GEORGIA DEPARTMENT OF NATURAL RESOURCES

ENVIRONMENTAL PROTECTION DIVISION

Air Protection Branch
Ambient Monitoring Program

2009 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 thirty years. The list of compounds monitored has grown over the thirty years to more than 200 pollutants using several types of samplers at sites statewide. 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 2009, and is an assessment of the data in conjunction with previous years' findings.

The Chemical Monitoring Activities, Photochemical Assessment Monitoring (PAMS), and Air Toxics Monitoring sections provide an in-depth discussion of the chemicals that are monitored and maps identify individual monitoring sites. These sections also contain discussions on health effects, measurement techniques, and attainment designations for the chemicals 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 a regulatory standard. The regulatory standard is health-based. Concentrations above the standard are considered unhealthy for sensitive groups.

Another set of compounds called air toxics are monitored throughout the state in the Air Toxics Network. The sources of these emitted compounds include vehicle emissions, stationary source emissions, and natural sources. These air toxic compounds do not have ambient air regulatory standards. However, the compounds monitored in the Air Toxics Network are analyzed annually for theoretical lifetime cancer risk and potential non-cancer health effects. 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 a small number of chemicals in the metals, volatile organic compounds, and carbonyls groups of the air toxics. 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 were well below the 'acceptable' hazard quotient of 1.

The Ambient Monitoring Program also operates an extensive network of meteorological stations. The Meteorological Report section discusses Georgia's climatology based on the meteorological data captured at the PAMS sites and the sites located statewide. 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 shows the Ambient Monitoring Program's undertaking 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 requirements for each monitored pollutant is provided, including field and laboratory techniques, as well as results of the quality assurance audits.

The Outreach and Education section provides information concerning the efforts of the Clean Air Campaign to change the commuting habits of residents of Atlanta. The voluntary program partners with the public and private sector to reduce vehicle congestion and aid in reducing vehicle emissions. This section includes a description of educational and news media outreach activities, and 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 2009. Included in the summary tables is information on where air toxic compounds were detected, the number of samples collected, and average and maximum concentrations.

Copies of this and previous annual reports are available in Adobe Acrobat format via the Ambient

Monitoring Internet website at http://www.air.dnr.state.ga.us/amp/. A limited number of print copies are available and may be requested at 404-363-7006. 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 Clean Air Campaign and the smog forecast.

GLOSSARY

Aerosols	A gaseous suspension of fine solid or liquid particles
AM	Annual Mean
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)
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
NAAQS	National Ambient Air Quality Standard
NAMS	National Ambient Monitoring Site
NATTS	National Air Toxics Trends Station
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
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 2009. 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. Few people realize, though, that the air quality monitoring that is required by the Act is performed almost entirely by state and local governments. The Ambient Monitoring Program conducts monitoring in Georgia, 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. Monitoring is performed to facilitate the protection of public health, as well as to protect our 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.

Due to budget constraints and lack of available personnel, the Ambient Air Monitoring Program temporarily discontinued certain samplers in 2009. Much consideration went in to deciding which samplers would be temporarily discontinued. Which pollutants are examined for attainment of the National Ambient Air Quality Standards, which pollutants are federally mandated, and the number of pollutants measured at each site are some of the factors that were considered in the decision making process. The samplers that are temporarily discontinued are shown in red in Table 2, on pages 4 and 5.

CHEMICAL 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 all identifiable effects on public health or welfare that may be expected from the presence of such pollutant in ambient air. Under the CAA, the EPA Administrator establishes 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.” In 1971, the EPA established standards for five “criteria” pollutants as required by the Clean Air Act. The standards and pollutants have changed over time to keep up with improvements in scientific knowledge and now consist of seven pollutants. For the most current list of standards, EPA’s website (http://www.epa.gov/air/criteria.html) should be referred. To summarize the list as of 2009, Table 1 below is included here.

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. Long-term averages are to protect against chronic effects.

The Georgia ambient air monitoring network provides information on the measured concentrations of criteria and non-criteria pollutants at pre-selected locations. The 2009 Georgia Air Sampling Network collected data at 61 locations in 36 counties, including all sites monitored during segmented sections of the year. Monitoring occurs year-round, with the exception of ozone, which is sampled from March through October, and the continuous (hourly) Photochemical Assessment Monitoring Stations (PAMS) volatile organic compounds that sample from June through August. Table 2 is a list of sites in the monitoring network along with details of pollutants monitored and their locations. Figure 1, is a spatial display of the air monitoring locations in the state. Please note that not all pollutants are monitored at all sites. Maps of the monitoring locations for individual pollutants are provided in each pollutant’s respective section.

The number of monitoring sites and their respective locations can vary from year to year. This variation depends on the availability of long-term space allocation, regulatory needs, and other factors such the sufficiency of resources. 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 networks 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 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 monitoring network are published on EPD’s website at http://www.air.dnr.state.ga.us/amp/. The data is updated hourly. Specific annual summary data for 2009 are available in Appendix A.

COMPOUND	PRIMARY STANDARD	SECONDARY STANDARD	UNITS	TIME INTERVAL
Sulfur Dioxide	–	0.5	ppm	3 Hour
	0.14	–		24 Hour
	0.03	–		Annual Mean
Particulate Matter ($PM_{2.5}$)	15.0	Same as Primary	μg/m^3	Annual Arithmetic Mean (3 years)
	98th percentile: 35.0	Same as Primary		24 Hour
Particulate Matter (PM_{10})	2nd Maximum: 150	Same as Primary	μg/m^3	24 Hour
Carbon Monoxide	2nd Maximum: 35.0	–	ppm	1 Hour
	2nd Maximum: 9.0	–		8 Hour Average
Ozone	4th Maximum: 0.075	Same as Primary	ppm	8 Hour Average
Nitrogen Dioxide	0.053	Same as Primary	ppm	Annual Mean
Lead	0.15*	Same as Primary	μg/m^3	Rolling 3-Month Average

*The lead standard changed from 1.5μg/m^3, averaged per calendar quarter. This standard was signed October 15, 2008, became effective January 12, 2009, and is to be implemented by January 1, 2010.

Table 1: National Ambient Air Quality Standards Summary

SITE ID	COMMON NAME	COUNTY	O_3	CO	$PM_{2.5}$ FRM	$PM_{2.5}$ Cont.	$PM_{2.5}$ Spec.	NO	NOx	NO_2	NOy	SO_2	TRS	Pb	PM_{10}	PM_{10} Cont.	Acid Rain	PAMS VOC	VOC	SVOC	Carbonyls	Meteorology	Aethalometer	Cr6	Metals
Rome MSA																									
131150003	*Coosa Elementary	Floyd										S													
131150004	Co. Health Dept.	Floyd																	NR	NR					NR
131150005	*Coosa High	Floyd			S		X								S										
Brunswick MSA																									
131270004	Arco Pump Station	Glynn													S										
131270006	Risley Middle	Glynn	S		S							S	M									NR			
131273001	Brunswick College	Glynn																	NR	NR	NR				NR
Valdosta MSA																									
131850003	Mason Elem.	Lowndes			S	S													NR	NR					NR
Warner Robins MSA																									
131530001	Robins Air Base	Houston			S	S													NR	NR					NR
Dalton MSA																									
132130003	Fort Mountain	Murray	S																			NR			
Albany MSA																									
130950007	Turner Elem.	Dougherty			S	S									S										
Gainesville MSA																									
131390003	Fair St. Elementary	Hall			S	S													NR	NR					NR
Athens-Clark County MSA																									
130590002	College Station Rd.	Clarke	S		S	S	X																		
Macon MSA																									
130210007	Allied Chemical	Bibb			S		X								S										
130210012	Forestry	Bibb	S		S	S						S							NR	NR		NR			NR
130210013	Lake Tobesofkee	Bibb	S								S											NR			
Columbus Georgia- Alabama MSA																									
132150001	Health Dept.	Muscogee			S																				
132150008	Airport	Muscogee	S		S	S						S													
132150011	Cusseta Elementary	Muscogee			S		X							S	S										
132151003	Crime Lab	Muscogee																				NR			
132155000	Columbus State	Muscogee																	NR	NR					NR
Savannah MSA																									
130510014	Shuman Middle School	Chatham													S										
130510017	Market St.	Chatham			S																				
130510021	E. President St.	Chatham	S									S							NR	NR	NR	NR			NR
130510091	Mercer Middle	Chatham			S																				
130511002	W. Lathrop & Augusta Ave.	Chatham				S						S										NR			
Augusta Georgia-South Carolina MSA																									
130730001	Riverside Park	Columbia	S								S											NR			
131890001	Fish Hatchery	McDuffie															G								
132450005	Med. College GA	Richmond			S																				
132450091	Bungalow Rd.	Richmond	S		S	S	X								S							NR			
132450092	Clara Jenkins School	Richmond																	NR	NR					NR

SITE ID	COMMON NAME	COUNTY	O$_3$	CO	PM$_{2.5}$ FRM	PM$_{2.5}$ Cont.	PM$_{2.5}$ Spec.	NO	NOx	NO$_2$	NOy	SO$_2$	TRS	Pb	PM$_{10}$	PM$_{10}$ Cont.	Acid Rain	PAMS VOC	VOC	SVOC	Carb-onyls	Meteoro-logy	Aethal-ometer	Cr6	Metals
Atlanta MSA																									
130150003	Cartersville	Bartow												S								NR			
130630091	Georgia DOT	Clayton			S																				
130670003	National Guard	Cobb	S		S																				
130670004	Macland Aquatic Center	Cobb			S																				
130770002	Univ. of West GA	Coweta	S			S																NR			
130850001	GA Forestry	Dawson	S														G		NR	NR	NR	NR			NR
130890002	South DeKalb	DeKalb	S/P	S/P	S	S	T	S/P	S/P	S/P	S/P							P	N	N	P/N	P	N	N	N
130890003	DMRC	DeKalb												S											
130892001	Police Dept.	DeKalb			S										S										
130893001	Tucker	DeKalb																				NR			
130970004	W. Strickland St.	Douglas	S																			NR			
131130001	Georgia DOT	Fayette	S																			NR			
131210020	Utoy Creek	Fulton																	NR	NR					NR
131210032	E. Rivers School	Fulton			S										S										
131210039	Fire Station#8	Fulton			S																				
131210048	Georgia Tech	Fulton			S			S	S	S		S				S						NR			
131210055	Confederate Ave.	Fulton	S			S						S										NR			
131210099	Roswell Road	Fulton		S																					
131350002	Gwinnett Tech	Gwinnett	S		S	S																			
131510002	County Extension	Henry	S			S																			
132230003	Yorkville	Paulding	S/P	S/P	S	S		S/P	S/P	S/P								P	NR	NR		P			NR
132470001	Monastery	Rockdale	S/P					S/P	S/P	S/P								P				P			
132970001	Fish Hatchery	Walton				S																			
Chattanooga Tennessee-Georgia MSA																									
132950002	Co. Health Dept.	Walker			S	S	X																		
Not In An MSA																									
130090001	Baldwin Co. Airport	Baldwin																	NR	NR					NR
130550001	Fish Hatchery	Chattooga	S												S		G								
130690002	General Coffee State Park	Coffee					X												NR	NR					NR
132410002	Lake Burton	Rabun															G								
132611001	Union High	Sumter	S																						
133030001	Co. Health Dept.	Washington			S										S										
133190001	Police Dept.	Wilkinson			S																				

Monitoring Types: S=SLAMS; P=PAMS; M=SPM; X=Supplemental Speciation; T=STN; N=NATTS; NR=Non-Regulatory; G=General Information

Samplers in red are temporarily not operational *Indicates sites consolidated in 2009, with all samplers at site 131150003.

Table 2: 2009 Georgia Air Monitoring Network

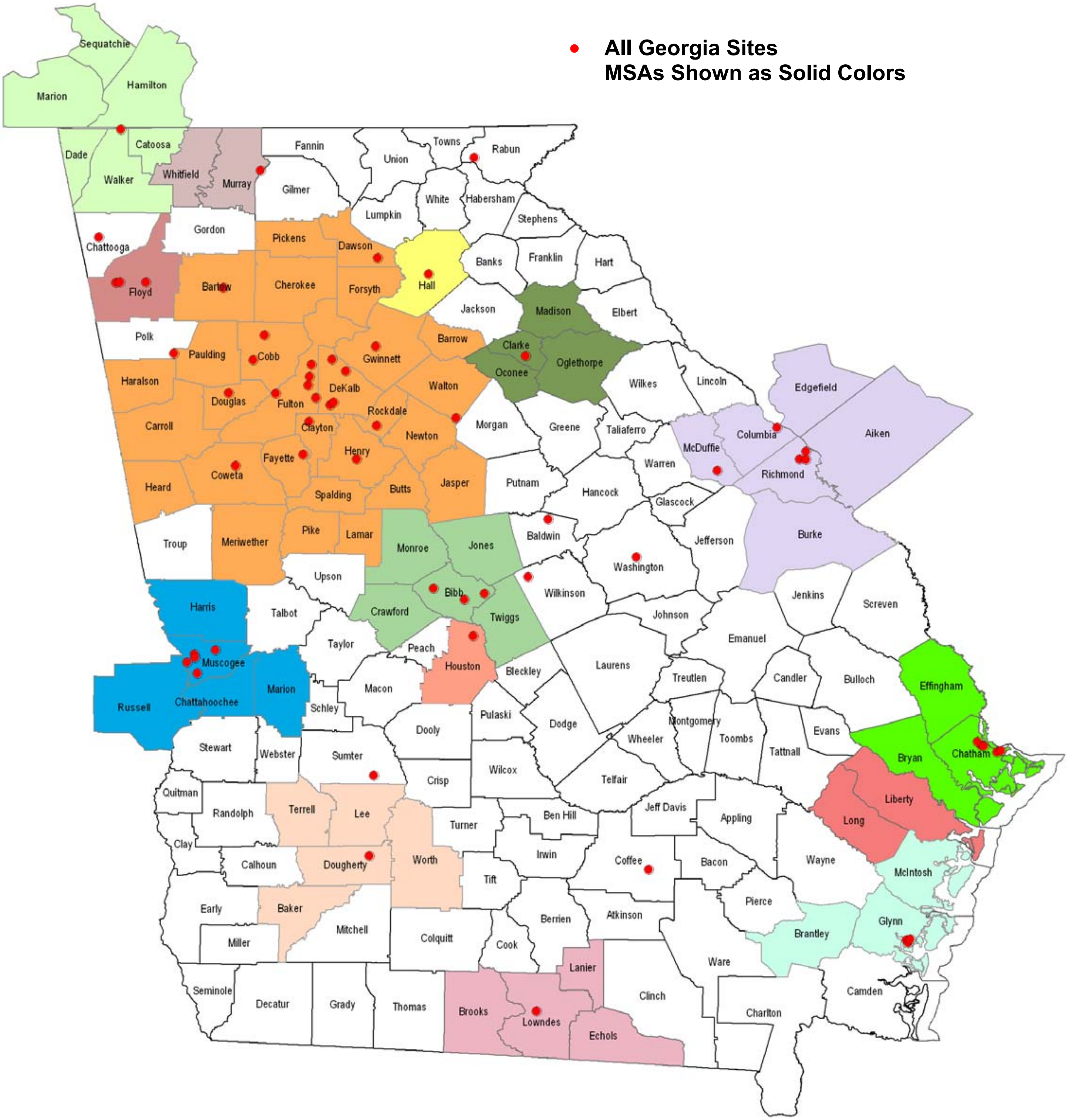
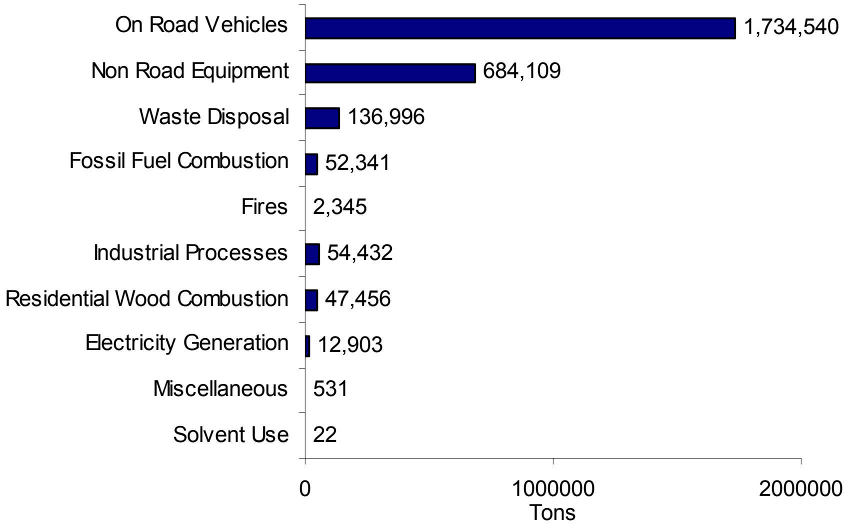


Figure 1: Georgia Air Monitoring Site Map

CARBON MONOXIDE (CO)

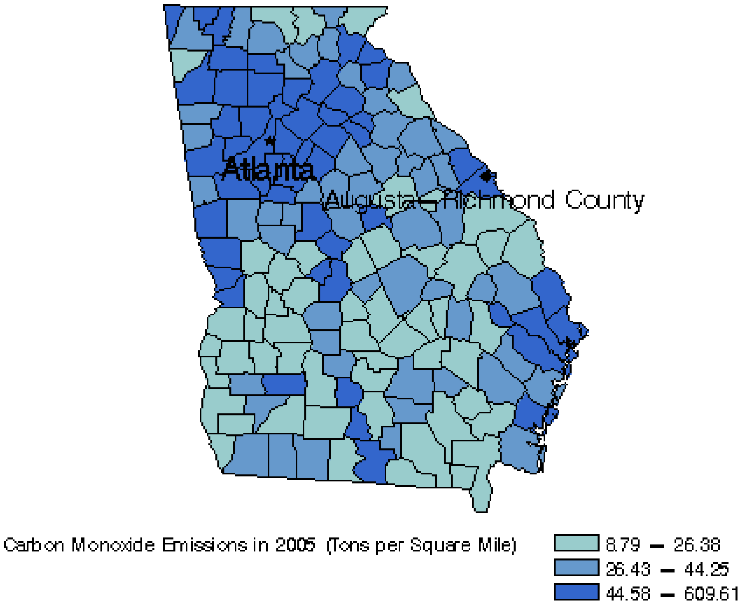
GENERAL INFORMATION

Carbon Monoxide (CO) is an odorless, colorless, and poisonous gas that is a by-product of the incomplete burning of fossil fuels. In most large metropolitan areas the primary source of CO pollution is engendered from automobile exhaust. The CO emissions from automobiles are responsible for approximately 60% of CO emissions nationwide. Other contributors of CO are fires, industrial processes, cigarettes, and other sources of incomplete burning in the indoor environment. Figure 2 and Figure 3 give a visual representation of the CO emissions in Georgia. These figures are taken from EPA's latest available data on air emission sources, based on 2005 data.



(From EPA's Air Emissions Sources)

Figure 2: Common Sources of Carbon Monoxide (CO) in Georgia in 2005



(From EPA's Air Emissions Sources)

Figure 3: Carbon Monoxide (CO) Emission in Georgia in 2005 – Spatial View

Higher concentrations of ambient CO may be present during the colder months of the year. During the winter months, cooler temperatures prevent complete combustion of fuels, causing an increase in CO emission. Fuel combustion in gas-powered automobiles is especially affected as friction is increased during cold engine operation. At the same time, winter is subjected to more frequent inversion layers. In standard conditions, the troposphere contains temperatures that increase 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. These increased emissions are therefore trapped by the cap that is formed by the inversion layer, locking in CO emissions near the earth's surface.

The Clean Air Act (CAA) requires that Metropolitan Statistical Areas (MSAs) with a population greater than 500,000, as determined by the last census (2000), to have at least two CO State and Local Air Monitoring Stations (SLAMS). In Georgia, only the Atlanta MSA meets the population requirement. Currently, the SLAMS site is located at Roswell Road (Figure 4). The Roswell Road site was established to monitor for CO at a microscale level. The purpose of microscale measurements is to measure peak concentrations in major urban traffic areas. A microscale site monitors an air mass that covers a distance of several meters to about 100 meters.

In substitution for a second SLAMS monitor, high sensitivity CO monitors have been installed at the Yorkville and South DeKalb sites. The purpose of these CO monitors is to aid in the detection of combustion and smoke plumes from power plants.

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. At the levels usually found in ambient air, CO primarily affects people with cardiovascular disease.

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 using specialized analyzers made for that specific purpose. The analyzers continuously measure the concentration of CO in ambient air using the non-dispersive infrared analysis and gas filter correlation methods.

ATTAINMENT DESIGNATION

Data collected from the continuous monitors is used to determine compliance with the Clean Air Act (CAA) 8-hour and 1-hour standard for CO. This standard requires that, for 8-hour averages, no concentration greater than 9 ppm may be observed more than once per year. For 1-hour averages, no concentration greater than 35 ppm may be observed more than once a year. 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.

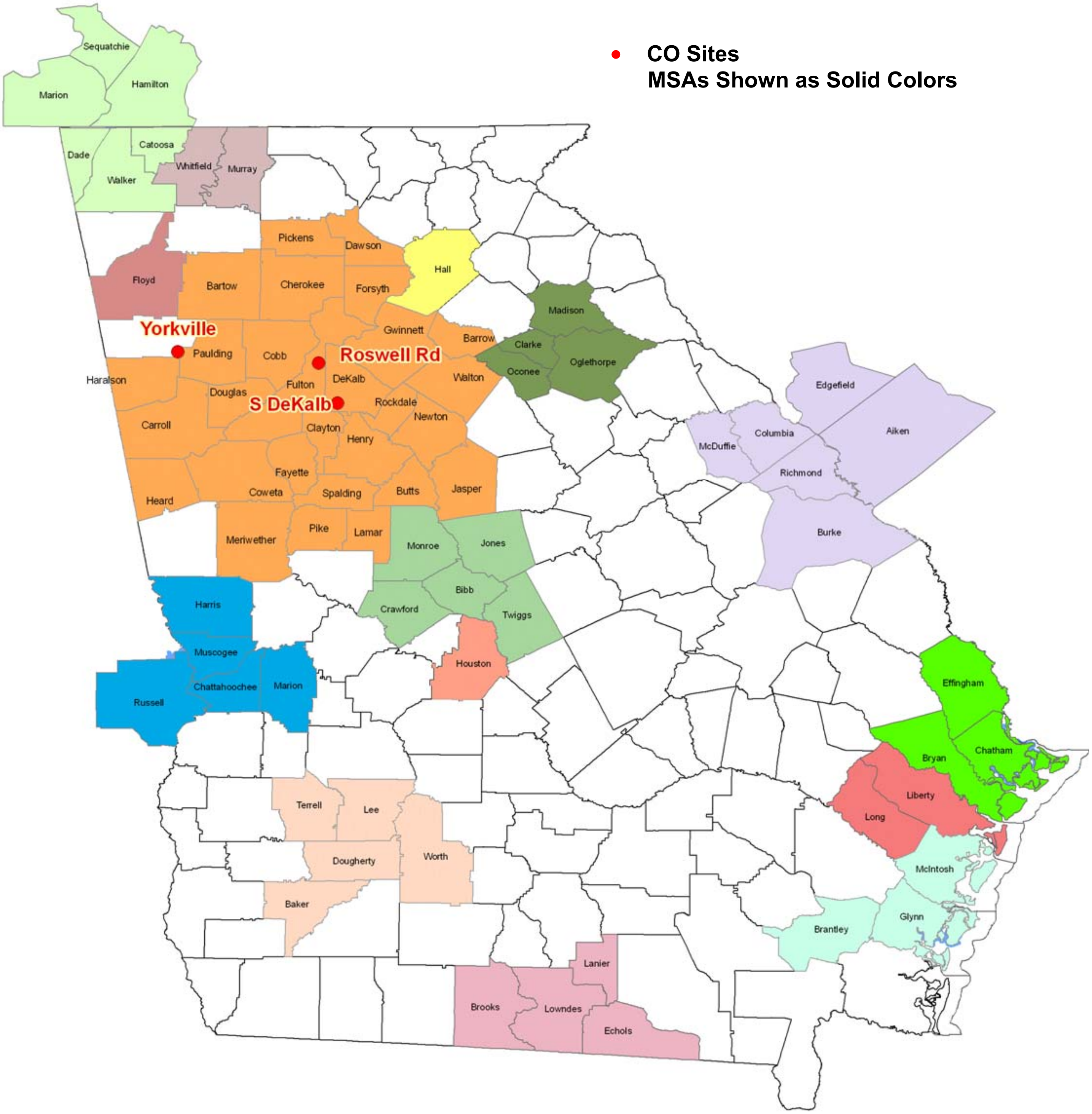


Figure 4: Carbon Monoxide Site Monitoring Map

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

GENERAL INFORMATION

Oxides of nitrogen (see Table 3 on the following page) exist in various forms in the atmosphere. The most common is nitric oxide (NO), but other forms such as nitrogen dioxide (NO_2), nitric acid (HNO_3) and dinitrogen pentoxide (N_2O_5) are also present. The bulk of these compounds in the atmosphere are produced from high temperature combustion and lightning. Nitrogen is a very stable molecule and is essentially inert unless subjected to extreme conditions. The oxides of nitrogen are less stable, however, and are key participants in atmospheric chemistry, converting back and forth between numerous states under different conditions. Many of these reactions involve the conversion of oxygen atoms between their atomic (O_2) and ozone (O_3) forms. As such, oxides of nitrogen are studied more intensely than their direct health impacts would imply; they are precursors of (and alternately by-products of) ozone formation. The many forms of oxides of nitrogen in the atmosphere are the reason that they are sometimes referred to using the generic terms NO_x or NO_y.

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 will attach itself to molecular oxygen (O_2) creating an ozone (O_3) molecule. This is the origin of all ground level ozone. Daytime levels of NO_2 and N_2O_5 are low but their concentration rises rapidly overnight. When the sun rises again in the morning, they are converted back to NO and ozone. 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. The following graph, Figure 5, is a representation of this typical diurnal pattern of NO_2. Refer to the ozone section and Figure 12 for a comparison of each diurnal pattern.

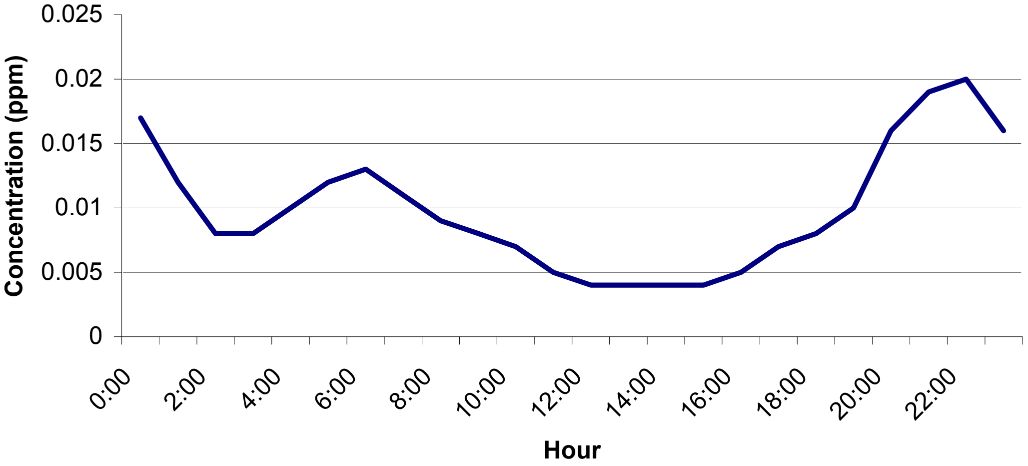
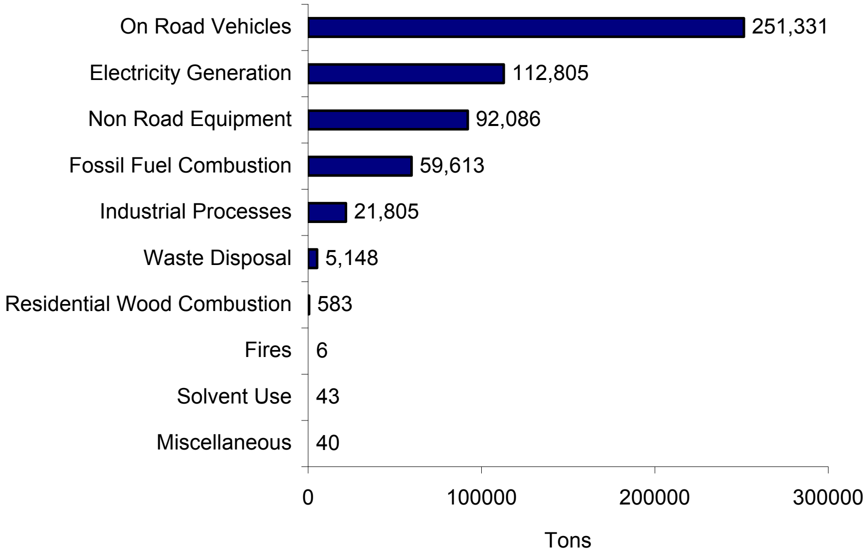


Figure 5: Typical Diurnal Pattern of Nitrogen Dioxide

ABBREVIATION	FULL NAME	CREATION PROCESSES	ELIMINATION PROCESSES
NO	Nitrous Oxide	Result of ozone photochemistry High-temperature combustion	Reacts with ozone to form NO_2 and oxygen
NO_2	Nitrogen Dioxide	High-temperature combustion Reaction of NO and ozone	Reacts with oxygen in strong sun to form ozone plus NO "Washes out" in rain
HNO_3	Nitric Acid	$NO_2 + H_2O$	"Washes out" in rain
PAN	Peroxyacetyl Nitrate	Oxidation of hydrocarbons in sunlight	Slow devolution to NO_2
NO_x	Name for NO + NO_2		
NO_y	Name for all atmospheric oxides of nitrogen- mostly NO, NO_2, HNO_3, N_2O_5, and PAN		

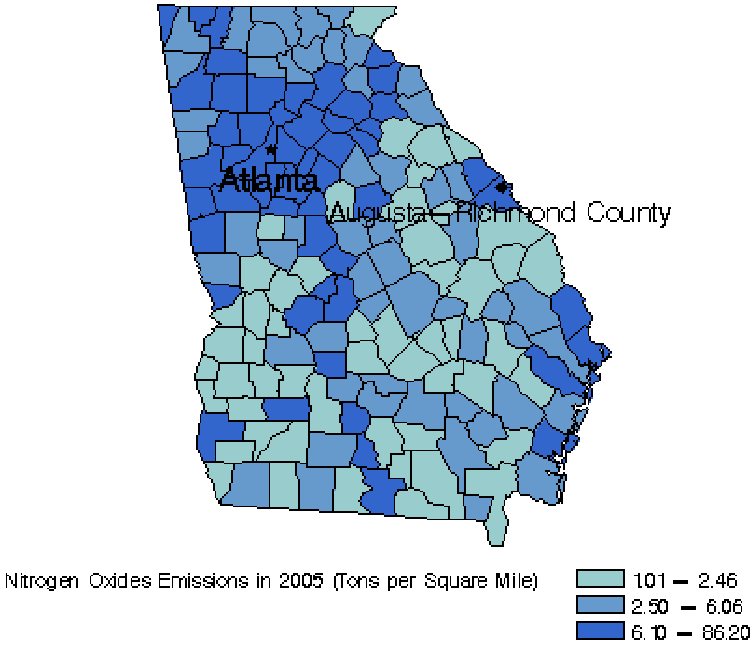
Table 3: Common Oxides of Nitrogen Species and Terms

Nitrogen dioxide (NO_2) is one of the important oxides of nitrogen. It is a light brown gas, and can be an important component of urban haze, depending upon local sources. Nitrogen oxides usually enter the air as the result of high-temperature combustion processes, such as those occurring in automobiles and power plants (Figure 6). Home heaters and gas stoves also produce substantial amounts of NO_2. NO_2 is formed from the oxidation of nitric oxide (NO), which has a pungent odor at high concentrations and a bleach smell at lower concentrations. NO_2 is a precursor to ozone formation and can be oxidized to form nitric acid (HNO_3), one of the compounds that contribute to acid rain. NO_2 and sulfur dioxide (SO_2) can react with other substances in the atmosphere to form acidic products that can be deposited in rain, fog, snow, or as particle pollution. Nitrate particles and NO_2 can block the transmission of light, reducing visibility. Figure 7 shows a spatial view of the varying concentrations of nitrogen oxides by county in Georgia during 2005. The following figures are taken from the latest emissions report from EPA, based on 2005 data.



(From EPA's Air Emissions Sources)

Figure 6: Common Sources of Nitrogen Oxides in Georgia in 2005



(From EPA's Air Emissions Sources)

Figure 7: Nitrogen Oxides Emission in Georgia in 2005 – Spatial View

Efforts are being taken to reduce the emissions of harmful nitrogen oxides. School bus retrofitting, truck stop electrification, and locomotive conversions are three methods that are being introduced as alternatives to previously unregulated combustion sources. 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 every 8 hours for every 10 hours of travel time. During this resting period, trucks idle their diesel engines 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, thus reducing oxides of nitrogen that would be produced by unnecessary idling. In addition, cool or warm air is pumped into the trucks via a hose hookup at the stops as another method of cutting down on idling and emissions. 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 lead to respiratory problems. Asthma sufferers, in particular, are sensitive to NO_2. This sensitivity was expressed in a study that examined changes in airway responsiveness of exercising asthmatics during exposure to relatively low levels of NO_2. Other studies also indicate a relationship between indoor NO_2 exposures and increased respiratory illness rates in young children, but definitive results are still lacking. In addition, many animal analyses suggest that NO_2 impairs respiratory defense mechanisms and increases susceptibility to infection. Several other observations also show that chronic exposure to relatively low NO_2 pollution levels may cause structural changes in the lungs of animals. These studies suggest that chronic exposure to NO_2 could lead to adverse health effects in humans, but specific levels and durations likely to cause such effects have not yet been determined.

MEASUREMENT TECHNIQUES

Oxides of nitrogen, particularly NO_2, are monitored using specialized analyzers that are developed specifically for measuring oxides of nitrogen in ambient air. The analyzers continuously measure the concentration of oxides of nitrogen in ambient air using the ozone-phase chemiluminescent method. There are two major instrument designs. While they are closely related, they do not monitor the same species. NO_x analyzers measure NO, NO_2, and NO_x. NO_y analyzers measure NO and NO_y, but cannot measure NO_2. The NO_y analyzers are also specialized for measuring trace-level concentrations; as such, they cannot measure higher concentrations. Because of these tradeoffs, it is necessary to operate a network of both instrument types to get a complete picture of local conditions.

Of the oxides of nitrogen, only NO_2 is regulated under the NAAQS. Therefore, only the NO_x type analyzers produce data directly relevant to the standard. NO_2 monitoring is required in urban areas with populations greater than 1,000,000. Atlanta is the only urban area in Georgia that meets that population requirement. Atlanta metro area has four NO_2 sites. They are located at the South DeKalb, Georgia Tech, Conyers, and Yorkville sites. The complete oxides of nitrogen monitoring network, including NO_x and NO_y monitor locations, can be found in Figure 8.

ATTAINMENT DESIGNATION

Data collected from the continuous monitors is used to determine compliance with the NAAQS primary and secondary annual standards for NO_2. This standard requires that a site's annual average concentration exceed 0.053 ppm no more than an average of once a year over a three-year period. The Atlanta MSA is in attainment of the NO_2 standard. For additional summary data on this topic, see Appendix A.

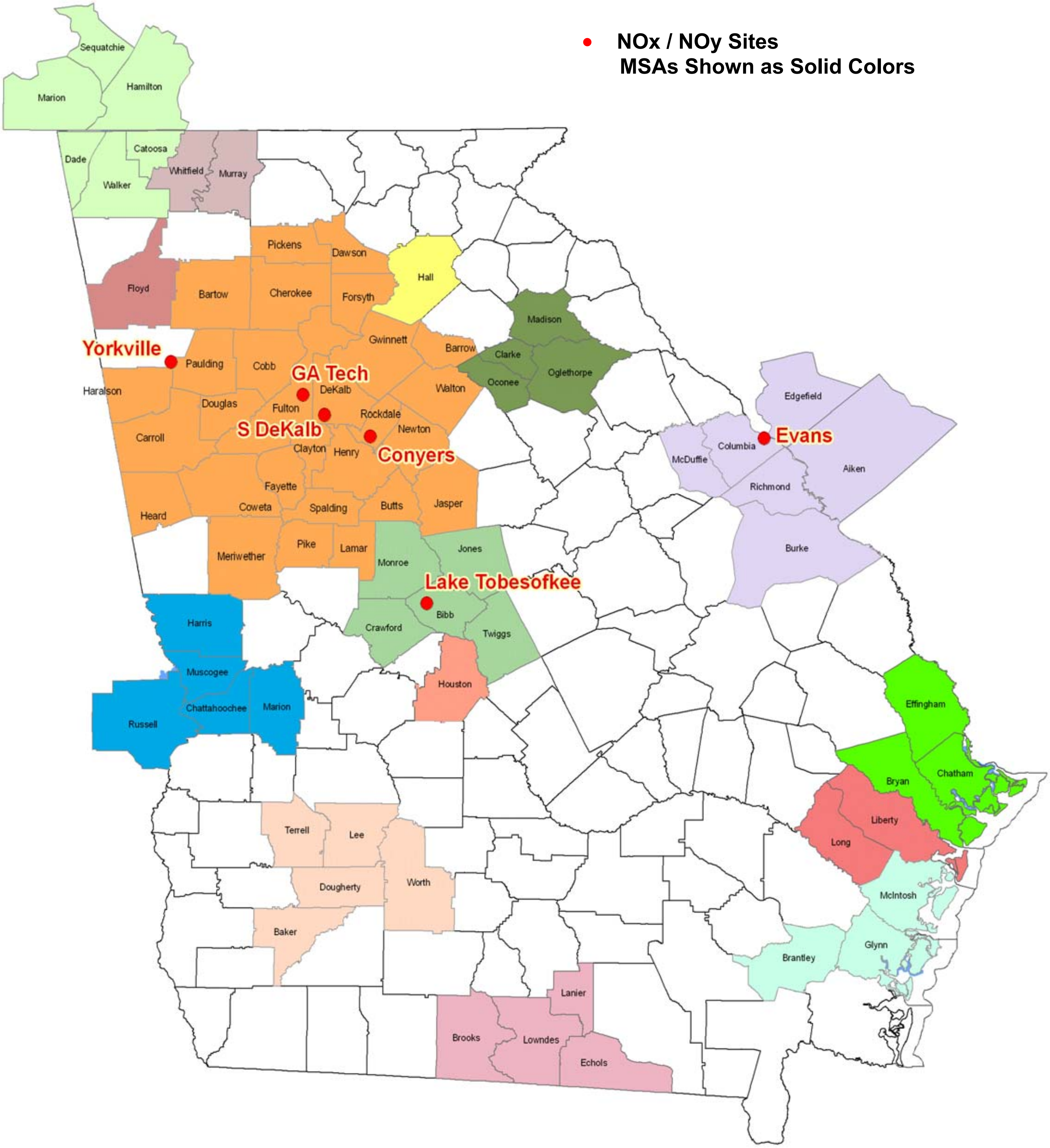


Figure 8: Oxides of Nitrogen Monitoring Site Map

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 by processing sulfur-containing ores. Most SO_2 emission in Georgia comes from electric generation (Figure 9). SO_2 is odorless at low concentrations, but pungent at very high concentrations. It can be oxidized in the atmosphere into sulfuric acid. When sulfur-bearing fuel is burned or ores that contain sulfur are processed, the sulfur is oxidized to form SO_2. SO_2 then can react with other pollutants to form aerosols. 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 leads to acidic deposition. SO_2 is also a precursor for sulfate particles. Major sources of SO_2 are fossil fuel-burning power plants and industrial boilers. Figure 9, below, shows common SO_2 sources and Figure 10, below, shows SO_2 emissions in Georgia. These figures are based on 2005 data and are taken from the latest emissions report from EPA.

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 SO_2.

The effects of short-term peak exposures to SO_2 have been evaluated in controlled human exposure studies. These studies show that SO_2 generally increases airway resistance in the lungs, and can cause significant constriction of air passages in sensitive asthmatics. These impacts have been observed in subjects engaged in moderate to heavy exercise while exposed to relatively high peak concentrations. These changes in lung function are accompanied by perceptible symptoms such as wheezing, shortness of breath, and coughing in these sensitive groups.

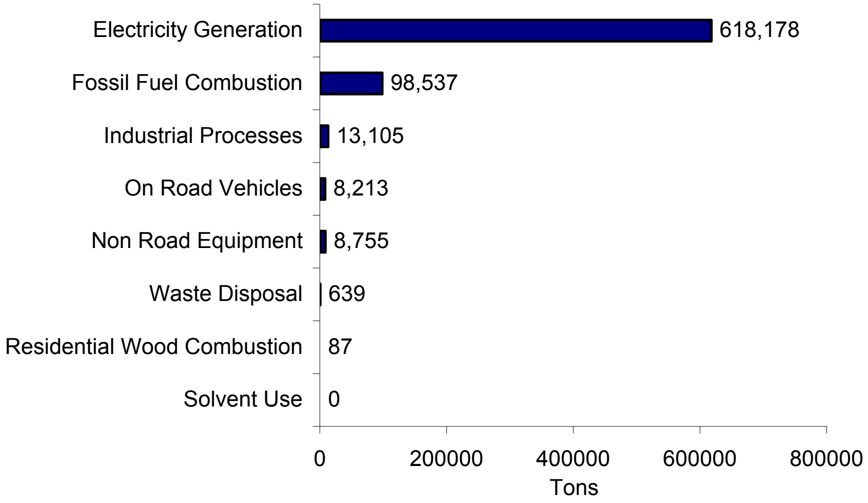
The presence of particle pollution appears to aggravate the impact of SO_2 pollution. Several studies of chronic effects have found that people living in areas with high particulate matter and SO_2 levels have a higher incidence of respiratory illnesses and symptoms than people living in areas without such a combination of pollutants.

MEASUREMENT TECHNIQUES

Sulfur dioxide is measured in the ambient air using EPA-approved “equivalent method” instruments as defined in 40 CFR Part 53, Appendix A. Georgia’s network consists of instruments using a pulsed UV fluorescence technique. In Brunswick, a variation of this instrument is configured to monitor for total reduced sulfur (TRS), which monitors for other sulfur-bearing compounds such as hydrogen sulfide. Figure 11 shows the locations of the Georgia SO_2 monitoring stations for 2009.

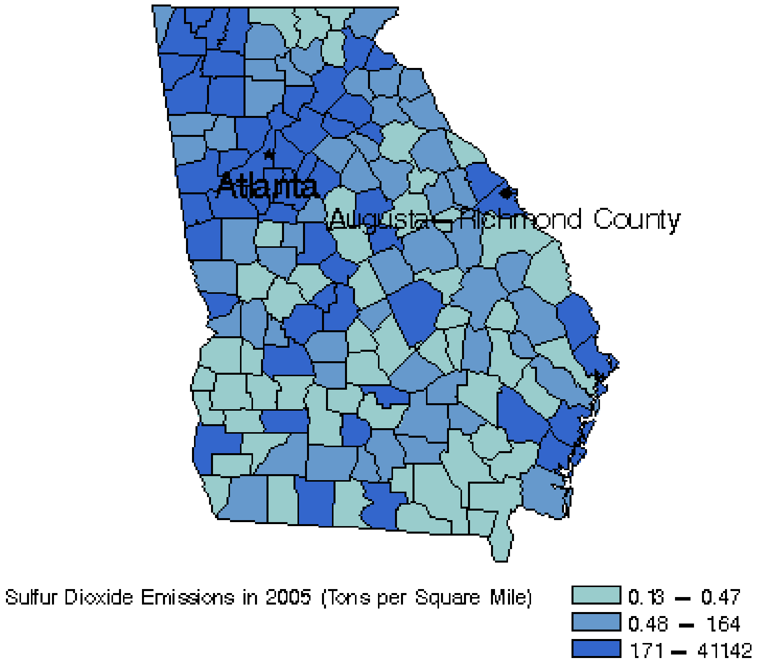
ATTAINMENT DESIGNATION

To determine if an SO_2 monitor is in attainment, the annual, 24-hour average, and 3-hour averages are evaluated. The data collected has to be at least 75 percent complete in each calendar quarter. A 24-hour block average is considered valid if at least 75 percent of the hourly averages for that 24-hour period are available [61 FR 25579, May 22, 1996]. To be considered in attainment, an SO_2 site must have an annual mean less than 0.03 parts per million (ppm), no more than one 24-hour average exceeding 0.14 ppm, and no more than one 3-hour average exceeding 0.50 ppm. For 2009, all of Georgia is in attainment of the sulfur dioxide standard. For additional summary data on this topic, see Appendix A.



(From EPA’s Air Emissions Sources)

Figure 9: Common Sources of Sulfur Dioxide (SO_2) in Georgia in 2005



(From EPA’s Air Emissions Sources)

Figure 10: Sulfur Dioxide Emission in Georgia in 2005 – Spatial View

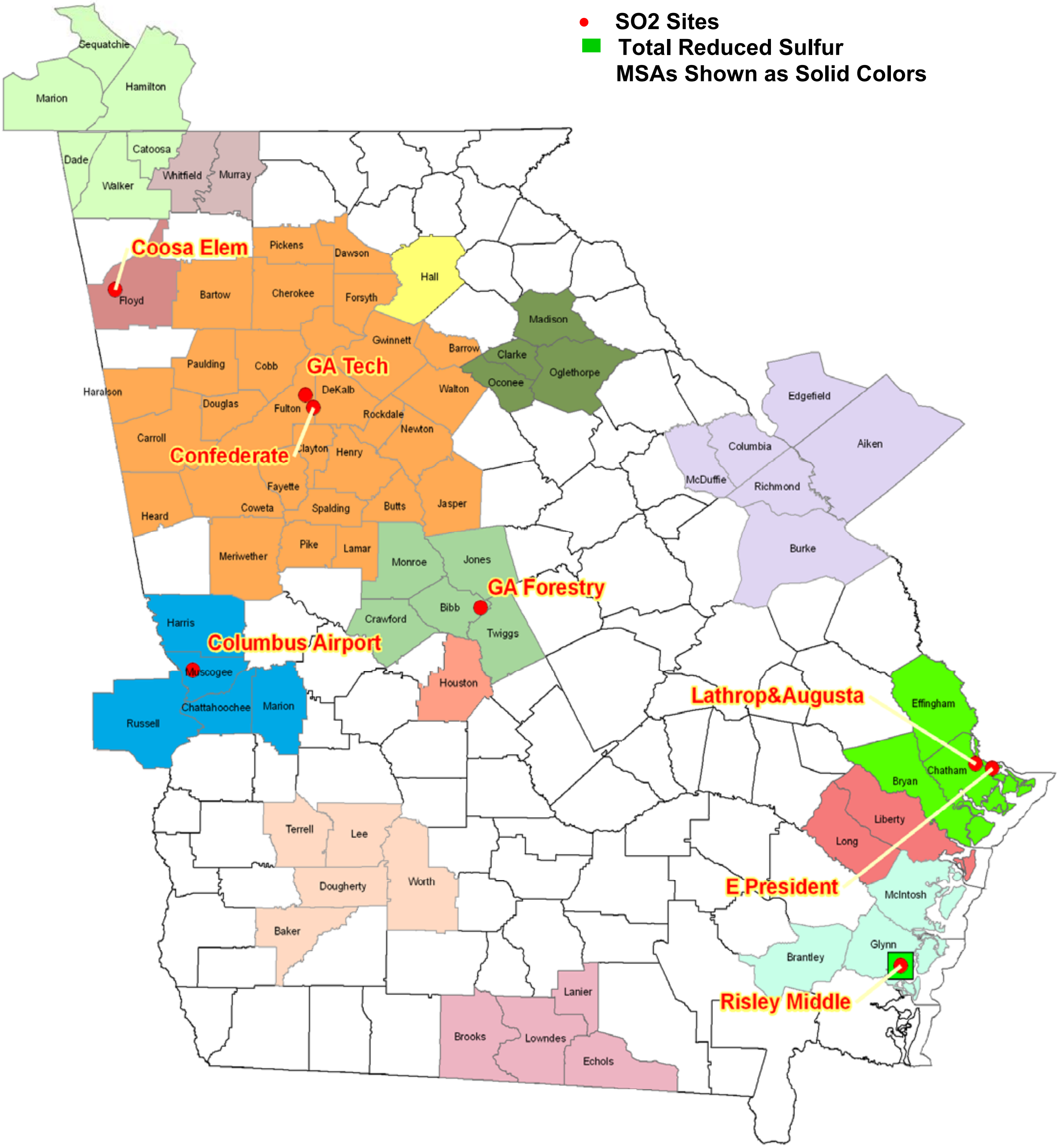


Figure 11: Sulfur Dioxide Monitoring Site Map

OZONE (O_3)

GENERAL INFORMATION

Ground level ozone is not a primary pollutant. Ozone is not directly emitted by any sources such as a mobile or stationary. Ozone formation occurs though a complex series of chemical reactions that take place in the presence of strong sunlight (photochemical reactions). For these reactions to take place, certain ingredients (precursors) must be available. Since the reactions must take place in the presence of strong sunlight, ozone concentrations have a strong diurnal pattern (Figure 12).

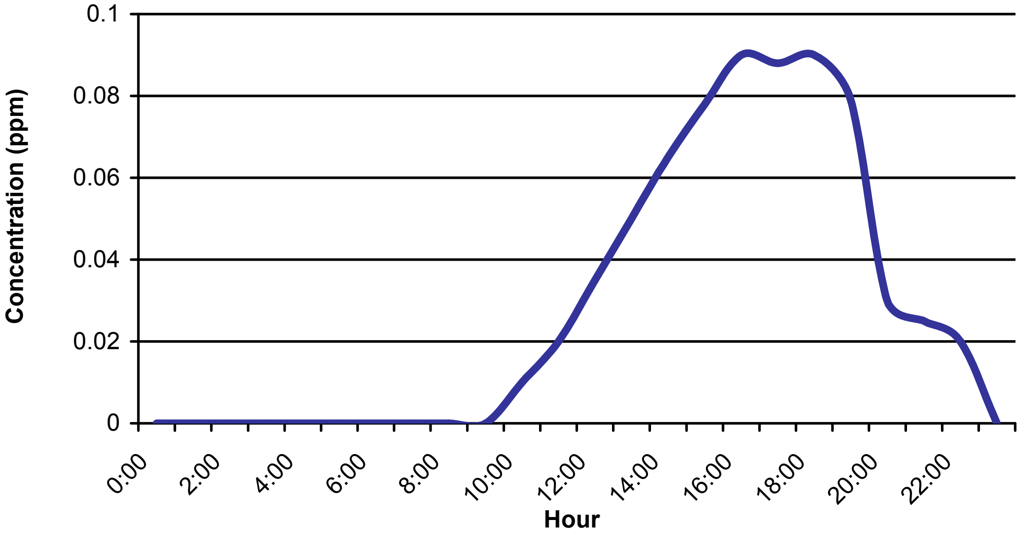


Figure 12: Typical Urban 1-Hour Ozone Diurnal Pattern

The precursors[1] to ozone, are oxides of nitrogen (NOx) and reactive organic substances (also known as VOCs or hydrocarbons). Examples of the reactive organic substances that contribute to ozone formation are: hydrocarbons found in automobile exhaust (benzene, propane, toluene); vapors from cleaning solvents (toluene); and biogenic emissions (isoprene). Sources of VOCs in Georgia are shown in Figure 13, on the following page, and it is followed by a spatial view of VOC emissions across the state in Figure 14. These figures are taken from the latest emissions report from EPA, based on 2005 data. Ozone is a colorless gas, however, when mixed with particles and other pollutants, such as NO_2, the atmospheric reaction forms smog, a brownish, pungent mixture (see Figure 15 and Figure 16). This type of pollution first gained attention in the 1940's as Los Angeles photochemical "smog". Since then, photochemical smog has been observed frequently in many other cities.

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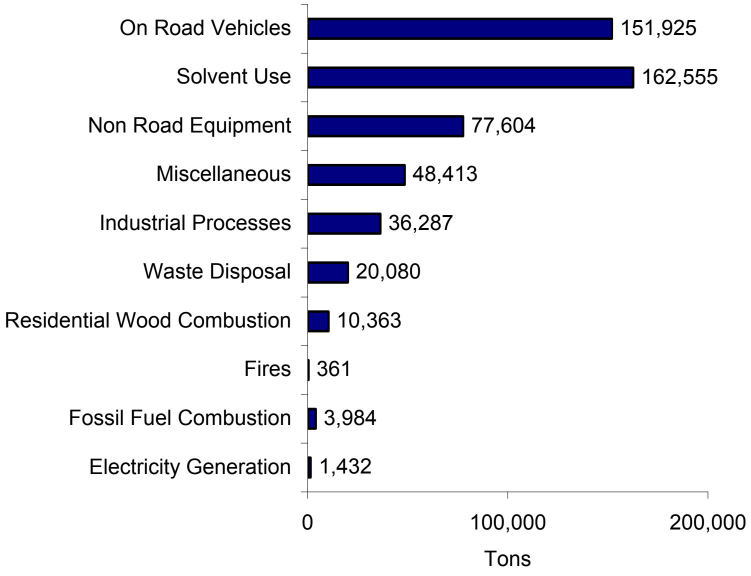
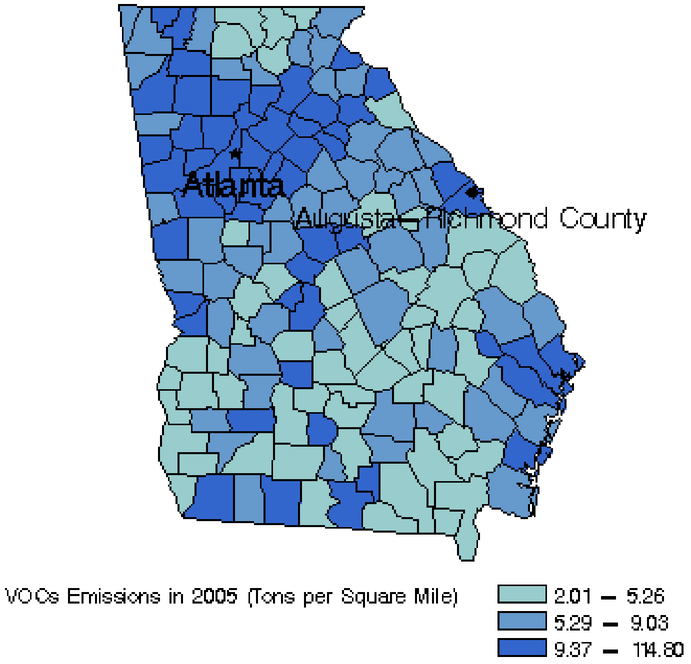
[1] For a more complete discussion on ozone precursors, please see the NO_2 section and the PAMS section of this report.



(From EPA's Air Emissions Sources)

Figure 13: Common Sources of Volatile Organic Compounds (VOCs) in Georgia in 2005



(From EPA's Air Emissions Sources)

Figure 14: Volatile Organic Compounds (VOCs) Emission in Georgia in 2005 – Spatial View

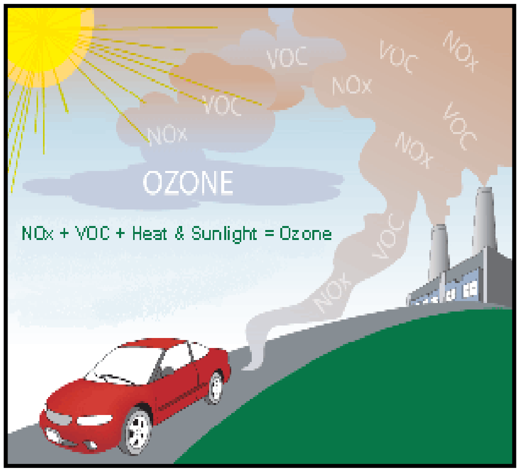


Figure 15: Demonstration of Ozone Formation

As indicated above, 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. You can only bake cookies until you run out of any one of the ingredients you need. If you run out of flour, it doesn't matter how much milk and sugar you have on hand; you can't make any more cookies 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. As it turns out, natural background hydrocarbon levels are quite low in Los Angeles, so in that area hydrocarbons are typically the reactant that limits how much ozone can be produced. The control measures that proved effective in reducing smog there involved reducing hydrocarbon emissions. These control measures and the science behind them have become relatively advanced because the Los Angeles ozone problem was so severe and developed so long ago. But many of the fundamental lessons learned about smog formation in Los Angeles over many years of research have proven to not apply in the same way in Georgia.

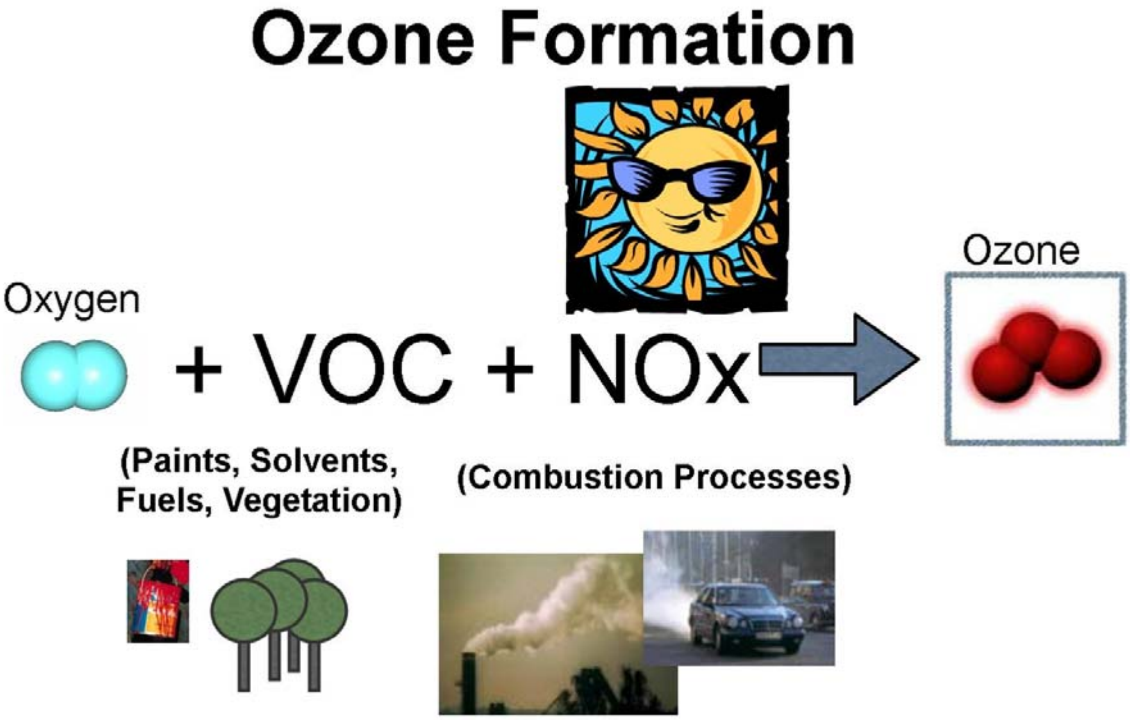


Figure 16: Ozone Formation Process

At the start of air quality control implementation in Georgia, the then-standard assumption was that Georgia was also hydrocarbon limited. However, the initial control measures seemed ineffective in actually reducing ozone levels. In time, researchers discovered that vegetation naturally emits large quantities of hydrocarbons. The solution to ozone control in Georgia, then, would have to focus on a different limiting reactant. Since there will always be strong sunshine in the summer, and there will always be oxygen, the only effective way left to control ozone production is to reduce emissions of oxides of nitrogen.

The control technologies that reduce hydrocarbon emissions are generally not effective on oxides of nitrogen, so a whole new set of control technologies had to be developed. This area has been in some ways unable to take full advantage of the technologies developed for Los Angeles, then, because those technologies were not suited to local conditions. With respect to reducing emissions from automobile engines, for example, the addition of relatively simple and inexpensive catalytic converters to existing engine designs was a great leap forward in reducing hydrocarbon emissions. Catalytic converters have been used with great success since the early 1970s. Thus far, emissions of oxides of nitrogen have proven more difficult to control than hydrocarbon emissions, especially given that the control measures have not had forty years to mature. Research on the topic continues, and new emissions control equipment is always under development. For example, where catalytic converters could be added to existing engine designs to greatly reduce hydrocarbon emissions, solutions for reducing emissions of oxides of nitrogen have generally required far more reengineering of the engines themselves. There is no easy “bolt on” solution.

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. The South DeKalb site began year-round monitoring as of November 2009. Many urban areas experience high levels of ground level ozone during the summer months. We also see high ozone levels in rural and mountainous areas. This is often caused by ozone and/or its precursors being transported by wind for many hundreds of miles.

A final difference between ozone and the other pollutants is that ozone is sometimes good. While ground level ozone is considered a hazardous pollutant, 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 chloroflourocarbons (CFC), which when released naturally migrate to the upper atmosphere. Once in the upper atmosphere, the 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.

The Georgia Environmental Protection Division monitors ground level ozone at 22 sites throughout the state (Figure 17).

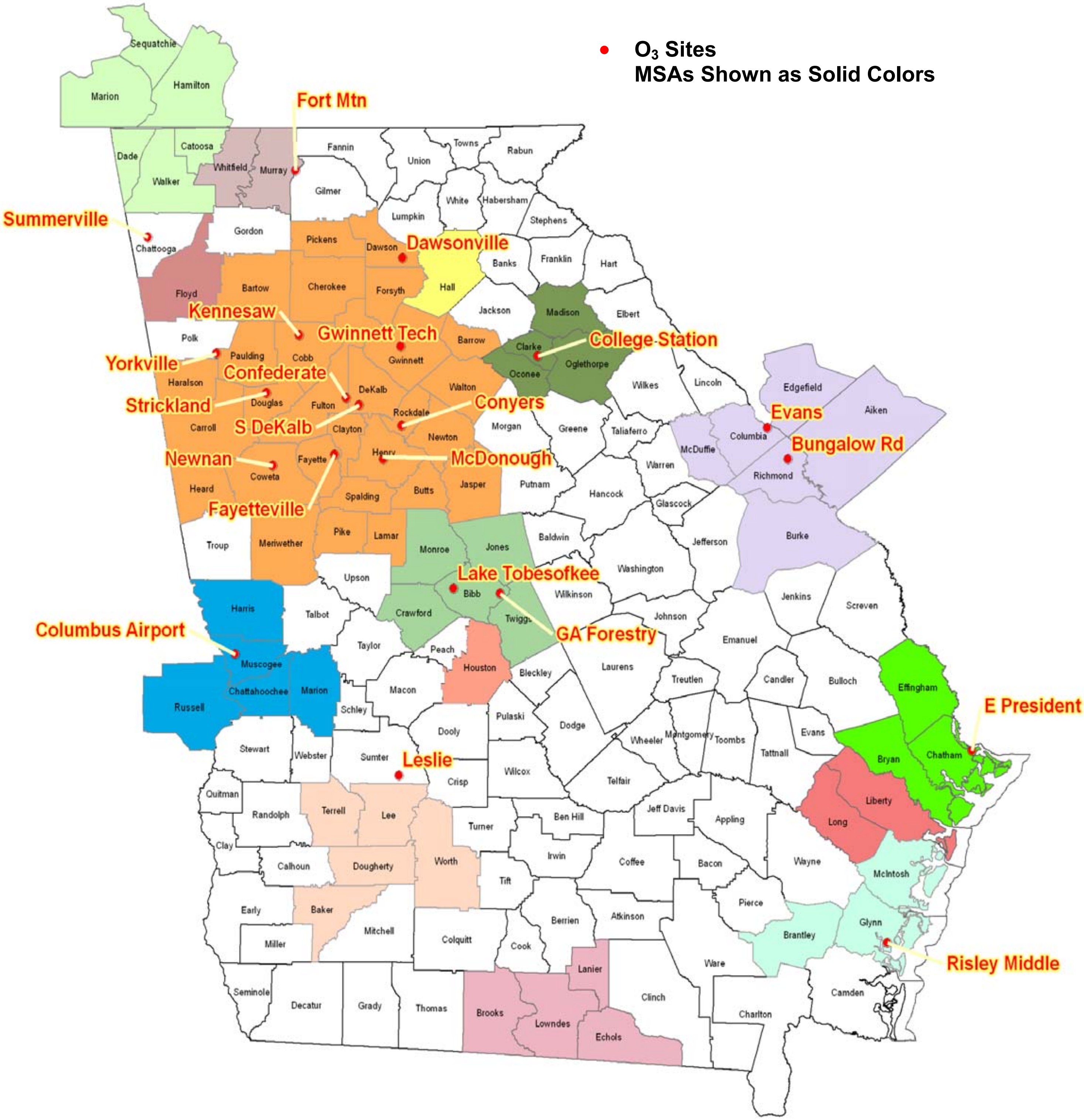


Figure 17: Ozone Monitoring Site Map

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.

The potential chronic effects of repeated exposure to ozone are of even greater concern. Laboratory studies show that people exposed over a six to eight hour period to relatively low ozone levels develop lung inflammation. Animal studies suggest that if exposures are repeated over a long period (e.g. months, years, lifetime), inflammation of this type may lead to permanent scarring of lung tissue, loss of lung function, and reduced lung elasticity.

MEASUREMENT TECHNIQUES

Ozone is monitored using specialized commercial instruments made for that specific purpose. The analyzers continuously measure the concentration of ozone in ambient air using the U.V. photometric method and are EPA-approved for regulatory air monitoring programs. Data gained from the continuous monitors is used to determine compliance with the NAAQS for ozone.

ATTAINMENT DESIGNATION

Ozone monitoring has been in place in the Atlanta area since 1980. The 1980 network consisted of two monitors located in DeKalb and Rockdale Counties. Currently the metro Atlanta ozone network includes eleven monitors located in ten counties.

In July 1997 the US EPA issued an 8-hour ozone standard intended to eventually replace the older 1-hour standard. This 8-hour standard is attained when the average of the fourth highest concentration measured is equal to or below 0.08 ppm (0.085 ppm with the EPA rounding convention) averaged over three years (see Table 1; 62 FR 38894, July 18, 1997). Areas EPA has declared in attainment of 1-hour standard are immediately exempt from that standard, but thereafter are subject to the 8-hour standard. In the summer of 2005, metro Atlanta was declared in attainment of the 1-hour standard. As of the printing of this report, then, only the 8-hour ozone standard is applicable in Georgia. 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. 63, No.60).

The Atlanta ozone nonattainment area currently consists of Bartow, Cherokee, Clayton, Cobb, Coweta, DeKalb, Douglas, Fayette, Forsyth, Fulton, Gwinnett, Henry, Paulding, Rockdale, Barrow, Carroll, Hall, Newton, Spalding, and Walton Counties. All other metropolitan statistical areas in Georgia are currently in attainment. Catoosa County is party of the Chattanooga Early Action Compact area. Figure 18, on the next page, shows the boundaries of these nonattainment areas. The designations process for the 2008 ground-level ozone standards is ongoing and final designations are scheduled to be determined in the spring of 2009.

A number of activities to aid in controlling the precursors to ozone formation have been implemented. A new State Implementation Plans (SIP) will be developed to assist in ozone reduction. As new areas are declared in nonattainment, these control measures may be expanded to include them. One activity could include a vehicle inspection program. However, as the vehicle fleet gets younger, this is not as beneficial. Other activities include installing controls on stationary emission sources, and the establishment of a voluntary mobile emissions reduction program. An example of such a program in metro Atlanta is called The Clean Air Campaign (CAC). Activities of The Clean Air Campaign include distributing daily ozone forecasts (as well as $PM_{2.5}$ forecasts produced by EPD) during the ozone season to enable citizens in the sensitive group category as well as industries to alter activities on days that are forecasted to be conducive to ozone formation. This is also done for the Macon and Columbus areas. In addition to the daily forecasts, citizens have access to forecast and monitoring data on an as needed basis by either calling 1-800-427-9605 or by accessing the Georgia DNR/EPD Ambient Air Monitoring website at http://www.air.dnr.state.ga.us/amp/index.php. For a more detailed discussion concerning the CAC, see the section titled “Outreach and Education”.

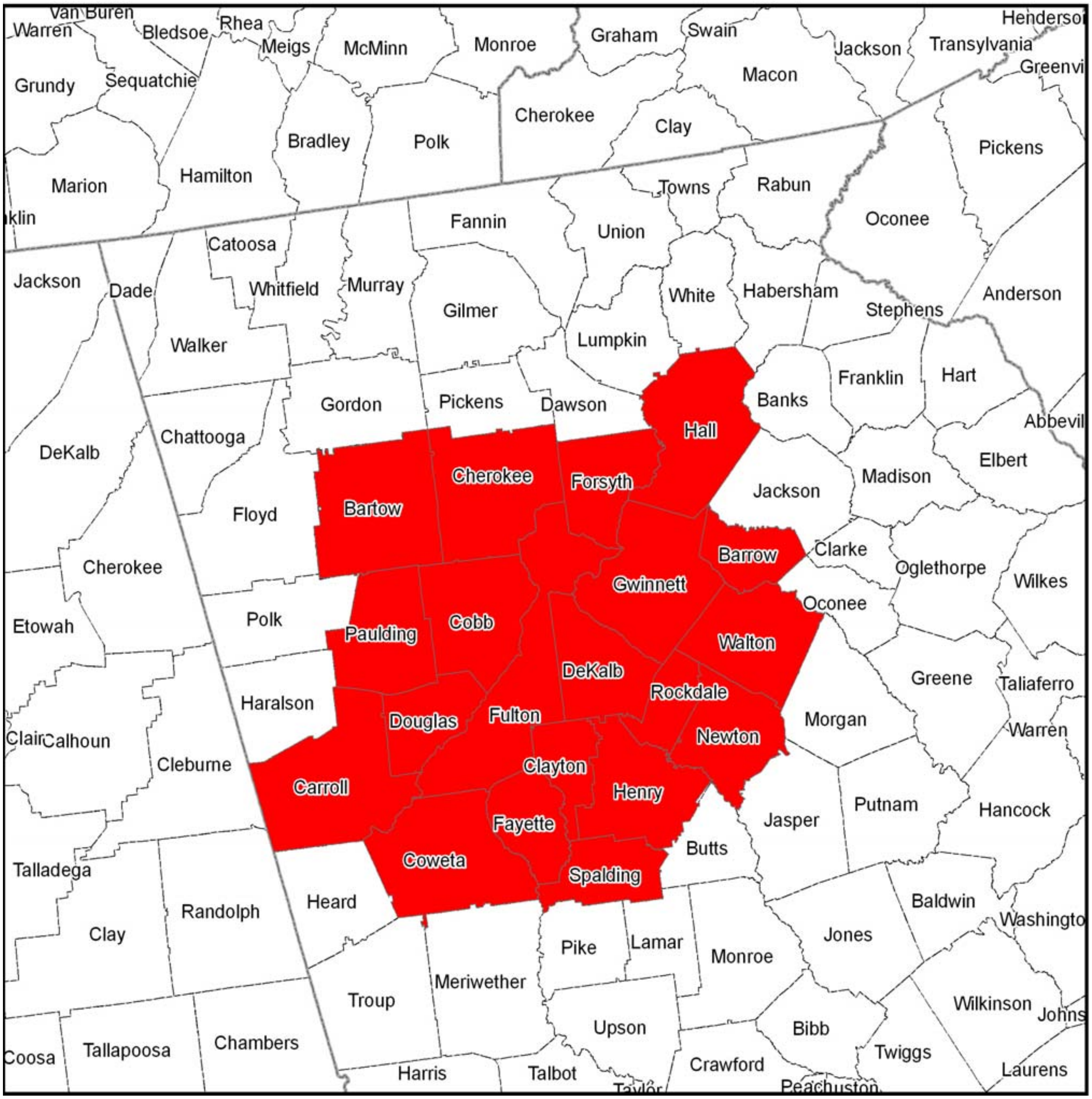


Figure 18: Georgia’s 8-Hour Ozone Nonattainment Area Map

Figure 19 shows how past air quality would relate to the new 0.075 ppm 8-hour standard (green line), and how current air quality relates to the old 0.080 ppm 8-hour standard (blue line). This chart was produced by comparing measurement data against both ambient standards. This demonstrates the relative strictness of each standard and shows how metro Atlanta's air quality has changed over time. Despite a great deal of fluctuation, over the course of the past twenty-five years, there has been a gradual reduction in the number of days exceeding either ozone standard. A trendline, produced by regression analysis, was created for both the 8-hour standards. The trendlines for both 8-hour ozone standards show that the number of days that exceed the ozone standard has fallen by about a day each year over this time period. Even with the new, lower 8-hour ozone standard, the data shows a decrease in the number of days with ozone exceedances for the metro Atlanta area. In 2009, the metro Atlanta area had a total of 14 days that violated the current (0.075 ppm) 8-hour standard.

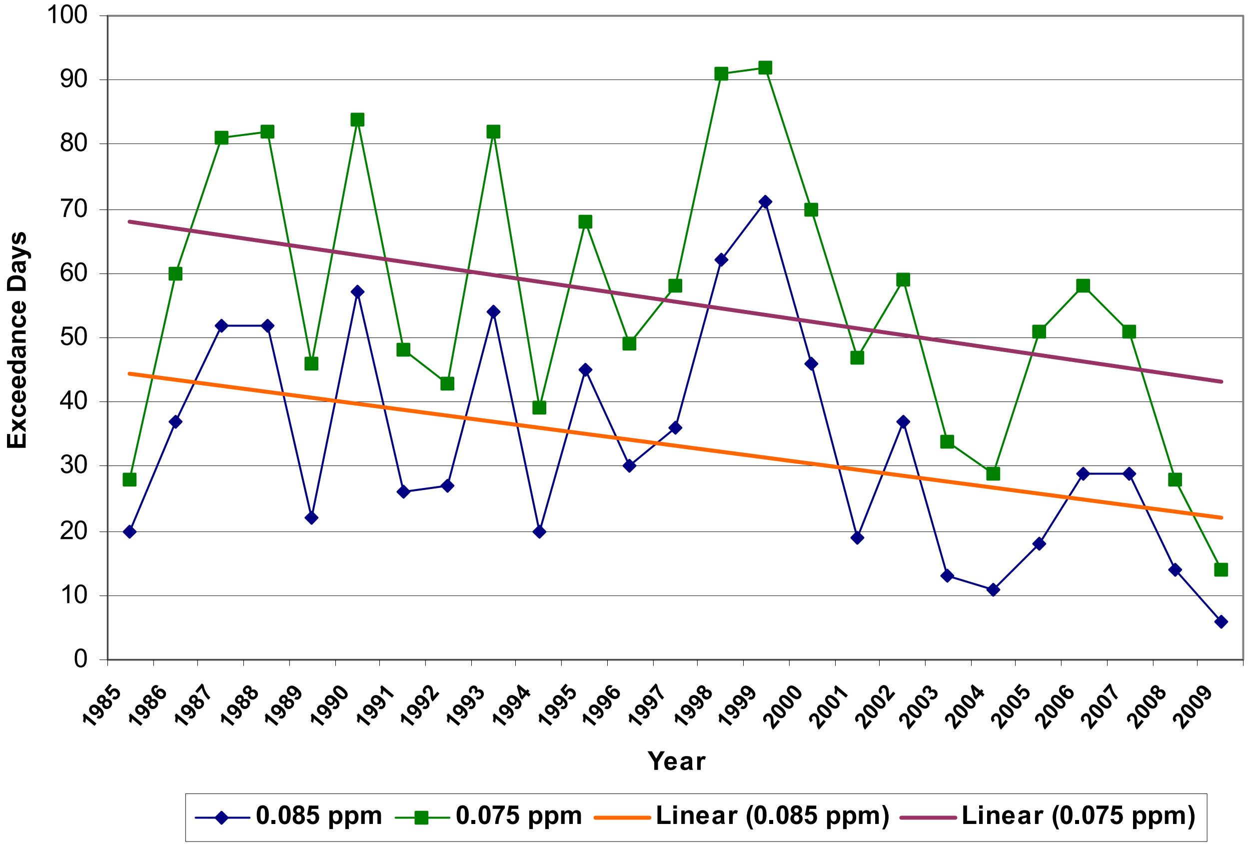
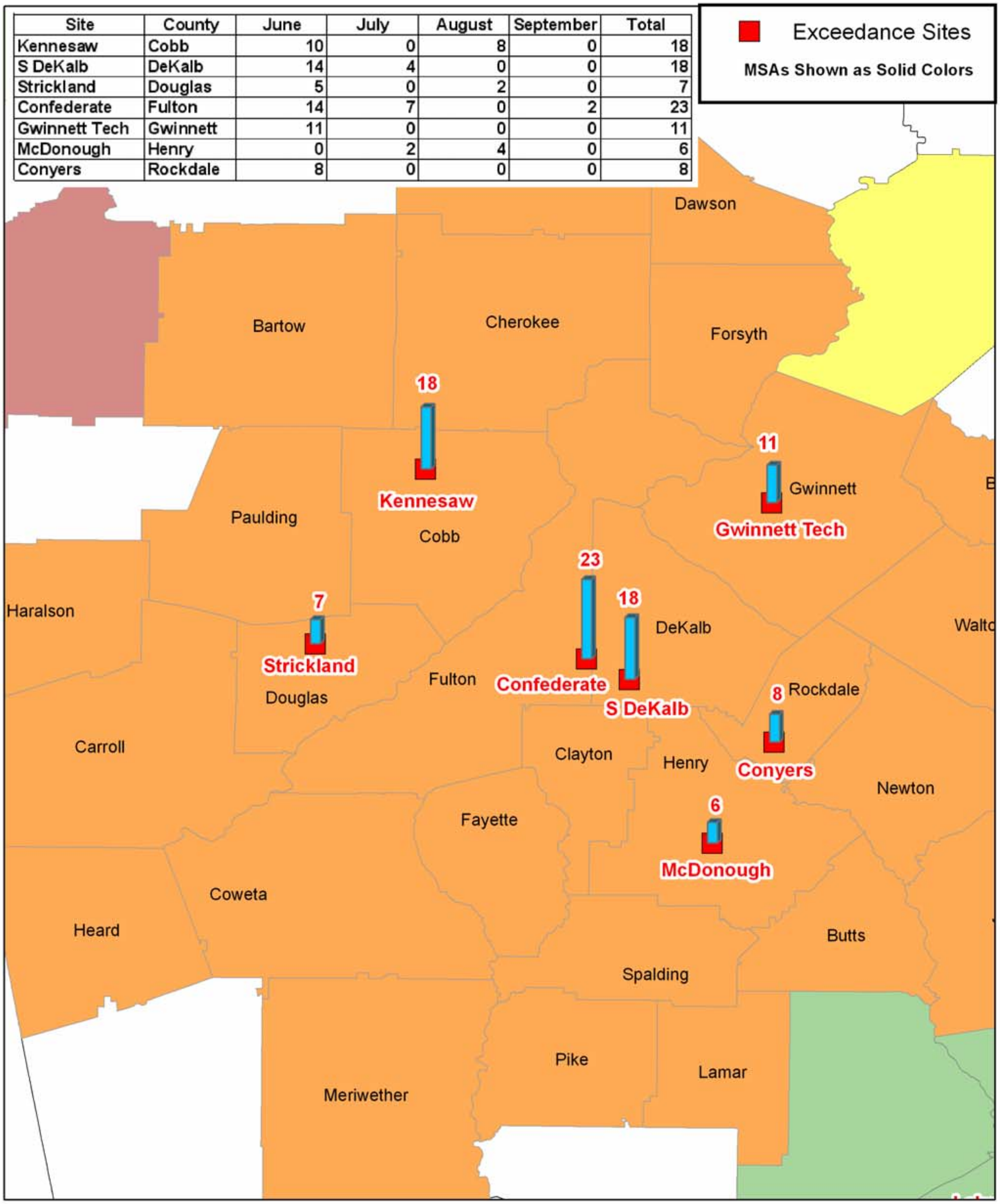


Figure 19: Metro Atlanta Ozone- Number of Violation Days per Year

Figure 20, on the following page, maps each metro Atlanta ozone monitor that exceeded the 8-hour ozone standard in 2009, and also indicates the monthly breakdown of the exceedances. Since the 8-hour increment is calculated as a running 8-hour timeframe, there are a number of averages each day. Figure 20 shows the number of times that each monitor had 8-hour averages above the 0.075 ppm standard. The Confederate Avenue site shows the highest number of 8-hour ozone averages above 0.075 ppm, with 23 total for the 2009 ozone season. Seven of the total ten ozone sites collecting data in 2009 in the metro Atlanta area had exceedances in 2009.

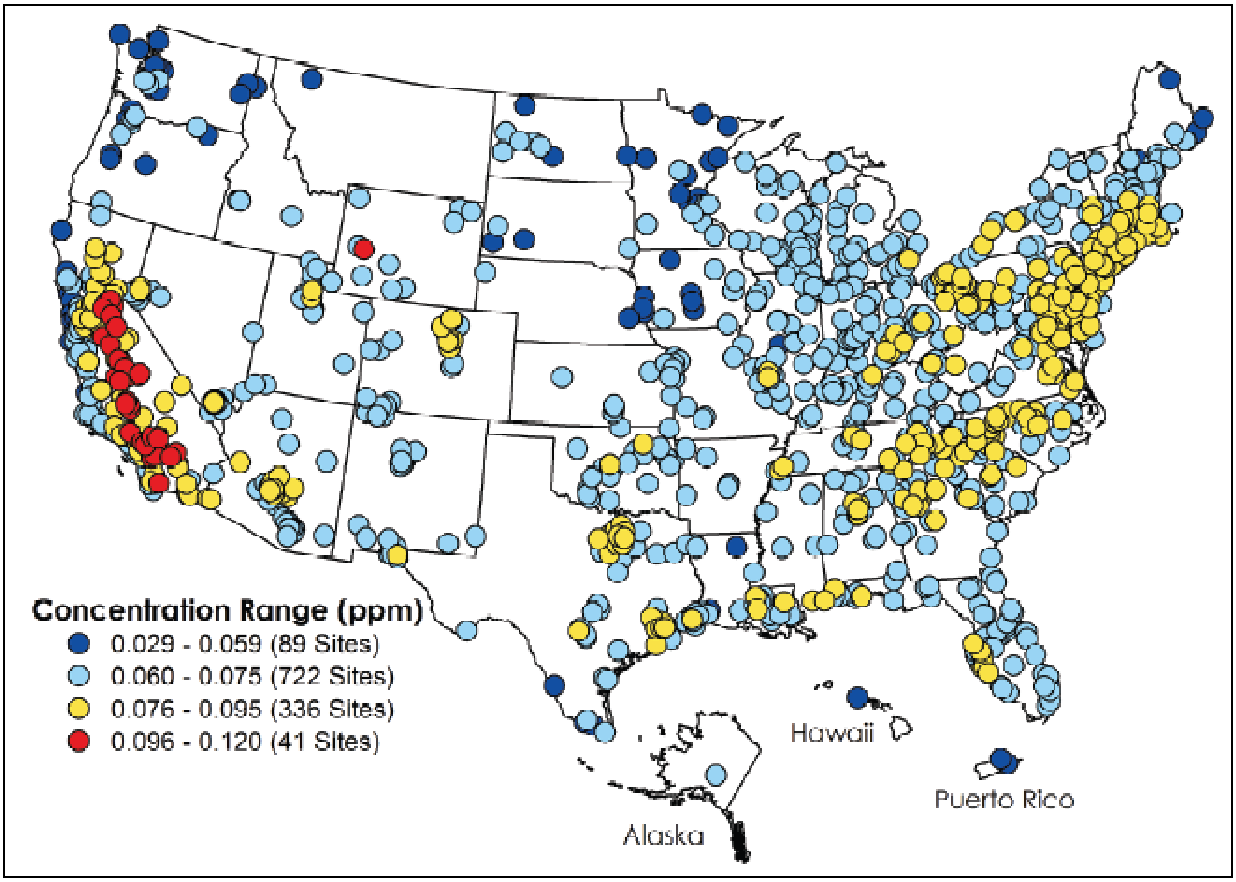
For additional ozone summary data, see Appendix A.



Site	County	June	July	August	September	Total
Kennesaw	Cobb	10	0	8	0	18
S DeKalb	DeKalb	14	4	0	0	18
Strickland	Douglas	5	0	2	0	7
Confederate	Fulton	14	7	0	2	23
Gwinnett Tech	Gwinnett	11	0	0	0	11
McDonough	Henry	0	2	4	0	6
Conyers	Rockdale	8	0	0	0	8

Figure 20: Metro Atlanta Ozone Exceedance Map

The following map was taken from the EPA document “Our Nation’s Air- Status and Trends through 2008”. It shows the fourth maximum reading for the 8-hour ozone readings across the United States. It is interesting to see the correlation of higher readings with the more populated areas across the United States. One can also see how Georgia’s ozone readings compare with other states across the country. Georgia’s fourth maximum ozone readings in 2008 were in the 0.060-0.075 ppm (light blue) and 0.076-0.095 ppm (yellow) ranges.



(From EPA’s “Our Nation’s Air Quality-Status and Trends through 2008”)

Figure 21: Ozone Concentrations in ppm, 2008 (Fourth Highest Daily Maximum 8-Hour Concentrations)

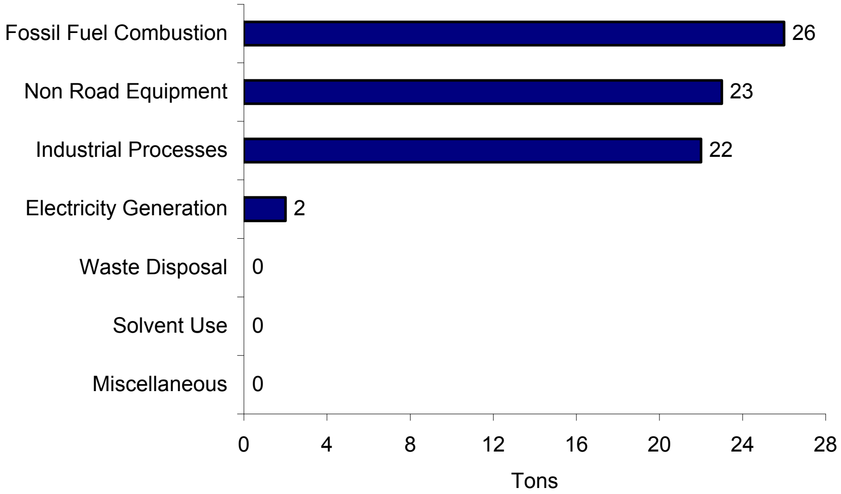
LEAD (Pb)

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 have decreased to nearly zero by the late 1980s**.** Since then, the concentrations have hovered just above zero. Based on data from EPA's Air Emission Sources for 2005, Georgia's primary source of lead emissions is fossil fuel combustion (Figure 22). Other sources of lead emissions include industrial processes (metals processing, iron and steel production), combustion of solid waste, and lead-acid battery manufacturing. Figure 23, on the following page, shows a spatial view of Georgia's lead emissions, also from EPA's Air Emission Sources, based on 2005 data.

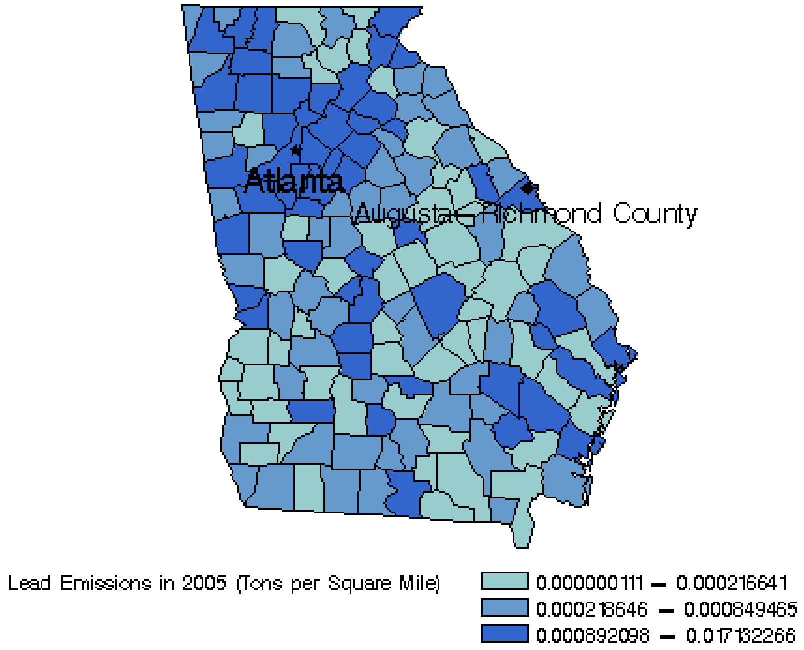
At the beginning of 2009, there were two dedicated lead monitors remaining in Georgia for comparison to the NAAQS lead standard. One was in the Atlanta area for monitoring long-term trends in ambient lead levels. The other was in Columbus for industrial source monitoring, given the historical issues with lead pollution in the area. At the end of 2008, EPA strengthened the standard and monitoring requirements. As well as lowering the standard, additional monitors were to be placed in areas with demonstrated lead emissions of 1.0 or more tons per year and urban areas of more than 500,000 (Federal Register, Vol. 73, No. 219, dated November 12, 2008). In response to this rule change, in December of 2009, GA EPD added a site to monitor another lead source in the Cartersville area. Since this time, EPA has proposed to lower the source-oriented monitors for lead emission level to 0.50 tons per year, change the population based requirement to include the 'NCore network', and treat airports with aircraft using leaded fuel as sources of lead when determining source-oriented monitoring requirements (Federal Register, Vol. 74, No. 249, dated December 30, 2009). If these changes are made in the rule, GA EPD will re-evaluate the need for additional lead monitors in Georgia.

The current criteria lead monitoring network is as indicated in Figure 24. 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 Georgia as a trace metal in the Georgia Air Toxics Monitoring Network and with the $PM_{2.5}$ speciation samplers. The equipment used at those sites can detect far smaller concentrations. For additional summary data on lead as collected as an Air Toxics trace metal, see Appendix D.



(From EPA's Air Emissions Sources)

Figure 22: Common Sources of Lead in Georgia in 2005



(From EPA's Air Emissions Sources)

Figure 23: Lead Emission in Georgia in 2005 – Spatial View

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 the 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, unlike measurements for the gaseous pollutants discussed earlier (ozone, SO2, NO2 and CO). Samples are collected on 8" x 10" pre-weighed fiberglass filters with a high-volume sampler for 24 hours, collecting all particulate sizes. The filter sample is shipped to a laboratory for analysis using inductively coupled plasma mass spectroscopy (commonly known as ICP-MS). Data gained from the lead sampler is used to determine compliance with the National Ambient Air Quality Standards for lead.

ATTAINMENT DESIGNATION

The 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. In order to comply with both the primary and secondary standard, the concentration of lead in the air must have an arithmetic mean no higher than 0.15 micrograms per cubic meter averaged on a rolling 3-month basis (Federal Register, Vol. 73, No. 219, dated November 12, 2008). On October 15, 2008 this standard was changed from the original standard of 1.5 µg/m^3 averaged per calendar quarter that has been in place since October 5, 1978 (43 FR 46258). This new lead standard became effective on January 12, 2009 and is to be implemented by January 1, 2010. All of Georgia is currently in attainment of the lead standard. For additional summary data on this topic, see Appendix A.

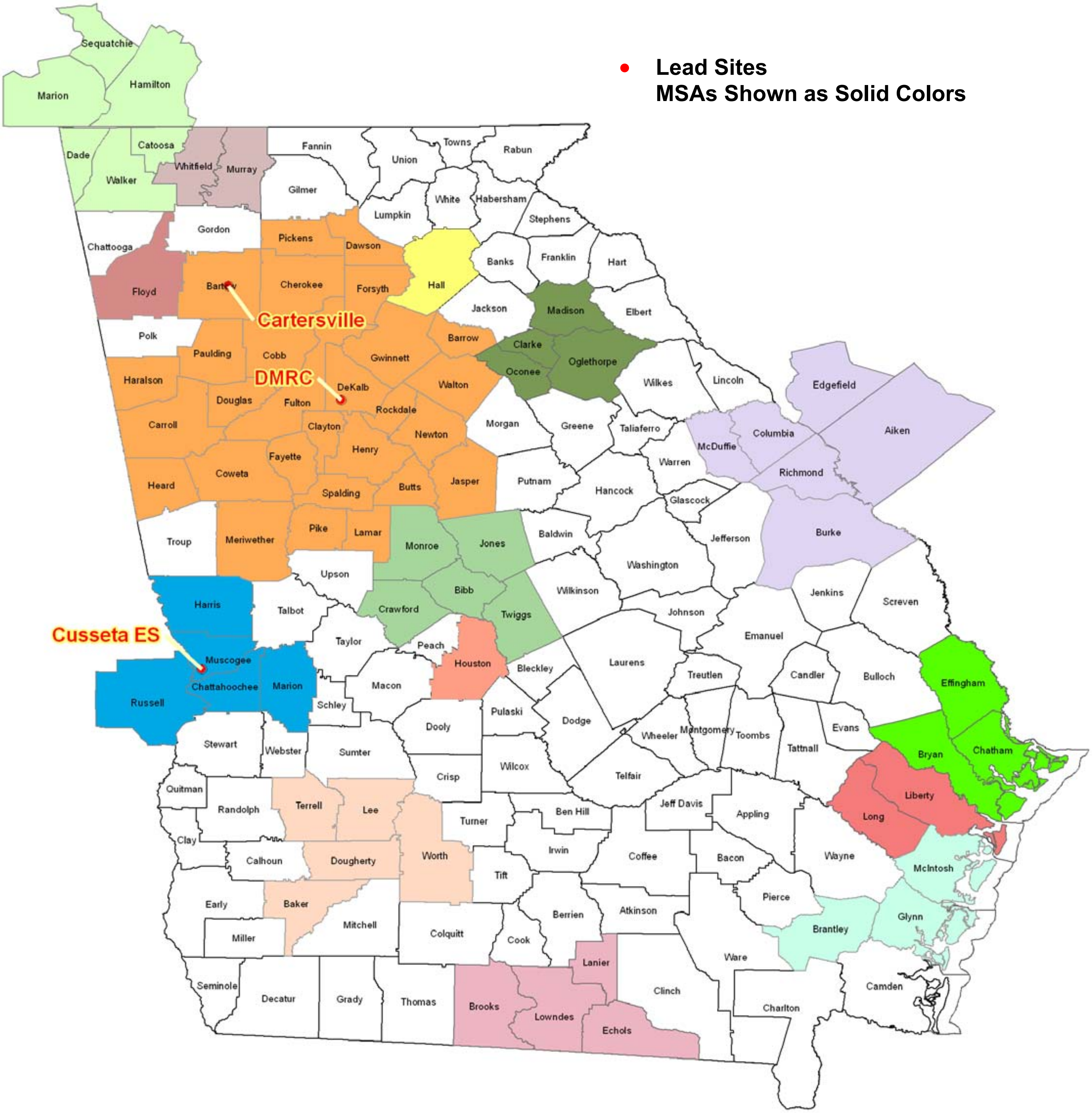


Figure 24: Lead Monitoring Site Map

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 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.

As diesel combustion and vehicle exhaust are sources of particulate matter, efforts are being made to reduce these emissions by retrofitting diesel engines and making alternative 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 promoted by GA EPD 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 more information about Georgia EPD's program, go to http://www.georgiaair.org/retrofit/index.htm. In addition, cleaner diesel fuels are available that reduce PM emissions, as well as other pollutant emissions, depending on the fuel. Ultra-low sulfur diesel fuel reduces sulfur and PM emissions. The use of biodiesel reduces PM, CO, hydrocarbons, and air toxics. Using emulsified diesel reduces both NOx and PM emissions.

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 two sizes of particles: PM_{10} (up to 10 microns in diameter) and $PM_{2.5}$ (up to 2.5 microns in diameter). Both of these particles are very small in size. For example, Figure 25 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.

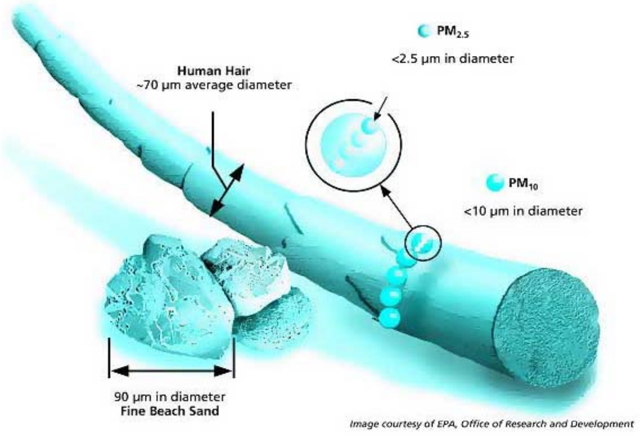


Image courtesy of EPA, Office of Research and Development

Figure 25: Analogy of Particulate Matter Size to Human Hair

Maps of each of the particulate matter networks (PM_{10}, $PM_{2.5}$ federal reference method, $PM_{2.5}$ continuous, and $PM_{2.5}$ speciation) are included in the following subsections that discuss particulate matter.

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 of particular concern. 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.

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.

For a map of the PM_{10} network, refer to Figure 26 on the next page.

HEALTH IMPACTS

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

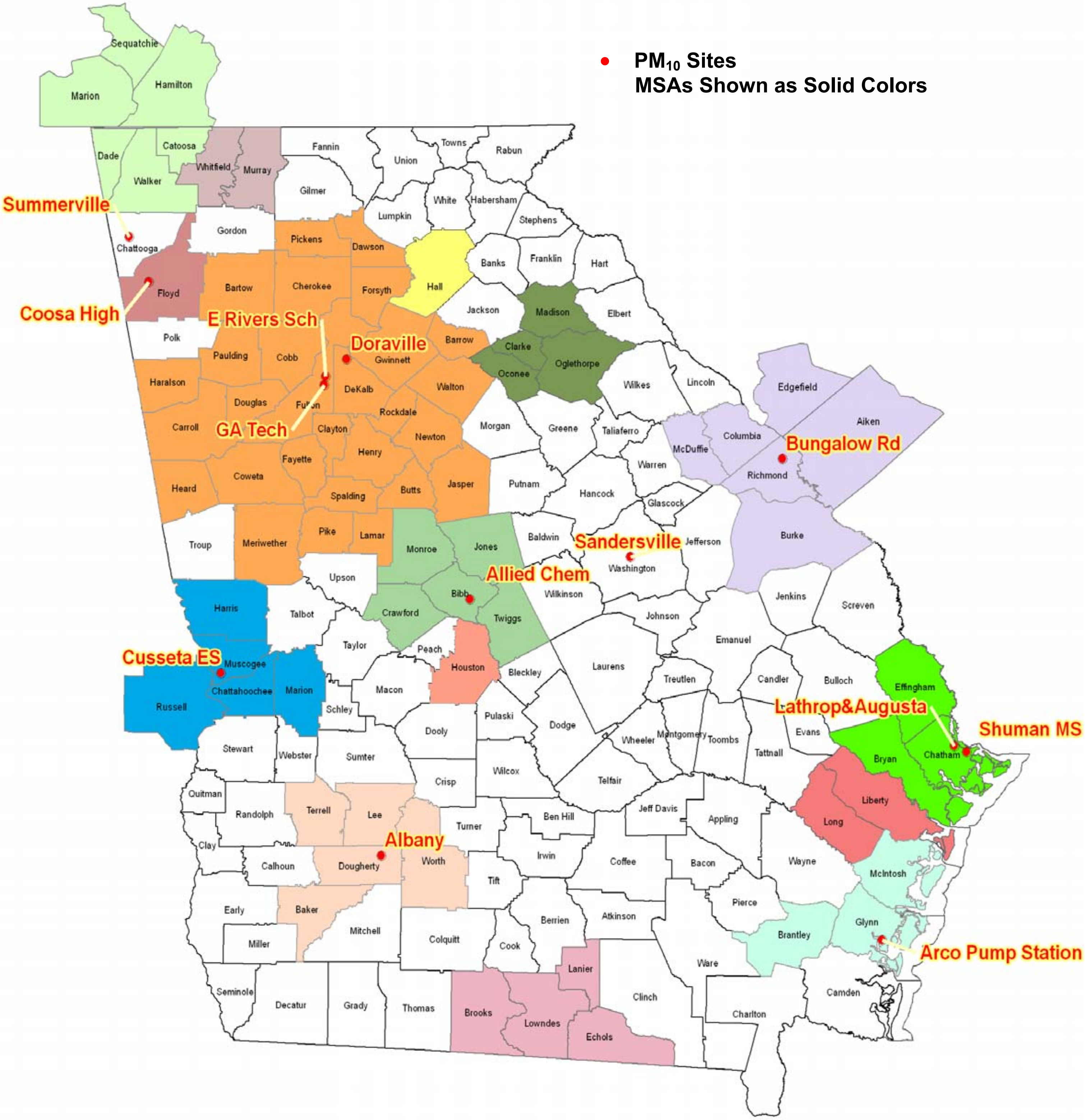


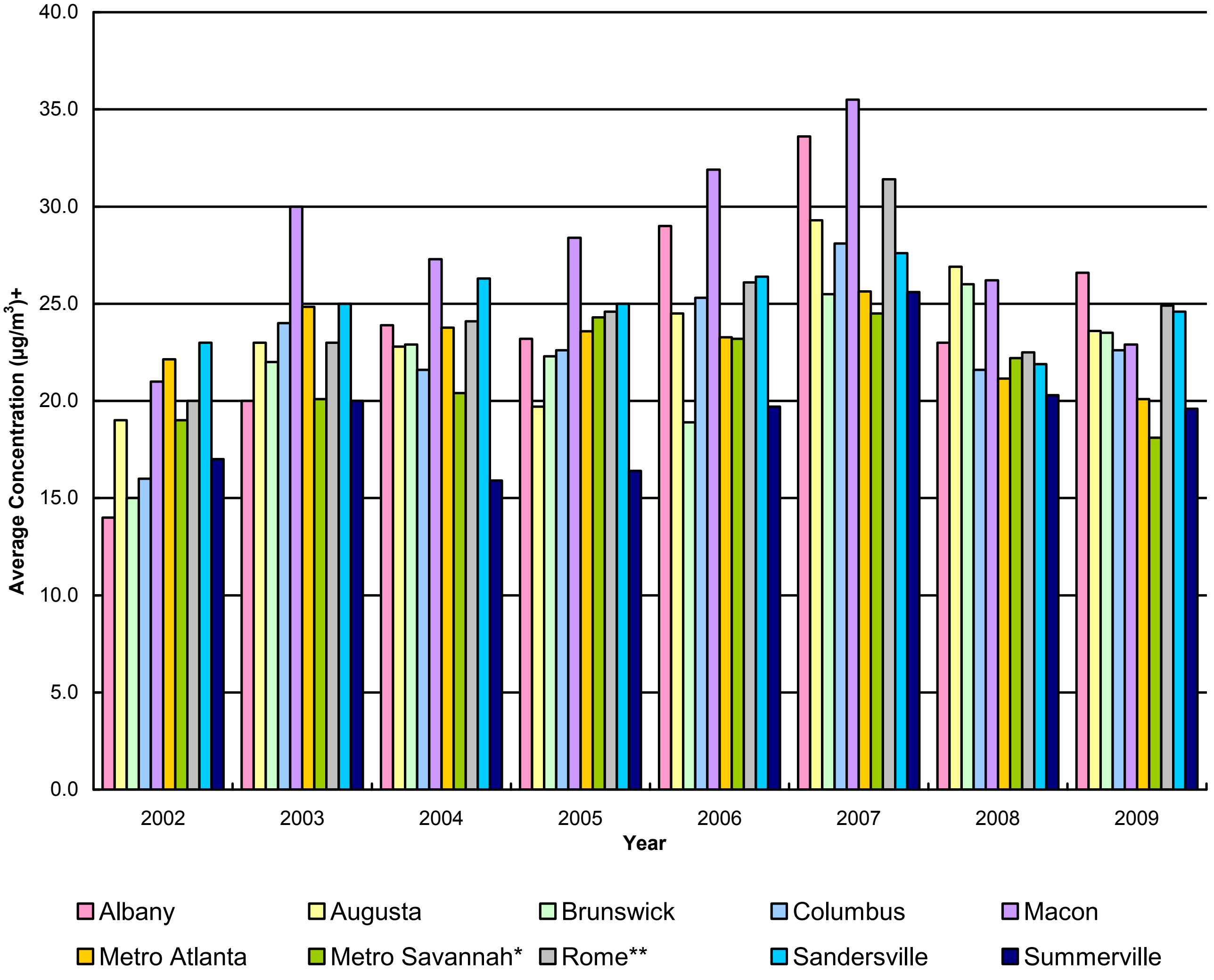
Figure 26: PM$_{10}$ Monitoring Site Map

MEASUREMENT TECHNIQUES

The Georgia PM_{10} monitoring network consists of two types of monitors. The first is an event monitor in which samples are collected for 24 hours on a quartz microfiber filter. A specialized sample-sorting device is used so that the filter collects only particles 10 microns in size and smaller. The filters are weighed in a laboratory before and after the sampling period. The change in the filter weight corresponds to the mass of PM_{10} particles collected. That mass, divided by the total volume of air sampled, corresponds to the mass concentration of the particles in the air. Because of the need for manual filter loading and unloading, and shipping back to the laboratory, there is significant time lag between taking the measurement and obtaining data. The other type of monitor is fundamentally similar, but has been greatly modernized. It draws particle-laden air through a filter and analyzes how the mass of the filter changes on an hourly or nearly continuous basis. This monitor gives much more information about how PM_{10} concentrations vary over time, is less labor-intensive, and produces results almost instantly.

ATTAINMENT DESIGNATION

The primary and secondary standards for PM_{10} are the same. In order for an area to be considered in compliance with the PM_{10} standard, the 24-hour concentration of 150 micrograms per cubic meter should not be exceeded more than once per year on average over three years [52 FR 24663, July 1, 1987, as amended at 62 FR 38711, July 18, 1997; 65 FR 80779, Dec. 22, 2000]. There was also an annual average standard for PM_{10} until December 17, 2006. EPA revoked the standard because of a lack of evidence of chronic health effects resulting from long-term exposure to moderate levels of PM_{10}.



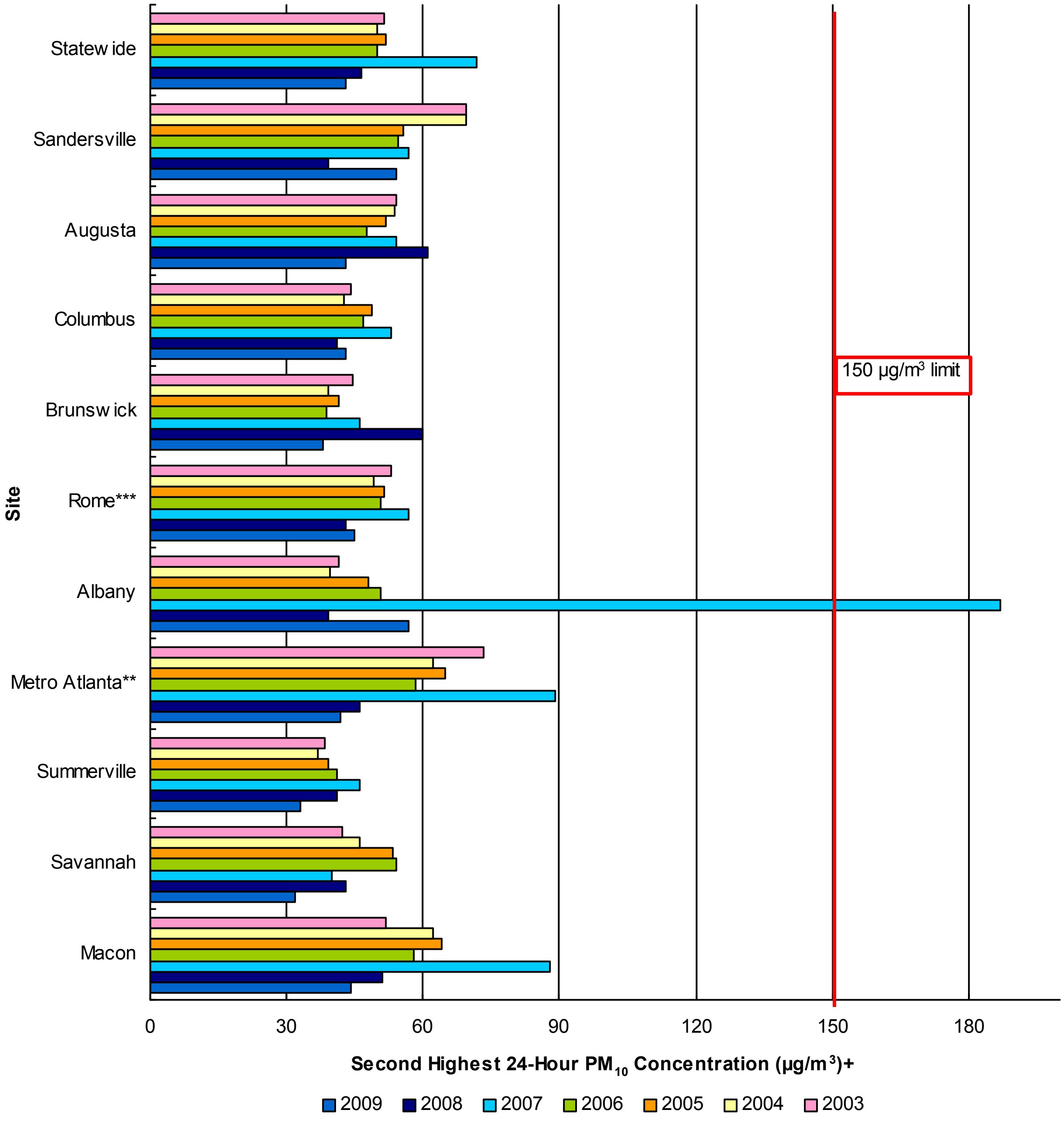
+ Includes exceptional event data for 2007
** Average includes one site for 2007,2008, and 2009*
***Rome data consolidated for 131150003 and 131150005*

Figure 27: PM_{10} Annual Arithmetic Mean Chart

Figure 27 shows the annual PM_{10} averages for metro areas in Georgia. On an annual basis, PM_{10} levels in Georgia are relatively low. However, there was an increase in the annual averages of PM_{10} for 2007 that is presumed to be a product of the Okefenokee Swamp wildfire. Due to this wildfire, Georgia EPD requested from the U.S. EPA that two PM_{10} data points from the Albany site be taken out of the dataset for regulatory purposes. The U.S. EPA has approved this request. However, since the public was exposed to these levels of PM_{10} concentrations, they are included in Figure 27 and Figure 28, on the following page. In 2008, with the exception of the Brunswick site, there was a noticeable reduction in annual average concentrations of PM_{10} across the state. In 2009, concentrations remained relatively consistent with the 2008 concentrations, with annual averages ranging from 18-27 µg/m^3.

Figure 28, below, shows how the same areas compare to the 24-hour standard for PM_{10}, which remains set at 150 µg/m^3. The standard allows one exceedance per year averaged over a 3-year period, therefore this chart shows the 2nd highest 24-hour average for each site or metro area. Although there is a great deal of variation from year to year at any given site, the statewide 24-hour average is relatively stable. It is believed that concentrations of PM_{10} in 2007 were above normal due to excessive smoke from the Okefenokee Swamp wildfire. For the 2007 data (shown in teal), the second highest value of 187 µg/m^3 for the Albany site is one of the two exceptional event datapoints that were taken out of the dataset for attainment purposes. The other datapoint was Albany's highest value of 189 µg/m^3. In 2008 (shown in dark blue), almost all the sites show a marked decline in the 2nd highest concentration of PM_{10}, with many sites' concentrations below the level of the 2006 concentrations (shown in green). The majority of the sites continued to show a decrease in PM_{10} concentration for 2009 (shown in lighter blue), as well. A few sites showed an increase in concentrations, but all sites' second highest PM_{10} concentrations remained below 60 µg/m^3.

For additional PM_{10} summary data, see Appendix A.



+ Includes all data for 2007 that was excluded for exceptional events
** 2007 and 2008 no data available*
*** 2007 and 2008 no data available from FS#8*
**** Sites consolidated, data combined for Rome-Coosa Elem and Coosa High*

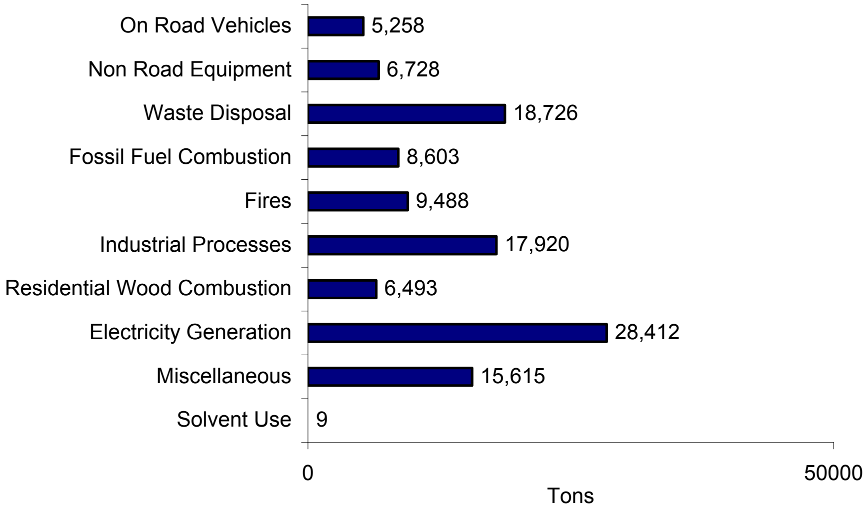
Figure 28: PM_{10} 24-Hour Design Values

$PM_{2.5}$

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.

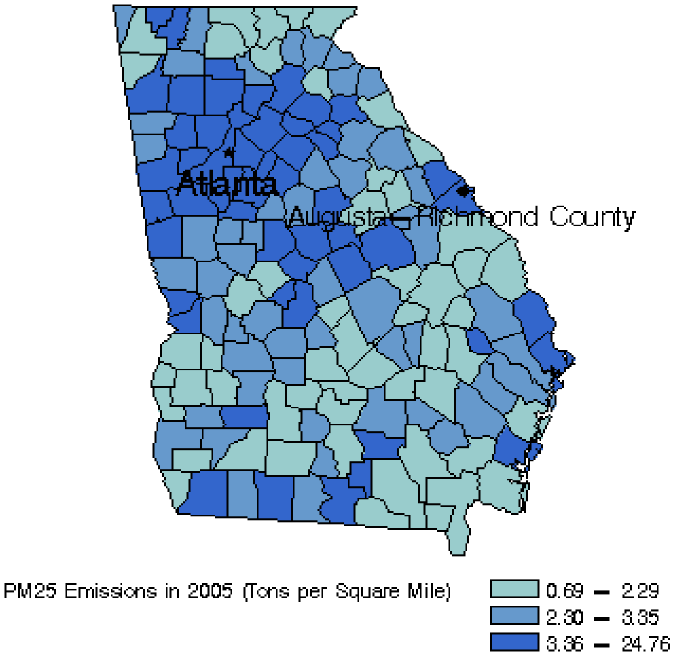
Fine particles are produced by various sources, including industrial combustion, residential combustion, and vehicle exhaust (Figure 29 and Figure 30). However, fine particles are also formed when combustion gases are chemically transformed. Fine particles can soil and accelerate the deterioration of 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 2005, Georgia’s primary source of $PM_{2.5}$ emissions is electricity generation, with over 28,000 tons attributed to this emission source. This information is displayed in Figure 29. Figure 30 shows a spatial view of Georgia’s $PM_{2.5}$ emissions, also from EPA’s Air Emission Sources, based on 2005 data.

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



(From EPA’s Air Emissions Sources)

Figure 29: Common Sources of Particulate Matter 2.5 in 2005



(From EPA's Air Emissions Sources)

Figure 30: Particulate Matter 2.5 Emission in Georgia in 2005 – Spatial View

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. These two techniques consist of an integrated method and a continuous method. At sites where mass $PM_{2.5}$ samples are taken on an integrated basis, the samples are measured using very similar techniques utilized for measuring PM_{10}. The official reference method requires that samples are collected on Teflon filters with a $PM_{2.5}$ sampler for 24 hours. A specialized particle size sorting device is used to filter the air, collecting only particles 2.5 microns in size and smaller. The filters are weighed in a laboratory before and after the sampling period. The change in the filter weight corresponds to the mass weight of $PM_{2.5}$ particles collected. That mass weight, divided by the total volume of air sampled, corresponds to the mass concentration of the particles in the air for that 24-hour period. The reference method filters are used for attainment determinations. However, due to the delay in collecting each filter, shipping it to the laboratory, and weighing, weeks may pass before the results are known. Although this method is very accurate, it is not useful for real-time determinations of $PM_{2.5}$ concentrations in ambient air.

At sites where the continuous method is utilized, Georgia EPD uses two types of instruments. One type is the MetOne BAM-1020, adapted from PM_{10} service by use of an inline BGI 'Sharp Cut Cyclone'. The sampling method for the BAM type of continuous $PM_{2.5}$ monitor was approved as Federal Equivalent Method (FEM) in Notices of the Federal Register/Vol.73, No.49 dated March 12, 2008 when used with a “Very Sharp Cut Cyclone”. When GA EPD begins operating the continuous BAM as an FEM with a “Very Sharp Cut Cyclone”, these samplers will be used for making attainment decisions relative to the NAAQS. At the other locations where Georgia EPD samples $PM_{2.5}$ on a continuous basis, GA EPD uses the Rupprecht & Patashnick TEOM Series 1400/1400a monitors, using an inline $PM_{2.5}$ cyclone for particle size selection and an inline Sample Equilibration System (SES), which uses a diffusion drying technique to minimize water vapor interference with the particle mass measurement. The instrument oscillates the sample filter on a microbalance continuously while particles are collected from ambient air. By measuring the change in the oscillation frequency, the change in filter mass can be determined. Because these analyzers (TEOM) are not approved as reference or equivalent method, the data collected from these samplers cannot be used for making attainment decisions relative to the NAAQS. Both types of samplers are used to support development of air quality models and forecasts, including the Air Quality Index (AQI), and to provide the public with information about pollutant concentrations in real time. Continuous samplers produce hourly averaged data that is available fifteen minutes after the end of each hour. The immediate availability of this data allows the public to make informed decisions regarding their outdoor physical activities. Continuous $PM_{2.5}$ data is reported every hour on Georgia’s Ambient Air Monitoring web page located at http://www.air.dnr.state.ga.us/amp/index.php. Figure 31 shows the location of Georgia’s $PM_{2.5}$ FRM monitors and Figure 32, on the following page, shows the location of $PM_{2.5}$ continuous and speciation monitors.

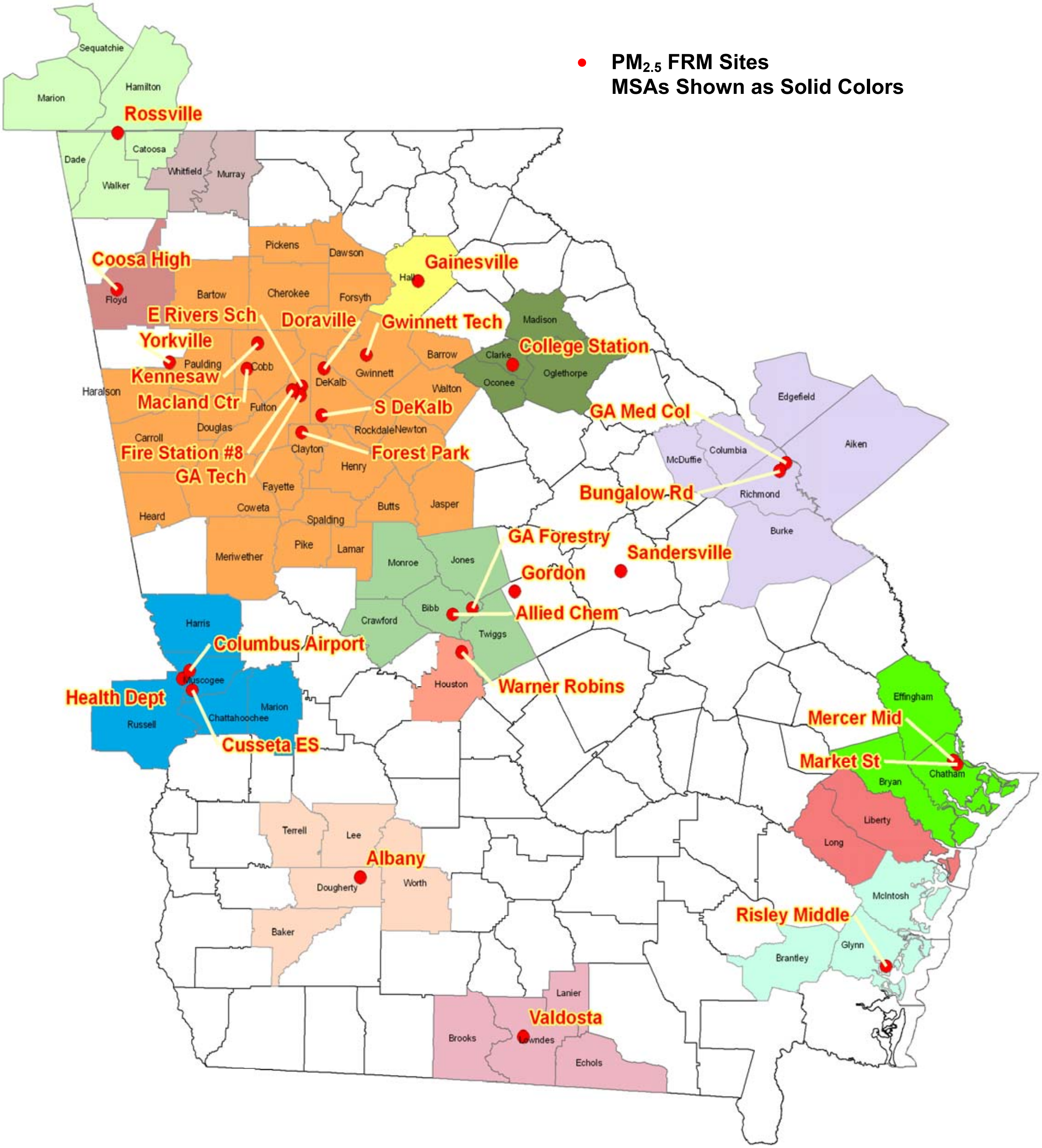


Figure 31: PM$_{2.5}$ Federal Reference Method Monitoring Site Map

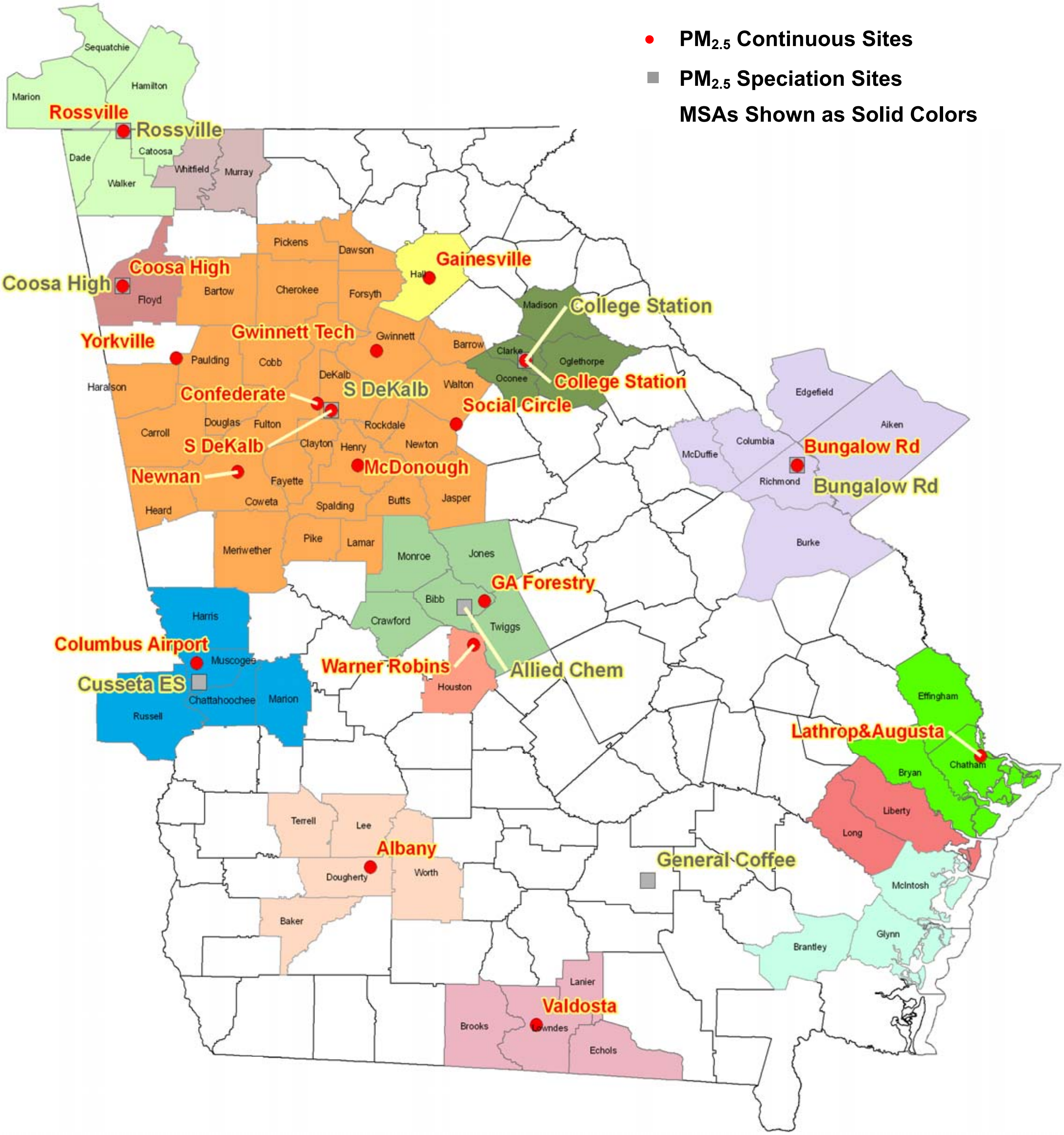
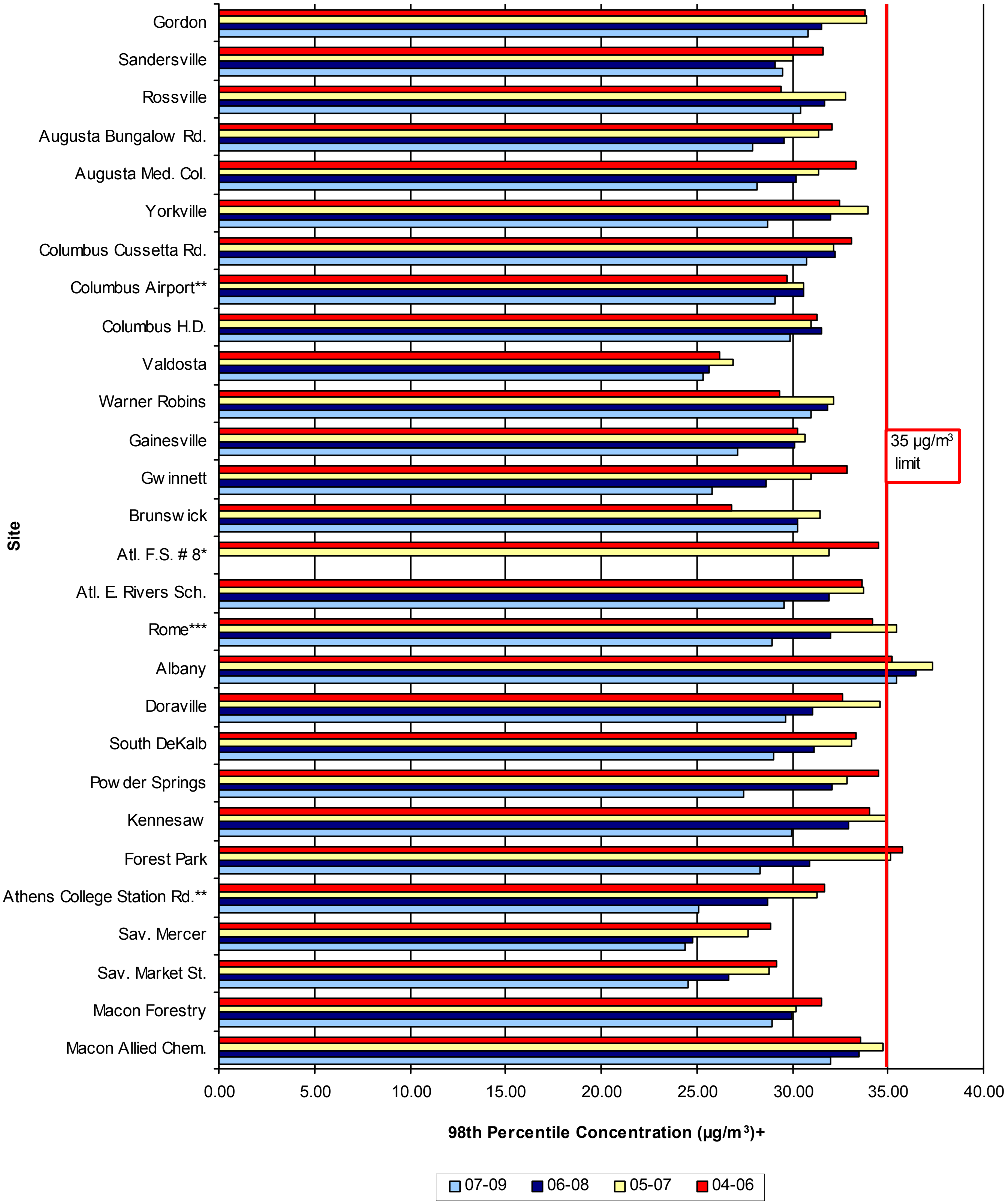


Figure 32: PM$_{2.5}$ Continuous and Speciation Monitoring Site Map

As can be seen in Figure 33 on the following page, the three-year averages of 98th percentile of $PM_{2.5}$ 24-hour data are compared to the 24-hour standard of 35 µg/m^3. For the 2003-2006 data, there were no exceptional events to consider. The 2007 data was affected by the Okefenokee Swamp wildfire. 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 33 the three-year average calculations including the 2007 data (2005-2007, 2006-2008, and 2007-2009) are not a regulatory comparison to the 24-hour standard. The 98th percentile of 24-hour average concentrations have consistently shown decreased averages from the 2004-2006 to the 2007-2009 averages. With the exception of the Albany site, all of the 2007-2009 24-hour averages (shown in light blue) are below the standard of 35 µg/m^3.

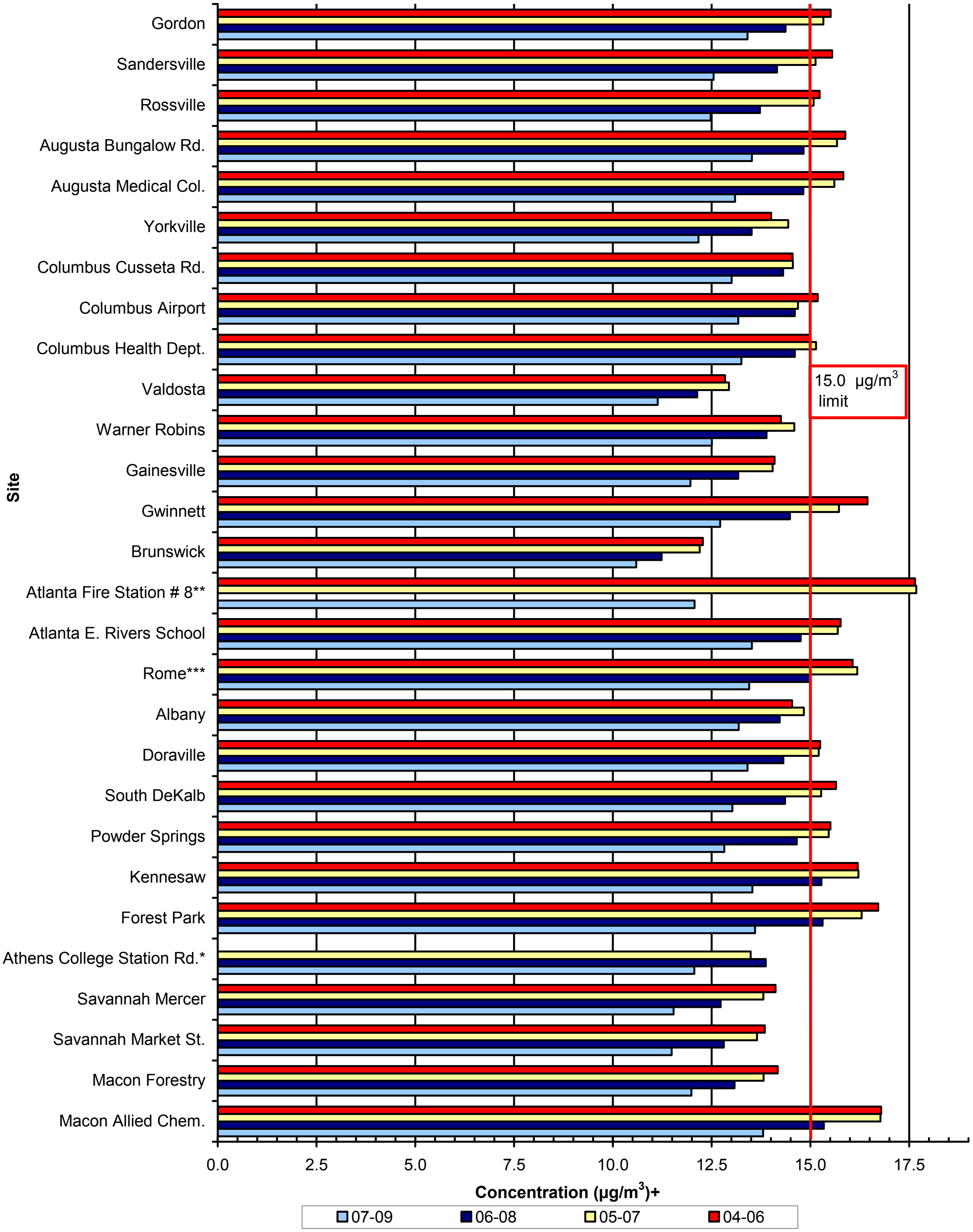


+ Includes all data from 2007 that was excluded for exceptional events
** Site was shut down from 9/06 to 12/08; 2004-2006 and 2005-2007 average not complete 3 years*
*** Sites established in 2005*
******* *Sites consolidated in 2009, data combined for Rome-Coosa Elem and Rome-Coosa High*

Figure 33: PM$_{2.5}$ Three-Year 24-Hour Averages, By Site

On the next page, Figure 34 also shows a non-regulatory comparison of three-year averages of annual $PM_{2.5}$ data to the annual standard of 15.0 µg/m^3. This graph includes the $PM_{2.5}$ exceptional event data for 2007 to show the complete data set that was collected, as well. Therefore, in Figure 34 the 2005-2007, 2006-2008 and 2007-2009 annual averages are not a regulatory comparison to the standard. A few monitoring sites across Georgia have 2006-2008 averages (shown in dark blue) above the $PM_{2.5}$ annual standard, but the majority of sites are below the annual standard for the 2006-2008 average. Almost all of the three-year averages are lower for the 2006-2008 timeframe, compared to previous averages. The 2007-2009 averages (shown in light blue) continue to show a decrease in concentration. All of the 2007-2009 annual averages are below the annual standard of 15.0 µg/m^3. The sites with the higher averages are generally in north and central Georgia, and the sites with lower averages are generally in the south and coastal areas.

For additional $PM_{2.5}$ summary data, see Appendix A.



+ Includes all data for 2007 that was excluded for exceptional events
** Site established 2005; only 2005-2009 data used for graph*
*** Site was shut down 9/06 to 12/08; averages do not include three full years*
**** Sites consolidated in 2009, data combined for Rome-Coosa Elem and Rome-Coosa High*

Figure 34: $PM_{2.5}$ Three-Year Annual Averages, By Site

ATTAINMENT DESIGNATION

In order for an area to be in attainment of the national primary and secondary annual ambient air $PM_{2.5}$ standard, the area must have an annual arithmetic mean concentration less than or equal to 15.0 micrograms per cubic meter [62 FR 38711, July 18, 1997]. In addition, there is a 24-hour primary and secondary standard that requires that the three year average of the 98th percentile of the 24-hour concentration be less than or equal to 35 micrograms per cubic meter [71 FR 61144, October 17, 2006]. All sample analyses used for determining compliance with the standards must use a reference method based on information present in 40 CFR Appendix L or an equivalent method as designated in accordance with Part 53.

The $PM_{2.5}$ annual standard attainment and nonattainment designations require three years of monitoring data. Therefore, Georgia's initial attainment status was not determined until late 2004. Based on the three years of data (2001-2003), EPA officially declared several areas of Georgia in nonattainment of the annual standard. Nonattainment areas included Walker and Catoosa Counties, which are a part of the metro Chattanooga nonattainment area. All of Bibb County and portions of Monroe County have been included in the Macon nonattainment area. Floyd County itself has been declared a nonattainment area. Finally, the metro Atlanta nonattainment area has been also declared. This includes Barrow, Bartow, Carroll, Cherokee, Clayton, Cobb, Coweta, DeKalb, Douglas, Fayette, Forsyth, Fulton, Gwinnett, Hall, Henry, Newton, Paulding, Rockdale, Spalding, and Walton Counties, along with portions of Heard and Putnam Counties. Figure 35, on the next page, illustrates the boundaries of Georgia's $PM_{2.5}$ annual standard nonattainment areas.

For the $PM_{2.5}$ 24-hour standard, the entire state of Georgia is classified as in attainment. The 24-hour standard is also based on three years of monitoring data, and this attainment status is based on the 2005-2007 data.

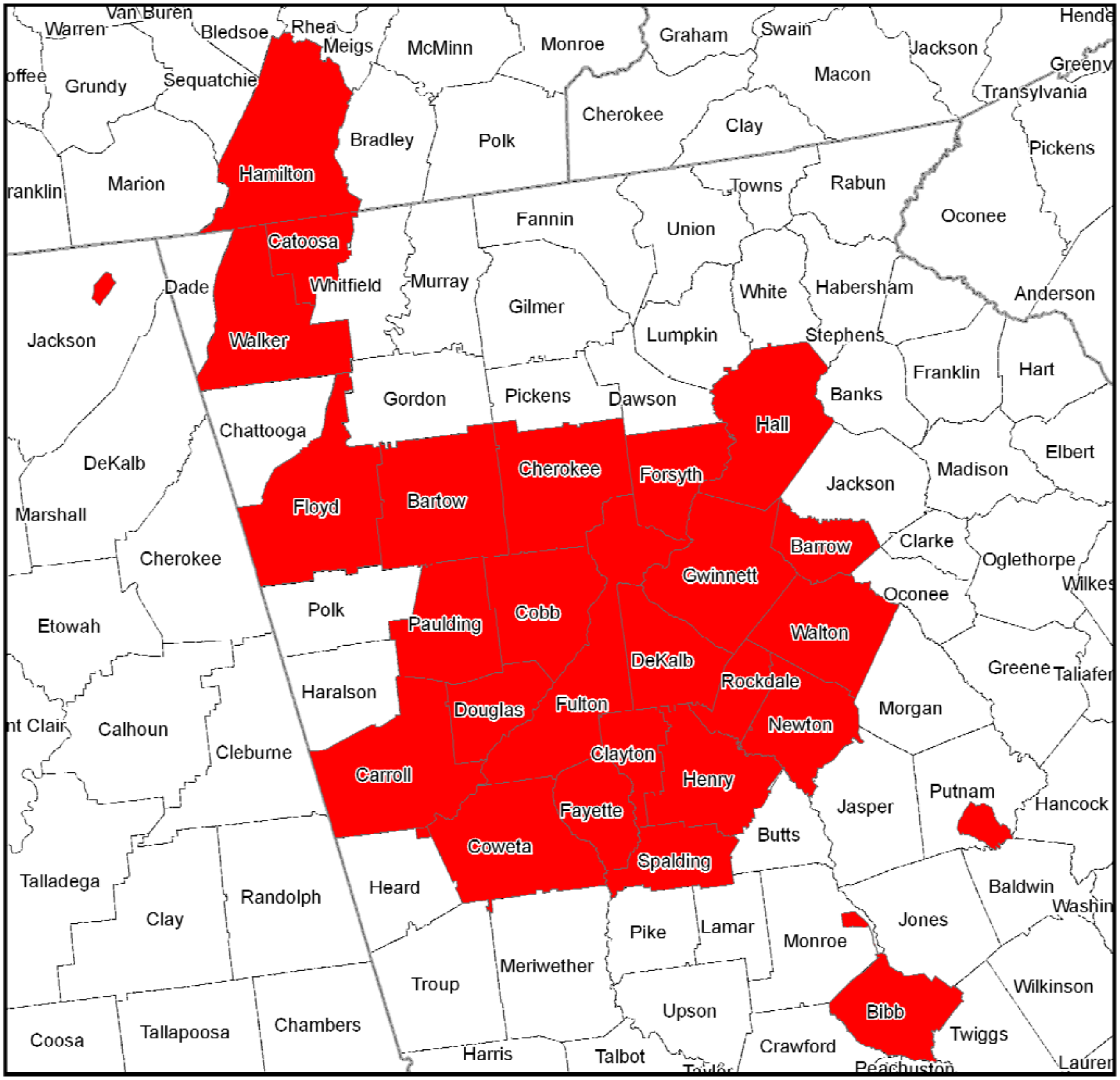
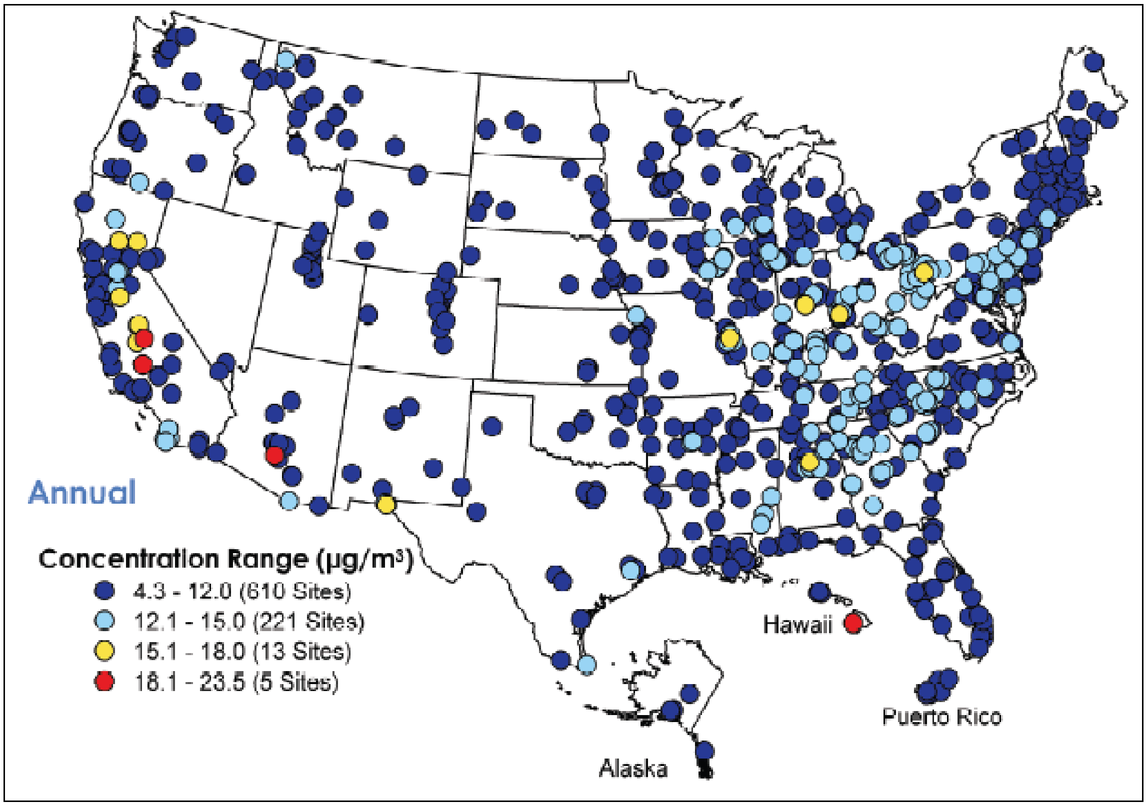


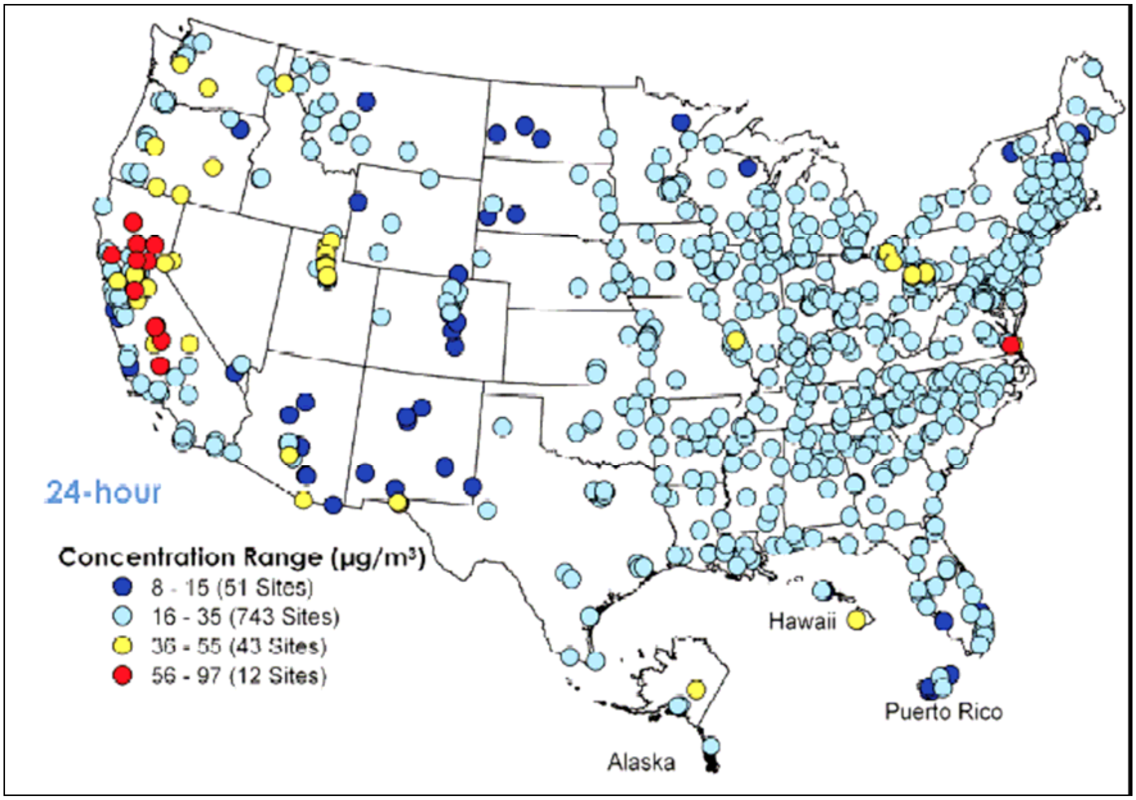
Figure 35: Georgia's $PM_{2.5}$ Nonattainment Area Map

Figure 36, on the next page, shows maps that were taken from the EPA document "Our Nation's Air - Status and Trends through 2008". The first map shows $PM_{2.5}$ annual average concentrations across the United States for 2008, and the second map shows the 24-hour average concentrations. This gives a comparison of Georgia's $PM_{2.5}$ data, compared to the rest of the country. It appears that for Georgia, the annual average concentrations were in the 4.3-12.0 µg/m^3 (light blue) and 12.1-15.0 µg/m^3 (dark blue) ranges. The 24-hour average concentrations were in the 16-35 µg/m^3 (light blue) range across Georgia.

Annual Concentrations



Daily Concentrations



(From EPA's "Our Nations Air- Status and Trends through 2008")

Figure 36: $PM_{2.5}$ Annual and 24-Hour Concentrations across the United States, 2008

$PM_{2.5}$ SPECIATION

As required by the National $PM_{2.5}$ Speciation program (40 CFR 58), 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 a national priority through listings in the National Ambient Air Quality Standards. 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 of 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, their size varies. 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 the main culprit. 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 37 illustrates the average concentrations of these six chemicals from 2003 to 2009. 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. Below the figures is a listing of the most significant chemical constituents of fine particulate matter.

Refer to Figure 32 for a map of Georgia's $PM_{2.5}$ Speciation monitors.

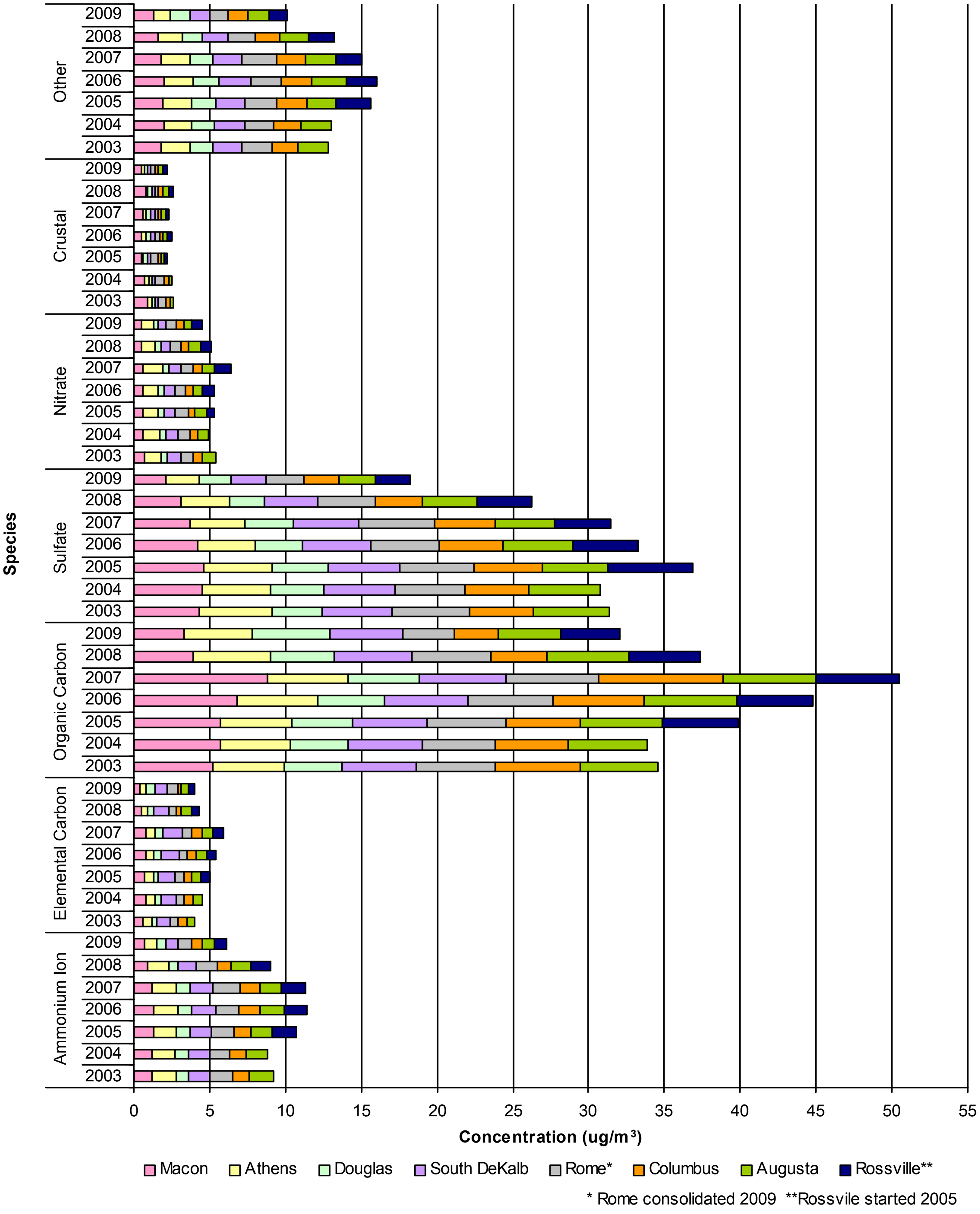


Figure 37: Speciation, by Species, 2003-2009

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: are 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 will help scientists and regulators track the progress and effectiveness of newly implemented pollution controls. The data will also improve scientific understanding of the relationship between particle composition, visibility impairment, and adverse human health effects.

Monitoring for the chemical speciation of fine particulate matter began late in 2001, therefore, limited data is available. As the data set becomes more robust, other conclusions may be drawn. However, some general observations can already be made. The concentrations of sulfate and organic carbon are generally less at the Douglas-General Coffee site than at the remaining seven sites. This is expected since the sulfate and organic carbon fractions are mainly caused by human activities. The Douglas-General Coffee site is considered a rural background site and will be used in future comparisons between rural and urban areas.

Figure 38 presents a different view of the same 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.

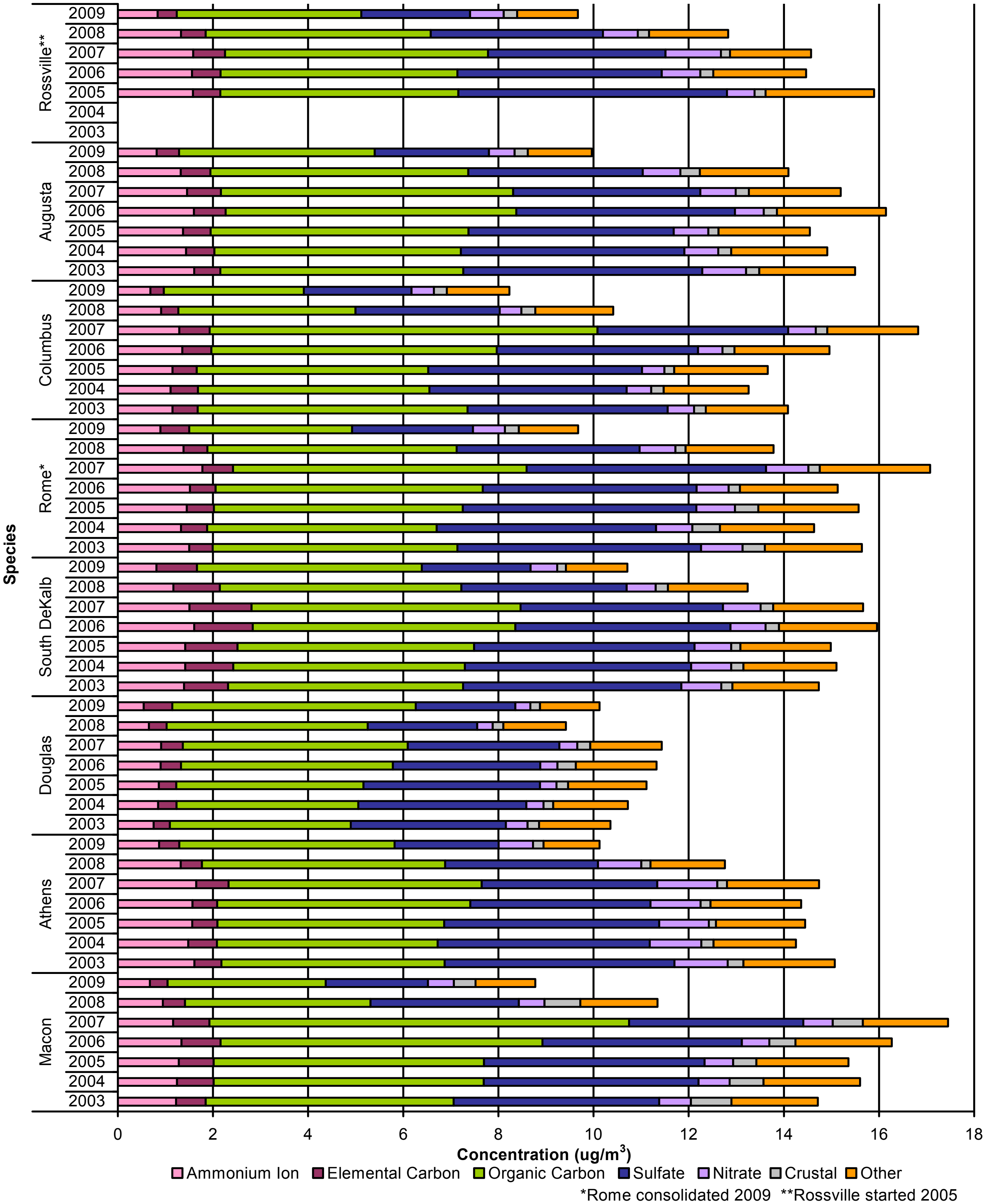


Figure 38: PM$_{2.5}$ Speciation, by Site, 2003-2009

Compared to the 2007 data, the total make up of the speciation parameters showed lower average concentrations for all the sites in 2008. The Columbus and Macon sites seem to show the biggest drop in total average concentration, with almost 6 µg/m^3 less than 2007 concentrations. In 2009, this overall decrease in average concentrations continued. The Columbus site continued to have the lowest overall average concentration (close to 8 µg/m^3), with the Macon site's average concentration as the second lowest (close to 9 μg/m^3). The South DeKalb site showed the highest total average concentration, with close to 11 μg/m^3. In comparison, the total $PM_{2.5}$ mass average concentrations sampled with the speciation monitor, the continuous $PM_{2.5}$ monitor, and the integrated $PM_{2.5}$ monitor at these sites range from around 10 to 12 μg/m^3.

Ammonium ion concentrations (shown in pink) are relatively even statewide, with concentrations lowest at the Douglas site. The concentrations ranged from 0.54-0.89 μg/m^3 in 2009. Ammonium ion is the third largest single contributor to the total speciation make up.

The South DeKalb area has the highest elemental carbon concentration, 0.85 μg/m^3 shown in burgundy, which is no surprise given the site location on major interstate trucking corridors. Cities with less heavy vehicle traffic generally have lower concentrations. The Columbus site has the least elemental carbon concentration, with 0.28 μg/m^3 in 2009.

Organic carbon concentrations (shown in green) are also relatively consistent throughout the state, usually consisting of about 4-5 μg/m^3 of the total speciation concentration. Organic carbon concentrations are much higher than typical ammonium ion or elemental carbon concentrations, having one of the largest contributions to the total $PM_{2.5}$ mass concentrations.

Sulfate (shown in dark blue) is also found in higher concentrations, with concentrations around 2-2.5 μg/m^3 in 2009. 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.

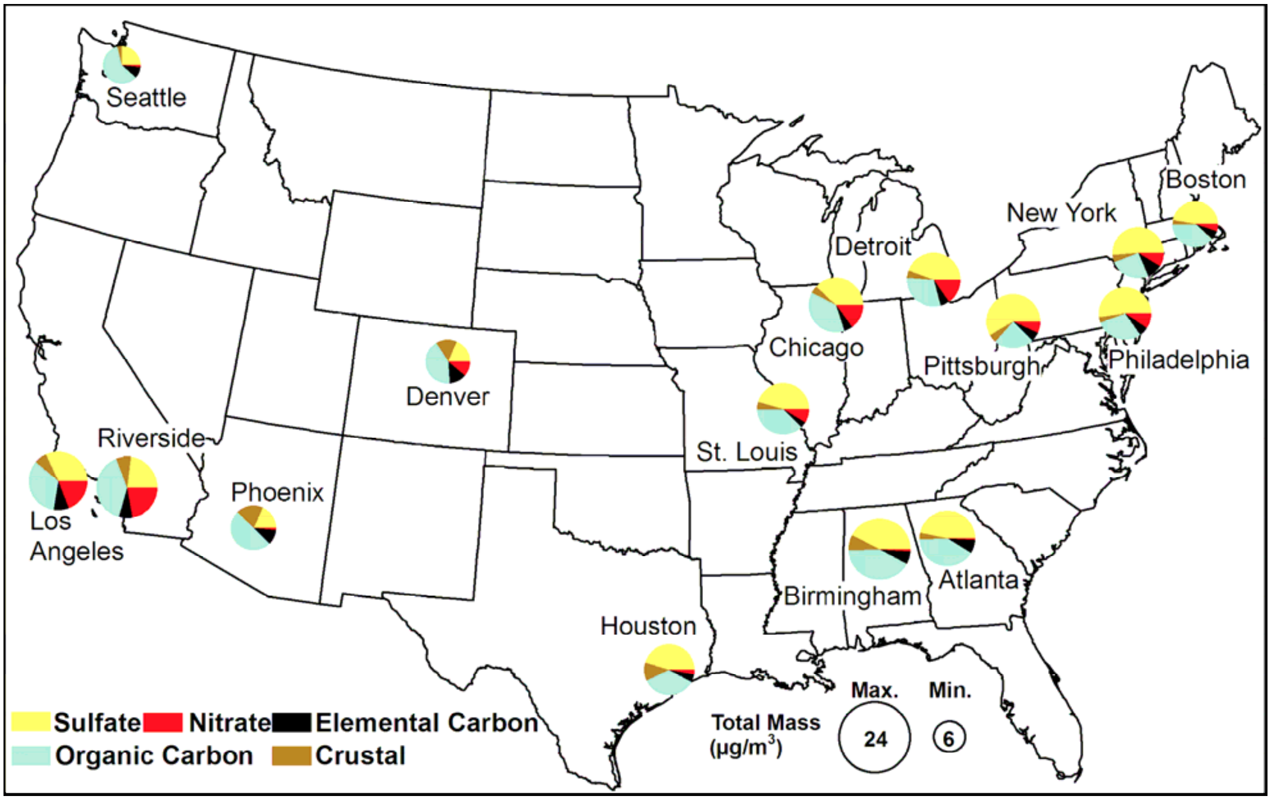
Nitrate concentrations (shown in purple) are relatively small (0.31-0.72 μg/m^3 in 2009), usually contributing the fourth or fifth largest single component of the total five major constituents. Atmospheric forms of nitrate can be formed from the conversion of NO_x. Other forms of nitrate can be found in fertilizers, animal and human organic waste, medications, and used in welding.

Crustal matter concentrations (shown in gray) are generally one of the lowest speciation concentrations (0.18-0.45 μg/m^3 in 2009) and consistent in most areas. Rome and Macon have in some years recorded unexpectedly high crustal matter concentrations. This may be a sign of poor dust control at agricultural, construction, or mining operations in those areas.

The section labeled ‘Other’ (shown in orange) 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 range from 1.18 to 1.35 μg/m^3 in 2009.

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

To show a comparison of Georgia’s $PM_{2.5}$ speciation data to the rest of the United States, the following map was taken from the EPA’s “Our Nation’s Air- Status and Trends through 2008.” In Georgia, as well as the other states in the Southeast, sulfate and organic carbon are the main contributors of $PM_{2.5}$ data, while nitrate is barely a contributor. In the North and the West, sulfate and organic carbon are still major contributors, however nitrate (shown in red) also shows considerable contribution. Nitrate’s predominant sources originate from highway vehicles, non-road mobile, electric utilities, and industrial boilers. In the East, the main sources of sulfate are electric utilities and industrial boilers. The major sources of organic carbon are highway vehicles, non-road mobile, waste burning, wildfires, and vegetation. In addition, woodstoves and fireplaces are principal contributors to organic carbon in the West. The composition of $PM_{2.5}$ seems to vary across the country depending on predominant sources.



(From EPA's "Our Nations Air- Status and Trends through 2008")

Figure 39: Four-Season Average of $PM_{2.5}$ Composition Data for 15 U.S. Cities

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. There are no ambient air quality standards regarding the speciation of particles.

ACID PRECIPITATION

In 2009, acid precipitation was not monitored at GA EPD's sites due to budget constraints. As the state budget allows, acid precipitation data will be collected at a future time. When collecting data, the samples were collected weekly and were weighed and analyzed for acidity, conductivity, and selected compounds. There are no national or state standards for acid precipitation, but it is generally desirable for rain to have a relatively neutral pH. However, in many regions of industrialized nations, rainfall absorbs air emissions that make it acidic, with lower pH numbers. Most of the culprits of this acidification are sulfur and nitrogen compounds, and the result is rain that contains excess acidity from sulfuric acid and nitric acid. The excess acidity in the rain causes damage to buildings and vehicles, and can acidify ponds and small lakes to the point of killing off all life in them. Figure 40 shows a diagram of the acid rain deposition process.

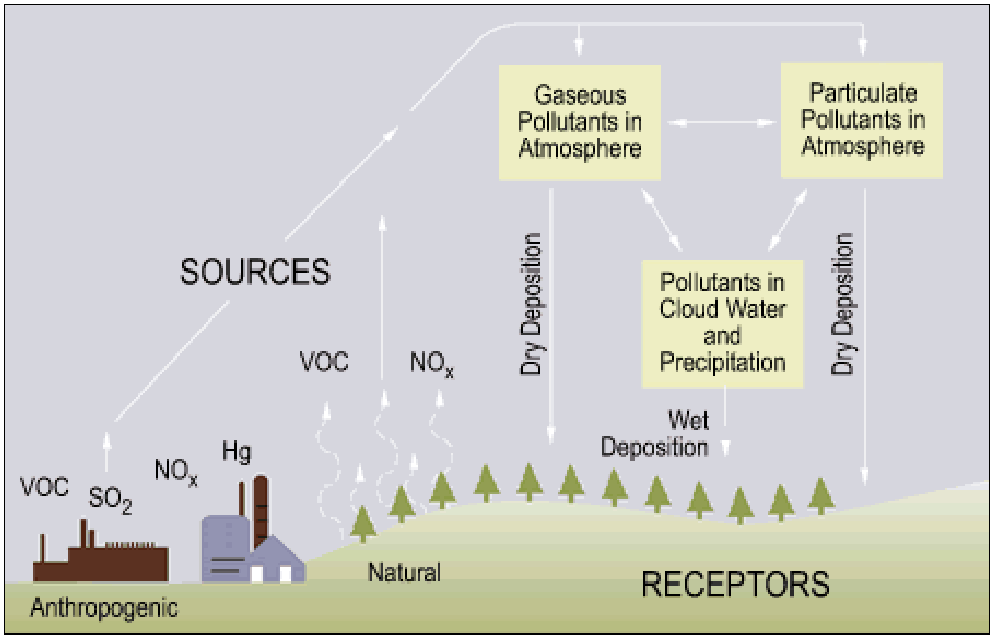


Figure 40: Process of Acid Rain Deposition

Figure 41: Acid Rain Monitors

Georgia's Acid Rain monitoring network is shown in Figure 42, on the following page.

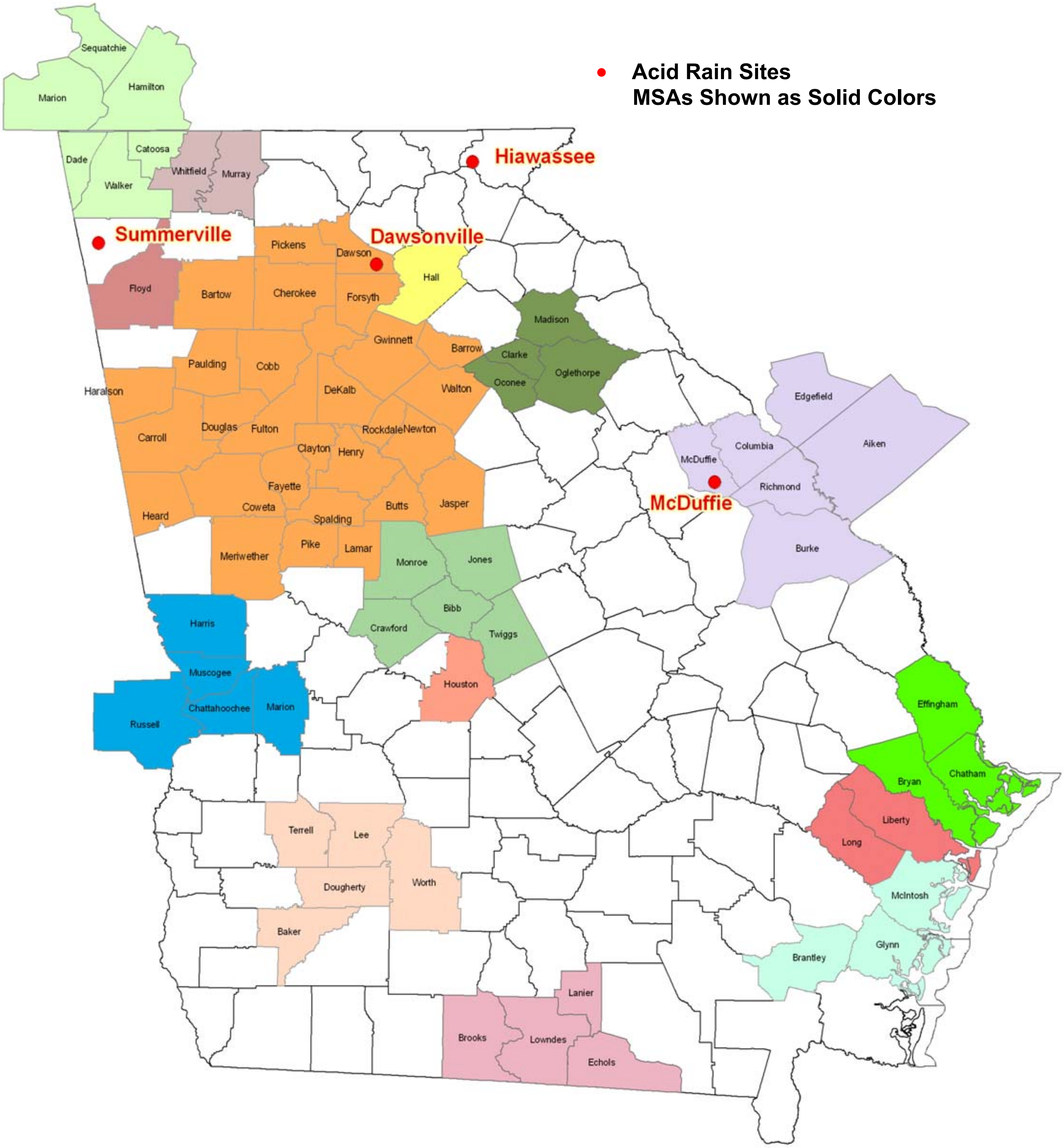


Figure 42: Acid Rain Monitoring Site Map

PHOTOCHEMICAL ASSESSMENT MONITORING STATIONS (PAMS)

GENERAL INFORMATION

Ozone is the most prevalent photochemical oxidant and an important contributor to smog. The understanding of the chemical processes in ozone formation and the specific understanding of the atmospheric mixture in 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), selected carbonyl compounds, and monitoring of meteorological parameters. These chemicals would be monitored at Photochemical Assessment Monitoring Stations (PAMS). Stated in Title 40, Part 58 of the Code of Federal Regulation (40 CFR Part 58), the increased monitoring of ozone and its precursors 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.

According to EPA, PAMS monitoring was to be implemented in cities that were classified as serious, severe, or extreme for ozone nonattainment. The classifications were based on the number of exceedances of the ozone standard, and the severity of those exceedances. Nineteen areas nationwide were required to implement a PAMS network. In the Atlanta metropolitan area, a network of four sites was established beginning in 1993. 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 set up 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. When the PAMS network was originally designed, there was a plan for a Type 4 site, which samples the air once it has returned to background levels far downwind from the metropolitan area. However, when the network was instituted, this type of site was not used. The PAMS network as it was set up for the 2009 monitoring year can be seen in Figure 43.

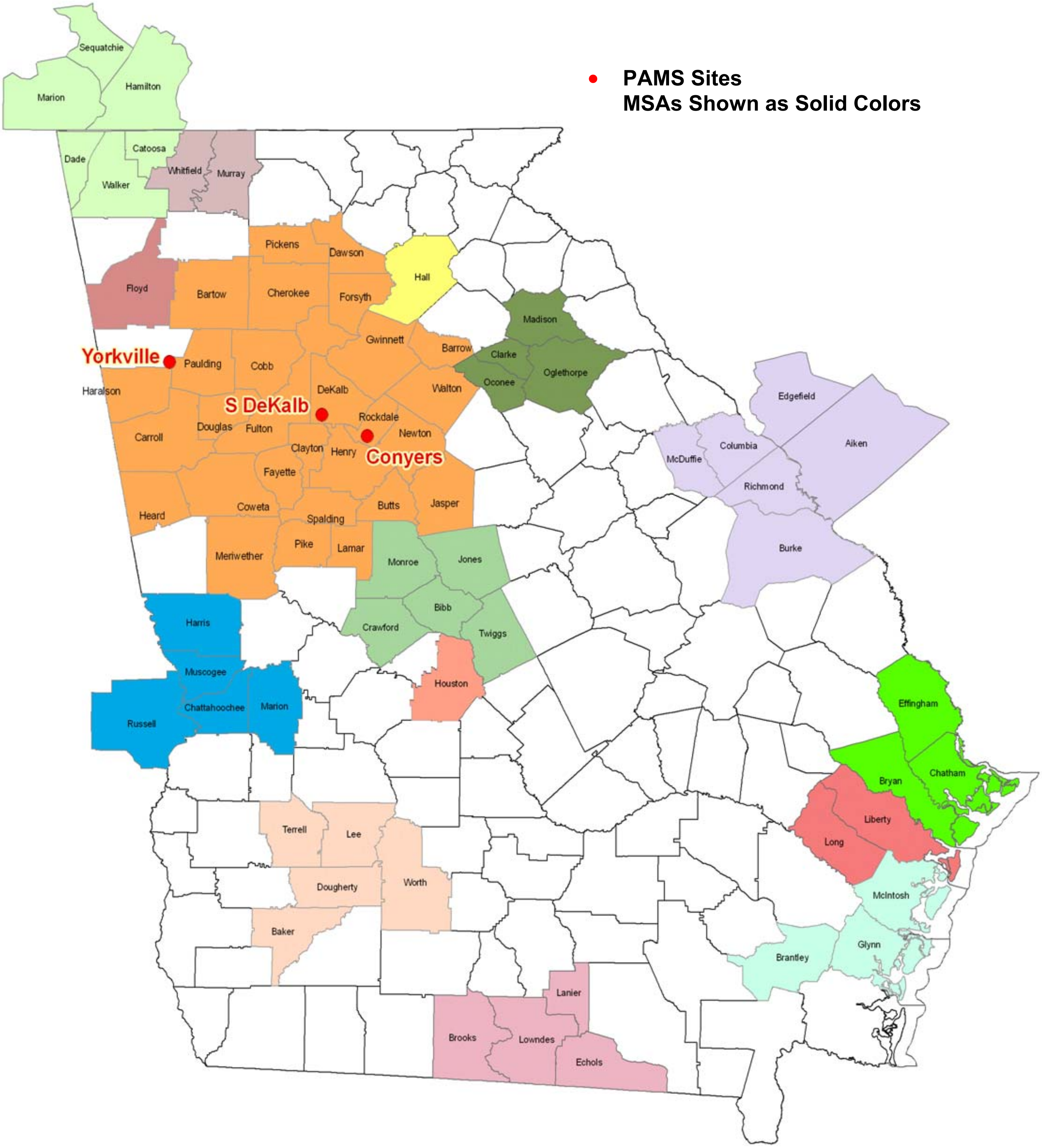


Figure 43: PAMS Monitoring Site Map

Of the fifty-six PAMS compounds monitored, the data consistently shows the same top ten volatile organic compounds (VOCs) for all three sites. These compounds are isoprene, m/p xylene, toluene, propane, ethane, isopentane or isopentane/cyclopentane, n-butane and n-pentane. Propane, ethane, isopentane, n-butane, and n-pentane have a limited reactivity for ozone formation and therefore were the most prevalent of the volatile organic compounds measured. However, when the characterization of the top ten species is based upon contributions to ozone formation potential, the list is slightly different. Isoprene, the tracer for VOC 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.

Figure 44 compares the seasonal occurrence of isoprene from 2003 to 2009. The figure represents a combination of the 6-day, 24-hour data from the three PAMS sites, and concentrations are given in parts per billion Carbon (ppbC). Evidence of isoprene's natural origin is shown in Figure 44, where the ambient concentration is essentially non-existent from November to May. During 2009, the laboratory facility moved its location, and during this time the PAMS canister data was not processed. Therefore, there is a break in the data from March until June of 2009 in the following two figures.

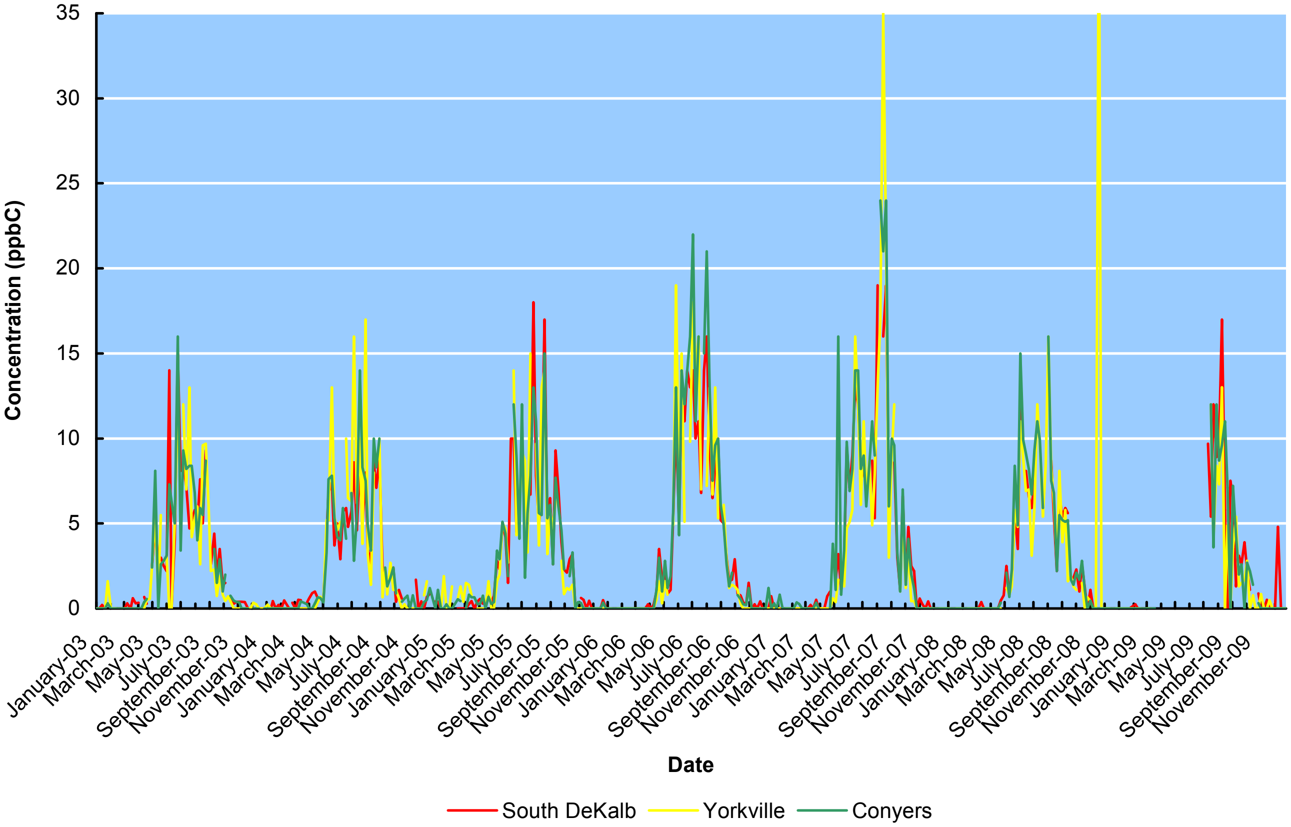


Figure 44: Isoprene Yearly Profile, 2003-2009

In Figure 44, all three sites exhibit the seasonal cycle of isoprene, with an occasional spike outside the consistent cycle. The site with the highest concentration of isoprene appears to vary year to year. With the Yorkville and Conyers sites being in a rural area, or semi-rural area, one would expect to see higher levels of isoprene. This has been true for most years. As part of the seasonal cycle, in 2003, Conyers had the highest concentration with 16 ppbC, in 2004 Yorkville had the highest with 17 ppbC, in 2005, South DeKalb had the highest with 18 ppbC, in 2006, Conyers had the highest concentration with 22 ppbC, and in 2007 Yorkville had the highest concentration with 35 ppbC. With the 2008 data added, Yorkville had the highest concentration again, with a spike outside of the normal season, with a reading of 44 ppbC. In 2009, the South DeKalb site had the highest concentration, with 17 ppbC. The levels of isoprene concentration appear to remain relatively constant over the past seven years, with the exceptional spike.

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, the most abundant species in urban air, m/p xylene, and isopentane also are 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. It has a substituted benzene ring possessing modest atmospheric reactivity. This hydrocarbon is in motor vehicle fuel and is also used as a common solvent in many products such as paint. Figure 45 compares the seasonal occurrence of toluene from 2003 to 2009. Again, this figure is a combination of the 6-day, 24-hour data from the three PAMS sites, and concentrations are given in parts per billion Carbon (ppbC).

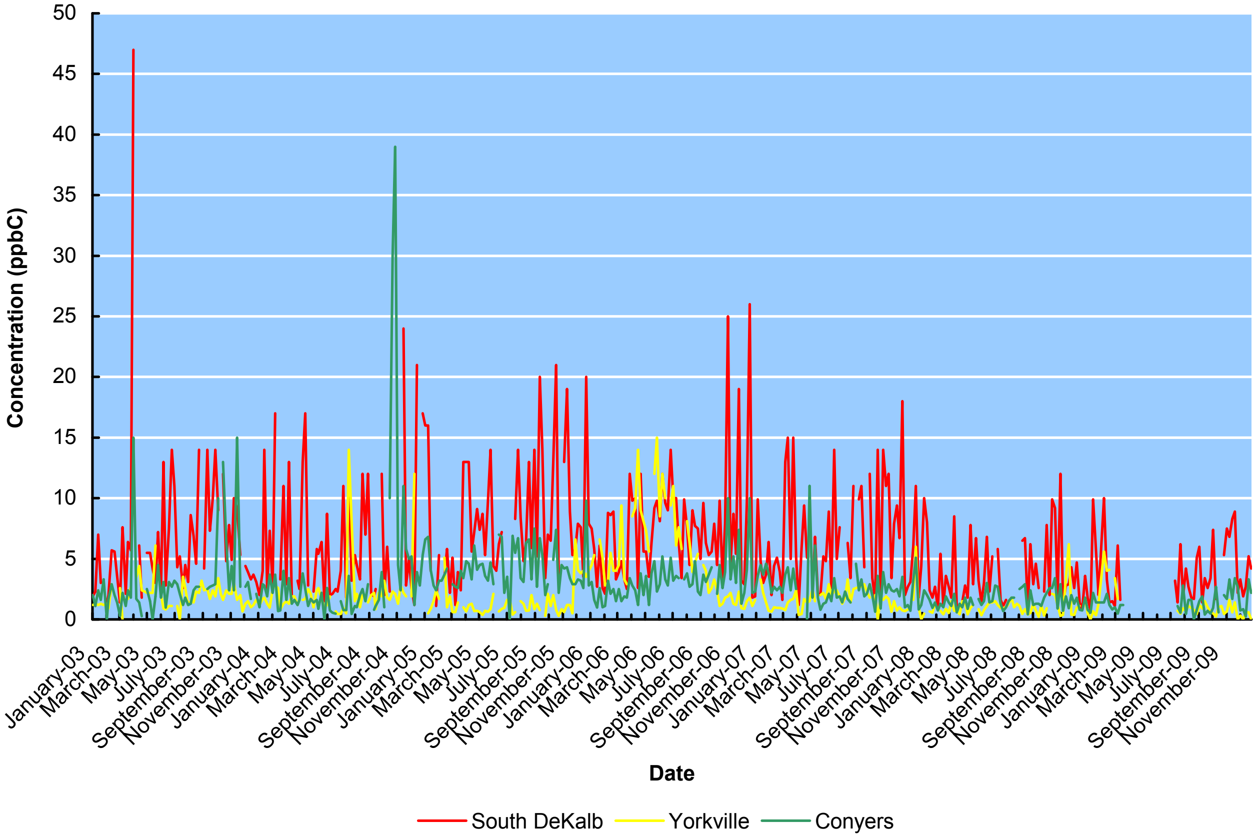


Figure 45: Toluene Yearly Profile, 2003-2009

As shown in Figure 45, the atmospheric levels of toluene are relatively constant throughout the year, suggesting a steady level of emissions year-round. There is an occasional spike in concentration, but no evident high or low pattern for the past seven years. 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. Yorkville appears to have an upward swing throughout 2006, but the levels decline through 2009 for all three sites. As the 2009 data is added, the lower levels of toluene data appear to continue. The highest concentration was found at the South DeKalb site, with 10 ppbC. As data is collected in the future, this site can be examined for a possible trend. The jaggedness of these graphs is an artifact of the sampling frequency.

In the following graph, Figure 46, the daily profiles of toluene and isoprene are plotted. 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.

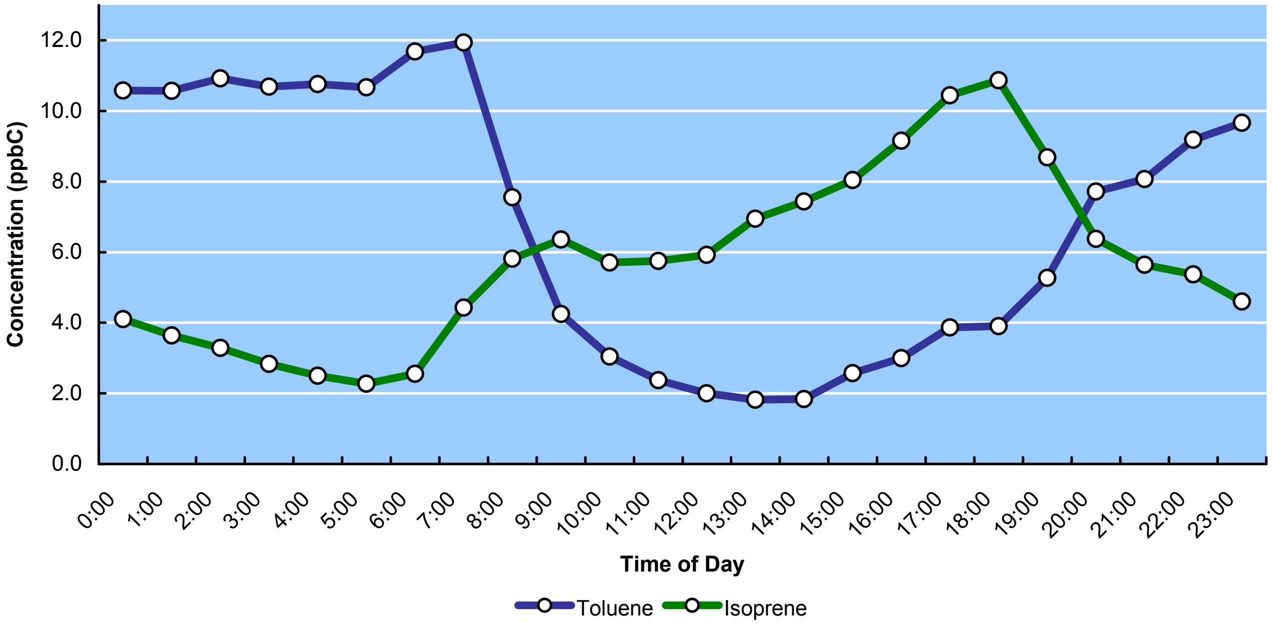


Figure 46: Toluene & Isoprene, Typical Urban Daily Profile

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. The majority of carbonyl compounds come from vehicle exhaust or 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 carbonyls compounds that Georgia 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 samples every six days throughout the year, and every three hours throughout the summer. Savannah, Dawsonville, and Brunswick are part of the Air Toxics Network and sample every twelve days. For a map of monitoring locations, see Figure 47.

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 the making of 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.

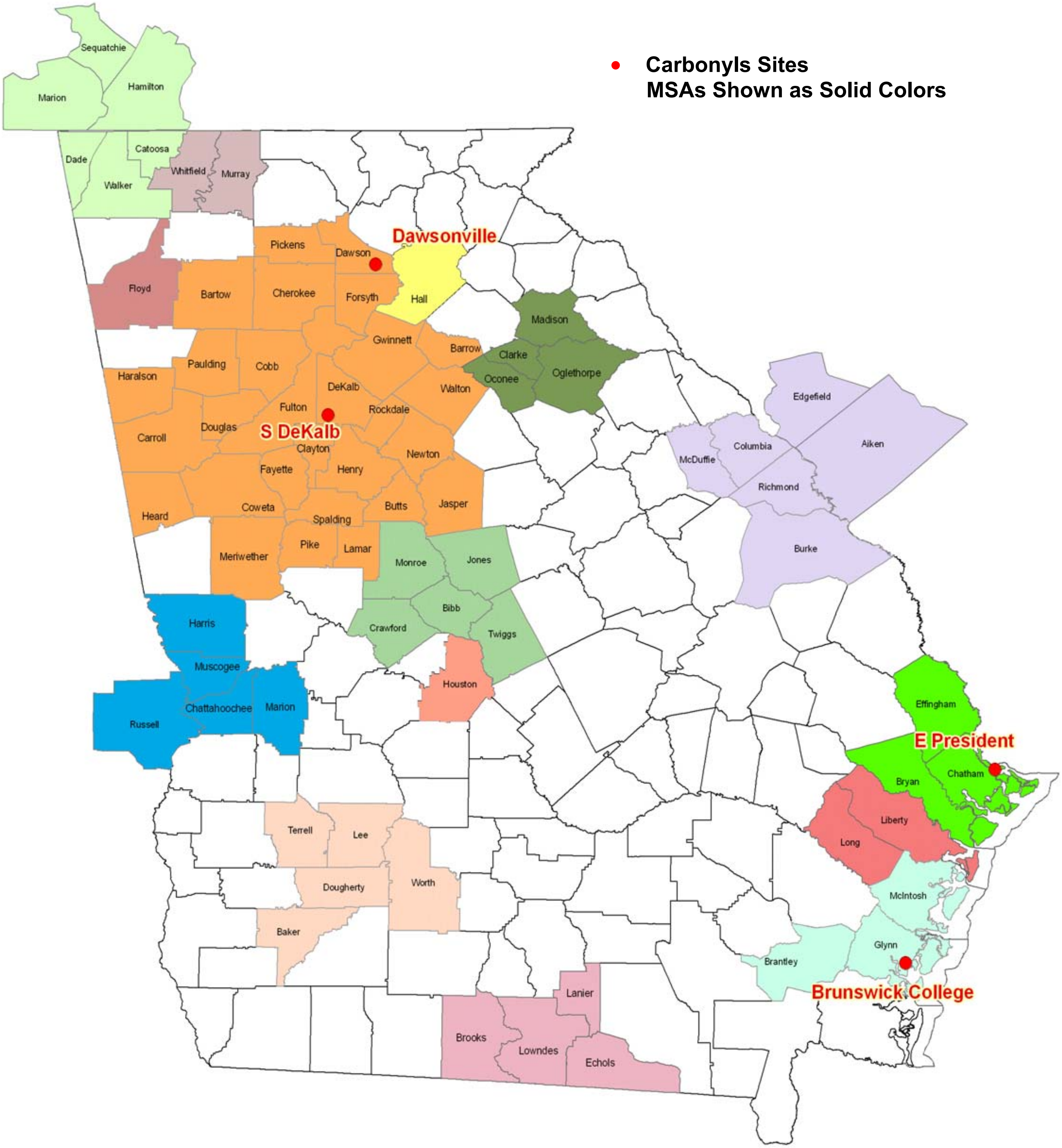


Figure 47: Carbonyls Monitoring Site Map

As part of the PAMS network, the South DeKalb site collects 3-hour samples of carbonyls during the summer months (June, July, and August). Samples are collected at hours 6:00, 9:00, 12:00, and 15:00, every three days. The average concentrations (shown in micrograms per cubic meter) of all the 3-hour samples of carbonyls collected during those months for 2005 through 2009 have been combined for a given hour and are shown in Figure 48. The early morning ambient concentrations are generally lower for all constituents. Almost all of the concentrations appear to peak at the 12:00 hour for all the carbonyls components except benzaldehyde, which tends to peak at the 15:00 hour. There are a few visible changes when comparing the 2005 data through 2009. All of the concentrations seem to gradually increase year to year from 2005 to 2007, and then decrease with the 2008 concentrations. With the 2009 carbonyl data, the average concentrations have increased. The largest increases are the formaldehyde concentrations, which have more than doubled from the 2008 concentrations. Acetaldehyde, acetone, and formaldehyde continue to be the biggest contributors, and generally follow the same pattern with the averages increasing from the 6:00 to 9:00, and again from the 9:00 to 12:00 hours, then decreasing at the 15:00 hour.

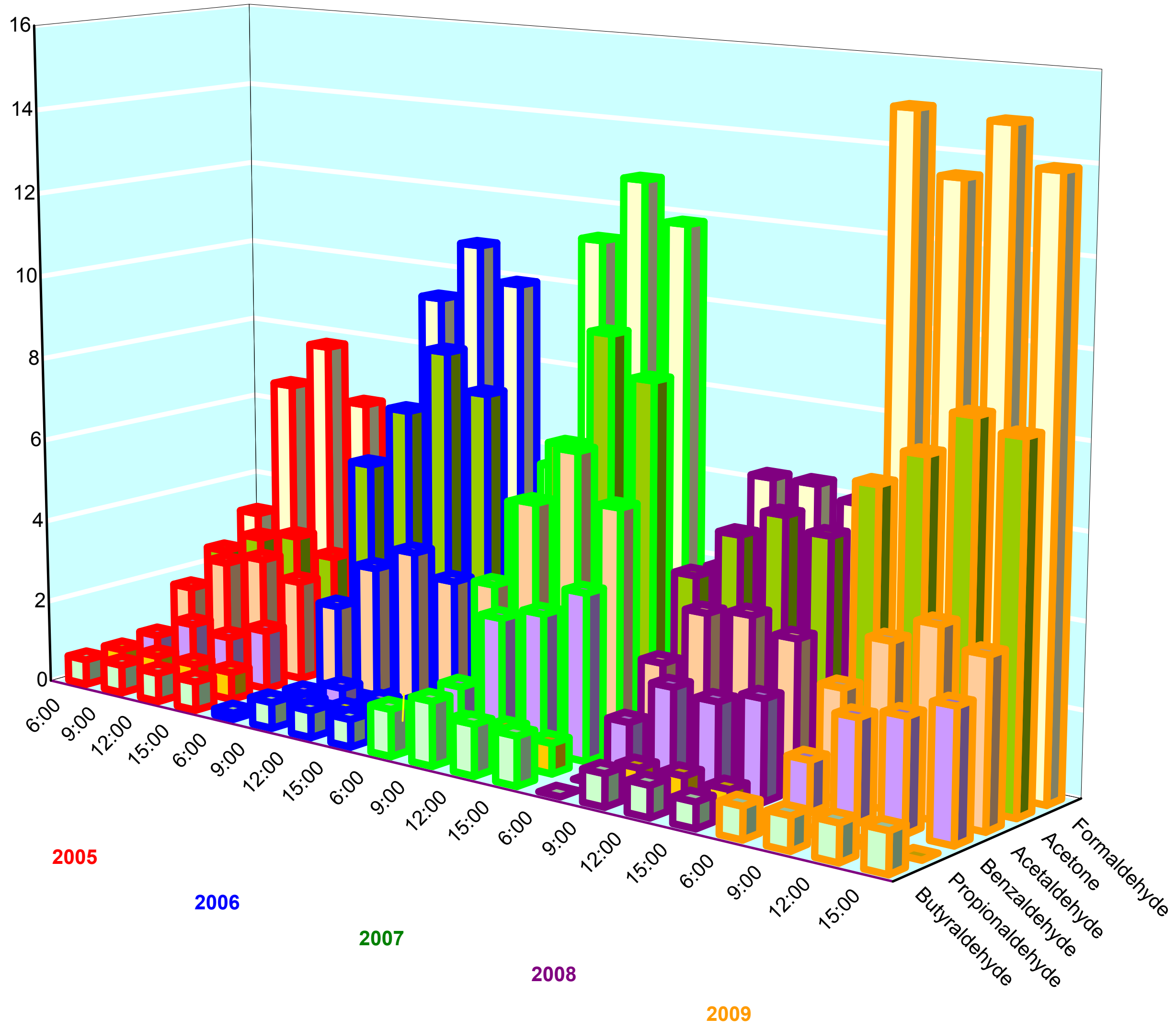


Figure 48: Average South DeKalb 3-Hour Carbonyls, June-August, 2005-2009

The next two graphs address the carbonyls data without the acrolein compound. Due to the differences in collection and analysis method and the sites included in sampling acrolein, it is discussed separately in later paragraphs. As can be seen in Figure 49, when the average concentration of the remaining carbonyls is compared with the total number of detections at each of the sampling sites, the carbonyl detections and concentrations tend to track each other directly. Because the South DeKalb site collects data every six days with the PAMS network, while Savannah, Dawsonville, and Brunswick collect data every twelve days with the Air Toxics Network (discussed in next section), the detections are shown as a percentage of the overall samples taken. A detection of any given pollutant is counted as any number that is above half the limit of detection. To compare the data collected from 2005 to 2009, there are some noticeable changes. The Dawsonville site had a visible increase in concentration from 2006 to 2007, almost tripling from 7.7 µg/m^3 to 21.3 µg/m^3. Then in 2008, the Dawsonville concentration dropped back down to 6.3 µg/m^3. The Brunswick site showed a lower average concentration from 2005 to 2006 (18.4 µg/m^3 to 10.5 µg/m^3), remained the same from 2006 to 2007, and then dropped again from 2007 to 2008 (10.6 µg/m^3 to 6.6 µg/m^3). In 2009, the Brunswick site did not collect carbonyl data; therefore the following graphs will not have data for Brunswick. The South DeKalb site has consistently had the highest concentrations of all four sites. Overall, the number of detections above detection limit, and average concentrations were lower in 2008. With the 2009 data, all of the sites showed a slight increase in total average concentrations. The percent detections remained relatively the same from 2008 to 2009 (around 40-50%).

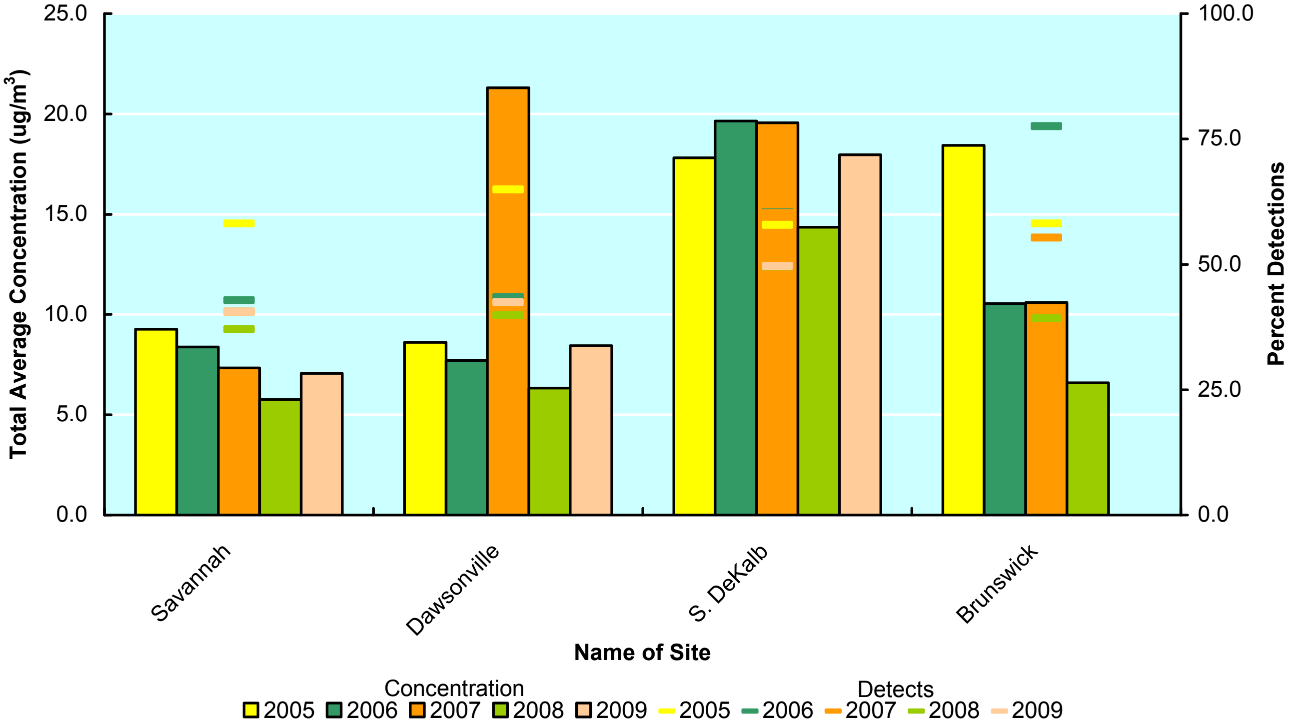


Figure 49: Average 24-Hour Carbonyls Concentration and Number of Detects, by Site, 2005-2009

Figure 50, below shows the six of the seven species in the analyte group according to their statewide annual abundance, based on number 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 (discussed below). A gradient is evident from this graph below, with formaldehyde as the most abundant carbonyl. For the most part, it appears that the number of detections track the average concentration. With the higher average concentration, there are higher percent detections. Acetaldehyde does not follow this pattern, however, having more detections compared to the concentration. For all the compounds, there appears to be a slight decrease from the

2005 to 2006 data, and then an increase from the 2006 to 2007 data. In 2008, there is a decrease in both concentrations and detections (shown in light green). With the 2009 data (shown in tan), the average concentrations and percent detections maintained about the same levels as the 2008 data. However, as stated earlier, the Brunswick site was not included in these calculations, as data was not collected at this site in 2009. This could be affecting the 2009 values. The proportion of each compound remained the same throughout all five years of data, with the biggest contributors (formaldehyde, acetone, and acetaldehyde) continuing through the years.

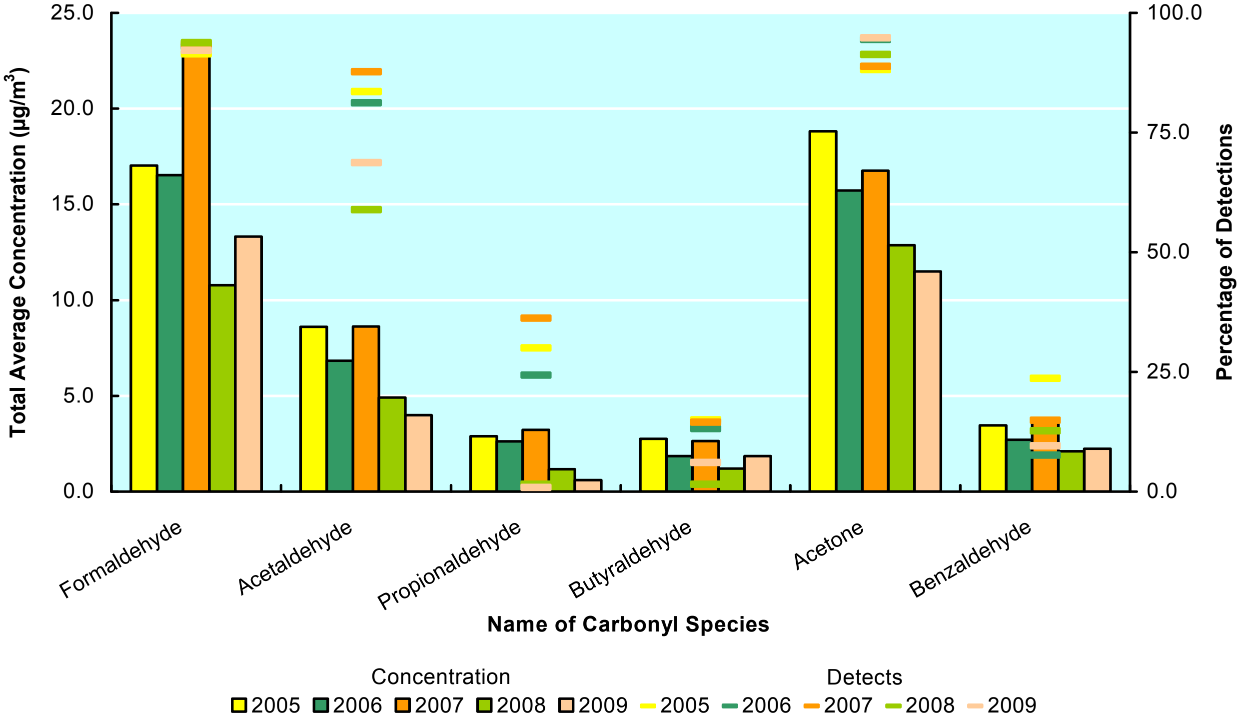


Figure 50: Average 24-Hour Carbonyls Concentration vs. Number of Detects, by Species, 2005-2009

Due to EPA research to improve acrolein sampling and analysis, a new 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 new School Air Toxics Monitoring Initiative. For more information on this study, please see EPA's website, http://www.epa.gov/ttnamti1/airtoxschool.html. Georgia EPD began using the new method for the National Air Toxics Trends Station (NATTS) at the South DeKalb site and at the other 14 Air Toxics sites (discussed in the next section). In previous years, acrolein was sampled, along with the six other carbonyls, with the method of a dinitrophenylhydrazine (DNPH) cartridge and analyzed with high performance liquid chromatography (HPLC) at select sites across the state. The DNPH sampling and HPLC analysis method was used on the data that is displayed in the three previous carbonyls graphs. Since acrolein is no longer collected with DNPH and analyzed with HPLC, it is not shown in the previous carbonyls graphs. Before the new methods were used, in 2005, there were a total of 4 detections above detection limit, in 2006 there was zero, and in 2007 there was one detection above the detection limit.

With the canister collection and GC/MS analysis method and additional sampling locations, the number of acrolein detections above detection limit drastically increased in 2007. Several sites had 100% detection, and all sites were above 80% (Figure 51, on the next page) in 2007. There appears to be variation in concentrations across the state. The average concentrations for the six month period from July through December in 2007 ranged from 0.399 μg/m^3 at the Savannah site to 1.04 μg/m^3 at the Brunswick site (using half the detection limit for non-detected samples). This is over two times the difference between the lowest concentration to the highest. In 2008, there is also a large difference between the lowest and highest concentrations. The Macon site had a concentration of 0.25 μg/m^3 and the Milledgeville site had 1.46 μg/m^3, which is almost six times the difference between the two sites. It appears that most sites had a decrease in concentration from 2007, except the Milledgeville site, which had double the concentration in 2008. The percent detections above detection limit decreased from around 80%-100% in 2007 to 52%-100% in 2008. In 2009, there were fewer sites collecting acrolein data. Six sites (shown in yellow in the graph below) collected acrolein data in 2009. There was a slight increase in average concentrations in 2009, but overall levels remained around the 2008 concentrations. The most noticeable increase for the 2009 data was at the South DeKalb site, with a 0.2 μg/m^3 increase from 2008. This average concentration slightly surpasses the 2007 average level. Acrolein may enter the environment as a result of combustion of trees and other plants, tobacco, gasoline, and oil. Additionally, it has a number of industrial uses as a chemical intermediate (ATSDR, 2005c). 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, 2005c; U.S. EPA, 2003).

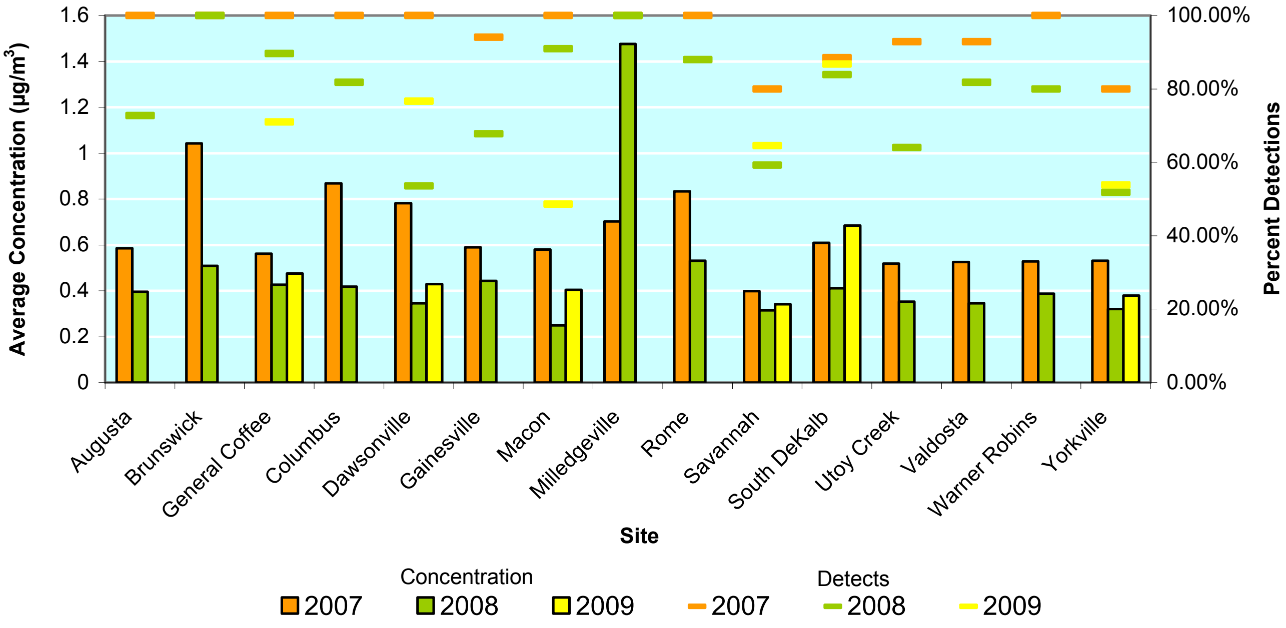


Figure 51: Acrolein Concentrations and Percent Detections, 2007- 2009

MEASUREMENT TECHNIQUES

A number of methods are used to conduct the PAMS hydrocarbon portion of the analyses. Throughout the year, 24-hour integrated hydrocarbon samples are taken and analyzed in the EPD laboratory for 56 hydrocarbon compounds. A 24-hour integrated carbonyl sample is taken once every sixth day throughout the year and analyzed. During June, July, and August, four integrated three-hour carbonyl samples are taken every third day. All analyses are conducted at the EPD Laboratory.

During June, July, and August, hydrocarbon samples are analyzed hourly on-site 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 type is an absorbent cartridge filled with dinitrophenylhydrazine (DNPH) coated silica that is attached to a pump to allow approximately 180 L of air to be sampled. The cartridge is analyzed using High Performance Liquid Chromatography. The other method is the canister sampler that is used for sampling volatile organic compounds. Acrolein is analyzed using this method. A SUMMA® polished canister is evacuated to a near-perfect vacuum and attached to a sampler with a pump controlled by a timer. The canister is filled to greater than 10 psig. The canister is analyzed using a gas chromatograph with mass spectroscopy detection (GC/MS). Specific annual summaries for the 2009 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

The citizens of Georgia have demonstrated a long-term interest in the quality of Georgia's air. Since the 1970's, ambient ozone concentrations have been monitored in several communities throughout the state. As the state's population grew, more compounds have been monitored in ambient air as required by the Federal Clean Air Act. In 1993, the EPD began to monitor a number of compounds that have no established ambient air standard. The monitoring has been conducted under two efforts, the first being the previously discussed Photochemical Assessment Monitoring Station (PAMS) project, a federally mandated program for areas in serious, severe, or extreme non-attainment of the ozone standard. The second effort is the EPD-sponsored monitoring activities for ambient concentration of hazardous air pollutants (HAPs). That effort was undertaken since monitoring only criteria pollutants would not provide an adequate understanding of the quality of Georgia's air.

In 1994, the EPD conducted an intensive air quality study in Savannah (GADNR, 1996a). Then in 1996, the EPD conducted an intensive study in Glynn County as part of a multimedia event with EPA (GADNR, 1996b). These studies provided detailed pictures of the air quality in the communities, but the studies 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 the 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, by 2002, the 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, monitoring for a common set of toxic compounds. From the list of 188 compounds identified by EPA as being HAPs, the toxic compounds include metals, volatile organic compounds, and semi-volatile organic compounds. In addition, three of the ATN sites (Brunswick, Dawsonville, and Savannah) monitor carbonyl compounds (as seen 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 National NATTS Network consists of 23 sites, 18 urban and 7 rural, with two of the urban sites added in 2007. At the South DeKalb site, the same compounds are monitored as at the other air toxics sites, as well as hexavalent chromium, black carbon, and carbonyls.

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

Air toxic compounds are released from many different sources, including mobile sources (such as vehicles), stationary industrial sources, small area sources, indoor sources (such as cleaning materials), and other environmental sources (such as wildfires). The lifetime, transportation, and make-up of these pollutants are affected by 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. The following section discusses air toxic compounds, possible sources, monitoring techniques, findings for 2009 and a comparison of 2009 data to previous years.

In 2004, the Air Toxics Network underwent changes to the detection limits and reporting limits of the chemicals in this network. Lowering the limit of detection helps the data better represent reality. Instead of only seeing the higher numbers that were detected and using those numbers for average concentrations, one is able to see both sides of the spectrum and have 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. Seeing only the higher levels of concentration, or possibly 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. With the lower limits included in the data, one is able to see all possible effects of the chemicals analyzed.

As stated earlier, in 2008, certain samplers within Georgia's ambient air monitoring network were temporarily discontinued. More than half of the Air Toxics Network was included in this process. Six out of the 15 total Air Toxics sites (including one NATTS site) collected data in 2009. The following section will reflect the data collected in 2009, and the other sites are shown for comparison to past data. Refer to Table 2 for complete list of temporarily discontinued samplers.

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 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 aircraft. 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, are 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 to 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, 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. It is also used as a toner in photographs and in photocopying. Selenium is also found in gasoline and diesel exhaust. Selenium is a micronutrient, needed at very low levels for the health of all living creatures. It is normally absorbed through the digestive tract, though, and is 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 in making the U.S. penny since 1982. Zinc compounds are used in making 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 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.

See Figure 52 for a map of monitoring locations for metals.

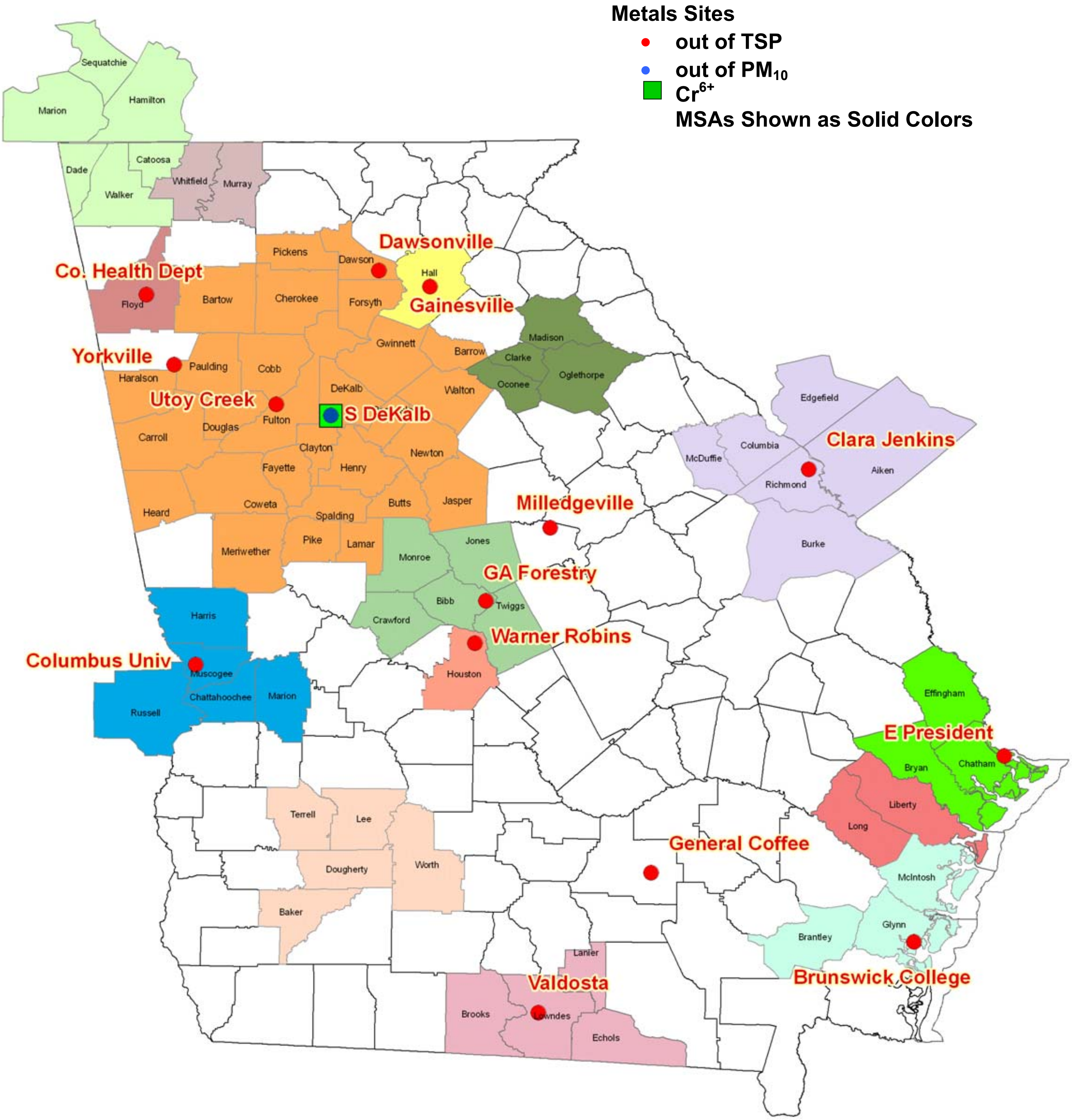


Figure 52: Metals Monitoring Site Map

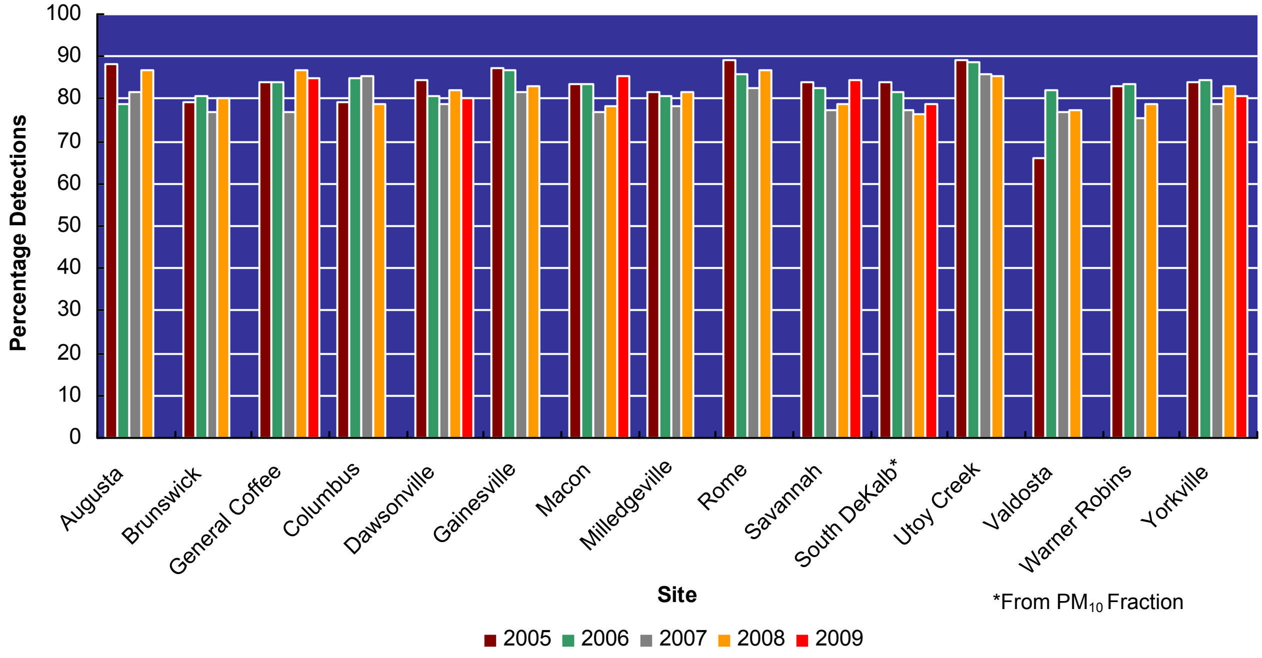


Figure 53: Percentage of Metals Detections by Site, 2005-2009

Figure 53 shows the percentage of metal species detected above the detection limit at each site for the years 2005 to 2009. 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, while the other samplers in the network collect samples from all the total suspended particles. Lower limits of detection (LOD) were introduced in September of 2004, therefore to be consistent, the data represented in these figures starts with the 2005 data. There have been only five full years of data collected at the lower limits, therefore true trends may not be discernible at this time. In 2009, six of the fifteen Air Toxics sites collected metals data, shown in red. With Figure 53, the distribution of metals at the various locations across the state can be examined as well as any changes in the past five years. The General Coffee, Dawsonville and Yorkville sites showed a decrease from the 2008 detections. The Macon, Savannah, and South DeKalb sites showed an increase from the 2008 detections. The distribution across the sites is relatively similar. For all the sites, the percent detections remain around 80% of the total samples collected. The variability across the various sampling locations is modest, considering the vast geographic distribution of the sites, and climatological and anthropogenic influences from nearby urban development.

Figure 54 shows the network's percentage of detections above detection limit and total average concentrations by metallic species at all Air Toxics sites during 2005 through 2009. The detection of any given pollutant is counted as any number that is above half the limit of detection. One point of interest when looking at data is to track the percentage of detections along with the concentration. When examining this aspect, it appears that most metals had several detections, almost consistently up to 100%. Therefore, each metal detection contributes little concentration to the overall total concentration. This does not seem to be the case for zinc. While its detection frequency was almost the same as the other metals, zinc had the highest average concentration for all five years. This would indicate that for each zinc detection, there was a higher concentration of that metal. With the 2009 data, there is a decrease in zinc concentrations, however, there were fewer sites collecting data across the state. 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. With the concentrations of zinc being much higher than the other metals, zinc is explored further in Figure 55 (on the following page), which examines the concentrations of zinc by site.

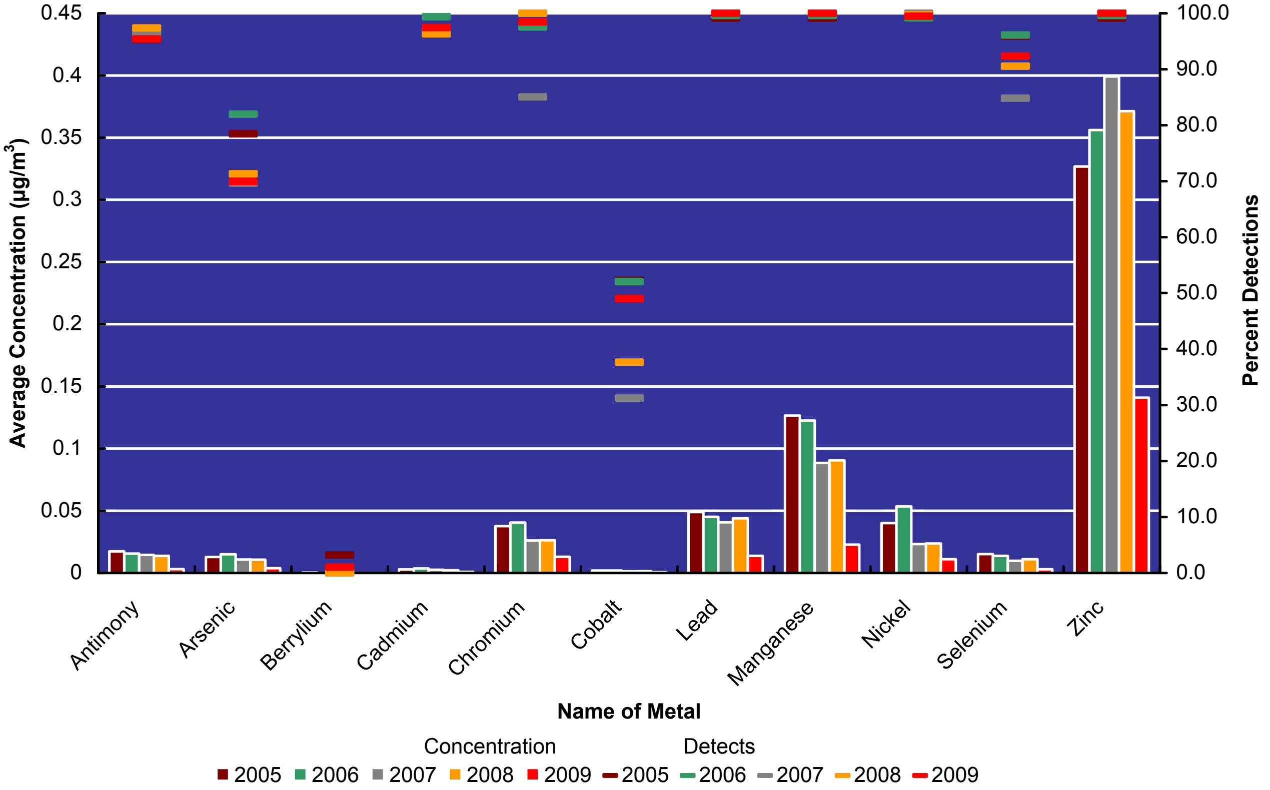


Figure 54: Average Concentration and Percentage Detections of Metals, by Species, 2005-2009

With Figure 55, the total average concentrations of zinc are investigated more closely, divided by site, for 2005 through 2009. Zinc can be released into the environment from mining, metal processing, steel production, burning coal, and burning certain wastes. Several sites had a consistent level of zinc through the five years of data, and a few sites even had a decrease in zinc levels. The General Coffee, Columbus, Gainesville, and Valdosta sites, however, had a noticeable increase in zinc levels from 2005 to 2006. With the 2007 and 2008 data, all four of these sites except the Valdosta site showed a slight decrease in concentration from the 2006 zinc levels. Another change to take note of is the increase of zinc at the Brunswick site from 2006 to 2007. In 2007, there was an increase of over two times the 2006 level of zinc at the Brunswick site. In 2008, the zinc levels at the Brunswick site are lower than the 2007 level, but remain higher than the 2006 level. In 2009, the Brunswick site did not collect Air Toxics data.

To look at the overall levels of zinc, the Utoy Creek site has consistently had the highest average concentration from 2005 to 2008, with levels almost nine times as high as the lowest concentrations, which were at the South DeKalb site. As noted earlier, the South DeKalb metals sampler is designed to take the sample from the smaller PM_{10} fraction of the air, while the other samplers collect samples from all the total suspended particles. This could be a reason for the lower levels at the South DeKalb site compared to the other sites around the state. With the zinc samples taken at the Utoy Creek site, several samples were at least a magnitude higher than most other zinc samples collected at the other sites. The Utoy Creek site is situated at the Utoy Creek Wastewater Treatment Facility. Zinc can be used to help keep galvanized steel from corroding, and is possibly used for this reason on the pipes at the wastewater treatment facility. In addition, there are industries in the area that discharge their wastewater into the Utoy Creek Wastewater Treatment Facility. Also, the sludge that is produced at the wastewater treatment facility is incinerated. These circumstances provide more possibilities for seeing higher levels of zinc at the Utoy Creek site. In 2009, however, the Utoy Creek site did not collect Air Toxics data. To look at the data collected at the other six sites (shown in purple), the Macon site's 2009 average concentration (0.05427 $\mu g/m^3$) more than doubled from the 2008 average concentration (0.02029 $\mu g/m^3$). The five other sites that collected data in 2009 collected concentrations at relatively the same levels as in 2008.

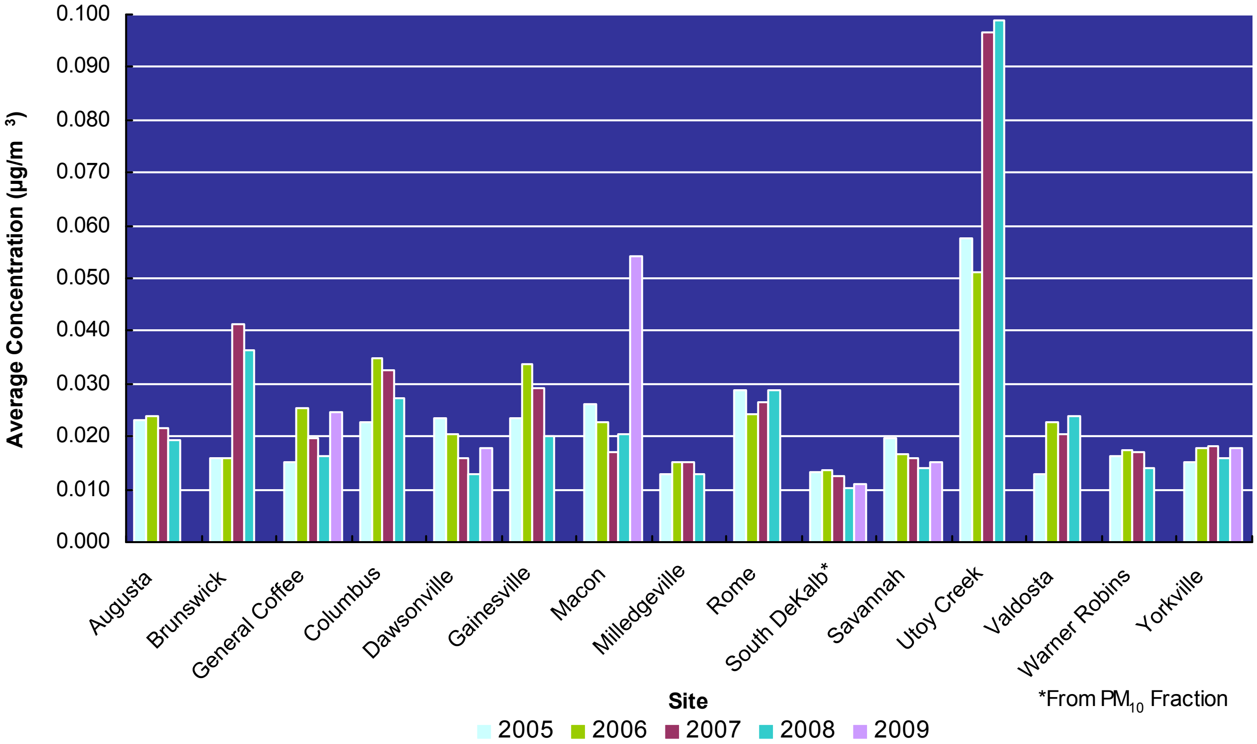


Figure 55: Average Concentration Comparison of Zinc, by Site, 2005-2009

With the Macon site's zinc levels more than doubling from 2008 to 2009, the Macon metals data was examined further. The following graph compares the concentrations of all eleven metals collected at the site every twelve days from 2005 through 2009. Obviously, the zinc levels are much higher than the other metals collected, and the 2009 zinc levels show a significant increase. Further investigation is being undertaken to help determine the cause of the increase in zinc concentrations.

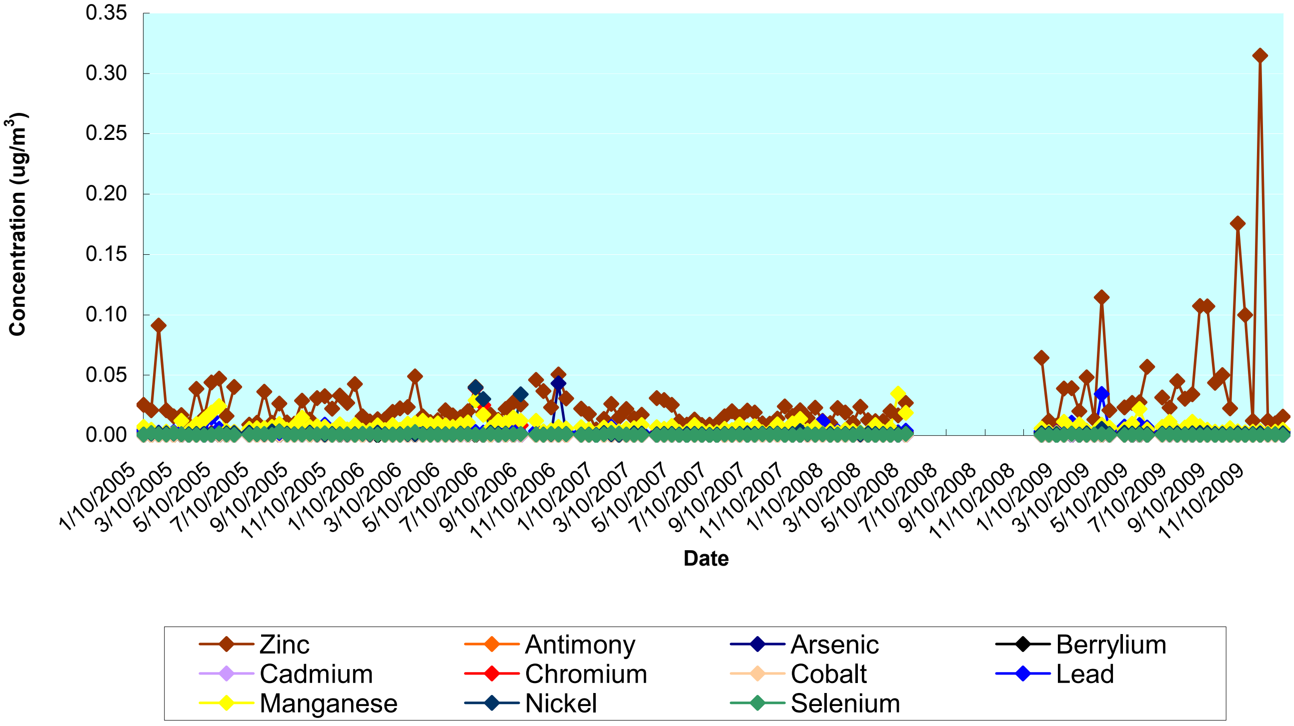


Figure 56: Comparison of Metals Collected at the Macon Site

HEXAVALENT CHROMIUM (Cr_6)

Hexavalent chromium (chromium in its +6 oxidation state) in the environment is almost always related to human activity. Hexavalent chromium can be released into the atmosphere through the production of stainless steel, chrome plating, coating processes, and painting. It is also found in vehicle engines. The presence of chromium compounds is common at hazardous waste sites. From locations such as these, exposure of populations residing or working nearby can occur through exposure to air containing particulates or mists of chromium compounds. These particles can also find their way into drinking water if soluble forms of chromium leach into groundwater. Human exposure can also occur through skin contact with soil at hazardous waste sites. Hexavalent chromium is absorbed most readily through the lungs or digestive tract. Other forms of the metal, such as chromium in the +3 oxidation state, occur naturally in the environment and are not as efficient at entering the body. In general, hexavalent chromium compounds are more toxic than other chromium compounds. The toxicity of hexavalent chromium is in part due to the generation of free radicals formed when biological systems reduce hexavalent chromium to the +3 oxidation state. Effects in humans exposed occupationally to high levels of chromium or its compounds, primarily hexavalent chromium, by inhalation may include nasal septum ulceration and perforation, and other irritating respiratory effects. Cardiovascular effects, gastrointestinal and hematological effects, liver and kidney effects, and increased risks of death from lung cancer may also result from such exposure. In addition to the respiratory effects, exposure to chromium compounds can be associated with allergic responses (e.g., asthma and dermatitis) in sensitized individuals. Hexavalent chromium dioxide is a tetravalent chromium compound with limited industrial application. It is used to make magnetic tape, as a catalyst in chemical reactions, and in ceramics. Because of its limited industrial uses, the potential for human exposure is less for chromium dioxide than for the more industrially important hexavalent chromium and chromium +3 compounds.

This is the fifth year hexavalent chromium has been monitored at the South DeKalb site. The data for 2005 through 2009 is presented in Figure 57. The sampler did not operate the last quarter of 2007 through part of May 2008. Observed concentrations range over an order of magnitude, from 0.01 to 0.3 ng/m^3 (nanograms per cubic meter). The graph is shown up to 0.12 ng/m^3 in order to observe the lower data points. The observed concentrations are represented with the points, while the black line represents a moving average across the data set. At this point, true trends are hard to define, but the 2009 data shows much lower concentrations than the previous year's concentrations. The highest data point of 0.3 ng/m^3 was observed in 2006, while the highest 2009 value was 0.09 ng/m^3. As the data set grows, possible seasonal variation in its concentration, the magnitude of its health risk, and which wind directions are most associated with elevated concentrations will be investigated.

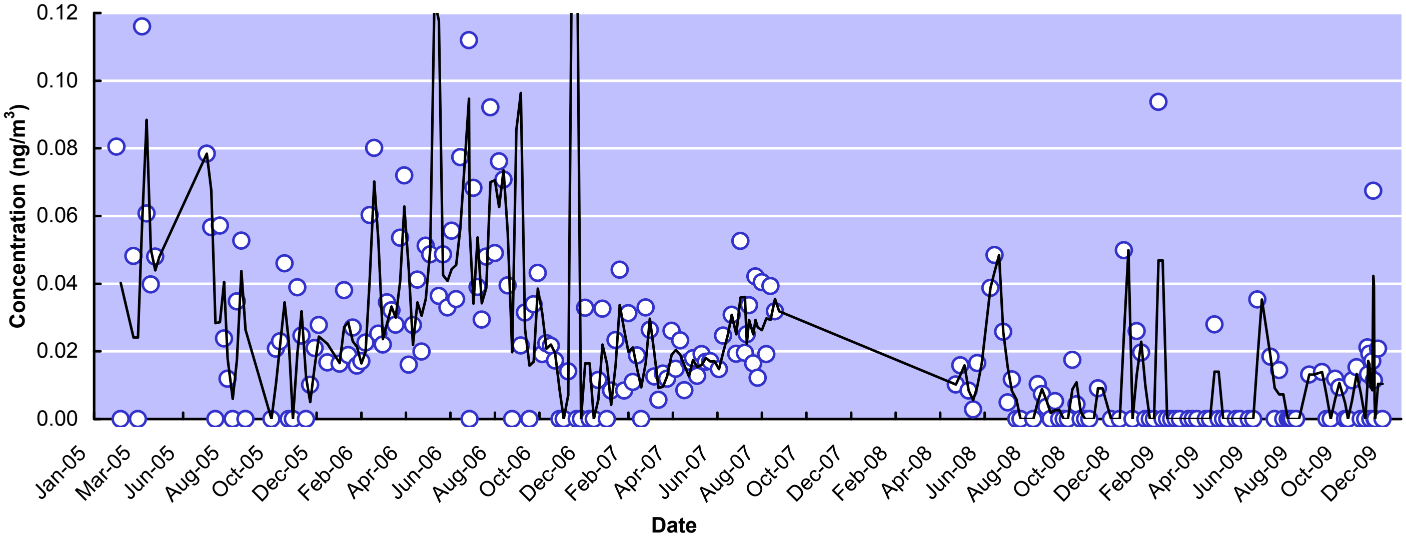


Figure 57: Hexavalent Chromium at South DeKalb

VOLATILE ORGANIC COMPOUNDS (TO-14/15)

Volatile organic compounds (VOCs) make up a group of chemicals from various industrial, stationary, and mobile sources. 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 it 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. It reaches the atmosphere by way of evaporative emissions as well as incomplete combustion processes. Benzene is found with burning coal and oil, gasoline service stations, and vehicle emissions. 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 58 shows the statewide detection distribution of air toxic (TO-15) type volatile organic compounds (VOCs) from 2005 to 2009 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. Again, the South DeKalb site has samples collected every six days, and Gainesville has an extra monthly sampling, compared to the other sites which have samples collected every twelve days. Therefore, the detections are shown in percentage of number of samples taken. The distribution is relatively even across the state, with the more urban or industrial sites near the upper extreme and the more rural sites near the lower extreme. In 2008, most sites showed a drop in the percentage of detections above the detection limit. The exceptions to this drop in detections were the Brunswick and Milledgeville sites. When each of these two site's data was examined more closely, the Brunswick site had higher percentages of chlorobenzene, styrene, and toluene detections in 2008. The Milledgeville site had higher percentage detections of cyclohexane and methyl chloroform in 2008. To note, the Augusta site had higher percentages of detections in 2006, which were attributed to methyl chloroform. The predominant volatile organic compounds that are detected above the detection limit are explored further in the following graph, Figure 59.

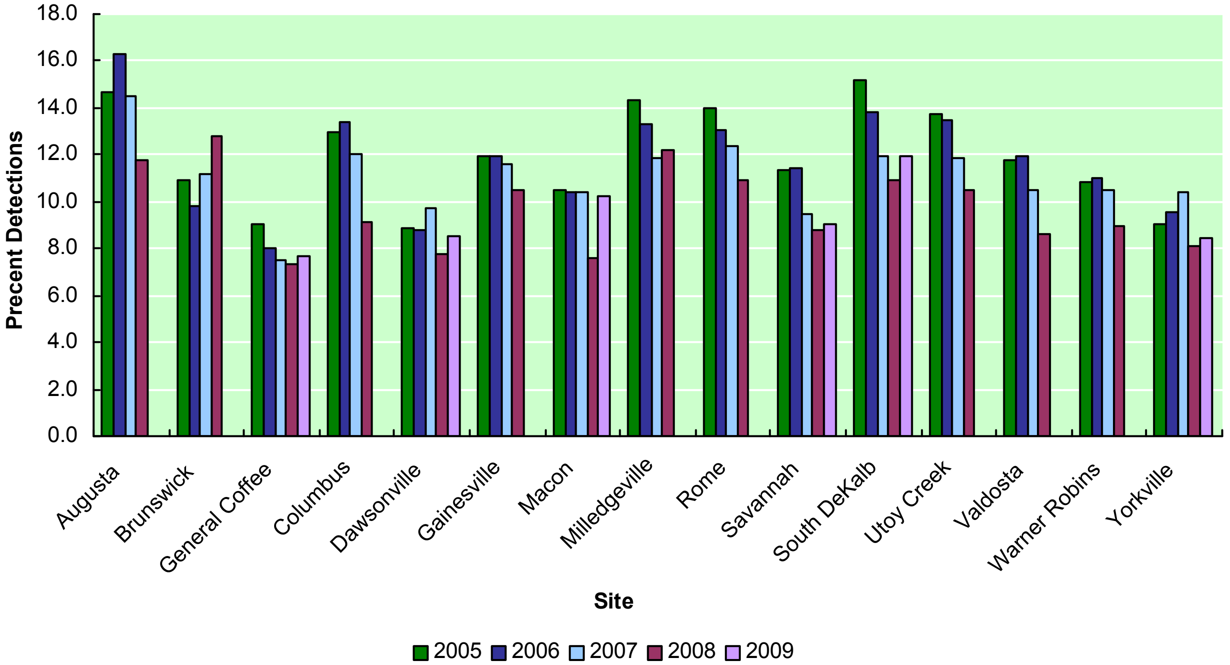


Figure 58: Total Volatile Organic Compounds Percent Detected per Site, 2005-2009

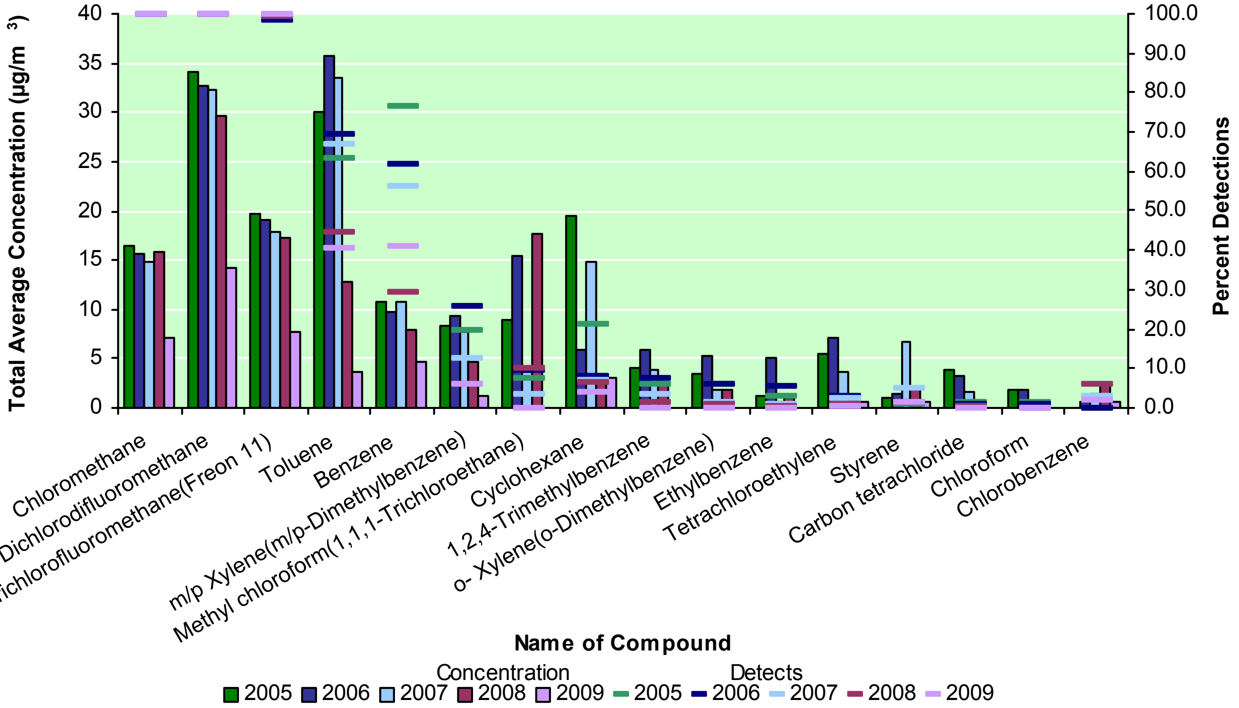


Figure 59: Average Concentration and Percent Detection of Volatile Organic Compounds (TO-15), Common Compounds, 2005–2009

Figure 59 compares the relationship between the concentrations observed and percent detections above detection limit, showing the top sixteen compounds of the VOCs group that were detected for 2005-2009. Although there are 42 species in this analyte group, only a relatively smaller subset is typically 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 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. It should be noted that six of the fifteen ATN sites collected data in 2009, causing the total averages to appear smaller. Chloromethane and trichlorofluoromethane consistently had the same pattern of the highest detection rates, but the total average concentrations were consistently the second and third highest over the five years. This would indicate that the concentrations of chloromethane and trichlorofluoromethane are relatively low per detection. Conversely, toluene had the fourth or fifth highest detection rate, but one of the top average concentrations for 2005 through 2007. This would indicate that each detection of toluene has a relatively high concentration compared to the other VOCs. However, there was an obvious decrease in the overall toluene levels from 2007 to 2008 (33.6 µg/m^3 to 12.7 µg/m^3) and again in 2009 (to 3.6 µg/m^3. Dichlorodifluoromethane had one of the highest levels of concentration and one of the highest detection rates consistently for the five years of data. This would indicate that for each detection the concentration had a consistent, average weight.

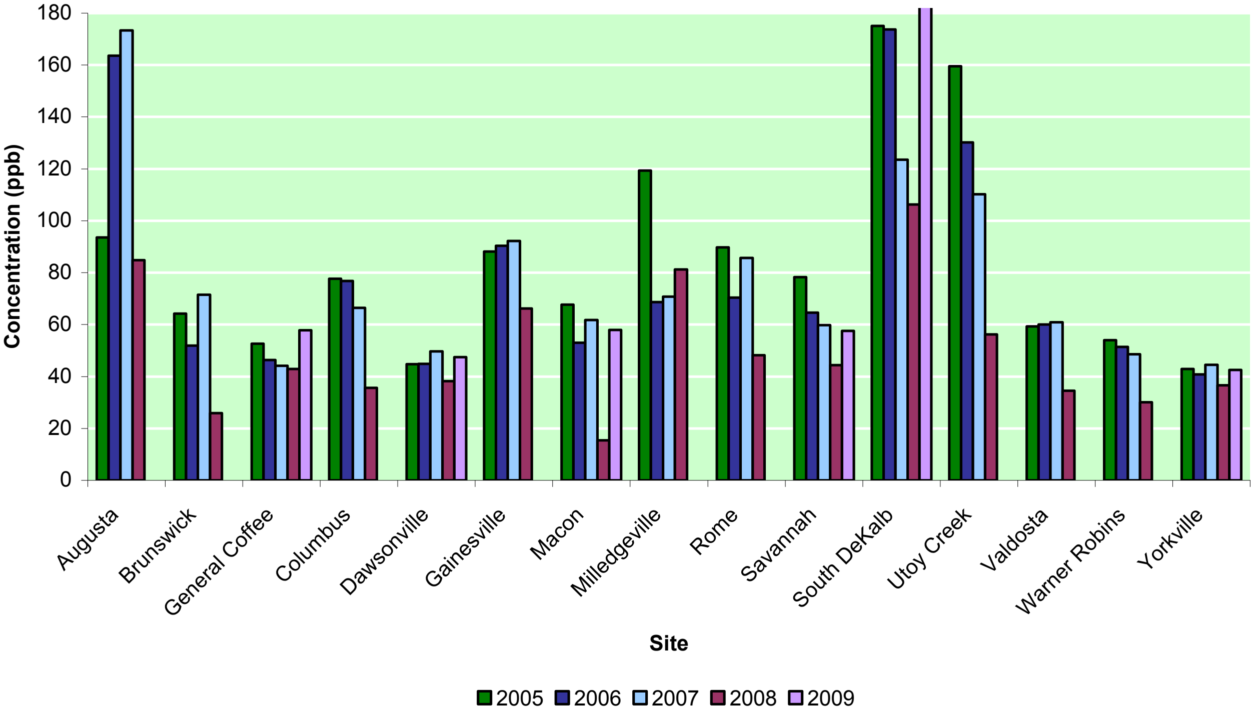


Figure 60: Total Volatile Organic Compound Loading all Species, by Site, 2005-2009

Figure 60 shows the total volatile organic compound concentration, or loading, at each site for 2005 through 2009. 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 60, it is important to note that the South DeKalb and Gainesville sites would appear elevated since these two sites have a larger number of scheduled samplings than the rest of the sites in the network. South DeKalb samples on a 6-day schedule, and Gainesville has an additional sample collected per month over the network's regular sample days. VOC levels at sites located close to or within urban centers (South DeKalb, Utoy Creek, and Augusta) generally show higher levels of these pollutants, while sites in smaller communities or rural areas (General Coffee, Dawsonville, and Yorkville) generally show lower levels. It is important to note that the Macon site was shut down for most of

2008 due to damage to the site, causing that value to appear much lower than the other Air Toxics sites. In looking at trends in the data, there seems to be some fluctuation of VOCs concentrations at most sites, and a slight decrease in 2008. Then, at most sites that collected samples in 2009, there was a slight increase in total VOC concentrations. As more data is collected, possible VOCs trends will be examined.

For a map of VOC and SVOC monitoring locations, see Figure 61 on the next page.

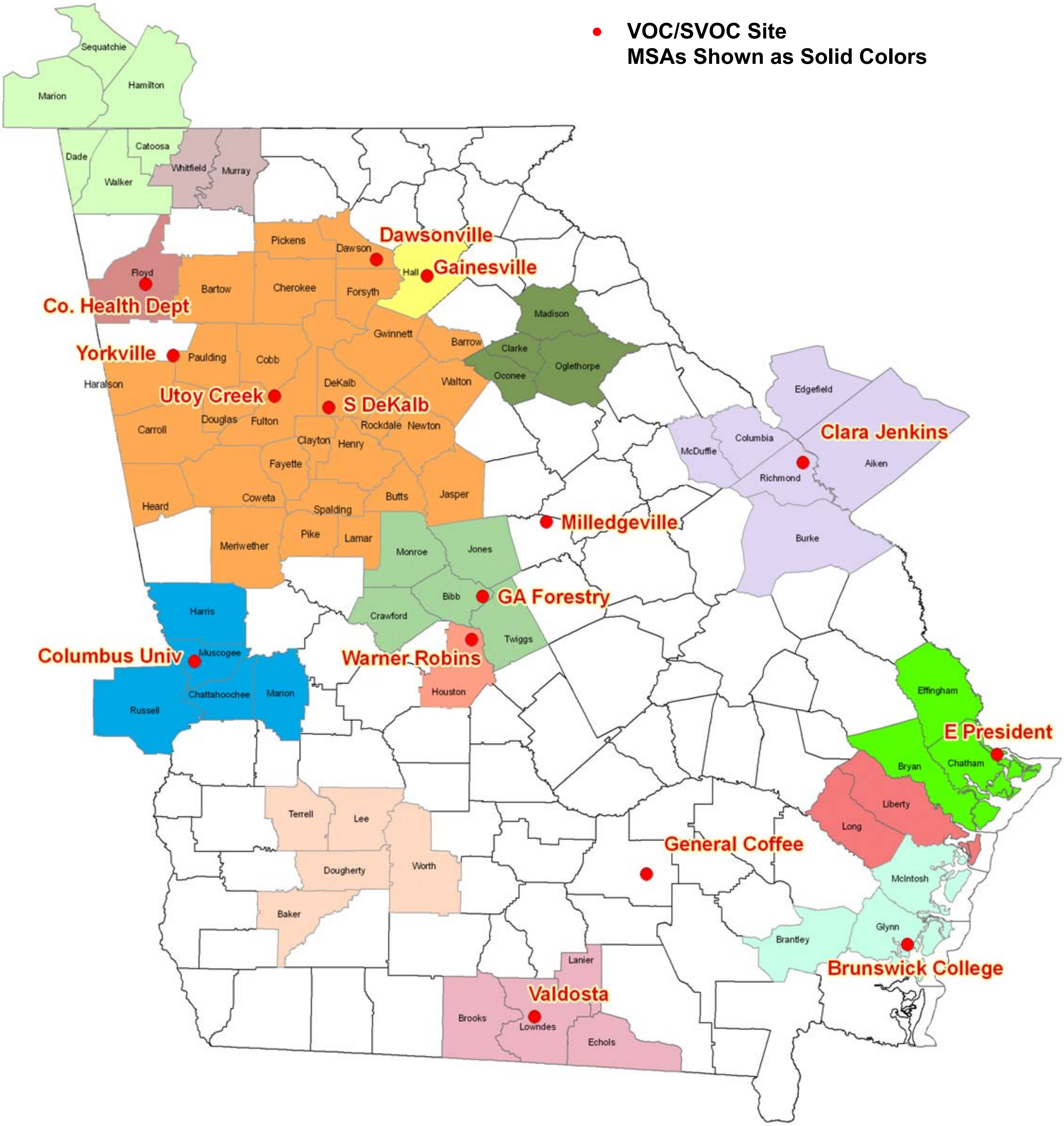


Figure 61: VOC and SVOC Monitoring Site Map

SEMI-VOLATILE ORGANIC COMPOUNDS

Polycyclic aromatic hydrocarbons (PAHs), also called semi-volatile organic compounds (SVOC) 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 move 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 61.

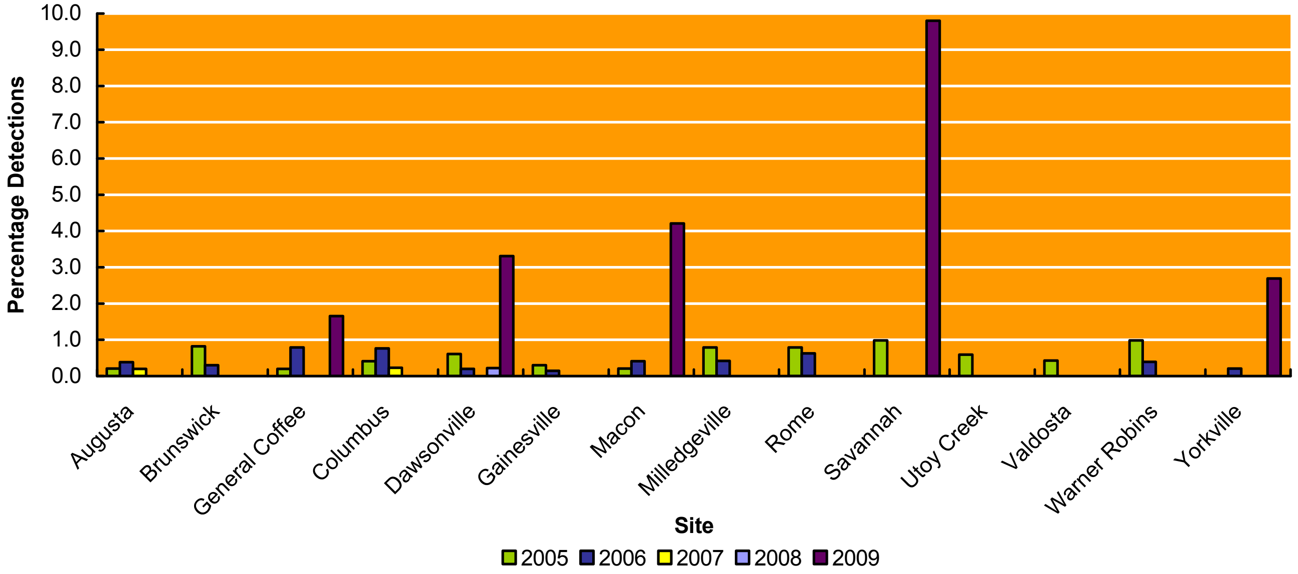


Figure 62: Semi-Volatile Organic Compounds Percentage of Detections Per Site, 2005-2009

Figure 62 displays the percentage of detections according to site for 2005 through 2009 for all semi-volatile organic compounds combined in the Air Toxics Network, except the South DeKalb site (discussed below). Detections were counted as any number that was above half of the method detection limit. As can be seen from this graph, the semi-volatile organic compounds are detected much less frequently than the other groups of compounds in the Air Toxics Network. Historically, the highest number of detects occurred in 2005, with 36 detects over the 14 sites (shown in green). That changed in 2009 when the five sites that collected semi-VOC samples had a total of 102 detections (shown in purple). This is still a relatively low number of detections, though a noteworthy increase. In the fourth quarter of 2009, the semi-VOCs laboratory analysis method changed from a gas chromatograph with Electron Capture Detector to a gas chromatograph. The gas chromatograph method is used by the EPA contractor to analyze samples from the South DeKalb site. The following graph was produced with this fourth quarter data and includes the South DeKalb site for comparison. The seventeen semi-VOCs that were collected at all sites were compared in this graph. Even though the same laboratory analysis method was used for this analysis, the South DeKalb data shows a significantly higher percentage of detections. 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.

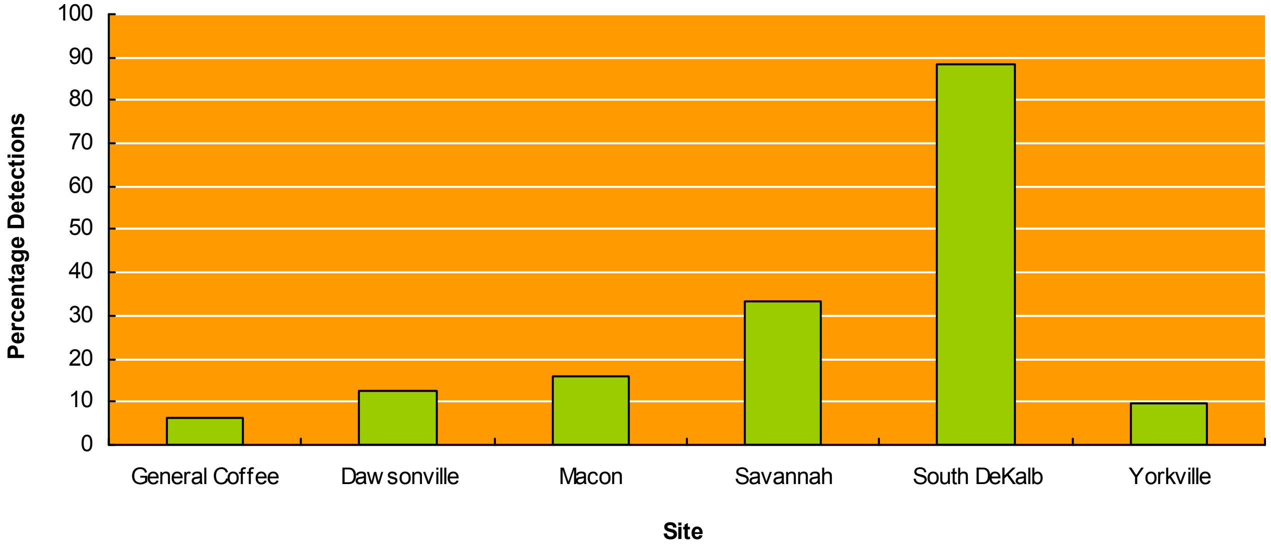


Figure 63: Comparison of Fourth Quarter 2009 Semi-VOCs Detects

Figure 64, on the following page, shows the percentage of detections for each semi-volatile organic compound compared to the total average concentration of those compounds across the statewide network of sites from 2005 through 2009. The y-axis is formatted in order to show the smaller concentrations and detections in more detail. 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. Even with the few detections and low concentrations, the relationship between these two measures can still be examined. With the 2005 data (shown in green), the compound with the highest number of detections was benzo(g,h,i)perylene, but this compound had one of the lowest detectable concentrations of the group. This would show that each detection of benzo(g,h,i)perylene had a low concentration. The compound with the highest average concentration was phenanthrene, but this compound had one of the lowest detection rates. In 2006 (shown in dark blue), phenanthrene again had the highest average concentration, though at about half the 2005 concentration level, and had the fewest number of detections of the compounds detected. This would mean that for each detection of phenanthrene, there was a higher concentration. In 2007, no detections occurred for phenanthrene above the detection limit for these sites. Overall, detections ceased for all but one of the semi-volatile compounds, leaving fluoranthene (shown in yellow) as the only compound that was found to be present above the detection limit at these sites in 2007. In 2008 (shown in light blue), the only compound detected above the detection limit was indeno(1,2,3-cd)pyrene, with an average concentration of 0.0008 µg/m^3. As discussed above, the 2009 data (shown in purple) had the highest number of detections since the 2005 data. There were detections of approximately half of the compounds in 2009. The naphthalene compound had the highest total average concentration with 0.17571 µg/m^3.

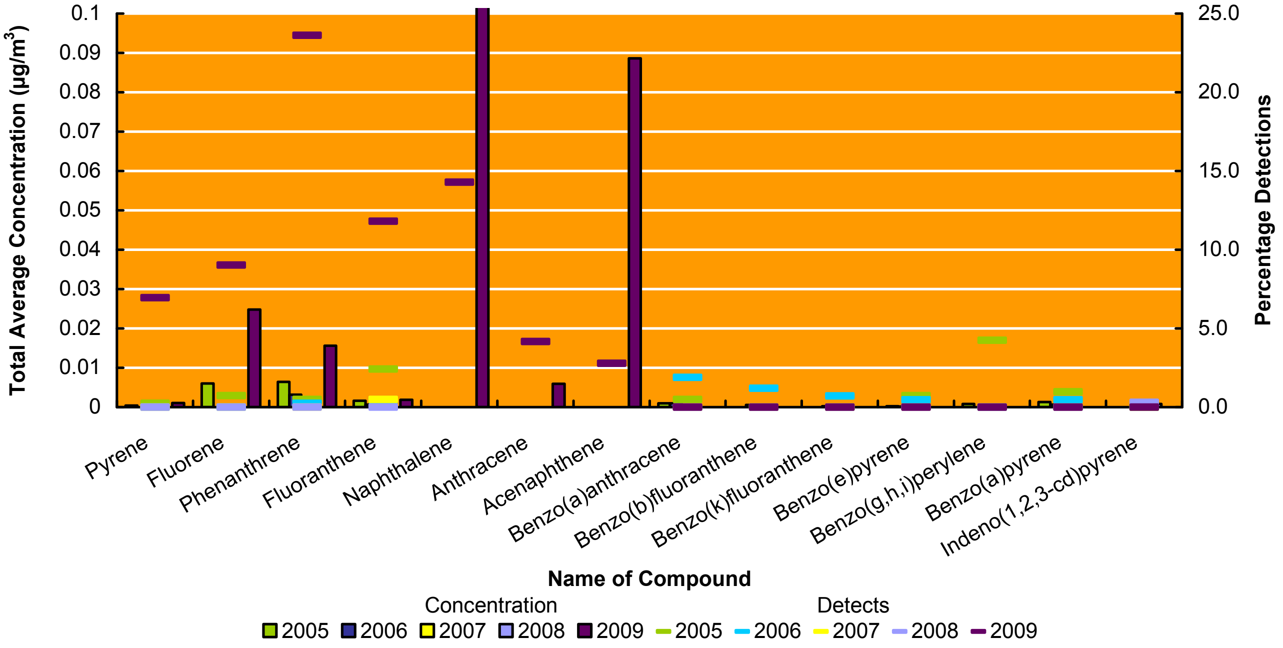


Figure 64: Total Average Concentration and Percentage Detections of Semi-Volatile Organic Compounds by Compound, 2005-2009

In April of 2007, the South DeKalb site had semi-volatile organic compounds added to its list of compounds to sample. Instead of the EPD laboratory analyzing this data as it does with the other Air Toxics sites, the South DeKalb site is part of the National Air Toxics Trends Sites (NATTS) Network, which uses the Eastern Research Group (ERG) to analyze this data. ERG is a multidisciplinary consulting firm, and in the laboratory at ERG, gas chromatography is used to separate and measure a number of pollutants detected in the troposphere. Until the fourth quarter of 2009, this differed drastically from the EPD's laboratory methods, in which liquid chromatography was instead used to sort out the compounds of interest. As a result of the dilution of pollutants necessary for liquid chromatography, several of the compounds analyzed by the ERG laboratory were not detected by the EPD laboratory. Furthermore, the detection limits used varied quite a bit from one laboratory medium to the other. Since the data was analyzed differently until the end of 2009, the South DeKalb data is shown separately.

Figure 65, below, is produced from the results of semi-volatile organic compounds at the South DeKalb monitor that were analyzed at ERG. The average concentrations and number of detections are shown. The detections were derived using any detection that was above half of the method detection limit. The concentrations of naphthalene in 2007, 2008, and 2009 were 0.083 µg/m^3, 0.085 µg/m^3, and 0.097 µg/m^3, respectively. These concentrations are an order of magnitude higher than the next highest concentrations of around 0.004 µg/m^3 for phenanthrene. Therefore, the y-axis is formatted in order to show the other concentrations and detections in more detail. In general, there has not been much change in the data over the last three years. A few of the compounds with lower average concentrations show a slight increase in the number of detections (mainly on the right half of the graph, shown with teal dashes). 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. According to ERG's results, naphthalene appears to be the largest threat of the semi-volatile organic compounds, and more than half the compounds have averages less than 0.0005 µg/m^3.

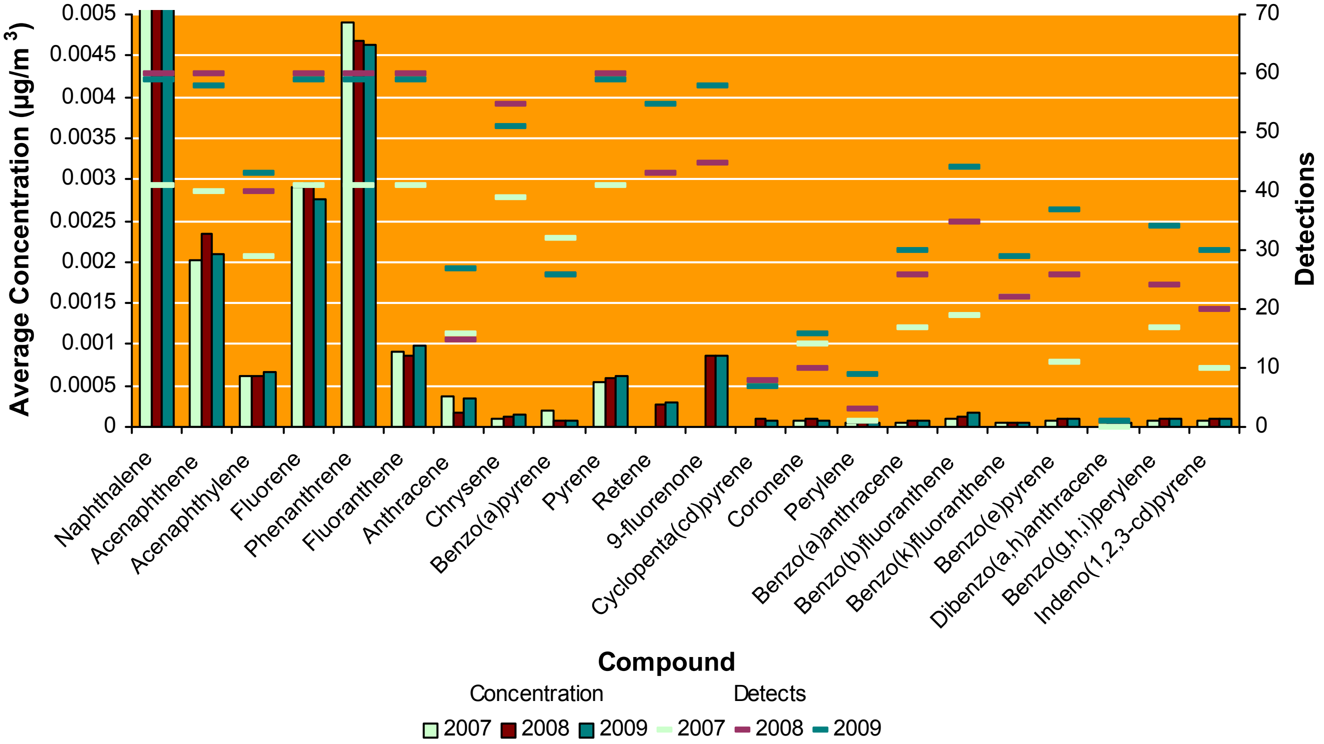
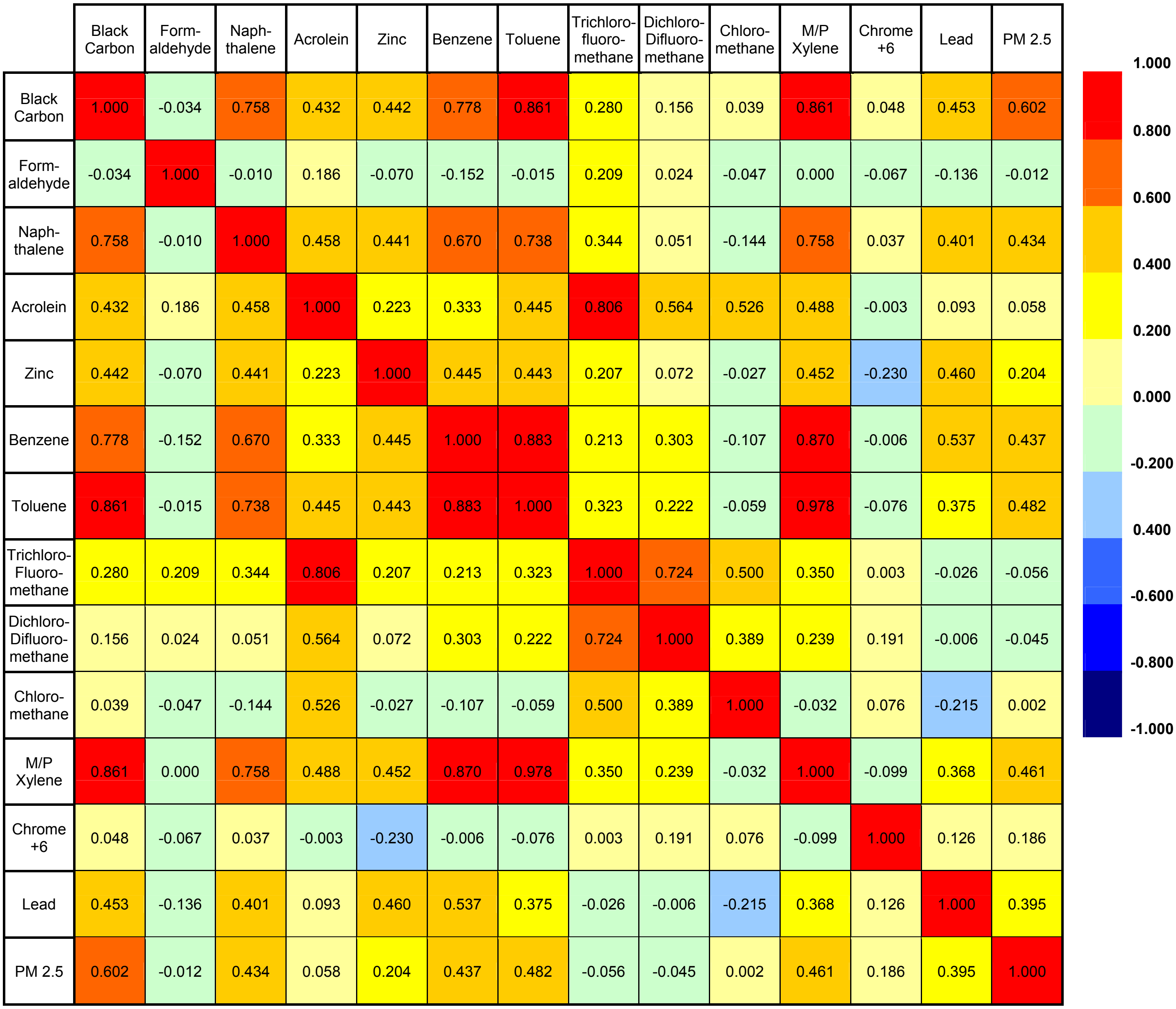


Figure 65: Semi-Volatile Organic Compounds at South DeKalb, 2007-2009

As part of the NATTS program, the South DeKalb site collects black carbon data. One source of black carbon is diesel exhaust. To give a comparison of a few other compounds that are also commonly seen at the South DeKalb site, correlations were performed and a correlation matrix was produced with the 2009 data. With this, an attempt was made to see what other compounds are found along with black carbon. The resulting data can be seen in Figure 66, below. The correlation values are given, as well as colors to show how well the compounds correlated. The red shows a perfect positive correlation of 1.0, while dark blue shows a perfect negative correlation of –1.0. The color scale is shown to the right of the correlation matrix. Data was compared when a sample day had a pair of data for both compounds. As can be seen in the correlation matrix, the toluene and m/p-xylene data have the strongest relationship, with 0.978. In 2008, the highest correlation was also between m/p-xylene and toluene, with 0.903, suggesting that the two compounds are consistently connected, and this relationship continues to strengthen in its common source. The black carbon data correlated well with the toluene and m/p-xylene data, with a value of 0.861 for each pairing. This could indicate that these compounds could be found in diesel exhaust, or they could be found in conjunction with diesel exhaust or other vehicle exhaust. The benzene data correlated well with toluene and m/p xylene with 0.883 and 0.870, respectively. Benzene's correlation with the black carbon data is a relatively strong relationship at 0.778, yet it is slightly weaker than black carbon's relationship with toluene and m/p xylene. This may suggest that while black carbon shares sources with benzene, these sources are less common and widespread as the sources shared by black carbon, toluene, and m/p xylene. Two other noteworthy correlations are black carbon with naphthalene and $PM_{2.5}$ data, which were 0.758 and 0.602, respectively. The black carbon data had the highest negative relationship to the formaldehyde data, with a correlation of –0.034. Chromium +6 and zinc have the overall highest negative relationship, with a correlation of –0.230. The majority of correlations fall within the range of -0.200 and 0.599.



	Black Carbon	Form-aldehyde	Naph-thalene	Acrolein	Zinc	Benzene	Toluene	Trichloro-fluoro-methane	Dichloro-Difluoro-methane	Chloro-methane	M/P Xylene	Chrome +6	Lead	PM 2.5
Black Carbon	1.000	-0.034	0.758	0.432	0.442	0.778	0.861	0.280	0.156	0.039	0.861	0.048	0.453	0.602
Form-aldehyde	-0.034	1.000	-0.010	0.186	-0.070	-0.152	-0.015	0.209	0.024	-0.047	0.000	-0.067	-0.136	-0.012
Naph-thalene	0.758	-0.010	1.000	0.458	0.441	0.670	0.738	0.344	0.051	-0.144	0.758	0.037	0.401	0.434
Acrolein	0.432	0.186	0.458	1.000	0.223	0.333	0.445	0.806	0.564	0.526	0.488	-0.003	0.093	0.058
Zinc	0.442	-0.070	0.441	0.223	1.000	0.445	0.443	0.207	0.072	-0.027	0.452	-0.230	0.460	0.204
Benzene	0.778	-0.152	0.670	0.333	0.445	1.000	0.883	0.213	0.303	-0.107	0.870	-0.006	0.537	0.437
Toluene	0.861	-0.015	0.738	0.445	0.443	0.883	1.000	0.323	0.222	-0.059	0.978	-0.076	0.375	0.482
Trichloro-Fluoro-methane	0.280	0.209	0.344	0.806	0.207	0.213	0.323	1.000	0.724	0.500	0.350	0.003	-0.026	-0.056
Dichloro-Difluoro-methane	0.156	0.024	0.051	0.564	0.072	0.303	0.222	0.724	1.000	0.389	0.239	0.191	-0.006	-0.045
Chloro-methane	0.039	-0.047	-0.144	0.526	-0.027	-0.107	-0.059	0.500	0.389	1.000	-0.032	0.076	-0.215	0.002
M/P Xylene	0.861	0.000	0.758	0.488	0.452	0.870	0.978	0.350	0.239	-0.032	1.000	-0.099	0.368	0.461
Chrome +6	0.048	-0.067	0.037	-0.003	-0.230	-0.006	-0.076	0.003	0.191	0.076	-0.099	1.000	0.126	0.186
Lead	0.453	-0.136	0.401	0.093	0.460	0.537	0.375	-0.026	-0.006	-0.215	0.368	0.126	1.000	0.395
PM 2.5	0.602	-0.012	0.434	0.058	0.204	0.437	0.482	-0.056	-0.045	0.002	0.461	0.186	0.395	1.000

Figure 66: Correlation Matrix of Common Compounds Found at South DeKalb, 2009

MONITORING TECHNIQUES

In 2009 air toxics samples were collected from a total of six sites, including a NATTS site, and two background (rural) sites.

The compounds sampled at the ATN sites are shown in Appendix D. The list was derived from the 188 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. Also, carbonyls are monitored at three of the air toxics sites (as well as one PAMS site).

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

The HIVOL sampler used for sampling metals is a timed sampler. The sampler is calibrated to collect 1300 to 2000 liters of air per minute. Particulate material is trapped on an 8.5” x 11” quartz fiber filter. The particulates include dust, pollen, diesel fuel by-products, particulate metal, etc. The filters are pre-weighed at a remote laboratory prior to use and weighed again after sampling. The filters are subjected to a chemical digestion process and are analyzed on an inductively coupled plasma spectrometer.

The PUF (polyurethane foam) sampler used for sampling semi-volatile organic compounds is a timed sampler. The sampler is calibrated to collect 198 to 242 liters (L) of air per minute. A multi-layer cartridge is prepared which collects both the particulate fraction and the volatile fraction of this group of compounds. The plug, filter and absorbent are extracted at a remote laboratory and until the fourth quarter were analyzed using a gas chromatograph with Electron Capture Detector. As of the fourth quarter of 2009, the labortory analysis method changed to gas chromatography.

The canister sampler used for sampling volatile organic compounds is a timed sampler. A SUMMA® polished canister is evacuated to a near-perfect vacuum and attached to a sampler with a pump controlled by a timer. The canister is filled to greater than 10 psig. The canister is 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 attached to a pump to allow approximately 180 L of air to be sampled. The cartridge is analyzed using High Performance Liquid Chromatography (HPLC). A 24-hour integrated carbonyl sample is taken every 6 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, South DeKalb monitors the above listed compounds, as well as hexavalent chromium and black carbon. In addition, the South DeKalb metals are sampled on a PM_{10} sampler.

The hexavalent chromium sampler used for sampling Cr+6 is a timed sampler. Samples are collected at a flow rate of 15 liters of air per minute using a 37 mm diameter substrate of bicarbonate impregnated cellulose. The filter is controlled by an auto cover which remains closed until sampling, and fully exposes the filter when the sampler is running. The sample is analyzed using the modified California Air Resources Board (CARB) SOP 039. The filters are extracted in deionized water via sonication, which is analzyed by ion chromatography. Cr+6 is separated through a column, forming a complex with diphenylcarbohydrazide. Dianex Peaknet chromatography software is used to determine the peak analysis.

The aethalometer is a continuous sampler used for sampling black and organic carbon. Operating at 60 watts / 110V AC, the aethalometer uses quartz tape to perform an optical analysis to determine the concentration of carbon particles passing through an air stream. The analysis is conducted using spectrophotometry, measuring the wavelength of the light energy absorbed and plotting the results on the site computer.

The PM_{10} sampler used for sampling toxic metal particles less than or equal to 10 microns in diameter is a timed sampler. Collecting 1020 to 1240 liters of air per minute, the sampler uses a 8.5” x 11” quartz glass fiber filter to trap particulate matter. 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 2009

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

After three consecutive years of drought, conditions in January hinted that more of the same was in store for the dry region (Table 4 and Table 5). Rainfall deficits ranged from -1.99 inches in Athens to -3.66 inches in Macon. In February, the severe weather season began early, with two severe thunderstorm events occurring on the 18th and 27-28th. However, precipitation totals were again below average in Athens (-0.72"), Atlanta (-0.98"), and Macon (-2.23"). Nevertheless, record rainfall in Columbus on the last day of the month, along with the fifth wettest February 28th in Atlanta, established a drought-reversing trend for the next several months. The first heavy snowfall in seven years occurred in March, with a daily and monthly record set in Columbus of 6.5". Surprisingly, this heavy snow event stretched from Columbus to Athens and was accompanied by thunderstorms through its duration. Two more heavy precipitation events during mid and late March contributed to monthly surpluses in all four cities. With all the cloud cover and precipitation, temperatures averaged near or within a degree above normal for all four locations. Plentiful rainfall continued over the next two months, as April totals exceeded the average in all four cities. Ample precipitation continued in May, as Atlanta, Columbus, and Macon all posted wetter than average totals.

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

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

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

Table 4: Temperature and Rainfall Statistics for Select Georgia Cities in 2009

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

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

Table 5: Comparison of Monthly Rainfall Amounts for 2009 and the 30 Year Average for Select Cities in Georgia

Extreme weather occurrences for 2009 continued during September. A persistent low-pressure system located over the lower Mississippi Valley brought a week with prolonged periods of heavy rain (Figure 67). This resulted in an 8-day period from the 14th through the 22nd, which produced many rainfall totals in excess of ten inches across north and central GA, including 18.62 inches in Tucker (Table 6, Figure 68). The epic flood which resulted, set or broke several high water marks in the local watersheds that dated back to 1919. This historic event saw the Sweetwater Creek Basin rise to the 500-year flood level.

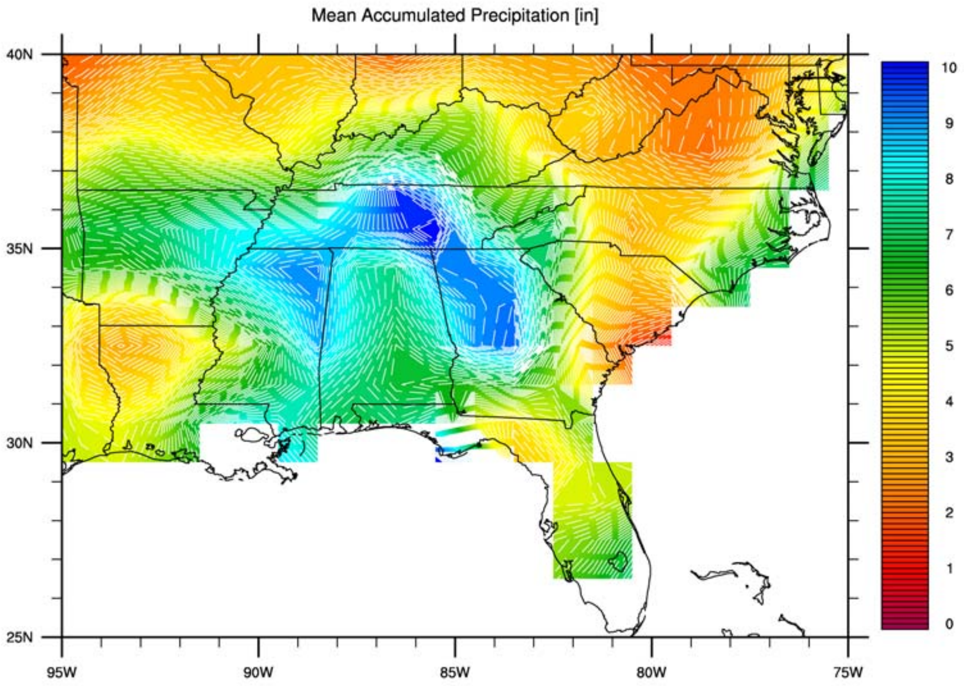


Figure 67: NCEP/NCAR/GPCC Composite Mean Accumulated Precipitation for September 2009

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

Table 6: Rainfall Accumulations from the EPD Meteorological Network for 14-22 September 2009

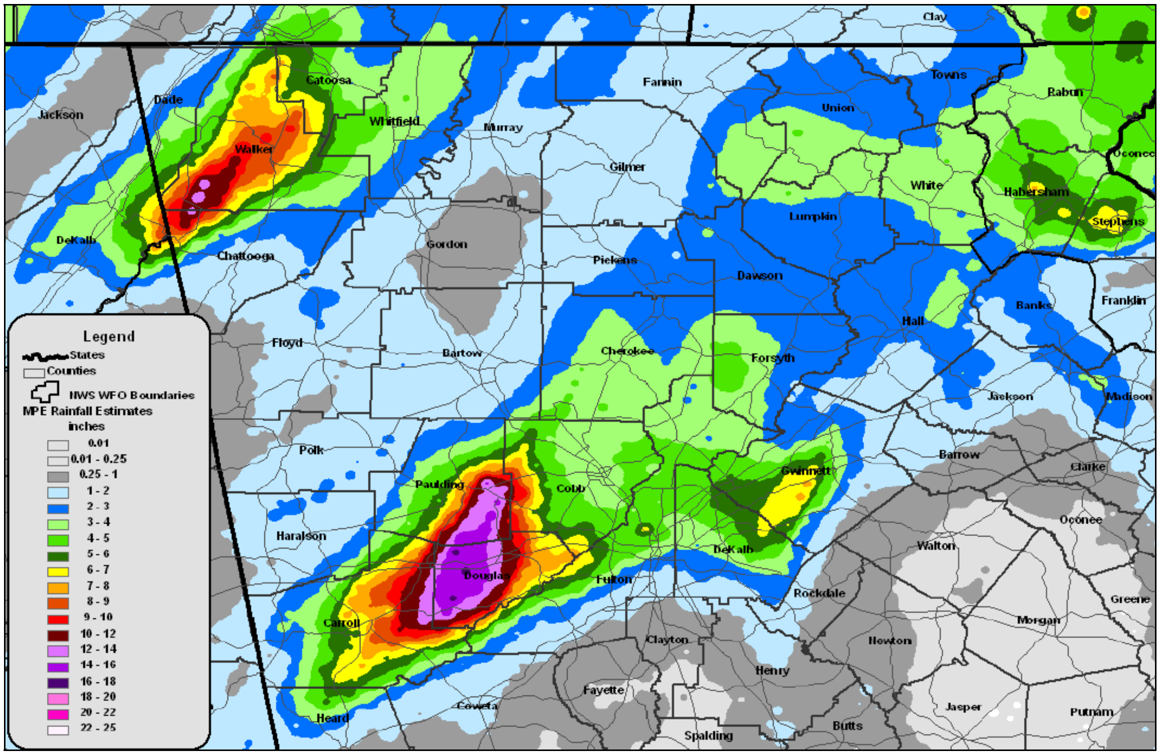
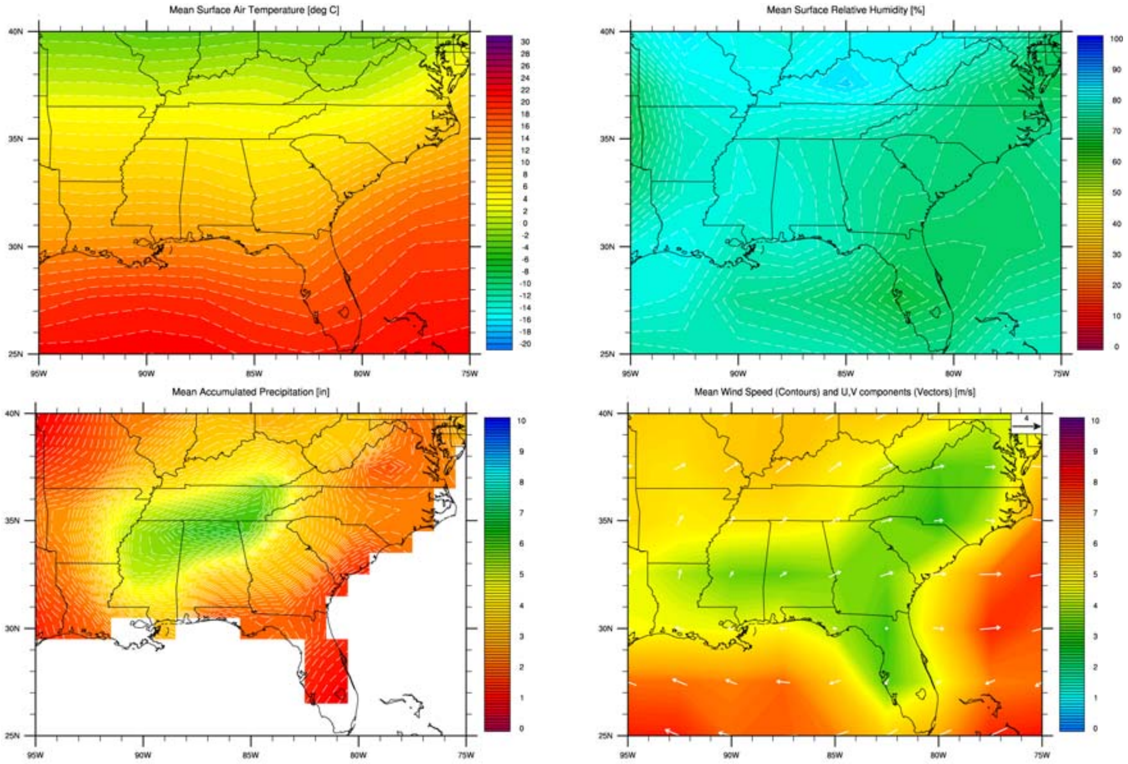


Figure 68: Southeast River Forecast Center 24 hour Multisensor Rainfall Estimates for 8AM September 20 to 8AM September 21, 2009

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

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

Seasonal composite means across the southeast for 2009 are seen in Figure 69 through Figure 72. The images depict NCEP/NCAR reanalysis data for the following surface meteorological parameters: air temperature, relative humidity, accumulated precipitation, wind speed and wind direction. The averages are in agreement with the climatological assessment for 2009 from the National Weather Service at Peachtree City.

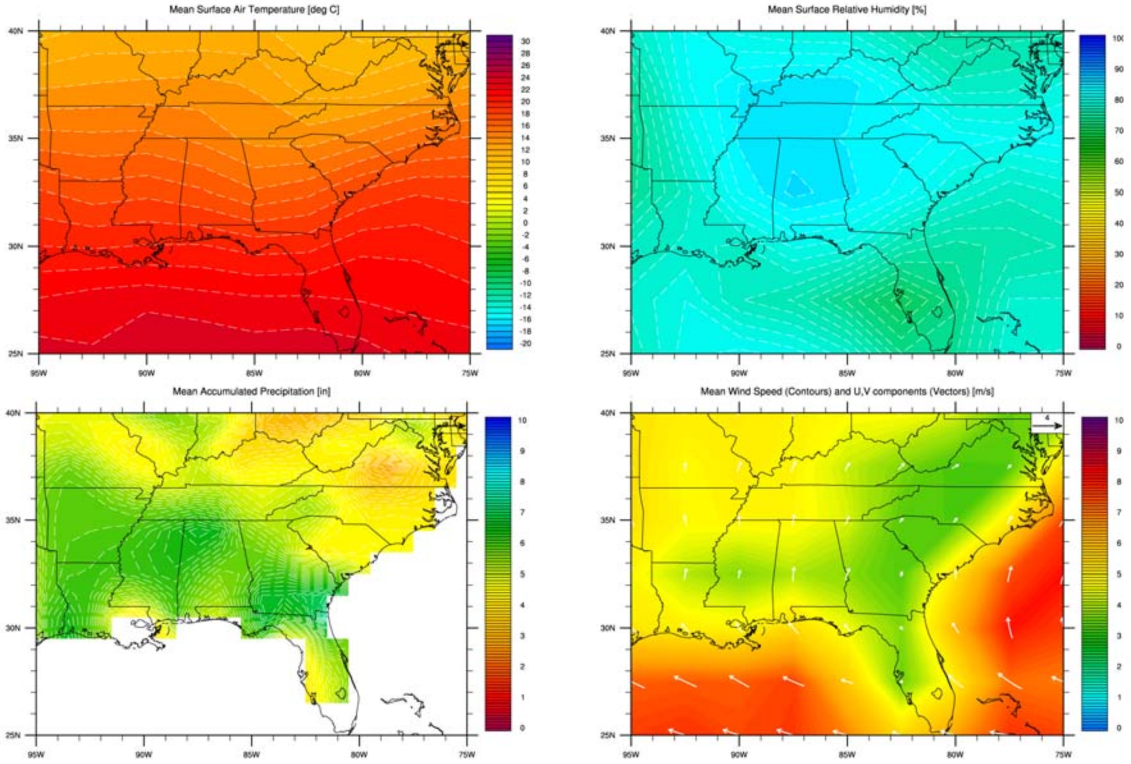

Mean Surface Air Temperature [deg C]

Mean Surface Relative Humidity [%]

Mean Accumulated Precipitation [in]

Mean Wind Speed (Contours) and U,V components (Vectors) [m/s]

Figure 69: NCEP/NCAR Composite Means for Surface a) Air Temperature, b) Relative Humidity, c) Accumulated Precipitation, and d) Wind Speed and Direction for December 2008- February 2009


Mean Surface Air Temperature [deg C]

Mean Surface Relative Humidity [%]

Mean Accumulated Precipitation [in]

Mean Wind Speed (Contours) and U,V components (Vectors) [m/s]

Figure 70: NCEP/NCAR Composite Means for Surface a) Air Temperature, b) Relative Humidity, c) Accumulated Precipitation, and d) Wind Speed and Direction for March-May 2009

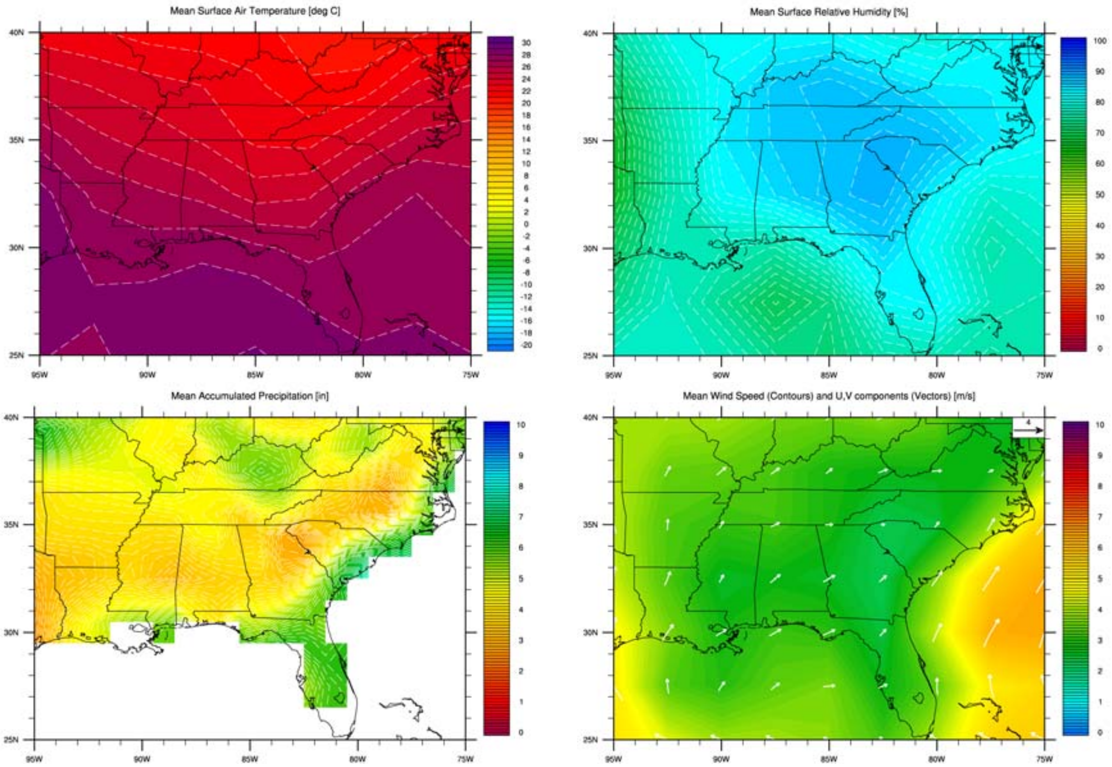


Figure 71: NCEP/NCAR Composite Means for Surface a) Air Temperature, b) Relative Humidity, c) Accumulated Precipitation, and d) Wind Speed and Direction for June-August 2009

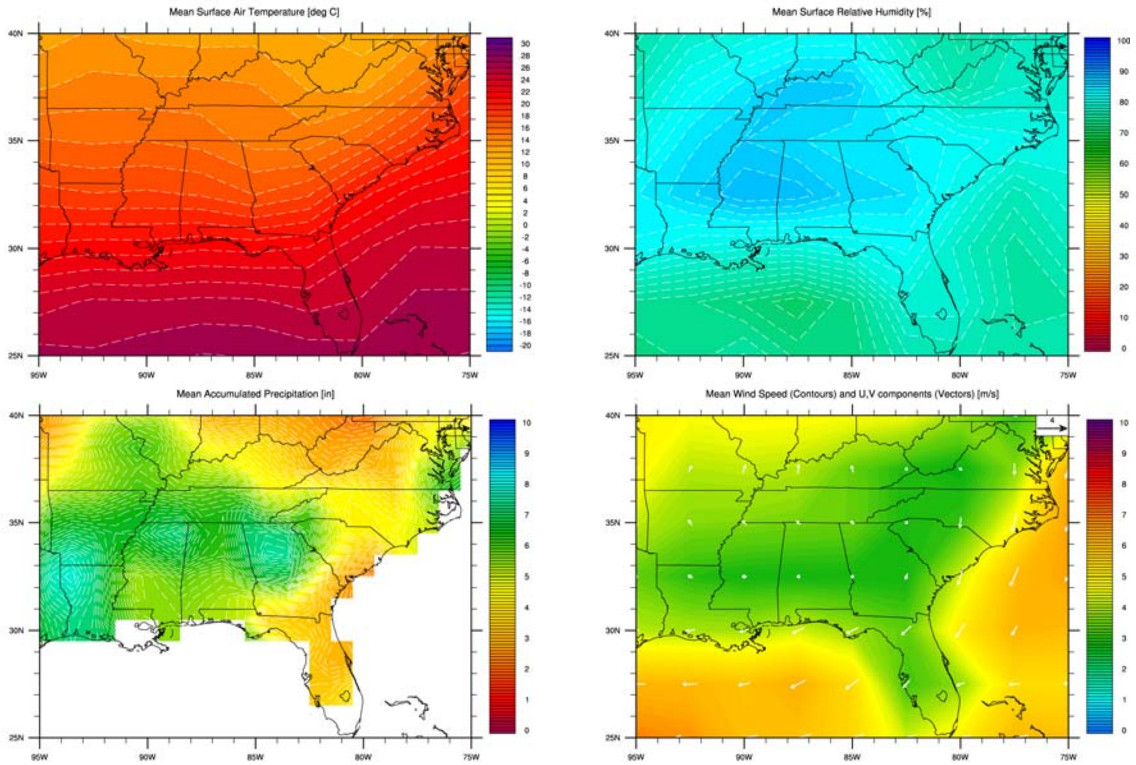


Figure 72: NCEP/NCAR Composite Means for Surface a) Air Temperature, b) Relative Humidity, c) Accumulated Precipitation, and d) Wind Speed and Direction for September-November 2009

SUMMARY OF METEOROLOGICAL MEASUREMENTS FOR 2009

A complete suite of meteorological instrumentation is used to characterize meteorological conditions around metropolitan Atlanta. The basic surface meteorological parameters measured at the Photochemical Assessment Monitoring Sites (PAMS) are shown in Table 7. The PAMS sites are Conyers, South DeKalb, Tucker, and Yorkville. South DeKalb is considered an NCORE and a NATTS site as well. The Tucker site primarily records meteorological data for possible future modeling or comparative purposes. All PAMS sensors measure hourly-averaged scalar wind speed and vector-averaged wind direction at the 10-meter level, and hourly-averaged surface temperature, relative humidity and barometric pressure at the 2-meter level. Several sites include instruments to record hourly-averaged precipitation, global solar radiation and total ultraviolet radiation. The standard deviation of the wind direction is also computed at the NCORE site (South DeKalb). Other surface meteorological measurements were made across the state in 2009 and are also shown in Table 7*.* All the meteorological sites are mapped in Figure 73. Upper air meteorological observations (primarily wind speed and direction) are made at Peachtree City using a PA5-LR SODAR system.

Statewide Monitoring Sites	Wind Speed (m/s)	Wind Direction (deg)	Sigth (deg)	Relative Humidity (%)	Solar Radiation (W/m2)	Total Ultraviolet Radiation (W/m2)	Barometric Pressure (mb)	Precip. (in)	Temp. (ºC)
Conyers	✓	✓		✓	✓	✓	✓	✓	✓
South Dekalb	✓	✓	✓	✓			✓	✓	✓
Tucker	✓	✓		✓	✓	✓	✓	✓	✓
Yorkville	✓	✓		✓	✓	✓	✓	✓	✓
Fort Mountain	✓	✓		✓					✓
Brunswick	✓	✓							
Confederate Avenue	✓	✓							
Dawsonville	✓	✓							
Savannah E. President	✓	✓							
Macon SE	✓	✓							
Douglasville	✓	✓							
Fayetteville*	✓	✓							
Newnan	✓	✓							
Savannah L&A	✓	✓							
Augusta	✓	✓		✓			✓	✓	✓
Macon West*	✓	✓		✓					✓
Columbus	✓	✓		✓			✓	✓	✓
Evans	✓	✓		✓					✓
Cartersville	✓	✓							

*Temporarily discontinued

Table 7: Meteorological Parameters Measured, 2009

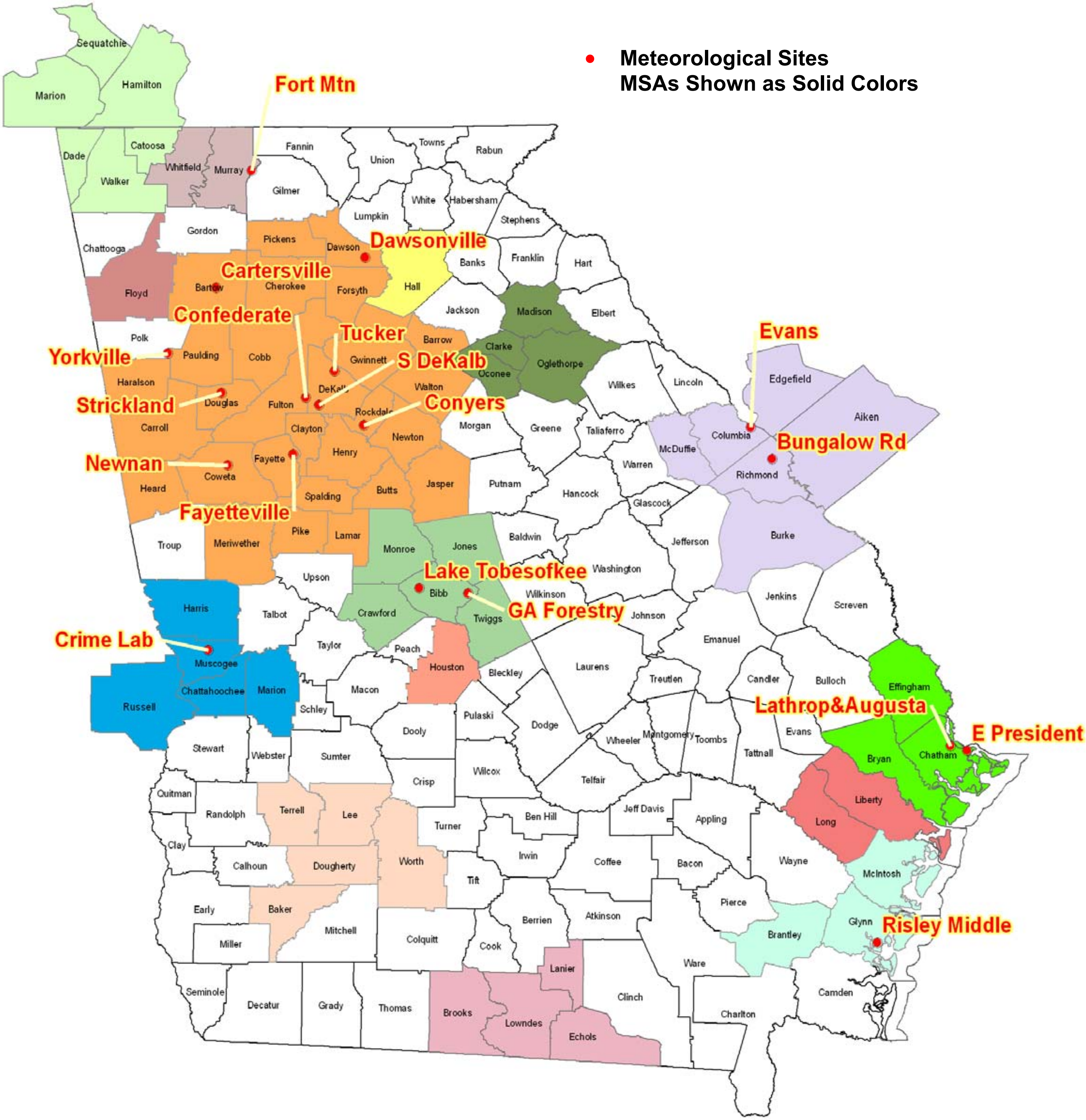
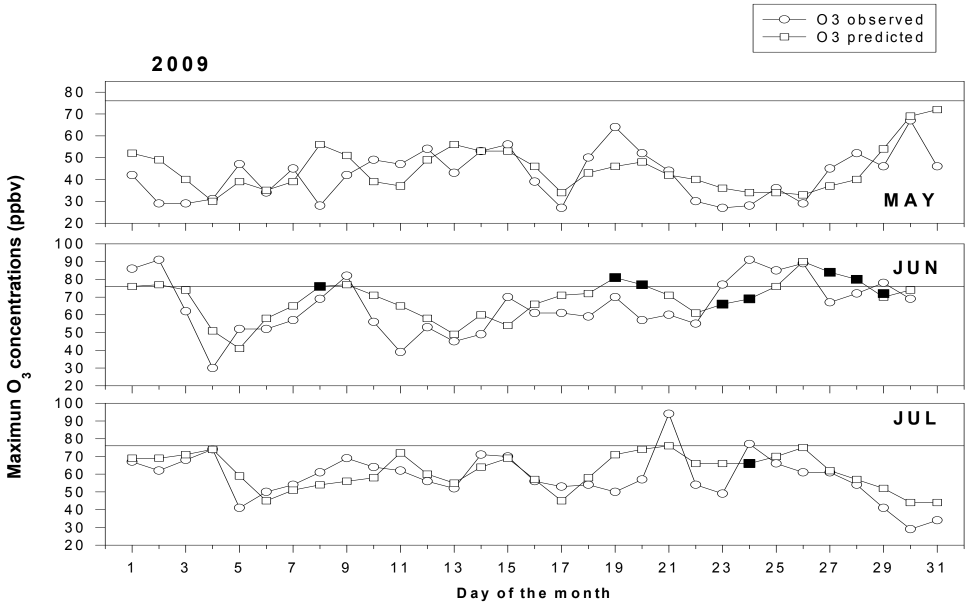


Figure 73: Meteorological Site Map

OZONE AND $PM_{2.5}$ FORECASTING AND DATA ANALYSIS

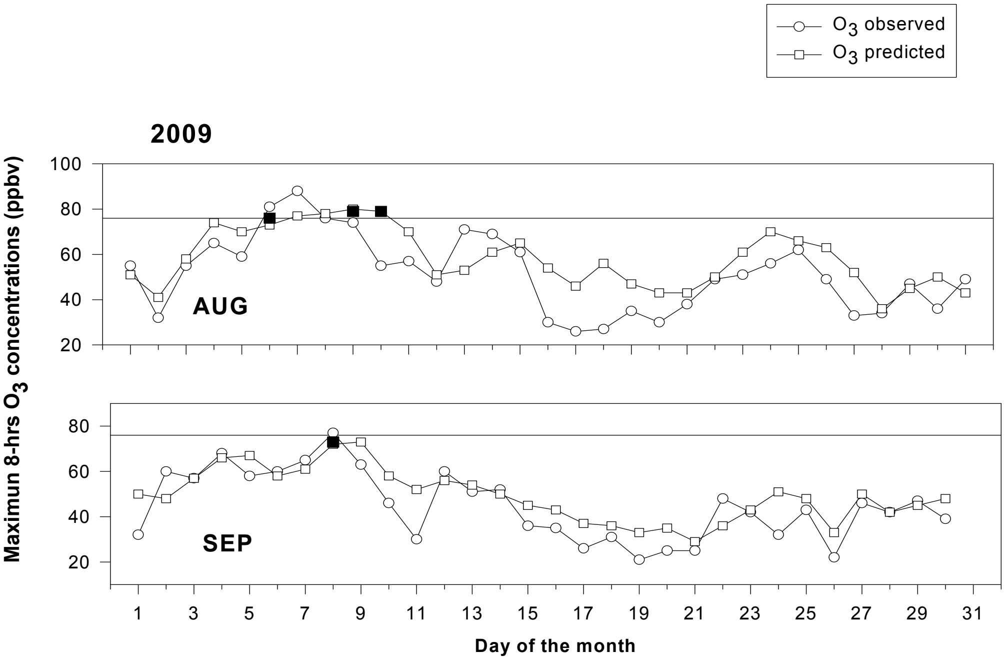
Each day a team of meteorologists from Georgia Department of Natural Resources, Environmental Protection Division (EPD) and Georgia Tech scientists meet at 1:30 EST to issue an air quality forecast for the Atlanta, Macon, Columbus, and Augusta metropolitan areas. The air quality forecast is then relayed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

Metropolitan Atlanta had 14 ozone violations during ozone season (May through September) in 2009, while Macon had 2 ozone violations, and Augusta did not exceed the ozone standard at all. This was considered to be a below average ozone season for Metro Atlanta. Monthly time series plots of ozone predictions and observations for Metro Atlanta during the 2009 ozone season are shown in Figure 74 and Figure 75. The dark squares shown in the figure indicate days where an ozone violation occurred, but was not forecasted, or did not occur and was forecasted. Overall forecasting performance for the team for the 2009 ozone season was 91.5% on an event to a non-event basis (binary error) and 73.9% on an AQI basis (color category). Most violations (8 out of the 14) occurred during June, with the highest concentration days occurring during a heat wave in late June. During this period, the Eastern-central part of the United States was dominated by high pressure, which provided a stable air mass with clear skies and low moisture, leading to the breakout of ozone violations. As shown in the figure, there were no major ozone episodes during May, August, or September for Metropolitan Atlanta. This could partly be attributed to the fact that return flow from the Gulf of Mexico allowed for moist, unstable conditions for much of the summer season. The synoptic regime for summer 2009 was somewhat abnormal. The Atlantic basin had only 11 named tropical systems, so tropical activity influencing the SE U.S. was not a major factor in keeping ozone levels from being elevated for extended periods. Parts of Metropolitan Atlanta did experience major flash flooding during the month of September, as reflected in the figure by the extended period of low ozone during the middle of the month, due to training of convective cells and high Gulf moisture fetch across the area.



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

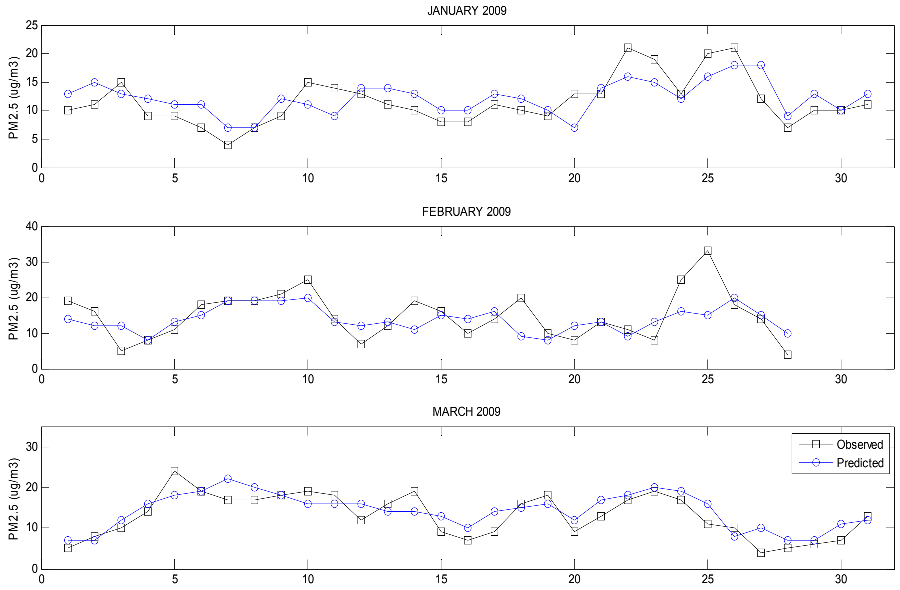
Figure 74: Monthly Time Series of Ozone Predictions and Observations for Metro Atlanta During 2008 Ozone Season (May-July)



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

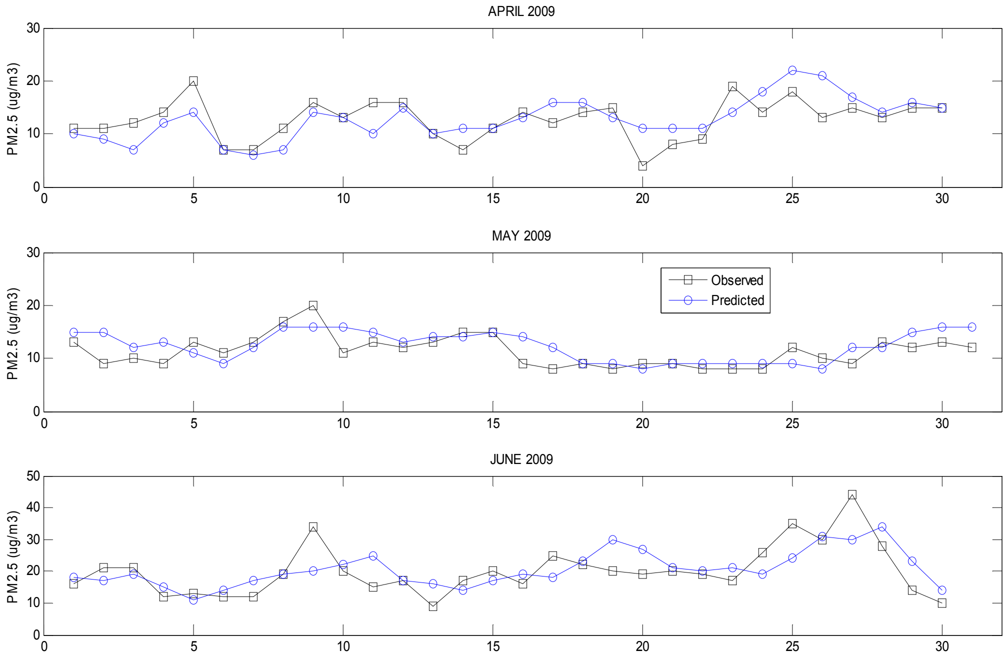
Figure 75: Monthly Time Series of Ozone Predictions and Observations for Metro Atlanta During 2008 Ozone Season (August-September)

Overall performance for $PM_{2.5}$ forecasting in 2009 for Metro Atlanta was 79.2% on an AQI basis. A total of four $PM_{2.5}$ violations were observed in Metropolitan Atlanta in 2009. Athens recorded one $PM_{2.5}$ violation, Macon had two violations, north Georgia mountains had one violation, while south central Georgia had five $PM_{2.5}$ violations in 2009. Monthly time series plots of $PM_{2.5}$ predictions and observations for Metropolitan Atlanta during 2009 (24-hour averages) are shown below in Figure 76 through Figure 79. Some seasonal variability in $PM_{2.5}$ does exist, as shown in the figure; however, June, July and September show periods of elevated $PM_{2.5}$, relative to other seasons. This enhancement can most likely be attributed to limited early morning mixing depth, and to the moist and unstable conditions (along with isolated convection) in the tropical air mass residing over the southeast. The elevated readings shown in the winter month of February can partly be attributed to local and regional fire activity.



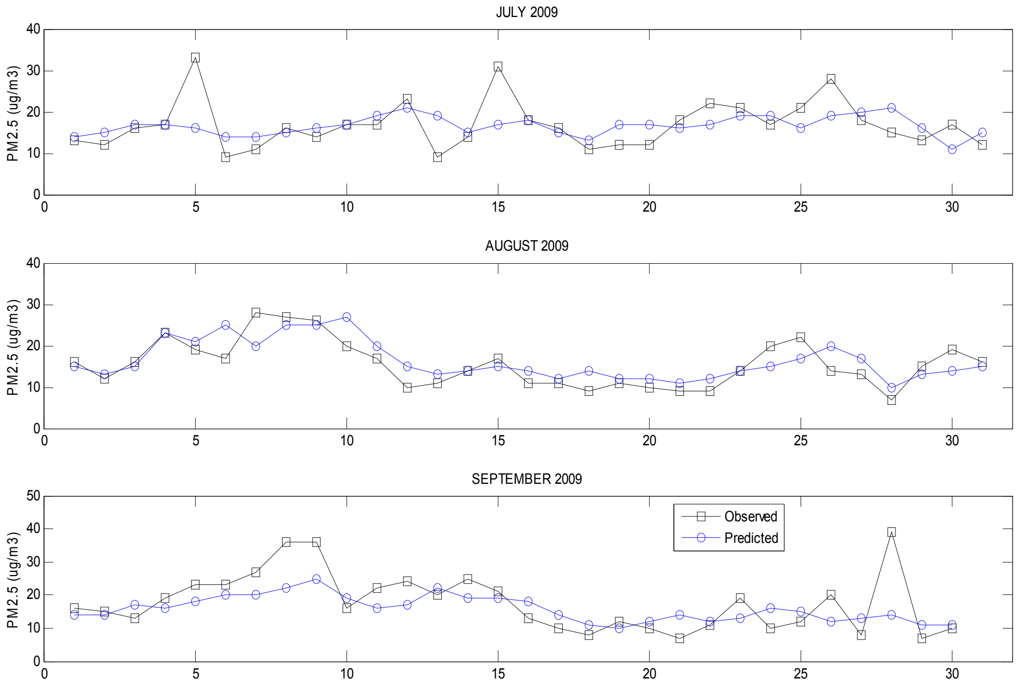
(Data compiled by Dr. Carlos Cardelino of Georgia Tech)

Figure 76: Monthly Times Series Plots of $PM_{2.5}$ Predictions and Observations for Metro Atlanta During 2008 (January-March)



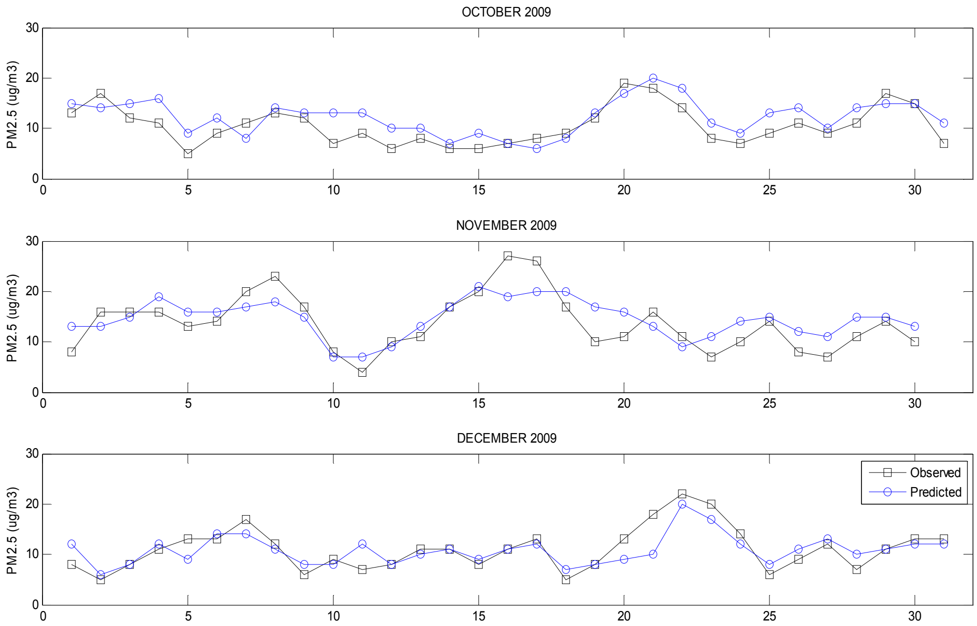
(Data compiled by Dr. Carlos Cardelino of Georgia Tech)

Figure 77: Monthly Times Series Plots of $PM_{2.5}$ Predictions and Observations for Metro Atlanta During 2008 (April-June)



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

Figure 78: Monthly Times Series Plots of PM$_{2.5}$ Predictions and Observations for Metro Atlanta During 2009 (July-September)



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

Figure 79: Monthly Times Series Plots of PM$_{2.5}$ Predictions and Observations for Metro Atlanta During 2009 (October-December)

SELECT METEOROLOGICAL AND AIR QUALITY STUDIES FOR 2009

Several smoke/fire events affected the southeast in 2009, elevating the $PM_{2.5}$ around the Atlanta area. One such event took place on June 10th with visible satellite imagery (Figure 80) showing an area of haze over the southeast, also highlighted by a Google satellite overlay image (Figure 81). Elevated $PM_{2.5}$ readings were recorded around the metro area, with hourly values at the Confederate Avenue site reaching as high as 41.1 $\mu g/m^3$. Widespread fire activity was also observed across the Midwest (Figure 82) on April 24th, 2009, with trajectories showing upper level transport of smoke into the southeast (Figure 83).

There were other parameters that were also in place to cause elevated ozone values across the region. On July 21st, 2009 Atlanta experienced a Code Orange day for ozone, with the South DeKalb air monitoring station reading a maximum 8-hour average concentration of 84 ppb at 7:00 pm that day. On both July 20th and July 22nd maximum 8-hour average concentrations were only in the green category, with South DeKalb reading 51 ppb on July 20th and 53 ppb on July 22nd. The July 21st event was dependent on two specific contributing factors: relative humidity and recirculation.

Humidity levels have a large effect on ozone concentrations, and how much moisture is in the air can sometimes be the difference between a good air quality day and a Code Orange ozone event. On July 20th, a stationary front was strung across southern Georgia, even as a dry pocket of air began to move in from the northwest. However, due to the sea breeze circulation along the coast, the stationary front pushed back into central Georgia in the afternoon, and the humidity rose for the latter half of the day. The temperature reached 81 degrees F, and the dewpoint reached 51 degrees, giving a relative humidity of 35%. The winds for the 20th were steady from the north, at between 5 and 10 knots. On the 21st, the stationary front had broken down and the dry pocket of air had moved overtop of north and central Georgia. The temperature that day went up to 85 degrees F, while the dewpoint again reached 51 degrees, giving a relative humidity of 31%. In addition, by mid-morning the winds had shifted, swinging around to blow from the east and southeast, then around from the west a few hours later, before going stagnant for the rest of the day. This caused a recirculation of pollution and ozone precursors back onto Atlanta, which coupled with the lower humidity, caused ozone levels to climb very quickly into the orange category. Values maxed out at the 8-hour average of 84 ppb. The next day, on the 22nd, the dry pocket of air had been pushed off to the southeast by an approaching cold front. The maximum temperature reached 83 degrees F, with a dewpoint of 53 degrees, bringing the relative humidity back up to 35%, and the winds had become fairly steady from the south and southwest, between 5 and 10 knots.

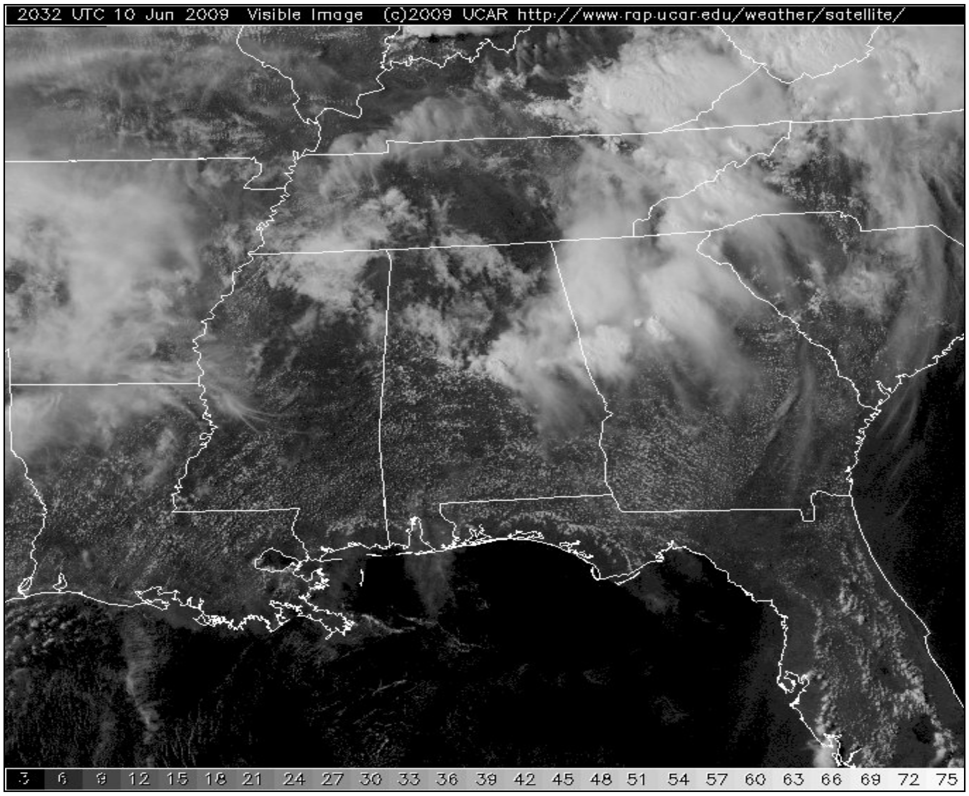


Figure 80: Visible Satellite Imagery of the Southeast U.S. on June 10, 2000

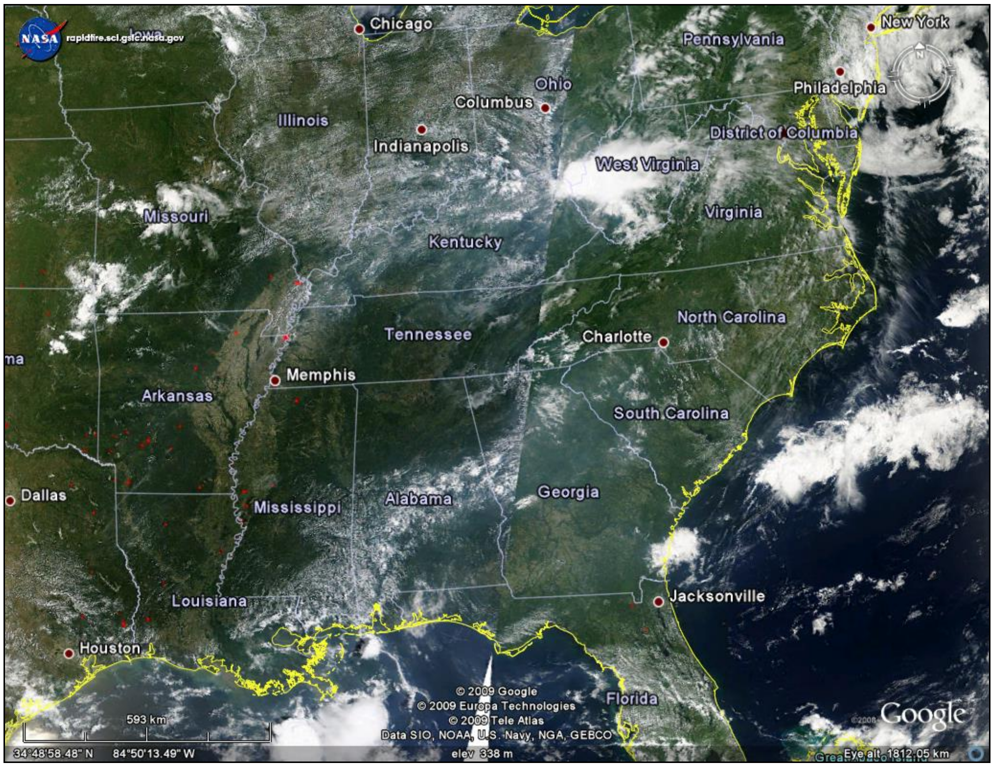


Figure 81: NASA Satellite Imagery Overlaid on Google Application for June 10, 2009

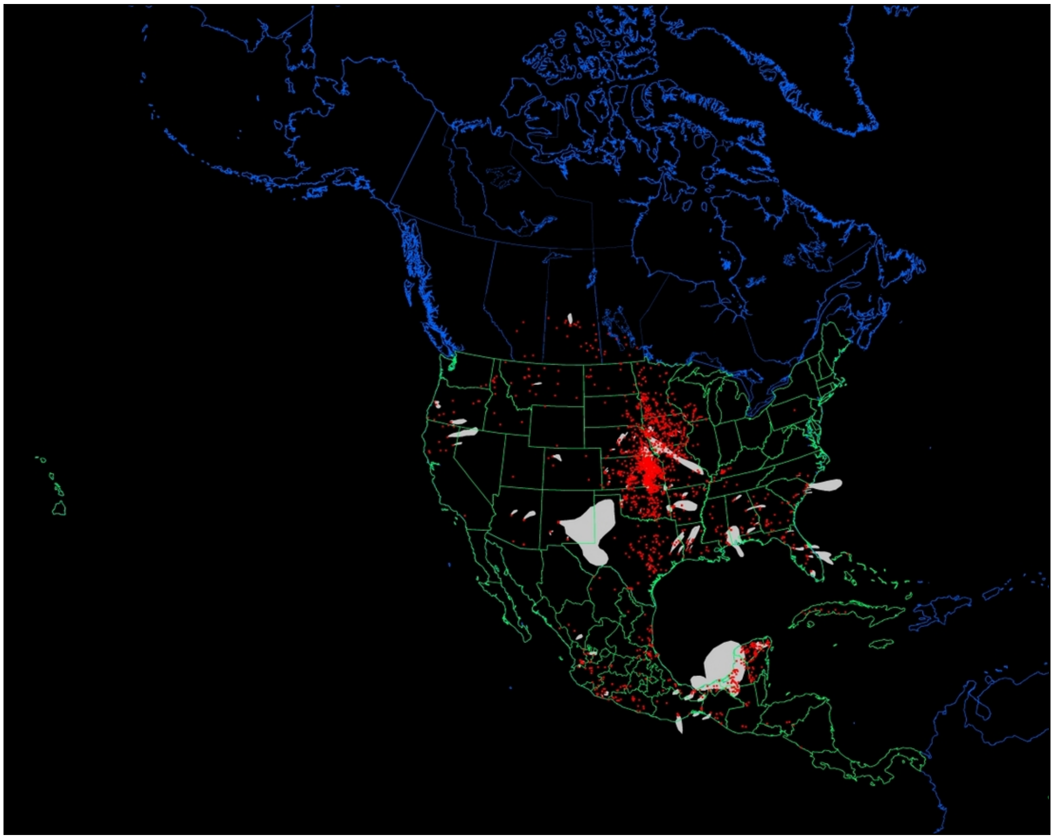


Figure 82: Hazard Mapping System Fire and Smoke Product for April 24, 2009

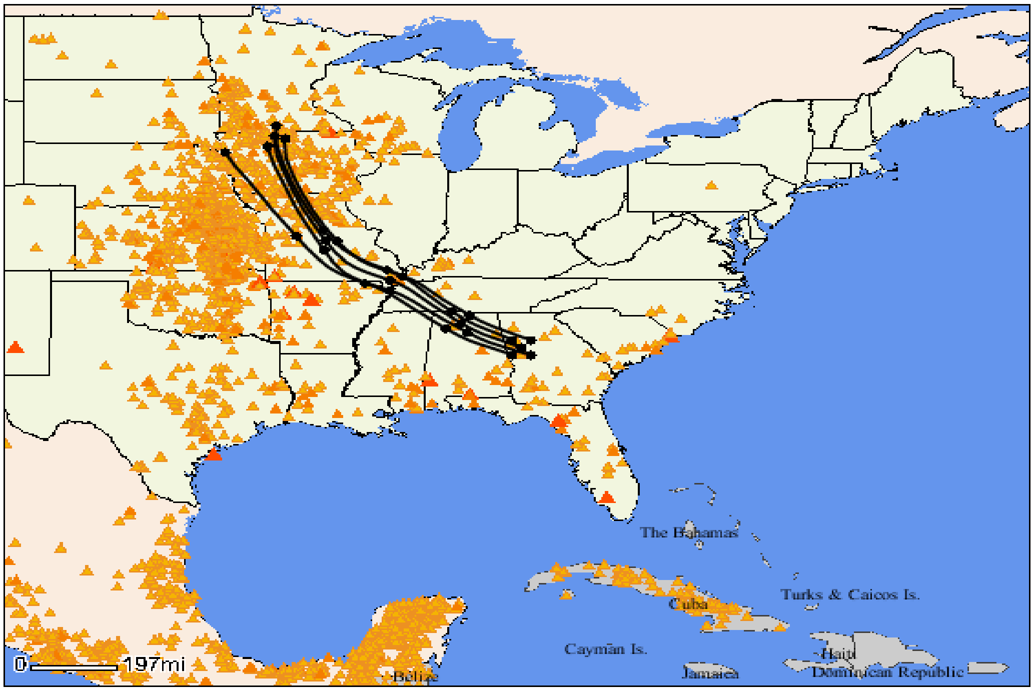


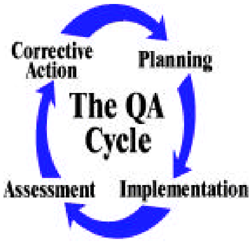
Figure 83: Smartfire Smoke Upper Level Trajectory and Fire Information for April 24, 2009

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 2009 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 on quality information on a large number of pollutants and for a vast air monitoring network. The Ambient Air Monitoring Program, directed by federal law, conducts various monitoring projects in support of the Georgia Department of Natural Resources (GA DNR), Georgia Environmental Protection Division (GA EPD), and the United States Environmental Protection Agency (U.S. EPA). The monitoring projects include gaseous criteria and non-criteria pollutants, particulate matter, air toxics, non-methane hydrocarbons, and meteorological parameters. 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 8 illustrates the types of performance audits currently performed by the QA program in 2009. 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.

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

Table 8: Audits Performed for Each Air Monitoring Program in 2009

QUALITY CONTROL AND QUALITY ASSESSMENT

The Quality Assurance Program supports all ambient monitoring programs undertaken by Georgia EPD, which in 2009 includes gaseous pollutants, particulate pollutants, air toxics contaminants, non-methane hydrocarbons and meteorological sensors run by the Ambient Monitoring Program. In 2009, 61 air monitoring sites operated in Georgia. Appendix E 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., toxics) 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 Air Sampling Network's (GASN) Quality Assurance Program is outlined in a five-volume *Quality Assurance Manual*. The volumes, listed below, guide the operation of the quality assurance programs used by the GASN.

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-five percent of the gaseous pollutant instruments audited in 2009 were found to be operating within the Georgia Ambient Air Monitoring control limits (±15%). The tables below summarize the 2009 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).

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	49	2.88	6.28	-5.68	-10.56	-0.80	4	0.12	-7.08	7.32	93
13-121-0048	Atlanta - Georgia Tech	6	3.31	2.28	-0.19	-3.87	3.50	4	2.83	-5.19	10.85	96
13-223-0003	Yorkville - King's Farm	50	1.78	6.92	-6.56	-9.57	-3.54	4	-0.68	-12.09	10.74	97
13-247-0001	Conyers - Monastery	49	4.85	5.82	-4.67	-12.90	3.56	4	-4.86	-13.45	3.72	95
Georgia Ambient Air Monitoring Program		154	3.17	6.19	-5.43	-11.15	0.29	16	-0.65	-9.60	8.30	95.3
95% LPL: 95% Lower Probability Limit			95% UPL: 95% Upper Probability Limit									

Table 9: NO Data Quality Assessment

NO2 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	49	2.86	2.82	1.62	-3.23	6.47	4	-2.61	-6.34	1.11	90
13-121-0048	Atlanta - Georgia Tech	6	5.53	1.98	0.96	-5.19	7.11	4	1.18	-4.49	6.86	96
13-223-0003	Yorkville - King's Farm	50	2.32	1.98	1.24	-2.71	5.18	4	-8.08	-17.93	1.76	94
13-247-0001	Conyers - Monastery	48	6.95	5.92	1.29	-10.48	13.06	4	7.38	-1.53	16.30	95
Georgia Ambient Air Monitoring Program		153	4.07	3.49	1.36	-6.23	8.96	16	-0.53	-7.99	6.92	93.8
95% LPL: 95% Lower Probability Limit			95% UPL: 95% Upper Probability Limit									

Table 10: NO_2 Data Quality Assessment

NOx 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	49	3.10	4.82	-4.10	-9.36	1.15	4	-0.27	-6.73	6.19	93
13-121-0048	Atlanta - Georgia Tech	6	5.06	3.56	0.37	-5.27	6.00	4	-1.29	-13.81	11.23	96
13-223-0003	Yorkville - King's Farm	50	1.86	5.79	-5.40	-8.57	-2.24	4	-0.72	-12.00	10.56	97
13-247-0001	Conyers - Monastery	49	4.28	3.56	-1.99	-9.25	5.26	4	-5.19	-13.06	2.68	92
Georgia Ambient Air Monitoring Program		154	3.15	4.68	-3.68	-9.16	1.80	16	-1.87	-11.71	7.98	94.5
95% LPL: 95% Lower Probability Limit			95% UPL: 95% Upper Probability Limit									

Table 11: NO_X 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 (%)	
13-121-0048	Atlanta - Georgia Tech	52	5.12	4.01	-0.05	0.00	8.67	9	-4.23	-9.31	0.85	97
13-223-0003	Yorkville - King's Farm	54	4.89	4.89	2.81	-5.35	11.37	6	0.00	-2.83	2.83	90
Georgia Ambient Air Monitoring Program		106	5.00	4.46	1.40	-7.14	9.94	15	-2.54	-6.89	1.81	94
95% LPL: 95% Lower Probability Limit			95% UPL: 95% Upper Probability Limit									

Table 12: CO Data Quality Assessment

SO2 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	43	3.46	3.19	2.07	-3.73	7.87	6	-5.99	-10.61	-1.37	91
13-051-0021	Savannah - E President St.	51	5.55	7.41	5.82	-3.62	15.26	3	3.14	1.97	4.32	98
13-051-1002	Savannah - L & A	50	2.35	7.38	6.90	2.90	10.89	3	-3.30	-4.08	-2.53	95
13-215-0008	Columbus Airport	47	3.52	7.70	6.96	1.01	12.91	3	-6.78	-7.41	-6.14	92
13-115-0003	Rome - Coosa Elementary	39	1.79	3.39	2.95	-0.03	5.93	6	0.77	-0.55	2.08	98
13-121-0048	Atlanta - Georgia Tech	15	2.37	3.81	3.00	-0.46	6.46	3	-2.11	-6.31	2.09	96
13-121-0055	Atlanta - Confederate Ave.	51	1.85	3.66	3.26	0.12	6.41	3	-6.63	-10.88	-2.37	95
13-127-0006	Brunswick - Risley School	51	3.46	4.99	3.97	-1.92	9.85	3	-6.42	-11.69	-1.15	96
Georgia Ambient Air Monitoring Program		347	3.14	5.41	4.57	-1.37	10.51	30	-3.25	-6.61	0.10	96.3
95% LPL: 95% Lower Probability Limit			95% UPL: 95% Upper Probability Limit									

Table 13: SO_2 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	21	2.09	1.45	0.66	-2.57	3.89	3	-2.19	-3.24	-1.15	98
13-051-0021	Savannah - East President St.	32	1.85	1.94	-1.24	-4.25	1.78	3	-1.89	-4.20	0.42	98
13-055-0001	Summerville - DNR Fish Hatchery	35	1.36	0.94	0.39	-1.84	2.63	3	1.43	-0.53	3.38	99
13-059-0002	Athens - Fire Station 7	38	1.06	1.07	0.82	-0.93	2.58	3	0.77	-2.94	4.47	99
13-067-0003	Kennesaw - Georgia National Guard	36	0.77	0.58	0.24	-1.03	1.52	3	2.19	1.14	3.24	98
13-073-0001	Evans - Riverside Park	36	2.50	2.25	-0.76	-4.90	3.35	3	0.83	-2.00	3.66	95
13-077-0002	Newnan - University of West Georgia	34	1.56	1.72	1.13	-1.44	3.69	3	3.79	1.47	6.12	94
13-085-0001	Dawsonville - Georgia Forestry	37	1.47	2.03	1.63	-0.79	4.09	3	1.12	-0.96	3.19	93
13-089-0002	Decatur - South DeKalb	49	2.08	1.94	0.67	-2.51	4.55	3	-0.24	-2.03	1.55	95
13-097-0004	Douglasville - West Strickland Street	37	0.38	2.28	2.19	1.57	2.82	3	2.37	1.92	2.82	94
13-121-0055	Atlanta - Confederate Ave.	35	1.34	1.08	0.45	-1.75	5.53	3	4.32	3.08	5.56	95
13-127-0006	Brunswick - Risley School	30	3.76	2.97	-0.56	-6.65	2.30	3	3.38	0.62	6.13	96
13-135-0002	Lawrenceville - Gwinnett Tech	37	0.96	0.97	0.70	-0.89	1.84	3	4.14	2.69	5.60	97
13-151-0002	McDonough - County Extension Office	34	1.18	0.51	-0.10	-2.04	1.27	3	1.05	-2.52	4.63	96
13-213-0003	Chatsworth - Fort Mountain	36	0.59	0.44	0.31	-0.67	5.79	3	1.43	-0.53	3.38	97
13-215-0008	Columbus - Airport	38	2.61	2.46	1.46	-2.86	1.01	3	14.32	13.08	15.56	96
13-223-0003	Yorkville - King's Farm	37	1.11	1.20	-0.82	-2.65	2.70	3	2.54	2.39	2.69	97
13-245-0091	Augusta - Bungalow Rd.	39	2.04	1.95	0.77	-2.50	3.89	3	-2.02	-3.66	-0.38	93
13-247-0001	Conyers - Monastery	36	1.23	1.19	0.77	-1.35	3.89	3	3.55	1.01	6.09	98
13-261-1001	Leslie - Union High School	34	1.71	1.80	1.08	-1.73	1.78	3	-1.55	-4.64	1.53	97
Georgia Ambient Air Monitoring Program		711	1.56	1.54	0.52	-2.33	3.37	60	1.97	-0.20	4.14	97.9
95% LPL: 95% Lower Probability Limit		95% UPL: 95% Upper Probability Limit										

Table 14: O_3 Data Quality Assessment

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 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 2009 flow audit results indicate that the flow rates of samplers in the network are almost all within bounds. Approximately ninety-eight percent of the instruments audited in 2009 operated within the Georgia Ambient Monitoring Program's control limits. The 2009 $PM_{2.5}$ 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 are shown in the tables below.

$PM_{2.5}$ Yearly Data Quality Assessment Summary of Integrated Sampling and Analyzation Using Federal Reference Method

Site Code	Site Name	Collocated (µg/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	29	4.97	12	0.01	0.72	+/-0.72	4	-0.16	-1.81	1.49	95
13-021-0012	Macon - Macon SE	NA	NA	13	-0.48	0.69	-0.69	3	-1.66	-4.18	0.85	90
13-051-0017	Savannah - Market Street (Scott)	33	10.27	34	-3.58	8.31	-8.31	4	-0.51	-3.26	2.25	97
13-051-0091	Savannah - Mercer Jr. High School	NA	NA	12	0.17	0.91	+/-0.91	2	-0.88	-6.19	4.43	89
13-059-0001	Athens - Fire Station 7	NA	NA	11	-0.18	0.49	+/-0.49	4	0.77	-5.63	7.18	80
13-063-0091	Forest Park - D.O.T.	NA	NA	14	0.78	1.21	0.00	2	1.00	-0.61	2.61	94
13-067-0003	Kennesaw - National Guard	NA	NA	12	-0.93	1.21	0.00	2	1.37	1.11	1.62	98
13-067-0004	Powder Springs - Macland Aquatic Center	NA	NA	15	0.47	1.07	0.00	2	0.51	-0.07	1.10	95
13-089-0002	Decatur - South DeKalb	43	20.49	14	-0.75	0.90	0.00	5	0.82	-0.17	1.82	90
13-089-2001	Doraville - Health Department	NA	NA	13	-0.17	0.42	0.00	3	-0.34	-1.11	0.44	85
13-095-0007	Albany - Turner Elem. School	NA	NA	5	-6.80	18.36	+/-18.36	3	0.15	-2.02	2.31	87
13-115-0005	Rome - Coosa High School	NA	NA	12	-0.18	0.94	0.00	2	0.97	-0.55	2.50	83
13-121-0032	Atlanta - E. Rivers School	28	6.00	12	0.64	1.01	0.00	4	-0.49	-1.81	0.83	98
13-121-0048	Atlanta - Georgia Tech	NA	NA	12	-0.45	0.74	0.00	2	-1.04	-1.28	-0.80	98
13-127-0006	Brunswick - Risley Middle Sch.	NA	NA	14	1.02	1.20	+1.2	2	-1.01	-1.66	-0.36	80
13-135-0002	Lawrenceville - Gwinnett Tech	NA	NA	13	0.46	0.59	+0.59	3	-0.46	-1.21	0.30	88
13-139-0003	Gainesville - Fair St. Elem. Sch.	NA	NA	12	0.17	0.56	+/-0.56	3	-1.18	-7.96	5.60	85
13-153-0001	Warner Robins - Warner Robins	NA	NA	14	-0.51	0.81	-0.81	2	-0.68	-3.22	1.87	93
13-185-0003	Valdosta - S. L. Mason School	NA	NA	12	-0.29	1.14	+/-1.14	2	0.69	-1.89	3.27	75
13-215-0001	Columbus - Health Department	NA	NA	18	1.79	2.91	+/-2.91	2	-0.24	-1.40	0.92	89
13-215-0008	Columbus - Airport	NA	NA	12	0.04	0.65	+/-0.65	4	2.11	1.41	2.82	92
13-215-0011	Columbus - Cussetta Rd. Sch.	NA	NA	13	2.35	3.70	+/-3.7	2	0.79	-0.06	1.63	95
13-223-0003	Yorkville - King's Farm	NA	NA	13	0.42	0.80	+0.8	2	0.70	-1.57	2.97	95
13-245-0005	Augusta - Med. Col. of GA	29	7.42	12	1.28	2.58	+/-2.58	4	-1.28	-4.62	2.06	95
13-245-0091	Augusta - Bungalow Rd. Sch.	NA	NA	12	2.45	3.04	+3.04	4	-0.53	-5.68	4.62	83
13-295-0002	Rossville - Health Department	NA	NA	12	-1.36	1.84	-1.84	1	-0.60	NA	NA	89
13-303-0001	Sandersville - Health Department	NA	NA	13	2.20	2.73	+2.73	3	-2.14	-4.33	0.04	87
13-319-0001	Gordon - Police Dept	NA	NA	11	0.72	0.90	+0.9	2	-0.71	-1.53	0.10	88
Georgia Ambient Air Monitoring Program		162	10.79	372	-0.06	2.19		78	-0.14	-2.76	1.88	90
95% LPL: 95% Lower Probability Limit								95% UPL: 95% Upper Probability Limit				

Table 15: $PM_{2.5}$ Data Quality Assessment for FRM 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	13	-0.50	0.69	-0.69	3	-1.24	-3.14	0.66	85
13-051-1002	Savannah - W. Lathrop & Augusta Ave.	12	0.17	0.91	+/-0.91	3	2.09	-5.86	10.03	82
13-059-0002	Athens - Fire Station 7	11	-0.18	0.49	+/-0.49	2	3.97	-3.67	11.61	82
13-077-0002	Newnan - University of West Georgia	11	1.23	1.96	+1.96	4	0.62	0.17	1.07	85
13-089-0002	Decatur - South DeKalb	14	0.63	1.04	+/-1.04	3	-0.15	-2.99	2.70	86
13-121-0055	Atlanta - Confederate Ave.	12	0.24	0.50	+0.5	2	-1.45	-1.85	-1.04	80
13-135-0002	Lawrenceville - Gwinnett Tech	12	-0.50	0.61	-0.61	3	-0.46	-1.21	0.30	85
13-151-0002	McDonough - County Extension Office	12	-0.58	1.24	+/-1.24	2	0.24	-0.26	0.74	83
13-215-0008	Columbus - Airport	12	4.52	5.64	+5.64	4	0.27	-1.15	1.70	82
13-223-0003	Yorkville - King's Farm	12	0.42	0.80	+0.8	2	0.70	-1.57	2.97	83
13-245-0091	Augusta - Bungalow Rd. Sch.	9	0.04	0.76	+/-0.76	4	-0.53	-5.68	4.62	83
13-297-0001	Social Circle - DNR Fish Hatchery	10	0.61	1.20	+/-1.2	2	0.76	-2.02	3.55	80
Georgia Ambient Air Monitoring Program		140	0.51	1.33		34	0.31	-3.59	4.50	84
95% LPL: 95% Lower Probability Limit			95% UPL: 95% Upper Probability Limit							

Table 16: $PM_{2.5}$ Data Quality Assessment for Semi-Continuous Samplers

PM_{10} Yearly Data Quality Assessment Summary of 24-Hour Integrated Measurements

Site Code	Site Name	Collocated (µg/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 (%)	
13-021-0007	Macon - Allied Chemical	57	17.08	12	0.23	0.86	+/-0.86	2	-0.66	-1.48	0.17	97
13-051-0014	Savannah - Shuman School	NA	NA	12	-0.64	1.30	-1.3	2	-0.51	NA	NA	92
13-055-0001	Summerville - DNR Fish Hatchery	NA	NA	13	0.31	2.23	+/-2.23	3	-8.02	-32.00	15.96	92
13-089-2001	Doraville - Police Department	NA	NA	13	0.30	0.68	+0.68	1	-1.45	NA	NA	88
13-095-0007	Albany - Turner Elem. School	NA	NA	12	0.20	2.80	+/-2.8	3	-0.43	NA	NA	89
13-115-0005	Rome - Coosa High School	NA	NA	12	-0.26	0.93	+/-0.93	3	-0.35	NA	NA	90
13-121-0032	Atlanta - E. Rivers School	41	14.82	10	0.22	0.63	+0.63	3	-0.50	-3.43	2.43	92
13-115-0005	Brunswick - Arco Pump Station	NA	NA	12	-0.86	2.24	-2.24	2	-0.47	NA	NA	89
13-121-0039	Columbus - Cussetta Rd. Elem. School	NA	NA	13	0.32	1.18	+/-1.18	2	-0.79	-6.50	4.93	91
13-245-0091	Augusta - Bungalow Rd. Elem. School	NA	NA	9	0.17	1.03	+/-1.03	2	1.69	NA	NA	89
13-303-0001	Sandersville - Health Department	NA	NA	12	-0.66	1.35	+/-1.35	3	0.15	NA	NA	90
Georgia Ambient Air Monitoring Program:		98	31.90	130	-0.06	1.40		26	-1.17	-3.40	2.18	93
NA: Not Applicable												
95% LPL: 95% Lower Probability Limit		95% UPL: 95% Upper Probability Limit										

Table 17: PM_{10} Data Quality Assessment of 24-Hour Integrated Samplers

<u>Precision (field)</u>: 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 2009 collocated $PM_{2.5}$ samplers were operated at Augusta Medical College,

Atlanta E. Rivers, Decatur-South DeKalb, Savannah Scott School and Macon Allied. Collocated PM_{10} samplers were operated at Atlanta E. Rivers and Macon Allied. Collocated TSP-Lead samplers were operated at Atlanta DMRC.

Particulate samplers (collocated PM_{10} and TSP) must have mass concentrations greater than or equal to 20 µg/m^3 to be used in data validity calculations. The difference between the mass concentrations must be no greater than 5 µg/m^3. If the mass concentrations are greater than 80 µg/m^3, the difference must be within ±7% of each other. TSP (lead) samplers must have both mass concentrations greater than or equal to 0.15 µg/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 6 µg/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 ±15.

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 2008 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. After samples are collected in the field, laboratory staff has up to 30 days to analyze the $PM_{2.5}$ samples. Filters are visually inspected for pinholes, 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 2009, when samples were analyzed, 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 2009.

QC Checks for Pre-weighed Filters	PM_{10}	$PM_{2.5}$
Total # of sample analyzed	707	5,643
Total # of replicates	43	382
Total % replicated	6.1%	6.4%
Total # out-of-range	0	0

Source: Laboratory Section, Quality Control Report

Table 18: Summary of Unexposed Filter Mass Replicates

QC Checks for Post-weighed Filters	PM_{10}	$PM_{2.5}$
Total # of samples analyzed	679	4,582
Total # of replicates	70	690
Total % replicated	10.3%	15.1%
Total # out-of-range	0	0

Source: Laboratory Section, Quality Control Report

Table 19: Summary of Exposed Filter Mass Replicates

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 (or cartridge) every 12 days over a 24-hour sampling period at each of the network stations. Toxic particulate samples are also 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 carbonyl and polycyclic aromatic hydrocarbons (PAH) compounds (also called semi-volatile organic compounds) 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 typically conducted annually at each site to ensure the accuracy of measuring toxic metals and carbonyl 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 data if an audit is found 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. Precision data for non-continuous toxics particulate samplers are obtained through collocated sampling whereby two identical samplers operate side-by side simultaneously and the same laboratory conducts filter analyses. The collocated toxic sampler located at the Utoy Creek site is intended to represent overall network precision. However, in 2009, the Utoy Creek site did not collect samples. This was one of the sites that was temporarily discontinued as explained earlier, due to funding.

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. Overall, the network is providing precise air toxic contaminants data.

Accuracy (field): The accuracy of air toxic samples is determined by comparing the instrument's flow rate to a certified variable orifice (PM_{10} and TSP), or a calibrated mass flow meter ($PM_{2.5}$ 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 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.

NATTS

There are currently 188 hazardous air pollutants (HAPs), or air toxics, 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 23 stations in the contiguous 48 states, with one in Georgia. 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.

There are 23 sites in the NATTS network. Georgia joined the network with one site established in Decatur at the South DeKalb Monitoring Station. The EPA Region in which the sites are located, the location of the sites (site identifier), whether the site is located in an urban or rural area, and the unique AQS identification code (site code) for all the sites are given in Table 20.

Region	Site Identifier	Type	AQS Site Code
I	Boston-Roxbury, MA	Urban	25-025-0042
I	Chittenden City, VT	Rural	50-007-0007
I	Providence, RI	Urban	44-007-0022
II	Bronx, NY	Urban	36-005-0110
II	Rochester, NY	Urban	36-055-1001
III	Washington, DC	Urban	11-001-0043
IV	Chesterfield, SC	Rural	45-025-0001
IV	Decatur, GA	Urban	13-089-0002
IV	Hazard, KY	Rural	21-193-0003
IV	Hillsborough City, Tampa, FL	Urban	12-057-3002
IV	Pinellas City, Tampa, FL	Urban	12-103-0026
V	Dearborn, MI	Urban	26-163-0033
V	Mayville, WI	Rural	55-027-0007
V	Northbrook, IL	Urban	17-031-4201
VI	Deer Park, TX	Urban	48-201-1039
VI	Harrison County, TX	Rural	48-203-0002
VII	St. Louis, MO	Urban	29-510-0085
VIII	Bountiful, UT	Urban	49-011-0004
VIII	Grand Junction, CO	Rural	08-077-0017, -0018
IX	Phoenix, AZ	Urban	04-013-9997
IX	San Jose, CA	Urban	06-085-0005
X	La Grande, OR	Rural	41-061-0119
X	Seattle, WA	Urban	53-033-0080

Table 20: NATTS Sites with EPA Region Numbers and AQS Site Codes

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”[2]. 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 21 below.

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

Table 21: Measurement Quality Objectives for the NATTS Program

Other compounds have been added to the list of compounds, including hexavalent chromium, acrolein, and polycyclic aromatic hydrocarbons (PAHs). GA EPD collects data to monitor for these compounds as part of the NATTS program, as well as organic carbon, additional carbonyls, and additional volatile organic compounds.

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[2] Quality Assurance Handbook for Air Pollution Measurement System. Volume 1. Principles. EPA-600/R-94/038A, January 1994.

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 22.

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

Table 22: MQO Data Sources for the Georgia NAATS Program

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 23 compounds having the AQS codes given in Table 23. The completeness of the 2009 AQS dataset was assessed for four compounds: benzene, 1,3-butadiene, formaldehyde, and arsenic. The results are shown in Table 24. The presence of 61 concentration values in the database indicates 100 percent completeness, since sampling is to occur every sixth day. Furthermore, the completeness data presented here are composite values for both the primary and collocated sampler at the South DeKalb site. Primary and collocated data are differentiated in AQS by use of parameter occurrence codes (POCs).

Compound Name	AQS Code
Benzene	45201
1,3-Butadiene	43218
Carbon Tetrachloride	43804
Chloroform	43803
1,2-Dibromoethane	43843
1,2-Dichloropropane	43829
1,2-Dichloroethane	43815
Dichloromethane	43802
1,1,2,2-Tetrachloroethane	43818
Tetrachloroethylene	43817
Trichloroethylene	43824
Vinyl Chloride	43860
Cis-1,3-Dichloropropene	43831
Trans-1,3-Dichloropropene	43830
Formaldehyde	43502
Acetaldehyde	43503
Arsenic	82103
Beryllium	82105
Cadmium	82110
Lead	82128
Manganese	82132
Mercury	82142
Nickel	82136

Table 23: 23 Selected HAPs and Their AQS Parameter Codes

	Completeness of Compound by AQS Number and by Name			
	45201	43218	43502	82103
Site	benzene	1,3-butadiene	formaldehyde	arsenic
Decatur, GA	96%	90%	90%	93%

Table 24: Percent Completeness of Georgia's 2009 AQS Data, Selected Compounds

PHOTOCHEMICAL ASSESSMENT MONITORING

In 1996, the Air Protection Branch began a routine seasonal sampling program to gather information about non-methane hydrocarbon (NMHC) species that were precursors to ozone formation in high ozone areas. In 1994, Federal regulations required states to establish photochemical assessment monitoring stations (PAMS) as part of their State Implementation Plan monitoring networks in areas designated as serious or higher for ozone. Monitoring is to continue until the ozone standard is reached. The PAMS program is intended to supplement ozone monitoring and add detailed sampling for its precursors. PAMS sites collect data on real-time total NMHC, PAMS speciated VOCs, carbonyls, and various meteorological parameters at ground level and aloft. As this is a descriptive data set, there are currently no mandatory data quality objectives or regulations for the data. However, efforts are made to ensure that accurate data are collected and that the analyzers are operating within PAMS audit standards.

<u>Accuracy (field and lab)</u>: 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 typically conducted annually at each monitoring site to assess the integrity of the sampling, analysis, and transport system. The 2009 PAMS speciated VOCs yearly data quality assessment summary for the three PAMS sites on the tables below show that the results were within the PAM's control limits of ±20%.

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	6	11.23	-2.83	25.29	64
43204	Propane[*]	12	15.24	12.35	3.22	-18.05	24.49	6	7.36	-5.89	20.60	64
43214	Isobutane[+]	NA	NA	NA	NA	NA	NA	6	12.32	-6.78	31.43	64
43216	Trans-2-Butene[+]	NA	NA	NA	NA	NA	NA	6	8.88	-10.75	28.52	64
43220	N-Pentane[+]	NA	NA	NA	NA	NA	NA	6	9.58	-8.95	28.11	64
43285	2-Methylpentane[+]	NA	NA	NA	NA	NA	NA	6	10.58	-5.45	26.62	64
43243	Isoprene[+]	NA	NA	NA	NA	NA	NA	6	-16.70	-35.06	1.66	64
43231	N-Hexane[+]	NA	NA	NA	NA	NA	NA	6	18.26	10.30	26.22	64
45201	Benzene[*]	12	19.12	19.23	10.82	-15.87	37.5	6	5.85	-6.61	18.31	64
43232	N-Heptane[+]	NA	NA	NA	NA	NA	NA	6	9.60	-3.9	23.11	64
45202	Toluene[+]	NA	NA	NA	NA	NA	NA	6	2.91	-6.97	12.79	64
45203	Ethylbenzene[+]	NA	NA	NA	NA	NA	NA	6	-5.51	-16.38	5.37	64
43238	N-Decane[+]	NA	NA	NA	NA	NA	NA	6	-29.21	-32.59	-25.84	64
45225	1,2,3-Trimethylbenzene[+]	NA	NA	NA	NA	NA	NA	6	-32.45	-41.2	-23.70	64
95% LPL: 95% Lower Probability Limit				95% UPL: 95% Upper Probability Limit								
PQAO: Primary Quality Assurance Organization												
* NIST traceable												
+ Only NIST traceable by weight												

Table 25: PAMS Speciated VOCs Yearly Data Quality Assessment for South DeKalb

PAMS Speciated VOCs Yearly Data Quality Assessment Summary for Conyers - Monastery 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	6	18.46	-0.76	37.68	66
43204	Propane[*]	11	8.28	11.46	8.18	-3.38	19.74	6	14.99	1.27	28.70	66
43214	Isobutane[+]	NA	NA	NA	NA	NA	NA	6	14.06	9.17	18.95	66
43216	Trans-2-Butene[+]	NA	NA	NA	NA	NA	NA	6	8.41	1.97	14.84	66
43220	N-Pentane[+]	NA	NA	NA	NA	NA	NA	6	-5.28	-28.51	17.95	66
43285	2-Methylpentane[+]	NA	NA	NA	NA	NA	NA	6	-35.26	-45.27	-25.25	66
43243	Isoprene[+]	NA	NA	NA	NA	NA	NA	6	-40.68	-54.99	-26.36	66
43231	N-Hexane[+]	NA	NA	NA	NA	NA	NA	6	17.53	10.11	24.96	66
45201	Benzene[*]	12	19.26	13.4	-0.89	-27.77	25.99	6	5.84	-1.36	13.05	66
43232	N-Heptane[+]	NA	NA	NA	NA	NA	NA	6	15.10	6.95	23.25	66
45202	Toluene[+]	NA	NA	NA	NA	NA	NA	6	8.73	0.53	16.92	66
45203	Ethylbenzene[+]	NA	NA	NA	NA	NA	NA	6	6.36	-1.74	14.45	66
43238	N-Decane[+]	NA	NA	NA	NA	NA	NA	6	-6.54	-15.74	2.66	66
45225	1,2,3-Trimethylbenzene[+]	NA	NA	NA	NA	NA	NA	6	5.08	-31.92	42.08	66

95% LPL: 95% Lower Probability Limit

95% UPL: 95% Upper Probability Limit

PQAO: Primary Quality Assurance Organization

* NIST traceable

+ Only NIST traceable by weight

Table 26: PAMS Speciated VOCs Yearly Data Quality Assessment for Conyers

PAMS Speciated VOCs Yearly Data Quality Assessment Summary for Yorkville – King's Farm 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	6	9.75	-0.33	19.84	64
43204	Propane[*]	12	2.60	5.61	4.65	1.02	8.29	6	5.84	-7.88	19.55	64
43214	Isobutane[+]	NA	NA	NA	NA	NA	NA	6	6.09	3.23	8.94	64
43216	Trans-2-Butene[+]	NA	NA	NA	NA	NA	NA	6	7.91	6.04	9.78	64
43220	N-Pentane[+]	NA	NA	NA	NA	NA	NA	6	6.25	4.25	8.25	64
43285	2-Methylpentane[+]	NA	NA	NA	NA	NA	NA	6	6.82	2.96	10.69	64
43243	Isoprene[+]	NA	NA	NA	NA	NA	NA	6	-14.83	-27.22	-2.43	64
43231	N-Hexane[+]	NA	NA	NA	NA	NA	NA	6	15.23	3.02	27.43	64
45201	Benzene[*]	13	10.38	17.24	-13.58	-28.32	1.17	6	3.10	-5.7	11.89	64
43232	N-Heptane[+]	NA	NA	NA	NA	NA	NA	6	14.54	5.48	23.59	64
45202	Toluene[+]	NA	NA	NA	NA	NA	NA	6	10.08	1.82	18.35	64
45203	Ethylbenzene[+]	NA	NA	NA	NA	NA	NA	6	12.24	1.16	23.33	64
43238	N-Decane[+]	NA	NA	NA	NA	NA	NA	6	4.84	-3.1	12.78	64
45225	1,2,3-Trimethylbenzene[+]	NA	NA	NA	NA	NA	NA	6	11.95	-16.32	40.21	64
95% LPL: 95% Lower Probability Limit					95% UPL: 95% Upper Probability Limit							
PQAO: Primary Quality Assurance Organization												
* NIST traceable												
+ Only NIST traceable by weight												

Table 27: PAMS Speciated VOCs Yearly Data Quality Assessment for Yorkville

PAMS Speciated VOCs Yearly Data Quality Assessment for GA EPD Ambient Air Monitoring Program (as a PQAO)

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	18	13.15	-1.78	28.08	64
43204	Propane[*]	35	8.72	9.76	5.27	-9.08	19.62	18	9.39	-4.17	22.95	64
43214	Isobutane[+]	NA	NA	NA	NA	NA	NA	18	10.82	-0.68	22.33	64
43216	Trans-2-Butene[+]	NA	NA	NA	NA	NA	NA	18	8.40	-3.58	20.38	64
43220	N-Pentane[+]	NA	NA	NA	NA	NA	NA	18	3.52	-13.68	20.71	64
43285	2-Methylpentane[+]	NA	NA	NA	NA	NA	NA	18	-5.95	-17.09	5.19	64
43243	Isoprene[+]	NA	NA	NA	NA	NA	NA	18	-24.07	-39.29	-8.84	64
43231	N-Hexane[+]	NA	NA	NA	NA	NA	NA	18	17.01	7.56	26.45	64
45201	Benzene[*]	37	16.09	16.64	-1.55	-24.81	21.706	18	4.93	-4.81	14.67	64
43232	N-Heptane[+]	NA	NA	NA	NA	NA	NA	18	13.08	2.58	23.58	64
45202	Toluene[+]	NA	NA	NA	NA	NA	NA	18	7.24	-1.57	16.05	64
45203	Ethylbenzene[+]	NA	NA	NA	NA	NA	NA	18	4.37	-5.75	14.48	64
43238	N-Decane[+]	NA	NA	NA	NA	NA	NA	18	-10.30	-17.59	-3.02	64
45225	1,2,3-Trimethylbenzene[+]	NA	NA	NA	NA	NA	NA	18	-5.14	-32.49	22.21	64
95% LPL: 95% Lower Probability Limit					95% UPL: 95% Upper Probability Limit							
PQAO: Primary Quality Assurance Organization												
* NIST traceable												
+ Only NIST traceable by weight												

Table 28: PAMS Speciated VOCs Yearly Data Quality Assessment for Ambient Monitoring Program

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 enusre 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 29 summarizes the 2009 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.

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 (%)	
61101	Wind Speed	52	13	0.58	-1.18	2.35	98.5
61102	Wind Direction	52	13	0.13	-0.46	0.71	98.4
62101	Ambient Temperature	9	9	-1.48	-6.58	3.62	94.8
64101	Barometric Pressure	6	6	0.16	-0.20	0.53	100.0
62201	Relative Humidity	9	9	3.55	-12.48	19.57	94.8

95% LPL: 95% Lower Probability Limit

95% UPL: 95% Upper Probability Limit

PQAO: Primary Quality Assurance Organization

Table 29: Meteorological Measurements Accuracy Results

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 manufactures 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 and engineering 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 AMP Quality Assurance Manual Volume II; 40 CFR 58, Appendix E; U.S. EPA's Quality Assurance Handbook Volume IV: U.S. EPA's Prevention of Significant Deterioration (PSD); and U.S. EPA's PAMS guidelines, 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, 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

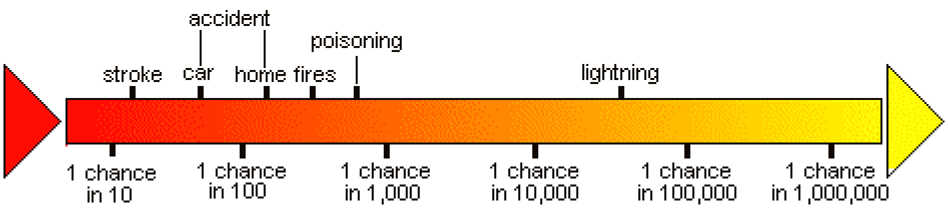
INTRODUCTION

In 2009, Air Toxic Network (ATN) samples were collected from a total of six of the previously established 15 ATN sites, including two background (rural) sites. As a result of severe decreases in resources, nine of the 15 ATN sites did not collect data in 2009. Therefore, the following risk assessment reflects data collected at only six ATN sites. The compounds sampled at the ATN sites are shown in Table 30. The list was derived from the 188 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. A carbonyls sampler is located at the Brunswick, Dawsonville, Savannah, South DeKalb (NATTS and PAMS) 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. Exceptions to this sampling schedule are the South DeKalb and Gainesville sites. The South DeKalb site samples every 6 days as part of the National Air Toxics Trends Station (NATTS) and PAMS network. The Gainesville site has an extra sample once a month.

Some of the chemicals monitored in the Air Toxics Network (ATN) are also monitored at sites in the Photochemical Assessment Monitoring Stations (PAMS) network. While the monitoring schedule and some analysis methods are different at the PAMS sites and ATN sites, several of the compounds from the PAMS sites were also evaluated and compared to concentrations measured at nearby ATN sites for this report.

To provide an idea of the size of 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] or 1×10^{-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 toxic data [(volatile organic compounds (VOC), semi-volatile organic compounds, and metals)] collected during 2009 from the Air Toxics Network was evaluated to assess the potential for health concerns. The data collected for the group of chemicals known as carbonyls were assessed separately from the other air toxics, with the exception of acrolein, because those chemicals were only monitored at three 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, 2006). Briefly, EPA’s prioritized chronic dose-response values for both noncancer (reference concentrations, RfC) and cancer (inhalation unit risks, IUR) were used to generate screening air concentrations. To screen for noncancer 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, 2006) and updated “Table 1. Prioritized Chronic Dose-Response Values for Screening Risk Assessments (4/27/2010)” (U.S. EPA, 2010). These screening values and the chemicals monitored are displayed in Table 30. For a limited number of chemicals, other resources such as toxicity values from the Regional Screening Table (http://www.epa.gov/region4/waste/ots/) 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.

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	0.005
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	9-Fluorenone	N/A
Benzo(k)fluoranthene	0.0091	Ideno(1,2,3-c,d)pyrene	0.0091
Benzo(g,h,i)perylene	0.3	Naphthalene	0.029
Benzo(a)pyrene	0.00091	Phenanthrene	0.3
Benzo(e)pyrene	0.3	Perylene	N/A
Chrysene	0.091	Pyrene	0.3
Coronene	N/A	Retene	N/A
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	100
Bromomethane (Methyl bromide)	0.5	Ethenylbenzene (Styrene)	100
1,3-Butadiene	0.03	1-Ethyl,4-methyl benzene (4-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	20
Chloroethene (Vinyl chloride)	0.11	Methanal (Formaldehyde)	0.0769
Chloromethane (Methyl chloride)	9.0	Methylbenzene/Phenylmethane (Toluene)	5000
Cyclohexane	6300*	Propanal (Propionaldehyde)	0.8
1,2-Dibromoethane (Ethylene bromide)	0.002	2-Propanone (Acetone)	32000*
1,2-Dichlorobenzene	0.091	Propenal (Acrolein)	0.002
1,3-Dichlorobenzene	N/A	1,1,2,2-Tetrachloroethane	0.017
1,4-Dichlorobenzene	0.091	Tetrachloroethene (Perchloroethylene)	0.17
Dichlorodifluoromethane (Freon 12)	210*	Tetrachlormethane (Carbon tetrachloride)	0.067
1,1-Dichloroethane (Ethylidene chloride)	0.63	1,2,4-Trichlorobenzene	20
cis-1,2-Dichloroethene	370	1,2,4-Trimethylbenzene	7.3*
1,1-Dichloroethene (1,1-Dichloroethylene)	210*	1,3,5-Trimethylbenzene	N/A
Dichloromethane (Methylene chloride)	2.10	1,1,1-Trichloroethane (Methylchloroform)	100
1,2-Dichloropropane (Propylene chloride)	0.3	1,1,2-Trichloroethane	0.063
cis-1,3-Dichloropropene	N/A	Trichloroethene (Trichloroethylene)	0.5
trans-1,3-Dichloropropene	N/A	Trichlorofluoromethane (Freon 11)	730*
1,1-Dichloro-1,2,2,2-tetrafluoroethane(Freon114)	N/A	Trichloromethane (Chloroform)	9.8
1,2-Dimethylbenzene (o-Xylene)	10		

*From Regional Screening Table (http://www.epa.gov/region4/waste/ots/)

Table 30: Compounds Monitored and Screening Values Used in Initial Assessment

Table 31 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 2009. Seventy-one chemicals were monitored at all the ATN sites, except the South DeKalb site, where 76 air toxic chemicals were monitored. In 2009, twenty-nine of the 71 sampled compounds were not detected at the sites, and an additional 20 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 6. 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 both the metals and VOCs group.

Location	County	Number of Compounds Monitored	Number of Compounds Detected	Number Greater than Screening Value
Dawsonville	Dawson	71*	22	6
Douglas	Coffee	71	17	6
Macon	Bibb	71	23	6
Savannah	Chatham	71*	25	7
South DeKalb	DeKalb	76*	41	6
Yorkville	Paulding	71	20	5

* 6 additional chemicals were monitored at these locations, but that information is summarized in Table 36.

Table 31: Summary of Chemicals Analyzed in 2009

Table 32, on the following page, shows only the chemicals that were detected above screening values at each ATN site in 2009. They also provide detailed information on how often they were detected (frequency), and the overall average (mean) in micrograms per cubic meter. 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.

Location	Chemical	Mean (µg/m^3)	Detection Frequency
Dawsonville	Arsenic	5.5×10^{-4}	15/24
	Chromium	2.29×10^{-3}	24/24
	Naphthalene	3.65×10^{-2}	4/26
	1,3-Butadiene	2.77×10^{-1}	1/30
	Benzene	5.15×10^{-1}	12/30
	Acrolein	4.29×10^{-1}	23/30
Douglas	Arsenic	9.6×10^{-4}	23/29
	Chromium	2.85×10^{-3}	29/29
	Nickel	2.46×10^{-3}	29/29
	Naphthalene	3.23×10^{-2}	2/26
	Benzene	4.4×10^{-1}	3/31
	Acrolein	4.75×10^{-1}	22/31
Macon	Arsenic	5.6×10^{-4}	20/29
	Chromium	2.08×10^{-3}	29/29
	Manganese	6.19×10^{-3}	29/29
	Naphthalene	3.62×10^{-2}	4/26
	Benzene	2.05	16/27
	Acrolein	4.04×10^{-1}	18/37
Savannah	Arsenic	6.3×10^{-4}	24/31
	Chromium	2.18×10^{-3}	30/31
	Nickel	2.23×10^{-3}	31/31
	Naphthalene	3.54×10^{-2}	4/23
	Trichloroethylene	6.78×10^{-1}	1/31
	Benzene	4.36×10^{-1}	5/31
	Acrolein	3.42×10^{-1}	20/31
South DeKalb	Arsenic	5.1×10^{-4}	36/57
	Chromium	1.69×10^{-3}	56/57
	Naphthalene	1.05×10^{-1}	59/59
	Dichloromethane	5.43	15/53
	Benzene	8.21×10^{-1}	41/53
	Acrolein	6.85×10^{-1}	46/53
Yorkville	Arsenic	6.2×10^{-4}	19/26
	Chromium	1.92×10^{-3}	25/26
	Naphthalene	3.53×10^{-2}	4/25
	Benzene	4.13×10^{-1}	4/26
	Acrolein	3.79×10^{-1}	14/26

Table 32: Site-Specific Detection Frequency and Mean Chemical Concentration, 2009

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 $\mu g/m^3$
IUR Inhalation unit risk ($1/(\mu g/m^3)$)
RfC Reference concentration ($\mu g/m^3$)

Figure 84: Formulas For Calculating Risk and Hazard Quotient

Figure 84 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.

On the following page, Table 33 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 1×10^{-4} or one in ten 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, Georgia 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 new 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 ATN sites. The HQ numbers for acrolein are much higher than for the other air toxic compounds. This may be due to methodological changes. Potential reasons for differences are still being investigated.

Location	Chemical	Cancer Risk	Hazard Quotient
Dawsonville	Arsenic	2 x 10^{-6}	0.04
	Chromium	3 x 10^{-5}	0.02
	Naphthalene	1 x 10^{-6}	0.01
	1,3-Butadiene	8 x 10^{-6}	0.1
	Benzene	4 x 10^{-6}	0.02
	Acrolein		21
Douglas	Arsenic	4 x 10^{-6}	0.06
	Chromium	3 x 10^{-5}	0.03
	Nickel	1 x 10^{-6}	0.03
	Naphthalene	1 x 10^{-6}	0.01
	Benzene	3 x 10^{-6}	0.01
	Acrolein		24
Macon	Arsenic	2 x 10^{-6}	0.04
	Chromium	2 x 10^{-5}	0.02
	Manganese		0.1
	Naphthalene	1 x 10^{-6}	0.01
	Benzene	2 x 10^{-5}	0.07
	Acrolein		20
Savannah	Arsenic	3 x 10^{-6}	0.04
	Chromium	3 x 10^{-5}	0.02
	Nickel	1 x 10^{-6}	0.02
	Naphthalene	1 x 10^{-6}	0.01
	Trichloroethylene	1 x 10^{-6}	0.001
	Benzene	3 x 10^{-6}	0.01
	Acrolein		17
South DeKalb	Arsenic	2 x 10^{-6}	0.03
	Chromium	2 x 10^{-5}	0.02
	Naphthalene	4 x 10^{-6}	0.03
	Dichloromethane	3 x 10^{-6}	0.005
	Benzene	6 x 10^{-6}	0.03
	Acrolein		34
Yorkville	Arsenic	3 x 10^{-6}	0.04
	Chromium	2 x 10^{-5}	0.02
	Naphthalene	1 x 10^{-6}	0.01
	Benzene	3 x 10^{-6}	0.01
	Acrolein		19

Table 33: Cancer Risk and Hazard Quotient by Location and Chemical, 2009

Table 34 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. It is considered appropriate to treat the potential for effects in an additive manner and to sum cancer risk and hazard quotients. 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.

In 2009, the aggregate theoretical cancer risk (excluding carbonyls) for all ATN sites exceeded 1 x 10^{-6}, with risks ranging from 3 x 10^{-5} to 5 x 10^{-5}. Both the Hazard Indices (HIs) calculated without the acrolein data and calculated with the acrolein data are shown. The HIs ranged from 0.08 to 0.2 without the acrolein data, and the HIs ranged from 17 to 34 with the acrolein data.

Location	Cancer Risk	Hazard Index without Acrolein	Hazard Index with Acrolein
Dawsonville	5 x 10^{-5}	0.2	21
Douglas	4 x 10^{-5}	0.1	24
Macon	4 x 10^{-5}	0.2	20
Savannah	4 x 10^{-5}	0.1	17
South DeKalb	4 x 10^{-5}	0.1	34
Yorkville	3 x 10^{-5}	0.08	19

Table 34: Aggregate Cancer Risk and Hazard Indices for Each Site, Excluding Carbonyls, 2009

The information from Table 34 is summarized in Figure 86. Figure 85 is shown as a comparison, with the different methods of collection and analysis for acrolein. It shows the combined or aggregate hazard index and theoretical cancer risk for each site from 2005 to 2006, and Figure 86 shows the data from 2007 to 2009. Note the hazard index in Figure 85 shows values up to 0.5 and in Figure 86, the values are up to 74. With the GC/MS analysis used for the acrolein compound, the hazard indices significantly increased starting with the 2007 data. The lowest hazard index was 20, at the Savannah site, and the highest was 52, at the Brunswick site in 2007. In 2008, the lowest hazard index was 13 at the Macon site, and the highest was at the Milledgeville site with 74. Then in 2009, the lowest hazard index was again at the Savannah site, with a HI of 17. The highest hazard index was at the South DeKalb site, with a HI of 34. These numbers increased from a range of 0.08 to 0.2 before the acrolein data was added to the hazard index. There seems to be more variation for cancer risk from site to site for 2005 and 2006, but for 2007 the cancer risk numbers appear to be almost identical from site to site across the state. In 2008 and 2009, the theoretical cancer risk seems to vary across the state a bit more than in 2007. Overall, the theoretical cancer risk seems consistently lower in the second graph showing 2007 through 2009 data, compared to the 2005 and 2006 data.

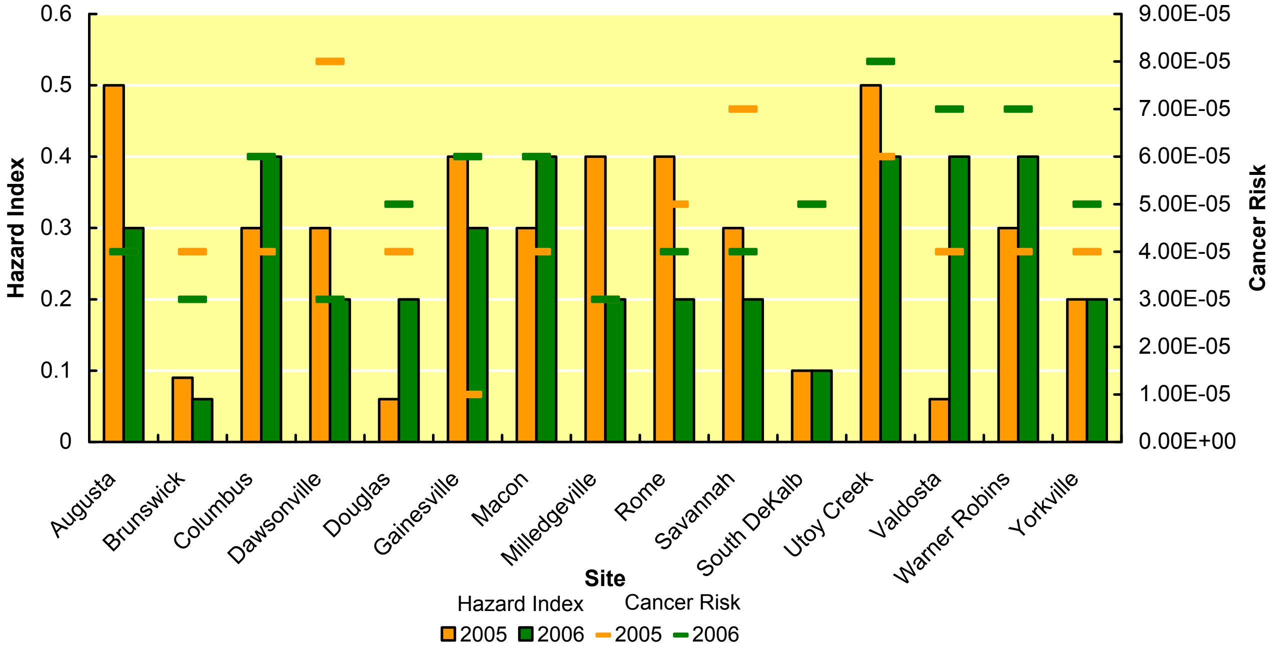


Figure 85: Aggregate Cancer Risk and Hazard Index by Site for 2005-2006

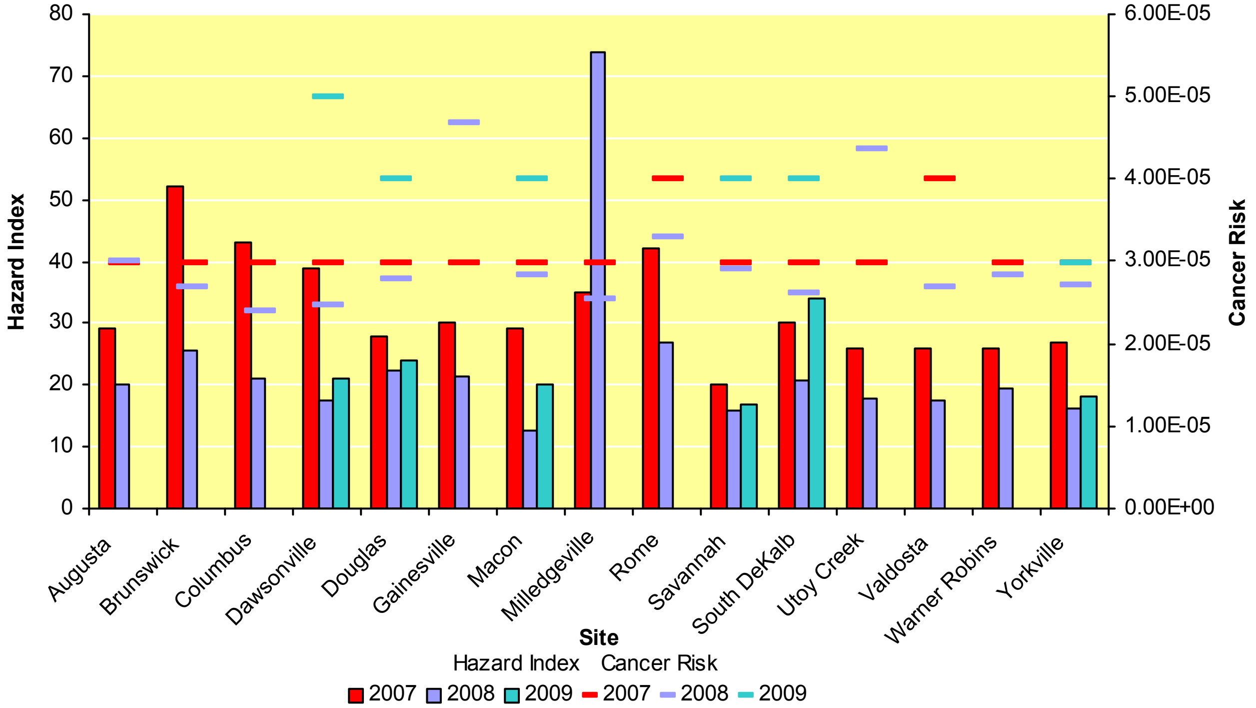


Figure 86: Aggregate Cancer Risk and Hazard Index by Site for 2007-2009

A few of the compounds collected from the PAMS network were evaluated in conjunction with the ATN 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 non-attainment. Fifty-four (54) chemicals are monitored on six-day intervals at these sites. In Georgia, as of 2007, PAMS sites are located in Conyers, South DeKalb, and Yorkville. Of the 54 chemicals monitored at these sites, many are ozone precursors, and are not truly comparable to the chemicals monitored at the ATN sites, or appropriate to evaluate as air toxics. Therefore, for this study, only twelve chemicals were assessed for their potential to have detrimental effects on human health if present in ambient air. Those twelve chemicals were benzene, cyclohexane, ethyl benzene, p-ethyltoluene, n-hexane, 1,2,3-trimethylbenzene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, styrene, toluene, m,p-xylene, and o-xylene.

Of those twelve chemicals evaluated from the PAMS network, only benzene and 1,2,4-trimethylbenzene were found in concentrations above the screening values in 2009. Table 35, on the next page, shows the number of samples collected, first and second highest sample concentrations (1st and 2nd Max), averages (means) in micrograms per cubic meter (µg/m^3), hazard quotients (HQ) and cancer risk (CR) for chemicals evaluated in the quantitative assessment at each of the three PAMS sites for 2009. Benzene was detected consistently and when evaluated as a potential carcinogen, produced theoretical cancer risks as great as 4 x 10^{-5} and hazard quotient of 0.2 at the South DeKalb site. The lowest theoretical cancer risk was at the Yorkville site with 1 x 10^{-5} and hazard quotient of 0.05. 1,2,4-trimethylbenzene was detected above the screening value at the South DeKalb and Yorkville sites, and when evaluated as a non-cancer hazard, produced a HQ of 2 at the South DeKalb site and HQ of 7 at the Yorkville site.

Location	Chemical	Detection Frequency	1st Max (µg/m^3)	2nd Max (µg/m^3)	Mean (µg/m^3)	HQ	CR
Conyers	Benzene	26/40	6.07	5.75	2.08	0.07	2 x 10^{-5}
South DeKalb	Benzene	39/39	15.65	15.33	5.62	0.2	4 x 10^{-5}
	1,2,4-Trimethybenzene	26/39	73.74	68.83	12.78	2	
Yorkville	Benzene	15/39	4.79	4.79	1.37	0.05	1 x 10^{-5}
	1,2,4-Trimethybenzene	9/32	93.40	58.99	11.70	2	

Table 35: Summary Data for Select VOCs at PAMS Sites, 2009

With the exclusion of acrolein, the carbonyls (acetaldehyde, acetone, benzaldehyde, butyraldehyde, formaldehyde, and propionaldehyde) were measured at only two of the ATN sites (Savannah and Dawsonville) and one PAMS/NATTS site (South DeKalb) in 2009. 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 36. This table also shows the sum of the cancer risk and hazard quotients, which are the aggregate cancer risk and hazard index (HI), per site. Of the six carbonyls sampled, acetaldehyde and formaldehyde were detected above the screening value for 2009. All the sites monitoring for acetaldehyde and formaldehyde detected these compounds with a relatively high detection frequency. Acetaldehyde was detected 50% to 89% of the time, with Savannah having the lowest detection frequency and South DeKalb having the highest detection frequency. Formaldehyde was detected 77% to 100% of the time, with the Dawsonville site having the lowest detection rate and the South DeKalb site having the highest. Acetaldehyde had relatively low theoretical cancer risks, ranging from 2 x 10^{-6} to 5 x 10^{-6}, and relatively low hazard quotients, ranging from 0.1 to 0.2. Formaldehyde had theoretical cancer risks, ranging from 1 x 10^{-4} to 3 x 10^{-5}, and hazard quotients, ranging from 0.3 to 0.8.

Location	Chemical	Detection Frequency	Mean (µg/m^3)	Cancer Risk	Hazard Quotient
Dawsonville	Acetaldehyde	16/31	9.29 x 10^{-1}	2 x 10^{-6}	0.1
	Formaldehyde	24/31	2.08	3 x 10^{-5}	0.2
	SUM			3 x 10^{-5}	0.3
Savannah	Acetaldehyde	15/30	8.96 x 10^{-1}	2 x 10^{-6}	0.1
	Formaldehyde	28/30	2.32	3 x 10^{-5}	0.2
	SUM			3 x 10^{-5}	0.3
South DeKalb	Acetaldehyde	48/54	2.16	5 x 10^{-6}	0.2
	Formaldehyde	54/54	8.92	1 x 10^{-4}	0.8
	SUM			1 x 10^{-4}	1

Table 36: Summary Observations, Cancer Risk, and Hazard Quotient for Carbonyls, 2009

SUMMARY AND DISCUSSION

In 2009, there were 71 air toxics compounds monitored at the 6 sites across the state, with the exception of the South DeKalb site that monitored 76 air toxic compounds. Of these compounds monitored, 29 were not detected and 20 compounds were detected at two sites or less. 44.4% of the compounds detected above the screening value were in the metals category, 44.4% were in the volatile organic compounds category, and 11.1% were in the semi-volatile organic compounds category. For the 2009 data, there was an average of 6 compounds per site that were above the screening value.

In 2009, five volatile organic compounds, 1,3-butadiene, dichloromethane, benzene, trichloroethylene, and acrolein, were evaluated in the quantitative assessment. (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 ATN sites. Average benzene concentrations at the ATN sites ranged from 0.41 to 2.05 µg/m^3. These concentrations correspond to the predicted theoretical lifetime cancer risk in the range of 3 x 10^{-6} to 2 x 10^{-5}. All three PAMS sites detected benzene above the screening value. Average concentrations of benzene measured in the PAMS network ranged from 1.37 to 5.62 µg/m^3. These concentrations correspond to predicted theoretical lifetime cancer risks in the range of 1 x 10^{-5} to 4 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, 1997). 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, 1997). 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.

Another volatile organic compound found above the screening value was 1,3-butadiene. It was detected above the screening value at only one site (Dawsonville) and with a low detection frequency, approximately to 3%. Lifetime theoretical cancer risk calculated from the mean concentration of 1,3-butadiene was 9 x 10^{-6}, with a non-cancer hazard quotient of 0.1. 1,3-Butadiene is used to process petroleum, make synthetic rubber, make plastics, and small amounts are in gasoline (ATSDR, 2009). With exposure to high levels of 1,3-butadiene for a short time, it can cause dry mouth and nose, nausea, headache, and decreased pulse rate and blood pressure. U.S. EPA and Department of Health and Human Services has classified 1,3-butadiene as a human carcinogen (ATSDR, 2009). Studies have shown that workers exposed to 1,3-butadiene may have an increased risk of cancers of the stomach, blood, and lymphatic system (ATSDR, 2009).

Dichloromethene, the third volatile organic compound found above screening values, was detected at one of the six sites, with a 28% detection rate. It was found at the South DeKalb site. Dichloromethene, also called methylene chloride, is used as an industrial solvent, paint stripper, can be found in aerosol and pesticides, and is used in making photographic film (ATSDR, 2001b). Breathing large amounts of dichloromethane can damage the central nervous system, causing unsteadiness, dizziness, nausea, and tingling or numbness in fingers and toes (ATSDR, 2001b). For this study, the chemical was evaluated as a carcinogen and a non-carcinogen. Theoretical cancer risk calculated from the mean ambient air concentrations (accounting for non-detected samples) was 3 x 10^{-6} for 2009. The non-cancer hazard quotient was 0.005 for 2009.

The fourth volatile organic compound detected above screening value was trichloroethylene. This compound was found at the Savannah site with a 3% detection frequency. Trichloroethylene is used as a solvent for cleaning metal parts, and is used as an ingredient in adhesives, paint removers, typewriter correction fluid and spot cleaner. Breathing large amounts can cause nervous system effects, abnormal heartbeat, coma, and possibly death (ATSDR, 2003). The theoretical lifetime cancer risk was 1 x 10^{-6}, and the hazard quotient was 0.001 for the Savannah site for 2009.

In 2009, one compound in the semi-volatile organic compound group was found above the screening value. Naphthalene was the only semi-volatile organic compound found above the screening value. It was detected at all six sites. The South DeKalb site had detections with every sample taken, or 100% detection frequency. The theoretical lifetime cancer risks ranged from approximately 1 x 10^{-6} to 4 x 10^{-6}, which includes adding the half detection limit for the non-detected samples. The non-cancer hazard quotient ranged from 0.01 to 0.03. 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).

Four metals, manganese, arsenic, chromium, and nickel, were evaluated in the quantitative assessment. Manganese was detected above the screening value for one of the six ATN sites. Manganese is a trace element, and small amounts are needed to support good health. However, exposure to very large amounts through inhalation can result in neurological effects (ATSDR, 2000a). Manganese was evaluated as a neurotoxin, but did not contribute significantly in the quantitative assessment with a HQ of 0.1. These HQs suggest that there is little potential for neurological effects from ambient air concentrations of manganese.

Arsenic was found at all six ATN sites. 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, so arsenic was evaluated as a carcinogen in this assessment. The detection frequency was high, with the lowest (88%) at the Dawsonville site, up to 100% at the Macon and Savannah sites. Theoretical lifetime cancer risks estimated from the data collected in 2009 ranged from 2×10^{-6} to 4×10^{-6}.

In 2009, total chromium was detected at all six ATN sites. Total chromium also had a high detection frequency, with 95% to 100% detections. The theoretical cancer risk ranged from 2×10^{-5} to 3×10^{-5}. The sites with the highest theoretical cancer risk were the Dawsonville, Douglas, and Savannah sites, with 3×10^{-5}. 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). As part of the NATTS network, sampling for chromium+6 takes place at the South DeKalb site. When the 2009 concentration of chromium+6 is compared to the total chromium concentration, it shows that the chromium+6 is 0.6% of the total chromium accounted for at the South DeKalb site. However the concentrations of chromium+6 detected were below the screening value and were not evaluated further as a potential cancer risk. The South DeKalb site is located within and representative of an urban area. Since the chromium+6 concentrations were below the screening value for the South DeKalb site, this could indicate that chromium+6 levels are low throughout the network. The other sites that measure for chromium, measure for the total form. Therefore, the measurements used in this study were for the total form, and distinctions cannot be made as to how much of the different states of chromium are present at the other ATN sites. In the interest of conservativeness, chromium was evaluated with the most stringent toxicity index as chromium+6, even though the chromium metal measured was not in this most toxic form. Data collected on the ratio of chromium+6 to total chromium (ATSDR, 2000b) indicates that this process may appreciably overestimate risk. Further work is needed to better understand chemical forms of chromium in Georgia's air, and determine if chromium is an important contributor to risk.

In 2009, nickel was detected above the screening value at two of the six ATN sites, with a theoretical lifetime cancer risk of 1 x 10^{-6} at both sites (Douglas and Savannah). When detected, nickel had a high detection frequency, occurring in 100% of the collected samples. Nickel is a naturally occurring element used in many consumer and industrial products such as stainless steel, alloys, and coins, and is also released in the burning of oil and coal. If large amounts are breathed, nickel can cause damage to the lungs and nasal cavities, and can be carcinogenic (ATSDR, 2005d).

Carbonyls were monitored at three sites in Georgia in 2009. Two sites, Dawsonville and Savannah are ATN sites, while the other site, South DeKalb, is in the PAMS network. Three carbonyls- formaldehyde, acetaldehyde, and acrolein- were detected with sufficient frequency, and have sufficient potential for toxicity to be included in the quantitative assessment.

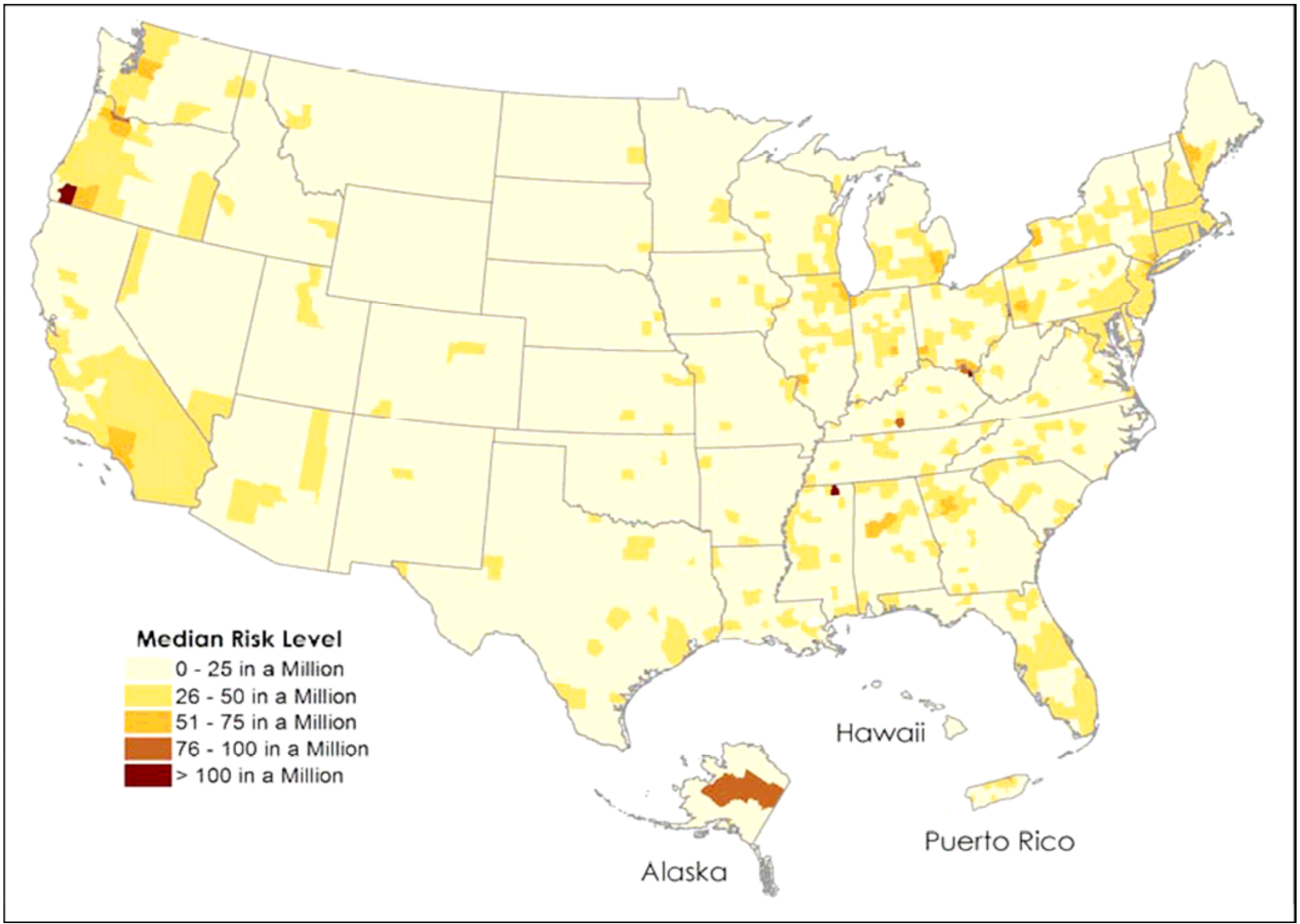
Formaldehyde, the simplest of the aldehydes, is produced by natural processes, and from the fertilizer, paper, and manufactured wood products industries (ATSDR, 1999). It is also found in vehicle emissions. Formaldehyde is a health concern because of its respiratory irritancy and potential as a carcinogen. It may cause irritation of the eye, nose, throat, and skin, and has the potential under certain exposure scenarios to cause cancers of the nose and throat (ATSDR, 1999). Acetaldehyde, as an intermediate product of plant respiration and a product of incomplete combustion, is ubiquitous in the environment. Acetaldehyde, like formaldehyde, is also a concern as an upper respiratory irritant, and because of its potential to cause nasal tumors in animal studies. However, research has shown it to be significantly less potent than formaldehyde (U.S. EPA, 1987; U.S. EPA 1991b).

In 2009, formaldehyde and acetaldehyde were detected at all three locations where carbonyls were assessed. As noted in past studies, concentrations of these aldehydes were higher at the PAMS site (South DeKalb) compared to the ATN sites. The South DeKalb site had an average concentration of 8.92 µg/m^3 for formaldehyde and 2.16 µg/m^3 for acetaldehyde. The major sources of formaldehyde are forest fires, marshes, stationary internal combustion engines and turbines, pulp and paper plants, petroleum refineries, power plants, manufacturing facilities, incinerators, cigarette smoke, and vehicle exhaust. Historically, the PAMS site has had higher levels of concentration possibly related to differences in siting criteria between the two networks. Type II PAMS sites are intentionally located in "urban core" locations to monitor precursors of ozone, but ATN sites are not. Historically, the difference could be that vehicle emissions play a greater role in measurements made at PAMS sites compared to ATN sites. When the theoretical cancer risk for formaldehyde was evaluated, the risk ranged from 1 x 10^{-4} to 3 x 10^{-5} for 2009. When acetaldehyde was evaluated for theoretical cancer risk, the risk ranged from 2 x 10^{-6} to 5 x 10^{-6}.

In 2007, acrolein began to be collected with the other VOCs in a canister and analyzed 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 2009, it was detected at all the sites, with the detection frequency ranging from 49% to 87% of samples. Acrolein was evaluated as a non-carcinogen, and the hazard quotients ranged from 17 to 34, accounting for the change in the data from Figure 85 to Figure 86, above. The average concentrations ranged from 0.342 µg/m^3 to 0.685 µg/m^3 (using half the detection limit for non-detected samples). Acrolein may enter the environment as a result of combustion of trees and other plants, tobacco, gasoline, and oil. Additionally, it has a number of industrial uses as a chemical intermediate (ATSDR, 2005c). 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, 2005c; U.S. EPA, 2003).

At the PAMS sites, benzene was detected above the screening value at all three sites, and 1,2,4-trimethylbenzene was detected above the screening value at the South DeKalb and Yorkville sites. When evaluated as a theoretical cancer risk, benzene's levels ranged from 1 x 10^{-5} at Yorkville to 4 x 10^{-5} at South DeKalb. As stated earlier, major sources of benzene to the environment include automobile service stations, exhaust from motor vehicles, and industrial emissions (ATSDR, 1997). 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). For this study, 1,2,4-trimethylbenzene was evaluated as a non-carcinogen with potential to cause central nervous system and irritant effects (U.S. EPA, 2004b). The 1,2,4-Trimethylbenzene HQ was approximately 2 at both the South DeKalb and Yorkville sites.

In Figure 87 below, a map is shown of the most recent official National Air Toxics Assessment that was done with 2002 data. The estimated risk levels are given per county across the United States. The map indicates that in more populated areas and transportation corridors, the estimated cancer risk levels are higher than the national average.



(From EPA's "Our Nation's Air- Status and Trends through 2008")

Figure 87: Estimated County-Level Cancer Risk From the 2002 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

One of the most important tasks of the Ambient Monitoring Program is maintaining effective public outreach and education. The program 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 them, and communicating the monitoring results directly with 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. This is done by issuing smog alerts and information provided in the Air Quality Index (AQI), maintaining a partnership with the Clean Air Campaign in the metro Atlanta nonattainment area, and other outreach strategies aimed at keeping the public up to date on air quality issues.

What is the Clean Air Campaign®?

The Clean Air Campaign® (CAC) is a not-for-profit organization that works to reduce traffic congestion and improve air quality in the metro Atlanta nonattainment area through a variety of voluntary programs and services, including free employer assistance, incentive programs, public information and children's education. EPD is a proud funding sponsor of the CAC.

The CAC works with more than 300 public and private sector employers, representing several hundred thousand employees, to reduce the number of single-occupancy vehicle commuters in metro Atlanta year-round. The program has helped reduce emissions and vehicle miles traveled by encouraging people to alter their commuting habits and to reconsider behaviors-driving in particular.

In addition to addressing commuters' driving habits, CAC utilizes the Air Quality Index (AQI) to relay air quality information to metro Atlanta residents.

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 state wide 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 pollutants: Ozone (O_3), Sulfur Dioxide (SO_2), Carbon Monoxide (CO), Particulate Matter 10 (PM_{10}), and Nitrogen Dioxide (NO_2). For Particulate Matter 2.5 ($PM_{2.5}$), the AQI is set up for the range of 15.5 to 40.4 $\mu g/m^3$ to be equivalent to the 51 to 100 AQI value. The AQI for a reporting region equates to the highest rating recoded 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. Figure 88 shows how the recorded concentrations correspond to the AQI index values, descriptors and health advisories.

Maximum Pollutant Concentration							AQI Value	Descriptor	EPA Health Advisory
$PM_{2.5}$	PM_{10}	SO_2	O_3	O_3	CO	NO_2			
(24hr) µg/m^3	(24hr) µg/m^3	(24hr) ppm	(8hr) ppm	(1hr) ppm	(8hr) ppm	(1hr) ppm			
0 – 15.4	0 – 54	0 – 0.034	0 – 0.059	None	0 – 4.4	None	0 to 50	**Good** **(green)**	Air quality is considered satisfactory, and air pollution poses little or no risk.
15.5 – 40.4	55 – 154	0.035 – 0.144	0.060 – 0.075	None	4.5 – 9.4	None	51 to 100	**Moderate** **(yellow)**	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people. For example, people who are unusually sensitive to the condition of the air may experience respiratory symptoms.
40.5 – 65.4	155 – 254	0.145 – 0.224	0.076 – 0.095	0.125 – 0.164	9.5 – 12.4	None	101 to 150	**Unhealthy for Sensitive Groups** **(orange)**	Members of sensitive groups (people with lung or heart disease) are at greater risk from exposure to particle pollution. Those with lung disease are at risk from exposure to ozone. The general public is not likely to be affected in this range.
65.5 – 150.4	255 – 354	0.225 – 0.304	0.096 – 0.115	0.165 – 0.204	12.5 – 15.4	None	151 to 200	**Unhealthy** **(red)**	Everyone may begin to experience health effects in this range. Members of sensitive groups may experience more serious health effects.
150.5 – 250.4	355 – 424	0.305 – 0.604	0.116 – 0.374	0.205 – 0.404	15.5 – 30.4	0.65 – 1.24	201 to 300	**Very Unhealthy** **(purple)**	AQI values in this range trigger a health alert. Everyone may experience more serious health effects. When the AQI is in this range because of ozone, most people should restrict their outdoor exertion to morning or late evening hours to avoid high ozone exposures.
250.5 – 500.4	425 – 604	0.605 – 1.004	None	0.405 – 0.604	30.5 – 50.4	1.25 – 2.04	301 to 500	**Hazardous** **(maroon)**	AQI values over 300 trigger health warnings of emergency conditions. The entire population is more likely to be affected.

Figure 88: The AQI

Each day the AQI value for metropolitan areas in Georgia are available to the public through the Environmental Protection Division's website http://www.air.dnr.state.ga.us/amp/. An analysis of AQI values for the 2009 monitoring year is listed in Table 37.

Air Quality Index Summary by Region							
Number of Days							
AQI Category	Good (0-50)	Moderate (51-100)	Unhealthy for Sensitive Groups (101-150)**	Unhealthy (151-200)**	Very Unhealthy (201-300)**	Hazardous (>300)**	Pollutants Monitored in 2009
Athens							
2009	301	64	0	0	0	0	O_3, $PM_{2.5}$
Atlanta							
2009	195	155	15	0	0	0	O_3, SO_2, CO, NO_2, PM_{10}, $PM_{2.5}$
Augusta							
2009	285	77	1	0	0	0	O_3, PM_{10}, $PM_{2.5}$
Chattanooga, TN-GA							
2009	255	72	1	0	0	0	O_3, $PM_{2.5}$
Columbus							
2009	297	68	0	0	0	0	O_3, SO_2, PM_{10}, $PM_{2.5}$
Macon							
2009	250	112	2	1	0	0	O_3, SO_2, PM_{10}, $PM_{2.5}$
Savannah							
2009	323	41	0	0	1	0	O_3, SO_2, PM_{10}, $PM_{2.5}$

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

Table 37: AQI Summary Data, 2009

In the following graph on the next page, the number of days that the AQI value was above 100 is plotted for each metropolitan statistical area (MSA) in Georgia where an AQI value is produced. The data was produced starting in 1972 and is shown through 2009. To be consistent, the most current standards were applied throughout the historical dataset. As one would expect, the Atlanta MSA (shown in yellow) has historically had the highest number of days above 100. The pattern across the timeframe seems to be cyclic over the past thirty-eight years. However, the number of days above 100 for the Atlanta-Sandy Springs-Marietta MSA has decreased dramatically over the past four years. The number dropped from 63 days in 2006 to 15 days in 2009. The remaining sites had three or fewer days above 100 in 2009. The Athens-Clarke County, Columbus GA-AL, and Savannah MSAs did not have any days above 100. The Augusta-Richmond County GA-SC MSA had one day above 100, and the Albany, Chattanooga TN-GA, and Macon MSAs had three days above 100 in 2009.

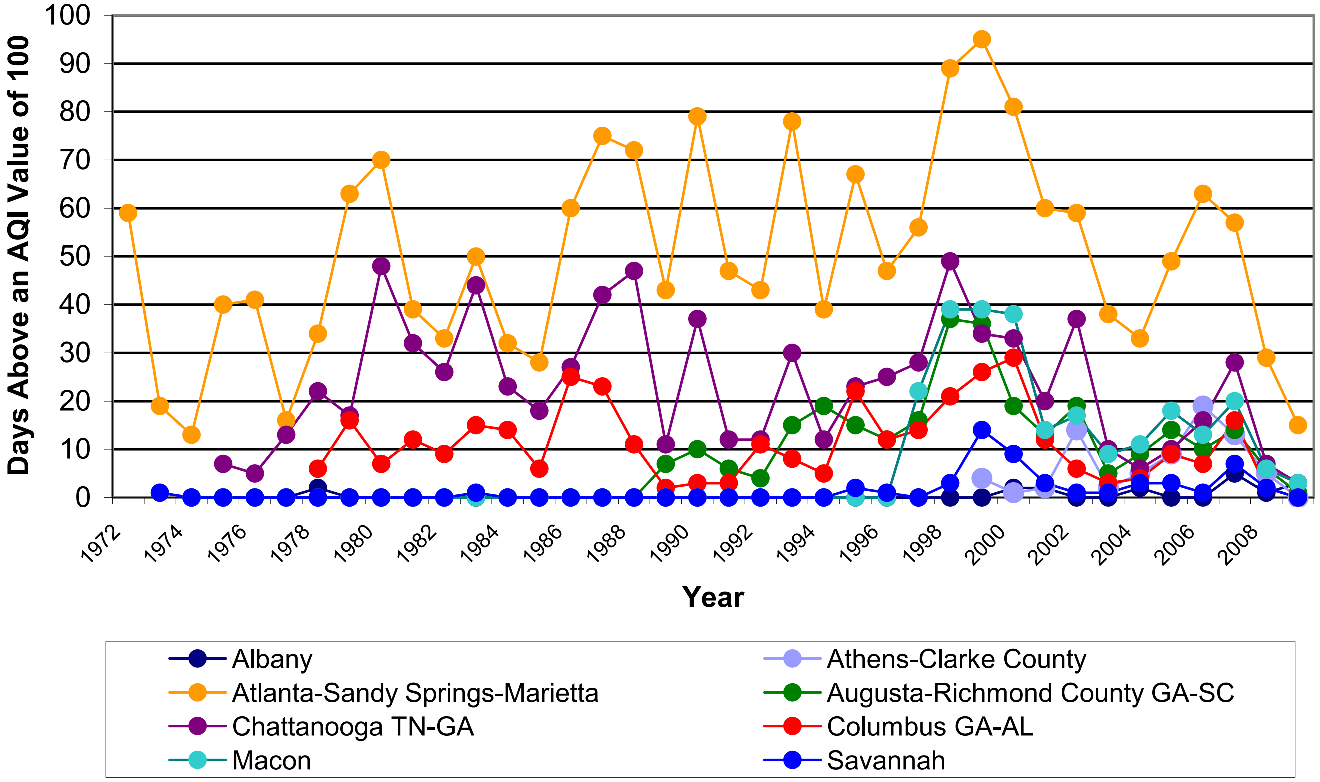


Figure 89: Number of Days with an AQI Value Above 100

How does Georgia's Ambient Monitoring Program (AMP) Cooperate with The Clean Air Campaign® (CAC)?

The Ambient Monitoring Program is responsible for measuring air pollutant levels in metro Atlanta and throughout the state. Equipment at fourteen continuous monitoring stations across metro Atlanta is used for these measurements of particulate matter (PM), sulfur dioxide (SO2), carbon monoxide (CO), nitrogen dioxide (NO2), and ozone (O3). 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 website maintained by CAC. The AQI is then displayed on The Clean Air Campaign's website. The CAC 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 CAC's website and become aware of what voluntary measures they can take to improve local air quality.

MEDIA OUTREACH

The Ambient Monitoring Program is in constant touch with citizens as well as the news media through phone calls, the AMP web site and media interviews. At many times throughout the year, the demand for a story puts AMP in the limelight. 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, the statewide air monitors, and the Clean Air Campaign.

OTHER OUTREACH OPPORTUNITIES

Meteorologists

In cooperation with The Clean Air Campaign, forecasters from the ambient monitoring program visit the weather centers of Atlanta's top four commercial television stations. During these visits, the group is briefed on how each station's weather team receives and uses ambient monitoring information in their daily smog forecasts. The EPD/Clean Air Campaign team provides input and direction to the weathercasters as to how they can best use the data to maximize the usefulness of this information for their viewers.

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 visits 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, such as weather patterns and conditions, as well as forecasting techniques.

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 draw excitement into 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 contracts with Georgia Institute of Technology in a joint forecasting effort.

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 also requires not just providing such data, but also providing guidance on how the data can be interpreted and what the limitations of the data set may be. We welcome these opportunities to serve the public and the research community and to ensure that the data we collect is put to its fullest and most advantageous use is 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 US 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 ozone maps are created that show daily ozone formation and transport at various spatial scales. The information is available on the EPA's AIRNOW website at: http://www.airnow.gov/. See Figure 90 for a sample map.

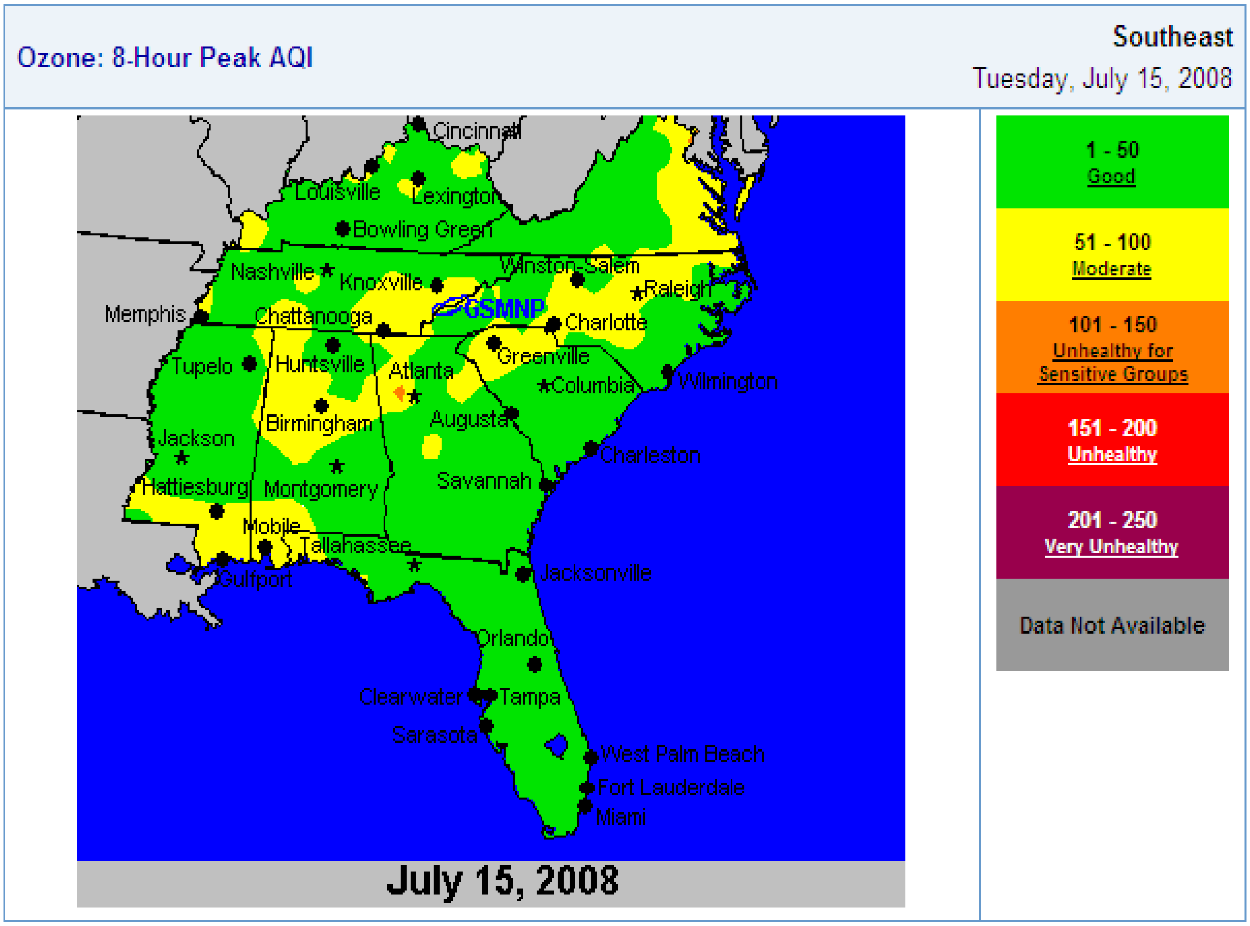


Figure 90: Sample AIRNOW Ozone Concentration Map

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 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. The three tiers are top, middle, and lower. Georgia's evaluation results are shown in Table 38.

Evaluation Criteria	Ozone Season (May 1-Septemeber 30, 2009)	PM2.5 Season (whole year)
Percent of Data Files Received	Middle Tier (97%)	Middle Tier (96%)
Average Data Arrival Time (minutes)	Top Tier (7 minutes)	Top Tier (15 minutes)
Percent Completeness of Files	Lower Tier (93%)	Lower Tier (93%)

Table 38: AIRNOW Participation Evaluation Results

GA EPD Website and Call-In System

The Ambient Monitoring Program also provides a public-access website with Georgia-specific current and historical air quality data 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 only 15 minutes after the hour ends. 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. Finally, the Ambient Monitoring Program also maintains an automated dial-in system that provides current air quality information for those who may not have ready access to the internet. These resources are listed below.

Ambient Monitoring Program Website:
http://www.air.dnr.state.ga.us/amp

Call-In System:
(800) 427-9605 (statewide)
(404) 362-4909 (metro Atlanta free calling zone)

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	
131210099	Atlanta	Fulton	Roswell Road	8524	3.3	2.7	0	2.0	1.5	0
132230003	Yorkville	Paulding	Yorkville	7897	0.512	0.502	0	0.5	0.5	0

Nitrogen Dioxide (NO_2)

Units: parts per million

Site ID	City	County	Site Name	Hours Measured	Max 1-Hour		Annual Arithmetic Mean
					1st	2nd	
130890002	Decatur	DeKalb	South DeKalb	8110	0.067	0.061	0.0107
131210048	Atlanta	Fulton	Georgia Tech	2771*	0.065	0.058	0.0156
132230003	Yorkville	Paulding	Yorkville	8259	0.033	0.025	0.0025
132470001	Conyers	Rockdale	Monastery	8051	0.021	0.021	0.0035

*Monitor ran partial year.

Nitric Oxide (NO)

Units: parts per million

Site ID	City	County	Site Name	Hours Measured	1st Max	Annual Arithmetic Mean
130890002	Decatur	DeKalb	South DeKalb	8111	0.394	0.0209
131210048	Atlanta	Fulton	Georgia Tech	2771*	0.321	0.0091
132230003	Yorkville	Paulding	Yorkville	8522	0.013	0.0050
132470001	Conyers	Rockdale	Monastery	8319	0.058	0.0052

*Monitor ran partial year.

Oxides of Nitrogen (NOx)

Units: parts per million

Site ID	City	County	Site Name	Hours Measured	1st Max	Annual Arithmetic Mean
130890002	Decatur	DeKalb	South DeKalb	8111	0.462	0.0283
131210048	Atlanta	Fulton	Georgia Tech	2771*	0.376	0.0208
132230003	Yorkville	Paulding	Yorkville	8522	0.033	0.0053
132470001	Conyers	Rockdale	Monastery	8051	0.067	0.0060

*Monitor ran partial year.

Reactive Oxides of Nitrogen (NOy)

Units: parts per million

Site ID	City	County	Site Name	Hours Measured	1st Max**	Annual Arithmetic Mean
130890002	Decatur	DeKalb	South DeKalb	6036	0.2010	0.02547

** The NO_y instrument is specialized for measurement of trace concentrations, so its range is only 0-0.200 ppm. Actual 1st Max appears to have exceeded the instrument's measurement range. Since all ambient concentrations exceeding the instrument's range are recorded as 0.200 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, and 1-Hour Maximum Observations

Units: parts per million

Site ID	City	County	Site Name	Hours Measured	Max 24 - Hour		Obs. ≥ 0.14	Max 3 - Hour		Obs. ≥ 0.5	Max 1-Hour		Annual Arithmetic Mean
					1st	2nd		1st	2nd		1st	2nd	
130210012	Macon	Bibb	Georgia Forestry Comm.	8540	0.011	0.006	0	0.034	0.018	0	0.039	0.037	0.0014
130510021	Savannah	Chatham	East President St.	8592	0.022	0.021	0	0.056	0.046	0	0.066	0.065	0.0026
130511002	Savannah	Chatham	W. Lathrop & Augusta Ave.	8611	0.024	0.022	0	0.079	0.065	0	0.157	0.100	0.0026
131150003	Rome	Floyd	Coosa Elem. School	6178*	0.008	0.007	0	0.044	0.024	0	0.064	0.054	0.0014
131210048	Atlanta	Fulton	Georgia Tech	2728*	0.010	0.008	0	0.053	0.023	0	0.124	0.039	0.0021
131210055	Atlanta	Fulton	Confederate Ave.	8590	0.015	0.010	0	0.084	0.022	0	0.116	0.079	0.0017
131270006	Brunswick	Glynn	Risley Middle School	8571	0.015	0.004	0	0.115	0.010	0	0.210	0.134	0.0011
132150008	Columbus	Muscogee	Columbus Airport	8250	0.007	0.007	0	0.019	0.019	0	0.026	0.023	0.0013

*Monitor ran partial year.

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	GA Forestry Comm.	241	0.089	0.088
130510021	Savannah	Chatham	E. President Street	244	0.082	0.079
130550001	Summerville	Chattooga	DNR Fish Hatchery	243	0.096	0.076
130590002	Athens	Clarke	College Station Rd.	243	0.081	0.078
130670003	Kennesaw	Cobb	Georgia National Guard	245	0.109	0.102
130730001	Evans	Columbia	Riverside Park	239	0.071	0.071
130770002	Newnan	Coweta	Univ. of West Georgia	238	0.080	0.080
130850001	Dawsonville	Dawson	GA Forestry Comm.	235	0.080	0.079
130890002	Decatur	DeKalb	South DeKalb	242	0.099	0.096
130970004	Douglasville	Douglas	W. Strickland St.	245	0.100	0.081
131210055	Atlanta	Fulton	Confederate Ave.	244	0.107	0.103
131270006	Brunswick	Glynn	Risley Middle School	238	0.078	0.078
131350002	Lawrenceville	Gwinnett	Gwinnett Tech.	245	0.099	0.094
131510002	McDonough	Henry	County Extension Office	245	0.104	0.088
132130003	Chatsworth	Murray	Fort Mountain	241	0.102	0.085
132150008	Columbus	Muscogee	Columbus Airport	238	0.083	0.081
132230003	Yorkville	Paulding	Yorkville	245	0.078	0.077
132450091	Augusta	Richmond	Bungalow Road Elementary School	227	0.081	0.080
132470001	Conyers	Rockdale	Conyers Monastery	243	0.097	0.093
132611001	Leslie	Sumter	Leslie Community Center	233	0.070	0.065

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	GA Forestry Comm.	241	0.077	0.076	0.074	0.070	2
130510021	Savannah	Chatham	E. President Street	244	0.075	0.066	0.063	0.062	0
130550001	Summerville	Chattooga	DNR Fish Hatchery	243	0.070	0.068	0.066	0.065	0
130590002	Athens	Clarke	College Station Road	243	0.074	0.072	0.067	0.067	0
130670003	Kennesaw	Cobb	Georgia National Guard	245	0.091	0.088	0.079	0.076	**4**
130730001	Evans	Columbia	Riverside Park	238	0.067	0.066	0.065	0.064	0
130770002	Newnan	Coweta	Univ. of West Georgia	237	0.071	0.071	0.066	0.065	0
130850001	Dawsonville	Dawson	GA Forestry Comm.	233	0.071	0.069	0.068	0.067	0
130890002	Decatur	DeKalb	South DeKalb	240	0.083	0.083	0.082	0.077	**5**
130970004	Douglasville	Douglas	W. Strickland St.	245	0.084	0.078	0.072	0.072	2
131210055	Atlanta	Fulton	Confederate Ave.	241	0.094	0.091	0.086	0.077	**5**
131270006	Brunswick	Glynn	Risley Middle School	238	0.066	0.064	0.059	0.057	0
131350002	Lawrenceville	Gwinnett	Gwinnett Tech.	244	0.084	0.081	0.076	0.073	3
131510002	McDonough	Henry	County Extension Office	244	0.081	0.077	0.075	0.074	2
132130003	Chatsworth	Murray	Fort Mountain	240	0.080	0.077	0.070	0.069	2
132150008	Columbus	Muscogee	Columbus Airport	237	0.068	0.067	0.066	0.065	0
132230003	Yorkville	Paulding	Yorkville	245	0.073	0.070	0.068	0.067	0
132450091	Augusta	Richmond	Bungalow Road Elementary School	224	0.070	0.068	0.066	0.065	0
132470001	Conyers	Rockdale	Conyers Monastery	242	0.087	0.081	0.076	0.070	3
132611001	Leslie	Sumter	Community Center	229	0.062	0.060	0.060	0.060	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)

Quarterly Composite Averages

Units: micrograms per cubic meter

Site ID	City	County	Site Name	Number of Observations	1st Quarter Composite Avg.	2nd Quarter Composite Avg.	3rd Quarter Composite Avg.	4th Quarter Composite Avg.	Number of Values > 1.5
130890003	Atlanta	DeKalb	DMRC	7*	0.0034	0.0026	0.0029		0
132150011	Columbus	Muscogee	Cusseta School	7*	0.0163	0.0103	0.0045		0

*Changed to 24-hour data as of August 2009.

Note: The analysis method used for lead cannot reliably distinguish concentrations smaller than 0.20. This is known as the Method Detection Limit (MDL). In cases where the analysis results in a raw data concentration less than the MDL for that method, EPA requires us to report a concentration of one half the MDL. For many purposes, however, these values could alternatively be interpreted as “Not Detected”. As of October 15, 2008, the NAAQS for lead was changed to 0.15 µg/m^3 on a rolling 3-month average. This new lead standard will be effective January 12, 2009 and implemented by January 1, 2010.

24-Hour Averages

Units: micrograms per cubic meter

Site ID	City	County	Site Name	Number of Observations	1st Quarter Avg.	2nd Quarter Avg.	3rd Quarter Avg.	4th Quarter Avg.	Number of Values > 1.5
130150003	Cartersville	Bartow	Cartersville	4*				0.0049	0
130890003	Atlanta	DeKalb	DMRC	25			0.0028	0.0034	0
132150011	Columbus	Muscogee	Cusseta School	25			0.0092	0.0280	0

*Monitor started sampling December 2009.

24-Hour Averages Using Federal Equivalent Method

Units: micrograms per cubic meter

Site ID	City	County	Site Name	Number of Observations	1st Quarter Avg.	2nd Quarter Avg.	3rd Quarter Avg.	4th Quarter Avg.	Number of Values > 1.5
130150003	Cartersville	Bartow	Cartersville	4*				0.0053	0
130890003	Atlanta	DeKalb	DMRC	15				0.0035	0
132150011	Columbus	Muscogee	Cusseta School	15				0.0286	0

*Monitor started sampling December 2009.

Fine Particulate Matter ($PM_{2.5}$)

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	Allied Chemical	310	25.2	1	12.31
130210012	Macon	Bibb	GA Forestry Comm.	108	24.6	1	10.64
130510017	Savannah	Chatham	Market St.	113	21.3	0	9.93
130510091	Savannah	Chatham	Mercer School	107	24.5	0	10.23
130590002	Athens	Clarke	College Station Rd.	111	19.5	0	10.32
130630091	Forest Park	Clayton	Georgia DOT	116	23.3	0	11.54
130670003	Kennesaw	Cobb	GA National Guard	341	24.1	0	11.22
130670004	Powder Springs	Cobb	Macland Aquatic Center	102	19.7	0	10.31
130890002	Decatur	DeKalb	South DeKalb	326	25.8	1	11.41
130892001	Doraville	DeKalb	Police Dept.	333	24.6	1	11.72
130950007	Albany	Dougherty	Turner Elem. School	178	31.6	1	11.80
131150003*	Rome	Floyd	Coosa Elementary*	335	24.5	2	11.35
131210032	Atlanta	Fulton	E. Rivers School	261	24.8	0	11.55
131210039	Atlanta	Fulton	Fire Station #8	113	24.7	0	12.07
131270006	Brunswick	Glynn	Risley Middle School	105	26.4	2	9.71

*Sites consolidated; data combined for Rome-Coosa Elem and Rome-Coosa High.

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

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
131350002	Lawrence-ville	Gwinnett	Gwinnett Tech	102	22.1	0	11.55
131390003	Gainesville	Hall	Fair St. Elem.	109	20.0	0	10.22
131530001	Warner Robins	Houston	Robins AFB	107	23.5	0	10.39
131850003	Valdosta	Lowndes	S.L. Mason Elem.	107	24.7	0	9.76
132150001	Columbus	Muscogee	Health Dept.	114	22.8	0	11.22
132150008	Columbus	Muscogee	Columbus Airport	60	25.0	0	11.79
132150011	Columbus	Muscogee	Cusseta Rd. School	113	23.8	1	11.01
132230003	Yorkville	Paulding	Yorkville	103	22.4	0	9.91
132450005	Augusta	Richmond	Medical College	95	23.7	0	10.92
132450091	Augusta	Richmond	Bungalow Rd. School	110	24.2	1	12.03
132950002	Rossville	Walker	Health Dept.	117	23.6	0	10.70
133030001	Sandersville	Washing-ton	Health Dept.	109	30.9	1	11.27
133190001	Gordon	Wilkinson	Police Dept.	119	27.4	1	12.51

Fine Particulate Matter ($PM_{2.5}$)

Annual Arithmetic Mean
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	GA Forestry Comm.	8537	80.0	76.6	10.06
130511002	Savannah	Chatham	Lathrop & Augusta Avenues	8648	70.2	66.3	9.95
130590002	Athens	Clarke	College Station Rd.	8663	153.8	64.5	9.50
130770002	Newnan	Coweta	Univ. of West Georgia	8385	86.4	73.1	9.89
130890002	Decatur	DeKalb	South DeKalb	8556	90.4	65.4	11.20
130950007	Albany	Dougherty	Turner Elem	7402	125.4	99.1	13.97
131150003*	Rome	Floyd	Coosa Elem*	7747	82.4	75.5	11.81
131210055	Atlanta	Fulton	Confederate Avenue	8624	87.5	86.7	13.77
131350002	Lawrenceville	Gwinnett	Gwinnett Tech	8662	67.5	57.6	10.07
131390003	Gainesville	Hall	Gainesville	7587	260.0	108.1	11.99
131510002	McDonough	Henry	County Extension Office	8661	85.3	79.9	9.98
131530001	Warner Robins	Houston	Warner Robins	6936	73.9	68.1	13.46
131850003	Valdosta	Lowndes	Valdosta	7759	62.7	58.2	13.22
132150008	Columbus	Muscogee	Columbus Airport	8602	85.3	80.3	9.89
132230003	Yorkville	Paulding	Yorkville	8615	55.4	49.6	8.95
132450091	Augusta	Richmond	Bungalow Rd. School	8272	69.1	68.7	10.27
132950002	Rossville	Walker	Health Department	7469	57.6	47.6	12.05

*Sites consolidated; data combined for Rome-Coosa Elem and Rome-Coosa High

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	1^{st} Max	Number Values ≥150	Annual Arith-metic Mean
130210007	Macon	Bibb	Allied Chemical	59	53	0	22.9
130510014	Savannah	Chatham	Shuman School	56	34	0	18.1
130550001	Summerville	Chattooga	DNR Fish Hatchery	60	37	0	19.6
130892001	Doraville	DeKalb	Police Dept.	56	35	0	20.6
130950007	Albany	Dougherty	Turner Elementary	55	71	0	26.6
131150003*	Rome	Floyd	Coosa Elem School*	60	45	0	24.9
131210032	Atlanta	Fulton	E. Rivers School	45	40	0	21.5
131270004	Brunswick	Glynn	Arco Pump Station	47	85	0	23.5
132150011	Columbus	Muscogee	Cusseta Rd. Elem. School	59	94	0	22.6
132450091	Augusta	Richmond	Bungalow Rd. Elem. School	58	46	0	23.6
133030001	Sandersville	Washington	Health Dept.	53	55	0	24.6

*Sites consolidated; data combined for Rome-Coosa Elem and Rome-Coosa High

Particulate Matter (PM_{10})

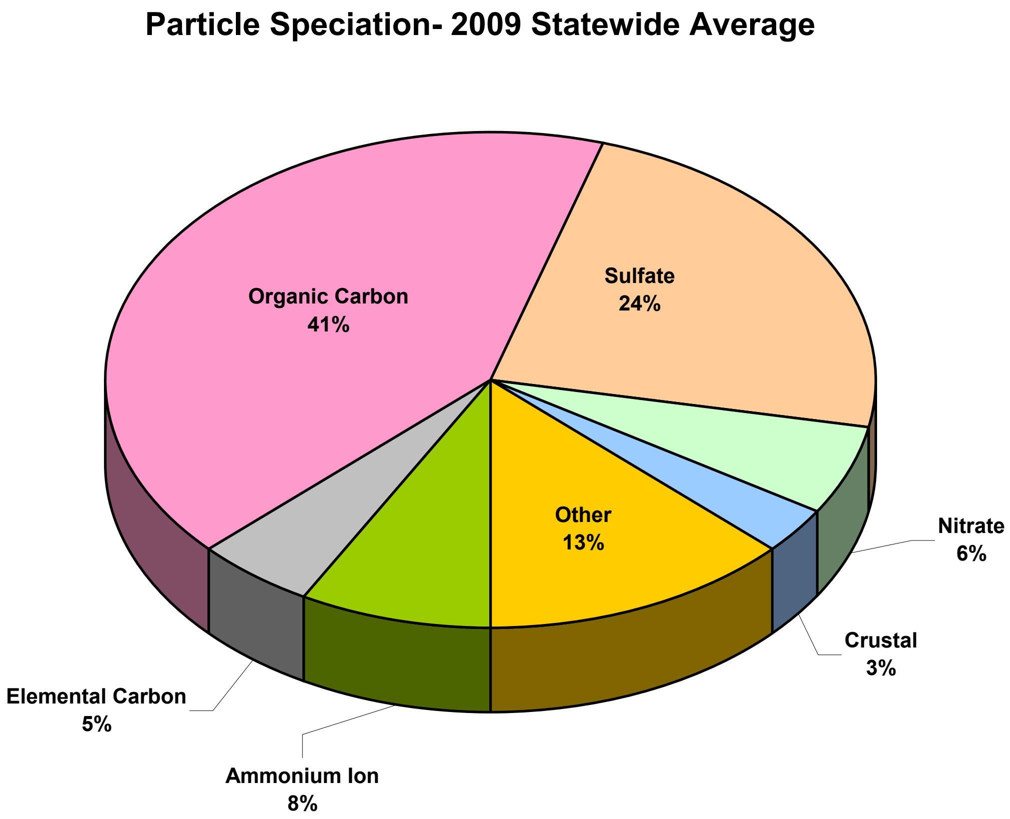
Hourly Averages of Semi-Continuous Measurements

Units: micrograms per cubic meter

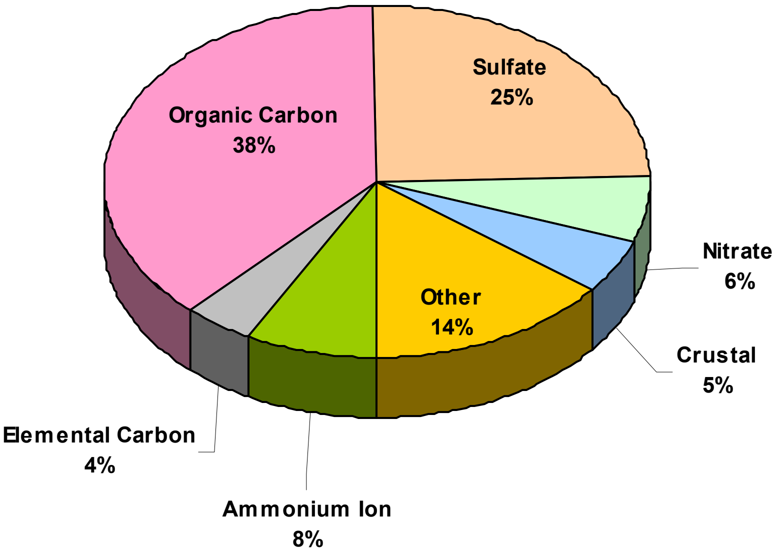
Site ID	City	County	Site Name	Hours Measured	1st Max	Annual Arithmetic Mean
131210048	Atlanta	Fulton	Georgia Tech	5483*	42	18.2

*Monitor ran partial year.

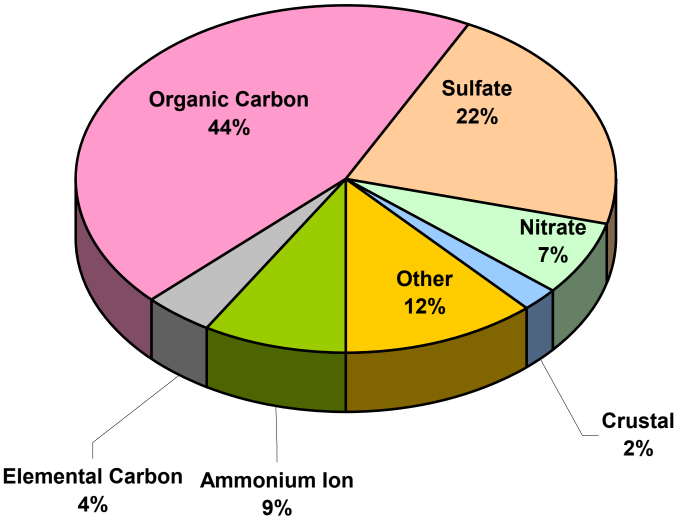
Appendix B: Additional $PM_{2.5}$ Particle Speciation Data

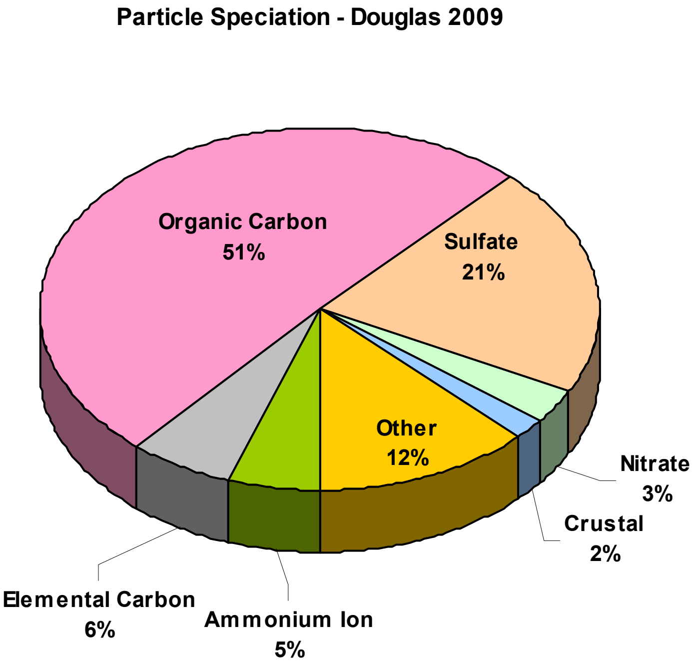


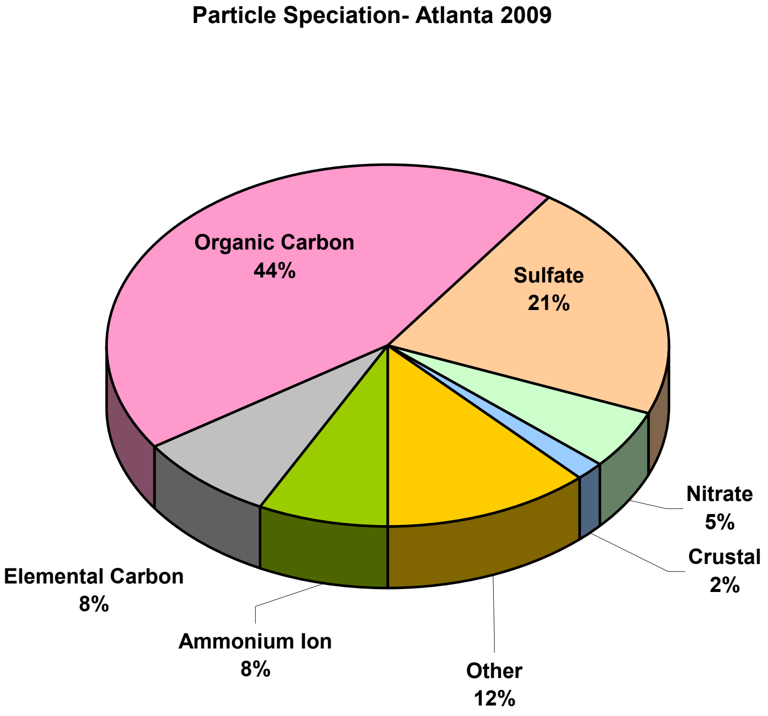
Particle Speciation - Macon 2009



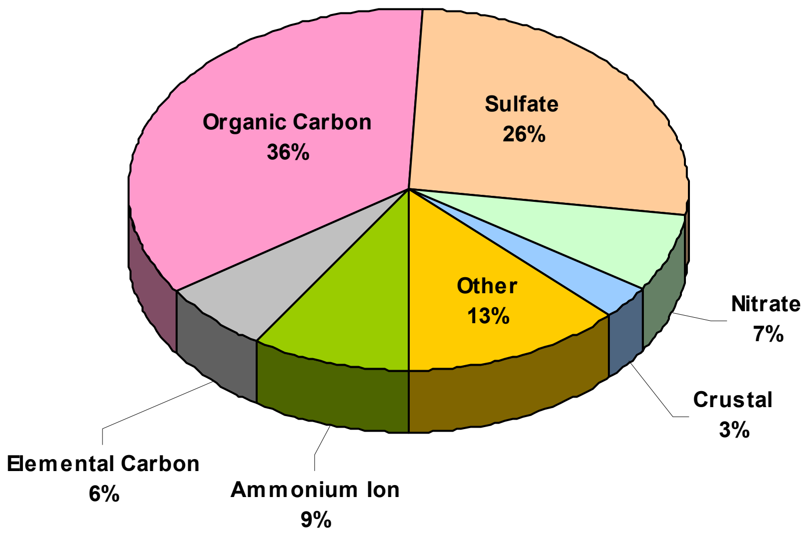
Particle Speciation - Athens 2009



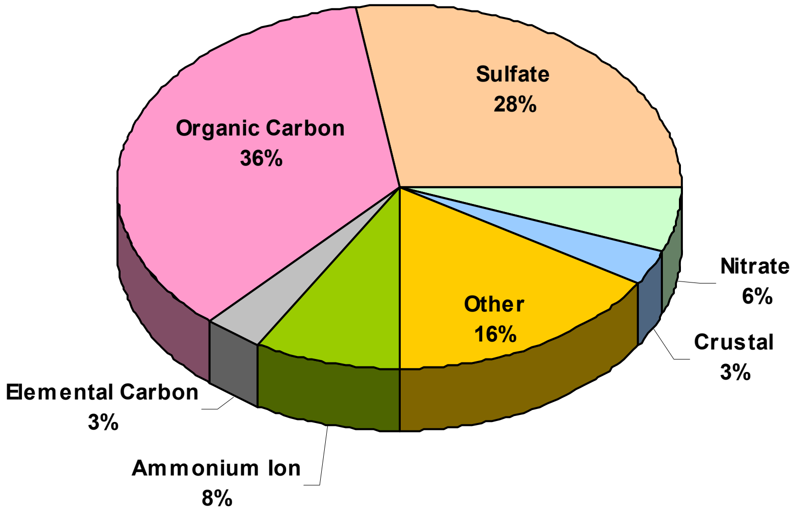

Particle Speciation - Douglas 2009
Organic Carbon 51%
Sulfate 21%
Nitrate 3%
Crustal 2%
Other 12%
Ammonium Ion 5%
Elemental Carbon 6%


Particle Speciation- Atlanta 2009
Organic Carbon 44%
Sulfate 21%
Nitrate 5%
Crustal 2%
Other 12%
Ammonium Ion 8%
Elemental Carbon 8%

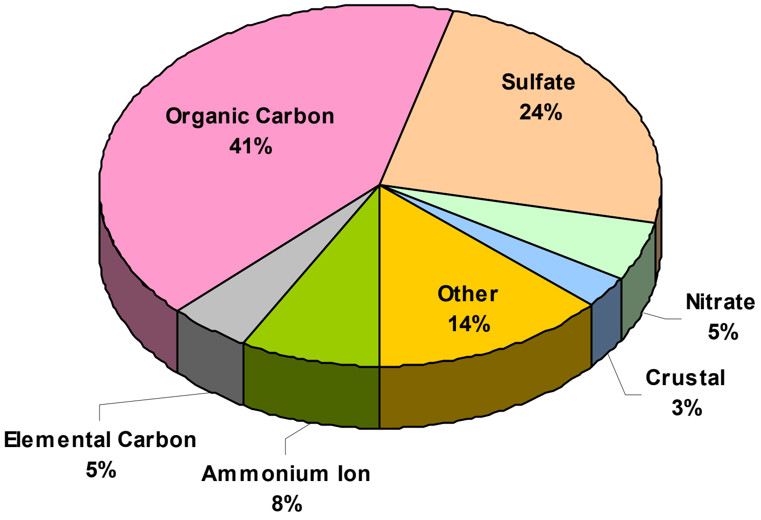
Particle Speciation - Rome 2009



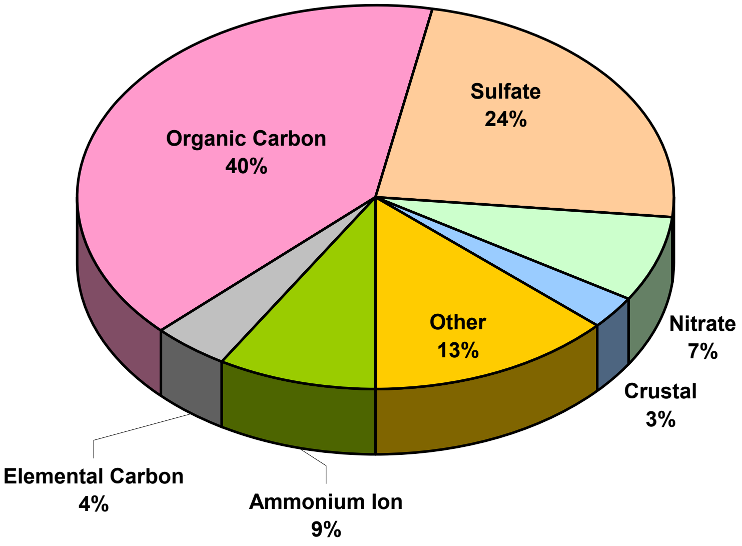
Particle Speciation - Columbus 2009



Particle Speciation - Augusta 2009



Particle Speciation - Rossville 2009



Appendix C: Additional PAMS Data

PAMS Continuous Hydrocarbon Data (June-August 2009)

(concentrations in parts per billion Carbon (ppbC))

Name	Site	#Samples	Avg.	1st Max	2nd Max
PAMSHC	S. DeKalb	1290	60.15	291.6	246.2
	Conyers	1962	33.37	116.5	110.3
	Yorkville	1379	21.54	86.1	83.8
TNMOC	S. DeKalb	1290	74.37	355.0	287.8
	Conyers	1962	37.65	129.7	123.9
	Yorkville	1379	28.38	93.9	91.5
Ethane	S. DeKalb	1425	3.606	15.00	14.90
	Conyers	1959	2.718	11.50	11.00
	Yorkville	1854	2.343	9.72	9.22
Ethylene	S. DeKalb	1425	2.251	29.68	18.02
	Conyers	1959	0.373	4.70	3.40
	Yorkville	1839	0.369	2.34	2.14
Propane	S. DeKalb	1425	4.554	39.69	37.14
	Conyers	1959	3.154	14.80	13.90
	Yorkville	1845	2.698	50.62	16.04
Propylene	S. DeKalb	1425	1.358	12.49	8.09
	Conyers	1959	0.563	2.90	2.00
	Yorkville	1843	0.375	2.05	1.58
Acetylene	S. DeKalb	1425	0.89	19.1	11.5
	Conyers	1959	0.19	4.2	2.7
	Yorkville	1870	0.16	3.8	1.9
n-Butane	S. DeKalb	1425	2.315	13.69	12.29
	Conyers	1959	1.091	4.80	4.20
	Yorkville	1867	0.751	19.21	2.78
Isobutane	S. DeKalb	1425	1.310	7.86	7.46
	Conyers	1959	0.538	2.60	2.50
	Yorkville	1864	0.321	2.67	1.45
trans-2-Butene	S. DeKalb	1425	0.181	1.31	1.23
	Conyers	1959	0.007	0.30	0.30
	Yorkville	1870	0.005	0.26	0.24
cis-2-Butene	S. DeKalb	1425	0.091	1.48	1.44
	Conyers	1959	0.007	0.60	0.30
	Yorkville	1871	0.005	0.01	0.01
n-Pentane	S. DeKalb	1425	5.685	38.12	34.66
	Conyers	1959	0.938	11.30	10.40
	Yorkville	1871	0.554	3.98	3.62
Isopentane	S. DeKalb	1425	4.415	28.20	25.17
	Conyers	1959	1.820	13.90	13.10
	Yorkville	1871	0.972	5.95	5.86
1-Pentene	S. DeKalb	1425	0.100	1.02	0.90
	Conyers	1959	0.005	0.20	0.01
	Yorkville	1867	0.005	0.49	0.22

PAMS Continuous Hydrocarbon Data (June-August 2009)(continued)

(concentrations in ppbC)

Name	Site	#Samples	Avg.	1st Max	2nd Max
trans-2-Pentene	S. DeKalb	1425	0.168	6.65	1.99
	Conyers	1959	0.007	0.60	0.20
	Yorkville	1869	0.007	0.52	0.43
cis-2-Pentene	S. DeKalb	1425	0.072	0.99	0.79
	Conyers	1959	0.005	0.20	0.20
	Yorkville	1866	0.005	0.24	0.01
3-Methylpentane	S. DeKalb	1425	0.867	5.27	5.02
	Conyers	1956	0.160	2.50	1.90
	Yorkville	1867	0.074	1.59	0.97
n-Hexane	S. DeKalb	1282	1.189	6.94	6.91
	Conyers	1749	0.478	3.70	2.30
	Yorkville	2065	0.073	3.31	2.81
n-Heptane	S. DeKalb	1282	0.532	5.25	3.95
	Conyers	1954	0.162	1.70	1.10
	Yorkville	2065	0.020	1.44	0.94
n-Octane	S. DeKalb	1282	0.172	1.54	1.50
	Conyers	1954	0.029	1.20	0.60
	Yorkville	2065	0.013	0.68	0.49
n-Nonane	S. DeKalb	1282	0.147	1.23	1.20
	Conyers	1954	0.062	0.50	0.50
	Yorkville	2065	0.018	3.63	0.44
n-Decane	S. DeKalb	1282	0.140	2.53	2.17
	Conyers	1954	0.034	1.60	0.70
	Yorkville	2065	0.019	1.22	1.06
Cyclopentane	S. DeKalb	1425	0.542	40.99	20.94
	Conyers	1959	0.030	0.60	0.50
	Yorkville	1871	0.010	0.34	0.28
Isoprene	S. DeKalb	1425	7.478	31.49	28.57
	Conyers	1958	6.642	60.20	59.00
	Yorkville	1872	7.415	67.66	65.18
2,2-Dimethylbutane	S. DeKalb	1425	0.114	1.12	0.94
	Conyers	1958	0.043	1.50	1.00
	Yorkville	1868	0.005	0.27	0.22
2,4-Dimethylpentane	S. DeKalb	1282	0.203	1.72	1.62
	Conyers	1954	0.051	0.70	0.60
	Yorkville	2065	0.008	0.72	0.68
Cyclohexane	S. DeKalb	1282	0.182	1.50	1.31
	Conyers	1954	0.036	0.60	0.40
	Yorkville	2065	0.006	0.31	0.24
3-Methylhexane	S. DeKalb	1282	1.009	4.98	4.05
	Conyers	1954	0.201	2.60	1.90
	Yorkville	2065	0.033	1.65	1.01
2,2,4-Trimethylpentane	S. DeKalb	1282	1.159	7.76	7.52
	Conyers	1954	0.437	3.40	2.40
	Yorkville	2065	0.077	2.09	1.76

PAMS Continuous Hydrocarbon Data (June-August 2009)(continued)

(concentrations in ppbC)

Name	Site	#Samples	Avg.	1st Max	2nd Max
2,3,4-Trimethylpentane	S. DeKalb	1282	0.303	2.25	2.25
	Conyers	1954	0.089	0.70	0.70
	Yorkville	2065	0.010	0.83	0.82
3-Methylheptane	S. DeKalb	1282	0.159	1.76	1.36
	Conyers	1954	0.035	0.70	0.50
	Yorkville	2065	0.010	1.27	1.15
Methylcyclohexane	S. DeKalb	1282	0.524	3.15	2.36
	Conyers	1954	0.056	0.90	0.60
	Yorkville	2065	0.011	1.40	1.36
Methylcyclopentane	S. DeKalb	1282	0.518	3.78	3.60
	Conyers	1954	0.212	2.00	1.20
	Yorkville	2065	0.028	2.89	2.70
2-Methylhexane	S. DeKalb	1282	0.487	3.43	2.84
	Conyers	1954	0.161	1.90	1.60
	Yorkville	2065	0.012	1.66	1.17
1-Butene	S. DeKalb	1425	0.348	2.29	1.18
	Conyers	1959	0.125	0.60	0.50
	Yorkville	1872	0.007	0.32	0.32
2,3-Dimethylbutane	S. DeKalb	1425	0.321	6.96	2.26
	Conyers	1956	0.038	1.50	1.30
	Yorkville	1867	0.012	0.43	0.42
2-Methylpentane	S. DeKalb	1425	1.215	7.70	7.06
	Conyers	1956	0.158	1.90	1.00
	Yorkville	1867	0.204	2.33	1.45
2,3-Dimethylpentane	S. DeKalb	1282	0.340	2.44	2.10
	Conyers	1954	0.072	0.80	0.70
	Yorkville	2065	0.010	0.74	0.68
n-Undecane	S. DeKalb	1282	0.424	4.25	4.05
	Conyers	1954	0.065	14.80	1.60
	Yorkville	2065	0.067	2.77	1.78
2-Methylheptane	S. DeKalb	1282	0.129	2.88	1.80
	Conyers	1954	0.028	0.40	0.30
	Yorkville	2065	0.008	1.16	0.79
m & p Xylenes	S. DeKalb	1282	1.472	17.93	10.23
	Conyers	1954	0.532	6.00	5.60
	Yorkville	2065	0.147	2.67	1.92
Benzene	S. DeKalb	1282	1.305	15.03	8.62
	Conyers	1954	0.551	5.00	2.40
	Yorkville	2065	0.107	1.63	1.10
Toluene	S. DeKalb	1282	3.752	26.83	20.77
	Conyers	1954	1.455	37.40	9.50
	Yorkville	2065	0.578	5.35	4.10
Ethylbenzene	S. DeKalb	1282	0.486	4.91	2.66
	Conyers	1954	0.171	2.10	1.70
	Yorkville	2065	0.020	0.82	0.68

PAMS Continuous Hydrocarbon Data (June-August 2009)(continued)

(concentrations in ppbC)

Name	Site	#Samples	Avg.	1st Max	2nd Max
o-Xylene	S. DeKalb	1282	0.565	5.47	4.11
	Conyers	1954	0.223	1.90	1.40
	Yorkville	2065	0.029	1.06	0.77
1,3,5-Trimethylbenzene	S. DeKalb	1282	0.192	2.83	1.79
	Conyers	1954	0.125	1.10	0.90
	Yorkville	2065	0.014	0.87	0.79
1,2,4-Trimethylbenzene	S. DeKalb	1282	0.835	9.68	4.60
	Conyers	1954	0.314	2.80	1.70
	Yorkville	2063	0.053	1.85	1.45
n-Propylbenzene	S. DeKalb	1282	0.098	1.49	1.18
	Conyers	1954	0.094	0.60	0.60
	Yorkville	2065	0.011	0.66	0.65
Isopropylbenzene	S. DeKalb	1282	0.207	2.52	2.39
	Conyers	1954	0.053	0.60	0.60
	Yorkville	2065	0.012	2.98	1.40
o-Ethyltoluene	S. DeKalb	1282	0.161	2.17	1.51
	Conyers	1954	0.056	0.90	0.70
	Yorkville	2065	0.010	0.60	0.58
m-Ethyltoluene	S. DeKalb	N/A			
	Conyers	N/A			
	Yorkville	875	0.568	5.04	3.61
m-Diethylbenzene	S. DeKalb	1282	0.044	2.11	2.00
	Conyers	1954	0.011	0.40	0.40
	Yorkville	1996	0.006	0.38	0.24
p-Diethylbenzene	S. DeKalb	1282	0.124	2.25	1.43
	Conyers	1954	0.048	0.70	0.60
	Yorkville	2065	0.011	0.84	0.82
Styrene	S. DeKalb	1282	0.614	2.93	2.67
	Conyers	1954	0.176	1.50	1.50
	Yorkville	2064	0.145	0.94	0.92
Beta Pinene and 1,2,3-Trimethylbenzene	S. DeKalb	1283	2.554	14.16	13.05
	Conyers	1954	5.491	30.20	29.90
	Yorkville	2065	1.933	16.93	12.94
Pinene and p-Ethyltoluene	S. DeKalb	N/A			
	Conyers	N/A			
	Yorkville	875	0.006	0.45	0.33
m and p-Ethyltoluene	S. DeKalb	1283	2.096	13.98	11.10
	Conyers	1954	3.545	19.90	19.50
	Yorkville	1190	1.075	5.44	5.11

N/A indicates not applicable

PAMS 2009 24-hour Canister Hydrocarbons

(concentrations in parts per billion Carbon (ppbC))

Name	Site	#Samples	#Detects	Avg.*	1st Max	2nd Max
PAMSHC	S. DeKalb	39	39	61.21	160.0	160.0
	Conyers	11	11	39.91	100.0	80.0
	Yorkville	39	39	23.19	54.0	46.0
TNMOC	S. DeKalb	39	39	234.54	430.0	410.0
	Conyers	11	11	153.55	350.0	230.0
	Yorkville	39	39	97.03	215.0	150.0
Ethane	S. DeKalb	39	32	4.62	14.0	13.0
	Conyers	40	40	4.72	9.6	9.2
	Yorkville	39	39	4.38	10.0	7.7
Ethylene	S. DeKalb	39	ND			
	Conyers	40	ND			
	Yorkville	39	ND			
Propane	S. DeKalb	39	37	6.35	19.0	17.0
	Conyers	40	38	4.56	11.0	10.0
	54Yorkville	39	37	4.36	12.0	8.3
Propylene	S. DeKalb	39	27	0.99	4.2	3.8
	Conyers	40	16	0.27	1.2	0.9
	Yorkville	39	3	0.12	0.4	0.3
Acetylene	S. DeKalb	39	30	1.36	5.4	5.1
	Conyers	40	26	0.82	2.5	2.4
	Yorkville	39	24	0.52	1.8	1.5
n-Butane	S. DeKalb	39	37	5.10	18.0	18.0
	Conyers	40	33	2.18	6.8	6.5
	Yorkville	39	31	1.54	4.4	4.1
Isobutane	S. DeKalb	39	30	1.61	6.0	5.7
	Conyers	40	24	0.57	1.9	1.6
	Yorkville	39	15	0.37	1.4	1.3
trans-2-Butene	S. DeKalb	39	4	0.13	0.5	0.4
	Conyers	40	5	5.96	100.0	71.0
	Yorkville	39	ND			
cis-2-Butene	S. DeKalb	39	3	0.12	0.6	0.3
	Conyers	40	1	0.11	0.6	
	Yorkville	39	ND			
n-Pentane	S. DeKalb	39	38	3.24	8.6	8.3
	Conyers	40	34	1.05	3.4	3.2
	Yorkville	39	32	0.59	1.6	1.5
Isopentane	S. DeKalb	39	38	6.00	27.0	15.0
	Conyers	40	38	1.92	5.8	5.0
	Yorkville	39	33	1.24	5.2	3.9
1-Pentene	S. DeKalb	39	6	0.15	1.0	0.5
	Conyers	40	4	0.16	1.4	0.5
	Yorkville	39	1	0.11	0.3	
trans-2-Pentene	S. DeKalb	39	11	0.71	6.2	5.9
	Conyers	40	13	1.71	7.8	7.3
	Yorkville	39	9	0.90	10.0	7.1

PAMS 2009 24-hour Canister Hydrocarbons (continued)

(concentrations in ppbC)

Name	Site	#Samples	#Detects	Avg.*	1st Max	2nd Max
cis-2-Pentene	S. DeKalb	39	3	0.20	3.7	0.3
	Conyers	40	2	0.25	3.1	3.0
	Yorkville	39	2	0.44	10.0	3.4
3-Methylpentane	S. DeKalb	39	29	1.43	4.1	3.9
	Conyers	40	19	0.38	2.9	1.0
	Yorkville	39	13	0.28	1.2	1.0
n-Hexane	S. DeKalb	39	32	1.08	3.2	3.0
	Conyers	40	9	0.17	0.8	0.5
	Yorkville	39	10	0.19	0.6	0.6
n-Heptane	S. DeKalb	39	14	0.28	1.2	1.1
	Conyers	40	ND			
	Yorkville	39	ND			
n-Octane	S. DeKalb	39	2	0.11	0.4	0.3
	Conyers	40	ND			
	Yorkville	39	ND			
n-Nonane	S. DeKalb	39	1	0.10	0.3	
	Conyers	40	ND			
	Yorkville	39	ND			
n-Decane	S. DeKalb	39	3	0.11	0.4	0.3
	Conyers	40	2	0.14	1.6	0.3
	Yorkville	39	ND			
Cyclopentane	S. DeKalb	39	1	0.1	0.2	
	Conyers	40	ND			
	Yorkville	39	ND			
Isoprene	S. DeKalb	39	19	2.70	17.0	12.0
	Conyers	40	15	2.23	12.0	12.0
	Yorkville	39	15	1.81	13.0	12.0
2,2-Dimethylbutane	S. DeKalb	39	31	1.04	3.5	2.9
	Conyers	40	11	0.52	4.3	2.7
	Yorkville	39	1	0.11	0.6	
2,4-Dimethylpentane	S. DeKalb	39	5	0.12	0.4	0.3
	Conyers	40	ND			
	Yorkville	39	ND			
Cyclohexane	S. DeKalb	39	6	0.14	0.5	0.4
	Conyers	40	2	0.11	0.2	0.2
	Yorkville	39	4	0.18	2.4	0.7
3-Methylhexane	S. DeKalb	39	16	0.39	1.5	1.4
	Conyers	40	2	0.11	0.3	0.3
	Yorkville	39	ND			
2,2,4-Trimethylpentane	S. DeKalb	39	24	1.04	4.4	4.4
	Conyers	40	8	0.18	0.9	0.7
	Yorkville	39	2	0.11	0.4	0.2
2,3,4-Trimethylpentane	S. DeKalb	39	8	0.20	1.0	0.9
	Conyers	40	ND			
	Yorkville	39	ND			

PAMS 2009 24-hour Canister Hydrocarbons (continued)

(concentrations in ppbC)

Name	Site	#Samples	#Detects	Avg.*	1st Max	2ndMax
3-Methylheptane	S. DeKalb	39	1	0.11	0.4	0.1
	Conyers	40	1	0.10	0.2	
	Yorkville	39	ND			
Methylcyclohexane	S. DeKalb	39	5	0.14	0.5	0.5
	Conyers	40	ND			
	Yorkville	39	ND			
Methylcyclopentane	S. DeKalb	39	16	0.37	1.5	1.4
	Conyers	40	ND			
	Yorkville	39	ND			
2-Methylhexane	S. DeKalb	39	17	0.97	8.3	4.6
	Conyers	40	ND			
	Yorkville	39	ND			
1-Butene	S. DeKalb	39	15	0.35	4.0	1.0
	Conyers	40	1	0.11	0.4	
	Yorkville	39	1	0.11	0.3	
2,3-Dimenthylbutane	S. DeKalb	39	13	0.25	0.9	0.9
	Conyers	40	6	0.19	0.9	0.9
	Yorkville	39	6	0.18	1.1	1.0
2-Methylpentane	S. DeKalb	39	28	1.14	3.7	3.7
	Conyers	40	17	0.25	0.9	0.9
	Yorkville	39	8	0.29	3.6	1.3
2,3-Dimethylpentane	S. DeKalb	39	22	1.07	4.1	3.7
	Conyers	40	ND			
	Yorkville	39	ND			
n-Undecane	S. DeKalb	39	17	0.29	0.9	0.9
	Conyers	40	1	0.14	1.5	
	Yorkville	39	2	0.13	1.1	0.3
2-Methylheptane	S. DeKalb	39	1	0.11	0.4	0.1
	Conyers	40	ND			
	Yorkville	39	ND			
m & p Xylenes	S. DeKalb	39	37	1.61	4.7	4.6
	Conyers	40	23	0.33	0.9	0.9
	Yorkville	39	9	0.28	1.9	1.2
Benzene	S. DeKalb	39	39	1.76	4.9	4.8
	Conyers	40	26	0.65	1.9	1.8
	Yorkville	39	15	0.43	1.5	1.5
Toluene	S. DeKalb	39	39	3.98	10.0	9.9
	Conyers	40	39	1.40	3.4	3.3
	Yorkville	39	35	1.17	5.6	4.1
Ethylbenzene	S. DeKalb	39	16	0.30	1.2	1.1
	Conyers	40	ND			
	Yorkville	39	3	0.12	0.5	0.3
o-Xylene	S. DeKalb	39	17	0.38	1.5	1.5
	Conyers	40	ND			
	Yorkville	39	5	0.16	0.8	0.5

PAMS 2009 24-hour Canister Hydrocarbons (continued)

(concentrations in ppbC)

Name	Site	#Samples	#Detects	Avg.*	1st Max	2ndMax
1,3,5-Trimethylbenzene	S. DeKalb	39	2	0.11	0.4	0.3
	Conyers	40	ND			
	Yorkville	39	3	0.13	0.7	0.3
1,2,4-Trimethylbenzene	S. DeKalb	39	26	2.60	15.0	14.0
	Conyers	3	ND			
	Yorkville	32	9	2.38	19.0	12.0
n-Propylbenzene	S. DeKalb	39	ND			
	Conyers	40	ND			
	Yorkville	39	1	0.11	0.3	
Isopropylbenzene	S. DeKalb	39	ND			
	Conyers	40	ND			
	Yorkville	39	ND			
o-Ethyltoluene	S. DeKalb	39	4	0.14	0.9	0.5
	Conyers	40	ND			
	Yorkville	39	2	0.11	0.3	0.2
m-Ethyltoluene	S. DeKalb	39	15	0.30	1.2	1.0
	Conyers	40	1	0.11	0.3	
	Yorkville	39	5	0.20	1.6	0.9
p-Ethyltoluene	S. DeKalb	39	9	0.19	0.8	0.7
	Conyers	40	7	0.20	1.0	0.9
	Yorkville	39	5	0.16	1.1	0.6
m-Diethylbenzene	S. DeKalb	39	ND			
	Conyers	40	ND			
	Yorkville	39	ND			
p-Diethylbenzene	S. DeKalb	39	ND			
	Conyers	40	ND			
	Yorkville	39	2	0.11	0.4	0.3
Styrene	S. DeKalb	39	31	0.48	1.4	1.1
	Conyers	40	12	0.22	1.7	0.6
	Yorkville	39	30	1.86	17.0	9.9
1,2,3-Trimethylbenzene	S. DeKalb	39	6	0.15	0.6	0.6
	Conyers	40	4	0.14	1.1	0.3
	Yorkville	39	5	0.17	1.0	0.9

ND indicates no detection

*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

2009 Metals

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

Name	Site	#Samples	#Detects	Avg.*	1st Max	2nd Max
Antimony	Macon	29	29	0.00056	0.00234	0.00143
	Savannah	31	31	0.00056	0.00159	0.00108
	General Coffee	29	26	0.00031	0.00142	0.00066
	Dawsonville	24	21	0.00045	0.00132	0.00109
	South DeKalb**	57	56	0.00077	0.00278	0.00211
	Yorkville	26	24	0.00045	0.00121	0.00094
Arsenic	Macon	29	20	0.00056	0.00114	0.00097
	Savannah	31	24	0.00063	0.00148	0.00147
	General Coffee	29	23	0.00096	0.00220	0.00219
	Dawsonville	24	15	0.00055	0.00161	0.00129
	South DeKalb**	57	36	0.00051	0.00177	0.00133
	Yorkville	26	19	0.00062	0.00161	0.00106
Beryllium	Macon	29	2	0.00003	0.00022	0.00009
	Savannah	31	ND			
	General Coffee	29	ND			
	Dawsonville	24	ND			
	South DeKalb**	57	ND			
	Yorkville	26	ND			
Cadmium	Macon	29	29	0.00015	0.00050	0.00031
	Savannah	31	31	0.00026	0.00068	0.00054
	General Coffee	29	29	0.00019	0.00176	0.00080
	Dawsonville	24	23	0.00015	0.00057	0.00021
	South DeKalb**	57	54	0.00006	0.00023	0.00015
	Yorkville	26	25	0.00014	0.00075	0.00041
Chromium	Macon	29	29	0.00208	0.00354	0.00347
	Savannah	31	30	0.00218	0.00409	0.00389
	General Coffee	29	29	0.00285	0.03048	0.00349
	Dawsonville	24	24	0.00229	0.00683	0.00392
	South DeKalb**	57	56	0.00169	0.01056	0.00350
	Yorkville	26	25	0.00192	0.00307	0.00305
*Chromium+6****	South DeKalb	58	21	0.00001	0.00009	0.00007
Cobalt	Macon	29	20	0.00021	0.00192	0.00106
	Savannah	31	18	0.00009	0.00023	0.00021
	General Coffee	29	20	0.00011	0.00055	0.00035
	Dawsonville	24	12	0.00007	0.00021	0.00012
	South DeKalb**	57	16	0.00006	0.00021	0.00011
	Yorkville	26	10	0.00007	0.00014	0.00012

2009 Metals (continued)

(concentrations in µg/m^3)

Name	Site	#Samples	#Detects	Avg.*	1st Max	2nd Max
Lead	Macon	29	29	0.00492	0.03437	0.01056
	Savannah	31	31	0.00248	0.00536	0.00505
	General Coffee	29	29	0.00180	0.00503	0.00378
	Dawsonville	24	24	0.00153	0.00395	0.00328
	South DeKalb**	57	57	0.00136	0.00456	0.00336
	Yorkville	26	26	0.00163	0.00369	0.00312
Manganese	Macon	29	29	0.00619	0.02916	0.01152
	Savannah	31	31	0.00439	0.01536	0.01312
	General Coffee	29	29	0.00355	0.00852	0.00749
	Dawsonville	24	24	0.00339	0.01105	0.00916
	South DeKalb**	57	57	0.00211	0.00509	0.00498
	Yorkville	26	26	0.00309	0.00688	0.00594
Nickel	Macon	29	29	0.00166	0.00548	0.00232
	Savannah	31	31	0.00223	0.00436	0.00428
	General Coffee	29	29	0.00246	0.01949	0.00292
	Dawsonville	24	24	0.00178	0.01562	0.00194
	South DeKalb**	57	57	0.00134	0.02308	0.00169
	Yorkville	26	25	0.00153	0.00357	0.00276
Selenium	Macon	29	28	0.00051	0.00130	0.00095
	Savannah	31	30	0.00045	0.00114	0.00097
	General Coffee	29	28	0.00046	0.00109	0.00105
	Dawsonville	24	21	0.00058	0.00138	0.00137
	South DeKalb**	57	49	0.00043	0.00241	0.00142
	Yorkville	26	25	0.00054	0.00094	0.00092
Zinc	Macon	29	29	0.05427	0.31489	0.17563
	Savannah	31	31	0.01518	0.03623	0.03482
	General Coffee	29	29	0.02480	0.05947	0.05777
	Dawsonville	24	24	0.01790	0.09780	0.02805
	South DeKalb**	57	57	0.01090	0.02285	0.02122
	Yorkville	25	25	0.01791	0.06704	0.04174

*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, *** Hexavalent Chromium, sample collected every 6 days, ND indicates no detection

2009 Semi-Volatile Compounds

(concentrations in µg/m^3)

Name	Site	#Samples	#Detects	Avg.**	1st Max	2nd Max
Acenaphthene	Macon	30	1	0.02908	0.00247	
	Savannah	27	2	0.02954	0.00430	0.00205
	General Coffee	29	ND			
	Dawsonville	29	1	0.03003	0.00093	
	South DeKalb*	59	58	0.00209	0.01740	0.00592
	Yorkville	29	ND			
Acenaphthylene	Macon	26	ND			
	Savannah	23	ND			
	General Coffee	25	ND			
	Dawsonville	25	ND			
	South DeKalb*	59	43	0.00066	0.00597	0.00349
	Yorkville	25	ND			
Anthracene	Macon	30	ND			
	Savannah	27	6	0.00596	0.00359	0.00208
	General Coffee	29	ND			
	Dawsonville	29	ND			
	South DeKalb*	59	27	0.00035	0.00492	0.00455
	Yorkville	29	ND			
Benzo(a)anthracene	Macon	28	ND			
	Savannah	25	ND			
	General Coffee	27	ND			
	Dawsonville	27	ND			
	South DeKalb*	59	30	0.00007	0.00048	0.00025
	Yorkville	27	ND			
Benzo(b)fluoranthene	Macon	30	ND			
	Savannah	27	ND			
	General Coffee	29	ND			
	Dawsonville	29	ND			
	South DeKalb*	59	44	0.00017	0.00102	0.00069
	Yorkville	29	ND			
Benzo(k)fluoranthene	Macon	29	ND			
	Savannah	27	ND			
	General Coffee	29	ND			
	Dawsonville	29	ND			
	South DeKalb*	59	29	0.00006	0.00028	0.00026
	Yorkville	29	ND			
Benzo(a)pyrene	Macon	30	ND			
	Savannah	27	ND			
	General Coffee	29	ND			
	Dawsonville	29	ND			
	South DeKalb*	59	26	0.00008	0.00060	0.00027
	Yorkville	29	ND			

2009 Semi-Volatile Compounds (continued)

(concentrations in µg/m^3)

Name	Site	#Samples	#Detects	Avg.**	1st Max	2nd Max
Benzo(e)pyrene	Macon	30	ND			
	Savannah	27	ND			
	General Coffee	29	ND			
	Dawsonville	29	ND			
	South DeKalb*	59	37	0.00010	0.00048	0.00031
	Yorkville	29	ND			
Benzo(g,h,i)perylene	Macon	30	ND			
	Savannah	27	ND			
	General Coffee	29	ND			
	Dawsonville	29	ND			
	South DeKalb*	59	34	0.00011	0.00053	0.00034
	Yorkville	29	ND			
Chrysene	Macon	30	ND			
	Savannah	27	ND			
	General Coffee	29	ND			
	Dawsonville	29	ND			
	South DeKalb*	59	51	0.00014	0.00072	0.00064
	Yorkville	29	ND			
Dibenzo(a,h)anthracene	Macon	30	ND			
	Savannah	27	ND			
	General Coffee	28	ND			
	Dawsonville	29	ND			
	South DeKalb*	59	1	0.00005	0.00006	
	Yorkville	29	ND			
Fluoranthene	Macon	30	4	0.00033	0.00086	0.00085
	Savannah	27	8	0.00081	0.00422	0.00265
	General Coffee	29	ND			
	Dawsonville	29	3	0.00031	0.00053	0.00047
	South DeKalb*	59	59	0.00099	0.01130	0.00212
	Yorkville	29	2	0.00043	0.00453	0.00043
Fluorene	Macon	30	3	0.00596	0.00201	0.00125
	Savannah	27	8	0.00702	0.01007	0.00926
	General Coffee	29	ND			
	Dawsonville	29	1	0.00606	0.00107	
	South DeKalb*	59	59	0.00275	0.01840	0.00637
	Yorkville	29	1	0.00578	0.00061	
Indeno(1,2,3-cd)pyrene	Macon	30	ND			
	Savannah	27	ND			
	General Coffee	29	ND			
	Dawsonville	29	ND			
	South DeKalb*	59	30	0.00010	0.00052	0.00035
	Yorkville	29	ND			
Naphthalene	Macon	26	4	0.03621	0.02727	0.01862
	Savannah	23	4	0.03541	0.02151	0.01590
	General Coffee	26	2	0.03225	0.00596	0.00417
	Dawsonville	26	4	0.03654	0.03569	0.01898

2009 Semi-Volatile Compounds (continued)

(concentrations in μg/m^3)

Name	Site	#Samples	#Detects	Avg.**	1st Max	2nd Max
Naphthalene (continued)	South DeKalb*	59	59	0.10486	0.2960	0.2920
	Yorkville	25	4	0.03530	0.01836	0.01268
Phenanthrene	Macon	30	8	0.00312	0.00475	0.00433
	Savannah	27	8	0.00466	0.01389	0.01299
	General Coffee	29	6	0.00245	0.00105	0.00085
	Dawsonville	29	6	0.00278	0.00284	0.00251
	South DeKalb*	59	59	0.00464	0.05290	0.01090
	Yorkville	29	6	0.00257	0.00183	0.00153
Pyrene	Macon	30	1	0.00028	0.00042	
	Savannah	27	8	0.00050	0.00221	0.00145
	General Coffee	29	ND			
	Dawsonville	29	1	0.00029	0.00046	
	South DeKalb*	59	59	0.00062	0.00618	0.00127
	Yorkville	29	ND			
Retene	South DeKalb*	59	55	0.00030	0.00149	0.00142
9-fluorenone	South DeKalb*	59	58	0.00085	0.00806	0.00245
Cyclopenta(cd)pyrene	South DeKalb*	59	7	0.00007	0.00022	0.00011
Coronene	South DeKalb*	59	16	0.00008	0.00025	0.00017
Perylene	South DeKalb*	59	9	0.00005	0.00021	0.00017

ND indicates no detection

*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.

2009 Volatile Organic Compounds

(concentrations in µg/m^3)

Name	Site	#Samples	#Detects	Avg.**	1st Max	2nd Max
Freon 113	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
Freon 114	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
1,3-Butadiene	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	1	0.2770	0.2876	
	South DeKalb*	53	ND			
	Yorkville	26	ND			
Cyclohexane	Macon	27	ND			
	Savannah	30	4	0.5016	1.3086	1.0331
	General Coffee	30	4	1.1077	9.6425	5.8544
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
Chloromethane	Macon	27	27	1.1781	1.5284	1.4252
	Savannah	31	31	1.2746	1.5491	1.4665
	General Coffee	31	31	1.3512	2.4785	1.8382
	Dawsonville	30	30	1.0513	1.2599	1.2186
	South DeKalb*	53	53	1.1360	1.6317	1.4252
	Yorkville	26	26	1.0446	1.3219	1.2806
Dichloromethane	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	15	5.4362	33.3350	31.5988
	Yorkville	26	ND			
Chloroform	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
Carbon tetrachloride	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			

2009 Volatile Organic Compounds (continued)

(concentrations in μg/m^3)

Name	Site	#Samples	#Detects	Avg.**	1st Max	2nd Max
Carbon tetrachloride (continued)	South DeKalb*	53	ND			
	Yorkville	26	ND			
Trichlorofluoromethane	Macon	27	27	1.2467	1.5173	1.4611
	Savannah	31	31	1.2762	1.5735	1.5735
	General Coffee	31	31	1.2399	1.5173	1.4611
	Dawsonville	30	30	1.2120	1.5173	1.4611
	South DeKalb*	53	53	1.5499	2.0793	2.0231
	Yorkville	26	26	1.2666	1.6297	1.5173
Chloroethane	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	1	0.3198	0.3323	
	Yorkville	26	ND			
1,1-Dichloroethane	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
Methyl chloroform	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
Ethylene dichloride	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
Tetrachloroethylene	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
1,1,2,2-Tetrachloroethane	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			

2009 Volatile Organic Compounds (continued)

(concentrations in µg/m^3)

Name	Site	#Samples	#Detects	Avg.**	1st Max	2nd Max
Bromomethane	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
1,1,2-Trichloroethane	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
Dichlorodifluoromethane	Macon	27	27	2.3662	2.9174	2.8680
	Savannah	31	31	2.3767	3.0163	2.8680
	General Coffee	31	31	2.3161	2.7691	2.7691
	Dawsonville	30	30	2.3125	3.0163	2.7691
	South DeKalb*	53	53	2.4444	3.3625	3.1647
	Yorkville	26	26	2.3716	3.1063	2.9174
Trichloroethylene	Macon	27	ND			
	Savannah	31	1	0.6778	0.8599	
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
1,1-Dichloroethylene	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
1,2-Dichloropropane	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
trans-1,3-Dichloropropylene	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
cis-1,3-Dichloropropylene	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			

2009 Volatile Organic Compounds (continued)

(concentrations in μg/m^3)

Name	Site	Samples	Detects	Avg.**	1st Max	2nd Max
cis-1,3-Dichloropropylene (continued)	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
cis-1,2-Dichloroethene	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
Ethylene dibromide	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
Hexachlorobutadiene	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
Vinyl chloride	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
m/p Xylene	Macon	27	ND			
	Savannah	31	1	0.5478	0.6950	
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	11	0.5917	1.0425	0.9990
	Yorkville	26	ND			
Benzene	Macon	27	16	2.0466	12.4577	5.4303
	Savannah	31	5	0.4359	1.3097	0.5111
	General Coffee	31	3	0.4400	1.1499	0.7347
	Dawsonville	30	12	0.5153	1.0222	0.8944
	South DeKalb*	53	41	0.8209	3.5137	2.0443
	Yorkville	26	4	0.4128	0.6069	0.5111
Toluene	Macon	27	15	0.6208	1.1677	1.0547
	Savannah	31	14	0.7516	3.0135	1.6574
	General Coffee	31	ND			
	Dawsonville	30	5	0.5079	0.7534	0.7534
	South DeKalb*	53	39	1.2274	3.6539	3.5785
	Yorkville	26	7	0.5107	0.9417	0.6780
Ethylbenzene	Macon	27	ND			

2009 Volatile Organic Compounds (continued)

(concentrations in µg/m^3)

Name	Site	#Samples	#Detects	Avg.**	1st Max	2nd Max
Ethylbenzene (continuted)	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
o- Xylene	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
1,3,5-Trimethylbenzene	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
1,2,4-Trimethylbenzene	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
Styrene	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	3	0.6171	2.4718	0.7245
Benzene,1-ethenyl-4-methyl	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
Chlorobenzene	Macon	27	4	0.6166	1.0592	0.8290
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
1,2-Dichlorobenzene	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			

2009 Volatile Organic Compounds (continued)

(concentrations in µg/m^3)

Name	Site	#Samples	#Detects	Avg.**	1st Max	2nd Max
1,2-Dichlorobenzene (continued)	Yorkville	26	ND			
1,3-Dichlorobenzene	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
1,4-Dichlorobenzene	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
Benzyl chloride	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			
1,2,4-Trichlorobenzene	Macon	27	ND			
	Savannah	31	ND			
	General Coffee	31	ND			
	Dawsonville	30	ND			
	South DeKalb*	53	ND			
	Yorkville	26	ND			

ND indicates no detection
*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.

2009 Black Carbon (NATTS)

(concentration in micrograms per cubic meter (µg/m^3))

Site ID	City	County	Site Name	Hours Measured	1st Max	2nd Max	Annual Arithmetic Mean
130890002	Decatur	DeKalb	South DeKalb	8419	9.48	9.32	1.197

2009 Carbonyl Compounds, 24-hour

(concentrations in micrograms per cubic meter)

Name	Site	#Samples	#Detects	Avg.**	1st Max	2nd Max
Formaldehyde	Savannah	30	28	2.3206	7.0588	4.5167
	Dawsonville	31	24	2.0761	5.0158	4.5421
	S. DeKalb*	54	54	8.9159	36.3529	30.000
Acetaldehyde	Savannah	30	15	0.8964	1.7824	1.6941
	Dawsonville	31	16	0.9293	1.6000	1.5579
	S. DeKalb*	54	48	2.1640	5.1177	5.0588
Propionaldehyde	Savannah	30	ND			
	Dawsonville	31	1	0.5997	1.7316	
	S. DeKalb*	54	ND			
Butyraldehyde	Savannah	30	1	0.5962	1.5882	
	Dawsonville	31	3	0.6486	1.8737	1.3222
	S. DeKalb*	54	3	0.6026	1.5529	1.2353
Acetone	Savannah	30	28	2.5990	6.5882	4.8278
	Dawsonville	31	30	3.2756	6.1667	5.8333
	S. DeKalb*	54	51	5.6168	10.2941	9.7059
Benzaldehyde	Savannah	30	1	0.6562	3.3882	
	Dawsonville	31	5	0.9228	4.2222	3.7368
	S. DeKalb*	54	5	0.6627	3.0941	1.5000
Acrolein	Macon	37	18	0.4041	0.6883	0.6425
(with canister method)	Savannah	31	20	0.3416	0.6425	0.4589
	General Coffee	31	22	0.4748	1.1013	0.9866
	Dawsonville	30	23	0.4287	0.7801	0.6883
	South DeKalb*	53	46	0.6847	1.2390	1.2390
	Yorkville	26	14	0.3786	1.0325	0.7801

ND indicates no detection,*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.

2009 Carbonyl Compounds, 3-hour (June-August)

(concentrations in micrograms per cubic meter)

Name	Site	Time	#Samples	#Detects	Avg.*	1st Max	2nd Max
Formaldehyde	S. DeKalb	0600	28	28	14.9627	37.5000	29.2222
		0900	25	25	13.5462	21.0556	20.5000
		1200	26	26	14.8308	22.7222	22.3889
		1500	26	26	13.9060	22.7222	21.3333
Acetaldehyde	S. DeKalb	0600	28	25	2.5203	5.3778	4.9111
		0900	25	25	3.7807	6.8333	6.4444
		1200	26	26	4.3421	7.3889	7.1111
		1500	26	26	3.8861	7.1667	5.7778
Propionaldehyde	S. DeKalb	0600	28	ND			
		0900	25	ND			
		1200	26	ND			
		1500	26	ND			
Butyraldehyde	S. DeKalb	0600	28	5	0.7422	2.0833	1.8611
		0900	25	4	0.7741	2.4833	2.0667
		1200	26	6	0.8590	3.1833	2.3167
		1500	26	8	0.9369	3.1889	2.4389
Acetone	S. DeKalb	0600	28	28	6.8407	12.3889	11.9444
		0900	25	25	7.6691	13.0556	11.6111
		1200	26	26	8.6784	14.0556	13.2222
		1500	26	26	8.3788	16.3889	12.8889
Benzaldehyde	S. DeKalb	0600	28	13	1.1751	3.6667	3.0056
		0900	25	18	2.3507	7.6667	6.5000
		1200	26	23	2.6007	9.1111	8.6667
		1500	26	23	3.0418	10.2778	5.2389

ND indicates no detection, * 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 2009

Parameter Measured	Ozone	Nitrogen Dioxide	Carbon Monoxide	Sulfur Dioxide
Sampling Schedule	Continuous hourly average			
Number of GASN Sites	20	4	3	8
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://www.epa.gov/ttn/airs/airsaqs/) and GA DNR/EPD Ambient Air Monitoring Program (http://www.air.dnr.state.ga.us/amp)			

Georgia Ambient Air Particulate Matter Monitoring as of January 2009

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 day, 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	TEOM; BAM	FRM sampler	TEOM; BAM	Speciation air sampling system (SASS)
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	14	1	28	17	8
Number of Collocated Sites	3	0	5	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://www.epa.gov/ttn/airs/airsaqs/) and GA DNR/EPD Ambient Air Monitoring Program (http://www.air.dnr.state.ga.us/amp)				

Georgia Organic Air Toxic Contaminant Monitoring as of January 2009

Parameter Measured	**Volatile Organic Compounds (VOCs)**	**Carbonyls**	**Semi - VOCs**	**Metals**
Method	TO-14A/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 AVOCS or ATEC2200	PUF sampler	High volume TSP
Sampling Media	Polished stainless steel canister	DNPH-coated silica cartridges and Polished stainless steel canister	Polyurethane Foam filter	Quartz micro-fiber filter 8 x 10 inch
Number of Sites Analyzed	6**	3	6**	6**
Number of Collocated Sites	1	1	1	1
Data Availability	U.S. EPA Air Quality System (AQS) (http://www.epa.gov/ttn/airs/airsaqs/) and GA DNR/EPD Ambient Air Monitoring Program (http://www.air.dnr.state.ga.us/amp)			

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

PAMS Monitoring as of January 2009

Parameter	54 PAMS-Speciated VOCs & Total NMHC	Continuous 54-PAMS Speciated VOCs & Total NMHC	Carbonyl Compounds
Sampling Schedule	24-hour 1 in 6 day schedule (all year)	Continuous hourly average (June-August)	3-hour sample (June-August); 24-hour, 1 in 6 day (all year)
Collection Equipment	ATEC 2200	Perkin-Elmer HC GC	ATEC 8000; PUF Sampler
Sampling Media	Polished stainless steel canister	Direct injection	DNPH – coated silica gel Cartridge; Polyurethane Foam
Number of Sites	3	3	1
Analysis Method	PAMS GC/FID	GC/FID	High performance liquid chromatograph/ultraviolet detector
Data Availability	U.S. EPA Air Quality System (AQS) (http://www.epa.gov/ttn/airs/airsaqs/) and GA DNR/EPD Ambient Air Monitoring Program (http://www.air.dnr.state.ga.us/amp)		

Georgia Meteorological Monitoring as of January 2009

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 (deg)**	**Total Ultraviolet Radiation**
Sampling Schedule	Continuous hourly average								
Number of Sites	17	17	8	8	6	3	6	1	3
Method Used	Propeller or cup anemometer	Wind vane potentiometer	Aspirated Thermocouple or thermistor	Thin film capacitor	Pressure transducer	Thermopile or pyranometer	Tipping bucket	Wind direction	UV radiometer
Data Availability	U.S. EPA Air Quality System (AQS) (http://www.epa.gov/ttn/airs/airsaqs/) and GA DNR/EPD Ambient Air Monitoring Program (http://www.air.dnr.state.ga.us/amp)								

Appendix F: Siting Criteria

Instrument	**Height Above Ground**		**Space Between Samplers**	**Height Above Obstruc-tions**	**Distance From Obstacles**	**Distance From Tree Dripline**	**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
Dichot, 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 dripline	1m	270, or on side of building 180

Instrument	**Height Above Ground**		**Space Between Samplers**	**Height Above Obstruc-tions**	**Distance From Obstacles**	**Distance From Tree Dripline**	**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 (Dichot), Lead (Pb), Tapered Element Oscillating Microbalalance (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
±2.25 mm of Mercury (Hg)	Barometric Pressure
±3% RH for 10-90% RH ±5% RH for <10% or >90% RH	Relative Humidity
±5% Watts/m^2	Solar Radiation
Less than or equal to 5° combined accuracy and orientation error	Wind Direction
±0.25 m/s between 0.5 and 5m/s and less that 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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