



**Allegheny County Health Department
Air Quality Program
301 39th St., Bldg. #7
Pittsburgh, PA 15201**

**PM_{2.5} Chemical Speciation and Related
Comparisons at Lawrenceville and Liberty:
18-Month Results**

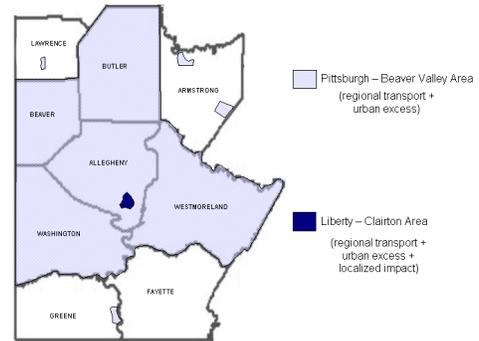
June 7, 2005
Prepared By
Jason Maranche

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1. Introduction

Allegheny County has operated two particulate matter – 2.5microns or less ($PM_{2.5}$) – chemical speciation monitors as part of EPA's STN network since 2001. Lawrenceville and Hazelwood were the initial sites of deployment, and species concentrations from these sites were nearly equal. The Hazelwood monitor was then moved to Liberty Borough in October 2003 to better ascertain $PM_{2.5}$ in Liberty-Clairton area.



Allegheny County was designated nonattainment for $PM_{2.5}$ as part of the Pittsburgh-Beaver Valley area in December 2004. At the same time, the Liberty Borough-Clairton area was designated a separate nonattainment area within Allegheny County.

Major species concentrations at Lawrenceville parallel those sampled at other Eastern U.S. metropolitan areas, while the concentrations at Liberty follow their own course. The differences in concentrations of many elements may provide clues to the regional, urban excess, and localized river valley components of $PM_{2.5}$ in Allegheny County.

This report shows species and pollutant comparisons between the two sites over the timeframe of October 2003-March 2005. All figures and tables represent 18-month data unless otherwise noted.

2. Sites

The Lawrenceville monitor site is an urban residential site, downwind from the Pittsburgh Central Business District (Downtown). Elevation is 918 feet above mean sea level (MSL), about 200 feet above river level.

The Liberty Borough monitor site is located in the Monongahela Valley, which contains a mix of urban residential, heavy industrial, and rural areas. The elevation is 1100 feet MSL, and the predominant winds are southwesterly.

Average temperature and pressure are lower at Liberty, coinciding with higher elevation. Elevation alone does not appear to play a role in PM_{2.5} concentrations at Liberty, as other sites such as South Fayette measure lower concentrations at higher elevations than Liberty.

The speciation sampling frequency is higher at Lawrenceville (1-in-3) than at Liberty (1-in-6), so averages at Lawrenceville represent a larger array of values. For some figures in this report, dates have been matched to compare concurrent sampling days only.

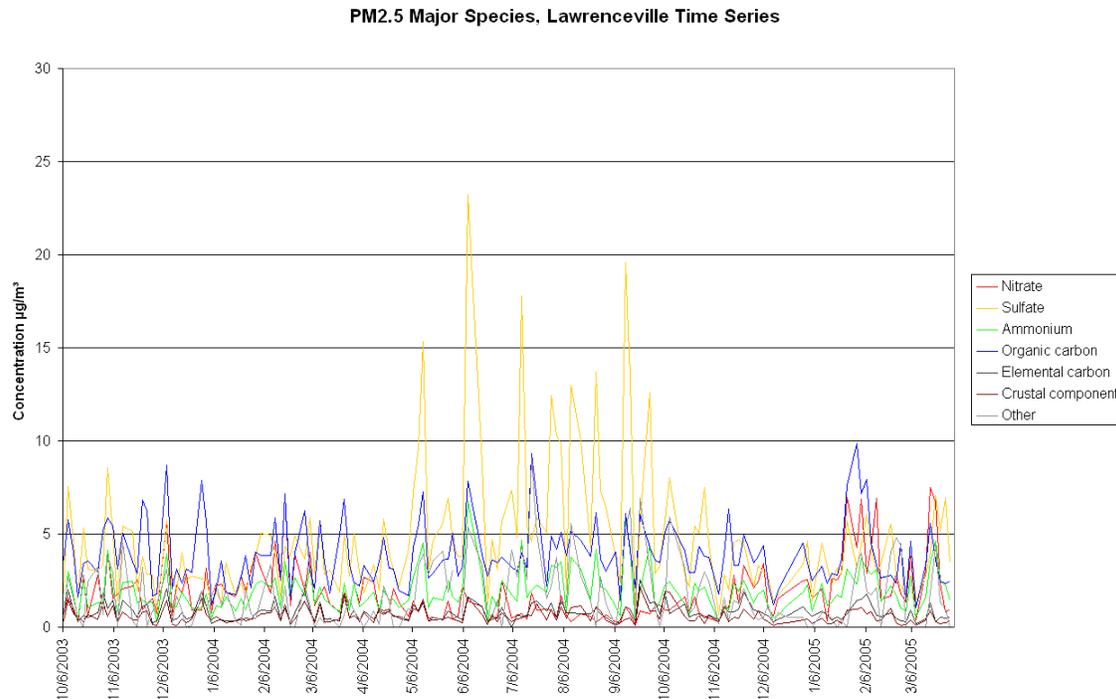
Both sites are collocated with other monitors, including daily PM_{2.5} filter-based (FRM) and hourly continuous PM_{2.5} monitors. Additionally, Lawrenceville measures ozone and NO_x, and Liberty measures PM₁₀, SO₂, H₂S, and benzene.

Sites near Liberty include Glassport (PM₁₀, SO₂) and Lincoln (PM₁₀). These nearby sites have been included in this analysis for possible correlation to Liberty.

3. Major Species

Below are time series plots for Lawrenceville and Liberty PM_{2.5} major species over the 18-month timeframe.

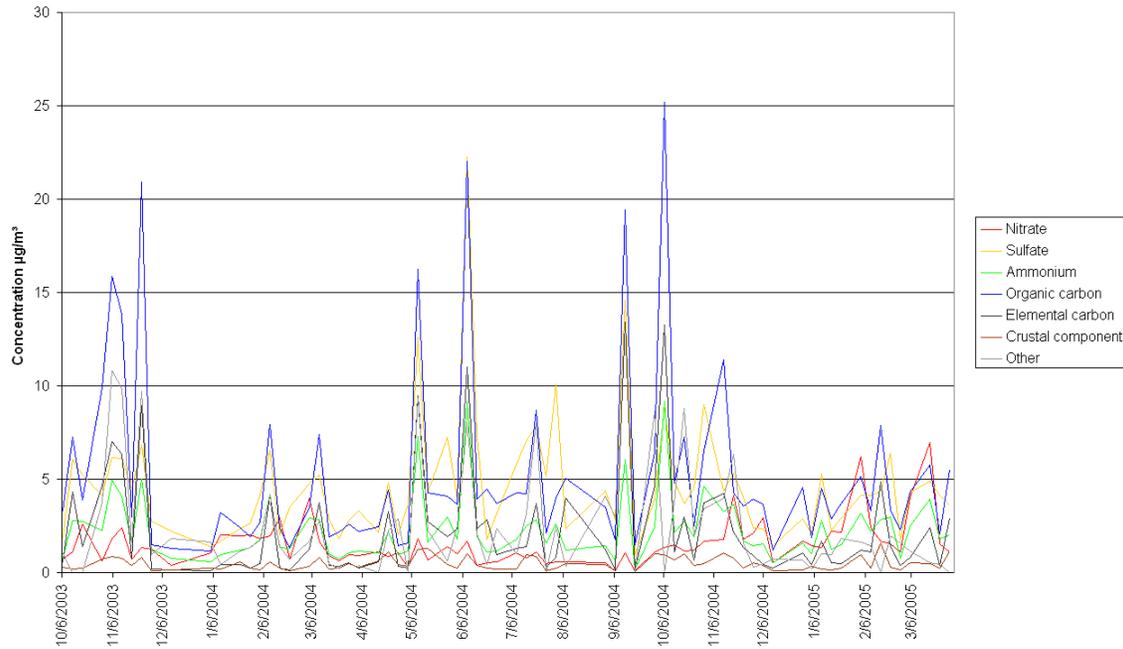
Lawrenceville is dominated by sulfates during summer months. In colder months, nitrates and organics tend to dominate.



In late January and early February 2005, an anomaly is evident by the exaggerated organic carbon and nitrate peaks. This is likely due to an exceptional high-pressure meteorological system that led to high PM_{2.5} throughout the Midwest and Northeast U.S.

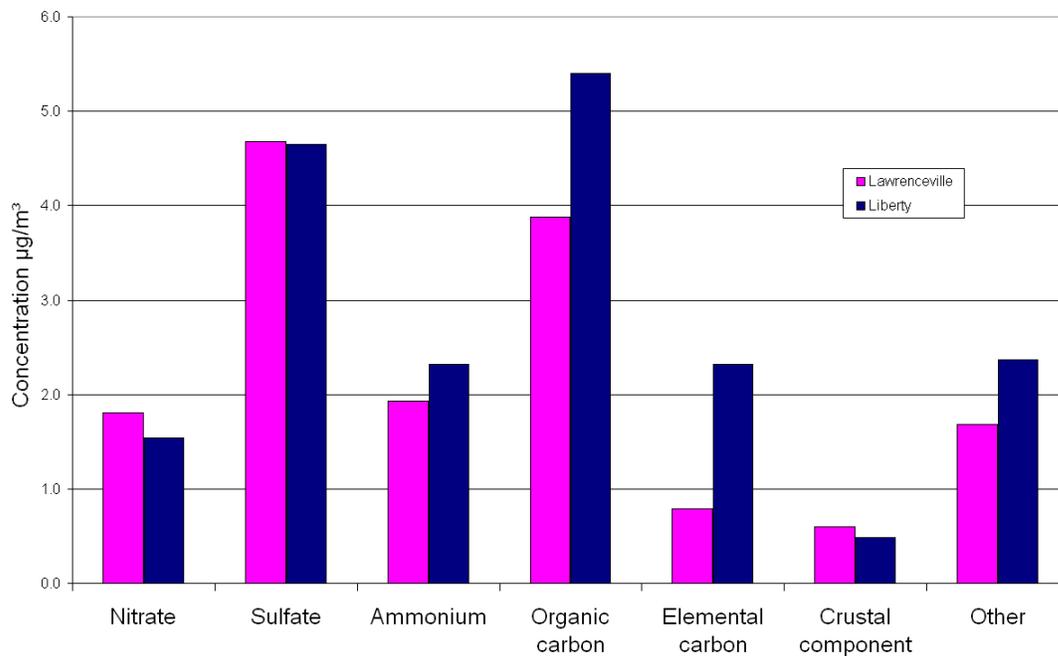
Liberty shows a much different pattern of major PM_{2.5} species over time. While it shows similar levels of sulfates and nitrates to Lawrenceville, it is dominated by organic and elemental carbon year-round.

PM2.5 Major Species, Liberty Time Series



The differences in average carbon levels, as well as ammonium and the “other” component, are shown below.

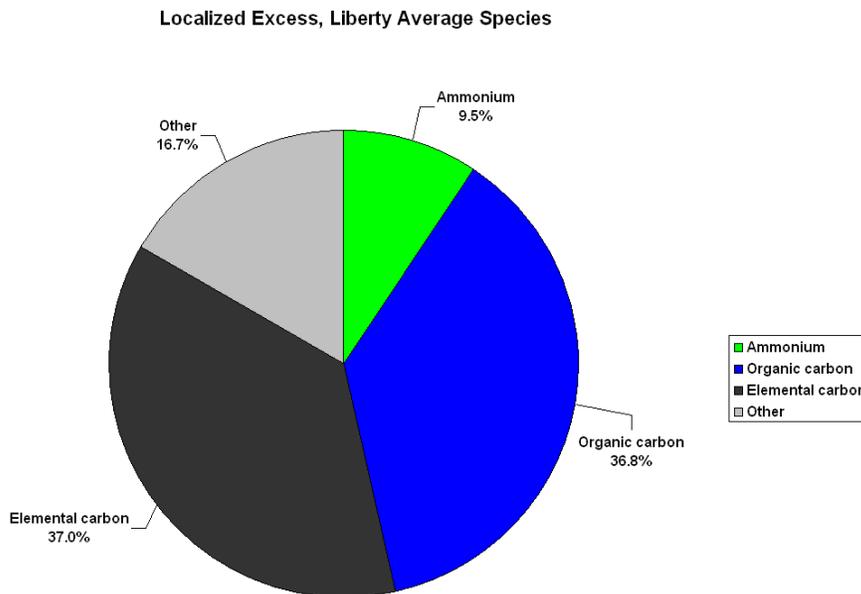
Major Species Averages, Lawrenceville and Liberty



Sulfates, nitrates, and crustal component are slightly lower at Liberty than at Lawrenceville.

Crustal component is a weighted average of the aluminum, silicon, calcium, iron, and titanium concentrations, representative of fine soil.

By calculating the differences of the average major species, localized excess at Liberty is given by the pie chart below. This excess represents the difference between the Lawrenceville and Liberty sites for species that are greater at Liberty.

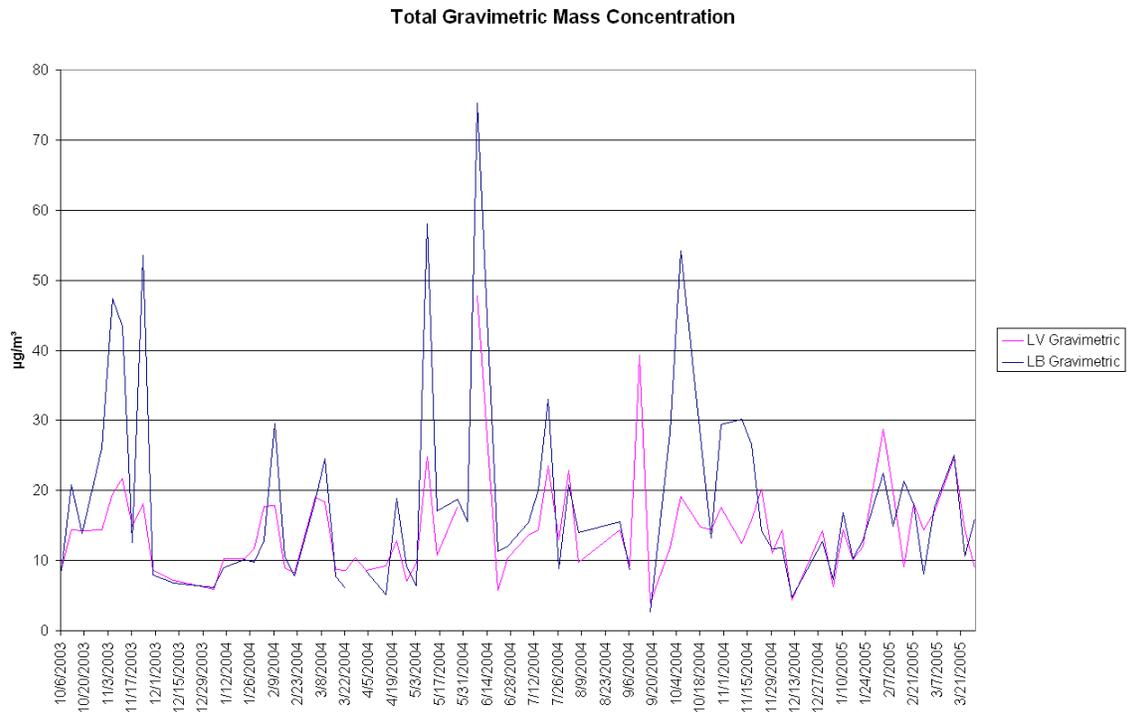


The “other” component is defined as the difference between the gravimetric (weighed) mass concentration and the sum of the major species. It can include the following:

- Non-crustal, non-sulfur trace elements
- Water
- Non-organic, non-elemental carbon
- Unknown species

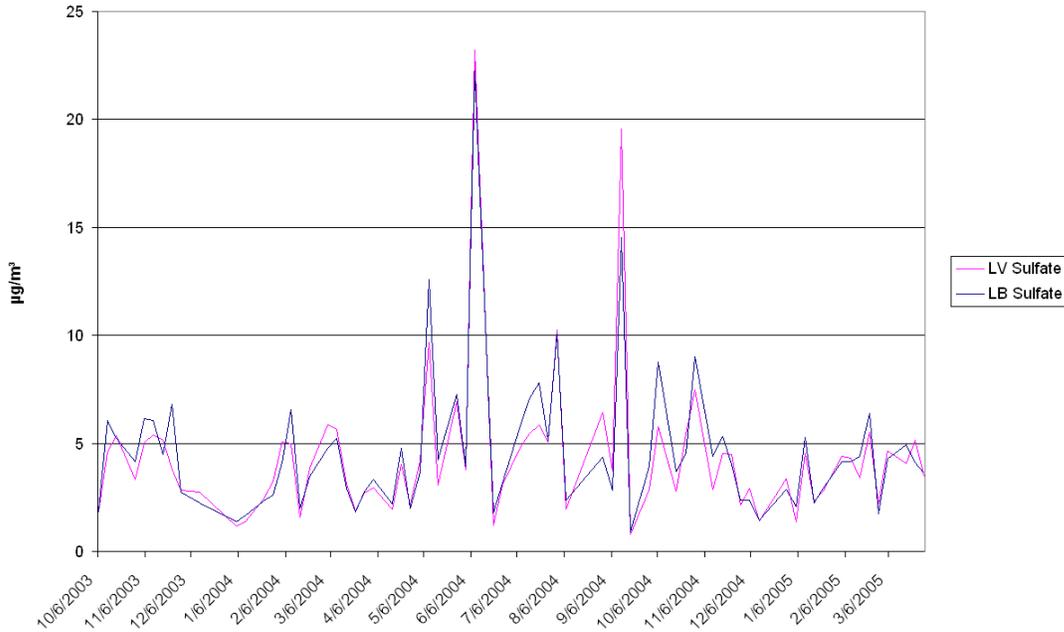
4. Matched Time Series, by Species

Concurrent sampling at Lawrenceville (LV) and Liberty (LB) occurs every 6 days. Plots of these date-matched samples reveal direct comparisons of species at the two sites. Plots for major species are given below.



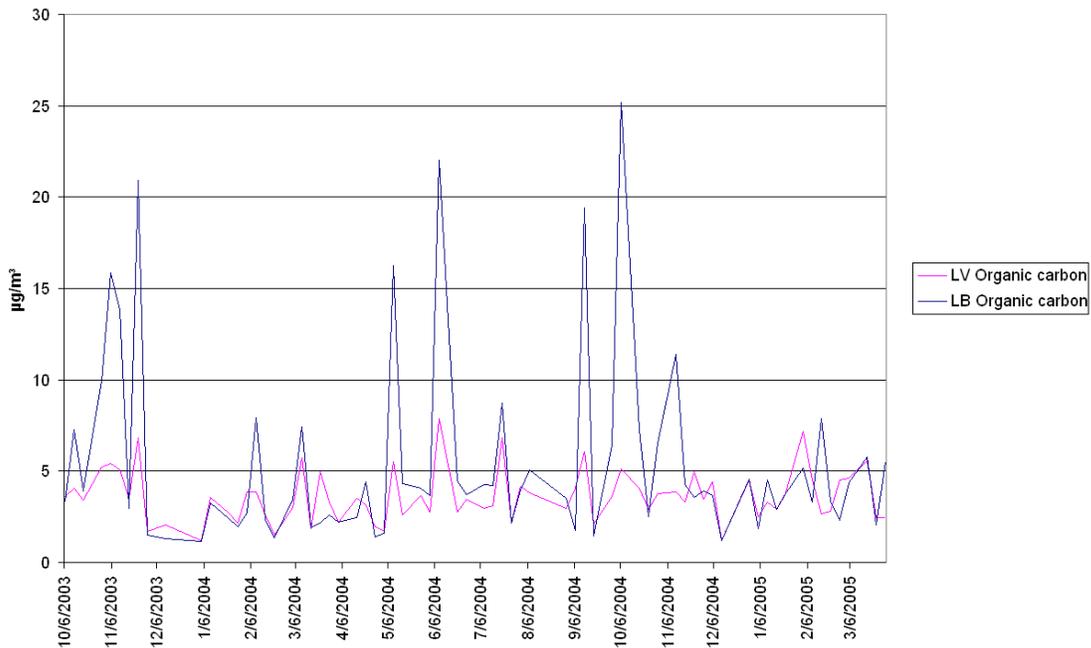
Total PM_{2.5} at Lawrenceville and Liberty show similar peaks at the same times, but to varying extents at each site. Liberty is generally the highest site on peak days, but can be lower for some peaks. On average or low PM_{2.5} days, Liberty and Lawrenceville are often nearly equal. This indicates that regional flow and meteorology may be the primary controlling factors in the formation of PM_{2.5} on low and average days. Wind speed aloft (upper air), relative humidity, and temperature can affect both sites on a broad-scale. Additional accumulation at Liberty may be dependent on local conditions such as surface wind and temperature.

Sulfate Time Series, Lawrenceville and Liberty

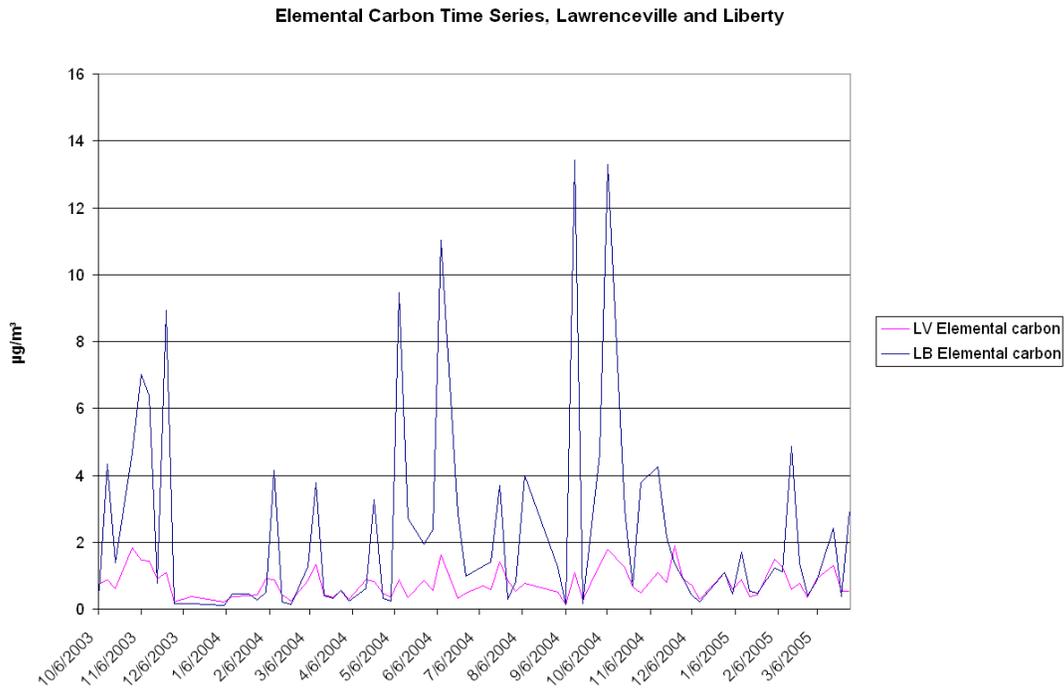


Sulfate is nearly identical at both sites year-round. This indicates that sulfate is primarily affected by regional flow upwind of Allegheny County. Minor differences in peaks may be indicative of local meteorology or minor source impacts.

Organic Carbon Time Series, Lawrenceville and Liberty

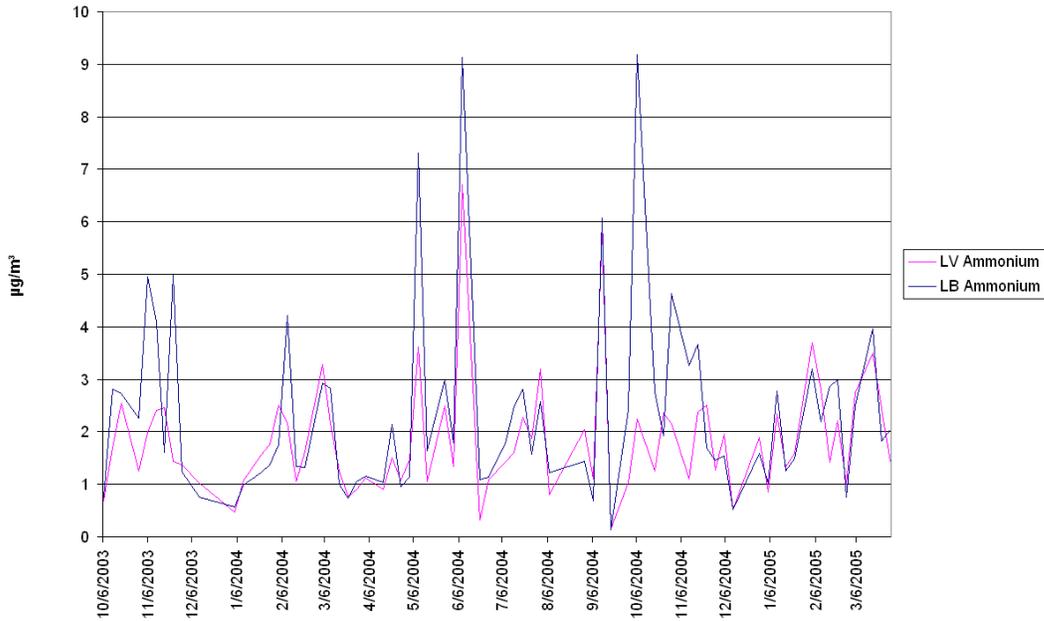


Organic carbon is similar to total mass concentration in that the peaks occur at the same times at both sites but to varying degrees. The peak discrepancies are higher for organic carbon than for total concentration, however, indicating that localized factors may be more controlling for organic carbon.



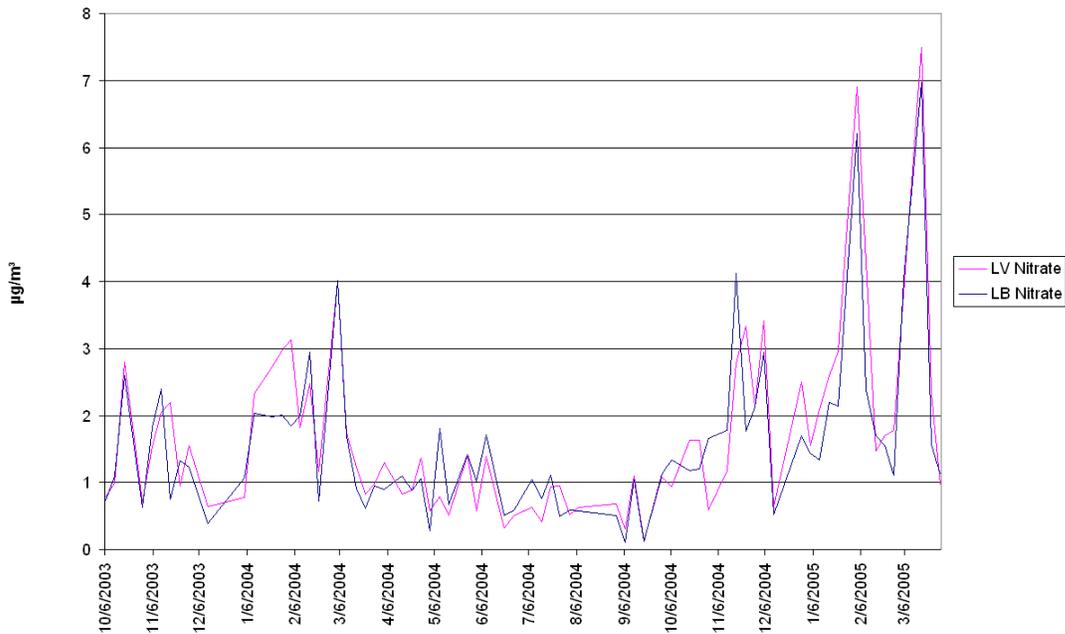
Similar to organic carbon, elemental carbon shows a localized influence at Liberty.

Ammonium Time Series, Lawrenceville and Liberty

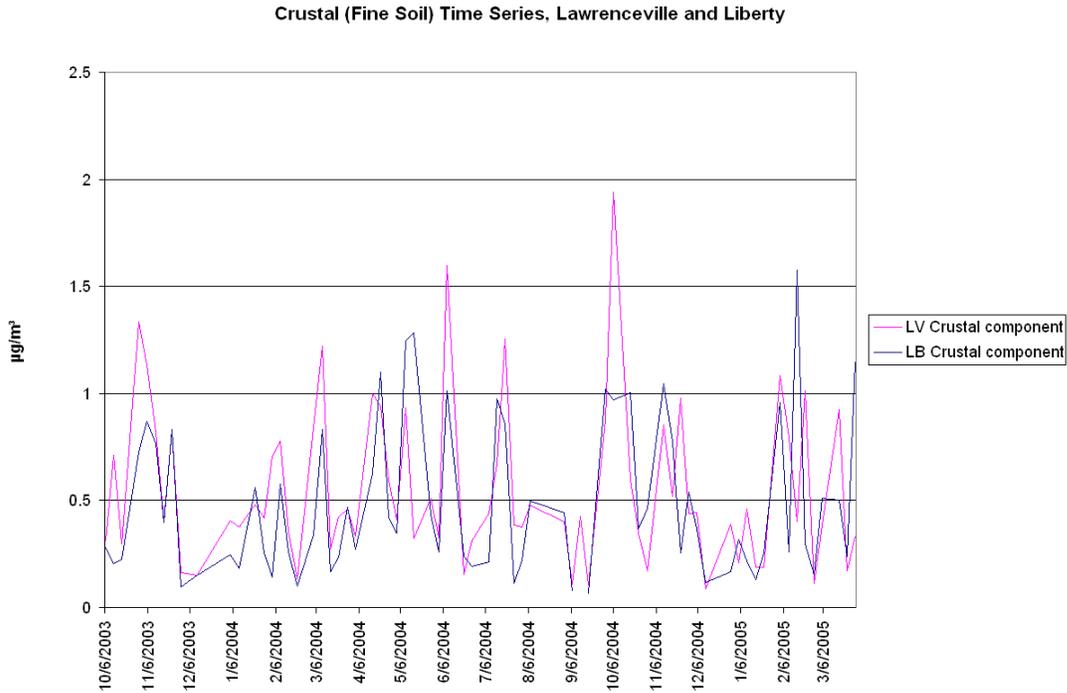


Ammonium can be higher at Liberty on certain days, but not as frequently as organic and elemental carbon.

Nitrate Time Series, Lawrenceville and Liberty

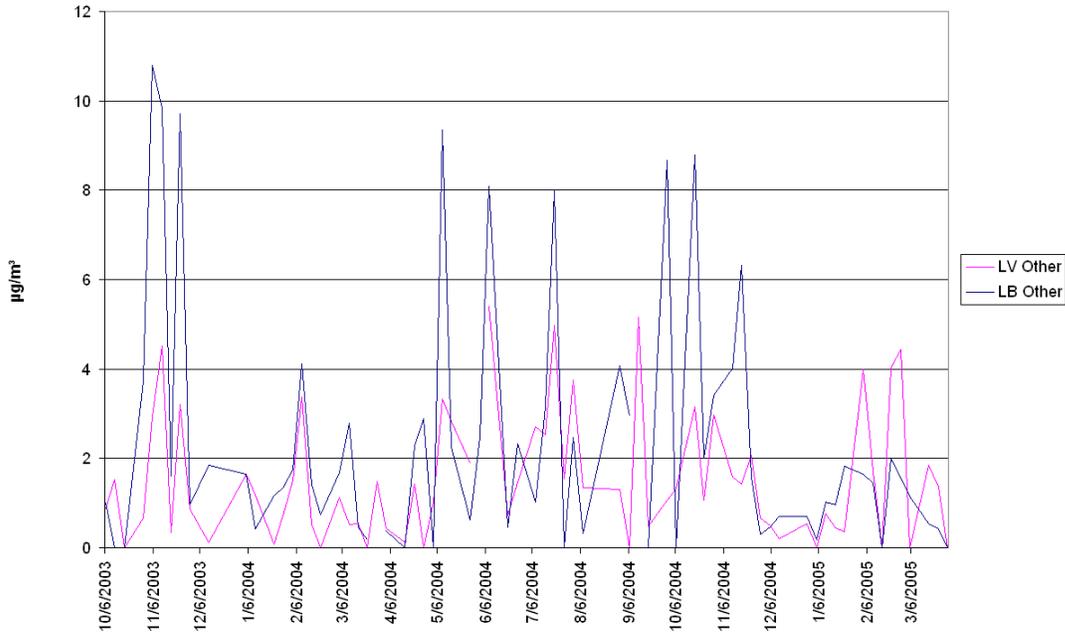


Nitrate appears to be a regional species like sulfate, although nitrate differences between Lawrenceville and Liberty can be more pronounced than sulfate differences.



The crustal component appears to be a regional-only species. Liberty crustal component is actually lower for many days, suggesting rural behavior for some crustal elements at Liberty.

"Other" Component Time Series, Lawrenceville and Liberty



The "other" component shows similar trends to organic carbon, with Liberty showing much greater concentrations than Lawrenceville on peak days.

5. Matched Time Series, Southwest PA Sites, by Species

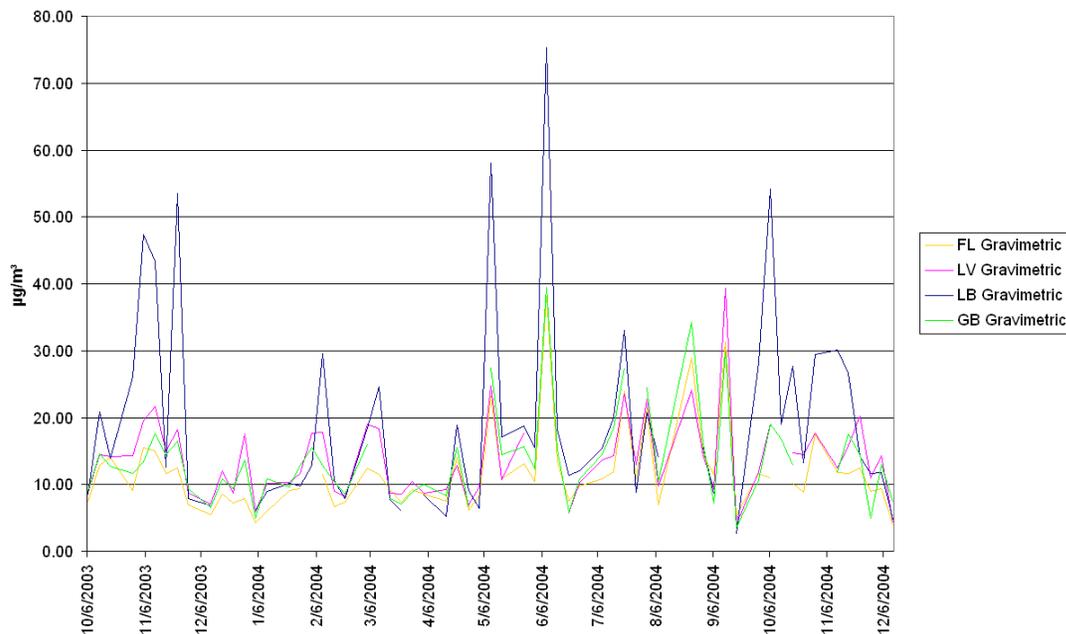
On a regional level, the Pennsylvania Dept. of Environmental Protection (PA DEP) operates two additional PM_{2.5} speciation monitors in Southwest PA: Florence and Greensburg.

Florence (FL) is upwind from Allegheny County, located in Hillman State Park in Washington County, about halfway between Weirton, WV and the Pittsburgh International Airport. It presumably monitors regional flow of particulates into the Southwest PA region from upwind sources primarily in the Ohio Valley and WV Northern Panhandle.

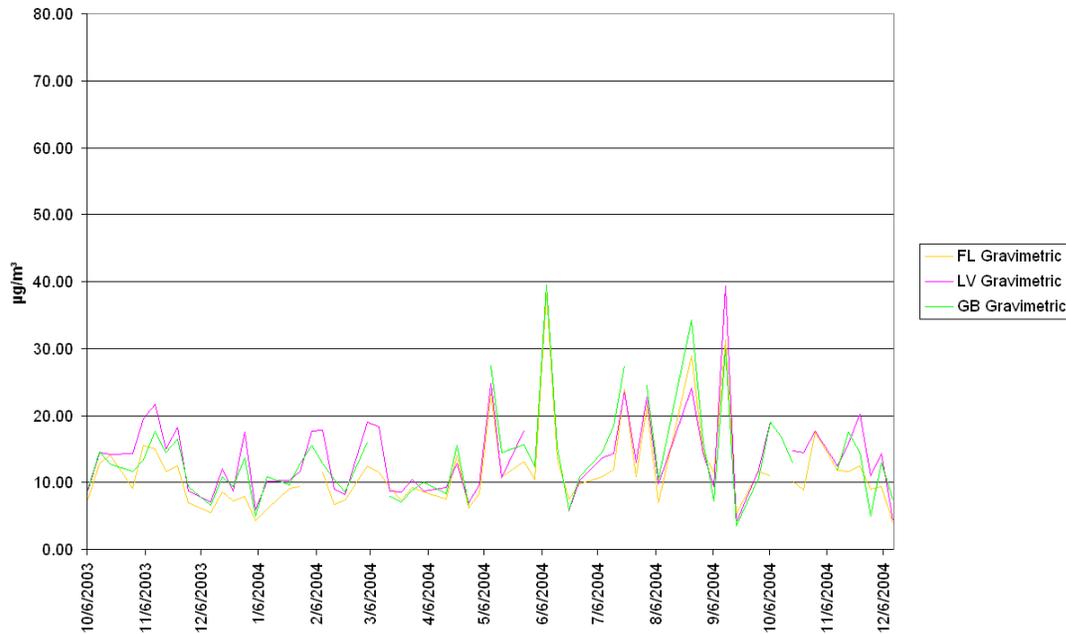
Greensburg (GB) is downwind from Allegheny County, situated east of Greensburg near the Westmoreland Mall. It presumably monitors outgoing regional flow from Southwest PA, in addition to some urban excess from Pittsburgh and/or Greensburg.

For the following plots, matched time series plots for major species are first given for all four sites in Southwest PA, and then without Liberty. Data is shown over the timeframe of Oct. 2003 – Dec. 2004.

Total Gravimetric PM_{2.5}, Speciation Monitors, Southwest PA

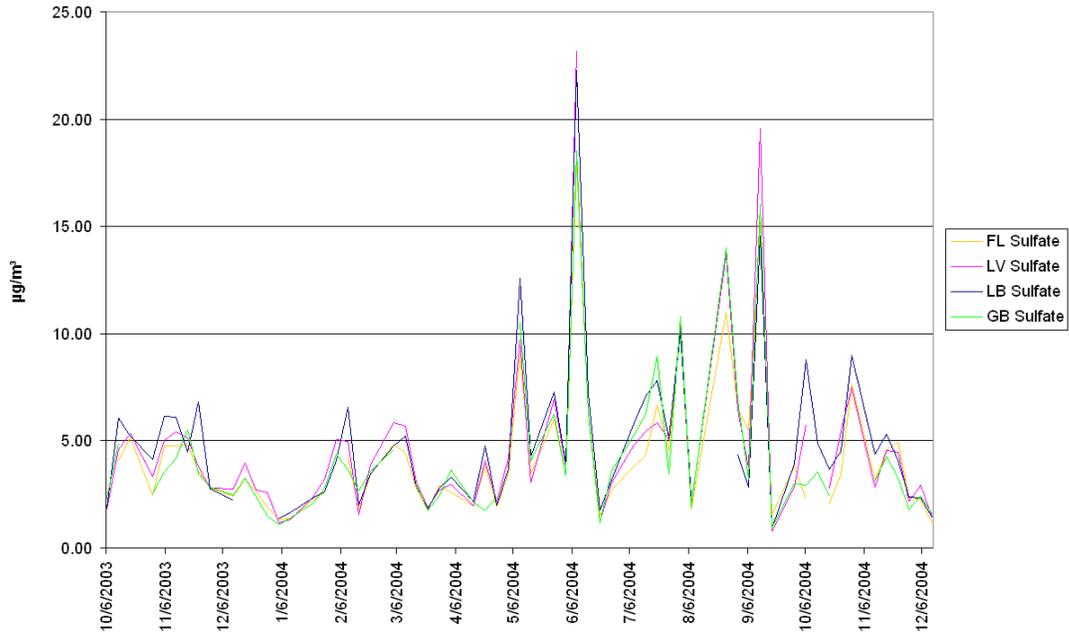


Total Gravimetric PM2.5, Speciation Monitors, Southwest PA w/o Liberty

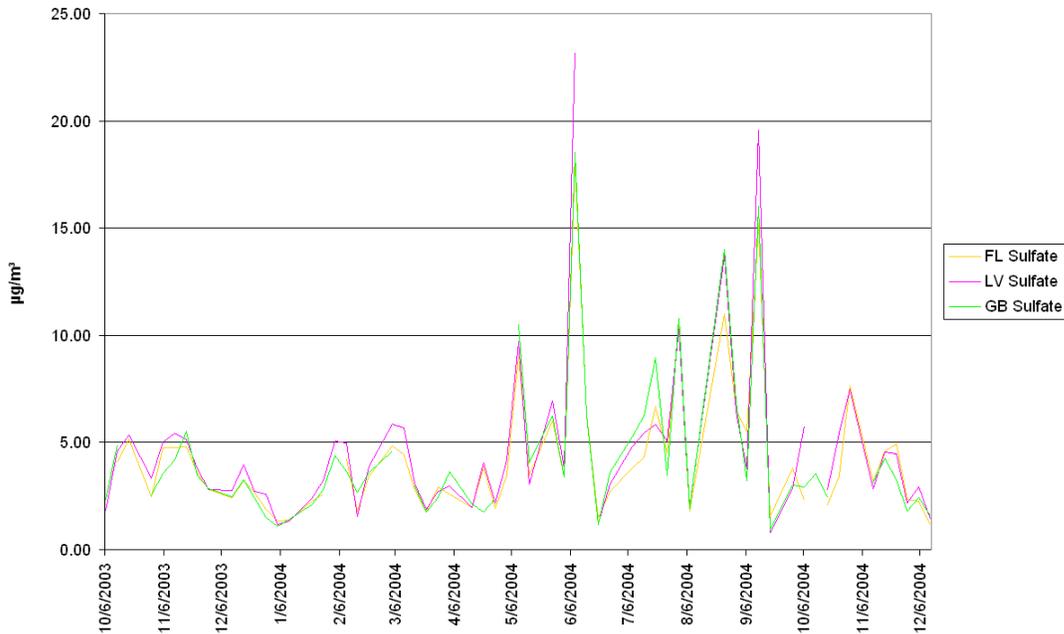


By total gravimetric (weighed) mass concentration, Florence, Lawrenceville, and Greensburg match well, indicative of the regional flow through the multi-county area. Liberty shows the highest mass concentrations, due to the regional flow plus localized excess. Lawrenceville and Greensburg show the next highest concentrations, due to gained urban excess. Accordingly, Florence is usually the lowest by total mass, since it reflects regional flow without localized urban excess.

Sulfate, Southwest PA

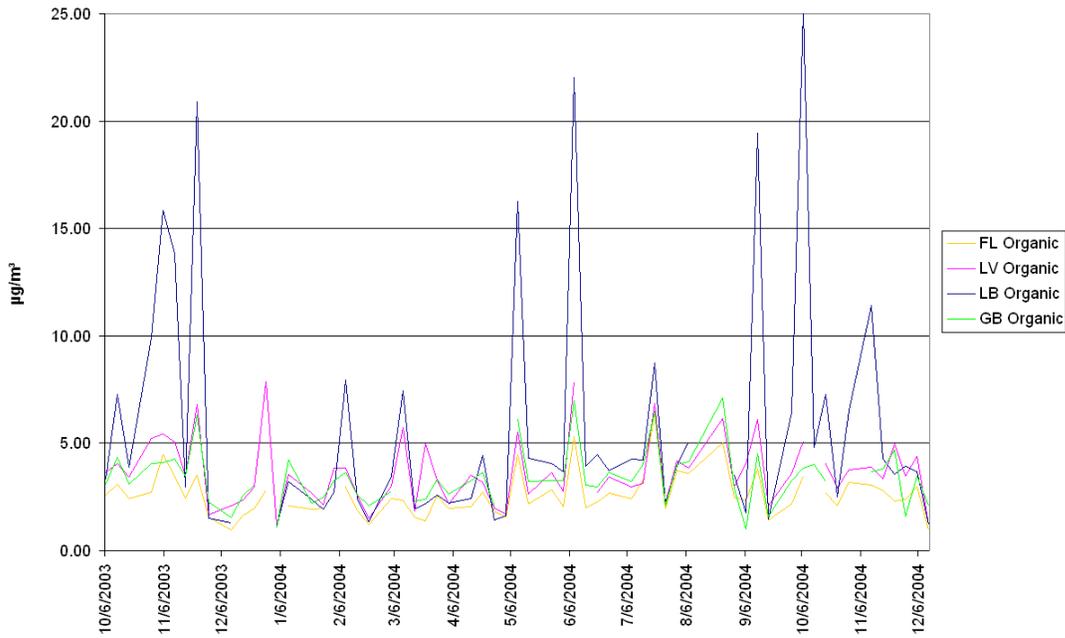


Sulfate, Southwest PA w/o Liberty

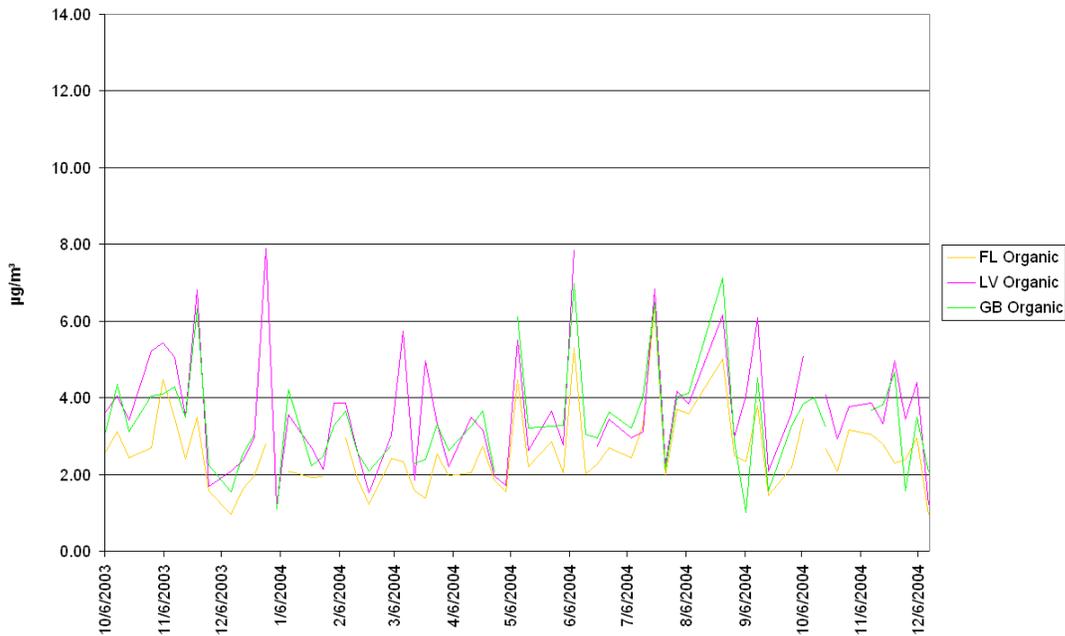


Sulfate time series plots strongly suggest that it is the result of regional flow for Southwest PA, as it is nearly equal at all sites.

Organic Carbon, Southwest PA

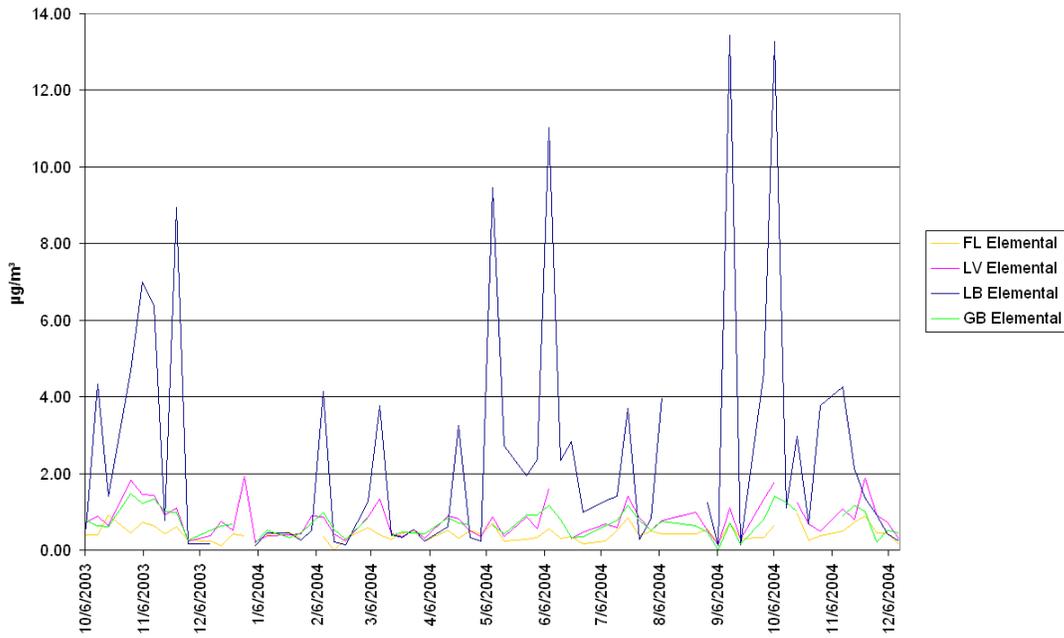


Organic Carbon, Southwest PA w/o Liberty

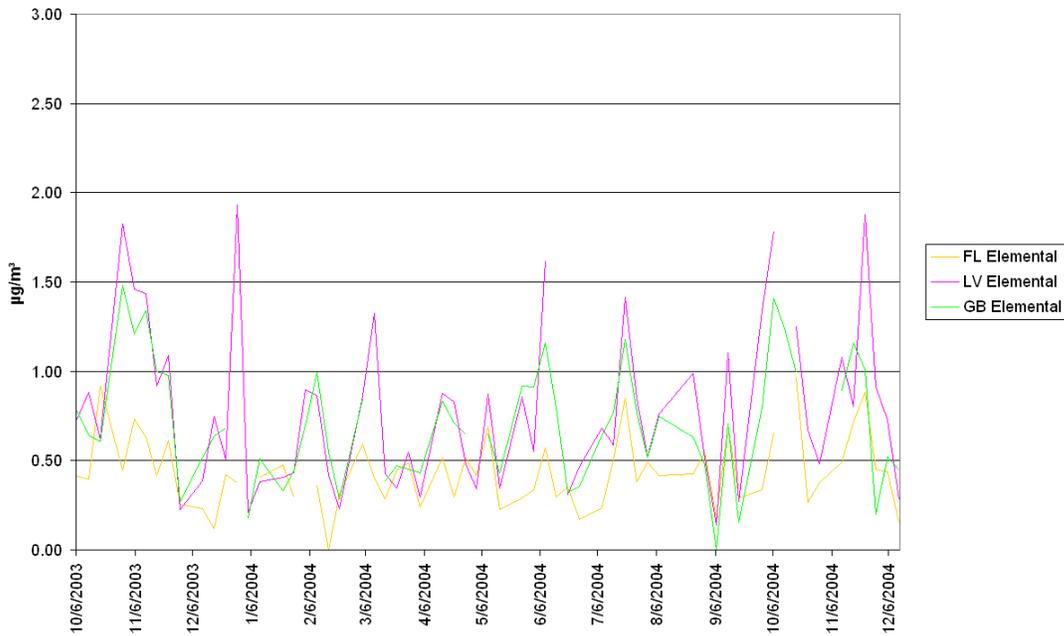


Organic carbon shows similar patterns to total mass in Southwest PA. Liberty is highest overall, with Lawrenceville and Greensburg showing urban influence.

Elemental Carbon, Southwest PA

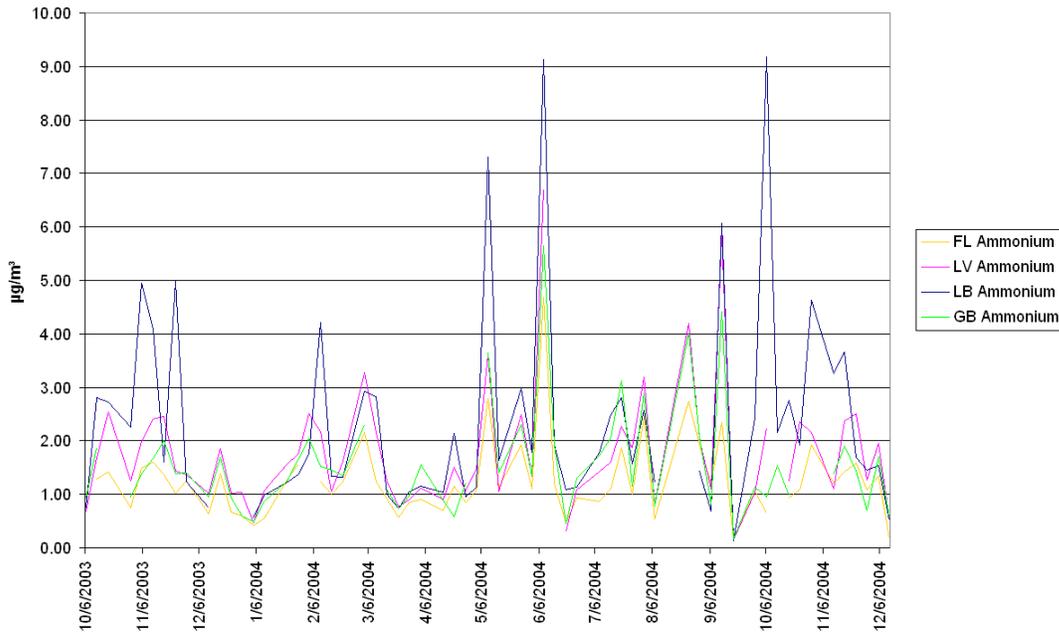


Elemental Carbon, Southwest PA w/o Liberty

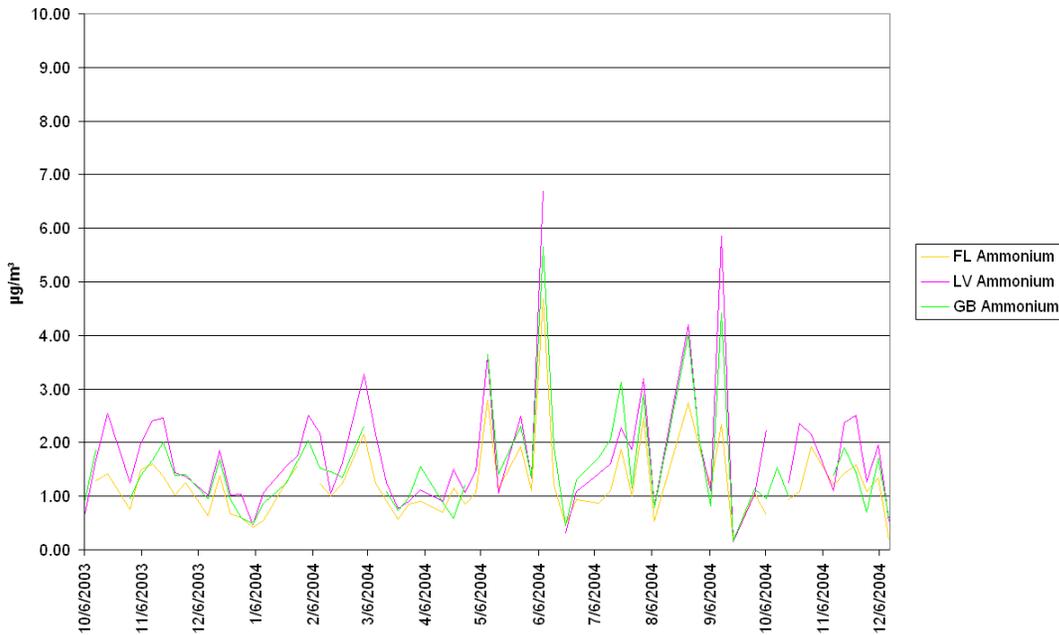


Elemental carbon is similar to organic carbon for Southwest PA. Higher concentrations at Lawrenceville for elemental carbon may be due to mobile source emissions.

Ammonium, Southwest PA

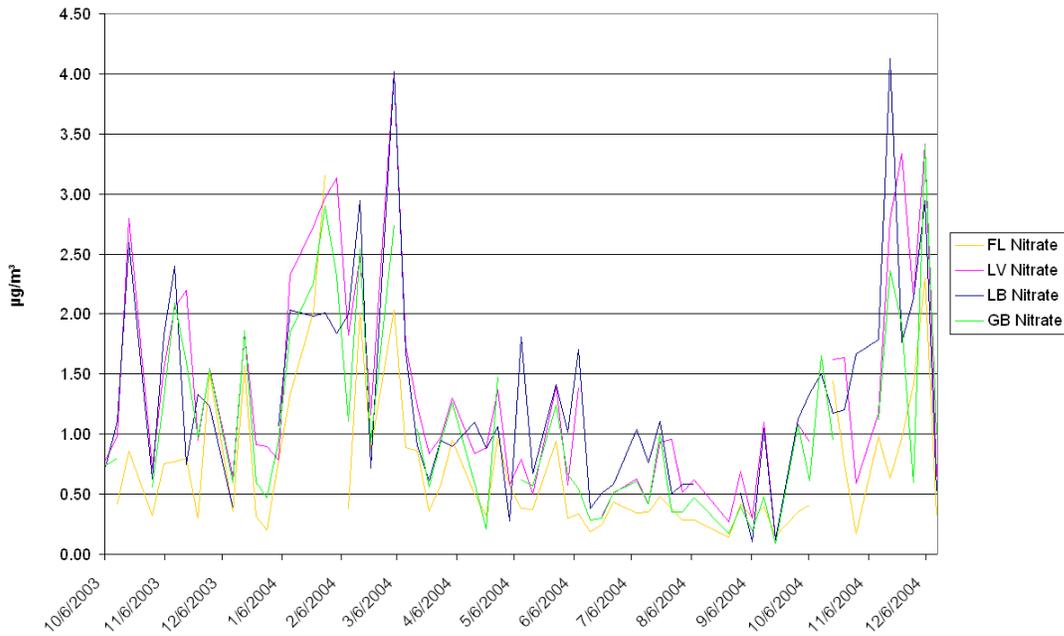


Ammonium, Southwest PA w/o Liberty

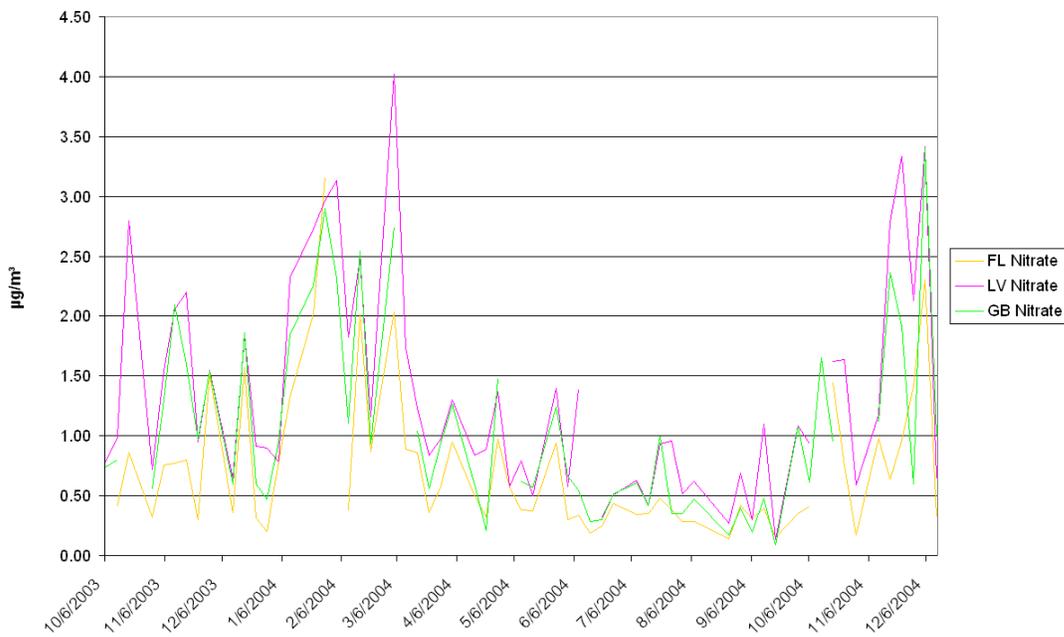


Ammonium is part of the localized excess at Liberty, although to a lesser extent than organic and elemental carbon. Excluding Liberty, ammonium appears to be both regional and urban, as it is highest at Lawrenceville.

Nitrate, Southwest PA

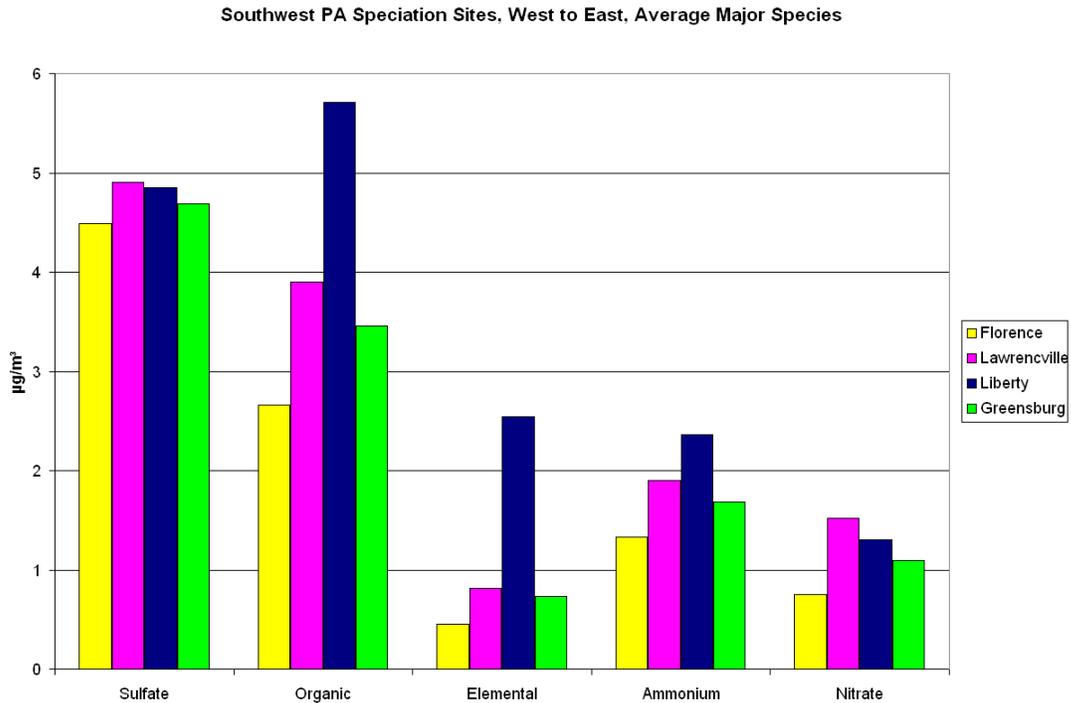


Nitrate, Southwest PA w/o Liberty



Nitrate appears to be regional, like sulfates, but with increased concentrations at Liberty and Lawrenceville. So, urban sources may have an influence on nitrate levels.

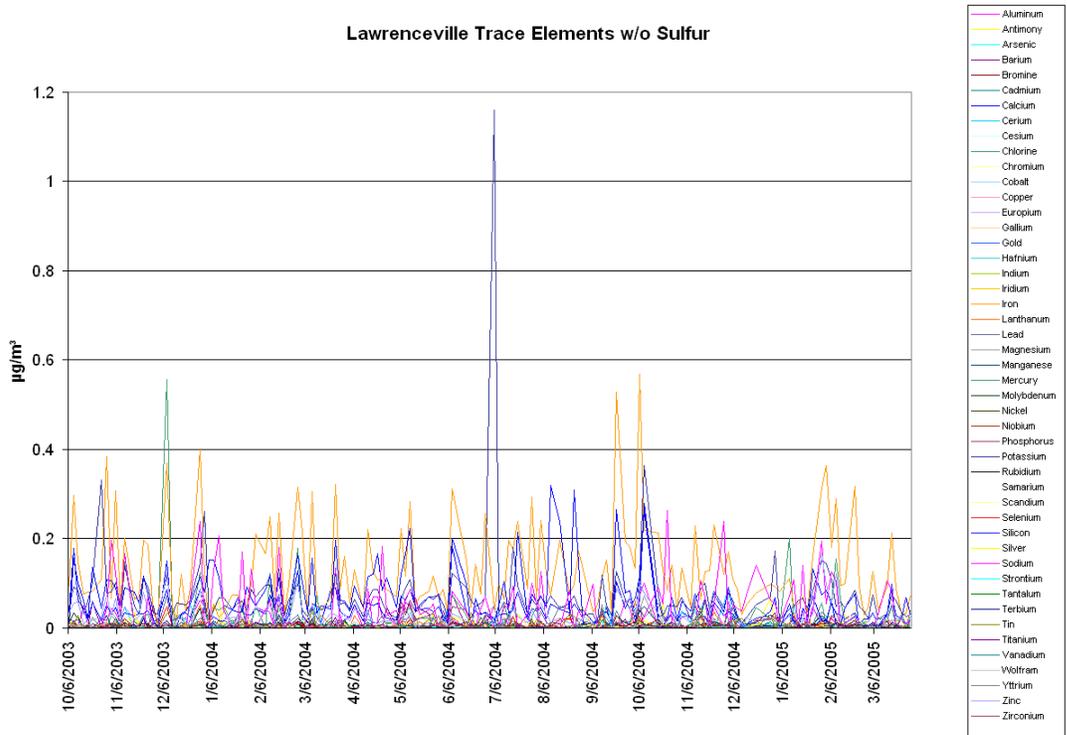
Below are averages for the southwest PA sites by major species, given in column clusters. Left-to-right in the column clusters is analogous to west-to-east geographically.



Florence can be considered the most rural of the sites, as average concentrations are lowest there for all species. A noticeable increase can be seen for all species from Florence to Lawrenceville, and a large increase is seen from Lawrenceville to Liberty for the localized Liberty-excess species. Greensburg is lower than the two Allegheny County sites but higher than Florence for all species, so it appears to be impacted by urban excess to a limited extent.

6. Trace Elements

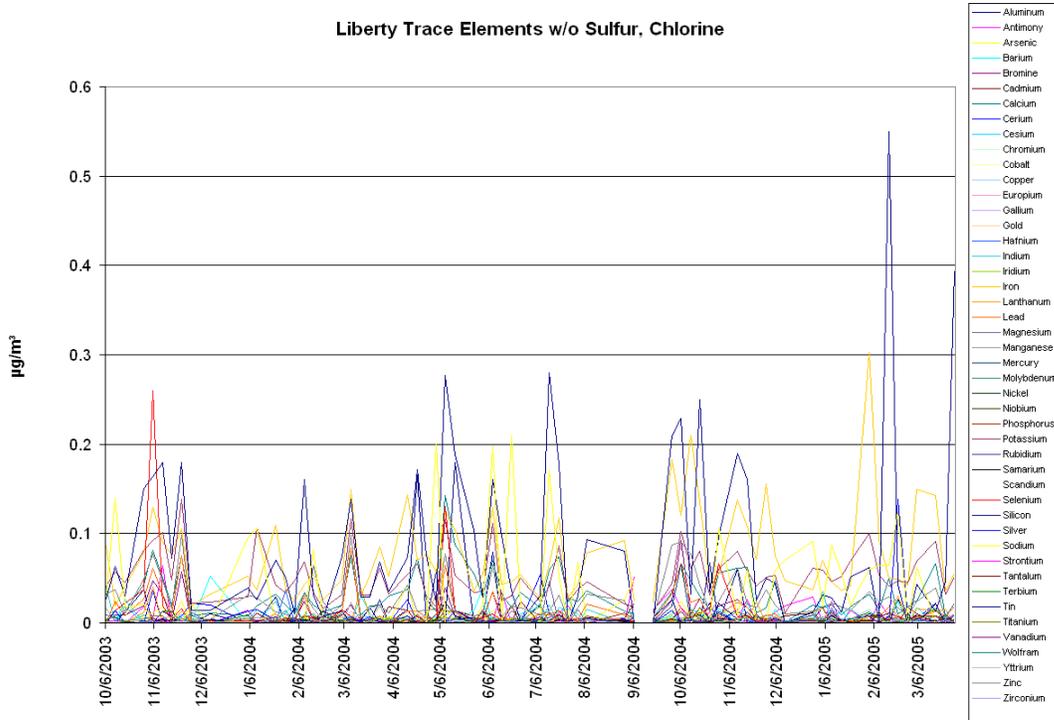
In addition to major species, 48 trace elements are analyzed from the speciation sites. Below are time series plots for Lawrenceville and Liberty trace elements. Sulfur, which is always much higher than the other elements, is excluded from these plots to allow for improved y-axis scaling.



Lawrenceville trace elements are generally dominated by crustal elements such as iron and silicon. The noticeable peak in the center is for potassium (date: 7/5/04) and is likely due to fireworks on the previous day. The Lawrenceville site is 2½ miles downwind of a large fireworks display that takes place annually in the downtown area on the 4th of July.

Small chlorine peaks can occur at Lawrenceville during winter months (example: 12/8/03), most likely due to the presence of road (rock) salt on streets near the monitor.

At Liberty, chlorine dominates the trace elements in addition to sulfur and therefore has been excluded from the graph below.

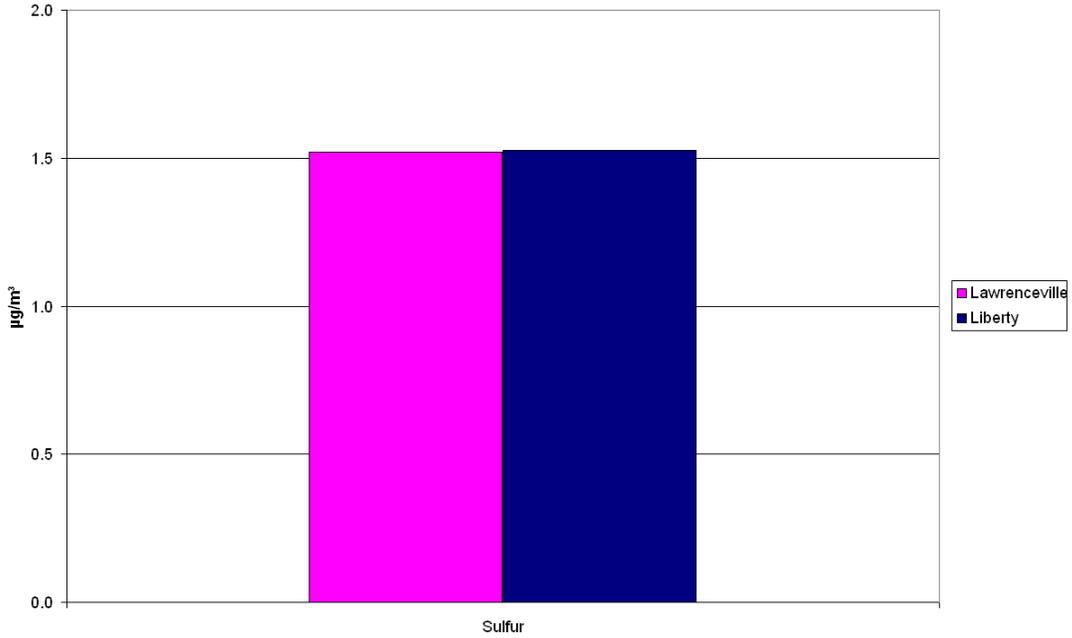


[Note: scale is different than Lawrenceville graph.]

Many elements such as crustal elements are present at Liberty like at Lawrenceville, but elements such as selenium and bromine show peaks that do not coincide with Lawrenceville. Similar to carbon and ammonium, many trace elements are part of the localized excess at Liberty. Comparing differences of each trace element should reveal dominant elements at each site.

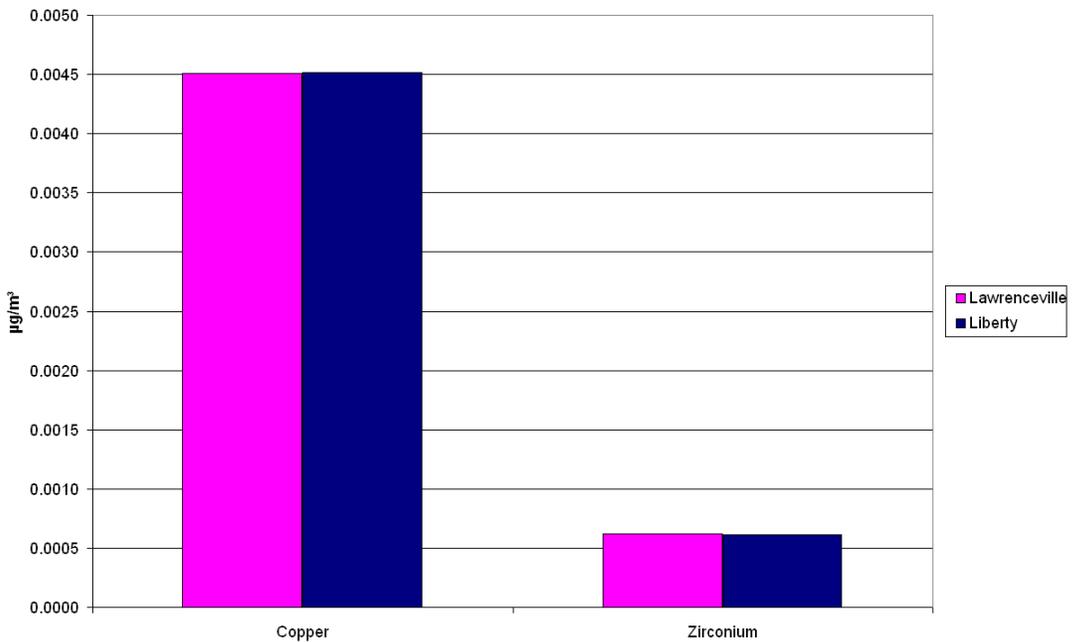
Below are average column graphs for each trace element.

Most Dominant Trace Element: Sulfur



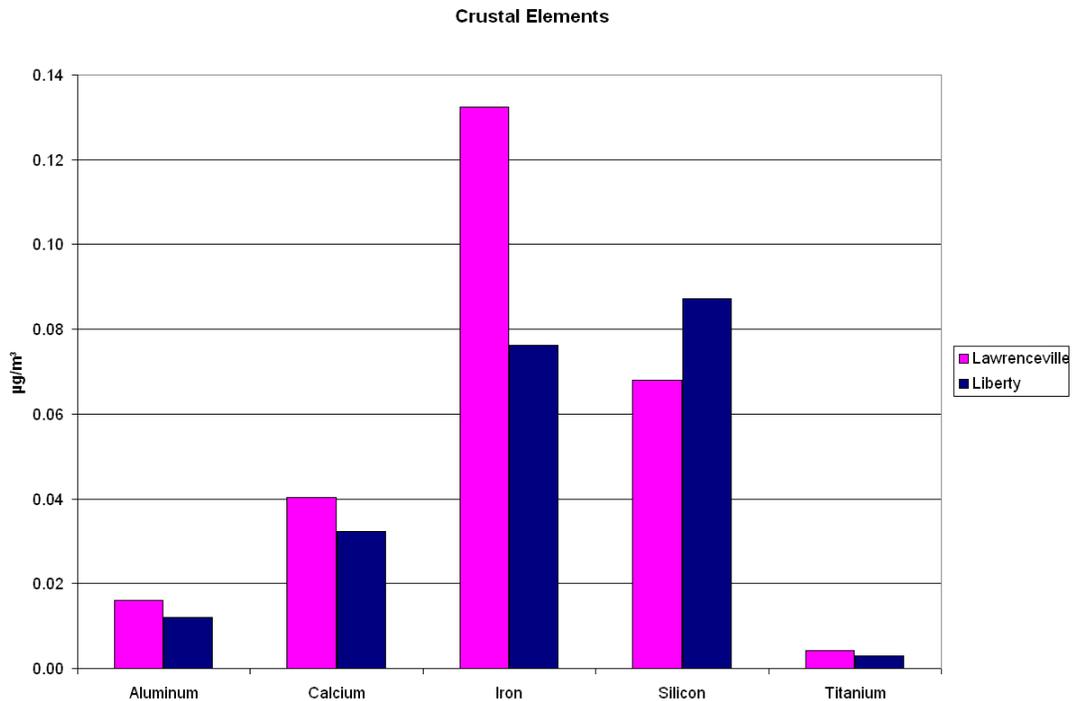
Sulfur is the most dominant element and is nearly equal for the sites. This follows the pattern of sulfate, which is also nearly equal on an average basis.

Additional Equal Trace Elements: Copper and Zirconium



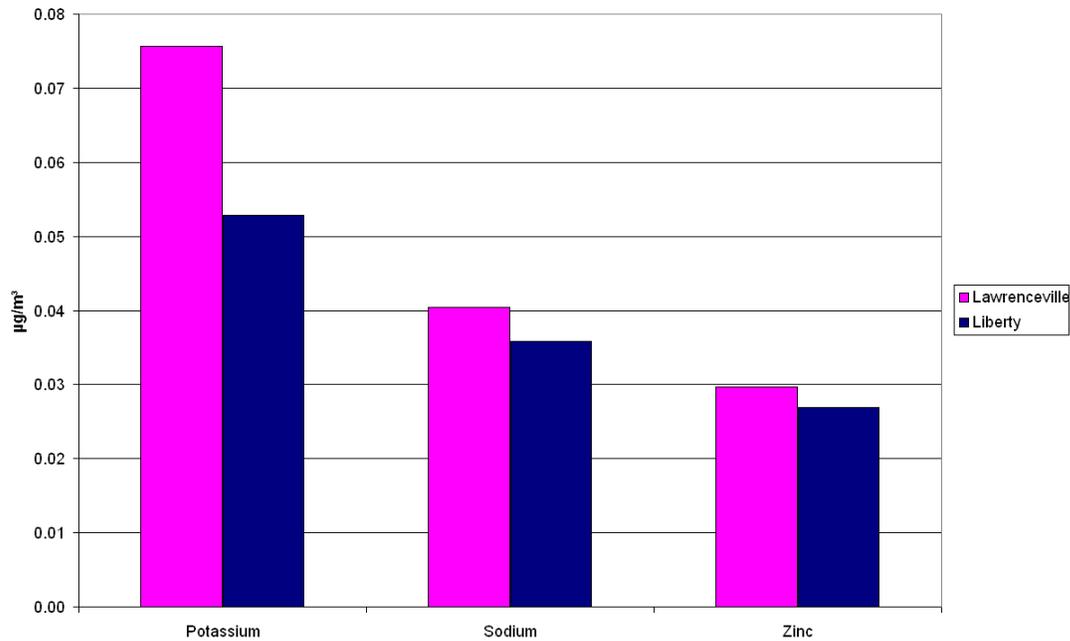
Although not as prevalent as sulfur, copper and zirconium are also nearly equal. Hence, these elements can be classified as regional-only trace elements.

The crustal elements in the chart below are constituents of fine soil. Collectively as a weighted sum, they compose the crustal component.



The crustal component is higher at Lawrenceville, and this holds true for each crustal element except silicon. As an individual element, silicon could be classified as Liberty-dominant. For this report, silicon will be grouped with the crustal component as a whole.

Lawrenceville-Dominant Trace Elements

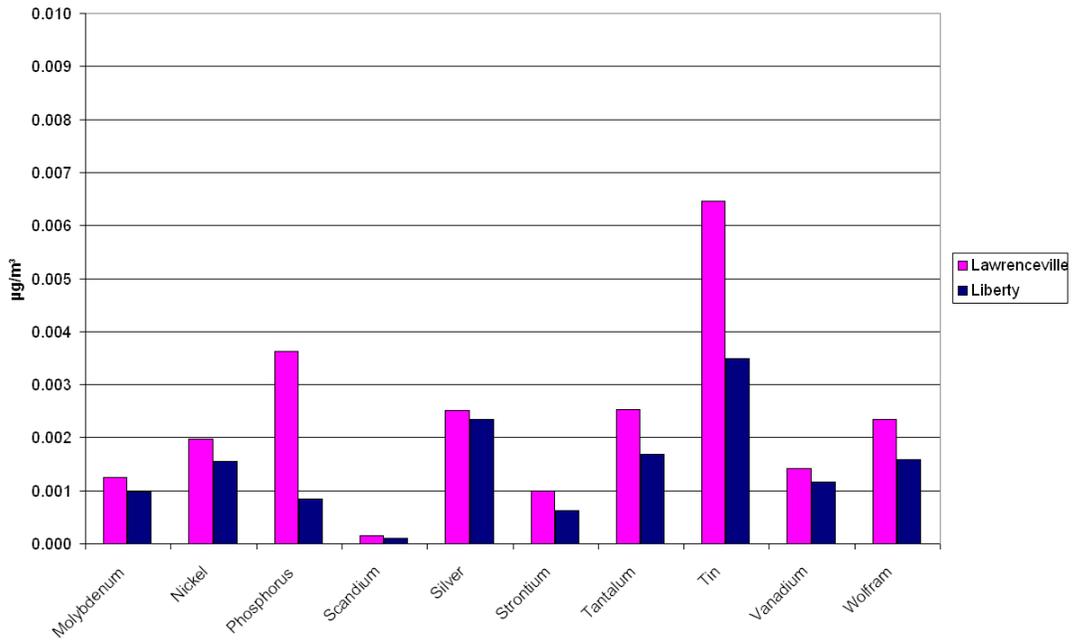
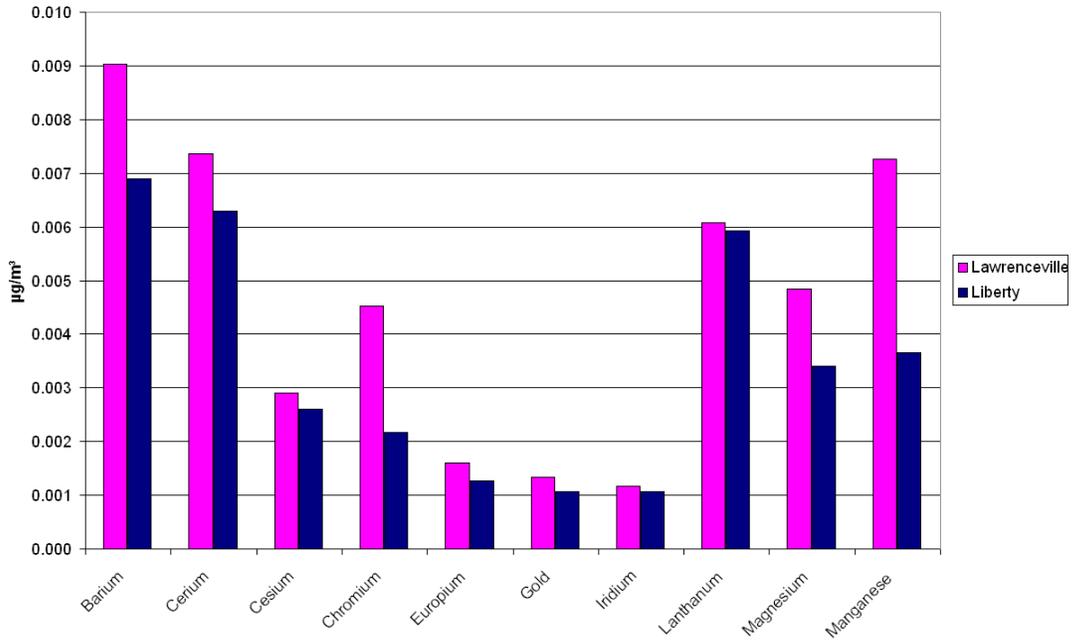


Potassium, sodium, and zinc are the most common Lawrenceville-dominant non-crystal trace elements. [Potassium and sodium are also measured as ions using the same analytical method by which the major species ammonium, nitrate, and sulfate are measured, but since the ionic concentrations of potassium and sodium are minute compared to the major ionic species, their trace element concentrations are given in this report.]

Potassium is a major ingredient in fireworks, and 4th of July fireworks near downtown Pittsburgh are the likely cause of the larger concentration of potassium at Lawrenceville. The higher sodium concentration at Lawrenceville may be due to airborne road salt from more heavily traveled streets than at Liberty. Possible sources of additional zinc at Lawrenceville may be urban sources.

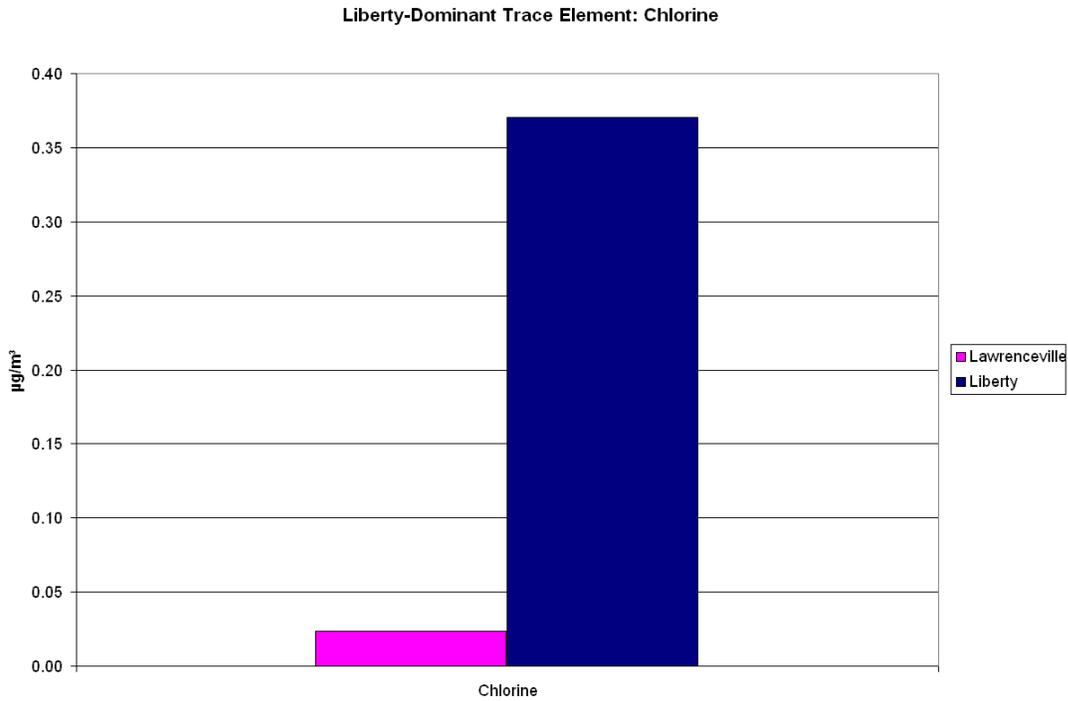
Additional Lawrenceville-dominant trace elements are shown in the charts to follow.

Additional Lawrenceville-Dominant Trace Elements

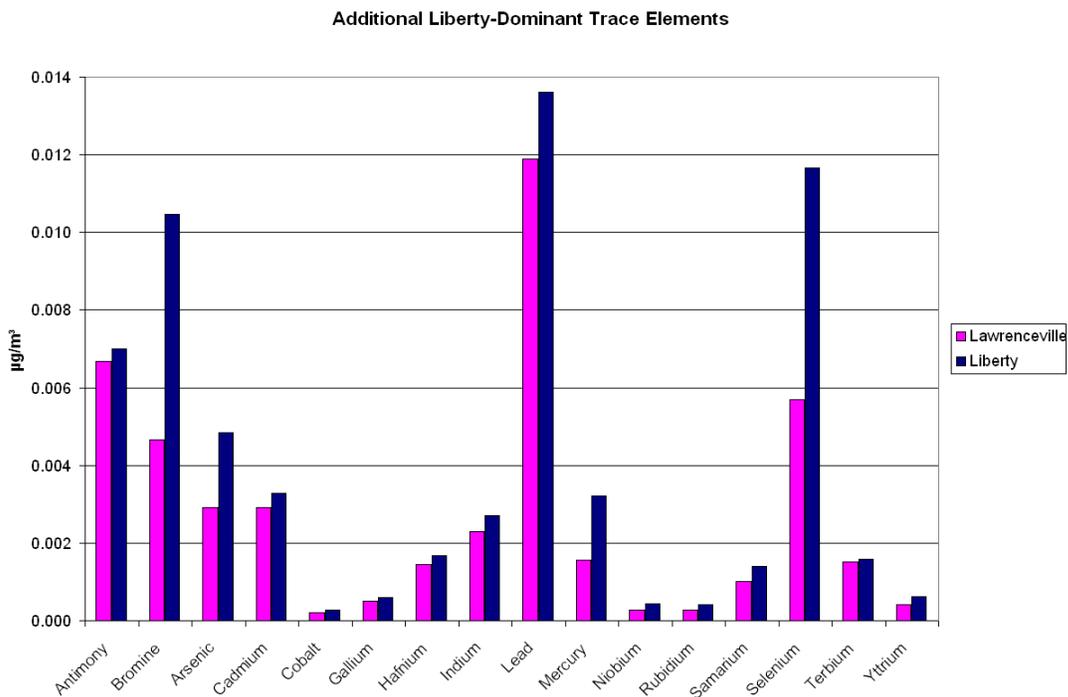


These Lawrenceville-dominant trace elements are likely urban and/or regional in nature. Barium, chromium, manganese, phosphorus, and tin show the most noticeable differences for these elements.

Liberty-dominant trace elements are given below.



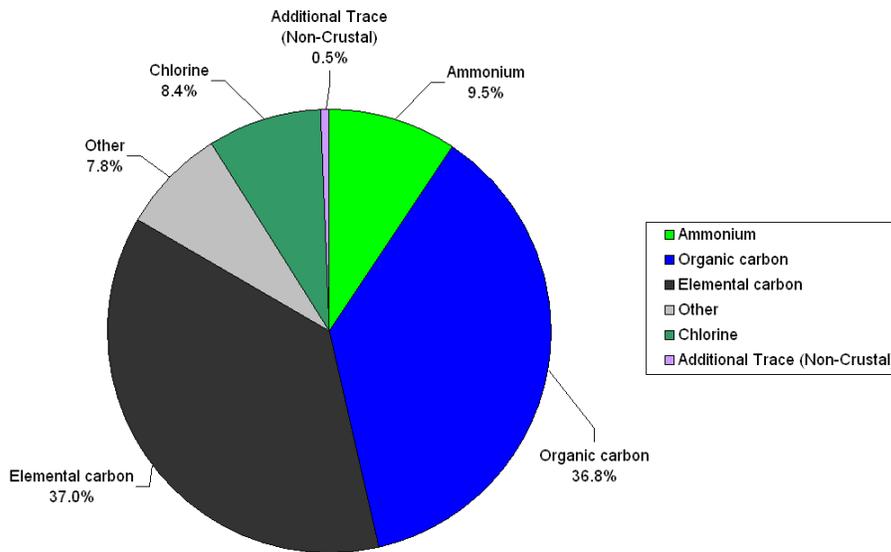
Chlorine is the most common Liberty-dominant trace element. While chlorine is a component of road salt, the amount of excess chlorine is unlikely due to airborne road salt alone.



Bromine is a halogen, like chlorine, although it is present at much smaller concentrations than chlorine. Arsenic, lead, mercury, and selenium are also noticeably higher trace elements at Liberty than at Lawrenceville, indicating possible local influences.

Taking the Liberty-dominant trace elements into account, the Liberty localized excess pie chart can be adjusted to include chlorine and additional non-crustal trace elements in place of a portion of the "other" component.

Localized Excess, Liberty Average Species (Adjusted Pie)

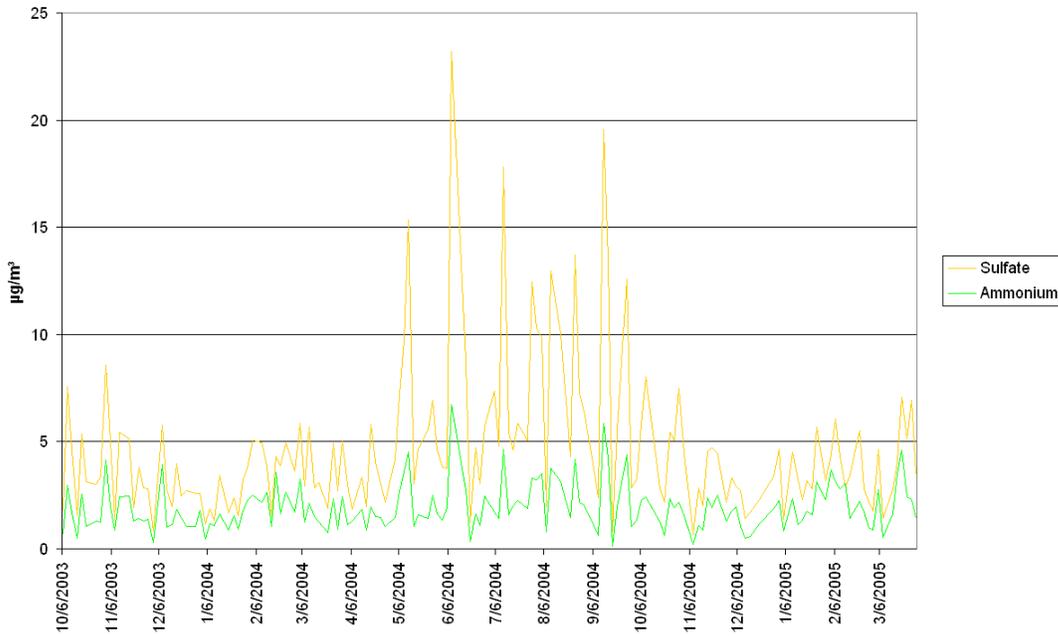


This adjusted localized excess pie chart represents the speciation of the Liberty excess, creating a PM_{2.5} fingerprint for the Liberty monitor. Without the excess PM_{2.5} components shown in the chart, Liberty would match Lawrenceville and be similar to other Eastern U.S. metropolitan sites.

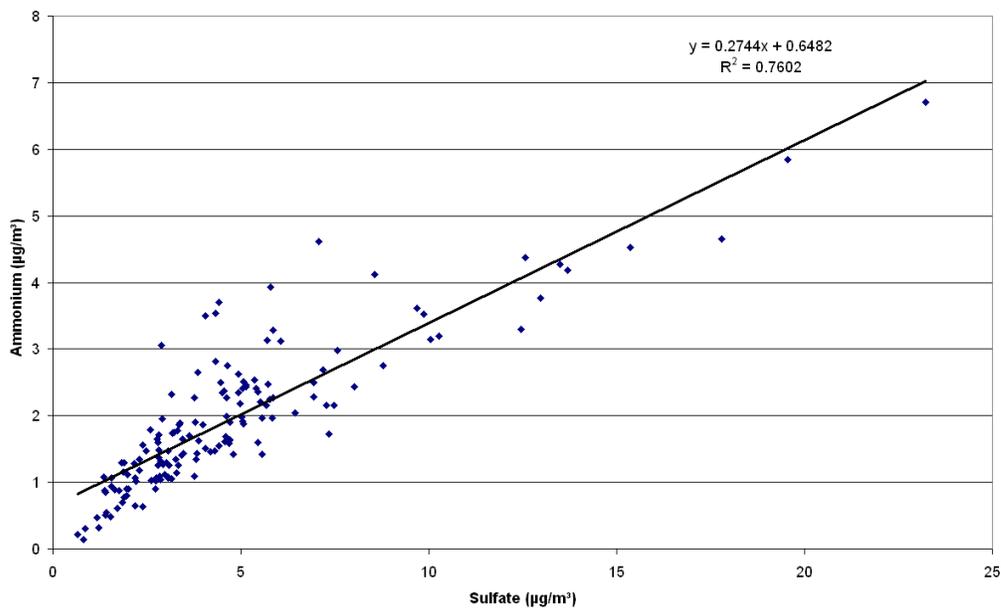
7. Species Correlations

Sulfate and nitrate generally exist as ammonium salts in PM_{2.5}. Hence, correlations can be drawn between ammonium, nitrate, and sulfate, varying by season.

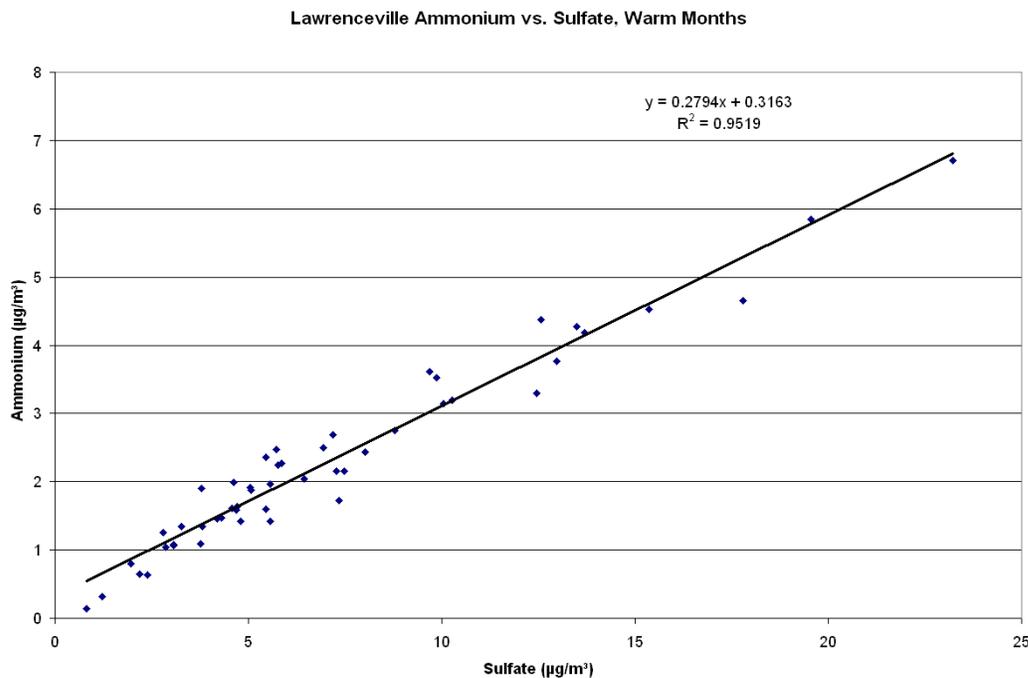
Lawrenceville Sulfate w/Ammonium



Lawrenceville Ammonium vs. Sulfate, Year-Round

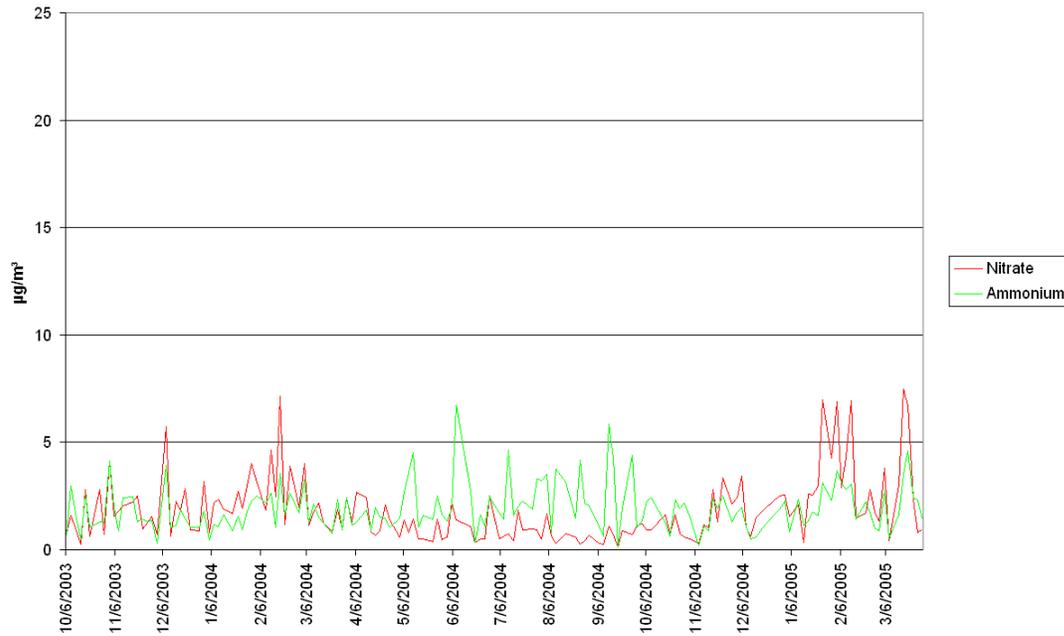


The time series and regression plots for Lawrenceville sulfate and ammonium show a moderate correlation year-round. During warm months when sulfate is most prevalent, the correlation between ammonium and sulfate increases, but the slope of the regression line is similar to that of the year-round basis. A Lawrenceville ammonium and sulfate regression plot for May through October is given below.



Sulfate commonly exists in two forms: ammonium sulfate and ammonium bisulfate. The slopes of the regression lines for Lawrenceville (0.274 – 0.279) are between that of a perfect ammonium sulfate regression (0.375) and a perfect ammonium bisulfate regression (0.188). So, a mixture of sulfate/bisulfate appears to be evident for Lawrenceville on a year-round basis.

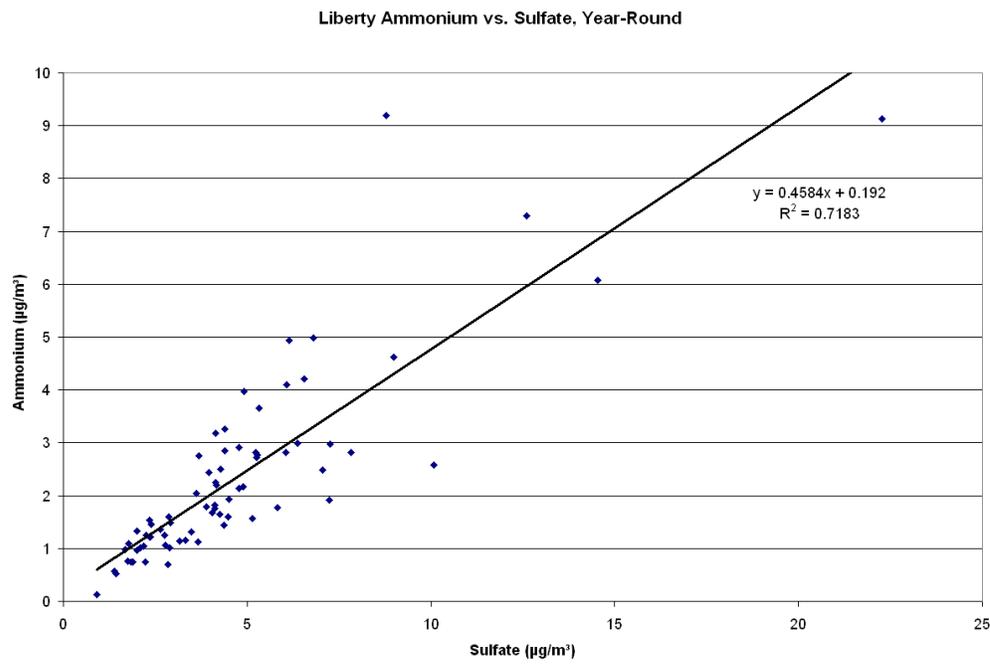
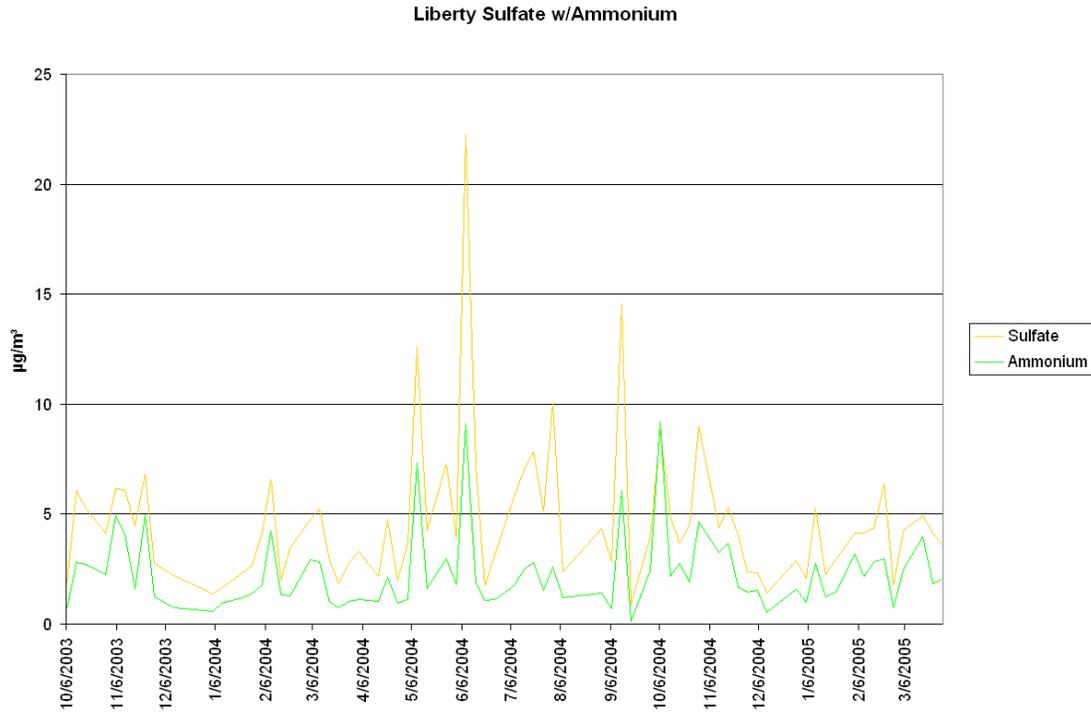
Lawrenceville Nitrate w/Ammonium



The times series plot for nitrate and ammonium shows the best correlation during winter when nitrates are more prevalent. The worst correlation occurs during warmer months when sulfates are more dominant.

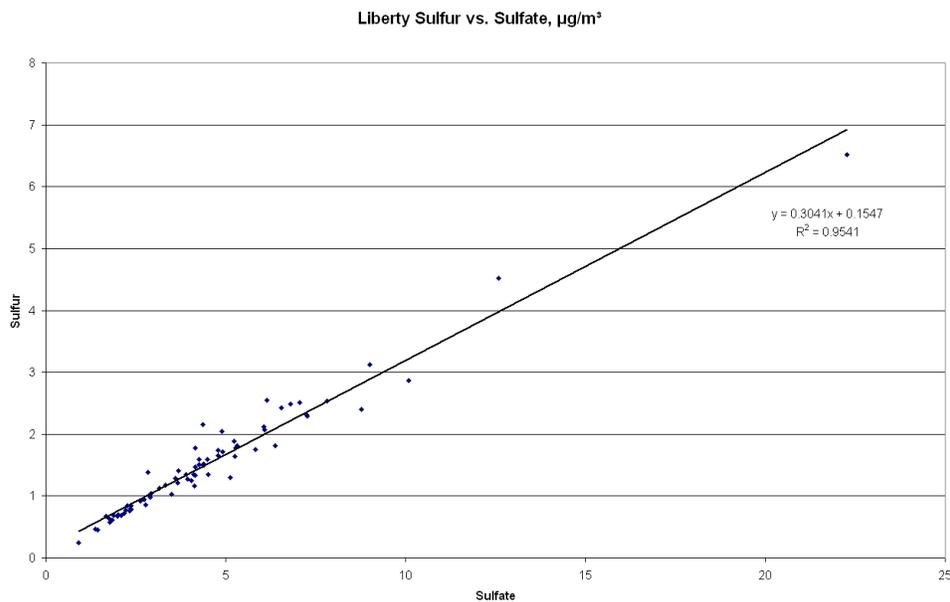
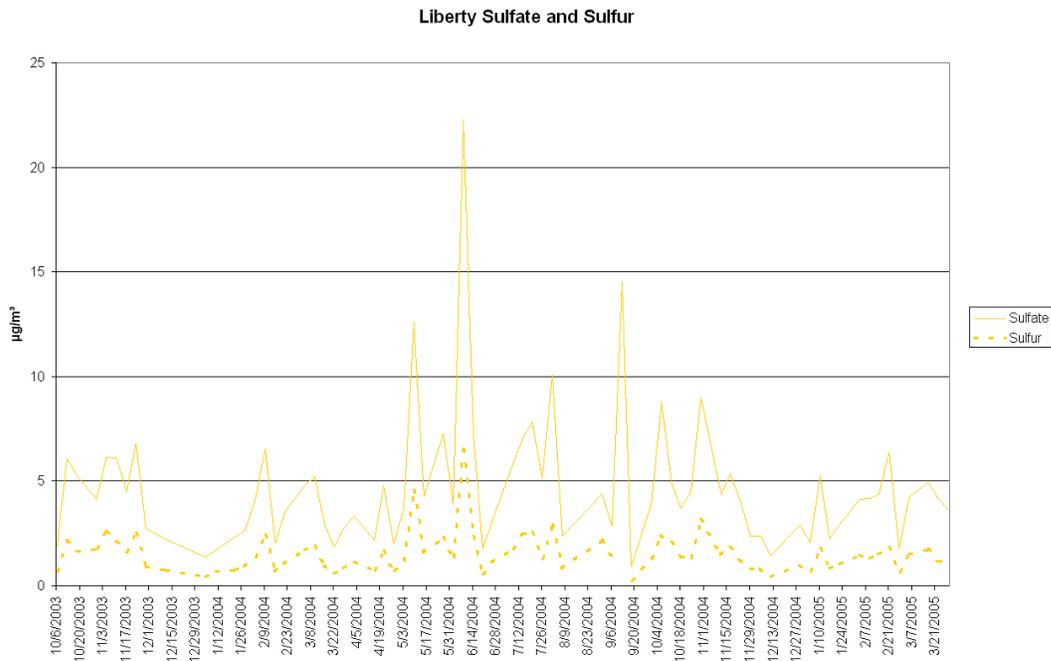
These trends for ammonium sulfate and ammonium nitrate salts are regional and are common to most speciation sites in the Eastern U.S.

Trends for sulfate and ammonium at Liberty are given in the charts below.



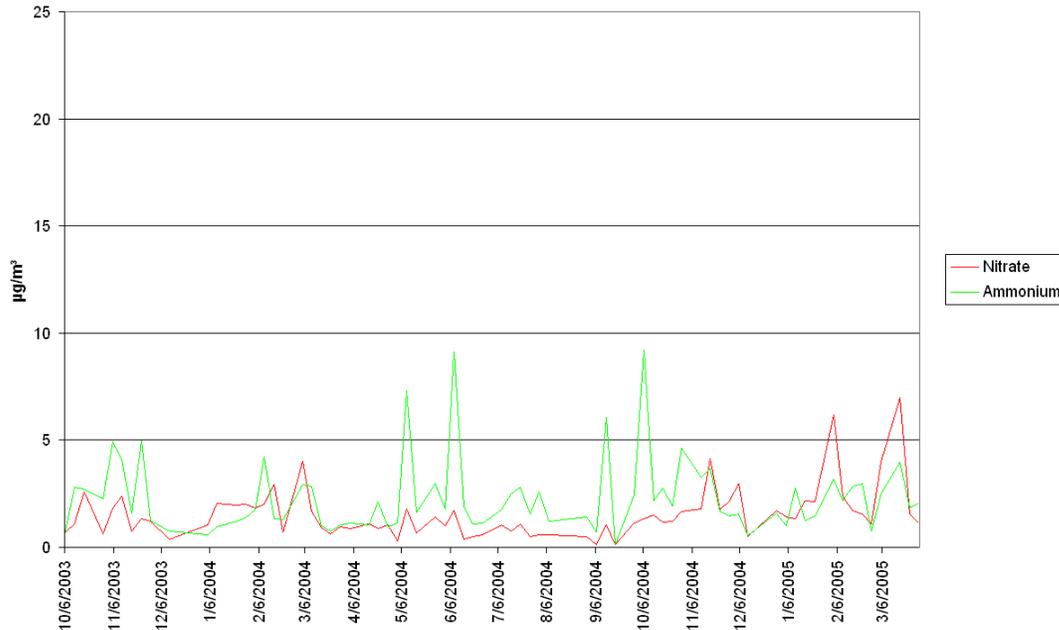
Liberty shows less of a year-round correlation for ammonium and sulfate than Lawrenceville, as the R^2 (0.718) value is lower for the Liberty regression. Also, the slope is considerably greater for the Liberty regression line (0.458), due to the higher concentrations of ammonium at Liberty.

To examine if sulfur is present as an element in any form other than sulfate at Liberty, time series and regression plots for Liberty sulfur and sulfate are shown below.



Liberty sulfur and sulfate show an excellent correlation (0.954), so it can be assumed that very few additional forms of sulfur are present.

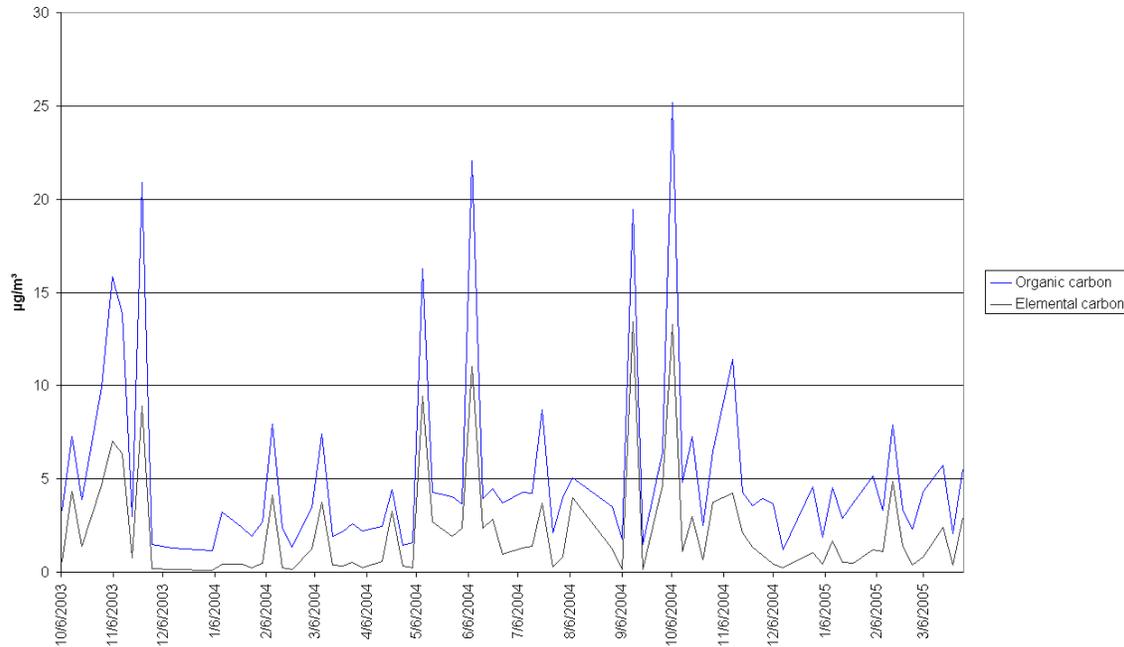
Liberty Nitrate w/Ammonium



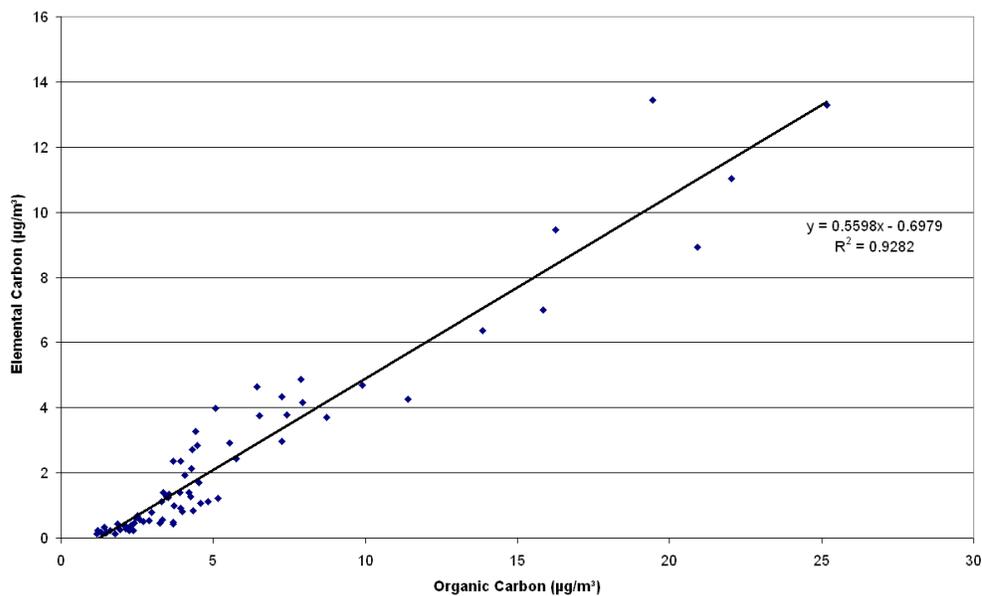
Liberty behaves similarly to Lawrenceville for nitrate and ammonium, but with higher overall concentrations for ammonium at Liberty. Ammonium is likely present in other forms than just ammonium sulfate and nitrate salts at Liberty.

One of the best correlations between species at either site is for organic carbon and elemental carbon at Liberty ($R^2 = 0.928$). Organic and elemental carbons also show strong correlations with total mass concentration at Liberty. Plots and correlations are shown below for organic carbon, elemental carbon, and total $PM_{2.5}$.

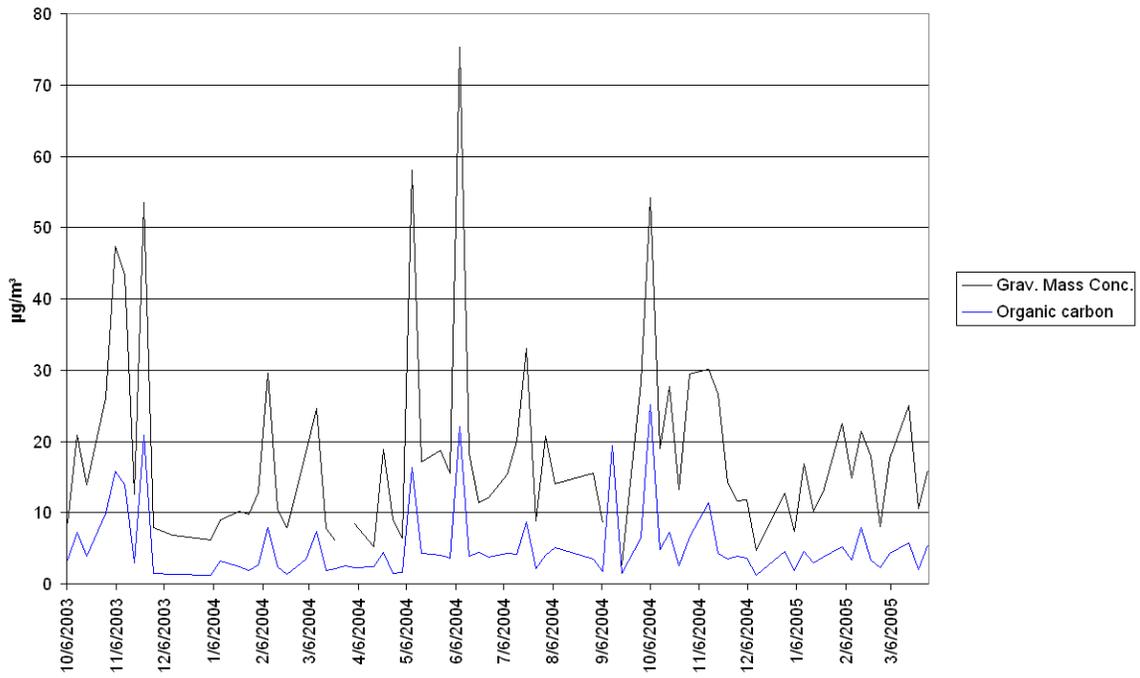
Liberty Organic and Elemental Carbon



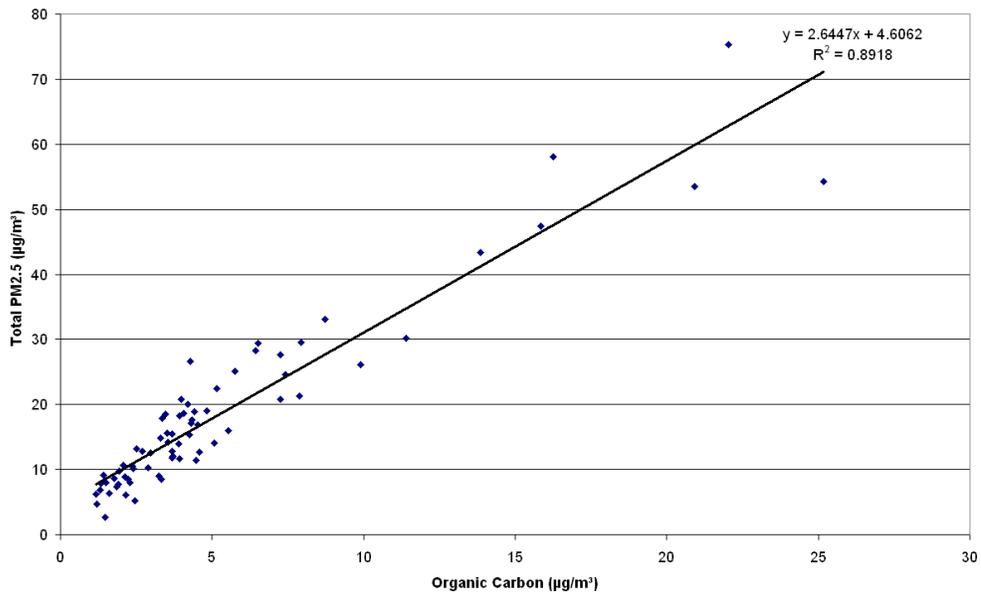
Liberty Elemental vs. Organic Carbon



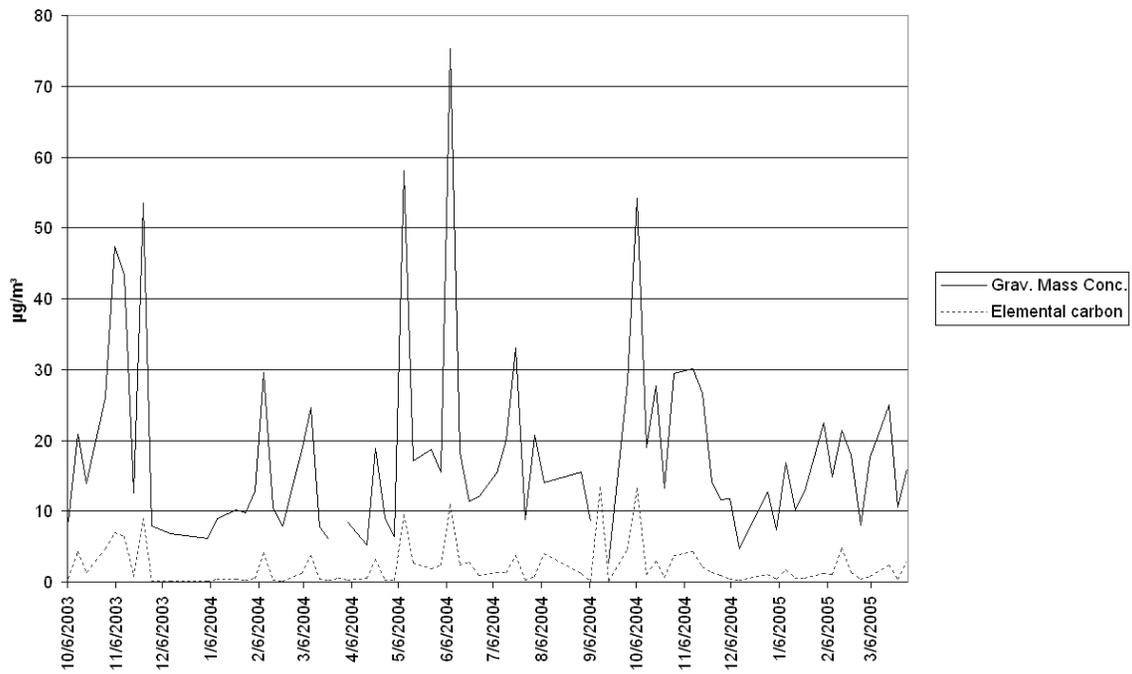
Liberty Total Gravimetric PM2.5 and Organic Carbon



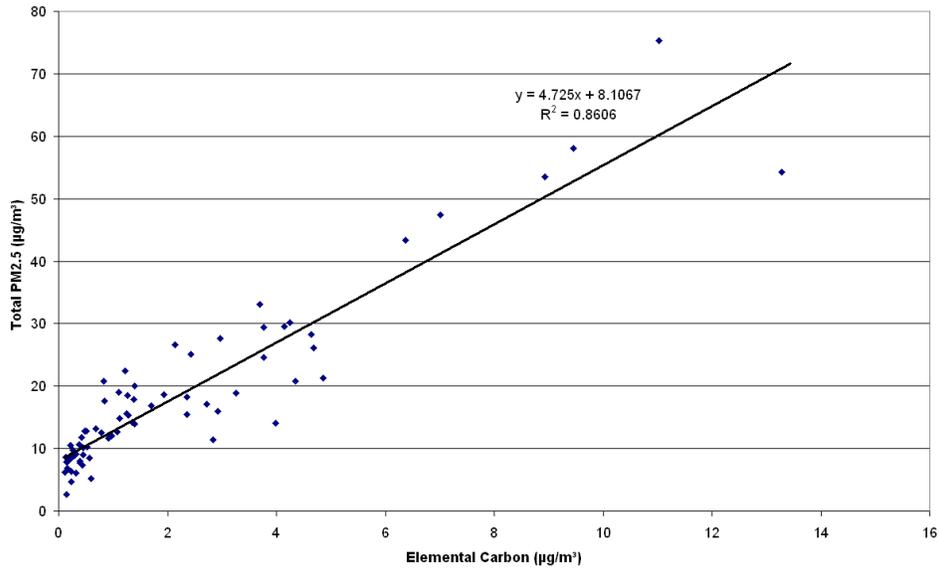
Liberty Total Gravimetric PM2.5 vs. Organic Carbon



Liberty Total Gravimetric PM2.5 and Elemental Carbon

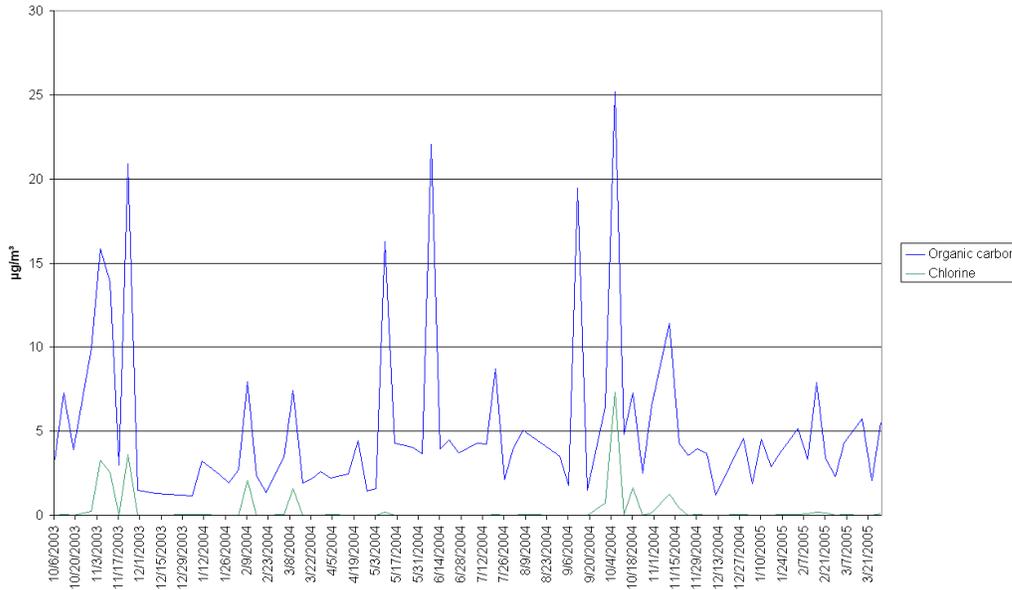


Liberty Total Gravimetric PM2.5 vs. Elemental Carbon

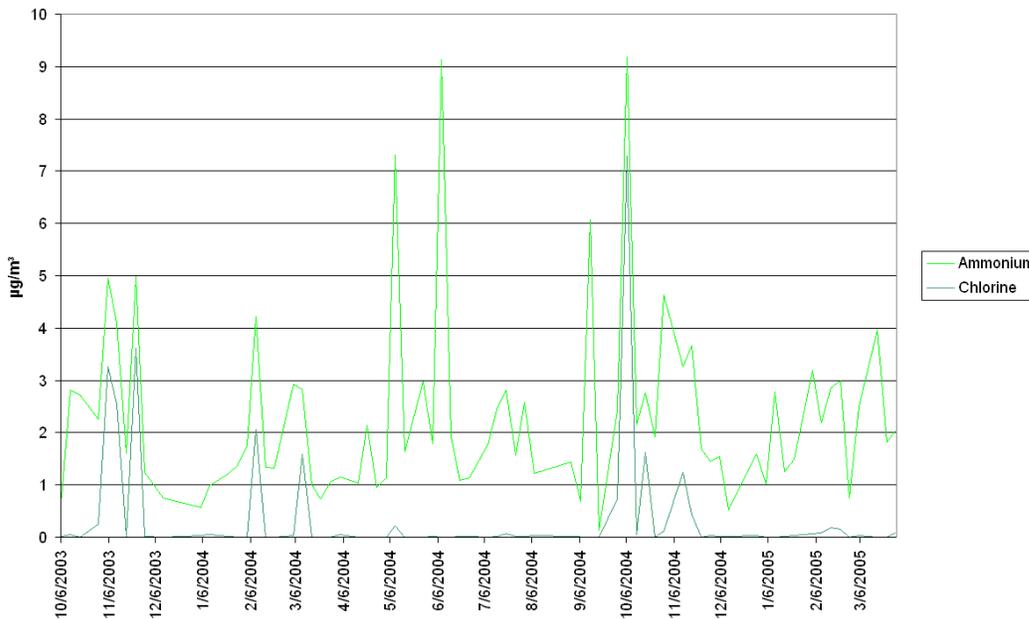


Additionally, chlorine can track organic carbon and ammonium in winter. Time series plots for chlorine with organic carbon and ammonium are given below.

Liberty Organic Carbon and Chlorine



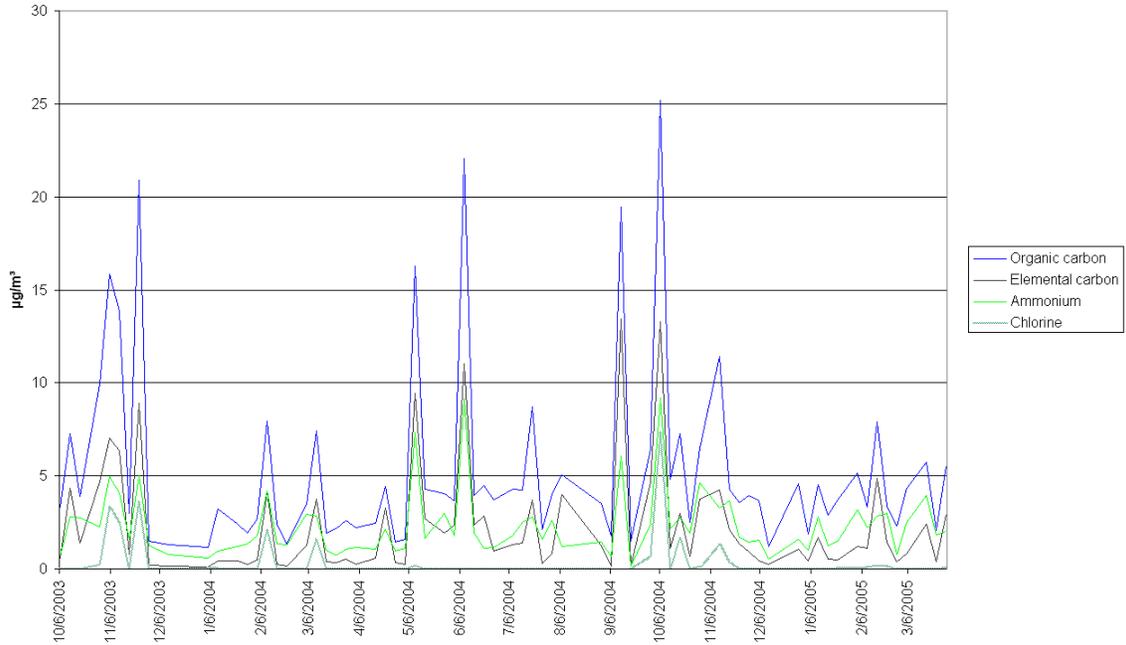
Liberty Ammonium and Chlorine



These plots suggest that chlorinated organic compounds and/or ammonium chloride salt may be a component of Liberty $\text{PM}_{2.5}$ during cold months.

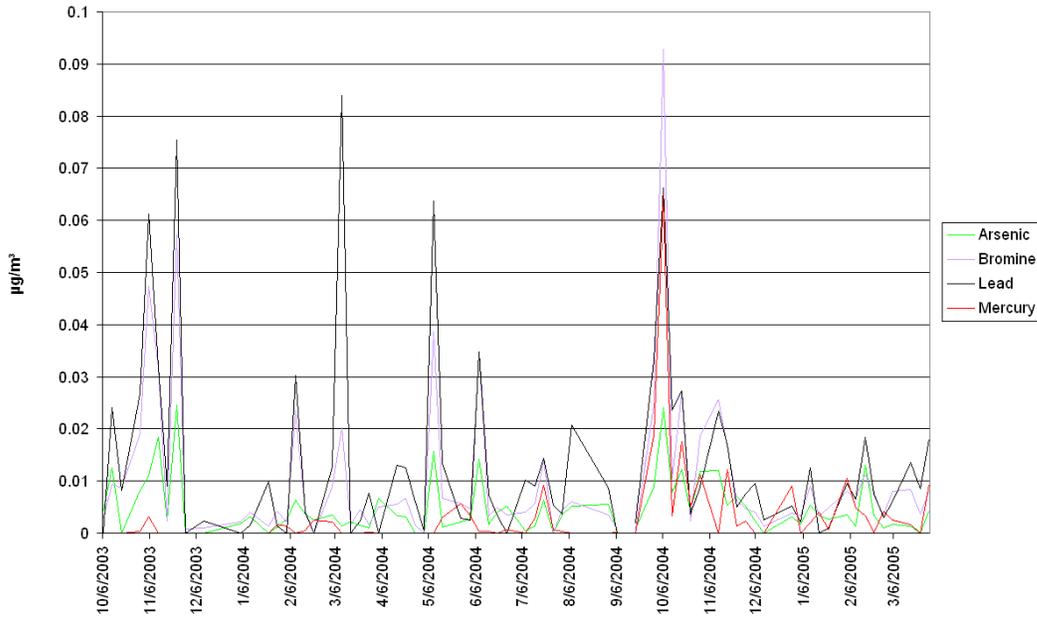
Ammonium can also track the carbons on some days, specifically on peak days. Carbons, ammonium, and chlorine are shown on the following plot as "peak species." These species correlate well on peak days, but not necessarily year-round.

Liberty Peak Species Time Series (Organic Carbon, Elemental Carbon, Ammonium, and Chlorine)



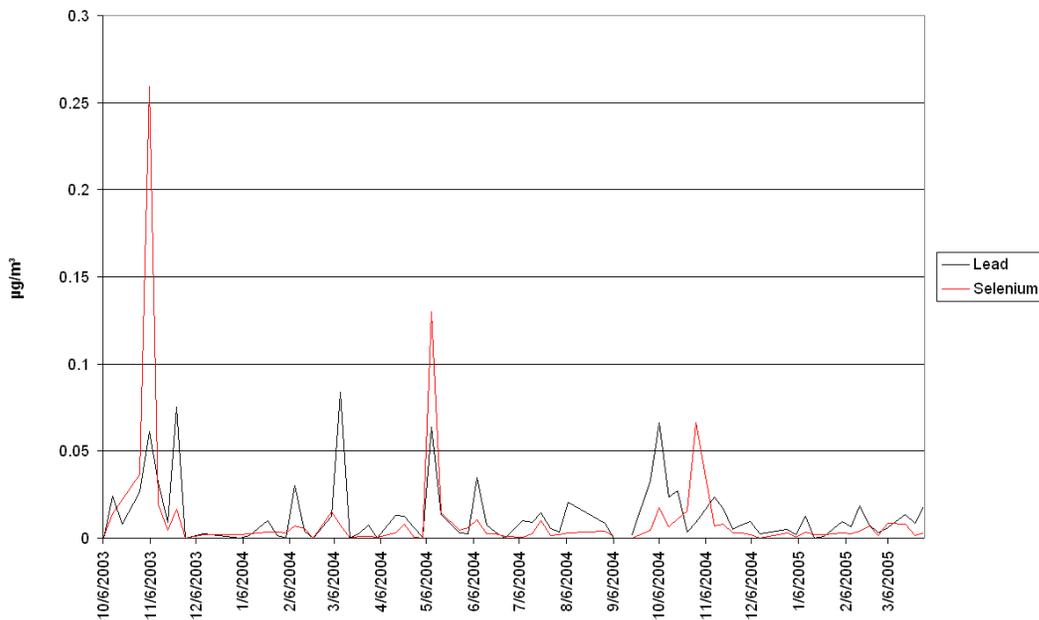
On a smaller scale, some Liberty-dominant trace elements also appear to correlate with one another. Liberty arsenic, bromine, lead, and mercury are shown in the time series plot below.

Liberty Arsenic, Bromine, Lead, and Mercury



Lead may also correlate with selenium sometimes at Liberty, as shown in the plot below.

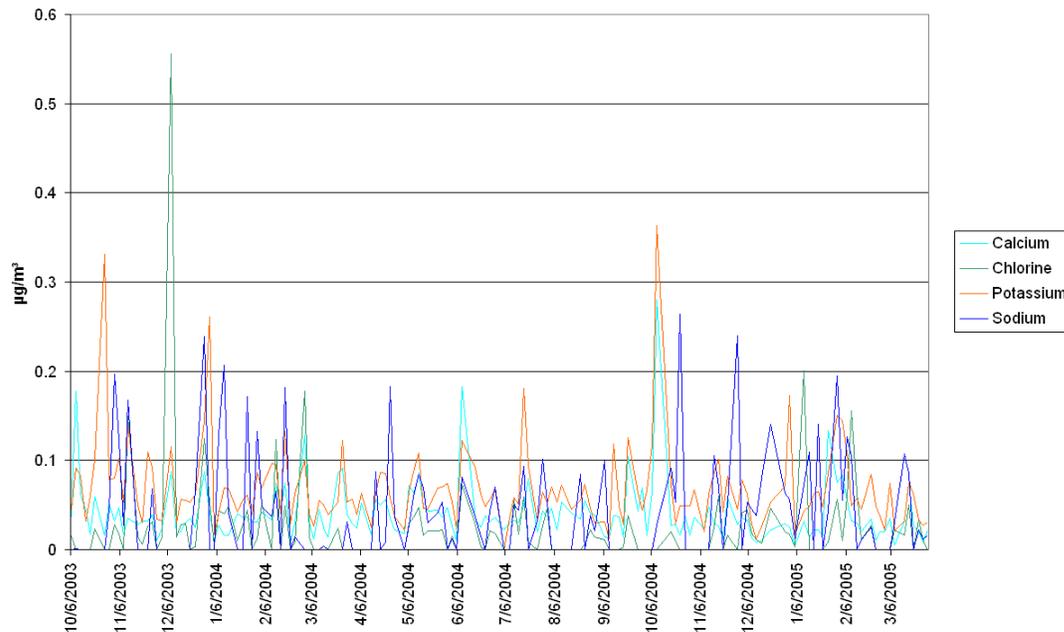
Liberty Lead and Selenium



Correlations of possible road (rock) salt trace elements at each site are shown next. Different forms of road (rock) salt can be used as ice-melting material. Sodium chloride is the cheapest, most common form and is the same chemical formula as table salt. Potassium chloride and calcium chloride can also be used as ice-melters, although calcium chloride is the most expensive salt and is generally used only on walkways.

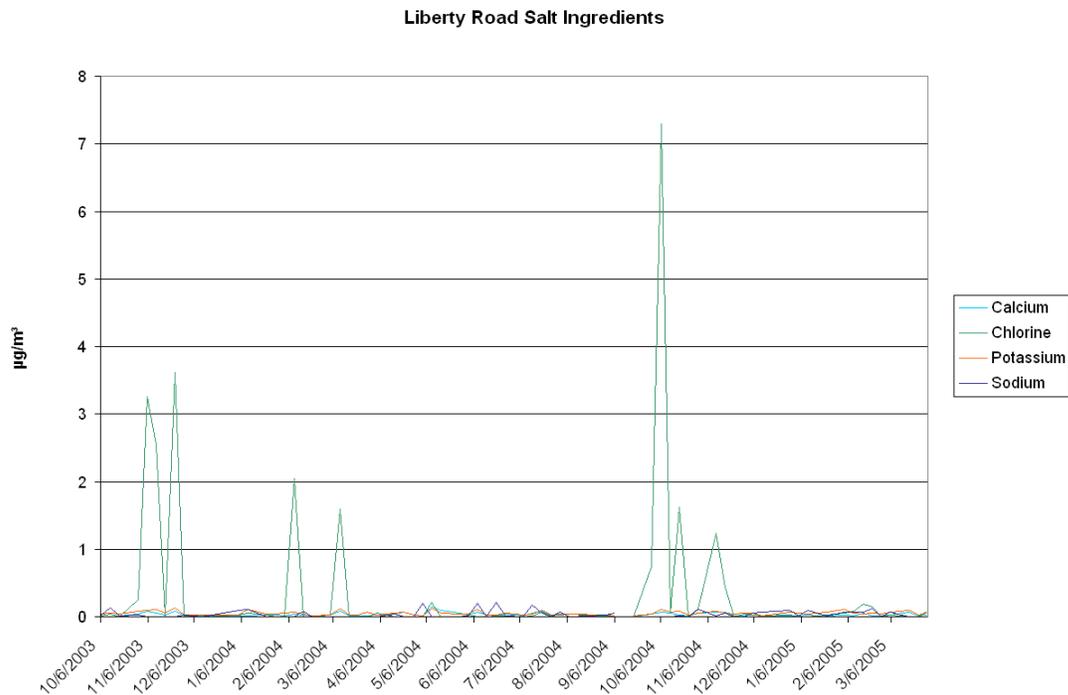
Mass ratios of the cation portion of each salt (sodium, potassium, calcium) are roughly 1:1 to the anionic portion (chloride). Plots of these elements should therefore show similar concentrations to one another if airborne road salt is a source of PM_{2.5}.

Lawrenceville Road Salt Ingredients (w/o 4th-of-July Potassium Peak)



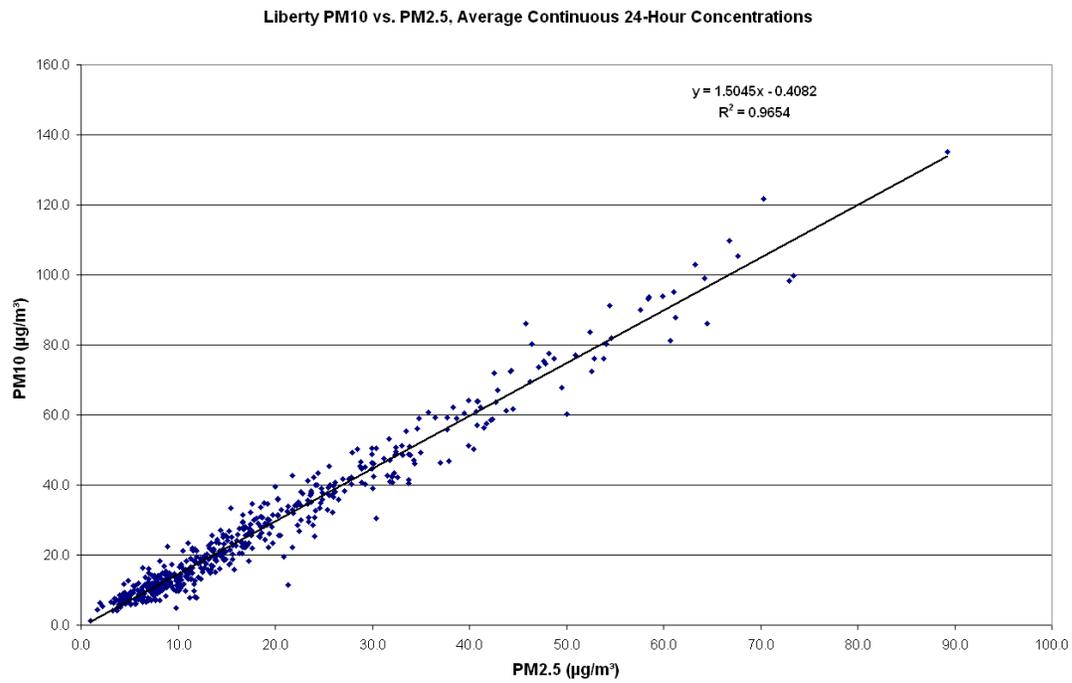
Road salt ingredients show similar concentration levels at Lawrenceville, signifying that one or more of the possible cations may be present with chloride as road salt. The highest chlorine peak (date: 12/8/03) may represent a combination of all three types of salt.

Road salt ingredients at Liberty are shown in the plot below.



At Liberty, road salt may be present as $PM_{2.5}$, but only a small portion of the total chlorine concentrations can be attributed to road salt. The cation concentrations are much lower than chlorine on the peak days. Therefore, the source of chlorine is not entirely from road salt at Liberty.

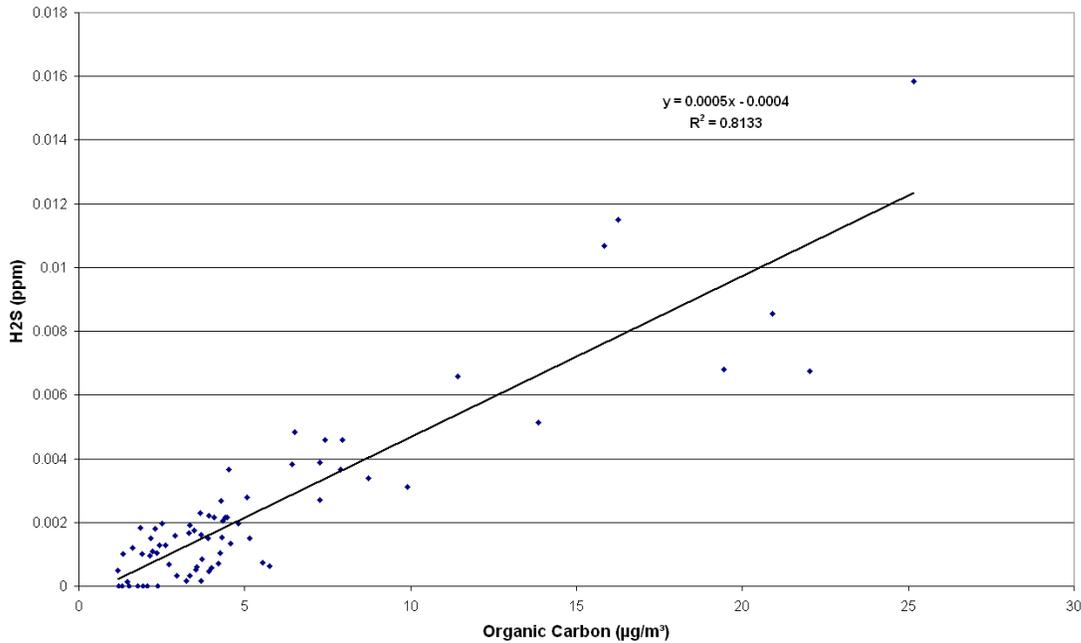
The Liberty site is collocated with several continuous monitors. Liberty continuous PM₁₀ and PM_{2.5} are plotted below.



The Liberty PM₁₀ and PM_{2.5} continuous monitors correlate extremely well, with PM_{2.5} constituting two-thirds of the PM₁₀ concentration.

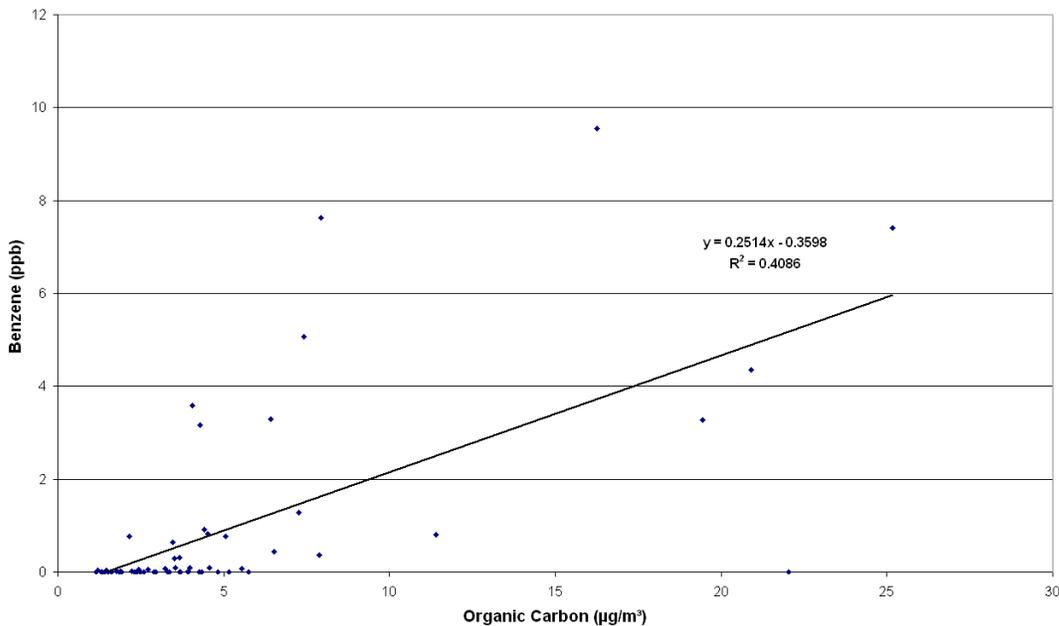
Regression plots for continuous gaseous pollutants and organic carbon (the most dominant PM_{2.5} species) are given below for Liberty.

Liberty H₂S (Average Continuous 24-Hour) vs. Organic Carbon



Hydrogen sulfide (H₂S) 24-hour averages appear to correlate well with organic carbon at Liberty. Liberty benzene and organic carbon are shown next.

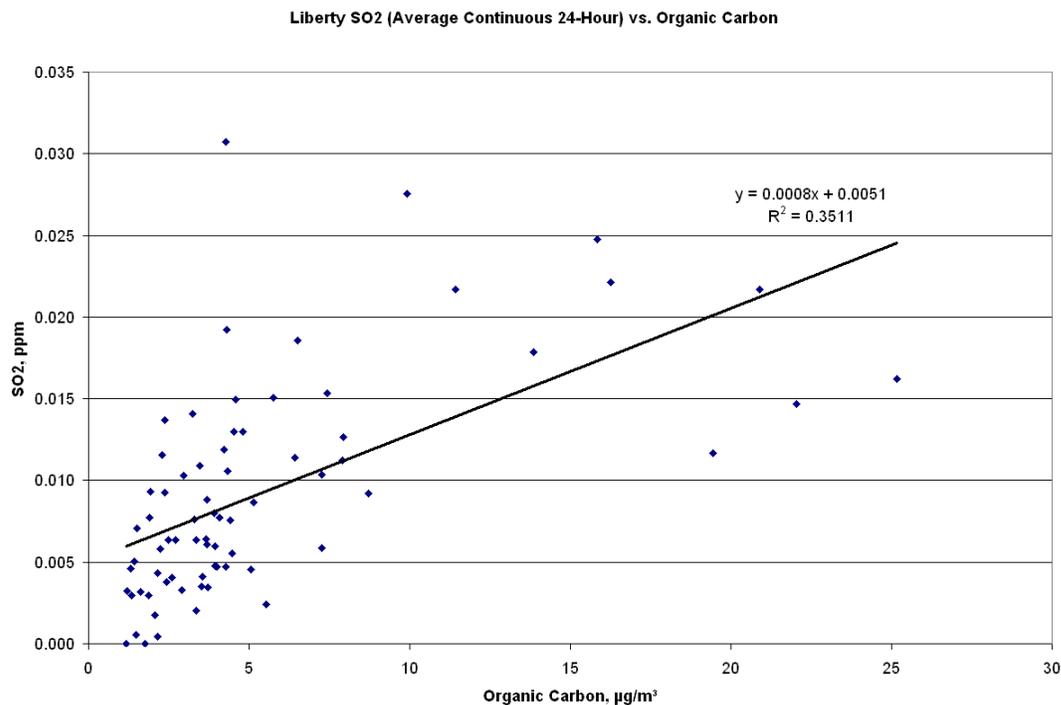
Liberty Benzene (Average Continuous 24-Hour) vs. Organic Carbon



Benzene itself is an organic carbon, but benzene 24-hour averages do not correlate well with organic carbon at Liberty. This is due to the different phases in which benzene and organic carbon are being sampled. The benzene monitor measures continuous gas-phase benzene, while the speciation monitor measures solid-phase organic carbon deposited over a 24-hour period. Gaseous benzene appears to behave differently than particulate-phase organic carbon on a 24-hour basis.

[Benzene appears to follow organic carbon better on an hourly level. Hourly plots for continuous monitors are shown later in this report in the Peak Days section.]

Liberty sulfur dioxide (SO₂) and organic carbon are shown below.

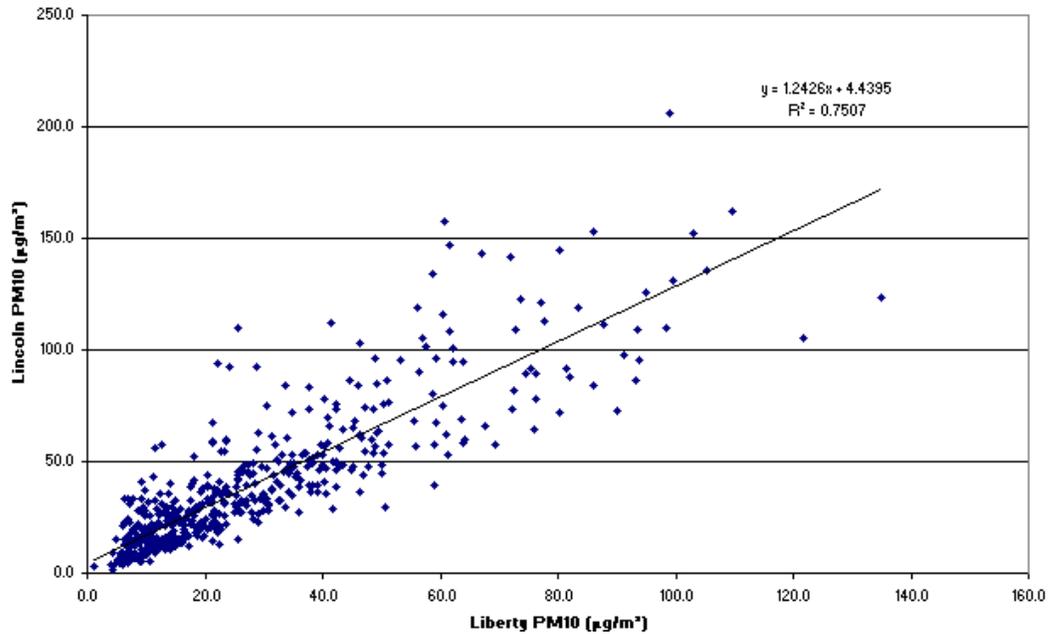


Sulfur dioxide, like benzene, does not correlate well with organic carbon on a 24-hour basis.

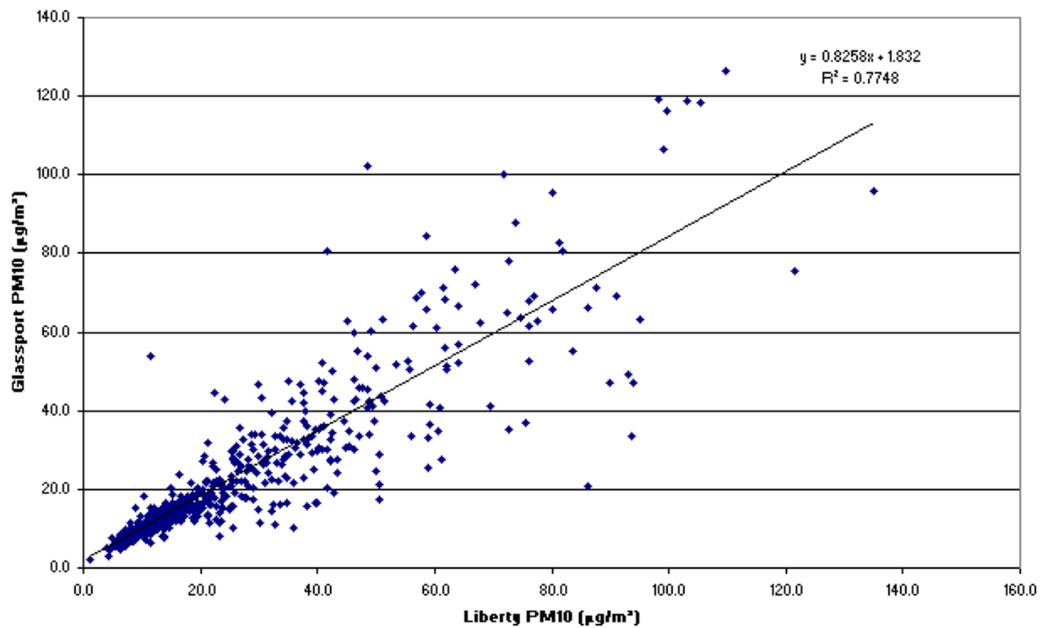
8. Site Correlations

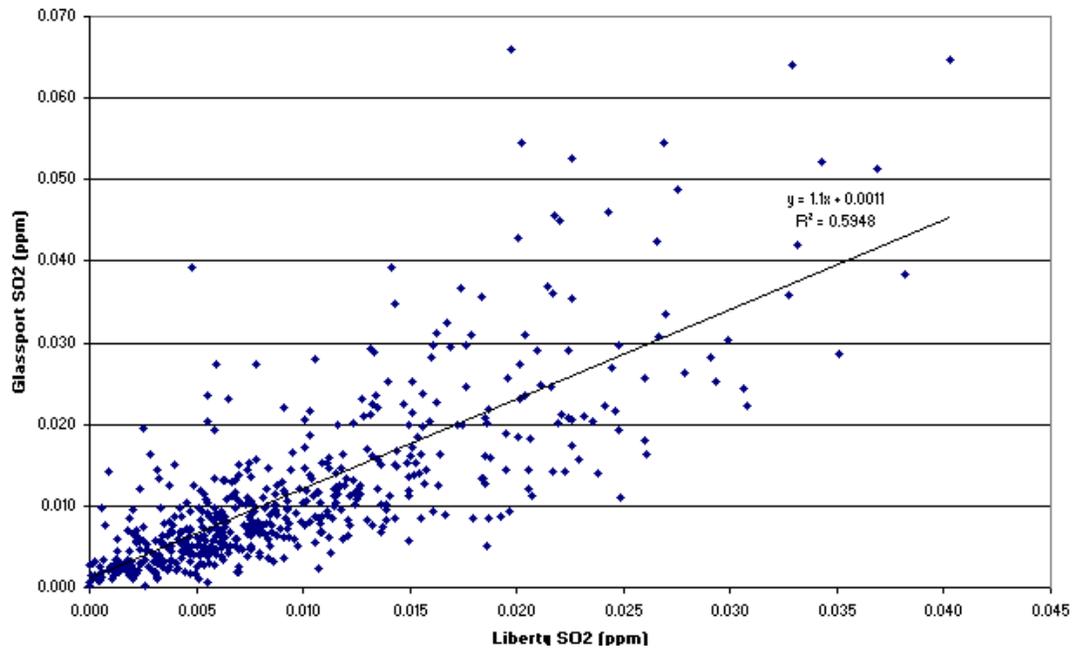
Liberty is located near two additional sites with PM₁₀ and SO₂ monitors: Lincoln and Glassport. Regression plots for these sites with Liberty are given below.

Lincoln vs. Liberty, Average PM₁₀ Continuous 24-Hour Concentrations



Glassport vs. Liberty, Average PM₁₀ Continuous 24-Hour Concentrations



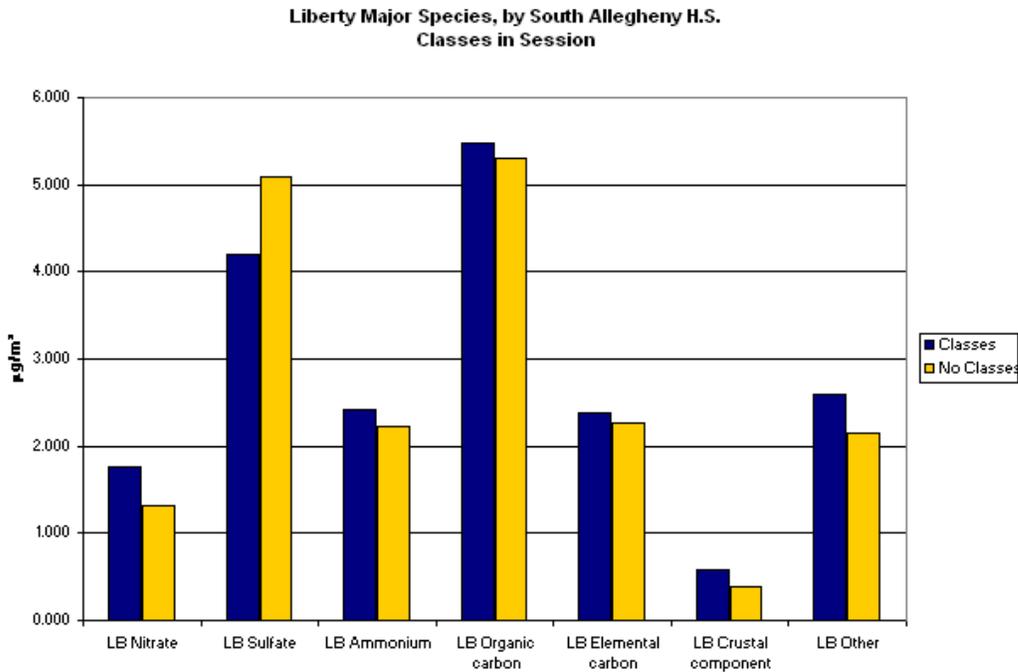
Glassport vs. Liberty, Average SO₂ Continuous 24-Hour Concentrations

These plots reveal that Liberty can correlate moderately with Glassport and Lincoln for PM₁₀ on a 24-hour average basis. Liberty is more site-specific for SO₂, however, as Glassport and Liberty do not correlate well.

9. Liberty School Buses

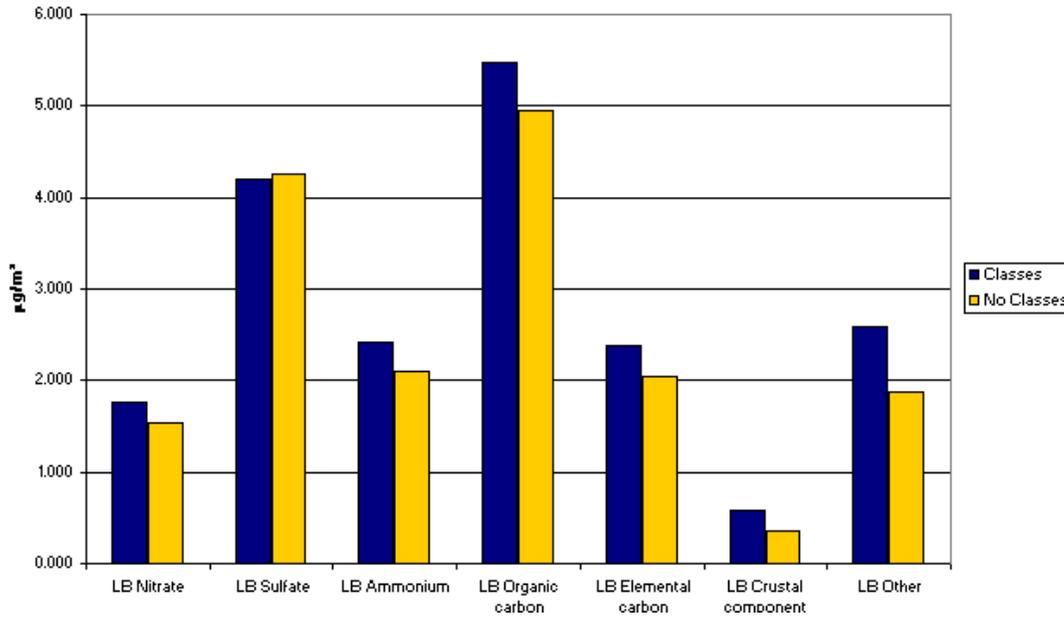
The Liberty site is located on the roof of South Allegheny High School, and school bus diesel emissions are a possible source of PM_{2.5} for that monitor. School buses line up on both sides of the high school in the morning and afternoon; the Liberty monitor is located near the center of the roof.

The column chart below shows average concentrations of major species on a classes-in-session basis. On a day when classes are not in session and school buses are not present, diesel emissions from buses are not impacting the speciation monitor.



This above chart represents year-round averages. However, PM_{2.5} can show a seasonal bias for certain species, such as sulfate in summer. To eliminate bias for summer days when classes are never in session, summer days can be removed from the averaging in order to show a more specific breakdown of species collected during the school year only.

Liberty Major Species, by South Allegheny H.S. Classes in Session (excluding summer break)

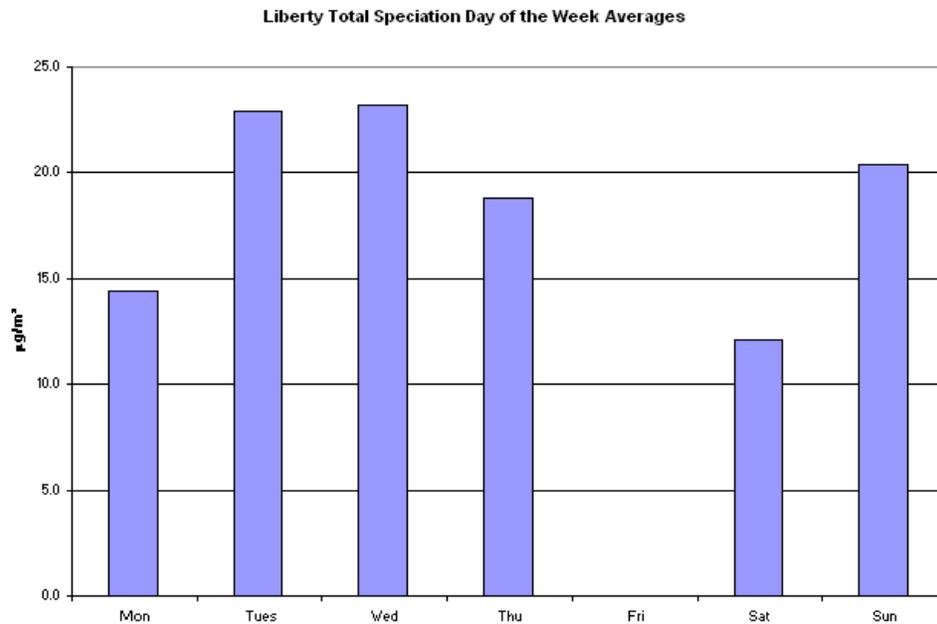
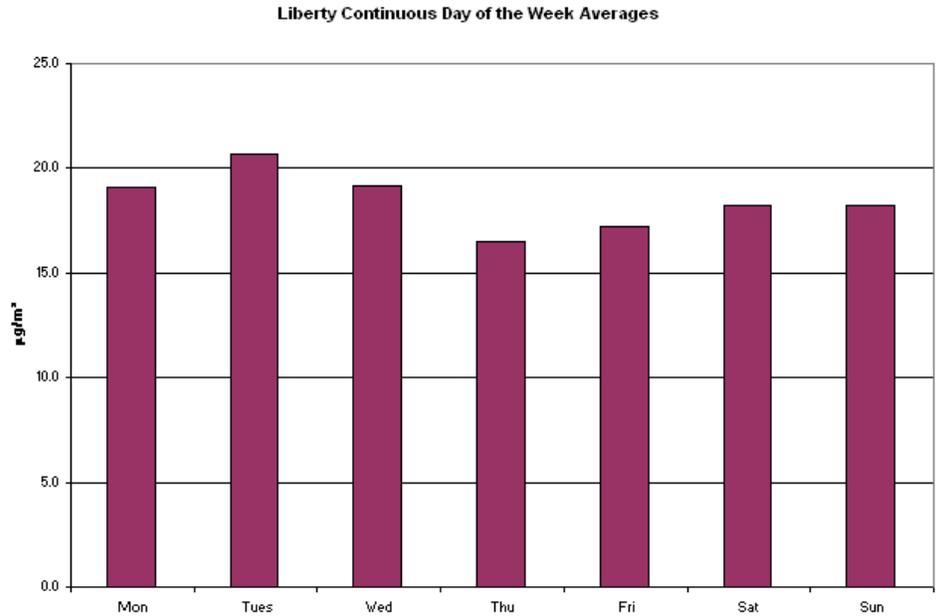


The adjusted column chart above represents a more specific analysis of days with or without school bus emissions during the course of a school year (autumn through spring).

It can be seen on the chart that all species except sulfate are higher during days when classes are in session. Diesel emissions are most commonly associated with elemental carbon. Since elemental carbon is indeed higher on class-days, school buses emissions may be impacting the Liberty monitor. However, higher concentrations for the additional species on class-days may suggest that the concentration differences are statistically random.

10. Days of the Week

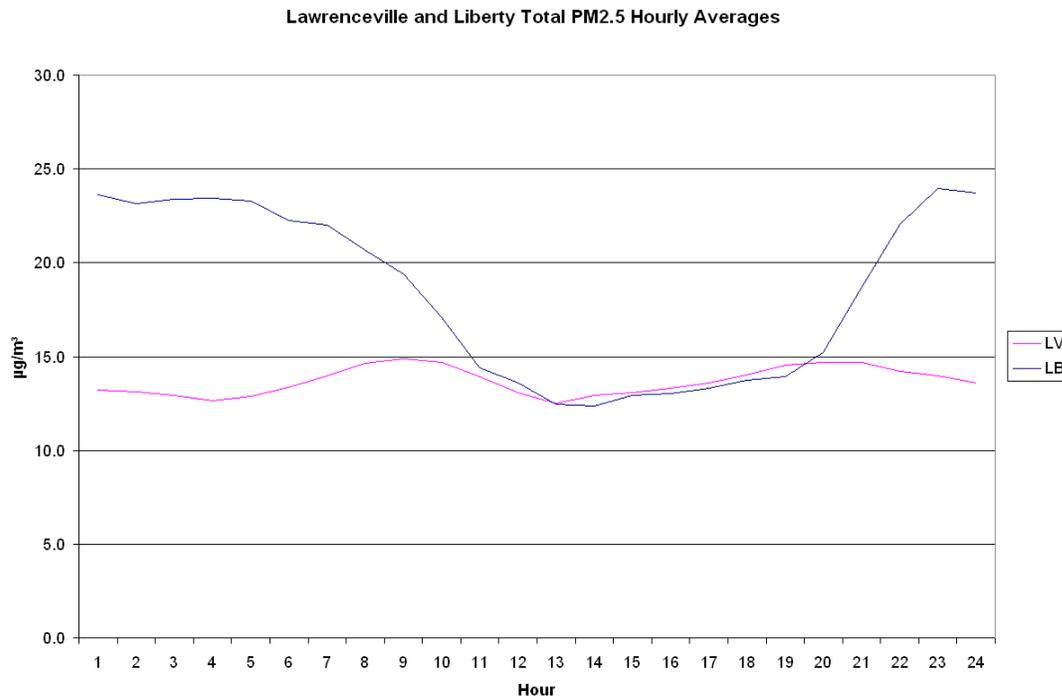
Below are column charts of average total PM_{2.5} concentrations for the continuous and speciation monitors.



Total PM_{2.5} concentrations show some variance by day of the week. For the speciation monitor, there are no Friday samples on account of invalid retrieval times following a weekend.

11. Liberty Peak Days

Peak $PM_{2.5}$ days usually occur simultaneously at Lawrenceville and Liberty, but the peaks have different species compositions and concentrations. Simultaneous peaking may be due to broad-scale inversions or other regional events. Liberty is much more greatly affected by inversions, however, as evident by the average hourly plot shown below.



Liberty $PM_{2.5}$ levels are highly influenced by nocturnal temperature inversions, when warmer upper-air layers trap pollutants close to surface level. Lawrenceville is moderately influenced by inversions near daybreak, but overall the levels remain steadier at Lawrenceville on a diurnal basis.

Meteorological parameters and hourly multi-pollutant plots are shown on the following pages for selected peak days at Liberty. These peak days coincide with high carbon and ammonium concentrations. Additionally, high chlorine concentrations are present on cold-weather peak days.

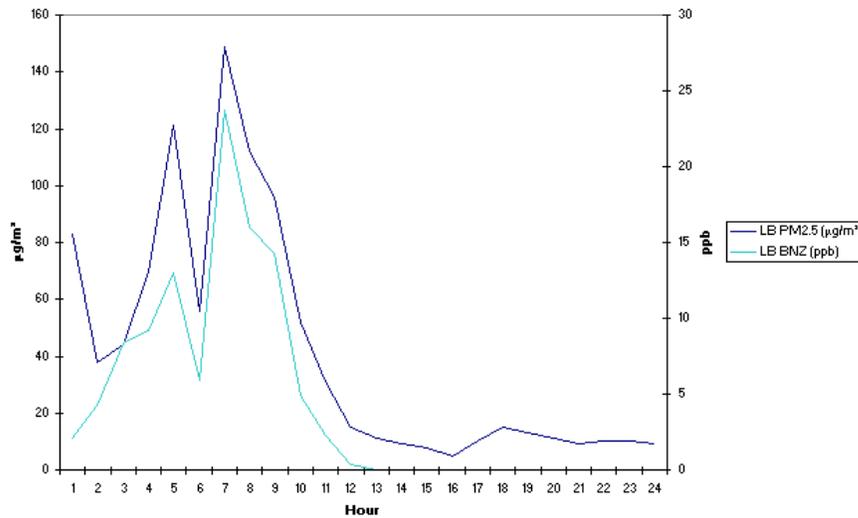
Benzene concentrations on the hourly plots represent gaseous benzene only.

Resultant wind parameters represent the sum of the vector components. Persistence is the ratio of resultant wind speed to scalar mean (average) wind speed.

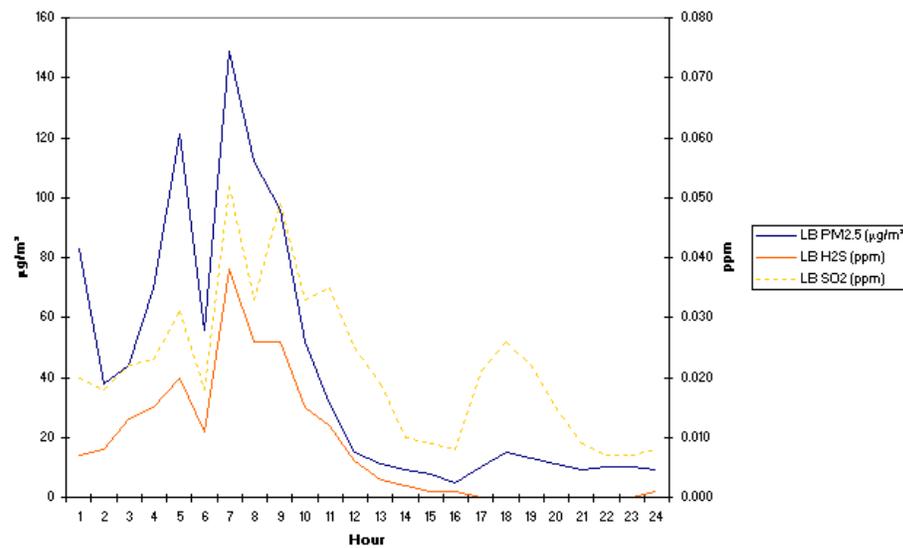
SAMPLING DATE: 11/23/03

Total PM_{2.5} Speciation 53.5 µg/m³
 Resultant wind speed 3.1 mph
 Resultant wind direction 164°
 Wind persistence 0.89

Liberty PM2.5 and Benzene, Hourly, 11/23/04



Liberty PM2.5, H2S, and SO2, Hourly, 11/23/03

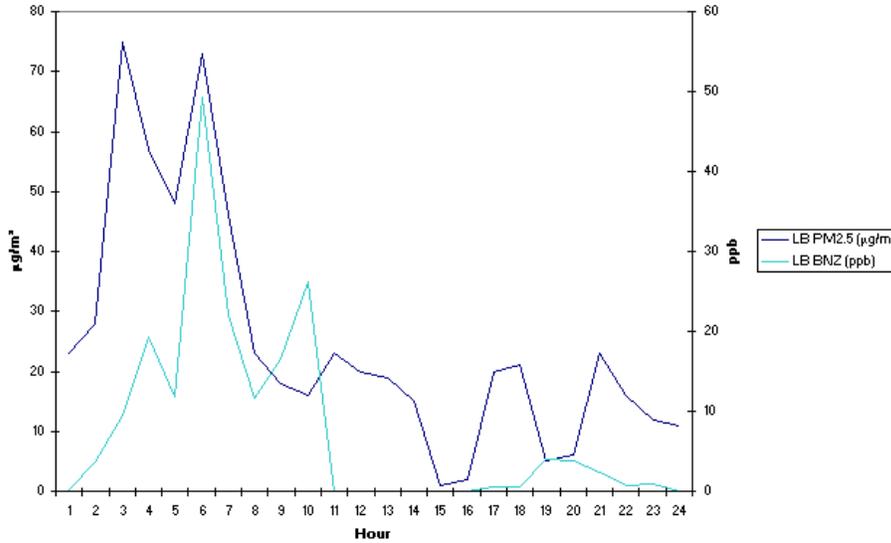


On this date, a morning inversion led to high total PM_{2.5}, benzene, and H₂S. Winds were persistent and from the south-southeast.

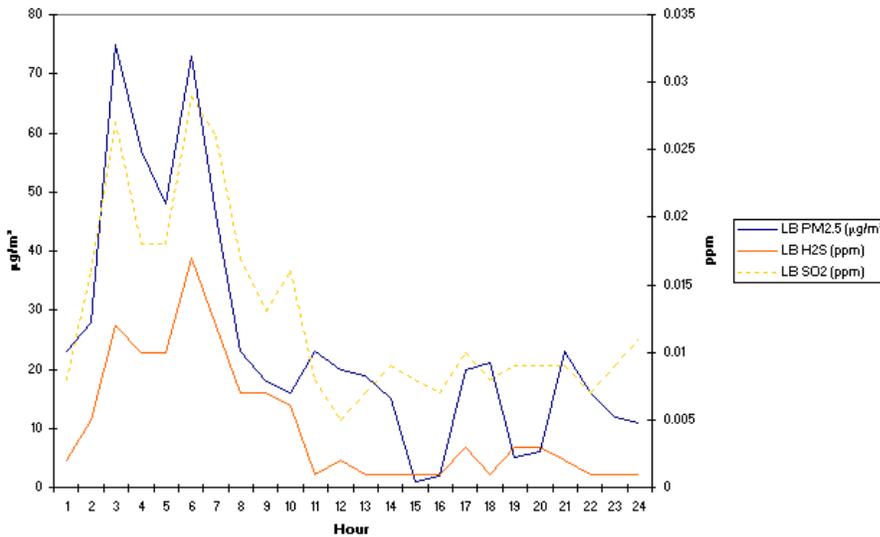
SAMPLING DATE: 2/9/04

Total PM_{2.5} Speciation 29.5 µg/m³
 Resultant wind speed 8.0 mph
 Resultant wind direction 216°
 Wind persistence 0.98

Liberty PM2.5 and Benzene, Hourly, 2/9/04



Liberty PM2.5, H2S, and SO2, Hourly, 2/9/04

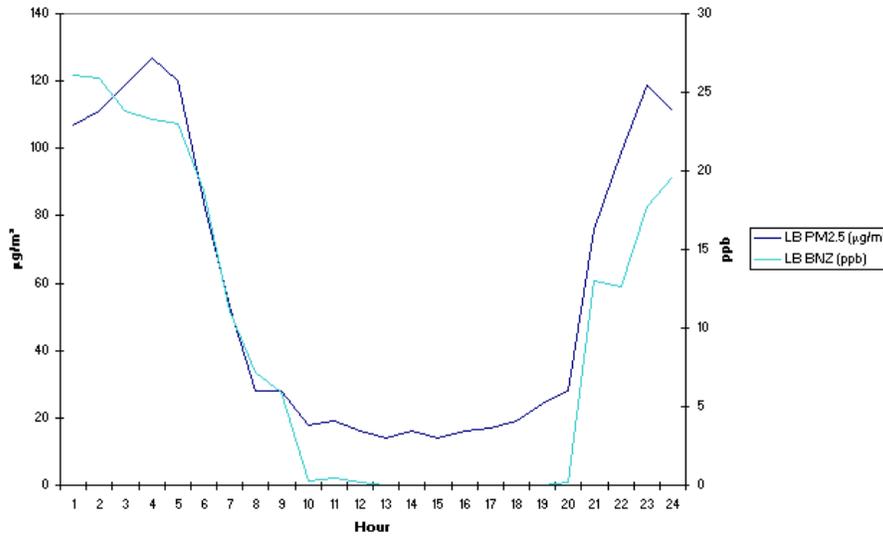


On 2/9/04, a morning inversion led to high total PM_{2.5}, benzene, and H₂S. Winds were persistent, strong, and from the south-southwest.

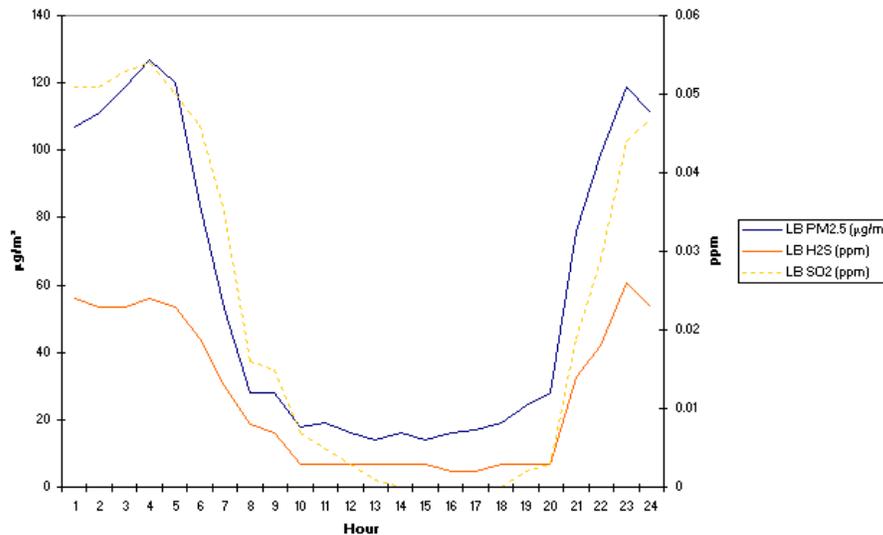
SAMPLING DATE: 5/9/04

Total PM_{2.5} Speciation 58.0 µg/m³
 Resultant wind speed 5.1 mph
 Resultant wind direction 227°
 Wind persistence 0.95

Liberty PM2.5 and Benzene, Hourly, 5/9/04



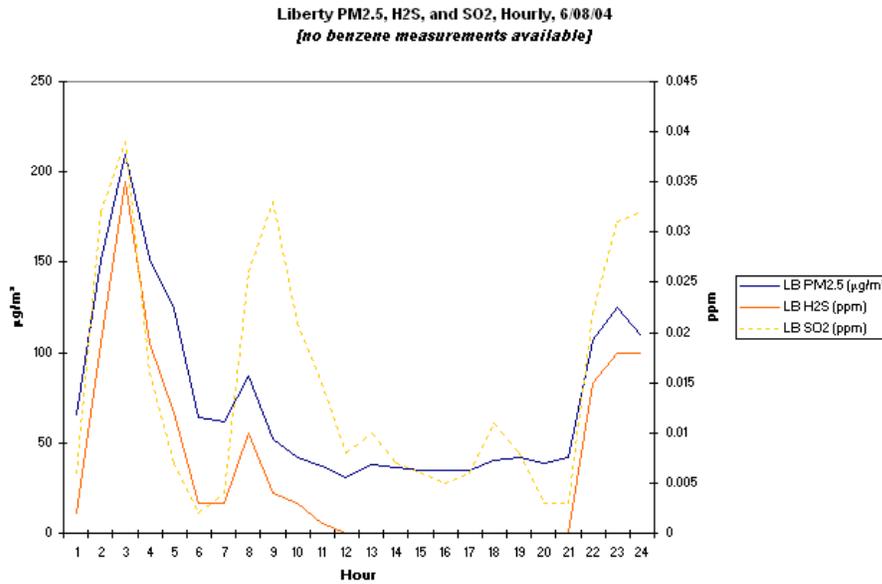
Liberty PM2.5, H2S, and SO2, Hourly, 5/9/04



On this date, nighttime inversions led to high total PM_{2.5}, benzene, and H₂S. Winds were persistent, strong, and from the southwest. All pollutants track together.

SAMPLING DATE: 6/8/04

Total PM_{2.5} Speciation 75.0 µg/m³
 Resultant wind speed 2.8 mph
 Resultant wind direction 212°
 Wind persistence 0.97

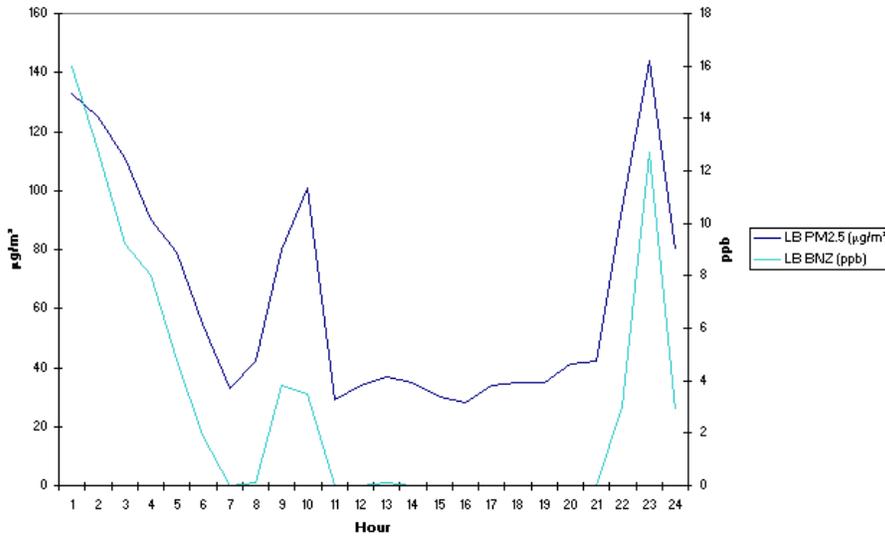


On 6/8/04, nighttime inversions led to very high total PM_{2.5} and H₂S concentrations. Winds were persistent and from the south-southwest.

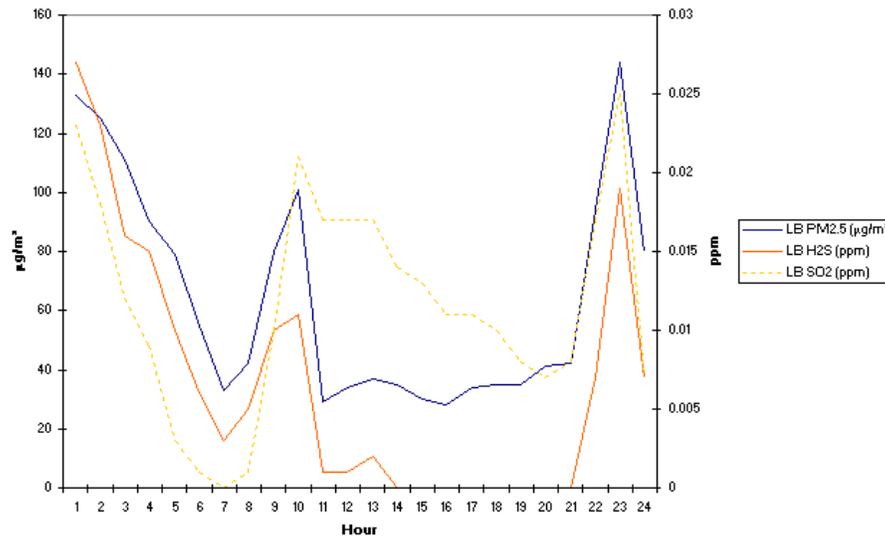
SAMPLING DATE: 9/12/04

Total PM_{2.5} Speciation 64.2 µg/m³
 Resultant wind speed 1.2 mph
 Resultant wind direction 216°
 Wind persistence 0.85

Liberty PM2.5 and Benzene, Hourly, 9/12/04



Liberty PM2.5, H2S, and SO2, Hourly, 9/12/04

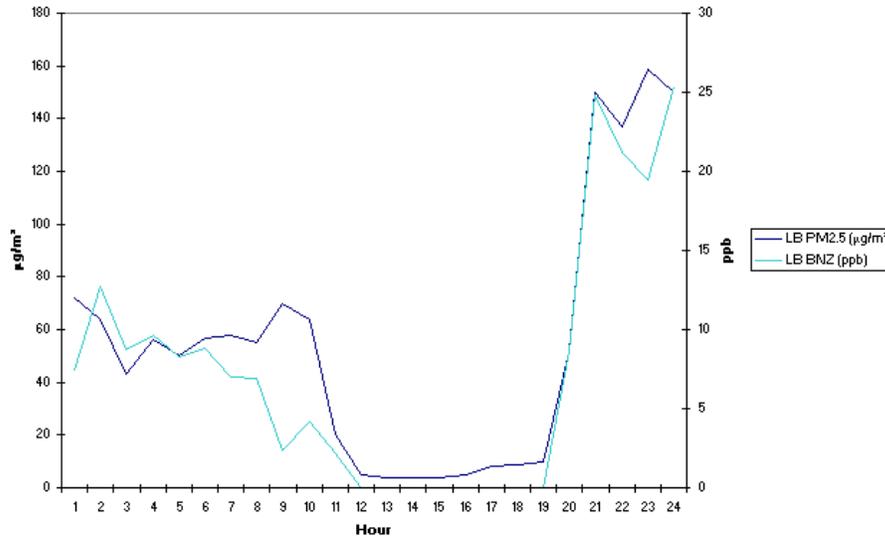


On this date, nighttime inversions led to high total PM_{2.5}, benzene, and H₂S concentrations. Winds were fairly persistent, weak, and from the south-southwest.

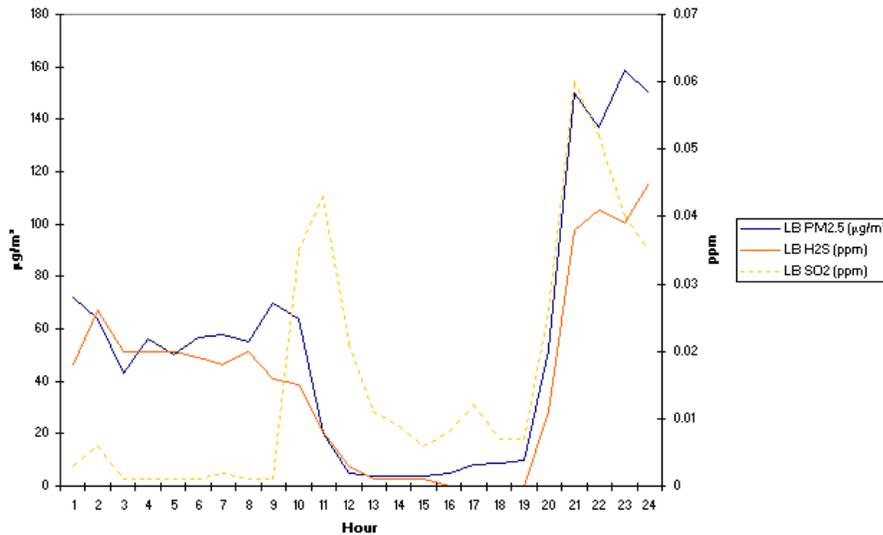
SAMPLING DATE: 10/6/04

Total PM_{2.5} Speciation 54.2 µg/m³
 Resultant wind speed 1.4 mph
 Resultant wind direction 219°
 Wind persistence 0.95

Liberty PM_{2.5} and Benzene, Hourly, 10/6/04



Liberty PM_{2.5}, H₂S, and SO₂, Hourly, 10/6/04

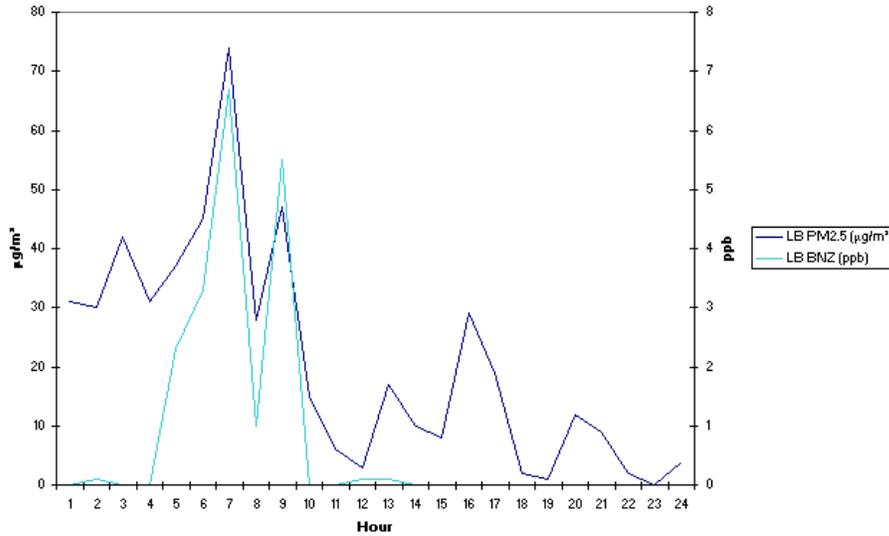


On 10/6/04, nighttime inversions led to high total PM_{2.5}, benzene, and H₂S concentrations. Winds were persistent, weak, and from the south-southwest.

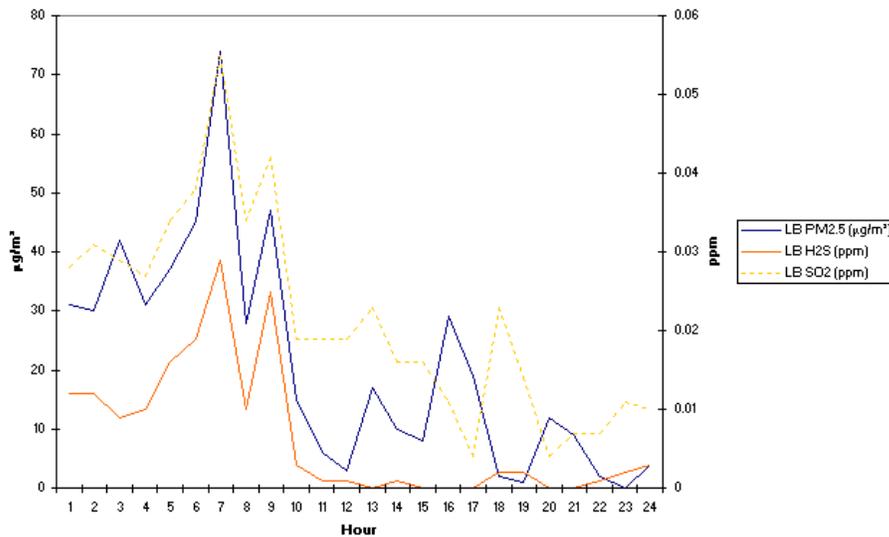
DATE: 11/11/04

Total PM_{2.5} Speciation 30.1 µg/m³
 Resultant wind speed 2.0 mph
 Resultant wind direction 125°
 Wind persistence 0.34

Liberty Pm2.5 and Benzene, Hourly, 11/11/04



Liberty PM2.5, H2S, and SO2, Hourly, 11/11/04



On 11/11/04, a morning inversion led to high total PM_{2.5}, benzene, and H₂S concentrations. Winds were not persistent and were from the southeast.

12. Conclusion

Lawrenceville is affected by both regional flow and urban excess for $PM_{2.5}$. The primary sources of the urban excess are from anthropogenic sources such as from light industry, residential and commercial heating, and mobile source emissions. The regional flow contribution is mostly attributed to upwind power plant emissions, but may also include $PM_{2.5}$ from biogenic sources such as trees.

At Liberty, regional flow is evident for some $PM_{2.5}$ species, while concentrations of other species do not follow regional flow. It is assumed that species that do not follow regional flow may be attributed to sources resident to the area, both stationary and mobile. Liberty is more highly influenced by inversions than Lawrenceville. Carbons and ammonium are prominent species on peak days at Liberty. Chlorine is also prominent on cold-weather peak days.

To gain further understanding of $PM_{2.5}$ in Allegheny County, future analysis may include the following:

- Additional correlations
- Deployment of additional monitors
- Source testing
- Dispersion modeling
- Wind or other meteorological studies

13. Additional Information

For more information concerning Allegheny County speciation monitoring and analysis, contact Jason Maranche at the ACHD Air Quality Program at 412-578-8104 or jmaranche@achd.net.

For general information about PM_{2.5} and air quality, visit EPA's web site: www.epa.gov.

For information concerning PA DEP Air Quality, visit: <http://www.dep.state.pa.us/dep/deputate/airwaste/aq/default.htm>.

For information about PM_{2.5} speciation collection and analysis methods, visit RTI's web site: www.rti.org.