Intraurban Variability of Ambient PM Arsenic and Other Air Toxics Metals in St. Louis
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The Missouri Department of Natural Resources (MoDNR) and Washington University participated in a project to collect and analyze air toxics metals data. It was funded through a Community Air Toxics Grant from the U.S. Environmental Protection Agency (USEPA). The study grew out of the southside St. Louis Community Air Project (CAP) which identified six hazardous air pollutants of concern including arsenic and health risk thresholds for each pollutant. However, the quality of the fine particulate matter (PM) arsenic data gathered by the CAP's speciation network data was poor. Since 2004 the Blair Street site in the City of St. Louis has been a National Ambient Air Toxics monitoring site with a 1-in-6 monitoring schedule and information on arsenic is being collected.

The project was divided into two phases. In phase I, MoDNR installed filter based monitors at the following sites: Blair Street, National Ambient Air Toxics site; Hall Street, industrial riverfront north of downtown; Arnold; and Washington University campus. Arnold and Washington University were considered suburban sites. The network was operated for one year with a total of 120 samples collected (once every three days). The aim was to see how the amount of heavy metals varied spatially and temporally. Chemical analysis was performed by Washington University. The signal for arsenic can be separated into a baseline level for all of the St. Louis area and an excess due to local sources. Arsenic concentrations were lower at the suburban sites and were highly correlated on a day-to-day basis. At the Arnold site, 70 percent of arsenic signal is from sources outside St. Louis and remainder coming from local sources. The arsenic concentrations at the downtown sites were elevated as much as 50 percent. The contributions at Blair Street and Hall Street sites are evenly divided. There was a weaker correlation between concentrations at the Blair Street and Hall Street sites which are only four kilometers (2.48 miles) apart. There is high intraurban variability in that there is a regional signal for arsenic with an urban excess. If there is only a single monitor it can be difficult to determine what emissions are being blown in from outside the region and what is locally emitted.

The next step was to examine the meteorological records and identify where emissions came from. Surface winds in St. Louis typically come from the south or north but air masses can come from the east. When a high pressure system sits over Lake Michigan, air moves clockwise and brings Ohio River Valley air here. If look at that portion of the arsenic concentration, there is a high level of correspondence to air masses from the eastern U.S. This is consistent with the National Air Toxics Assessment (NATA) emissions inventory which indicates that most of the arsenic is from the fly ash of coal-fired power plants. A regional scale industrial signature is being seen.

For days with an excess arsenic level at Blair Street site or Hall Street site (30 to 50 percent), the prevalent wind direction was identified. For Hall Street, the wind was from the southeast. For Blair Street, the wind was blowing from the north. General triangulation was used to highlight potential local sources of arsenic located between these sites. It appears there is a coal-fired industrial boiler in the area of interest as well as an incinerator operated by the Metropolitan St. Louis Sewer District and coal piles. A detailed emissions inventory of facilities would need to be performed. None of this excess shows up in the NATA inventory. Arsenic in NATA is driven by coal-fired power plants.

In Phase II, MoDNR deployed a Cooper Environmental Services Xact 620 monitor for one month at six different sites to gather high time resolution (every two hours) lead, arsenic and mercury data. Particles are collected on a filter tape and analyzed by x-ray fluorescence. The monitor was deployed for a month at the following sites: Blair Street; Hall Street; Arnold; S. Broadway; Margaretta; and East St. Louis though the assistance of the Illinois Environmental Protection Agency (IEPA). Data was analyzed as was monitor performance. Data analysis identified very distinct plumes which do not show up in the 24-hour data. When lead data for all six sites was examined, a signature consistent with the location of the Doe Run lead smelter in Herculaneum could be observed. This is an indicator of the sensitivity of this piece of equipment.

When the high time resolution arsenic data from the Blair Street site was examined, three zones of elevated arsenic coming into the site were noted. The northeast node was similar to that found with the filter analysis and the southeast node represented regional transport from the Ohio River valley. The third node was from the northwest around Fairgrounds Park. Monitor and meteorological data were examined for elevated arsenic levels when the wind came from the northwest. The elevated arsenic level occurred at different times but not for multiple hours. It did not occur at night or on weekends. The source could be a small metal-cleaning or welding or plating facility within a few blocks of the Blair Street site. This analysis highlights the need to understand what facilities are within ½ to one mile radius of an air toxics monitoring site and could influence monitor readings.

In conclusion, this study observed urban-scale spatial gradients in PM10 arsenic which are not captured in NATA. Regional transport from the eastern U.S. dominates the measurements at the suburban sites. Along the industrial riverfront, there are local sources influences. This was the first deployment of the high time resolution measurement equipment for automated ambient PM elemental analysis. The equipment is very promising, based on initial performance evaluation. The equipment can identify intermittent sources which would not be detected by time-integrated measurements.