Environmental Monitoring of Heavy Metals in Air: Model for Student Air Quality Inquiries

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Abstract

A pilot study was designed to measure heavy metals in ambient air. Air samples were sent to a contracted lab for bulk analysis using ICP-MS methods for arsenic, lead, cadmium and total dust. Concentrations were below detection limits and OSHA personal exposure levels. At this time, further review of proper sampling equipment and rates is warranted to determine if levels in air are lower than EPA ambient air standards. The study justifies use of the NSLS to analyze samples to identify any heavy metal present before performing bulk analysis.

Introduction

Deposition and bioaccumulation of air toxics have multimedia effects on water bodies, soil, ecosystems and humans in urban and rural settings. Airborne dust may be spreading arsenic and other heavy metals within and between continents.

It has been noted that metals especially arsenic, create cardiovascular and respiratory problems at lower levels of exposure than previously observed and recommended by agencies such as the EPA. If dust and aerosols with heavy metals serve as an exposure path to humans (in addition to what we drink and eat), there could be serious health effects. (Morman, 2010)

Anthropogenic sources such as electric utility facilities, metal mining, industrial plants, car exhausts and pesticides all contribute to releasing several air toxics into ambient air. (Kampa, Castanas 2008) The EPA has set goals to establish present air toxic levels in order to assess progress as years of monitored data become available. (Hagelstein, Heinze, 2008)

Figure1:High Volume Air sampler

Figure 2:PVC Air filters: post sampling

Materials and Methods

To gather baseline data on heavy metals in air (arsenic, lead, cadmium) around Brookhaven National Lab, an air sampling project was begun. Using 3 JST-GAST high volume air samplers with flow rates of 15 liters per minute, PVC air cassettes (37mm, 5um pore size), ambient air from the picnic area near NSLS-II construction, Building 30 and the main security gate were collected for 24 hours on July 16th , 22nd , and 27th 2010. A Canon digital camera was used to take photos of sites for documentation purposes. A Kestrel portable weather station was used to acquire weather data (air temperature, wind speed, relative humidity, dewpoint). A Garmin eTrex HC unit was used to mark site locations for use with Google Maps. The NCAR website was used for ozone data for sampling period.

Results

Results from bulk analysis of air samples are summarized in Table 1. Table 2 shows weather data. Access to Ozone and upper air wind maps were used from http://www.dec.ny.gov/airmon and http://www.rap.ucar.edu/weather/ .

Table 1: Air Analysis Results

Sampling Dates	Sample site	Sampled volume* (L)	Analyte	Results mg/m3	OSHA PEL mg/m3	EPA Ambient Air Risk Based Conc mg/m3
7/16/10, 7/22/10, 7/27/10	Main gate	19018.46	arsenic	<0.000014-0.000020	0.01	4.10E-07
			cadmium	<0.0000011-0.0000016	0.005	9.90E-07
			lead	<0.0000013-0.0000088	0.05	3.70E-07
			total dust	0.018-0.026		
	Building 30	19786.4	arsenic	<0.000014-0.000018	0.01	4.10E-07
			cadmium	<0.0000011-0.0000014	0.005	9.90E-07
			lead	<0.0000077- 0.000013	0.05	3.70E-07
			total dust	0.015-0.024		
	Picnic area	18978.767	arsenic	<0.000014-0.000021	0.01	4.10E-07
			cadmium	<0.0000011-0.0000016	0.005	9.90E-07
			lead	<0.0000089-0.000013	0.05	3.70E-07
			total dust	0.017-0.041		
	Blank	0	arsenic	<0.00030mg/sample		
			cadmium	<0.000046 mg/sample		
			lead	<0.00033mg/sample		
			total dust	<0.050 mg/sample		

*avg of all 3 days

Table 2: Weather data for Sampling dates

Date	Time	Location	air temp F	wind speed mph	directio n	relative humidity %	dewpoint F	barometer mb	notes
7/16/2010	7 11 MSG		73 1	1 7 NW		85 3	68 2	1013 0	
	7 23 Bldg 30		72 2	1 1 NW		87 8	68 8	1012 7	rain day
	7 53 picnic		72 0	0 8 NW		87 8	68 3	1013 7	before
7/17/2010	6 56 MSG		76 8	0 8		84 7	71 9	1013 1	humid
	7 10 Bldg 30		76 5	1 1		88 5	72 9	1012 3	
	7 34 picnic		79 5	0 8		81 2	73 7	1013 0	
7/22/2010	13 00 MSG		87 0	4 NW		58 1	65 2	1010 2	heavy rain
	13 13 Bldg30		84 9	2 5 NW		50 4	64 6	1009 6	day
	13 30 picnic		84 6	4 7 W		49 5	63 3	1010 2	before
7/23/2010	12 34 MSG		82 2	0 6 W		62 2	68 7	1013 4	
	12 46 Bldg30		81 6	0 7 W		64 9	68 6	1012 1	
	13 00 picnic		78 6	1 1 W		72 1	68 0	1012 9	
7/27/2010	14 15 MSG		96 4	0 7		27 4	56 4	1014 6	
	14 00 Bldg30		91 3	1 2		31 5	56 5	1013 9	no rain for
	13 42 picnic		86 3	1 2 WSW		36 6	55 8	1014 7	3 days
7/28/2010	14 07 MSG		87 7	3 7 SW		58 1	68 9	1012 4	
	13 55 Bldg30		86 8	2 9 SW		58 7	72 0	1012 0	
	13 34 picnic		83 6	1 WSW		64 5	71 9	1013 1	

Picnic area NSLS II

Building 30 patio

Main security gate

Figure 3:Sampling Sites

Classroom Applications

Students can perform several inquiry experiments:

•Collect air quality data in their school district as it applies to high traffic areas or industry sites.

•Perform air quality monitoring and work with local EPA to assess particulate matter or ozone at local sites. (Air Toxics Campaign)

•Collect rainwater, snowmelt and analyze for heavy metals using NSLS X-ray spectroscopy.

•Create a GIS map of air sampling sites and look for distributive relationships among data.

•Attempt to correlate air action alerts, ozone with hospital visits for respiratory distress.

•Collect weather data to analyze changes in local climate, comparing to regional, global climate changes due to atmospheric aerosols.

•Identify metal species based on NSLS X-ray spectroscopy of air filters.

Discussion

While concentrations for heavy metals were well below OSHA PEL limits, each metal was detected at a upper limit a factor of 10 greater than EPA ambient air risk concentrations. Still, sample concentrations seem to be below detection limits thus requiring further testing with appropriate detection analysis**.** One would expect potentially varying results based on the below sample site descriptions.

The main security gate has a traffic flow of personal autos and construction trucks which peaks between the hours of 7 to 10am and 3 to 5pm.

The NSLS II has typical construction traffic, and transport of dust from disturbed soil on site toward the Picnic sampling area based on wind patterns.

Building 30 patio served as a control since it was blocked from most car exhaust, bordered by forest which could filter out particulates. It was the least disturbed area with little to no construction vehicles and automobiles.

Weather data was fairly consistent at sites for each day and the month as a whole.

With only 3 samples for each site, statistical analysis was not performed. However, with further sampling, correlations could be made about traffiic, weather, wind patterns and the presence, transport patterns and possible exposure pathways of heavy metals in the atmosphere.

Figure 4: Air sample set ups for each location

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