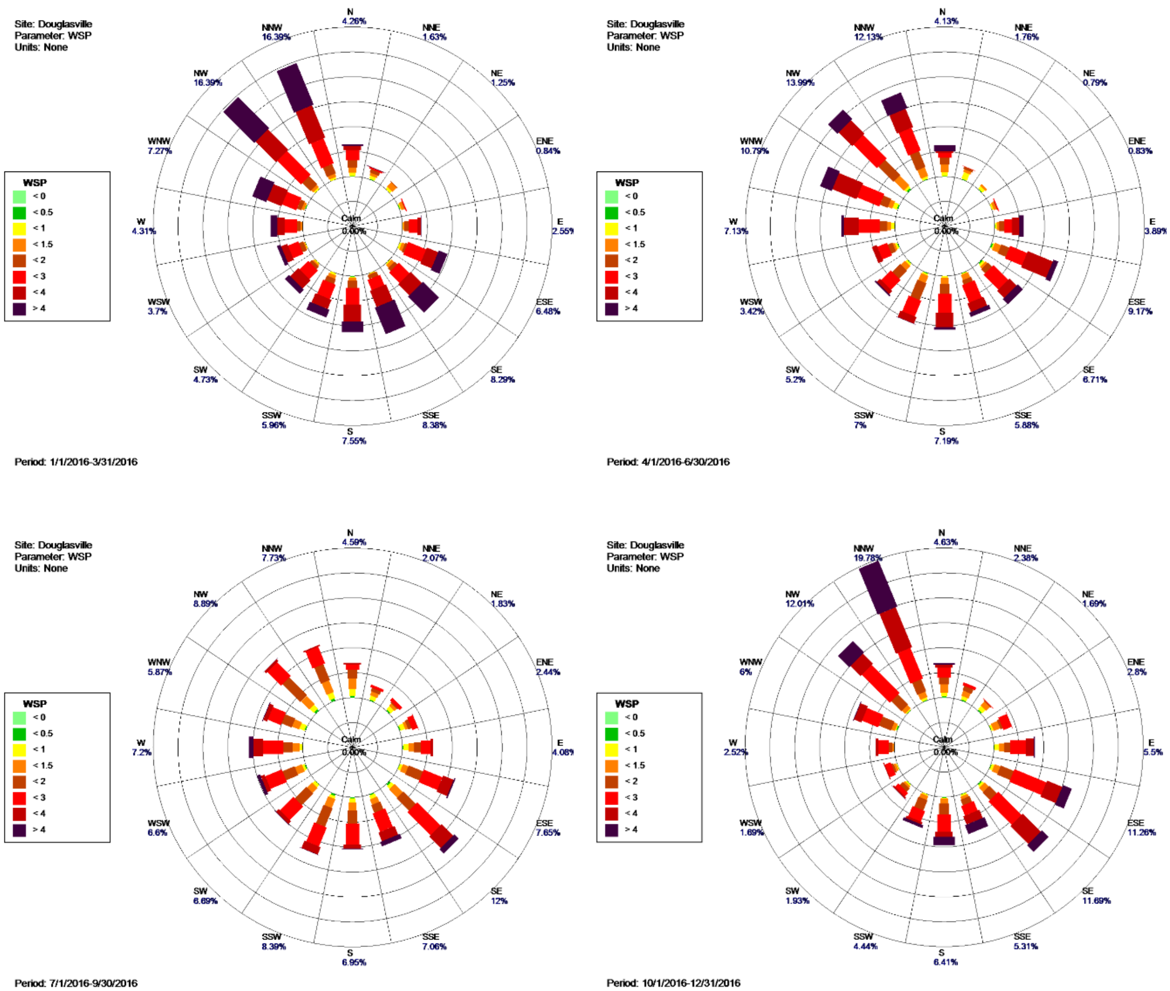




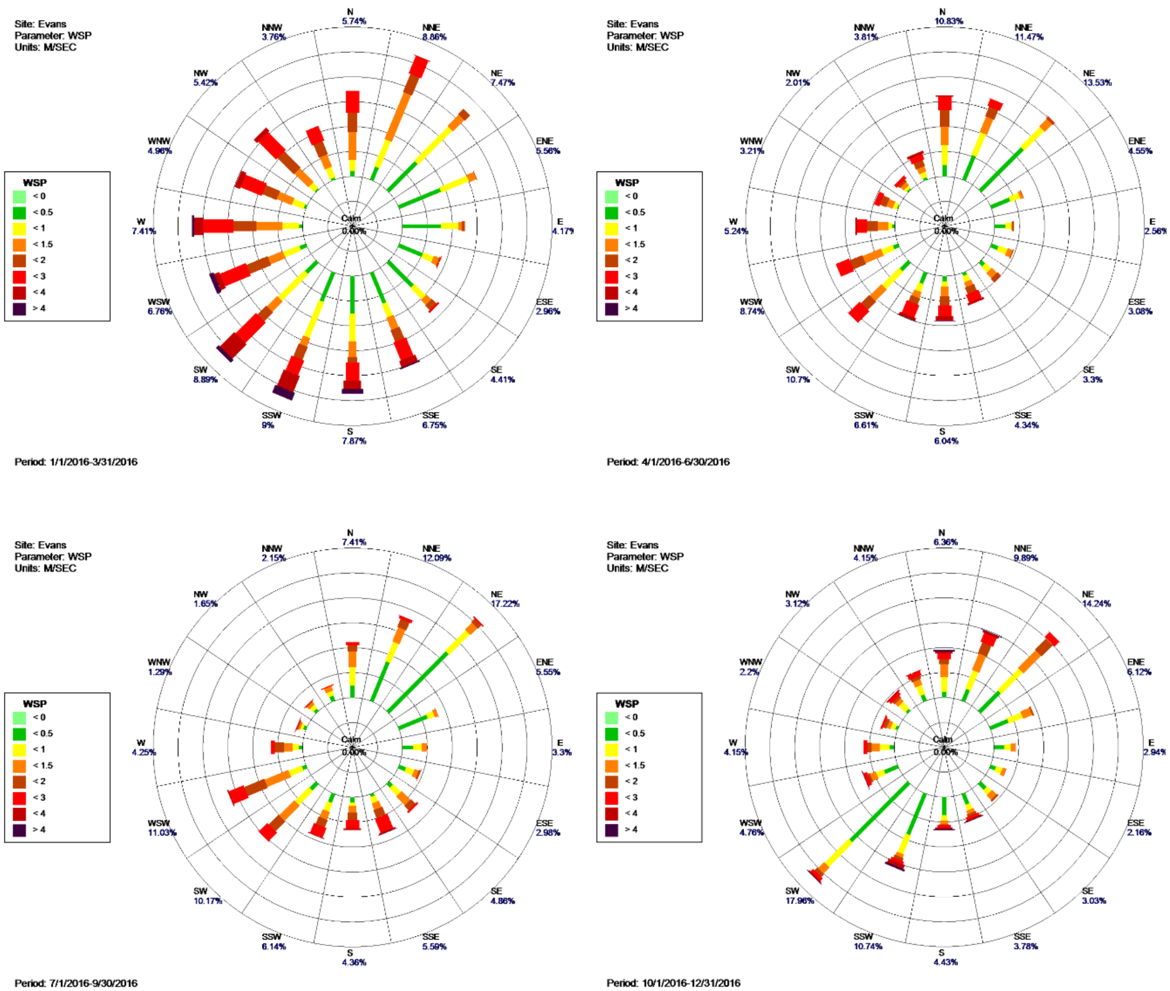
Conyers, 2016 Quarterly Winds



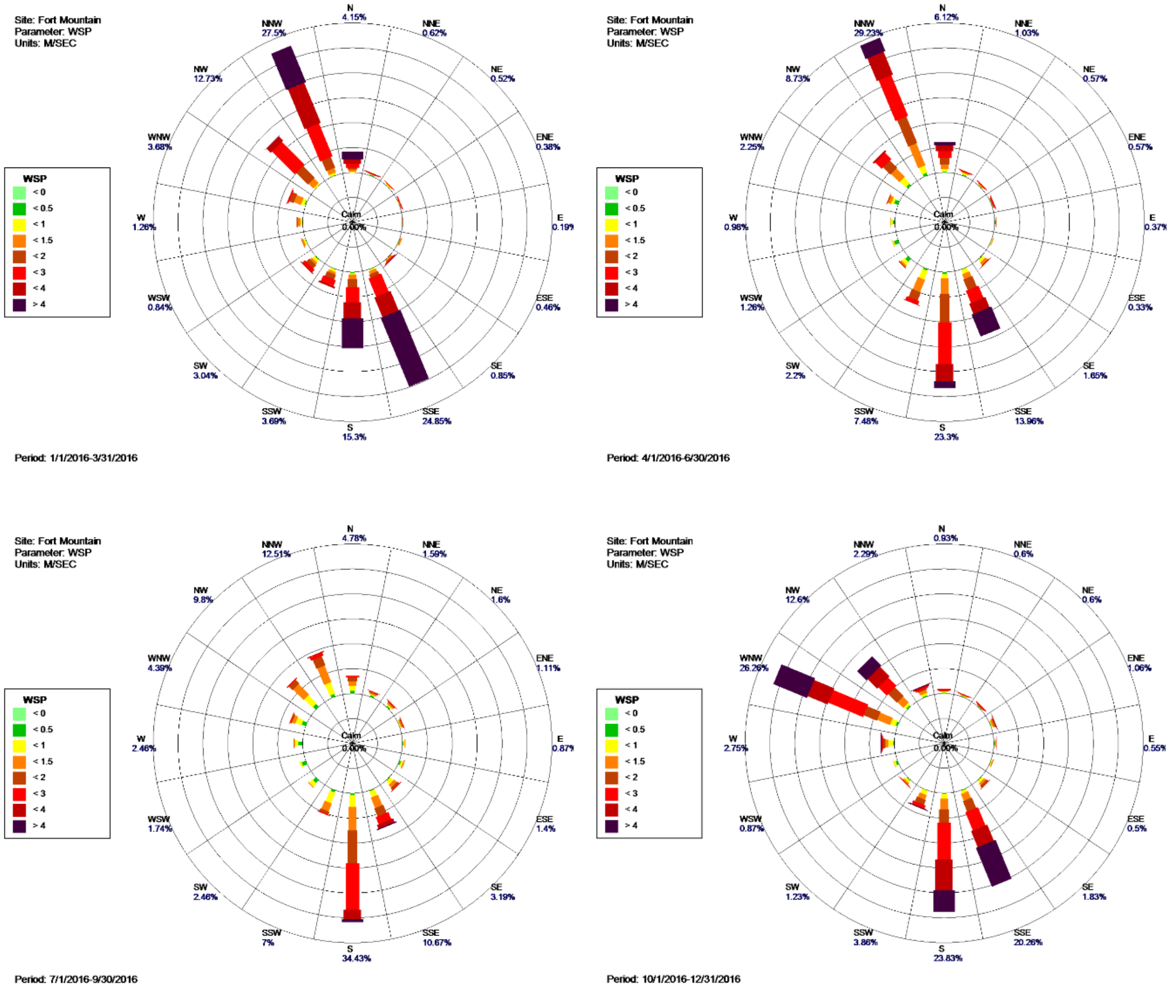
Dawsonville, 2016 Quarterly Winds



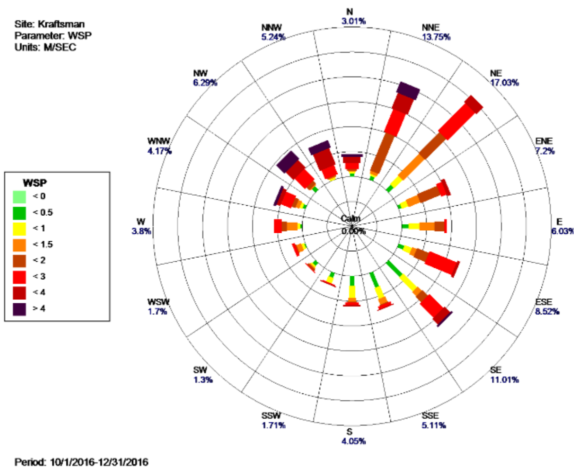
Douglasville, 2016 Quarterly Winds



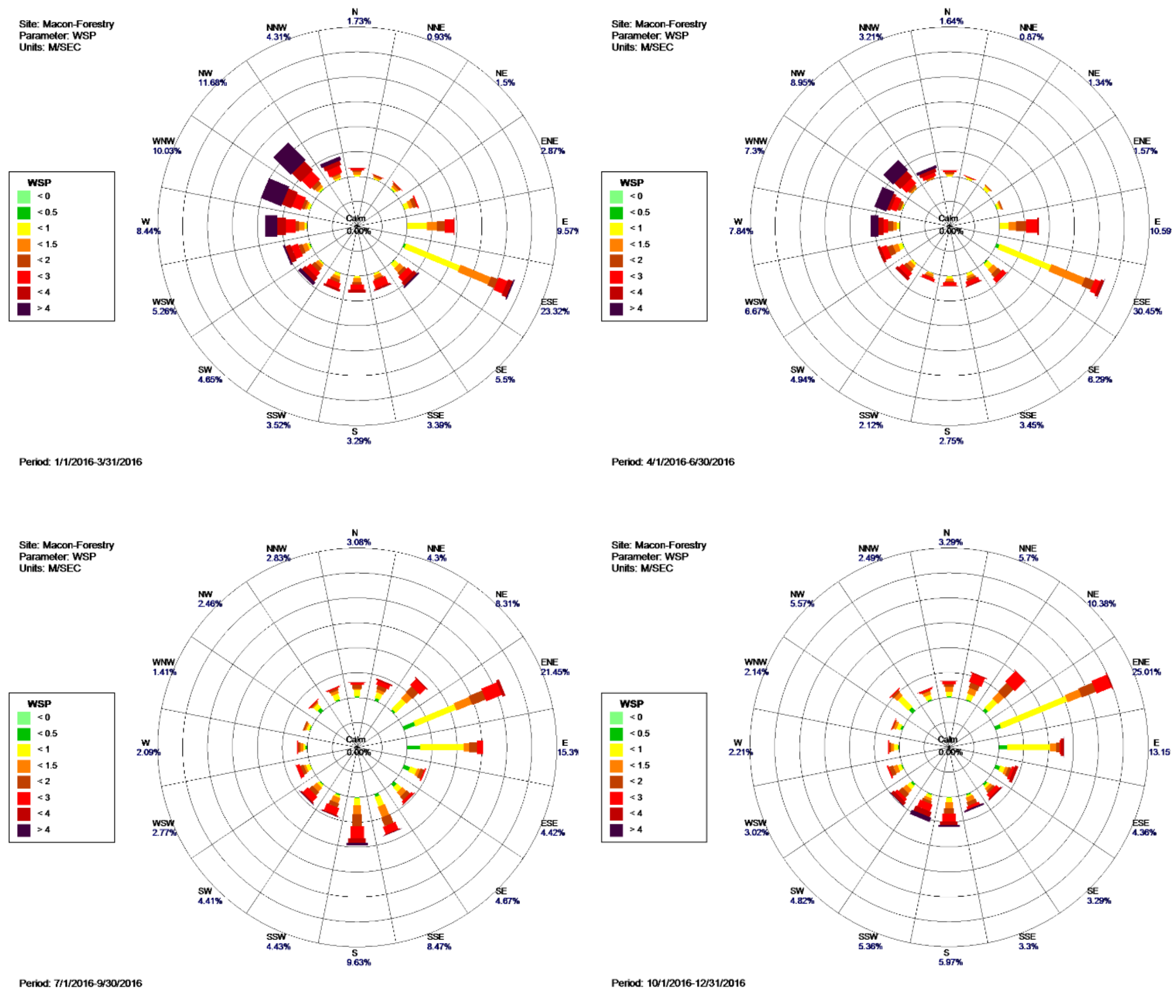
Evans, 2016 Quarterly Winds



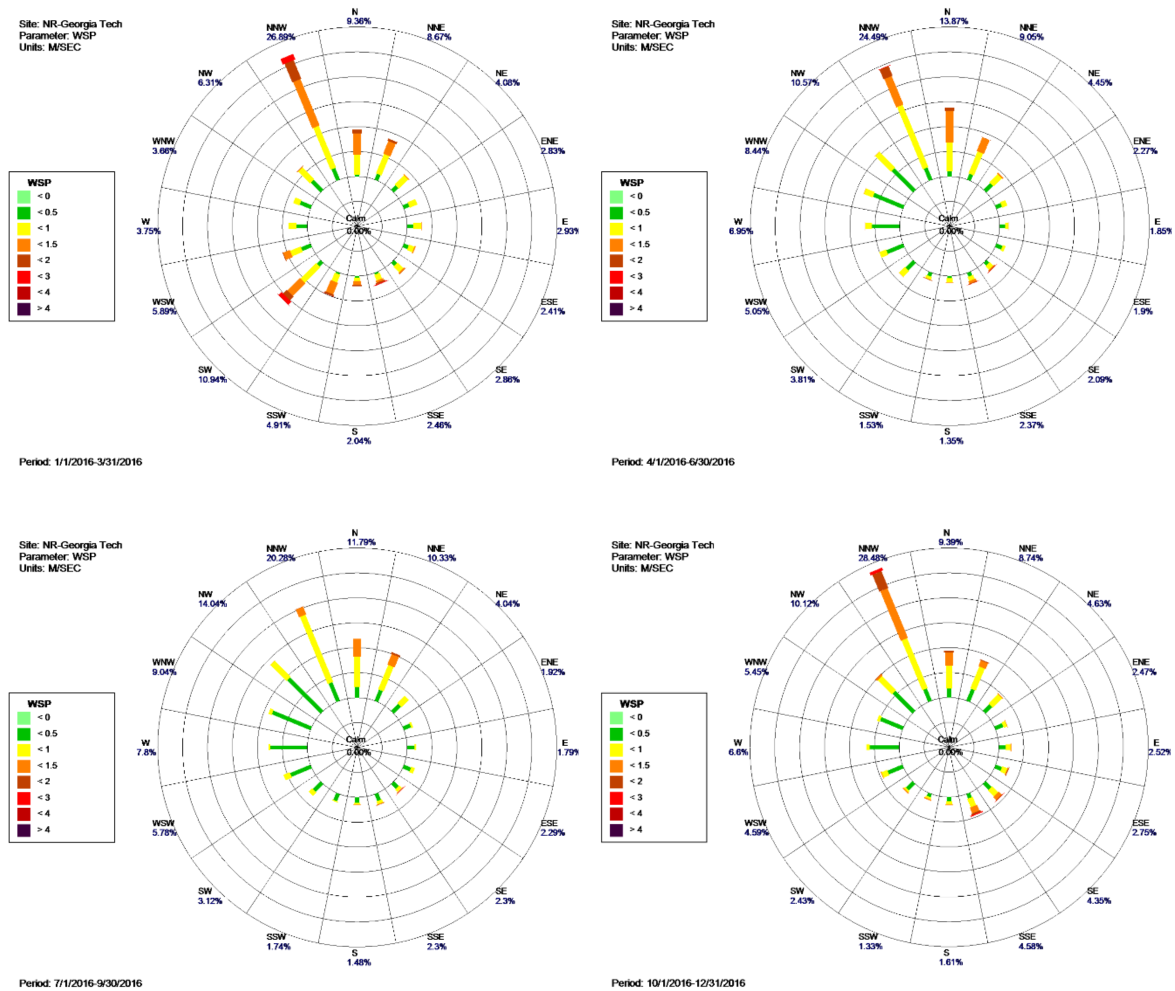
Fort Mountain, 2016 Quarterly Winds



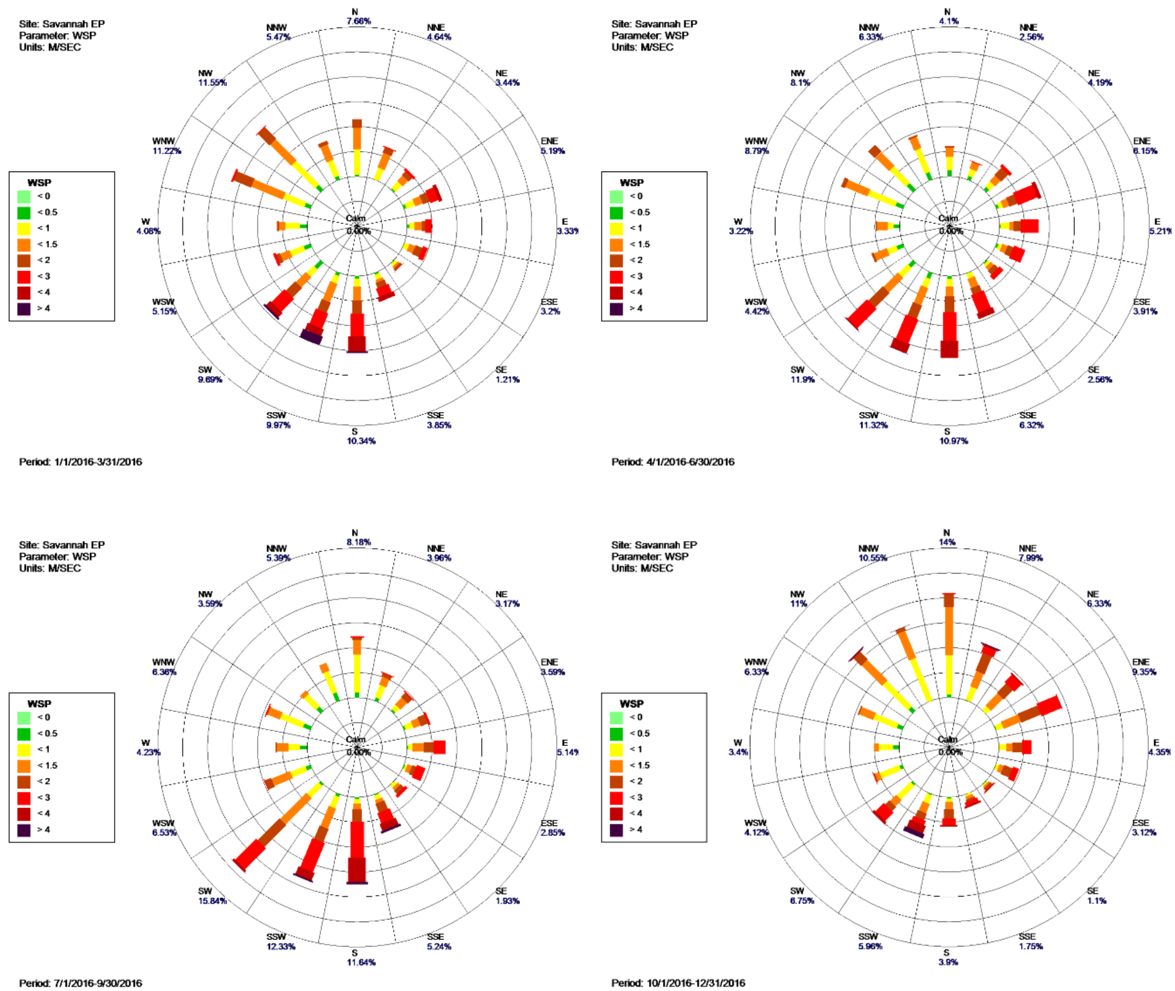
Kraftsman, 2016 Quarterly Winds



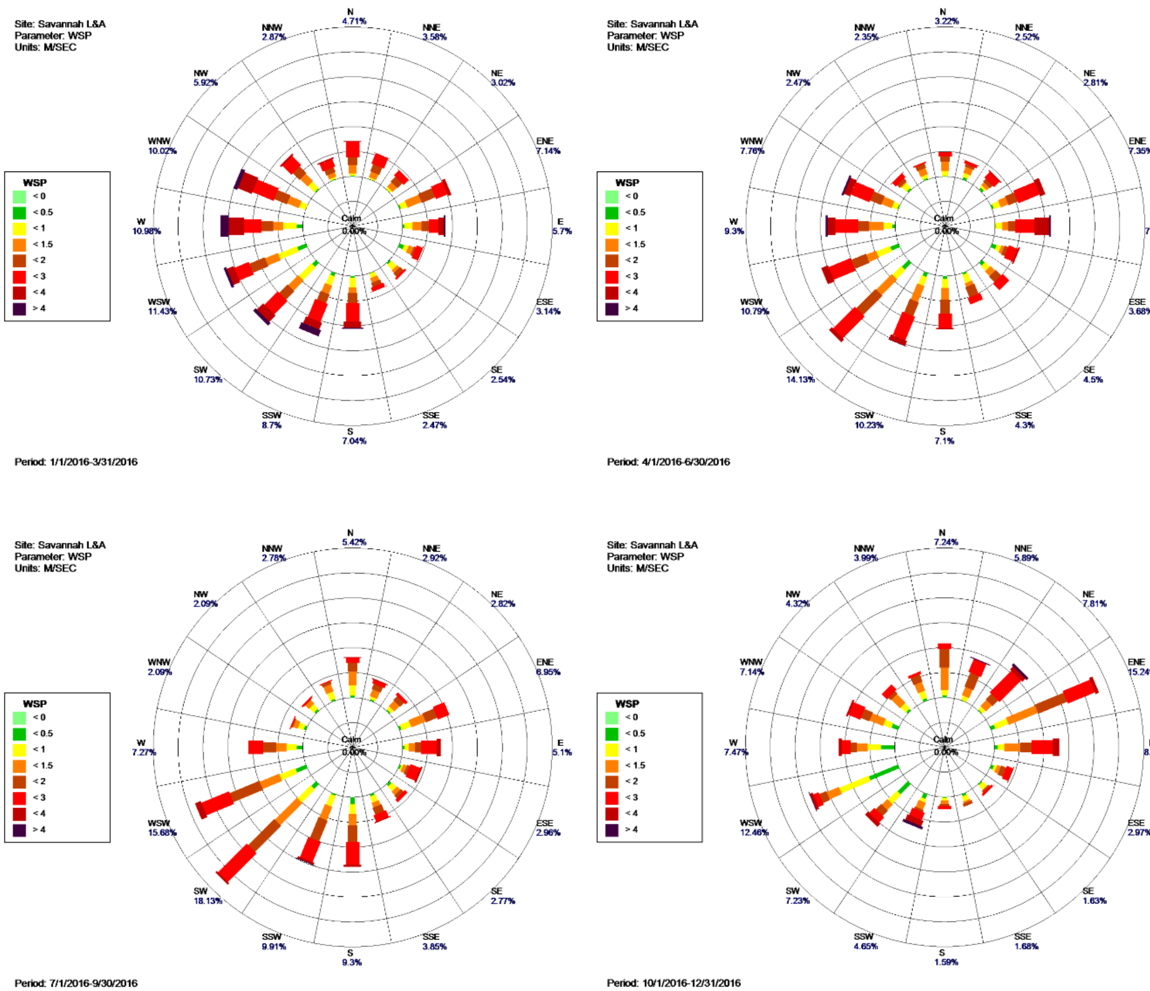
Macon-Forestry, 2016 Quarterly Winds



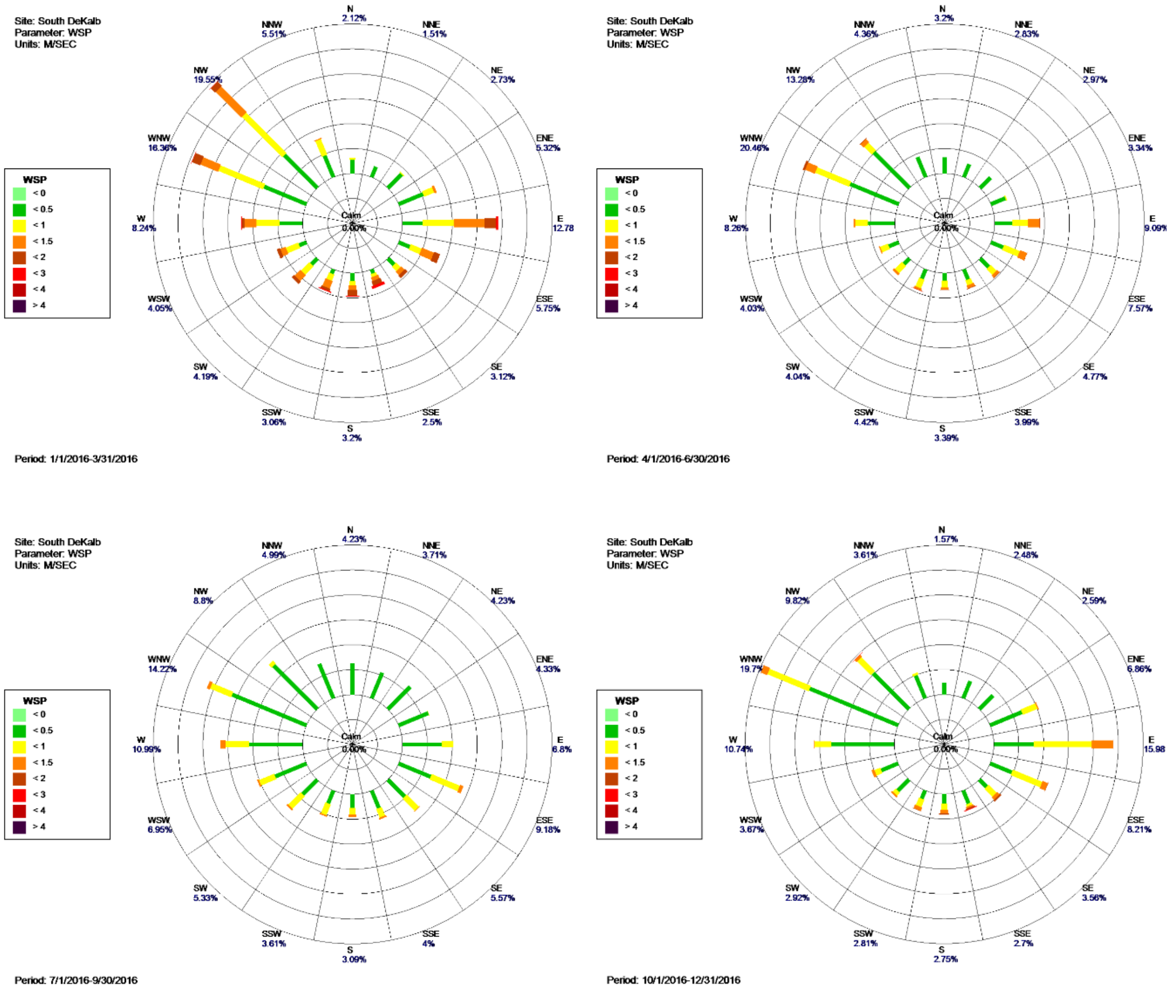
NR-GA Tech, 2016 Quarterly Winds



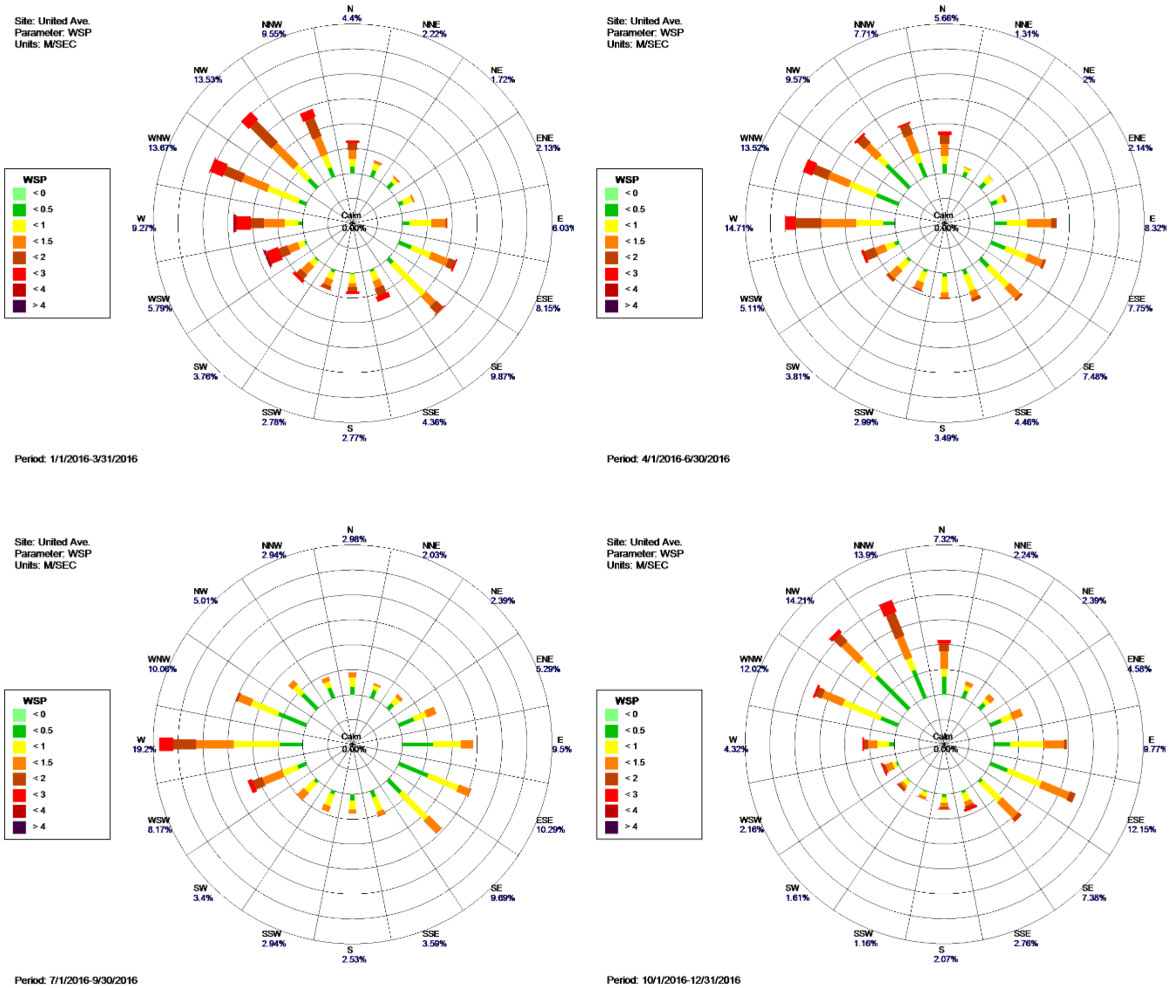
Savannah- E President, 2016 Quarterly Winds



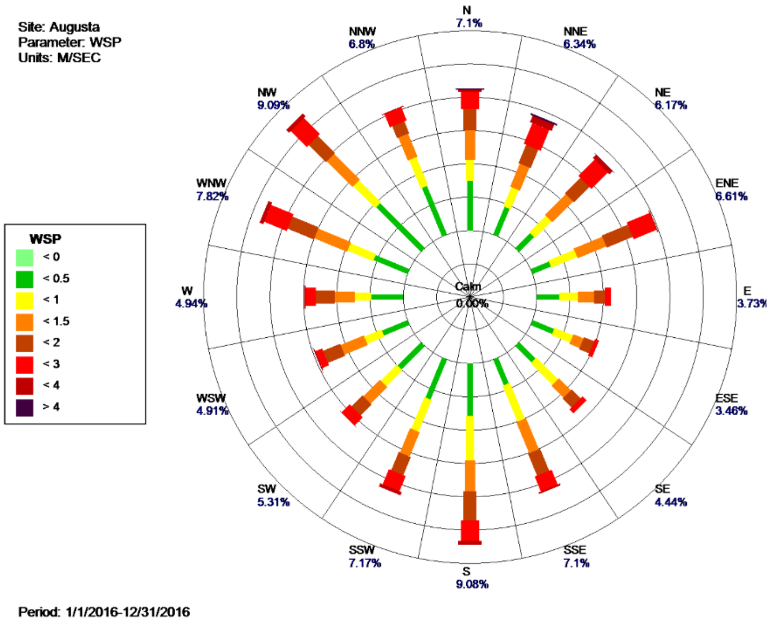
Savannah- L&A, 2016 Quarterly Winds



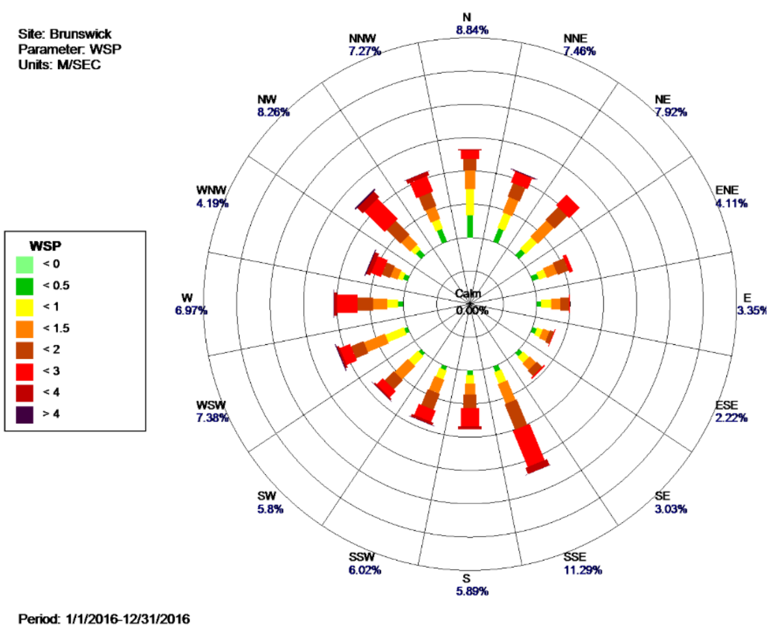
South DeKalb, 2016 Quarterly Winds



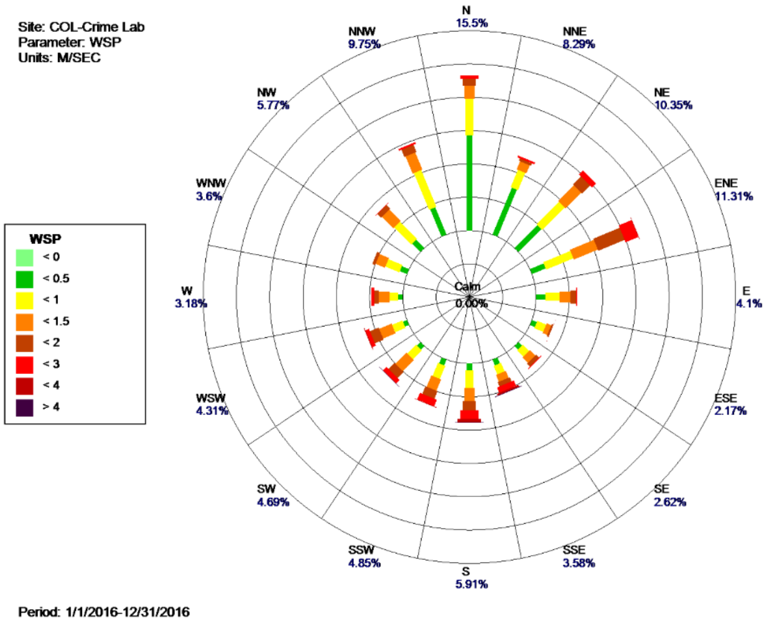
United Ave, 2016 Quarterly Winds



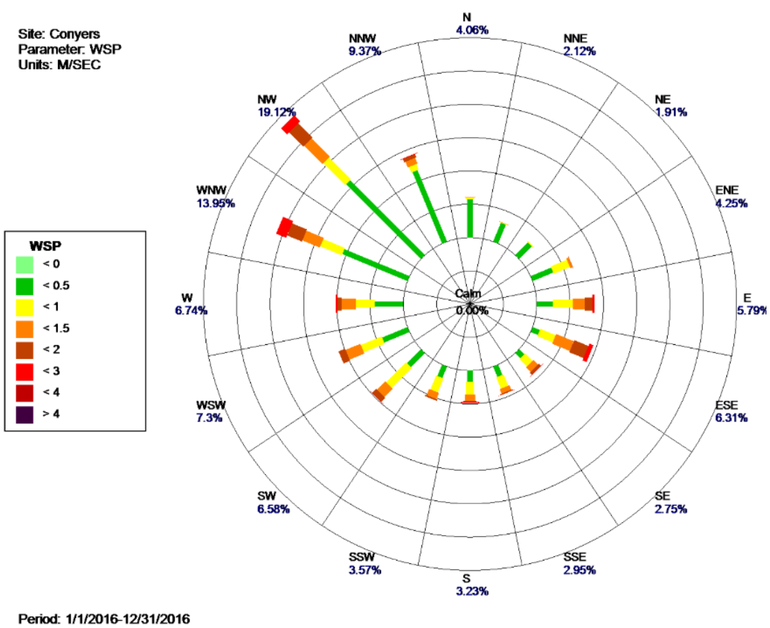
Augusta, 2016 Annual Winds



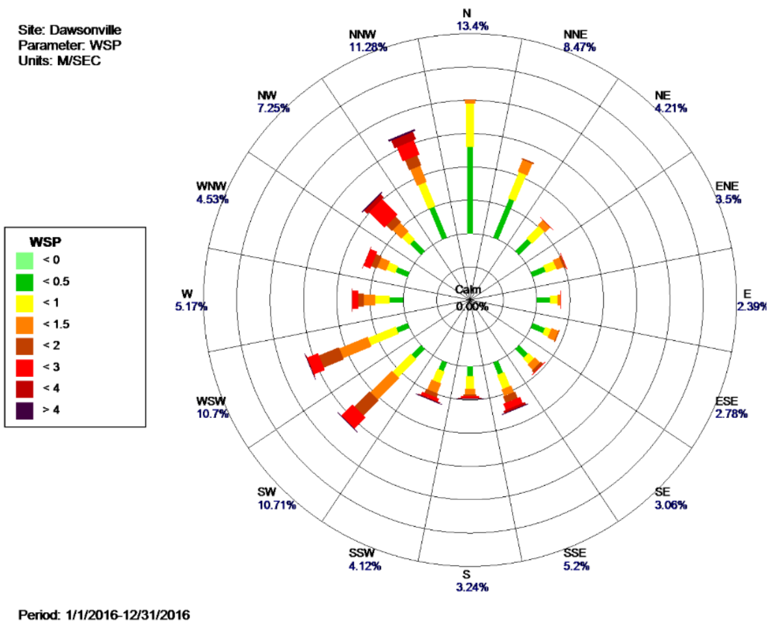
Brunswick, 2016 Annual Winds



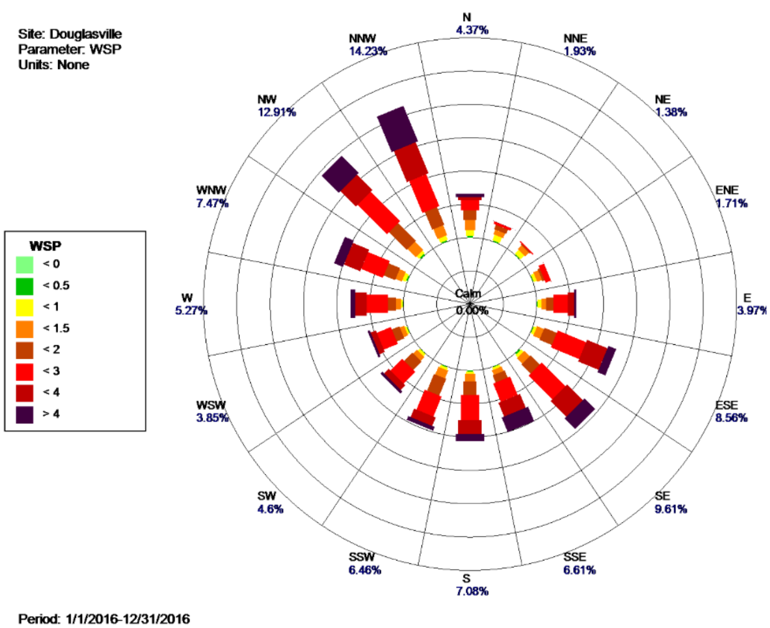
Columbus-Crime Lab, 2016 Annual Winds



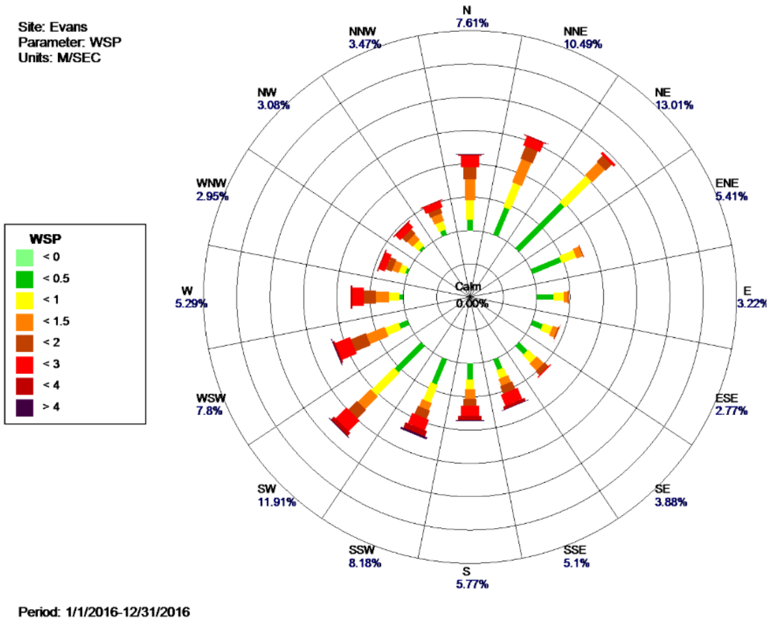
Conyers, 2016 Annual Winds



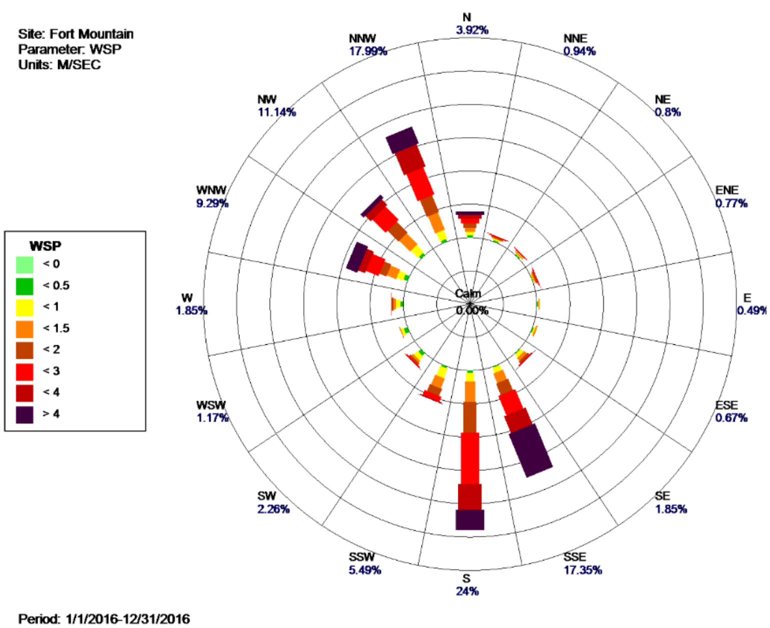
Dawsonville, 2016 Annual Winds



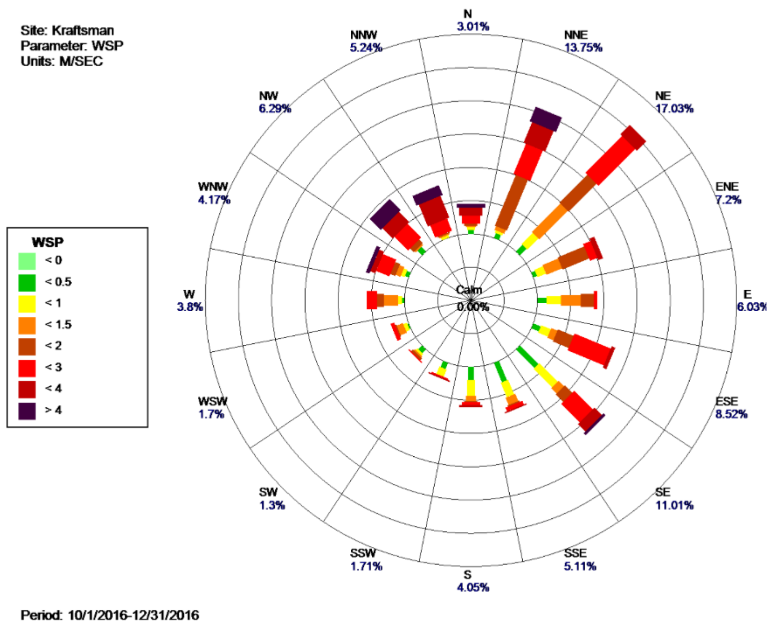
Douglasville, 2016 Annual Winds



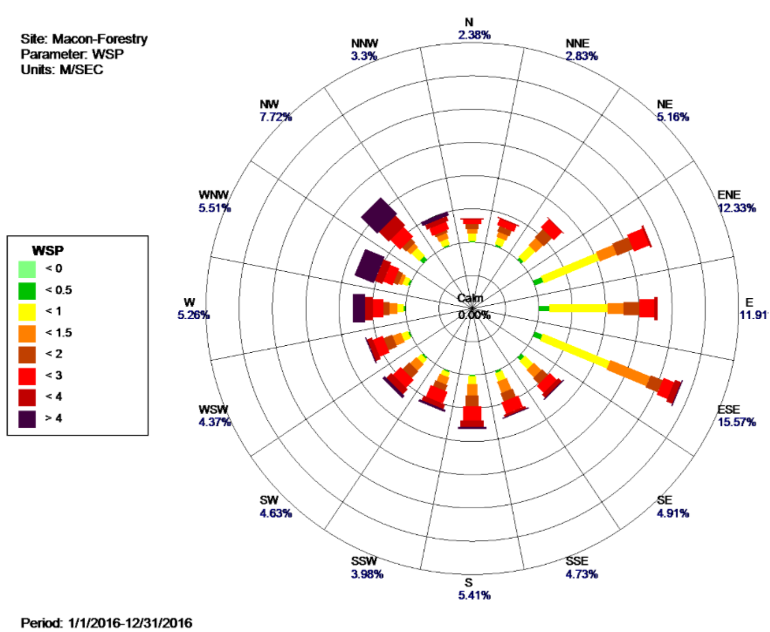
Evans, 2016 Annual Winds



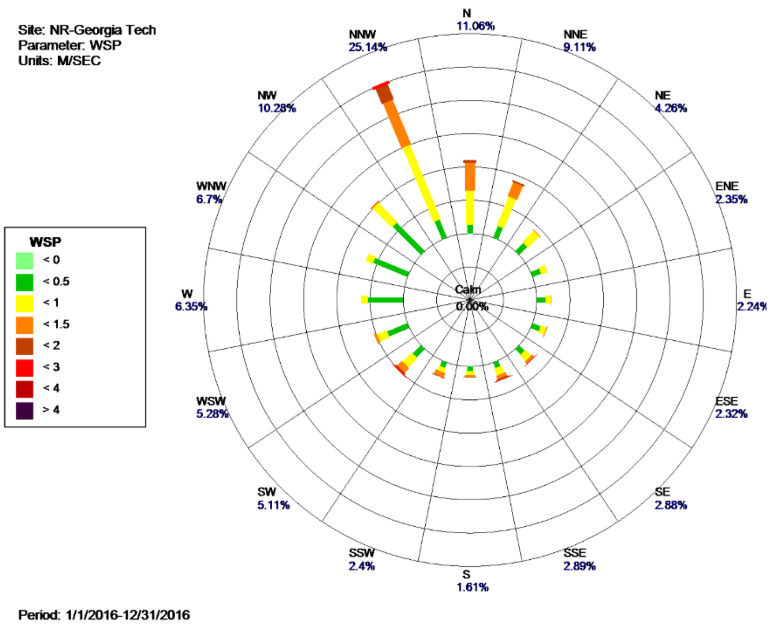
Fort Mountain, 2016 Annual Winds



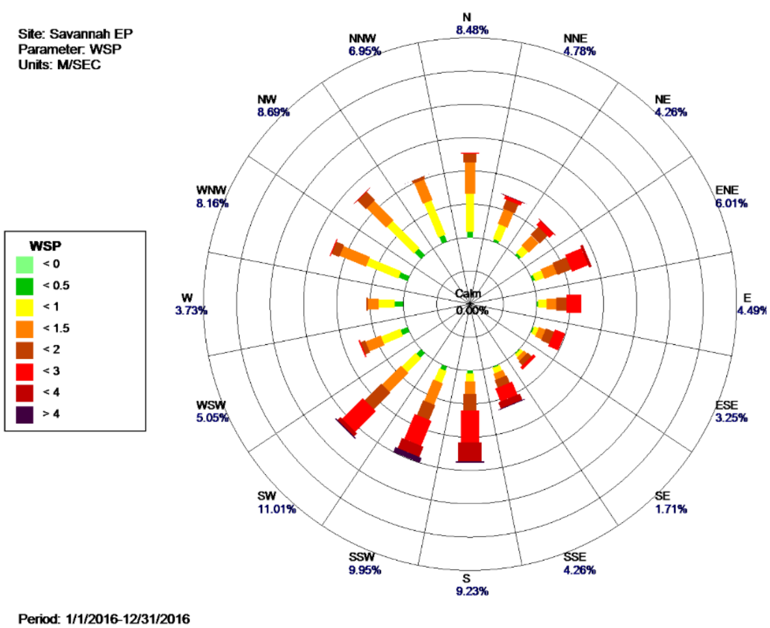
Kraftsman, 2016 Annual Winds



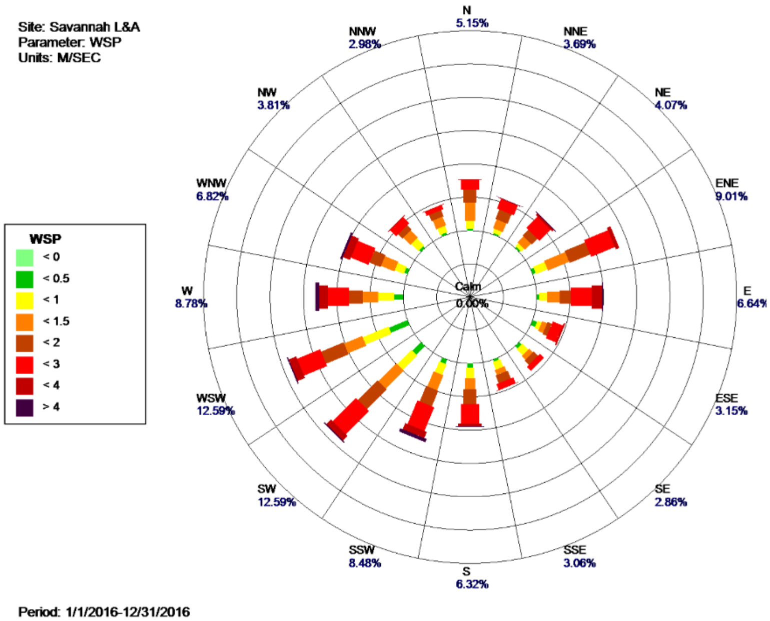
Macon-Forestry, 2016 Annual Winds



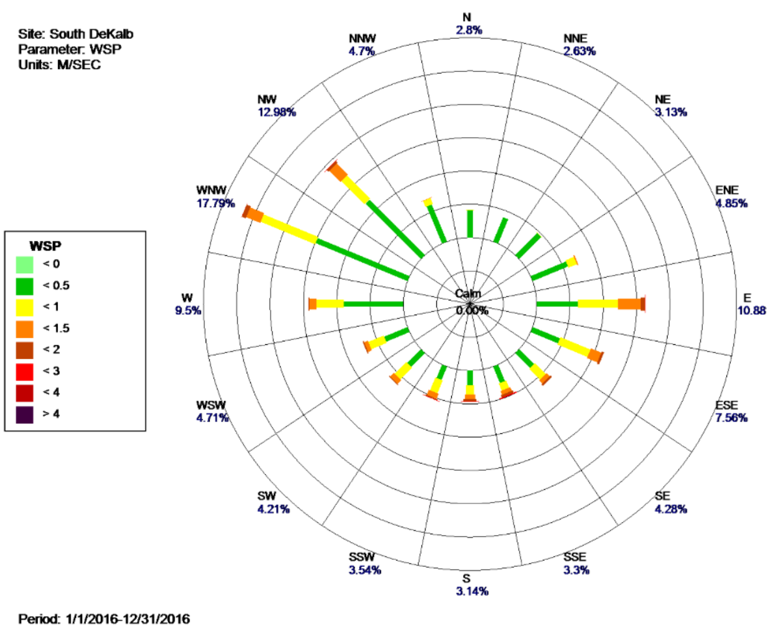
NR-GA Tech, 2016 Annual Winds



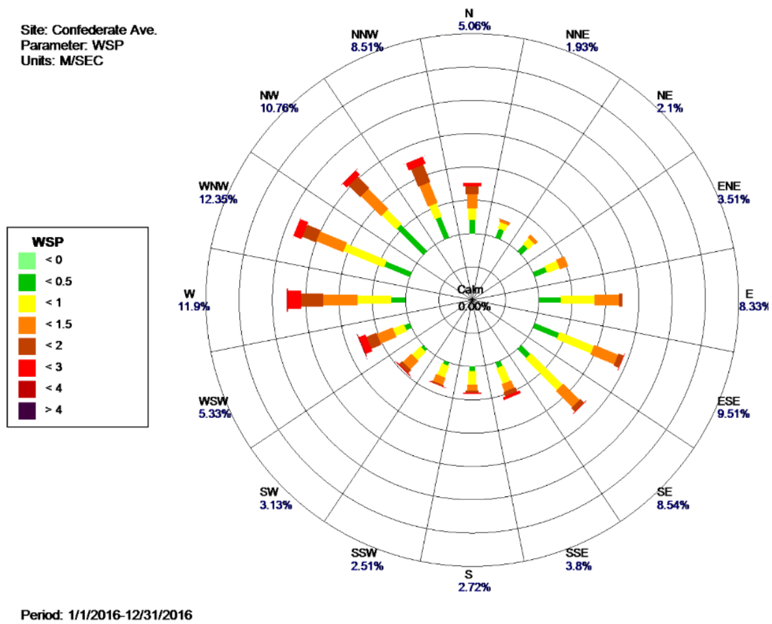
Savannah- E President, 2016 Annual Winds



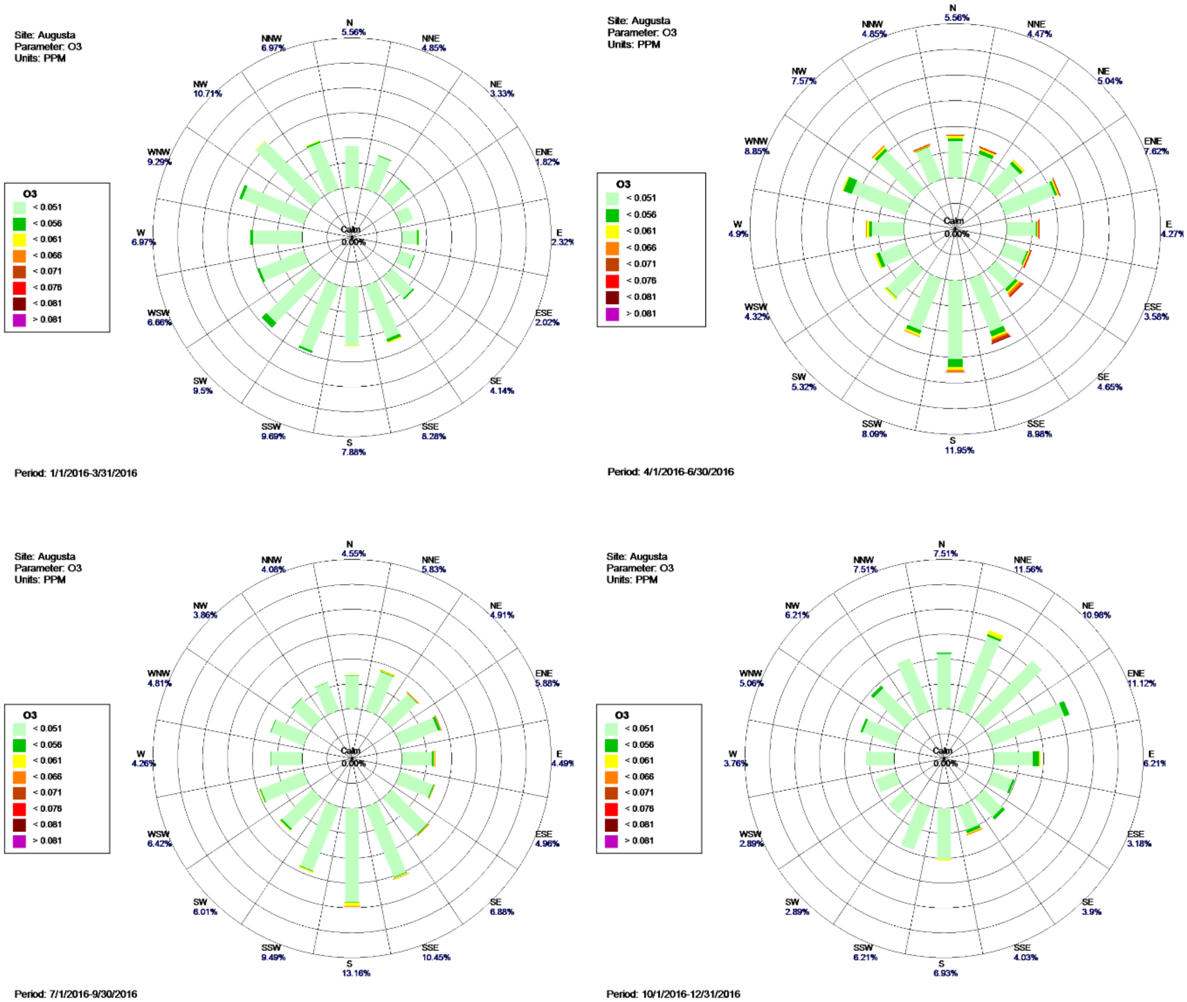
Savannah- L&A, 2016 Annual Winds



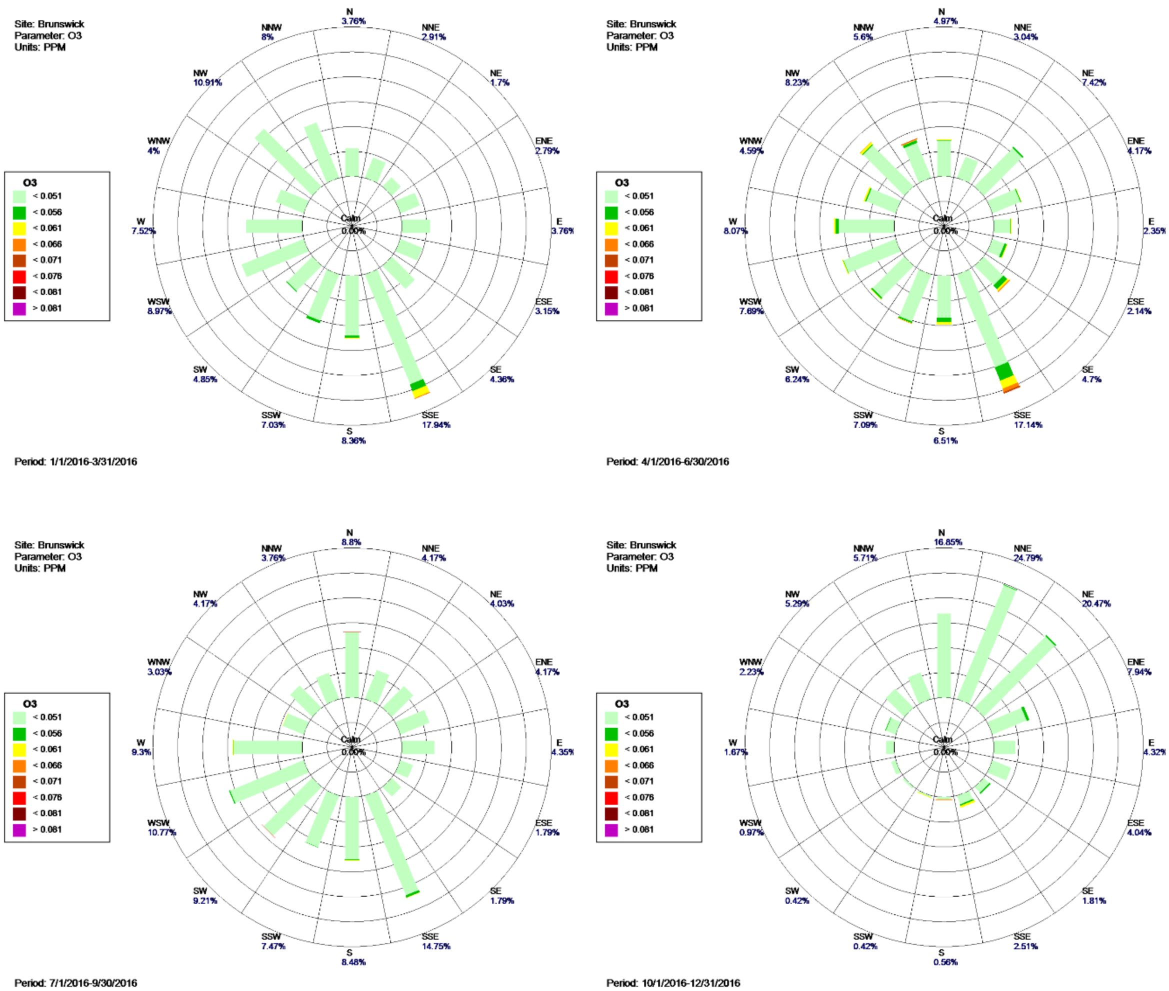
South DeKalb, 2016 Annual Winds



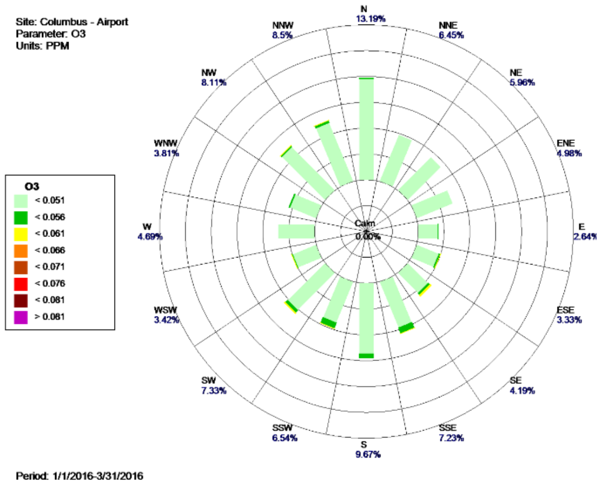
United Ave, 2016 Annual Winds

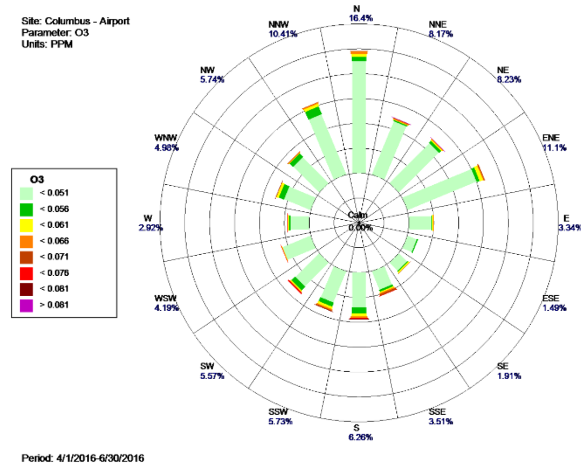


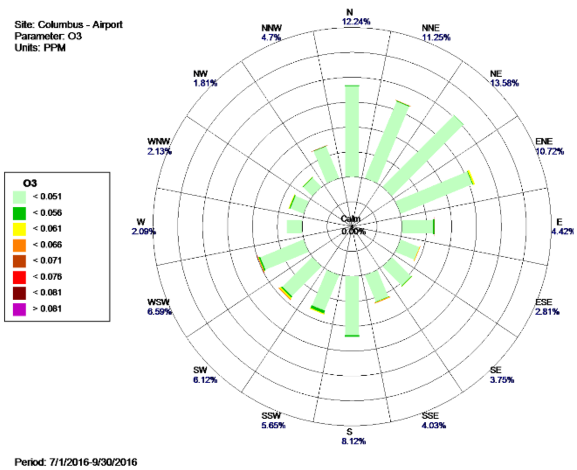
Augusta, 2016 Quarterly Ozone

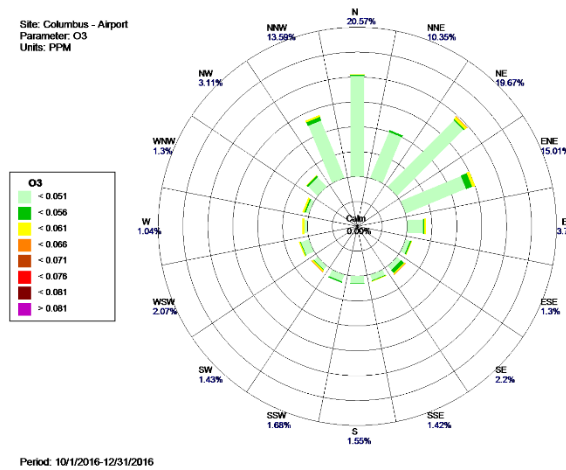


Brunswick, 2016 Quarterly Ozone

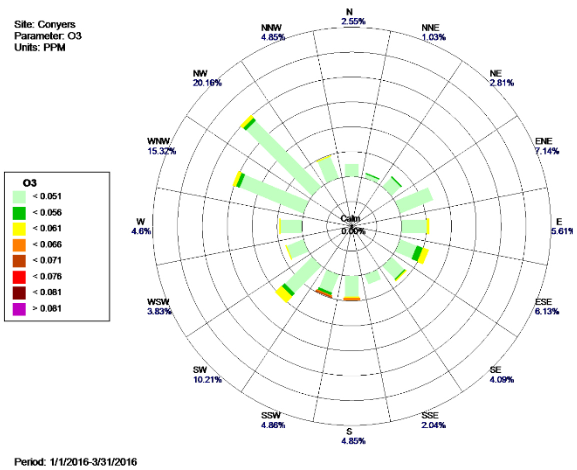


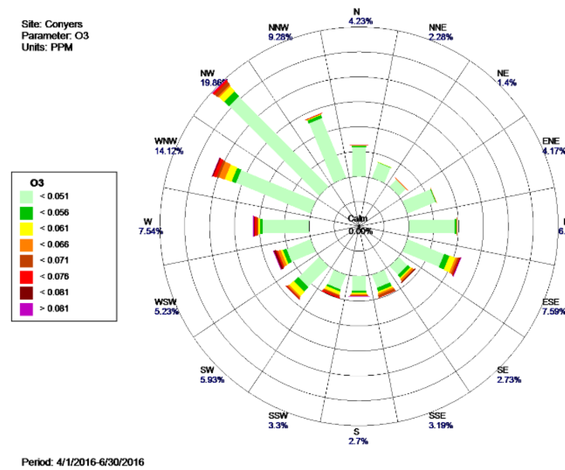


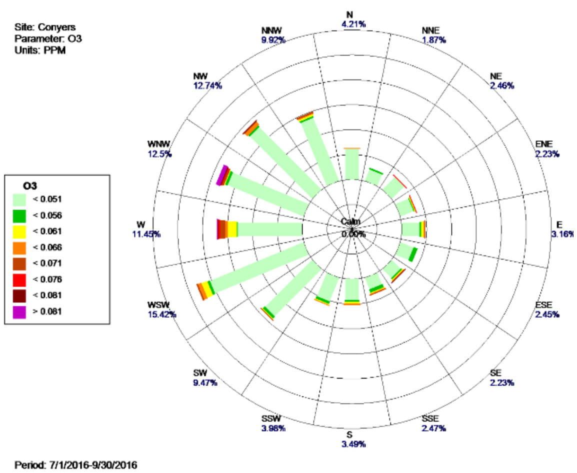




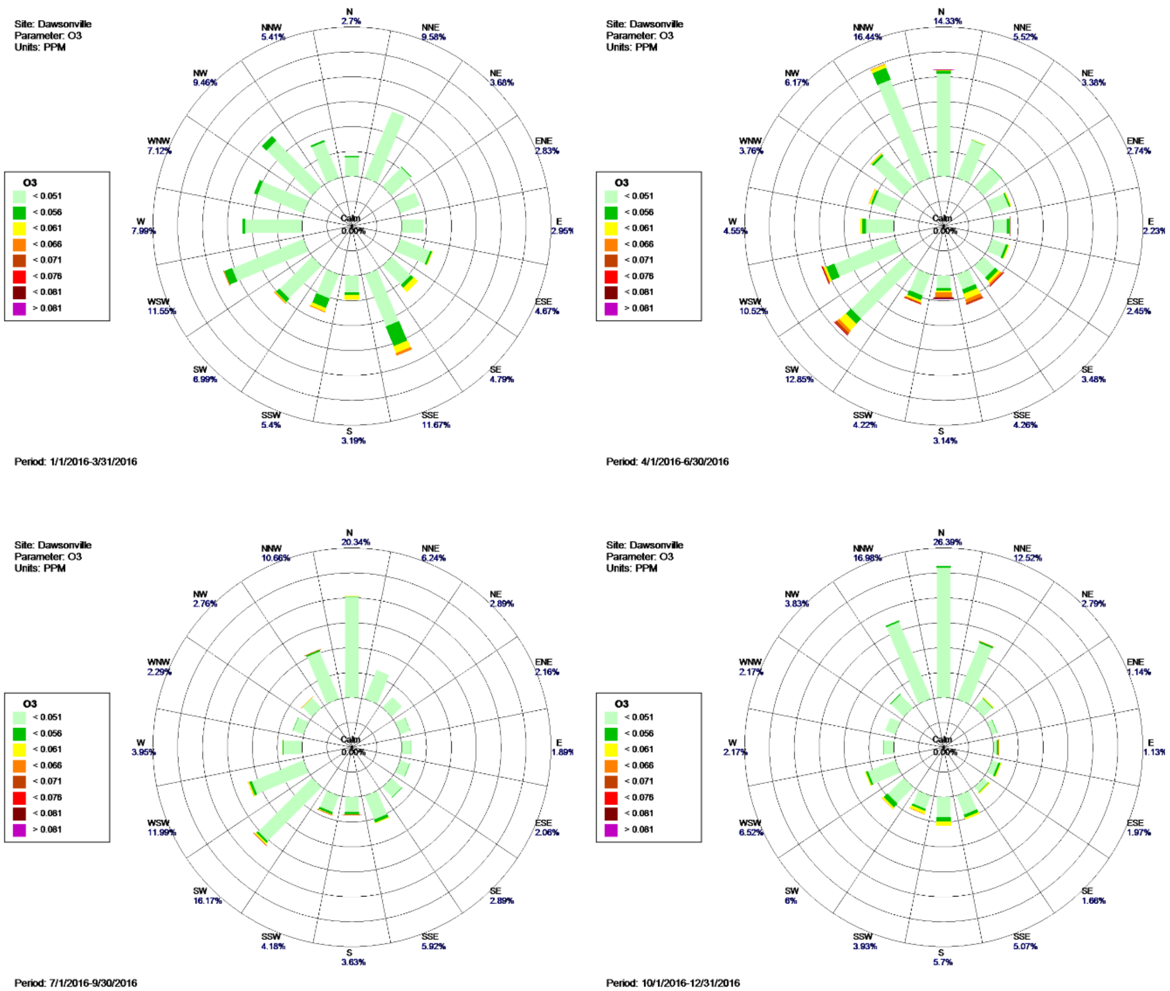
Columbus-Airport, 2016 Quarterly Ozone



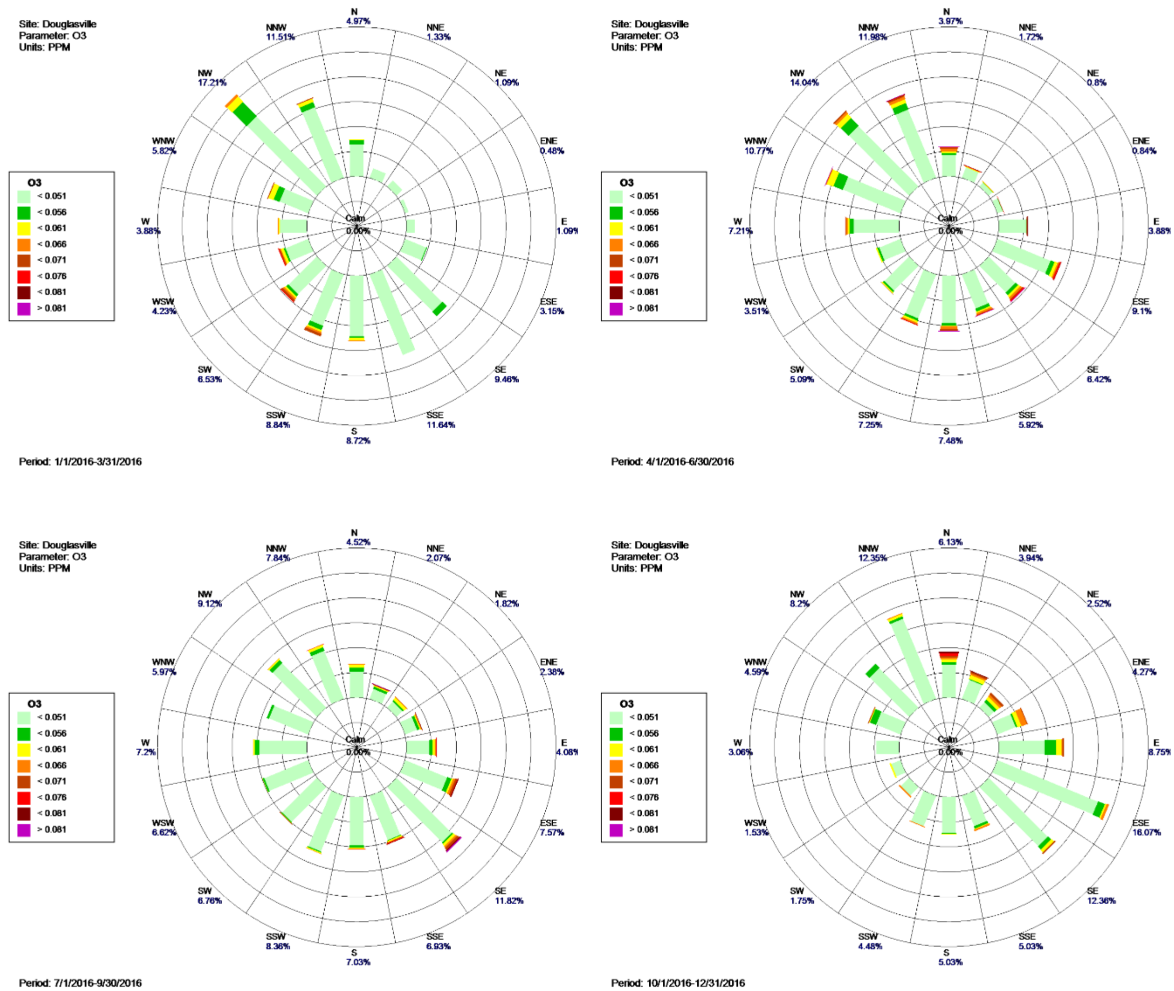




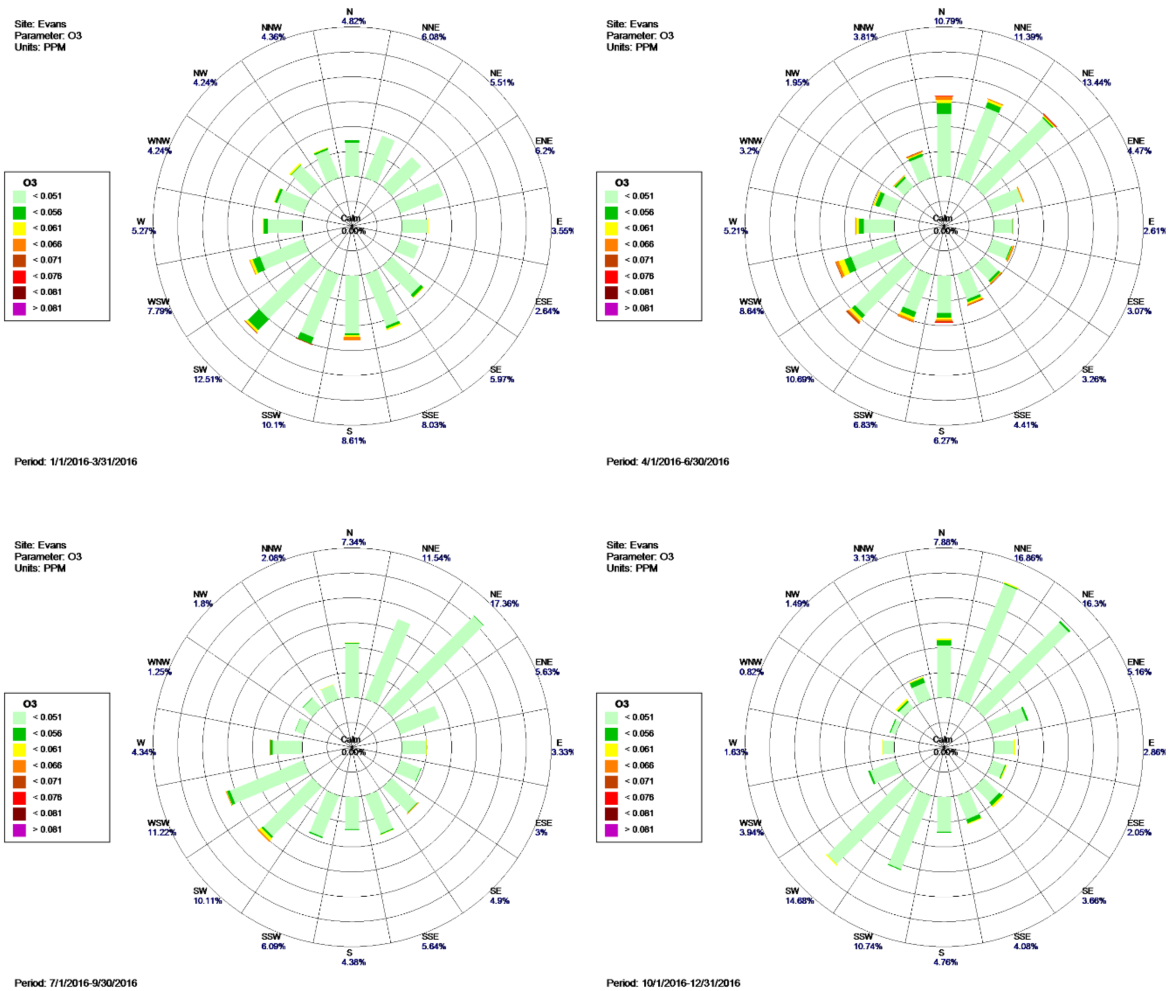
Conyers, 2016 Quarterly Ozone



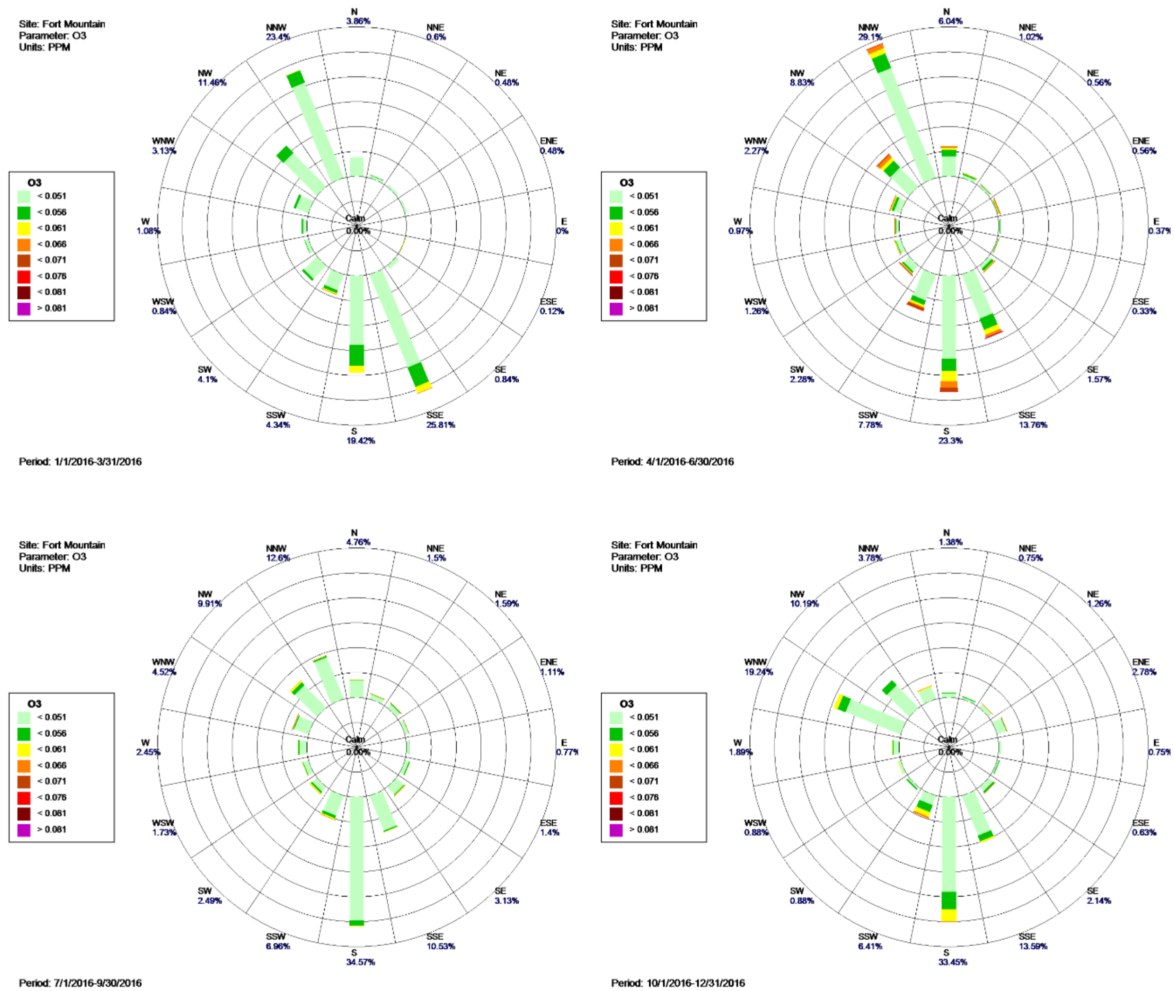
Dawsonville, 2016 Quarterly Ozone



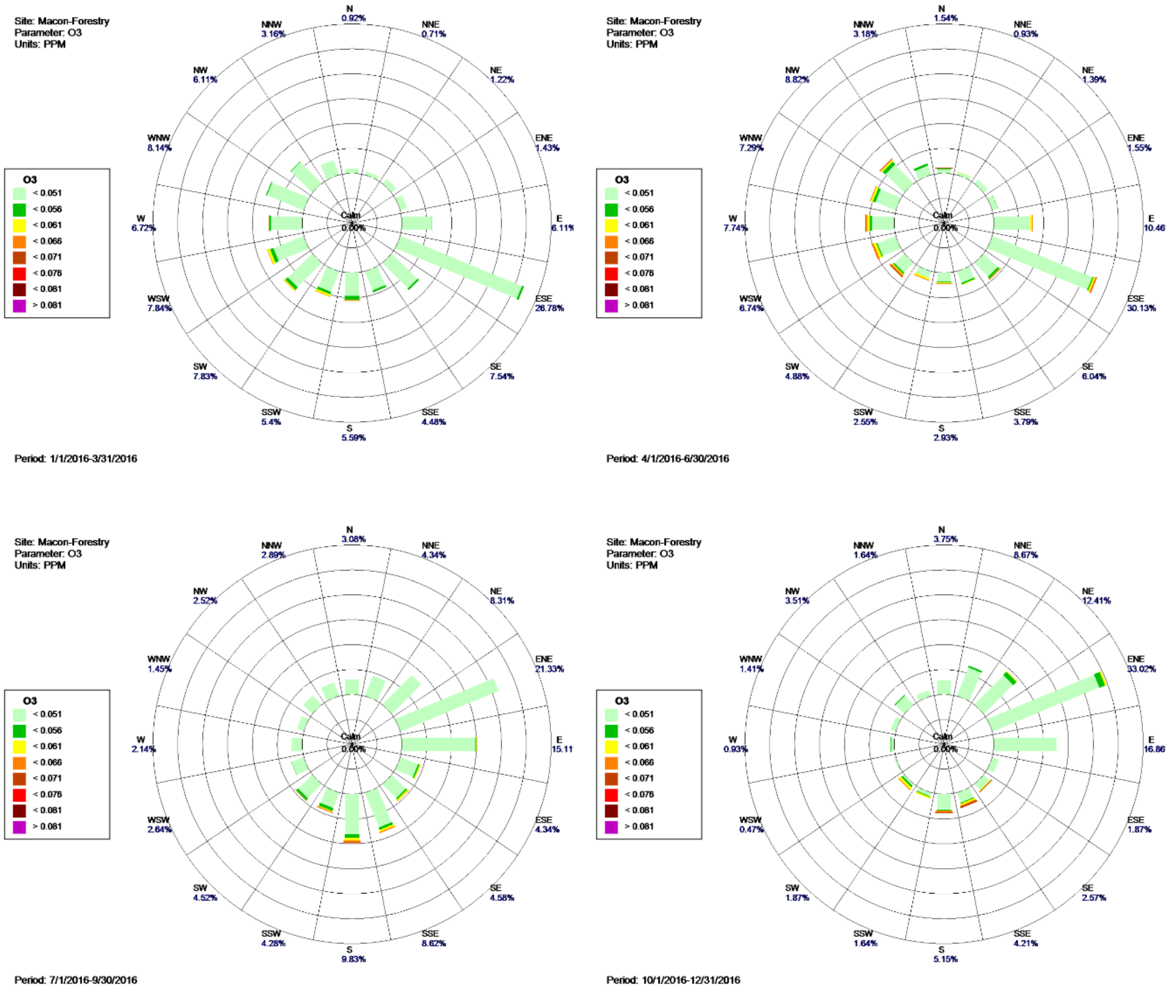
Douglasville, 2016 Quarterly Ozone



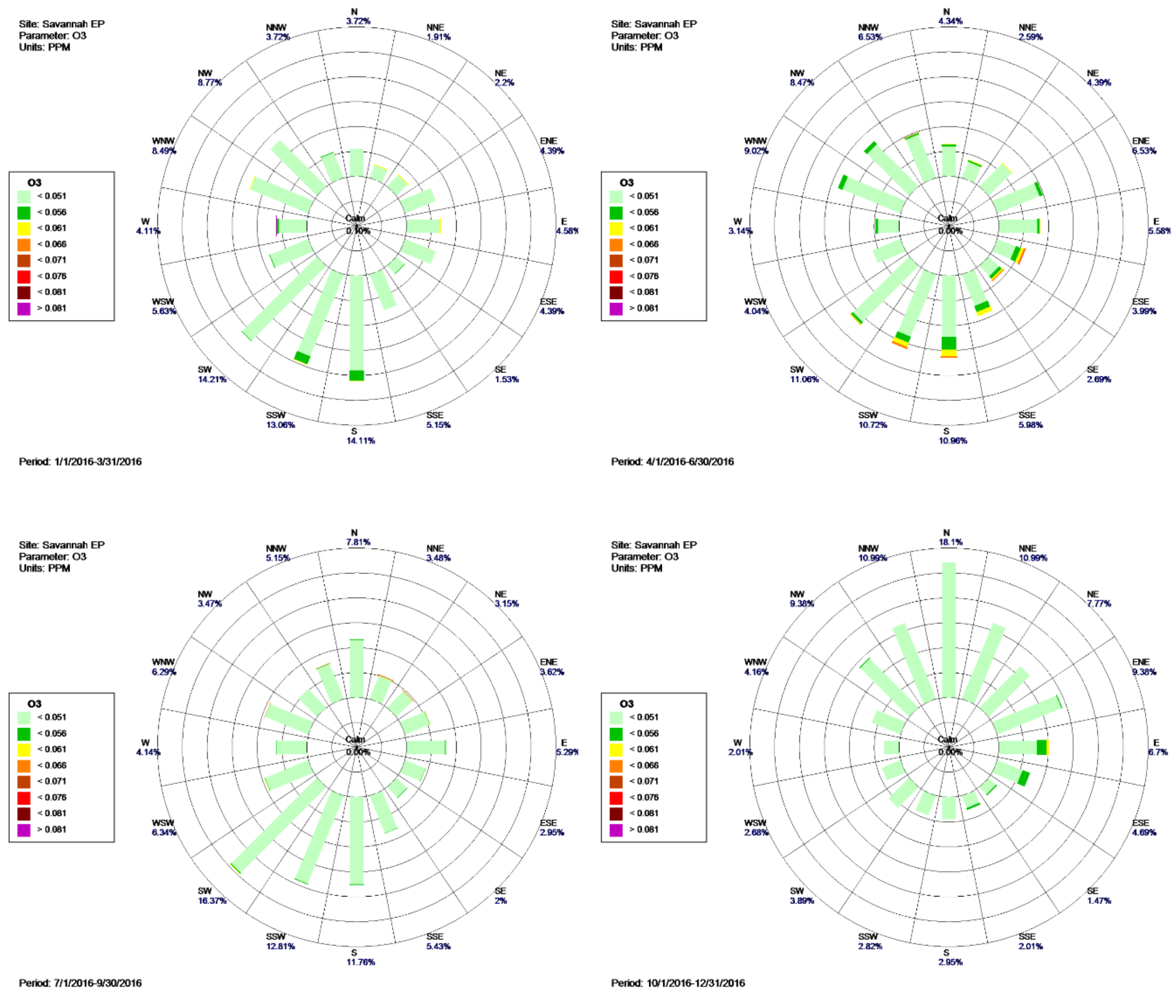
Evans, 2016 Quarterly Ozone



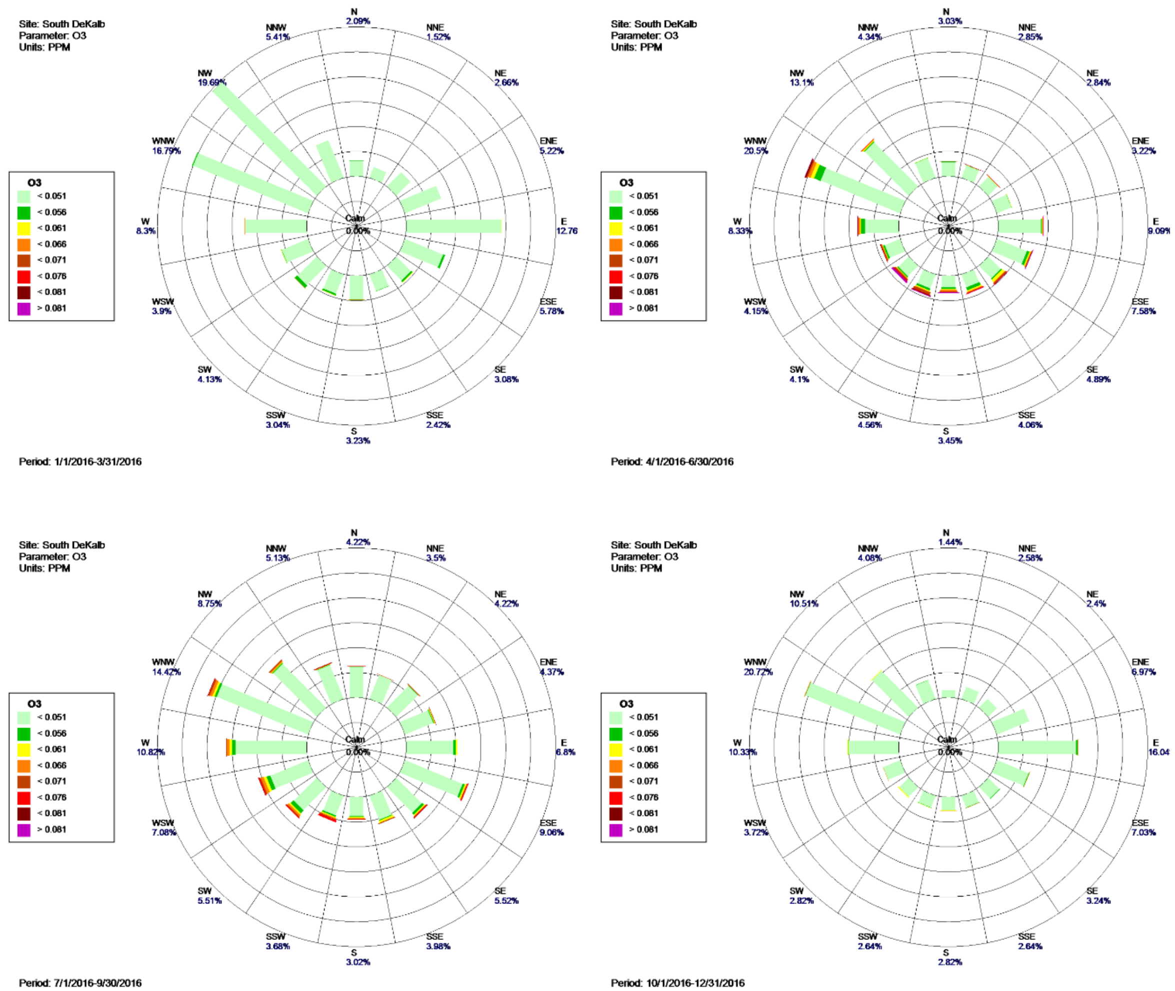
Fort Mountain, 2016 Quarterly Ozone



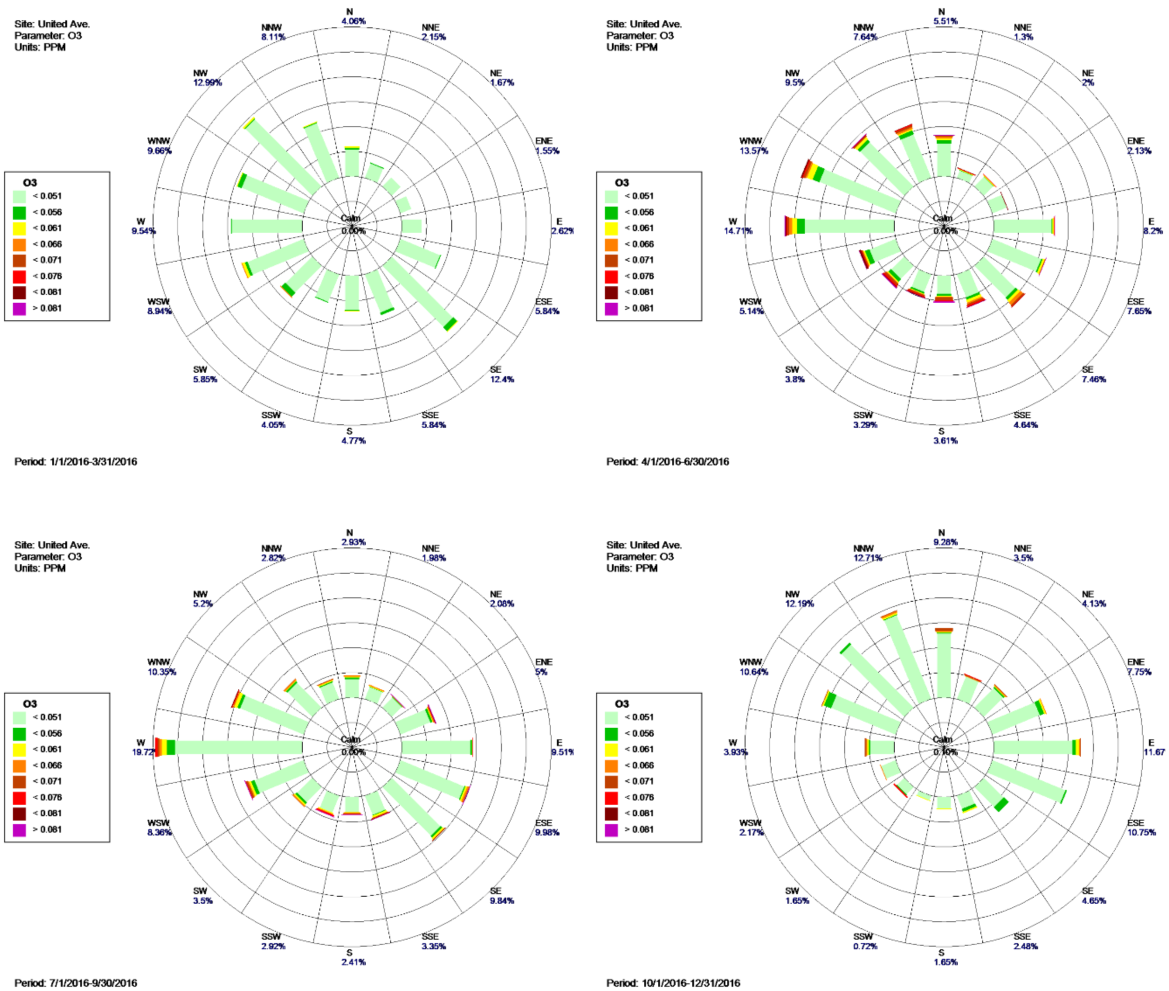
Macon-Forestry, 2016 Quarterly Ozone



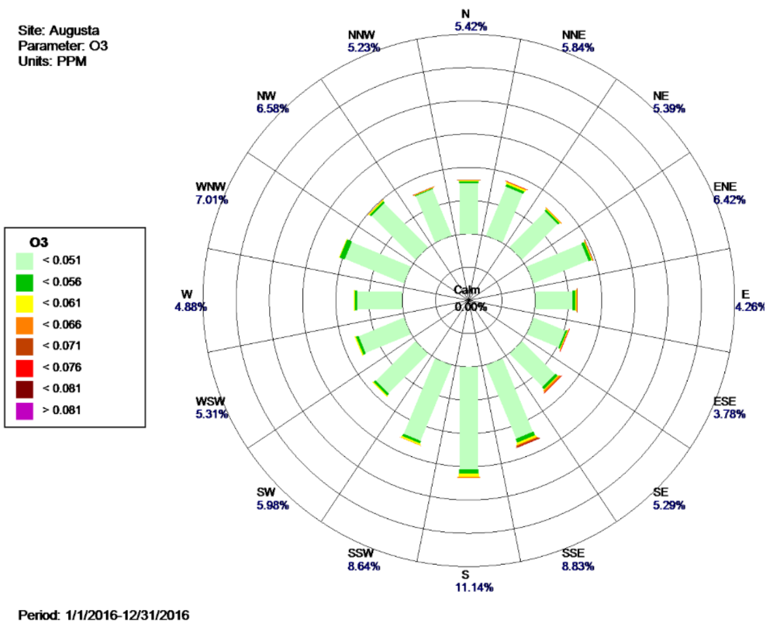
Savannah-E President, 2016 Quarterly Ozone



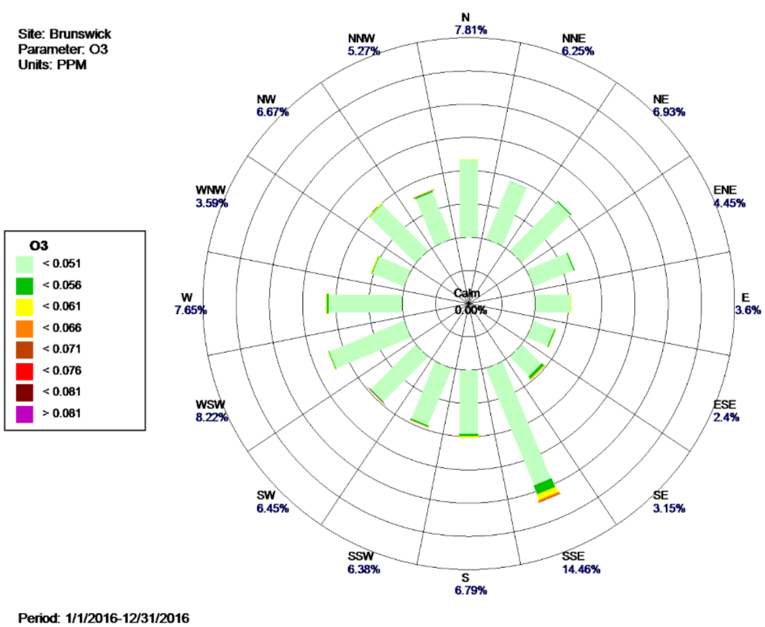
South DeKalb, 2016 Quarterly Ozone



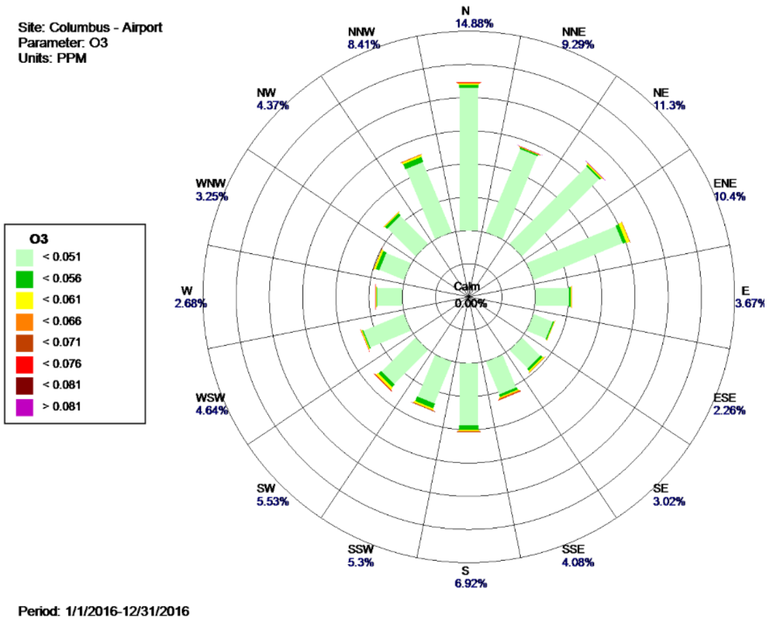
United Ave, 2016 Quarterly Ozone



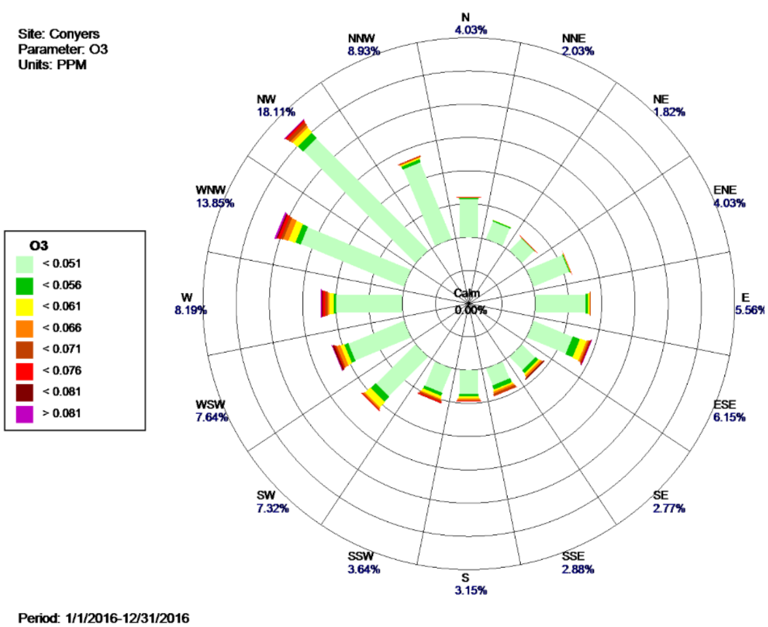
Augusta, 2016 Annual Ozone



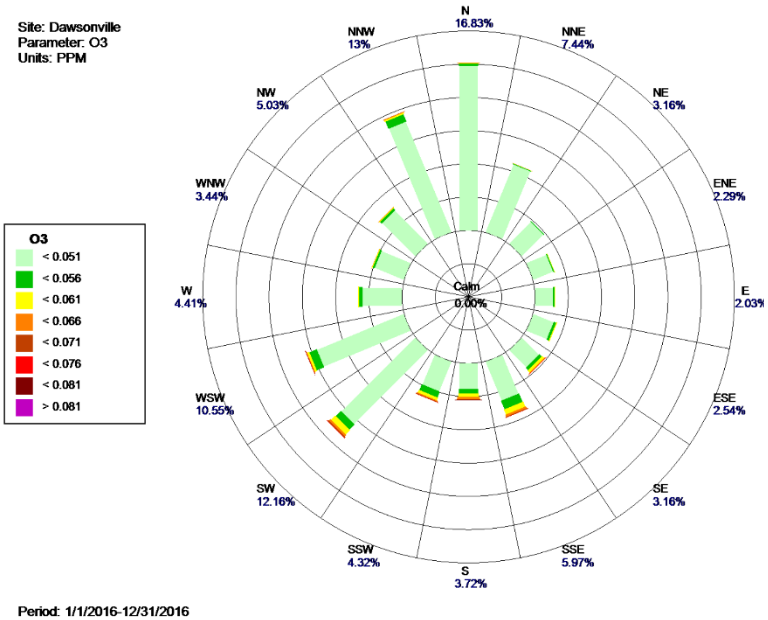
Brunswick, 2016 Annual Ozone



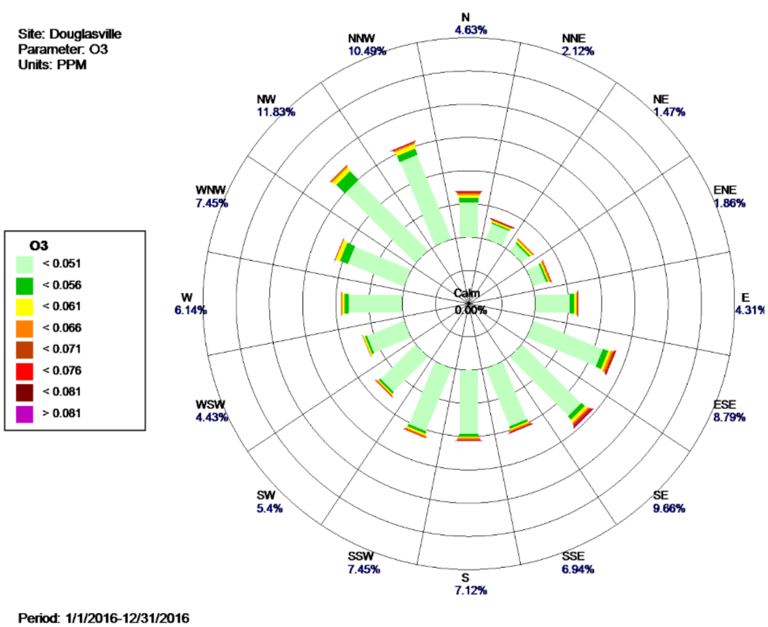
Columbus-Airport, 2016 Annual Ozone



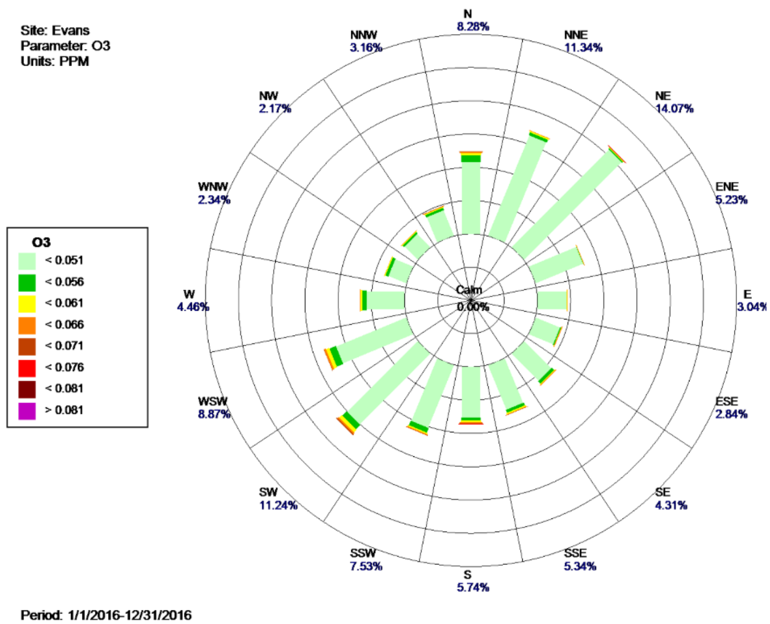
Conyers, 2016 Annual Ozone



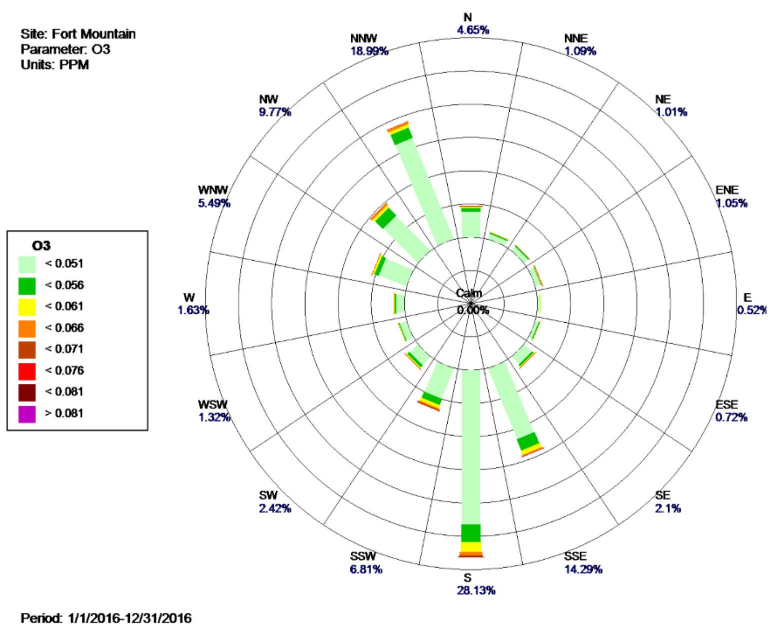
Dawsonville, 2016 Annual Ozone



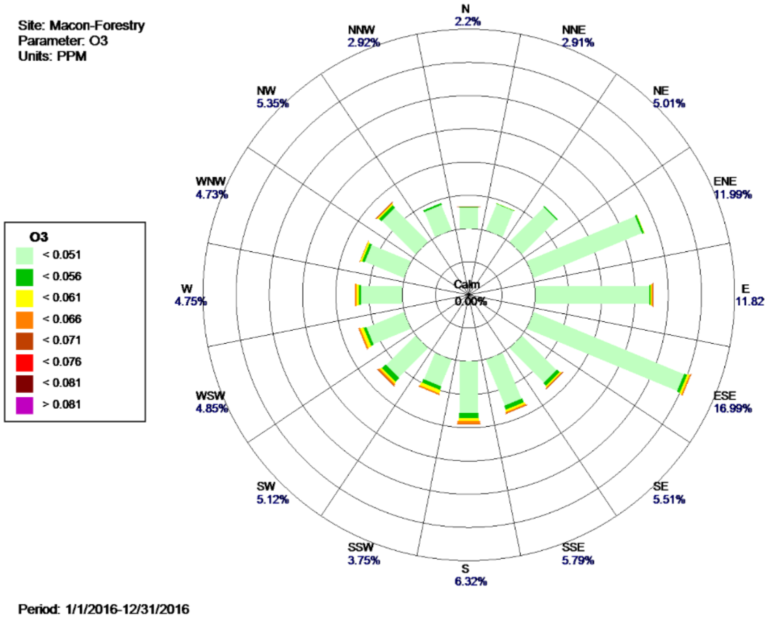
Douglasville, 2016 Annual Ozone



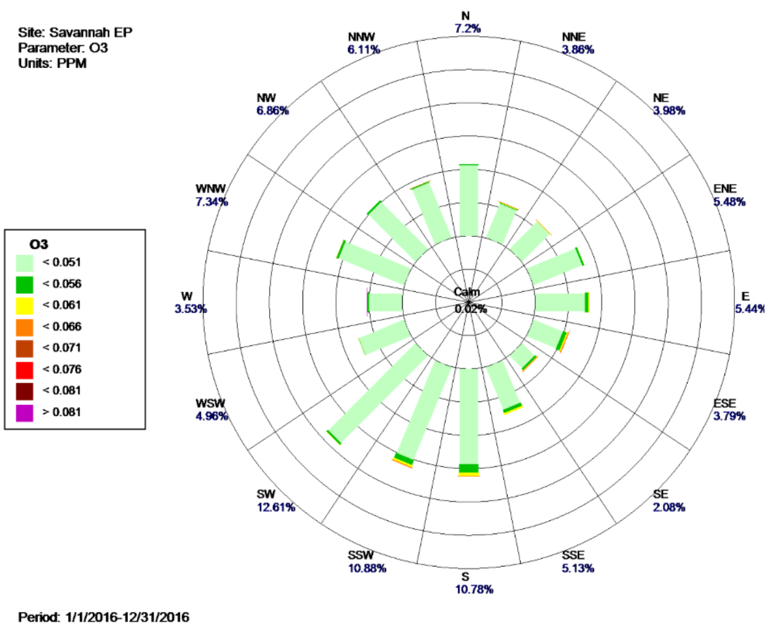
Evans, 2016 Annual Ozone



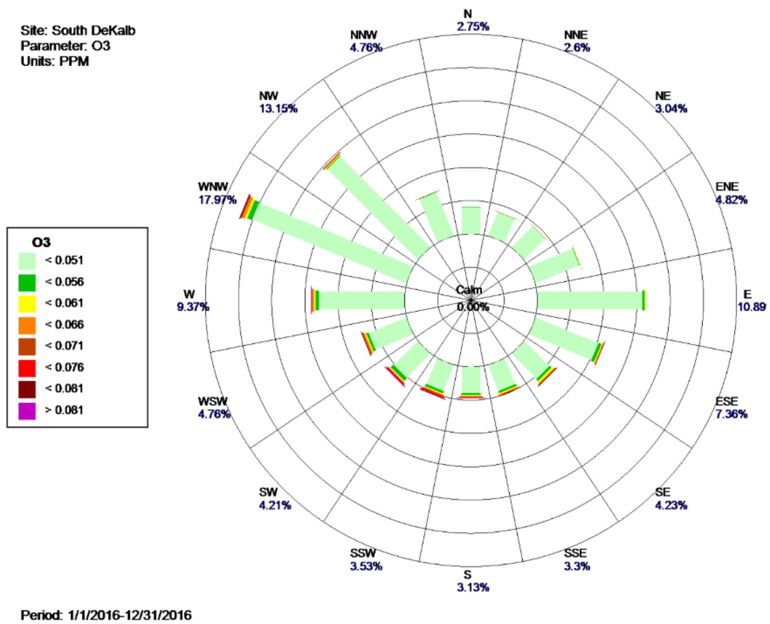
Fort Mountain, 2016 Annual Ozone



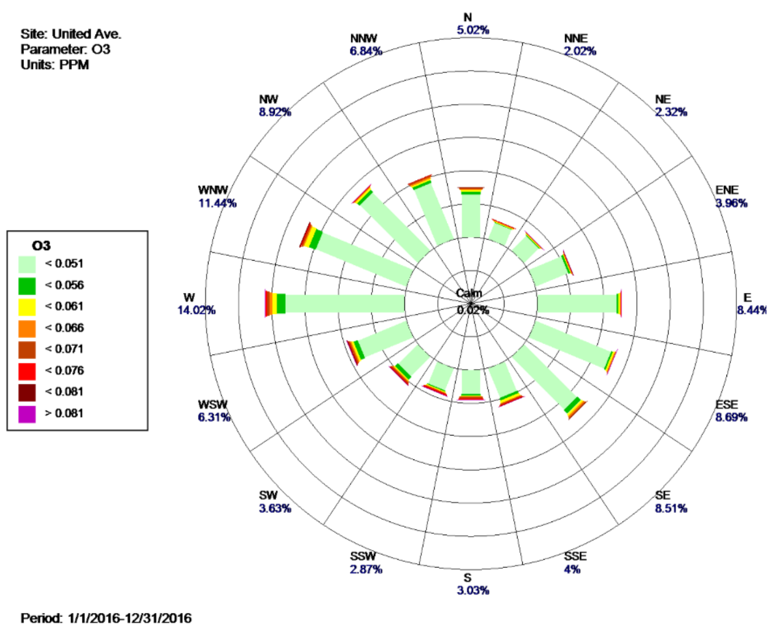
Macon-Forestry, 2016 Annual Ozone



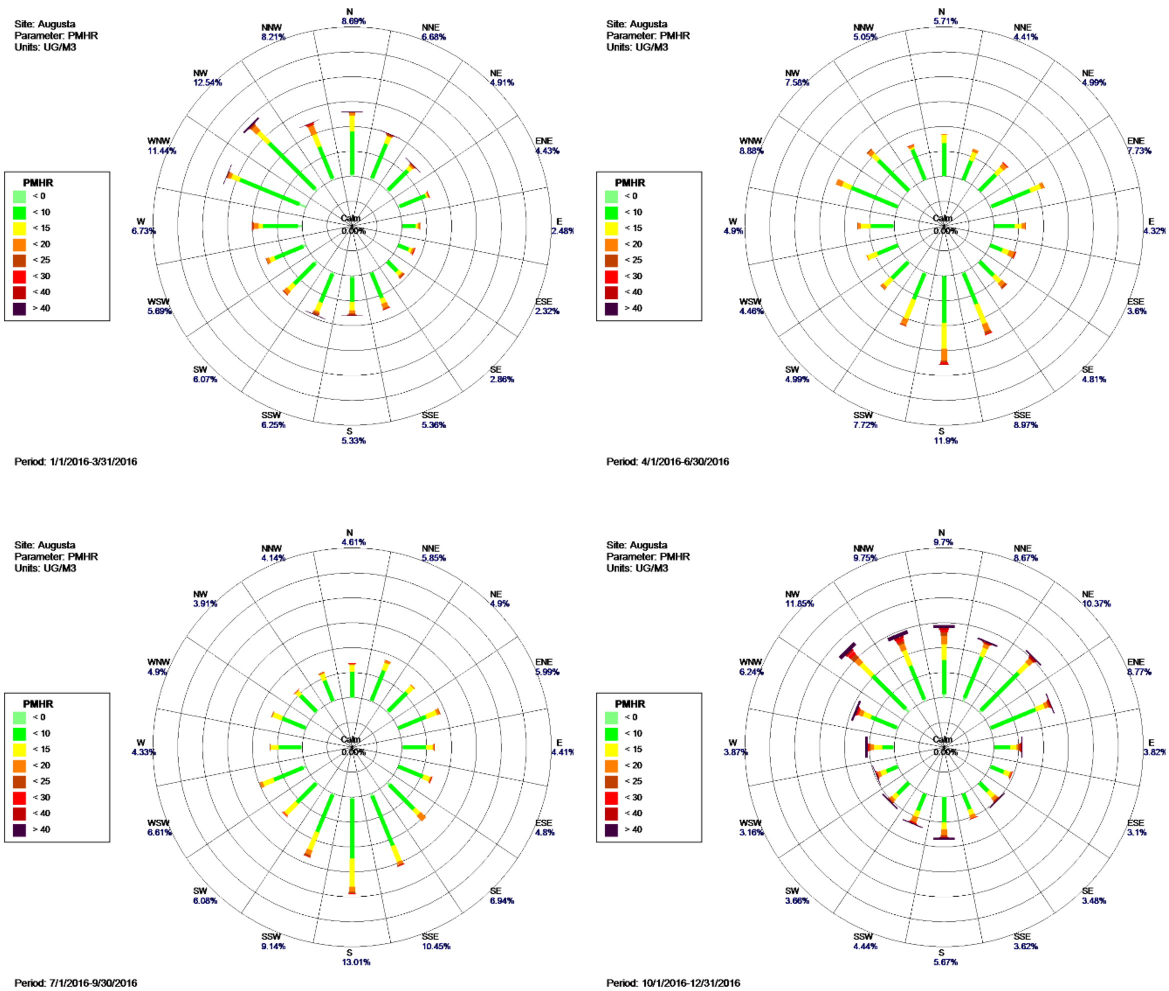
Savannah- E President, 2016 Annual Ozone



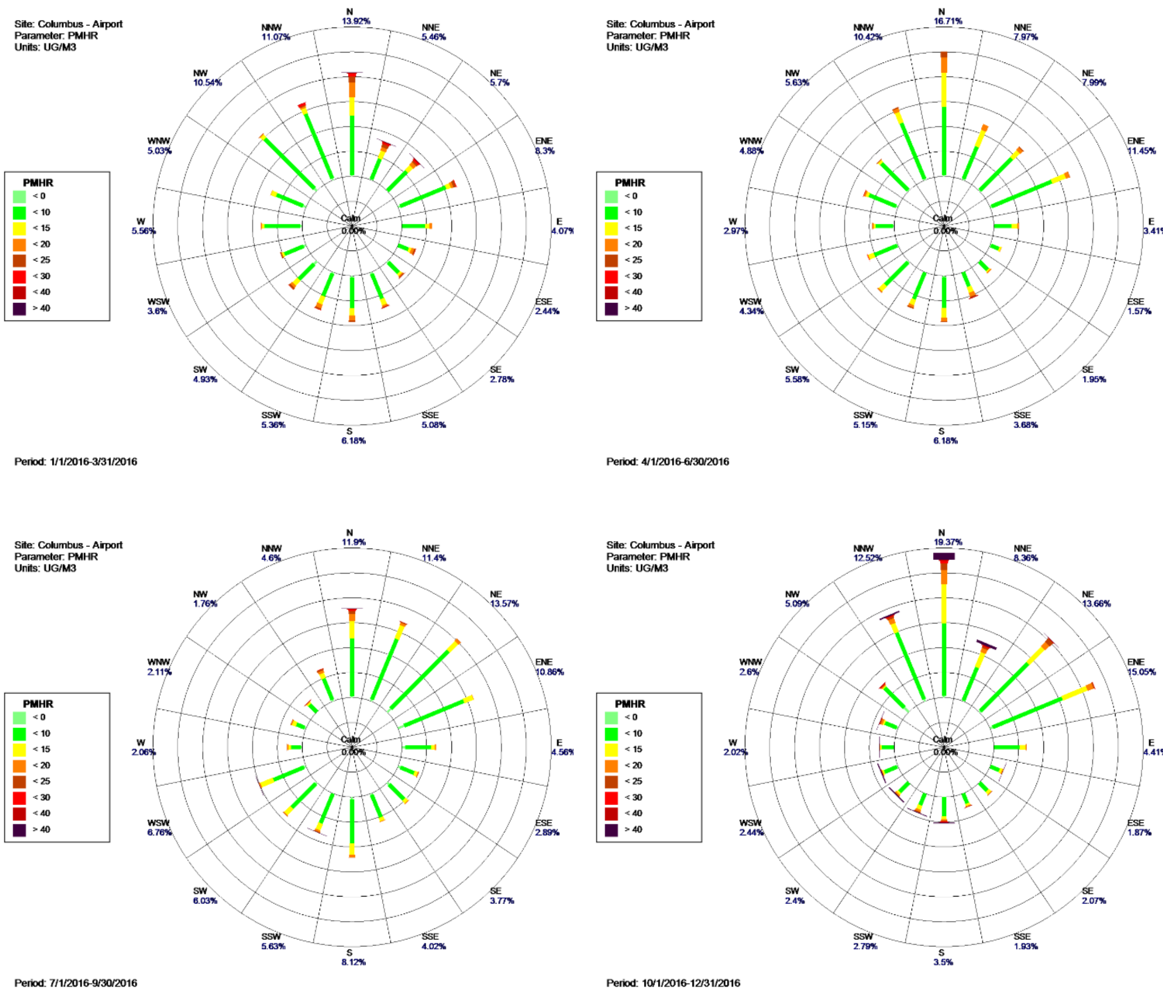
South DeKalb, 2016 Annual Ozone



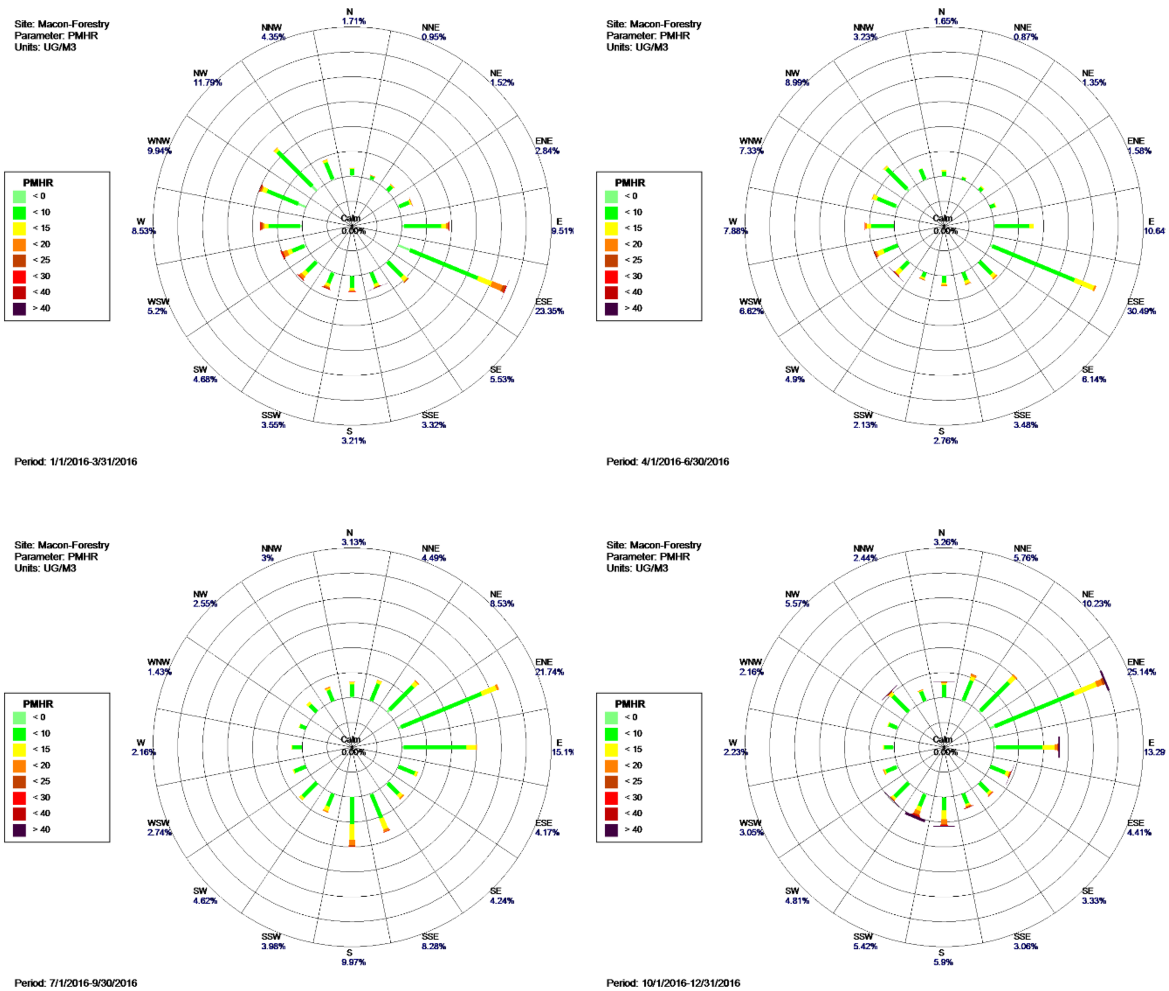
United Ave, 2016 Annual Ozone



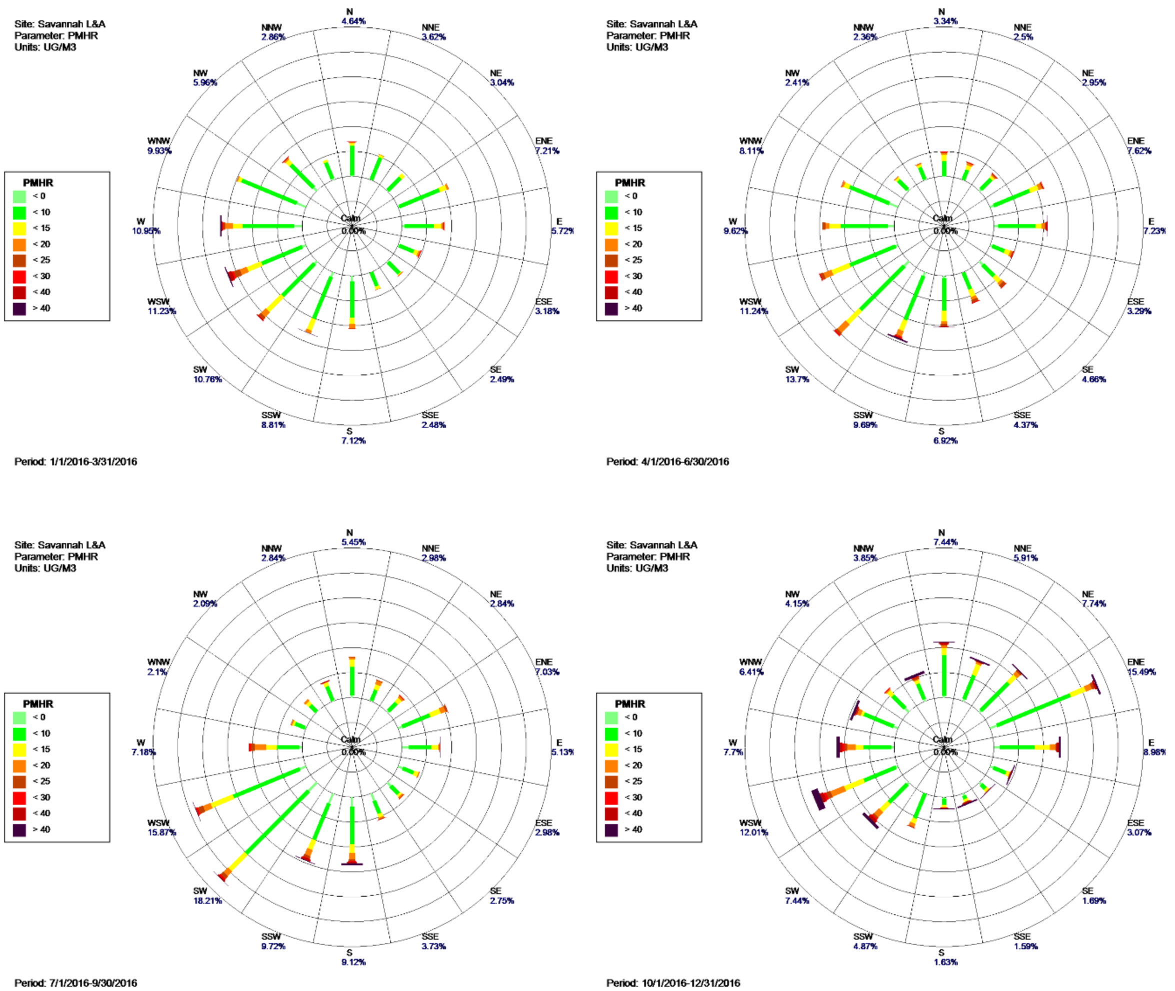
Augusta, 2016 Quarterly $PM_{2.5}$



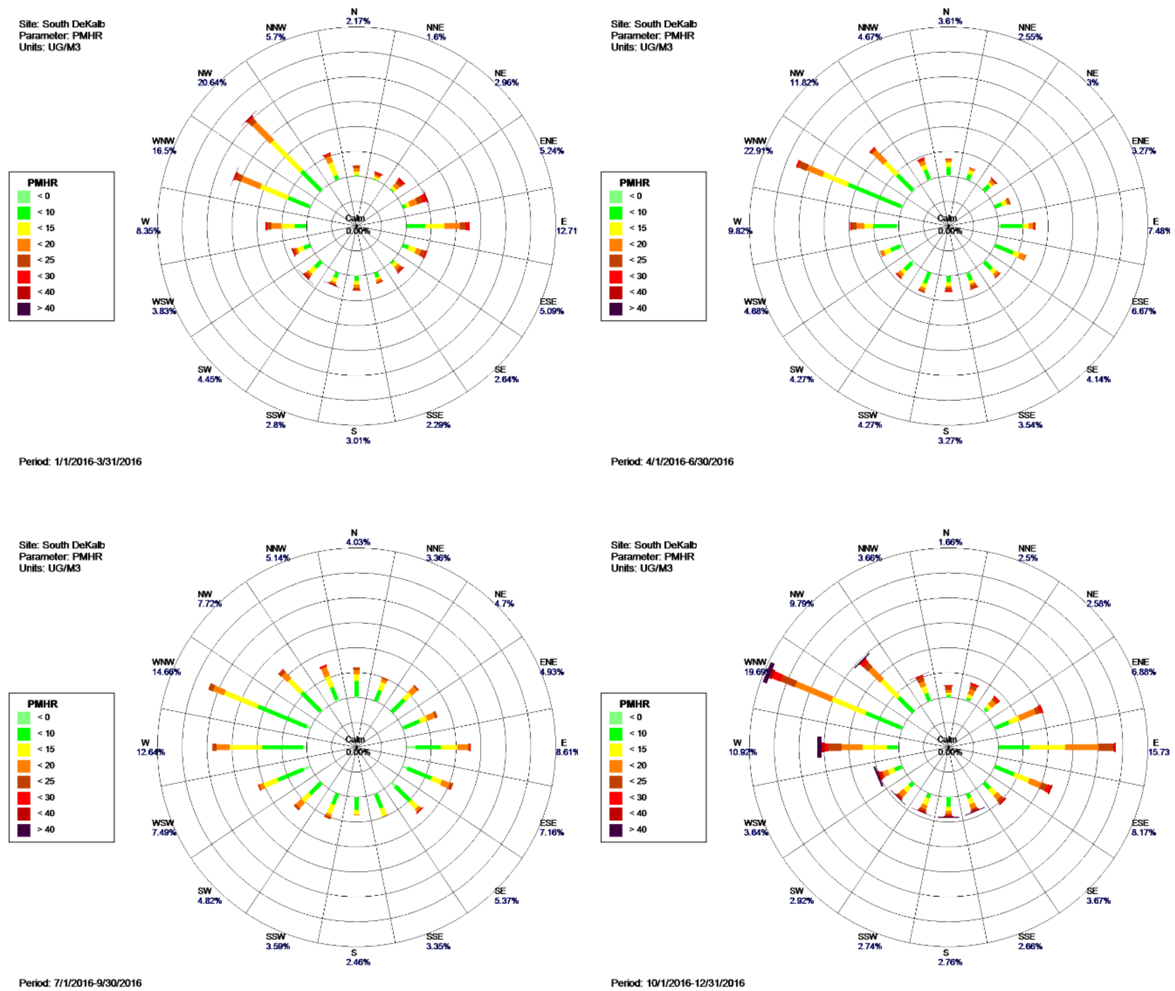
Columbus-Airport, 2016 Quarterly $PM_{2.5}$



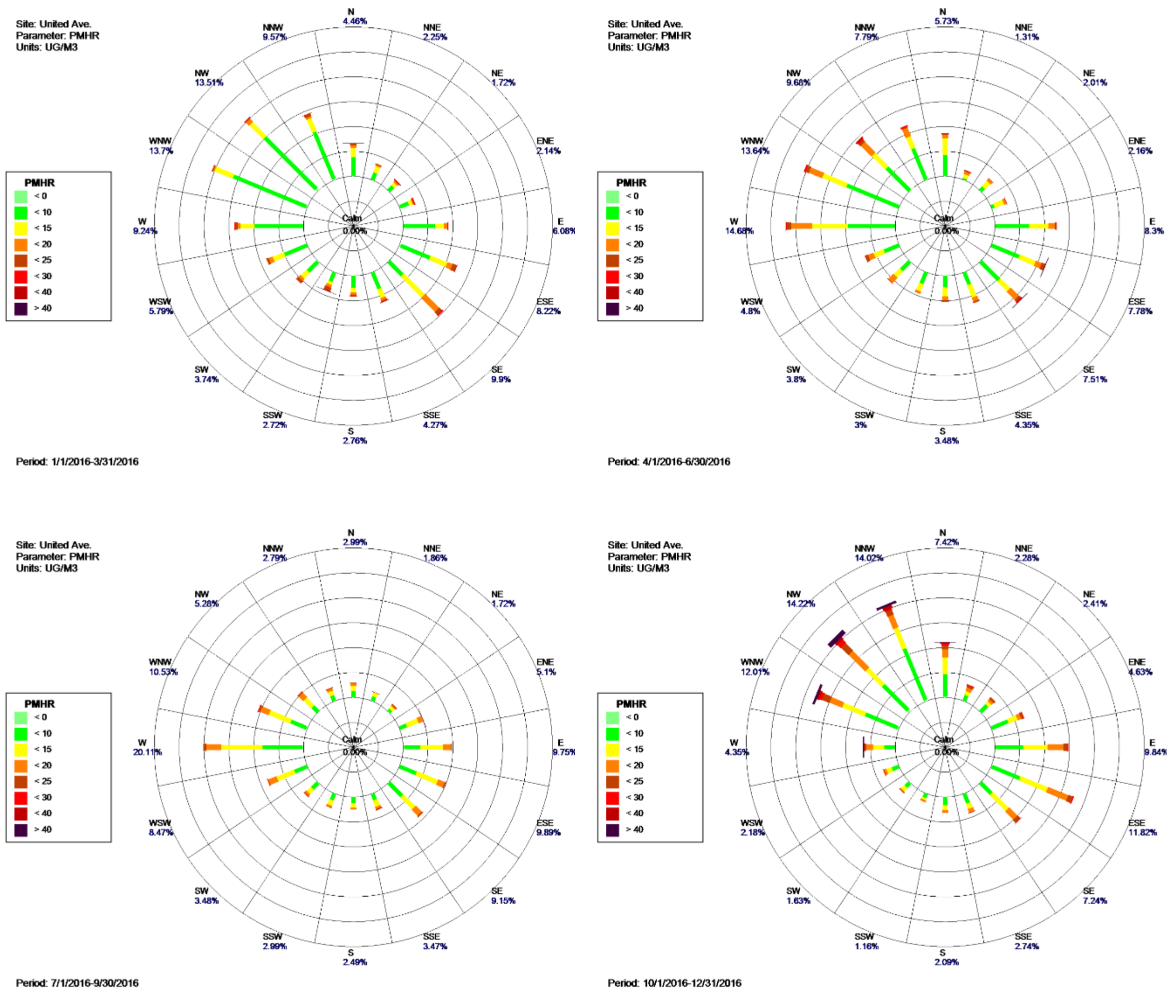
Macon-Forestry, 2016 Quarterly $PM_{2.5}$



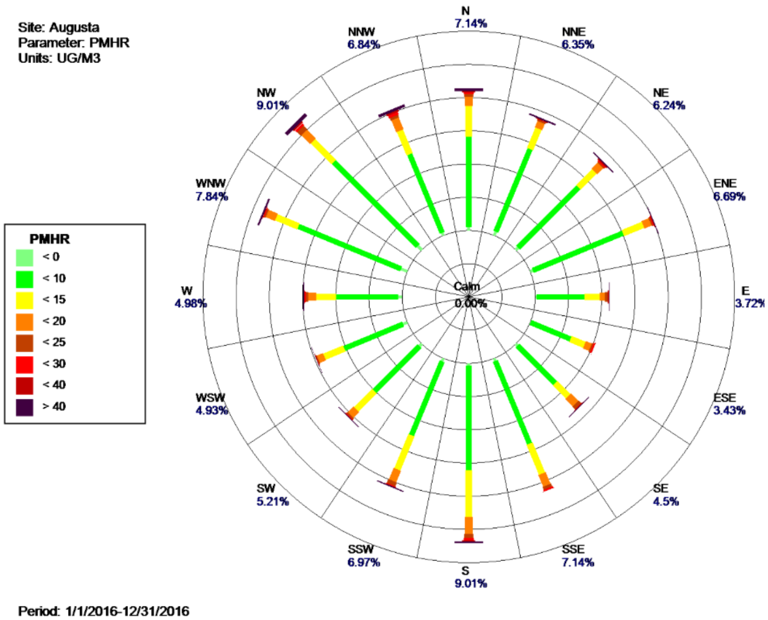
Savannah-L&A, 2016 Quarterly $PM_{2.5}$



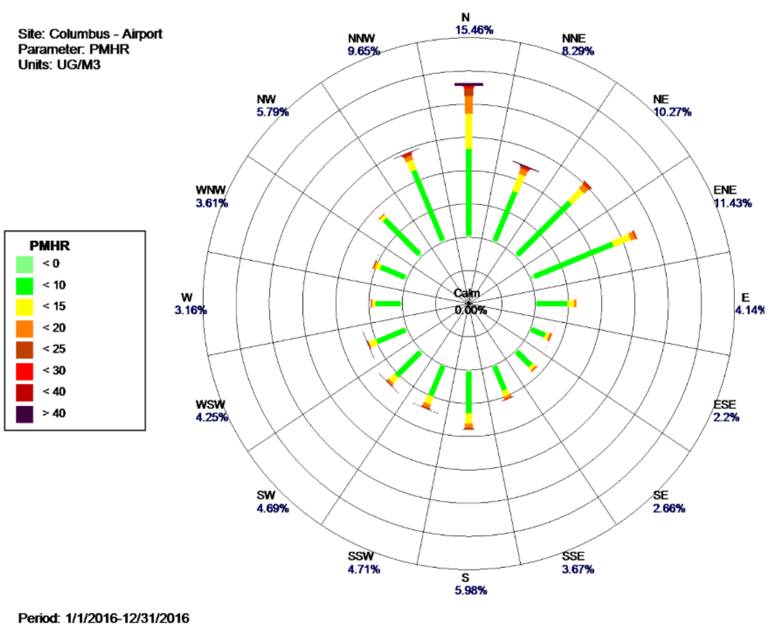
South DeKalb, 2016 Quarterly $PM_{2.5}$



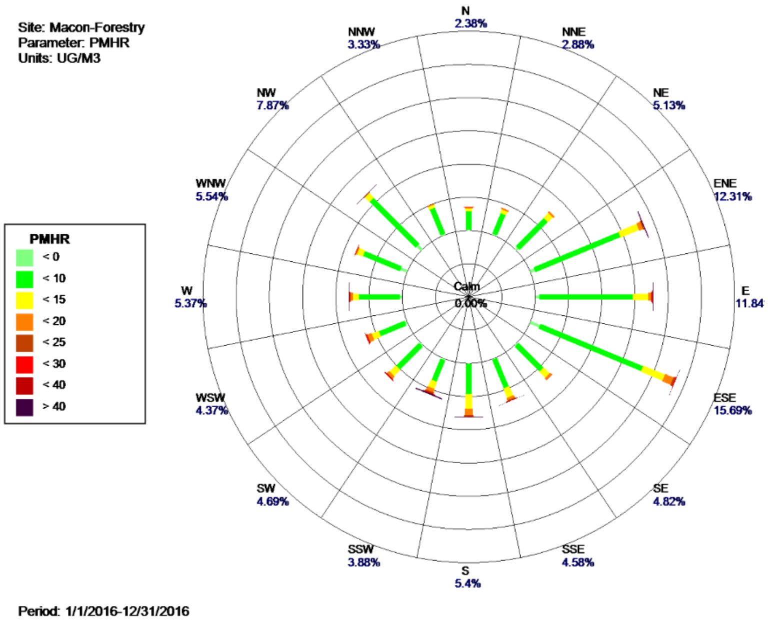
United Ave, 2016 Quarterly $PM_{2.5}$



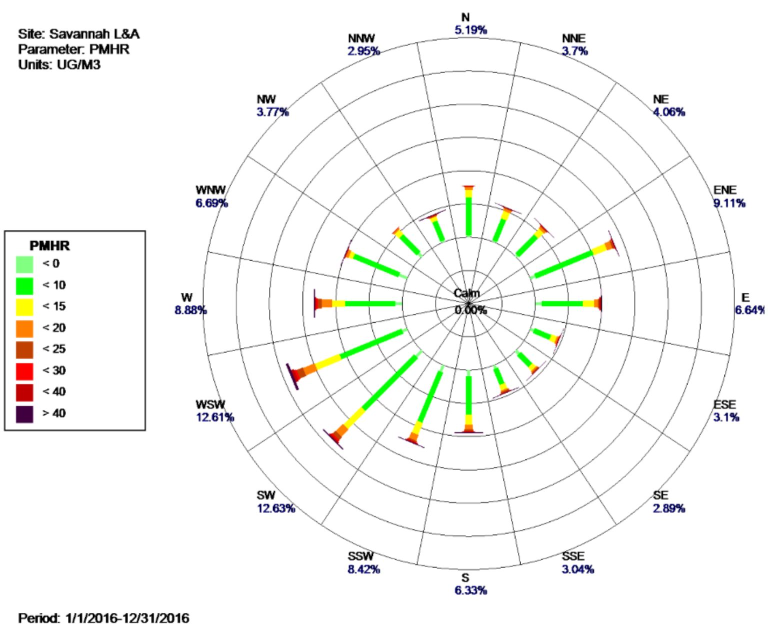
Augusta, 2016 Annual $PM_{2.5}$



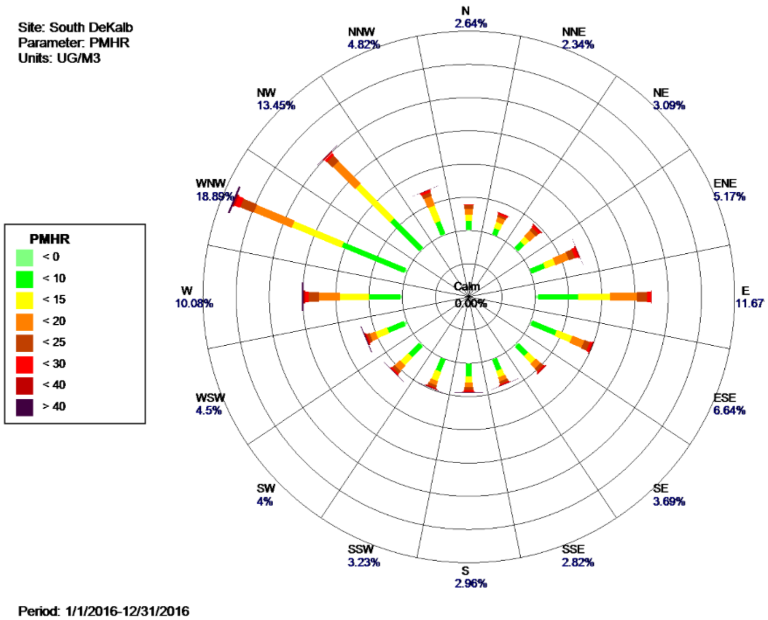
Columbus-Airport, 2016 Annual $PM_{2.5}$



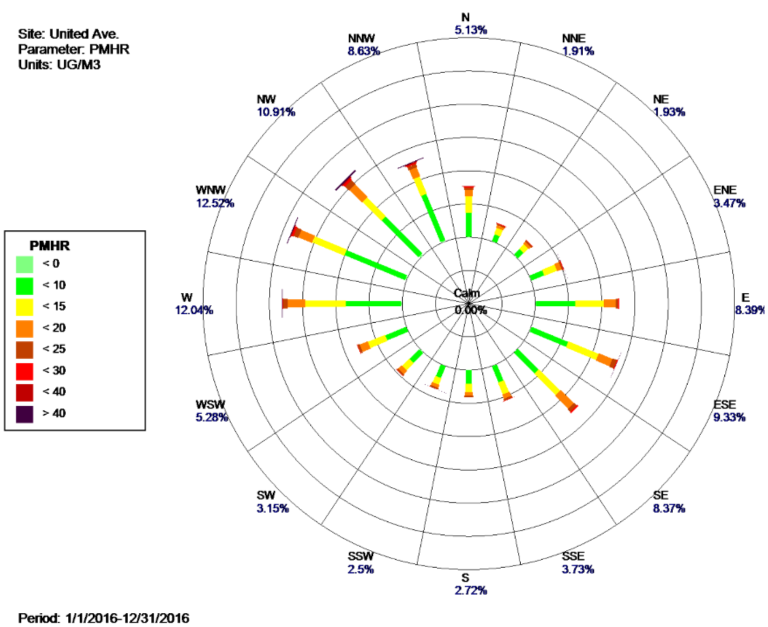
Macon-Forestry, 2016 Annual $PM_{2.5}$



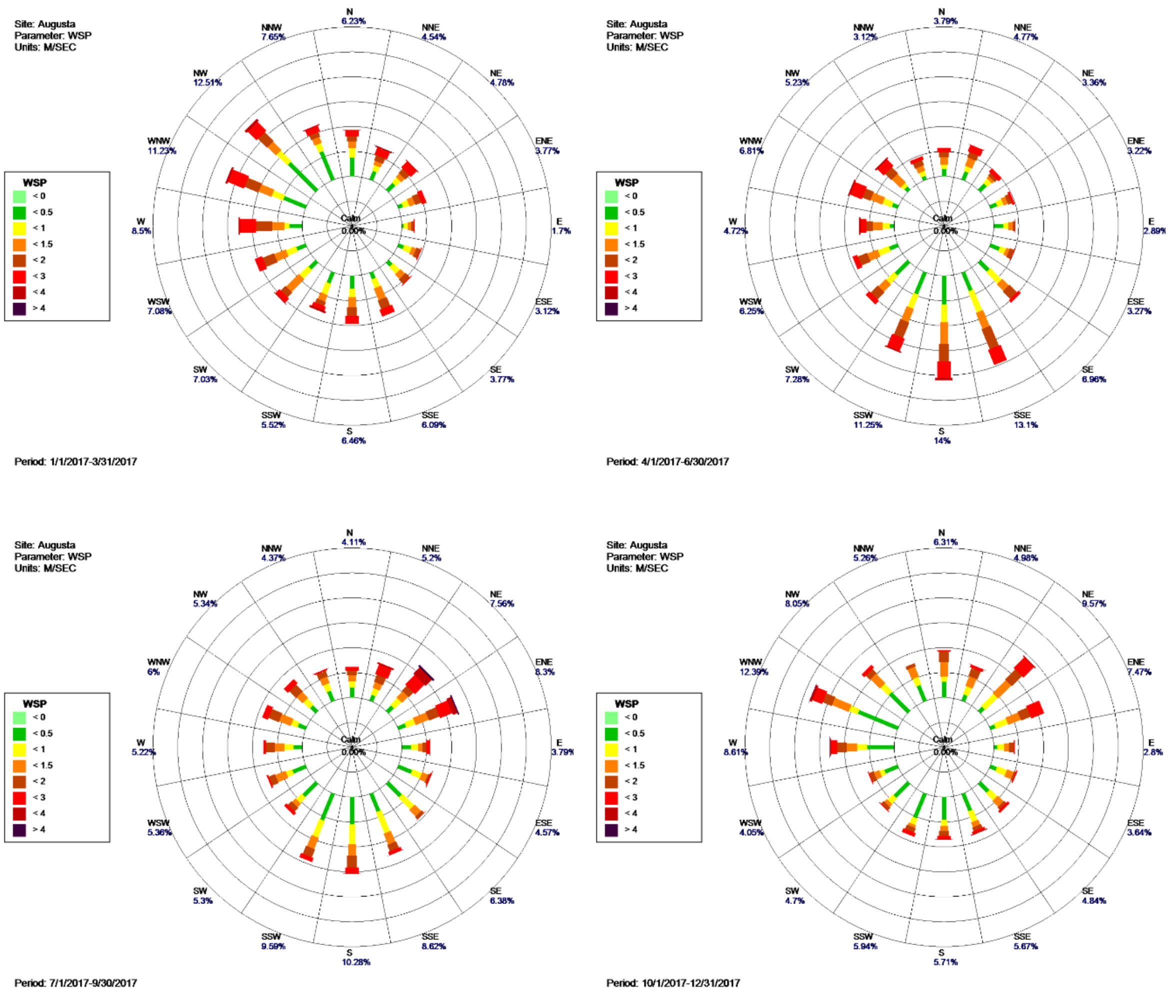
Savannah-L&A, 2016 Annual $PM_{2.5}$



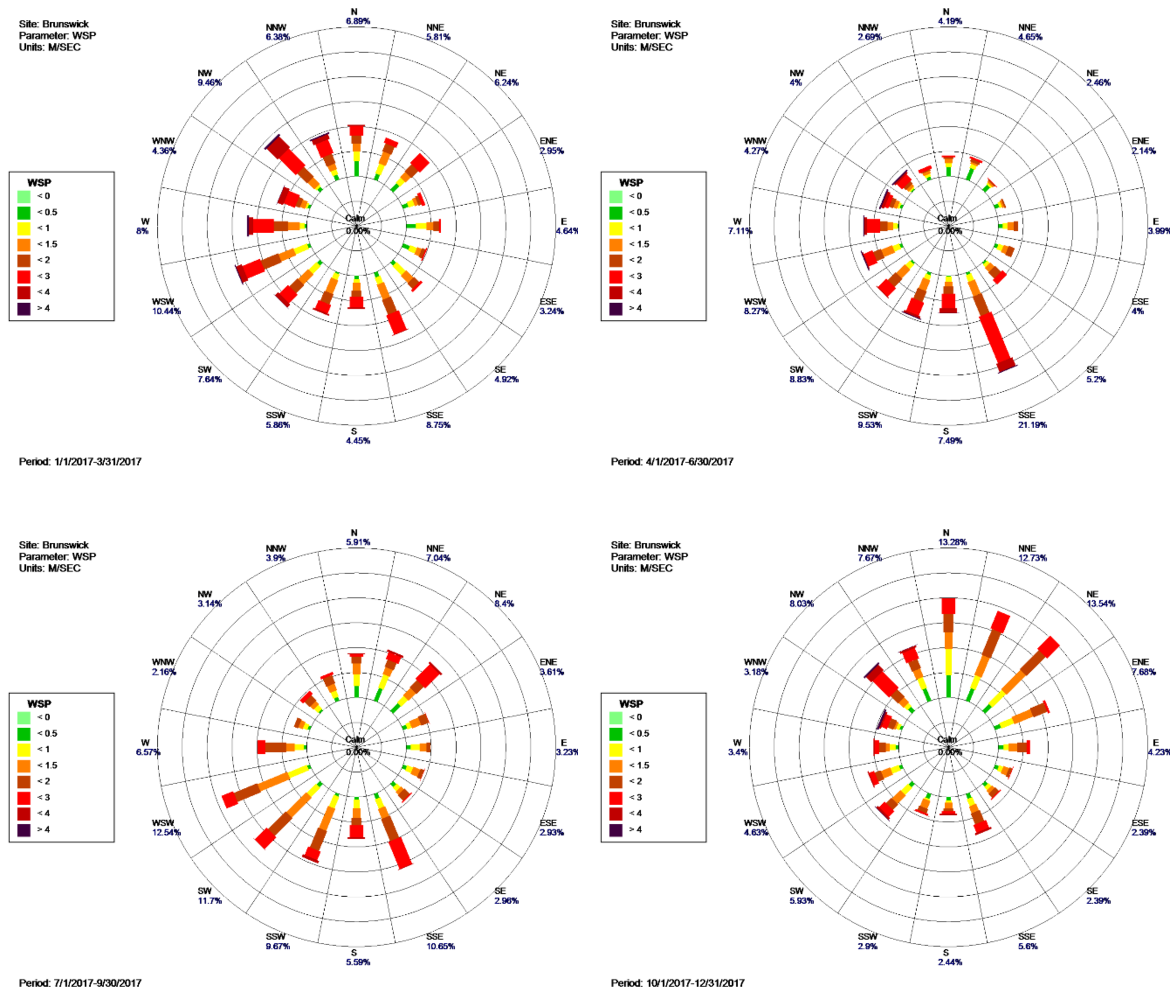
South DeKalb, 2016 Annual $PM_{2.5}$



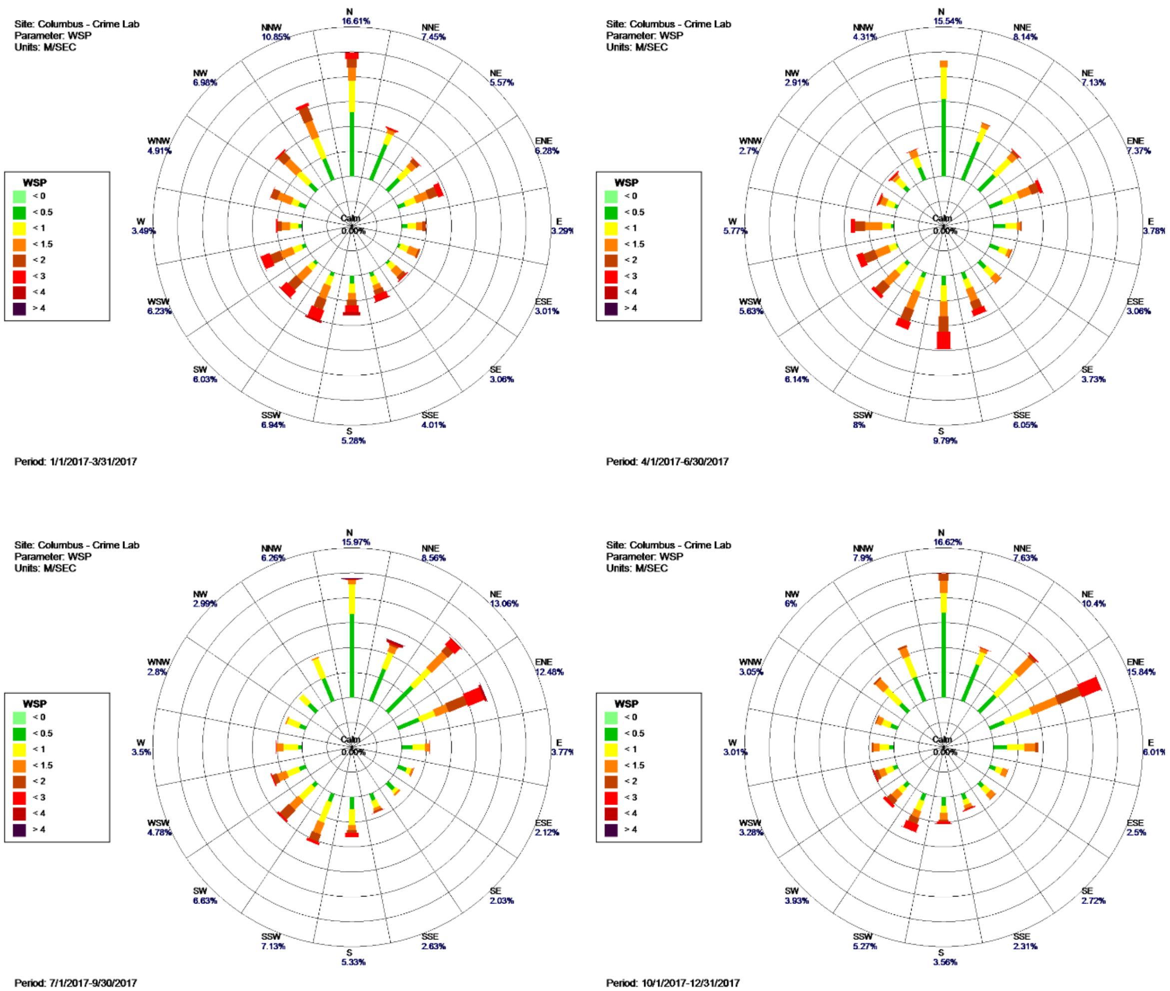
United Ave, 2016 Annual $PM_{2.5}$



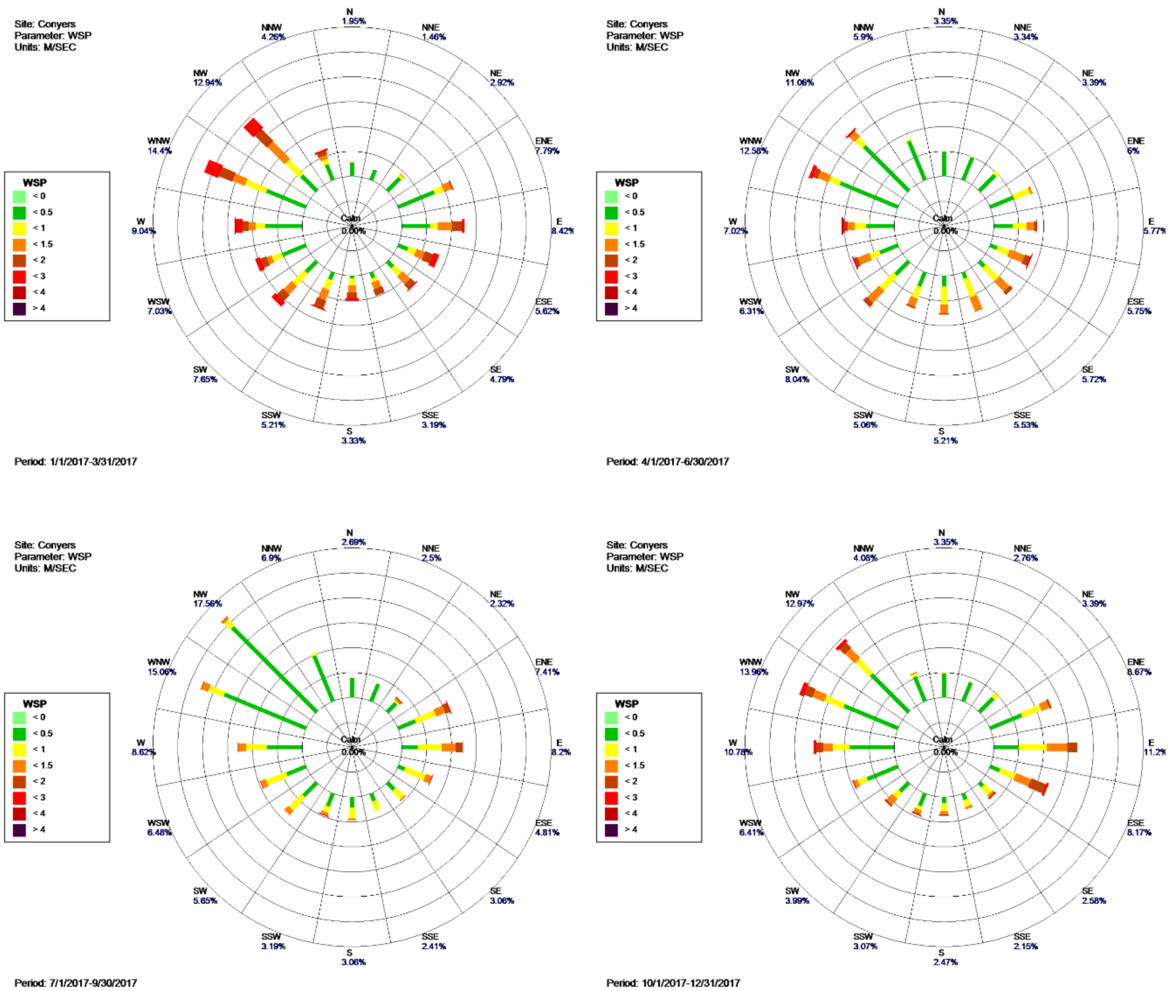
Augusta, 2017 Quarterly Winds



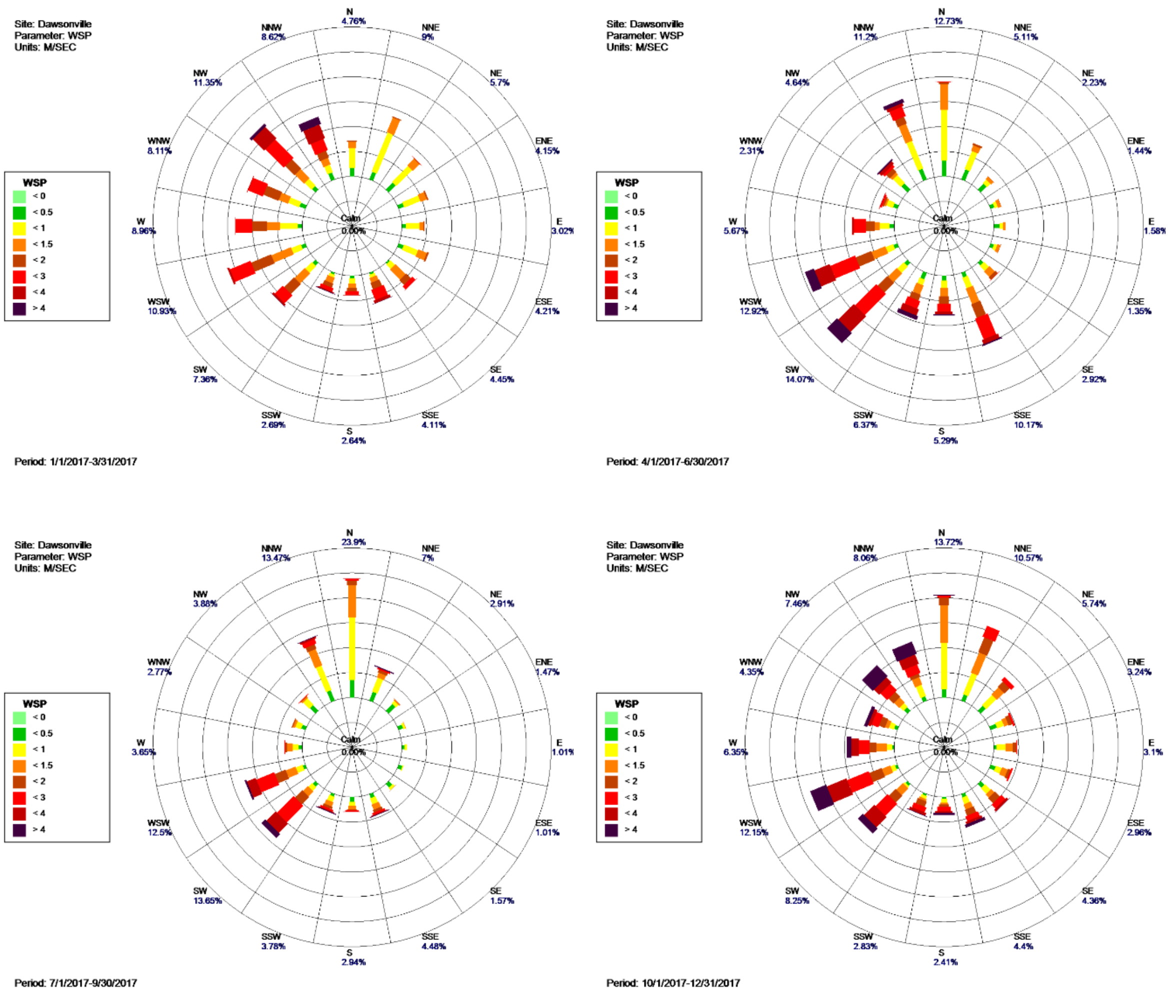
Brunswick, 2017 Quarterly Winds



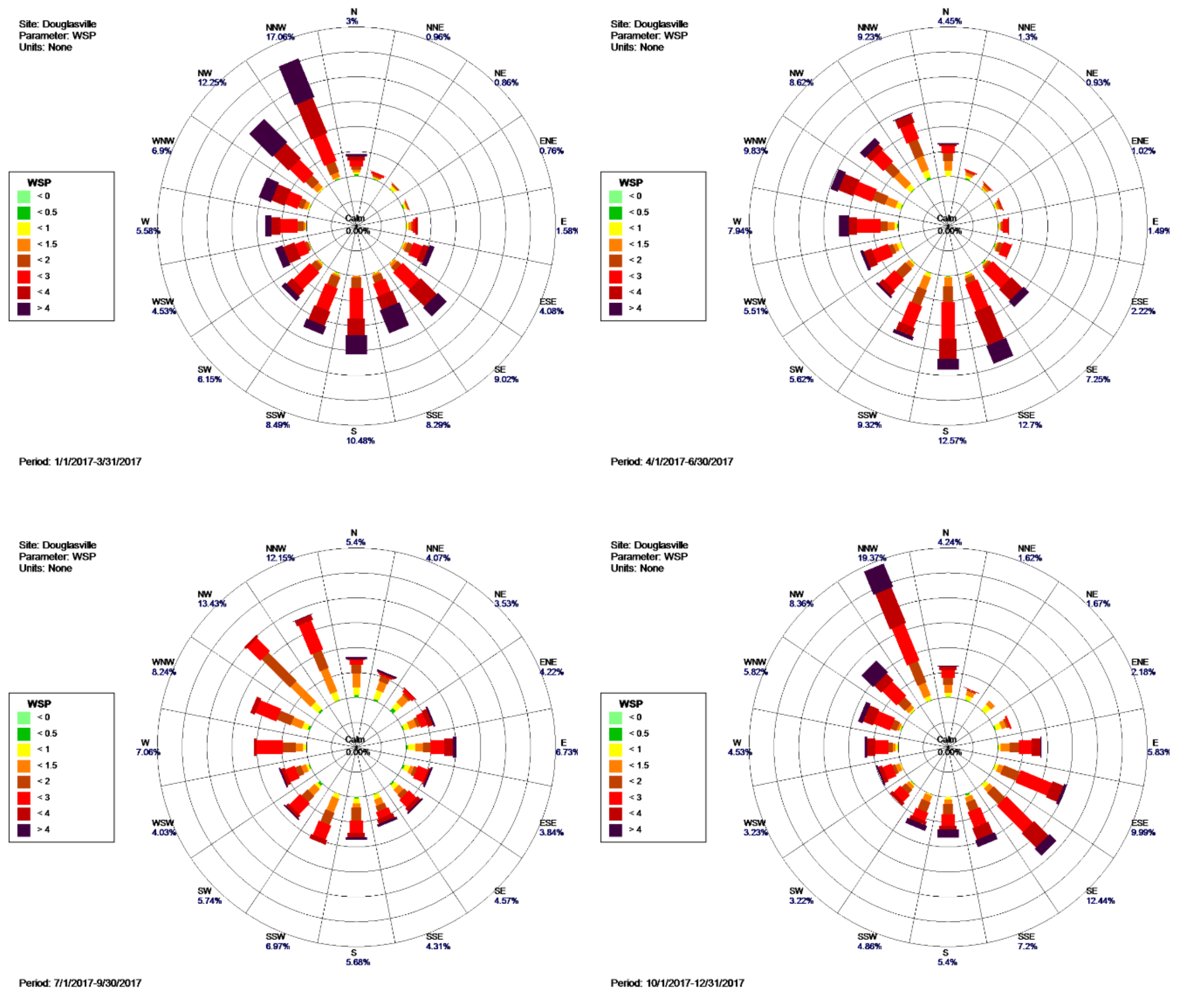
Columbus-Crime Lab, 2017 Quarterly Winds



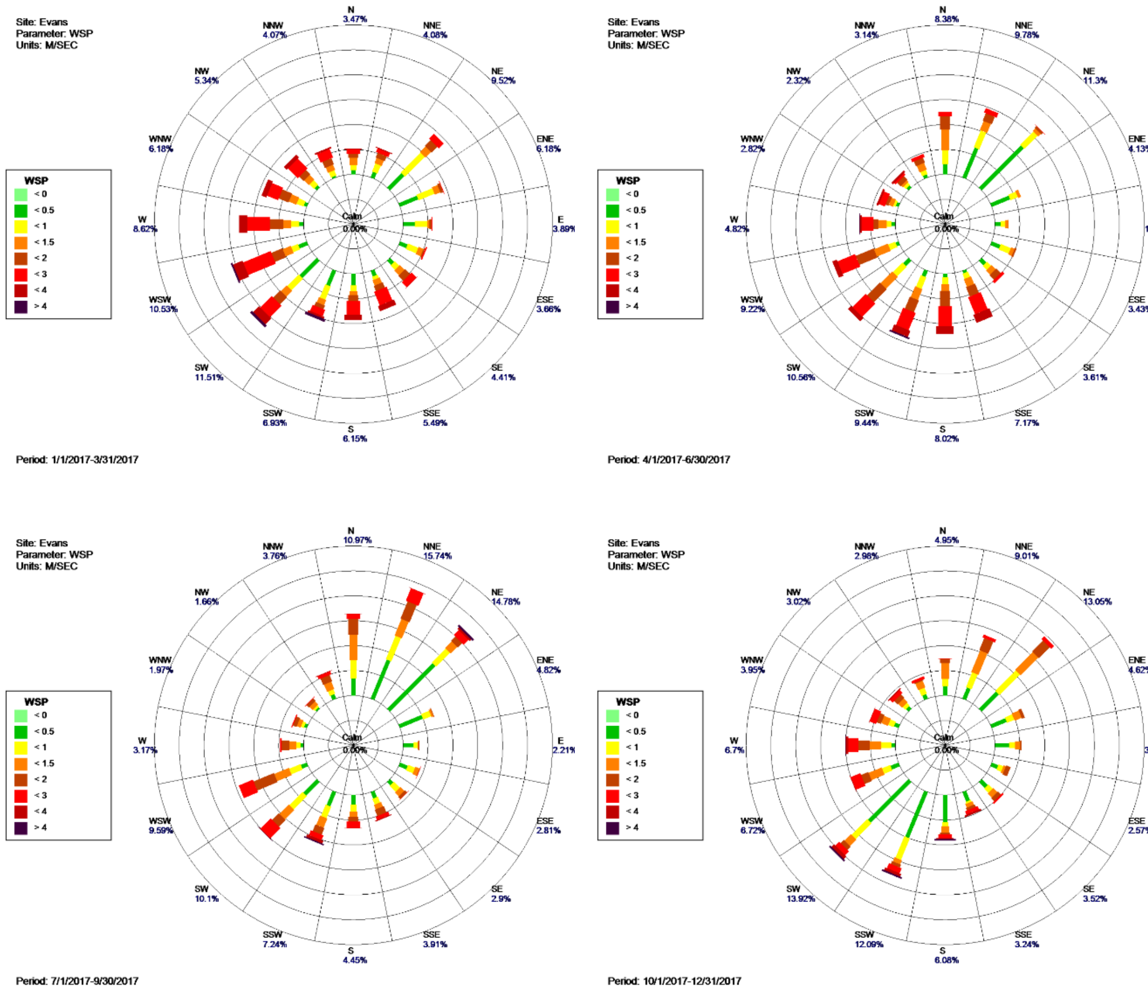
Conyers, 2017 Quarterly Winds



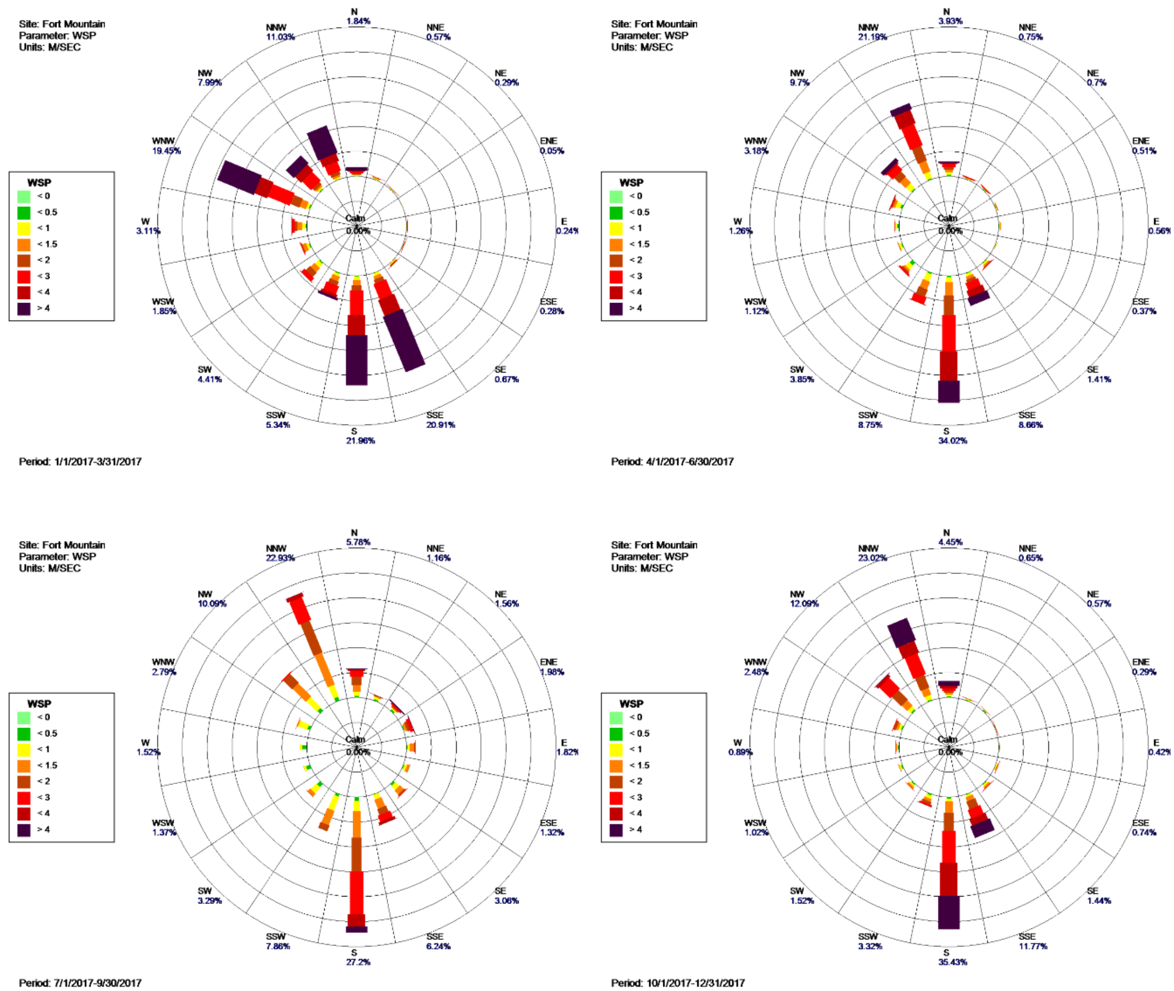
Dawsonville, 2017 Quarterly Winds



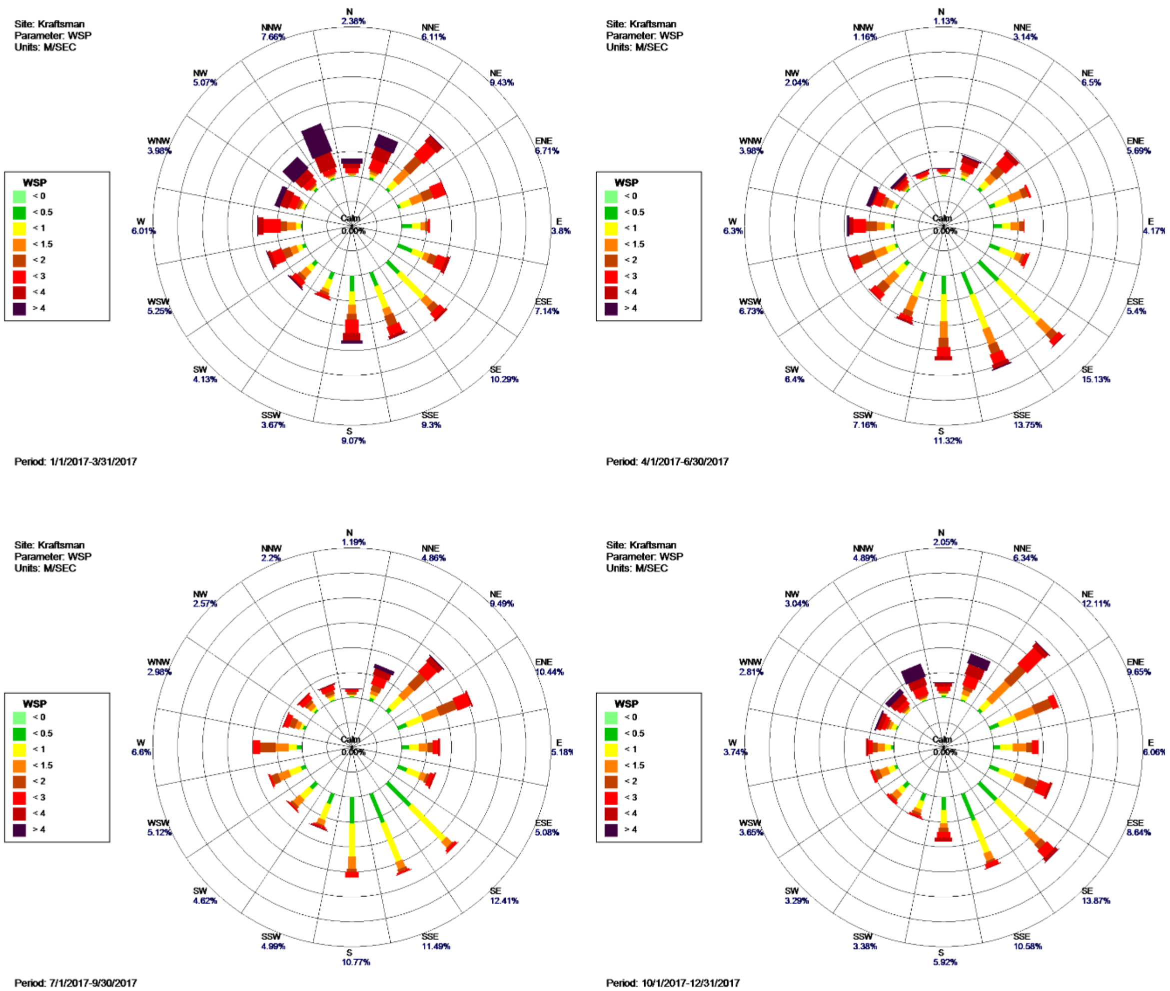
Douglasville, 2017 Quarterly Winds



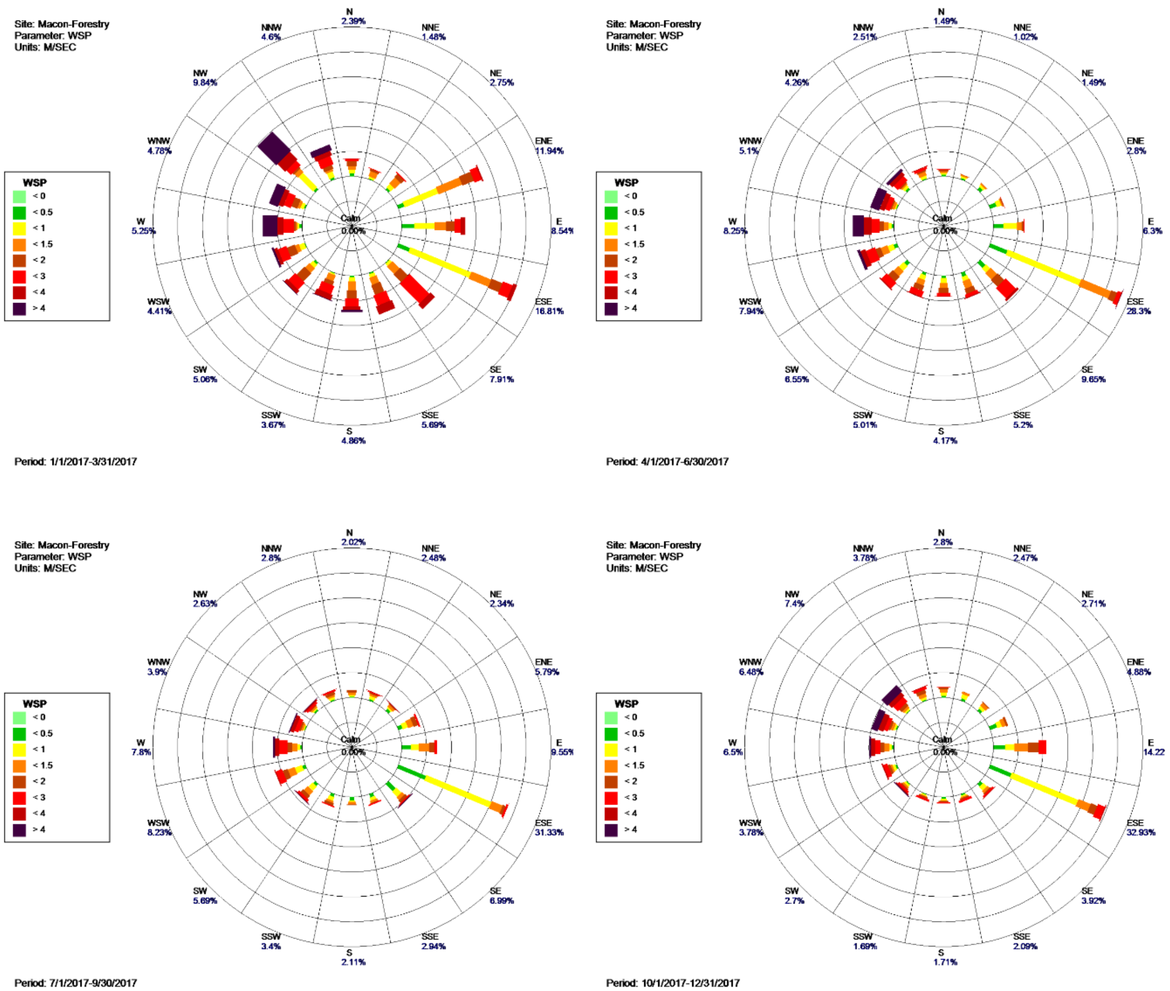
Evans, 2017 Quarterly Winds



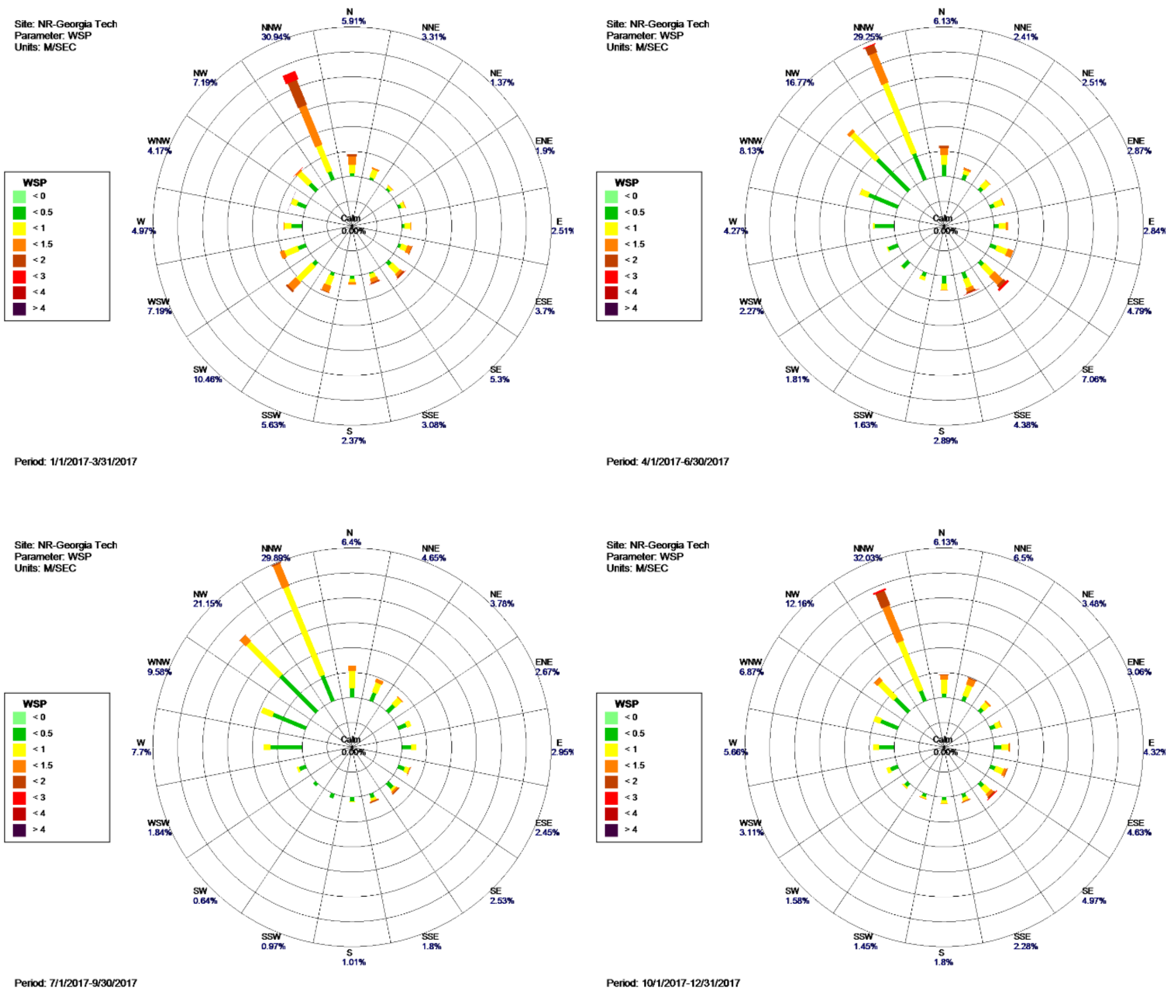
Fort Mountain, 2017 Quarterly Winds



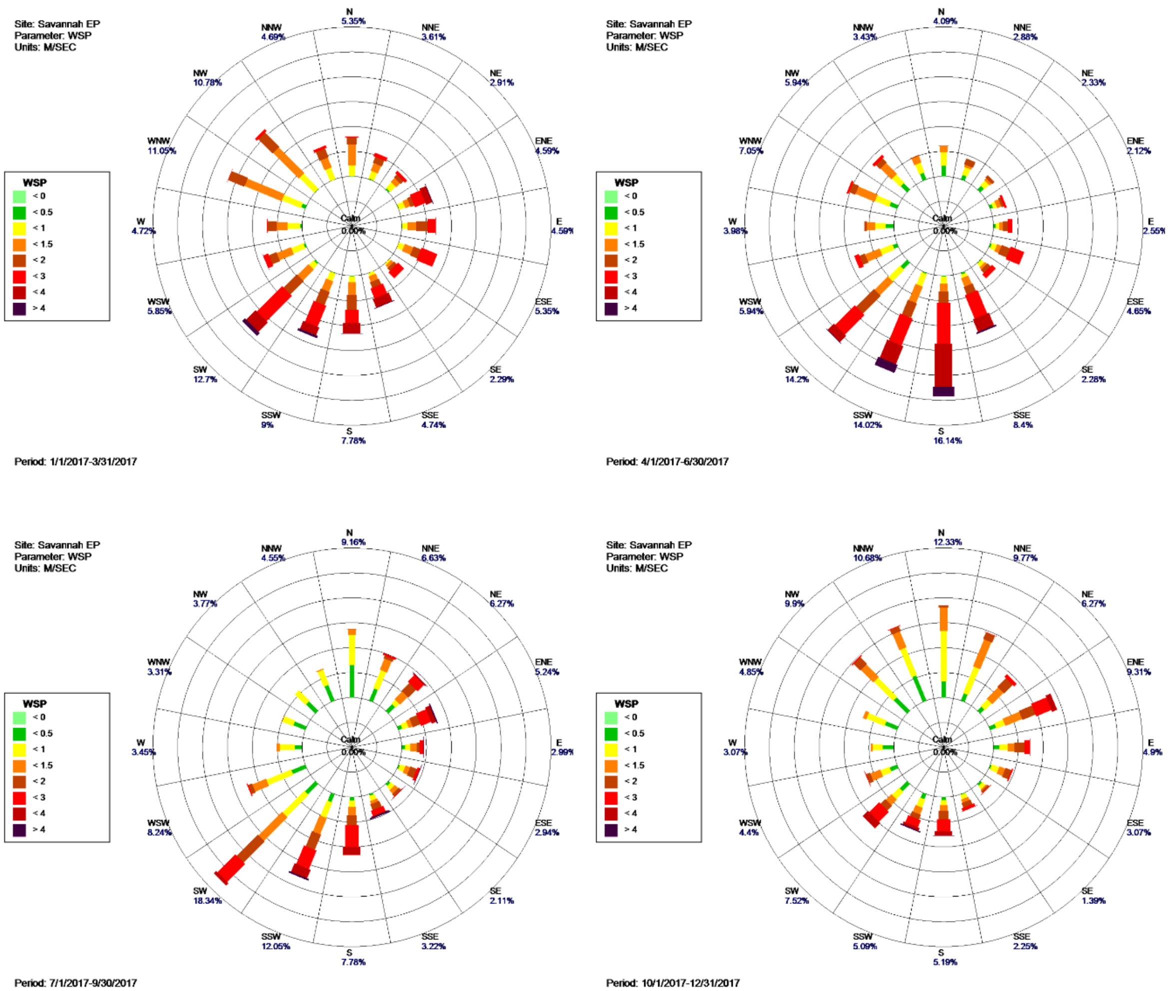
Kraftsman, 2017 Quarterly Winds



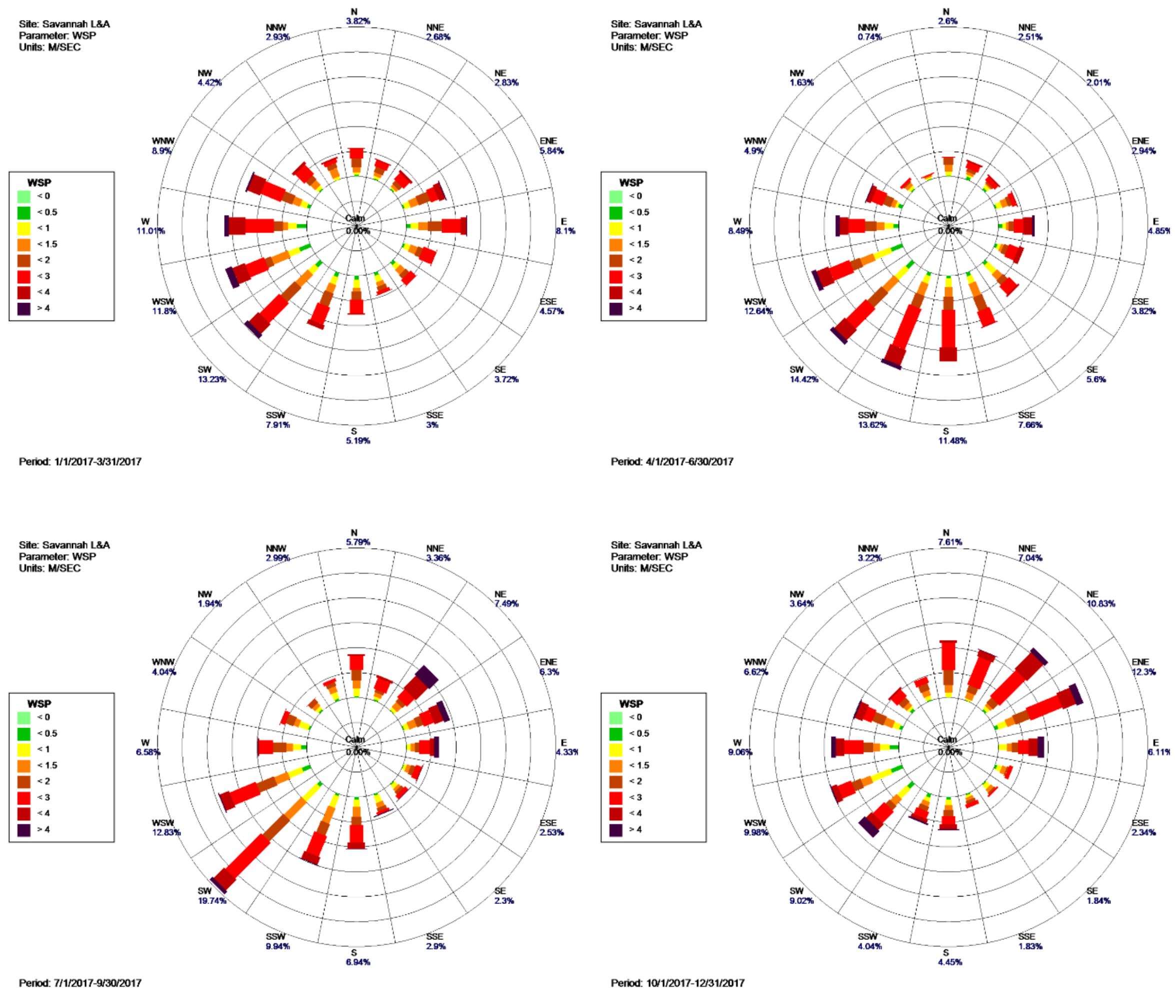
Macon-Forestry, 2017 Quarterly Winds



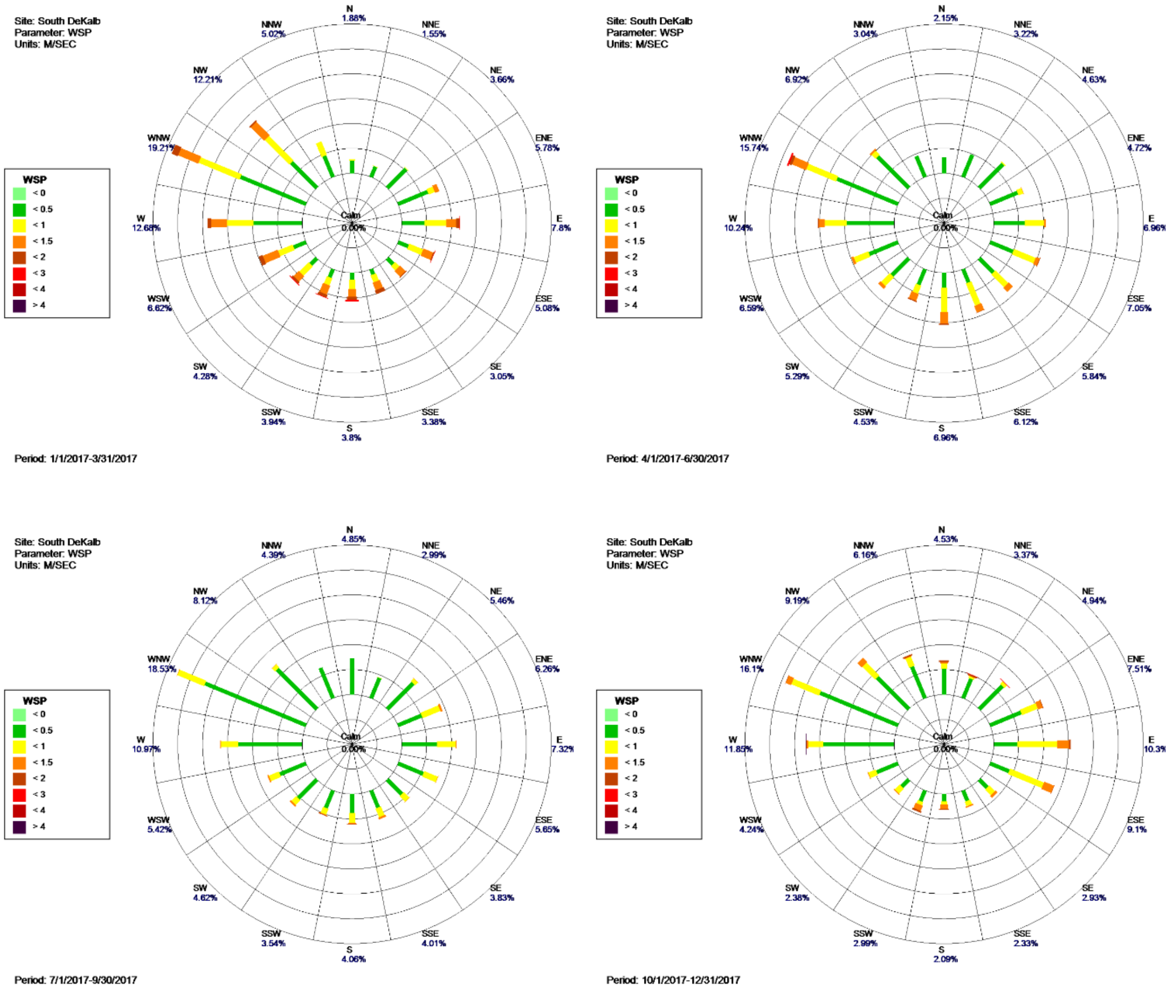
NR-GA Tech, 2017 Quarterly Winds



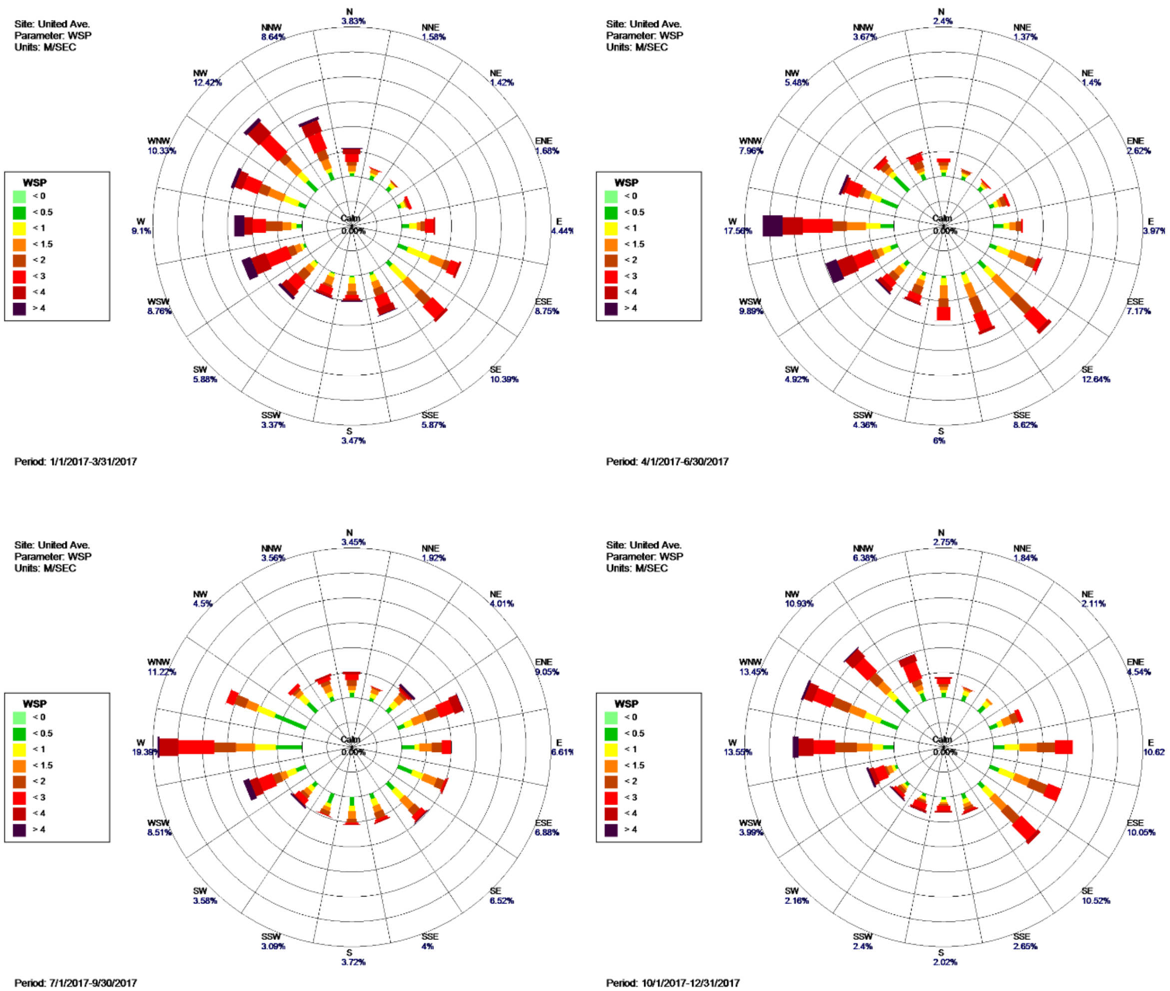
Savannah- E President, 2017 Quarterly Winds



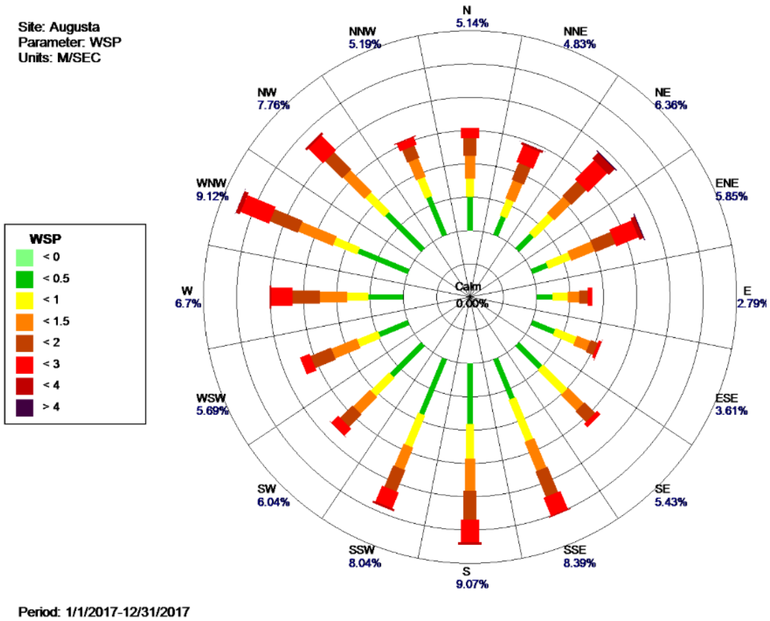
Savannah- L&A, 2017 Quarterly Winds



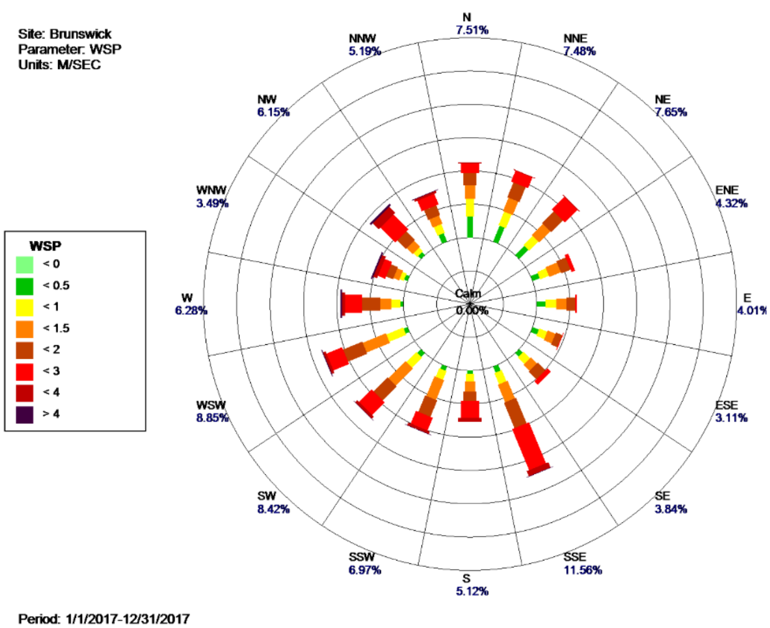
South DeKalb, 2017 Quarterly Winds



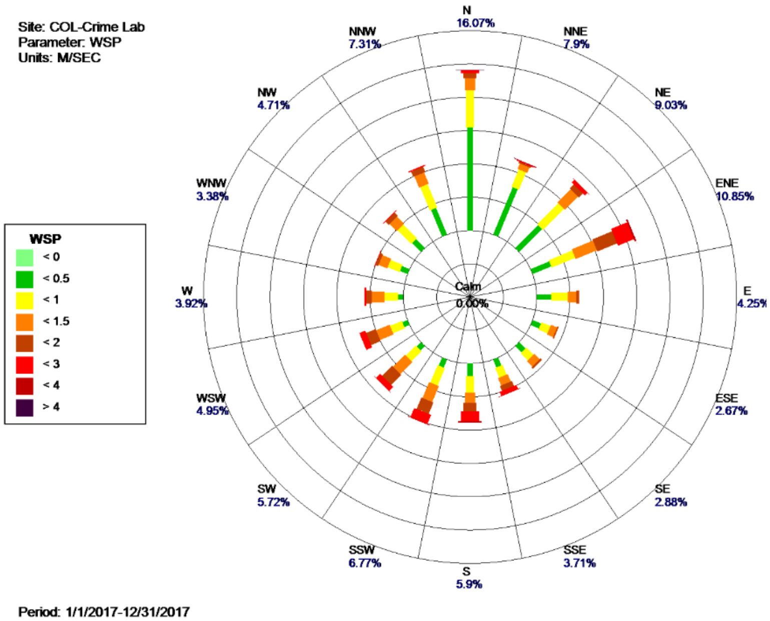
United Ave, 2017 Quarterly Winds



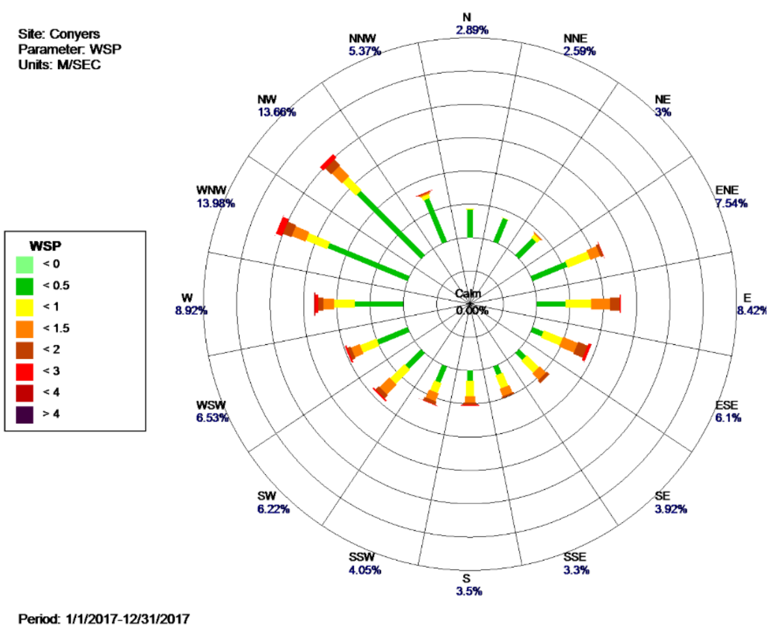
Augusta, 2017 Annual Winds



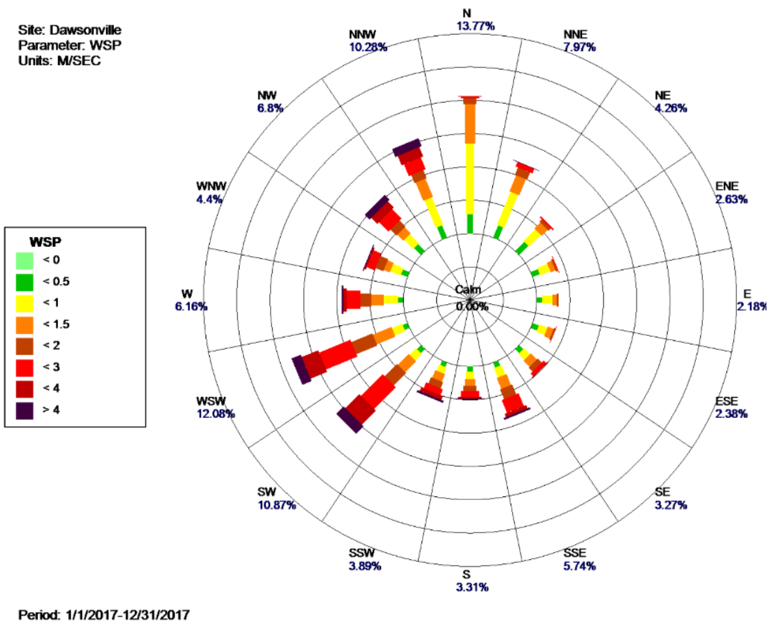
Brunswick, 2017 Annual Winds



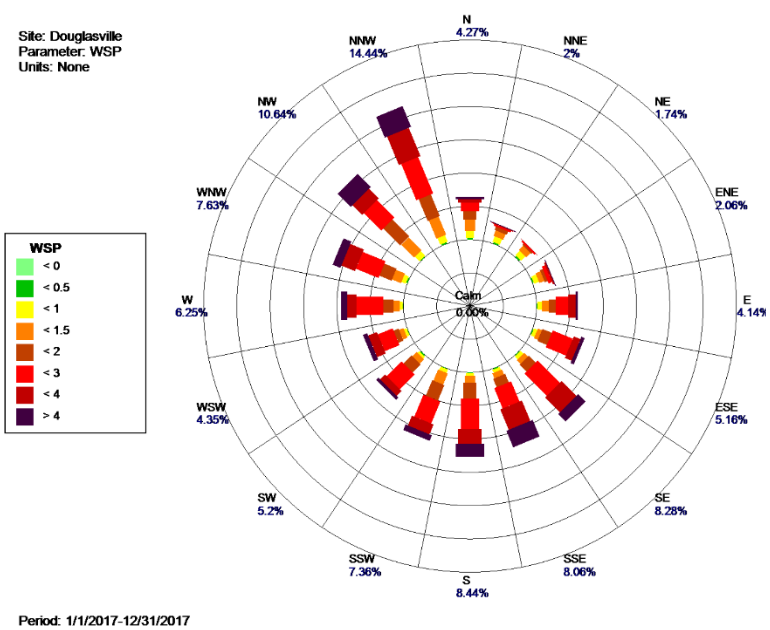
Columbus-Crime Lab, 2017 Annual Winds



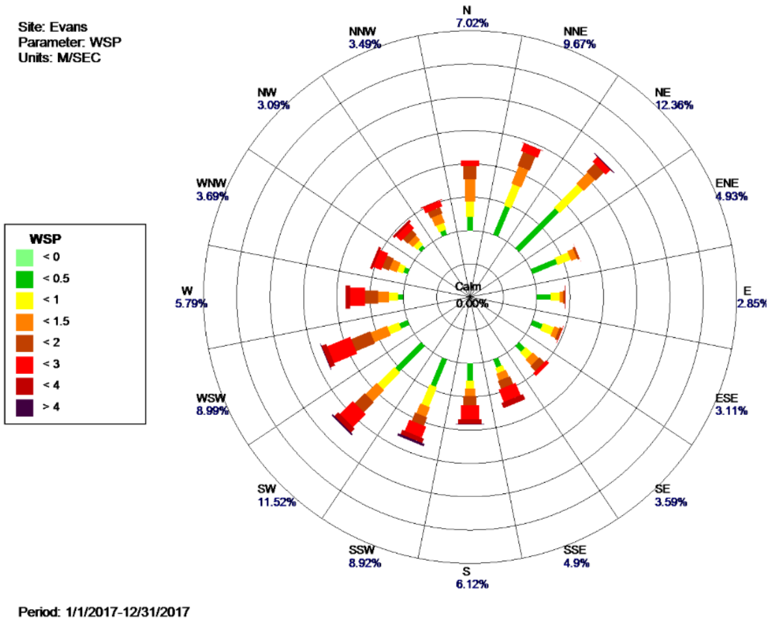
Conyers, 2017 Annual Winds



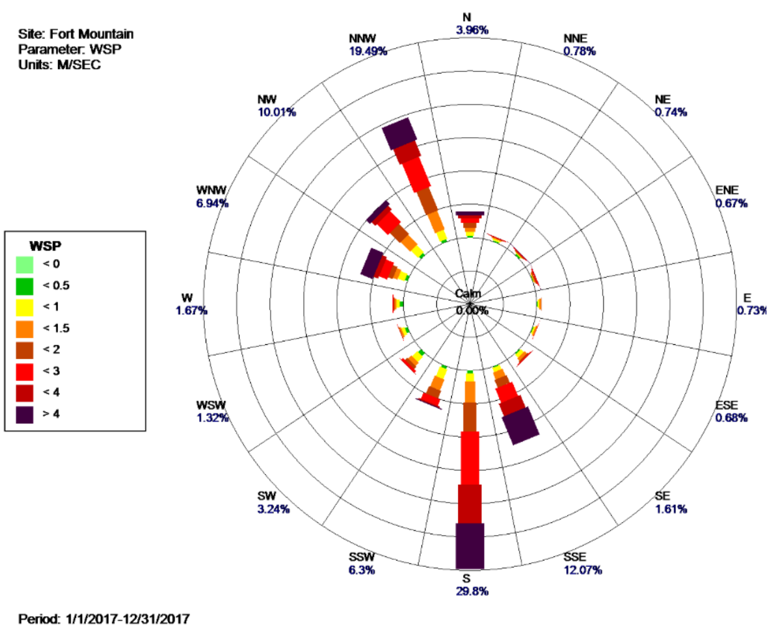
Dawsonville, 2017 Annual Winds



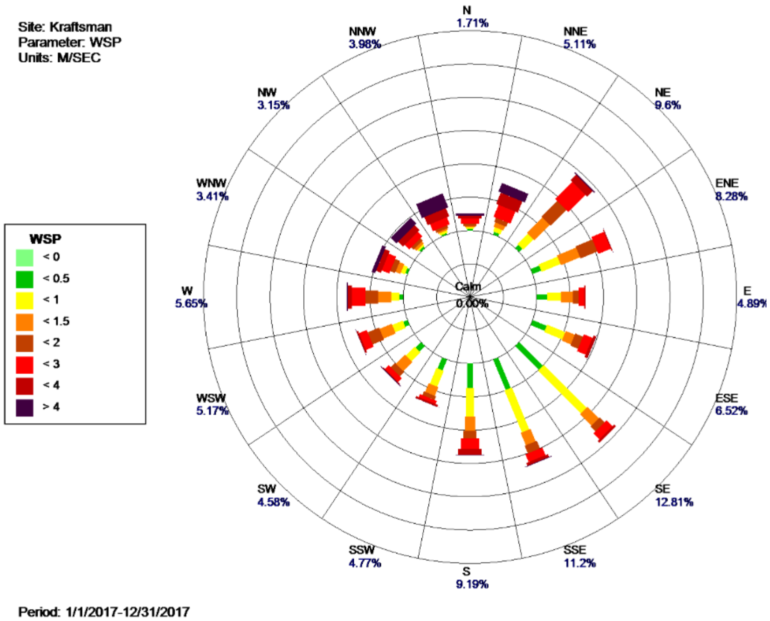
Douglasville, 2017 Annual Winds



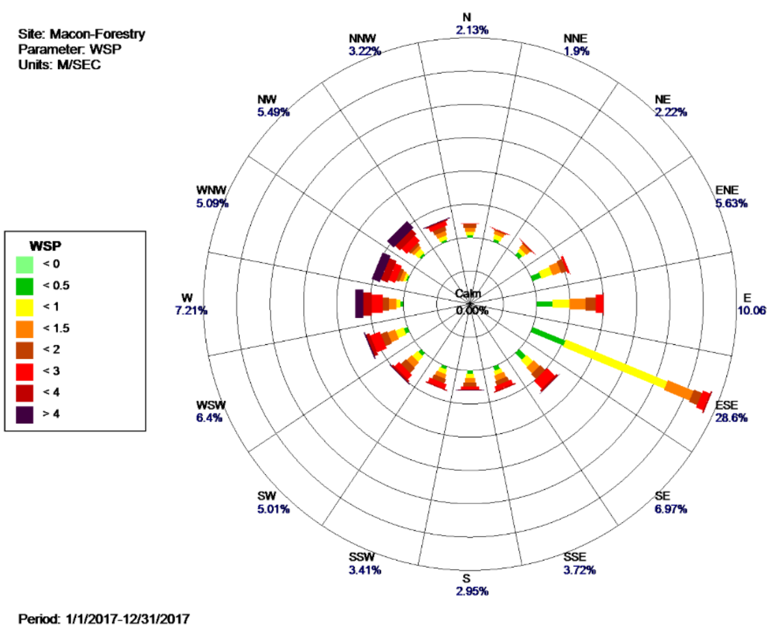
Evans, 2017 Annual Winds



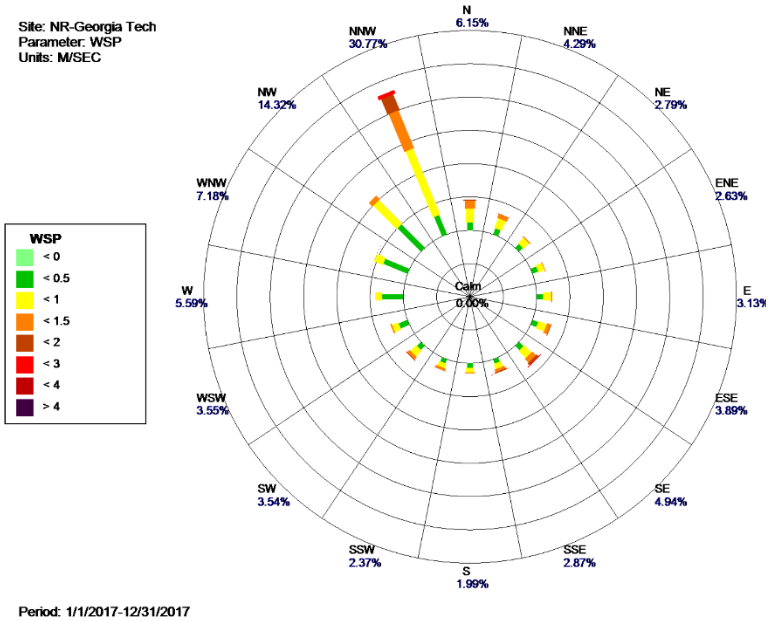
Fort Mountain, 2017 Annual Winds



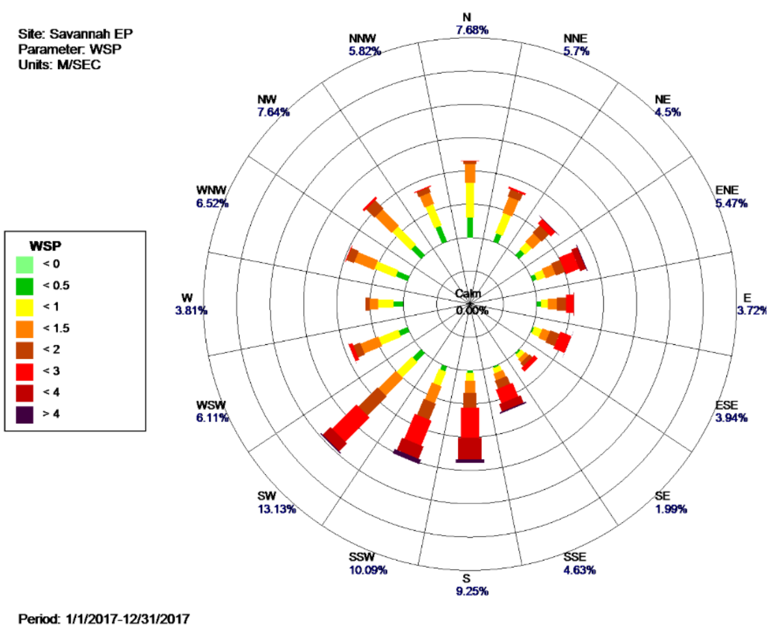
Kraftsman, 2017 Annual Winds



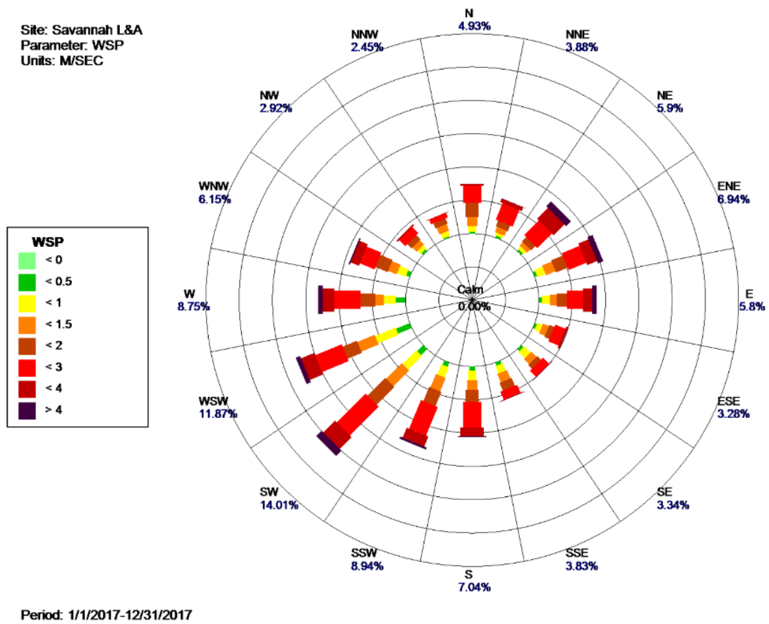
Macon-Forestry, 2017 Annual Winds



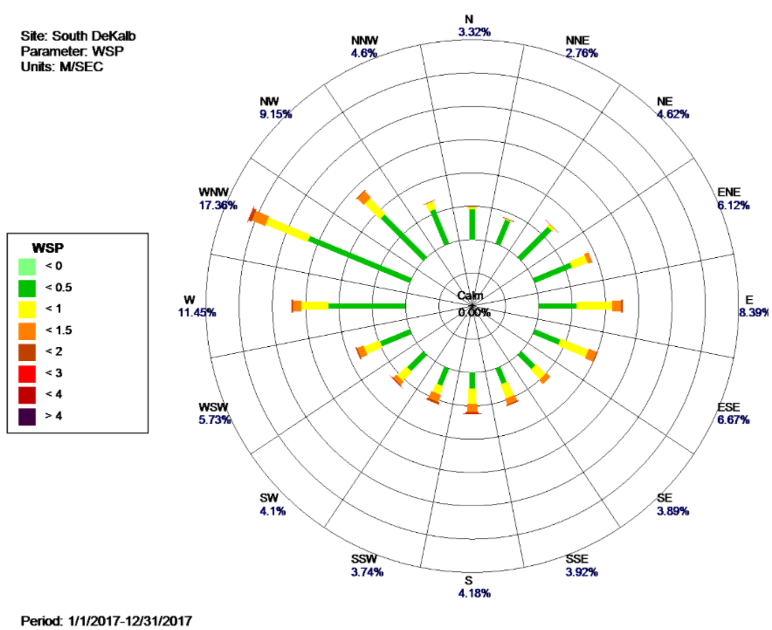
NR-GA Tech, 2017 Annual Winds



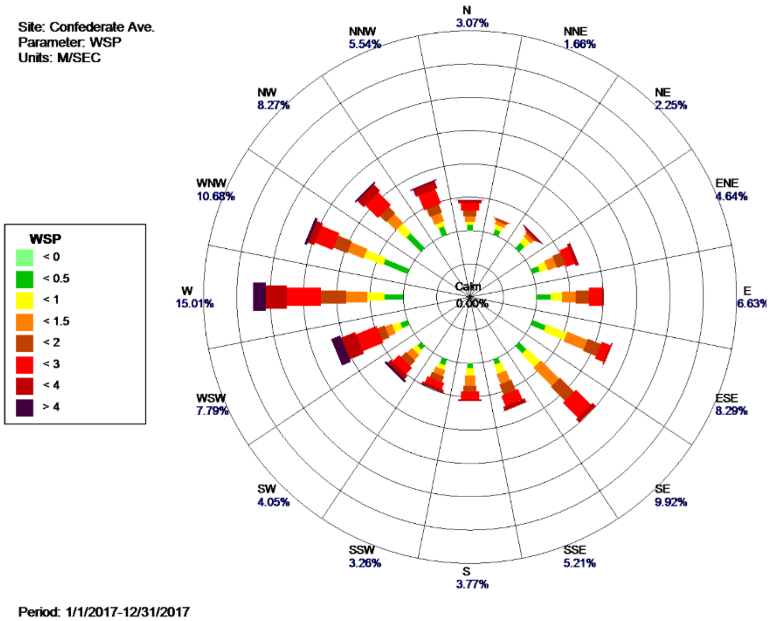
Savannah- E President, 2017 Annual Winds



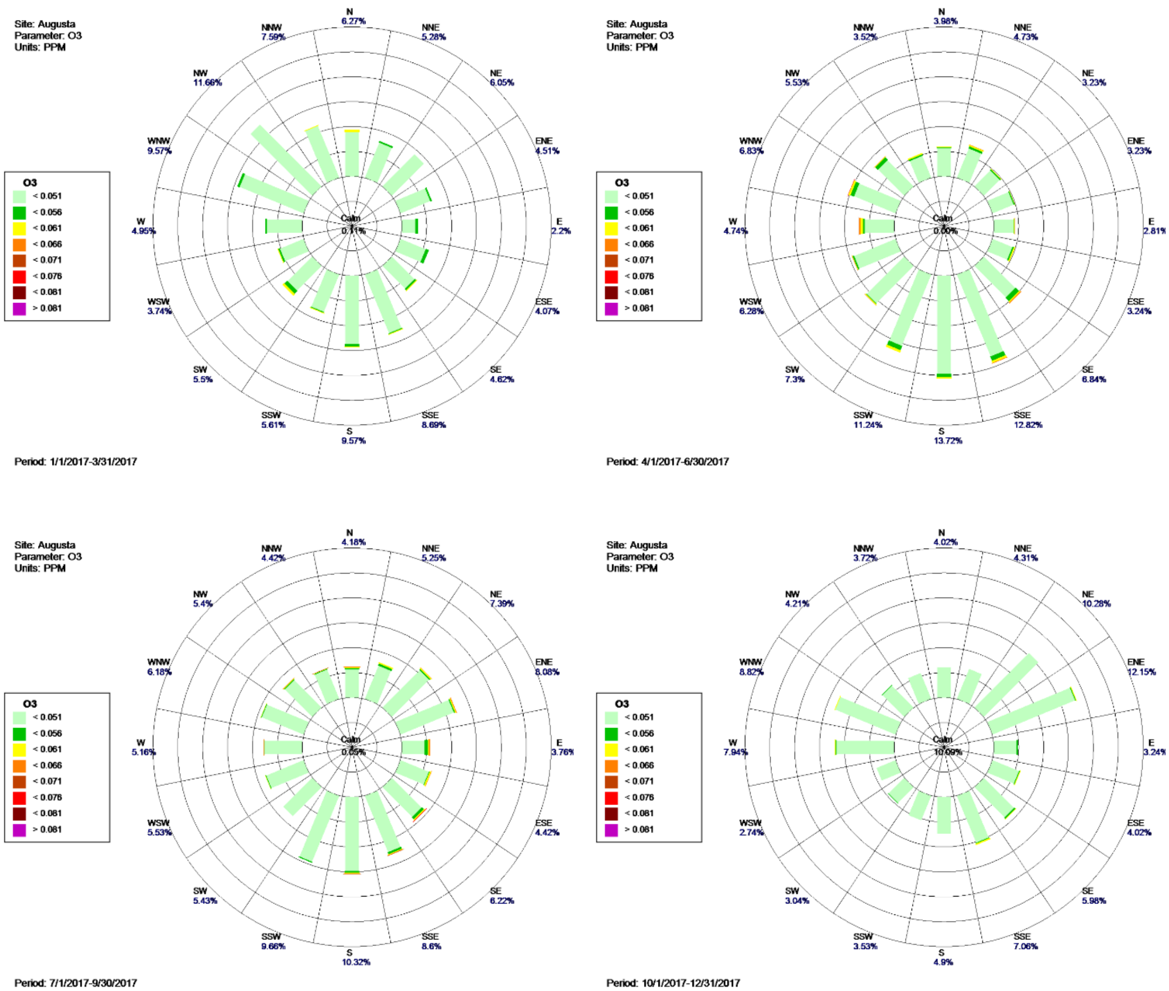
Savannah- L&A, 2017 Annual Winds



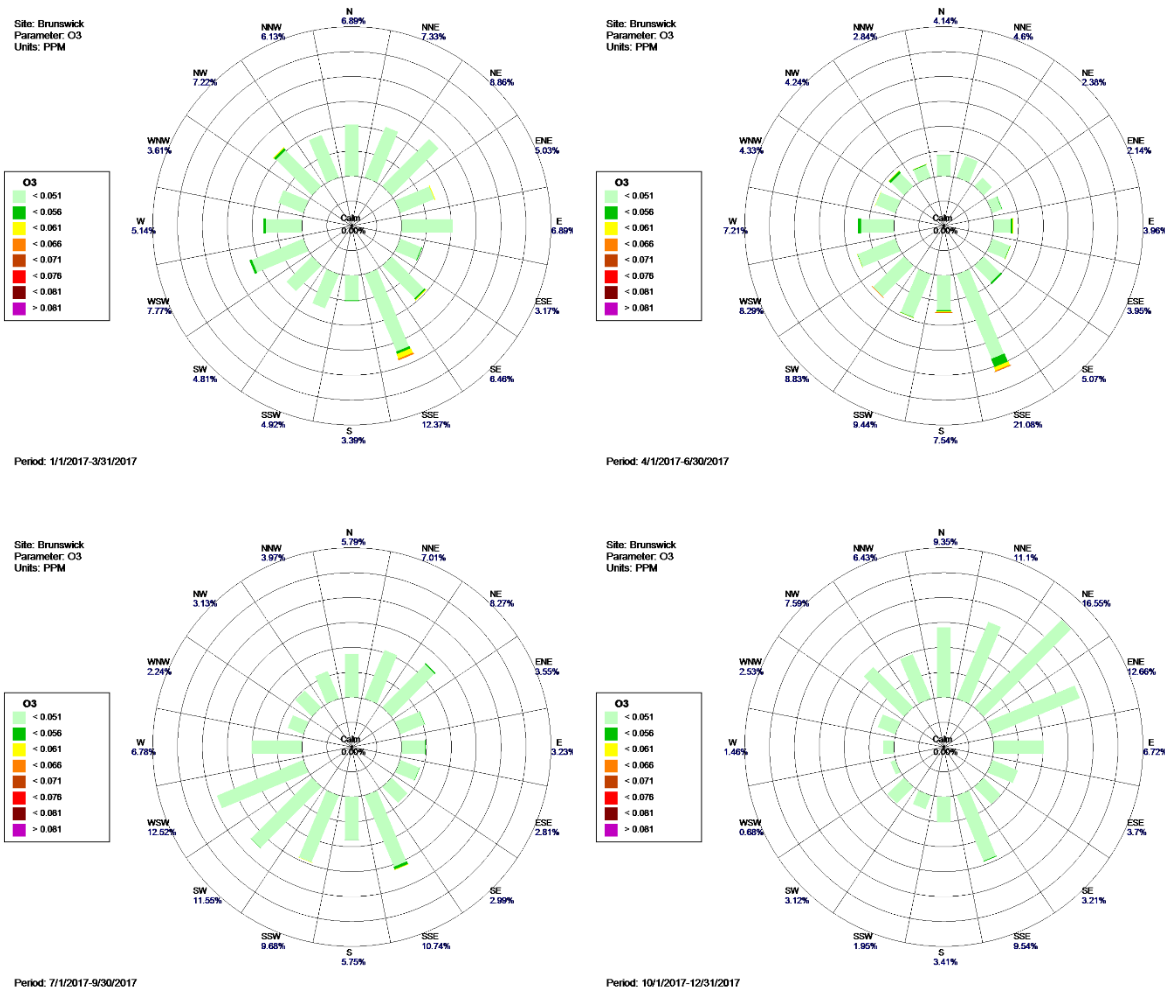
South DeKalb, 2017 Annual Winds



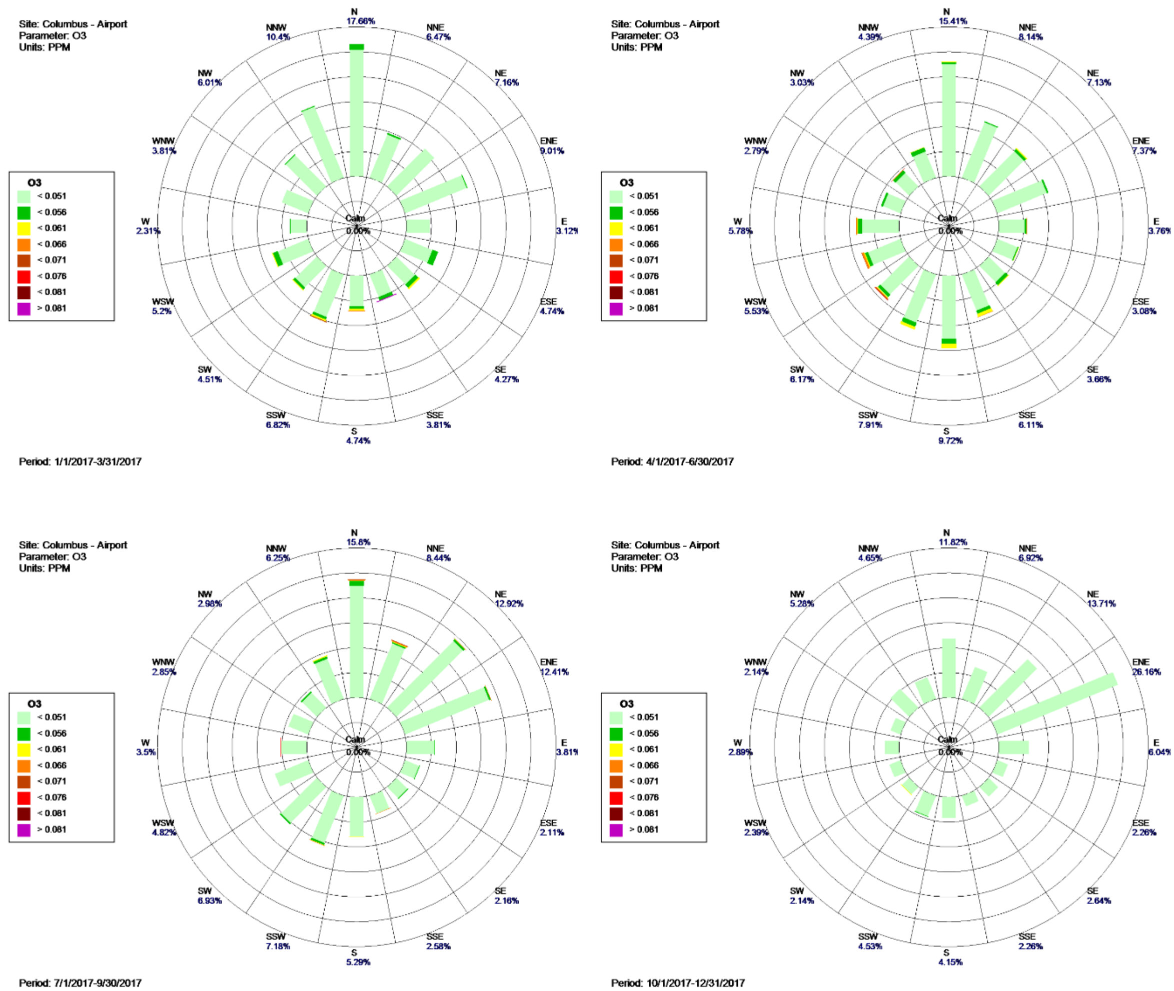
United Ave, 2017 Annual Winds



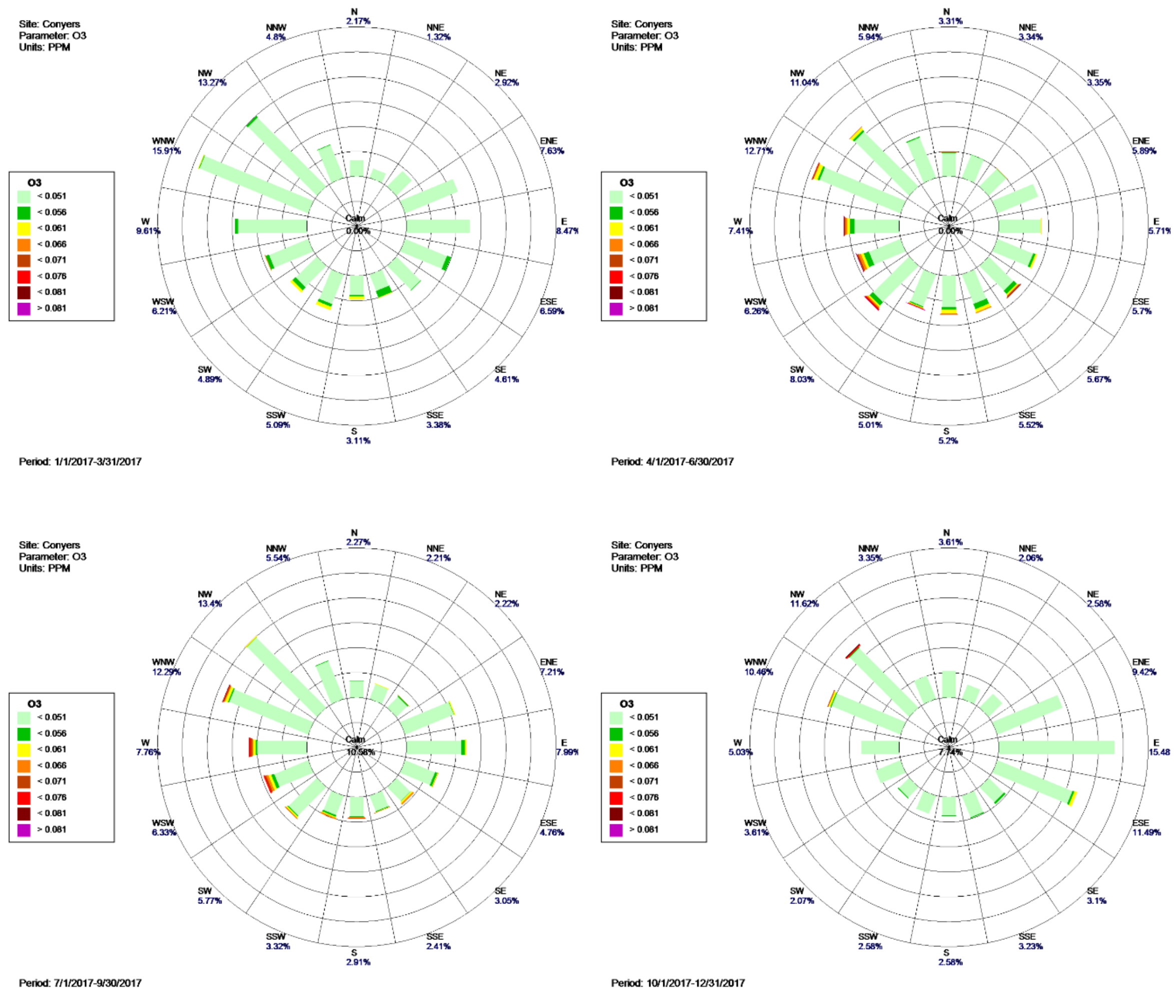
Augusta, 2017 Quarterly Ozone



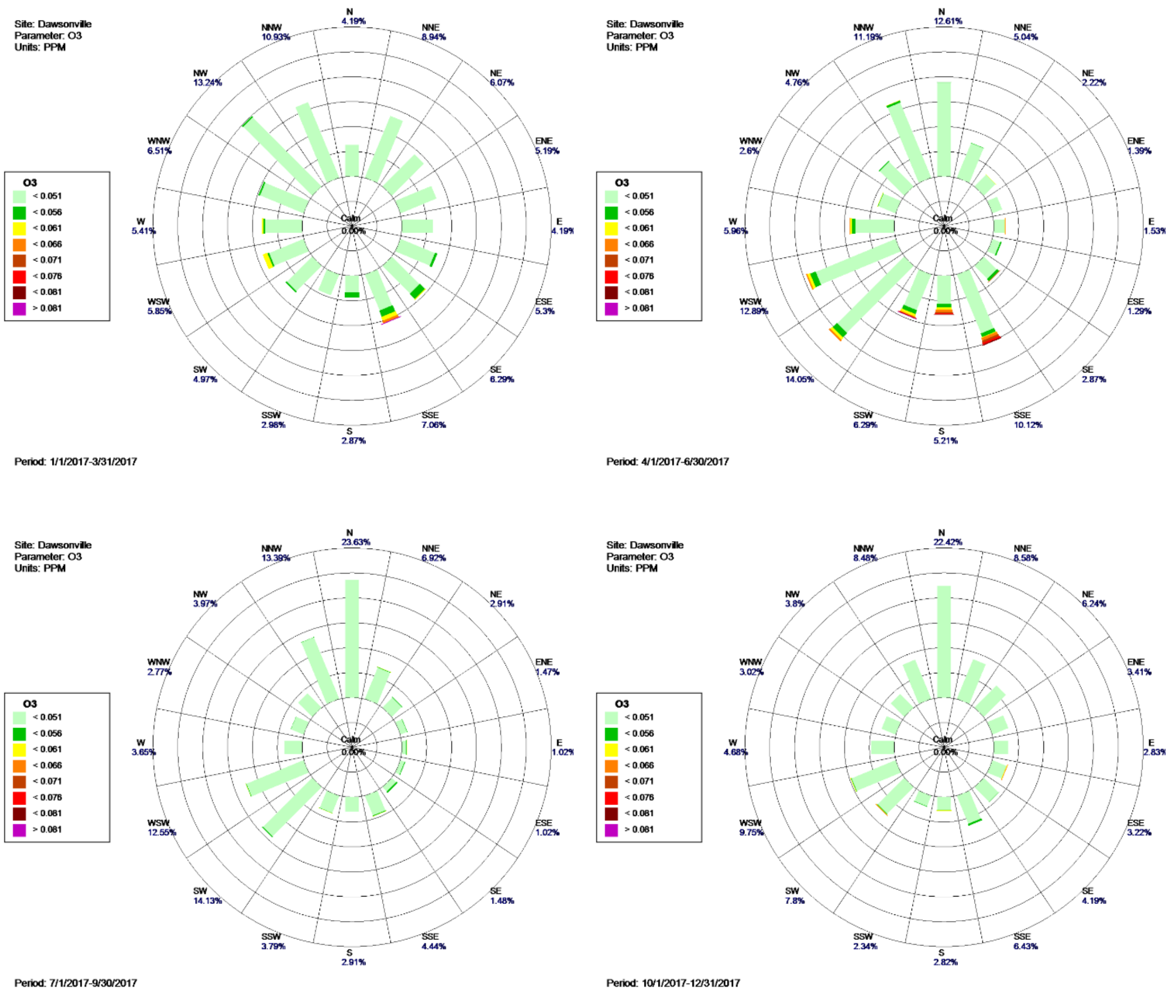
Brunswick, 2017 Quarterly Ozone



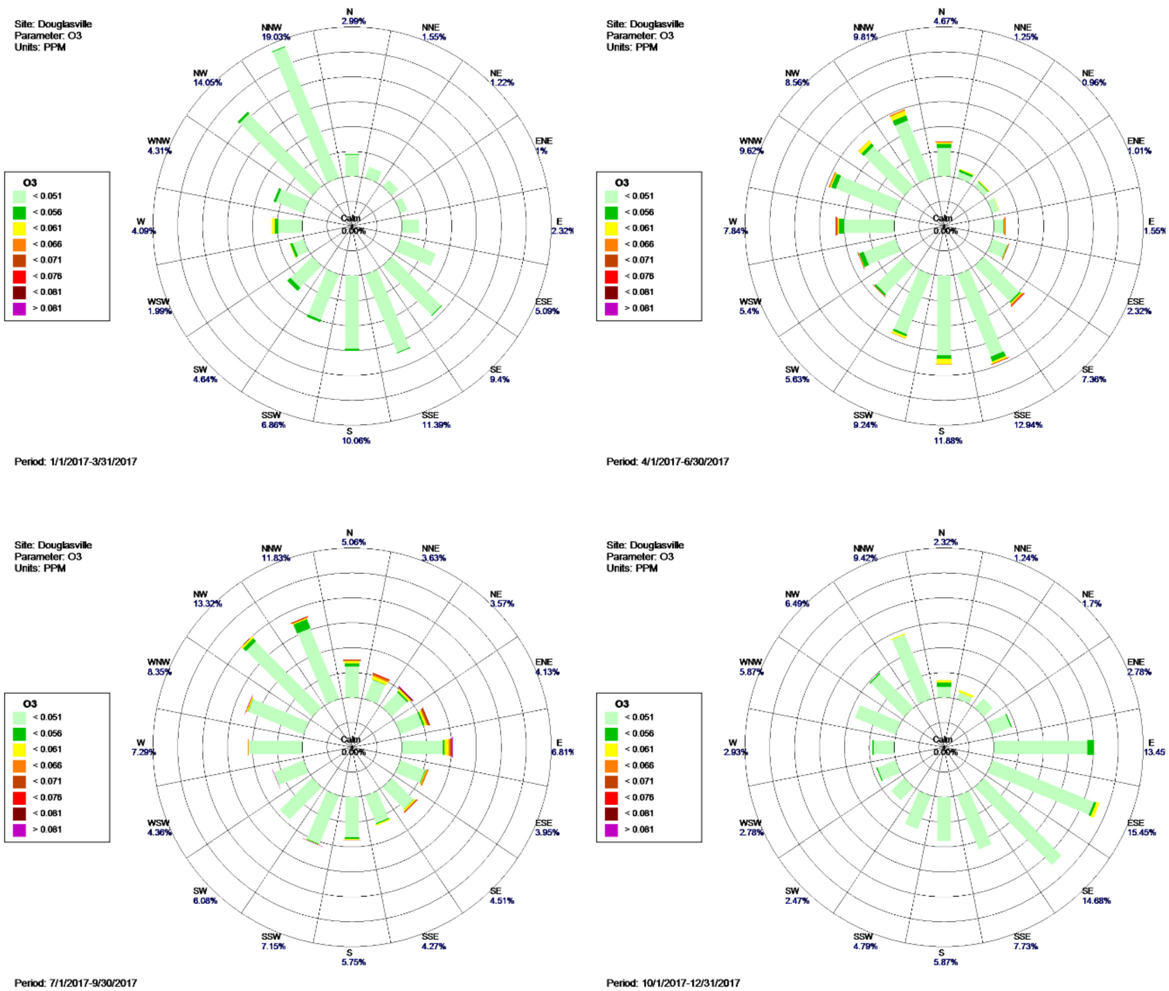
Columbus-Airport, 2017 Quarterly Ozone



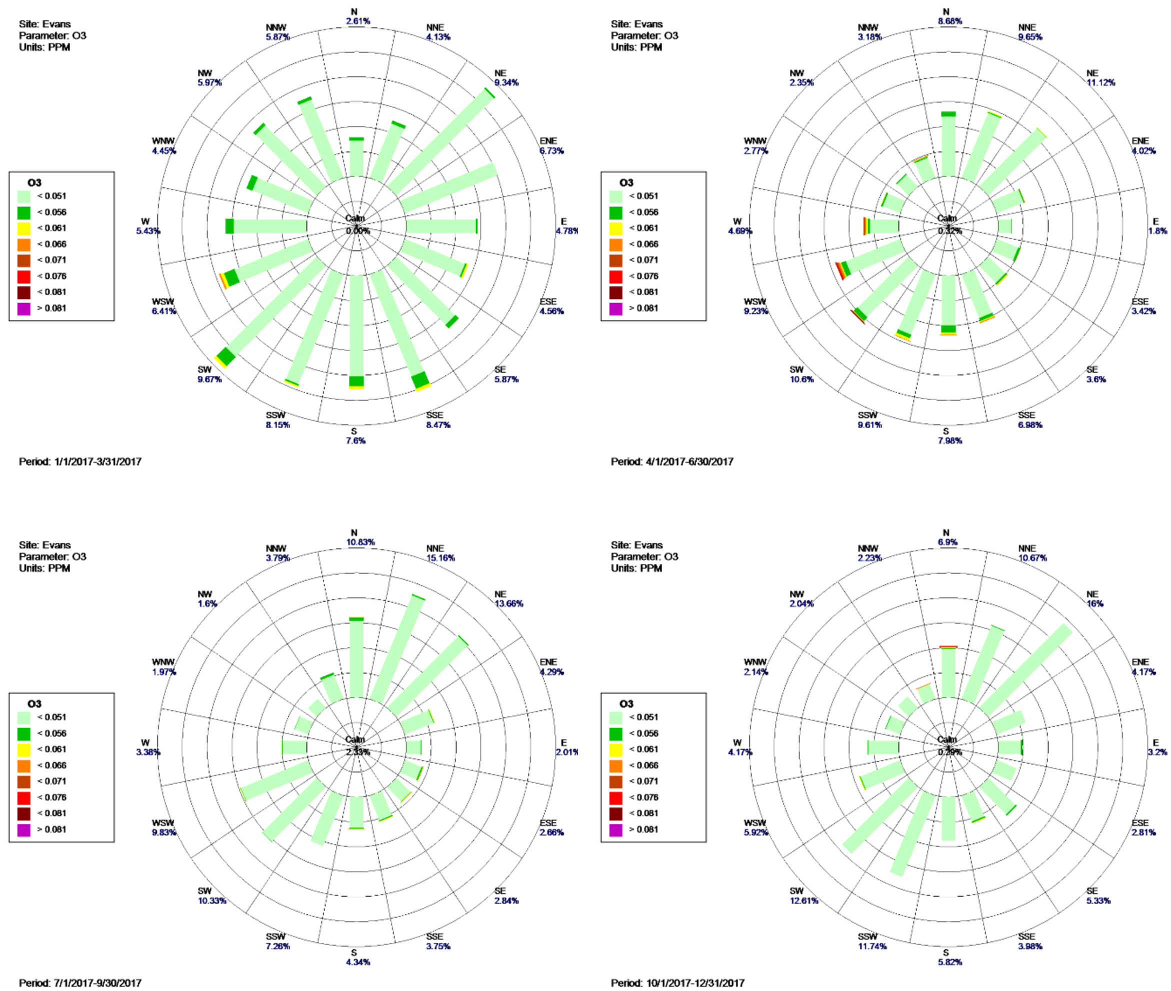
Conyers, 2017 Quarterly Ozone



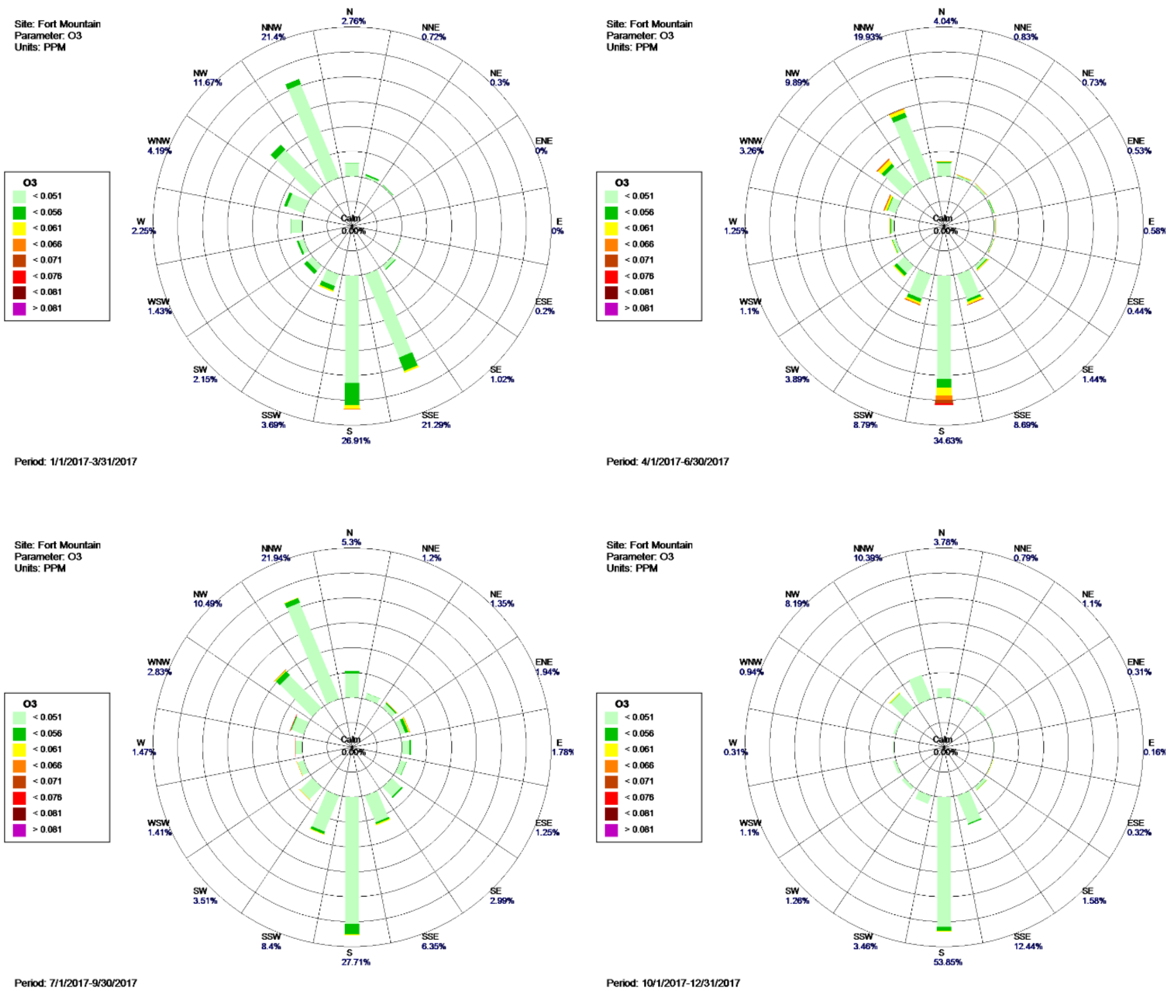
Dawsonville, 2017 Quarterly Ozone



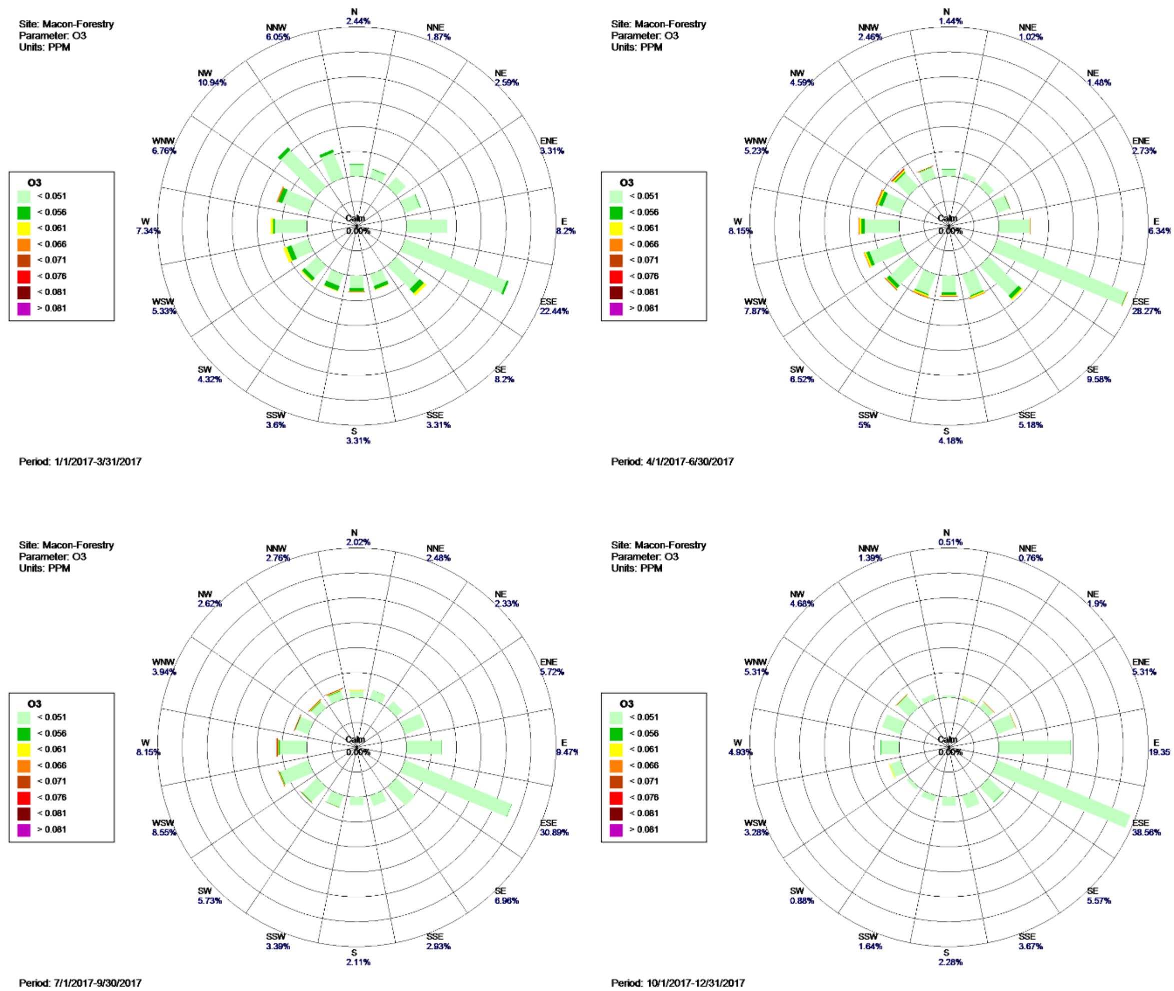
Douglasville, 2017 Quarterly Ozone



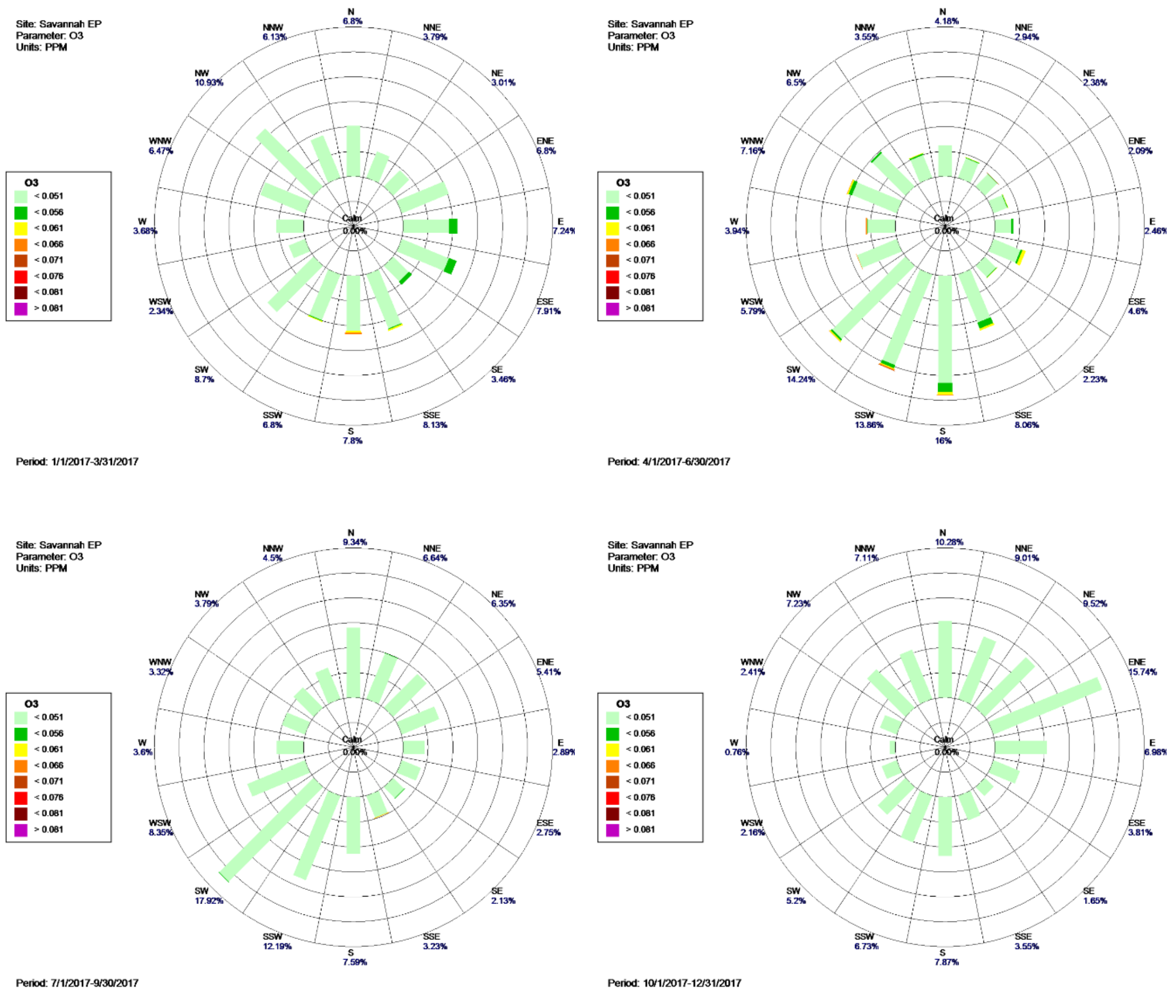
Evans, 2017 Quarterly Ozone



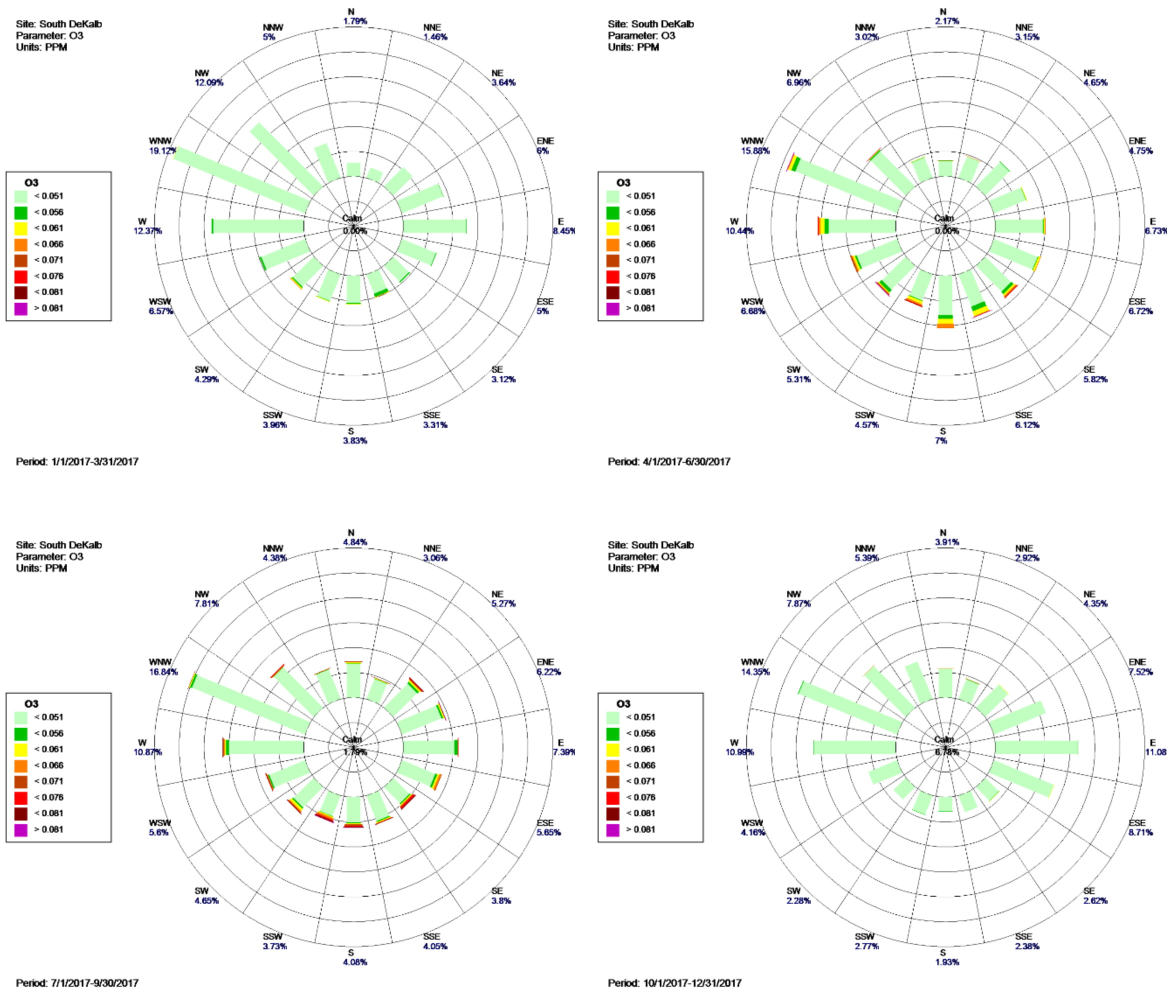
Fort Mountain, 2017 Quarterly Ozone



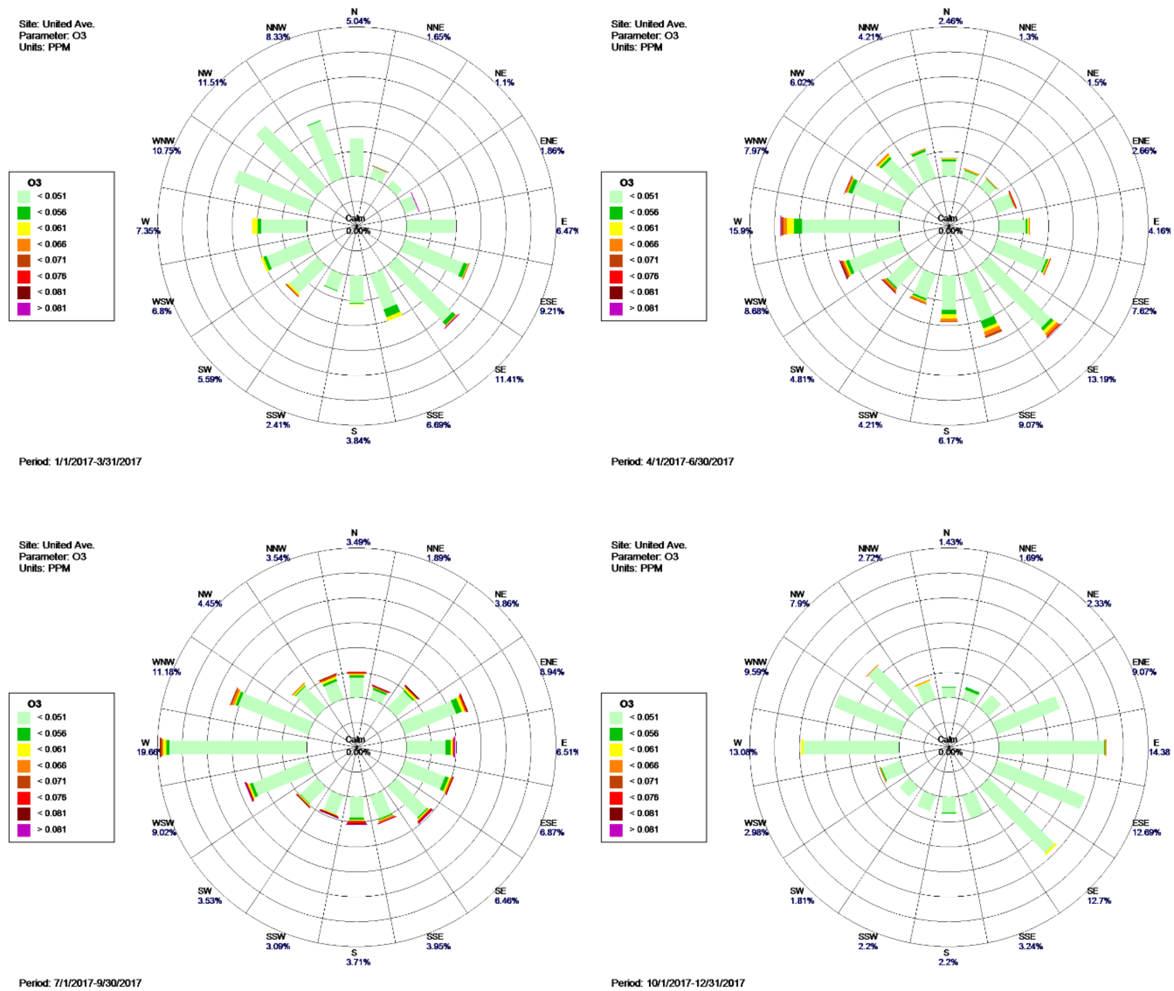
Macon-Forestry, 2017 Quarterly Ozone



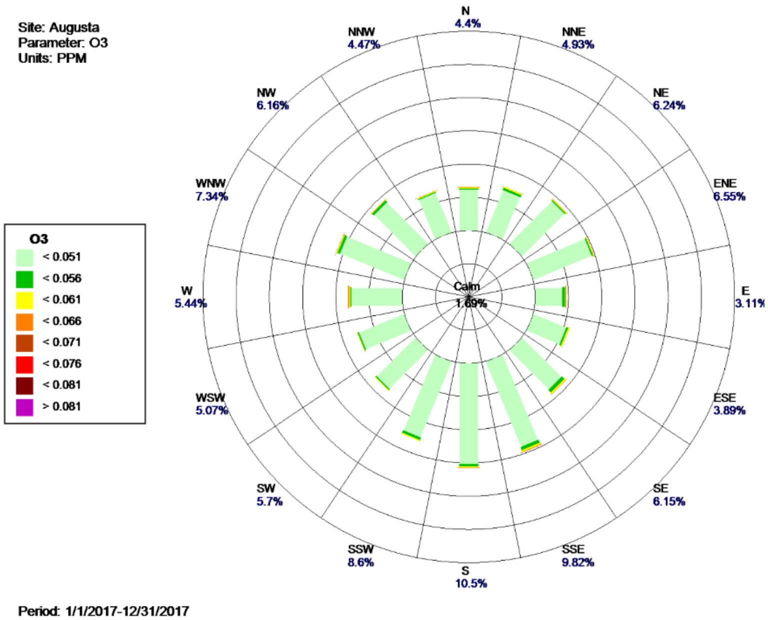
Savannah-E President, 2017 Quarterly Ozone



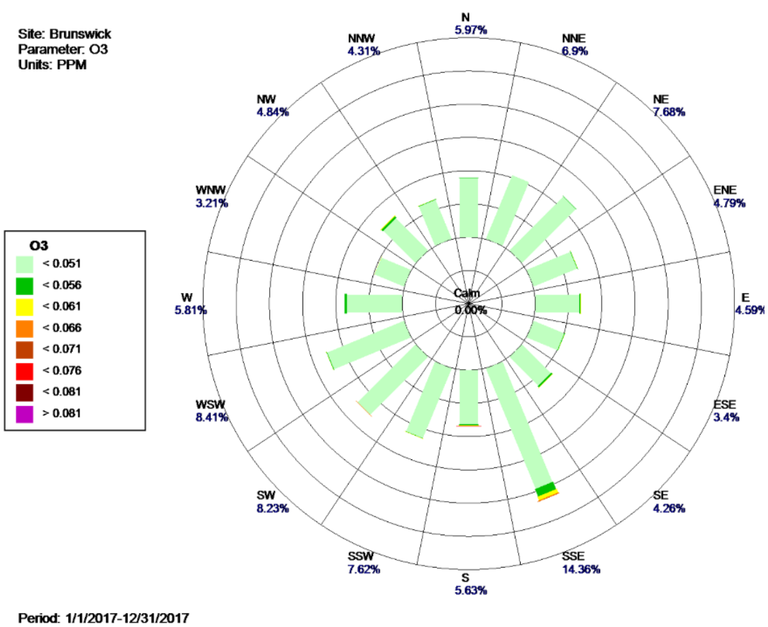
South DeKalb 2017 Quarterly Ozone



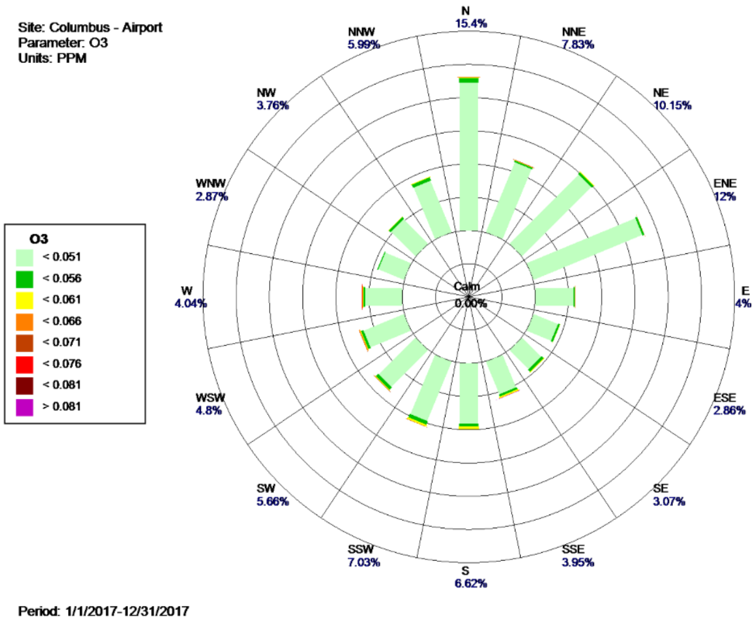
United Ave, 2017 Quarterly Ozone



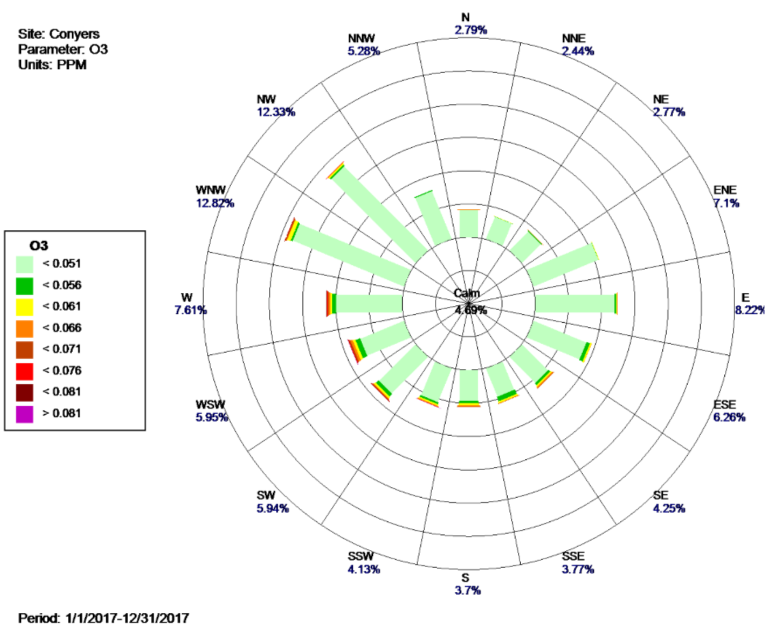
Augusta, 2017 Annual Ozone



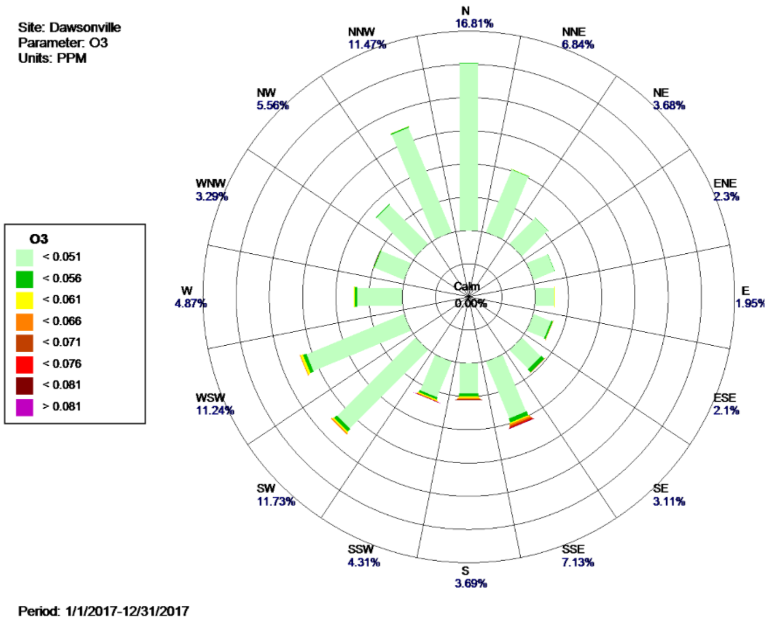
Brunswick, 2017 Annual Ozone



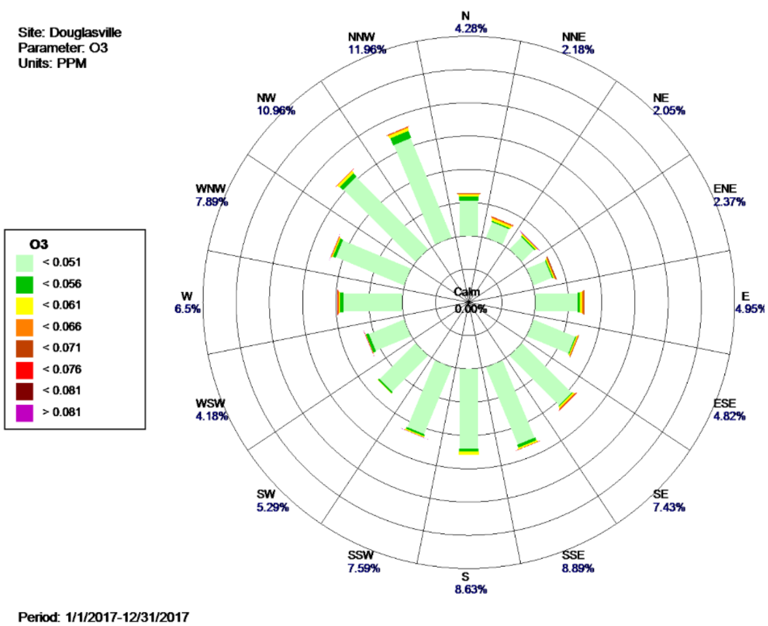
Columbus-Airport, 2017 Annual Ozone



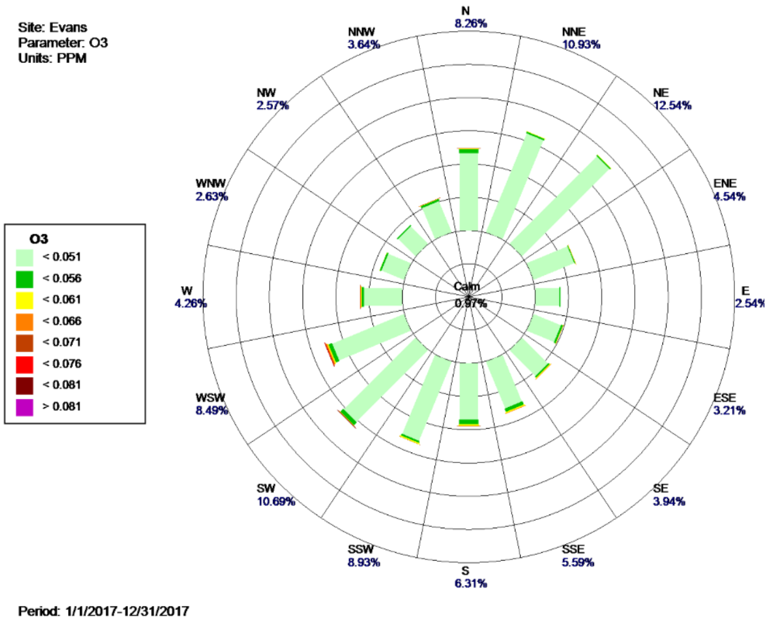
Conyers, 2017 Annual Ozone



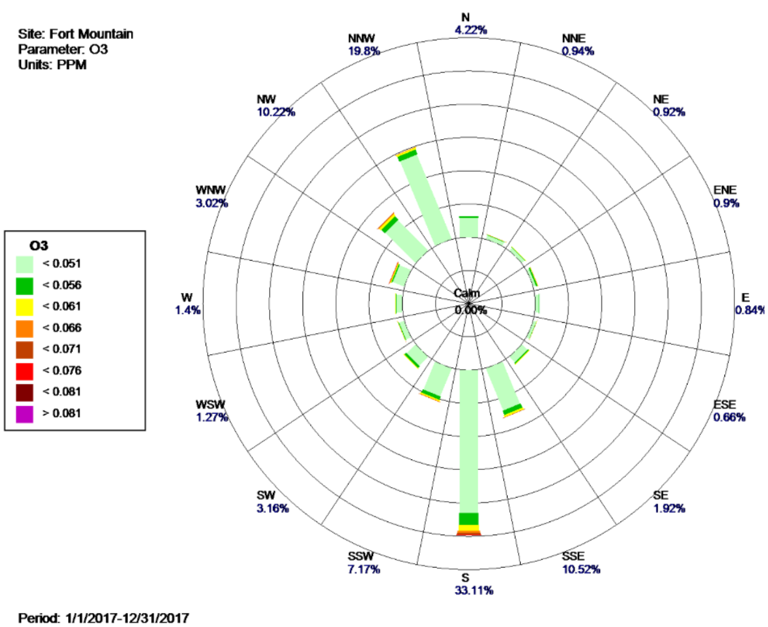
Dawsonville, 2017 Annual Ozone



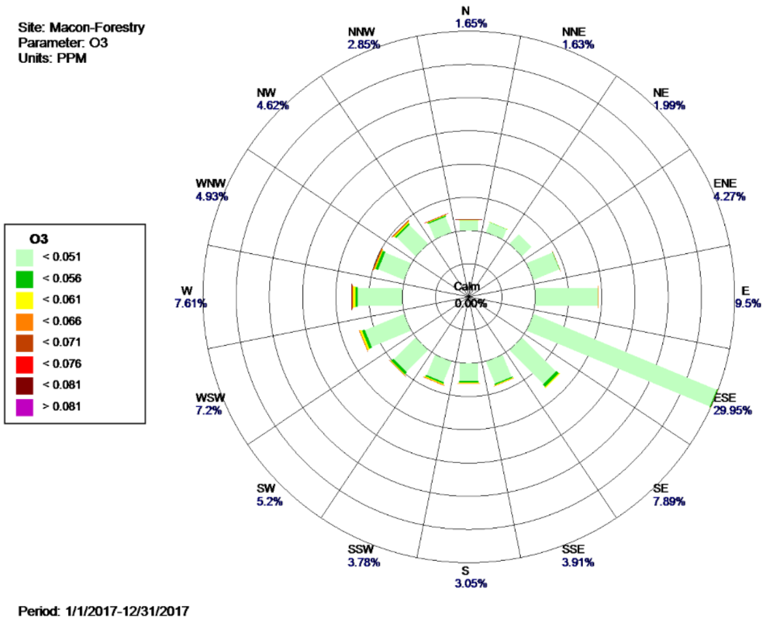
Douglasville, 2017 Annual Ozone



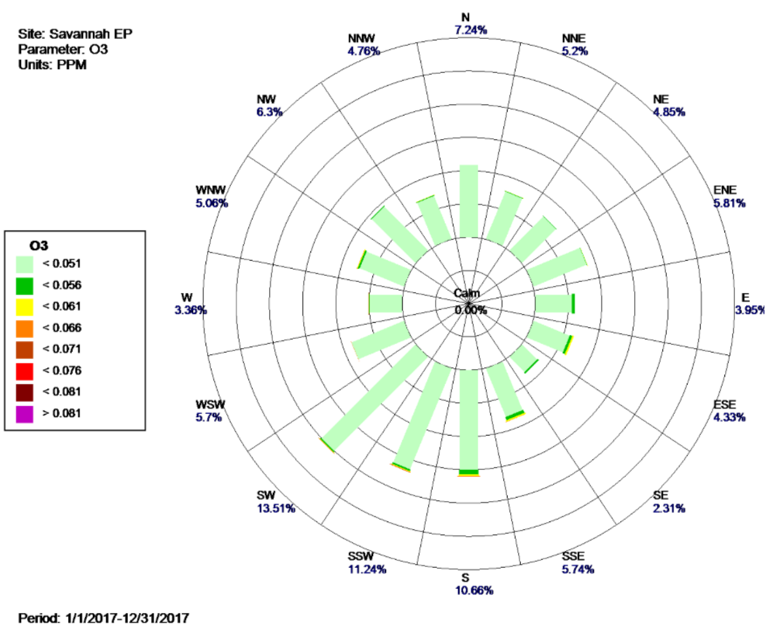
Evans, 2017 Annual Ozone



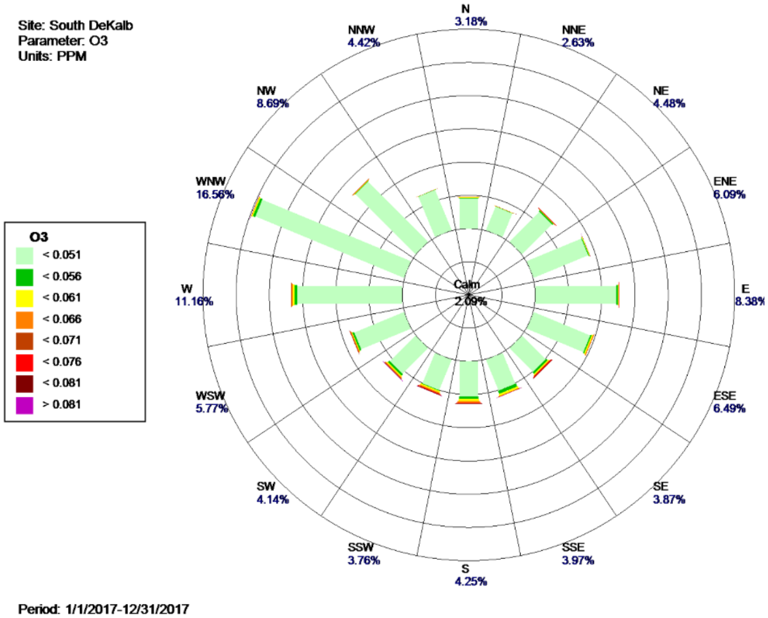
Fort Mountain, 2017 Annual Ozone



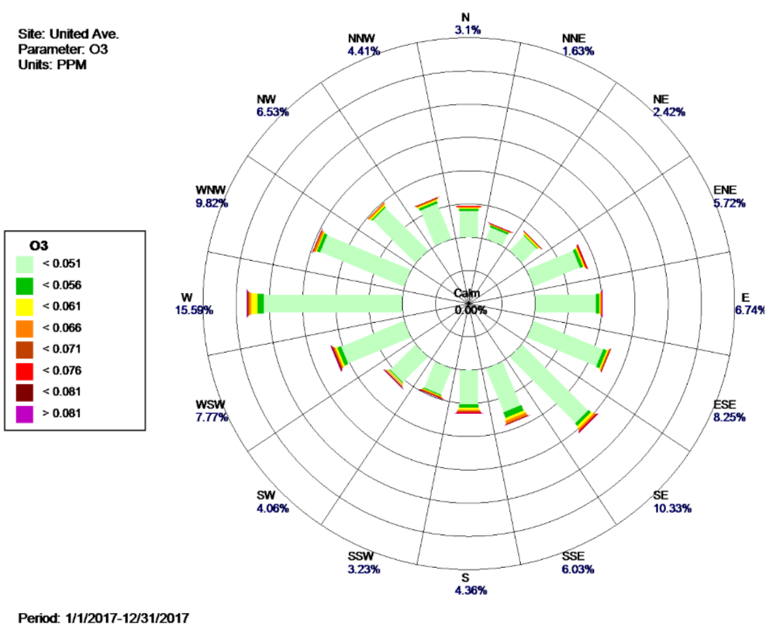
Macon-Forestry, 2017 Annual Ozone



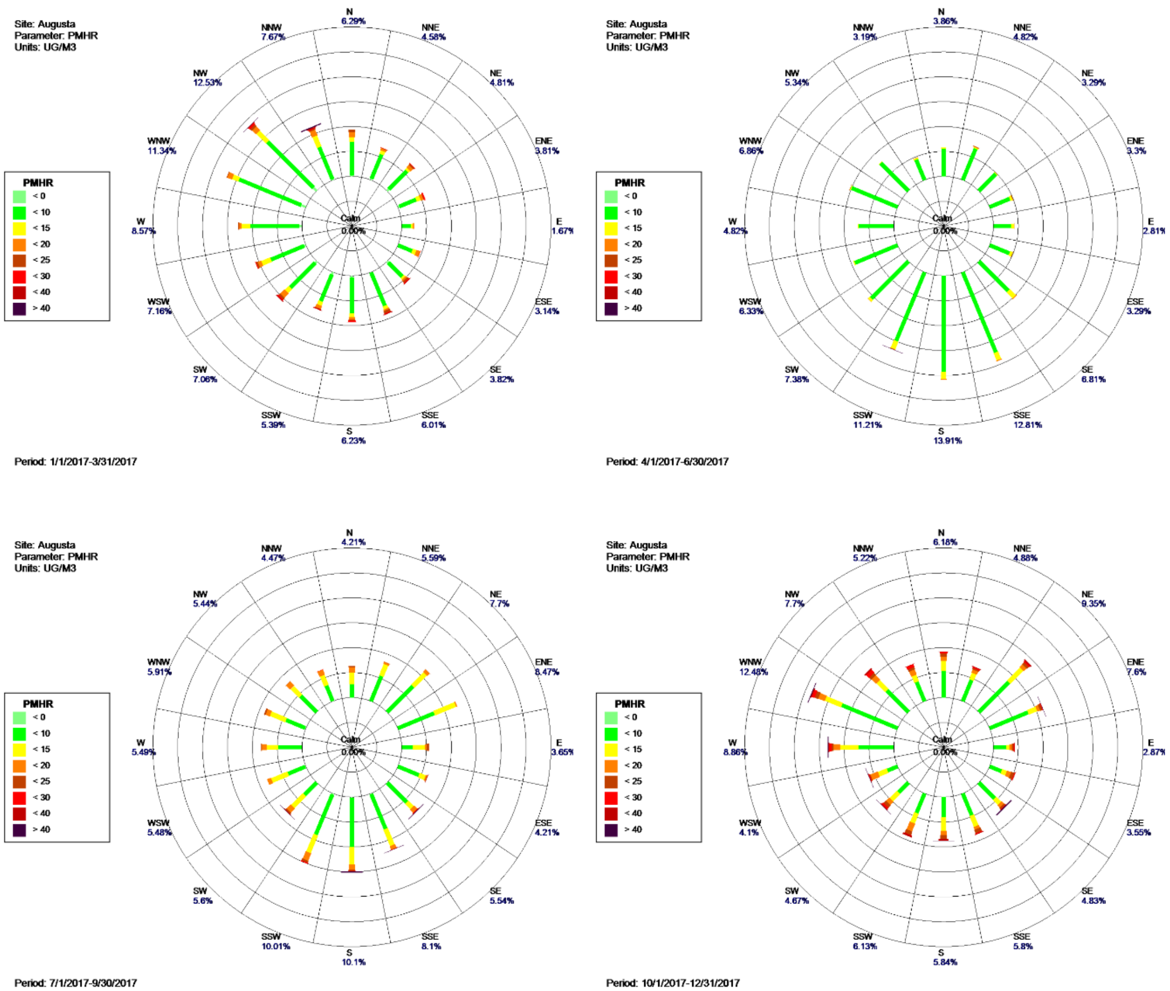
Savannah-E President, 2017 Annual Ozone



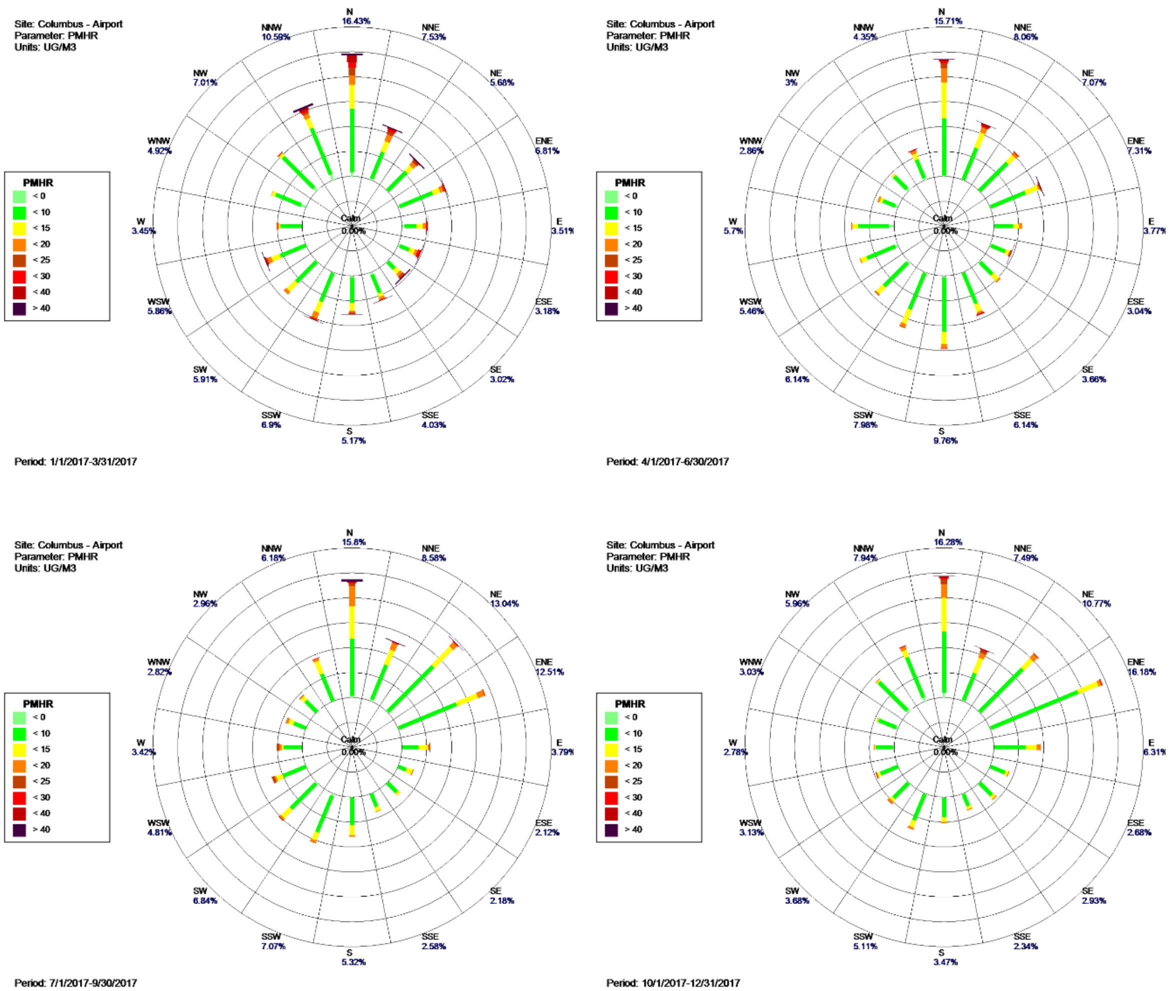
South DeKalb, 2017 Annual Ozone



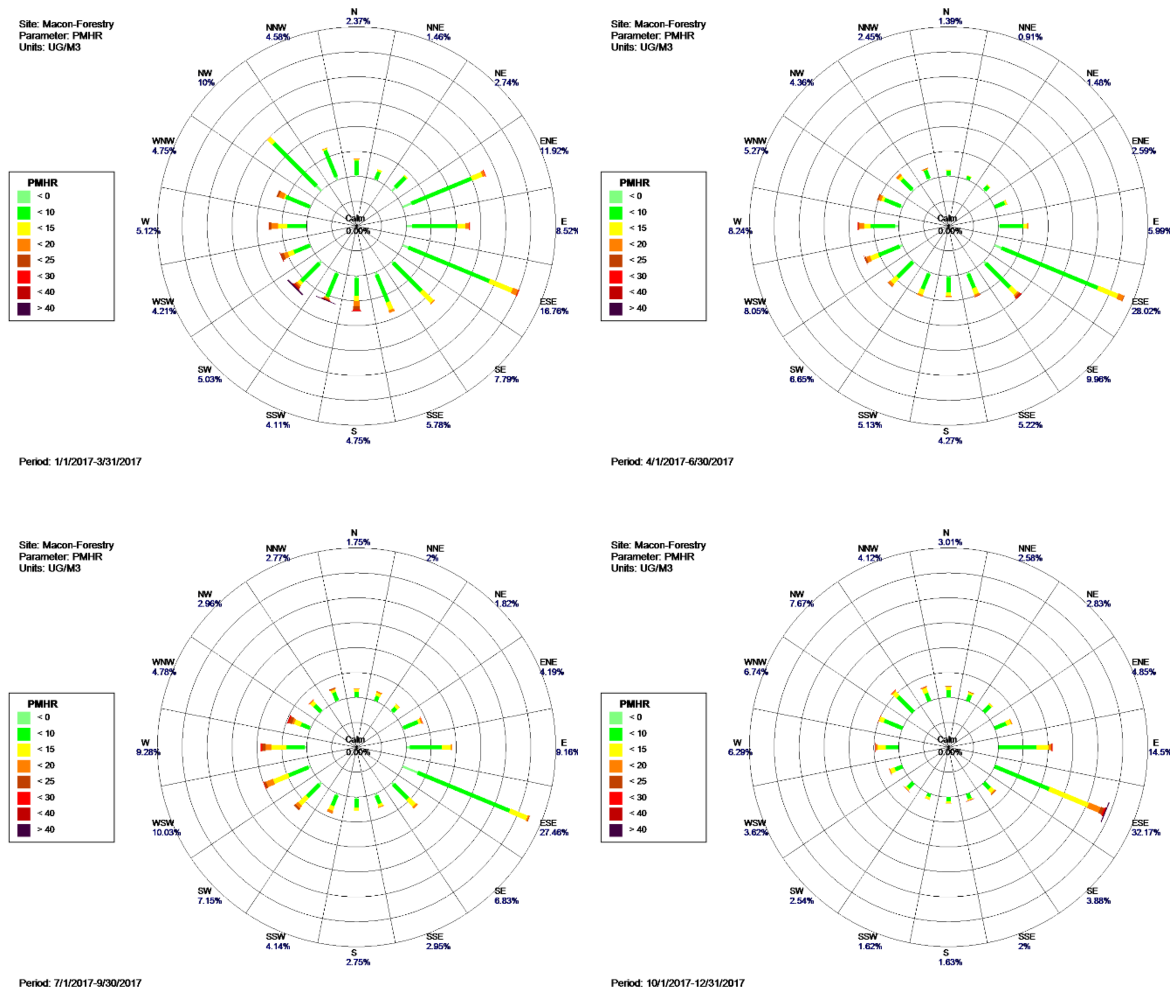
United Ave, 2017 Annual Ozone



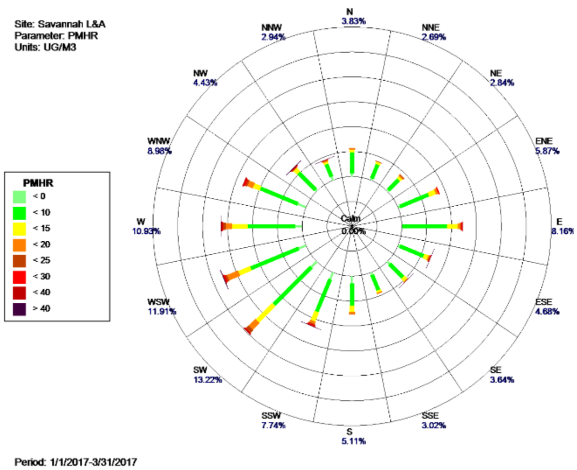
Augusta, 2017 Quarterly $PM_{2.5}$

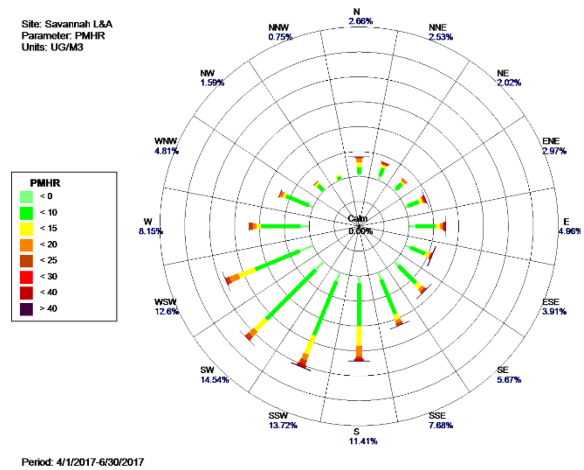


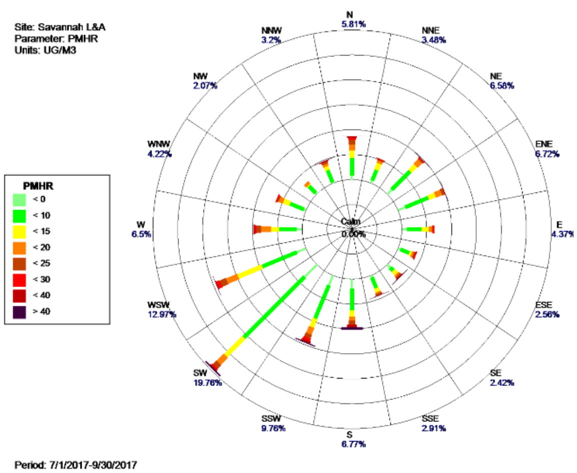
Columbus-Airport, 2017 Quarterly $PM_{2.5}$

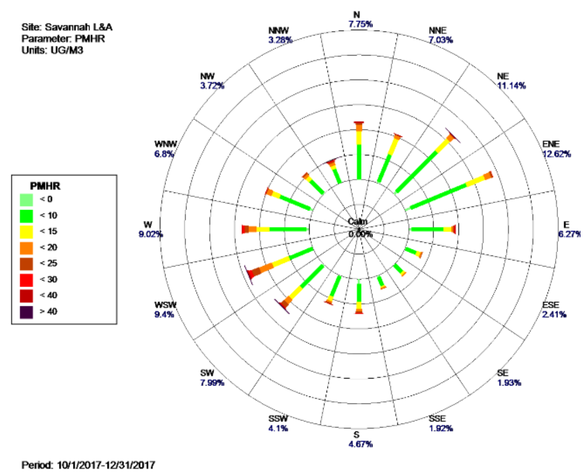


Macon-Forestry, 2017 Quarterly $PM_{2.5}$

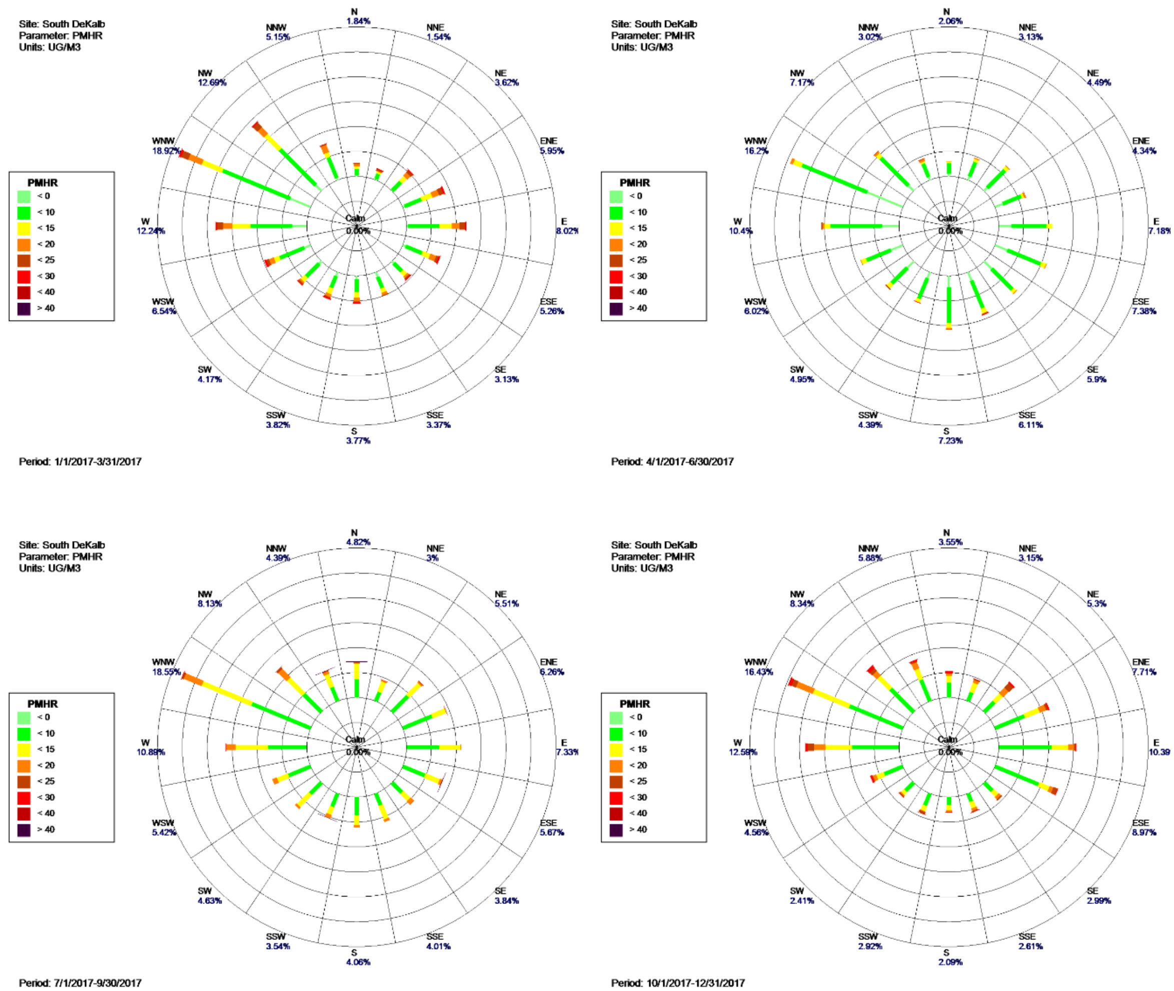




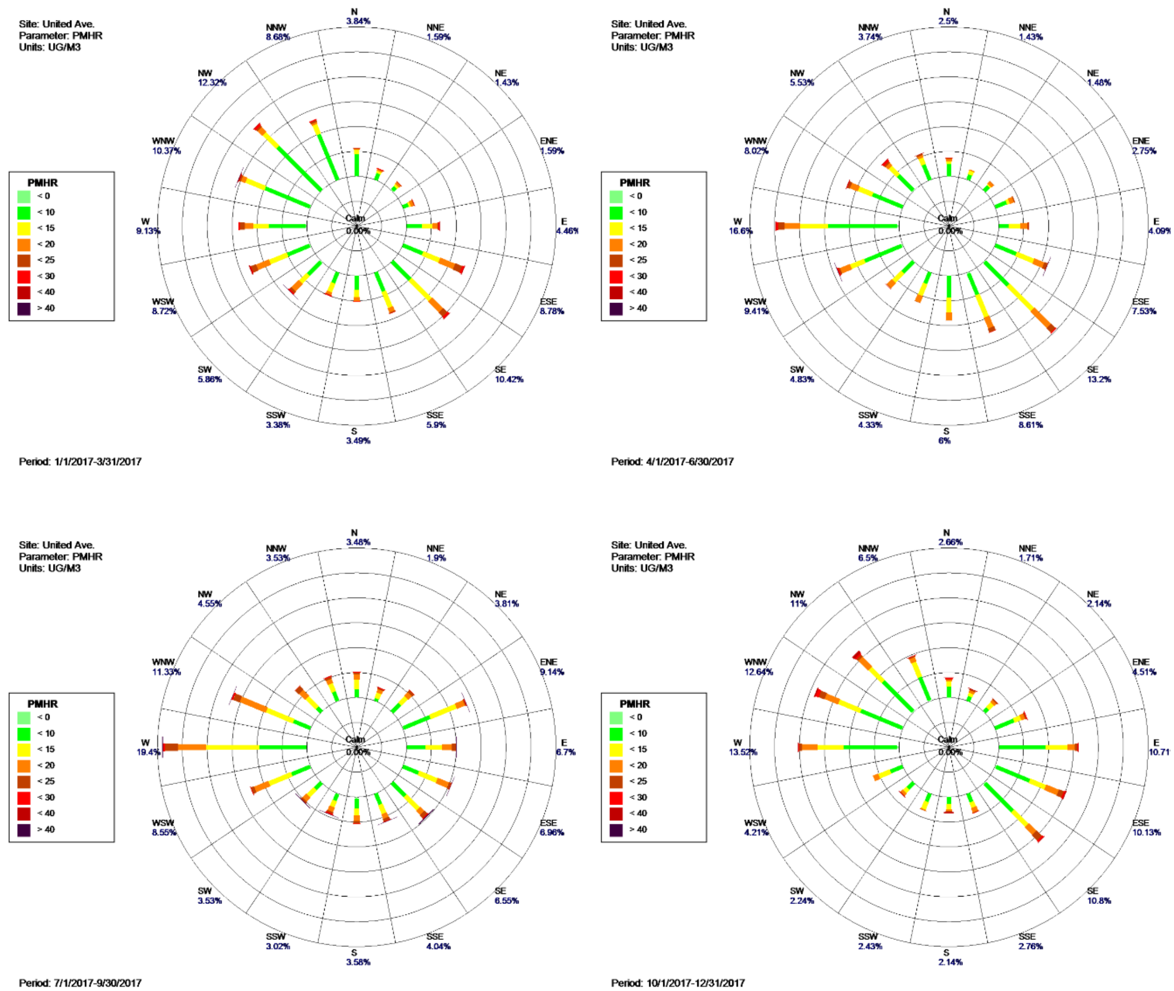




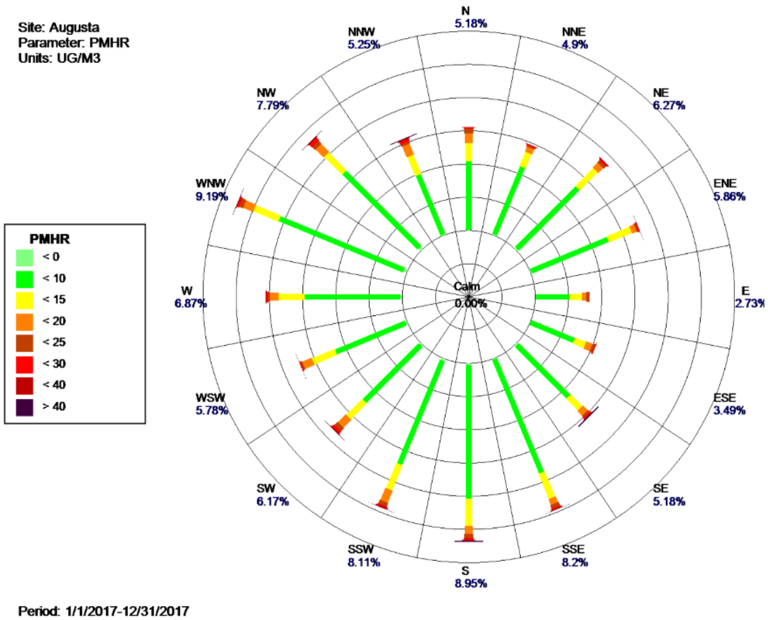
Savannah-L&A, 2017 Quarterly $PM_{2.5}$



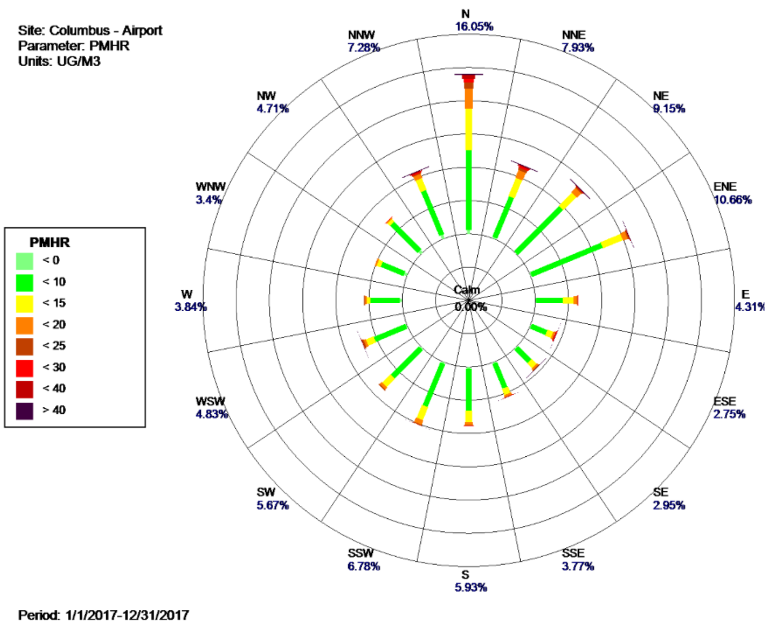
South DeKalb, 2017 Quarterly $PM_{2.5}$



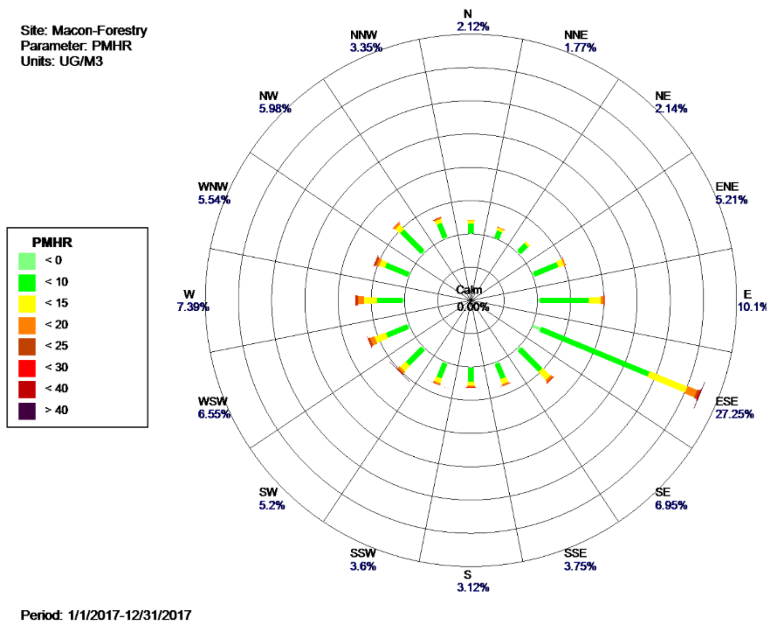
United Ave, 2017 Quarterly $PM_{2.5}$



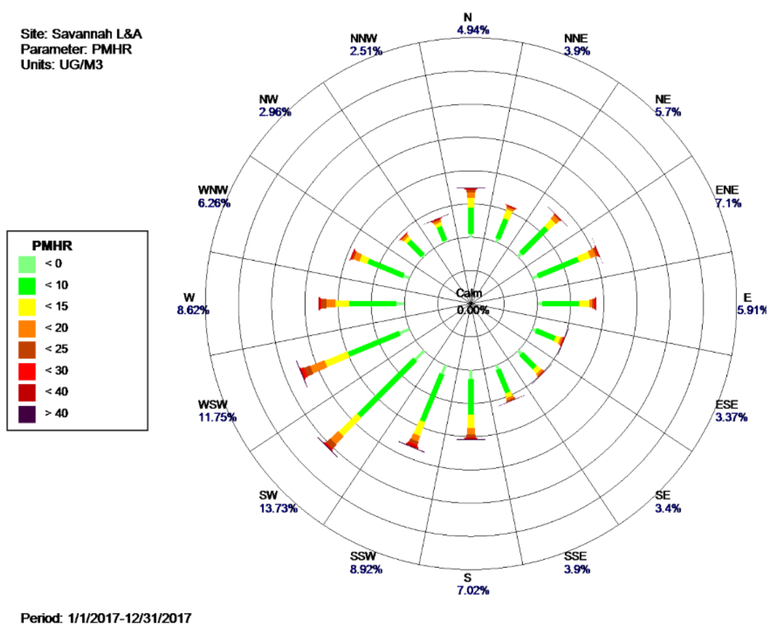
Augusta, 2017 Annual $PM_{2.5}$



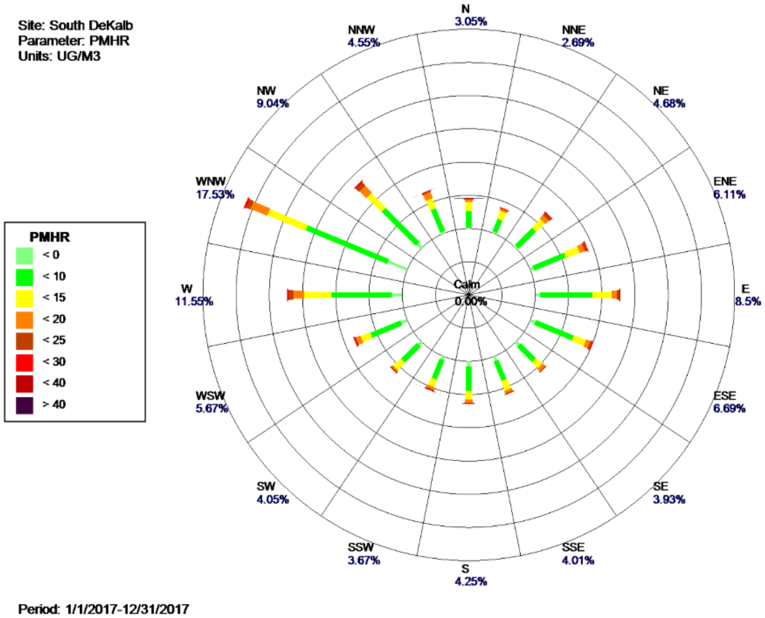
Columbus, 2017 Annual $PM_{2.5}$



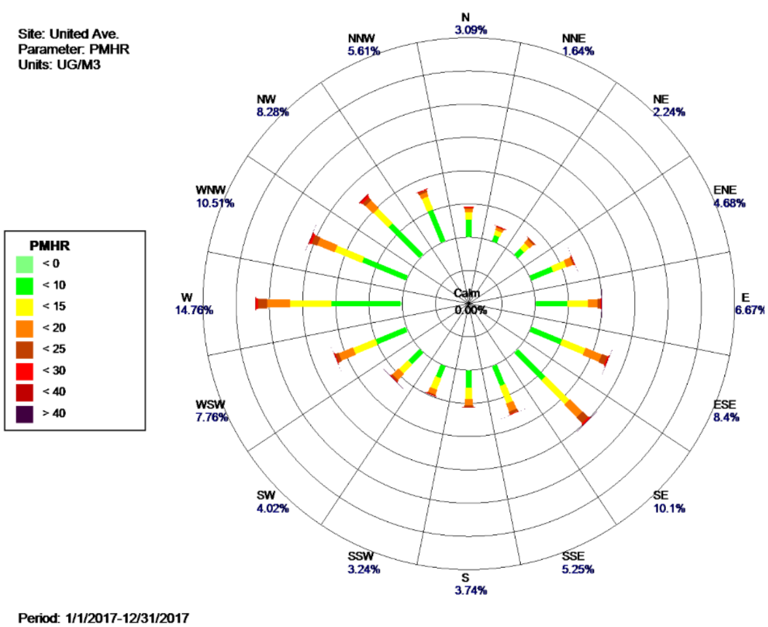
Macon-Forestry, 2017 Annual $PM_{2.5}$



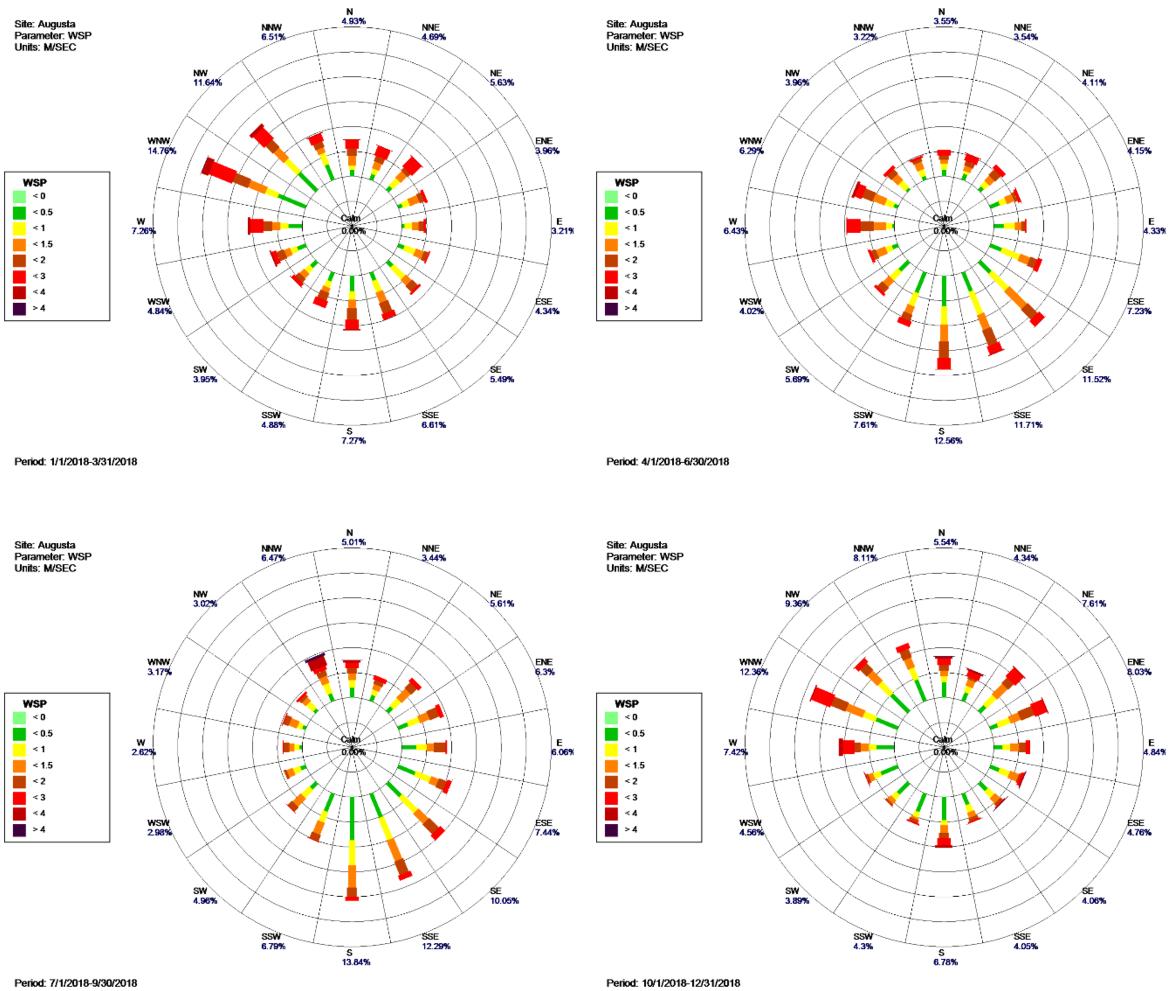
Savannah-L&A, 2017 Annual $PM_{2.5}$



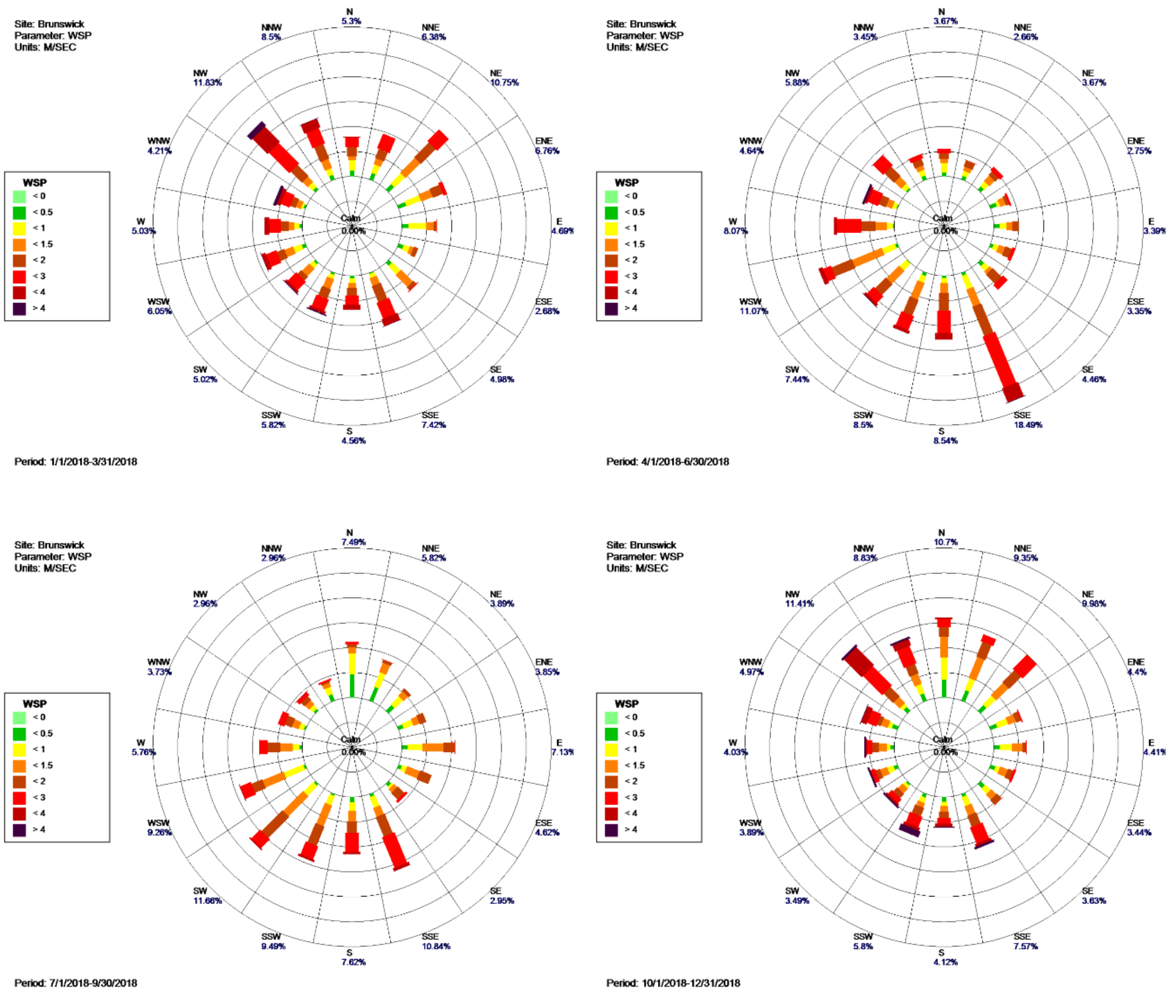
South DeKalb, 2017 Annual $PM_{2.5}$



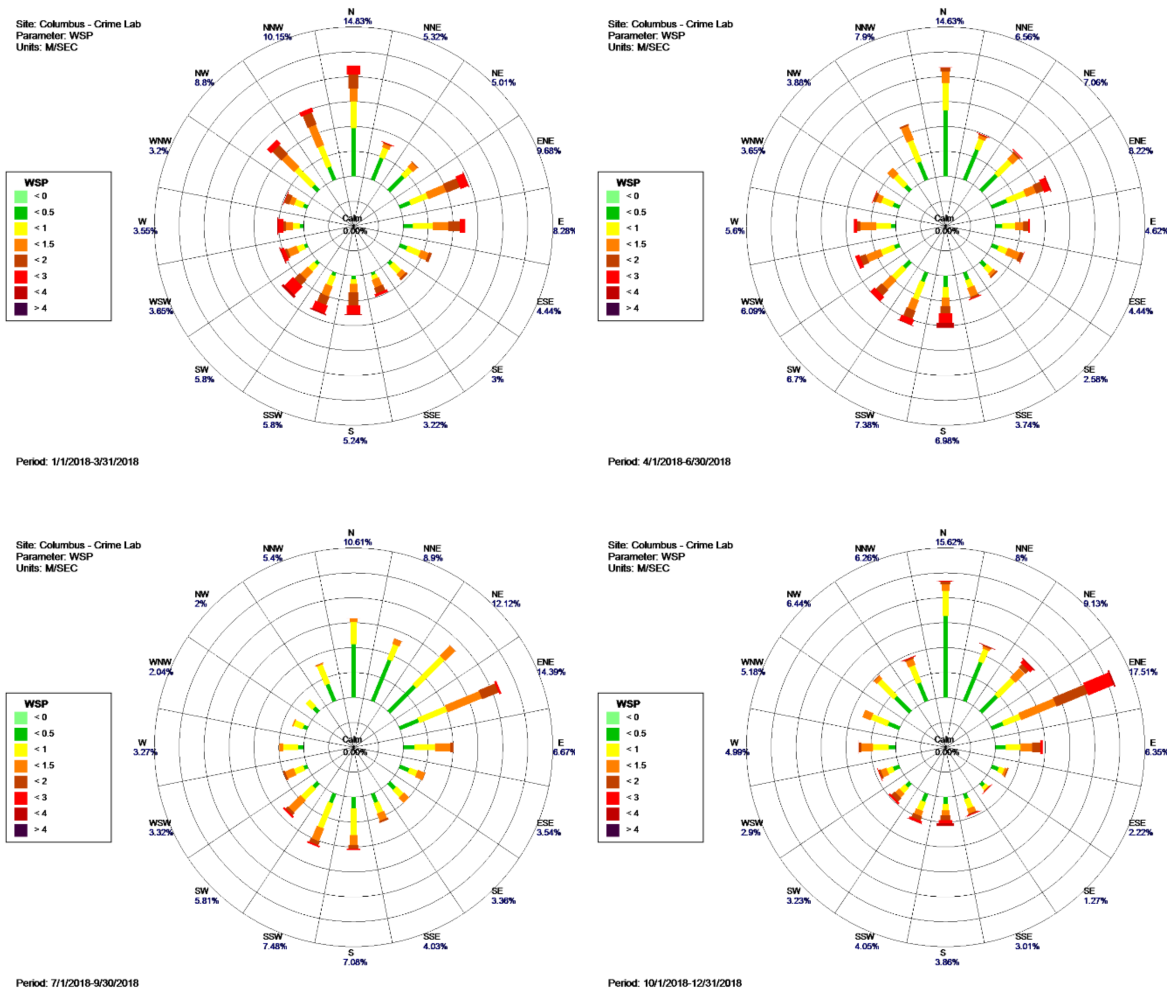
United Ave, 2017 Annual $PM_{2.5}$



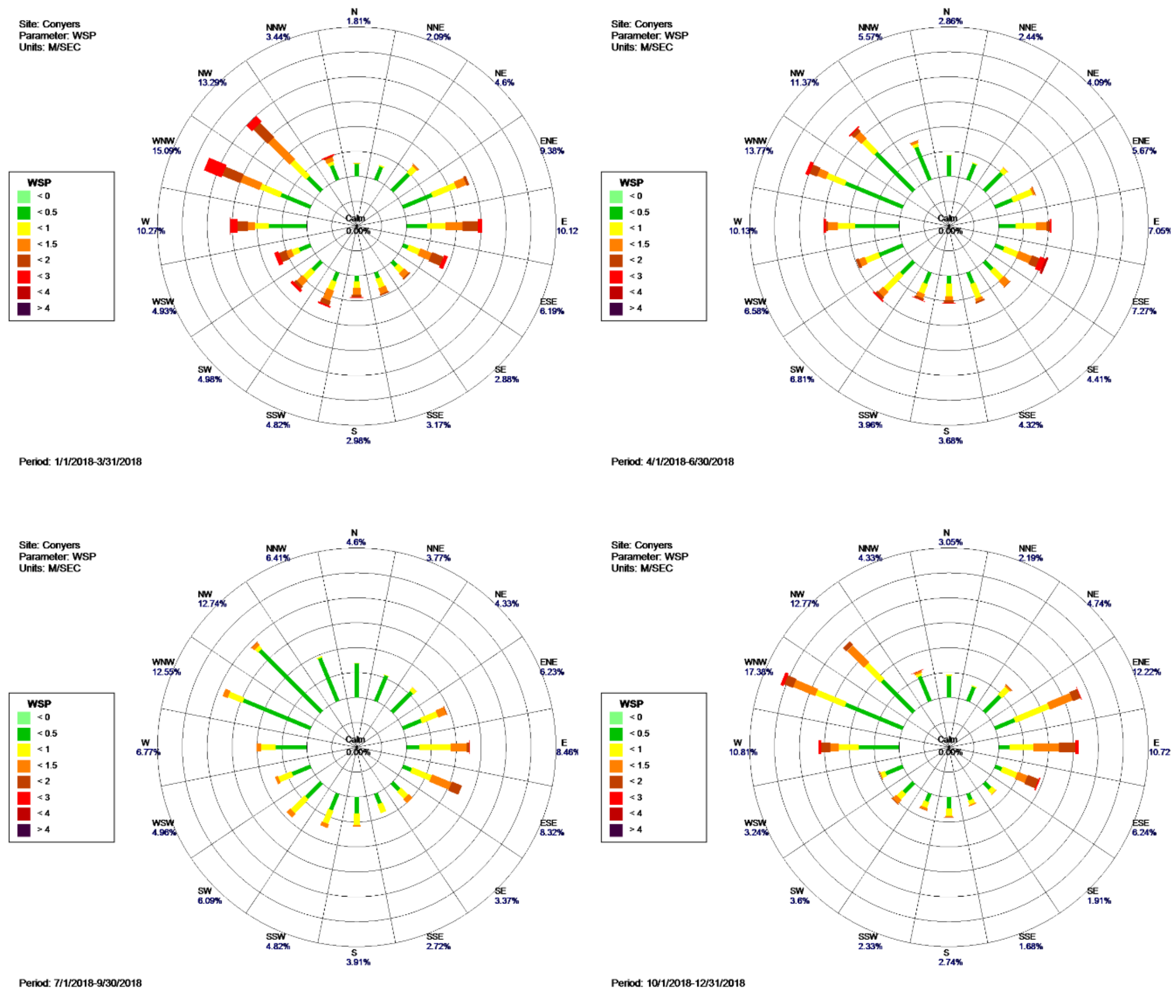
Augusta, 2018 Quarterly Winds



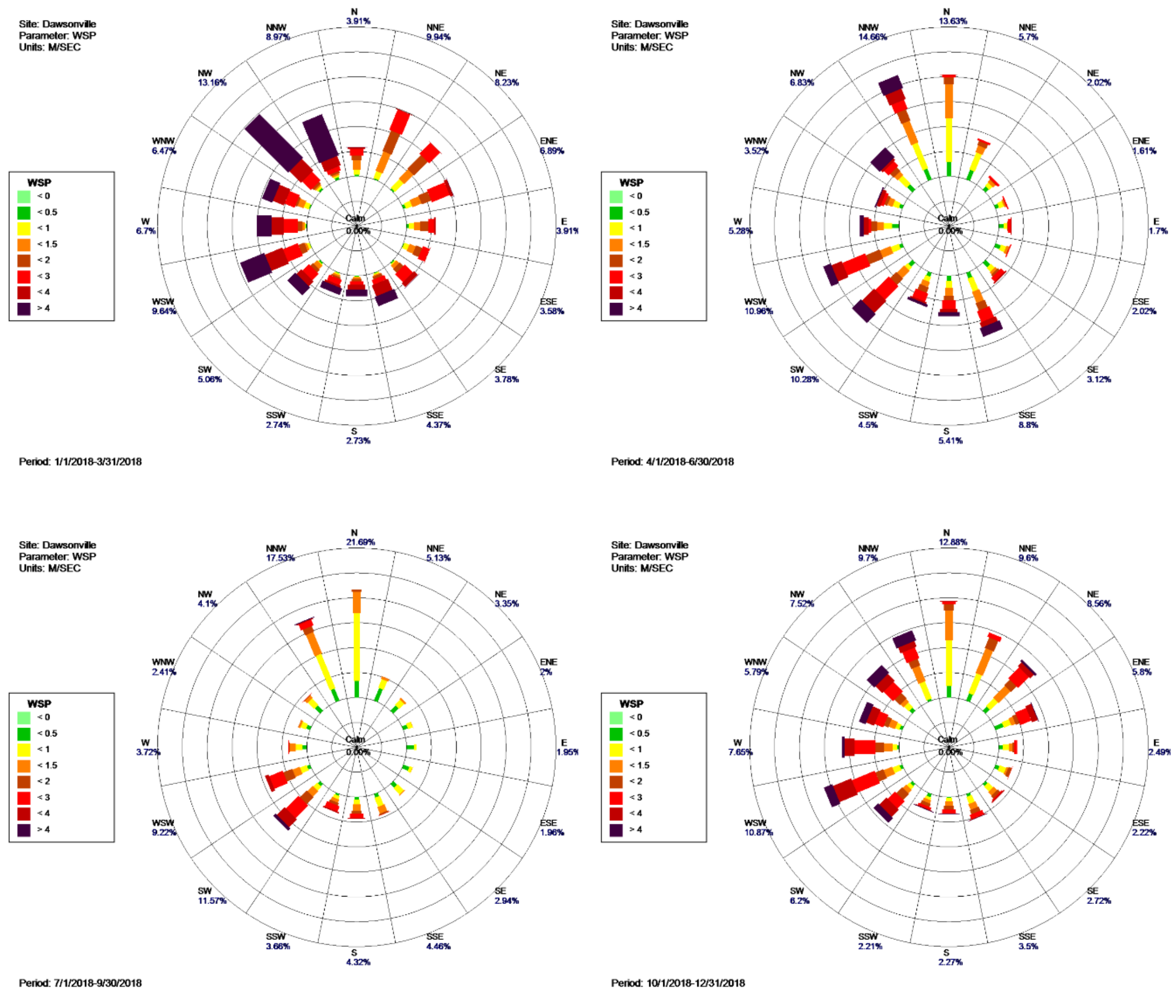
Brunswick, 2018 Quarterly Winds



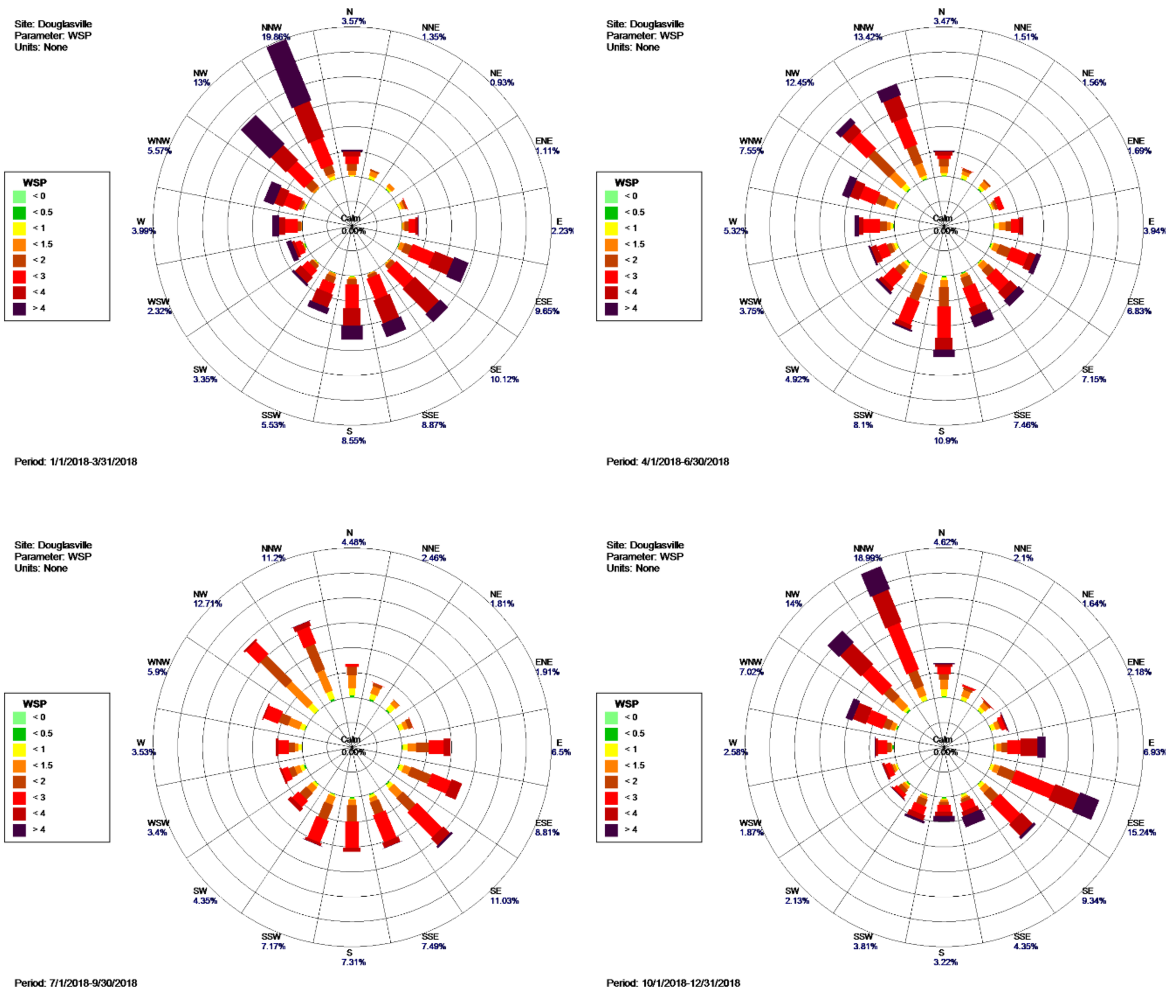
Columbus-Crime Lab, 2018 Quarterly Winds



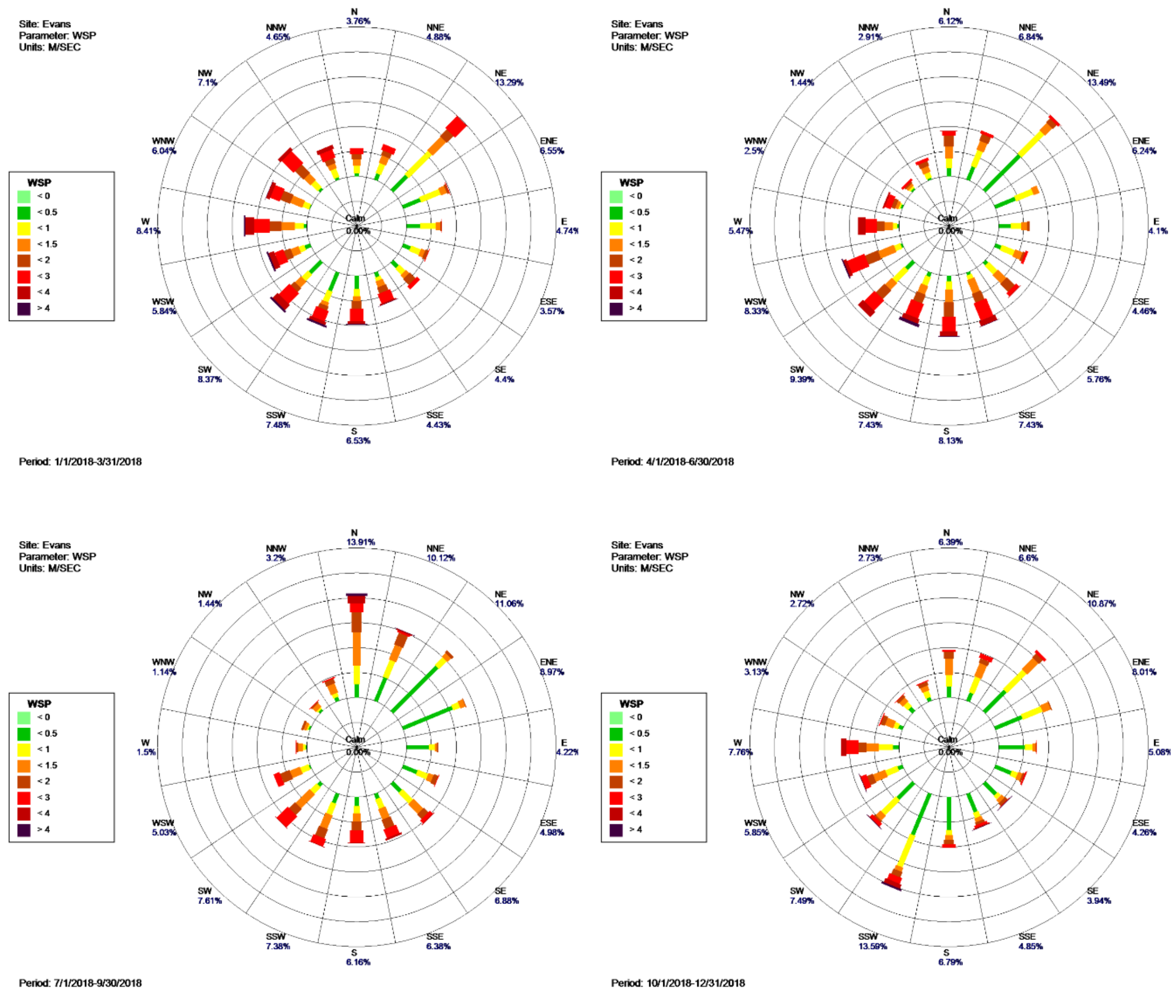
Conyers, 2018 Quarterly Winds



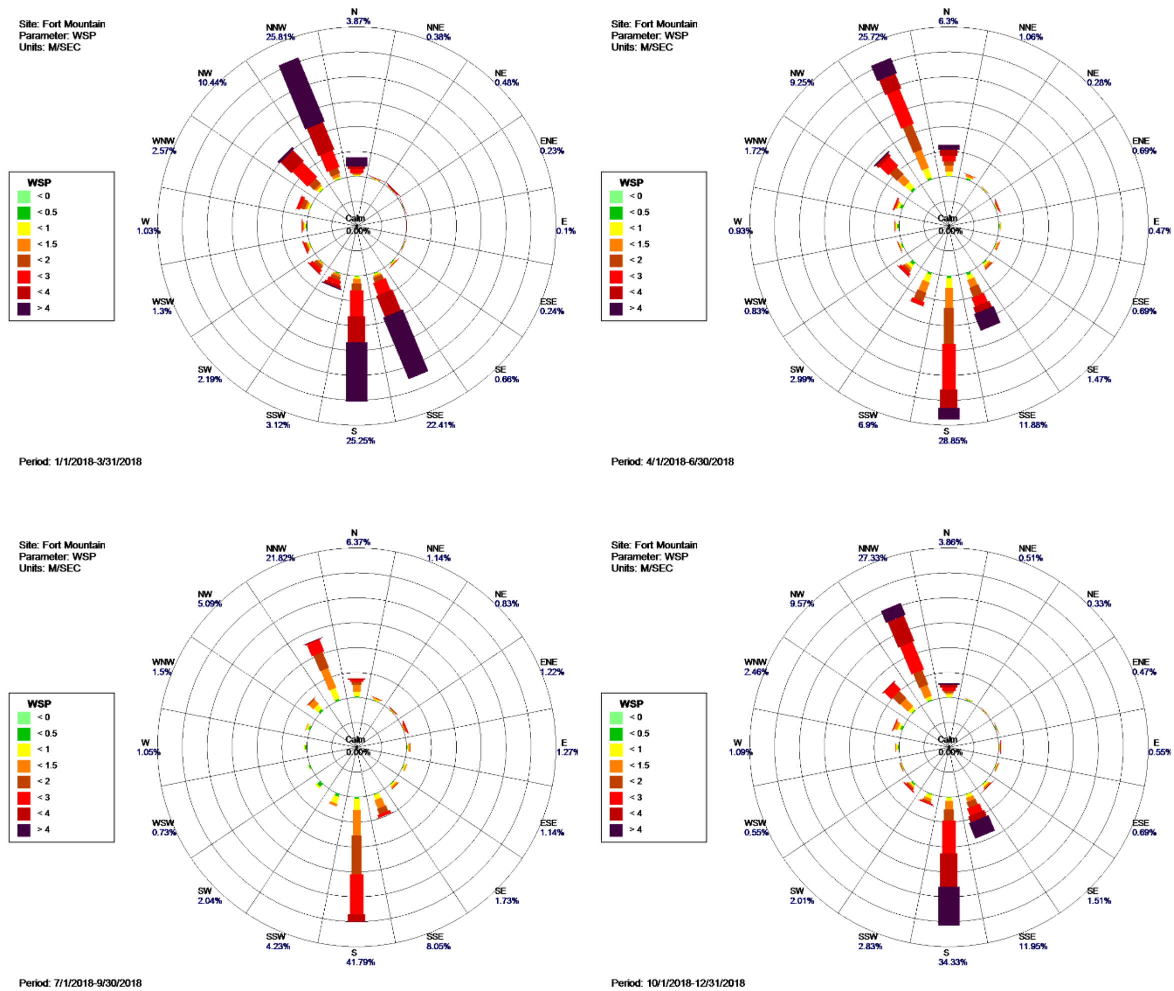
Dawsonville, 2018 Quarterly Winds



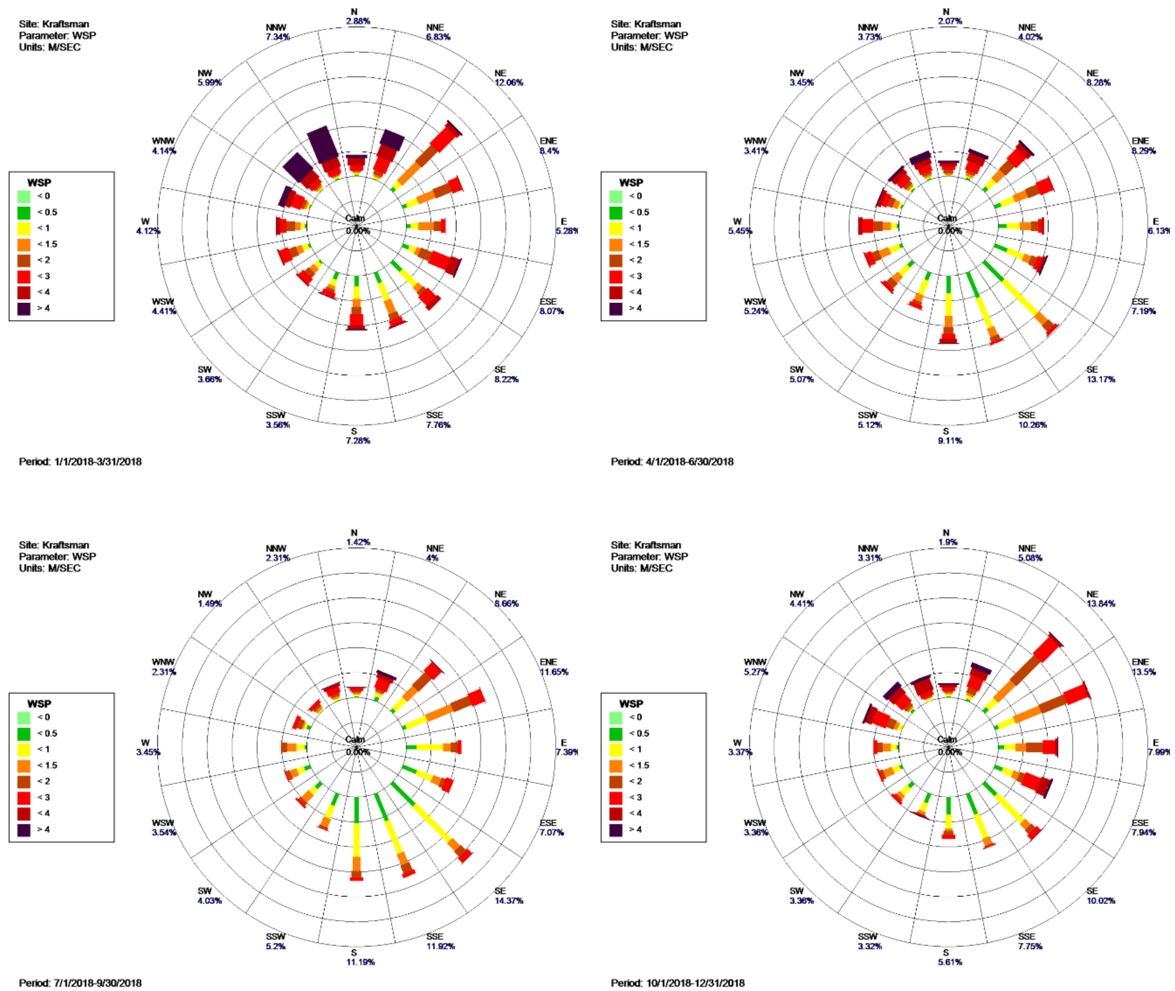
Douglasville, 2018 Quarterly Winds



Evans, 2018 Quarterly Winds



Fort Mountain, 2018 Quarterly Winds



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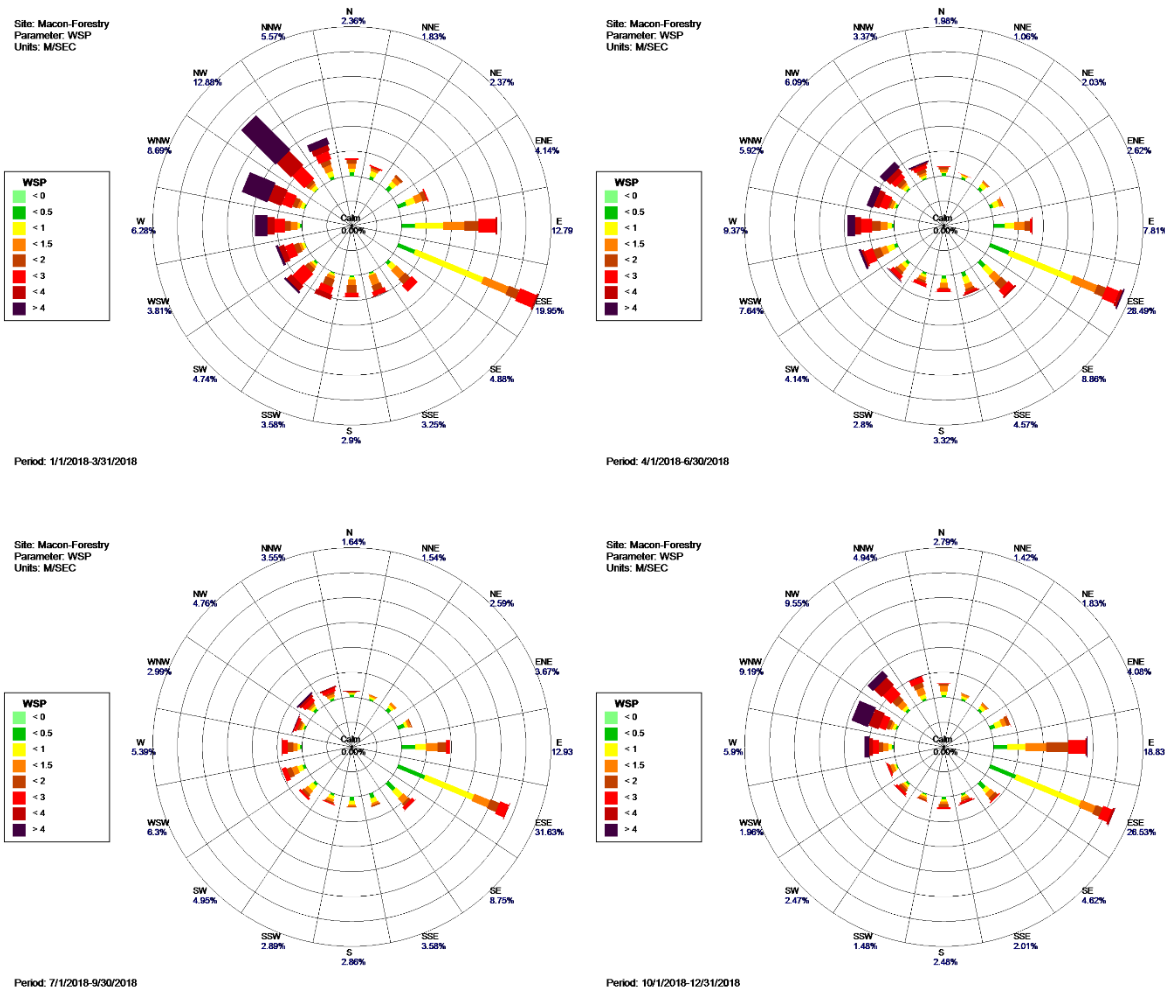

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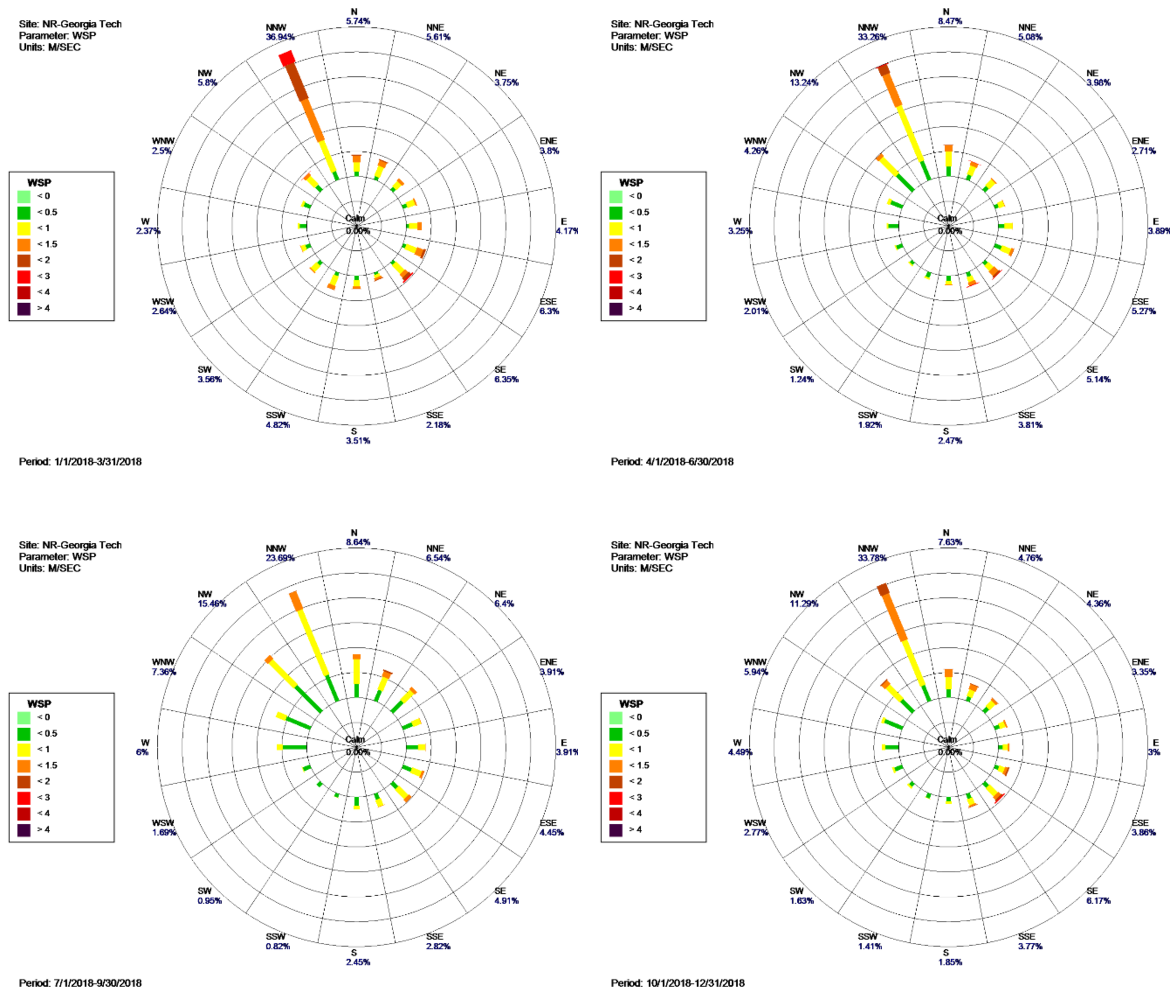

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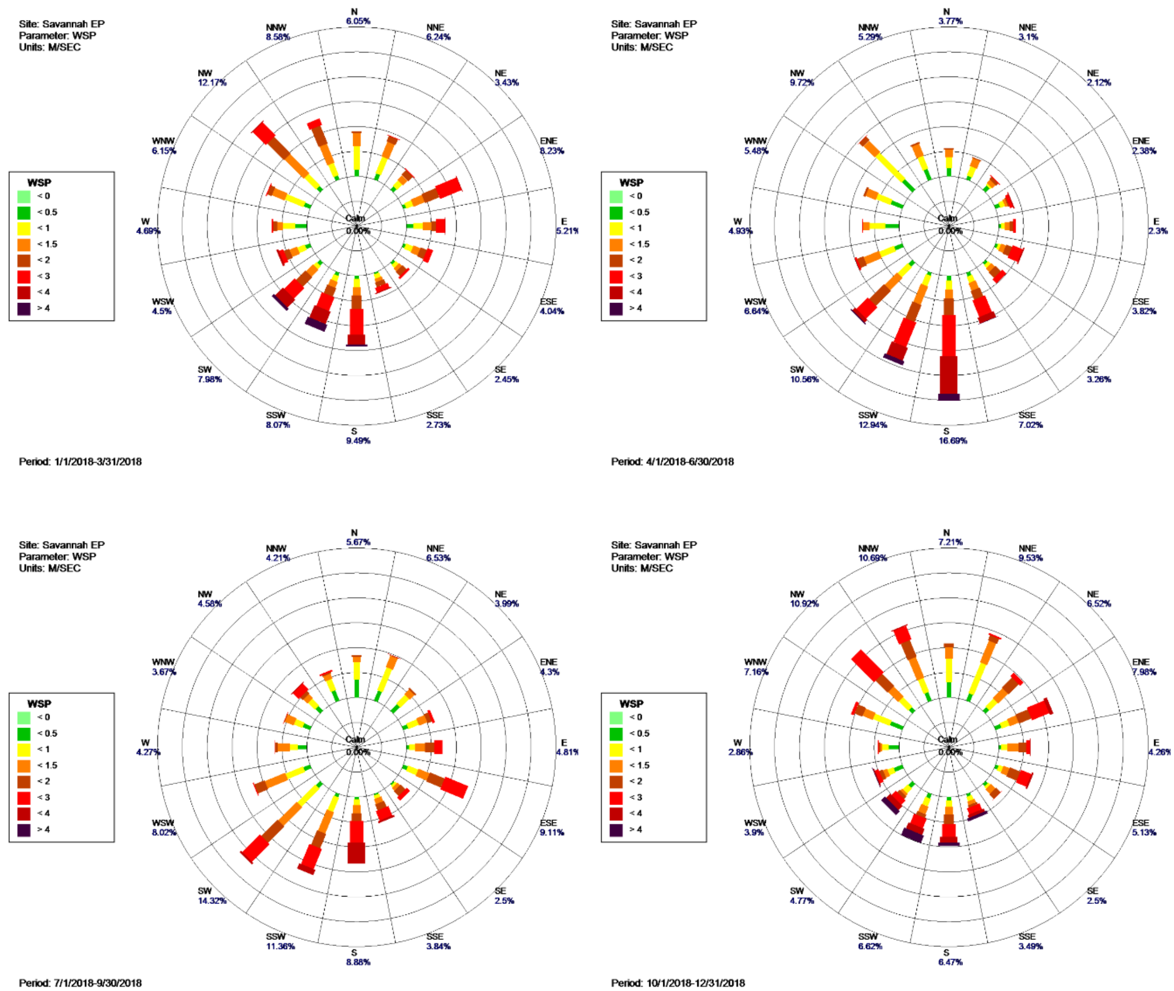

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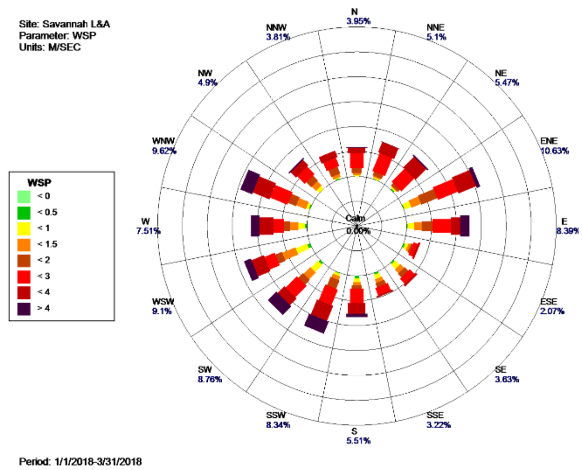

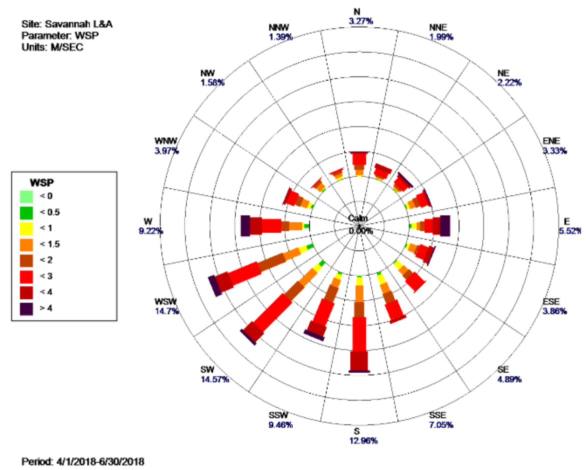

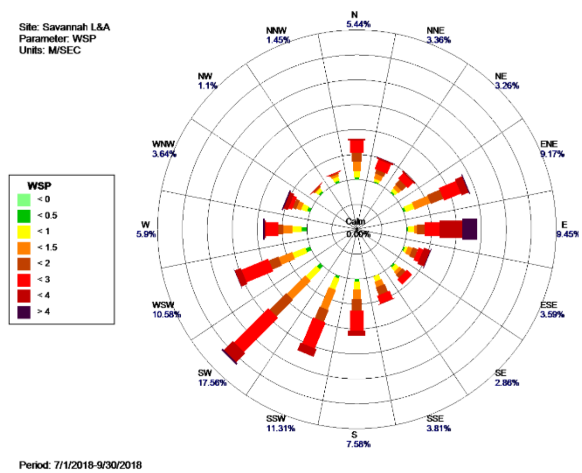

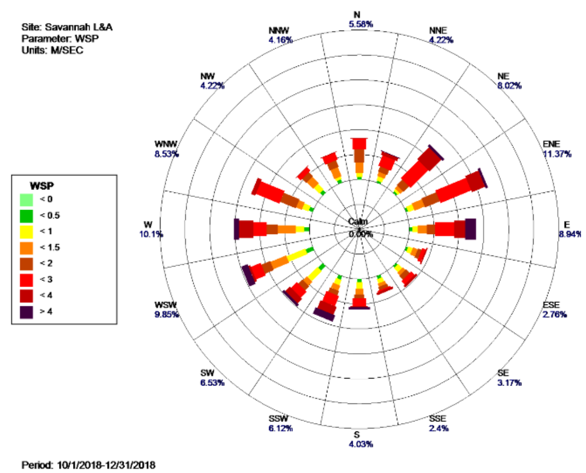

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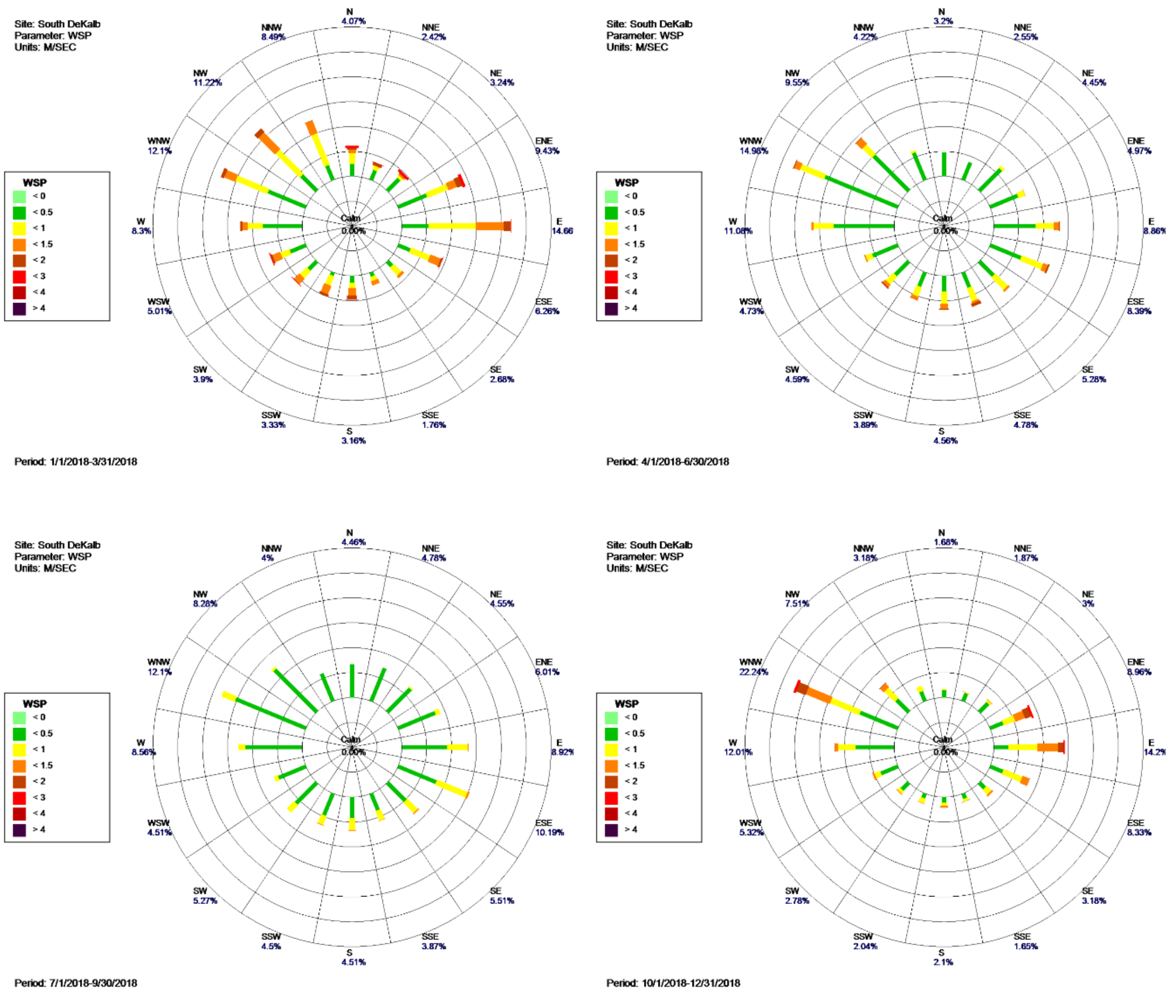

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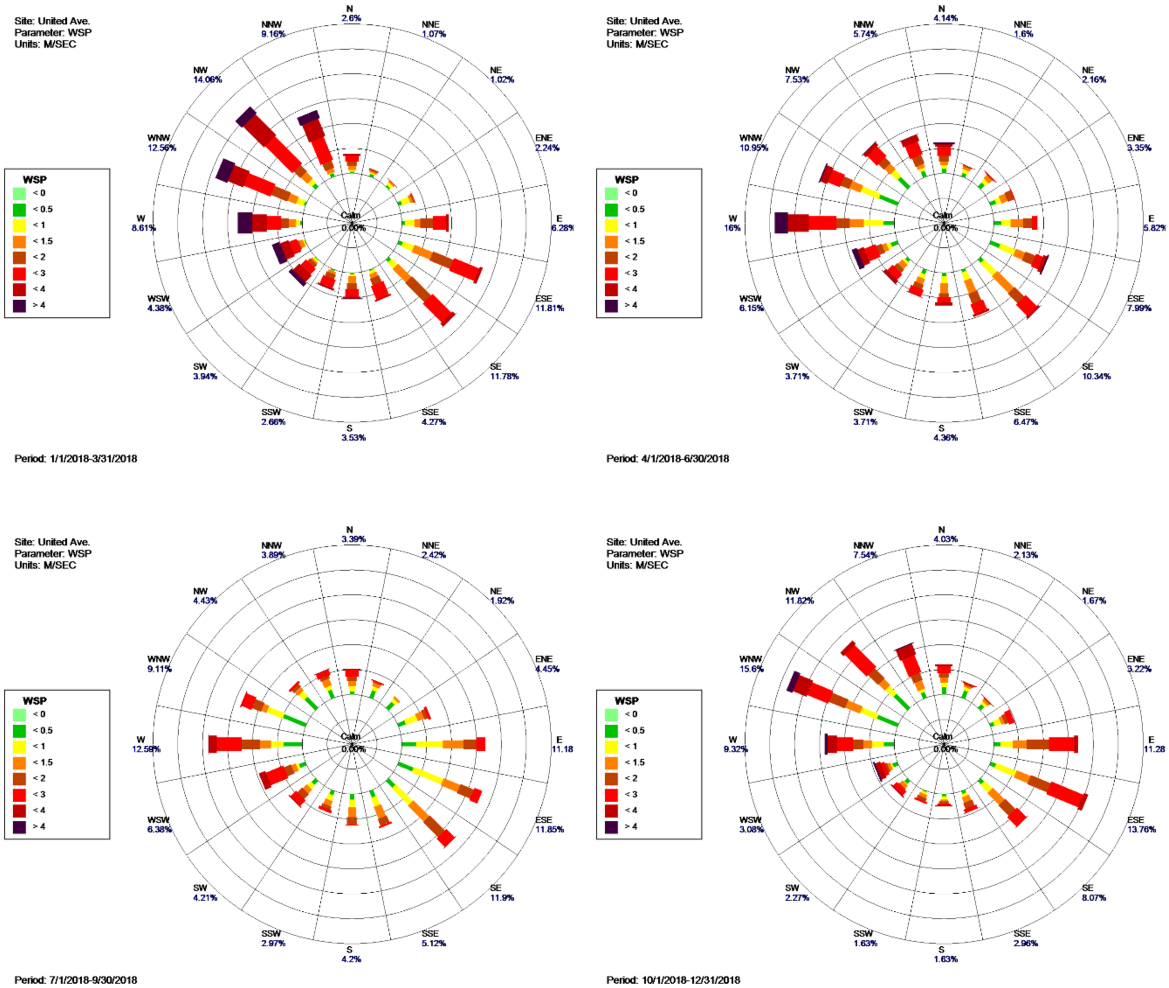

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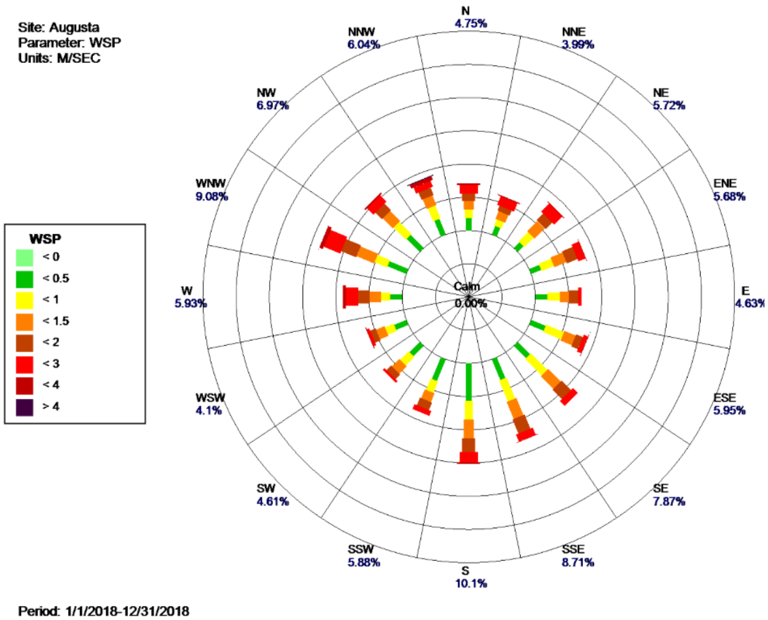

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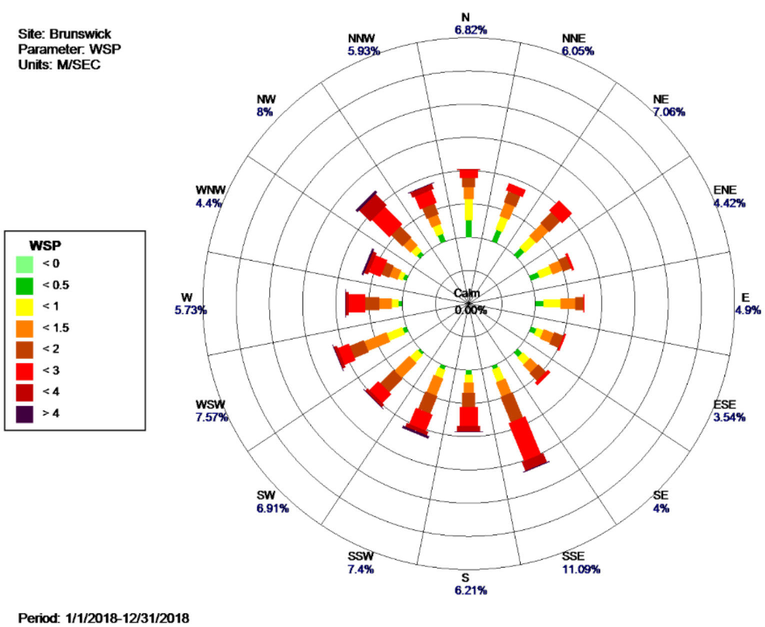

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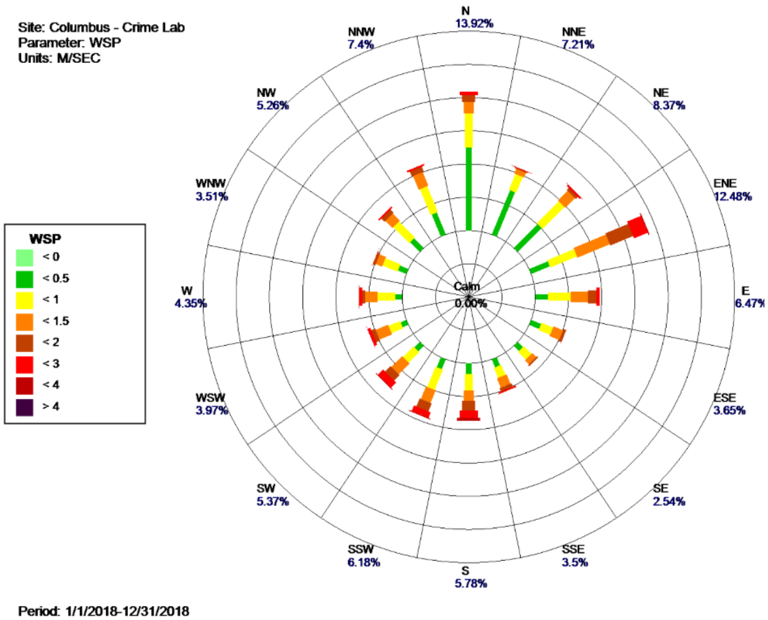

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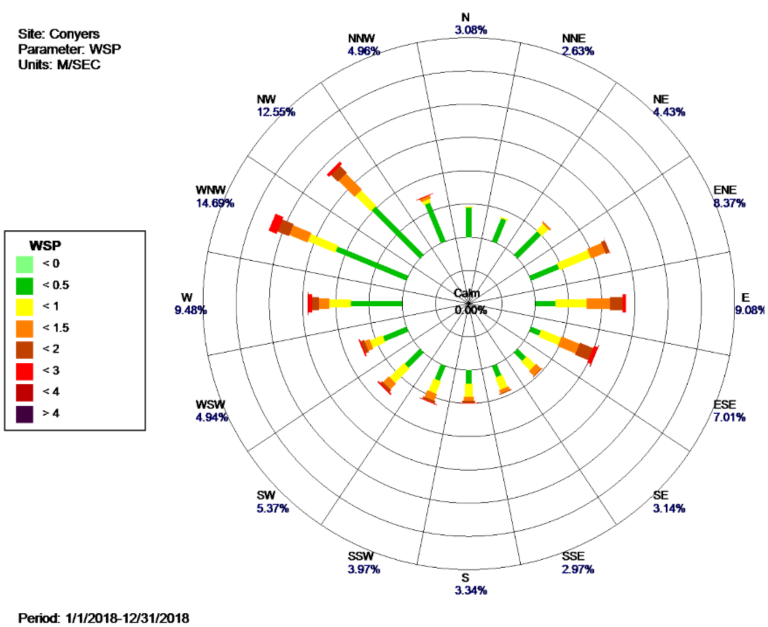
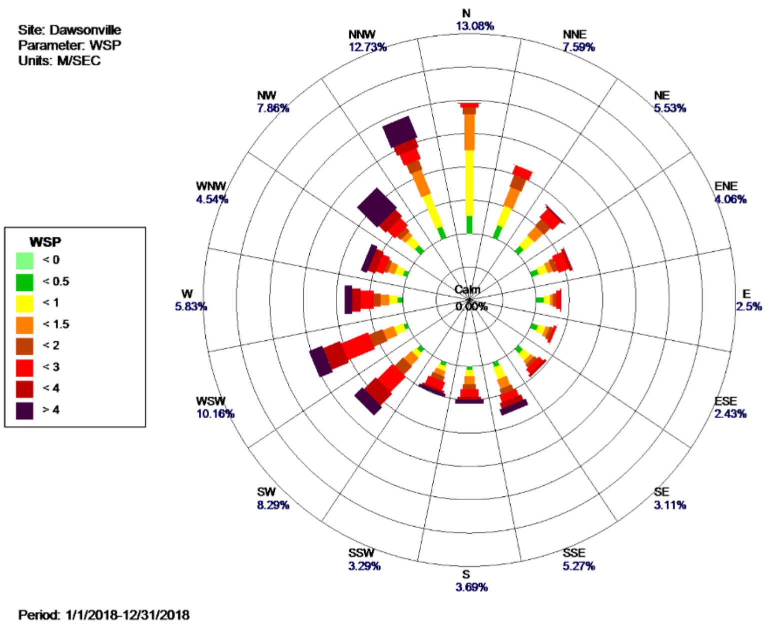
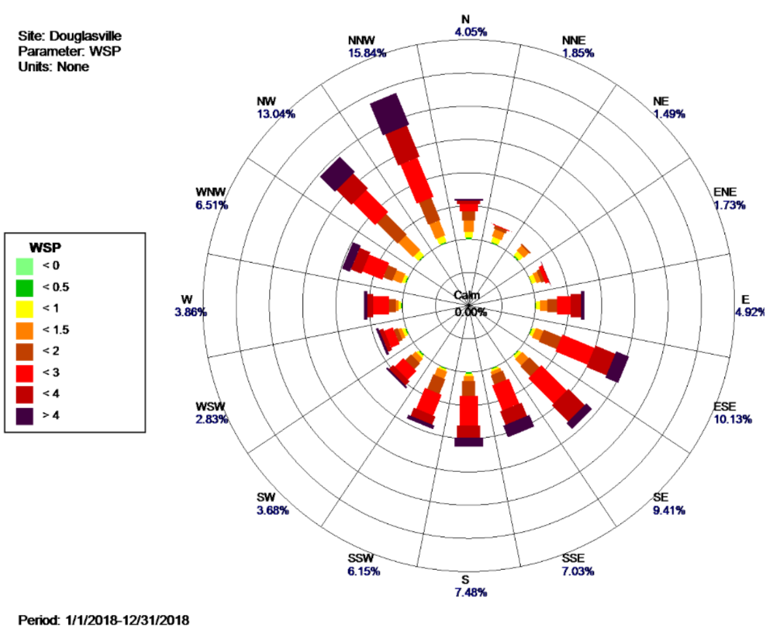


Conyers, 2018 Annual Winds



Dawsonville, 2018 Annual Winds



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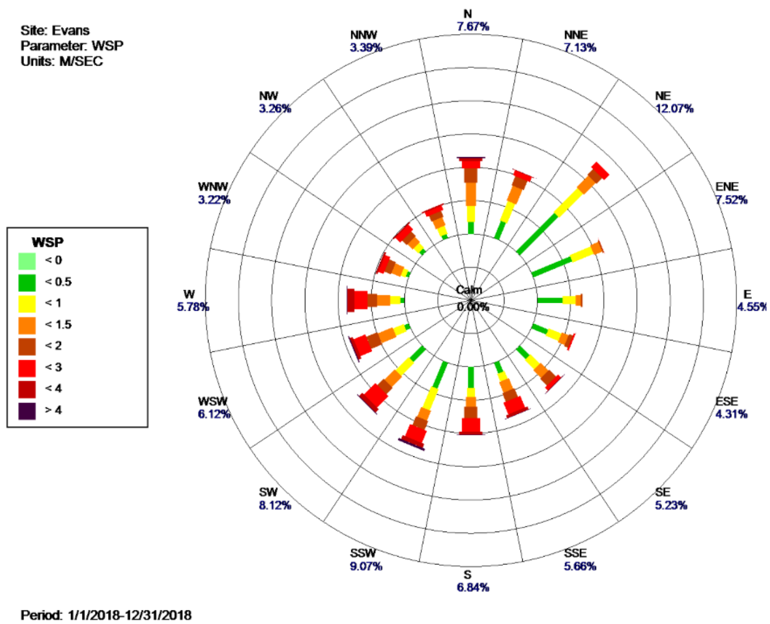
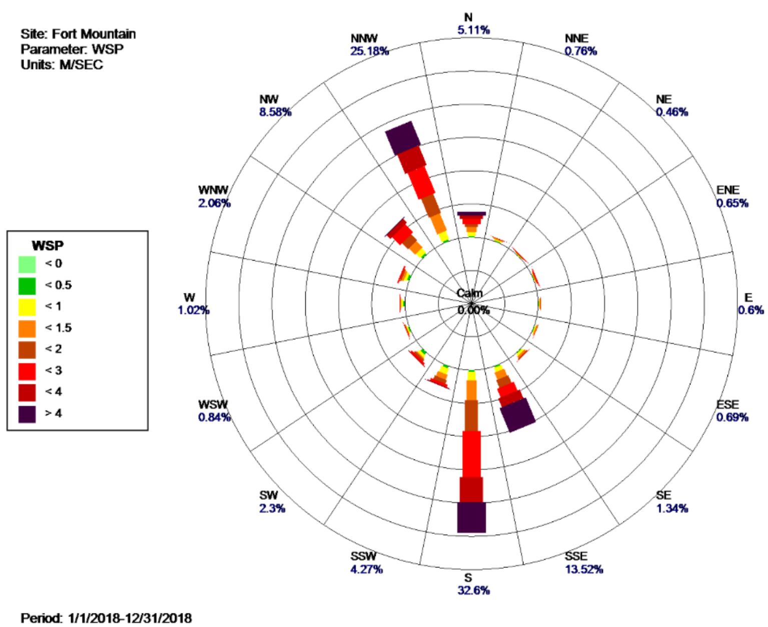
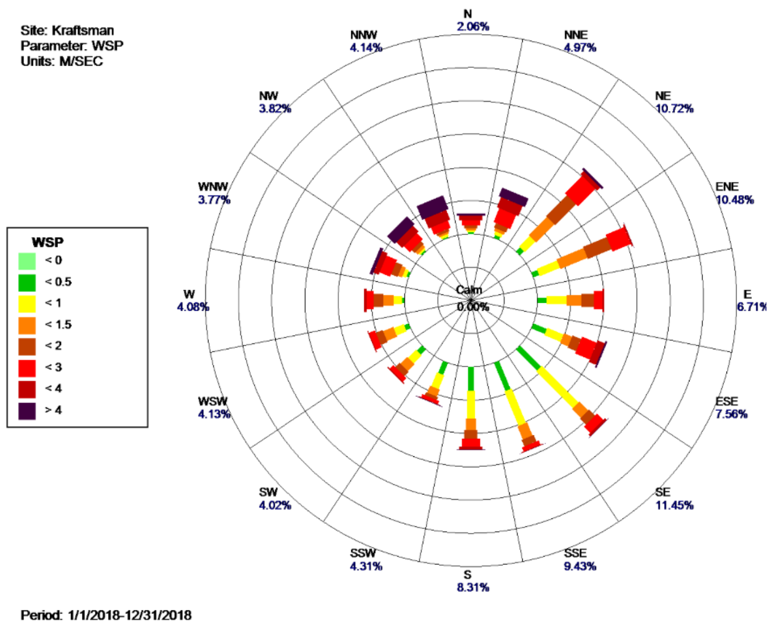


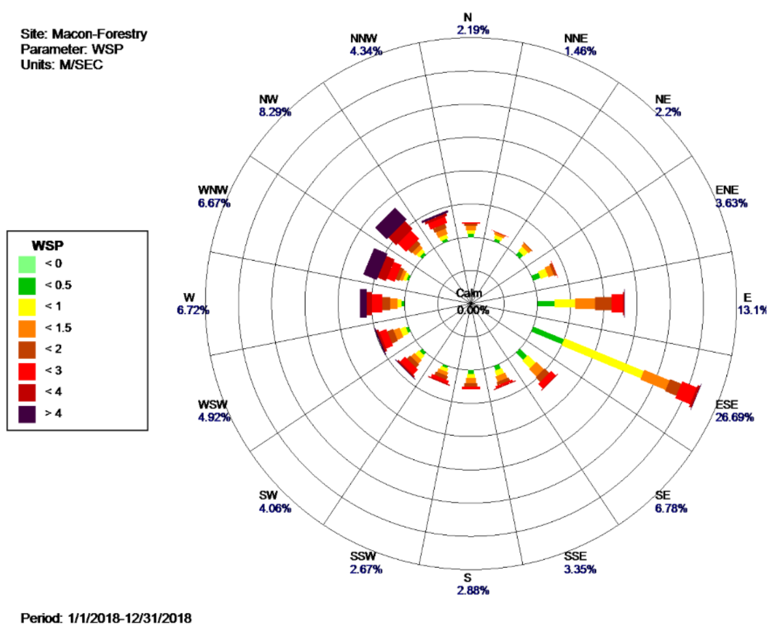
Evans, 2018 Annual Winds



Fort Mountain, 2018 Annual Winds



Kraftsman, 2018 Annual Winds



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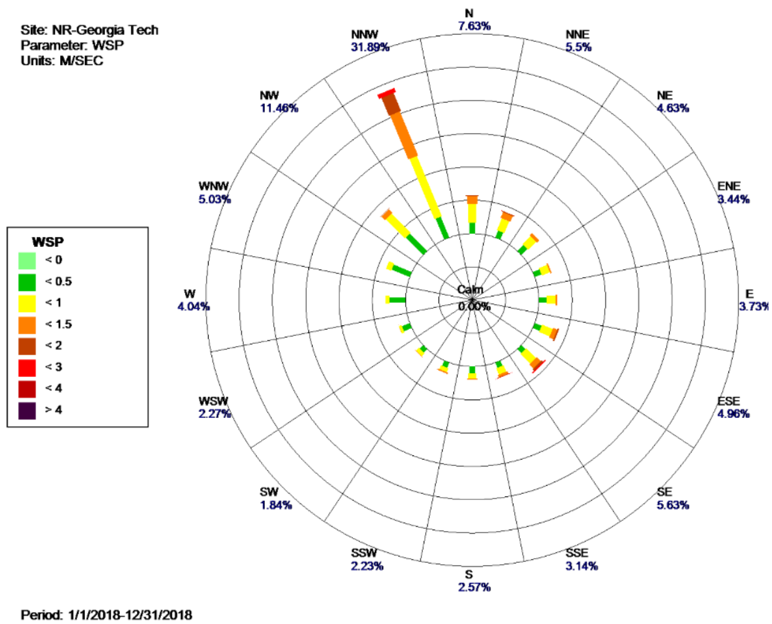
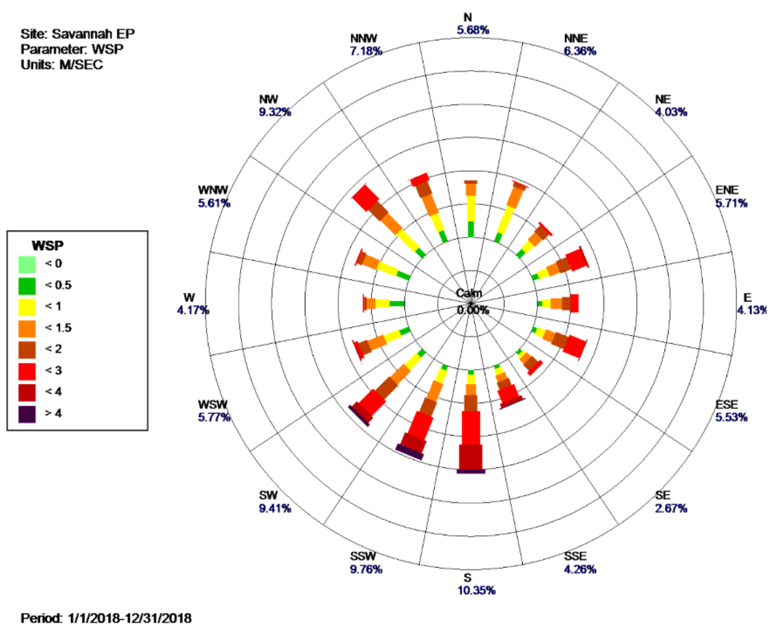
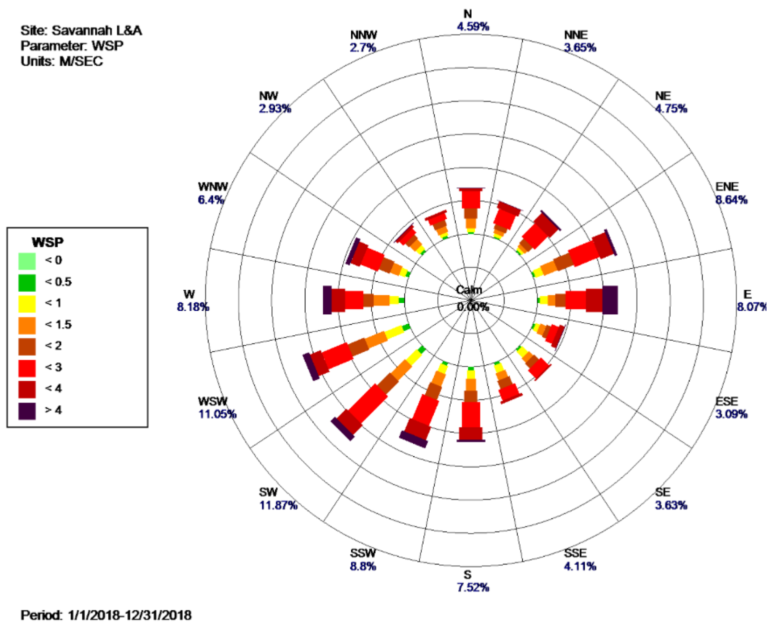


NR-GA Tech, 2018 Annual Winds



Savannah- E President, 2018 Annual Winds



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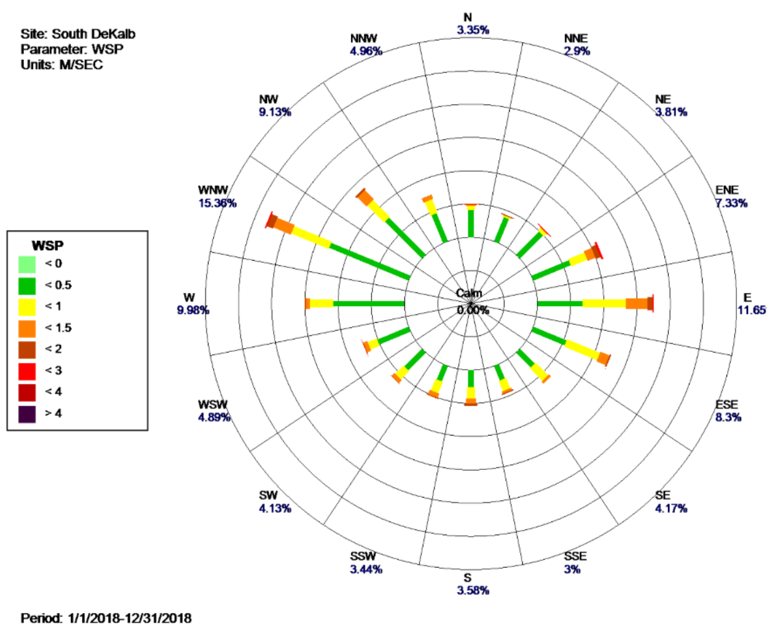

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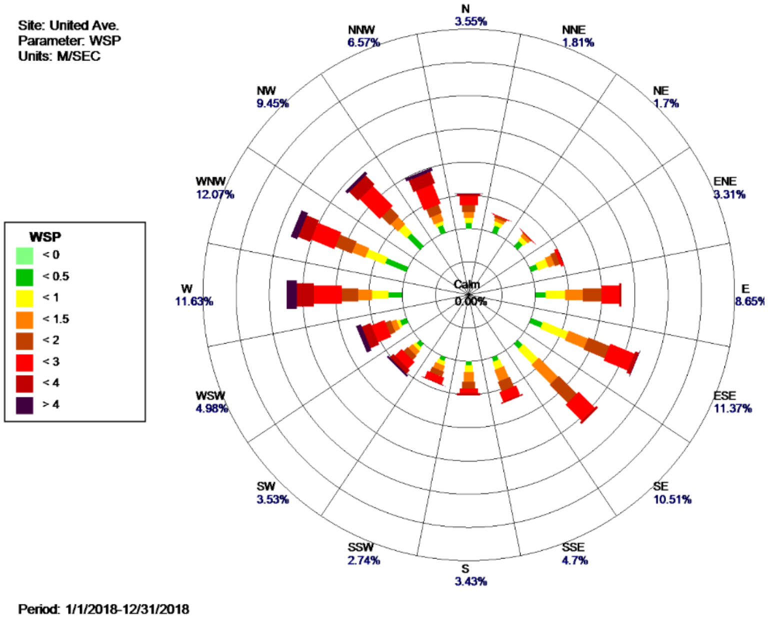

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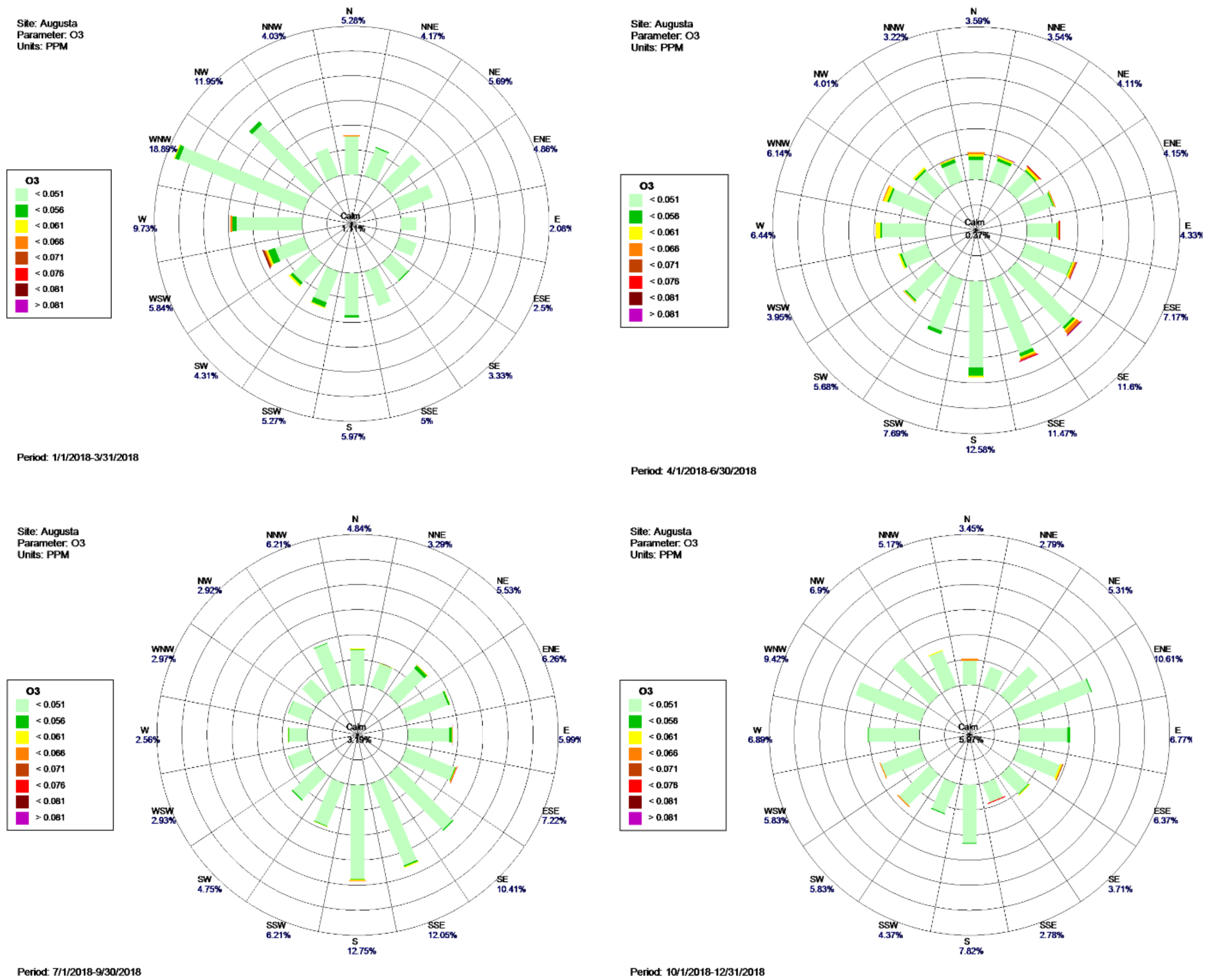
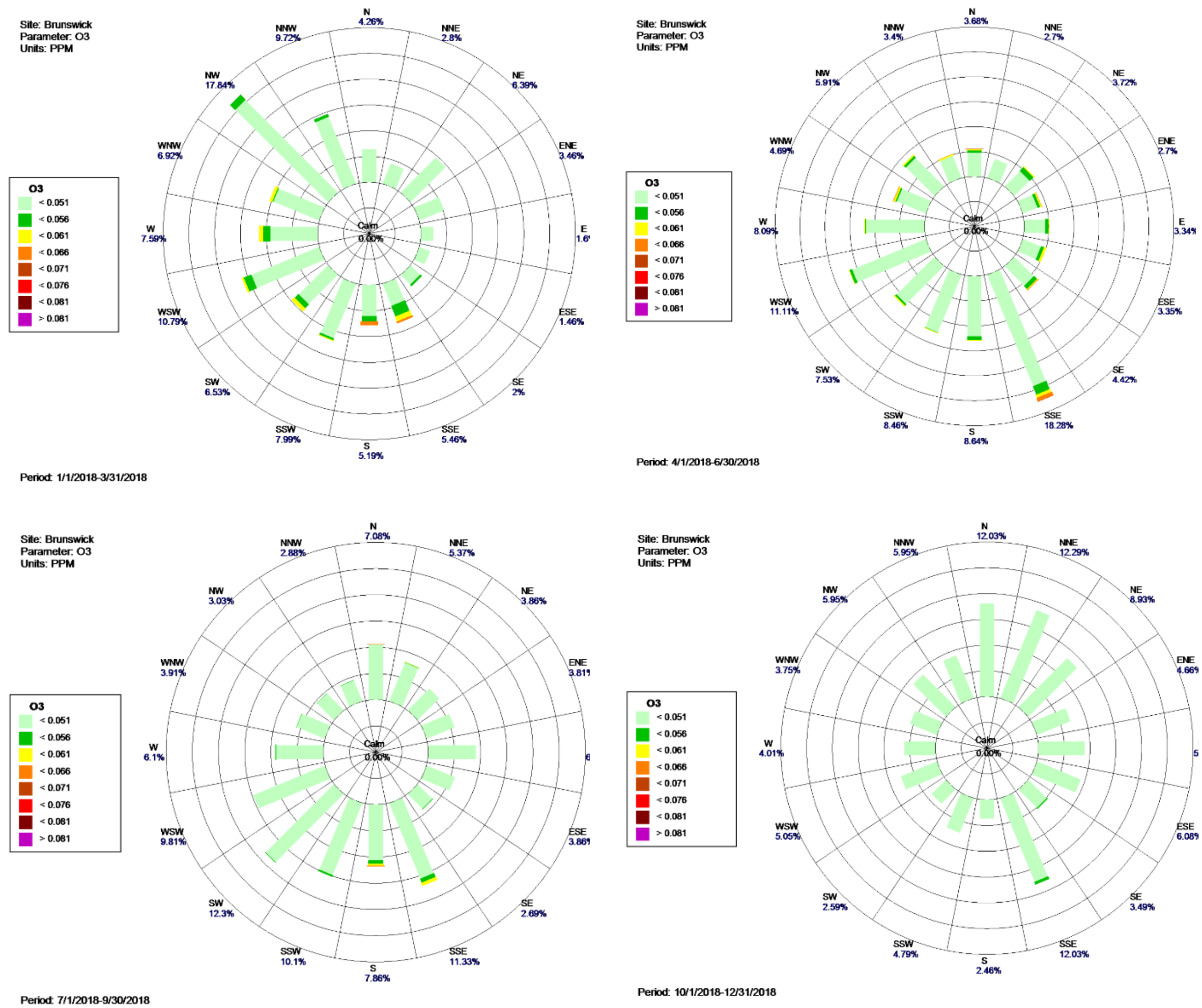
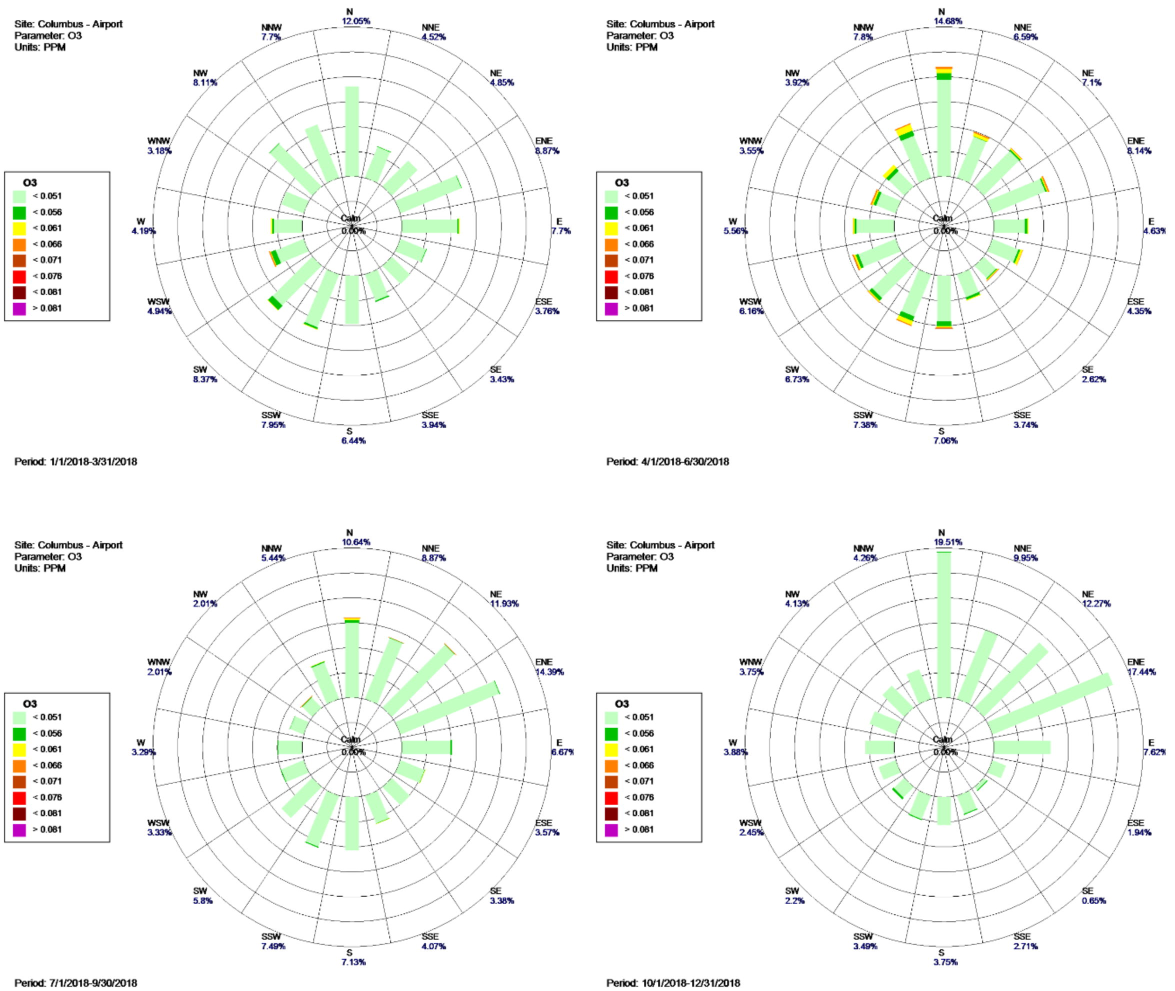


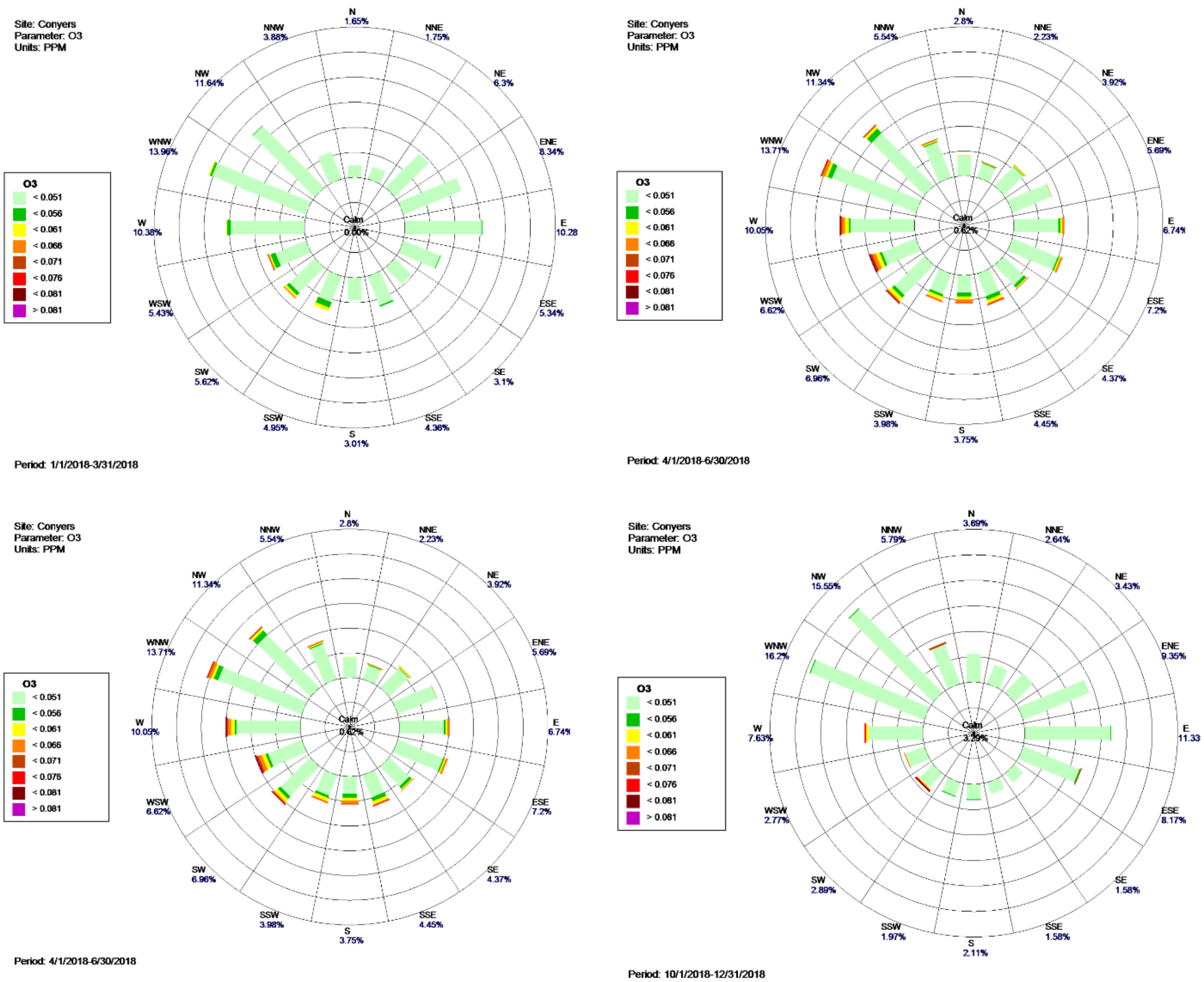
Augusta 2018, Quarterly Ozone



Brunswick, 2018 Quarterly Ozone



Columbus-Airport, 2018 Quarterly Ozone



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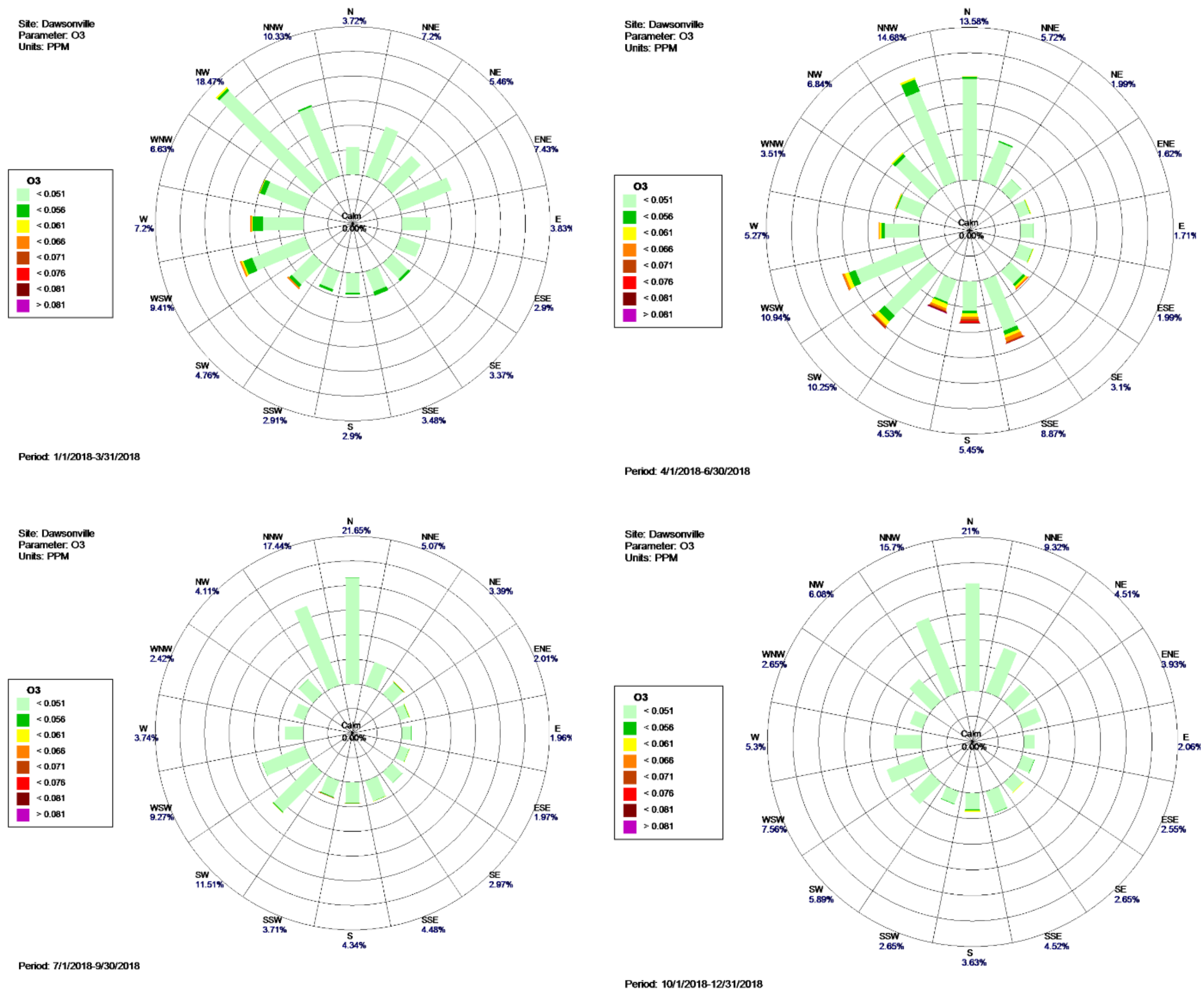

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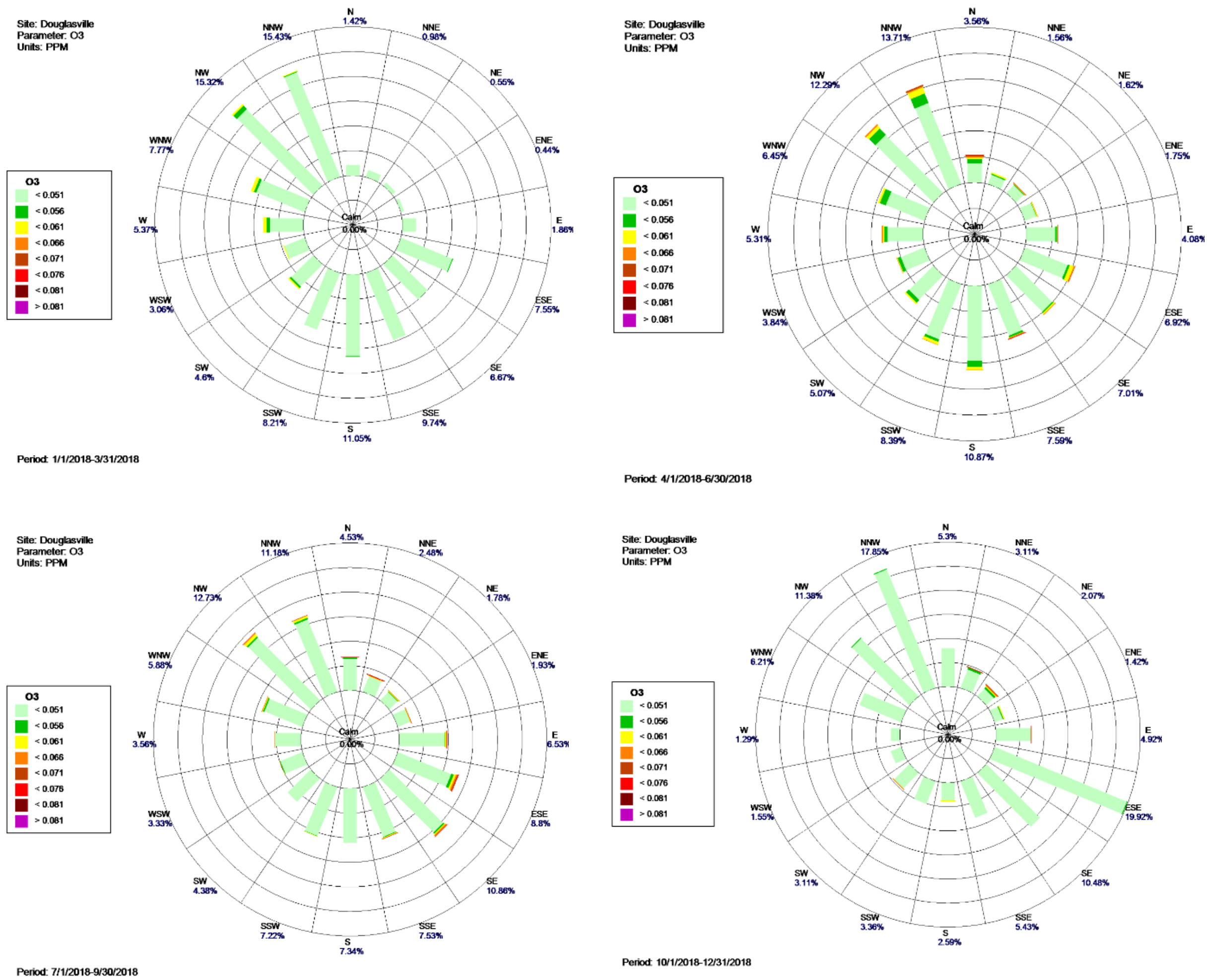

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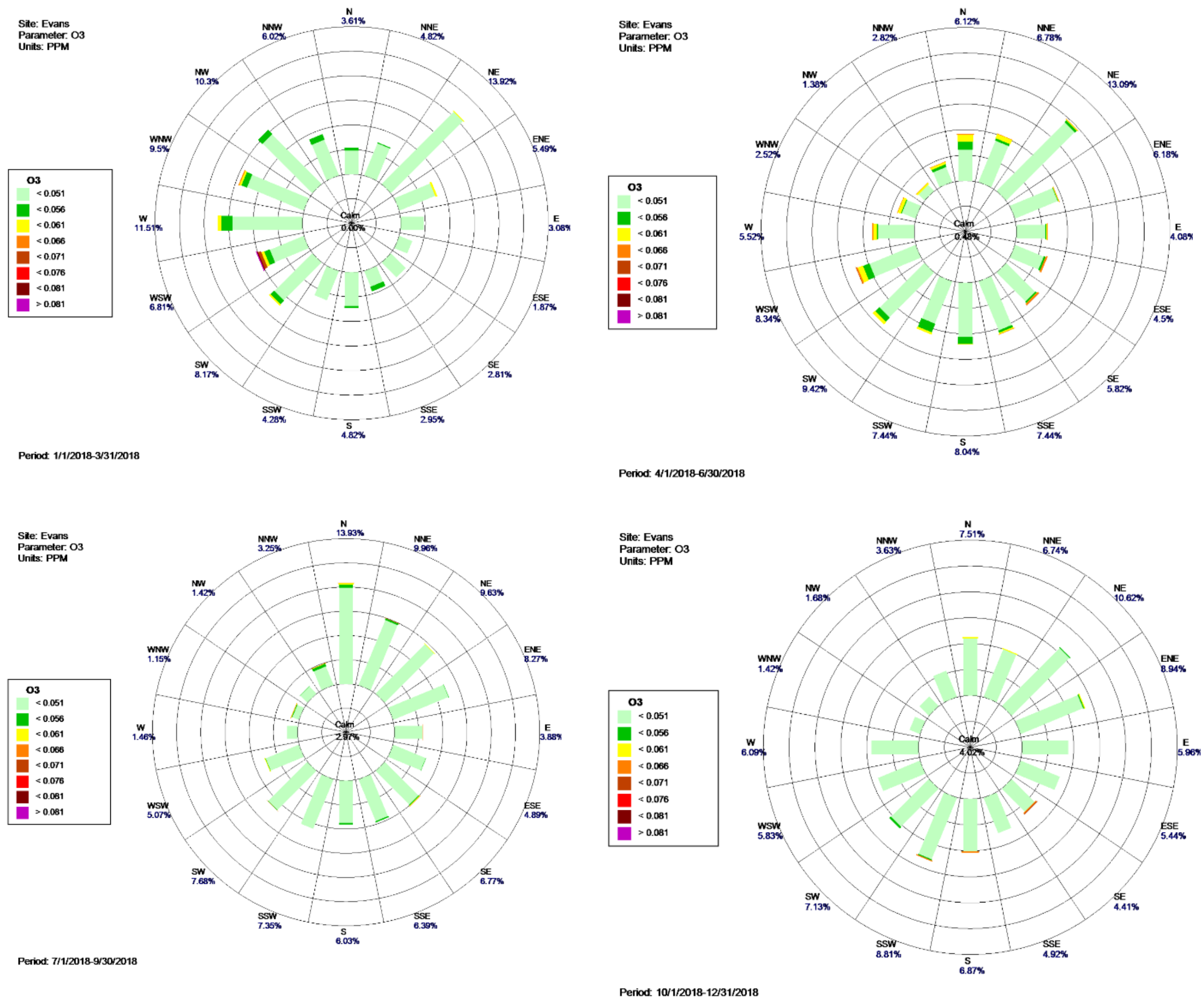

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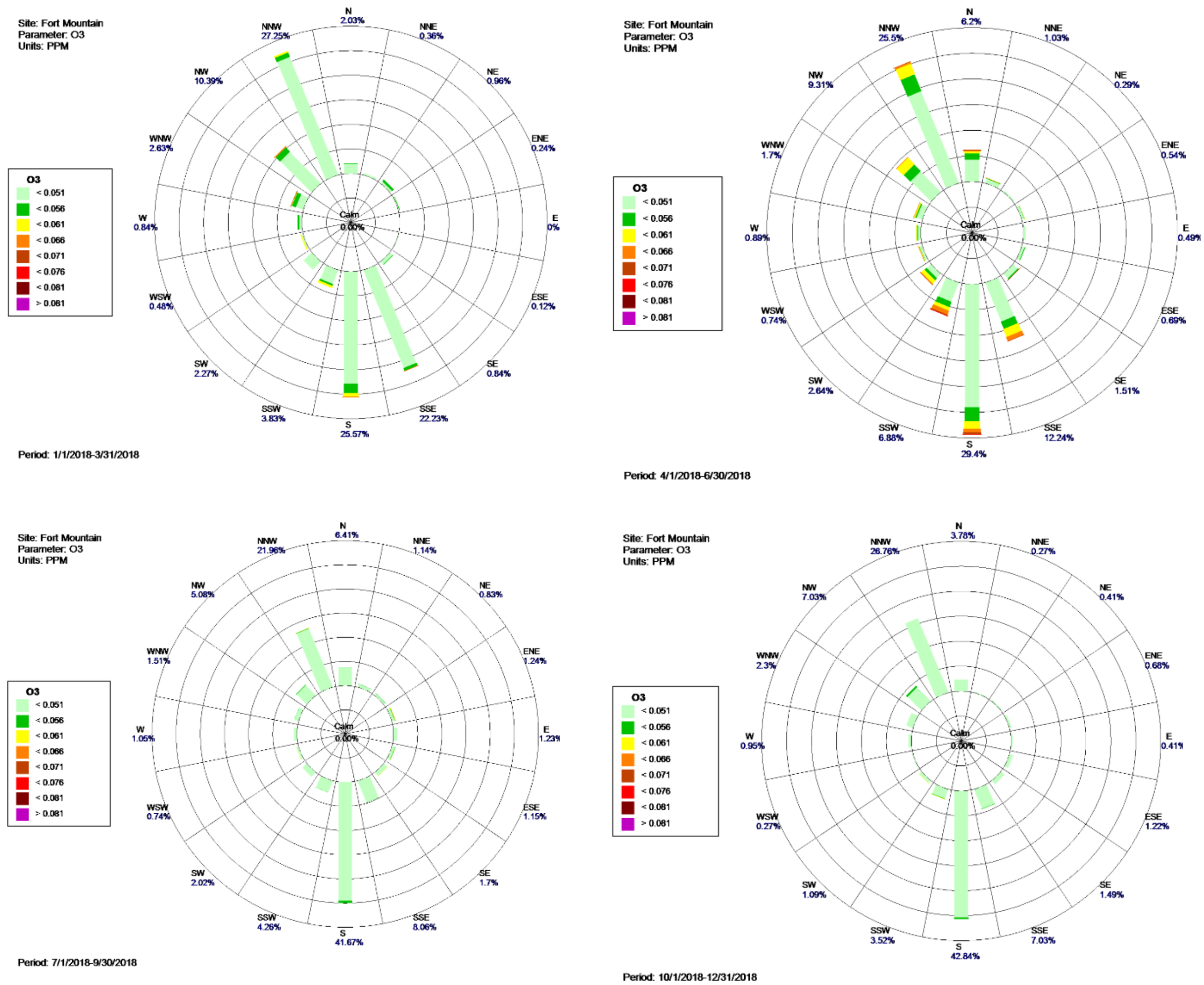

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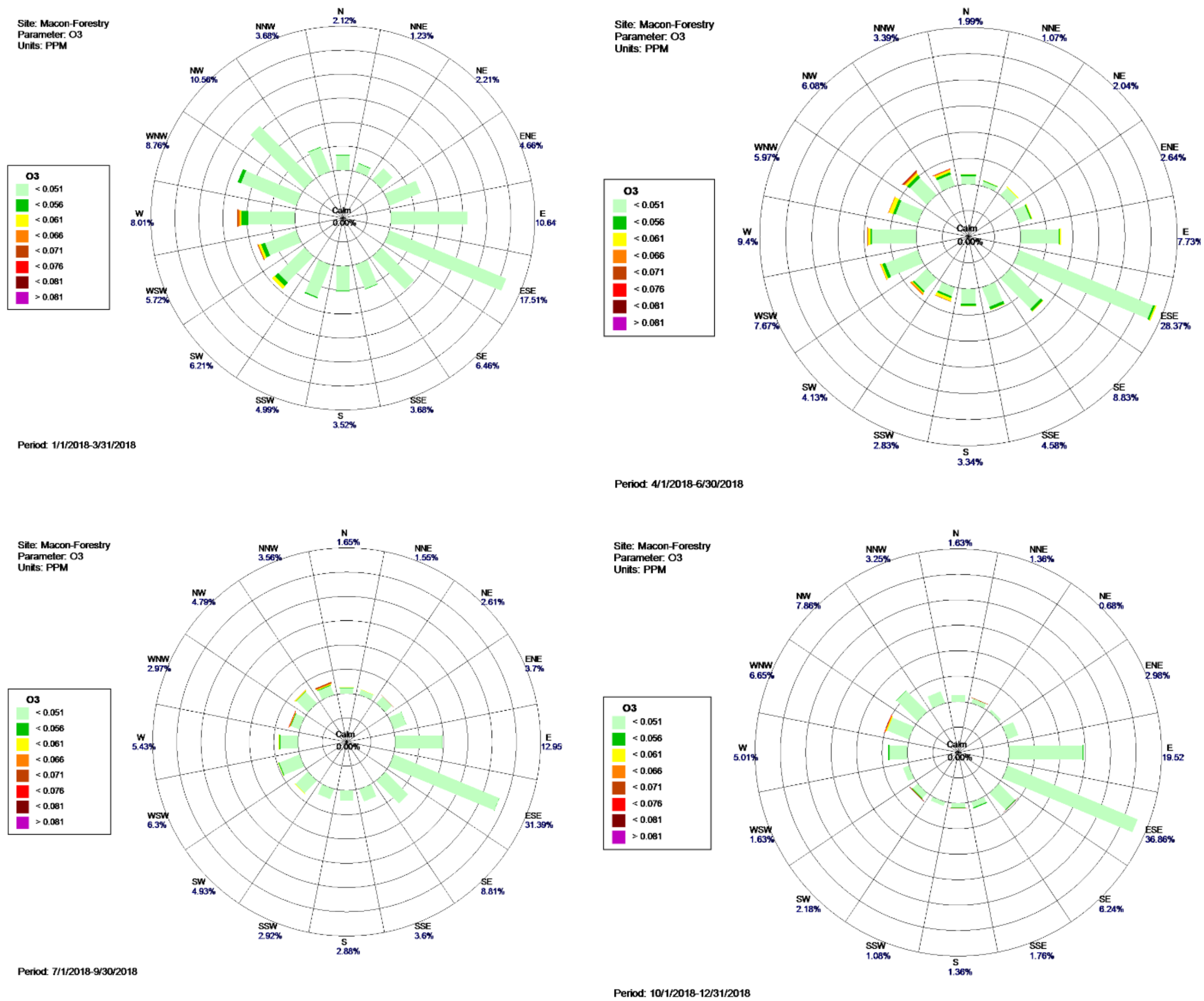

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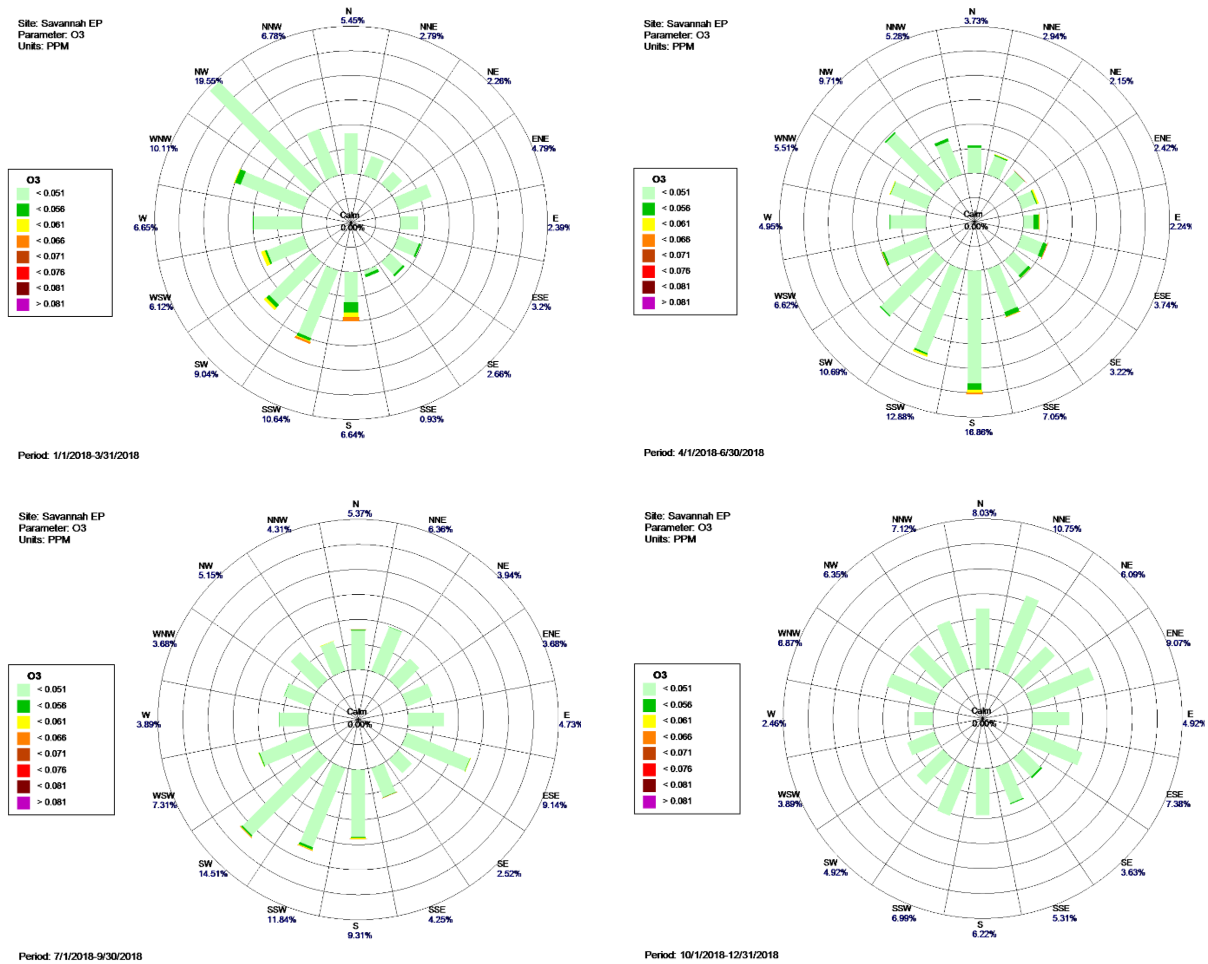

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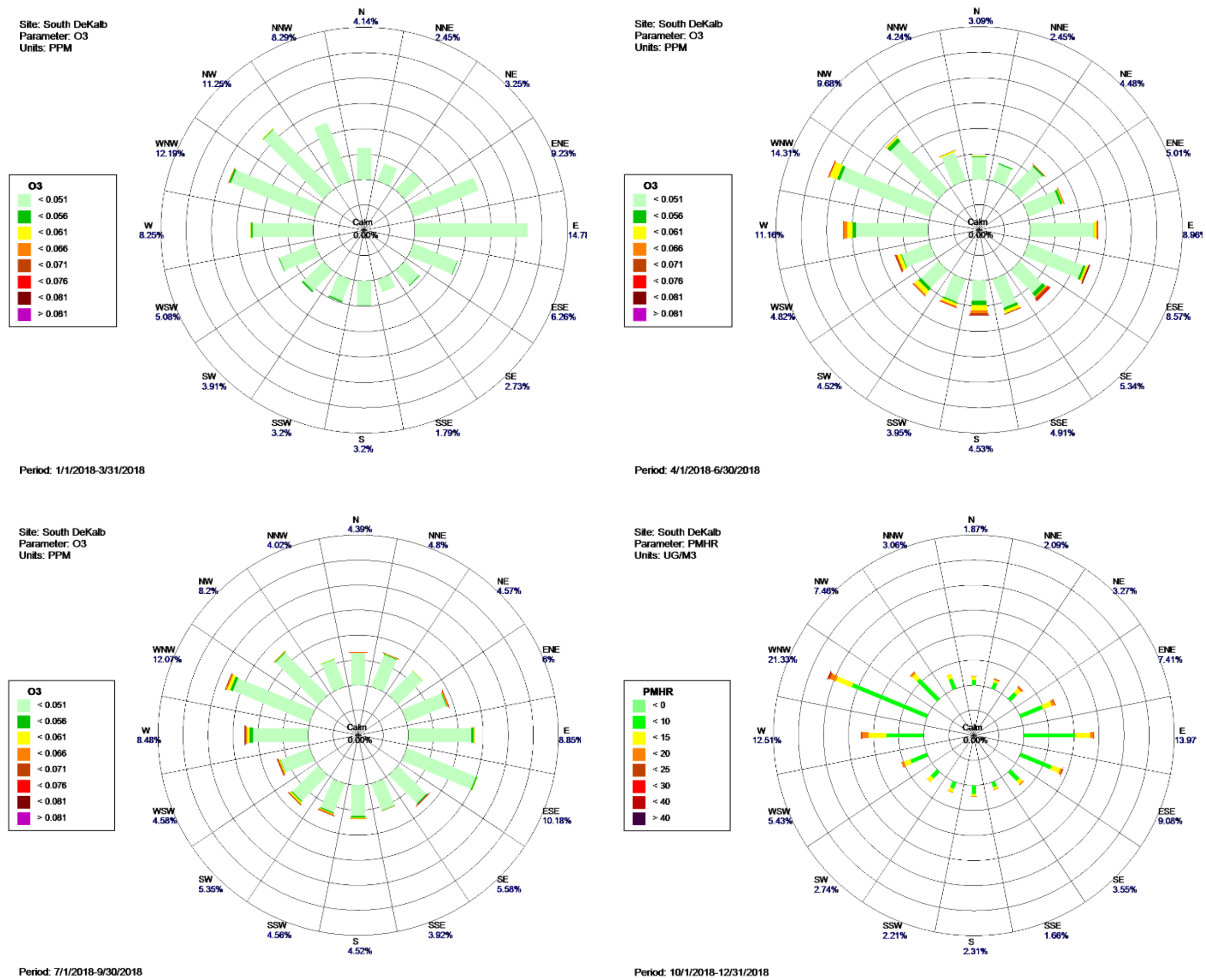

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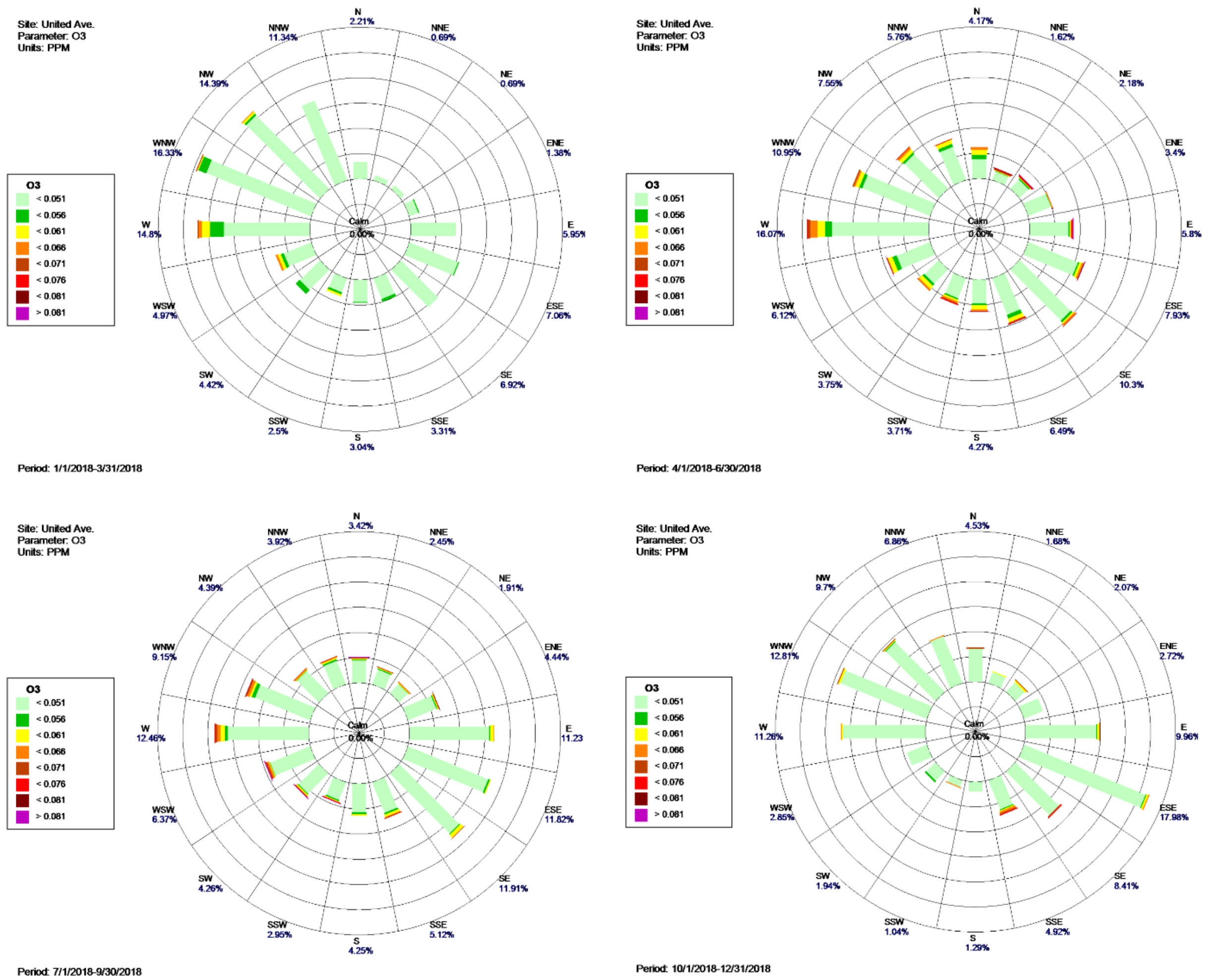

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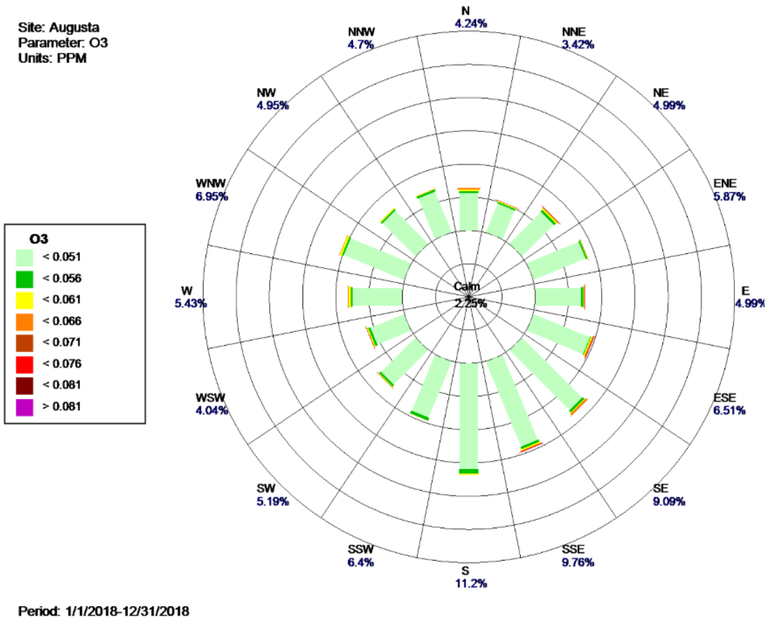

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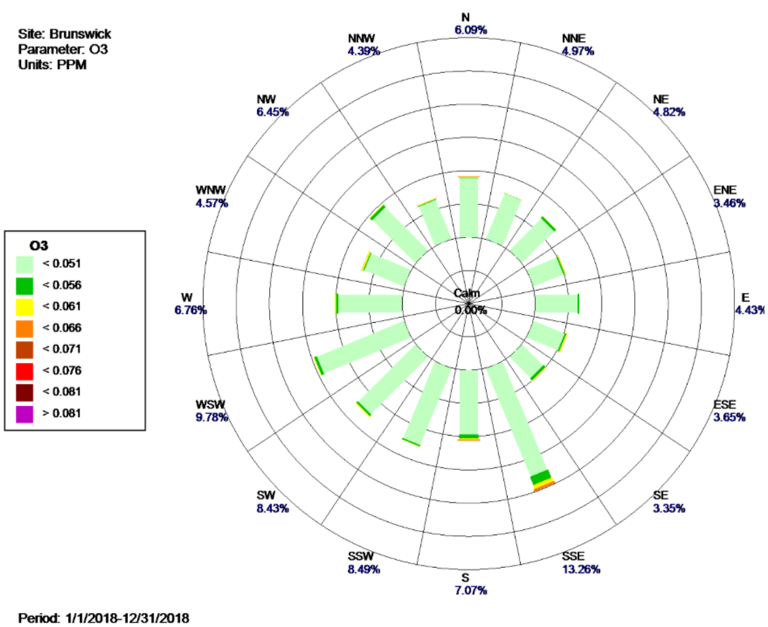

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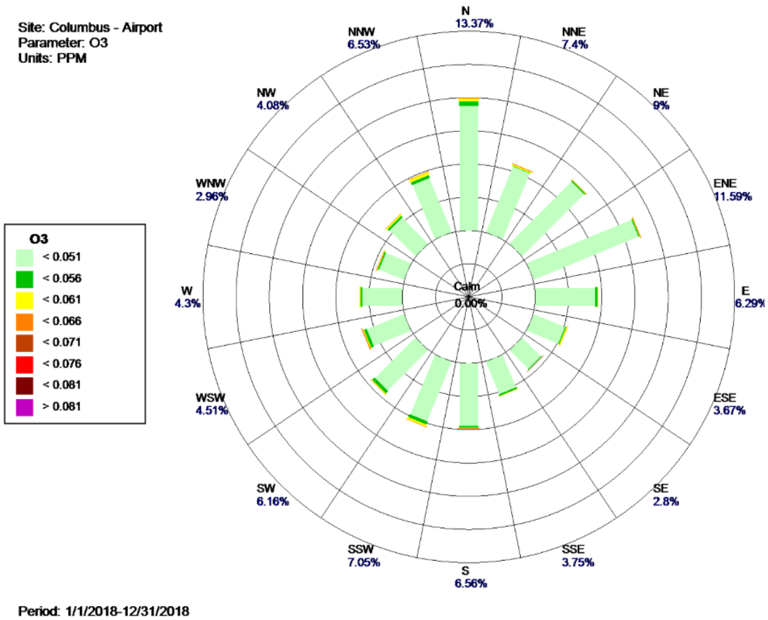
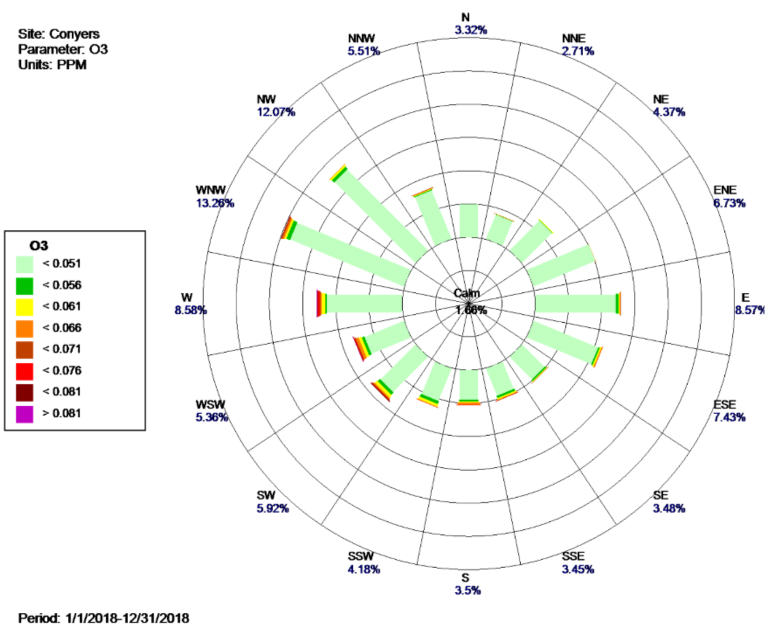


Columbus-Airport, 2018 Annual Ozone



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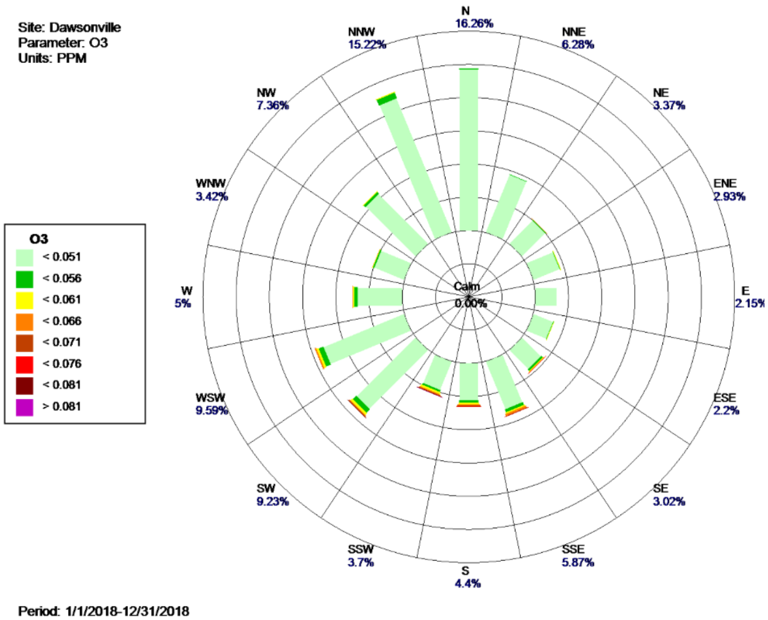

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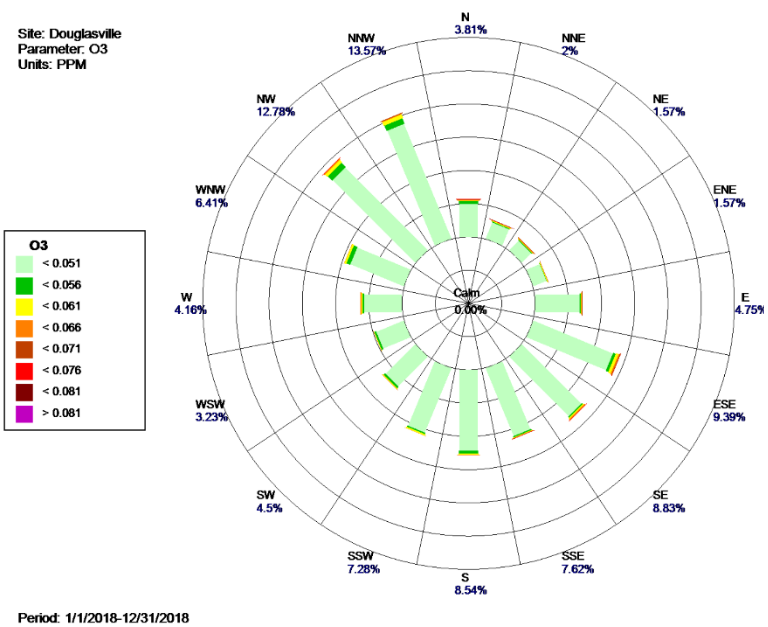

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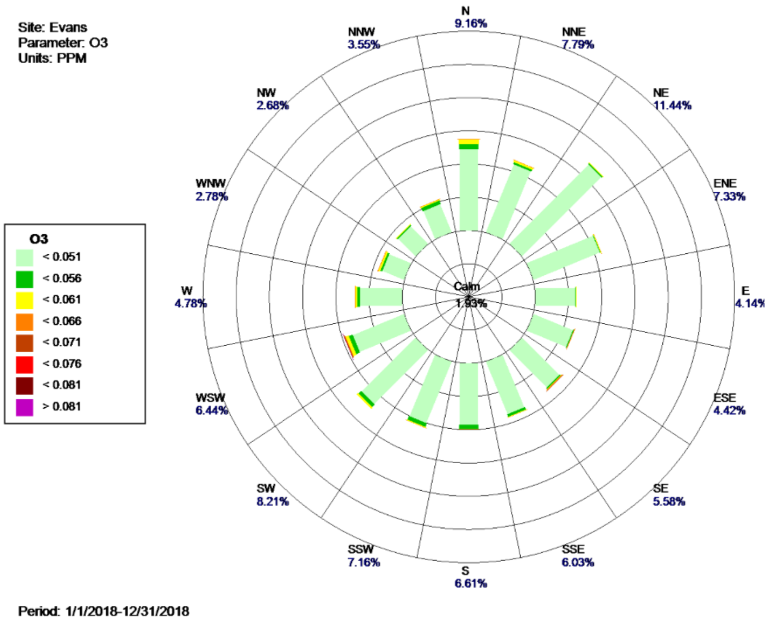
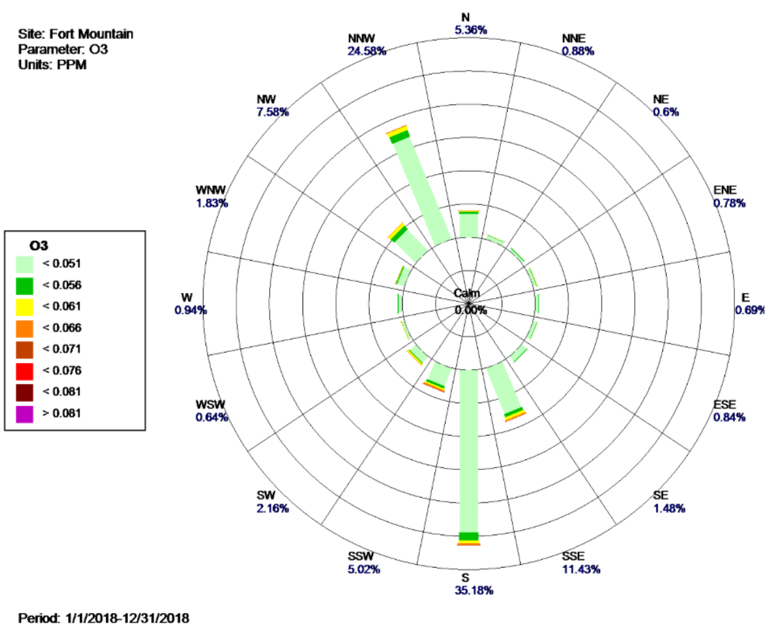


Evans, 2018 Annual Ozone



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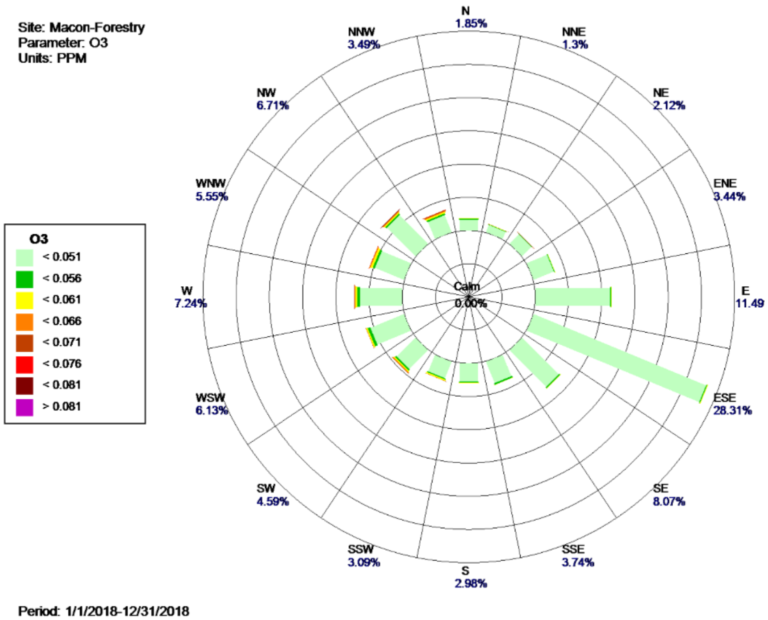

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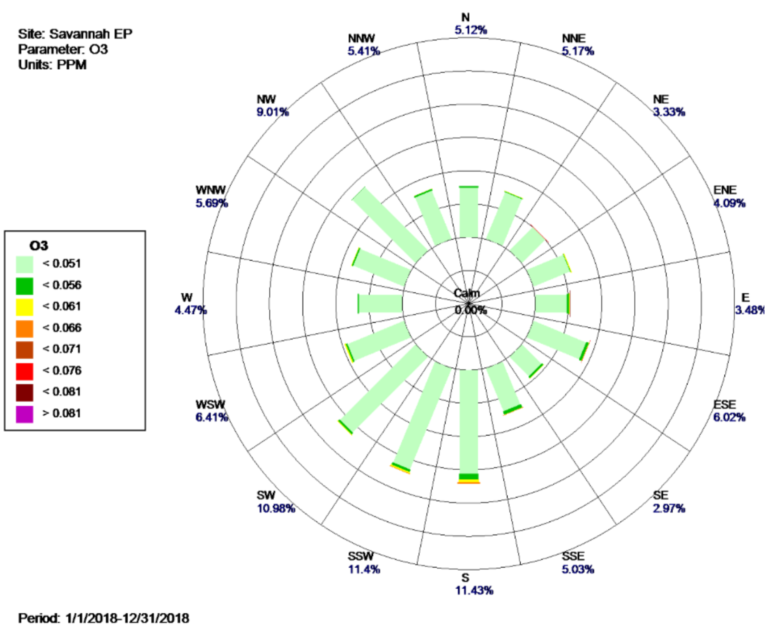
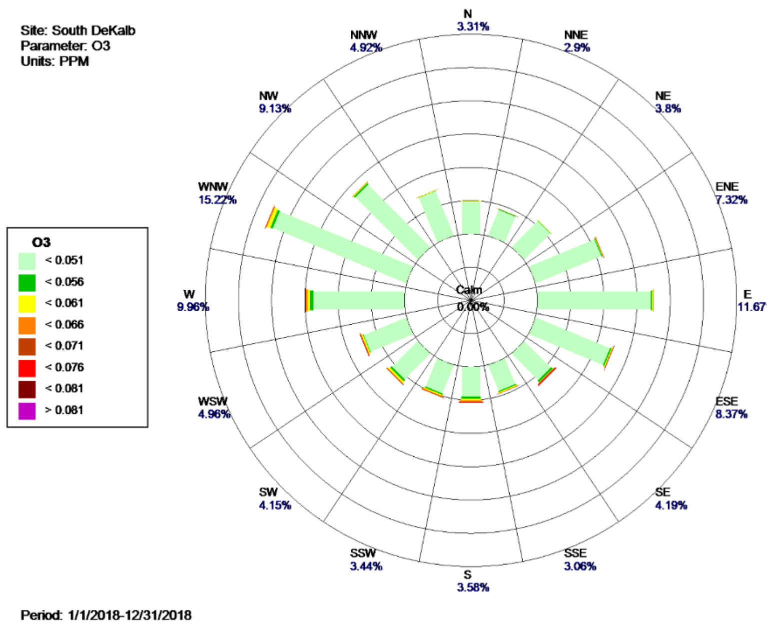
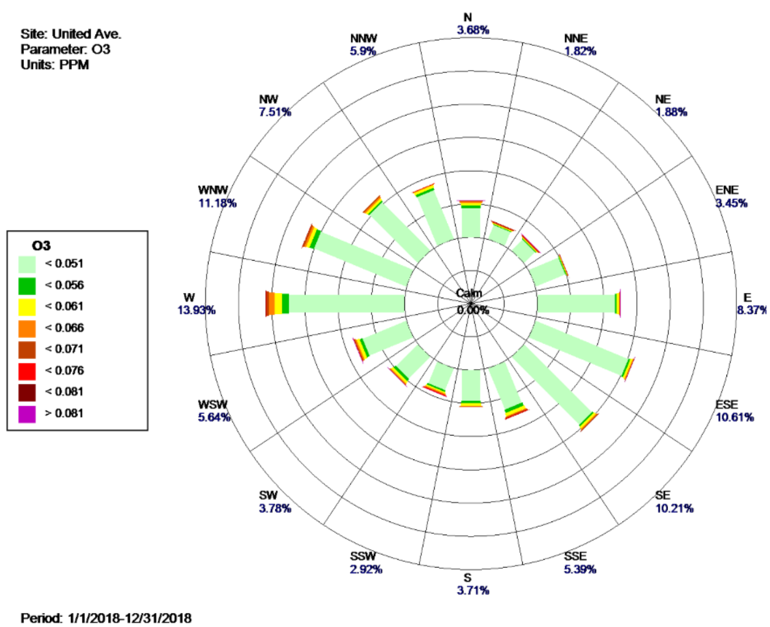


Savannah-E President, 2018 Annual Ozone



South DeKalb, 2018 Annual Ozone



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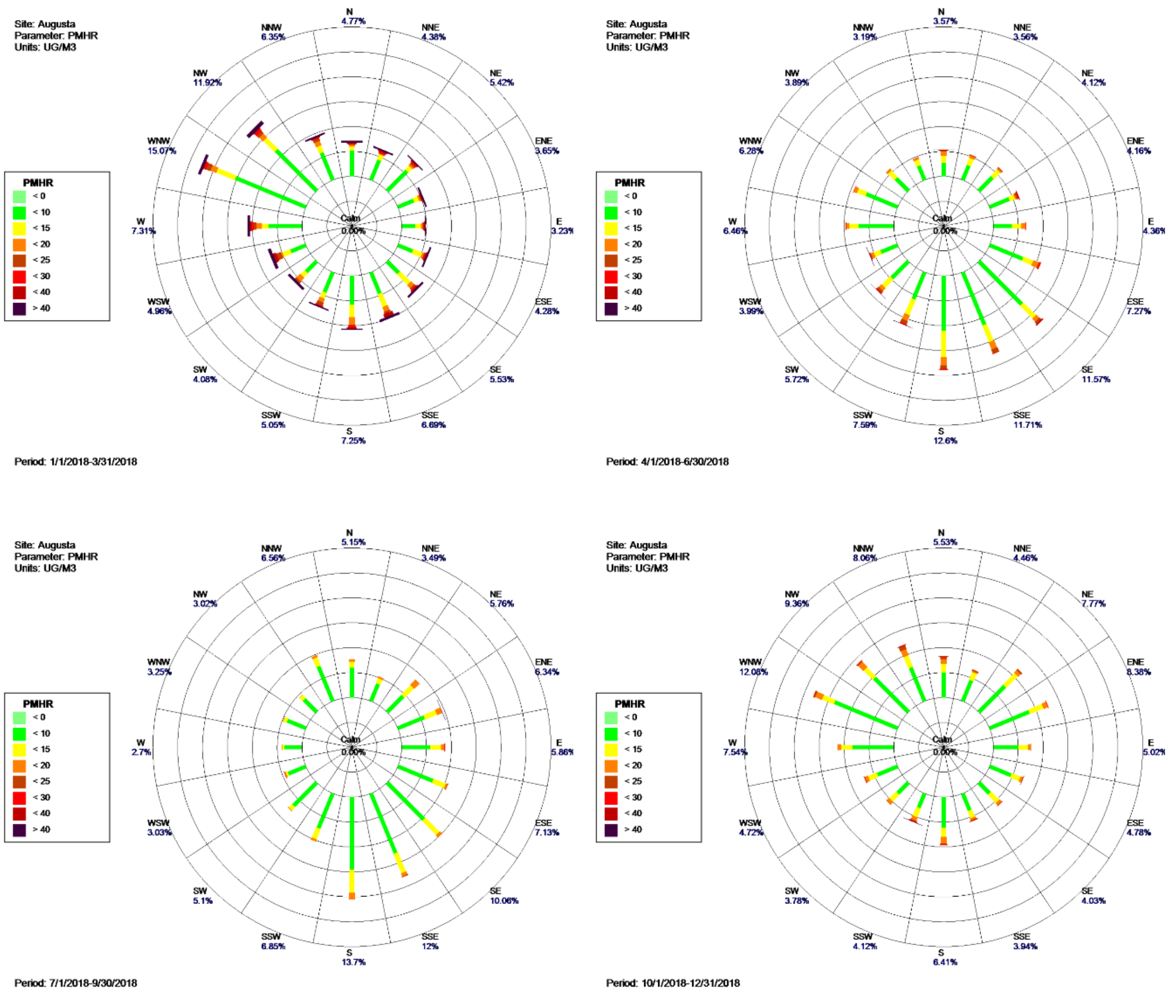
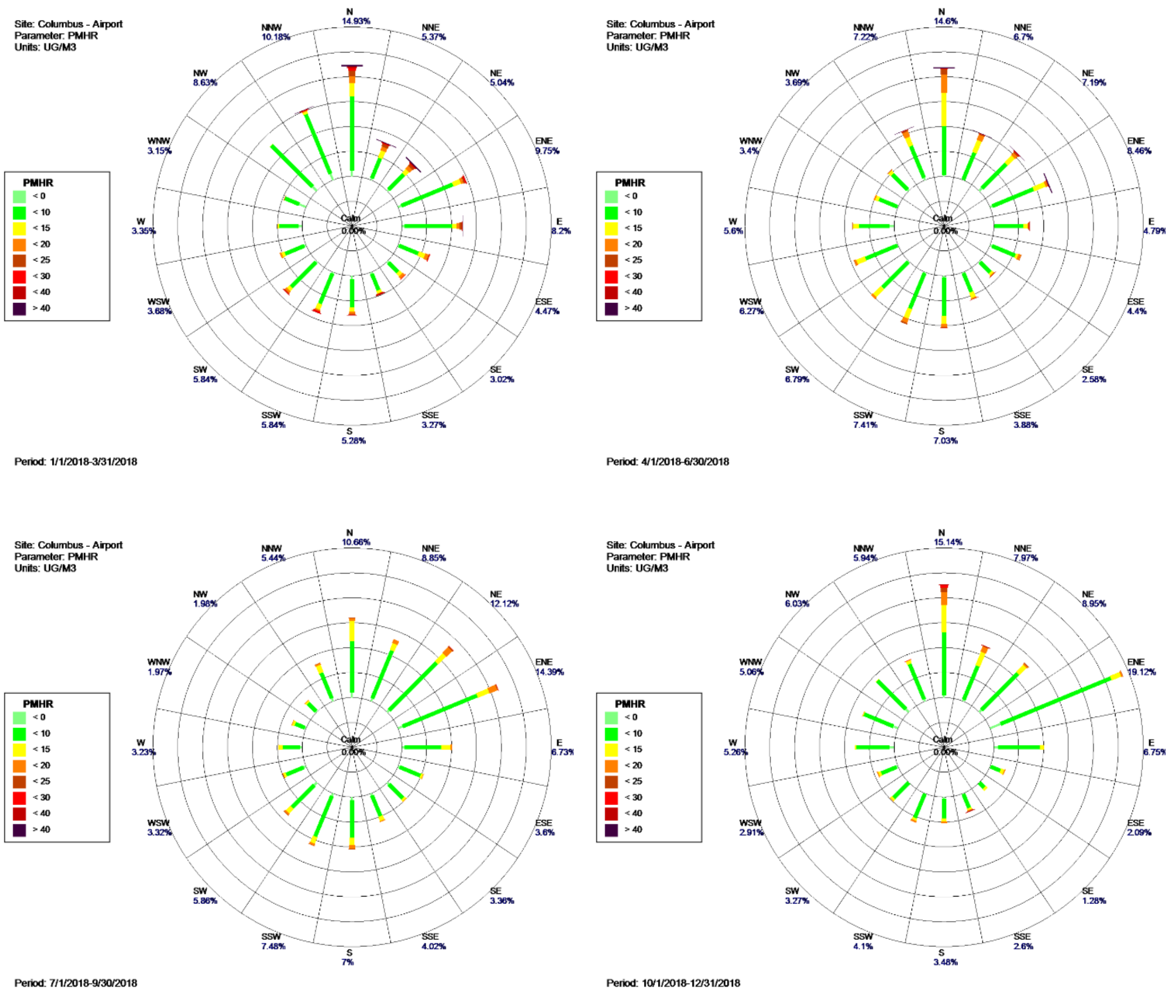


Augusta, 2018 Quarterly $PM_{2.5}$



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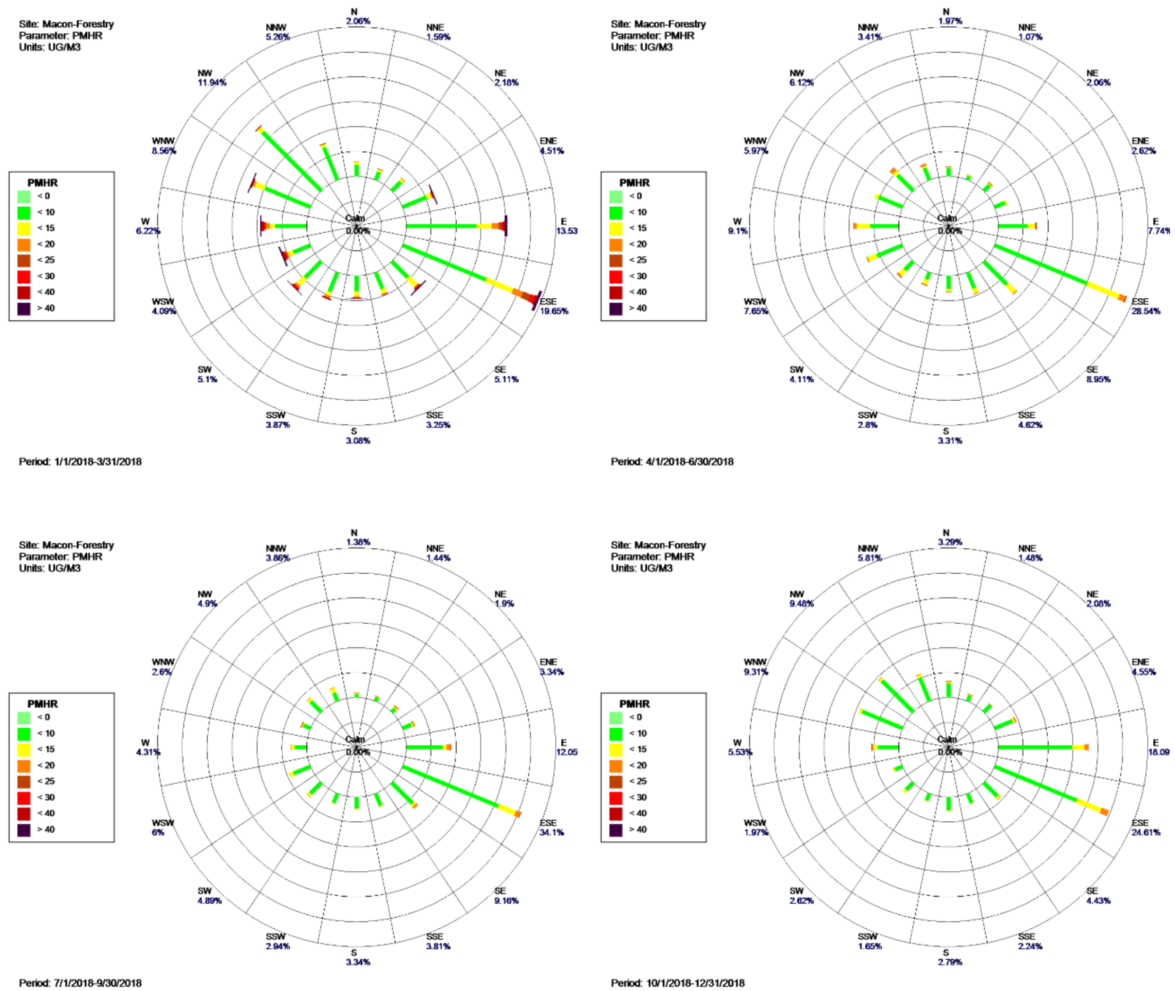

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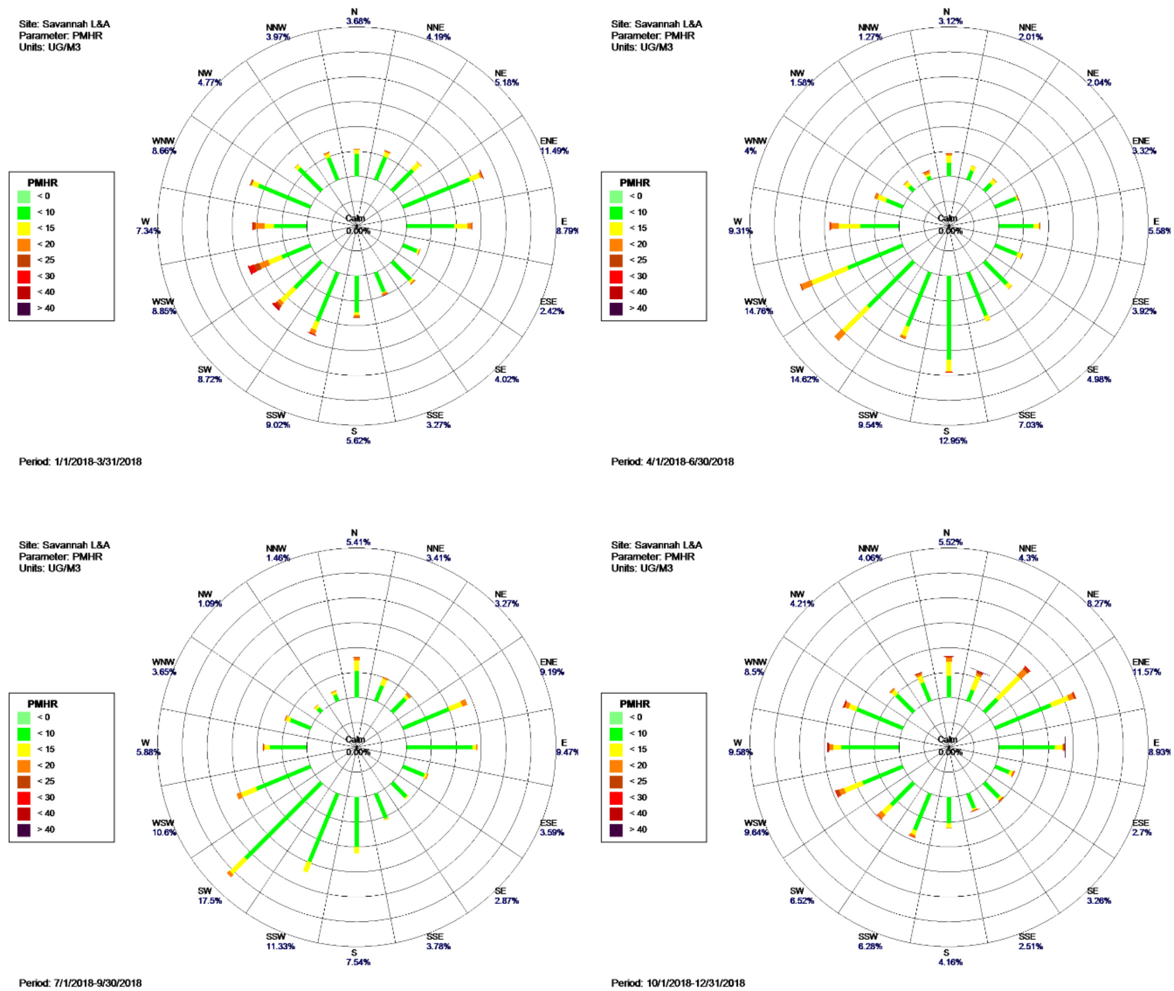
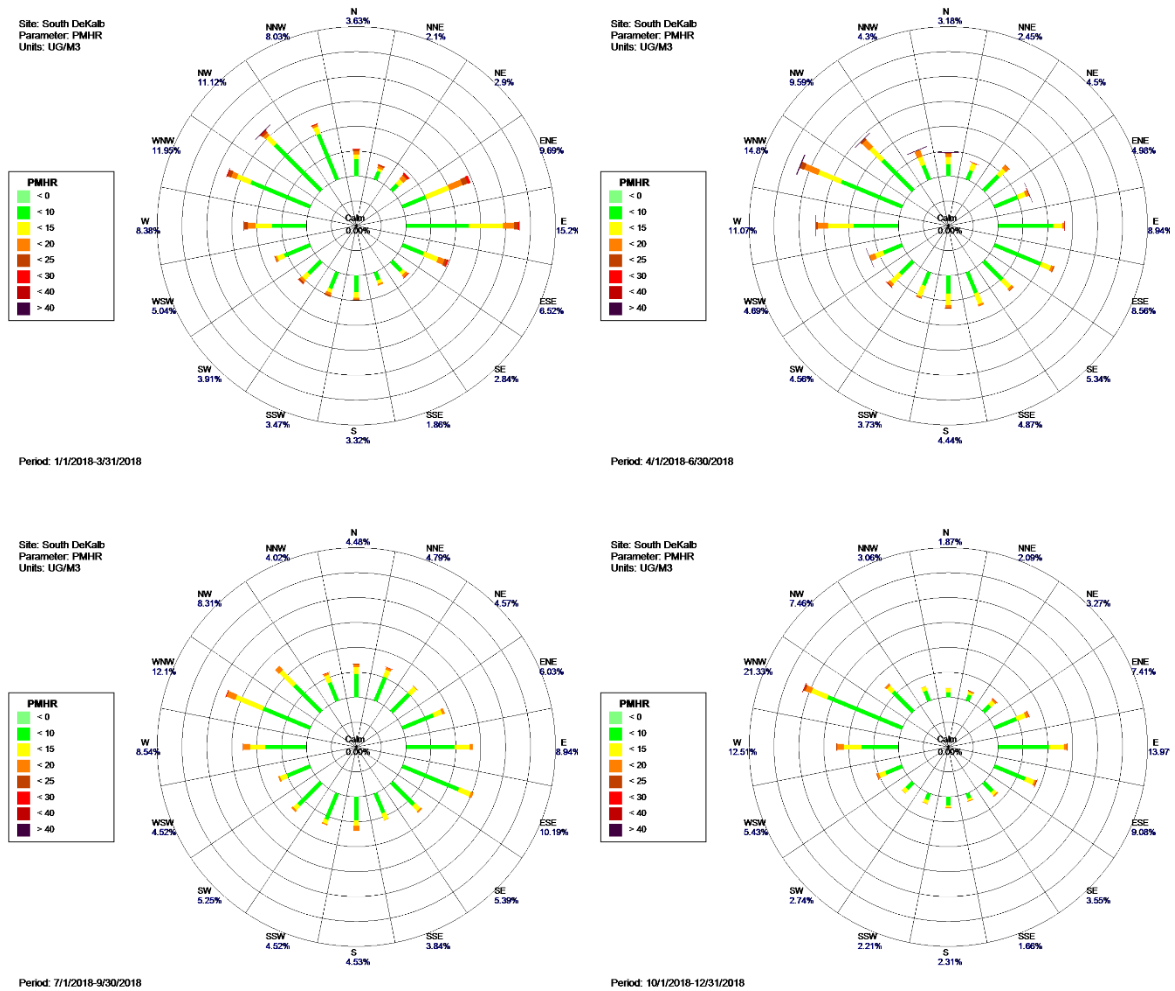
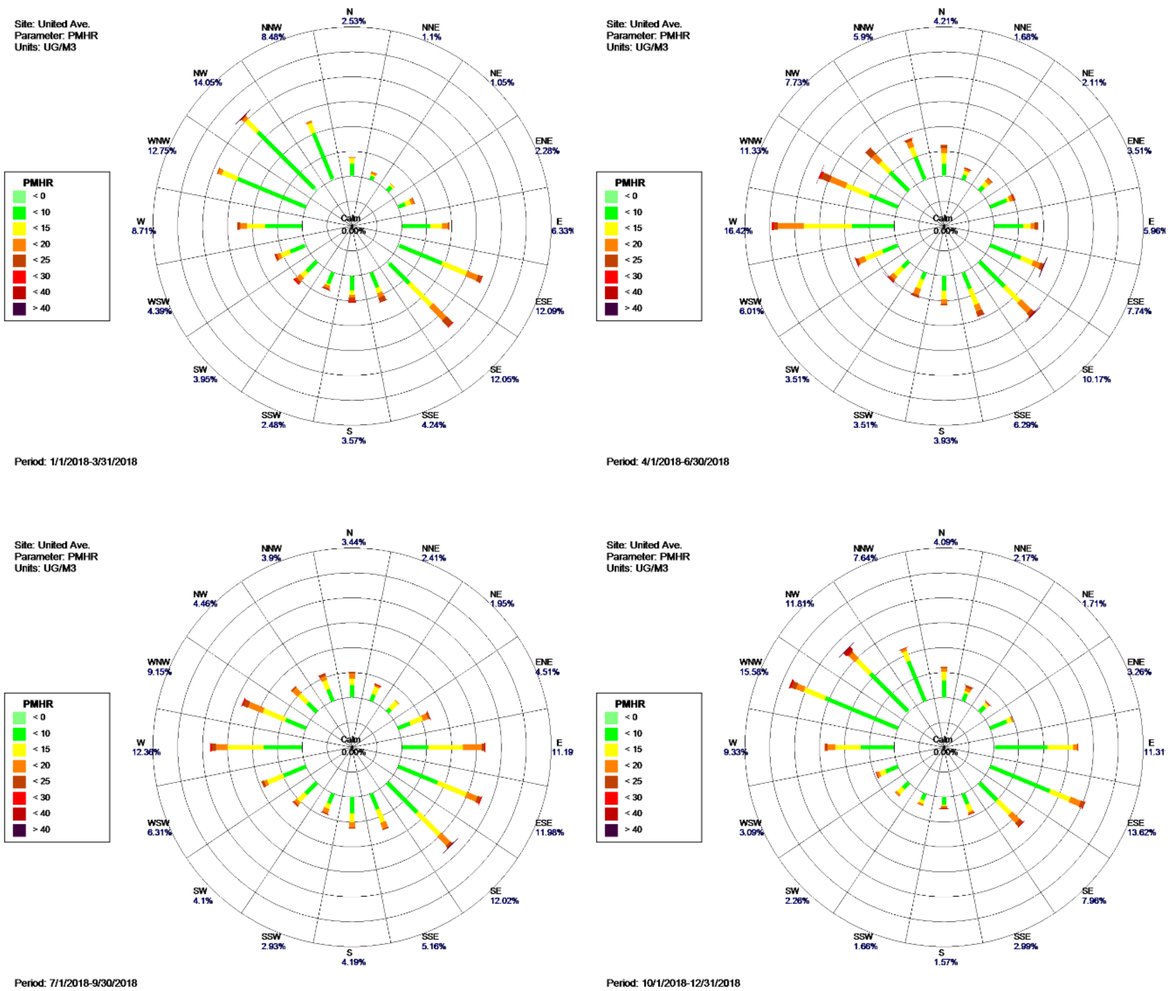


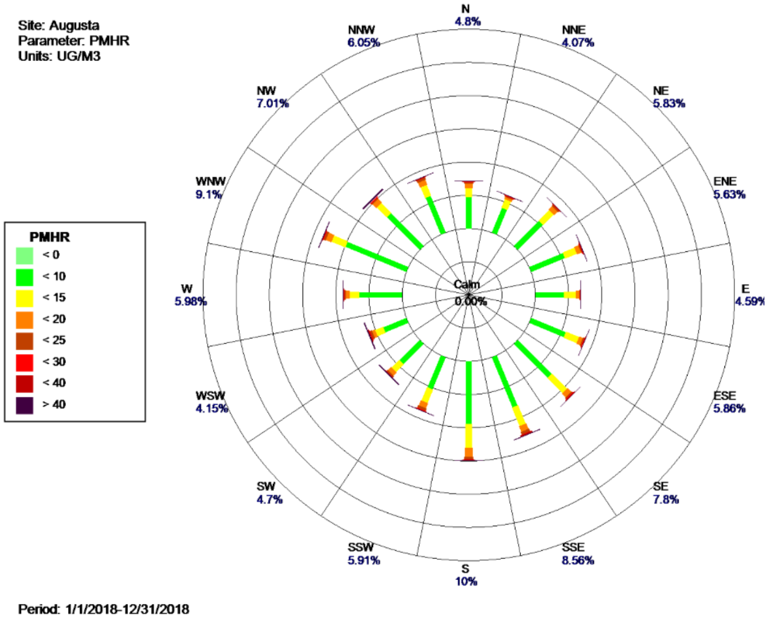
Savannah-L&A, 2018 Quarterly $PM_{2.5}$



South DeKalb, 2018 Quarterly $PM_{2.5}$



United Ave, 2018 Quarterly $PM_{2.5}$



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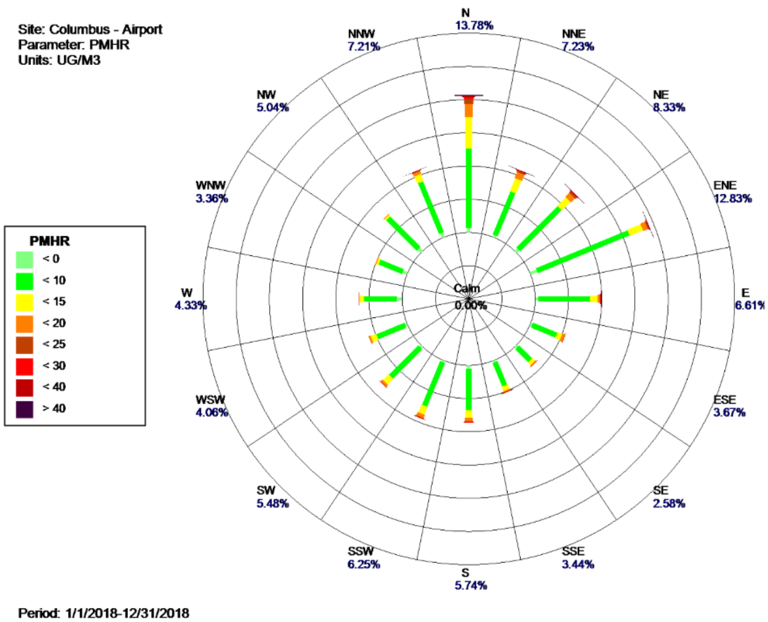
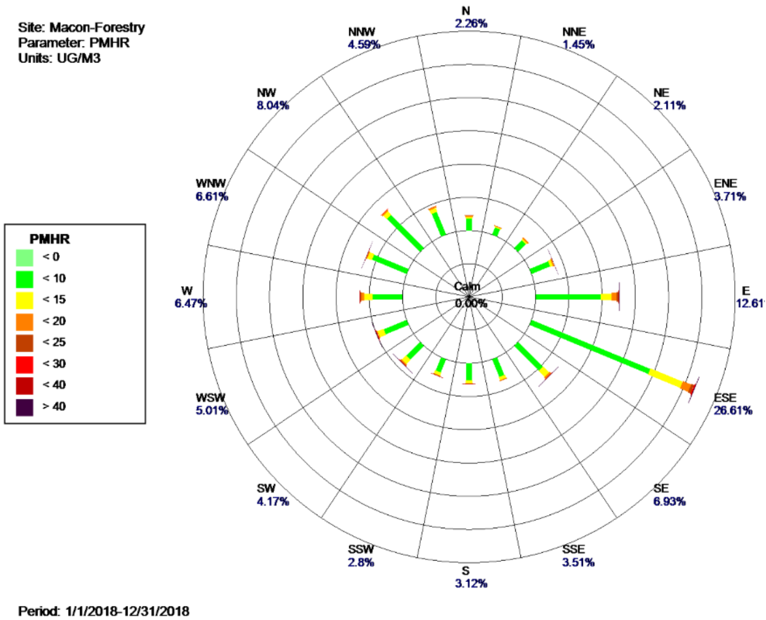


Columbus-Airport, 2018 Annual $PM_{2.5}$



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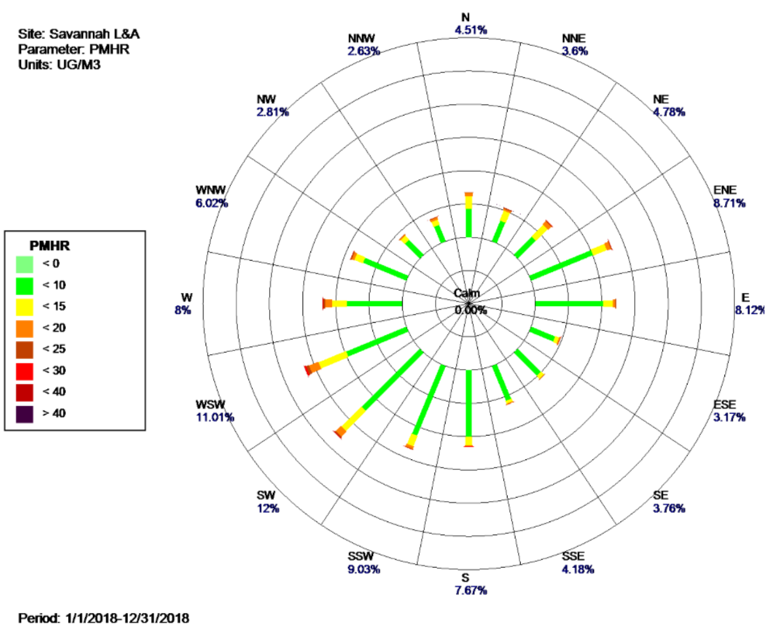

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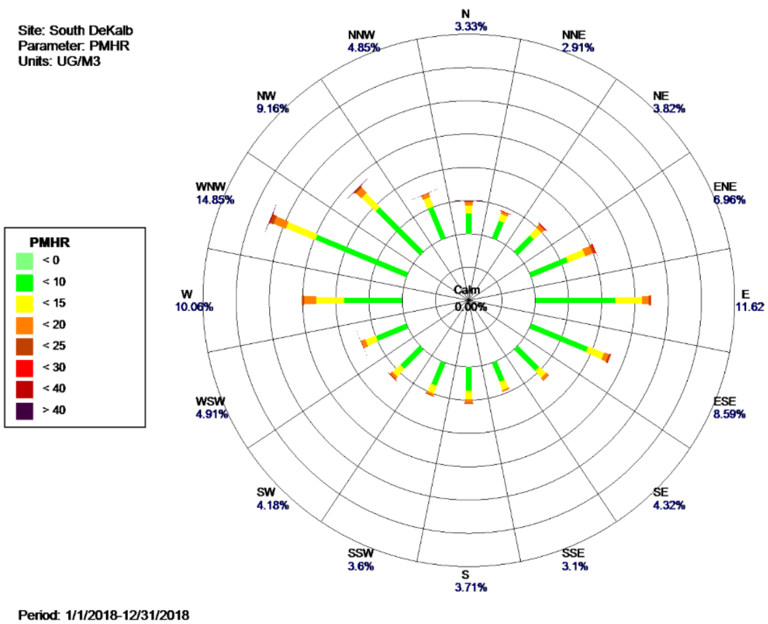
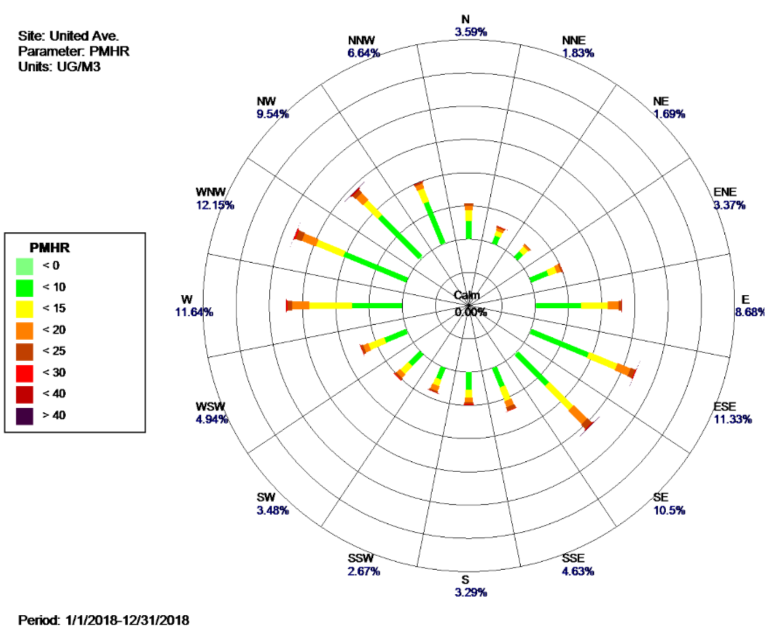


South DeKalb, 2018 Annual $PM_{2.5}$



United Ave, 2018 Annual $PM_{2.5}$

Appendix F:
Memorandum of Agreement

Georgia Department of Natural Resources
Environmental Protection Division

MEMORANDUM OF AGREEMENT

ON AIR QUALITY MONITORING FOR CRITERIA POLLUTANTS FOR

THE CHATTANOOGA-WALKER COUNTY

METROPOLITAN STATISTICAL AREA MSA

December 28, 2017

Participating Agencies:

Georgia
Georgia Department of Natural Resources (GA DNR)
Environmental Protection Division GA EPD APB

Tennessee
Chattanooga-Hamilton County Air Pollution Control Bureau (CHCAPCB)

I. PURPOSE/OBJECTIVES/GOALS

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 and GAEPDAPB (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) (March 28, 2016)[1].

II. BACKGROUND

The Chattanooga-Hamilton Co-Walker Co, GA MSA consists of the following counties: Dade, Walker, Catoosa, Hamilton, Marion, and Sequatchie. GA EPD APB has jurisdiction over Dade, Walker, and Catoosa Counties in Georgia and CHCAPCB has jurisdiction over Hamilton County, Tennessee. The State of Tennessee has jurisdiction over Marion and Sequatchie Counties in Tennessee, but does not have any permanent air monitoring sites in those counties. The CHCAPCB and GA EPD APB are required by the Clean Air Act to measure for certain criteria pollutants in the ambient air in the Chattanooga-Hamilton County-Walker Co, GA Metropolitan Statistical Area (MSA). The United States Environmental Protection Agency (EPA) has established minimum monitoring requirements based on the size of the MSA and the quality of the air in the

MSA 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.

40 CFR 58 Appendix D, Section 2, (e)[1] states (in part):

"...The EPA recognizes that there may be situations where the EPA Regional Administrator and the affected State or local agencies may need to augment or to divide the overall MSA/CSA monitoring responsibilities and requirements among these various agencies to achieve an effective network design. Full monitoring requirements apply separately to each affected State or local agency in the absence of an agreement between the affected agencies and the EPA Regional Administrator."[1]

Currently each air pollution control agency (affected agency) conducts monitoring in its respective jurisdiction and coordinates its monitoring with the other air pollution control agencies within the MSA.

I. ROLES AND RESPONSIBILITIES

The parties agree to the following terms and conditions:

- CHCAPCB and GA EPD APB (the "affected agencies") commit to conducting appropriate monitoring in their respective jurisdictions of the MSA; as needed, to collectively meet EPA minimum monitoring requirements for the entire MSA for PM10, PM2.5, and ozone, as well as other criteria air pollutant monitoring deemed necessary to meet the needs of the MSA as determined reasonable by all affected agencies. The minimum air quality monitoring requirement (for PM10, PM2.5, and ozone described in 40 CFR 58) for the MSA shall apply to the MSA in its entirety and shall not apply to any sole affected agency within the MSA unless agreed upon by all affected agencies.

- The affected agencies commit to coordinating monitoring "...responsibilities and requirements...to achieve an effective network design..."[1] regarding criteria air pollutant monitoring conducted in the MSA and commit to communicate unexpected or unplanned changes in monitoring activities within their jurisdictions to the other affected agencies of this MOA. As conditions warrant, the affected agencies may conduct telephone conference calls, meetings, or other communications to discuss monitoring activities for the MSA. Each affected agency shall inform the other affected agencies via telephone or e-mail of any monitoring changes occurring in its jurisdiction of the MSA at its earliest convenience after learning of the need for the change or making the changes. Such unforeseen changes may include evictions from monitoring sites, destruction of monitoring sites due to natural disasters, or similar occurrences that result in a loss of more than 25% data in a quarter or a permanent change in the monitoring network. At least once a year in the second quarter of the year or before June 15th, each agency shall make available to the other agencies who are a party to this agreement, a copy of its proposed monitoring plan for the MSA for the next year. The CHCAPCB will submit the network review that is submitted to the State of Tennessee for inclusion in the State's monitoring plan.

- Each party reserves the right to revoke or terminate this MOA at any time and for any reason by giving thirty (30) days written notice prior to the date of termination.

III. LIMITATIONS

A. All commitments made in this MOA are subject to the availability of appropriated funds and each party's budget priorities. Nothing in this MOA, in and of itself, obligates CHCAPCB or GA EPD APB to expend appropriations or to enter into any contract, assistance agreement, interagency agreement or other financial obligation.

B. This MOA is neither a fiscal nor a funds obligation document. Any endeavor involving reimburse or contribution of funds between parties to this MOA will be handled in accordance with applicable laws, regulations, and procedures, and will be subject to separate subsidiary agreements that will be effected in writing by representatives of the parties.

C. Except as provided in Section III, this MOA does not create any right or benefit, substantive or procedural, enforceable by law or equity against CHCAPCB or GA EPD APB, their officers or employees, or any other person. This MOA does not direct or apply to any person outside CHAPCD or GAEPD APB.

V. PROPRIETARY INFORMATION AND INTELLECTUAL PROPERTY

No proprietary information or intellectual property is anticipated to arise out of this MOA.

VI. POINTS OF CONTACT

The following individuals are designated points of contact for the MOA:

GA EPD APB

DeAnna G. Oser
GAEPD APB Ambient Monitoring Program
4244 International Parkway, Suite 120
Atlanta, GA 30354

DeAnna.Oser@dnr.ga.gov
Voice: (404) 363-7004
FAX: (404) 363-7100

CHCAPCB

Robert Colby
CHCAPCB
6125 Preservation Dr
Chattanooga, Tn 37416

bcolby@chattanooga.gov
Voice: (423) 643-5999
FAX: (423) 643-5972

VII. MODIFICATION/DURATION/TERMINATION

This MOA will be effective when signed by all parties. This MOA may be amended at any time by the mutual written consent of the parties. The parties will review this MOA at least once every 10 years to determine whether it should be revised, renewed, or cancelled. This MOA may be revoked or terminated by an affected agency at any time and for any reason by giving thirty (30) days written notice prior to the date of termination.

VIII. REFERENCE

1 – United States Environmental Protection Agency, Title 40 Code of Federal Regulations, Part 58, Appendix D, "Network Design Criteria for Ambient Air Quality Monitoring", Section 2 (e), "General Monitoring Requirements".

IX. APPROVALS

Georgia Department of Natural Resources, Environmental Protection Division Air Protection Branch (GA EPD APB)

BY: ____________________

TITLE: DIRECTOR

DATE: 1/24/18

Chattanooga-Hamilton County Air Pollution Bureau (CHCAPCB)

BY: ____________________

TITLE: Director

DATE: January 3, 2018

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BUREAU OF AIR QUALITY

DHEC MOA#: 2017-429

MEMORANDUM OF AGREEMENT ON AIR QUALITY MONITORING FOR CRITERIA POLLUTANTS FOR THE AUGUSTA - RICHMOND COUNTY METROPOLITAN STATISTICAL AREA (MSA)

January 2017

Participating Agencies:

Georgia
Georgia Department of Natural Resources
Environmental Protection Division
Air Protection Branch (GA EPD)

South Carolina
Department of Health and Environmental Control (SCDHEC)
Bureau of Air Quality

I. PURPOSE/OBJECTIVES/GOALS

The purpose of this Memorandum of Agreement (MOA) is to renew the Augusta - Richmond County Metropolitan Statistical Area (MSA) Criteria Pollutant Air Quality Monitoring Agreement between SCDHEC and GA EPD (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 any 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).

II. BACKGROUND

The Augusta - Richmond County MSA consists of the following counties: Burke, Columbia, McDuffie, Lincoln, Richmond, Aiken and Edgefield. GA EPD has jurisdiction over Burke, Columbia, McDuffie, Lincoln, and Richmond Counties in Georgia and SCDHEC has jurisdiction over Aiken and Edgefield Counties, South Carolina. The SCDHEC and GA EPD are required by the Clean Air Act to measure for certain criteria pollutants in the ambient air in the Augusta - Richmond County Metropolitan Statistical Area (MSA). The EPA has established minimum monitoring requirements based on the size of the MSA and the quality of the air in the MSA for PM10, PM2.5, and ozone.

40 CFR 58 Appendix D, Section 2(e) states (in part):

> "…The EPA recognizes that there may be situations where the EPA Regional Administrator and the affected State or local agencies may need to augment or to divide the overall MSA/CSA monitoring responsibilities and requirements among these various agencies to achieve an effective network design. Full monitoring requirements apply separately to each affected State or local agency in the absence of an agreement between the affected agencies and the EPA Regional Administrator."

Currently each air pollution control agency (affected agency) conducts monitoring in its respective jurisdiction and coordinates its monitoring with the other air pollution control agency within the MSA.

III. ROLES AND RESPONSIBILITIES

The parties agree to the following terms and conditions:

- SCDHEC, and GA EPD (the "affected agencies") commit to conducting appropriate monitoring in their respective jurisdictions of the MSA; as needed, to collectively meet EPA minimum monitoring requirements for the entire MSA for PM10, PM2.5, and ozone, as well as any other criteria air pollutant monitoring deemed necessary to meet the needs of the MSA as determined reasonable by all affected agencies. The minimum air quality monitoring requirements (for PM10, PM2.5, and ozone described in 40 CFR 58) for the MSA shall apply to the MSA in its entirety and shall not apply to any sole affected agency within the MSA unless agreed upon by all affected agencies.

- The affected agencies commit to coordinating monitoring "responsibilities and requirements…to achieve an effective network design" regarding criteria air pollutant monitoring conducted in the MSA and commit to communicate unexpected or unplanned changes in monitoring activities within their jurisdictions to the other affected agency. As conditions warrant, the affected agencies may conduct telephone conference calls, meetings, or other communications to discuss monitoring activities for the MSA. Each affected agency shall inform the other affected agency via telephone or e-mail of any monitoring changes occurring in its jurisdiction of the MSA at its earliest convenience after learning of the need for the change or making the changes. Such unforeseen changes may include evictions from monitoring sites, destruction of monitoring sites due to natural disasters, or similar occurrences that result in an extended (greater than 1 quarter) or permanent change in the monitoring network. At least once a year in the second quarter of the year or before June 15th, each affected agency shall make available to the other affected agency, a copy of its proposed monitoring plan for its jurisdiction within the MSA for the next year.

- Each party reserves the right to revoke or terminate this MOA at any time and for any reason by giving thirty (30) days written notice prior to the date of termination.

IV. LIMITATIONS

A. All commitments made in this MOA are subject to the availability of appropriated funds and each party's budget priorities. Nothing in this MOA, in and of itself, obligates SCDHEC or GA EPD to expend appropriations or to enter into any contract, assistance agreement, interagency agreement or other financial obligation.

B. This MOA is neither a fiscal nor a funds obligation document. Any endeavor involving reimbursement or contribution of funds between parties to this MOA will be handled in accordance with applicable laws, regulations, and procedures, and will be subject to separate subsidiary agreements that will be effected in writing by representatives of the parties.

C. Except as provided in Section III, this MOA does not create any right or benefit, substantive or procedural, enforceable by law or equity against SCDHEC or GA EPD, their officers or employees, or any other person. This MOA does not direct or apply to any person outside SCDHEC or GA EPD.

V. PROPRIETARY INFORMATION AND INTELLECTUAL PROPERTY

No proprietary information or intellectual property is anticipated to arise out of this MOA.

VI. POINTS OF CONTACT

The following individuals are designated points of contact for the MOA:

GA EPD: DeAnna Oser
GA EPD Ambient Monitoring Program
4244 International Parkway, Suite 120
Atlanta, GA 30354

DeAnna.Oser@dnr.ga.gov
Voice: (404) 363-7004
FAX: (404) 363-7100

SCDHEC: Micheal Mattocks
SCDHEC Bureau of Environmental Services
8231 Parklane Road
Columbia, SC 29223

mattocm@dhec.sc.gov
Voice: (803) 896-0902
FAX: (803) 896-0980

In the event that a point of contact needs to be changed, notification may be made via email to the other parties.

VII. MODIFICATION/DURATION/TERMINATION

This MOA will be effective when signed by all parties. This MOA may be amended at any time by the mutual written consent of the parties. The parties will review this MOA at least once every 10 years to determine whether it should be revised, renewed, or cancelled. This MOA may be revoked or terminated by an affected agency at any time and for any reason by giving thirty (30) days written notice prior to the date of termination.

VIII. REFERENCE

United States Environmental Protection Agency, Title 40 Code of Federal Regulations, Part 58, Appendix D, "Network Design Criteria for Ambient Air Quality Monitoring", Section 2 (e), "General Monitoring Requirements."

IX. APPROVALS

Georgia Department of Natural Resources, Environmental Protection Division (GA EPD)

BY: ____________________

TITLE: Director

DATE: 2/21/17

South Carolina Department of Health and Environmental Control (SCDHEC) Bureau of Air Quality

BY: ____________________

TITLE: Bureau Chief

DATE: 03/01/17

THIS AGREEMENT IS NOT OFFICIAL AND BINDING UNTIL SIGNED BY THE DHEC CONTRACTS MANAGER.

____
Francine Miller
DHEC Contracts Manager
DATE: 3-6-17