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DEPARTMENT OF NATURAL RESOURCES

ENVIRONMENTAL PROTECTION DIVISION

ENVIRONMENTAL PROTECTION DIVISION
Air Protection Branch
Ambient Monitoring Program

2015 Ambient Air Surveillance Report

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EXECUTIVE SUMMARY

The Ambient Monitoring Program of the Air Protection Branch of the Environmental Protection Division (EPD) has monitored air quality in the State of Georgia for more than forty years. During that time, the list of monitored compounds has grown to more than 200 pollutants at 42 sites in 31 counties across the state. This monitoring is performed to protect public health and environmental quality. The resulting data is used for a broad range of regulatory and research purposes, as well as to inform the public. This report is the summary of the monitoring data from 2015, and is an assessment of the data in conjunction with previous years' findings and shows an overall decrease in air pollution concentrations since GA EPD began monitoring ambient air decades ago.

The monitoring sections provide an in-depth discussion of the chemicals that are monitored. Maps identify individual monitoring sites. These sections also contain discussions on general health effects and attainment designations for the criteria pollutants that are monitored. Additionally, these sections discuss trends and common sources for the monitored pollutants.

Six pollutants fall within the criteria pollutant list. These pollutants are carbon monoxide, sulfur dioxide, lead, ozone, nitrogen dioxide, and particulate matter (now regulated in two size categories). The ambient concentrations of these pollutants must meet the National Ambient Air Quality Standards (NAAQS) set by U.S. EPA. Concentrations above the standard are considered unhealthy for sensitive groups. The ambient concentrations of the criteria pollutants measured in Georgia are below the NAAQS, except for ozone in the Atlanta Area. Some monitors in the Atlanta Area remain above the 2015 NAAQS for ozone.

Air toxics are also monitored but are not compared to ambient air regulatory standards. Air toxic monitoring results are screened for theoretical lifetime cancer risk and potential non-cancer health effects on a yearly basis. This analysis is presented in the Risk Assessment section of this report. Estimates of theoretical cancer risk posed by these compounds are primarily driven by arsenic, chromium, and benzene. The estimates of theoretical lifetime cancer risk related to air toxic pollutants in the areas monitored across the state ranged from 1 in 10,000 to 1 in 1,000,000. The potential risk of non-cancer health effects from air toxic pollutants is estimated differently, and most chemicals fell well below the hazard quotient of 1.

The Ambient Monitoring Program also operates an extensive network of meteorological stations. The meteorological sites provide, at a minimum, wind speed and wind direction data. Some stations are very sophisticated and provide information on barometric pressure, relative humidity, solar radiation, temperature, and precipitation. A discussion of the Georgia ozone and $PM_{2.5}$ forecasting effort is also included in this section.

The Quality Assurance section describes the Ambient Monitoring Program's procedures to produce quality data. The data has to be collected and measured in a certain manner to meet requirements that are set forth by the EPA.

The Outreach and Education section explains how the Air Quality Index (AQI) is used to offer the public an easy to use indicator of air quality.

The appendices of this document contain summary tables for the pollutants measured during 2015. Included in the summary tables is information about the location of air pollutant detections, the number of samples collected, as well as average and maximum concentrations.

Copies of this and previous annual reports are available on the Georgia EPD’s Ambient Air Monitoring website at http://amp.georgiaair.org/. Real time air monitoring information for the criteria pollutants may be found at the above website by selecting the pollutant of concern. In addition, the website also provides links to the air quality index (AQI).

GLOSSARY

Aerosols	A gaseous suspension of fine solid or liquid particles
APB	Air Protection Branch
AQCR	Air Quality Control Region
Anthropogenic	Resulting from human activity
ARITH MEAN	Arithmetic Mean
AQS	Air Quality System
By-product	Something produced in making something else; secondary result
BAM	Beta Attenuation Monitor
CAA	Clean Air Act
CFR	Code of Federal Regulations
CO	Carbon Monoxide
CV	Coefficient of Variation
DNR	Department of Natural Resources (state agency)
EPA	Environmental Protection Agency (federal agency)
EPD	Environmental Protection Division (state agency)
FEM	Federal Equivalent Method- equivalent measurement technique for a given pollutant
FRM	Federal Reference Method- the official measurement technique for a given pollutant
GEO MEAN	Geometric Mean
HAP	Hazardous Air Pollutant
HI	Hazard Index
HQ	Hazard Quotient
IUR	Inhalation Unit Risk
LOD	Limit of Detection
$\mu g/m^3$	Micrograms per cubic meter
m/s	Meters per second
MDL	Method Detection Limit
Mean	Average
MSA	Metropolitan Statistical Area, as defined by the U.S. Census Bureau
N_2	Nitrogen Gas
NAAQS	National Ambient Air Quality Standard
NATTS	National Air Toxics Trends Station
NEI	National Emission Inventory
NMHC	Non-Methane Hydrocarbons
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
NO_y	Reactive Oxides of Nitrogen
NUM OBS	Number of Observations
NWS	National Weather Service
ODC	Ozone Depleting Chemicals
O_3	Ozone
PAH	Polycyclic Aromatic Hydrocarbons
PAMS	Photochemical Assessment Monitoring Station
Pb	Lead
$PM_{2.5}$	Particles with an aerodynamic diameter of 2.5 microns or less
PM_{10}	Particles with an aerodynamic diameter of 10 microns or less
ppb	Parts per billion
ppbC	Parts per billion Carbon
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
RfC	Reference Concentration
Screening Value	Initial level of air toxic compounds used in risk assessment
SLAMS	State and Local Air Monitoring Site
SO_2	Sulfur Dioxide
SPMS	Special Purpose Monitoring Site
TEOM	Tapered Element Oscillating Microbalance
TNMOC	Total Non-Methane Organic Compounds
TRS	Total Reduced Sulfur
TSP	Total Suspended Particulates
UV	Ultraviolet
VOC	Volatile Organic Compound
w/m^2	Watts per square meter

INTRODUCTION

This report summarizes the air quality data collected by the State of Georgia during calendar year 2015. The Air Protection Branch is a subdivision of the state’s Department of Natural Resources (DNR), Environmental Protection Division (EPD).

The United States Environmental Protection Agency (EPA) regulates air quality standards nationwide through authority granted by Congress in the Clean Air Act. The air quality monitoring that is required by the Clean Air Act is performed almost entirely by state and local governments. In Georgia, the Ambient Monitoring Program of the Air Protection Branch conducts this ambient air monitoring, both to satisfy Clean Air Act monitoring requirements and to exceed them in cases where additional monitoring proves beneficial to the citizens and industries of the state. Ambient monitoring is performed to facilitate the protection of public health, as well as to protect the natural environment. The data is collected and quality assured using equipment and techniques specified by EPA. Once the data is ready, it is submitted to EPA’s national air quality database (AQS), where it is available to a broad community of data users.

Despite the technical nature of the information collected, every effort has been made to make the data relevant and useful to those who do not routinely study air quality data. To provide additional information for those who have interest in more detailed technical information, extensive appendices are included. Further information about air quality in Georgia and nationwide is available from EPA.

CRITERIA POLLUTANT MONITORING ACTIVITIES

This section contains a summary of the National Ambient Air Quality Standards (NAAQS) and the monitoring techniques used to measure ambient air quality for comparison with these standards.

The Clean Air Act (CAA) requires the EPA Administrator to identify pollutants that may endanger public health or welfare. The Administrator is required to issue air quality criteria that reflect current scientific knowledge, useful in indicating the type and extent of identifiable effects on public health or welfare that may be expected from the presence of such pollutants in ambient air. Under the CAA, the EPA Administrator establishes National Ambient Air Quality Standards (NAAQS) 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.” The standards and pollutants have changed over time to keep up with improvements in scientific knowledge and consist of six pollutants. These pollutants are carbon monoxide, sulfur dioxide, lead, ozone, nitrogen dioxide, and particulate matter (regulated in two size categories). For the most current list of NAAQS, please refer to EPA’s website (https://www.epa.gov/criteria-air-pollutants/naaqs-table). The following table displays 2015 criteria pollutants and standards.

Table 1. National ambient air quality standards

Pollutant [links to historical tables of NAAQS reviews]		**Primary/ Secondary**	**Averaging Time**	**Level**	**Form**
Carbon Monoxide (CO)		primary	8 hours	9 ppm	Not to be exceeded more than once per year
			1 hour	35 ppm	
Lead (Pb)		primary and secondary	Rolling 3 month average	0.15 µg/m^3 (1)	Not to be exceeded
Nitrogen Dioxide (NO$_2$)		primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		primary and secondary	1 year	53 ppb (2)	Annual Mean
Ozone (O$_3$)		primary and secondary	8 hours	0.075 ppm (3)	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution (PM)	PM$_{2.5}$	primary	1 year	12.0 µg/m^3	Annual mean, averaged over 3 years
		secondary	1 year	15.0 µg/m^3	annual mean, averaged over 3 years
		primary and secondary	24 hours	35 µg/m^3	98th percentile, averaged over 3 years
	PM$_{10}$	primary and secondary	24 hours	150 µg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO$_2$)		primary	1 hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

(1) In areas designated nonattainment for the Pb standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have not been submitted and approved, the previous standards (1.5 µg/m3 as a calendar quarter average) also remain in effect.
(2) The level of the annual NO2 standard is 0.053 ppm. It is shown here in terms of ppb for the purposes of clearer comparison to the 1-hour standard level.
(3) This is the 2008 ozone standard. Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O3 standards additionally remain in effect in some areas. Revocation of the previous (2008) O3 standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.
(4) The previous SO2 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 implementation plans providing for attainment of the current (2010) standard have not been submitted and approved and which is designated nonattainment under the previous SO2 standards or is not meeting the requirements of a SIP call under the previous SO2 standards (40 CFR 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 require NAAQS.

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

As shown in Table 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, while 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 42 sites in 31 counties across the state. Table 2, below, is a list of sites in the monitoring network along with details of pollutants monitored and their locations. Some monitoring is conducted year-round, although some pollutants have limited monitoring periods. Ozone, with the exception of the South DeKalb and CASTNET sites, is sampled from March through October, and the continuous (hourly) Photochemical Assessment Monitoring Stations (PAMS) volatile organic compounds are sampled from June through August. Figure 1 is a spatial display of the air monitoring locations in the state. Not all pollutants are monitored at all sites. Maps of the monitoring locations for individual pollutants are provided in each pollutant's respective section in this report. For more details regarding the ambient air monitoring network, refer to Georgia EPD's Ambient Air Monitoring Plan found on Georgia EPD's Ambient Air Monitoring website at http://amp.georgiaair.org/.

The number of monitoring sites and their respective locations can vary from year to year depending on the availability of long-term space allocation, regulatory needs, and funding. Once a site is established, the most common goal for its use is to monitor for long-term trends. 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 Part 53, Appendix A, 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.

In general, the basic ambient air monitoring objectives that govern the selection of sites are: 1) to measure the highest observable concentration; 2) to determine representative concentrations in areas of high population density; 3) to determine the impact of significant sources or source categories on ambient pollution levels; 4) to determine the general background concentration levels; and 5) to determine the concentration of a number of compounds which contribute to the formation of ground level ozone. Data collected from continuous monitors in Georgia's Ambient Air Monitoring network are presented on Georgia EPD's Ambient Air Monitoring website at http://amp.georgiaair.org/. The data is updated hourly at 15 minutes past the hour, Eastern Standard Time. Specific annual summary data for 2015 are available in Appendix A.

Table 2. 2015 Georgia 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	NOx	NO_2	NOy	SO_2	Pb	PM_{10}	PM_{10} Cont.	PAMS VOC	VOC	SVOC	Carb-onyls	Met	Black Carbon	Metals
Rome MSA																						
131150003	Rome	Floyd			S	S	X					S										
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	S																
Athens-Clark County MSA																						
130590002	Athens	Clarke	S		S	S	X															
Macon MSA																						
130210007	Macon-Allied	Bibb			S		X															
130210012	Macon-Forestry	Bibb	S		S	S						S					NR	NR		NR		NR
Columbus Georgia- Alabama MSA																						
132150001	Columbus-Health Dept.	Muscogee			S																	
132150008	Columbus-Airport	Muscogee	S		S	S																
132150009	Columbus-UPS	Muscogee											S									
132150010	Columbus-Ft. Benning	Muscogee											S									
132150011	Columbus-Cusseta	Muscogee			S		X						S									
132151003	Columbus-Crime Lab	Muscogee																		NR		
Savannah MSA																						
130510021	Savannah-E. President St.	Chatham	S									S					NR	NR	NR	NR		NR
130510091	Savannah-Mercer	Chatham			S																	
130511002	Savannah-L&A	Chatham				S						S								NR		
Augusta Georgia-South Carolina MSA																						
130730001	Evans	Columbia	S																	NR		
132450091	Augusta	Richmond	S		S	S	X					S		S						NR		

SITE ID	Site Name	COUNTY	O_3	CO	$PM_{2.5}$ FRM	$PM_{2.5}$ Cont.	$PM_{2.5}$ Spec.	PM Coarse	NO/ NOx	NO_2	NOy	SO_2	Pb	PM_{10}	PM_{10} Cont.	PAMS VOC	VOC	SVOC	Carb-onyls	Met	Black Carbon	Metals
Atlanta-Sandy Springs-Roswell MSA																						
130630091	Forest Park	Clayton			S																	
130670003	Kennesaw	Cobb	S		S																	
130770002	Newnan	Coweta	S			S														NR		
130850001	Dawsonville	Dawson	S														NR	NR	NR	NR		NR
130890002	South DeKalb	DeKalb	S/P/C	S/P/C	S/C	S/C	T/C	C	S/P	S/P	S/P/C	C			C	P	N	N	P/N	P	N	N
130890003	DMRC	DeKalb							R	R			S				R				R	
130970004	Douglasville	Douglas	S																	NR		
131210039	Fire Station #8	Fulton			S									S								
131210055	Confederate Ave.	Fulton	S			S						S								NR		
131210056	GA Tech-Near Road	Fulton		R	R				R	R										R	R	
131350002	Gwinnett Tech	Gwinnett	S		S	S																
131510002	McDonough	Henry	S			S																
132230003	Yorkville	Paulding	S/P	S/P	S	S			S/P	S/P						P	NR	NR		P		NR
132319991	EPA CASTNET	Pike	A																			
132470001	Conyers	Rockdale	S/P						S/P	S/P						P				P		
Chattanooga Tennessee-Georgia MSA																						
132950002	Rossville	Walker			S	S	X															
Not In An MSA																						
130550001	Summerville	Chattooga	S																			
130690002	General Coffee	Coffee					X										NR	NR				NR
132611001	Leslie	Sumter	S																			
133030001	Sandersville	Washington			S																	
133190001	Gordon	Wilkinson			S																	

Monitoring Types: S=SLAMS; P=PAMS; C=NCore; X=Supplemental Speciation; T=STN; N=NATTS; R=Near-Road; NR=Non-Regulatory; A=CASTNET

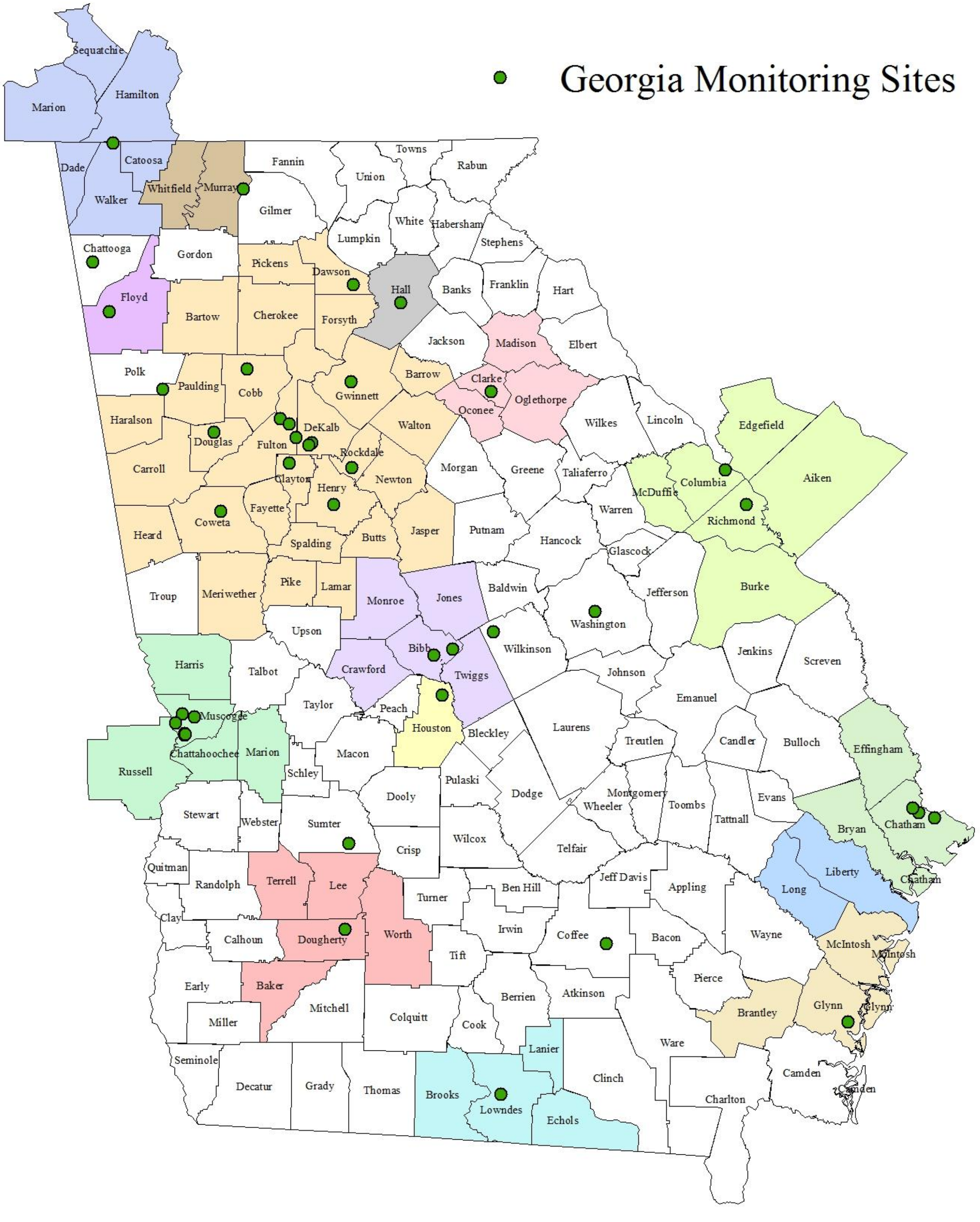


Figure 1. Georgia's air monitoring sites, MSAs shown as solid colors

CARBON MONOXIDE (CO)

GENERAL INFORMATION

Carbon monoxide (CO) is an odorless, colorless, and poisonous gas that is a by-product of incomplete burning. In most large metropolitan areas, the primary source of CO pollution is engendered from mobile sources. Mobile sources are on-road and non-road vehicles, aircraft, locomotives, and commercial marine vessels. The CO emissions from mobile sources are responsible for approximately 57% of CO emissions in Georgia. Other contributors of CO are fires, miscellaneous (waste disposal, charcoal grilling, structure fires, commercial cooking), biogenics (vegetation and soil), fuel combustion, industrial processes, and solvents. Figure 2 gives a visual representation of the CO emissions in Georgia. This figure was taken from EPA's 2014 National Emission Inventory.

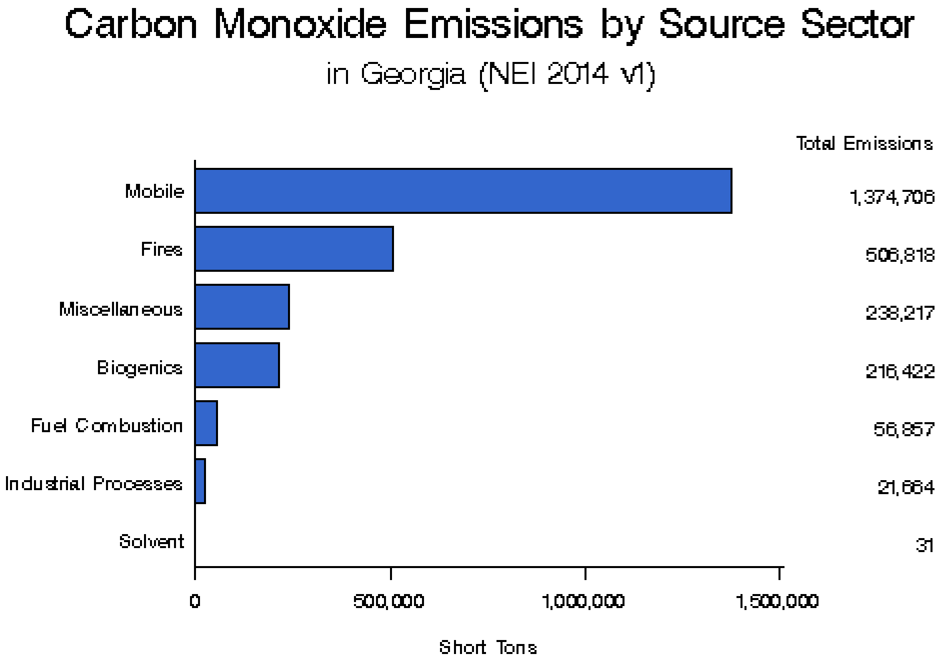


Figure 2. Common sources of carbon monoxide (CO) in Georgia, National Emission Inventory

In colder months, a few factors come together that can cause concentrations of ambient CO to be found at higher levels than the rest of the year. Cooler temperatures prevent complete combustion of fuels, causing an increase in CO emissions. At the same time, winter is subjected to more frequent atmospheric inversion layers. In standard conditions, the troposphere contains temperatures that decrease with increasing altitude. An inversion layer can occur when a layer of warmer air traps cooler air near the surface, disrupting the descending temperature gradient of the troposphere and preventing the usual mixing that would occur in normal conditions. During this time, the increased CO emissions can be trapped by the cap that is formed by the inversion layer, locking in CO emissions near the earth's surface.

On August 12, 2011, EPA finalized changes to the monitoring requirements for the carbon monoxide (CO) monitoring network. According to these changes, EPA is requiring that a CO monitor be collocated with a nitrogen dioxide (NO_2) near-road monitor in urban areas with populations of one million or more. EPA specified that in areas with 2.5 million or more, the CO monitors should be operational by January 1, 2015 (Federal Register: Vol. 76, No. 169, Page 54293, 08/31/11). For the State of Georgia, this monitoring requirement would be one CO monitor located in the Atlanta-Sandy Springs-Roswell MSA, collocated with the NO_2 near-road monitor.

GA EPD has three CO monitors collecting samples at the South DeKalb, Yorkville, and Georgia Institute of Technology. The Georgia Institute of Technology site collocated with an NO_2 near-road monitor, as required by EPA for urban areas with populations of 2.5 million or more. Georgia's current CO monitoring network is shown in Figure 3.

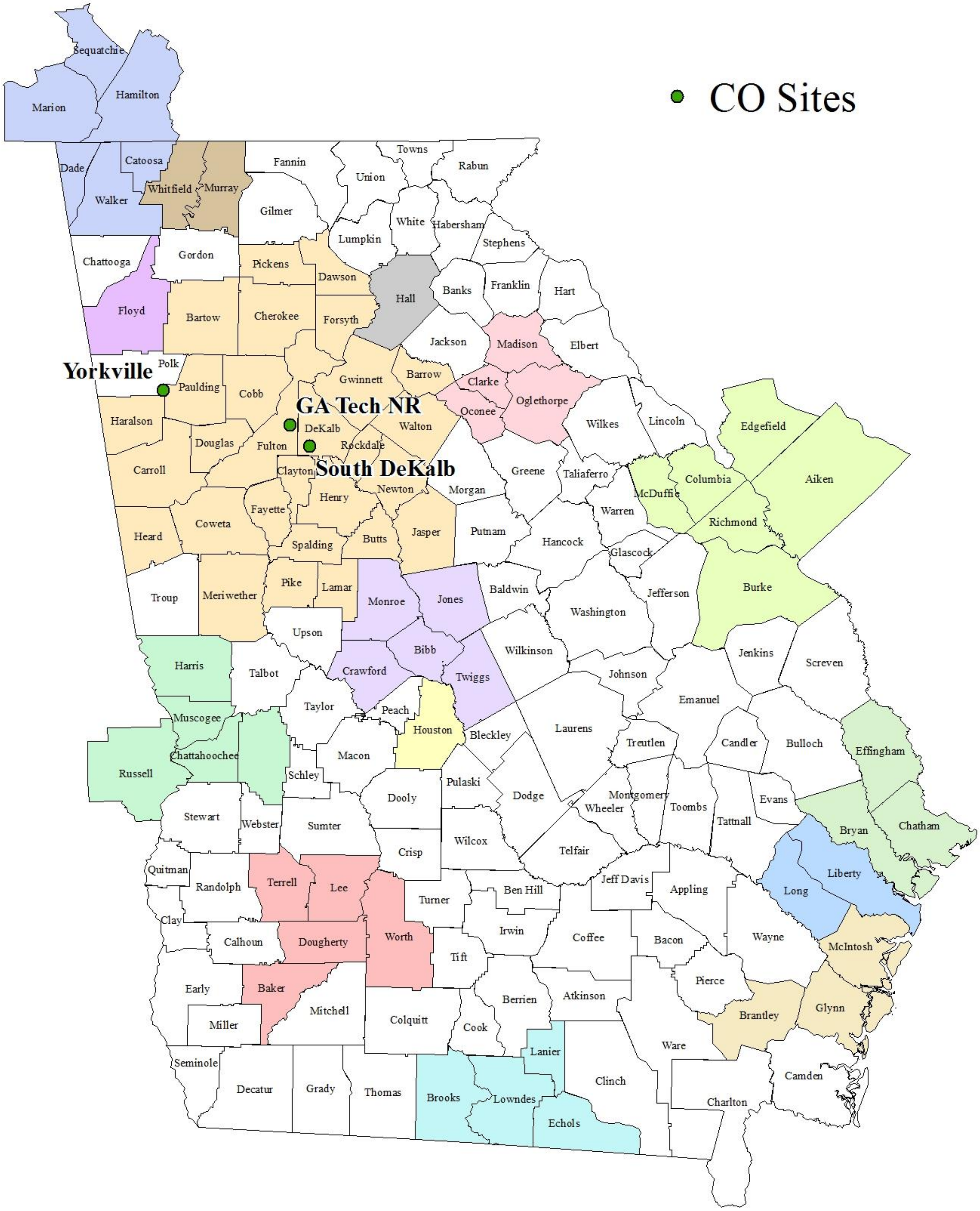


Figure 3. Georgia carbon monoxide monitoring sites, MSAs shown as solid colors. GA Tech NR began sampling June 2014.

HEALTH IMPACTS

Once 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.

Negative health effects of CO include weakening the contractions of the heart that reduces 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.

MEASUREMENT TECHNIQUES

CO is monitored on a real-time continuous sampler using an EPA-approved reference method of non-dispersive infrared analysis.

ATTAINMENT DESIGNATION

Data collected from the continuous monitors are used to determine compliance with the Clean Air Act (CAA) 8-hour and 1-hour NAAQS for CO. Figure 4 and Figure 5 show how Georgia’s CO compares to the two NAAQS. In Figure 4, Georgia’s CO values have dropped considerably since 1995 and are well below the NAAQS. If the data shows that these criteria are met, then the area is considered to be in attainment of the standard. All of Georgia is in attainment of both the 8-hour and 1-hour standards for carbon monoxide.

For additional summary data on carbon monoxide see Appendix A.

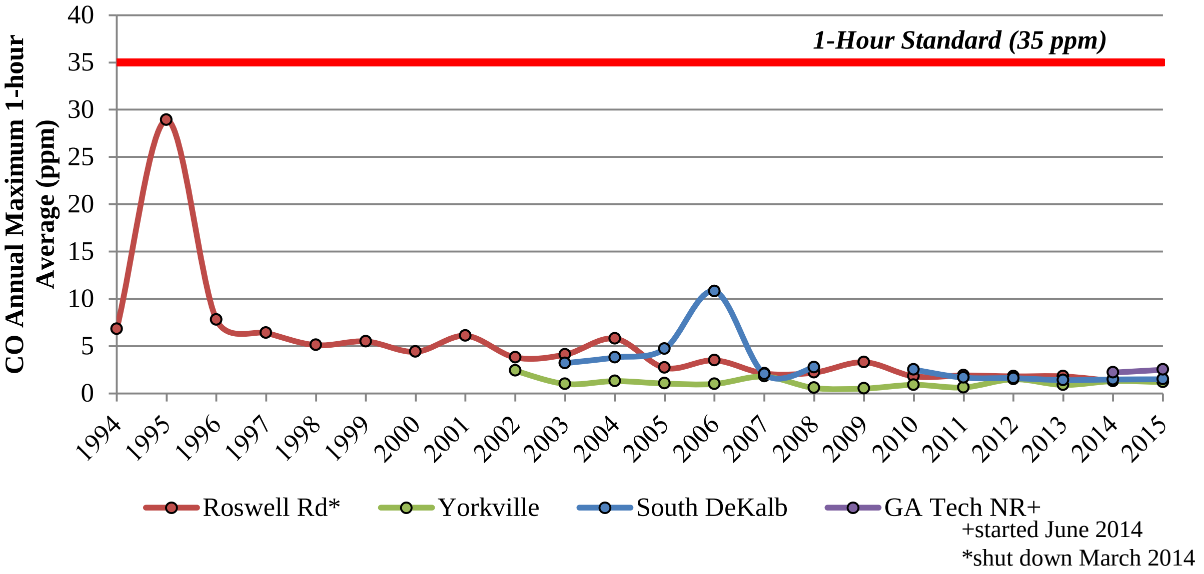


Figure 4. Carbon monoxide annual maximum 1-hour average compared to the 1-hour standard

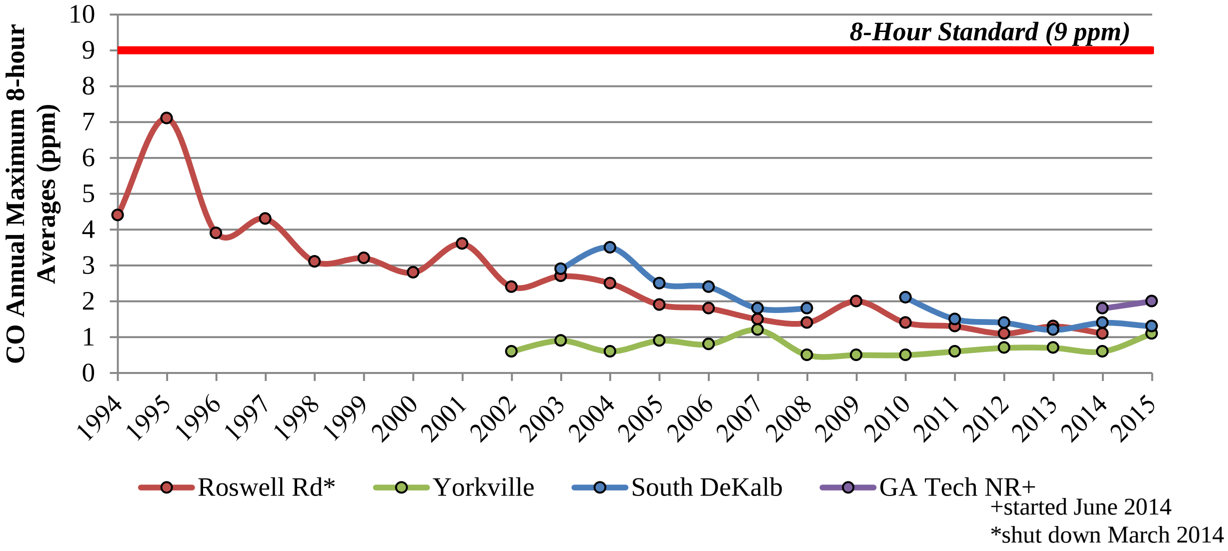


Figure 5. Carbon monoxide annual 8-hour average compared to the 8-hour standard

OXIDES OF NITROGEN (NO, NO_2, NO_x and NO_y)

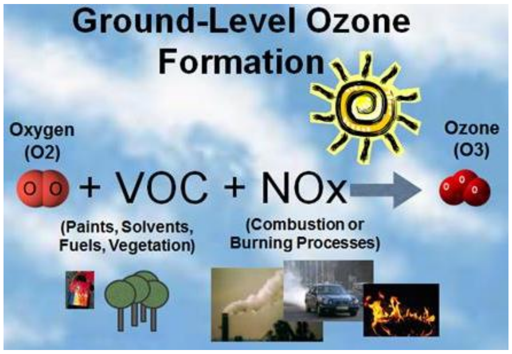
GENERAL INFORMATION

Oxides of nitrogen exist in various forms in the atmosphere (Table 3). 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. EPA set the standard for NO_2 to be an indicator for all forms of nitrogen oxides. 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.

Table 3. Common oxides of nitrogen species and terms

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		

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 6 is a representation of the typical diurnal pattern of NO_2. Refer to the ozone section and Figure 19 for a comparison of the ozone diurnal pattern.



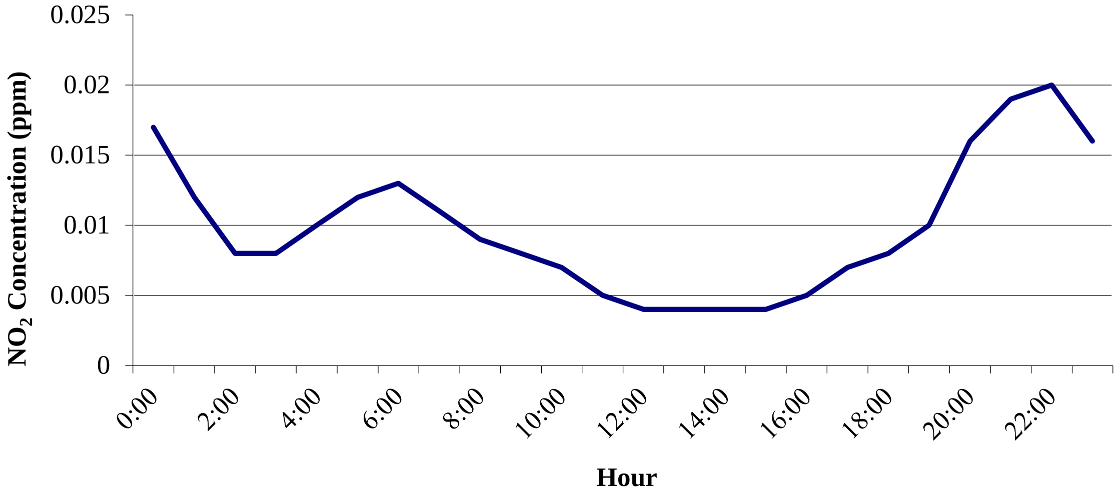


Figure 6. Typical diurnal pattern of nitrogen dioxide

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 mobile sources and industries (Figure 7). Fires, biogenics, and waste disposal produce substantial amounts of NOx. 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.

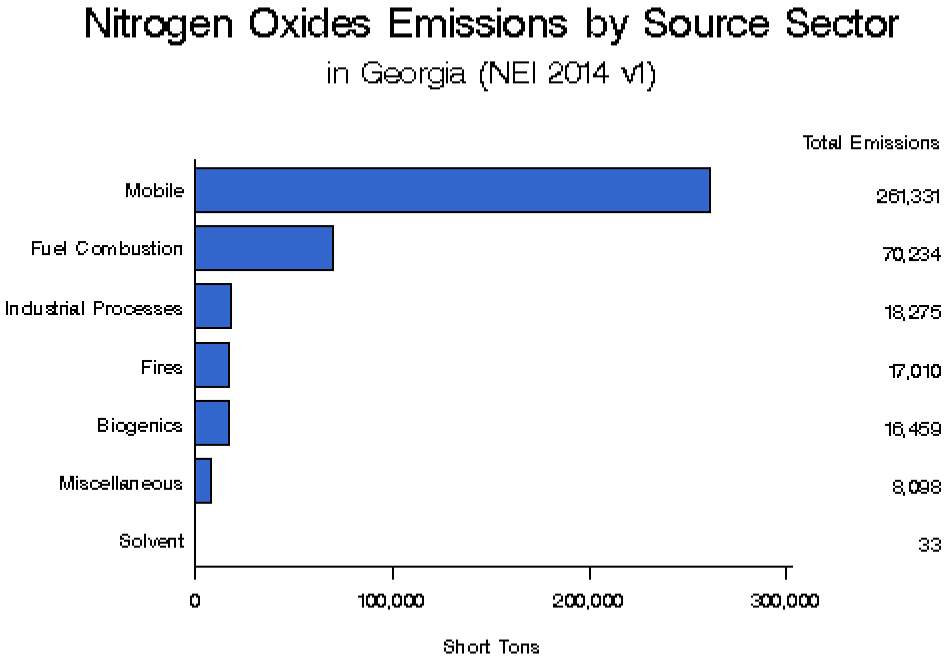


Figure 7. Common sources of nitrogen oxides in Georgia[1]

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[1] https://www.epa.gov/air-emissions-inventories/air-emissions-sources

Controlling ozone formation in the southeastern United States is driven by targeting NO_x reductions due to the volatile organic compound biogenics. Therefore, Georgia has focused efforts on reducing the emissions of nitrogen oxides, particularly in the Atlanta ozone nonattainment area. Reduction strategies include both regulatory and non-regulatory strategies.

Two State Rules were implemented in order to reduce NO_x emissions across Georgia. State Rule 391-3-1-.02(2)(lll) requires controls on fuel burning equipment, limiting NO_x emissions in the Atlanta 13-county nonattainment area plus 12 other surrounding counties, and is effective only May through September. All affected units were required to comply with this state rule effective October 7, 1999. Then in 2007, State Rule 391-3-1-.02(2)(sss) was added. This is a multi-pollutant control for electric utility steam generating units, which affects the 13-county Atlanta nonattainment areas plus surrounding counties. This rule requires coal fired power plants to install Selective Catalytic Reduction (SCR) and Flue Gas Desulfurization (FGD) controls to reduce three criteria pollutants, PM, NO_x, and SO_2, and has had rolling start dates between 2008 and 2014. Figure 8 shows how NO_x concentrations have declined as these controls have been implemented at various industries in the Atlanta area.

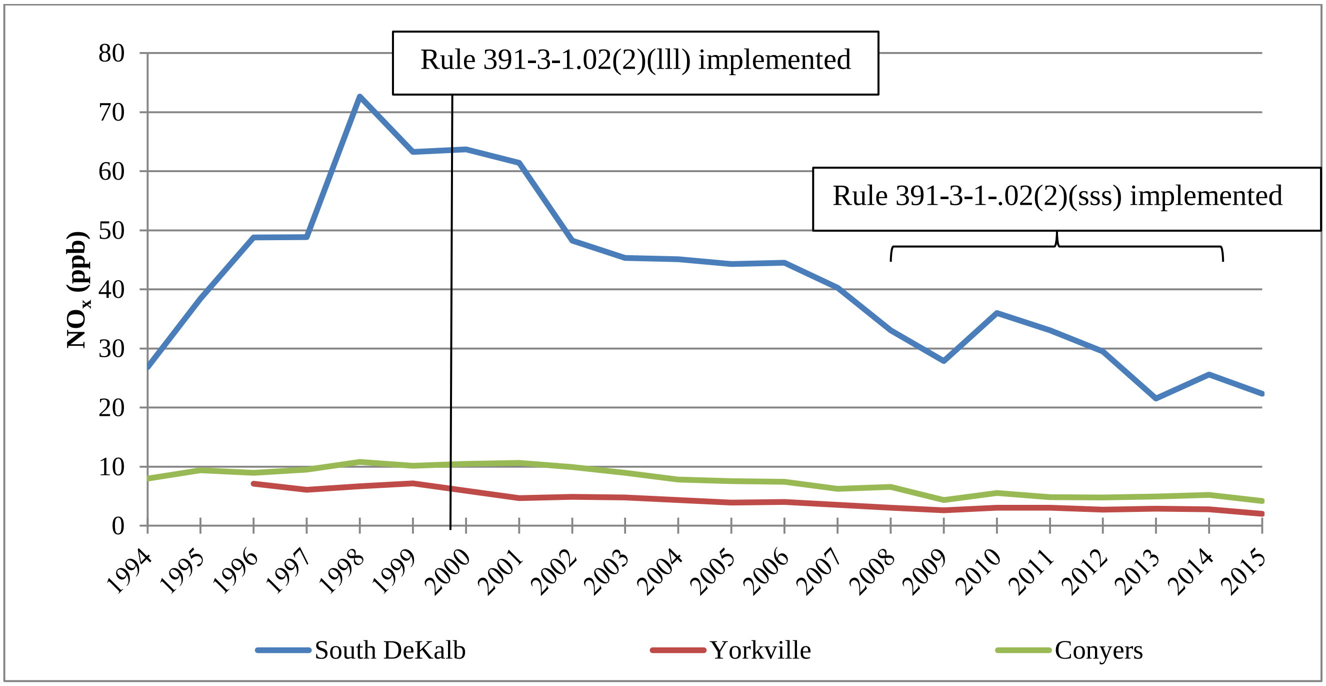


Figure 8. Implementation of NO_x Controls

School bus retrofitting, truck stop electrification, and locomotive conversions are three voluntary programs 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.

HEALTH IMPACTS

Exposure to high levels of NO_2 for short durations (less than three hours) can aggravate respiratory diseases. Asthma sufferers, in particular, are sensitive to NO_2. Exposure to high levels of NO_2 for longer durations may cause an increased susceptibility of respiratory infections and the development of asthma.

MEASUREMENT TECHNIQUES

Oxides of nitrogen, particularly NO_2, are monitored using specialized analyzers that continuously measure the concentration of oxides of nitrogen in ambient air with the ozone-phase chemiluminescent method.

ATTAINMENT DESIGNATION

NO_2 is an indicator for the larger group of nitrogen oxides, and it is regulated under the NAAQS. GA EPD monitors other oxides of nitrogen as precursors of ozone. NO_2 monitoring is required in urban areas with populations greater than 1,000,000. The Atlanta-Sandy Springs-Roswell MSA is the only urban area in Georgia that meets that population requirement. In 2015, the Atlanta-Sandy Springs-Roswell MSA had five NO_2 sites collecting data. They are located at the South DeKalb, Conyers, DMRC, GA Tech, and Yorkville sites. Figure 9 shows the complete oxides of nitrogen monitoring network, including NO_x and NO_y monitoring locations.

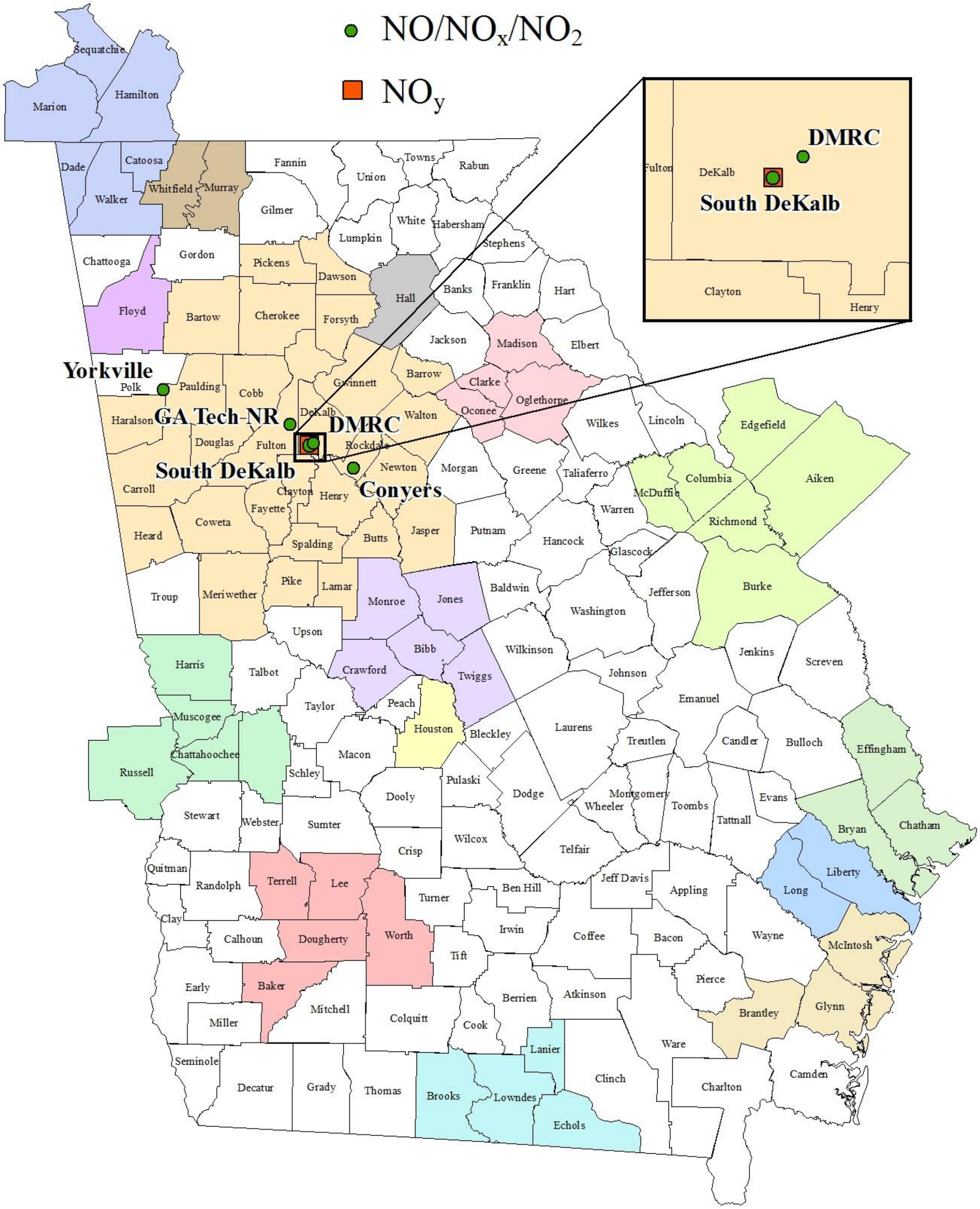
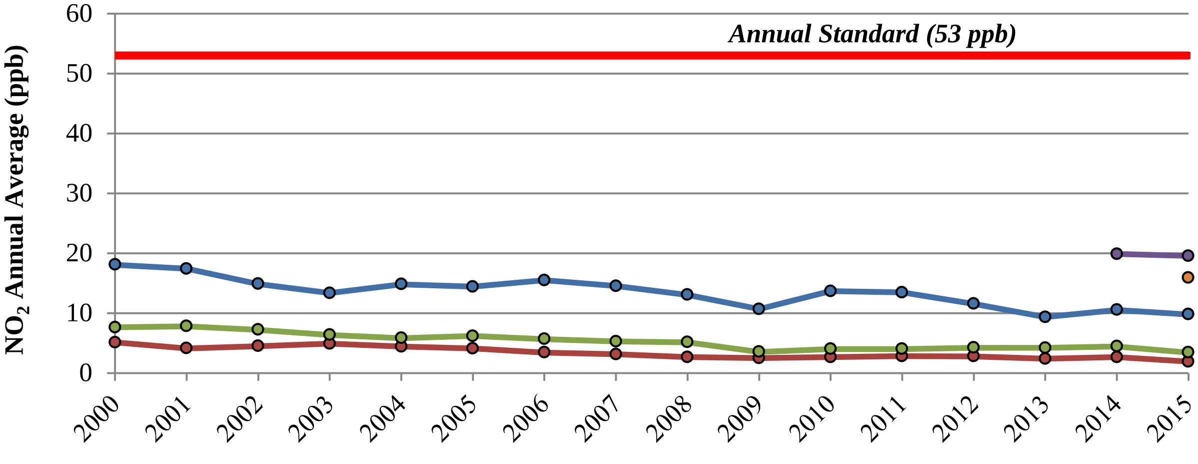


Figure 9. Georgia oxides of nitrogen monitoring sites, MSAs shown as solid colors

Data collected from these monitors is used to determine compliance with the NAAQS for NO_2. Figure 10 shows Georgia's annual average NO_2 concentrations from 2000 to 2015. Annual average concentrations are well below the standard of 53 ppb.



*started June 2014
**started January 2015

Figure 10. Nitrogen dioxide annual averages compared to the annual standard

The level for the 1-hour standard is 100 parts per billion. For this standard, EPA is interested in monitoring near-road concentrations and the effects of traffic emissions. GA EPD operates two near-road sites: Georgia Tech near-road site and the DMRC site. Figure 11 indicates that the 1-hour design values are well below the 100 ppb standard. Since the design value is a three-year average, this figure includes the sites where NO_2 data has been collected for over three years. For additional summary data on this topic see Appendix A.

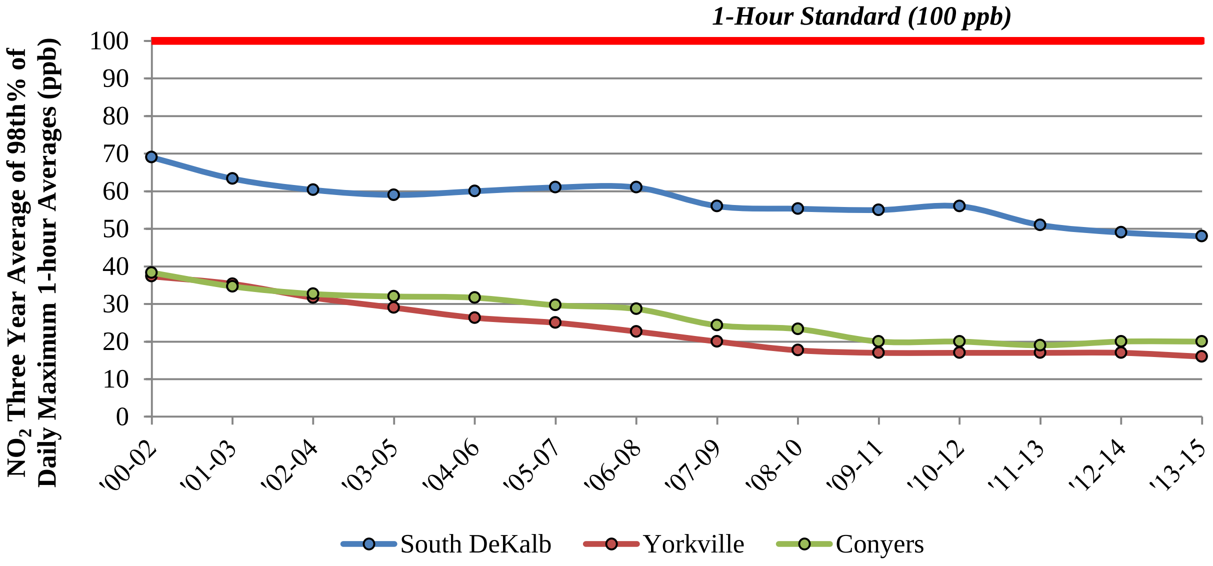


Figure 11. Nitrogen dioxide 1-hour design values compared to the 1-hour standard

With a complete year of NO_2 data at the near-road sites at DMRC and Georgia Tech, a daily average of the hourly data was compared to the other NO_2 sites. The following graph shows this comparison. The two sites that are on the outskirts of the Atlanta-Sandy Springs-Roswell MSA (Conyers and Yorkville, shown in pink and purple) show the lowest daily averages, while the three sites within the city have higher averages. The two near-road sites (shown in green and brown) display the highest daily averages.

An interesting observation is the comparison between the South DeKalb site (shown in blue), which is about 580 meters from the interstate, and the DMRC site (shown in brown), which is about 38 meters from the interstate. These two sites are approximately one mile apart, and one reason the DMRC site was chosen as a near-road site is to be able to make comparisons between these sites. Both sites seem to track each other, with the South DeKalb site collecting about 5 ppb less in concentration than the DMRC site, which is closer to the interstate.

Another noteworthy pattern is that the Saturday and Sunday hourly average concentrations appear to be lower than the weekday concentrations. This could be attributed to less vehicular traffic traveling on the nearby interstates on the weekends. In addition, the cyclical diurnal pattern, as discussed in Figure 6, is apparent in this graph.

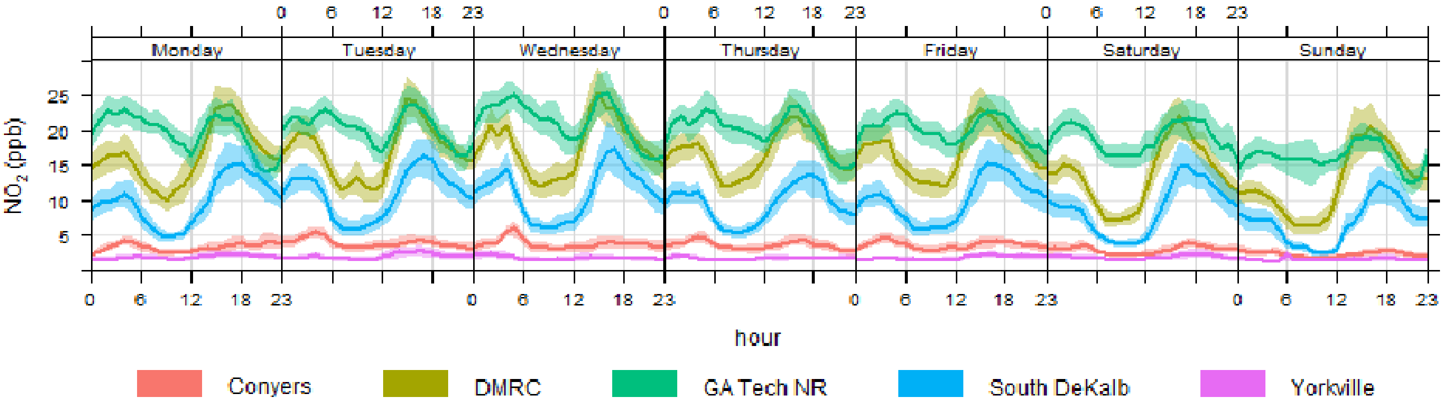


Figure 12. 2015 Day of the week average hourly NO_2 concentrations

Figure 13 is a visualization of decreasing NO_2 levels (higher levels shown with darker red) in the Atlanta area and the northern part of the state. There was a 42% decrease in NO_2 between the 2005-2007 to 2009-2011 timeframes. This image was produced using data gathered by NASA's Aura satellite equipped with an Ozone Monitoring Instrument (OMI)[2]

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[2] http://www.nasa.gov/content/goddard/new-nasa-images-highlight-us-air-quality-improvement/#.U7095vldXpX

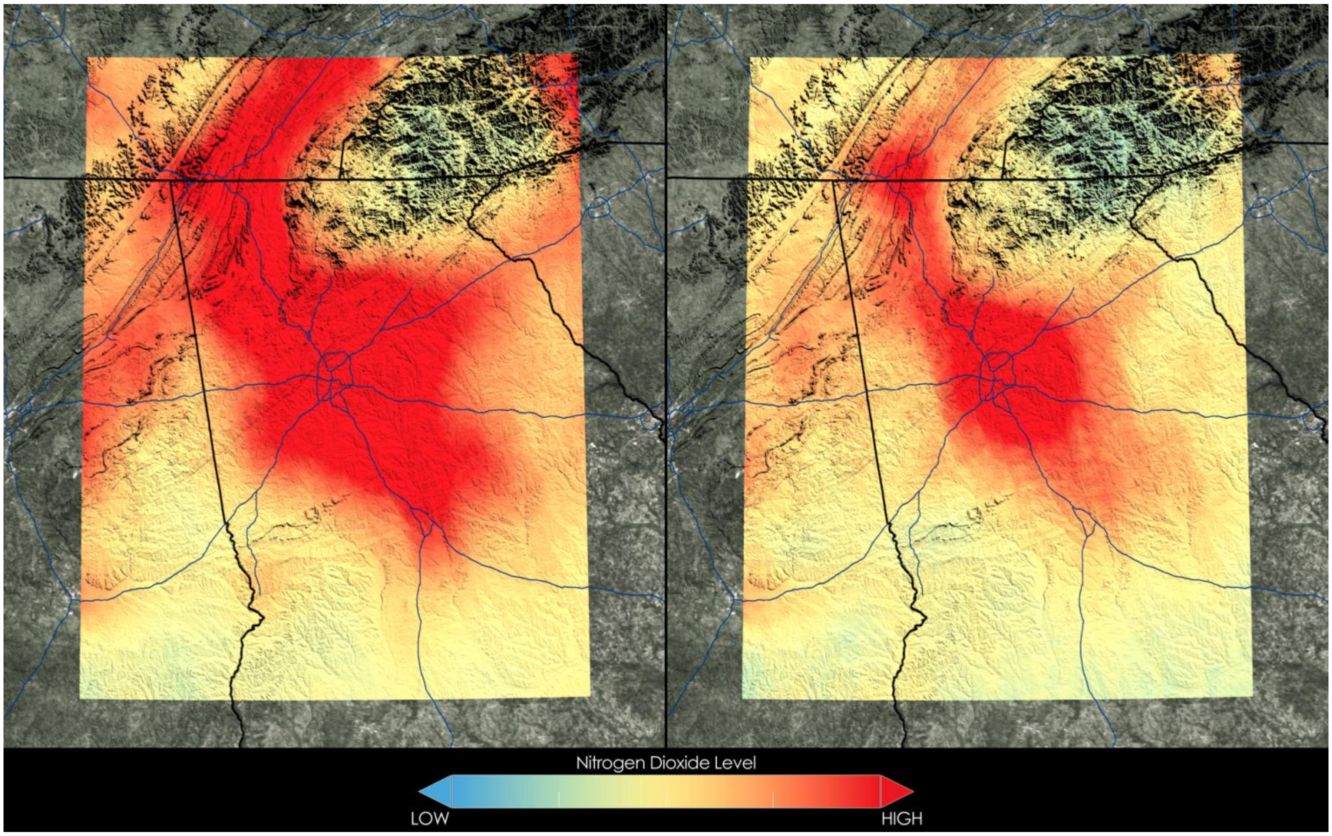

Figure 13. Satellite data show that Atlanta has seen decrease in nitrogen dioxide between the 2005-2007 (left) and 2009-2011 (right) periods.

SULFUR DIOXIDE (SO_2)

GENERAL INFORMATION

Sulfur dioxide (SO_2) is a colorless reactive gas that is formed by burning sulfur-containing material, such as coal or diesel fuel, or by processing sulfur-containing clays. Most SO_2 emissions in Georgia come from electric generation and large industrial boilers (Figure 14). It can be oxidized in the atmosphere into sulfuric acid. Sulfur is oxidized to form SO_2 during combustion. SO_2 then can react with other pollutants to form aerosols, which are solid or liquid particles in a gas. In liquid form, SO_2 may be found in clouds, fog, rain, aerosol particles, and in surface liquid films on these particles. Both SO_2 and NO_2 are precursors to the formation of acid rain that lead to acidic deposition[3]. SO_2 is also a precursor for sulfate particles, which make up some of particulate matter. Figure 14 shows common SO_2 sources. These figures are based on EPA's 2014 NEI.

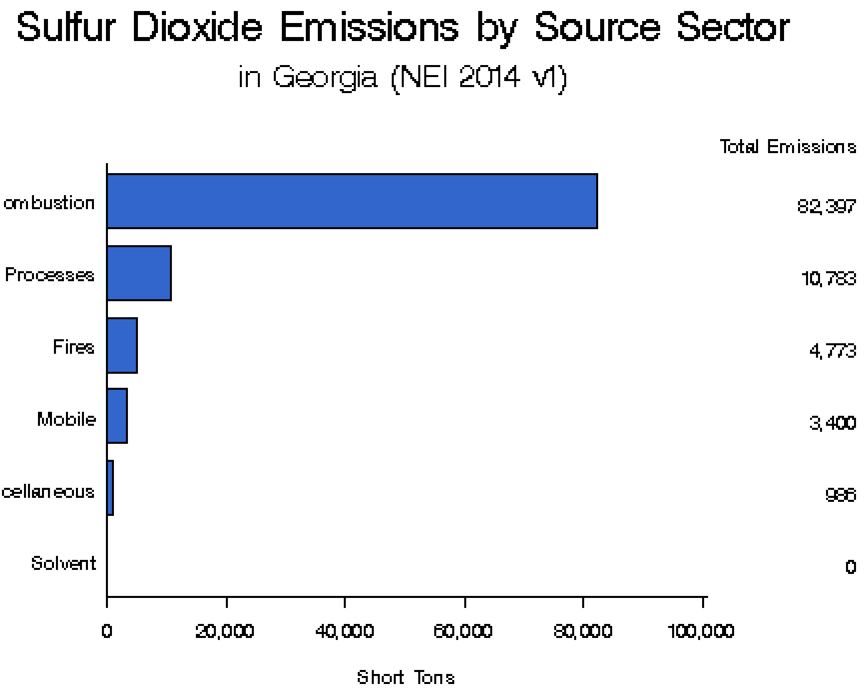

Figure 14. Common sources of sulfur dioxide (SO_2) in Georgia

Figure 15 compares the concentrations of sulfur dioxide from 2005-2007 and 2011-2014 in Georgia on a scale of 0 to 1 in Dobson units (DU)[4]. These maps were created by NASA using satellite data and depict multi-year averages of sulfur dioxide concentrations over the eastern United States. According to analyses of satellite data, levels of sulfur dioxide have dropped by about 80 percent between 2005 and 2014.

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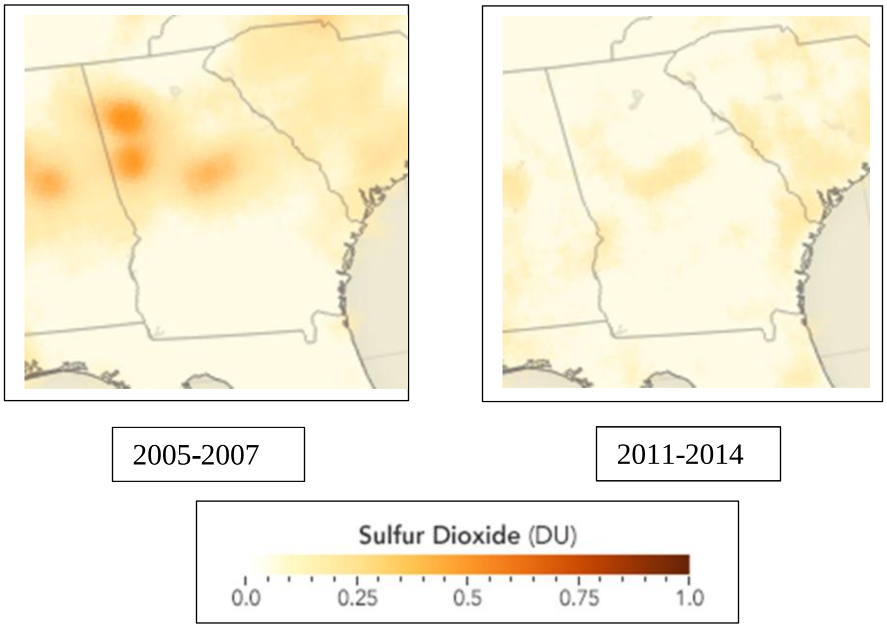
[3] Acid deposition causes damage to forests, man-made structures, and streams and lakes, which can be deadly for aquatic wildlife.

[4] A Dobson unit is a measurement of density of a gas in a column of the Earth's atmosphere.



http://earthobservatory.nasa.gov/IOTD/view.php?id=87182

Figure 15. Statewide SO_2 Concentration Comparison from 2005 to 2014

Efforts have been made to decrease SO_2 concentrations in Georgia. One such effort has been implementing State Rule 391-3-1-.02(2)(sss). In 2007, this State Rule was added, which affects the 13-county Atlanta nonattainment areas plus surrounding counties. This is a multi-pollutant control for electric utility steam generating units. It requires coal fired power plants to install controls to reduce three criteria pollutants, PM, NO_x, and SO_2, and has had rolling start dates between 2008 and 2014. These controls are called Selective Catalytic Reduction (SCR) and Flue Gas Desulfurization (FGD). Figure 16 shows the decrease in SO_2 concentrations as these controls have been implemented at various industries across the state.

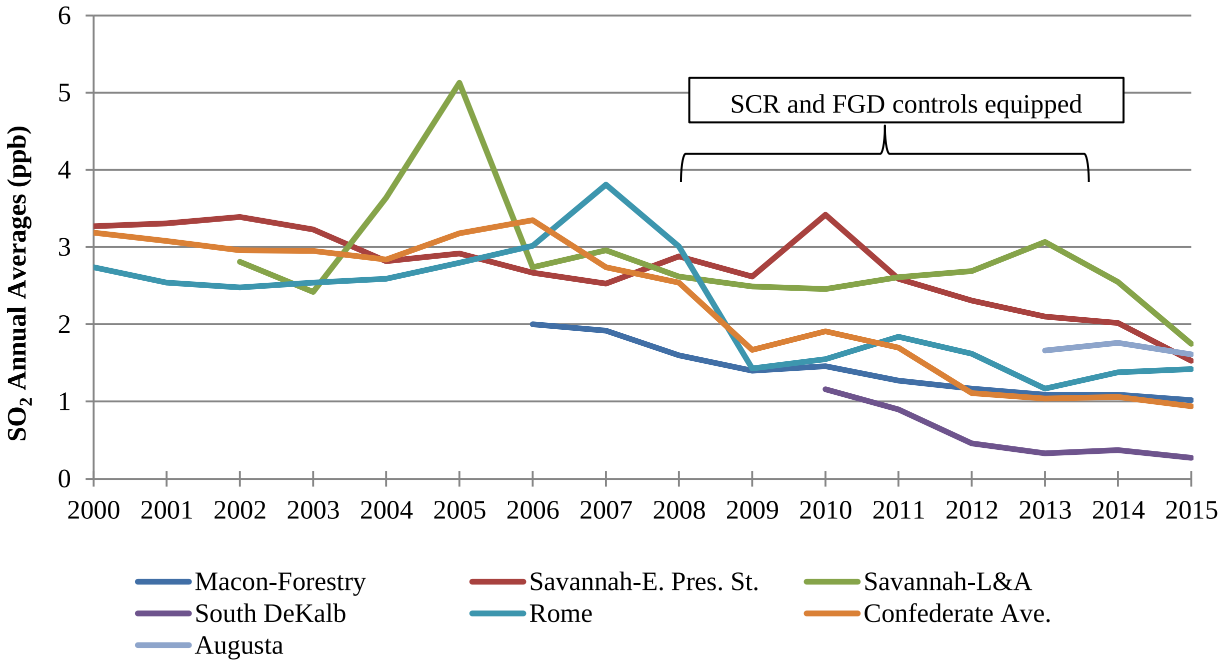


Figure 16. Implementation of SO_2 Controls

HEALTH IMPACTS

Exposure to 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 this air pollutant.

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.

MEASUREMENT TECHNIQUES

Sulfur dioxide is measured in the ambient air using continuous samplers with pulsed ultraviolet fluorescence technique. Figure 18 shows the locations of the Georgia SO_2 monitoring stations for 2015.

ATTAINMENT DESIGNATION

EPA strengthened the SO_2 primary National Ambient Air Quality Standard (NAAQS) in 2010 and has developed a 4-phase process for designations. Refer to EPA's information on the SO_2 data requirements rule for details[5]. All the SO_2 design[6] values for 2013-2015 were below the 1-hour standard, with the highest design value occurring at the Savannah L&A site (70 ppb). For additional SO_2 summary data see Appendix A.

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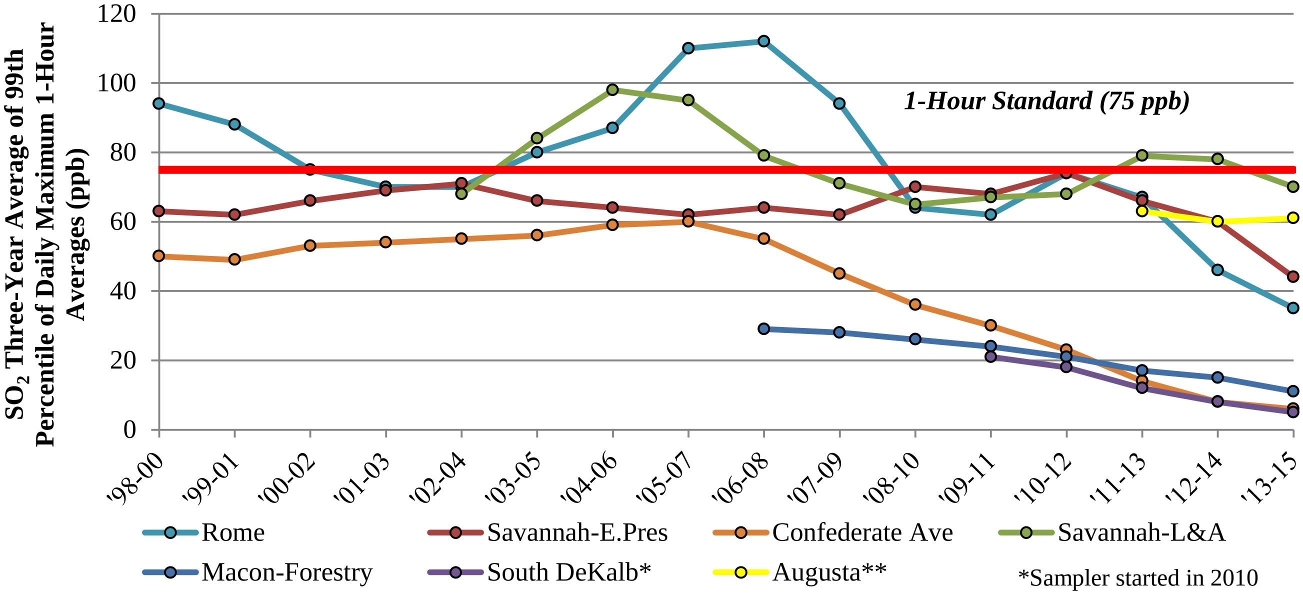
[5] https://www.epa.gov/so2-pollution/final-data-requirements-rule-2010-1-hour-sulfur-dioxide-so2-primary-national-ambient

[6] Three-year average of the 99th percentile of annual daily maximum 1-hour averages



*Sampler started in 2010
**Sampler started in 2013

Figure 17. SO_2 three-year averages of the 99^{th} percentile of annual daily max 1-hour averages

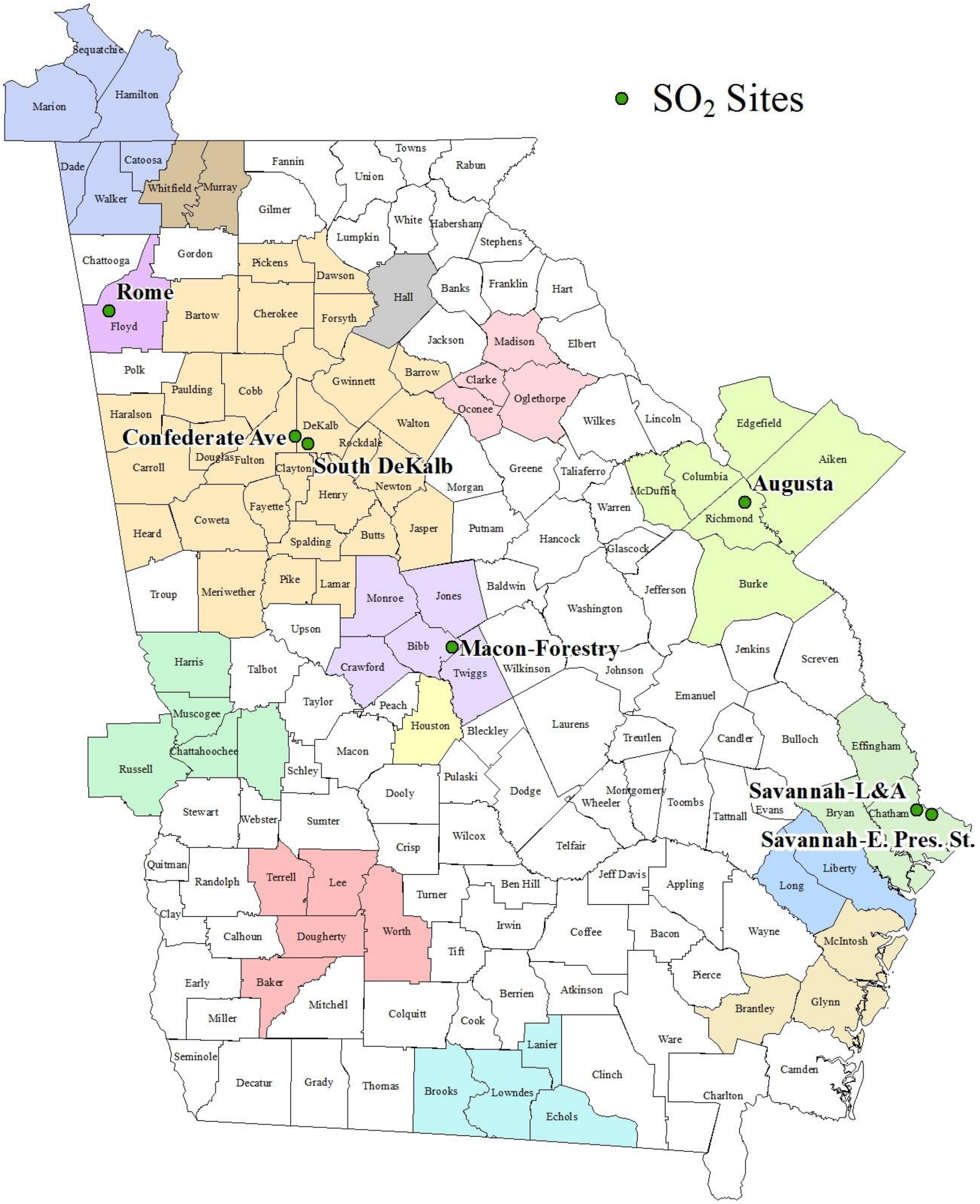


Figure 18. Georgia’s sulfur dioxide monitoring sites, MSAs shown as solid colors

OZONE (O_3)

GENERAL INFORMATION

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 19 shows this typical diurnal pattern of ozone concentration throughout the day.

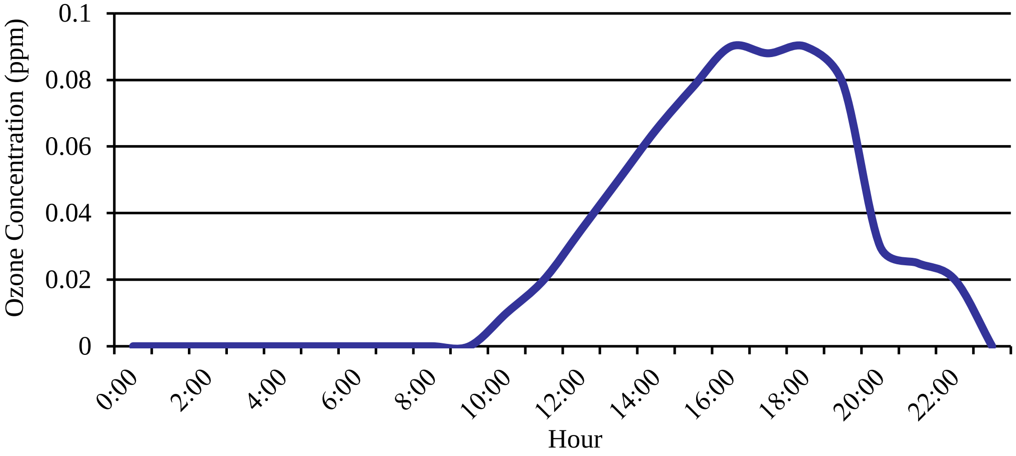
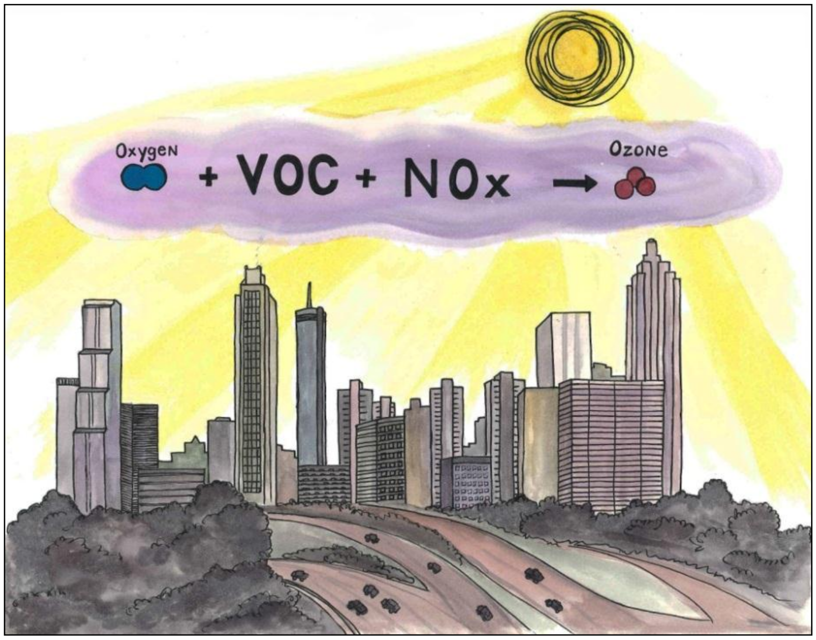


Figure 19. Typical urban 1-hour ozone diurnal pattern

For these photochemical reactions to take place, certain components, or precursors, must be available. The precursors[7] to ozone are oxides of nitrogen (NO_x) and photochemically reactive volatile organic compounds (VOCs) (Figure 20). Common sources of NO_x include combustion processes from fossil fuel-fired utilities, mobile sources and industrial processes. Examples of the most common 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 20. Ozone formation process

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[7] For a more complete discussion on ozone precursors see the NO_2 section and the PAMS section of this report.

Sources of VOCs in Georgia are shown in Figure 21. In Georgia, biogenic emissions are the most common source of volatile organic compounds. This figure is taken from the latest emissions report from EPA, based on 2014 data.

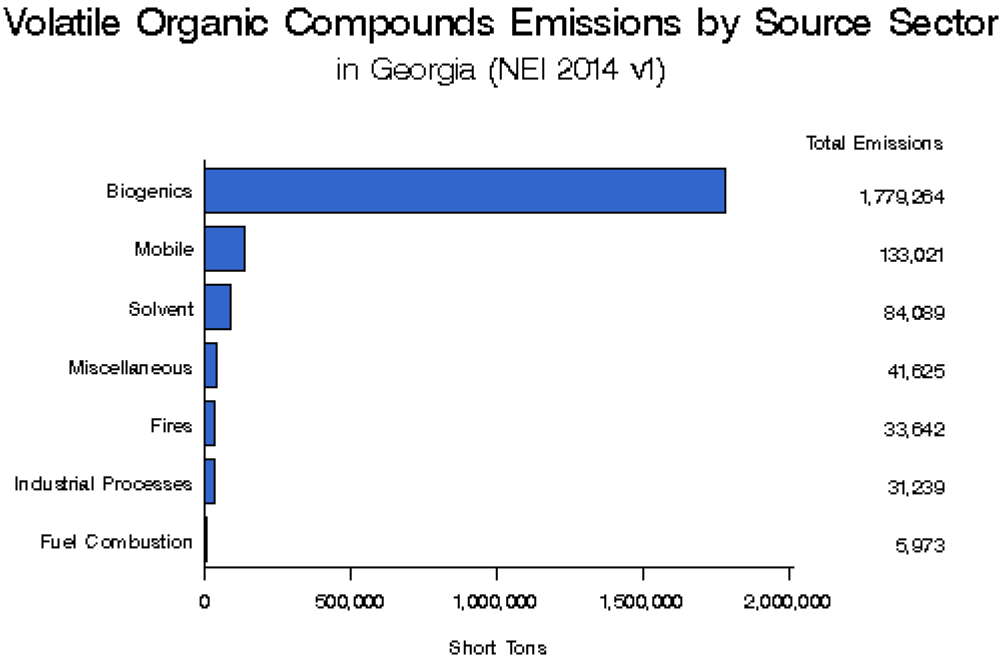


Figure 21. Common sources of VOCs in Georgia in 2014

Ozone is a colorless gas; however, when mixed with particles and other pollutants, such as NO_2, the atmospheric reaction forms a brownish, pungent odor. This type of pollution first gained attention in the 1940's in Los Angeles as photochemical "smog" and has since been observed frequently in many other cities.

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.” This limiting reactant can be thought of in terms of household baking. One can only bake cookies until any one of the ingredients is gone. If the flour is gone, it does not matter how much milk and sugar there is; no more cookies can be made without more flour. In the same way, ozone production can only occur until the process has consumed all of any one of the required ingredients. Vegetation naturally emits large quantities of hydrocarbons, and Georgia has a lot of vegetation. Since there will always be strong sunshine in the summer, and there will always be oxygen, the most effective way to control ozone production in Georgia is to reduce emissions of oxides of nitrogen.

A final difference between ozone and the other pollutants is that ozone is sometimes good. While high levels of ground level ozone is considered potentially hazardous to your health the ozone in the upper atmosphere, approximately 10-22 miles above the earth’s surface, protects life on earth from the sun’s harmful ultraviolet (UV) rays. This ozone is gradually being depleted due to man-made products called ozone depleting chemicals, including chlorofluorocarbons (CFCs), which when released naturally, migrate to the upper atmosphere. In the upper atmosphere, CFCs break down due to the intensity of the sun’s UV rays, releasing chlorine and bromine atoms. These atoms react with the ozone and destroy it. Scientists say that one chlorine atom can destroy as many as 100,000 “good” ozone molecules. The destruction of this ozone may lead to more harmful ultraviolet rays reaching the earth's surface, causing increased skin cancer rates. This reduction in the protection provided by ozone in the upper atmosphere is usually referred to as the "ozone hole" and is most pronounced in polar regions.

With the exception of the South DeKalb site, ozone in Georgia, unlike other pollutants previously discussed, is only monitored during the "summer" months (March through October), according to EPA's 40 Code of Federal Regulations Part 58 monitoring requirements. Many urban areas experience high levels of ground level ozone during the summer months. High ozone levels can also be seen in rural and mountainous areas. This is often caused by ozone and/or its precursors being transported by wind and temperature-driven air movement for many hundreds of miles.

As part of the Clean Air Status and Trends Network (CASTNET), EPA established a monitoring site in Georgia in 1988. The CASTNET site is part of a national air quality monitoring network put in place to assess long-term trends in atmospheric deposition and ecological effects of air pollutants. The CASTNET site is one of 85 regional sites across rural areas of the United States and Canada measuring nitrogen, sulfur, and ozone concentrations, and deposition of sulfur and nitrogen. Like the South DeKalb ozone monitor, the CASTNET ozone monitor also collects data year-round.

In 2015, the GA EPD monitored ground level ozone at 20 sites throughout the state and the EPA collected data at the CASTNET site (Figure 22).

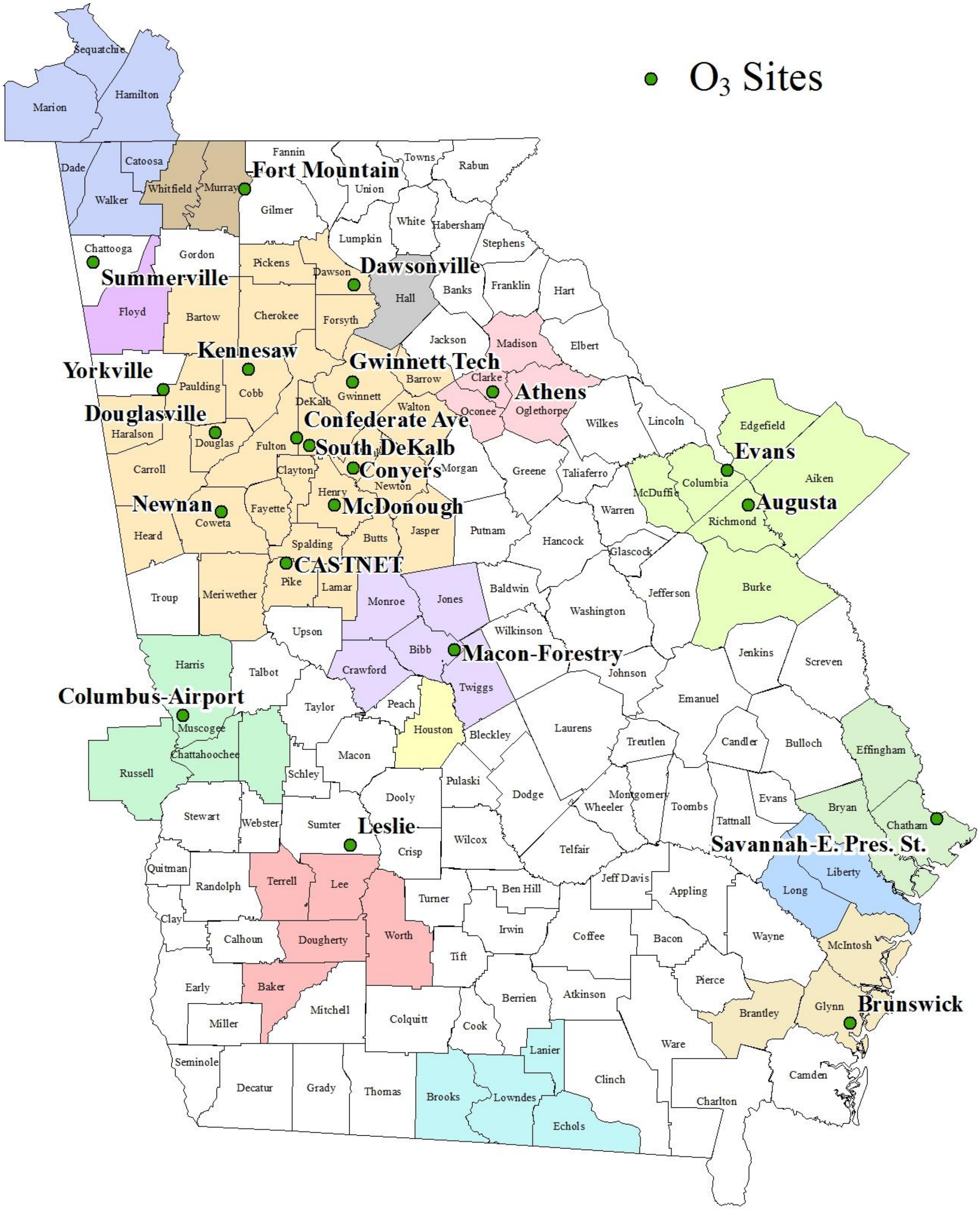


Figure 22. Georgia’s ozone monitoring sites, MSAs shown as solid colors

HEALTH IMPACTS

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 also suggest that even at lower ozone concentrations some healthy individuals engaged in moderate exercise for six to eight 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. Repeated exposure may cause permanent scarring of lung tissue.

MEASUREMENT TECHNIQUES

Georgia's ozone analyzers continuously measure the concentration of ozone in ambient air using the ultraviolet photometric method.

ATTAINMENT DESIGNATION

Ozone monitoring has been in place in the Atlanta area since the 1970's. The 1970's network consisted of two monitors located in DeKalb and Rockdale Counties. Currently the Atlanta-Sandy Springs-Roswell MSA ozone network includes ten monitors located in ten counties.

On March 27, 2008 the ozone primary standard level was lowered to 0.075 ppm for the 8-hour averaging time, fourth maximum value, averaged over three years (Federal Register, Vol. 73, No. 60, page 16436). With the implementation of the 2008 ground-level ozone standard, the boundary of the Atlanta nonattainment area is defined as a 15-county area (Figure 23). The Atlanta area is now attaining this standard and EPD has submitted a redesignation request to EPA.

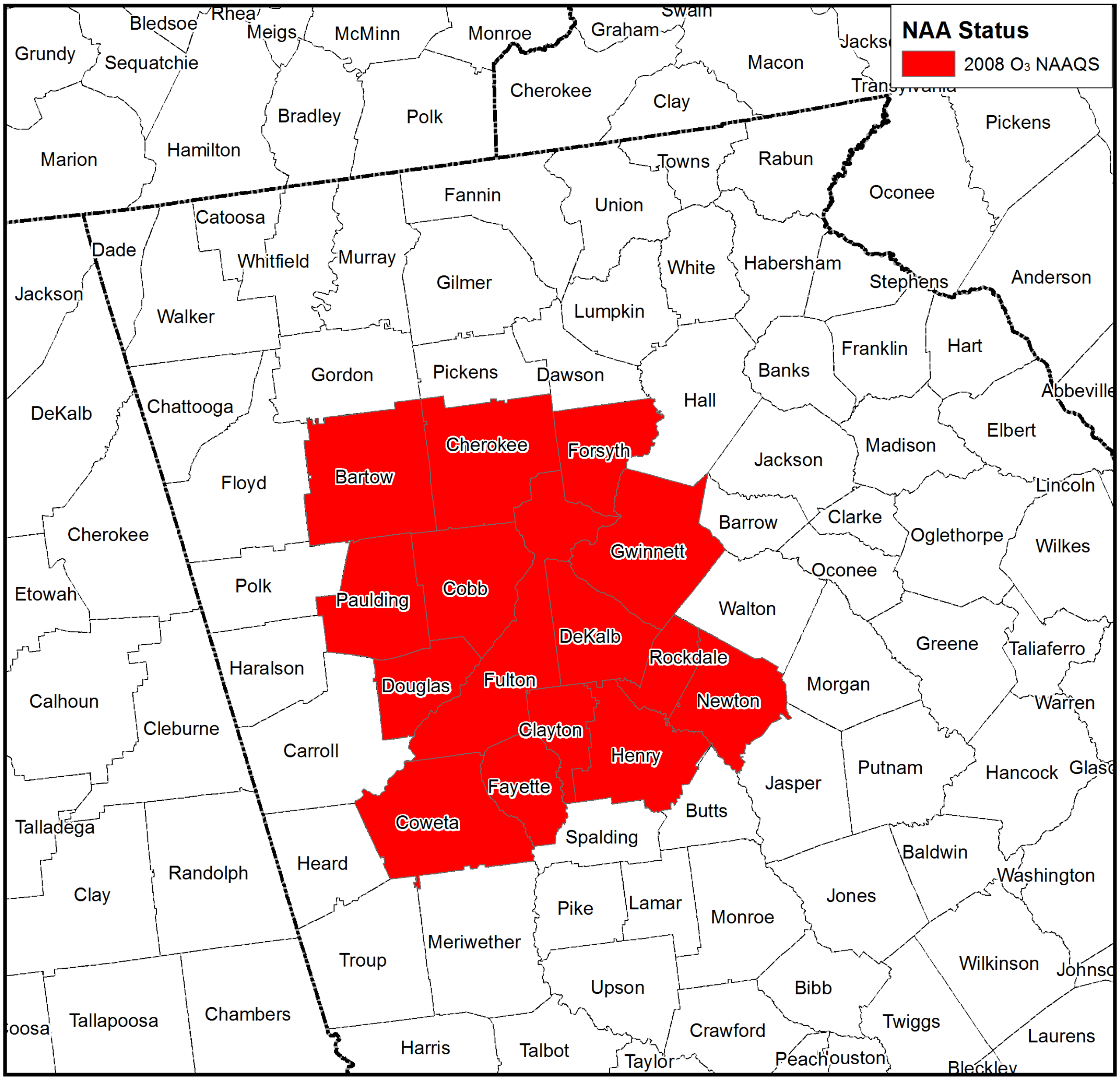
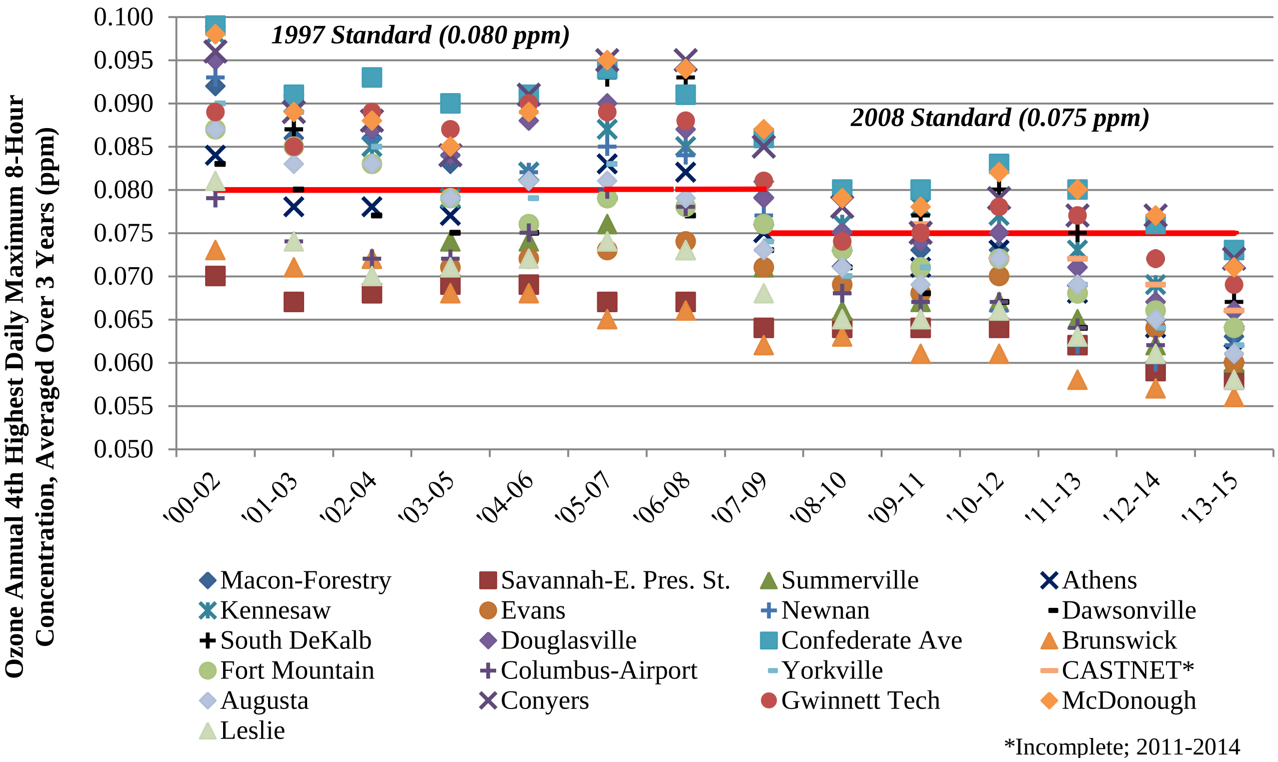


Figure 23. Georgia’s 8-hour ozone nonattainment area (NAA) map for the 2008 standard

Efforts to control ozone formation have led to lower and lower ozone concentrations (Figure 24 and Figure 25) in Georgia. With the 2013-2015 ozone data, GA EPD has met the 2008 national ambient air quality standard of 0.075 ppm for ozone. GA EPD has submitted to EPA a request for redesignation of attainment of this 0.075 ppm standard for the 15-county Atlanta nonattainment area. A maintenance plan to show how GA EPD proposes to maintain this level of ozone below the 2008 standard has been submitted to EPA, and GA EPD is awaiting approval of its maintenance plan and final redesignation to attainment for the 15-county Atlanta nonattainment area. On October 1, 2015, EPA lowered the ozone standard to 0.070 ppm[8]. However, all the ozone data for 2015 was compared to the 2008 standard of 0.075 ppm for this report.



*Incomplete; 2011-2014

Figure 24. Ozone design values for GA EPD's ozone sites and EPA's CASTNET site.

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[8] https://www.epa.gov/ozone-pollution/2015-revision-2008-ozone-national-ambient-air-quality-standards-naaqs-supporting

Figure 25 shows the number of exceedance days per year in relation to the 0.075 ppm 8-hour ozone standard (red line) and the old 0.085 ppm 8-hour ozone standard (blue line). The term ‘exceedance’ is defined as a daily maximum 8-hour average greater than the respective standard (0.075 or 0.085 ppm). Therefore, this does not indicate a violation of the standard, which is determined by using and 8-hour average of the fourth maximum daily value, averaged over three years. This chart was produced by comparing measurement data against both ambient standards. This figure compares the relative strictness of each standard and shows how the Atlanta-Sandy Springs-Roswell MSA’s air quality has changed over time. Despite a great deal of fluctuation, over the course of the past thirty years, there has been a gradual reduction in the number of days exceeding either ozone standard. Even with the lower 8-hour ozone standard, the data shows a decrease in the number of days with ozone exceedances for the Atlanta-Sandy Springs-Roswell MSA. In 2015, the Atlanta-Sandy Springs-Roswell MSA area had a total of 7 days that exceeded the current (0.075 ppm) 8-hour standard.

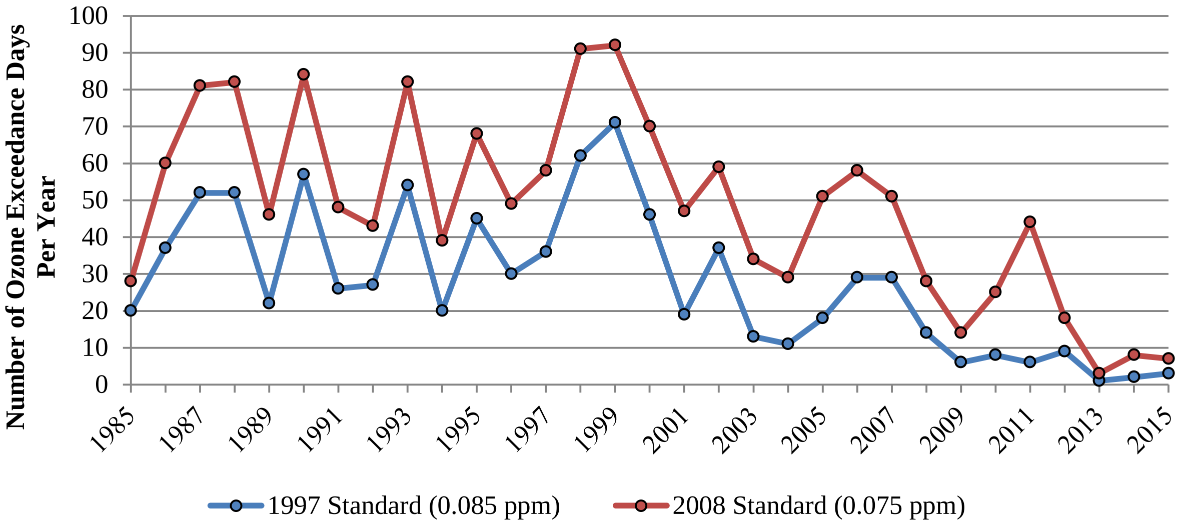
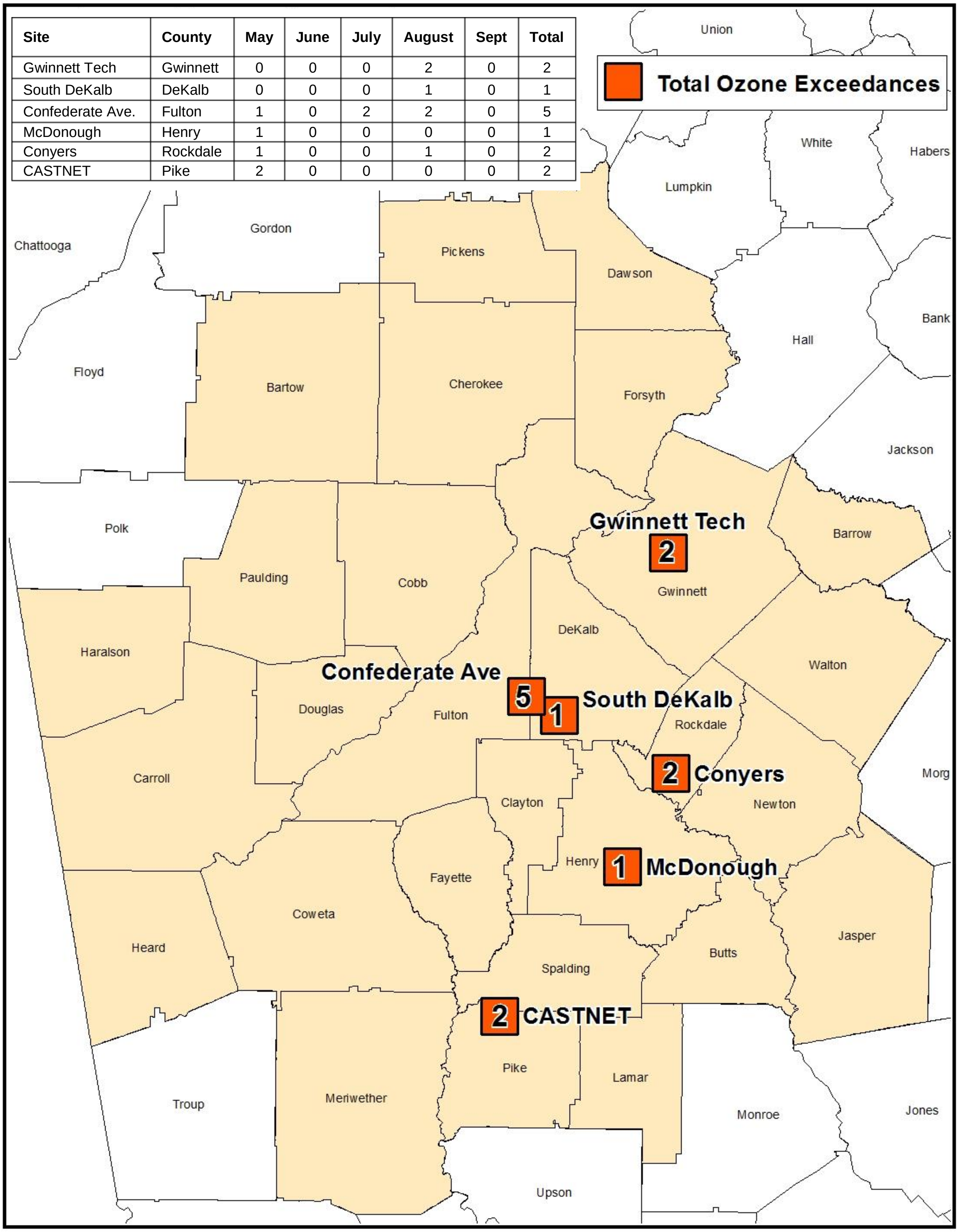


Figure 25. Number of ozone exceedance days per year in relation to the current (red line) and former (blue line) standards in the Atlanta-Sandy Springs-Roswell MSA.

The Atlanta-Sandy Springs-Roswell MSA ozone monitors which exceeded the 8-hour ozone standard (0.075 ppm) in 2015 are mapped along with a table of the monthly breakdown of the exceedances (Figure 26). Since the 8-hour increment is calculated as a running 8-hour timeframe, there are a number of averages each day. Of the eleven ozone sites collecting data in the Atlanta-Sandy Springs-Roswell MSA, six sites experienced exceedances during the 2015 ozone season.



Site	County	May	June	July	August	Sept	Total
Gwinnett Tech	Gwinnett	0	0	0	2	0	2
South DeKalb	DeKalb	0	0	0	1	0	1
Confederate Ave.	Fulton	1	0	2	2	0	5
McDonough	Henry	1	0	0	0	0	1
Conyers	Rockdale	1	0	0	1	0	2
CASTNET	Pike	2	0	0	0	0	2

Figure 26. The number of days each monitor had 8-hour averages above the 0.075 ppm ozone standard in the Atlanta-Sandy Springs-Roswell MSA, including a table of the monthly breakdown of exceedances.

Figure 27 was taken from EPA's "Our Nation's Air- Status and Trends through 2015" (https://gispub.epa.gov/air/trendsreport/2016/). It shows the fourth maximum reading for the 8-hour ozone readings across the United States. Georgia's fourth maximum ozone readings in 2015 were in the 0.055-0.07 ppm (light blue) and 0.07-0.085 ppm (green) ranges.

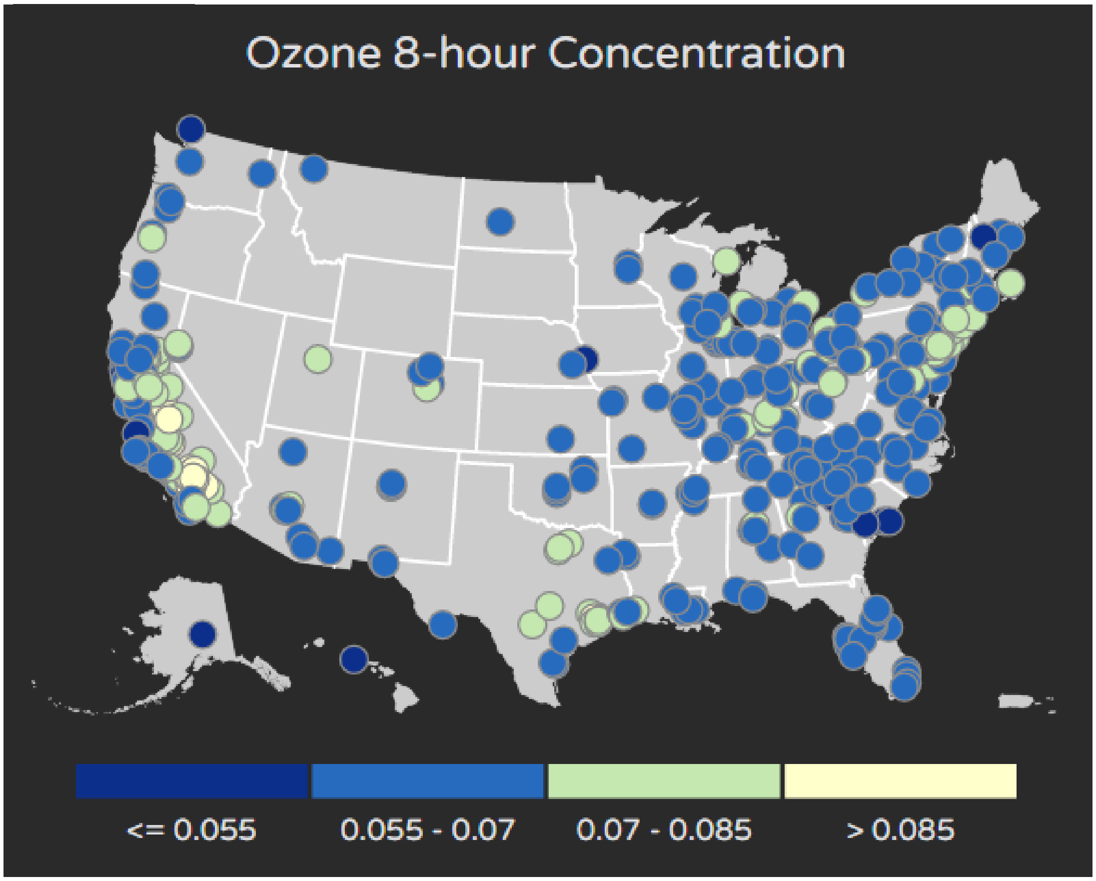


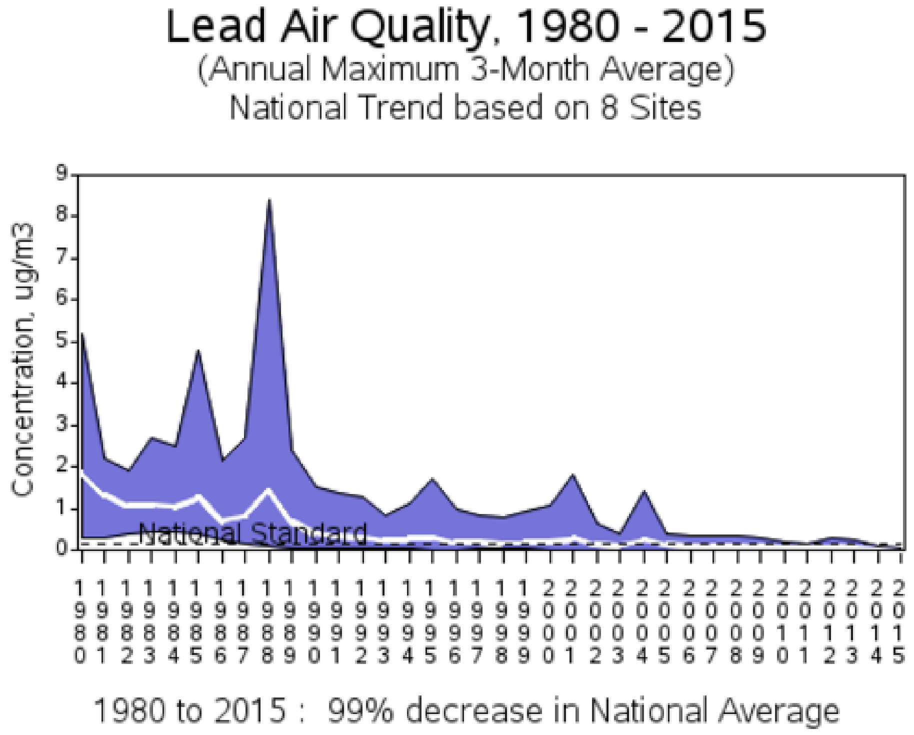
Figure 27. Ozone concentrations (ppm) for the U.S. in 2015

GA EPD has implemented a number of activities to aid in controlling ozone formation. One way to help control ozone formation is to regulate NO_x emissions, which is discussed in the previous Oxides of Nitrogen section. The vehicle emissions inspection program in Cherokee, Clayton, Cobb, Coweta, DeKalb, Douglas, Fayette, Forsyth, Fulton, Gwinnett, Henry, Paulding, and Rockdale Counties helps control the precursors to ozone. Other activities include voluntary mobile emissions reduction programs. An example of a program to aid in controlling ozone formation is Georgia Commute Options, sponsored by Georgia Department of Transportation, which rewards commuters for trying an alternative for driving alone to and from work. In addition, 'Smog Alerts' are sent on days with unhealthy air quality forecasted. For a more detailed discussion concerning Georgia Commute Options, see the section in this report titled "Outreach and Education". Furthermore, citizens have access to forecast and monitoring data on an as needed basis by accessing the GA EPD's Ambient Air Monitoring website at http://amp.georgiaair.org/. For additional ozone summary data see Appendix A.

LEAD (Pb)

GENERAL INFORMATION

In the past, the Clean Air Act required extensive lead monitoring in order to detect the high levels of airborne lead that resulted from the use of leaded gasoline. With the phase-out of leaded gasoline, lead concentrations decreased drastically by the late 1980s**.** Figure 28 was taken from EPA's document "Our Nation's Air Quality-Status and Trends through 2015" showing this significant decrease of the annual maximum three-month lead averages across the United States from 1980 through 2015.



https://www.epa.gov/air-trends/lead-trends

Figure 28. Lead national average, 1980-2015

Since then, the concentrations have hovered just above detection level. Based on data from EPA's Air Emission Sources for 2014, Georgia's primary source of lead emissions comes from mobile sources (Figure 29). Other sources of lead emissions include industrial processes (metals processing, iron and steel production), fuel combustion of solid waste, and lead-acid battery manufacturing.

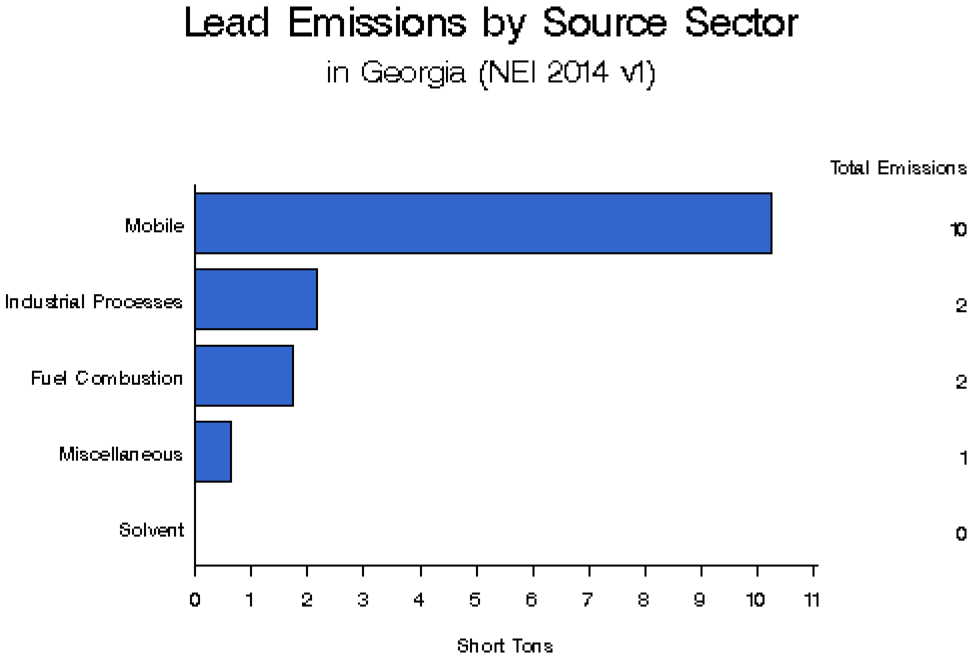


Figure 29. Common sources of lead in Georgia

The current criteria lead monitoring network is shown in Figure 30. For summary data on criteria lead monitoring, see Appendix A. In addition to the criteria network sites, lead is also being monitored at sites throughout the state as a trace metal in the Georgia Air Toxics Monitoring Network, the National Air Toxics Trends Station (NATTS), and with $PM_{2.5}$ speciation samplers. For additional summary data concerning lead collected as an Air Toxics trace metal, see Appendix D.

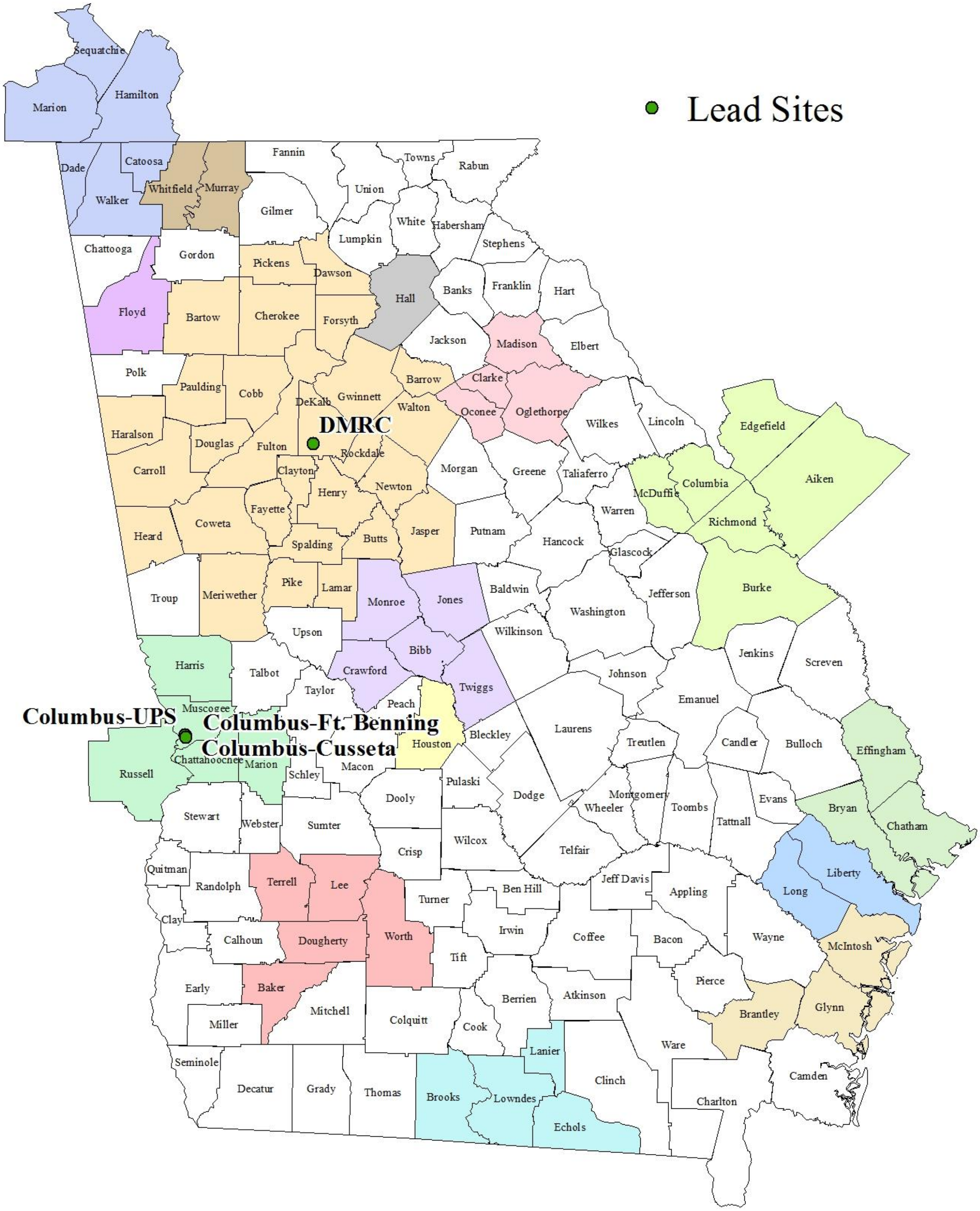


Figure 30. Georgia’s lead monitoring sites, MSAs shown as solid colors.

HEALTH IMPACTS

Exposure to lead occurs mainly through inhalation and ingestion of lead in food, water, soil, or dust. Lead particles can re-enter the environment through re-entrainment of dust from vehicle traffic, construction activities, and agricultural activities. 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 lead-containing dust and dirt.

MEASUREMENT TECHNIQUES

Since lead is a particulate, the measurement for ambient air lead concentrations is performed using a manual method, collecting a 24-hour total suspended particulate (100 microns or less) sample on an 8”x10” pre-weighed fiberglass filter.

ATTAINMENT DESIGNATION

Compliance with the national primary and secondary ambient air quality standards for lead and its compounds is determined based on the assumption that all lead is elemental lead. Figure 31 shows how Georgia’s lead data compares to the rolling three-month average standard for 2010 through 2015. The last of the three months used for each average is indicated on the graph. The two monitors in the Columbus GA-AL MSA are located near a lead battery manufacturer, and have shown higher readings compared to the other monitors in the Columbus GA-AL MSA or the Atlanta-Sandy Springs-Roswell MSA. For additional summary data on this topic see Appendix A.

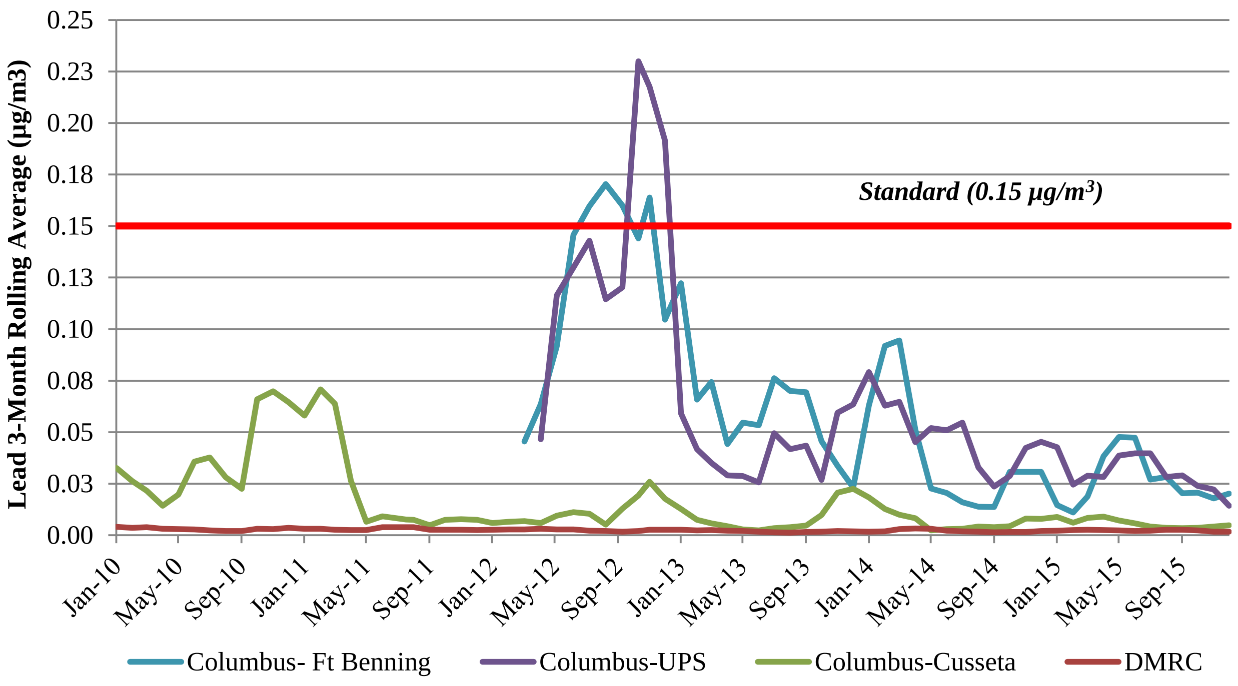


Figure 31. Georgia’s lead design values, 2010-2015

PARTICULATE MATTER

GENERAL INFORMATION

Particulate matter is a broad range of material that consists of solid particles, fine liquid droplets, or condensed liquids absorbed onto solid particles. Airborne particulates are not a single pollutant as discussed for the other criteria pollutants, but rather a mixture of many different air pollutants. Primary sources that emit particles include combustion, incineration, construction, mining, metals smelting, metal processing, and grinding. Other sources include motor vehicle exhaust, road dust, wind blown soil, forest fires, open burning of vegetation for land clearing or waste removal, ocean spray, and volcanic activity.

There are two ways (primary and secondary) that particulate matter is formed. Primary particulate is emitted directly from a source, like a vehicle's tailpipe or a factory's smokestack. However, a great deal of particulate matter is not directly emitted from such sources. In fact, the vast majority of primary air pollution is in the form of gases. Those gaseous air pollutants readily react in the atmosphere with oxygen and with each other. While many of those reactions produce other gases, they frequently produce particles. Particles formed through this process are known as secondary particulate matter. Examples of secondary particulates include:

- Atmospheric sulfate particles, formed from the oxidation of gaseous SO_2.
- Atmospheric nitrate particles, such as ammonium nitrate, formed from a complex series of reactions that transform gaseous NO_x.
- Atmospheric calcium nitrate or sodium nitrate particulates formed from a series of atmospheric reactions involving gaseous nitric acid (HNO_3) reacting with sodium chloride/calcium carbonate.

Since diesel combustion and vehicle exhaust are sources of particulate matter, efforts are being made to reduce these emissions by retrofitting diesel engines and making cleaner diesel fuels available. Retrofitting is defined as the addition of an emission control device designed to remove emissions from an exhaust engine. Currently, school buses and diesel powered commercial trucks are being retrofitted for emission reduction. One method is a particulate trap, which essentially filters exhaust from the engine. In some cases, as the particulate accumulates in the filter, the particulate is oxidized or burned off in order to regenerate the filter and reuse it. Regeneration is achieved by various techniques that reduce the temperature necessary to oxidize accumulated particulate matter. Disposable filters are also used when the particulate matter cannot be cleaned by oxidation. For information about Georgia EPD's program, go to http://www.gaderprogram.org/html/Retrofit.html.

In addition to retrofitting, alternative diesel fuels are available that emit less particulate matter, as well as other pollutants. Ultra-low sulfur diesel fuel is one fuel that emits less sulfur and particulate matter. Biodiesel fuel emits less particulate matter, carbon monoxide, hydrocarbons, and air toxics. Also, emulsified diesel emits less nitrogen oxides and particulate matter.

Particulate pollution may be categorized by size since there are different health impacts associated with the different sizes. The Georgia Ambient Air Monitoring Program currently monitors for three

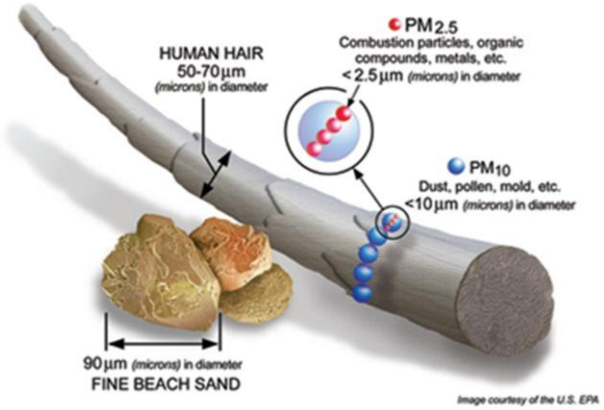


Figure 32. Comparison of particulate matter size to human hair

sizes of particles: PM_{10} (up to 10 microns in diameter), $PM_{2.5}$ (up to 2.5 microns in diameter) and PM_{coarse} (PM_{10} minus $PM_{2.5}$). All of these particles are very small in size. For example, Figure 32 shows how 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.

PM_{10}

Particulate matter (PM) less than or equal to 10 microns in diameter is defined as PM_{10}. These particles can be solid matter or liquid droplets from smoke, dust, fly ash, or condensing vapors that can be suspended in the air for long periods of time. PM_{10} represents part of a broad class of chemically diverse particles that range in size from molecular clusters of 0.005 microns in diameter to coarse particles of 10 microns in diameter (for comparison, an average human hair is 70-100 microns in diameter, as shown in the previous figure). PM results from all types of combustion. The carbon-based particles that result from incomplete burning of diesel fuel in buses, trucks, and cars are examples of major sources of PM_{10}. Another important combustion source is the burning of wood in stoves and fireplaces in residential settings. Also of concern are the sulfate and nitrate particles that are formed as a by-product of SO_2 and NO_2 emissions, primarily from fossil fuel-burning power plants and vehicular exhausts. Figure 33 shows Georgia's most important source of PM_{10} is dust, with almost 600,000 short tons attributed to this source. This data is taken from the latest emissions report from EPA based on 2014 data.

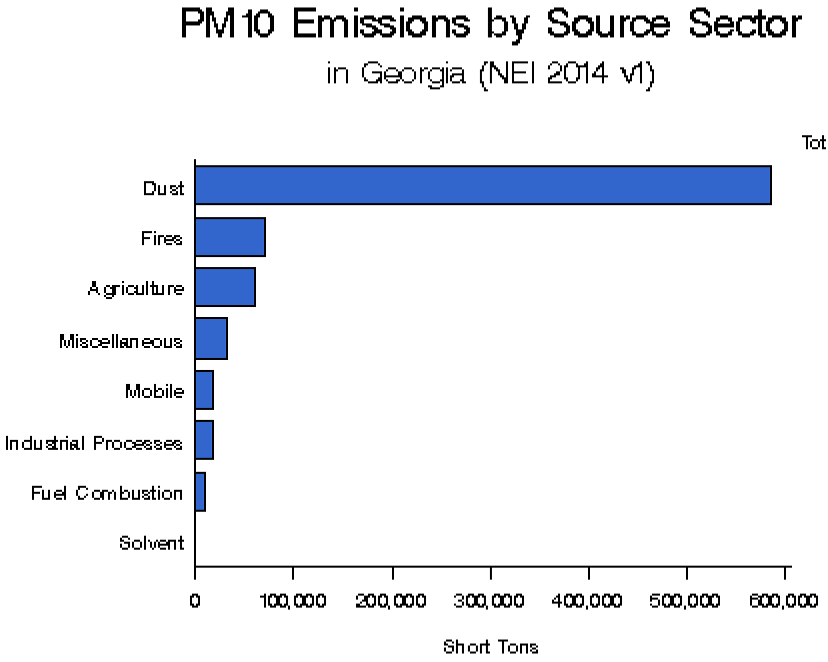


Figure 33. Common sources of PM_{10} in Georgia

HEALTH IMPACTS

The U.S. national ambient air quality standard was originally based on particles up to 25-45 microns in size, termed "total suspended particles" (TSP). In 1987, EPA replaced TSP with an indicator that includes only those particles smaller than 10 microns, termed PM_{10}. These smaller particles cause adverse health effects because of their ability to penetrate deeply into the lungs. The observed human health effects of PM include breathing and respiratory problems, aggravation of existing respiratory and cardiovascular disease, alterations in the body's defense system against inhaled materials and organisms, and damage to lung tissue. Groups that appear to be most sensitive to the effects of PM include individuals with chronic lung or cardiovascular disease, individuals with influenza, asthmatics, elderly people, and children.

MEASUREMENT TECHNIQUES

The Georgia PM_{10} monitoring network consists of two types of EPA-approved reference or equivalent monitors. Both types of monitors are used to determine attainment with the PM_{10} standard. The first type is an integrated low-volume monitor that collects a 24-hour sample through an impaction inlet device that only allows particles with 10 microns or less in size to reach the filter media. The second type of PM_{10} monitor that GA EPD operates is a continuous beta ray attenuation monitor, with an inlet designed to cut out particles larger than 10 microns in size.

For a map of the PM_{10} network, refer to Figure 34.

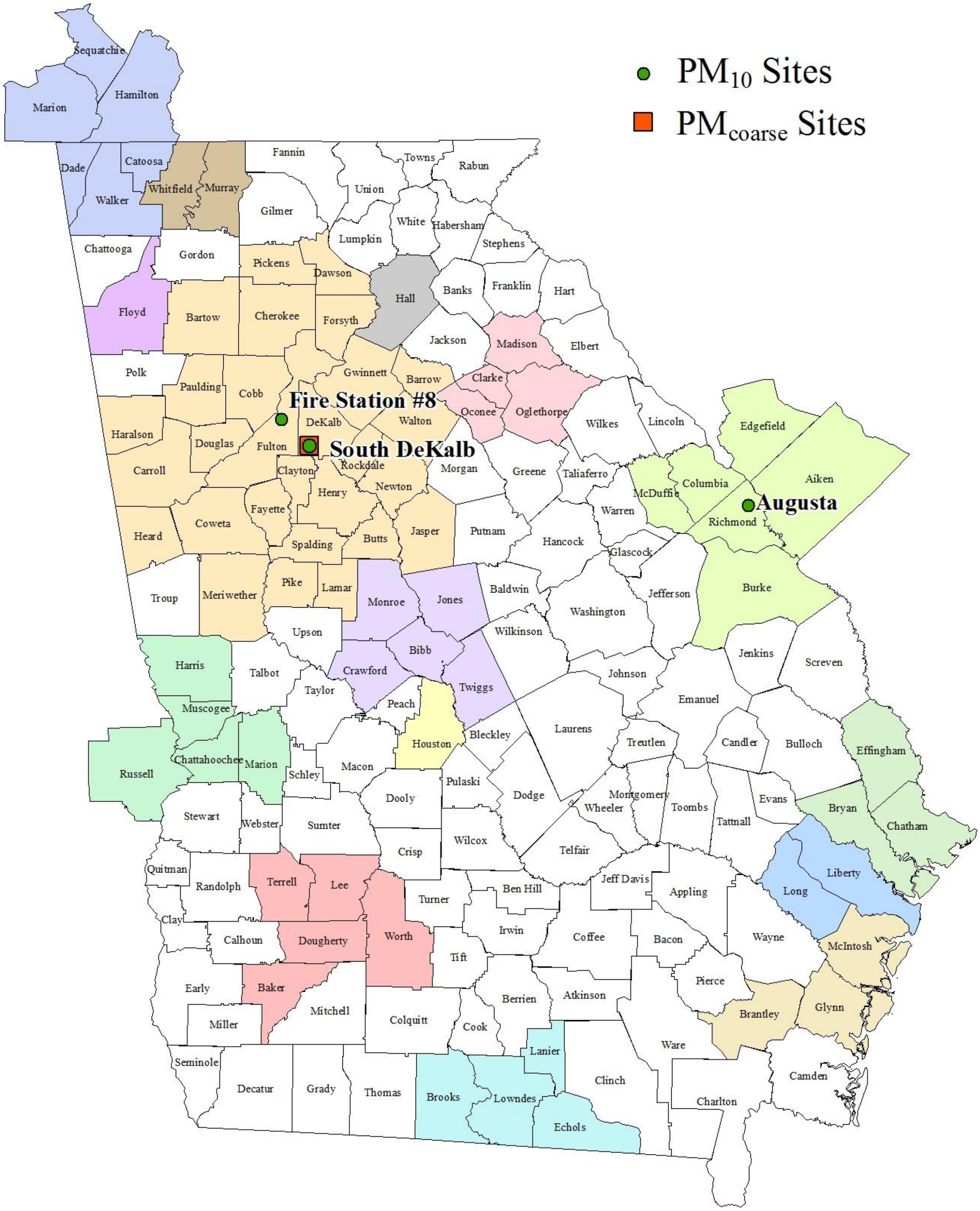


Figure 34. Georgia’s PM$_{10}$ and PM$_{coarse}$ monitoring site map, MSAs shown as solid colors

ATTAINMENT DESIGNATION

Figure 35 shows how Georgia compares to the 24-hour standard for PM_{10}, which is 150 µg/m^3. The standard allows one exceedance per year, averaged over a 3-year period; therefore, this chart shows the second highest 24-hour average for each site. All three samplers collected data well below the standard. For additional PM_{10} summary data, see Appendix A.

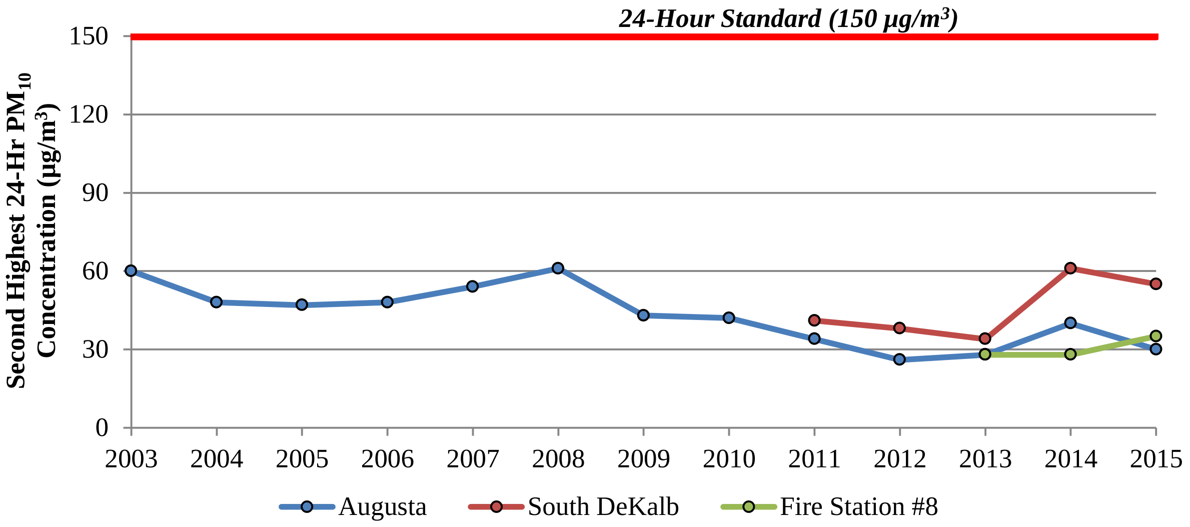
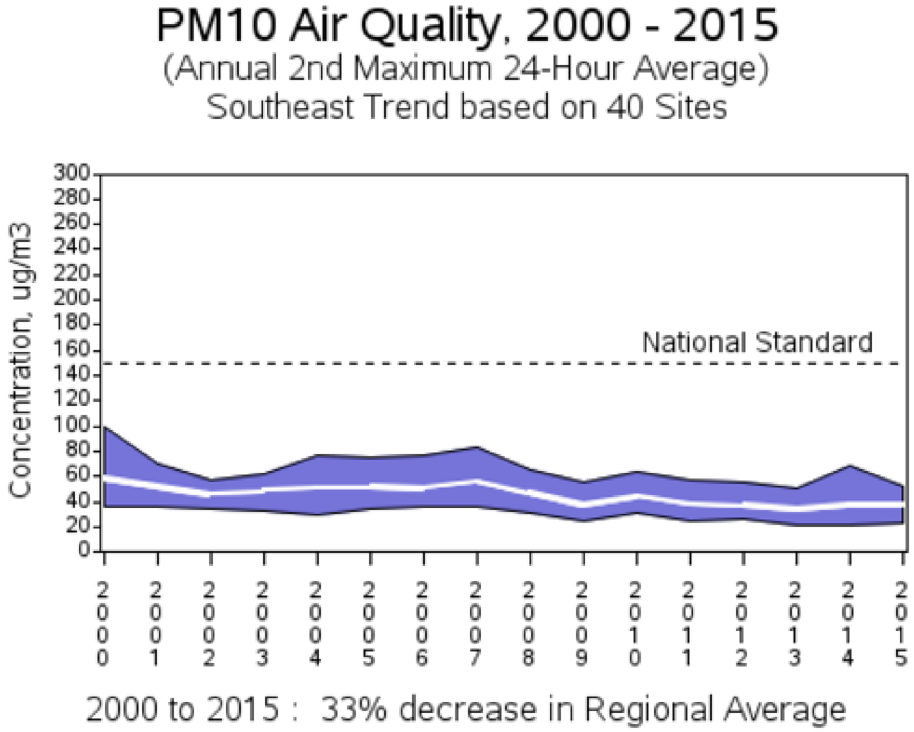


Figure 35. Georgia’s second highest 24-hour PM_{10} concentrations

Figure 36 was taken from EPA’s document “Our Nation’s Air Quality-Status and Trends through 2015” showing this significant decrease of the annual PM_{10} averages across the Southeast region of the United States from 1980 through 2015. There was a 33% decrease in this timeframe.



https://www.epa.gov/air-trends/particulate-matter-pm10-trends

Figure 36. PM_{10} regional annual second maximum 24-hour concentrations, 2000-2015

PM_{Coarse}

PM_{coarse}, or $PM_{10-2.5}$, is described as particulate matter (PM) less than 10 microns in diameter and greater than 2.5 microns in diameter. The composition of PM_{coarse} is predominantly crustal matter (from construction, demolition, mining, agricultural activities, sea spray, dust) and organic materials (from resuspension of biological material from soil surfaces and roads). Composition and sources can vary greatly by region. Regional relative humidity can affect the level of water present within the particles and affect how much dissolved gases or reactive species enter the lungs. The amount of water within the PM_{coarse} material can also affect size and particle deposition characteristics.

HEALTH IMPACTS

At this point, there is a limited amount of available data on health effects of PM_{coarse} material. Studies have shown that short-term exposure to high levels of ambient PM_{coarse} is associated with decreased lung function, increased hospital admissions for respiratory systems, and possible premature death[9].

MEASUREMENT TECHNIQUES

GA EPD measures PM_{coarse} with two beta attenuation particle monitors networked together. The PM_{10} unit has an inlet that only allows particles of 10 microns or smaller in size, while the $PM_{2.5}$ unit has a "Very Sharp Cut Cyclone®" (VSCC) inlet allowing only particles of 2.5 microns in size or smaller. Each hour, the PM_{10} sampler measures the PM_{10} concentration, collects the $PM_{2.5}$ concentration from the $PM_{2.5}$ sampler, and calculates the $PM_{10-2.5}$ concentration.

ATTAINMENT DESIGNATION

There is no NAAQS for PM_{coarse}. PM_{coarse} measurements are performed as part of the NCore requirements at the South DeKalb site and began January 1, 2011. Figure 37 displays daily averages at the South DeKalb site from 2011 through 2015. During the five year span, PM_{coarse} daily average concentrations have been found primarily in the 0-20 µg/m^3 range and have fallen by about 3 µg/m^3 (shown by the black trend line). The peak PM_{coarse} daily average concentrations occurred in the spring and summer months. At this point, the highest concentration collected is 50 µg/m^3 in July 2014. However, in the following figure, the scale is smaller to show a more detailed view.

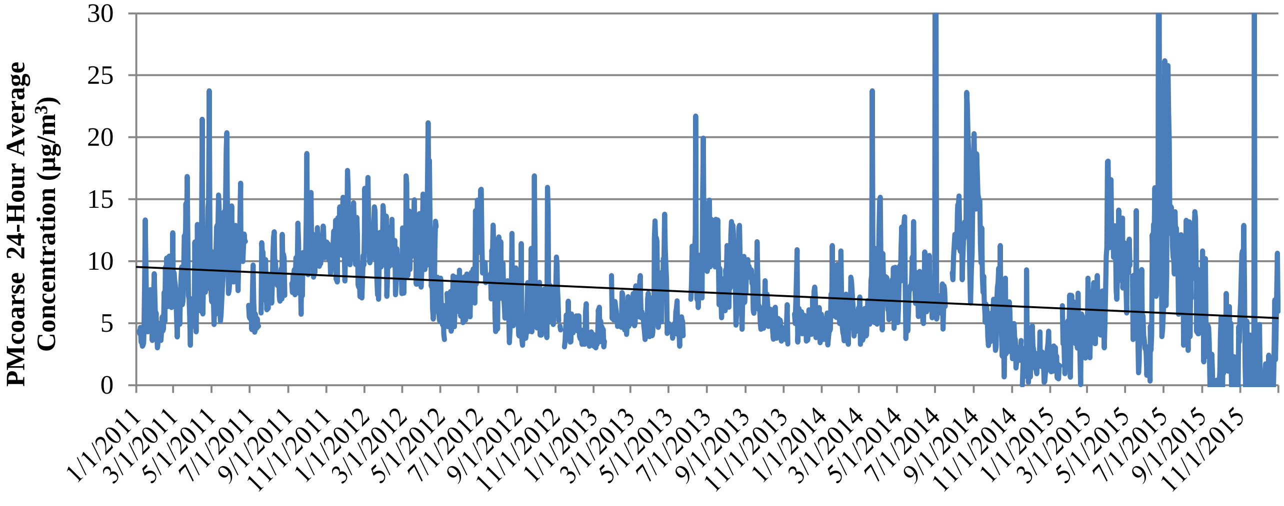


Figure 37. PM_{coarse} daily averages at the South DeKalb site, 2011-2015

For a map that includes the location of Georgia EPD's PM_{coarse} monitor, refer to Figure 34 in the previous section.

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[9] https://www.ncbi.nlm.nih.gov/pubmed/16055881

$PM_{2.5}$

The U.S. EPA defines 2.5 particulate matter as solid particles and liquid droplets present in the air that are less than or equal to 2.5 microns in diameter. These particles and droplets are invisible to the naked eye. However, collectively, they may appear as a fog-like haze or clouds and are often referred to as “fine” particles.

Fine particles are produced by various sources, including fires, industrial combustion, residential combustion, and vehicle exhaust (Figure 38). However, fine particles are also formed when combustion gases are chemically transformed. Fine particles can soil and accelerate the deterioration of man-made materials. In addition, fine particles impair visibility and are an important contributor to haze, particularly in humid conditions. The visibility effect is roughly doubled at 85% relative humidity as compared to humidity under 60% (U.S. EPA, 2004a). Based on data from EPA’s Air Emission Sources for 2014, Georgia’s primary source of $PM_{2.5}$ emissions is dust, with over 64,000 short tons attributed to this emission source. This information is displayed in Figure 38.

Considerable effort is being undertaken to analyze the chemical composition of fine particles ($PM_{2.5}$) so that pollution control efforts can be focused in areas which create the greatest hazard reductions. Therefore, Georgia currently monitors 53 particle species including gold, sulfate, lead, arsenic, and silicon. This speciation data is discussed further in the $PM_{2.5}$ Speciation section.

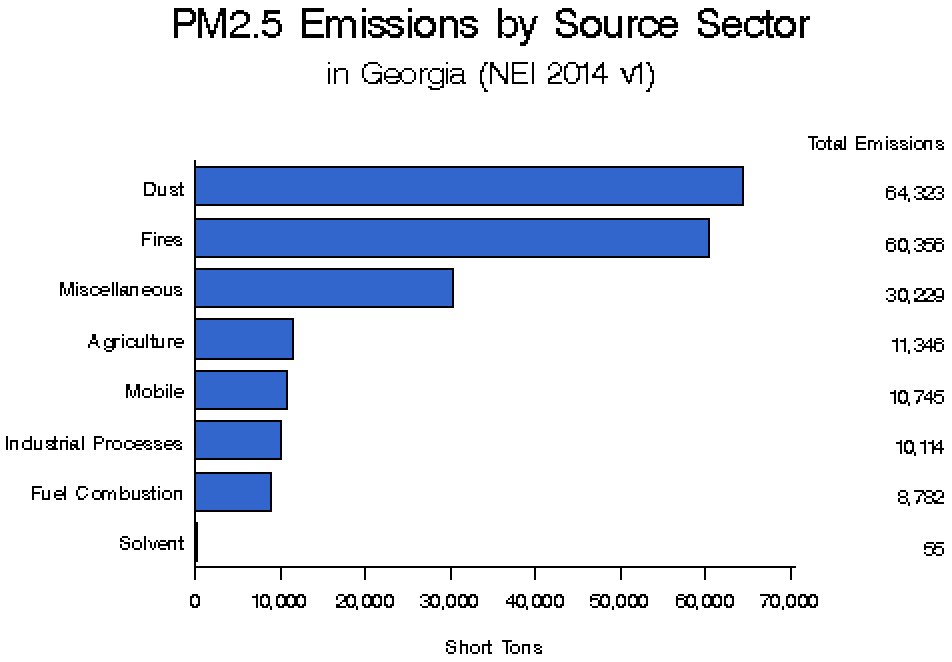


Figure 38. Common sources of $PM_{2.5}$ in Georgia

HEALTH IMPACTS

Fine particles 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. Therefore, children, the elderly, and individuals with cardiovascular disease or lung diseases such as emphysema and asthma are especially vulnerable.

MEASUREMENT TECHNIQUES

$PM_{2.5}$ mass concentrations are measured with two types of methods: integrated and continuous. The integrated samplers' official reference method requires that samples are collected on Teflon filters for 24 hours, using a specialized particle size sorting device to collect only particles 2.5 microns in size and smaller. The reference method filters are used for attainment determinations. The continuous method consists of two types of instruments. One type GA EPD uses is the beta attenuation method with the inlet designed to cut out particles larger than 2.5 microns in size. Currently, GA EPD has two BAM samplers running as Federal Equivalent Method (FEM) samplers that can be used for attainment designations in Georgia: one at the South DeKalb site and one at the Albany site. At the other locations where GA EPD samples $PM_{2.5}$ on a continuous basis, the tapered element oscillating microbalance (TEOM) method is used. As configured in the Georgia ambient air monitoring network, the TEOM analyzers are not approved as reference or equivalent method, and the data collected from these samplers cannot be used for making attainment decisions relative to the NAAQS.

Both types of $PM_{2.5}$ continuous samplers are used to support the development of air quality models and forecasts, including the Air Quality Index (AQI), and provide the public with information about pollutant concentrations in real time. Continuous $PM_{2.5}$ data is reported every hour, at fifteen minutes after the end of each hour, on Georgia's Ambient Air Monitoring web page located at http://amp.georgiaair.org/ . The immediate availability of this data allows the public to make informed decisions regarding their outdoor activities. Figure 39 shows the location of Georgia's $PM_{2.5}$ FRM monitors and Figure 40 shows the location of $PM_{2.5}$ continuous and speciation monitors.

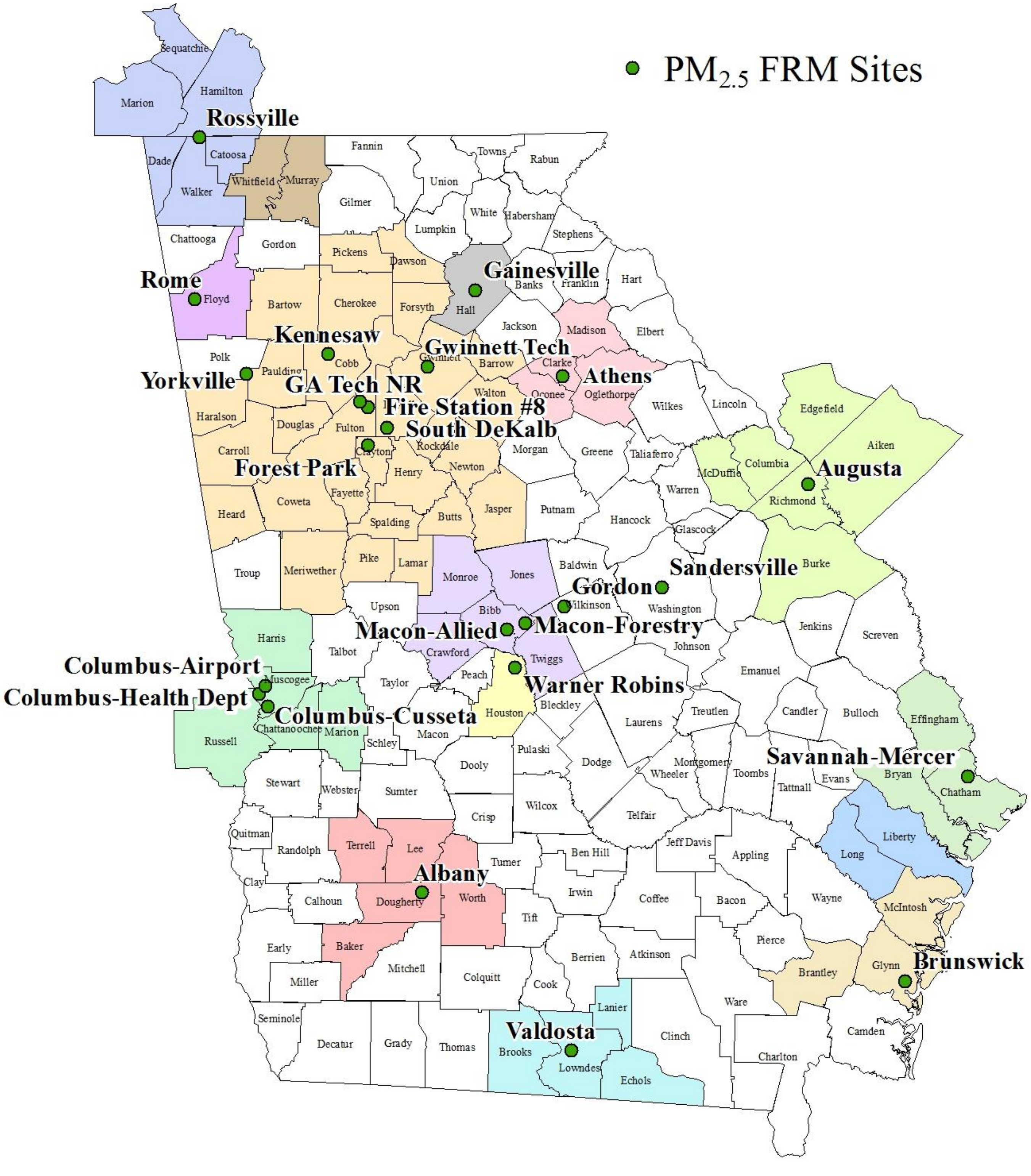


Figure 39. Georgia's $PM_{2.5}$ FRM monitoring sites, MSAs shown as solid colors

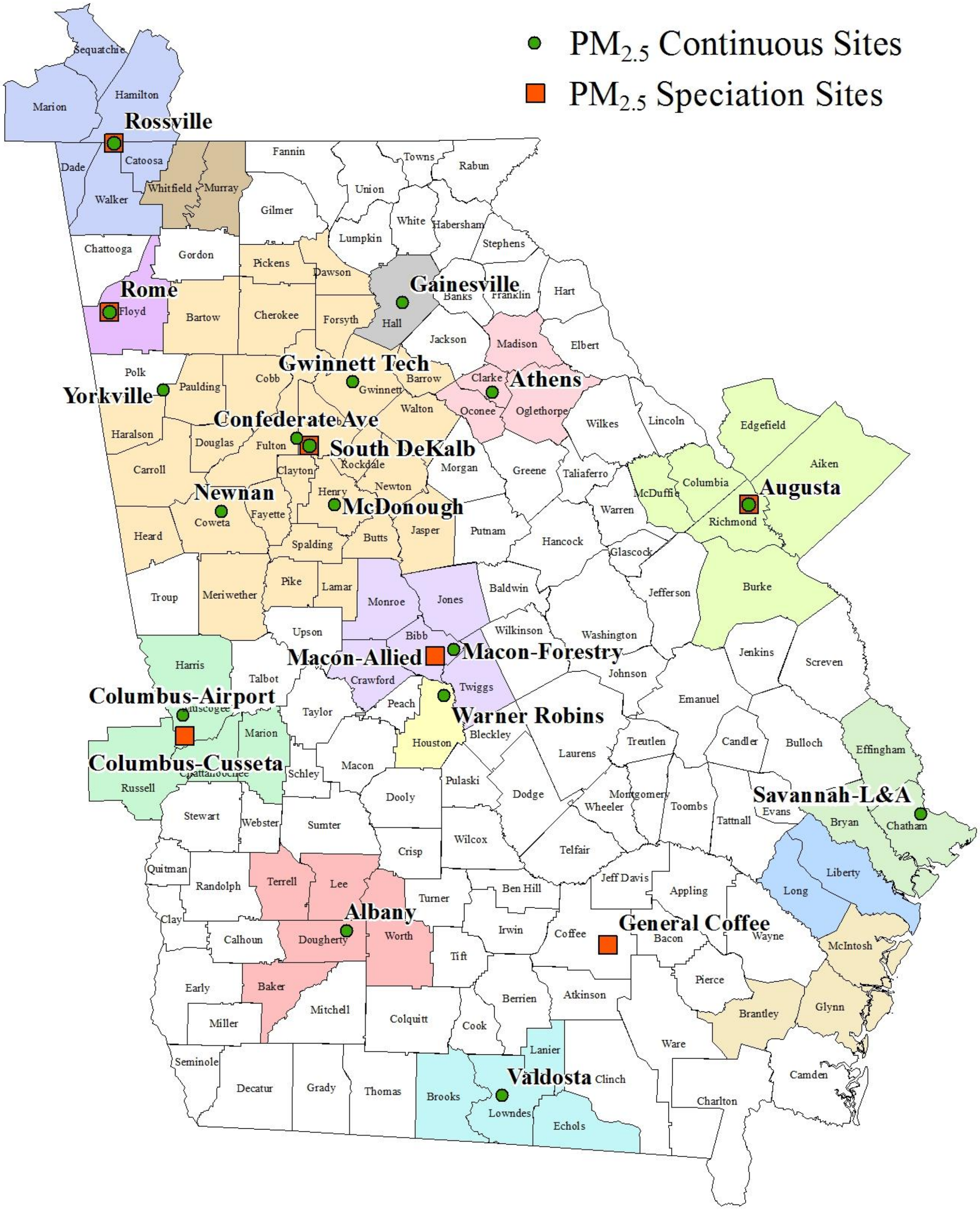


Figure 40. Georgia’s $PM_{2.5}$ continuous and $PM_{2.5}$ speciation monitoring sites, MSAs shown as solid colors

Efforts have been made to decrease $PM_{2.5}$ concentrations in Georgia. One such effort has been implementing State Rule 391-3-1-.02(2)(sss). In 2007, this State Rule was added, which affects the 13-county Atlanta nonattainment areas plus surrounding counties. This is a multi-pollutant control for electric utility steam generating units. It requires coal fired power plants to install controls to reduce three criteria pollutants, PM, NOx, and SO_2, and has had rolling start dates between 2008 and 2014. These controls are called Selective Catalytic Reduction (SCR) and Flue Gas Desulfurization (FGD).
Figure 41 shows the decrease in $PM_{2.5}$ concentrations as these controls have been implemented at various industries across the state.

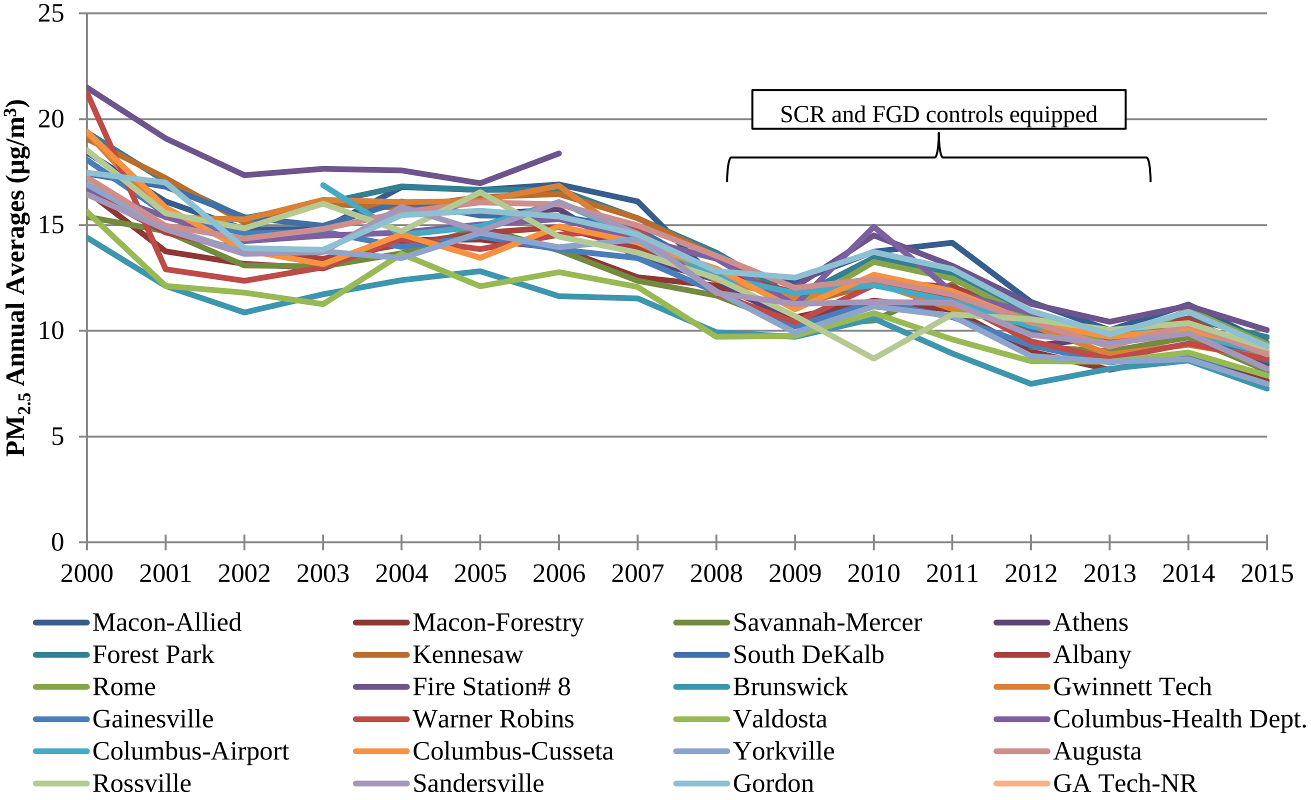


Figure 41: Implementation of PM Controls

Another undertaking for GA EPD involves reducing emissions from locomotives. Railroads play a critical role in making freight movement efficient and clean. The use of railroads for shipping has a lower overall impact on air quality compared to moving equivalent tons of cargo by trucks. However, older locomotives typically found in rail yards can adversely impact local air quality. Recent air quality and health evaluation studies indicate that railroad emissions are major contributors to both ozone and $PM_{2.5}$ concentrations in polluted urban areas. For example, the Fire Station #8 monitoring site, located near a rail yard, had historically high $PM_{2.5}$ concentrations (displayed in purple in Figure 41). $PM_{2.5}$ speciation (explained in detail in the following section) was used to determine that the nearby rail yard was an important source of air pollution impacting this site. As shown in Figure 41, $PM_{2.5}$ concentrations at the Fire Station #8 site have decreased significantly since 2000.

GA EPD is partnering with the rail industry to reduce local impacts through modernization efforts. Through incentive programs, GA EPD is encouraging local rail industries to convert older locomotives. New locomotive technology is more efficient, cleaner, and reduces emissions and fuel consumption. Some methods being implemented to increase engine efficiency include in-cylinder strategies like better fuel injection timing, better rings, and oil separators to keep oil from volatilizing.

Exhaust gas recirculation (EGR) is also being implemented in some engines as a NO_x emissions reduction technique.

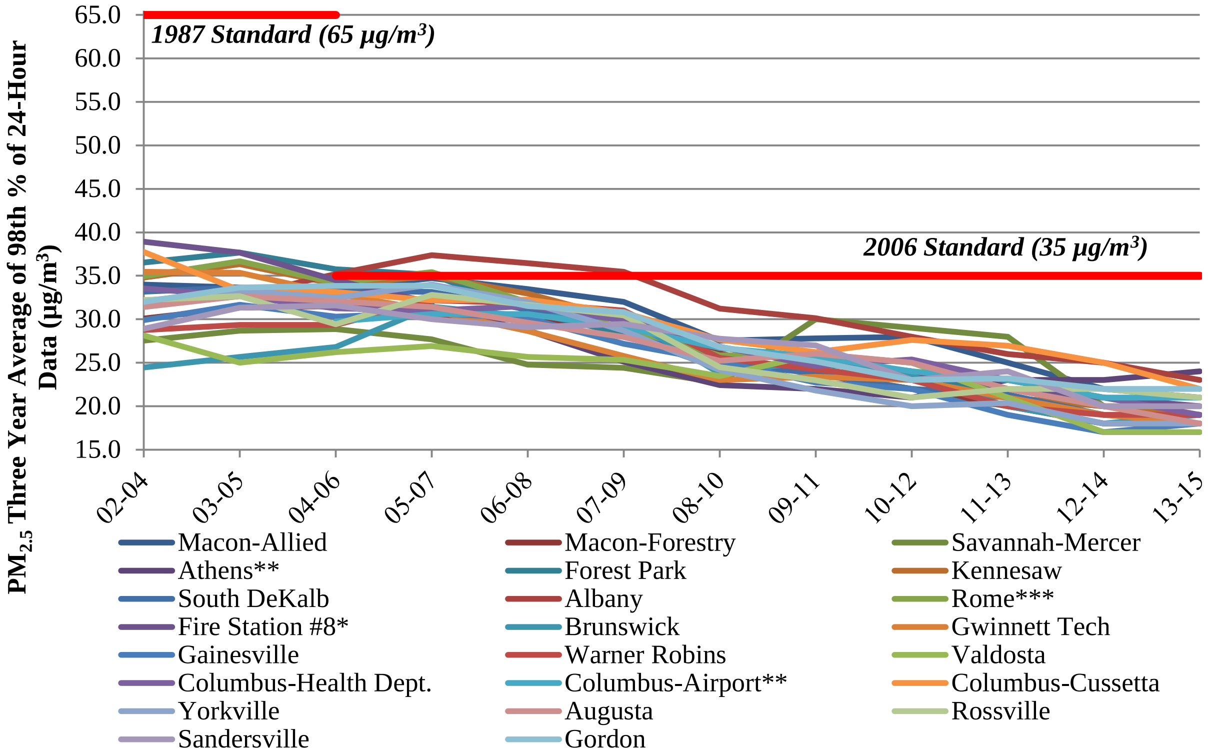
Another method is the conversion of locomotives to clean 'Mother' locomotives and 'Slug' sets. A 'Mother-Slug' set refers to two locomotive units that operate in tandem. The Mother locomotive is equipped with a diesel engine and main generator that provides electric power for traction motors in both units. The Slug does not have a diesel engine and cannot operate without the Mother. The Mother-Slug coupling allows the Mother's excess electrical power to drive the Slug's traction motors, providing significant fuel savings compared to using two diesel locomotives, as well as producing fewer emissions. Thus far 22 locomotives have been converted to Mother-Slug sets in Georgia, with several more Mother-Slug sets and conversions to clean locomotives to be completed by the end of 2017.

In addition to converting locomotives, some industries are also installing electric plugin stations. The primary objective is to use these systems during the winter to allow the engines to shut down while keeping the cooling water from freezing. The plugins will allow the diesel engine to be shut down when temperatures drop below freezing and still keep the cooling water warm.

ATTAINMENT DESIGNATION

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 $\mu g/m^3$. The secondary annual standard is 15.0 $\mu g/m^3$. 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 micrograms per cubic meter.

Figure 42 shows the three-year averages of 98th percentile of $PM_{2.5}$ 24-hour data compared to the 24-hour standard of 35 $\mu g/m^3$. The 2007 data was affected by the Sweat Farm/Big Turnaround/Bugaboo Fire in the Okefenokee Swamp. To show the complete data set that was collected, the 2007 data includes the exceptional event data that was taken out for regulatory purposes. Therefore, in Figure 42, the three-year average calculations including the 2007 data are not a regulatory comparison to the 24-hour standard. In addition, another wildfire took place in the Okefenokee Swamp (Honey Prairie Fire) in the summer of 2011. A few of the sites were affected by this, and the upswing with 2011 data, especially at the Savannah-Mercer site (shown in green) is due to this. Overall, the 98th percentile of 24-hour average concentrations show a general downward trend and all of the 2013-2015 averages are well below the 24-hour standard. The Georgia Tech-near road $PM_{2.5}$ monitor was added to the network at the beginning of 2015; however, since one year of data is collected at this point, the next two graphs do not include data from this site, as these graphs show averages of three years.



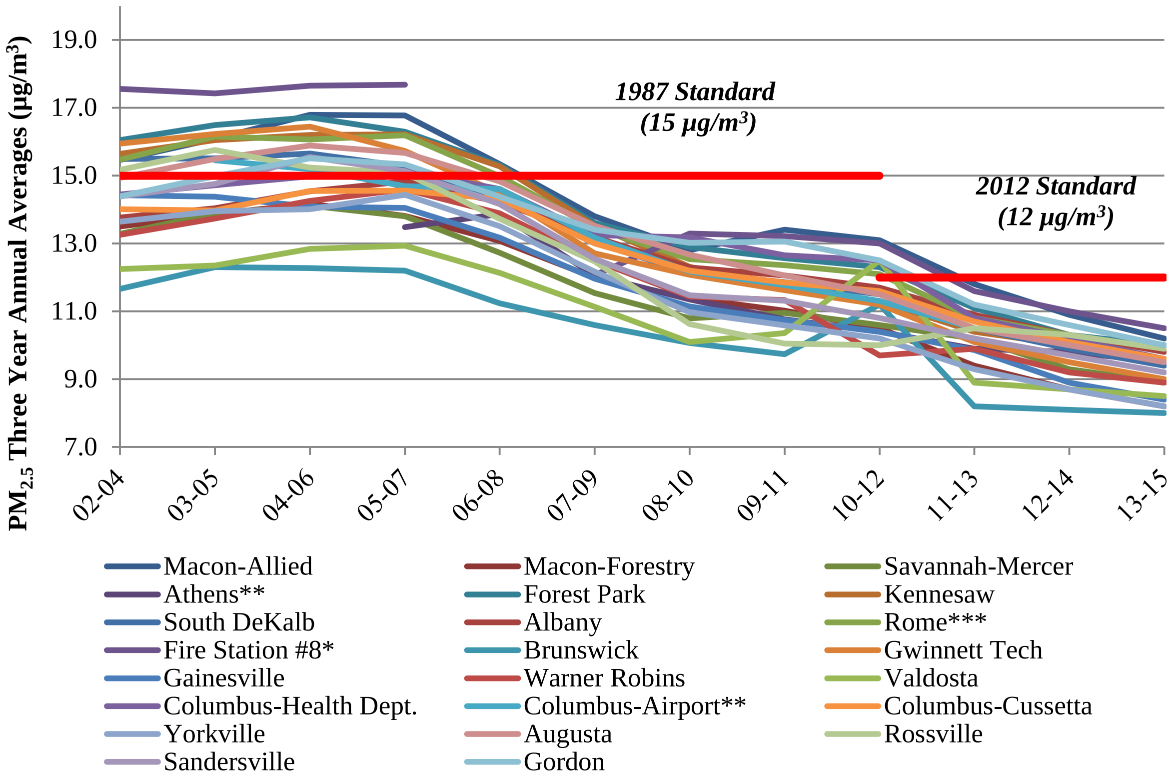
** Site was shut down from 9/06 to 12/08; averages including those years are incomplete*

*** Sites established in 2005; 04-06 and 05-07 averages incomplete*

******* *Sites consolidated in 2009, data combined for Rome-Coosa Elem and Rome-Coosa High*

Figure 42. Comparison of the three-year averages of the 98th percentile of $PM_{2.5}$ 24-hour data to the 24-hour standard, includes all data from 2007 that was excluded for exceptional events

Figure 43 shows a comparison of three-year averages of annual $PM_{2.5}$ data to the annual standard of 12.0 µg/m^3. This graph also includes the $PM_{2.5}$ exceptional event data for 2007 to show the complete data set that was collected. Therefore, in Figure 43 the annual averages are not a regulatory comparison to the standard. There is an overall continual decreasing trend in the annual $PM_{2.5}$ data since the 2002-2004 design value year. For the 2013-2015 design values, the lowest was 8.0 µg/m^3 at the Brunswick site (shown in teal) and the highest was 10.5 µg/m^3 at the Fire Station #8 site (shown in purple). For additional $PM_{2.5}$ summary data, see Appendix A.



** Site was shut down 9/06 to 12/08; averages including those years are incomplete*

*** Site established 2005; 04-06 and 05-07 averages incomplete*

********* *Sites consolidated in 2009, data combined for Rome-Coosa Elem and Rome-Coosa High*

Figure 43. Comparison of the $PM_{2.5}$ three-year annual averages to the annual standard, includes all data for 2007 that was excluded for exceptional events

Designations for the $PM_{2.5}$ annual standard require three years of monitoring data. Georgia’s initial designations for the 1997 annual standard were determined December 17, 2004. Based on the three years of data (2001-2003), EPA officially declared several areas of Georgia in nonattainment of the 1997 annual standard. These nonattainment areas included several areas throughout Georgia. Walker and Catoosa Counties, which are a part of the metro Chattanooga nonattainment area was redesignated as attainment on December 19, 2014. All of Bibb County and portions of Monroe County were included in the Macon nonattainment area, but redesignated attainment on May 13, 2014. Floyd County itself was declared a nonattainment area and redesignated on May 14, 2014. Finally, the metro Atlanta nonattainment area was also declared a nonattainment area and was redesignated as attainment on February 24, 2016. The boundaries of Georgia’s four $PM_{2.5}$ annual standard nonattainment areas for the 1997 $PM_{2.5}$ annual standard are shown in Figure 44. All areas of Georgia were designated unclassifiable/attainment for the 2006 24-hour $PM_{2.5}$ standard based on 2005-2007 data.

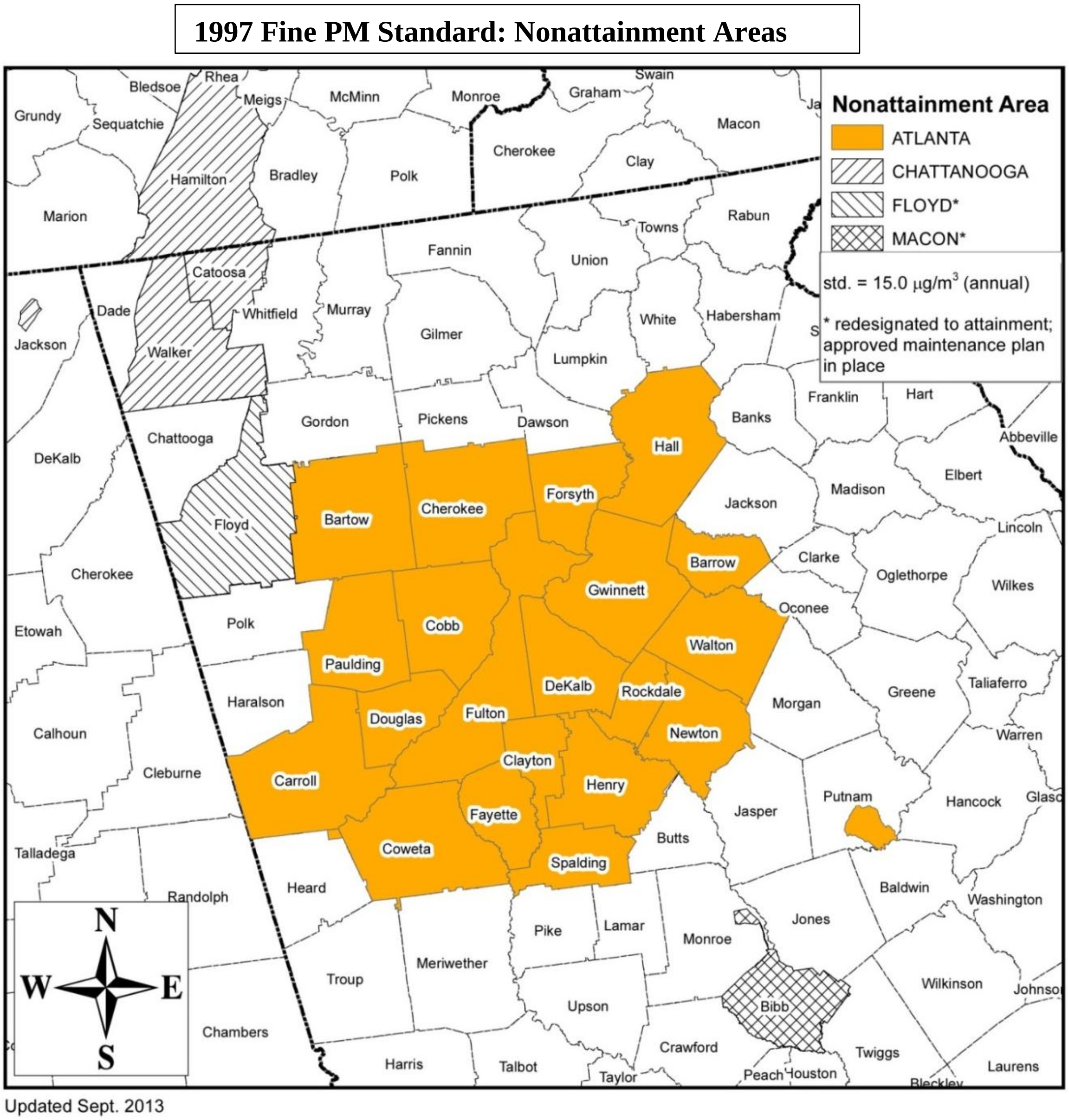
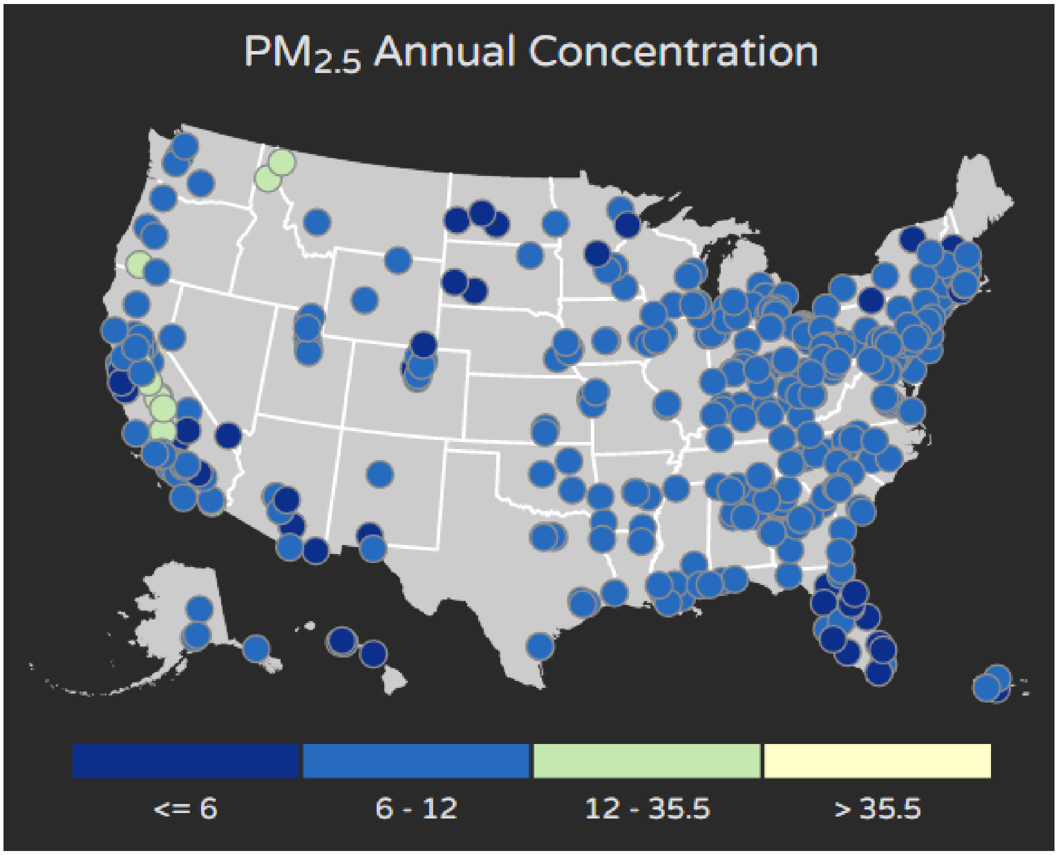


Figure 44. Map of Georgia's nonattainment areas for $PM_{2.5}$

Currently all areas are designated unclassifiable/attainment for the 2012 annual $PM_{2.5}$ Standard. EPA designated all but 22 counties as unclassifiable/attainment based on 2011- 2013 monitoring data and deferred designations on 22 counties on January 15, 2014[80 FR 2206]. EPA designated 8 of the deferred counties as unclassifiable/attainment on March 31, 2015 based on 2012-2014 monitoring data. The remaining 14 deferred counties were designated unclassifiable/attainment on September 6, 2016 [81 FR 61136]. EPA also corrected the "Georgia – 2012 Annual $PM_{2.5}$ NAAQS (Primary)" table in Section 81.311 of the Federal Register by adding "Unclassifiable/ Attainment" to the Designation Type column for Greene County on September 22, 2016 [81 FR 65289].

Figure 45, taken from EPA's website "Our Nation's Air – Status and Trends through 2015" (https://gispub.epa.gov/air/trendsreport/2016/), shows (a) $PM_{2.5}$ annual and (b) 24-hour concentrations across the United States in 2015. This figure shows how Georgia's $PM_{2.5}$ concentrations compare with the other states' concentrations. The annual $PM_{2.5}$ average concentrations in Georgia ranged from 6-12 $\mu g/m^3$ while the 24-hour average concentrations ranged from 12-35.4 $\mu g/m^3$.

a.



b.

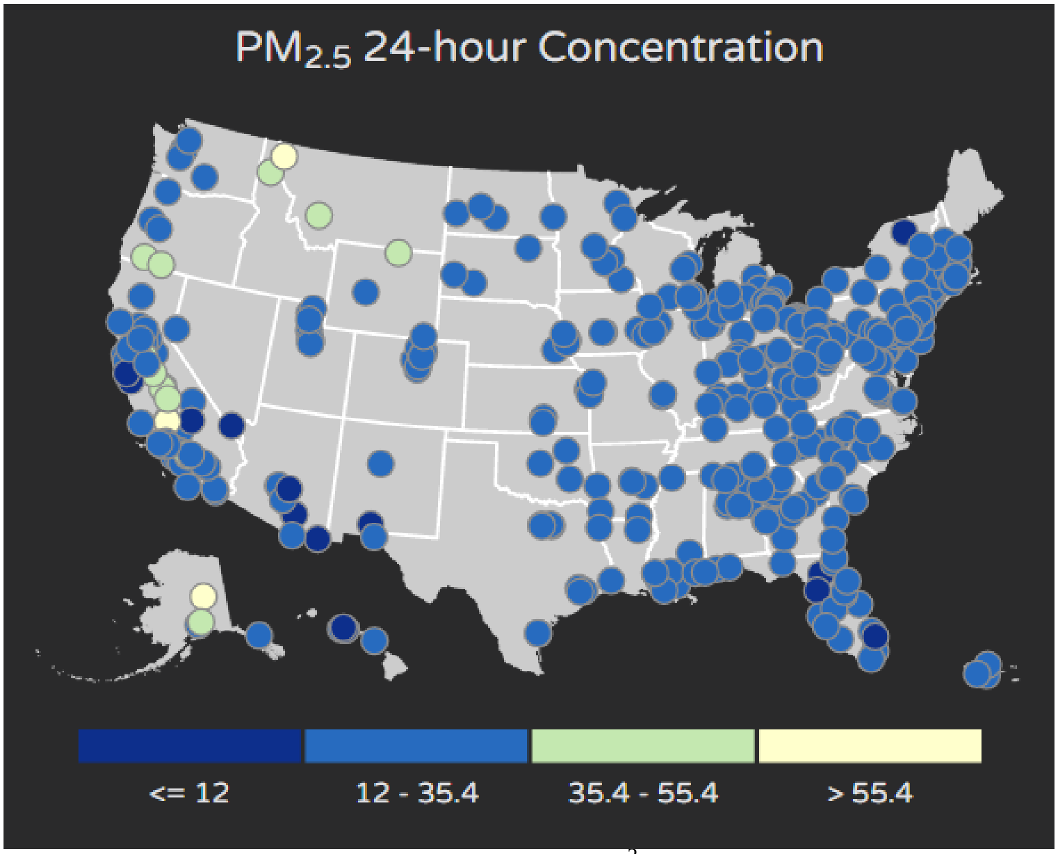


Figure 45. (a) $PM_{2.5}$ average annual concentrations (μg/m^3) and (b) average 24-hour concentrations (μg/m^3) across the United States in 2015

$PM_{2.5}$ SPECIATION

As required by the national $PM_{2.5}$ speciation program (40 CFR 58), GA EPD monitors the mass concentration of fine particulate matter (in micrograms per cubic meter of air) along with the chemical composition of those particles. Attempts to control the concentration of fine particulate matter are considered a national priority. Therefore, regulations intended to reduce levels of fine particulate matter are now being implemented on a widespread basis. The desired reduction of fine particulate matter concentrations is expected to produce benefits in human health and assist in the improvement of visibility by reducing the presence of haze.

It is known that particulate matter has varying health effects depending on their size and chemical composition. The particles that compose fine particulate matter are not uniform. While they are all smaller than 2.5 microns in diameter, size does vary. Some fine particles are emitted into the air directly from engine exhaust, fossil fuel combustion, unpaved roads, and the tilling of fields; others are formed in the atmosphere through reactions between gaseous pollutants. Each individual particle, regardless of its source, has a distinct chemical composition. The overall composition of all particles that make up the fine particulate matter in a given volume of air may also vary, depending on local sources and a variety of other factors. Within the make-up of the particulate matter, some chemicals are more toxic than others. There has been some disagreement on whether the quantity or toxicity of fine particulate matter is most responsible for health concerns. This reinforces the need to monitor and analyze both the species of particulate matter and weight of the species.

Georgia currently monitors fifty-three species, which include gold, sulfate, lead, arsenic, and silicon. However, there are only approximately six chemicals that are detected frequently. Of these, sulfate and organic carbon are detected in the highest concentrations, with magnitudes of up to five to nine times greater than the other major species. Figure 46 illustrates the average concentrations of these six chemicals from 2003 to 2015. The chemical elements typical of the Earth's crust are grouped together as "crustal". All of the sites are shown for one bar, showing how each site makes up the total of each of the major constituents of the speciation data. Note that the Rossville site began collecting data in 2005; therefore, the red bars are not included in the 2003 and 2004 data. With the exception of the 2007 data, which was affected by the Okefenokee Swamp wildfire, there is a general downward trend in the data. Below the figures is a listing of the most significant chemical constituents of fine particulate matter.

Refer to Figure 40 for a map of Georgia's $PM_{2.5}$ Speciation monitors.

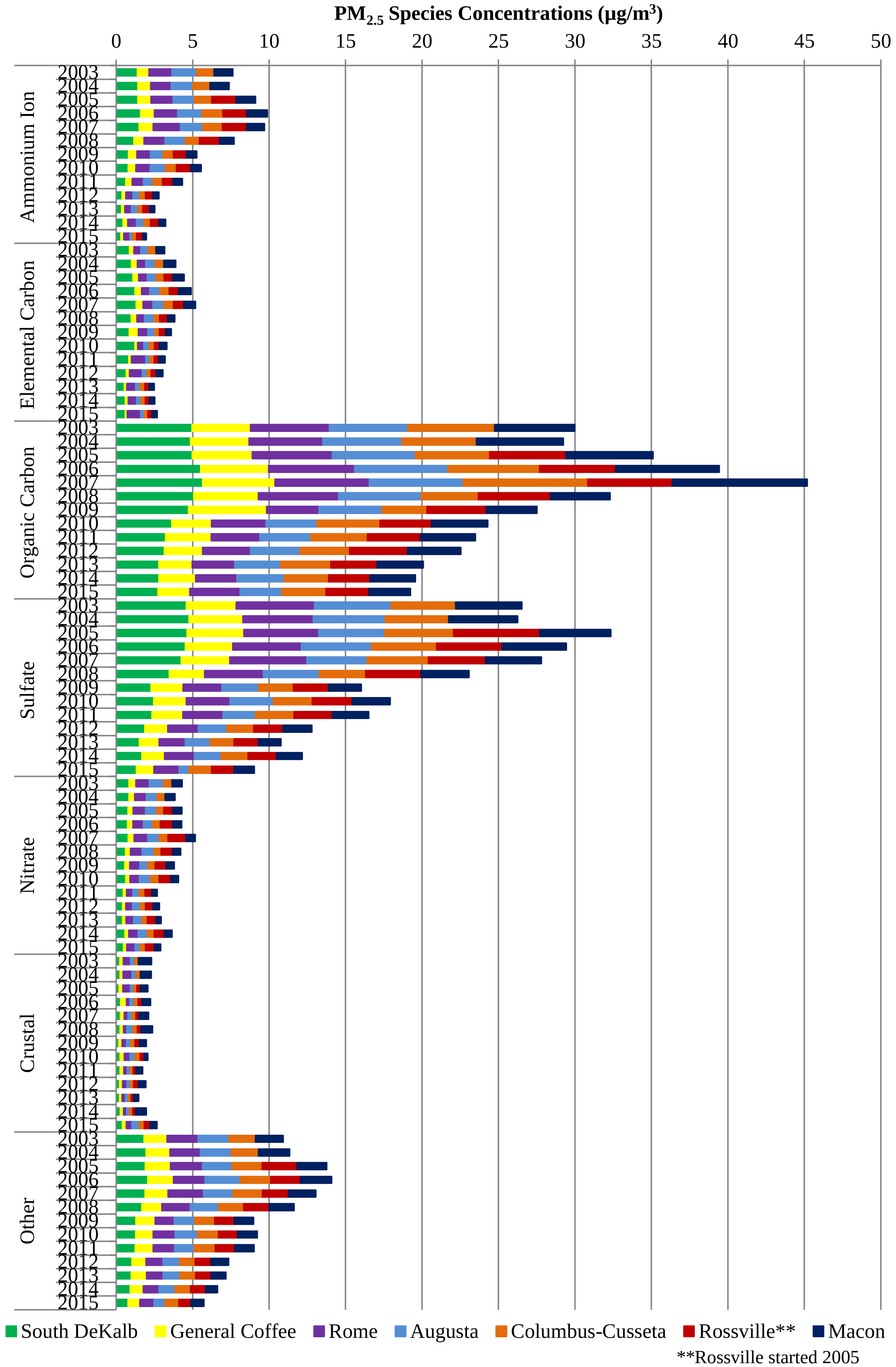


Figure 46. PM$_{2.5}$ speciation, by species

PREDOMINANT SPECIES FOUND IN $PM_{2.5}$

Ammonium Ion: commonly released by fertilizer production, livestock production, coke production, and some large refrigeration systems. Ironically, it can be emitted by NO_x control systems installed on large fossil fuel combustion systems, which use ammonia or urea as a reactant.

Sulfate products: formed during the oxidation of SO_2 in the atmosphere. SO_2 is primarily produced by coal burning boilers.

Nitrate products: formed through a complex series of reactions that convert NO_x to nitrates. Vehicle emissions and fossil fuel burning produce NO_x.

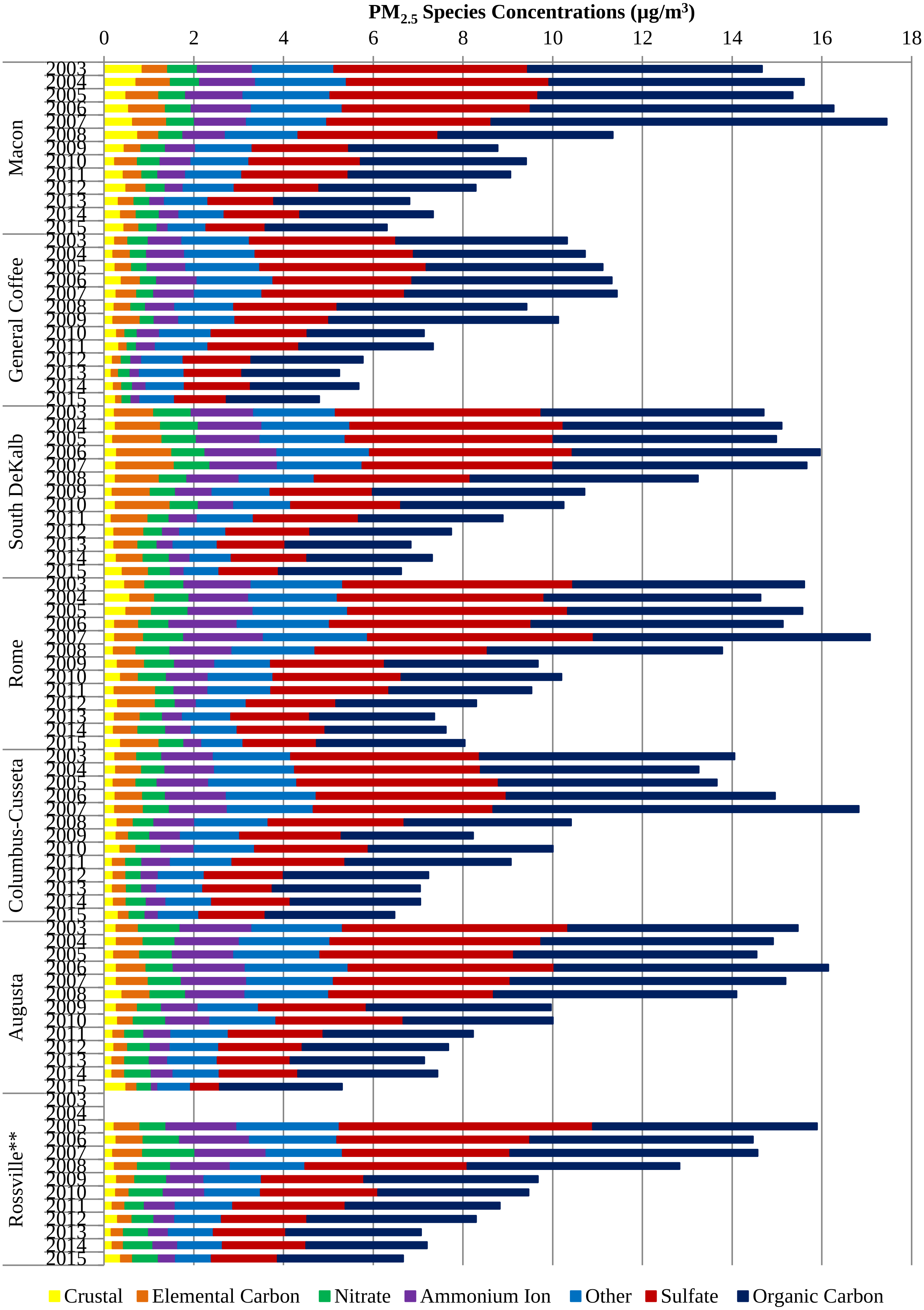
Crustal products: components that are the result from the weathering of Earth's crust. They may include ocean salt and volcanic discharges. Crustal products include aluminum, calcium, iron, titanium, and silicon. These components are released by metals production, and can be resuspended in the atmosphere by mechanisms that stir up fine dust, such as mining, agricultural processes, and vehicle traffic.

Elemental carbon: carbon in the form of soot. Sources of elemental carbon include diesel engine emissions, wood-burning fireplaces, and forest fires.

Organic carbon: consist of hundreds of organic compounds that contain more than 20 carbon atoms. These particles may be released directly, but are also formed through a series of chemical reactions in the air, mostly as a result of the burning of fossil fuels and wood.

Data on the composition of fine particulate matter is a useful input to scientific models of air quality. Ultimately, it helps scientists and regulators track the progress and effectiveness of newly implemented pollution controls. The data also improves scientific understanding of the relationship between particle composition, visibility impairment, and adverse human health effects.

Figure 47 presents a different view of the above $PM_{2.5}$ speciation data to facilitate visualization of trends. Each site is shown with all species making up the composition of each bar. Each year is shown separately.



**Rossville started 2005

Figure 47. $PM_{2.5}$ speciation, by site

Figure 47 shows a general trend downward of the $PM_{2.5}$ speciated parameters, except in 2007 when the data was affected by the Sweat Farm/Big Turnaround/Bugaboo Fire in the Okefenokee Swamp, as discussed in the PM_{10} and $PM_{2.5}$ sections. The rural background site, General Coffee, continues to show the smallest total average concentration. In 2015, the General Coffee site showed an overall concentration of approximately 4.8 µg/m^3. The remaining sites had overall concentrations of 5.5 to 8.0 µg/m^3.

Ammonium ion concentrations (shown in purple) are relatively even statewide, with concentrations lowest at the Augusta site. The concentrations ranged from 0.146 µg/m^3 at the Augusta site to 0.402 µg/m^3 at the Rome site in 2015. Ammonium ion is the third largest single contributor to the total speciation make up.

The Rome site had the highest elemental carbon concentration in 2015, 0.858 µg/m^3, shown in orange. Cities with less heavy vehicle traffic generally have lower concentrations. The General Coffee site had the lowest elemental carbon concentration, with 0.143 µg/m^3 in 2015.

Organic carbon concentrations (shown in dark blue) are relatively consistent throughout the state, usually consisting of about 3 µg/m^3 of the total speciation concentration. The General Coffee site collected a slightly lower concentration of 2.072 µg/m^3. Organic carbon concentrations are much higher than typical ammonium ion or elemental carbon concentrations, having one of the largest contributions (about 40%-50%) to the total $PM_{2.5}$ mass concentrations.

Sulfate (shown in red) is also found in higher concentrations, with concentrations around 0.65-1.64 µg/m^3 in 2015. Concentrations are relatively consistent statewide, though somewhat lower in rural areas, and their relatively large observed mass means that they are also a major contributor to overall $PM_{2.5}$ mass concentrations.

Nitrate concentrations (shown in green) are relatively small (0.205-0.577 µg/m^3 in 2015), usually contributing the fourth or fifth largest single component of the total five major constituents. Atmospheric forms of nitrate can be formed from the conversion of NO_x. Other forms of nitrate can be found in fertilizers, animal and human organic waste, medications, and used in welding.

Crustal matter concentrations (shown in yellow) are generally one of the lowest speciation concentrations (0.258-0.491 µg/m^3 in 2015) and consistent in most areas. Rome and Macon have in some years recorded unexpectedly high crustal matter concentrations. This may be attributed to local industry, or possibly a sign of poor dust control at agricultural, construction, or mining operations in those areas.

The section labeled ‘Other’ (shown in light blue) is a make-up of all the rest of the compounds not included in the five major contributors or crustal make-up. This is a total of the remaining 43 compounds in the speciation sample. Concentrations ranged from 0.728 to 0.923 µg/m^3 in 2015.

For $PM_{2.5}$ speciation summary data see Appendix B.

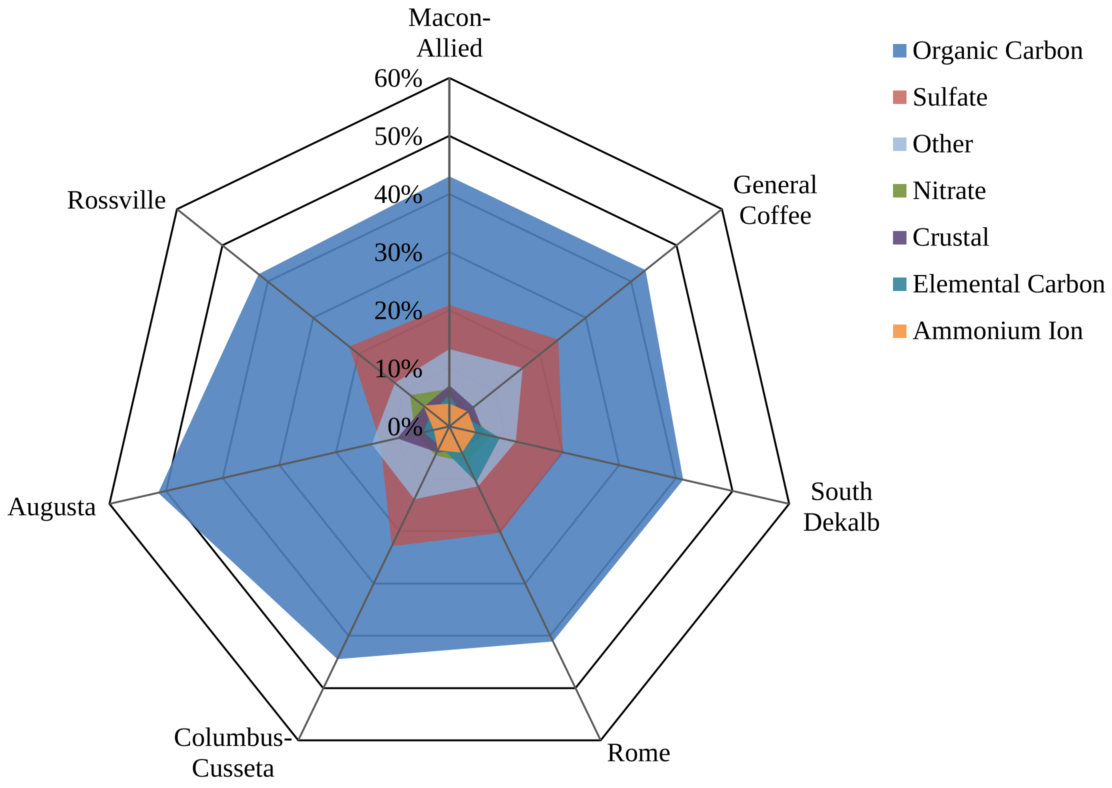


Figure 48. Percent composition of $PM_{2.5}$ for each site in 2015

Figure 48 compares the percent composition of $PM_{2.5}$ for each site based on 2015 annual averages. Organic carbon makes up 41-51% of $PM_{2.5}$ for all sites with Augusta having the largest percentage. Sulfate is the second largest portion of $PM_{2.5}$ for all sites except Augusta and ranges from 12-24%. Nitrate, crustal, elemental carbon, and ammonium ion make up no more than 11% of $PM_{2.5}$ for all sites.

MEASUREMENT TECHNIQUES

Particle speciation measurements require the use of a wide variety of sampling and analytical techniques, but all generally use filter media to collect the particles to be analyzed. Laboratory techniques currently in use are gravimetric (microweighing); 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.

ATTAINMENT DESIGNATION

Particle speciation measurements are performed to support the regulatory, analytical, and public health purposes of the program. Currently, there are no ambient air quality standards regarding the speciation of particles.

PHOTOCHEMICAL ASSESSMENT MONITORING STATIONS (PAMS)

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 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.

As described in the Technical Assistance Document (TAD), 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. The monitoring sites were selected depending on the pollutants monitored in relation to the prevailing winds in the area. The Yorkville site serves as a Type 1 site. It is a rural background site, upwind of the city, which aids in determining the role of transport of pollutants into the Atlanta area. The South DeKalb and Tucker sites were the primary and secondary wind directions for an urban core-type site, serving as Type 2 sites. These sites are expected to measure the highest precursor concentrations of NO_x and VOCs in the Atlanta area. The Conyers site is the downwind site where titration of the precursors has occurred and the ozone concentrations should be at their highest. The Conyers site serves as a Type 3 site. Until the end of 2006, this was the setup of the PAMS network. At the end of 2006, the Tucker site was shut down. From that point, South DeKalb has served as the urban core-type site. The PAMS network as it was set up for the 2015 monitoring year is shown in Figure 49.

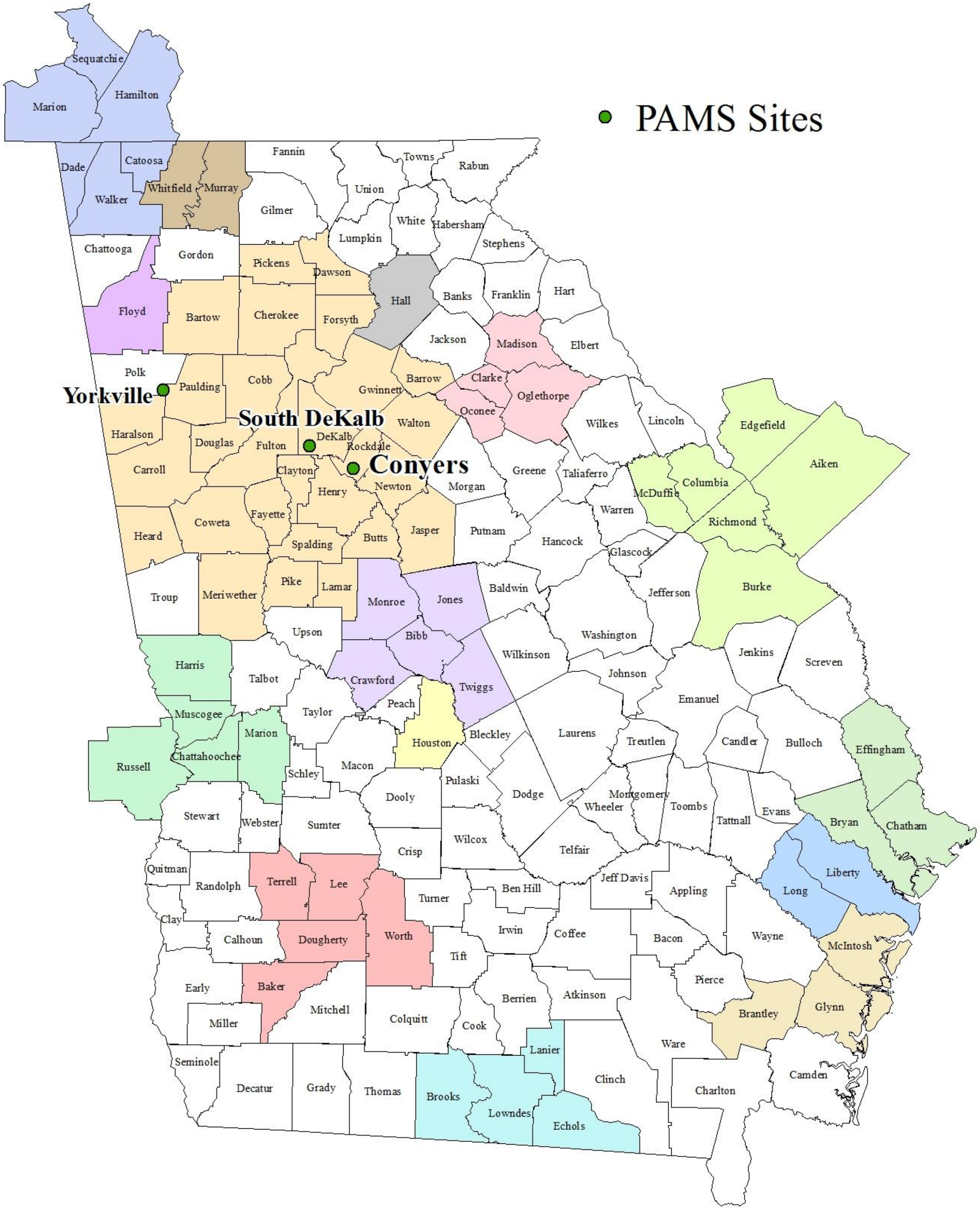


Figure 49. Georgia PAMS monitoring sites, MSAs shown as solid colors

Of the fifty-six PAMS compounds monitored, the same volatile organic compounds (VOCs) consistently show the highest average concentrations at all three sites. These compounds include isoprene, m/p xylene, toluene, propane, ethane, isopentane, n-butane and n-pentane. Propane, ethane, isopentane, n-butane, and n-pentane have a limited reactivity for ozone formation, and therefore are the most prevalent of the volatile organic compounds measured. However, when the characterization of the top compounds is based upon contributions to ozone formation potential, the list is slightly different.

Isoprene, the tracer for VOCs emissions from vegetation, is by far the largest contributor to ozone formation at every site. 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 amount of isoprene emissions from conifers varies seasonally, with emissions increasing as length of daylight and temperature increase.

Figure 50 shows the seasonal occurrence of isoprene in Georgia from 2003 to 2015. This figure represents a combination of the 6-day, 24-hour data shown as monthly averages over the thirteen years from the three PAMS sites. Ambient concentrations are shown to increase during the summer months (May-September) and are essentially non-existent from October to April.

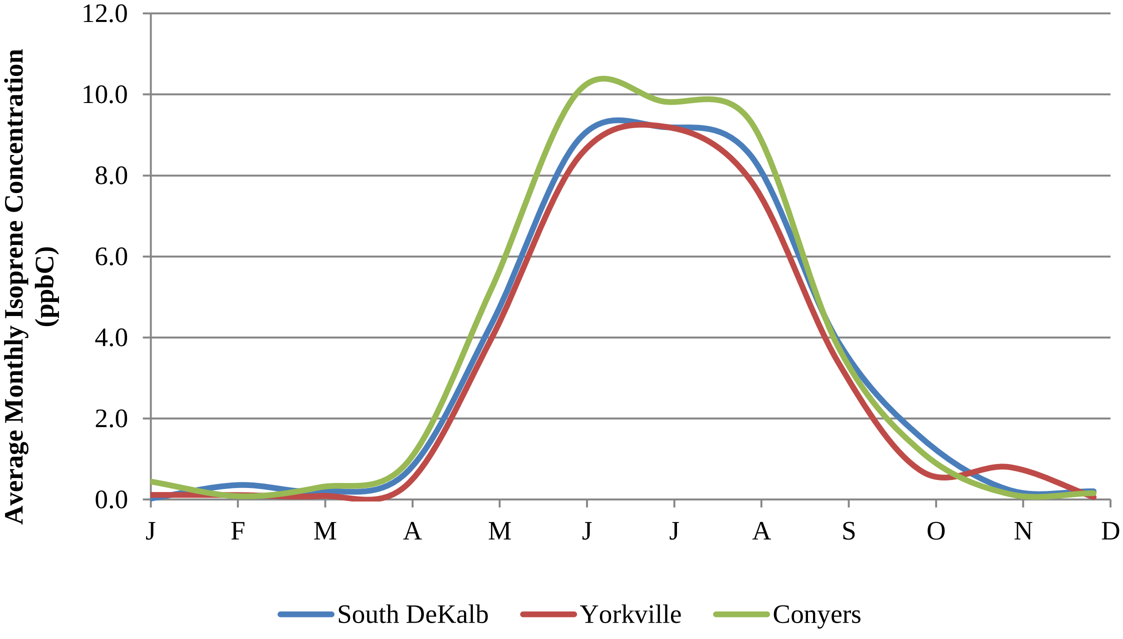


Figure 50. Average yearly profile of isoprene, 2003-2015

The anthropogenic compounds detected at all sites with the highest ozone formation potential were 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 51 compares the seasonal occurrence of toluene with monthly averaged data from 2003 through 2015. This figure is a combination of the 6-day, 24-hour data from the three PAMS sites, and concentrations are given in parts per billion Carbon (ppbC).

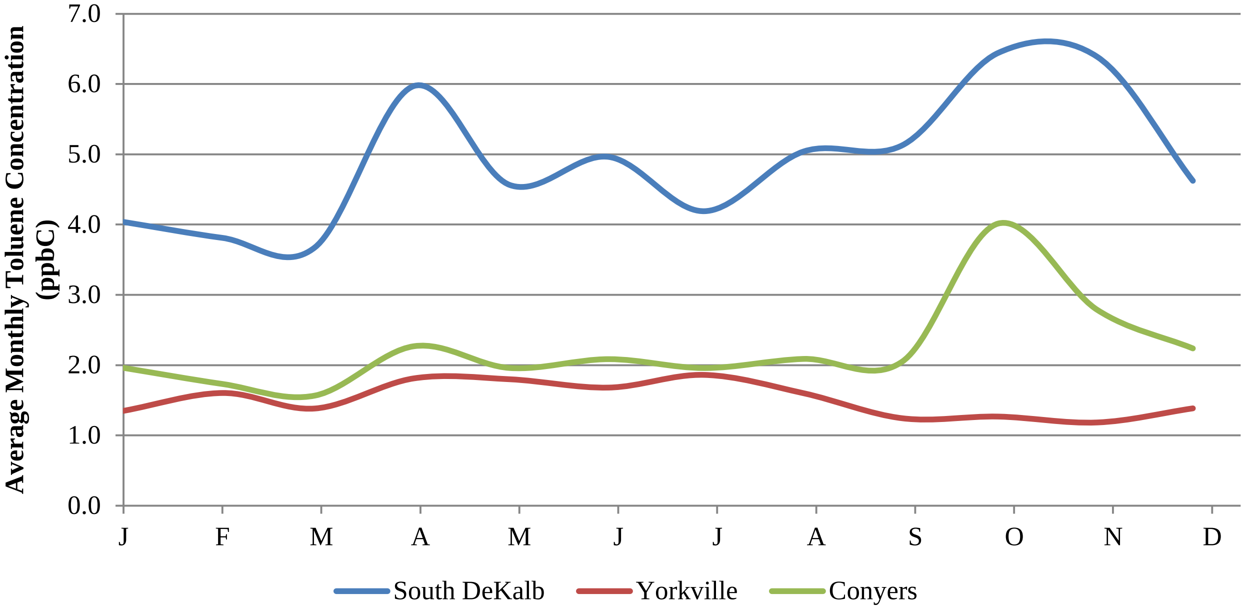


Figure 51. Toluene average annual occurrence, 2003-2015

As shown in Figure 51, the atmospheric levels of toluene are relatively constant throughout the year, suggesting a steady level of emissions year-round. Over the past thirteen years, an occasional spike in concentration has occurred without evidence of a pattern. Overall, the PAMS site that is situated in the urban area (South DeKalb) has slightly higher levels of toluene, while the sites located on the outskirts of the Atlanta metropolitan area (Yorkville and Conyers) show lower levels of toluene.

Figure 52 plots the daily profiles of toluene and isoprene. This graph uses data gathered in the summer, and shows a constant background of toluene emissions with higher levels resulting from morning and evening rush hour traffic. The graph shows the typical diurnal, or daily, profile for a typical urban area. During morning hours, when the nocturnal inversion has not yet broken, emissions become trapped within the boundary layer, resulting in a temporary increase in atmospheric concentration. Nighttime toluene levels are constant from midnight to 5:00 am. From 6:00 am to 7:00 am, increased vehicular activity releasing emissions into an atmosphere with limited dispersing ability produces an increase in the ambient concentration. This behavior is typical of area source anthropogenic emissions with modest to long atmospheric lifetimes. Isoprene, on the other hand, exhibits very different behavior. At night, emission levels are at zero as photosynthesis ceases. At sunrise (about 6:00 am) concentrations begin to rise and continue to do so throughout the daylight hours. The vertical flux, or mass input per unit area, in the atmosphere of this substance is massive, being only slightly influenced by the enhanced mid-morning mixing. This effect can be seen at 9:00 am when a slight drop in concentration occurs followed by a quick resumption in rise.

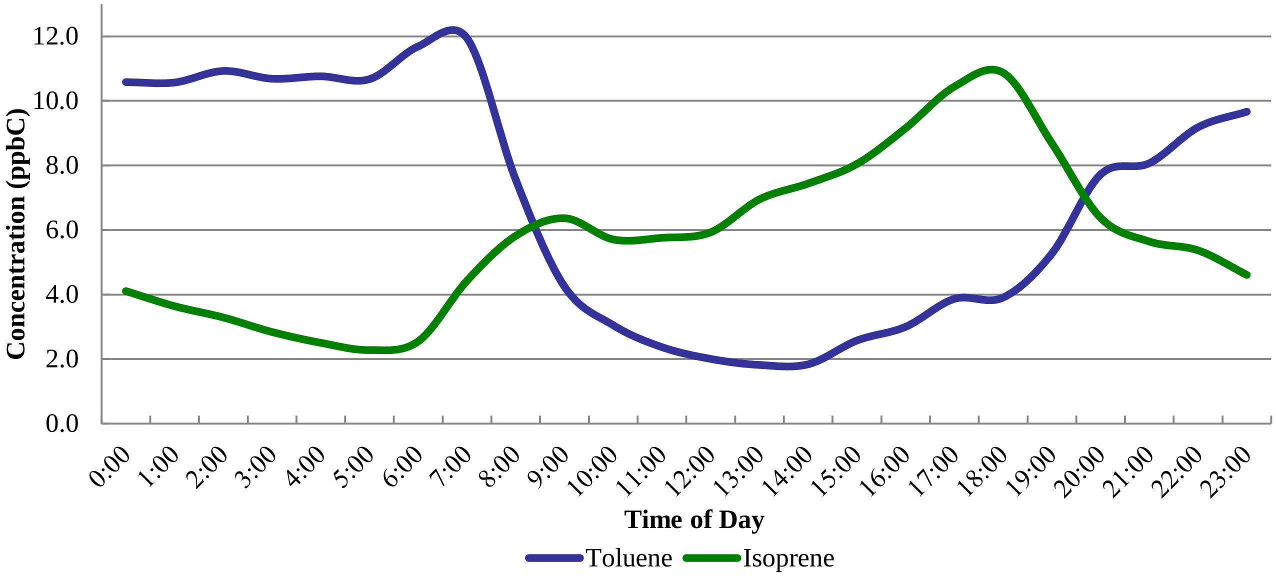


Figure 52. Typical urban daily profile of toluene & isoprene

CARBONYL COMPOUNDS

Carbonyl compounds define a large group of substances, which include acetaldehyde, acrolein, and formaldehyde. These compounds can act as precursors to ozone formation. Some of the sources of carbonyl compounds include vehicle exhaust and the combustion of wood. 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. Each of the seven carbonyl compounds that GA EPD monitors is discussed further in the following paragraphs. The South DeKalb site is part of both the PAMS network and the National Air Toxics Trends Stations (NATTS) network, and collects samples every six days throughout the year, and every three hours throughout the summer. For a map of locations monitoring carbonyl compounds, see Figure 53.

Acrolein is primarily used as an intermediate in the manufacture of acrylic acid. It can be formed from the breakdown of certain organic pollutants in outdoor air, from forest fires and wildfires, as well as from vehicle exhaust. It is also found in cigarette smoke.

Acetaldehyde is mainly used as an intermediate in the production of other chemicals. Acetaldehyde is formed as a product of incomplete wood combustion (in fireplaces and woodstoves, forest fires, and wildfires), pulp and paper production, stationary internal combustion engines and turbines, vehicle exhaust, and wastewater processing.

Formaldehyde is used mainly to produce resins used in particleboard products and as an intermediate in the production of other chemicals. The major sources of emissions to the air are forest fires and wildfires, marshes, stationary internal combustion engines and turbines, pulp and paper plants, petroleum refineries, power plants, manufacturing facilities, incinerators, cigarette smoke, and vehicle exhaust.

Acetone is used industrially as a reactant with phenol to produce bisphenol A, which is an important component of polymers. It is used in nail polish removers, superglue removers, and as a drying agent. It is also used to dissolve plastic. Acetone is highly volatile and evaporates quickly. Inhalation of acetone can lead to liver damage.

Benzaldehyde is the simplest form of the aromatic aldehydes. It has an almond scent and is used in the food industry. It is also used as an industrial solvent, and is used in making pharmaceuticals, plastic additives, and aniline dyes. Liquid phase oxidation or chlorination of toluene can form benzaldehyde. In addition, benzaldehyde can be formed from a reaction between benzene and carbon monoxide. The combustion of gasoline, diesel fuel, wood burning, and incinerators emit benzaldehyde into the atmosphere.

Butyraldehyde is used in the manufacture of synthetic resins, solvents, and plasticizers. It is emitted into the air by combustion of gasoline, diesel fuel, and wood.

Propionaldehyde is a highly volatile compound that is produced or used in making propionic acid, plastics, rubber chemicals, alkyd resins, and is also used as a disinfectant and preservative. It is released into the atmosphere by combustion of gasoline, diesel fuel, wood, and polyethylene.

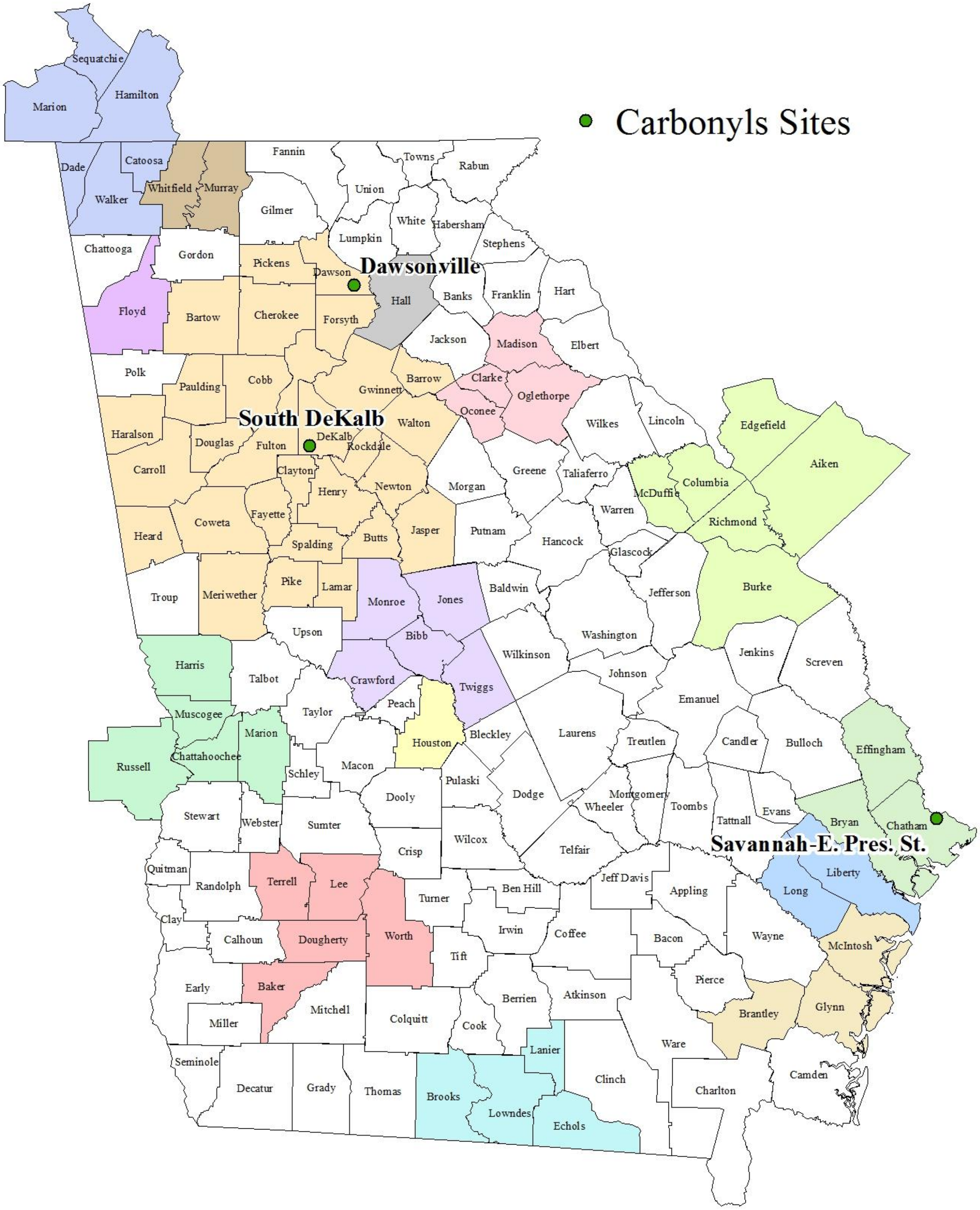


Figure 53. Georgia’s carbonyls monitoring sites, MSAs shown as solid colors

The next two graphs address 24-hour samples of carbonyls data. Due to the differences in sampling method, analysis method, and the sites collecting acrolein data, acrolein is discussed separately in later paragraphs. Figure 54 shows the average concentration of the other six carbonyls and the detection percentage at each of the sampling sites. Detections are shown as a percentage of the overall samples taken since the South DeKalb site collects data every six days with the PAMS and NATTS networks, while the Savannah and Dawsonville sites collect data every twelve days with the Air Toxics Network (discussed in next section). A detection of any given pollutant is counted as any number that is above half the limit of detection. There are some notable changes in concentrations between 2005 and 2015. The Savannah site had a dramatic increase in 2010, but levels have dropped back down the next few years. The Dawsonville site had a visible increase in concentration in 2007 and 2010, but levels have come back down the following years. The South DeKalb site has consistently had overall higher average concentrations. In 2014, percent detections ranged from 35% at the Dawsonville site, to 48% at the South DeKalb site. In 2015, there were issues with the carbonyls sampler at the South DeKalb site; therefore no carbonyls data was collected. At the Savannah and Dawsonville sites, the total average carbonyls concentrations and percent detections remained relatively consistent for 2015.

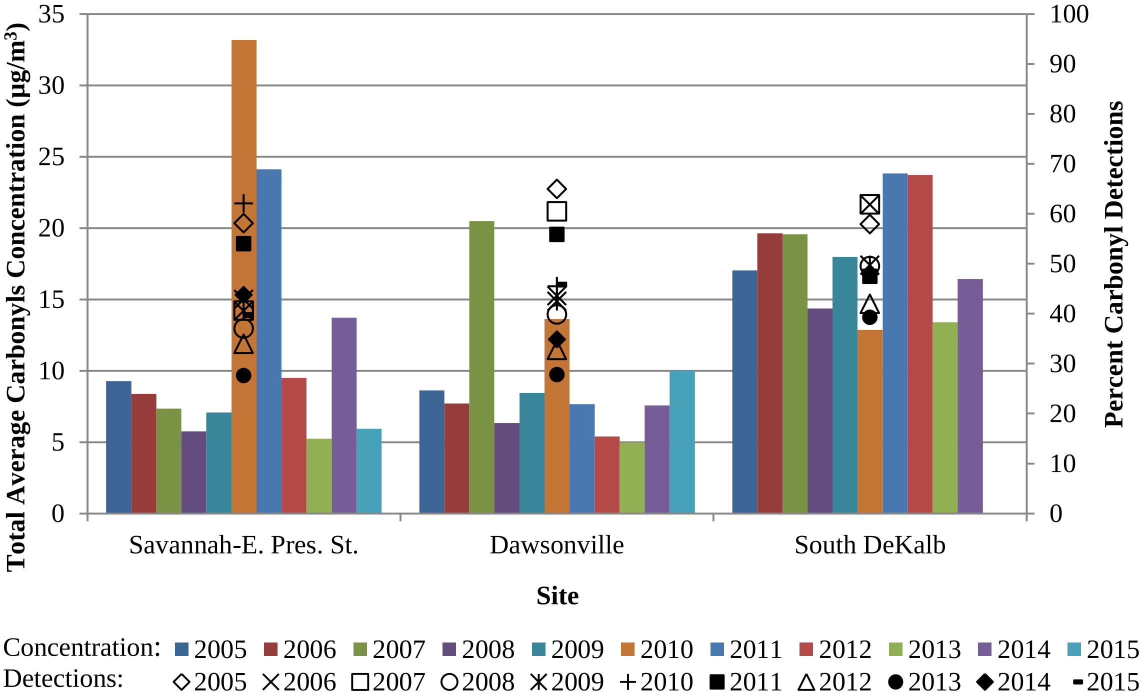


Figure 54. Average 24-hour carbonyl concentrations and number of detects, by site, 2005-2015

Figure 55 shows the statewide annual abundance of six species of carbonyls, based on percentage of detections and average concentration. A graph of the seventh carbonyl, acrolein, is shown separately as it is collected with the canister method and involves all the Air Toxics sites (Figure 56). A gradient is evident from this graph, with formaldehyde and acetone being the most abundant carbonyls. In general, it appears that there is a positive correlation with the number of detections and the average concentration. However, acetaldehyde does not follow this pattern, having a higher percentage of detections and lower concentrations. All the compounds showed an increase in total average concentrations in 2010, mainly attributed to the Savannah site (Figure 54). Overall, the average concentrations declined in 2012 and 2013, which attributed to the general decrease in percent detections. There was a slight increase in overall average concentrations in 2014. In 2015, the South DeKalb carbonyls sampler did not collect data; therefore without this data in the following graph, the averages could appear smaller than if the South DeKalb data had been included. The relative proportion of each compound to the others has remained the same throughout all eleven years, with formaldehyde, acetone, and acetaldehyde remaining the principal contributors.

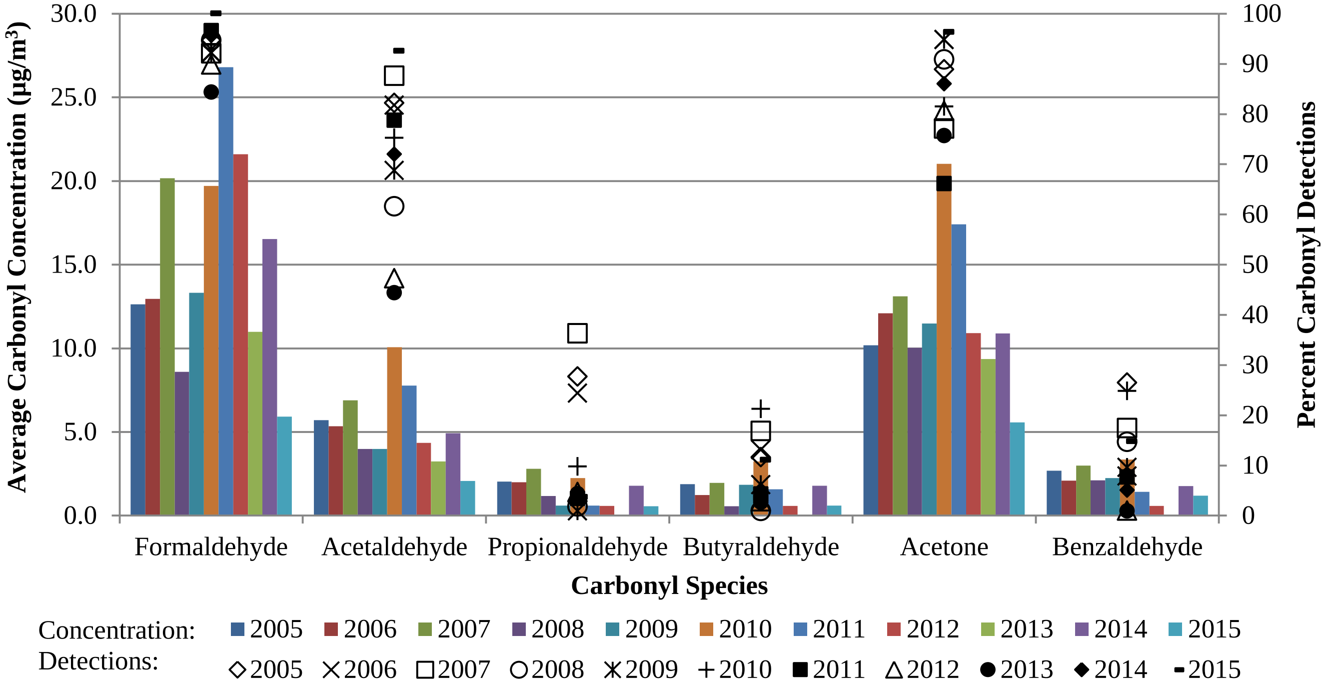


Figure 55. Average 24-hour carbonyl concentrations and number of detects, by species, 2005-2015

Acrolein is a carbonyl that may enter the environment as a result of combustion of trees and other plants, tobacco, gasoline, and oil. Additionally, it can be used as a pesticide for algae, weeds, bacteria, and mollusks (ATSDR, 2011). The potential for acrolein to cause health effects is not well understood. At very low concentrations, it is an eye and upper respiratory irritant. At very high concentrations it may produce more serious damage to the lining of the upper respiratory tract and lungs (ATSDR, 2011; U.S. EPA, 2003).

A new acrolein sampling and analysis method was developed by EPA and implemented in Georgia in July of 2007. The sampling method uses the volatile organic compounds (VOCs) canister collection method, and the analysis method uses gas chromatograph and mass spectroscopy (GC/MS). This change occurred due to EPA's findings during the School Air Toxics Monitoring Initiative. For more information on this study, please see EPA's website, http://www.epa.gov/ttnamti1/airtoxschool.html. GA EPD began using this new method for the National Air Toxics Trends Station (NATTS) at the South DeKalb site and other Air Toxics sites (discussed in the next section). In previous years, acrolein was sampled along with the six other carbonyls with a dinitrophenylhydrazine (DNPH) cartridge method and analyzed with high performance liquid chromatography (HPLC) at select sites across the state. The DNPH sampling and HPLC analysis method were used on the data that is displayed in the three previous carbonyls graphs. Before the new methods were used there were a total of four detections in 2005, zero in 2006, and one in 2007 in Georgia. With the canister collection, GC/MS analysis method, and the addition of Air Toxics sites, the number of acrolein detections drastically increased during the second half of 2007. After the implementation of the new sampling and analysis methods in 2007, 80% to 100% of the acrolein samples were greater than the detection limit (Figure 56).

Figure 56 shows relatively stable concentrations for all years with the exception of 2010 which had an abrupt increase. Every site had at least twice the 2009 concentration. The Savannah site had the highest increase from 0.34 µg/m^3 in 2009 to 4.25 µg/m^3 in 2010. Concentrations have subsequently returned to a relatively normal range. In 2015, GA EPD added VOCs to the list of pollutants monitored at the DMRC site in DeKalb County. The DMRC site is part of the Near-road monitoring network. Acrolein levels at the DMRC site are similar to concentrations collected at other sites around the state.

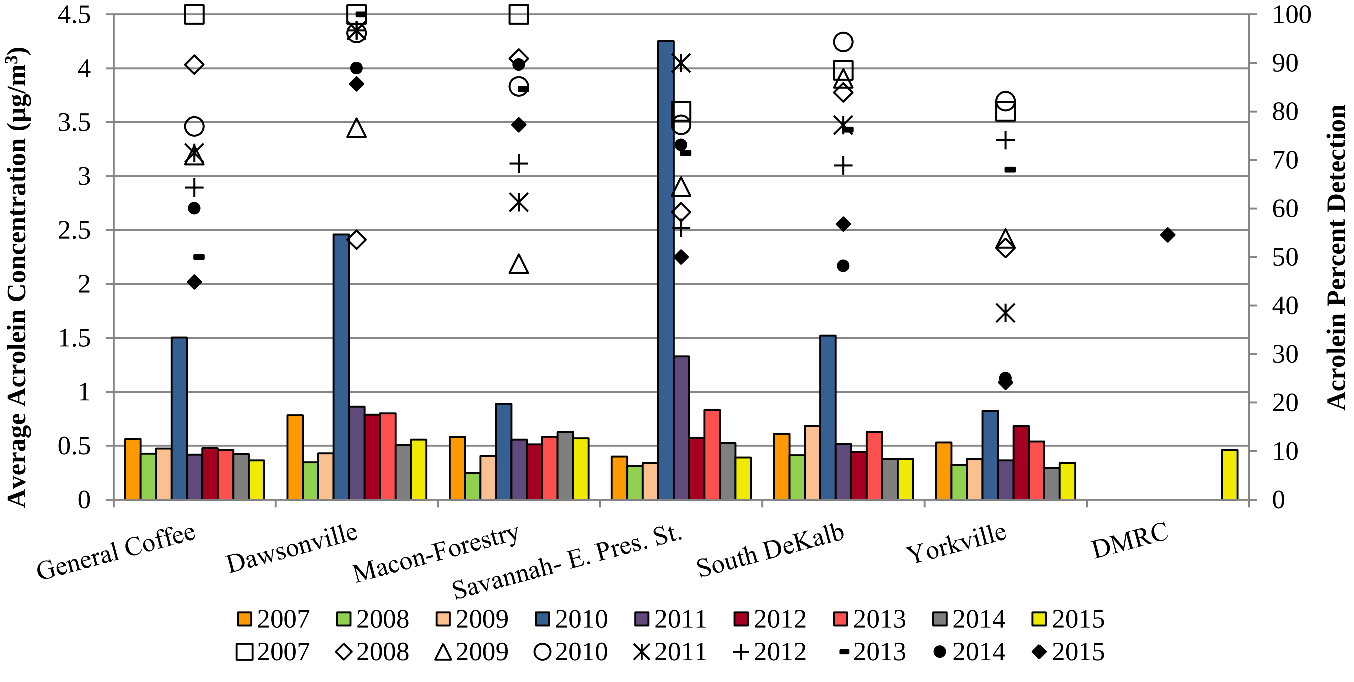


Figure 56. Acrolein concentrations and percent detections, 2007- 2015

MEASUREMENT TECHNIQUES

A number of methods are used to conduct the PAMS hydrocarbon portion of the analyses. Throughout the year, 24-hour integrated volatile organic compounds samples are taken with a SUMMA® polished canister every sixth day at the PAMS sites (Conyers, South DeKalb, and Yorkville) and analyzed in the GA EPD laboratory for 56 hydrocarbon compounds. The canister is analyzed using a gas chromatograph with mass spectroscopy detection (GC/MS).

Additionally, from June through August, hydrocarbon samples are analyzed hourly at the PAMS sites (South DeKalb and Yorkville) using a gas chromatography unit with a Flame Ionization Detector (FID). The gas chromatograph produces analyses of the ambient air for the same 56 hydrocarbons.

The carbonyls are sampled with two types of methods. One method includes an absorbent cartridge filled with dinitrophenylhydrazine (DNPH) coated. The cartridge is analyzed using High Performance Liquid Chromatography. Twenty-four hour integrated samples are collected throughout the year, every 12 days at the Air Toxics sites (Dawsonville and Savannah) and every 6 days at the NATTS site (South DeKalb). Also, during June, July, and August, four integrated three-hour carbonyl samples are taken every third day at the NATTS site (South DeKalb). All analyses are conducted at the GA EPD laboratory. Another collection method is the canister sampler that is used for sampling volatile organic compounds (described above); acrolein is analyzed using this method. Specific annual summaries for the 2015 PAMS data may be found in Appendix C.

ATTAINMENT DESIGNATION

There are no specific ambient air standards for the hydrocarbon and aldehyde species measured. PAMS measurements are performed to support the regulatory, analytical, and public health purposes of the ambient air monitoring program. By performing these measurements, GA EPD can better understand the characterization of precursor emissions within the area, transport of ozone and its precursors, and the photochemical processes leading to nonattainment. In addition, by studying local atmospheric chemistry, it improves the ability to control the formation of secondary pollutants like ozone and particulate matter. By making such data available, scientists can study air quality and how it relates to human health. This data can serve to guide policymakers toward making decisions that protect public health.

AIR TOXICS MONITORING

GENERAL INFORMATION

Air toxic pollutants, or hazardous air pollutants (HAPs), are a group of air pollutants that have a wide variety of sources. Air toxic compounds are released from mobile sources (such as vehicles), stationary industrial sources, small area sources, indoor sources (such as cleaning materials), and other environmental sources (such as volcanoes and wildfires). The lifetime, transportation, and make-up of these pollutants are affected by both 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, some HAPs that are no longer used, but were commonly used in the past, can still be found in the environment today.

All of these air toxic pollutants can potentially have negative health and environmental effects. Negative effects on human health range from headaches, nausea, and dizziness to cancer, birth defects, problems breathing, and other serious illnesses. These effects can vary depending on frequency of exposure, length of exposure time, health of the person that is exposed, along with the toxicity of the compound. People can be exposed to HAPs by breathing contaminated air, consuming food or water contaminated by air pollutants, or touching contaminated water or soil. These air pollutants also affect the environment. Wildlife experience 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.

In order for GA EPD to expand the understanding of the quality of Georgia’s air regarding ambient concentrations of hazardous air pollutants, GA EPD began state-sponsored monitoring activities. HAPs monitoring efforts were undertaken to provide a more complete picture of the state’s air quality. In 1994, GA EPD conducted an intensive air quality study in Savannah (GADNR, 1996a). Following the study, in 1996, GA EPD conducted an additional study in Glynn County as part of a multimedia event with EPA (GADNR, 1996b). These studies provided detailed pictures of the air quality in local communities, but were not long-term studies and could not provide information on seasonal variation or trends. A reassessment of the air toxic monitoring program occurred, and in 1996 GA EPD embarked on establishing a statewide hazardous air pollutant-monitoring network. The network was not designed to monitor any one particular industry, but to provide information concerning trends, seasonal variations, and rural versus urban ambient concentrations of air toxics. In order to evaluate the rural air quality, two background sites were proposed: one in North Georgia and one in South Georgia. The majority of the other sites were located in areas with documented emissions to the atmosphere of HAPs exceeding one million (1,000,000) pounds per year as indicated by the 1991 Toxic Release Inventory (GADNR, 1993).

After six years, the 2002 Air Toxics Network (ATN) consisted of fourteen sites statewide, including a collocated (where two sets of monitors sample side by side) site at Utoy Creek, which monitored for a common set of toxic compounds. From the list of 187 HAPs compounds identified by EPA, toxic compounds included metals, volatile organic compounds, and semi-volatile organic compounds. In addition, select sites monitored carbonyl compounds (discussed in the previous section).

In 2003, a National Air Toxics Trends site was added to the network at the South DeKalb site, bringing the total to fifteen air toxics sites. 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, 20 urban and 7 rural. The South DeKalb site monitors the same compounds as other air toxics sites, as well as black carbon, and carbonyls (already being monitored with PAMS network).

With the inception of the NATTS network, there was an effort to standardize detection limits for all air toxic monitoring and evaluate air toxics data at a level that would reflect potential cancer risk. Therefore, in 2004, the laboratory methodology was changed for the Air Toxics Network compounds, which lowered detection and reporting limits. This enabled analysis of a broader range of data. Instead of only seeing the higher numbers that were detected and using those numbers for average concentrations, now both sides of the spectrum show a truer average for each chemical. Also, including the lower concentrations for each chemical allows for a better understanding of what levels can cause chronic health problems and potential cancer risk. Seeing only the higher levels of concentration (spikes) only yields data useful for identifying acute health effects. However, with the lower concentration levels included in the data, there can be further assessment of potential chronic health effects and potential cancer risk. In addition, all possible effects of the analyzed chemicals can be viewed, with lower limits included in the data.

In 2008, nine of the 15 Air Toxics samplers (including the collocated Utoy Creek site mentioned above) were discontinued due to budgetary constraints and lack of available personnel. The NATTS site and the remaining five sites in the Air Toxics Network are reflected in the following subsections and included in the following maps of the current network. In addition, in 2015, the DMRC site began to collect VOCs as part of the Near-road monitoring network, and this data is shown along with the Air Toxics Network data. The following section discusses air toxic compounds, possible sources, monitoring techniques, 2015 findings, and a comparison of 2015 data to previous years.

METALS

The metals subcategory includes antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, nickel, selenium, and zinc.

Antimony is used as a hardener in lead for storage batteries, in matches, as an alloy in internal combustion engines, and in linotype printing machines. Antimony compounds are used in making materials flame-retardant, and in making glass, ceramic enamels, and paints. Forms of the antimony metal are also used in medicines, and can be found in gasoline and diesel exhaust.

Arsenic occurs naturally at trace levels in soil and water. Most people are not exposed to arsenic through air pollution, but it can be found in food. The arsenic found in air comes mainly from the burning of coal or fuel oil, from metal smelters or iron foundries, and from the burning of waste.

Beryllium is a lightweight and rigid metal and used in watch springs, computer equipment, and is used in the production of beryllium-copper as an alloying agent. This strong alloy is used to conduct heat and electricity in spot welding, electrical contacts, and high-speed aircrafts. Until 1949, beryllium was used in fluorescent lighting until it was determined to have caused berylliosis, a disease that primarily affects the respiratory system and skin. Beryllium in ambient air is mainly a result of the burning of coal or fuel oil.

Cadmium emissions, like beryllium and arsenic, occur mainly from the burning of fossil fuels such as coal or oil. The incineration of municipal waste and the operation of zinc, lead, or copper smelters also release cadmium in the air. For nonsmokers, food is generally the largest source of cadmium exposure.

Chromium sources include the combustion of coal and oil, electroplating, vehicle exhaust, iron and steel plants, and metal smelters. The emissions from these sources are a combination of elemental chromium and compounds including chromium ions. The most toxic form is hexavalent chromium.

Cobalt is used as a pigment (blue and green coloring agent), as a drying agent for paints, inks and varnishes, and as a catalyst for the petroleum and chemical industries. It is used as an alloy for parts in turbine aircraft engines, corrosion-resistant alloys, magnets, battery electrodes, and steel-belted tires. Cobalt also has a medicinal use as a radioactive metal in radiotherapy. It is also found in gasoline and diesel exhaust. Cobalt is actually necessary to many forms of life, when ingested through the digestive tract, in small amounts, as a micronutrient. It is a central component of vitamin B-12. As with most micronutrients, however, human activity can cause it to accumulate in unnatural locations or in unnatural concentrations. In those cases, it may be harmful and is considered a pollutant.

Lead is used in the manufacturing of batteries. The largest source of lead in the atmosphere used to be from the combustion of leaded gasoline. With the elimination of lead from gasoline, lead levels in the air have decreased considerably. Other sources of lead emissions include combustion of solid waste, coal, oils, emissions from iron and steel production, and lead smelters. Exposure to lead can also occur from food and soil. Children are at particular risk to lead exposure, because they commonly put hands, toys, and other items in their mouths that may come in contact with lead-containing dust and dirt. Lead-based paints were commonly used for many years. Flaking paint, paint chips, and weathered paint powder may be a major source of lead exposure, particularly for children.

Manganese is a naturally occurring substance found in many types of rock and soil. It is ubiquitous in the environment and found in low levels in water, air, soil, and food. Manganese can also be released into the air by combustion of coal, oil, wood, and the operation of iron and steel production plants.

Nickel is found in the air as a result of oil and coal combustion, residential heating, nickel metal refining, lead smelting, sewage sludge incineration, manufacturing facilities, mobile sources, and other sources.

Selenium is a by-product of mining and smelting sulfide ores, such as silver, copper, and pyrite. It is found in soils, and can also be released by burning coal. Selenium has photovoltaic and photoconductive properties and is therefore used in photocells and solar panels. It is used as a pigment (red coloring agent) in enamels and glass, and also as a toner in photographs and in photocopying. Selenium is found in gasoline and diesel exhaust. It is also a micronutrient, needed at very low levels for the health of all living creatures. However, it is normally absorbed through the digestive tract, and not desirable in the air.

Zinc is found in gasoline and diesel exhaust. It is used to prevent corrosion of galvanized steel. It is also used in die-casting, and as part of battery containers. Zinc has been used as the primary metal for producing the U.S. penny since 1982. Zinc compounds are used to make white pigment, sunscreen, deodorant, calamine lotions, and pigments for glow-in-the-dark items. It is also used in the rubber industry. Like selenium, zinc is also a micronutrient that is needed for the health of living beings when consumed through the digestive system. When found in the air, though, it may be considered a pollutant.

For a map of the current metals monitoring locations, see Figure 57.

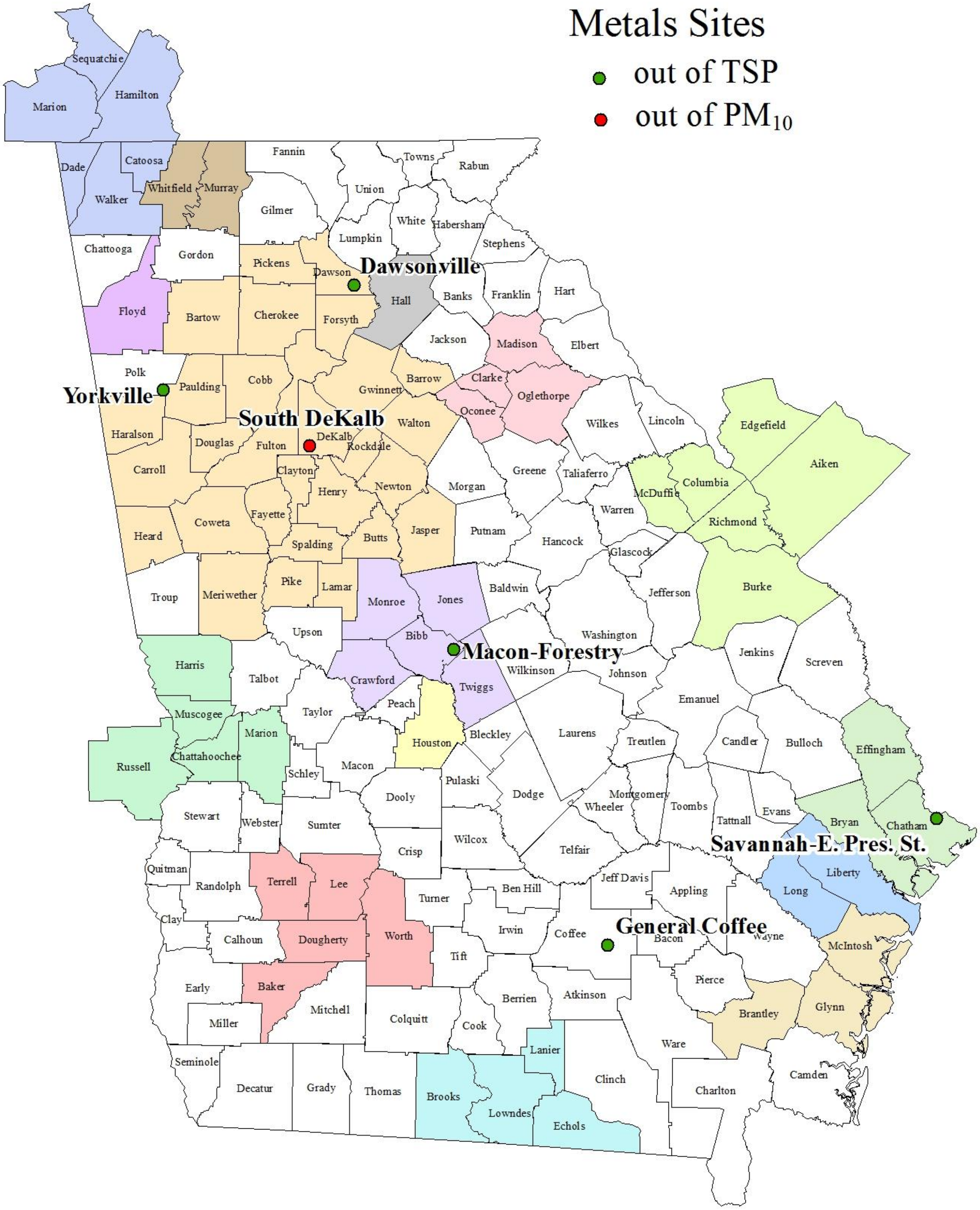


Figure 57. Metals monitoring site map, MSAs shown as solid colors

Figure 58 shows the percentage of the 11 metal species detected out of the total number of samples collected at each site from 2005 through 2015. Following EPA's guidance, a detection of any given pollutant is counted as any number that is above half the limit of detection. It is important to note that the South DeKalb metals sampler is designed to take the sample from the smaller PM_{10} fraction of the air as part of the NATTS network, while the other samplers in the Air Toxics Network collect samples from all the total suspended particles (TSP). Lower limits of detection (LOD) were introduced in September of 2004; therefore to be consistent, the data represented in these figures starts with 2005 data. In Figure 58, the distribution of metals at various locations across the state can be clearly examined, as well as any changes to pollutant levels in the past ten years. The distribution across these six sites is relatively similar. For all sites, the percent detections remain around 65% to 75% of the total samples collected in 2015. Variability across sampling locations is modest, considering the vast geographic distribution of the sites, and climatological and anthropogenic influences from local urban development.

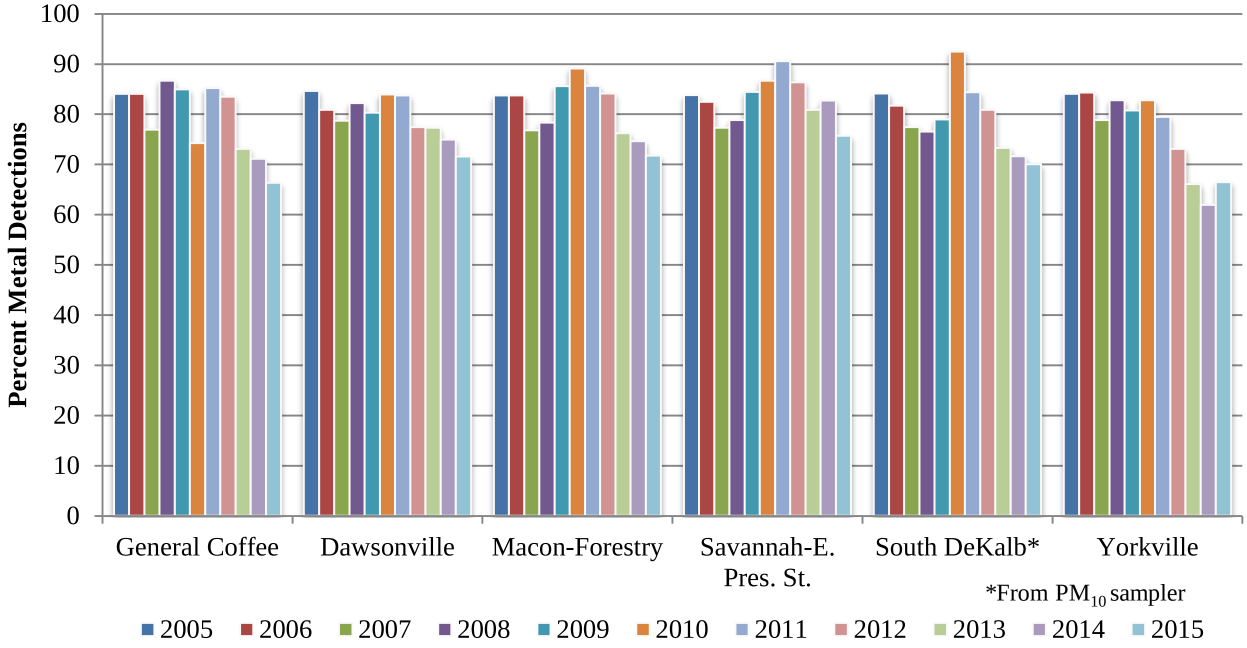


Figure 58. Percent of metals detections by site, 2005-2015

Figure 59 tracks the annual percent detection of each monitored metal species along with its annual average concentration for all the Air Toxics sites. This figure shows that most metals had several detections, with many up to 100% detection rate in some years, however, the overall concentrations remained low. This indicates that each detection contributed little to the overall concentration, with the exception of zinc. Its detection rate was similar to other metals (e.g. lead, manganese, and nickel) but it had the highest average concentration for all years shown. This would indicate that each zinc detection was associated with a higher concentration relative to the other metals. Some metals including zinc, nickel, antimony, lead, chromium, and cadmium have been associated with emissions from tires and brake linings. The use of vehicles on Georgia's roads could be a reason for higher levels associated with some of these metals.

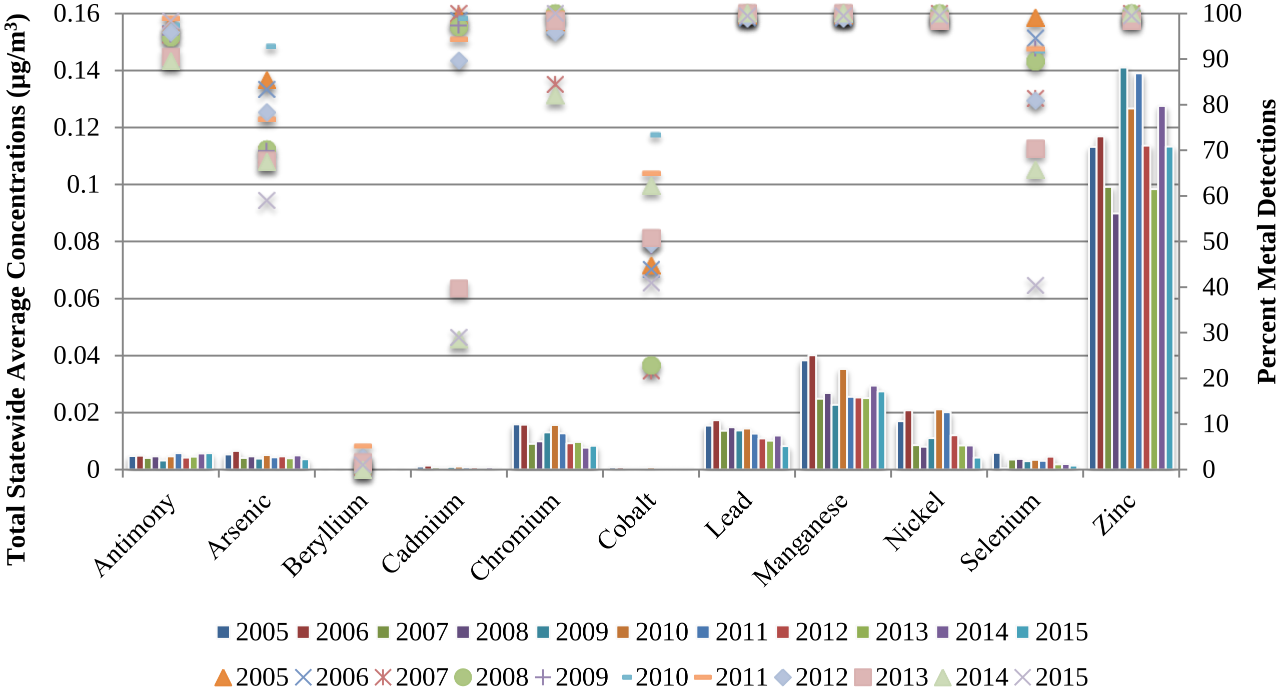


Figure 59. Total average concentration and percent detections of metals, by species, 2005-2015

Because concentrations of zinc were much higher than other metals, Figure 60 examines the total average concentrations of zinc per site. It is important to note that zinc does not have a health based screening value (see Risk Assessment section for more details) that is considered harmful to humans. In addition, zinc is not one of the 187 hazardous air pollutants; however, it is reported here for completeness.

With a few exceptions, most sites have had a consistent level of zinc throughout the thirteen years of data. As noted earlier, the South DeKalb metals sampler is designed to take the sample from the smaller PM_{10} fraction of particles in the air, while the other samplers collect samples from all the total suspended particles (TSP). The lower levels generally seen at the South DeKalb site, in comparison, could be due to the larger particles (larger than PM_{10} size) being restricted by the sampler, indicating that some of the zinc sample could be lost in the larger, restricted fraction of particles. An obvious change over the ten years of data is the Macon site’s 2009 average zinc concentration, which more than doubled from the 2008 average concentration. This data was investigated further; however, results were inconclusive as to the cause of the Macon site’s higher values in 2009. The changes in zinc levels at the Macon site could be due to changes in local industry. Zinc can be released into the environment from mining, metal processing, steel production, burning coal, and burning certain wastes. In 2010, the average zinc concentration for the Macon site decreased by about half again, resulting in a level near that of 2008. There had been a general downward trend in zinc concentrations at all the sites until 2014. The South DeKalb site showed the biggest increase in 2014 zinc concentrations. In 2015, zinc concentrations remained relatively consistent, with a slight decrease at most sites.

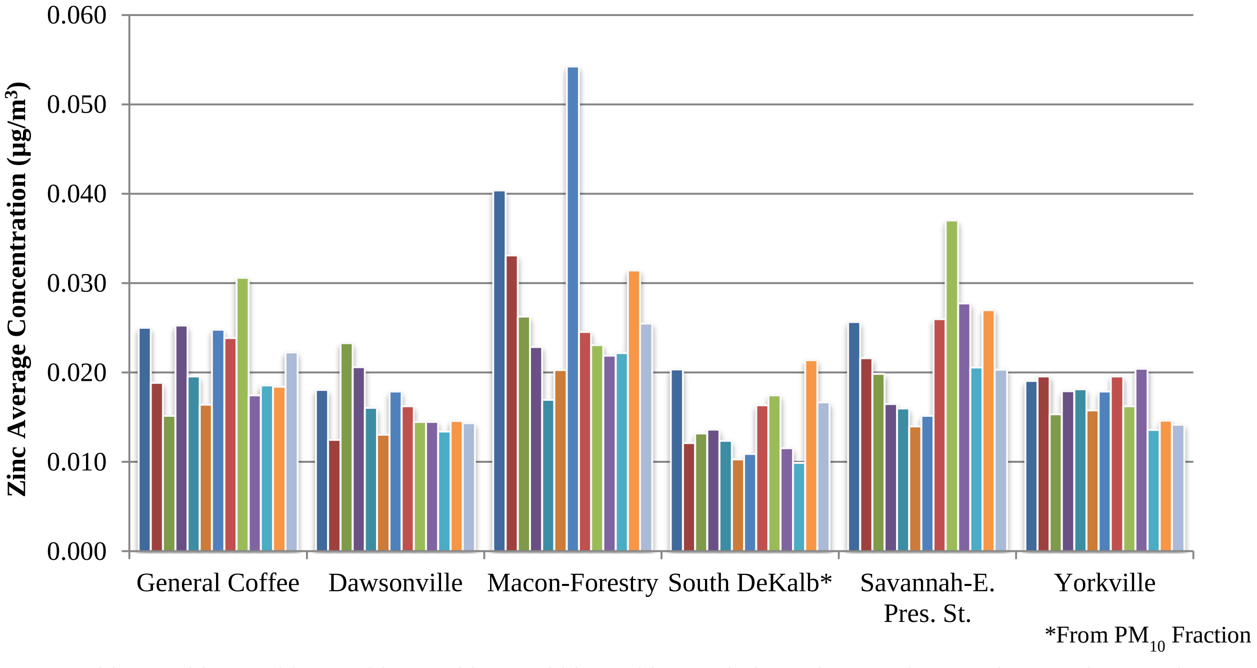


Figure 60. Average concentration comparison of zinc by site, 2005-2015

VOLATILE ORGANIC COMPOUNDS (TO-14/15)

Volatile organic compounds (VOCs) make up a group of chemicals from various industrial, stationary, and mobile sources. VOCs reach the atmosphere by way of evaporative emissions as well as incomplete combustion processes. Chlorinated compounds are very stable in the atmosphere, with lifetimes of several years. Dichlorodifluoromethane, a chlorinated compound, was the refrigerant of choice for automotive cooling. This material has not been manufactured since the mid-1990s (cars now use R-134a), yet dichlorodifluoromethane remains prevalent in the environment. Chloromethane is a volatile industrial solvent. Toluene is a major component of paints, solvents and is also present in gasoline. Benzene is found in vehicle emissions, evaporation from gasoline service stations, emissions from the burning of coal and oil, and in industrial solvents. Carbon tetrachloride and the Freons are generally used as refrigerants, industrial solvents, and as fire suppressants (though generally known as Halon in that application). The atmospheric reactivity of aromatic compounds is relatively high, with lifetimes in the weeks to months range.

Figure 61 shows the statewide detection distribution of air toxic (TO-15) type volatile organic compounds (VOCs) from 2005 to 2015 across the state's Air Toxics Network. The detection of any given pollutant is counted as any number that is above half the limit of detection. The South DeKalb site has samples collected every six days; therefore, all of the site's detections are shown as a percentage of samples taken. The distribution is relatively even across the state, although the sites are located in different geographic regions, and have different local influences. The percentage of detections has remained relatively low throughout the eleven years shown here. Out of all the VOCs samples taken, the percent detections have consistently been about 8% to 15%. With the addition of the VOCs sampler at the DMRC site for Near-road monitoring in 2015, this site showed the highest percentage of VOCs collected. As more data is collected at the DMRC site, this will be monitored for a possible trend of highest percent detections at this Near-road site.

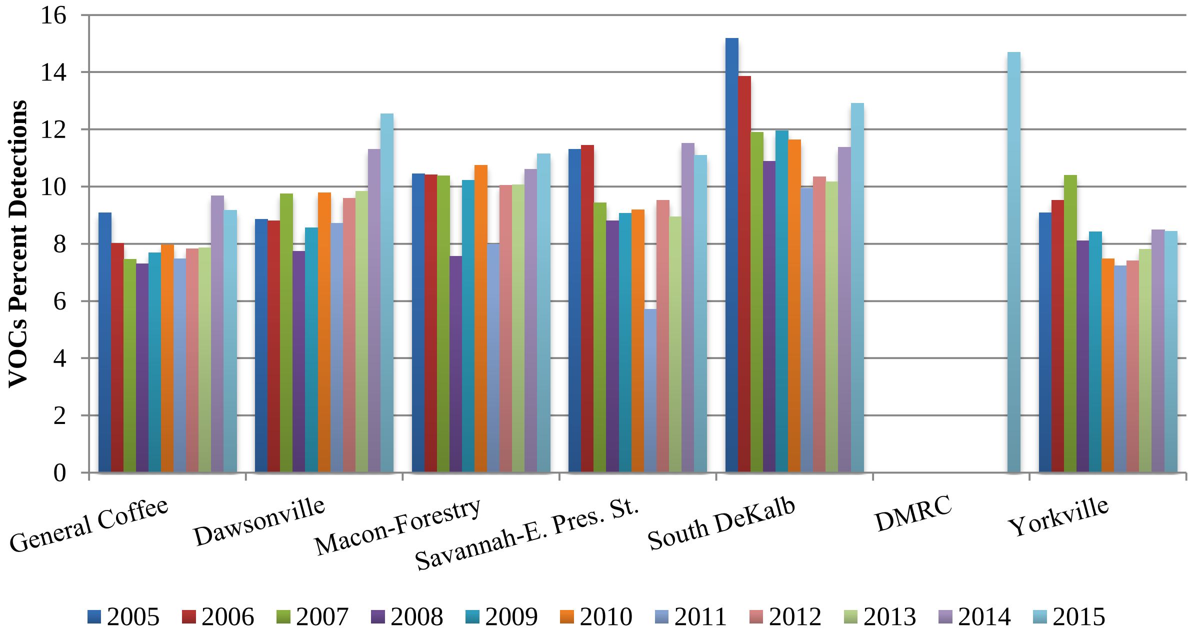


Figure 61. Percent detected total volatile organic compounds per site, 2005-2015

Figure 62 shows the top ten VOCs detected from 2005-2015 and examines the relationship between the concentrations observed and percent detections above detection limit. Although there are 42 species in this analyte group, only a relatively small subset is detected with any regularity. The percentage of detections was derived using any detection that was above half of the method detection limit. To obtain the average concentration for compounds with a minimum of one detection, the half method detection limit for that compound was substituted for any number lower than that compound's half method detection limit. Chloromethane, trichlorofluoromethane, and dichlorodifluoromethane consistently have the highest detection rates, and dichlorodifluoromethane consistently has the highest concentrations. Although there have been some noticeable fluctuations with benzene and cyclohexane, the proportions of these VOCs have remained relatively consistent throughout the years.

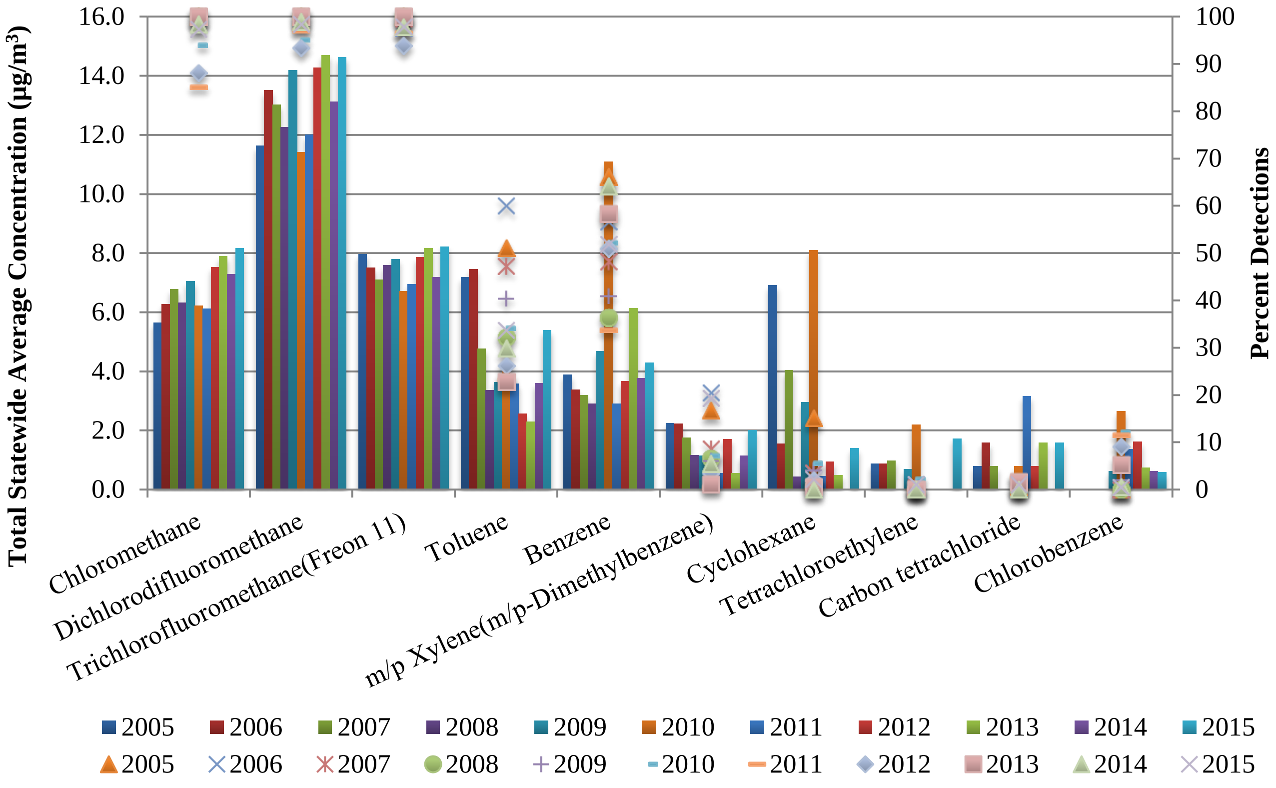


Figure 62. Total average concentration and percent detection of common volatile organic compounds (TO-15), 2005–2015

Figure 63 shows the total volatile organic compound concentration, or loading, at each site for 2005 through 2015. This "total loading" measurement is produced by adding all the detected concentrations of all VOCs, even those below half of the detection limit as discussed earlier. It is intended as a surrogate measure showing general trends in overall VOC concentrations. When considering Figure 63, it is important to note that the South DeKalb site would appear elevated since this site has a larger number of scheduled samplings than the rest of the sites in the network. Samples are collected on a 6-day schedule at the South DeKalb site, as part of the NATTS network, as opposed to every twelve days at the other Air Toxics sites. It is important to note that the Macon site was shut down for most of 2008 (shown in dark purple) due to damage to the site, causing that value to appear much lower than the other Air Toxics sites. In 2010, the Macon site had a significant increase in total concentration. These higher concentrations seem to be attributed primarily to cyclohexane, dichloromethane, and benzene samples. Then in 2011, the Macon site had a dramatic decrease, to levels below those of 2009, while the other sites' total concentrations remained relatively stable. Since then, there has been little fluctuation at each site.

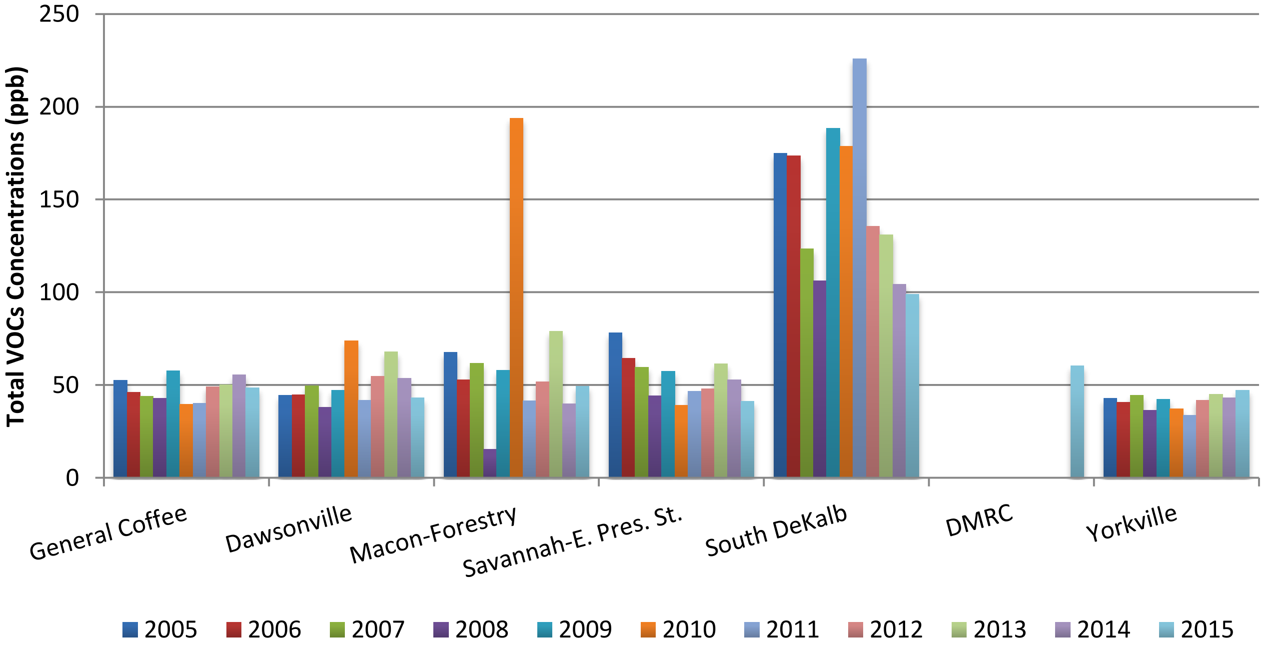
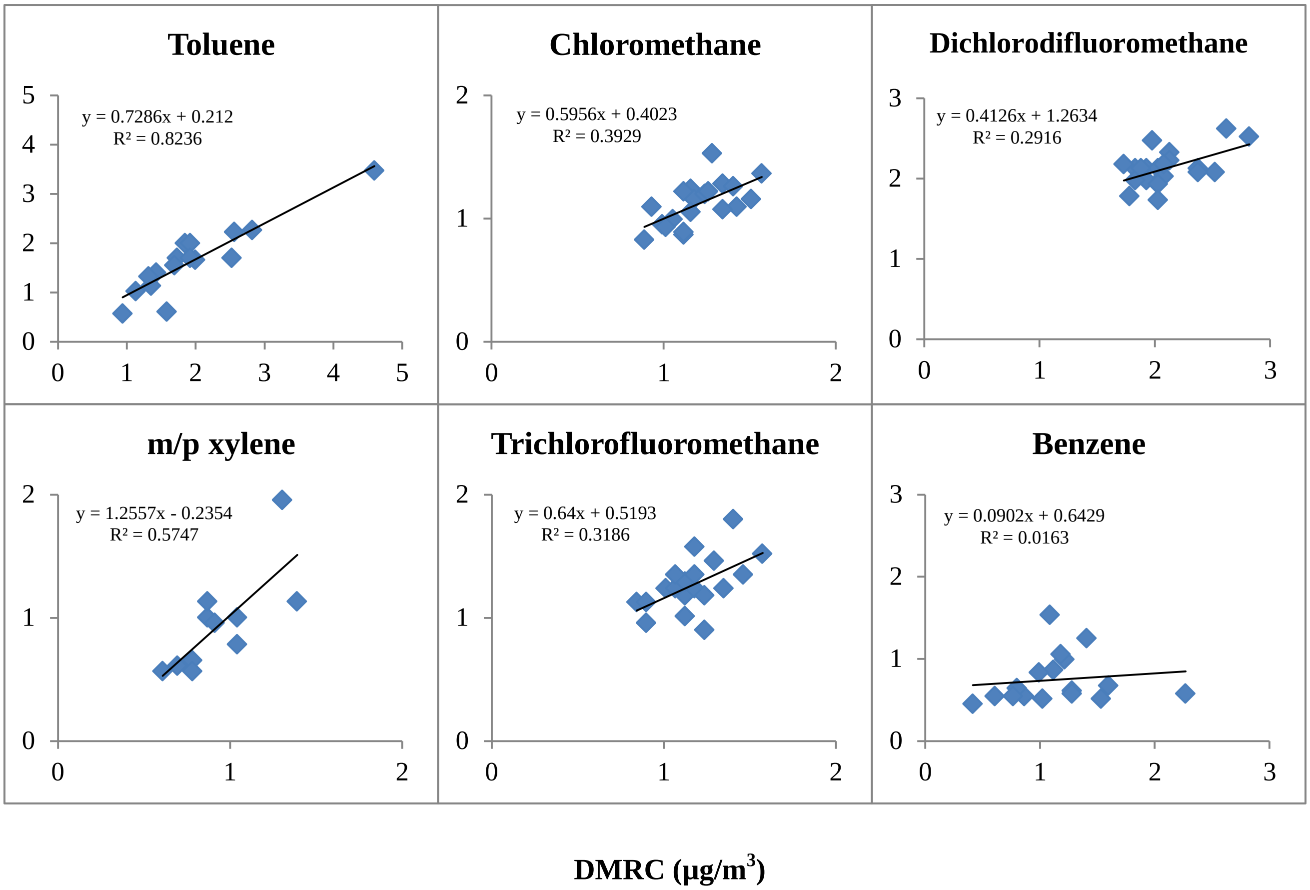


Figure 63. Total volatile organic compound loading for each site, 2005-2015

As stated earlier, VOCs were collected at the DMRC site as of April 2015. Since VOCs data is also collected at the nearby South DeKalb site, the data was investigated for correlations between the data collected at each site. The DMRC site is set up as part of the Near-road Monitoring and is located within 40 meters of a heavily traveled interstate, and the South DeKalb site is approximately a mile away from the DMRC site and is located 580 meters from the same interstate. At this point, data from the DMRC site is limited; however, there is a clear correlation for toluene, which is found in gasoline. The toluene correlation has an R^2 of 0.8236. M/p-xylene has a weaker correlation (R^2 of 0.5747), while the other four compounds shown here have even lower correlations. This could indicate that further downwind of the interstate, at the South DeKalb site, that the compounds have dissipated in the air and a lower concentration is collected. Below the scatterplots, the correlation coeffecients are also listed.



VOC	Correlation Coefficient (r)
Toluene	0.9075
m/p xylene	0.7581
Chloromethane	0.6268
Trichlorofluoromethane	0.5645
Dicholrodifluoromethane	0.5400
Benzene	0.1278

Figure 64. Comparison of select VOCs at the South DeKalb and DMRC sites

The black carbon samplers collect data every hour and therefore have more data to compare. The scatterplot shows a relatively high correlation (r=0.7425) between the South DeKalb and DMRC sites.

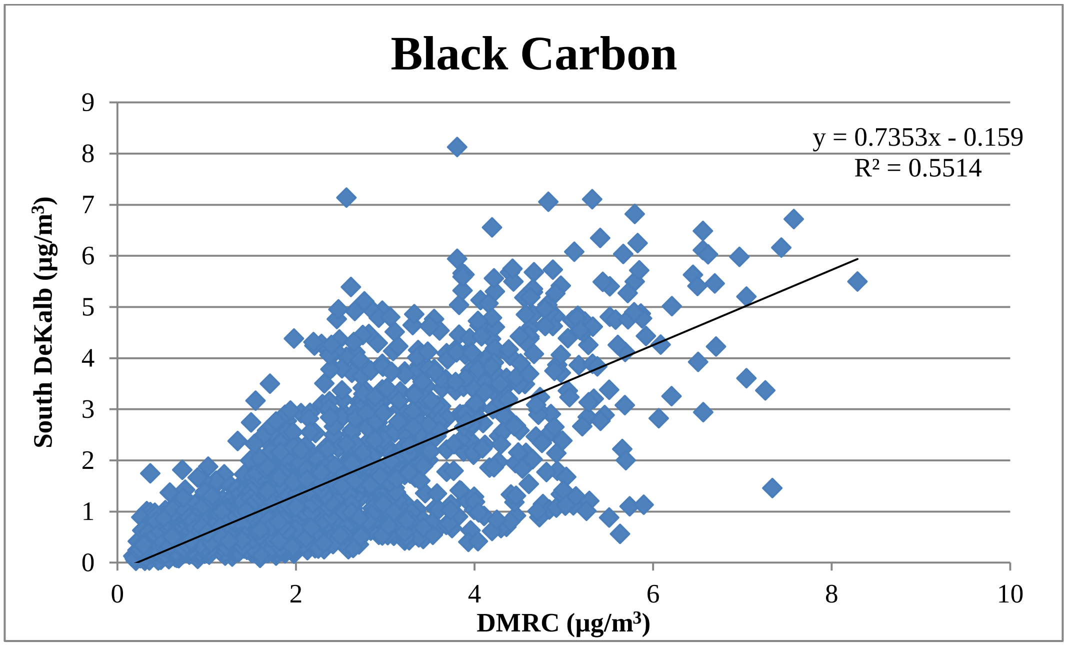


Figure 65. Comparison of black carbon at the South DeKalb and DMRC sites

For a map of volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOC) monitoring locations see Figure 66.

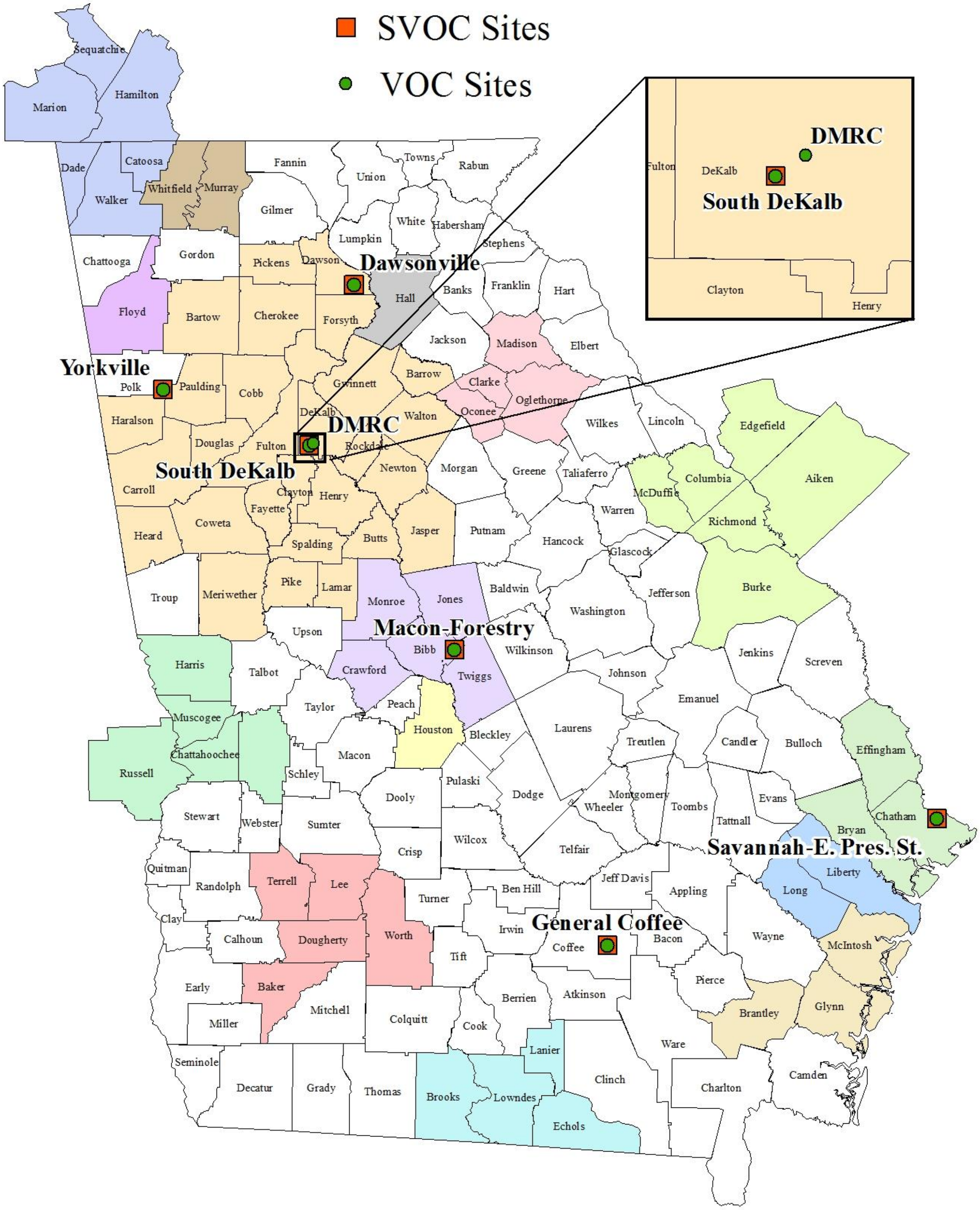


Figure 66. VOC and SVOC monitoring site map, MSAs shown as solid colors

SEMI-VOLATILE ORGANIC COMPOUNDS

Polycyclic aromatic hydrocarbons (PAHs), also called semi-volatile organic compounds (SVOCs) 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 fuel, fat or tobacco. Over 100 different chemicals are comprised within this designation. Many of them are known or suspected carcinogens. Some environmental facts about this class of compounds are listed below.

- PAHs enter the air mostly as releases from volcanoes, forest fires, burning coal, and automobile exhaust.
- PAHs can occur in air attached to dust particles.
- Some PAH particles can readily evaporate into the air from soil or surface waters.
- PAHs can break down by reacting with sunlight and other chemicals in the air over a period of days to weeks.
- PAHs can enter water through discharges from industrial and wastewater treatment plants.
- Most PAHs do not dissolve easily in water. They stick to solid particles and settle to the bottoms of lakes or rivers.
- Microorganisms can break down PAHs in the soil or water after a period of weeks to months.
- In soils, PAHs are most likely to stick tightly to particles. Certain PAHs can seep through soil to contaminate groundwater.
- PAH content of plants and animals may be much higher than the PAH content of the soil or water in which they live.

For a map of SVOC monitoring locations see Figure 66.

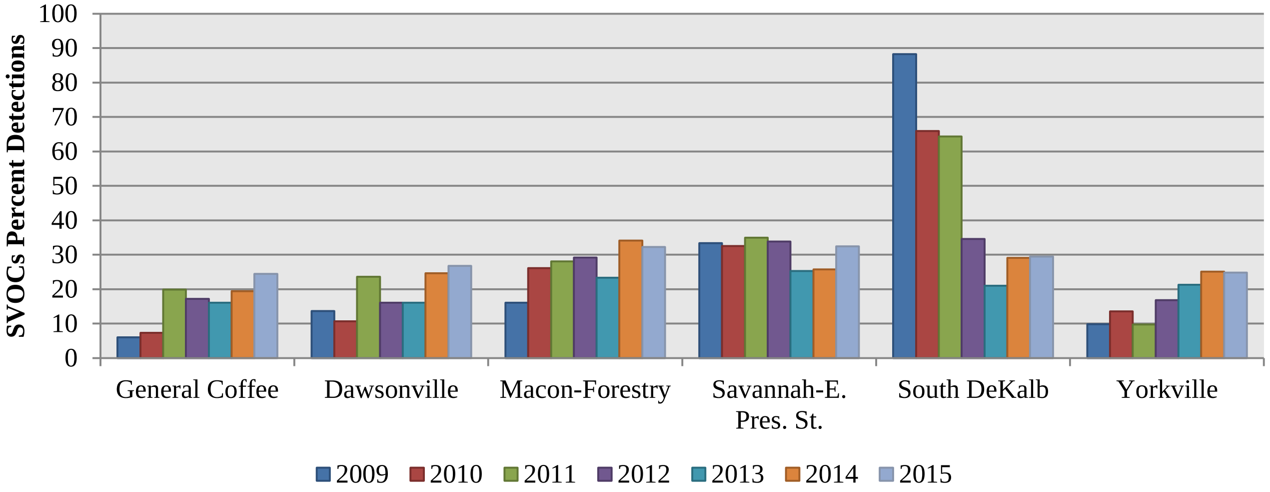


Figure 67. Percent detections of semi-volatile organic compounds per site, 2009-2015

Figure 67 displays the percentage of detections (according to site) from the fourth quarter of 2009 through 2015 for all semi-volatile organic compounds combined in the Air Toxics Network, as well as the South DeKalb (NATTS) site. Prior to the fourth quarter of 2009, the semi-VOCs data collected within the Air Toxics Network was analyzed by the GA EPD laboratory with a gas chromatograph with Electron Capture Detector, while the semi-VOCs data collected within the NATTS network were analyzed with a gas chromatograph by an EPA contract laboratory. Then, in the fourth quarter of 2009, the GA EPD laboratory began analyzing the Air Toxics Network data with a gas chromatograph, the same method used to analyze data from the South DeKalb site. This caused an increase in detection rate for the five sites in the Air Toxics Network. Traditionally, there were only a few compounds that would have any detections, and most compounds would have no detections. Since the change in laboratory analysis method, the detection rates have ranged from about 6% to 35%, for the five sites in the Air Toxics Network. Even though the same laboratory analysis method is used for this analysis, the South DeKalb data has shown some significantly higher percentages, up to 88% detection rate. As of July 2012, the GA EPD laboratory began analyzing the semi-VOCs collected at the South DeKalb site as well. Detections were counted as any number that was above half of the method detection limit. As data is collected in the future, the relationship between these sites will continue to be tracked. In addition, the data will be observed for possible continuing increase in detections with the gas chromatograph laboratory analysis method.

Figure 68 shows the percentage of detections compared to the total average concentration for the seventeen semi-volatile organic compounds that all six sites have in common from fourth quarter 2009 through 2015. The percentage detections were derived using any detection that was above half of the method detection limit. To obtain the average concentration for compounds with at least one detection, the half method detection limit for that compound was substituted for any number lower than that compound's half method detection limit. As discussed above, until 2009, the percentage of detections and average concentrations were very low. Before the laboratory analysis method change for the Air Toxics Network data, the percent detections were below 10% and the average concentrations were below 0.01 µg/m^3. With the laboratory analysis change in the last quarter of 2009, there were significant increases in detections and concentrations for some compounds. Since the analysis method is the same, the following graph combines the Air Toxics Network data and the NATTS data. The largest semi-VOC contributor in both total average concentration and percent detections is naphthalene. The concentrations of naphthalene range from about 0.09 µg/m^3 to 0.21 µg/m^3, and percent detections are around 92 to 100%. These concentrations are approximately four to nine-fold higher than the next highest concentrations of around 0.015 to 0.033 µg/m^3 for phenanthrene. Phenanthrene's total detections have been in the 80% to 100% range, indicating that there were several small concentrations detected, as compared to having higher concentrations for each detection of naphthalene. Over half of the compounds continue to have low average concentrations and percent detections below 50%. Polycyclic aromatic hydrocarbons such as these are found in the air from the burning of coal, oil, gas, and garbage, and are found in dyes, cigarette smoke, coal tar, plastics, and pesticides. They have been found to bother the skin and mucous membranes and have even been linked to cancer.

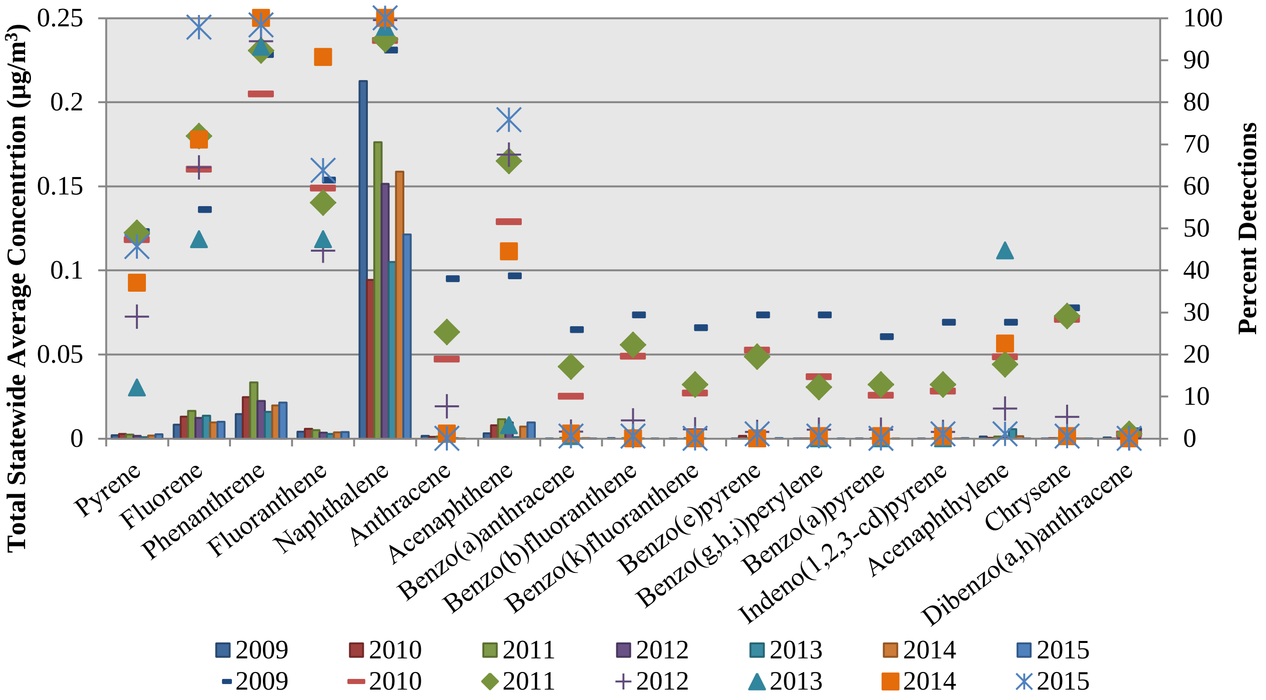


Figure 68. Total average concentration and percentage detections of semi-volatile organic compounds by compound, 2009-2015

MONITORING TECHNIQUES

In 2015 air toxics samples were collected from a total of six sites, including a NATTS site, and two background (rural) sites. Also in 2015, the DMRC site in DeKalb County had volatile organic compounds (VOCs) added to the list of pollutants collected as part of the Near-road Monitoring Network.

The compounds sampled at the Air Toxic Network (ATN) sites are shown in Appendix D. The list was derived from the 187 compounds EPA has designated as Hazardous Air Pollutants (HAPS). Many of the HAPS do not have standardized ambient air sampling and analytical methods. In order to collect the compounds of interest for the Georgia network, three types of samplers are used at all locations: the HIVOL, PUF, and canister. In addition, carbonyls were monitored at two of the ATN sites, as well as one NATTS/PAMS site, in 2015.

This equipment samples for metals, semi-volatile organic compounds (SVOCs), and volatile organic compounds (VOCs) once every twelve days following a pre-established schedule that corresponds to a nationwide sampling schedule for the Air Toxics Network. The South DeKalb site collects samples every six days, as part of the National Air Toxics Trends (NATTS) network, and the DMRC site collects VOCs samples every twelve days as part of the Near-road Monitoring Network. On the run day, the sampler runs midnight to midnight and takes a 24-hour integrated sample.

The HIVOL sampler is calibrated to collect 1300 to 2000 liters of air per minute on an 8.5” x 11” quartz fiber filter. The filters are subjected to a chemical digestion process and are analyzed on an inductively coupled plasma spectrometer.

The PUF (polyurethane foam) sampler used for sampling SVOCs 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 a gas chromatograph.

The canister sampler used for sampling VOCs is a SUMMA® polished canister. The canister is filled to greater than 10 psig and analyzed using a gas chromatograph with mass spectroscopy detection (GC/MS).

The carbonyls are sampled with two types of methods. One type is an absorbent cartridge filled with dinitrophenylhydrazine (DNPH) coated silica that is analyzed using High Performance Liquid Chromatography (HPLC). A 24-hour integrated carbonyl sample is taken every six days throughout the year. The other method used for collecting carbonyls is the cansiter sampler that is used for sampling volatile organic compounds. Acrolein is a carbonyl compound that is collected using the canister method, described above, and analyzed with the GC/MS method.

As part of the National Air Toxics Trends network, metals are monitored on a PM_{10} sampler at the South DeKalb site. The PM_{10} sampler samples toxic metal particles less than or equal to 10 microns in diameter on a 8.5” x 11” quartz glass fiber filter. The sample is analyzed using inductively coupled plasma mass spectrometry (ICP-MS). In 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.

ATTAINMENT DESIGNATION

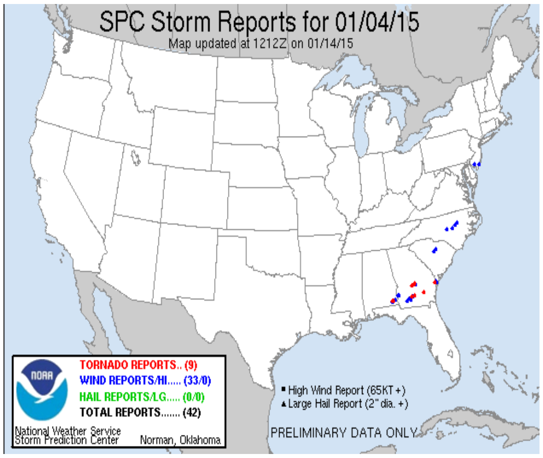
Currently, there are no attainment standards for the air toxics compounds, with the exception of lead, which has its designation as a criteria pollutant. Air toxics measurements are performed to support the regulatory, analytical, and public health purposes of the program. While it is understood that these compounds are toxic, it is not well understood what airborne concentrations of each compound may be harmful. By collecting data about their current concentrations, researchers can later compare GA EPD’s data with health data to determine what levels of each compound may be safe.

METEOROLOGICAL REPORT

STATE CLIMATOLOGY AND METEOROLOGICAL SUMMARY OF 2015

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 20th 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 12th. 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 22nd – 23rd.



Several tornadoes and scattered wind damage were reported ahead of a strong cold front that pushed through the state on January 4th. 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.

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 16th 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 17th, 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 20th. 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 20th and the morning of the 21st. The precipitation impacted Metro Atlanta and further north, with totals up to 2” in extreme northwest Georgia. On February 25th, 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.

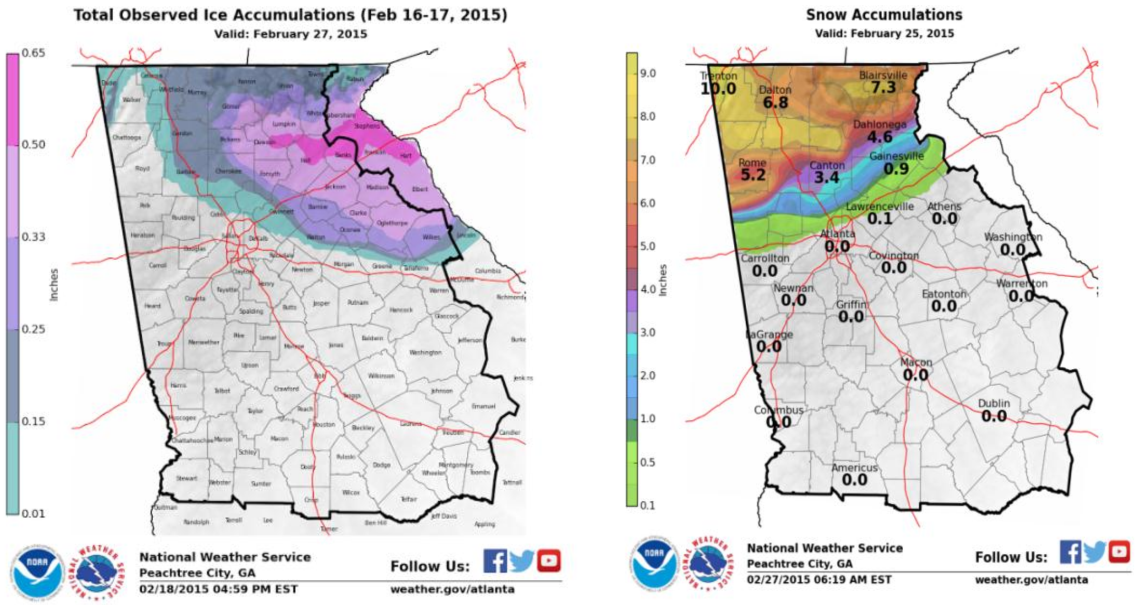


Figure 69. Ice and snow accumulations, February 2015

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.

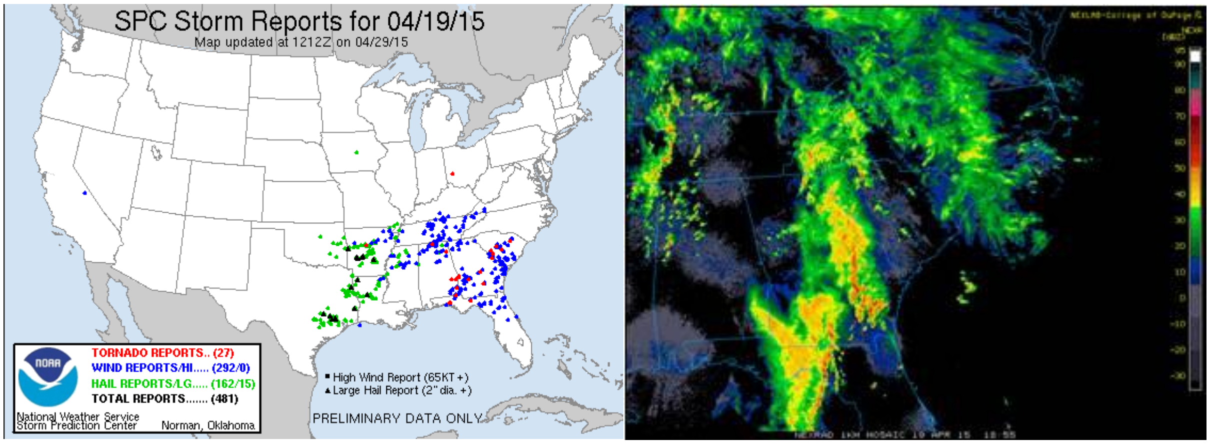


Figure 70. Wind and tornado reports, April 2015

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.

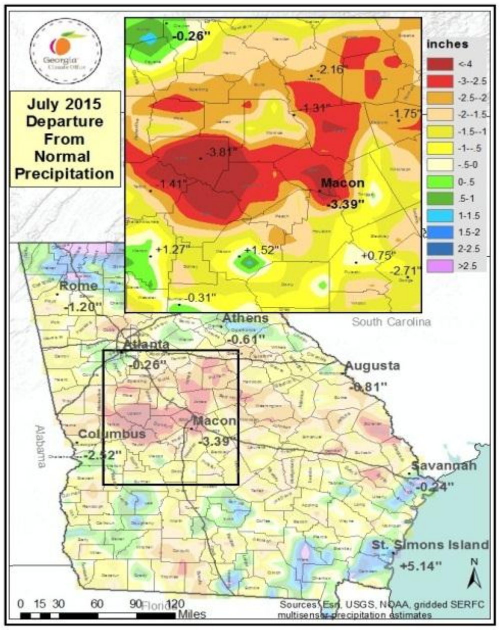
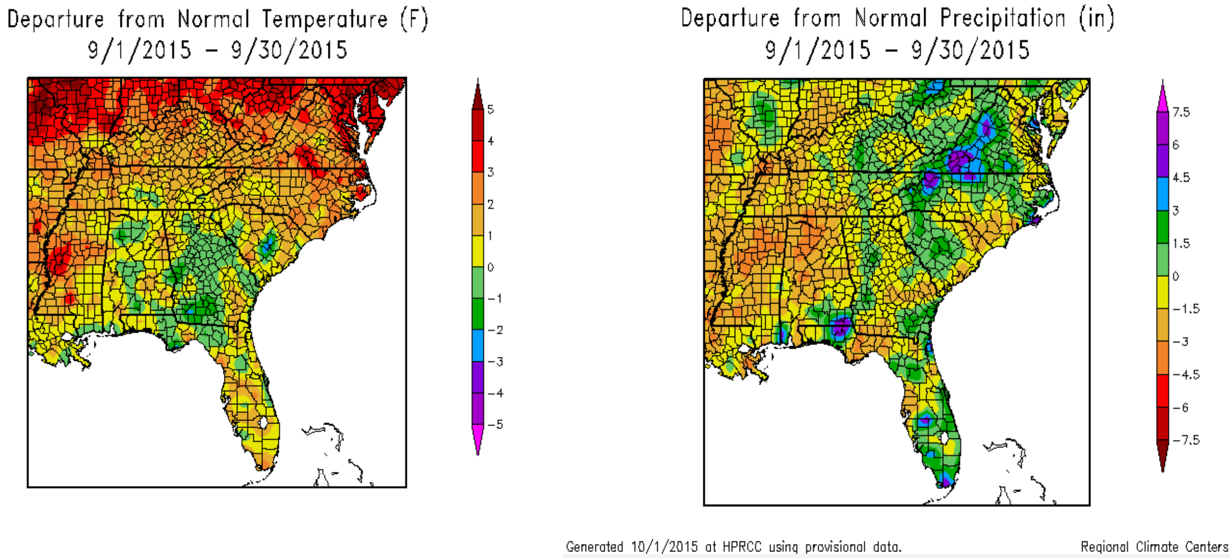


Figure 71. Departure from normal precipitation, July 2015

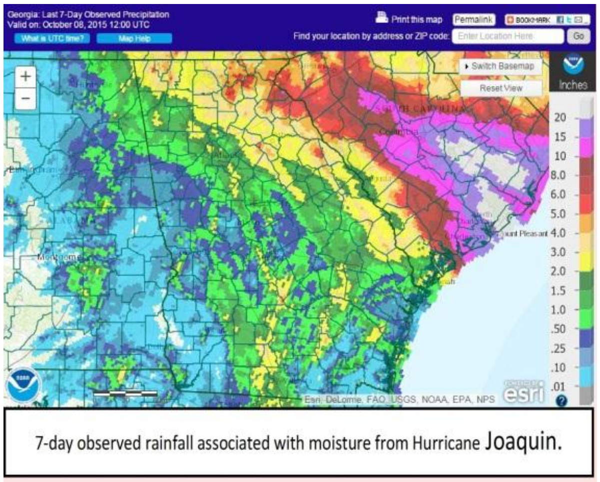
Georgia's cooler than normal temperatures during September, compared to the rest of the country, were a welcome sign of climatological fall. September was characterized by abundant tropical moisture, hybrid cold air damming events, and cold frontal passages, all of which brought cloudy conditions that 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.



Generated 10/1/2015 at HPRCC using provisional data. Regional Climate Centers

Figure 72. 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.


Georgia: Last 7-Day Observed Precipitation
Valid on: October 08, 2015 12:00 UTC

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

Figure 73. 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”).

SUMMARY OF METEOROLOGICAL MEASUREMENTS FOR 2015

A complete suite of meteorological instrumentation is used to characterize meteorological conditions around metropolitan Atlanta. The basic surface meteorological parameters were measured at the Photochemical Assessment Monitoring Sites (PAMS). The PAMS sites are South DeKalb and Yorkville. The South DeKalb site is also a National Core Multi-pollutant site (NCore) and a National Air Toxics Trends Station (NATTS) site as well. All PAMS sensors measure hourly-averaged scalar wind speed and vector-averaged wind direction at the 10-meter level, and hourly-averaged surface temperature, relative humidity and barometric pressure at the 2-meter level. Several sites include instruments to record precipitation, global solar radiation and total ultraviolet radiation. The standard deviation of the wind direction is also computed at the South DeKalb (NCore, NATTS) site. A ceilometer was installed at South DeKalb to monitor the evolution of the atmospheric boundary layer and the growth of the mixing height. A map of the GA EPD meteorological network, as well as specific instruments at each site, is detailed in the figure and chart below.

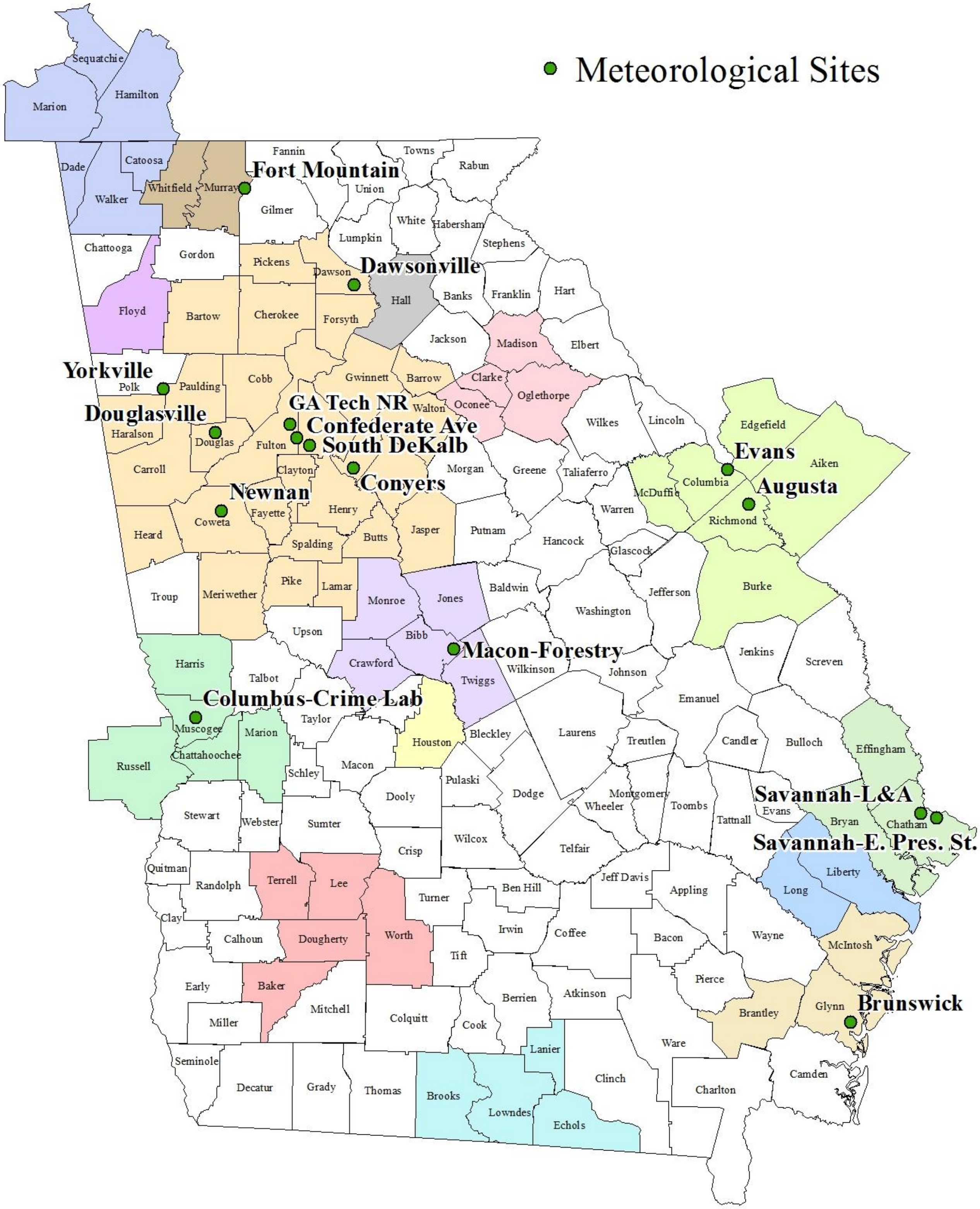


Figure 74. Meteorological Site Map

Table 4. List of equipment at each meteorological site

PARAMETER	COMPANY	INSTRUMENT	MODEL	LOCATION															
				Augusta	Brunswick	Col Cr Lab	Conf Ave.	Conyers	Dawsonville	S. DeKalb	Sav. Pres	Yorkville	Macon SE	Douglasville	Newnan	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
	R.M. Young	Ultrasonic Anemometer	85000				X						X			X	X		
Ambient Temperature/ Relative Humidity	R.M. Young	TEMP/RH Probe	41375VC	X		X						X				X			
	R.M. Young	TEMP/RH SENSOR, DEG C	41382VC					X		X	X						X		
Barometric Pressure	R.M. Young	Barometric Pressure Sensor	61201	X				X				X							
	R.M. Young	Barometric Pressure Sensor	61302V			X				X	X								
Precipitation	Novalynx	Tipping Bucket Rain Gauge	260-2501	X		X		X		X		X							
Solar Radiation	Eppley Lab	Standard Precision Pyronometer	PSP/SPP					X				X							
Total Ultraviolet Radiation	Eppley Lab	Total Ultraviolet Radiometer	TUVR					X				X							
Data Logger	ESC	Data System Controller	8832	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
	ESC	Data System Controller	8816			X													
Towers	Aluma Tower Inc.	Crank-Up Tower	T-135	X	X	X	X	X		X	X	X	X	X	X			X	X
	Aluma Tower Inc.	Fold-Over Tower	FOT-10						X							X	X		

OZONE AND $PM_{2.5}$ FORECASTING

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 8thth. 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.

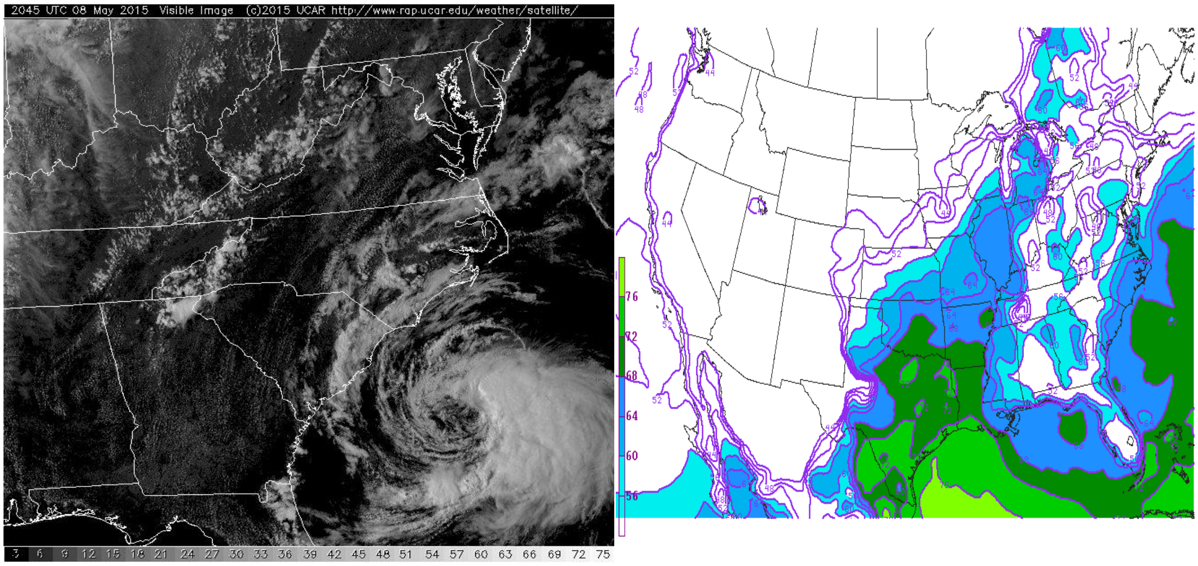


Figure 75. Tropical system off coast of Georgia, May 2015

A more classical setup for an ozone violation occurred on May 13th 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.

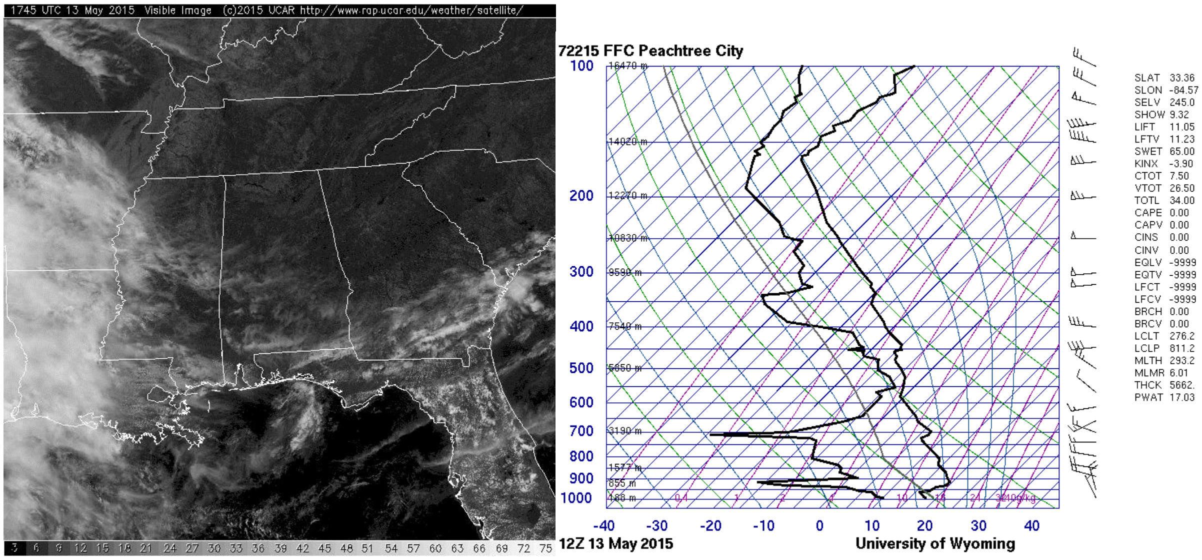


Figure 76. Wind Conditions, May 2015

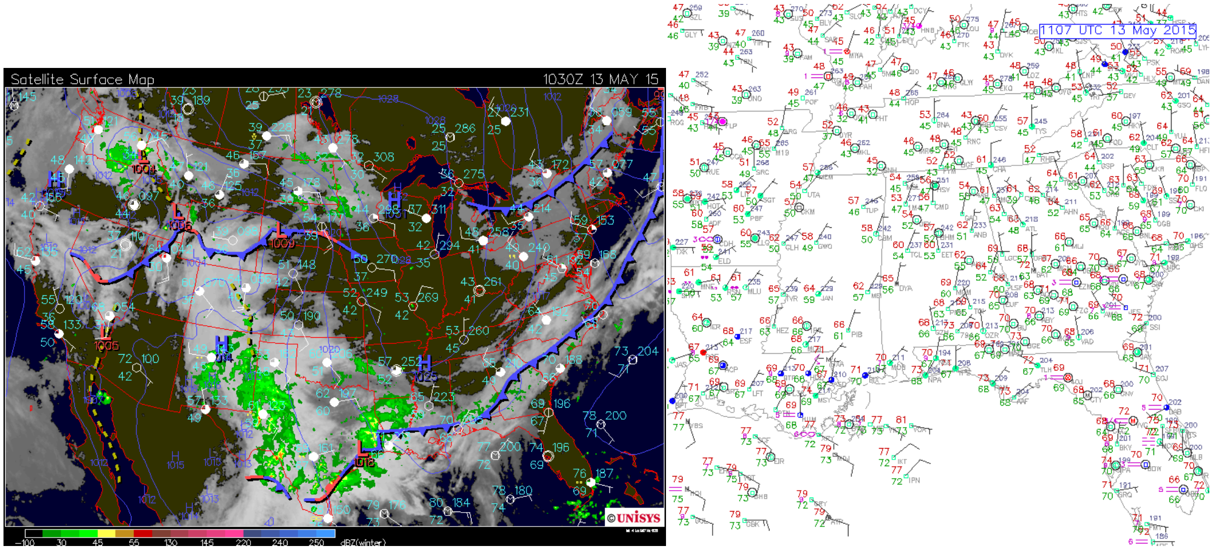


Figure 77. Wind Conditions, May 2015

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.

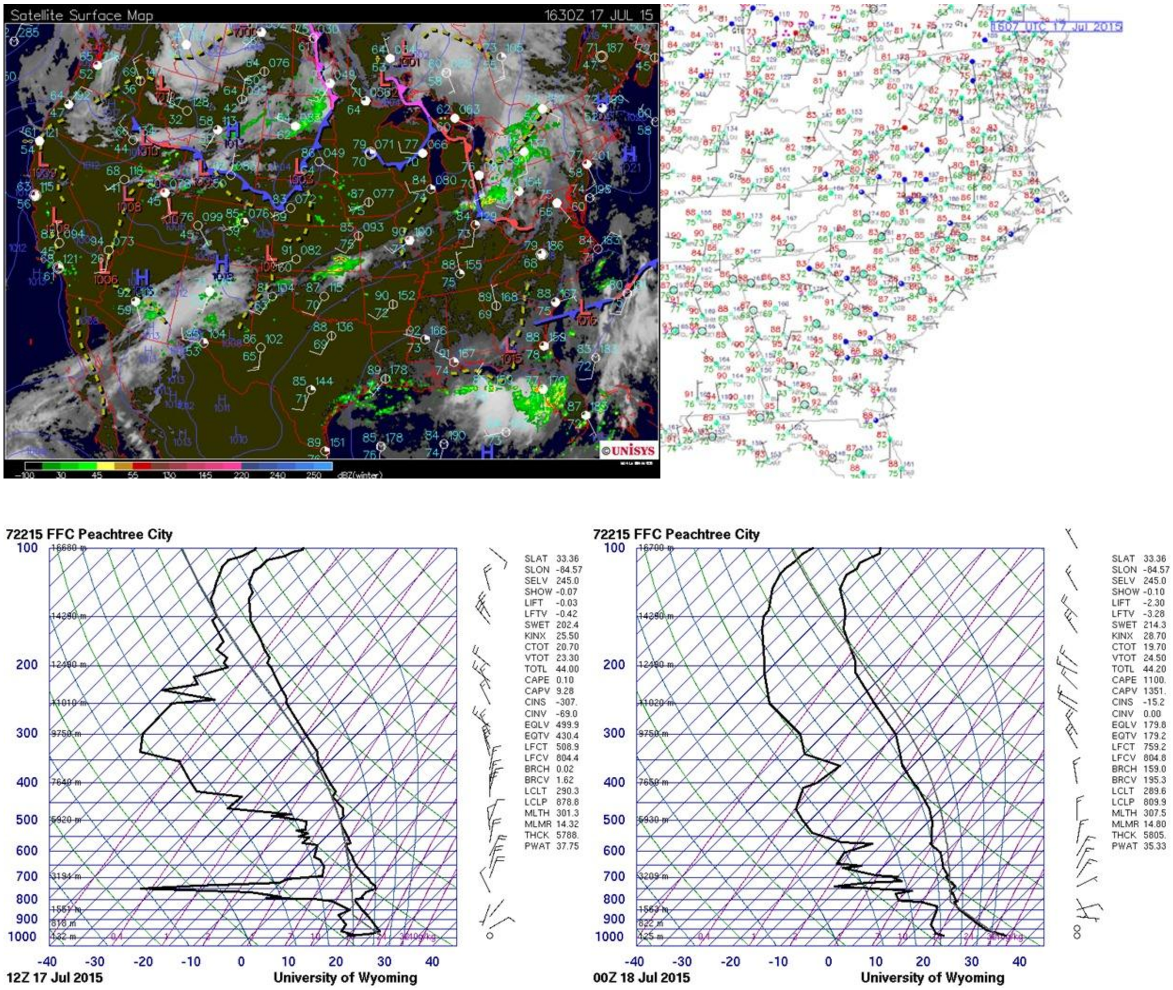


Figure 78. Wind conditions, July 17, 2015

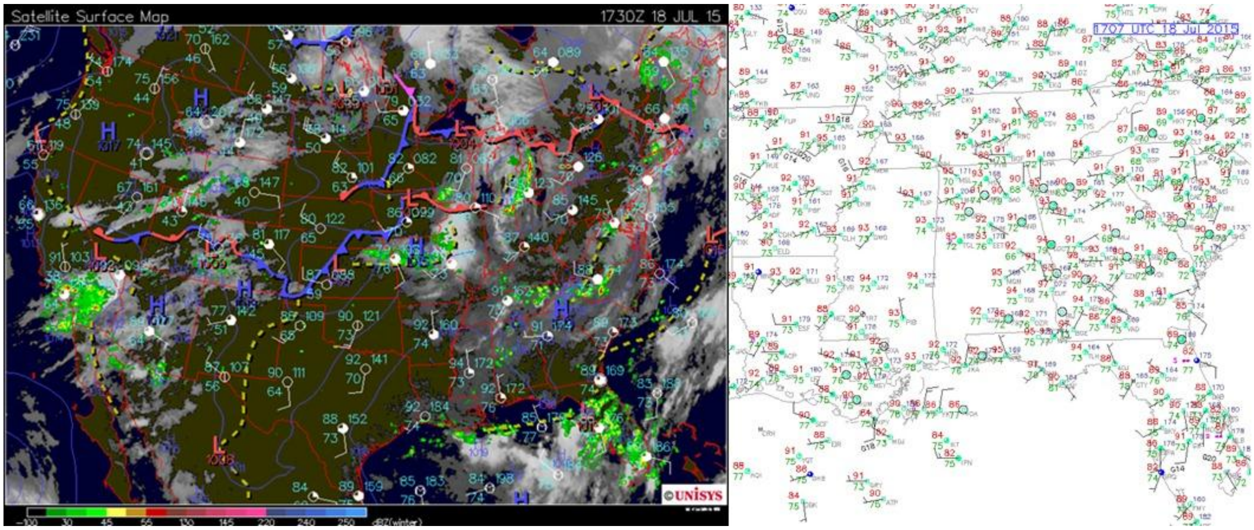


Figure 79. Wind conditions, July 18, 2015

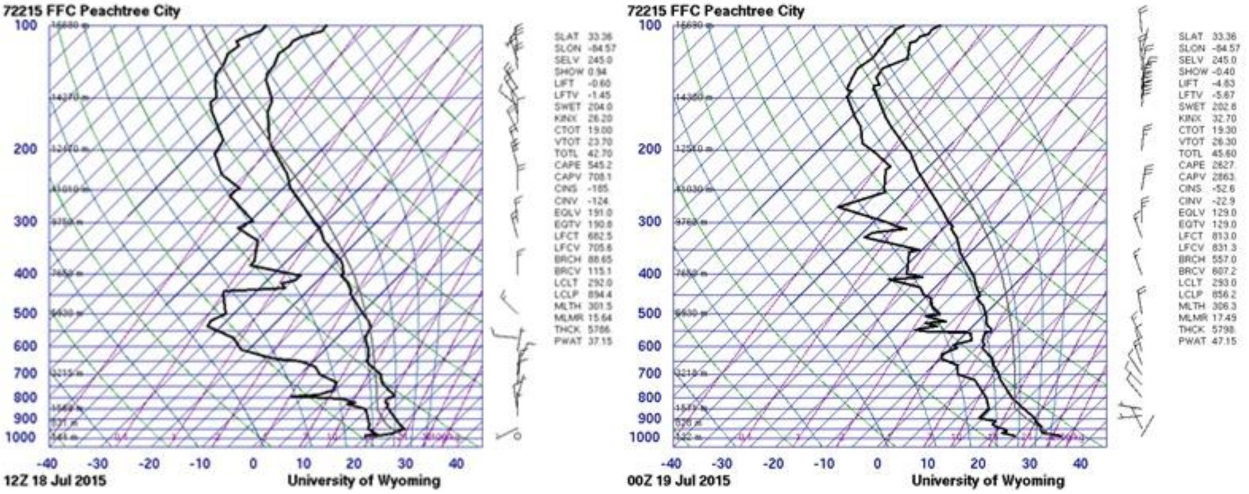


Figure 79. Wind conditions, July 18, 2015 (continued)

STASTICAL ANALYSIS OF FORECASTING

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, AIRS parameter code 44201) and preliminary and final PM (daily 24-hour average, AIRS 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 both 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:

		Observed # of days in AQI category			
Metro Area and Pollutant	**Total # of days in record**	**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:

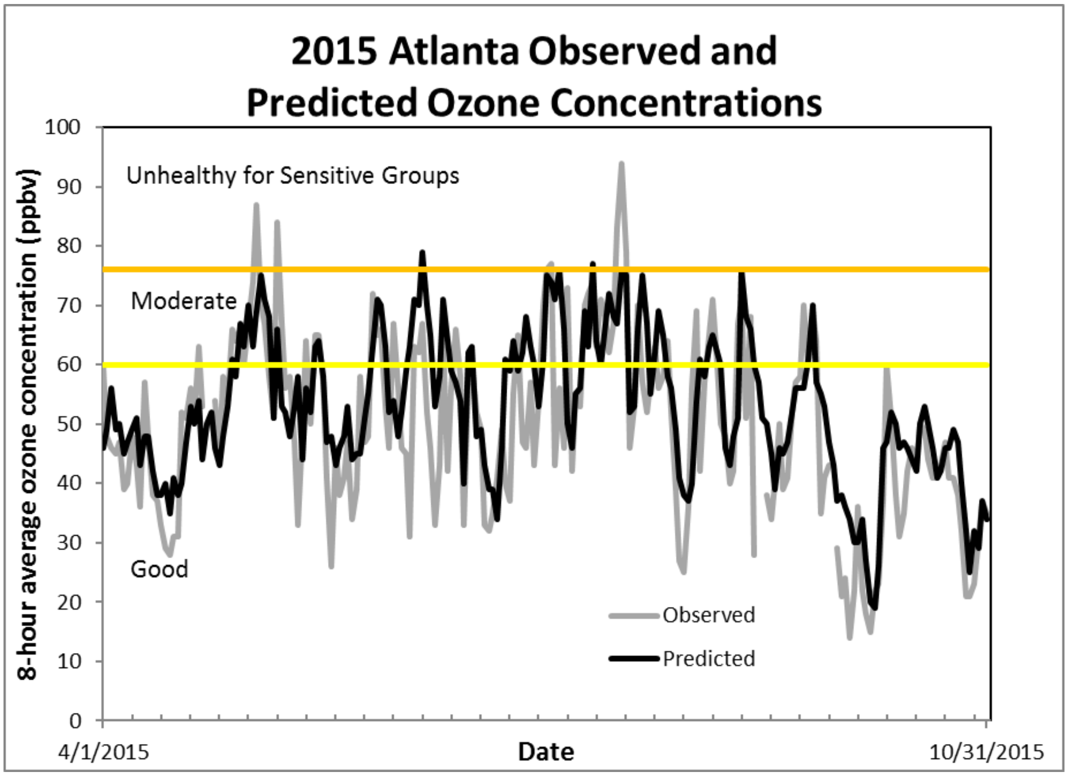


Figure 80. Atlanta observed and predicted ozone, 2015

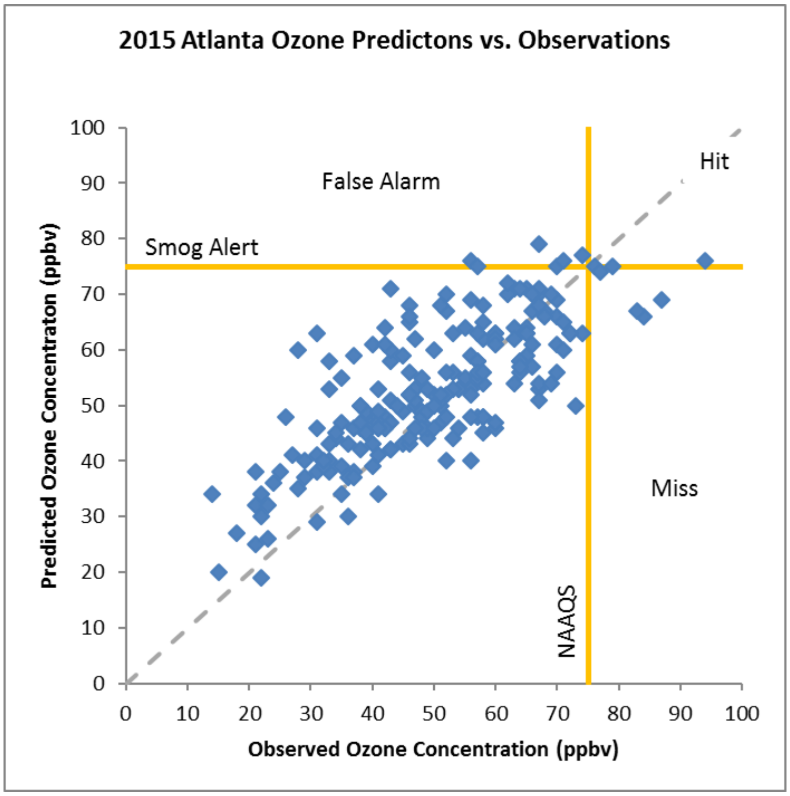


Figure 81. Atlanta observed vs. predicted ozone, 2015

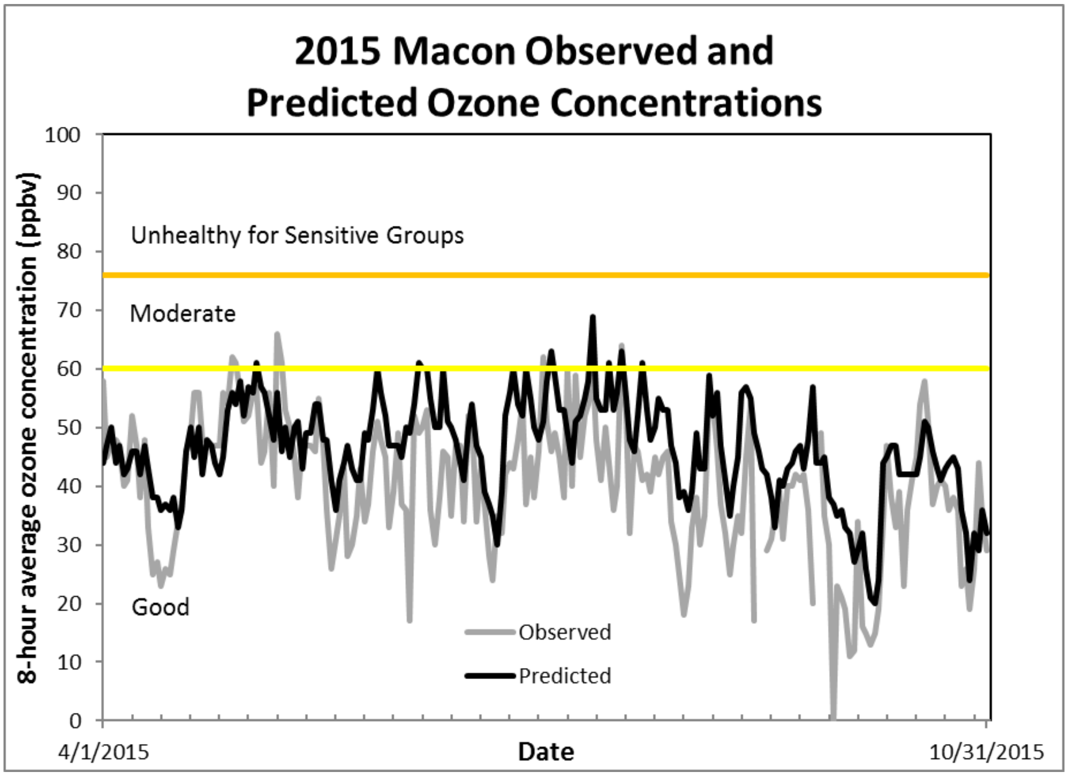


Figure 82. Macon observed and predicted ozone, 2015

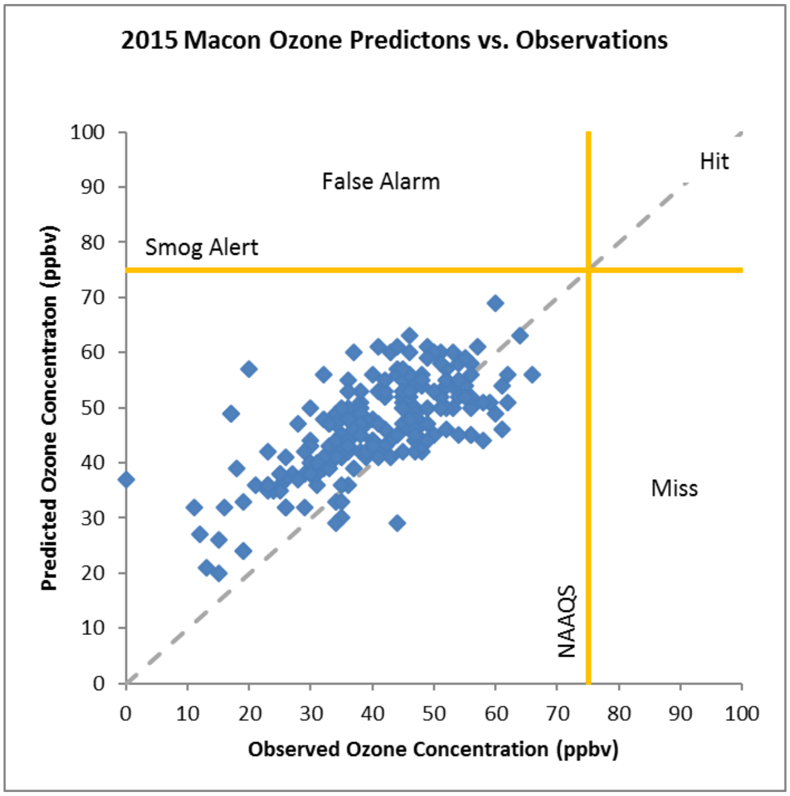


Figure 83. Macon ozone predictions vs. observations, 2015

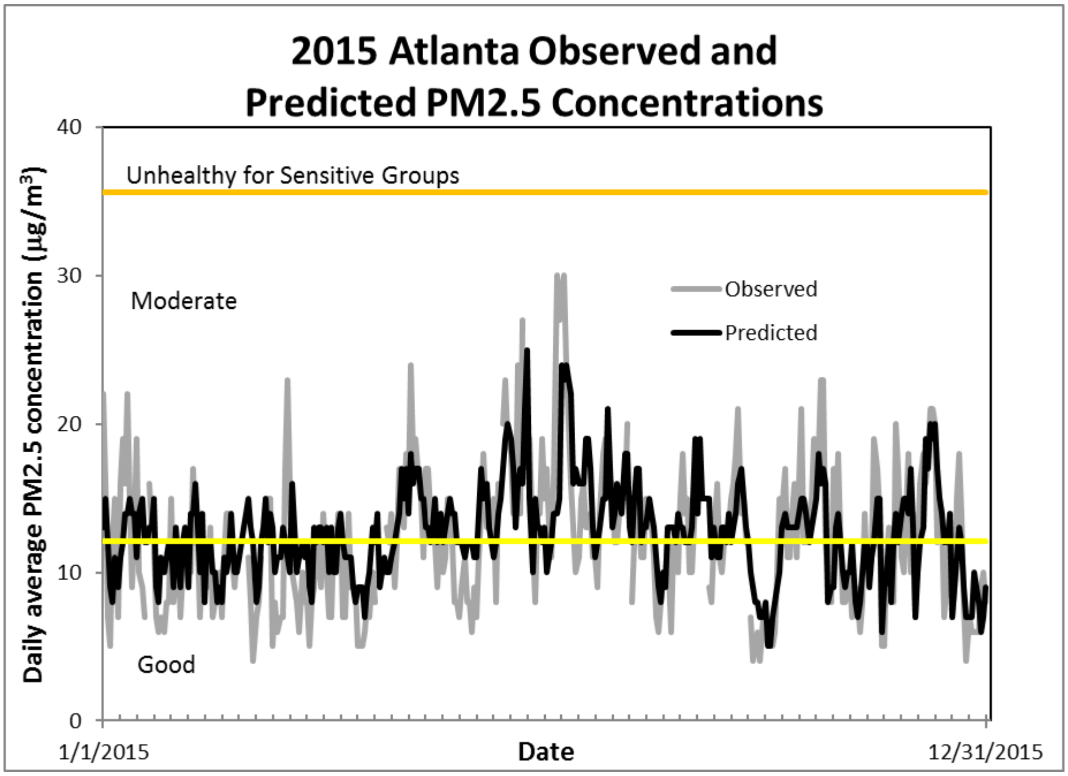


Figure 84. Atlanta observed and predicted $PM_{2.5}$ concentrations, 2015

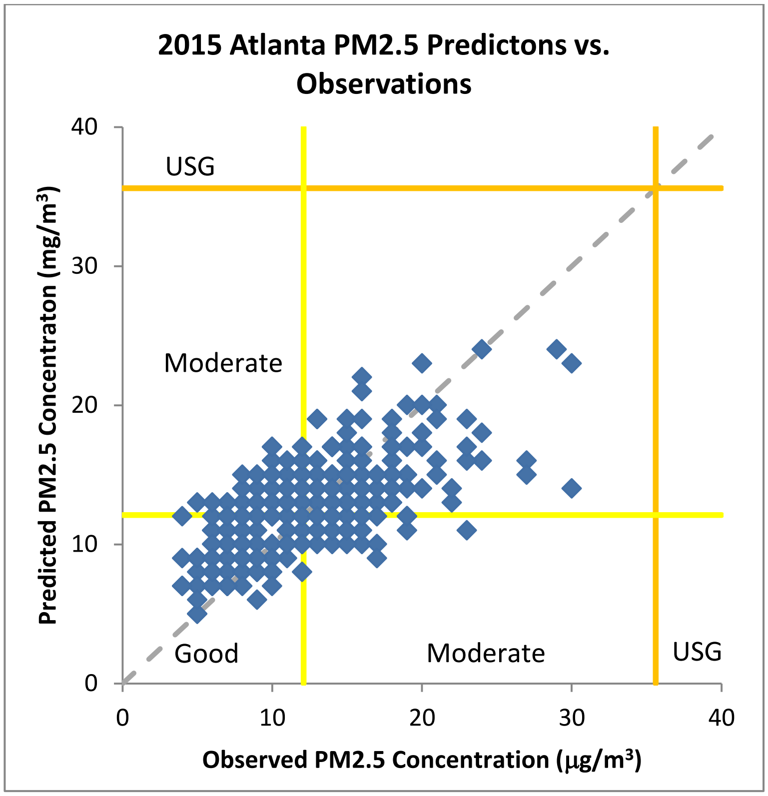


Figure 85. Atlanta $PM_{2.5}$ predictions vs. observations, 2015

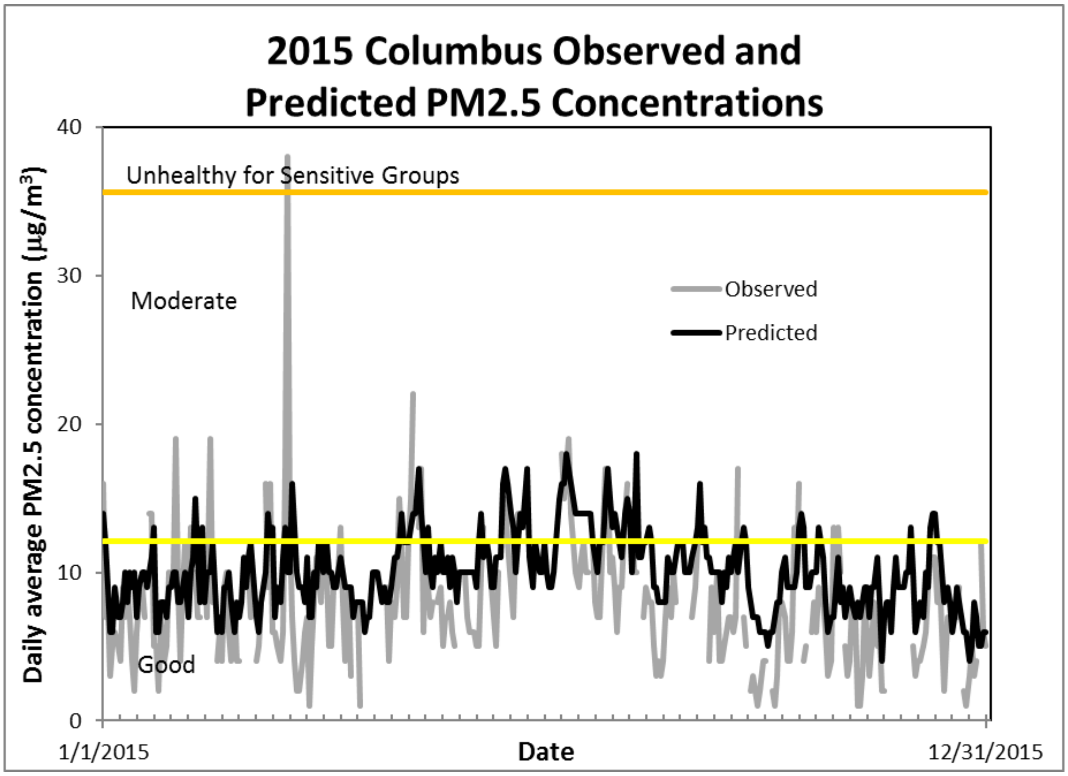


Figure 86. Columbus observed and predicted $PM_{2.5}$ concentrations, 2015

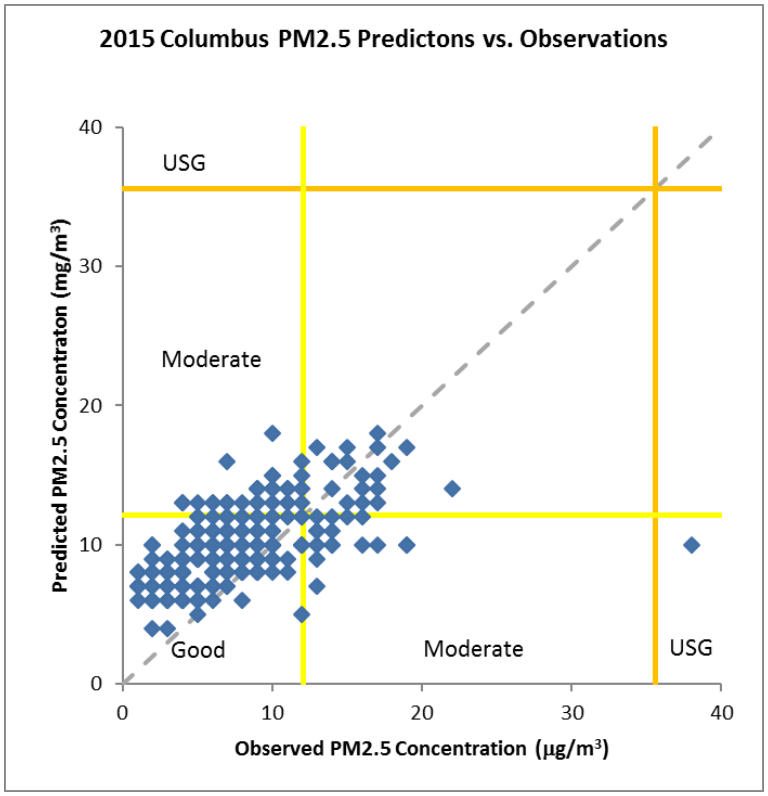


Figure 87. Columbus $PM_{2.5}$ predictions vs. observations, 2015

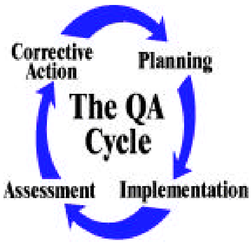
(Data compiled by Dr. Michael Chang of Georgia Tech)

QUALITY ASSURANCE

The purpose of this report is to provide ambient air quality users and the general public, with a summary of the quality of the 2015 ambient air monitoring data in quantifiable terms. It presents an overview of various quality assurance and quality control activities. The tables included in this report provide summary data for ambient air monitoring stations in the statewide network.

The Georgia Air Protection Branch mission is to promote and protect public health, welfare, and ecological resources through effective and efficient reduction of air pollutants while recognizing and considering the effects on the economy of the state. The Ambient Air Monitoring Program provides a key element of that mission through collecting and reporting quality information on a large number of pollutants and for a vast air monitoring network. Data from these monitoring sources provide the means to determine the nature of the pollution problem and assess the effectiveness of the control measures and programs.

It is the goal of the Ambient Monitoring Program to provide accurate, relevant, and timely measurements of air pollutants and their precursors associated with the corresponding meteorological data to support Georgia's Air Protection Branch for the protection of environment and public health. The Quality Assurance Unit conducts various quality assurance activities to ensure that data collected comply with procedures and regulations set forth by the U.S. EPA and can be considered good quality data and data for record.



What is quality assurance? Quality assurance is an integrated system of management activities that involves planning, implementing, assessing, and assuring data quality through a process, item, or service that meets users needs for quality, completeness, representativeness and usefulness. Known data quality enables users to make judgment about compliance with quality standards, air quality trends and health effects based on sound data with a known level of confidence. The objective of quality assurance is to provide accurate and precise data, minimize data loss due to malfunctions, and to assess the validity of the air monitoring data to provide representative and comparable data of known precision and accuracy.

Quality assurance (QA) is composed of two activities: quality control and quality assessment. Quality control (QC) is composed of a set of internal tasks performed routinely at the instrument level that ensures accurate and precise measured ambient air quality data. Quality control tasks address sample collection, handling, analysis, and reporting. Examples include calibrations, routine service checks, chain-of-custody documentation, duplicate analysis, development and maintenance of standard operating procedures, and routine preparation of quality control reports.

Quality assessment is a set of external, quantitative tasks that provide certainty that the quality control system is satisfactory and that the stated quantitative programmatic objectives for air quality data are indeed met. Staff independent of those generating data perform these external tasks. Tasks include conducting regular performance audits, on-site system audits, inter-laboratory comparisons, and periodic evaluations of internal quality control data. Performance audits ascertain whether the samplers are operating within the specified limits as stated in the Standard Operating Procedures (SOPs). Table 5 illustrates the types of performance audits performed by the QA Unit in 2015. Field and laboratory performance audits are the most common. System audits are performed on an as-needed basis or by request. Whole air sample comparisons are conducted for the toxic air contaminants and non-methane hydrocarbons.

Table 5. Audits performed for each air monitoring program in 2015

Air Monitoring Program	Field Performance Audit	Laboratory Performance Audit	Performance Audit	Whole Air Audit
Gaseous Pollutants	X	X	X	
Particulate Matter	X	X	X	
Air Toxic Contaminants	X	X		X
Non-Methane Hydrocarbons	X	X	X	X
Meteorology	X		X	

QUALITY CONTROL AND QUALITY ASSESSMENT

The Quality Assurance Unit supports all ambient air monitoring programs undertaken by Georgia EPD, which in 2015 includes gaseous pollutants, particulate pollutants, air toxics contaminants, non-methane hydrocarbons and meteorological sensors run by the Ambient Monitoring Program. In 2015, 42 air monitoring sites operated in Georgia (see Table 2 on pages 5-6 for details). Appendix E of this document provides information about the air monitoring network (i.e., sampling schedules, number of instruments, collection/analysis method, etc.). The air quality monitors collect data in both real-time and on a time integrated basis. The data is used to define the nature, extent, and trends of air quality in the state; to support programs required by state and federal laws; and to track progress in attaining air quality standards. The precision and accuracy necessary depends on how the data will be used. Data that must meet specific requirements (i.e., criteria pollutants) are referred to as *controlled data sets*. Criteria for the accuracy, precision, completeness, and sensitivity of the measurement in controlled data sets must be met and documented. The process by which one determines the quality of data needed to meet the monitoring objective is sometimes referred to as the Data Quality Objectives Process. Data quality indicators associated with measurement uncertainty include:

Precision: A measurement of mutual agreement among individual measurements of the same property usually under prescribed similar conditions, expressed generally in terms of the standard deviation.

Bias: The systematic or persistent distortion of a measurement process, which causes errors in one direction.

Accuracy: The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (imprecision) and systematic error (bias) components that are due to sampling and analytical operations.

Completeness: A measure of the amount of valid data obtained from a measurement system compared to the amount that is expected to be obtained under correct, normal conditions.

Detectability: The low critical range value of a characteristic that a method specific procedure can reliably discern.

Data without formal data quality objectives (i.e., GA EPD’s air toxics network) are called *descriptive data sets*. The data quality measurements are made as accurately as possible in consideration of how the data are being used. Quantified quality assessment results describe the measurement variability in standard terminology, but no effort is made to confine the data set to values within a predetermined quality limit.

The Georgia Ambient Air Monitoring Program's (AAMP) Quality Assurance Program is outlined in a five-volume *Quality Assurance Manual* provided by EPA. The volumes, listed below, guide the operation of the quality assurance programs used by the AAMP.

Volume I: Quality Assurance Plan
Volume II: Standard Operating Procedures for Air Quality Monitoring
Volume III: Laboratory Standard Operating Procedures
Volume IV: Monitoring Methods for the State Ambient Air Quality standards
Volume V: Audit Procedures for Air Quality Monitoring

Volume I lists the data quality objectives and describes quality control and quality assessment activities used to ensure that the data quality objectives are met.

Sampling Cone

GASEOUS POLLUTANTS

Ambient concentrations of carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), and sulfur dioxide (SO_2) are continuously monitored by an automated network of stations run by the Georgia Ambient Air Monitoring Program. Exposure to these pollutants may cause adverse health effects such as: respiratory impairment, fatigue, permanent lung damage, and increased susceptibility to infection in the general population. Gaseous criteria and non-criteria pollutant data are a controlled data set and are subject to meeting mandatory regulations.

Accuracy: Annually, EPA conducts field through-the-probe (TTP) performance audits for gaseous pollutants to verify the system accuracy of the automated methods and to ensure the integrity of the sampling system. Accuracy is represented as an average percent difference. The average percent difference is the combined differences from the certified value of all the individual audit points. The upper and lower probability limits represent the expected accuracy of 95 percent of all the single analyzer's individual percent differences for all audit test levels at a single site. Bias is the systematic or persistent distortion of a measurement process, which causes errors in one direction. Overall, the responses of the individual analyzers indicate that as a whole, the network is providing accurate data. Ninety-six percent of the gaseous pollutant instruments audited in 2015 were found to be operating within the Georgia Ambient Air Monitoring control limits (±15%). The tables below summarize the 2015 performance audit results for each gaseous pollutant.

Precision: On a weekly basis, site operators confirm the linear response of the instrument by performing zero, precision and span checks. The zero precision check confirms the instrument's ability to maintain a stable reading. The span precision check confirms the instrument's ability to respond to a known concentration of gas. The degree of variability in each of these weekly measurements is computed as the precision of that instrument's measurements.

Annually, the Quality Assurance Unit conducts a precision data analysis as an overall indicator of data quality. The analysis addresses three parameters: precision data submission, precision data validity, and a combination of the two referred to as data usability rates. The precision performance goal for all three parameters is 85%. The submission rate is the number of precision points submitted for a pollutant divided by the expected number of bi-weekly submissions. Data validity is the percent difference of the actual and indicated values of each precision check. These differences should not exceed ±15% for gaseous analyzers. Usable data rates are determined by multiplying the data submission and data validity rates that indicate the completeness of verifiable air quality data on the official database. The tables below show the Georgia annual Data Quality Assessment summary for the gaseous pollutants (NO, NO_2, NO_X, CO, SO_2, O_3).

Table 6. NO data quality assessment

NO Yearly Data Quality Assessment Summary												
Site Code	**Site Name**	**No. of Obs.**	**Precision CV (%)**	**Absolute Bias Estimate (%)**	**Validation of Bias**			**Annual Performance Evaluation Bias**				**Completeness (%)**
					Avg (%)	**95% LPL (%)**	**95% UPL (%)**	**No. of Obs.**	**Avg (%)**	**95% LPL (%)**	**95% UPL (%)**	
13-089-0002	Decatur - S. DeKalb	54	3.39	4.30	-3.63	-9.42	2.16	8	-4.01	-14.35	6.34	93%
13-223-0003	Yorkville - King's Farm	69	5.57	8.09	-6.88	-16.58	2.81	8	-4.56	-5.38	-3.57	92%
13-247-0001	Conyers - Monastery	57	5.78	5.02	-1.95	-11.91	7.95	8	-8.00	-12.06	-3.25	96%
13-121-0056	Atlanta - Georgia Tech	61	2.15	7.56	-6.57	-21.24	14.66	4	-6.68	-8.25	-5.11	96%
13-089-0003	Atlanta - DMRC	57	3.88	3.59	-1.69	-8.37	4.93	8	-0.46	-6.47	5.54	96%
Georgia Ambient Air Monitoring Program		298	3.01	5.85	-4.29	-11.93	3.35	28	-5.82	-18.42	6.78	94.6%

Table 7. NO_2 data quality assessment

NO_2 Yearly Data Quality Assessment Summary												
Site Code	**Site Name**	**No. of Obs.**	**Precision CV (%)**	**Absolute Bias Estimate (%)**	**Validation of Bias**			**Annual Performance Evaluation Bias**				**Completeness (%)**
					Avg (%)	**95% LPL (%)**	**95% UPL (%)**	**No. of Obs.**	**Avg (%)**	**95% LPL (%)**	**95% UPL (%)**	
13-089-0002	Decatur - S. DeKalb	60	5.94	5.04	-1.68	-11.92	8.55	8	-1.57	-3.47	0.32	93%
13-223-0003	Yorkville - King's Farm	61	7.26	6.37	3.03	-9.50	15.56	8	0.73	0.00	0.11	92%
13-247-0001	Conyers - Monastery	58	4.36	3.27	0.09	-7.39	7.58	8	-1.95	-14.13	8.07	96%
13-121-0056	Atlanta - Georgia Tech	61	5.78	5.73	3.35	-6.62	13.31	4	-3.48	-10.76	3.80	96%
13-089-0003	Atlanta DMRC	58	6.26	6.95	4.66	-6.10	15.42	8	0.00	0.00	0.00	96%
Georgia Ambient Air Monitoring Program		240	4.38	3.67	0.37	-9.27	10.01	28	-0.80	-7.85	6.25	94.6%

Table 8. NO_x data quality assessment

NO_x Yearly Data Quality Assessment Summary												
Site Code	**Site Name**	**No. of Obs.**	**Precision CV (%)**	**Absolute Bias Estimate (%)**	**Validation of Bias**			**Annual Performance Evaluation Bias**				**Completeness (%)**
					Avg (%)	**95% LPL (%)**	**95% UPL (%)**	**No. of Obs.**	**Avg (%)**	**95% LPL (%)**	**95% UPL (%)**	
13-089-0002	Decatur - S. DeKalb	54	3.87	3.38	-1.86	-8.48	4.76	8	3.55	-4.24	11.34	93%
13-223-0003	Yorkville - King's Farm	69	4.97	5.54	-4.17	-12.81	4.47	8	5.29	3.80	6.79	92%
13-247-0001	Conyers - Monastery	57	5.16	4.40	1.27	-7.58	10.13	8	-4.72	-9.50	0.07	96%
13-121-0056	Atlanta - Georgia Tech	61	5.78	4.80	-2.69	-12.66	7.29	4	-9.39	-12.42	-6.35	96%
13-089-0003	Atlanta DMRC	58	4.05	3.46	-0.46	-7.39	6.52	8	-0.25	-1.12	0.61	96%
Georgia Ambient Air Monitoring Program		241	3.51	3.38	-1.31	-10.73	8.11	28	1.18	-4.17	6.53	94.6%

Table 9. CO data quality assessment

CO Yearly Data Quality Assessment Summary												
Site Code	**Site Name**	**No. of Obs.**	**Precision CV (%)**	**Absolute Bias Estimate (%)**	**Validation of Bias**			**Annual Performance Evaluation Bias**				**Completeness (%)**
					Avg (%)	**95% LPL (%)**	**95% UPL (%)**	**No. of Obs.**	**Avg (%)**	**95% LPL (%)**	**95% UPL (%)**	
13-121-0056	Georgia Tech	61	4.26	5.21	4.29	0.00	11.75	9	0.12	-0.27	0.50	98
13-223-0003	Yorkville - King's Farm	52	4.05	3.43	-1.52	-9.05	4.75	3	-7.14	-0.80	0.80	94
13-089-0002	Decatur-South DeKalb	55	8.01	5.82	-3.36	-16.49	10.94	6	1.35	-7.13	9.83	97
Georgia Ambient Air Monitoring Program		168	8.06	7.22	-0.02	-6.59	6.55	18	-1.13	-1.63	-0.63	97.7%

Table 10. SO_2 data quality assessment

SO_2 Yearly Data Quality Assessment Summary												
Site Code	**Site Name**	**No. of Obs.**	**Precision CV (%)**	**Absolute Bias Estimate (%)**	**Validation of Bias**			**Annual Performance Evaluation Bias**				**Completeness (%)**
					Avg (%)	**95% LPL (%)**	**95% UPL (%)**	**No. of Obs.**	**Avg (%)**	**95% LPL (%)**	**95% UPL (%)**	
13-021-0012	Macon - Forestry	59	2.73	3.18	-2.55	-7.25	2.14	8	4.44	-17.93	15.16	98%
13-051-0021	Savannah - East President St.	50	1.79	2.27	-1.77	-4.81	1.27	4	-3.97	-6.70	-1.23	98%
13-051-1002	Savannah - L & A	57	2.22	1.98	-0.81	-4.63	3.01	8	2.94	1.71	4.18	99%
13-215-0008	Augusta-Bungalow	58	2.43	3.26	2.70	-1.51	6.84	4	4.62	3.77	5.46	98%
13-115-0003	Rome - Coosa Elementary	50	2.07	3.11	-2.68	-6.19	0.84	4	2.13	-0.37	4.63	90%
13-121-0055	Atlanta - Confederate Ave.	57	2.71	2.02	-0.57	-5.22	4.08	4	0.63	-1.34	2.61	96%
13-089-0002	Atlanta-South DeKalb	59	3.25	2.97	-1.80	-7.58	3.62	4	3.55	-11.82	18.92	96%
Georgia Ambient Air Monitoring Program		390	2.92	3.17	-1.21	-5.92	2.91	36	2.42	-5.85	10.68	96.4%

Table 11. O_3 data quality assessment

O_3 Yearly Data Quality Assessment Summary												
Site Code	**Site Name**	**No. of Obs.**	**Precision Estimate CV (%)**	**Absolute Bias Estimate (%)**	**Validation of Bias**			**Annual Performance Evaluation Bias**				**Completeness (%)**
					Avg (%)	**95% LPL (%)**	**95% UPL (%)**	**No. of Obs.**	**Avg (%)**	**95% LPL (%)**	**95% UPL (%)**	
13-021-0012	Macon - Forestry	35	1.43	0.97	0.01	-2.34	2.35	4	-0.60	-1.68	0.47	99%
13-051-0021	Savannah - East President St.	37	3.27	2.44	0.26	-5.32	5.50	4	2.11	-1.39	5.61	98%
13-055-0001	Summerville - DNR Fish Hatchery	30	2.84	2.49	-0.86	-5.45	3.73	4	3.80	2.74	4.85	99%
13-059-0002	Athens - Fire Station 7	34	2.78	2.33	1.00	-3.55	5.55	4	-2.50	-7.62	2.61	93%
13-067-0003	Kennesaw - Georgia National Guard	34	1.56	1.77	-1.24	-3.79	1.32	4	1.38	0.78	1.97	96%
13-073-0001	Evans - Riverside Park	35	1.02	0.70	-0.46	-2.13	1.21	4	-1.30	-1.92	-0.68	98%
13-077-0002	Newnan - University of West Georgia	39	4.83	3.62	0.38	-7.68	8.40	4	0.37	-6.97	7.71	96%
13-085-0001	Dawsonville - Georgia Forestry	35	3.80	3.26	-1.54	-7.79	4.70	4	2.25	-0.66	5.16	98%
13-089-0002	Decatur - South DeKalb	60	1.52	1.85	-2.26	-4.18	1.04	4	-4.00	-6.83	-1.17	97%
13-097-0004	Douglasville - West Strickland Street	37	1.52	1.09	-0.17	-2.67	2.35	4	-2.44	-3.93	-0.96	97%
13-121-0055	Atlanta - Confederate Ave.	35	2.31	1.87	0.47	-3.32	4.27	4	2.63	0.19	5.06	99%
13-127-0006	Brunswick - Risley School	35	2.63	2.00	0.40	-3.92	4.72	4	2.12	-3.14	7.37	99%
13-135-0002	Lawrenceville - Gwinnett Tech	35	1.54	1.14	-0.29	-2.83	2.26	4	3.97	-6.42	14.36	99%
13-151-0002	McDonough - County Extension Office	36	1.35	0.88	0.06	-2.16	2.28	4	-1.84	-6.61	2.93	98%
13-213-0003	Chatsworth - Fort Mountain	36	1.26	1.70	1.31	-0.75	3.42	4	0.25	-0.89	1.39	98%
13-215-0008	Columbus - Airport	36	1.62	2.40	-2.01	-4.69	0.66	4	-0.75	-5.86	4.36	90%
13-223-0003	Yorkville - King's Farm	33	2.20	1.86	0.36	-3.23	3.96	4	-1.37	-4.33	1.58	98%
13-245-0091	Augusta - Bungalow Rd.	38	2.43	1.66	0.12	-3.97	4.08	4	1.63	-5.27	8.54	98%
13-247-0001	Conyers - Monastery	36	1.94	1.67	0.67	-2.70	3.70	4	2.00	-5.86	9.86	99%
13-261-1001	Leslie - Union High School	36	1.96	1.69	1.14	-2.09	4.36	4	-0.75	-1.45	-0.05	99%
Georgia Ambient Air Monitoring Program		732	2.18	1.87	-0.19	-4.11	3.72	80	0.35	-4.26	4.95	97.2%

PARTICULATE MATTER

Particulate matter is a mixture of substances that include elements such as carbon, metals, nitrates, organic compounds and sulfates; complex mixtures such as diesel exhaust and soil. Particles with an aerodynamic diameter of 10 microns or smaller pose an increased health risk because they can deposit deep in the lung and contain substances that are particularly harmful to human health. Respirable particulate matter (PM_{10}) and fine particulate matter ($PM_{2.5}$) increase the chance of respiratory disease, lung damage, cancer, and premature death.

Particulate matter monitoring is conducted using both manual and continuous type samplers. Manual samplers are operated on a six-day sampling schedule for PM_{10}, and a similar, or more frequent schedule, for $PM_{2.5}$. The Georgia Ambient Monitoring particulate program also includes total suspended particulates (TSP), sulfate, mass and lead monitoring. Particulate matter is a controlled data set, and as such is subject to formal data quality objectives and federal and state regulations.

Accuracy (field): The accuracy of particulate samplers is determined by comparing the instrument's flow rate to a certified variable orifice (PM_{10} and TSP), or a calibrated mass flow meter (TEOM, BAM, and $PM_{2.5}$ samplers) that is certified against a National Institute of Standards and Technology (NIST) traceable flow device or calibrator. Since an accurate measurement of particulate matter is dependent upon flow rate, the Ambient Monitoring Program conducts semi-annual flow rate audits at each site. The average percent difference between the sampler flow rates and the audit flow rates represents the combined differences from the certified value of all the individual audit points for each sampler. The upper and lower probability limits represent the expected flow rate accuracy for 95 percent of all the single analyzer’s individual percent differences for all audit test levels at a single site.

Overall, the 2015 flow audit results indicate that the flow rates of samplers in the network are almost all within bounds. The 2015 $PM_{2.5}$ yearly data quality assessment summary of integrated and analyzation using federal reference method, the $PM_{2.5}$ yearly data quality assessment summary semi-continuous measurements, and the PM_{10} yearly data quality assessment summary of 24-hour integrated measurements and semi-continuous measurements are shown in the tables below.

Table 12. $PM_{2.5}$ data quality assessment for FRM samplers

$PM_{2.5}$ Yearly Data Quality Assessment Summary of Integrated Sampling and Analyzation Using Federal Reference Method												
Site Code	**Site Name**	**Collocated ($\mu g/m^3$)**		**One-Point Flow Rate Check (L/min)**				**Semi-Annual Flow Check (L/min) (Bias %)**				**Completeness (%)**
		No. of Obs.	**Precision Estimate CV (%)**	**No. of Obs.**	**Avg (%)**	**Absolute Bias (%)**	**Signed Bias (%)**	**No. of Obs.**	**Avg (%)**	**95% LPL (%)**	**95% UPL (%)**	
13-021-0007	Macon - Allied Chemical	24	0.71	24	-0.99	1.63	-1.63	4	-0.12	-0.54	0.30	89%
13-021-0012	Macon - Macon SE	NA	NA	25	-0.53	0.84	-0.84	2	-0.06	-1.22	1.10	100%
13-051-0091	Savannah - Mercer Jr. High School	NA	NA	24	-0.49	1.00	+/-1	2	0.85	-1.18	2.88	97%
13-059-0002	Athens - Fire Station 7	NA	NA	21	0.06	0.43	+/-0.43	2	0.15	-0.27	0.57	97%
13-063-0091	Forest Park - D.O.T.	NA	NA	24	-1.00	1.49	-1.49	2	-1.10	-1.50	-0.69	100%
13-067-0003	Kennesaw - National Guard	NA	NA	29	0.14	1.81	+/-1.81	2	-1.16	-2.21	-0.10	94%
13-089-0002	Decatur - South DeKalb	29	0.37	27	-1.11	1.40	-1.4	6	-0.66	-1.15	-0.16	98%
13-095-0007	Albany - Turner Elem. School	28	0.97	28	0.22	1.13	+/-1.13	6	1.56	-0.60	3.72	95%
13-115-0003	Rome - Coosa High School	NA	NA	22	0.27	0.63	+0.63	2	0.24	-0.26	0.74	92%
13-127-0006	Brunswick - Risley Middle Sch.	NA	NA	24	1.19	0.91	+0.91	2	1.25	-0.88	3.38	98%
13-135-0002	Lawrenceville - Gwinnett Tech	NA	NA	24	0.17	0.55	+/-0.55	2	0.00	-1.00	1.00	96%
13-139-0003	Gainesville - Fair St. Elem. Sch.	NA	NA	24	0.02	0.53	+/-0.53	2	0.21	-1.54	1.97	94%
13-153-0001	Warner Robins - Warner Robins	NA	NA	24	-1.17	2.04	-2.04	2	-0.74	-0.99	-0.50	93%
13-185-0003	Valdosta - S. L. Mason School	NA	NA	25	-0.24	0.61	-0.61	2	0.48	-0.19	1.15	95%
13-215-0001	Columbus - Health Department	NA	NA	29	-0.40	1.35	+/-1.35	2	0.56	-2.64	3.75	94%
13-215-0008	Columbus - Airport	NA	NA	27	-0.45	0.77	+/-0.77	2	0.11	-4.13	4.36	100%
13-215-0011	Columbus - Cussetta Rd. Sch.	NA	NA	27	-0.22	0.77	+/-0.77	2	-0.48	-1.30	0.35	94%
13-223-0003	Yorkville - King's Farm	NA	NA	24	1.88	2.14	+2.14	2	1.93	0.29	3.56	95%
13-245-0091	Augusta - Bungalow Rd. Sch.	NA	NA	24	-0.13	0.72	+/-0.72	2	1.93	-0.39	4.25	94%
13-295-0002	Rossville - Health Department	NA	NA	28	-0.42	1.13	+/-1.13	2	1.12	0.36	1.89	100%
13-303-0001	Sandersville - Health Department	NA	NA	25	-0.32	0.74	+/-0.74	2	1.15	-3.36	5.65	98%
13-319-0001	Gordon - Police Dept.	NA	NA	25	0.58	0.95	+/-0.95	2	-0.21	-0.79	0.37	95%
Georgia Ambient Air Monitoring Program		81	2.05	566	-0.15	1.08		56	0.31	-3.08	2.76	96%

Table 13. $PM_{2.5}$ data quality assessment for semi-continuous samplers

$PM_{2.5}$ Yearly Data Quality Assessment Summary of Semi-Continuous Measurements										
Site Code	**Site Name**	**One-Point Flow Rate Check (L/min)**				**Semi-Annual Flow Check (L/min) (Bias %)**				**Completeness (%)**
		No. of Obs.	**Avg (%)**	**Absolute Bias (%)**	**Signed Bias (%)**	**No. of Obs.**	**Avg (%)**	**95% LPL (%)**	**95% UPL (%)**	
13-021-0012	Macon - Macon SE	3	0.31	1.13	+1.13	3	-0.71	-2.12	0.70	96%
13-051-1002	Savannah - W. Lathrop & Augusta	2	5.10	5.35	+5.35	2	2.46	1.76	3.15	95%
13-059-0002	Athens - Fire Station 7	2	0.81	1.76	+1.76	2	-0.39	-1.13	0.35	96%
13-077-0002	Newnan - University of West Georgia	3	0.11	1.66	+/-1.66	2	0.82	-0.95	2.59	98%
13-121-0055	Atlanta - Confederate Ave.	3	0.13	5.74	+/-5.74	3	-0.38	-5.00	4.23	98%
13-135-0002	Lawrenceville - Gwinnett Tech	2	-0.39	0.60	-0.6	2	-0.21	-0.95	0.54	98%
13-151-0002	McDonough - County Extension	2	-0.59	4.33	-4.33	2	-0.36	-0.69	-0.03	99%
13-215-0008	Columbus - Airport	2	1.50	2.63	+2.63	2	-2.11	-4.18	-0.04	92%
13-223-0003	Yorkville - King's Farm	2	-1.37	2.05	-2.05	2	0.03	-0.55	0.61	98%
13-245-0091	Augusta - Bungalow Rd. Sch.	2	3.18	3.56	+3.56	2	-1.77	-2.25	-1.29	99%
13-185-0003	Valdosta - SL Mason	2	1.68	5.05	+5.05	2	-0.35	-2.33	1.62	96%
13-153-0001	Warner Robbins	2	-0.15	1.55	+/-1.55	2	-0.59	-2.90	1.72	92%
13-295-0002	Rossville	2	1.22	7.03	+7.03	2	-0.15	-0.23	-0.07	97%
13-115-0003	Rome-Coosa	12	-2.43	4.12	-4.12	2	0.30	-1.53	2.13	88%
13-139-0003	Gainesville - Boys and Girls Club	2	0.57	3.44	+3.44	2	0.81	0.74	0.88	82%
Georgia Ambient Air Monitoring Program		31	-0.13	4.92		30	-0.20	-3.64	2.73	95%

Table 14. PM_{10} data quality assessment of 24-hour integrated and semi-continuous samplers

PM_{10} Yearly Data Quality Assessment Summary of 24-Hour Integrated and Semi-Continuous Measurements												
Site Code	**Site Name**	**Collocated ($\mu g/m^3$)**		**One-Point Flow Rate Check (L/min)**				**Semi-Annual Flow Check (L/min)**				**Completeness (%)**
		No. of Obs.	**Precision Estimate CV (%)**	**No. of Obs.**	**Avg (%)**	**Absolute Bias (%)**	**Signed Bias (%)**	**No. of Obs.**	**Avg (%)**	**95% LPL (%)**	**95% UPL (%)**	
13-245-0091	Augusta - Bungalow Rd. Elem. School	21	7.34	4	-0.21	0.41	-0.41	4	1.03	0.04	2.02	75%
13-121-0039	Atlanta Fire Station #8	NA	NA	2	1.43	1.62	+1.62	2	0.82	0.39	1.24	97%
13-089-0002	Atlanta South DeKalb	NA	NA	2	0.25	2.27	+/-2.27	2	0.16	-1.93	2.24	96%
Georgia Ambient Air Monitoring Program		21	7.34	8	0.31	1.18		8	0.76	-1.38	2.90	89%
NA: Not Applicable												

Precision (field): Precision data for non-continuous particulate samplers is obtained through collocated sampling whereby two identical samplers are operated side-by-side and the same laboratory conducts filter analyses. Collocated samplers are located at selected sites and are intended to represent overall network precision. Validity of the data is based on the percent difference of the mass concentrations of the two samplers. In 2015 collocated $PM_{2.5}$ samplers were operated at Decatur-South DeKalb, Albany-Turner Elementary School, and Macon-Allied. Collocated PM_{10} samplers were operated at Augusta-Bungalow Road Elementary School site, and collocated TSP-Lead samplers were operated at Atlanta-DMRC site and Columbus-Fort Benning site.

Particulate samplers (collocated PM_{10} and TSP) must have mass concentrations greater than or equal to 3 $\mu g/m^3$ to be used in data validity calculations. The coefficient of variation cannot exceed 15%. TSP (lead) samplers must have both mass concentrations greater than or equal to 0.02 $\mu g/m^3$ to be used in data validity calculations. For collocated $PM_{2.5}$ samplers, data *probability limits* validity is based on the sampler's coefficient of variation, which cannot exceed 10%. Both sample masses must also be greater than 3 $\mu g/m^3$.

Precision for continuous $PM_{2.5}$ monitors is based on the comparison of the sampler's/analyzer's indicated and actual flow rates. The differences between the flow rates must be within ±10%.

Accuracy (lab): Annual performance audits for PM_{10} and $PM_{2.5}$ mass analysis programs include an on-site check and assessment of the filter weighing balance, relative humidity and temperature sensors, and their documentation. The performance audits conducted in 2015 found that the Ambient Monitoring Program was operating in accordance with U.S. EPA guidelines and that the data were of good quality and should be considered data-for-record.

Precision (lab): Laboratories perform various quality control tasks to ensure that quality data are produced. Tasks include duplicate weighing on exposed and unexposed filters, replicate analysis on every tenth filter, and a calibration of the balance before each weighing session. Upon receipt of particulate matter filters from the field, laboratory staff has up to 30 days (up to 10 days in summer) to analyze the PM_{10} and $PM_{2.5}$ samples. Filters are visually inspected for damage, loose material, poor workmanship, discoloration, non-uniformity, and irregularities, and are equilibrated in a controlled environment for a minimum of 24 hours prior to the filters being weighed. If room conditions are not within the established U.S. EPA control limits, weighing is done only after the proper environment is re-established and maintained for 24 hours.

In 2015, there were no occurrences in which the Georgia's Ambient Monitoring laboratory balance room was outside of control limits. The analytical precision results indicate that the Ambient Monitoring Program is providing precise particulate matter data. The tables below show the unexposed and exposed filter replicate results for the Air Protection Branch's (APB) laboratory in 2015.

Table 15. Summary of unexposed filter mass replicates 2015

QC Checks for Pre-weighed Filters	PM_{10}	$PM_{2.5}$
Total # of sample analyzed	150	6580
Total # of replicates	13	725
Total % replicated	8.6%	11.1%
Total # out-of-range	0	0

Source: Laboratory Section, Quality Control Report

Table 16. Summary of exposed filter mass replicates 2015

QC Checks for Post-weighed Filters	PM_{10}	$PM_{2.5}$
Total # of samples analyzed	138	5137
Total # of replicates	16	524
Total % replicated	11.6%	8.6%
Total # out-of-range	0	0

Source: Laboratory Section, Quality Control Report

AIR TOXICS

In 1996, the Air Protection Branch established an Air Toxics Network in major urban areas of the state to determine the average annual concentrations of air toxics. The program was established to assess the effectiveness of control measures in reducing air toxics exposures. Compounds identified as air toxics vaporize at ambient temperatures, play a critical role in the formation of ozone, and have adverse chronic and acute health effects. Sources of air toxics include motor vehicle exhaust, waste burning, gasoline marketing, industrial and consumer products, pesticides, industrial processes, degreasing operations, pharmaceutical manufacturing, and dry cleaning operations. Under the current air toxic sampling schedule, ambient air is collected in a stainless steel canister, on a quartz filter, and on a multi-layer cartridge every 12 days over a 24-hour sampling period at each of the network stations. Toxic particulate samples are collected and analyzed for air toxic contaminants to support the Georgia Air Toxic Network. By using a low-flow multi-channel sampler capable of sampling onto filters or cartridges, ambient air is collected and analyzed for carbonyls, polycyclic aromatic hydrocarbons (PAH) compounds (also called semi-volatile organic compounds or semi-VOCs), volatile organic compounds (VOCs), and toxic metals. The quality of the air toxic data set is governed by a series of quality assurance activities, including audits. The laboratory and monitoring staff are made aware of any exceedance found during an audit, and every effort is made to ensure that the data collected is as accurate as possible.

Flow audits of the toxic metal, VOCs, semi-VOCs and carbonyl samplers are conducted annually at each site to ensure the accuracy of measuring these compounds. Flow rates are a determining factor in calculating concentration and are included as part of the Quality Assurance Program. Although toxics data are a descriptive data set, completeness is issued based on the operating parameters of the sampler. Corrections are made to the samplers if an audit finds the sampler to be outside the Air Toxic Program control limits.

Precision (field and lab): As part of the Air Toxic Program laboratory analyses, internal QC techniques such as blanks, control samples, and duplicate samples are applied to ensure the precision of the analytical methods and that the toxics data are within statistical control.

Stainless steel canisters used to collect ambient air samples are also checked for contamination. Canisters are analyzed for aromatic and halogenated hydrocarbons. One canister per batch of eight is assayed to ensure individual compound measurements fall below the limit of detection. In the event a compound exceeds canister cleanliness criteria, the canister and all other canisters represented in the batch are re-cleaned until compounds meet the cleanliness criteria. In addition, Xontech 910A air samplers are checked for cleanliness. Failed air collection media are re-cleaned and re-tested until they pass Xontech 910A cleanliness criteria.

Accuracy (field): The accuracy of air toxic samples is determined by comparing the instrument's flow rate to a certified variable orifice, or a calibrated mass flow meter, that is certified against a National Institute of Standards and Technology (NIST) traceable flow device or calibrator. Since an accurate measurement of air toxics data is dependent upon flow rate, the Ambient Monitoring Program conducts annual flow rate audits at each site. The percent difference between the sampler flow rates and the audit flow rates is computed for each air toxics sampler.

NATTS

There are currently 187 hazardous air pollutants (HAPs), or air toxics, with emissions regulated under the Clean Air Act (CAA). These compounds have been associated with a wide variety of adverse human health and ecological effects, including cancer, neurological effects, reproductive effects, and developmental effects. According to the Government Performance Results Act (GPRA), the U.S. Environmental Protection Agency (U.S. EPA) is committed to reducing air toxics emissions by 75 percent from 1993 levels in order to significantly reduce Americans’ risk of cancer and of other serious health effects caused by airborne toxic chemicals. Early efforts toward this end have focused on emissions reductions through the assessment of technical feasibility. However, as new assessment tools are developed, more attention is being placed on the goal of risk reduction associated with exposure to air toxics.

To meet the GPRA goals, the National Air Toxics Trends Station (NATTS) network has been established, consisting of 27 stations nationwide, with one in Georgia. at 20 urban and 7 rural locations – which are representative of different parts of the country. NATTS monitoring was established at neighborhood-scale sites with preexisting $PM_{2.5}$ speciation sampling. Georgia has one NATTS site operating at the South DeKalb Monitoring Station. Having data of sufficient quality is paramount for a network such as the NATTS. As such, Georgia has closely followed the Quality System (QS) for the NATTS, established by U.S. EPA, two aspects of which are Technical Systems Audits (TSAs) and Instrument Performance Audits (IPAs) of each network station and its affiliated sample analysis laboratory. Another integral part of the QS is the quarterly analysis of performance evaluation (PE) samples. Furthermore, the sampling and analytical techniques selected to collect and quantify the air toxics of concern must demonstrate acceptable analytical and overall sampling precision, as well as suitable overall method detection limits that are compatible with expected ambient air toxics concentrations.

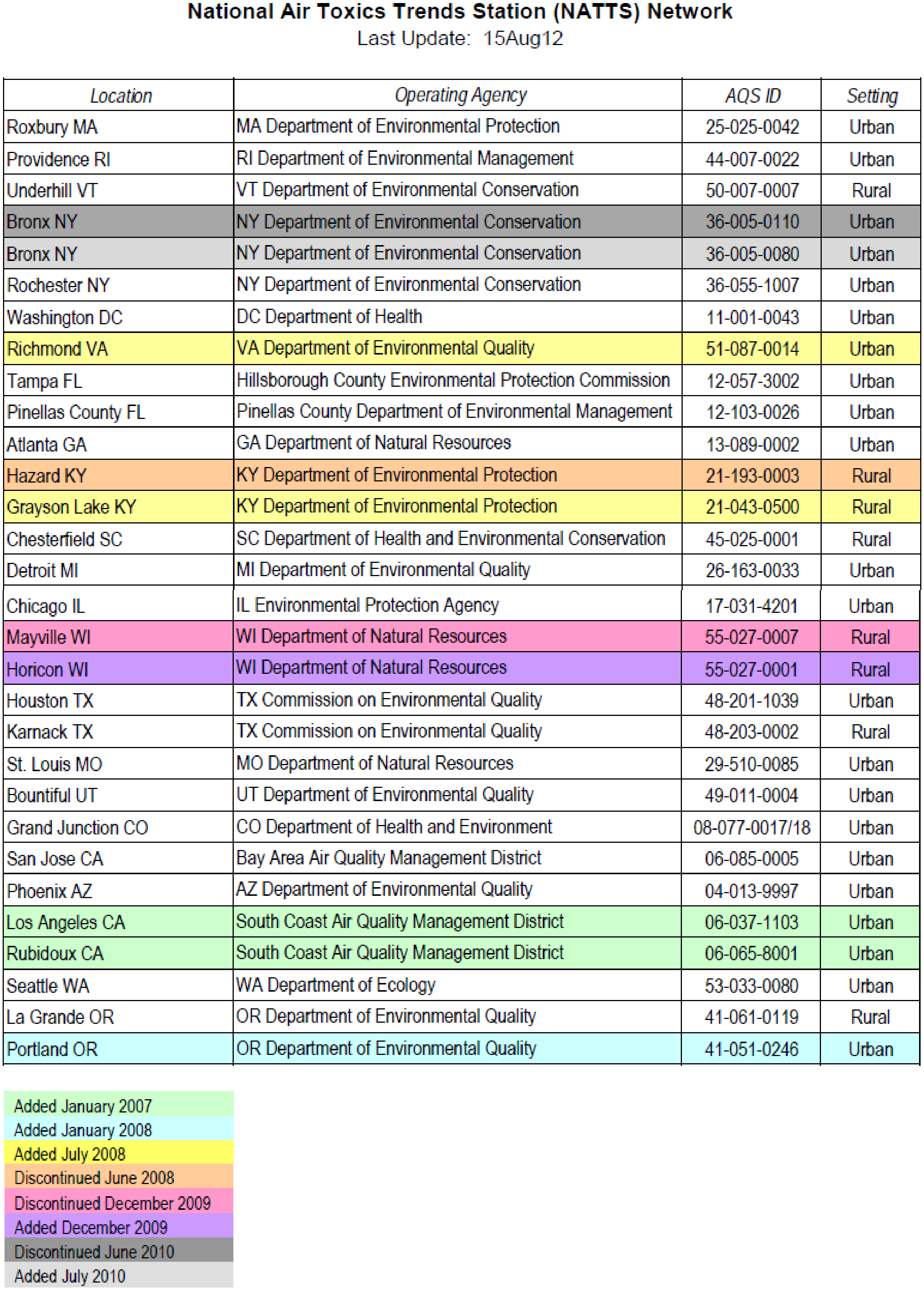
Measured Pollutants:
- Acrolein
- Benzene
- 1,3-Butadiene
- Carbon tetrachloride
- Chloroform
- Perchlorethlyene (Tetrachloroethylene)
- Trichloroethylene
- Vinyl chloride
- Acetaldehyde
- Formaldehyde
- Benzo (a) pyrene
- Naphthalene
- Arsenic compounds (PM10)
- Beryllium compounds (PM10)
- Cadmium compounds (PM10)
- Lead compounds (PM10)
- Manganese compounds (PM10)
- Nickel compounds (PM10)

GA EPD collects data to monitor for these compounds as part of the NATTS program, as well as organic carbon, additional carbonyls, additional volatile organic compounds, and polycyclic aromatic hydrocarbons (PAHs)

Georgia joined the network with one site established in Decatur at the South DeKalb Monitoring Station. The location of all sites, whether the site is located in an urban or rural area, the unique AQS identification code (site code), and current status for all the sites are given in

Table **17**. The list was taken from the U.S. EPA website, http://www.epa.gov/ttnamti1/natts.html.

Table 17. Current list of NATTS sites with AQS site codes



National Air Toxics Trends Station (NATTS) Network

Last Update: 15Aug12

Location	*Operating Agency*	*AQS ID*	*Setting*
Roxbury MA	MA Department of Environmental Protection	25-025-0042	Urban
Providence RI	RI Department of Environmental Management	44-007-0022	Urban
Underhill VT	VT Department of Environmental Conservation	50-007-0007	Rural
Bronx NY	NY Department of Environmental Conservation	36-005-0110	Urban
Bronx NY	NY Department of Environmental Conservation	36-005-0080	Urban
Rochester NY	NY Department of Environmental Conservation	36-055-1007	Urban
Washington DC	DC Department of Health	11-001-0043	Urban
Richmond VA	VA Department of Environmental Quality	51-087-0014	Urban
Tampa FL	Hillsborough County Environmental Protection Commission	12-057-3002	Urban
Pinellas County FL	Pinellas County Department of Environmental Management	12-103-0026	Urban
Atlanta GA	GA Department of Natural Resources	13-089-0002	Urban
Hazard KY	KY Department of Environmental Protection	21-193-0003	Rural
Grayson Lake KY	KY Department of Environmental Protection	21-043-0500	Rural
Chesterfield SC	SC Department of Health and Environmental Conservation	45-025-0001	Rural
Detroit MI	MI Department of Environmental Quality	26-163-0033	Urban
Chicago IL	IL Environmental Protection Agency	17-031-4201	Urban
Mayville WI	WI Department of Natural Resources	55-027-0007	Rural
Horicon WI	WI Department of Natural Resources	55-027-0001	Rural
Houston TX	TX Commission on Environmental Quality	48-201-1039	Urban
Karnack TX	TX Commission on Environmental Quality	48-203-0002	Rural
St. Louis MO	MO Department of Natural Resources	29-510-0085	Urban
Bountiful UT	UT Department of Environmental Quality	49-011-0004	Urban
Grand Junction CO	CO Department of Health and Environment	08-077-0017/18	Urban
San Jose CA	Bay Area Air Quality Management District	06-085-0005	Urban
Phoenix AZ	AZ Department of Environmental Quality	04-013-9997	Urban
Los Angeles CA	South Coast Air Quality Management District	06-037-1103	Urban
Rubidoux CA	South Coast Air Quality Management District	06-065-8001	Urban
Seattle WA	WA Department of Ecology	53-033-0080	Urban
La Grande OR	OR Department of Environmental Quality	41-061-0119	Rural
Portland OR	OR Department of Environmental Quality	41-051-0246	Urban

Added January 2007
Added January 2008
Added July 2008
Discontinued June 2008
Discontinued December 2009
Added December 2009
Discontinued June 2010
Added July 2010

(Source: http://www.epa.gov/ttnamti1/natts.html)

Several Measurement Quality Objectives (MQOs) have been established for the NATTS network in order to ensure that only data of the highest quality are collected by the NATTS network, and to meet the NATTS Data Quality Objective (DQO): "to be able to detect a 15 percent difference (trend) between two consecutive 3-year annual mean concentrations within acceptable levels of decision error" (U.S. EPA, 1994b). Initially, the four compounds of primary importance to the NATTS program were benzene, 1,3-butadiene, formaldehyde, and PM_{10} arsenic. The Data Quality Objective MQOs for these four compounds are summarized in Table 18 below.

Table 18. Measurement quality objectives for the NATTS program

Compound	Completeness	Precision (Coefficient of Variation)	Laboratory Bias	Method Detection Limit (MDL)
Benzene	> 85 %	< 15 %	< 25 %	0.044 µg/m^3
1,3-Butadiene	> 85 %	< 15 %	< 25 %	0.020 µg/m^3
Formaldehyde	> 85 %	< 15 %	< 25 %	0.014 µg/m^3
Arsenic	> 85 %	< 15 %	< 25 %	0.046 ng/m^3

The MQOs require that: (1) sampling occurs every sixth day and is successful 85 percent of the time; (2) precision as measured by the coefficient of variation (CV) be controlled to less than 15 percent; and (3) that laboratory (measurement) bias be less than 25 percent. Data acquired to assess compliance with the above stated MQOs are derived from a variety of sources. These sources are given in Table 19.

Table 19. MQO data sources for the Georgia NATTS program

Criteria	Data Source	MQO Limit
Completeness	Air Quality System (AQS)	< 15 %
Precision	AQS and Proficiency Testing	< 15 %
Bias - Laboratory	Proficiency Testing	< 25 %
Bias - Field	Audits of Sampler Flowrates	< 10 %
MDL	Laboratories	0.046 ng/m^3 to 0.044 µg/m^3

The Air Quality System (AQS) database contains raw data that is used to assess data completeness, and to estimate precision from results of replicate analyses and collocated sampling. In addition, results from the analysis of proficiency testing samples allow one to calculate laboratory precision and bias.

Completeness (of NATTS Data): The AQS database was accessed and the raw data records analyzed for 23 compounds. The completeness of the 2015 AQS dataset was assessed for three compounds: benzene, 1,3-butadiene, and arsenic. The results are shown in Table 20, on the next page. The percent completeness ranged from 83% to 97%, with sampling occurring every sixth day. Primary and collocated data are differentiated in AQS by use of parameter occurrence codes (POCs).

Table 20. Percent completeness of Georgia's 2015 AQS data, selected compounds

	Completeness of Compound by AQS Number and by Name		
	45201	**43218**	**82103**
Site	**benzene**	**1,3-butadiene**	**arsenic**
Decatur, GA	97%	97%	83%

PHOTOCHEMICAL ASSESSMENT MONITORING

Section 182(c)(1) of the 1990 Clean Air Act Amendments (CAAA) required the Administrator to promulgate rules for the enhanced monitoring of ozone, oxides of nitrogen (NOx), and volatile organic compounds (VOC) to obtain more comprehensive and representative data on ozone air pollution. Immediately following the promulgation of such rules, the affected States were to commence such actions as were necessary to adopt and implement a program to improve ambient monitoring activities and the monitoring of emissions of NOx and VOC. Each State Implementation Plan (SIP) for the affected areas must contain measures to implement the ambient monitoring of such air pollutants. The subsequent revisions to Title 40, Code of Federal Regulations, Part 58 (40 CFR 58) required States to establish Photochemical Assessment Monitoring Stations (PAMS) as part of their SIP monitoring networks in ozone nonattainment areas classified as serious, severe, or extreme.

The principal reasons for requiring the collection of additional ambient air pollutant and meteorological data are the lack of attainment of the National Ambient Air Quality Standard (NAAQS) for ozone nationwide, and the need for a more comprehensive air quality database for ozone and its precursors.

The chief objective of the enhanced ozone monitoring revisions is to provide an air quality database that will assist air pollution control agencies in evaluating, tracking the progress of, and, if necessary, refining control strategies for attaining the ozone NAAQS. Ambient concentrations of ozone and ozone precursors will be used to make attainment/nonattainment decisions, aid in tracking VOC and NOx emission inventory reductions, better characterize the nature and extent of the ozone problem, and prepare air quality trends. In addition, data from the PAMS will provide an improved database for evaluating photochemical model performance, especially for future control strategy mid-course corrections as part of the continuing air quality management process. The data will be particularly useful to States in ensuring the implementation of the most cost-effective regulatory controls.

Data Quality Objectives

Data Quality Objectives (DQOs) are statements that relate the quality of environmental measurements to the level of uncertainty that decision-makers are willing to accept for results derived from the data. It is never possible to be absolutely certain that a future data set will satisfy the data needs exactly. There is always a chance that variables, variation, and uncertainty beyond the program's control will lead to “softness" in the data and a resulting uncertainty that the subsequent decisions are appropriate. For example, it is not possible to be 100% certain that a downward trend in ozone concentration has been confirmed or denied, since it is possible that local meteorology unexpectedly affected the two highest-reading days, one way or the other. By carefully designing the equipment and schedules, however, it is possible to reduce to acceptable levels the possibility of making an erroneous call.

PAMS Target Parameters

The data collected at the PAMS sites include measurements of O_3, NO_x, and a target list of VOCs including several carbonyls, as well as surface and upper air meteorology. Most PAMS sites measure 56 target hydrocarbons on either an hourly or 3-hour basis during the O_3 season. The Type 2 sites also collect data on 3 carbonyl compounds (formaldehyde, acetaldehyde, and acetone) every three hours during the O_3 monitoring period. Included in the monitored VOC species are ten compounds classified as hazardous air pollutants (HAPs). All stations must measure O_3, NO_x, and surface meteorological parameters on an hourly basis. Below are the parameters monitored at the surface PAMS sites:

Ozone, nitrogen oxides, VOC sums

Ozone	44201
Nitric Acid	42601
Nitrogen Dioxide	42602
Oxides of Nitrogen	42603
Total NMOC	43102
Sum of Targeted HCs	43000

Surface Meteorological

Temperature	62101
Wind Speed	61101/3
Wind Direction	61102/4
Relative Humidity	62201
Solar Radiation	63301
UV Radiation	63302/4
Barometric Pressure	64101
Precipitation	65102

Hydrocarbons (HCs) - listed in elution sequence

Ethylene	43203
Acetylene	43206
Ethane	43202
Propylene	43205
Propane	43204
Isobutane	43214
1-Butene	43280
n-Butane	43212
t-2-Butene	43216
c-2-Butene	43217
Isopentane	43221
1-Pentene	43224
n-Pentane	43220
Isoprene	43243
t-2-pentene	43226
c-2-pentene	43227
2,2-Dimethylbutane	43244
Cyclopentane	43242
2,3-dimethylbutane	43284
2-methylpentane	43285
3-Methylpentane	43230
2-Methyl-1-Pentene	43246
n-hexane	43231
Methylcyclopentane	43262
2,4-dimethylpentane	43247
Benzene	45201
Cyclohexane	43248
2-methylhexane	43263
2,3-dimethylpentane	43291
3-methylhexane	43249
2,2,4-trimethylpentane	43250
n-Heptane	43232
Methylcyclohexane	43261
2,3,4-trimethylpentane	43252
Toluene	45202
2-methylheptane	43960
3-methylheptane	43253
n-Octane	43233
Ethylbenzene	45203
m&p-Xylenes	45109
Styrene	45220
o-Xylene	45204
n-Nonane	43235
Isopropylbenzene	45210
n-Propylbenzene	45209
m-Ethyltoluene	45212
p-Ethyltoluene	45213
1,3,5-Trimethylbenzene	45207
o-Ethyltoluene	45211
1,2,4-trimethylbenzene	45208
n-Decane	43238
1,2,3-trimethylbenzene	45225
m-Diethylbenzene	45218
p-Diethylbenzene	45219
n-Undecane	43954

Carbonyls	
Formaldehyde	43502
Acetone	43551
Acetaldehyde	43503

Accuracy (field and lab): Laboratory performance audits are conducted annually to assess the laboratory’s ability to measure ambient levels of hydrocarbons. Through-the-probe *sampler* performance audits are conducted semi-annually at each monitoring site to assess the integrity of the sampling, analysis, and transport system. The 2015 PAMS speciated VOCs yearly data quality assessment summary for the two PAMS sites on the tables below show that most results were within the PAMS’ control limits of ±20%.

Table 21. PAMS speciated VOCs yearly data quality assessment for South DeKalb

PAMS Speciated VOCs Yearly Data Quality Assessment Summary for Decatur - South DeKalb Site												
Parameter Code	**Parameter Name**	**2-Comp. Std. Weekly Check**			**Validation of Bias**			**Annual Perform, Evaluation Bias**				**Completeness (%)**
		No. of Obs.	**Precision Estimate CV (%)**	**Absolute Bias Estimate (%)**	**Avg (%)**	**95% LPL (%)**	**95% UPL (%)**	**No. of Obs.**	**Avg (%)**	**95% LPL (%)**	**95% UPL (%)**	
43202	Ethane+	NA	NA	NA	NA	NA	NA	3	-24.19	-38.30	-10.08	55%
43204	Propane*	3	18.65	15.91	-5.70	-17.57	6.17	3	-27.25	-45.31	-9.18	55%
43214	Isobutane+	NA	NA	NA	NA	NA	NA	3	-27.03	-36.01	-18.04	55%
43216	Trans-2-Butene+	NA	NA	NA	NA	NA	NA	3	-31.81	-37.35	-26.28	55%
43220	N-Pentane+	NA	NA	NA	NA	NA	NA	3	-18.76	-43.02	5.50	55%
43285	2-Methylpentane+	NA	NA	NA	NA	NA	NA	3	-27.54	-35.12	-19.96	55%
43243	Isoprene+	NA	NA	NA	NA	NA	NA	3	-43.05	-49.81	-36.30	55%
43231	N-Hexane+	NA	NA	NA	NA	NA	NA	3	-53.29	-84.19	-22.39	55%
45201	Benzene*	3	24.01	33.77	-20.64	-35.91	-5.36	3	-24.49	-34.78	-14.2	55%
43232	N-Heptane+	NA	NA	NA	NA	NA	NA	3	-18.67	-23.67	-13.66	55%
45202	Toluene+	NA	NA	NA	NA	NA	NA	3	-25.76	-32.5	-19.02	55%
45203	Ethylbenzene+	NA	NA	NA	NA	NA	NA	3	-22.06	-34.56	-9.56	55%
43238	N-Decane+	NA	NA	NA	NA	NA	NA	3	-12.50	-33.72	8.72	55%
45225	1,2,4-Trimethylbenzene+	NA	NA	NA	NA	NA	NA	3	3.95	-14.31	22.22	55%
* NIST traceable												
+ Only NIST traceable by weight												

Table 22. PAMS speciated VOCs yearly data quality assessment for Yorkville-King Farm

PAMS Speciated VOCs Yearly Data Quality Assessment Summary for Yorkville-King Farm												
Parameter Code	**Parameter Name**	**2-Comp. Std. Weekly Check**			**Validation of Bias**			**Annual Perform, Evaluation Bias**				**Completeness (%)**
		No. of Obs.	**Precision Estimate CV (%)**	**Absolute Bias Estimate (%)**	**Avg (%)**	**95% LPL (%)**	**95% UPL (%)**	**No. of Obs.**	**Avg (%)**	**95% LPL (%)**	**95% UPL (%)**	
43202	Ethane[+]	NA	NA	NA	NA	NA	NA	6	-3.01	-8.47	2.45	31%
43204	Propane[*]	5	5.31	5.46	2.89	-2.48	8.26	6	-8.59	-14.04	-3.14	31%
43214	Isobutane[+]	NA	NA	NA	NA	NA	NA	6	-5.95	-17.87	5.97	31%
43216	Trans-2-Butene[+]	NA	NA	NA	NA	NA	NA	6	-3.43	-7.83	0.97	31%
43220	N-Pentane[+]	NA	NA	NA	NA	NA	NA	6	4.93	-8.61	18.47	31%
43285	2-Methylpentane[+]	NA	NA	NA	NA	NA	NA	6	-9.01	-19.73	1.70	31%
43243	Isoprene[+]	NA	NA	NA	NA	NA	NA	6	-25.50	-50.02	-0.98	31%
43231	N-Hexane[+]	NA	NA	NA	NA	NA	NA	6	-39.92	-133.53	53.70	31%
45201	Benzene[*]	5	4.93	7.14	-4.71	-9.7	0.28	6	-8.69	-20.1	2.71	31%
43232	N-Heptane[+]	NA	NA	NA	NA	NA	NA	6	-1.32	-10.13	7.49	31%
45202	Toluene[+]	NA	NA	NA	NA	NA	NA	6	-6.54	-17.75	4.68	31%
45203	Ethylbenzene[+]	NA	NA	NA	NA	NA	NA	6	-6.66	-20.05	6.73	31%
43238	N-Decane[+]	NA	NA	NA	NA	NA	NA	6	1.22	-6.81	9.24	31%
45225	1,2,4-Trimethylbenzene[+]	NA	NA	NA	NA	NA	NA	6	2.06	-28.68	32.8	31%
* NIST traceable												
+ Only NIST traceable by weight												

Table 23. PAMS speciated VOCs yearly data quality assessment for Ambient Monitoring Program Summary

PAMS Speciated VOCs Yearly Data Quality Assessment for GA EPD Ambient Air Monitoring Program Summary												
Parameter Code	**Parameter Name**	**2-Comp. Std. Weekly Check**			**Validation of Bias**			**Annual Perform, Evaluation Bias**				**Completeness (%)**
		No. of Obs.	**Precision Estimate CV (%)**	**Absolute Bias Estimate (%)**	**Avg (%)**	**95% LPL (%)**	**95% UPL (%)**	**No. of Obs.**	**Avg (%)**	**95% LPL (%)**	**95% UPL (%)**	
43202	Ethane[+]	NA	NA	NA	NA	NA	NA	9	-10.07	-18.91	-1.23	33.8%
43204	Propane[*]	8	10.31	9.38	-0.33	-8.46	7.80	9	-14.81	-25.51	-4.11	33.8%
43214	Isobutane[+]	NA	NA	NA	NA	NA	NA	9	-12.98	-24.14	-1.81	33.8%
43216	Trans-2-Butene[+]	NA	NA	NA	NA	NA	NA	9	-12.89	-17.64	-8.14	33.8%
43220	N-Pentane[+]	NA	NA	NA	NA	NA	NA	9	-2.97	-20.26	14.33	33.8%
43285	2-Methylpentane[+]	NA	NA	NA	NA	NA	NA	9	-15.19	-25.11	-5.27	33.8%
43243	Isoprene[+]	NA	NA	NA	NA	NA	NA	9	-31.35	-52.38	-10.32	33.8%
43231	N-Hexane[+]	NA	NA	NA	NA	NA	NA	9	-44.38	-125.20	36.45	33.8%
45201	Benzene[*]	8	12.09	17.13	-10.68	-20.40	-0.97	9	-13.96	-25.05	-2.86	33.8%
43232	N-Heptane[+]	NA	NA	NA	NA	NA	NA	9	-7.10	-15.01	0.81	33.8%
45202	Toluene[+]	NA	NA	NA	NA	NA	NA	9	-12.95	-23.09	-2.81	33.8%
45203	Ethylbenzene[+]	NA	NA	NA	NA	NA	NA	9	-11.79	-24.94	1.35	33.8%
43238	N-Decane[+]	NA	NA	NA	NA	NA	NA	9	-3.36	-16.57	9.86	33.8%
45225	1,2,4-Trimethylbenzene[+]	NA	NA	NA	NA	NA	NA	9	2.69	-25.06	30.44	33.8%
* NIST traceable												
+ Only NIST traceable by weight												

METEOROLOGY

The Ambient Monitoring Program monitors meteorological parameters such as wind speed, wind direction, ambient temperature, relative humidity, barometric pressure, total ultra violet radiation, precipitation and total solar radiation. Real-time meteorological data are generated to characterize meteorological processes such as transport and diffusion, and to make air quality forecasts and burn day decisions. The data are also used for control strategy modeling, case study analysis, and urban airshed modeling. A state/local meteorology subcommittee of the Air Monitoring Technical Advisory Commission (AMTAC) agreed to define the level of acceptability for meteorological data as those used by the U.S. EPA for both the Prevention of Significant Deterioration (PSD) and Photochemical Assessment Monitoring Stations (PAMS) programs. The Quality Assurance Unit audits to those levels.

The data variability collected by this element of the monitoring program is generally described as meeting or not meeting the PSD requirements. Station operators are notified if an exceedance is found during an audit, and every effort is made to ensure that the data meets the audit standards. The wind speed, wind direction, ambient temperature and relative humidity data sets are controlled data sets, and subject to meeting PAMS objectives. Since the inception of the meteorological audit program, the data quality has improved significantly.

Accuracy (field): The accuracy of meteorological sensors is checked by annual performance audits. Table 24 summarizes the 2015 data quality assessment results. The average difference (average degree difference with respect to ambient temperature) represents the combined differences from the certified value of all the individual audit points for each sensor. The upper and lower probability limits represent the expected accuracy of 95 percent of all the single sensor's individual percent differences for all audit test levels at a single site.

Table 24. Meteorological Yearly Data Quality Assessment Summary

Meteorological Measurements Yearly Data Quality Assessment Summary for GA EPD Ambient Air Monitoring Program (as a PQAO)							
Parameter Code	Parameter Name	Annual Audit (Bias %)					Completeness (%)
		No. of Obs.	No. of Site	Avg (%)	95% LPL (%)	95% UPL (%)	
62101	Ambient Temperature	8	8	0.36	-1.45	2.17	96%
64101	Barometric Pressure	6	6	-0.02	-0.11	0.07	96%
62201	Relative Humidity	8	8	-0.25	-6.47	5.98	92.9%
95% LPL: 95% Lower Probability Limit				95% UPL: 95% Upper Probability Limit			

QUALITY CONTROL REPORTS

Quality Control (QC) reports are summaries of the quality control activities conducted by the laboratory to support accurate and precise measurements. These activities include: blanks, duplicates, controls, spiked samples, limits of detection, calibrations, and audit results.

STANDARDS LABORATORY

The U.S. EPA Region IV Standards Laboratory yearly performs technical support and certification services for Georgia's ozone primary standard. Flow rate transfer standards and certification of compressed gas cylinders are sent to the manufacturers for re-certification to ensure that all are traceable to standards of the NIST. A calibration establishes a correction factor to adjust or correct the output of an instrument; a certification establishes traceability of a transfer standard to a NIST-traceable standard; and verification establishes comparability of a standard to a NIST-traceable standard of equal rank.

LABORATORY AND FIELD STANDARD OPERATING PROCEDURE

Standard Operating Procedures (SOPs) are guidance documents for the operation of quality assurance programs used by the Georgia Ambient Monitoring Program. The SOPs are intended for field operators and supervisors; laboratory, data processing personnel; and program managers responsible for implementing, designing, and coordinating air quality monitoring projects. Each SOP has a specific method that must be followed to produce data-for-record. The SOPs are developed and published to ensure that, regardless of the person performing the operation, the results will be consistent.

SITING EVALUATIONS

To generate accurate and representative data, ambient monitoring stations should meet specific siting requirements and conditions. It is assumed that the stations meet the siting criteria in place at the time initial operation began. The siting requirements of the Quality Assurance Manual Volume II and 40

CFR 58, Appendix E present siting criteria to ensure the collection of accurate and representative data. The siting criterion for each pollutant varies depending on the pollutant's properties, monitoring objective and intended spatial scale. The U.S. EPA's siting criteria are stated as either "must meet" or "should meet". According to 40 CFR 58, Appendix E, the "must meet" requirements are necessary for high quality data. Any exception from the "must meet" requirements must be formally approved through the Appendix E waiver provision. The "should meet" criteria establish a goal for data consistency. Siting criteria are requirements for locating and establishing stations and samplers to meet selected monitoring objectives, and to help ensure that the data from each site are collected uniformly. There are four main monitoring objectives: to determine highest concentrations expected to occur in the area covered by the network; to determine representative concentrations in areas of high population density; to determine the impact on ambient pollution levels of significant sources or source categories; and to determine general background concentration levels. Typical siting designations are: micro, middle, neighborhood, urban, and regional. These designations represent the size of the area surrounding the monitoring site which experiences relatively uniform pollutant concentrations. Typical considerations for each of these site designations are, for example, the terrain, climate, population, existing emission sources, and distances from trees and roadways. The Quality Assurance Unit conducts siting evaluations annually. Physical measurements and observations include probe/sensor height above ground level, distance from trees, type of ground cover, residence time, obstructions to air flow, and distance to local sources. These measurements and observations are taken to determine compliance with 40 CFR Part 58, Appendix E requirements.

RISK ASSESSMENT

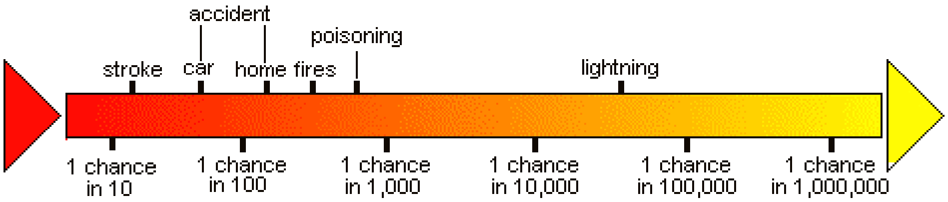
INTRODUCTION

In 2015, GA EPD collected air toxic samples from five Air Toxics Network (ATN) sites (including two rural background sites) and one National Air Toxics Trends Station (NATTS) site. The following risk assessment reflects data collected at these six locations. Compounds sampled at these sites are shown in Table 25. The list was derived from the 187 compounds EPA has designated as Hazardous Air Pollutants (HAPS). Many of the HAPS do not have standardized ambient air sampling and analytical methods. In order to collect the compounds of interest for the Georgia network, at least three types of samplers are used at all locations: HIVOL, PUF, and canister. In addition, a carbonyls sampler is located at the Dawsonville, Savannah, and South DeKalb sites. This equipment samples for metals, semi-volatile organic compounds, volatile organic compounds, and carbonyls once every twelve days following a pre-established schedule that corresponds to a nationwide sampling schedule. On the twelfth day the sampler runs midnight to midnight and takes a 24-hour composite sample. An exception to this sampling schedule is the South DeKalb site, which samples every six days as part of the National Air Toxics Trends Station (NATTS) and Photochemical Assessment Monitoring Stations (PAMS) networks. In addition, during June, July, and August, the South DeKalb site collects four integrated three-hour carbonyls samples every third day as part of the PAMS and NATTS networks.

Some of the chemicals monitored in the ATN are also monitored at sites in the PAMS network. The monitoring schedule and some analysis methods are different at the PAMS sites and ATN sites. To account for this, several of the compounds from the PAMS sites were evaluated and compared to concentrations measured at nearby ATN sites for this report.

To put into perspective the risks from environmental hazards as risk analysts will describe them, the continuum below presents risk statistics for some familiar events. Risk analysts describe cancer risks numerically in scientific notation, for example 1 x 10[-5], 1 x 10^{-5} or 1.00E-05, which means that there is one chance in 100,000 of an event occurring. It is important to note that these risk statistics are population averages, while risk analysts usually estimate risk to the maximum exposed individual. Additionally, it should be noted that these risk values are considered additional risk. That is, risk above and beyond the normal background risk from exposure in everyday life.

Putting Risks in Perspective



RESULTS AND INTERPRETATION

The air toxics data [volatile organic compounds (VOCs), semi-volatile organic compounds, and metals] collected during 2015 from the Air Toxics Network was evaluated to assess the potential for health concerns. Carbonyls data were assessed separately from the other air toxics, with the exception of acrolein, because those chemicals were only monitored at two of the ATN sites and one of the PAMS locations.

The initial evaluation consisted of a comparison of the monitored results to "health based" screening values. These values were calculated using procedures recommended in EPA's latest guidance on risk assessment for air toxics, 'A Preliminary Risk-Based Screening Approach for Air Toxics Monitoring Data Sets' (U.S. EPA, 2010). Briefly, EPA's prioritized chronic dose-response values for both noncancerous (reference concentrations, RfC) and cancer (inhalation unit risks, IUR) were used to generate screening air concentrations. To screen for noncancerous effects, the reference concentration was used as a starting point. However, to account for possible exposure to multiple contaminants, the screening air concentration was obtained by dividing the RfC by 10. Screening values for the cancer endpoint were determined by calculating air concentrations equivalent to a risk level of one in one million. Most screening values utilized in this assessment are listed in Appendix A of the previously mentioned guidance document (U.S. EPA, 2010) and updated "Table 1. Prioritized Chronic Dose-Response Values for Screening Risk Assessments (5/09/2014)" (U.S. EPA, 2014). These screening values and the chemicals monitored are displayed in Table 25. For a limited number of chemicals, other resources such as toxicity values from the Regional Screening Table (http://www2.epa.gov/risk/risk-based-screening-table-generic-tables) were used to calculate conservative screening values. These compounds are indicated with an asterisk. When available, both the names derived from the International Union of Chemistry (IUC) and the common names are given. It is important to emphasize that the screening values were calculated in a very conservative manner. Assumptions were made that accounted for the potential for continuous exposure to air toxics for 24 hours per day for 70 years. The conservative screening process was utilized so that the chance of underestimating the potential for health impacts would be minimized, as chemicals were excluded from further quantitative analysis.

Because results for many of the chemicals assessed were routinely below detection limits of the analytical methods available, the initial review of the data was based on an assessment of the number of chemicals detected and the frequency with which they were detected. The process included determining how often (if at all) a chemical was detected (present), if it was present above detection limits, and if those concentrations were above screening values of concern.

Table 25. Compounds monitored and screening values used in initial assessment

Chemical	**Screen Value (µg/m^3)**	**Chemical**	**Screen Value (µg/m^3)**
Metals			
Antimony	0.02	Cobalt	0.01
Arsenic	0.00023	Lead	0.15
Beryllium	0.00042	Manganese	0.3
Cadmium	0.00056	Nickel	0.0021
Chromium	0.000083	Selenium	2
Chromium VI	0.000083	Zinc	N/A
Semi-Volatiles			
Acenaphthene	0.3	Cyclopenta(cd)pyrene	N/A
Acenaphthylene	0.3	Dibenzo(a,h)anthracene	0.00083
Anthracene	0.3	Fluoranthene	0.3
Benzo(a)anthracene	0.0091	Fluorene	0.3
Benzo(b)fluoranthene	0.0091	Indeno(1,2,3-c,d)pyrene	0.0091
Benzo(k)fluoranthene	0.0091	Naphthalene	0.029
Benzo(g,h,i)perylene	0.3	Phenanthrene	0.3
Benzo(a)pyrene	0.00091	Perylene	N/A
Benzo(e)pyrene	0.3	Pyrene	0.3
Chrysene	0.091		
Volatile Organic Compounds			
Benzene	0.13	1,3 and 1,4-Dimethylbenzene (m/p-Xylene)	10
Benzenecarbonal (Benzaldehyde)	N/A	Ethanal (Acetaldehyde)	0.45
Benzyl chloride	0.02	Ethylbenzene	0.4
Bromomethane (Methyl bromide)	0.5	Ethenylbenzene (Styrene)	100
1,3-Butadiene	0.03	Benzene,1-ethenyl-4-methyl (p-Ethyltoluene)	N/A
Butanal (Butyraldehyde)	N/A	Freon 113	N/A
Chlorobenzene (Phenyl chloride)	100	Hexachloro-1,3-Butadiene(Hexachlorobutadiene)	0.045
Chloroethane (Ethyl chloride)	1000	n-Hexane	70
Chloroethene (Vinyl chloride)	0.11	Methanal (Formaldehyde)	0.0769
Chloromethane (Methyl chloride)	9.0	Methylbenzene/Phenylmethane (Toluene)	40
Cyclohexane	6300*	Propanal (Propionaldehyde)	0.8
1,2-Dibromoethane (Ethylene dibromide)	0.002	2-Propanone (Acetone)	32000*
1,2-Dichlorobenzene	20*	Propenal (Acrolein)	0.002
1,3-Dichlorobenzene	N/A	1,1,2,2-Tetrachloroethane	0.017
1,4-Dichlorobenzene	0.091	Tetrachloroethene (Perchloroethylene)	3.846
Dichlorodifluoromethane (Freon 12)	100*	Tetrachlormethane (Carbon tetrachloride)	0.17
1,1-Dichloroethane (Ethylidene chloride)	0.63	1,2,4-Trichlorobenzene	20
cis-1,2-Dichloroethene	N/A	1,2,3-Trimethylbenzene	5.2*
1,1-Dichloroethene (1,1-Dichloroethylene)	210*	1,2,4-Trimethylbenzene	7.3*
Dichloromethane (Methylene chloride)	100	1,3,5-Trimethylbenzene	N/A
1,2-Dichloropropane (Propylene dichloride)	0.1*	1,1,1-Trichloroethane (Methyl chloroform)	5000
cis-1,3-Dichloropropene	N/A	1,1,2-Trichloroethane	0.063
trans-1,3-Dichloropropene	N/A	Trichloroethene (Trichloroethylene)	0.244
1,1-Dichloro-1,2,2,2-tetrafluoroethane(Freon114)	N/A	Trichlorofluoromethane (Freon 11)	730*
1,2-Dimethylbenzene (o-Xylene)	10	Trichloromethane (Chloroform)	9.8

*From Regional Screening Table (http://www2.epa.gov/risk/risk-based-screening-table-generic-tables)

Table 26 summarizes the total number of chemicals monitored at each site (excluding all carbonyls except acrolein), the number of chemicals detected, and the number of chemicals detected above the health based screening values for 2015. Seventy chemicals were monitored at all the Air Toxics sites, except the South DeKalb site, where 71 air toxic chemicals were monitored and the DMRC site where 42 chemicals were monitored. In 2015, 32 of the 71 sampled compounds were not detected at the sites, and an additional 13 compounds had 2 or fewer sites with detections. The number of chemicals that were detected at concentrations above the screening levels was even less, with a mean value of 4 per site. Of the three categories of chemicals measured at all sites (VOC, semi-VOC, metals), most of the chemicals that were detected above screening values belonged to the metals group.

Table 26. Summary of chemicals analyzed in 2015

Location	**County**	**Number of Compounds Monitored**	**Number of Compounds Detected**	**Number of Compounds Greater than Screening Value**
Macon-Forestry	Bibb	70	28	4
Savannah-E. Pres. St.	Chatham	70	28	6
General Coffee	Douglas	70	28	5
Dawsonville	Dawson	70	24	4
DMRC	DeKalb	42	8	2
South DeKalb	DeKalb	71	29	6
Yorkville	Paulding	70	24	4

* 6 additional carbonyls were monitored at these locations but not included in this analysis, compounds that exceeded their screening value are summarized in Table 31

Table 27 shows the average concentration and detection frequency of the chemicals that were detected above screening values at each Air Toxics site in 2015. The number of detects were counted as any number that was above half the method detection limit. The average was computed using the sample concentration when it was above half the method detection limit and substituting half the method detection limit if the sample concentration was below this limit.

Table 27. Site-specific detection frequency and mean concentration for chemicals that exceeded their screening values in 2015

Site	Chemical	Annual Average (µg/m^3)	Detection Frequency
Macon-Forestry	Arsenic	4.4E-04	13/24
	Chromium	1.5E-03	24/24
	Acrolein	5.7E-01	17/22
	Benzene	4.2E-01	5/22
Savannah-E. Pres. St.	Arsenic	6.1E-04	13/27
	Chromium	1.4E-03	27/27
	Carbon tetrachloride	7.9E-01	1/20
	Bromomethane	5.7E-01	1/20
	Acrolein	3.9E-01	10/20
	Benzene	4.5E-01	6/20
General Coffee	Arsenic	4.4E-04	13/29
	Chromium	1.4E-03	29/29
	Carbon tetrachloride	7.9E-01	1/29
	Acrolein	3.6E-01	13/29
	Benzene	5.0E-01	8/29
Dawsonville	Arsenic	7.0E-04	18/27
	Chromium	1.2E-03	27/27
	Acrolein	5.6E-01	18/21
	Benzene	7.8E-01	21/21
DMRC	Benzene	1.1E+00	19/22
	Acrolein	4.6E-01	12/22
South DeKalb	Arsenic	6.9E-04	38/58
	Chromium	1.7E-03	58/58
	Naphthalene	5.0E-02	56/56
	Ethylbenzene	5.4E-01	1/44
	Acrolein	3.8E-01	25/44
	Benzene	5.9E-01	29/44
Yorkville	Arsenic	6.8E-04	19/28
	Chromium	1.2E-03	28/28
	Acrolein	3.4E-01	7/29
	Benzene	4.7E-01	9/29

Formula For Calculating Risk Using IUR For Carcinogens

$$Risk = IUR * Conc$$

Formula For Calculating Hazard Quotient Using RfC For Noncarcinogens

$$HQ = \frac{Conc}{RfC}$$

Equation Parameters
Risk: Theoretical lifetime cancer risk (unitless probability)
HQ: Hazard quotient (unitless ratio)
Conc: Measured ambient air concentration in µg/m^3
IUR: Inhalation unit risk (1/(µg/m^3))
RfC: Reference concentration(µg/m^3

Figure 88. Formulas for calculating theoretical cancer risk and hazard quotient

Figure 88 shows the formulas used to calculate cancer risk and non-cancer hazard for chemicals that were carried beyond the screening process into the quantitative assessment.

Table 28 shows the theoretical cancer risk and non-cancer hazard that would result from an individual breathing air containing the detected chemicals at the estimated concentrations daily for seventy years, or a full lifetime. These cancer risk and hazard quotient estimates are likely conservative because they were calculated assuming continuous exposure to outdoor air at breathing rates typical of moderate exertion. Real risk cannot be calculated, but may be substantially lower. Lifetime cancer risks for the limited number of chemicals exceeding screening values (and excluding that from carbonyls) exceeded 1×10^{-6} or one in one million, a value generally deemed as insignificant. However, lifetime cancer risks for these chemicals did not exceed 2×10^{-5} or two in one-hundred thousand. This value is generally taken as a crude upper limit for "allowable" risk in many regulatory contexts.

Individual hazard quotients (HQs) are ratios that relate daily exposure concentrations, or dose, to a concentration or an amount thought to be without appreciable risks of causing deleterious non-cancer effects in sensitive individuals as well as the general population. HQ values less than 1.0 indicate the air "dose" is less than the amount required to cause toxic effects other than cancer.

In July of 2007, GA EPD changed the analysis method for acrolein. The sampling method changed from a dinitrophenylhydrazine (DNPH) cartridge with high performance liquid chromatography (HPLC) analysis to the VOCs canister collection with gas chromatograph with mass spectroscopy (GC/MS) analysis. This change occurred due to EPA's findings during the School Air Toxics Monitoring Initiative. For more information on this study, please see EPA's website, http://www.epa.gov/ttnamti1/airtoxschool.html. With this GC/MS analysis method, there were several more detections of acrolein than have been seen in previous years, with the HPLC cartridge method. These results are shown along with the other hazard quotients for the Air Toxics sites. The HQ numbers for acrolein are significantly higher than for the other air toxic compounds. This may be due to methodological changes. Potential reasons for differences are still being investigated.

Table 28. Cancer risk and hazard quotient by location for chemicals that exceeded their screening value in 2015

Site	Chemical	Cancer Risk	Hazard Quotient
Macon-Forestry	Arsenic	2.E-06	0.03
	Chromium	2.E-05	0.02
	Acrolein	NA	28
	Benzene	3.E-06	0.01
Savannah-E. Pres. St.	Arsenic	3E-06	0.04
	Chromium	6E-06	0.01
	Acrolein	NA	20
	Carbon tetrachloride	5E-06	0.008
	Bromomethane	NA	0.1
	Benzene	4E-06	0.01
General Coffee	Arsenic	2.E-06	0.03
	Chromium	2.E-05	0.01
	Acrolein	NA	18
	Carbon tetrachloride	5.E-06	0.008
	Benzene	4.E-06	0.02
Dawsonville	Arsenic	3.E-06	0.05
	Chromium	1.E-05	0.01
	Acrolein	NA	28
	Benzene	6.E-06	0.03
DMRC	Benzene	8.E-06	0.04
	Acrolein	NA	23
South DeKalb	Arsenic	3.E-06	0.05
	Chromium	2.E-05	0.02
	Naphthalene	2.E-06	0.5
	Acrolein	NA	19
	Benzene	5.E-06	0.02
	Ethylbenzene	1.E-06	0.0005
Yorkville	Arsenic	3.E-06	0.05
	Chromium	1.E-05	0.01
	Acrolein	NA	17
	Benzene	4.E-06	0.02

For screening purposes, it is generally considered appropriate to treat the potential for effects in an additive manner and to sum cancer risk and hazard quotients, respectively. For example, if cancer risk for two separate chemicals were 1 x 10^{-4} and 2 x 10^{-4}, then the sum or aggregate cancer risk would equal 3 x 10^{-4}. Likewise, if cancer risk for two separate chemicals were 1 x 10^{-4} and 1 x 10^{-5}, then total cancer risk for the two would equal 1.1 x 10^{-4}, or rounded to 1 x 10^{-4}. Similarly, if hazard quotients were 0.6 and 0.5 for two different chemicals, it would indicate that each chemical alone is not likely to result in detrimental effects. However, summing the two would yield a hazard index (HI) of 1.1 or rounded to 1. Comparing this value to the threshold value of 1.0, this HI suggests at least the potential for detrimental effects from the combination of the two chemicals. Table 29 shows total or aggregate theoretical cancer risk and hazard indices (added hazard quotients) for the chemicals (VOCs, semi-VOCS, and metals) carried through the quantitative assessment.

In 2015, the aggregate theoretical cancer risk (excluding carbonyls) for all Air Toxics sites was 1 x 10^{-4}, with risks ranging from 8 x 10^{-6} to 3 x 10^{-5}. The HIs ranged from 0.06 to 0.6 without acrolein data and from 17 to 28 with acrolein data.

Table 29. Aggregate cancer risk and hazard indices with and without acrolein data for all Air Toxics sites in 2015. Carbonyls data were excluded.

Site	Aggregate Cancer Risk	HI without Acrolein	HI withAcrolein
Macon-Forestry	2.E-05	0.06	28
Savannah-E. Pres. St.	2.E-05	0.2	20
General Coffee	3.E-05	0.07	18
Dawsonville	2.E-05	0.08	28
DMRC	8.E-06	0.04	23
South DeKalb	3.E-05	0.6	19
Yorkville	2.E-05	0.07	17

Figure 89 summarizes the information in Table 29 and also shows the previous eight years of hazard indices and cancer risk for comparison. With the GC/MS analysis used for the acrolein compound, the hazard indices significantly increased starting with the 2007 data. Before this method change, the highest hazard index generally seen with the Air Toxics data was 0.5. In 2007, the lowest hazard index was 20, at the Savannah site, and the highest was 39, at the Dawsonville site. In 2008 and 2009, the hazard indices were lower overall, with values ranging from 12 at the Macon site to 34 at the South DeKalb site. Then in 2010, there was a dramatic increase at all the sites, with the highest hazard index reading of 213 at the Savannah site. Subsequently, in 2011, the hazard indices decreased drastically, with the lowest value of 18 at the Yorkville site, and the highest value of 66 at the General Coffee site. From 2012 to 2015, hazard index values remained generally low. The lowest hazard index value recorded in 2015 was at the Yorkville site (17) and the highest at the Macon and Dawsonville sites (28). The aggregate theoretical cancer risks have remained relatively consistent through the nine years, with values ranging from 2 x 10^{-5} to 3 x 10^{-5}.

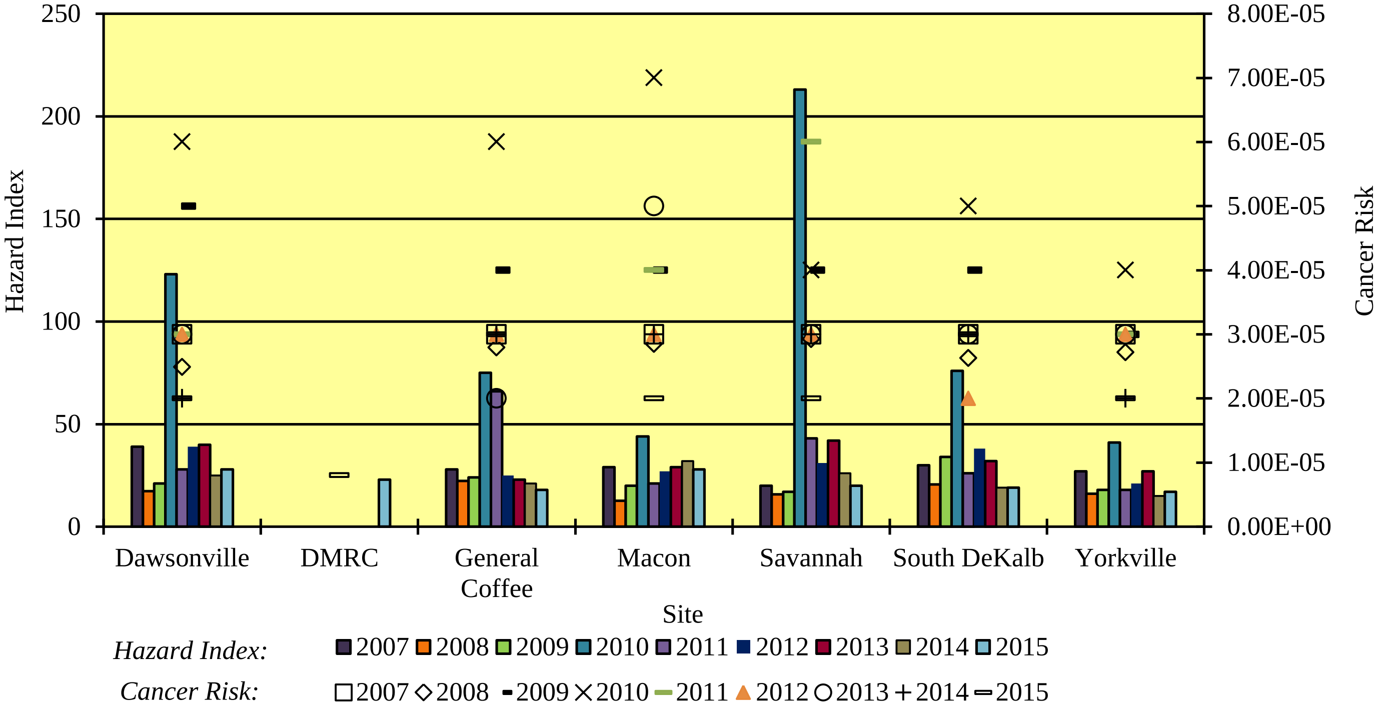


Figure 89. Aggregate cancer risk and hazard index by site for 2007-2015, excluding carbonyls

A few of the compounds collected from the PAMS network were evaluated in conjunction with the Air Toxics data. The PAMS network is a federally mandated network required to monitor for ozone precursors in those areas classified as serious, severe, or extreme for ozone nonattainment. Fifty-six chemicals are monitored on six-day intervals at these sites. In Georgia, the PAMS sites are located in Conyers, South DeKalb, and Yorkville. Of the 56 chemicals monitored at these sites, many are ozone precursors and have not had a screening value developed for determining the toxicity of those compounds. Therefore, for this study, only eleven chemicals were assessed for their potential to have detrimental effects on human health if present in ambient air. Those eleven chemicals were benzene, cyclohexane, ethylbenzene, n-hexane, 1,2,3-trimethylbenzene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, styrene, toluene, m/p-xylenes, and o-xylene.

Of these eleven, only benzene, 1,2,4-trimehtylbenzene, and ethylbenzene were found in concentrations above their screening values. Table 30 shows the detection frequency, first and second maximum sample concentrations, averages, hazard quotients (HQ) and cancer risk (CR) for these chemicals. Benzene produced theoretical cancer risks ranging from 1 x 10^{-5} to 3 x 10^{-5} and hazard quotients ranging from 0.06 to 1. 1,2,4-trimethylbenzene had a hazard quotient range of 3 to 16. Ethylbenzene had a theoretical cancer risk ranging from 1 x 10^{-7} to 4 x 10^{-6} and a hazard quotient range of 0.00004 to 0.002.

Table 30. Detection frequency, 1st and 2nd maximums, mean, cancer risks, and hazard quotients for VOCs from the PAMs network which exceeded their screening levels in 2015.

Site	**Chemical**	**Detection Frequency**	**1st Max**	**2nd Max**	**Annual Avg**	**CR**	**HQ**
South DeKalb	Benzene	33/33	11.5	9.6	3.9	3.E-05	1
	Ethylbenzene	20/33	4.88	3.9	1.5	4.E-06	0.002
	1,2,4-Trimethylbenzene	33/33	59.0	59.0	34.4	NA	5
Yorkville	Benzene	23/25	4.2	4.2	1.7	1.E-05	0.06
	Ethylbenzene	1/25	1.30	ND	0.04	1.E-07	0.00004
	1,2,4-Trimethylbenzene	25/25	211.4	196.7	109.6	NA	16
Conyers	Benzene	24/24	6.4	5.4	3.6	3.E-05	0.1
	Ethylbenzene	8/24	3.9	2.6	0.7	2.E-06	0.0007
	1,2,4-Trimethylbenzene	24/24	63.9	45.2	23.5	NA	3

With the exclusion of acrolein, the carbonyls (acetaldehyde, acetone, benzaldehyde, butyraldehyde, formaldehyde, and propionaldehyde) are measured at only two of the ATN sites (Savannah and Dawsonville) and one PAMS/NATTS site (South DeKalb) in 2015. For that reason, their results are displayed separately from the rest of the data. Detection frequency, average (mean) concentration in micrograms per cubic meter (µg/m^3), cancer risk, and non-cancer HQs for the carbonyls are shown in Table 31. Of the six carbonyls sampled, only acetaldehyde and formaldehyde were detected above the screening value in 2015. All the sites monitoring for acetaldehyde and formaldehyde detected these compounds with a relatively high detection frequency. Formaldehyde was detected 85% to 93% of the time (Savannah and Dawsonville, respectively). Acetaldehyde was detected 69% to 75% of the time (Savannah and Dawsonville, respectively). Formaldehyde's theoretical cancer risks ranged from 3 x 10^{-5} to 5 x 10^{-5} with hazard quotients ranging from 0.2 to 0.4. Acetaldehyde had relatively low theoretical cancer risks, ranging from 2 x 10^{-6} to 3 x 10^{-6}, and a relatively low hazard quotient of 0.1 for both sites.

Table 31. Detection frequency, average concentration, cancer risk, and hazard quotient, 2015

Site	Chemical	Detection Frequency	Annual Average (µg/m^3)	Cancer Risk	Hazard Quotient
Dawsonville	Formaldehyde	26/28	3.8	5.E-05	0.4
	Acetaldehyde	21/28	1.2	3.E-06	0.1
Savannah-E. Pres. St.	Formaldehyde	22/26	2.1	3.E-05	0.2
	Acetaldehyde	18/26	0.9	2.E-06	0.1

SUMMARY AND DISCUSSION

In 2015, there were 70 air toxics compounds monitored at 6 sites across the state, with the exception of the South DeKalb site that monitored 71 air toxic compounds and DMRC that monitored 42 compounds. Of these compounds monitored, 32 were not detected and 13 compounds were detected at two sites or less. 37% of the compounds detected above the screening value were in the metals category, 35% were in the volatile organic compounds category, and 23% were in the semi-volatile organic compounds category. There was an average of 4 compounds per site that were above the screening value.

Of the volatile organic compounds, benzene exceeded the screening value and so was evaluated in the quantitative assessment (Table 27 and Table 28) (acrolein is discussed along with the carbonyls, as it was previously detected with the carbonyls). Benzene was found above the screening value at all six Air Toxics sites. Average benzene concentrations at the Air Toxics sites ranged from 0.4 to 1.1 µg/m^3. These concentrations correspond to the predicted theoretical lifetime cancer risk ranging from 3 x 10^{-6} to 8 x 10^{-6}. All three PAMS sites detected benzene above the screening value as well. Average concentrations of benzene measured in the PAMS network ranged from 1.7 to 3.9 µg/m^3. These concentrations correspond to predicted theoretical lifetime cancer risks in the range of 1 x 10^{-5} to 3 x 10^{-5} for the PAMS sites. Major sources of benzene to the environment include automobile service stations, exhaust from motor vehicles, and industrial emissions (ATSDR, 1997a). Most data relating effects of long-term exposure to benzene are from studies of workers employed in industries that make or use benzene, where people were exposed to amounts hundreds or thousands of times greater than those reported herein. Under these circumstances of high exposure, benzene can cause problems in the blood, including anemia, excessive bleeding, and harm to the immune system. Exposure to large amounts of benzene for long periods of time may also cause cancer of the blood-forming organs, or leukemia (ATSDR, 1997a). The potential for these types of health effects from exposure to low levels of benzene, as reported in this study, are not well understood. Benzene has been determined to be a known carcinogen (U.S. EPA, 2000) and was evaluated as such in this study.

Naphthalene was the only compound in the semi-volatile organic group found above the screening value (Table 27). It was detected at one out of the six sites, with a theoretical cancer risk of 2 x 10^{-6}, with a non-cancer hazard quotient of 0.5 (Table 28). Naphthalene is found in moth repellents, petroleum, coal, and is used in making polyvinyl chloride (PVC) plastics. Exposure to large amounts can cause hemolytic anemia (ATSDR, 2005e).

Two metals (arsenic and chromium) were evaluated in the quantitative assessment (Table 27 and Table 28). Arsenic was found above the screening value at all six Air Toxics sites (Table 27). Arsenic occurs naturally in soil and rocks, and was used extensively in the past as a pesticide on cotton fields and in orchards (ATSDR, 2005b). However, the majority of arsenic found in the atmosphere comes from the burning of coal and oil, incineration, and smelting operations. Arsenic has been recognized as a human poison since ancient times. Inhalation of large quantities of some forms of arsenic may cause irritation of the throat and upper respiratory tract. Long-term exposure either by inhalation or ingestion may result in a unique pattern of skin changes, and circulatory and peripheral nervous disorders (ATSDR, 2005b). Inhalation of some forms of arsenic may also cause cancer, therefore arsenic was evaluated as a carcinogen in this assessment. The detection frequency ranged from 45% to 68% at the General Coffee and Yorkville sites, respectively. Theoretical lifetime cancer risks ranged from 2 x 10^{-6} to 3 x 10^{-6}, and HQs ranged from 0.03 to 0.05.

Total chromium was detected at all six Air Toxics sites and displayed with a 100% detection frequency at all six sites. The theoretical cancer risk ranged from 6 x 10^{-6} to 2 x 10^{-5} (Table 28). Chromium is a naturally occurring element and is common in low amounts in foodstuffs (ATSDR, 2000b). Natural processes such as wind generating dust and even volcanoes may release chromium into the atmosphere. However, many human activities such as coal and oil combustion, electroplating, smelting, and iron and steel production also release it into the atmosphere.

The chemistry of chromium is complex. It may occur in different forms or oxidation states in the environment, having very different degrees of toxicity. Chromium+3 is the form that often predominates in the natural environment, and is also an essential element required for good nutrition. Hexavalent chromium (chromium+6) is the most toxic form of chromium and is often related to releases from industrial activities (ATSDR, 2000b). Inhaling large amounts of chromium+6 may cause upper respiratory track irritation, and chromium+6 has also been shown to be a carcinogen, causing increases in the risk of lung cancer (ATSDR, 2000b). Studies have shown that in ambient air, even near industrial sites, chromium+6 is usually only a small portion of total chromium, with measured concentrations for chromium+6 accounting for a range of values from 1 to 25% of total chromium (ATSDR, 2000b).

Carbonyls were monitored at three sites in Georgia in 2015 (Table 31). Two sites, Dawsonville and Savannah are ATN sites, while the other site, South DeKalb, is in the PAMS/NATTS network. However, the South DeKalb site was unable to collect data due to machine malfunctions. Three carbonyls, formaldehyde, acetaldehyde, and acrolein, were detected above their screening levels and included in the quantitative assessment.

Formaldehyde, the simplest of the aldehydes, is produced by natural processes, and from the fertilizer, paper, and manufactured wood products industries (ATSDR, 1999). It is also found in vehicle emissions. Formaldehyde is a health concern because of its respiratory irritancy and as a possible 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, like formaldehyde, is also a concern as an upper respiratory irritant, and because of its potential to cause nasal tumors in animal studies. However, research has shown it to be significantly less potent than formaldehyde. Acetaldehyde, as an intermediate product of plant respiration and a product of incomplete combustion, is ubiquitous in the environment. (U.S. EPA, 1987; U.S. EPA 1991b). Recent studies of acetaldehyde background levels have found average background concentrations at 0.16 µg/m^3 in remote areas of North America (McCarthy, Hafner, & Montzka, 2006).

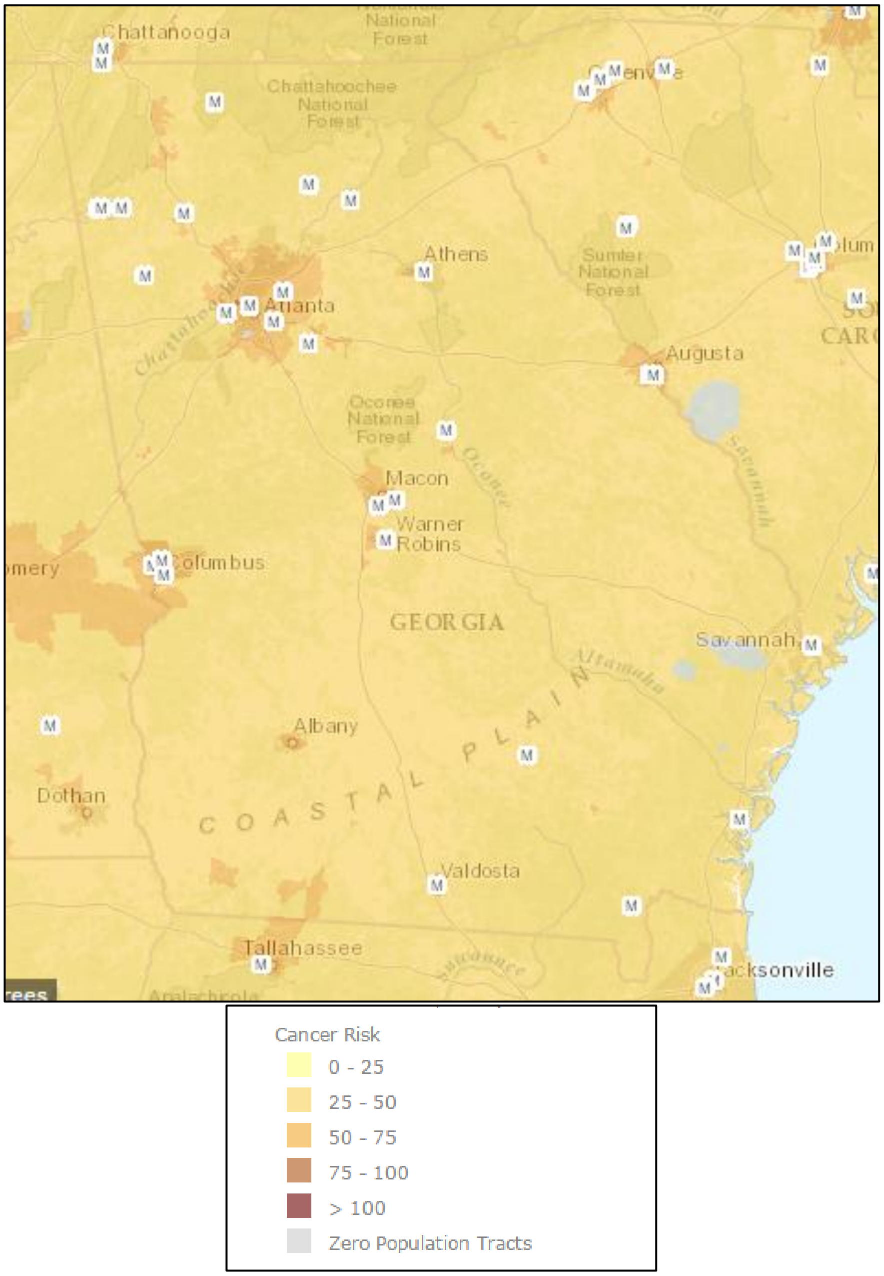
Formaldehyde and acetaldehyde were detected at both locations where carbonyls were assessed (Table 31). The highest average concentrations of both formaldehyde and acetaldehyde were found at the Dawsonville site, 3.79 µg/m^3 and 1.16 µg/m^3, respectively. As discussed above, 0.16 µg/m^3 of the acetaldehyde average concentration could be attributed to the background concentration. The theoretical cancer risk for formaldehyde ranged from 3 x 10^{-5} to 5 x 10^{-5} and the hazard quotients ranged from 0.2 to 0.4. Acetaldehyde theoretical cancer risk ranged from 2 x 10^{-6} to 3 x 10^{-6} and the hazard quotient was 0.1 for both sites.

Due to EPA research to improve acrolein sampling and analysis, GA EPD began collecting acrolein with the other VOCs in a canister and analyzing it using a GC/MS method. This method was started in July of 2007, drastically changing the number of detections that were found across the state. In previous years, acrolein was analyzed along with the carbonyls, at select sites. With the GC/MS and canister method, this allowed acrolein to be sampled at all of the air toxics sites. In 2015, it was detected at all the sites, with a detection frequency ranging from 24% to 86% (Table 27). Acrolein was evaluated as a potential non-carcinogen, and the hazard quotients ranged from 17 to 28 (Table 28). The average concentrations ranged from 0.34 µg/m^3 to 0.57 µg/m^3 with the highest average occurring at the Macon site. Acrolein may enter the environment as a result of combustion of trees and other plants, tobacco, gasoline, and oil. Additionally, it can be used as a pesticide for algae, weeds, bacteria, and mollusks (ATSDR, 2011). The potential for acrolein to cause health effects is not well understood. At very low concentrations, it is an upper respiratory irritant. At very high concentrations it may produce more serious damage to the lining of the upper respiratory tract and lungs (ATSDR, 2011; U.S. EPA, 2003).

Of the PAMS compounds assessed, benzene and 1,2,4-trimethylbenzene, and ethylbenzene were the only compounds detected above the screening value at all sites (Table 30). When evaluated as a theoretical cancer risk, the levels of benzene ranged from 1 x 10^{-5} at the Yorkville to 3 x 10^{-5} at the Conyers and South DeKalb sites, with hazard quotients ranging from 0.06 to 0.1, at the Yorkville and South DeKalb sites respectively. As stated earlier, major sources of benzene to the environment include automobile service stations, exhaust from motor vehicles, and industrial emissions (ATSDR, 1997a). 1,2,4-Trimethylbenzene occurs naturally in coal tar and petroleum crude oil. It is a component of gasoline, and has other uses in industry as an intermediate in the production of dyes, drugs, and coatings. Exposure to very large amounts of 1,2,4-trimethylbenzene may cause skin and respiratory irritancy and nervous system depression, fatigue, headache, and drowsiness. However, risks resulting from exposure to low ambient concentrations of 1,2,4-trimethylbenzene have not been studied extensively (U.S. EPA, 1994a). 1,2,4-trimethylbenzene was evaluated as a non-carcinogen with potential to cause central nervous system and irritant effects (U.S. EPA, 2004b). 1,2,4-trimethylbenzene hazard quotients ranged from 3 at the Conyers site to 16 at Yorkville site. The theoretical cancer risk of ethylbenzene ranged from 1 x 10^{-76} at the Yorkville site to 4 x 10^{-6} at the

South DeKalb site, and the hazard quotients ranged from was 0.00004 at the Yorkville site to 0.002 at the South DeKalb site. Ethylbenzene is a colorless liquid found in many products including inks, pesticides, and paints and naturally occurs in coal tar and petroleum. Breathing high levels may cause dizziness and throat and eye irritation. Breathing relatively low levels for several days to weeks has been found to cause hearing damage in animals while breathing relatively low levels for several months to years caused kidney damage (ATSDR, 2010).

Figure 90 shows the most recent estimated chronic cancer risk (values listed as part of a million) based on the National Air Toxics Assessment (NATA) of 2011 air toxics emissions inventory data. The estimated total cancer risk levels are given per tract across the United States, and this map zooms in to show Georgia. The map indicates that the estimated tract level total cancer risk is higher in more populated areas and along transportation corridors.



Source: https://gispub.epa.gov/NATA/

Figure 90. Estimated cancer risk from the 2011 national air toxics assessment

As stated previously, the estimates of risk presented herein are likely overestimates due to conservative assumptions used in this exercise. Conservative assumptions were used to estimate the potential for possible exposures (high inhalation rates and long term exposure) and toxicity values. In the absence of good exposure information, this practice is warranted to decrease the potential for underestimating risk.

The results presented herein suggest that the majority of calculated risk is due to a small number of chemicals. The risk values presented in this report should not be interpreted as indicators of true or “real” risk, but for relative comparisons of a chemical’s contribution to aggregate risk, or for comparisons of risk between locations within the monitoring network or in other areas of the country.

OUTREACH AND EDUCATION

Maintaining effective public outreach and education is important to the Ambient Monitoring Program's mission. The Ambient Monitoring Program (AMP) seeks to address the air quality issues that are most vital to the citizens of Georgia by identifying the pollutants that represent the greatest risks, continually monitoring the pollutants, and then communicating the monitoring results directly to the public. The goal is to provide an understanding of the presence of air pollution throughout the state, and to educate the public on the steps they can take to improve air quality and protect health. AMP accomplishes this goal by issuing smog alerts and providing information about the Air Quality Index (AQI), maintaining a partnership with Georgia Commute Options, and conducting other outreach strategies aimed at keeping the public up to date on air quality issues.

Georgia Commute Options: Improving the Health and Wellness of the Metro Atlanta Region

With over 2.3 million commuters on the road in metro Atlanta, and the majority of air pollution coming from tailpipes of our vehicles, the current state of traffic congestion and its impact on the air we all breathe is a source of discussion in our region.

Georgia Commute Options, a program of the Georgia DOT, offers free programs and services that reward commuters for trying an alternative for driving alone to and from work in areas where air quality is a concern. By reducing the number of cars on the road, we can make an immediate improvement to traffic congestion and air quality in our region.

The programs have been making great strides over the past 18 years – each workday in metro Atlanta, the employers and commuters participating in Georgia Commute Options collectively eliminate 1.1 million vehicle miles of travel, save a combined $500,000 on commute costs, and keep 550 tons of pollution out of the air. More information on the programs and services offered by Georgia Commute Options can be found at GaCommuteOptions.com.

The Air Quality Index

The Air Quality Index (AQI) is a national air standard rating system developed by the U.S. Environmental Protection Agency. The AQI is used statewide 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, and Very Unhealthy. To protect public health the EPA has set an AQI value of 100 to correspond to the NAAQS for the following criteria 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. Therefore, the larger the AQI value, the greater level of air pollution present, and the greater expectation of potential health concerns. 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.

Error! Reference source not found. Figure 91 shows how the recorded concentrations correspond to the AQI values, descriptors and health advisories. Each day the AQI values for Athens, Atlanta, Augusta, Columbus, Macon, North Georgia Mountains, and Savannah are available to the public through Georgia EPD's Ambient Air Monitoring website at http://amp.georgiaair.org/. Table 32 shows a summary of the 2015 AQI values for these sites as well as all sites that collect criteria data in Georgia.

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)* ppm	(8hr)^ ppm	(1hr) ppm	(8hr) ppm	(1hr) ppm	**AQI Value**	**Descriptor**	**EPA Health Advisory**
0.0–12.0	0– 54	0–0.035	0.000–0.059	None	0.0–4.4	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	0.060–0.075	None	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	0.076 –0.095	0.125 –0.164	9.5–12.4	0.101-0.360	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	0.186–0.304*	0.096–0.115	0.165–0.204	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	0.305–0.604*	0.116–0.374	0.205–0.404	15.5–30.4	0.650–1.249	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	0.605–0.804*	None^	0.405 –0.504	30.5–40.4	1.250–1.649	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	505–604	0.805–1.004*	None^	0.505–0.604	40.5–50.4	1.650–2.049	401 to 500		

Figure 91. The AQI, *AQI values of 200 or greater are calculated with 24-hr SO_2 concentrations, ^AQI values of 301 or greater are calculated with 1-hr O_3 concentrations.

Table 32. 2015 AQI summary data, most days had an AQI value in the ‘Good’ (0-50) category for all the sites.

***AQI numbers above 100 may not be equivalent to a violation of the standard*

Air Quality Index Summary by CBSA						
Number of Days						
Pollutants Monitored in 2015	**Good (0-50)**	**Moderate (51-100)**	**Unhealthy for Sensitive Groups (101-150)****	**Unhealthy (151-200)****	**Very Unhealthy (201-300)****	**Hazardous (>300)****
Albany						
$PM_{2.5}$	230	134	1	-	-	-
Americus						
O_3	237	8	1	-	-	-
Athens-Clark County						
O_3, $PM_{2.5}$	302	56	-	-	-	-
Atlanta-Sandy Springs-Roswell						
O_3, NO_2, $PM_{2.5}$, CO, SO_2, PM_{10}	142	208	13	2	-	-
Augusta-Richmond County, GA-SC						
O_3, $PM_{2.5}$, PM_{10}	265	99	1	-	-	-
Brunswick						
O_3, $PM_{2.5}$	326	28	-	-	-	-
Chattanooga, TN-GA						
O_3, $PM_{2.5}$	264	95	-	-	-	-
Columbus, GA-AL						
O_3, $PM_{2.5}$	276	73	1	-	-	-
Dalton						
O_3	261	23	-	-	1	-
General Coffee						
$PM_{2.5}$	56	4	-	-	-	-
Gainesville						
$PM_{2.5}$	149	115	-	-	-	-
Macon						
O_3, SO_2, $PM_{2.5}$	251	114	-	-	-	-
Rome						
SO_2, $PM_{2.5}$	260	105	-	-	-	-
Savannah						
O_3, SO_2, $PM_{2.5}$	299	65	-	1	-	-
Summerville						
O_3	173	18	-	-	-	-
Valdosta						
$PM_{2.5}$	276	81	-	-	-	-
Warner Robins						
$PM_{2.5}$	282	70	-	-	-	-

Figure 92 shows the number of days that the AQI value was above 100 for each metropolitan statistical area (MSA) in Georgia where an AQI value is produced. The data was generated starting in 1972 and is shown through 2015. To be consistent, the most current standards were applied throughout the historical dataset. As one would expect, the Atlanta-Sandy Springs-Roswell MSA (shown in orange below) has historically had the highest number of days with the AQI above 100. The pattern materializing across the forty-three year timeframe seems to be cyclic. However, the number of days above 100 for the Atlanta-Sandy Springs-Roswell MSA decreased dramatically from 1999 to 2004 and from 2006 to 2009. The number dropped from 95 days in 1999 to 33 days in 2004 and from 63 days in 2006 to 15 days in 2009. More recently, the Atlanta-Sandy Springs-Roswell MSA's number of days with AQI above 100 decreased from 44 days in 2011 to 19 days in 2012, and then 3 in 2013. There was a slight increase in 2014, with the Atlanta-Sandy Springs-Roswell MSA having nine days with AQI above 100, and again in 2015 with 15 days above 100. The remaining MSA sites had one or no days with the AQI above 100 in 2015. The majority of sites did not have any days with AQI above 100 in 2015.

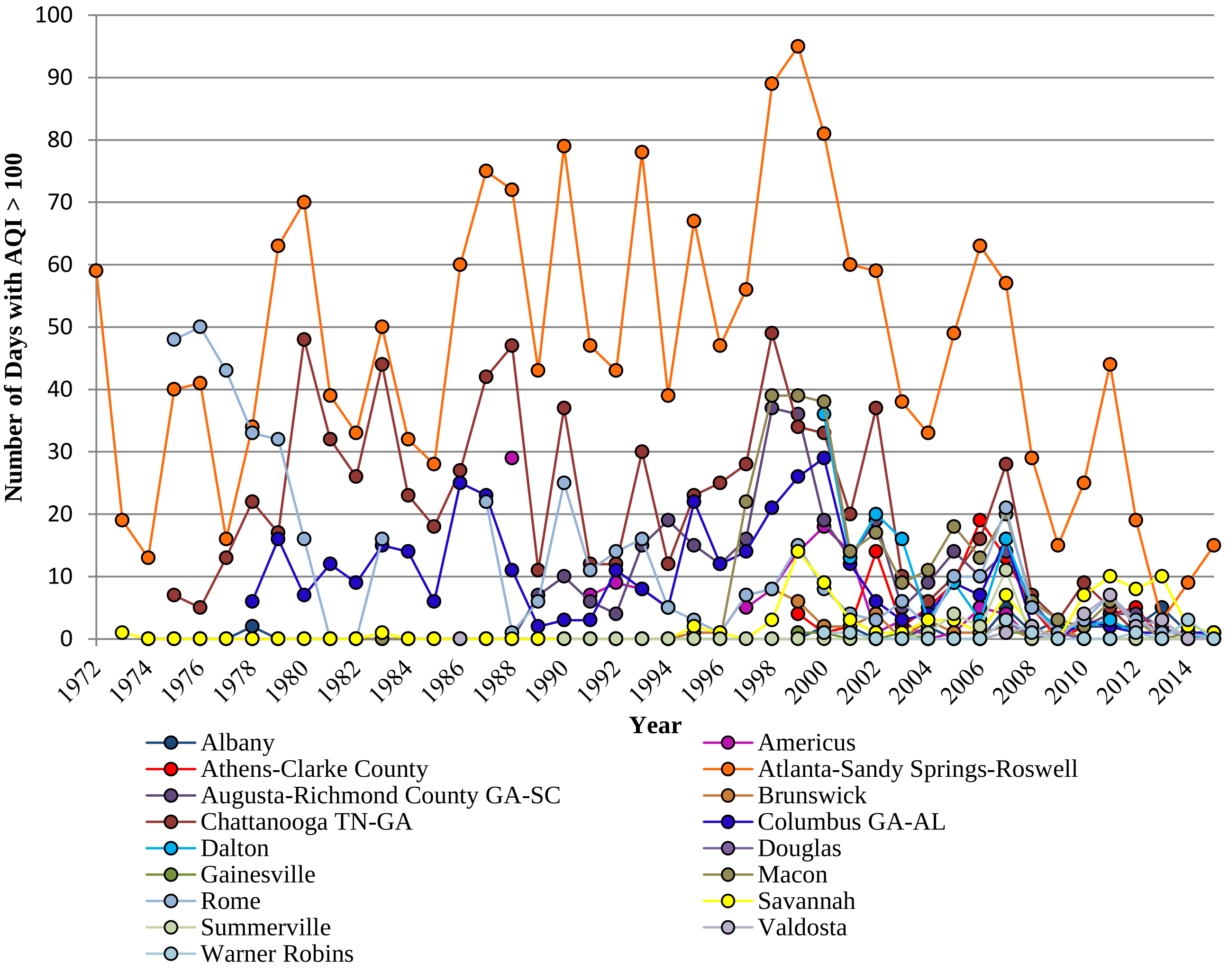


Figure 92. The number of days each MSA had an AQI value above 100

Figure 93 displays in more detail the 2015 AQI values for the Atlanta-Sandy Springs-Roswell MSA. There were 15 days with an AQI value above 100, all occurred between May and August. Ozone is a major driver of an elevated AQI and can be higher in the summer months due to increased sunlight. Higher ozone and $PM_{2.5}$ concentrations are the primary sources of AQI values in the “Unhealthy for Sensitive Groups” category in the Atlanta-Sandy Springs-Roswell MSA.

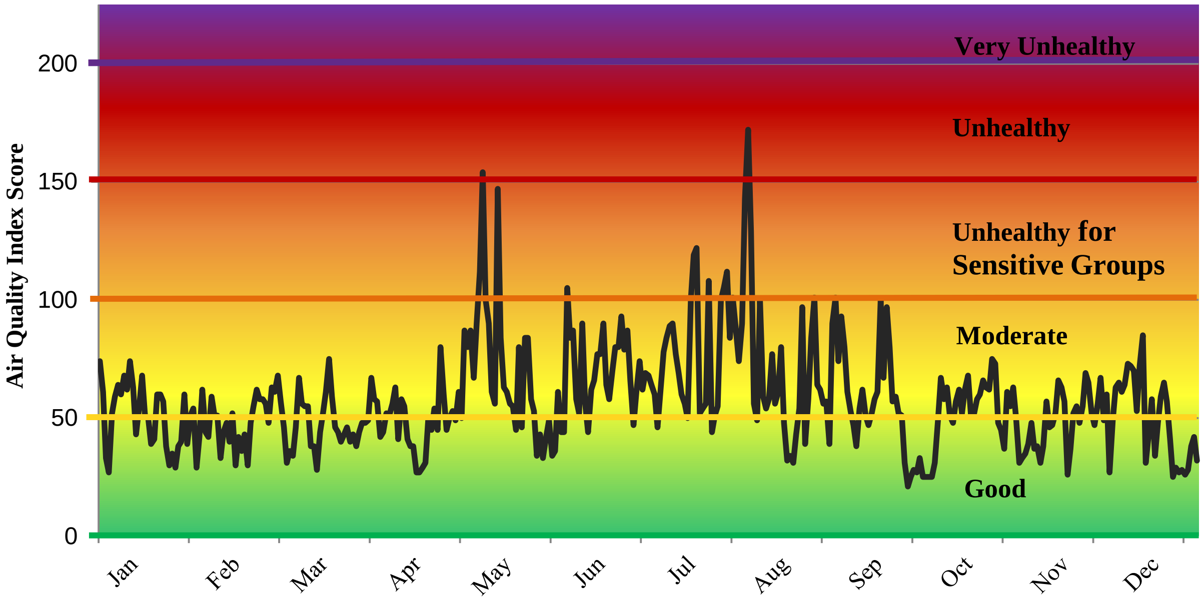
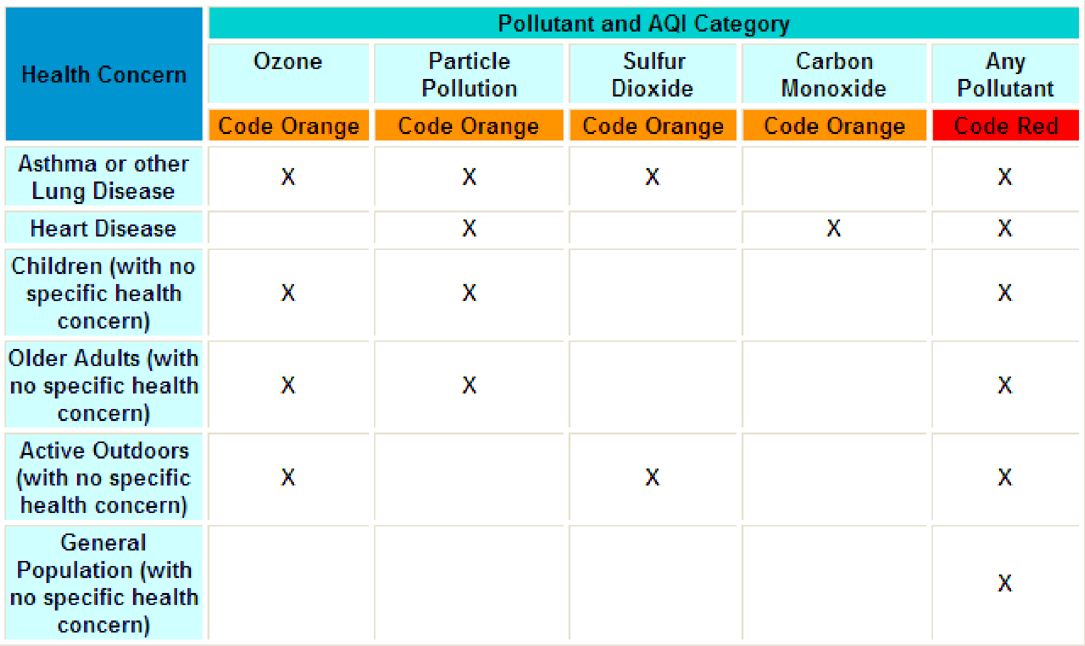


Figure 93. 2015 AQI Values for the Atlanta-Sandy Springs-Roswell MSA

When pollution levels are higher causing the AQI values to be above 100, members of sensitive groups, such as children, older adults or people with lung disease, may experience health effects. The general public is more likely to be affected when AQI values are greater than 150. Table 33 can be used as a guide to outline the health concerns of each group of sensitive populations that can be affected when the AQI is Code Orange or Code Red. This table also shows which pollutant(s) affects each sensitive population. It is used as an illustration, with the understanding that some individuals can be more sensitive than others.

Table 33. The health concerns of sensitive populations when AQI values exceed 100 (Code Orange) and the general population when the AQI values exceed 150 (Code Red) and which pollutants affect each population



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

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

Figure 94 shows the number of days each MSA had an AQI value exceeding 100 and which pollutant was the primary driver (critical pollutant) of that AQI value. Combining the data shown in Figure 94 with Table 33, we can infer which sensitive groups would be most affected on days with an AQI value >100 based on the critical pollutant for that day. For example, Savannah had one day with an AQI score >100 and the critical pollutant was SO_2, so we can infer using Table 33 that those with asthma or other lung disease and active individuals would have been most likely to experience health effects during that day.

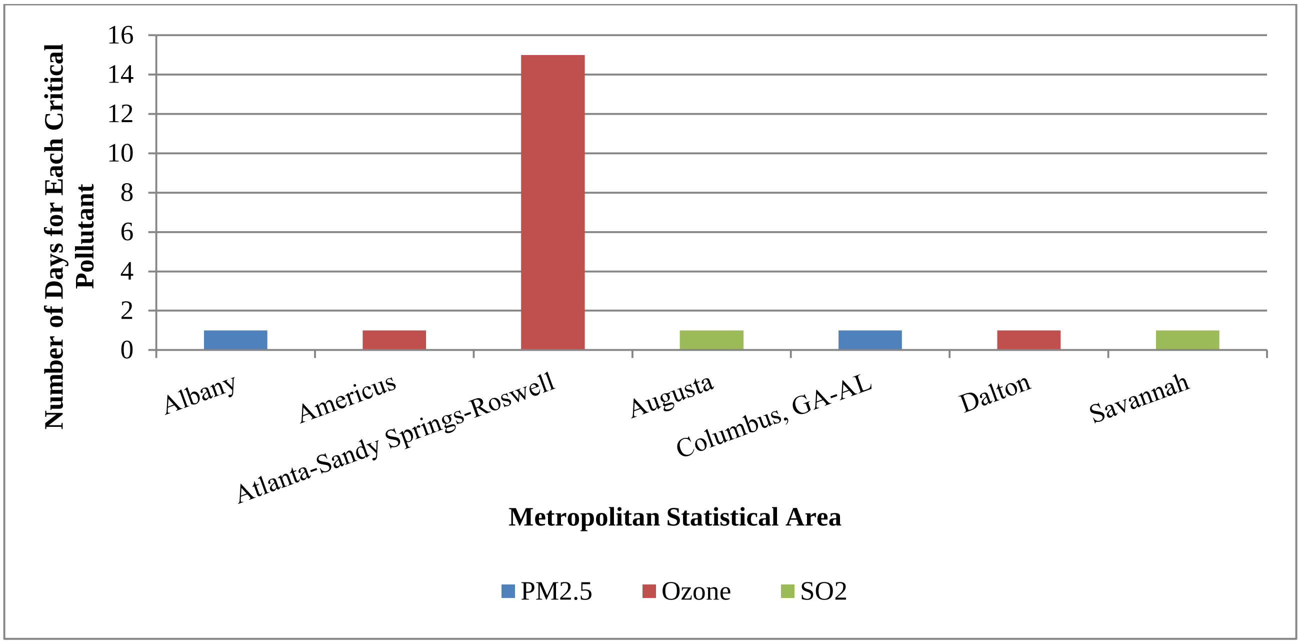


Figure 94. The number of days each MSA had an AQI value exceeding 100 in 2015 and which pollutant was the critical pollutant for those days

How does Georgia's Ambient Monitoring Program (AMP) Cooperate with Georgia Commute Options?

The Ambient Monitoring Program is responsible for measuring air pollutant levels in metro Atlanta and throughout the state. Equipment at twelve continuous monitoring stations across metro Atlanta is used for these measurements of particulate matter (PM), sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), and ozone (O_3). This data is reported hourly on a website which is maintained and updated by the Ambient Monitoring Program. Based on these levels, AMP calculates the Air Quality Index (AQI), which represents overall air quality in a way that is quick and easy for the general public to understand. The Ambient Monitoring Program's website is linked to a websites maintained by Georgia Commute Options. The AQI is then displayed on Georgia Commute Options' website. Georgia Commute Options also distributes AQI information to people who have signed up to receive daily air quality forecasts via e-mail. When a smog alert is forecasted, an automated fax blast informs all local media as well. Through these connections, thousands of metro Atlanta citizens and businesses keep abreast of current air quality conditions. The Ambient Monitoring Program also encourages the public to access the Georgia Commute Options' website and learn about voluntary measures that are available locally to improve air quality.

MEDIA OUTREACH

The Ambient Monitoring Program is accessible to public citizens, as well as the news media, through phone calls, website updates and media interviews. At many times throughout the year, the demand for a story puts AMP in the spotlight. The Program Manager and staff of the Ambient Monitoring Program make themselves available to television and newspaper reporters, thus educating the public about the AQI, statewide air monitors, and Georgia Commute Options.

OTHER OUTREACH OPPORTUNITIES

Meteorologists

Forecasters from the Ambient Monitoring Program issue air quality forecasts on a daily basis. In addition, forecasters answer questions for the news media and calls from the public. For more information regarding the work done by the Ambient Monitoring Program's meteorologists, refer to the Meteorological Section of this report.

Elementary and Middle Schools

Educating school children and incorporating air quality information into the classroom-learning environment is also an outreach strategy for the Ambient Monitoring Program. AMP staff visit Georgia classrooms to discuss air quality, forecasting, and monitoring. Each program presented by the AMP is designed to supplement grade-specific curricula. Learning opportunities include meteorological lessons and forecasting techniques, among other relevant topics.

In many situations, these lessons involve hands-on activities and mini-field trips to the monitoring sites. High School students simulate forecasting conditions and use scientific methods to create their own forecasts. AMP staff also participate in Career Days at both elementary and high schools to promote environmental and meteorological careers.

Colleges and Universities

The Ambient Monitoring Program works with colleges and universities in several capacities. Utilizing a more technical, advanced approach, AMP has participated in several college-level seminars, providing scientific expertise on the subject of meteorology and forecasting. Through this close contact with university staff, AMP staff have co-authored scientific papers in peer-reviewed scientific journals. AMP staff provide technical data to professors as well as students, thus incorporating real-time data into college courses and projects. Additionally, AMP works with Georgia Institute of Technology in a joint forecasting effort.

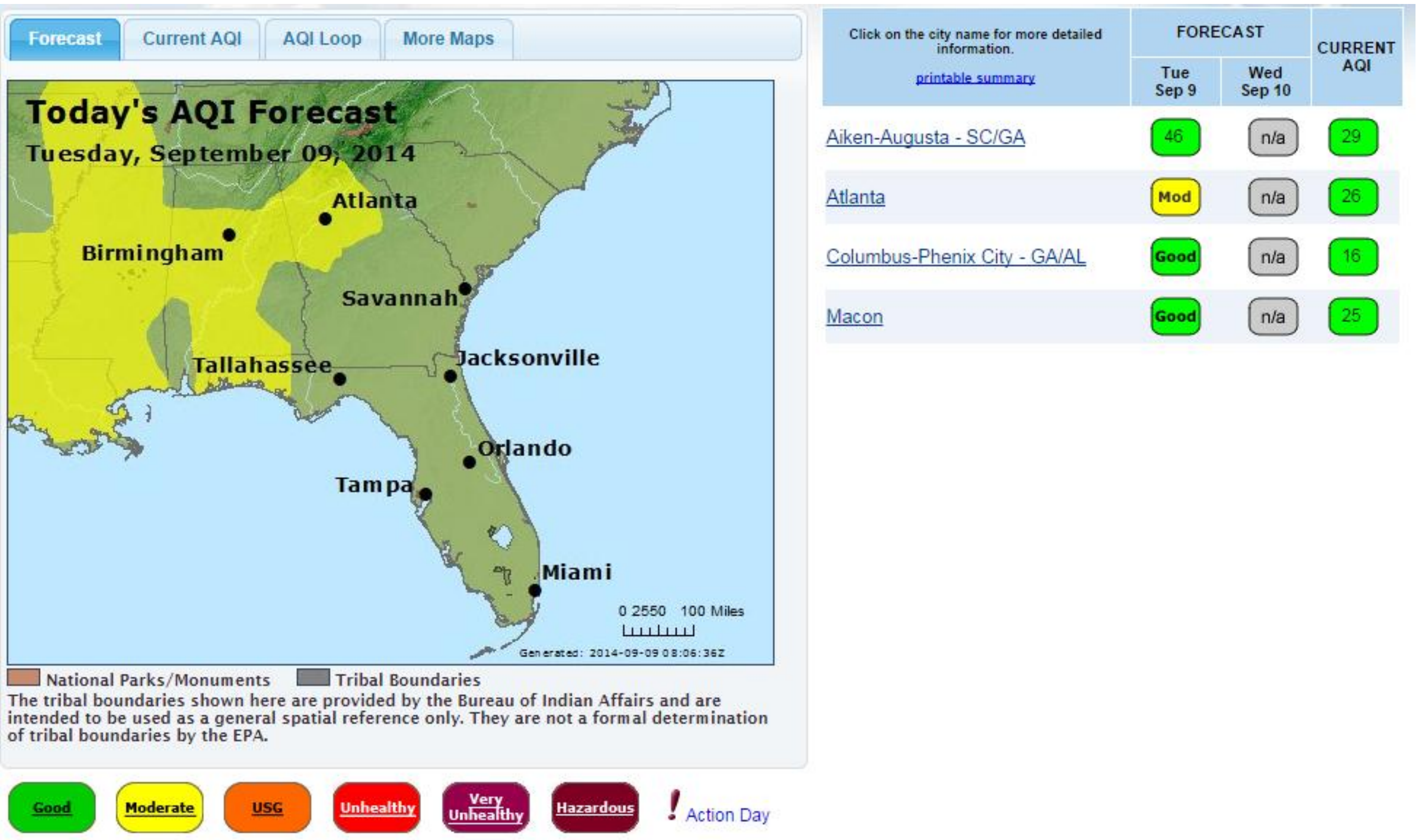
AMP also hosts an annual Air Quality Seminar and Air Monitoring Station fieldtrip for college interns in the Centers for Disease Control and Prevention's (CDC) Environmental Health Summer Intern Program, thereby reaching top college students from all over the country.

Monitoring Data Requests

AMP also regularly receives requests for specific, detailed monitoring data from members of the research community and the broader public. Completely fulfilling the needs of these data users often requires not just data, but also providing guidance on how the data can be interpreted and what the limitations of the data set may be. AMP welcomes these opportunities to serve the public and the research community, and to ensure that the data collected is put to its fullest and most advantageous use in protecting the health and welfare of Georgia's citizens and the state's natural environment.

EPA AirNow Website

Georgia supplies ozone and particulate matter data to the U.S. EPA every hour for pollution mapping activities. AirNow is a cooperative effort between EPA, states, and local air pollution control agencies to provide near real-time information on ground level ozone and $PM_{2.5}$ concentrations. EPA uses the data to produce maps that display ozone and $PM_{2.5}$ contours covering the Midwest, New England, Mid-Atlantic, Southeastern, South central and Pacific coastal regions of the country. Color-coded, animated concentration gradient AQI maps are created that show daily ozone and $PM_{2.5}$ formation and transport at various spatial scales. The information is available on the EPA's AirNow website at: http://www.airnow.gov/. See Figure 95 for a sample map.



The tribal boundaries shown here are provided by the Bureau of Indian Affairs and are intended to be used as a general spatial reference only. They are not a formal determination of tribal boundaries by the EPA.

Click on the city name for more detailed information. printable summary	FORECAST		CURRENT AQI
	Tue Sep 9	Wed Sep 10	
Aiken-Augusta - SC/GA	46	n/a	29
Atlanta	Mod	n/a	26
Columbus-Phenix City - GA/AL	Good	n/a	16
Macon	Good	n/a	25

Figure 95. Sample AirNow ozone concentration map

The AirNow Data Management Center (DMC) regularly evaluates the performance of monitoring agencies that participate in the AirNow project based on three criteria:

1. Percent of hourly data files received
2. Average arrival time (earlier in the hour is better)
3. Percent completeness of the data within the submission files

There is a three-tier system (top, middle, and lower) set up to evaluate each agency based on these performance criteria. An agency is placed in a tier based on how it performs these three criteria, with respect to all participating agencies.

GA EPD Website

The Ambient Monitoring Program also provides a public-access website with Georgia-specific current and historical air quality data, often more promptly and with more detail than what is available at the AirNow website. AMP's website provides hourly information about current pollutant concentrations from Georgia's continuous and semi-continuous monitoring equipment, and is updated with each hour's data two or three hours after the hour ends, depending on daylight savings time. The site also offers downloads of bulk data, and electronic copies of archived Annual Reports such as this one, on a self-serve basis to facilitate research projects and satisfy public interest on these topics. The Ambient Monitoring Program website can be accessed at http://amp.georgiaair.org/.

Appendix A: Additional Criteria Pollutant Data

Carbon Monoxide (CO)

Units: parts per million

Site ID	City	County	Site Name	Hours Measured	Max 1 - Hour		Obs. ≥ 35	Max 8 - Hour		Obs. ≥ 9
					1st	2nd		1st	2nd	
130890002	Atlanta	DeKalb	South DeKalb	8365	1.494	1.419	0	1.3	1.2	0
131210056	Atlanta	Fulton	GA Tech Near Road	8622	2.5	2.3	0	2.0	1.8	0
132230003	Yorkville	Paulding	Yorkville	8166	1.200	1.100	0	1.1	1.0	0

Nitrogen Dioxide (NO_2)

Units: parts per billion

Site ID	City	County	Site Name	Hours Measured	98th %	Max 1-Hour		Annual Arithmetic Mean
						1st	2nd	
130890002	Decatur	DeKalb	South DeKalb	8179	48.4	60.1	57.8	9.78
130890003	Atlanta	DeKalb	DMRC	8426	54.1	65.2	57.3	15.86
131210056	Atlanta	Fulton	GA Tech Near Road	8396	49.3	62.4	52.9	19.54
132230003	Yorkville	Paulding	Yorkville	8023	13.0	17.3	15.9	1.88
132470001	Conyers	Rockdale	Monastery	8438	18.3	23.4	21.3	3.42

Nitric Oxide (NO)

Units: parts per billion

Site ID	City	County	Site Name	Hours Measured	Max 1-Hour		Annual Arithmetic Mean
					1st	2nd	
130890002	Decatur	DeKalb	South DeKalb	8179	272.6	247.1	12.91
130890003	Atlanta	DeKalb	DMRC	8426	414.9	376.4	30.04
131210056	Atlanta	Fulton	GA Tech Near Road	8396	252.5	241.5	32.62
132230003	Yorkville	Paulding	Yorkville	8023	25.2	8.4	1.07
132470001	Conyers	Rockdale	Monastery	8438	43.8	39.0	1.35

Oxides of Nitrogen (NO_x)

Units: parts per billion

Site ID	City	County	Site Name	Hours Measured	Max 1-Hour		Annual Arithmetic Mean
					1st	2nd	
130890002	Decatur	DeKalb	South DeKalb	8179	288.7	280.1	22.35
130890003	Atlanta	DeKalb	DMRC	8425	468.1	417.4	45.85
131210056	Atlanta	Fulton	GA Tech Near Road	8396	288.8	282.9	51.98
132230003	Yorkville	Paulding	Yorkville	8023	18.5	17.9	2.01
132470001	Conyers	Rockdale	Monastery	8438	52.4	50.4	4.19

Reactive Oxides of Nitrogen (NO_y)

Units: parts per billion

Site ID	City	County	Site Name	Hours Measured	Max 1-Hour		Annual Arithmetic Mean
					1st	2nd	
130890002	Decatur	DeKalb	South DeKalb	8425	200.0	200.0	21.78

** The NO_y instrument is specialized for measurement of trace concentrations, so its range is only 0-200 ppb. Actual 1st Max appears to have exceeded the instrument's measurement range. Since all ambient concentrations exceeding the instrument's range are recorded as 200 instead of the actual (higher) value, the reported annual arithmetic mean may be biased slightly downward from the true concentration.

Sulfur Dioxide (SO_2)

24-Hour, 3-Hour, 1-Hour Maximum Observations, 99th Percentile 1-hour, and Maximum 5-minute

Units: parts per billion

Site ID	City	County	Site Name	Hours Measured	Max 24 - Hour		Max 3 - Hour		Max 1-Hour		99th Pctl 1- Hr	Maximum 5-Minute Average	Annual Arithmetic Mean
					1st	2nd	1st	2nd	1st	2nd			
130210012	Macon	Bibb	Macon-Forestry	8609	2.8	2.6	8.1	7.5	13.1	10.5	8.2	27.2	1.02
130510021	Savannah	Chatham	Savannah-E. Pres. St	8594	20.7	11.0	130	21.1	257.3	36.5	31.2	508.3	1.53
130511002	Savannah	Chatham	Savannah-L&A	8649	16.3	13.3	37.5	33.5	57.9	57.7	49.6	135.5	1.75
130890002	Decatur	DeKalb	South DeKalb	8374	1.4	1.2	4.6	2.7	5.4	5.1	3.8	7.4	0.27
131150003	Rome	Floyd	Rome	7856	11.8	8.9	55.6	53.5	72.8	71.5	42.5	185.5	1.42
131210055	Atlanta	Fulton	Confederate Ave.	8448	1.4	1.3	4.1	2.5	4.4	4.3	3.9	24.0	0.94
132450091	Augusta	Richmond	Augusta	8584	9.5	8.0	47.3	32.5	104.1	67.7	63.1	199.3	1.61

Ozone (O_3)

1-Hour Averages

Units: parts per million

Site ID	City	County	Site Name	Days Measured	1st Max	2nd Max
130210012	Macon	Bibb	Macon-Forestry	245	0.081	0.075
130510021	Savannah	Chatham	Savannah-E. Pres. St.	241	0.083	0.076
130550001	Summerville	Chattooga	Summerville	191	0.078	0.073
130590002	Athens	Clarke	Athens	209	0.080	0.071
130670003	Kennesaw	Cobb	Kennesaw	237	0.079	0.075
130730001	Evans	Columbia	Evans	243	0.077	0.067
130770002	Newnan	Coweta	Newnan	237	0.083	0.081
130850001	Dawsonville	Dawson	Dawsonville	242	0.082	0.078
130890002	Decatur	DeKalb	South DeKalb	241	0.106	0.087
130970004	Douglasville	Douglas	Douglasville	235	0.083	0.081
131210055	Atlanta	Fulton	Confederate Ave.	245	0.105	0.097
131270006	Brunswick	Glynn	Brunswick	244	0.070	0.068
131350002	Lawrenceville	Gwinnett	Gwinnett Tech	245	0.105	0.094
131510002	McDonough	Henry	McDonough	243	0.096	0.086
132130003	Chatsworth	Murray	Fort Mountain	240	0.269	0.070
132150008	Columbus	Muscogee	Columbus- Airport	220	0.087	0.076
132230003	Yorkville	Paulding	Yorkville	240	0.077	0.076
132319991	Williamson	Pike	CASTNET	244	0.102	0.093
132450091	Augusta	Richmond	Augusta	242	0.076	0.072
132470001	Conyers	Rockdale	Conyers	243	0.093	0.091
132611001	Leslie	Sumter	Leslie	245	0.147	0.067

Ozone (O_3)

8-Hour Averages

Units: parts per million

Site ID	City	County	Site Name	Days Measured	1st Max	2nd Max	3rd Max	4th Max	Number of Days ≥ 0.075
130210012	Macon	Bibb	Macon-Forestry	245	0.066	0.064	0.062	0.062	0
130510021	Savannah	Chatham	Savannah-E. Pres. St.	241	0.060	0.059	0.058	0.058	0
130550001	Summerville	Chattooga	Summerville	189	0.069	0.064	0.063	0.063	0
130590002	Athens	Clarke	Athens	209	0.069	0.063	0.062	0.061	0
130670003	Kennesaw	Cobb	Kennesaw	235	0.074	0.069	0.067	0.066	0
130730001	Evans	Columbia	Evans	241	0.065	0.061	0.060	0.059	0
130770002	Newnan	Coweta	Newnan	235	0.073	0.071	0.069	0.066	0
130850001	Dawsonville	Dawson	Dawsonville	241	0.071	0.070	0.068	0.063	0
130890002	Decatur	DeKalb	South DeKalb	239	0.085	0.074	0.072	0.071	1
130970004	Douglasville	Douglas	Douglasville	234	0.074	0.070	0.070	0.070	0
131210055	Atlanta	Fulton	Confederate Ave.	245	0.094	0.087	0.083	**0.077**	**5**
131270006	Brunswick	Glynn	Brunswick	244	0.058	0.056	0.055	0.055	0
131350002	Lawrenceville	Gwinnett	Gwinnett Tech	245	0.087	0.079	0.072	0.071	2
131510002	McDonough	Henry	McDonough	243	0.084	0.074	0.072	0.070	1
132130003	Chatsworth	Murray	Fort Mountain	237	0.104	0.067	0.066	0.063	1
132150008	Columbus	Muscogee	Columbus- Airport	218	0.069	0.065	0.062	0.062	0
132230003	Yorkville	Paulding	Yorkville	240	0.067	0.067	0.065	0.065	0
132319991	Williamson	Pike	CASTNET	244	0.090	0.078	0.071	0.068	2
132450091	Augusta	Richmond	Augusta	240	0.066	0.063	0.063	0.060	0
132470001	Conyers	Rockdale	Conyers	243	0.081	0.076	0.073	0.068	2
132611001	Leslie	Sumter	Leslie	245	0.063	0.061	0.059	0.057	0

4th max used in 3-year average, therefore if number above 0.075 is more than 4 per site, it is shown in bold.

Lead (Pb)

3-Month Rolling Averages Using Federal Equivalent Method

Units: micrograms per cubic meter

Site ID	130890003	132150009	132150010	132150011
City	Atlanta	Columbus	Columbus	Columbus
County	DeKalb	Muscogee	Muscogee	Muscogee
Site Name	DMRC	Columbus-UPS	Columbus-Ft. Benning	Columbus-Cusseta
Number of Obs.	59	59	60	55
Nov 2014-Jan 2015	0.0022	0.0427	0.0146	0.0122
Dec 2014-Feb 2015	0.0025	0.0245	0.0110	0.0095
Jan 2015-Mar 2015	0.0026	0.0289	0.0188	0.0084
Feb 2015-Apr 2015	0.0025	0.0283	0.0383	0.0090
Mar 2015-May 2015	0.0023	0.0387	0.0477	0.0072
Apr 2015-Jun 2015	0.0020	0.0397	0.0473	0.0057
May 2015-Jul 2015	0.0021	0.0397	0.0271	0.0042
Jun 2015-Aug 2015	0.0026	0.0283	0.0283	0.0037
Jul 2015-Sep 2015	0.0026	0.0291	0.0203	0.0035
Aug 2015-Oct 2015	0.0024	0.0239	0.0207	0.0035
Sep 2015-Nov 2015	0.0017	0.0222	0.0178	0.0042
Oct 2015-Dec 2015	0.0017	0.0144	0.0202	0.0048
# of Values ≥ 0.15	0	0	0	0

Fine Particulate Matter ($PM_{2.5}$)

98th% and Annual Arithmetic Mean
Integrated Sampling (midnight to midnight) Using Federal Reference Method

Units: micrograms per cubic meter

Site ID	City	County	Site Name	Days Meas-ured	98th Percen-tile	Values Exceeding Applicable Daily Standard	Annual Arith-metic Mean
130210007	Macon	Bibb	Macon-Allied	326	20.6	0	9.43
130210012	Macon	Bibb	Macon-Forestry	111	17.7	0	7.63
130510091	Savannah	Chatham	Savannah-Mercer	117	18.1	0	8.11
130590002	Athens	Clarke	Athens	117	18.9	0	8.42
130630091	Forest Park	Clayton	Forest Park	121	17.8	0	9.70
130670003	Kennesaw	Cobb	Kennesaw	342	17.2	0	8.93
130890002	Decatur	DeKalb	South DeKalb	358	16.5	0	8.60
130950007	Albany	Dougherty	Albany	346	21.2	0	8.77
131150003	Rome	Floyd	Rome	336	19.2	0	9.39
131210039	Atlanta	Fulton	Fire Station #8	120	17.5	0	10.04
131210056	Atlanta	Fulton	GA Tech Near Road	118	22.5	0	10.48
131270006	Brunswick	Glynn	Brunswick	118	15.5	0	7.27

Fine Particulate Matter ($PM_{2.5}$) (continued)

98^{th}% and Annual Arithmetic Mean
Integrated Sampling (midnight to midnight) Using Federal Reference Method

Units: micrograms per cubic meter

Site ID	City	County	Site Name	Days Measured	98th Percentile	Values Exceeding Applicable Daily Standard	Annual Arithmetic Mean
131350002	Lawrenceville	Gwinnett	Gwinnett Tech	116	18.3	0	8.71
131390003	Gainesville	Hall	Gainesville	114	18.1	0	7.92
131530001	Warner Robins	Houston	Warner Robins	112	18.4	0	8.65
131850003	Valdosta	Lowndes	Valdosta	115	15.3	0	7.88
132150001	Columbus	Muscogee	Columbus-Health Dept.	114	19.5	0	9.17
132150008	Columbus	Muscogee	Columbus Airport	121	20.9	0	8.93
132150011	Columbus	Muscogee	Columbus-Cusseta	114	19.0	0	9.12
132230003	Yorkville	Paulding	Yorkville	115	15.9	0	7.49
132450091	Augusta	Richmond	Augusta	114	18.3	0	8.89
132950002	Rossville	Walker	Rossville	121	17.7	0	9.18
133030001	Sandersville	Washington	Sandersville	118	19.0	0	8.20
133190001	Gordon	Wilkinson	Gordon	115	20.2	0	9.28

Fine Particulate Matter ($PM_{2.5}$)

Hourly Averages of Semi-Continuous Measurements

Units: micrograms per cubic meter

Site ID	City	County	Site Name	Hours Meas-ured	1st Max	2nd Max	Annual Arith-metic Mean
130210012	Macon	Bibb	Macon-Forestry	8452	56.3	52.1	7.22
130511002	Savannah	Chatham	Savannah-L&A	8295	89.5	87.6	8.00
130590002	Athens	Clarke	Athens	8451	97.5	78.9	7.12
130770002	Newnan	Coweta	Newnan	8604	62.5	57.5	7.55
130890002	Decatur	DeKalb	South DeKalb	8429	67.0	50.0	11.85
130950007	Albany	Dougherty	Albany	8371	101.0	95.0	10.80
131150003	Rome	Floyd	Rome	1893	92.0	78.0	10.94
131210055	Atlanta	Fulton	Confederate Avenue	8560	46.4	43.8	10.25
131350002	Lawrenceville	Gwinnett	Gwinnett Tech	8610	310.9	289.2	7.69
131390003	Gainesville	Hall	Gainesville	6087	57.0	57.0	12.70
131510002	McDonough	Henry	McDonough	8669	95.9	84.6	7.49
131530001	Warner Robins	Houston	Warner Robins	8065	530.0	359.0	9.04
131850003	Valdosta	Lowndes	Valdosta	8396	244.0	71.0	9.91
132150008	Columbus	Muscogee	Columbus-Airport	8090	140.0	134.6	7.95
132230003	Yorkville	Paulding	Yorkville	8600	65.1	64.5	10.19
132450091	Augusta	Richmond	Augusta	8633	80.0	62.0	8.38
132950002	Rossville	Walker	Rossville	8519	77.0	49.0	9.61

Except for the South DeKalb and Albany monitors, these semi-continuous methods for measuring $PM_{2.5}$ are not approved for use in making attainment determinations.

Particulate Matter (PM_{10})

24-Hour Integrated Measurements

Units: micrograms per cubic meter

Site ID	City	County	Site Name	Days Measured	1st Max	Number Values $\geq$150	Annual Arith-metic Mean
131210039	Atlanta	Fulton	Fire Station #8	58	78	0	16.4
132450091	Augusta	Richmond	Augusta	47	33	0	13.2

Particulate Matter (PM_{10})

Hourly Averages of Semi-Continuous Measurements

Units: micrograms per cubic meter

Site ID	City	County	Site Name	Hours Measured	1st Max	Annual Arithmetic Mean
130890002	Decatur	DeKalb	South DeKalb	8433	671	17.6

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

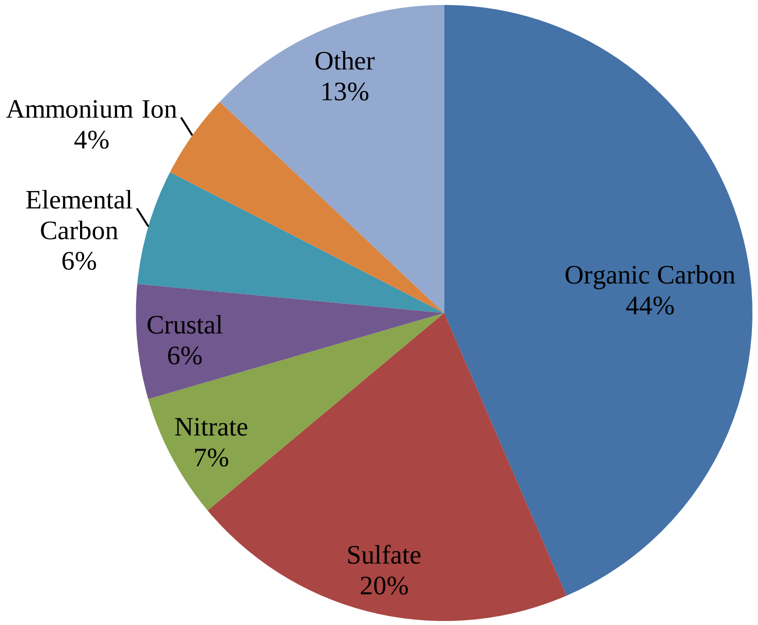
Hourly Averages of Semi-Continuous Measurements

Units: micrograms per cubic meter

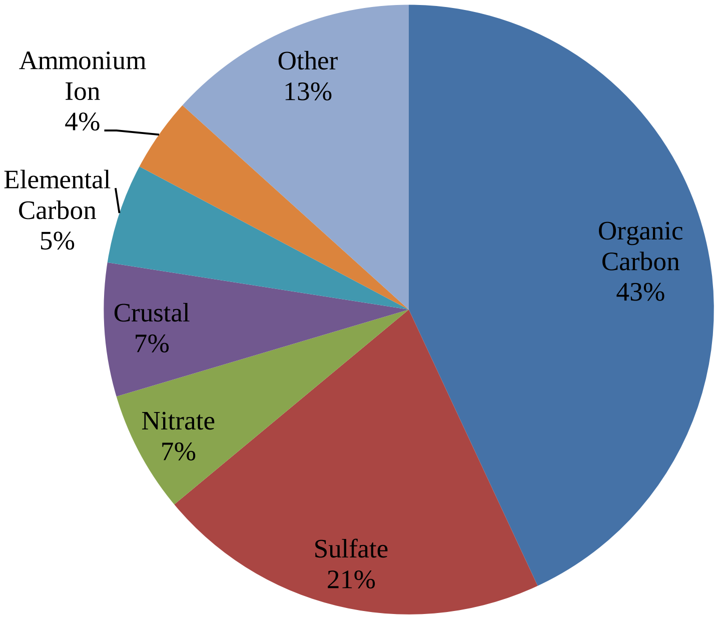
Site ID	City	County	Site Name	Hours Measured	1st Max	Annual Arithmetic Mean
130890002	Decatur	DeKalb	South DeKalb	8393	676.0	5.87

Appendix B: Additional $PM_{2.5}$ Particle Speciation Data

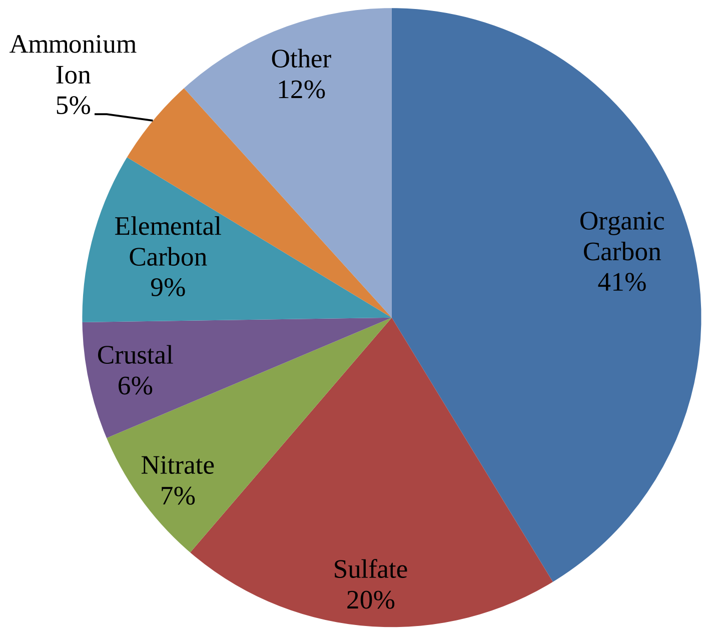
Statewide Average $PM_{2.5}$ Speciation



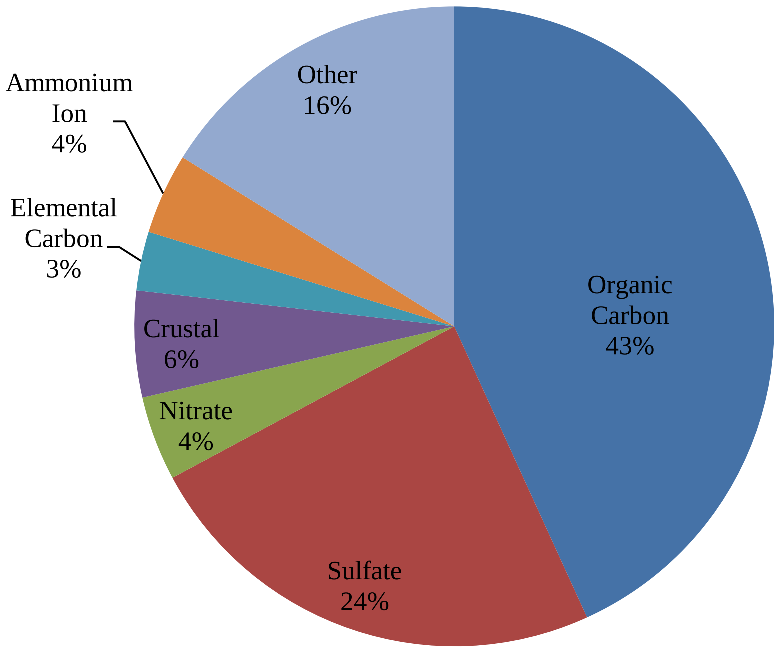
Macon-Allied $PM_{2.5}$ Speciation



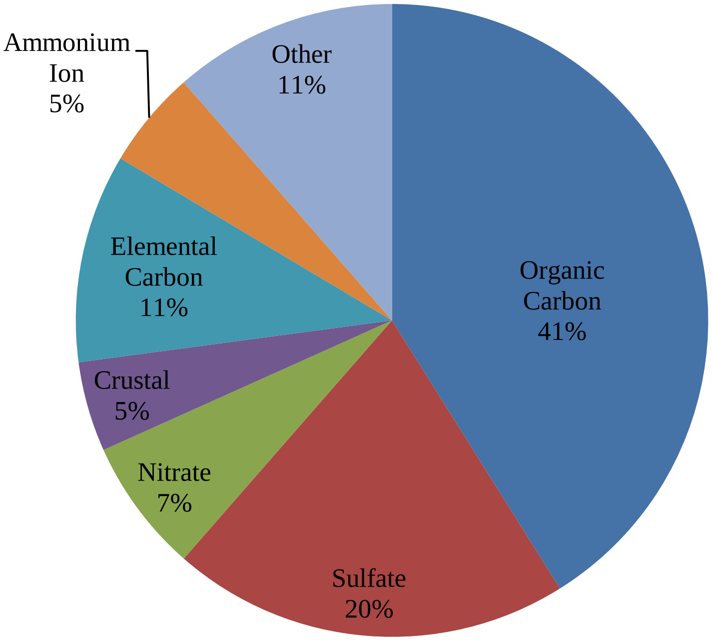
South Dekalb $PM_{2.5}$ Speciation



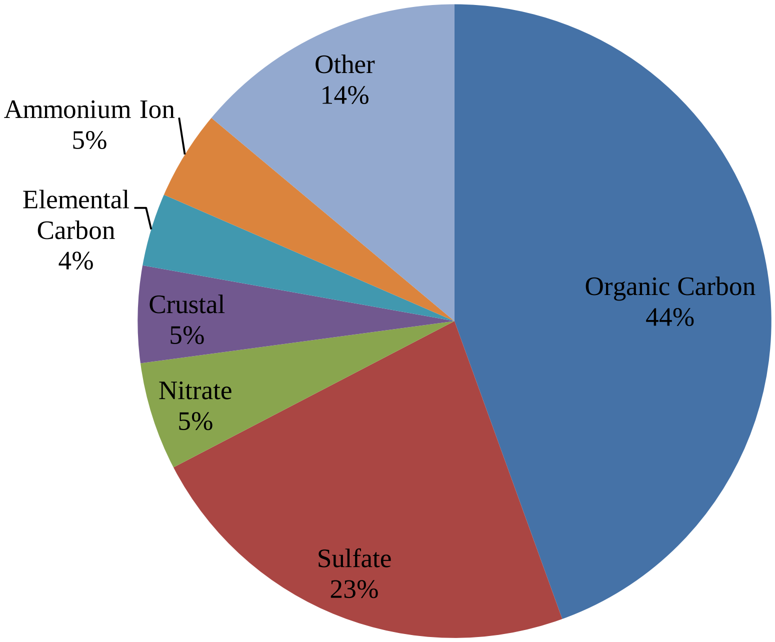
General Coffee $PM_{2.5}$ Speciation



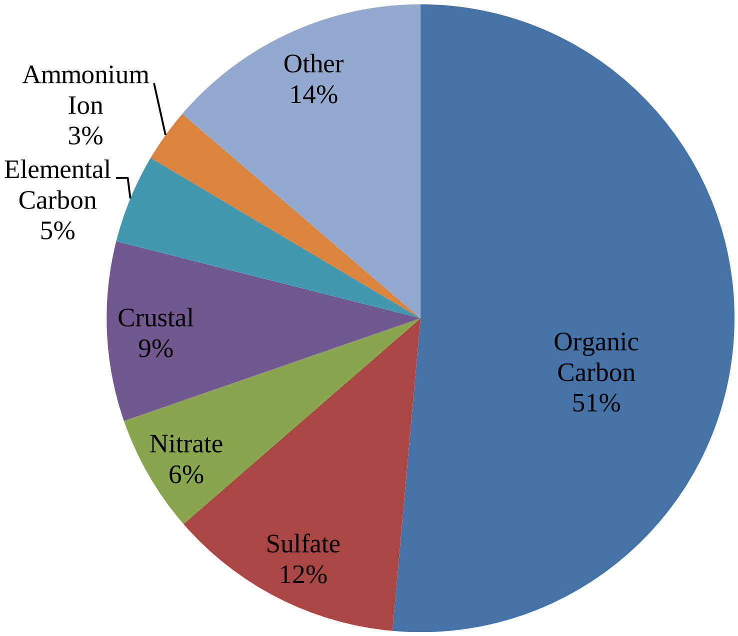
Rome $PM_{2.5}$ Speciation



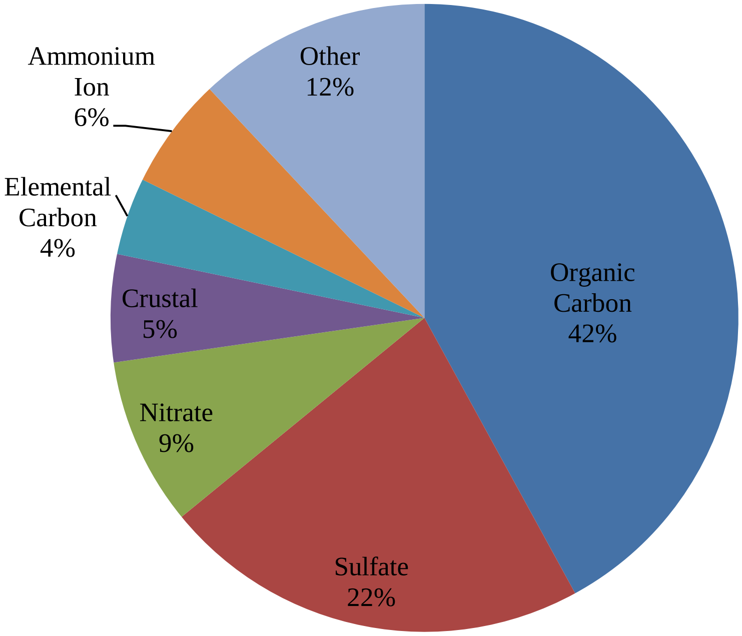
Columbus-Cusseta $PM_{2.5}$ Speciation



Augusta $PM_{2.5}$ Speciation



Rossville $PM_{2.5}$ Speciation



Appendix C: Additional PAMS Data

PAMS Continuous Hydrocarbon Data (June-August 2015)

(concentrations in parts per billion Carbon (ppbC))

Name	Site	#Samples	Avg.	1st Max	2nd Max
PAMSHC	S. DeKalb	380	35.13	131.1	126.4
	Yorkville	1787	28.53	84.0	82.3
TNMOC	S. DeKalb	481	31.24	139.3	135.9
	Yorkville	1787	35.99	107.4	97.5
Ethane	S. DeKalb	481	3.466	12.08	11.86
	Yorkville	1868	3.280	8.11	8.06
Ethylene	S. DeKalb	481	1.346	7.23	6.88
	Yorkville	1868	0.395	3.50	3.42
Propane	S. DeKalb	389	3.372	22.57	21.24
	Yorkville	1868	2.754	24.07	23.97
Propylene	S. DeKalb	389	0.885	3.29	3.26
	Yorkville	1868	0.325	2.33	2.07
Acetylene	S. DeKalb	481	0.440	2.60	2.20
	Yorkville	1868	0.260	1.10	1.00
n-Butane	S. DeKalb	481	1.551	8.26	7.84
	Yorkville	1868	0.867	6.02	4.99
Isobutane	S. DeKalb	481	0.725	3.97	3.90
	Yorkville	1867	0.380	1.27	1.22
trans-2-Butene	S. DeKalb	481	0.069	0.41	0.30
	Yorkville	1868	0.060	0.41	0.38
cis-2-Butene	S. DeKalb	481	0.051	0.46	0.33
	Yorkville	1868	0.012	0.49	0.35
n-Pentane	S. DeKalb	481	1.764	10.77	9.68
	Yorkville	1868	0.645	8.70	7.11
Isopentane	S. DeKalb	481	2.544	19.03	13.92
	Yorkville	1868	1.010	18.38	16.89
1-Pentene	S. DeKalb	481	0.100	0.44	0.38
	Yorkville	1868	0.052	0.48	0.38
trans-2-Pentene	S. DeKalb	481	0.070	0.99	0.47
	Yorkville	1868	0.017	1.22	1.13
cis-2-Pentene	S. DeKalb	481	0.035	0.44	0.39
	Yorkville	1868	0.007	0.57	0.54
3-Methylpentane	S. DeKalb	481	0.372	2.39	2.36
	Yorkville	1868	0.161	2.24	2.21
n-Hexane	S. DeKalb	479	0.621	7.56	3.94
	Yorkville	1789	0.334	2.69	2.42
n-Heptane	S. DeKalb	479	0.165	1.39	1.07
	Yorkville	1789	0.100	0.60	0.58
n-Octane	S. DeKalb	479	0.191	2.20	1.65
	Yorkville	1789	0.067	0.59	0.35

PAMS Continuous Hydrocarbon Data (June-August 2015)(continued) (concentrations in ppbC) **Name**	**Site**	**#Samples**	**Avg.**	**1st Max**	**2nd Max**
n-Nonane	S. DeKalb	479	0.121	2.30	1.74
	Yorkville	1789	0.093	0.35	0.33
n-Decane	S. DeKalb	479	0.160	3.30	2.98
	Yorkville	1789	0.085	0.72	0.52
Cyclopentane	S. DeKalb	479	0.108	0.61	0.57
	Yorkville	1868	0.111	0.81	0.59
Isoprene	S. DeKalb	481	3.828	16.07	14.84
	Yorkville	1868	10.048	66.74	62.31
2,2-Dimethylbutane	S. DeKalb	481	0.096	0.53	0.51
	Yorkville	1868	0.033	0.48	0.42
2,4-Dimethylpentane	S. DeKalb	481	0.103	1.10	0.94
	Yorkville	1789	0.022	0.82	0.75
Cyclohexane	S. DeKalb	479	0.082	0.71	0.61
	Yorkville	1789	0.039	0.38	0.35
3-Methylhexane	S. DeKalb	479	0.198	1.59	1.43
	Yorkville	1789	0.104	0.94	0.79
2,2,4-Trimethylpentane	S. DeKalb	479	0.417	3.13	3.11
	Yorkville	1789	0.212	2.54	2.18
2,3,4-Trimethylpentane	S. DeKalb	479	0.178	1.24	1.06
	Yorkville	1789	0.064	0.56	0.49
3-Methylheptane	S. DeKalb	479	0.062	0.50	0.49
	Yorkville	1789	0.039	0.34	0.31
Methylcyclohexane	S. DeKalb	479	0.132	1.16	1.04
	Yorkville	1789	0.060	0.51	0.42
Methylcyclopentane	S. DeKalb	479	0.208	2.77	1.91
	Yorkville	1789	0.096	1.30	1.19
2-Methylhexane	S. DeKalb	479	0.117	0.91	0.90
	Yorkville	1789	0.063	0.73	0.65
1-Butene	S. DeKalb	481	0.223	0.61	0.60
	Yorkville	1868	0.144	0.67	0.54
2,3-Dimethylbutane	S. DeKalb	481	0.191	2.20	1.65
	Yorkville	1868	0.068	1.40	1.31
2-Methylpentane	S. DeKalb	481	0.558	3.72	3.53
	Yorkville	1868	0.240	3.74	3.63
2,3-Dimethylpentane	S. DeKalb	479	0.149	1.33	1.32
	Yorkville	1789	0.049	0.85	0.63
n-Undecane	S. DeKalb	479	0.109	5.77	1.75
	Yorkville	1789	0.191	2.48	2.47
2-Methylheptane	S. DeKalb	479	0.046	0.62	0.60
	Yorkville	1789	0.040	0.44	0.35

PAMS Continuous Hydrocarbon Data (June-August 2015)(continued)
(concentrations in ppbC)

Name	Site	#Samples	Avg.	1st Max	2nd Max
m & p Xylenes	S. DeKalb	479	0.449	2.89	2.59
	Yorkville	1789	0.328	3.47	1.42
Benzene	S. DeKalb	479	0.371	3.07	2.32
	Yorkville	1789	0.415	1.59	1.34
Toluene	S. DeKalb	479	1.282	8.39	8.13
	Yorkville	1789	0.836	3.55	3.38
Ethylbenzene	S. DeKalb	479	0.152	1.06	0.95
	Yorkville	1789	0.116	1.11	0.91
o-Xylene	S. DeKalb	479	0.209	1.55	1.45
	Yorkville	1789	0.149	0.89	0.61
1,3,5-Trimethylbenzene	S. DeKalb	479	0.139	1.20	1.10
	Yorkville	1789	0.074	0.99	0.43
1,2,4-Trimethylbenzene	S. DeKalb	479	0.270	1.96	1.68
	Yorkville	1789	0.212	1.16	0.97
n-Propylbenzene	S. DeKalb	479	0.061	0.76	0.73
	Yorkville	1789	0.055	0.90	0.52
Isopropylbenzene	S. DeKalb	479	0.039	0.93	0.87
	Yorkville	1789	0.032	0.51	0.39
o-Ethyltoluene	S. DeKalb	479	0.110	1.12	1.05
	Yorkville	1789	0.064	0.66	0.56
m-Ethyltoluene	S. DeKalb	479	0.752	3.88	3.74
	Yorkville	1789	1.404	8.57	7.53
m-Diethylbenzene	S. DeKalb	479	0.068	1.27	1.23
	Yorkville	1789	0.034	1.14	0.98
p-Diethylbenzene	S. DeKalb	479	0.074	0.94	0.90
	Yorkville	1789	0.053	0.92	0.77
Styrene	S. DeKalb	479	0.106	1.44	1.26
	Yorkville	1789	0.138	0.85	0.83
1,2,3-Trimethylbenzene	S. DeKalb	479	1.248	5.68	5.52
	Yorkville	1789	2.071	9.01	8.86
p-Ethyltoluene	S. DeKalb	479	0.088	1.16	1.11
	Yorkville	1789	0.101	1.14	0.82

PAMS 2015 24-hour Canister Hydrocarbons
(concentrations in parts per billion Carbon (ppbC))

Name	Site	#Samples	#Detects^	Avg.*	1st Max	2nd Max
PAMSHC	S. DeKalb	31	31	65.19	170	110
	Yorkville	24	24	43.83	73	63
	Conyers	23	23	42.04	88	82
TNMOC	S. DeKalb	33	33	151.97	350	330
	Yorkville	25	25	71.72	160	120
	Conyers	24	24	99.75	200	170
Ethane	S. DeKalb	33	26	5.88	18	18
	Yorkville	25	16	3.14	15	8.6
	Conyers	24	21	6.70	16	13
Ethylene	S. DeKalb	33	2	0.07	1.5	0.7
	Yorkville	25	ND			
	Conyers	24	ND			
Propane	S. DeKalb	33	32	8.15	20	15
	Yorkville	25	25	3.80	18	6.3
	Conyers	24	24	6.18	13	12
Propylene	S. DeKalb	33	29	0.96	3.1	2.6
	Yorkville	25	15	0.19	0.8	0.5
	Conyers	24	21	0.93	11	1.4
Acetylene	S. DeKalb	33	28	1.36	4.5	3.3
	Yorkville	25	17	0.39	1.8	1.0
	Conyers	24	23	1.35	2.9	2.8
n-Butane	S. DeKalb	33	31	5.34	25	17
	Yorkville	25	20	1.32	7.6	5.9
	Conyers	24	22	3.17	9.0	7.0
Isobutane	S. DeKalb	33	23	1.35	6.6	4.1
	Yorkville	25	7	0.15	1.6	0.6
	Conyers	24	17	0.88	2.9	2.8
trans-2-Butene	S. DeKalb	33	ND			
	Yorkville	25	ND			
	Conyers	24	ND			
cis-2-Butene	S. DeKalb	33	1	0.01	0.4	
	Yorkville	25	ND			
	Conyers	24	ND			
n-Pentane	S. DeKalb	33	33	2.73	7.7	5.4
	Yorkville	25	23	0.86	1.9	1.8
	Conyers	24	24	1.36	3.5	3.3
Isopentane	S. DeKalb	33	33	4.70	13	9.1
	Yorkville	25	24	1.41	3.7	2.6
	Conyers	24	23	2.05	5.0	4.8
1-Pentene	S. DeKalb	33	6	0.05	0.4	0.4
	Yorkville	25	1	0.02	0.6	
	Conyers	24	2	0.02	0.3	0.2

PAMS 2015 24-hour Canister Hydrocarbons (continued)
(concentrations in ppbC)

Name	Site	#Samples	#Detects^	Avg.*	1st Max	2nd Max
trans-2-Pentene	S. DeKalb	33	4	0.05	0.7	0.3
	Yorkville	25	ND			
	Conyers	24	ND			
cis-2-Pentene	S. DeKalb	33	1	0.01	0.4	
	Yorkville	25	ND			
	Conyers	24	1	0.08	1.8	
3-Methylpentane	S. DeKalb	33	27	0.69	2.3	1.7
	Yorkville	25	11	0.17	0.7	0.6
	Conyers	24	11	0.33	1.2	1.0
n-Hexane	S. DeKalb	33	31	1.53	8.6	5.8
	Yorkville	25	16	0.27	1.1	0.6
	Conyers	24	17	0.59	2.6	2.2
n-Heptane	S. DeKalb	33	26	0.44	1.5	1.2
	Yorkville	25	5	0.07	1.0	0.2
	Conyers	24	8	0.19	0.9	0.7
n-Octane	S. DeKalb	33	9	0.09	0.8	0.5
	Yorkville	25	1	0.01	0.3	
	Conyers	24	6	0.09	0.6	0.6
n-Nonane	S. DeKalb	33	12	0.18	1.5	1.0
	Yorkville	25	ND			
	Conyers	24	3	0.08	1.0	0.6
n-Decane	S. DeKalb	33	19	0.67	13	1.1
	Yorkville	25	2	0.08	1.8	0.2
	Conyers	24	11	0.33	2.2	0.9
Cyclopentane	S. DeKalb	33	11	0.15	1.6	0.7
	Yorkville	25	1	0.02	0.6	
	Conyers	24	4	0.08	0.8	0.7
Isoprene	S. DeKalb	33	15	3.16	14	14
	Yorkville	25	15	4.07	22	19
	Conyers	24	7	1.13	8.6	5.7
2,2-Dimethylbutane	S. DeKalb	33	15	0.41	2.1	1.2
	Yorkville	25	ND			
	Conyers	24	16	0.80	2.7	2.3
2,4-Dimethylpentane	S. DeKalb	33	8	0.08	0.6	0.4
	Yorkville	25	ND			
	Conyers	24	2	0.03	0.6	0.2
Cyclohexane	S. DeKalb	33	12	0.15	0.7	0.7
	Yorkville	25	1	0.01	0.2	
	Conyers	24	7	0.25	3.5	0.7
3-Methylhexane	S. DeKalb	33	23	0.45	1.6	1.1
	Yorkville	25	6	0.08	1	0.3
	Conyers	24	10	0.25	0.9	0.8

PAMS 2015 24-hour Canister Hydrocarbons (continued)
(concentrations in ppbC)

Name	Site	#Samples	#Detects^	Avg.*	1st Max	2nd Max
2,2,4-Trimethylpentane	S. DeKalb	33	33	1.62	4.4	3.4
	Yorkville	25	13	0.20	0.6	0.6
	Conyers	24	10	0.26	1.1	1.1
2,3,4-Trimethylpentane	S. DeKalb	33	16	0.22	0.8	0.7
	Yorkville	25	ND			
	Conyers	24	3	0.05	0.6	0.3
3-Methylheptane	S. DeKalb	33	6	0.07	0.6	0.6
	Yorkville	25	ND			
	Conyers	24	1	0.01	0.2	
Methylcyclohexane	S. DeKalb	33	12	0.18	0.8	0.8
	Yorkville	25	1	0.02	0.5	
	Conyers	24	3	0.03	0.3	0.2
Methylcyclopentane	S. DeKalb	33	26	0.53	2.1	1.5
	Yorkville	25	6	0.07	0.4	0.3
	Conyers	24	10	0.23	1.0	0.8
2-Methylhexane	S. DeKalb	33	22	0.36	1.3	0.9
	Yorkville	25	2	0.04	0.8	0.2
	Conyers	24	6	0.12	0.8	0.6
1-Butene	S. DeKalb	33	14	0.16	0.9	0.8
	Yorkville	25	ND			
	Conyers	24	13	0.33	1.0	0.9
2,3-Dimenthylbutane	S. DeKalb	33	18	0.27	1.1	0.8
	Yorkville	25	4	0.04	0.3	0.2
	Conyers	24	4	0.09	0.8	0.5
2-Methylpentane	S. DeKalb	33	28	1.03	3.8	2.3
	Yorkville	25	17	0.30	0.9	0.7
	Conyers	24	17	0.42	1.4	1.3
2,3-Dimethylpentane	S. DeKalb	33	16	0.21	0.8	0.7
	Yorkville	25	2	0.02	0.4	0.2
	Conyers	24	6	0.11	0.8	0.5
n-Undecane	S. DeKalb	33	18	0.94	13	5.5
	Yorkville	25	1	0.56	14	
	Conyers	24	7	0.61	9.1	2.4
2-Methylheptane	S. DeKalb	33	4	0.05	0.6	0.6
	Yorkville	25	ND			
	Conyers	24	2	0.05	0.6	0.5
m & p Xylenes	S. DeKalb	33	29	1.29	3.8	3.6
	Yorkville	25	14	0.24	1.1	0.8
	Conyers	24	20	0.56	1.7	1.4
Benzene	S. DeKalb	33	33	1.22	3.6	3.0
	Yorkville	25	23	0.52	1.3	1.3
	Conyers	24	24	1.12	2.0	1.7

PAMS 2015 24-hour Canister Hydrocarbons (continued) (concentrations in ppbC)

Name	**Site**	**#Samples**	**#Detects^**	**Avg.***	**1st Max**	**2ndMax**
Toluene	S. DeKalb	33	33	2.66	7.0	6.2
	Yorkville	25	21	0.66	2.9	1.1
	Conyers	24	24	1.51	3.3	3.1
Ethylbenzene	S. DeKalb	33	20	0.35	1.1	0.9
	Yorkville	25	1	0.01	0.3	
	Conyers	24	8	0.16	0.9	0.6
o-Xylene	S. DeKalb	33	24	0.44	1.4	1.2
	Yorkville	25	3	0.05	0.5	0.4
	Conyers	24	7	0.16	0.9	0.7
1,3,5-Trimethylbenzene	S. DeKalb	33	8	0.22	3.8	1.1
	Yorkville	25	ND			
	Conyers	24	1	0.08	2.0	
1,2,4-Trimethylbenzene	S. DeKalb	33	33	7.0	12	12
	Yorkville	25	25	22.27	43	40
	Conyers	24	24	4.77	13	9.2
n-Propylbenzene	S. DeKalb	33	3	0.02	0.3	0.2
	Yorkville	25	ND			
	Conyers	24	3	0.07	1.2	0.3
Isopropylbenzene	S. DeKalb	33	2	0.02	0.4	0.2
	Yorkville	25	ND			
	Conyers	24	1	0.01	0.3	
o-Ethyltoluene	S. DeKalb	33	16	0.22	0.6	0.6
	Yorkville	25	8	0.14	0.7	0.7
	Conyers	24	6	0.15	1.7	0.5
m-Ethyltoluene	S. DeKalb	33	17	0.28	1.1	1.0
	Yorkville	25	2	0.02	0.3	0.3
	Conyers	24	5	0.23	4.1	0.4
p-Ethyltoluene	S. DeKalb	33	21	0.42	2.1	1.0
	Yorkville	25	9	0.12	0.5	0.5
	Conyers	24	13	0.36	2.1	1.0
m-Diethylbenzene	S. DeKalb	33	8	0.08	0.5	0.5
	Yorkville	25	ND			
	Conyers	24	1	0.05	1.1	
p-Diethylbenzene	S. DeKalb	33	9	0.09	0.8	0.4
	Yorkville	25	1	0.02	0.4	
	Conyers	24	3	0.07	1.0	0.4
Styrene	S. DeKalb	33	26	0.47	1.1	1
	Yorkville	25	11	0.19	0.7	0.6
	Conyers	24	23	0.88	1.6	1.4
1,2,3-Trimethylbenzene	S. DeKalb	33	15	0.21	1.2	0.8
	Yorkville	25	1	0.01	0.3	
	Conyers	24	10	0.22	1.5	0.7

ND indicates no detection. ^Detect is counted as any value above half method detection limit.*When a detected concentration is below one half of the method detection limit, then one half of the method detection level is used to calculate the average.

Appendix D: Additional Toxics Data

2015 Metals
(concentrations in micrograms per cubic meter (µg/m^3))

Name	**Site**	**#Samples**	**#Detects^**	**Avg.***	**1st Max**	**2nd Max**
Antimony	Macon-Forestry	22	22	0.00072	0.00130	0.00064
	Savannah-E. Pres. St.	26	26	0.00074	0.00145	0.00124
	General Coffee	28	27	0.00035	0.00174	0.00095
	Dawsonville	25	24	0.00109	0.01200	0.00092
	Yorkville	27	27	0.00058	0.00188	0.00087
	South DeKalb**	58	57	0.00222	0.01195	0.00261
Arsenic	Macon-Forestry	24	13	0.00044	0.00082	0.00042
	Savannah-E. Pres. St.	27	13	0.00061	0.00264	0.00144
	General Coffee	29	13	0.00044	0.00079	0.00056
	Dawsonville	27	18	0.00070	0.00170	0.00063
	Yorkville	28	19	0.00068	0.00188	0.00120
	South DeKalb**	58	38	0.00069	0.00218	0.00040
Beryllium	Macon-Forestry	24	ND			
	Savannah-E. Pres. St.	27	1	0.00003	0.00003	
	General Coffee	29	ND			
	Dawsonville	27	ND			
	Yorkville	28	ND			
	South DeKalb**	58	1	0.00003	0.00019	
Cadmium	Macon-Forestry	24	5	0.00004	0.00019	0.00008
	Savannah-E. Pres. St.	27	14	0.00017	0.00063	0.00012
	General Coffee	29	9	0.00006	0.00018	0.00013
	Dawsonville	27	9	0.00004	0.00017	0.00010
	Yorkville	28	7	0.00004	0.00022	0.00010
	South DeKalb**	58	12	0.00004	0.00032	0.00016
Chromium	Macon-Forestry	24	24	0.00150	0.00360	0.00104
	Savannah-E. Pres. St.	27	27	0.00141	0.00289	0.00174
	General Coffee	29	29	0.00137	0.00300	0.00138
	Dawsonville	27	27	0.00116	0.00223	0.00146
	Yorkville	28	28	0.00124	0.00237	0.00169
	South DeKalb**	58	58	0.00165	0.00353	0.00211
Cobalt	Macon-Forestry	24	16	0.00008	0.00022	0.00007
	Savannah-E. Pres. St.	27	20	0.00008	0.00015	0.00015
	General Coffee	29	4	0.00006	0.00012	0.00006
	Dawsonville	27	13	0.00008	0.00059	0.00009
	Yorkville	28	9	0.00006	0.00017	0.00006
	South DeKalb**	58	17	0.00008	0.00061	0.00011

2015 Metals (continued)
(concentrations in µg/m^3)

Name	Site	#Samples	#Detects^	Avg.*	1st Max	2nd Max
Lead	Macon-Forestry	24	24	0.00146	0.00270	0.00193
	Savannah-E. Pres. St.	27	27	0.00163	0.00364	0.00219
	General Coffee	29	29	0.00093	0.00173	0.00129
	Dawsonville	27	27	0.00140	0.00235	0.00170
	Yorkville	28	28	0.00127	0.00267	0.00153
	South DeKalb**	58	57	0.00154	0.00515	0.00217
Manganese	Macon-Forestry	24	24	0.00782	0.02071	0.00307
	Savannah-E. Pres. St.	27	27	0.00466	0.01172	0.00647
	General Coffee	29	29	0.00286	0.01321	0.00207
	Dawsonville	27	27	0.00485	0.03119	0.00535
	Yorkville	28	28	0.00334	0.00912	0.00262
	South DeKalb**	58	57	0.00389	0.03913	0.00205
Nickel	Macon-Forestry	24	24	0.00077	0.00403	0.00046
	Savannah-E. Pres. St.	27	27	0.00079	0.00188	0.00110
	General Coffee	29	29	0.00074	0.00146	0.00086
	Dawsonville	27	27	0.00056	0.00129	0.00073
	Yorkville	28	28	0.00066	0.00167	0.00065
	South DeKalb**	58	57	0.00068	0.00139	0.00048
Selenium	Macon-Forestry	24	12	0.00028	0.00158	0.00023
	Savannah-E. Pres. St.	27	15	0.00024	0.00068	0.00022
	General Coffee	29	13	0.00017	0.00046	0.00019
	Dawsonville	27	12	0.00019	0.00070	0.00045
	Yorkville	28	13	0.00018	0.00048	0.00033
	South DeKalb**	58	13	0.00029	0.00466	0.00036
Zinc	Macon-Forestry	24	24	0.02550	0.06732	0.01784
	Savannah-E. Pres. St.	27	27	0.02033	0.03887	0.03137
	General Coffee	29	29	0.02228	0.05814	0.02158
	Dawsonville	27	27	0.01435	0.02530	0.01947
	Yorkville	28	28	0.01415	0.02292	0.02256
	South DeKalb**	58	57	0.01666	0.04289	0.01925

*When a detected concentration is below one half of the method detection limit, then one half of the method detection level is used to calculate the average.

** Selected PM_{10} Hi-Vol, sample collected every 6 days

ND indicates no detection

^Detect is counted as any value above half method detection limit.

2015 Semi-Volatile Compounds

(concentrations in µg/m^3)

Name	Site	#Samples	#Detects^	Avg.**	1st Max	2nd Max
Acenaphthene	Macon-Forestry	21	20	0.00325	0.01001	0.00807
	Savannah-E. Pres. St.	30	29	0.00211	0.00536	0.00343
	General Coffee	27	2	0.00025	0.00189	0.00118
	Dawsonville	19	17	0.00093	0.00312	0.00184
	South DeKalb*	56	54	0.00265	0.04225	0.0066
	Yorkville	29	16	0.00040	0.00124	0.00120
Acenaphthylene	Macon-Forestry	21	ND			
	Savannah-E. Pres. St.	30	ND			
	General Coffee	27	ND			
	Dawsonville	19	ND			
	South DeKalb*	56	2	0.00019	0.00163	0.00088
	Yorkville	29	ND			
Anthracene	Macon-Forestry	21	ND			
	Savannah-E. Pres. St.	30	ND			
	General Coffee	27	ND			
	Dawsonville	19	ND			
	South DeKalb*	56	ND			
	Yorkville	29	ND			
Benzo(a)anthracene	Macon-Forestry	21	ND			
	Savannah-E. Pres. St.	30	ND			
	General Coffee	27	1	0.00016	0.00053	
	Dawsonville	19	ND			
	South DeKalb*	56	ND			
	Yorkville	29	ND			
Benzo(a)pyrene	Macon-Forestry	21	ND			
	Savannah-E. Pres. St.	30	ND			
	General Coffee	27	ND			
	Dawsonville	19	ND			
	South DeKalb*	56	ND			
	Yorkville	29	ND			
Benzo(b)fluoranthene	Macon-Forestry	21	ND			
	Savannah-E. Pres. St.	30	ND			
	General Coffee	27	ND			
	Dawsonville	19	ND			
	South DeKalb*	56	1	0.00016	0.00043	
	Yorkville	29	ND			
Benzo(e)pyrene	Macon-Forestry	21	1	0.00015	0.00015	
	Savannah-E. Pres. St.	30	1	0.00015	0.00016	
	General Coffee	27	ND			
	Dawsonville	19	ND			
	South DeKalb*	56	ND			
	Yorkville	29	ND			

2015 Semi-Volatile Compounds (continued)

(concentrations in µg/m^3)

Name	**Site**	**#Samples**	**#Detects^**	**Avg.****	**1st Max**	**2nd Max**
Benzo(g,h,i)perylene	Macon-Forestry	21	1	0.00015	0.00015	
	Savannah-E. Pres. St.	30	ND			
	General Coffee	27	ND			
	Dawsonville	19	ND			
	South DeKalb*	56	ND			
	Yorkville	29	ND			
Benzo(k)fluoranthene	Macon-Forestry	21	ND			
	Savannah-E. Pres. St.	30	ND			
	General Coffee	27	ND			
	Dawsonville	19	ND			
	South DeKalb*	56	ND			
	Yorkville	29	ND			
Chrysene	Macon-Forestry	21	ND			
	Savannah-E. Pres. St.	30	ND			
	General Coffee	27	ND			
	Dawsonville	19	ND			
	South DeKalb*	56	ND			
	Yorkville	29	1	0.00015	0.00015	
Dibenzo(a,h)anthracene	Macon-Forestry	15	ND			
	Savannah-E. Pres. St.	15	ND			
	General Coffee	12	ND			
	Dawsonville	14	ND			
	South DeKalb*	56	ND			
	Yorkville	14	ND			
Fluoranthene	Macon-Forestry	21	17	0.00120	0.00310	0.00286
	Savannah-E. Pres. St.	30	26	0.00068	0.00147	0.00146
	General Coffee	27	13	0.00086	0.00309	0.00307
	Dawsonville	19	8	0.00027	0.00066	0.00065
	South DeKalb*	56	42	0.00069	0.00257	0.00236
	Yorkville	29	10	0.00028	0.00128	0.00070
Fluorene	Macon-Forestry	21	21	0.00238	0.00621	0.00594
	Savannah-E. Pres. St.	30	30	0.00179	0.00410	0.00269
	General Coffee	27	24	0.00124	0.00254	0.00219
	Dawsonville	19	18	0.00095	0.00224	0.00181
	South DeKalb*	56	56	0.00279	0.0325	0.0073
	Yorkville	29	29	0.00096	0.00193	0.00152
Indeno(1,2,3-cd)pyrene	Macon-Forestry	21	1	0.00015	0.00015	
	Savannah-E. Pres. St.	30	ND			
	General Coffee	27	ND			
	Dawsonville	19	ND			
	South DeKalb*	56	1	0.00016	0.00043	
	Yorkville	29	ND			

2015 Semi-Volatile Compounds (continued)
(concentrations in µg/m^3)

Name	Site	#Samples	#Detects^	Avg.**	1st Max	2nd Max
Naphthalene	Macon-Forestry	20	20	0.01977	0.04379	0.03490
	Savannah-E. Pres. St.	28	28	0.01855	0.04737	0.03755
	General Coffee	25	25	0.01463	0.02691	0.02454
	Dawsonville	19	19	0.00980	0.02197	0.01700
	South DeKalb*	56	56	0.04976	0.14301	0.12386
	Yorkville	27	27	0.00880	0.02041	0.01489
Phenanthrene	Macon-Forestry	21	21	0.00641	0.01533	0.0149
	Savannah-E. Pres. St.	30	29	0.00348	0.00684	0.00663
	General Coffee	27	27	0.00369	0.00658	0.00613
	Dawsonville	19	17	0.00166	0.00409	0.00292
	South DeKalb*	56	56	0.00453	0.02925	0.01369
	Yorkville	29	29	0.00173	0.00389	0.00341
Pyrene	Macon-Forestry	21	11	0.00039	0.00116	0.00112
	Savannah-E. Pres. St.	30	17	0.00030	0.00062	0.00062
	General Coffee	27	16	0.00108	0.00428	0.00284
	Dawsonville	19	6	0.00022	0.00072	0.00047
	South DeKalb*	56	27	0.00029	0.00072	0.00071
	Yorkville	29	6	0.00022	0.00133	0.00046
Perylene	South DeKalb*	56	2	0.00016	0.00037	0.00022

ND indicates no detection
^Detect is counted as any value above half method detection limit.
*Sample collected every 6 days and analyzed at ERG laboratory with gas chromatography.
**When a detected concentration is below one half of the method detection limit, then one half of the method detection level is used to calculate the average.

2015 Volatile Organic Compounds

(concentrations in µg/m^3)

Name	Site	#Samples	#Detects^	Avg.**	1st Max	2nd Max
Freon 113	Macon-Forestry	19	2	0.96211	0.99640	0.95808
	Savannah-E. Pres. St.	17	2	0.97611	1.22634	0.95808
	General Coffee	25	1	0.97187	0.95808	
	Dawsonville	18	1	0.96446	0.95808	
	South DeKalb*	41	ND			
	DMRC	22	ND			
	Yorkville	25	ND			
Freon 114	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			
1,3-Butadiene	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			
Cyclohexane	Macon-Forestry	22	1	0.44847	0.82650	
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	2	0.47475	0.96425	0.82650
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	1	0.47144	1.61857	
Chloromethane	Macon-Forestry	22	22	1.12942	1.77628	1.42515
	Savannah-E. Pres. St.	20	20	1.27438	1.54908	1.52843
	General Coffee	29	28	1.16555	1.87955	1.69366
	Dawsonville	21	20	1.20238	1.56973	1.50777
	South DeKalb*	44	44	1.13928	1.59039	1.52843
	DMRC	22	21	1.15054	1.56973	1.50777
	Yorkville	29	27	1.10109	2.04479	1.42515
Dichloromethane	Macon-Forestry	22	9	1.61387	24.9665	0.76393
	Savannah-E. Pres. St.	20	5	0.47138	0.72920	0.62503
	General Coffee	29	4	0.45081	0.52086	0.48613
	Dawsonville	21	8	0.48531	0.69448	0.62503
	South DeKalb*	44	14	0.47982	0.72920	0.72920
	DMRC	22	6	0.48456	0.76393	0.69448
	Yorkville	29	5	0.45620	0.65975	0.62503

2015 Volatile Organic Compounds (continued)
(concentrations in µg/m^3)

Name	Site	#Samples	#Detects^	Avg.**	1st Max	2nd Max
Chloroform	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			
Carbon tetrachloride	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	1	0.78787	0.81775	
	General Coffee	29	1	0.78738	0.81775	
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			
Trichlorofluoromethane	Macon-Forestry	22	22	1.12648	1.40491	1.40491
	Savannah-E. Pres. St.	20	19	1.13938	1.74209	1.34871
	General Coffee	29	29	1.18400	1.62969	1.51730
	Dawsonville	21	21	1.21223	1.62969	1.46110
	South DeKalb*	44	42	1.23376	1.79828	1.57350
	DMRC	22	22	1.15713	1.57350	1.46110
	Yorkville	29	28	1.16365	1.68589	1.57350
Chloroethane	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			
1,1-Dichloroethane	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			
Methyl chloroform	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			

2015 Volatile Organic Compounds (continued) (concentrations in µg/m^3) Name	Site	#Samples	#Detects^	Avg.**	1st Max	2nd Max
Ethylene dichloride	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			
Tetrachloroethylene	Macon-Forestry	22	1	0.84919	0.88155	
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	1	0.86519	1.35624	
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			
1,1,2,2-Tetrachloroethane	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			
Bromomethane	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	1	0.57382	0.89137	
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			
1,1,2-Trichloroethane	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			
Dichlorodifluoromethane	Macon-Forestry	22	22	2.10603	2.91742	2.62074
	Savannah-E. Pres. St.	20	20	2.08670	2.52184	2.37350
	General Coffee	29	28	2.01287	2.42294	2.42294
	Dawsonville	21	21	2.10036	2.62074	2.42294
	South DeKalb*	44	44	2.10828	2.86798	2.81853
	DMRC	22	22	2.10828	2.81853	2.62074
	Yorkville	29	27	2.09898	3.51080	2.67018

2015 Volatile Organic Compounds (continued)

(concentrations in $\mu g/m^3$)

Name	Site	#Samples	#Detects^	Avg.**	1st Max	2nd Max
Trichloroethylene	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			
1,1-Dichloroethylene	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	19	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			
1,2-Dichloropropane	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			
trans-1,3-Dichloropropylene	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			
cis-1,3-Dichloropropylene	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			
cis-1,2-Dichloroethene	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			

2015 Volatile Organic Compounds (continued) (concentrations in µg/m³)						
Name	**Site**	**#Samples**	**#Detects^**	**Avg.****	**1st Max**	**2nd Max**
Ethylene dibromide	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			
Hexachlorobutadiene	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			
Vinyl chloride	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			
m/p Xylene	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	2	0.55163	0.69497	0.56466
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	18	0.68016	1.95460	1.12933
	DMRC	22	16	0.77592	1.38994	1.30307
	Yorkville	29	ND			
Benzene	Macon-Forestry	22	5	0.42034	0.60691	0.54303
	Savannah-E. Pres. St.	20	6	0.44720	0.79857	0.47914
	General Coffee	29	8	0.50282	1.66102	1.11800
	Dawsonville	21	21	0.78032	1.34160	1.27771
	South DeKalb*	44	29	0.58695	1.53325	1.24577
	DMRC	22	19	1.08533	2.26793	2.04434
	Yorkville	29	9	0.46592	0.92634	0.73468
Toluene	Macon-Forestry	22	4	0.47942	0.56503	0.52736
	Savannah-E. Pres. St.	20	9	0.57539	1.24307	0.71571
	General Coffee	29	1	0.54165	2.52380	
	Dawsonville	21	1	0.47176	0.48969	
	South DeKalb*	44	27	1.11422	3.46552	2.97583
	DMRC	22	20	1.73790	4.59558	2.82515
	Yorkville	29	1	0.47151	0.48969	

2015 Volatile Organic Compounds (continued) (concentrations in µg/m^3)						
Name	**Site**	**#Samples**	**#Detects^**	**Avg.****	**1st Max**	**2nd Max**
Ethylbenzene	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	1	0.54344	0.56466	
	DMRC	22	ND			
	Yorkville	29	ND			
o- Xylene	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			
1,3,5-Trimethylbenzene	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	21	ND			
	Yorkville	29	ND			
1,2,4-Trimethylbenzene	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			
Styrene	Macon-Forestry	21	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			
Benzene,1-ethenyl-4-methyl	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			

2015 Volatile Organic Compounds (continued)

(concentrations in µg/m^3)

Name	Site	#Samples	#Detects^	Avg.**	1st Max	2nd Max
Chlorobenzene	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	1	0.5788	0.64474	
	Yorkville	29	ND			
1,2-Dichlorobenzene	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			
1,3-Dichlorobenzene	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			
1,4-Dichlorobenzene	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			
Benzyl chloride	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			
1,2,4-Trichlorobenzene	Macon-Forestry	22	ND			
	Savannah-E. Pres. St.	20	ND			
	General Coffee	29	ND			
	Dawsonville	21	ND			
	South DeKalb*	44	ND			
	DMRC	22	ND			
	Yorkville	29	ND			

ND indicates no detection

^Detect is counted as any value above half method detection limit.

*Sample collected every 6 days
**When a detected concentration is below one half of the method detection limit, then one half of the method detection level is used to calculate the average.

2015 Black Carbon (concentrations in micrograms per cubic meter)							
Site ID	**City**	**County**	**Site Name**	**Hours Measured**	**Annual Mean**	**1st Max**	**2nd Max**
130890002	Decatur	DeKalb	South DeKalb	6432	1.285	9.21	8.13
130890003	Decatur	DeKalb	DMRC	2878	1.765	8.29	7.58
131210056	Atlanta	Fulton	GA Tech NR	4178	2.622	10.39	10.14

2015 Carbonyl Compounds, 24-hour
(concentrations in micrograms per cubic meter)

Name	Site	#Samples	#Detects^	Avg.**	1st Max	2nd Max
Formaldehyde	Savannah-E. Pres. St.	26	22	2.12729	6.63158	5.37118
	Dawsonville	28	26	3.79408	7.66667	6.44444
Acetaldehyde	Savannah-E. Pres. St.	26	18	0.90695	1.93158	1.69444
	Dawsonville	28	21	1.16263	1.97036	1.93333
Propionaldehyde	Savannah-E. Pres. St.	26	ND			
	Dawsonville	28	1	0.56506	0.64764	
Butyraldehyde	Savannah-E. Pres. St.	26	ND			
	Dawsonville	28	4	0.59148	1.05000	0.76111
Acetone	Savannah-E. Pres. St.	26	20	2.29527	5.84211	4.53684
	Dawsonville	28	23	3.27103	6.00000	5.66667
Benzaldehyde	Savannah-E. Pres. St.	26	2	0.600956	1.12632	1.01053
	Dawsonville	28	2	0.595645	1.15556	0.97778
Acrolein	Macon-Forestry	22	17	0.56788	1.10135	1.00957
(with canister method)	Savannah-E. Pres. St.	20	10	0.39006	1.07840	0.66540
	General Coffee	29	13	0.36316	0.75718	0.64245
	Dawsonville	21	18	0.55668	0.75718	0.75718
	South DeKalb*	44	25	0.37833	0.91779	0.64245
	DMRC	22	12	0.45785	1.33080	0.87190
	Yorkville	29	7	0.33942	0.89485	0.64245

ND indicates no detection
^Detect is counted as any value above half method detection limit.
* Sample collected every 6 days
** When a detected concentration is below one half of the method detection limit, then one half of the method detection level is used to calculate the average.

Appendix E: Monitoring Network Survey

Georgia Gaseous Criteria Pollutant Monitoring as of January 2015

Parameter Measured	Ozone	Nitrogen Dioxide	Carbon Monoxide	Sulfur Dioxide
Sampling Schedule	Continuous hourly average			
Number of AAMP Sites	20	5	3	7
Method Used	Ultraviolet photometry	Ultraviolet photometry	Non-dispersive Infrared photometry	Ultraviolet fluorescence detector
EPA Reference Method	Ultraviolet photometry	Ultraviolet photometry	Non-dispersive Infrared photometry	Spectrophotometry (pararosaniline method)
Data Availability	U.S. EPA Air Quality System (AQS) (http://www2.epa.gov/aqs) and GA DNR/EPD Ambient Air Monitoring Program (http://amp.georgiaair.org/)			

Georgia Ambient Air Particulate Matter Monitoring as of January 2015

Parameter Measured	**PM_{10}**		**$PM_{2.5}$**		
	Mass (integrated)	**Mass (semi-continuous)**	**Mass (integrated)**	**Mass (semi-continuous)**	**Speciated**
Sampling Schedule	Every 6 days	Continuous hourly averages	Varies; daily, every third day, or every sixth day	Continuous hourly averages	1 in 6 days; 1 in 3 days for South DeKalb
Collection Method	Mass sequential, single channel	BAM	FRM sampler	TEOM; BAM	Speciation air sampling system (SASS) and URG
Sampling Media	Teflon filter – 46.2mm,	Proprietary filter; filter tape	Teflon filter – 46.2mm	Proprietary filter; filter tape	Teflon, nylon & quartz filter – 46.2mm
Number of Sites Analyzed	2	1	24	17	8
Number of Collocated Sites	1	0	3	0	0
Analysis Method	Method 016 Electronic analytical balance	Method 079; TEOM gravimetric at 50 degrees C; Method 122 Beta Attenuation Monitor	Method 055 Electronic analytical balance	Method 703 R&P TEOM with SCC at 30 degrees C; Beta Attenuation Monitor	Method 055 Electronic analytical balance Method 014 x-ray fluorescence Method 062 filter preparation Method 064 Ion chromatography Method 065 Thermal/optical carbon
Data Availability	U.S. EPA Air Quality System (AQS) (http://www2.epa.gov/aqs) and GA DNR/EPD Ambient Air Monitoring Program (http://amp.georgiaair.org/)				

Georgia Organic Air Toxic Contaminant Monitoring as of January 2015

Parameter Measured	Volatile Organic Compounds (VOCs)	Carbonyls	Semi - VOCs	Metals
Method	TO-15	TO-11A	TO – 13A	10-2.I
Sampling Schedule	Every 12 days, 24-hour; 1 in 6 day schedule for South DeKalb	Every 12 days, 24-hour; 1 in 6 day schedule for South DeKalb	Every 12 days, 24-hour; 1 in 6 day schedule for South DeKalb	Every 12 days, 24-hour; 1 in 6 day schedule for South DeKalb*
Collection Equipment	AVOCS or ATEC2200	ATEC100 and or ATEC8000	PUF sampler	High volume TSP
Sampling Media	Polished stainless steel canister	DNPH-coated silica cartridges	Polyurethane Foam filter Plus resin	Quartz micro-fiber filter 8 x 10 inch
Number of Sites Analyzed	7	3	6	6
Number of Collocated Sites	1	1	1	1
Data Availability	U.S. EPA Air Quality System (AQS) (http://www2.epa.gov/aqs) and GA DNR/EPD Ambient Air Monitoring Program (http://amp.georgiaair.org/)			

* Sampler at this site is a PM_{10} Hi-Vol
** 5 GA ATN sites, 1 NATTS (South DeKalb)

PAMS Monitoring as of January 2015

Parameter	56 PAMS-Speciated VOCs & Total NMHC	Continuous 56-PAMS Speciated VOCs & Total NMHC	Carbonyl Compounds
Sampling Schedule	24-hour 1 in 6 day schedule (all year)	Continuous hourly average (June-August)	4-3-hour sample (June-August); 24-hour, 1 in 6 day (all year)
Collection Equipment	ATEC 2200	Perkin-Elmer GC	ATEC 8000; PUF Sampler
Sampling Media	Polished stainless steel canister	Direct injection	DNPH – coated silica gel Cartridge
Number of Sites	3	2	3
Analysis Method	PAMS GC/FID	GC/FID	High performance liquid chromatograph/ultraviolet detector
Data Availability	U.S. EPA Air Quality System (AQS) (http://www2.epa.gov/aqs) and GA DNR/EPD Ambient Air Monitoring Program (http://amp.georgiaair.org/)		

Georgia Meteorological Monitoring as of January 2015

Parameter Measured	Wind Speed (m/s)	Wind Direction (degrees)	Ambient Temperature (ºC)	Relative Humidity (%)	Atmosphere Pressure (mb)	Solar Radiation (w/m^2)	Precip (in)	Sig. Theta (degrees)	Total Ultraviolet Radiation
Sampling Schedule	Continuous hourly average								
Number of Sites	16	16	8	8	6	3	6	1	3
Method Used	Propeller or ultrasonic anemometer	Wind vane potentiometer	Aspirated Thermocouple or thermistor	Thin film capacitor	Pressure transducer	pyranometer	Tipping bucket	Wind direction	UV radiometer
Data Availability	U.S. EPA Air Quality System (AQS) (http://www2.epa.gov/aqs) and GA DNR/EPD Ambient Air Monitoring Program (http://amp.georgiaair.org/)								

Appendix F: Siting Criteria

Instrument	Height Above Ground		Space Between Samplers	Height Above Obstructions	Distance From Obstacles	Distance From Tree Drip line	Distance from Walls, Parapets, etc.	Airflow Arc
	Micro	Other						
PM_{10}, AISI Nephelometer	2-7m	2-15m	2m		2 times height or obstacle above inlet	Should be 20m, must be 10m if considered an obstruction	2m	270
Dicot, TEOM, $PM_{2.5}$	2-7m	2-15m	1m		2 times height or obstacles above inlet	Should be 20m, must be 10m if considered an obstruction	2m	270
Lead, TSP	207m	2-15m	2m		2 times height of obstacles above inlet	Micro and middle: no trees between sampler and source Neighborhood: should be 20m, must be 10m if considered an obstruction	2m	270
O_3	3-15m	3-15m		1m	2 times height of obstacles above inlet	Should be 20m, must be 10m if considered an obstruction	1m	270, or on side of building 180
CO	2.5–3.5m	3-5m	1m	2 times height of obstacle above inlet	Micro: must be no trees between sampler and road Others: must be 10m if trees, 5m above sampler	Micro: must be no trees between sampler and road Others: must be 10m if trees, 5m above sampler	1m	270, or on side of building 180
NO_2	3-15m	3-15m		1m	2 times height of obstacle above inlet	Should be 20m, if individual tree 5m above probe, must be 10m from drip line	1m	270, or on side of building 180

Instrument	Height Above Ground		Space Between Samplers	Height Above Obstructions	Distance From Obstacles	Distance From Tree Drip line	Distance from Walls, Parapets, etc.	Airflow Arc
	Micro	Other						
SO_2	3-15m	3-15m		1m	2 times height of obstacle above inlet	Should be 20m, must be 10m if considered an obstruction	1m	270, or on side of building 180
H_2S	3-15m	3-15m		1m	2 times height of obstacle above inlet	Should be 20m, must be 10m if considered an obstruction	1m	270, or on side of building 180
CH_4, THC, NMHC, PAMS	3-15m	3-15m		1m	2 times height of obstacle above inlet	Should be 20m, must be 10m in direction of urban core	1m	270, or on side of building 180
Toxics: Gaseous 910, 910A, 929, 920	3-15m	3-15m		2m	2 times height of obstacle above inlet			
Temperature and Relative Humidity	1.25-2m	2.25-2m			4 times height of obstacle above sensor	1 tower width from tower side	4.5m	
Wind Speed and Direction	10m	10m			1.5 times height of obstacle above sensor	2 tower widths from tower side, 1 tower width from tower top		
Solar Radiation	1.5m	1.5m						

Appendix G: Instrument and Sensor Control Limits

ARB’S CONTROL AND WARNING LIMITS		
LIMITS		INSTRUMENT
Control	Warning	
±15%	±10%	All gaseous criteria and non-criteria analyzers
±15%	±10%	Total suspended particulate (TSP) samplers
±10%	±7%	PM_{10} Dichotomous (Dicot), Lead (Pb), Tapered Element Oscillating Microbalance (TEOM), Toxic Air Contaminant (XonTech920) Samplers, Beta Attenuation Monitors (BAM), and Carbonyl (XonTech9250) Samplers
±4% (Flow)	None	$PM_{2.5}$
±5% (Design)	None	
±20%	None	Laboratory audits (Toxics, PAMS, Motor Vehicle Exhaust and Total Metals)

ACCEPTANCE CRITERIA FOR METEOROLOGICAL (MET) SENSORS	
LIMITS	SENSOR
±1.0° Celsius (±0.5°C PAMS only)	Ambient Temperature
±1mb~ _ 0.75mm Mercury (Hg)	Barometric Pressure
±5% RH for <10% or >90% RH	Relative Humidity
±5% Watts/m^2	Solar Radiation and total uv radiation
Less than or equal to 5° combined accuracy and orientation error	Wind Direction
Between 0.5 and 5m/s and less 0.2m/s ±5% difference above 5 m/s	Horizontal Wind Speed
Less than or equal to 0.5m/s	Horizontal Wind Speed Starting Threshold
±0.25 m/s between 0.5 and 5 m/s and less than 5% difference above 5 m/s	Vertical Wind Speed
Less than or equal to 0.5 m/s	Vertical wind Speed Starting Threshold

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