

# Monitoring, Sampling and Analysis of Fine Particles at DOE's National Energy Technology Laboratory

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## *The NETL - OST PM<sub>2.5</sub> research program objectives*

- Provide insight into the degree to which the local coal-fired electric power generating stations contribute to the primary particulate matter load in ambient air in Pittsburgh;
- Provide state-of-the-art characterization of the organic components on the particles;
- Provide insight into the formation and atmospheric chemistry of secondary PM<sub>2.5</sub> formed from reaction of SO<sub>x</sub>, NO<sub>x</sub> and NH<sub>3</sub>;
- Provide comparisons of the mass of PM<sub>2.5</sub> as measured by a variety of commercially available instruments that measure PM<sub>2.5</sub> mass when they are co-located at NETL and when scattered over South Park Township; and
- Study the diurnal and seasonal variation in fine particles at NETL to correlate with sampling stations located in urban Pittsburgh and Morgantown, part of the Upper Ohio River Valley Project (UORVP).



# NETL – OST's PM<sub>2.5</sub> PARTNERSHIPS

- 1) CONSOL RESEARCH
- 2) R. J. LEE CORPORATION
- 3) CHEMICON CORPORATION
- 4) BRIGHAM YOUNG UNIVERSITY
- 5) ALLEGHENY COUNTY HEALTH DEPARTMENT
- 6) MINE SAFETY AND HEALTH ADMINISTRATION
- 7) NETL's ENVIRONMENTAL SAFETY AND HEALTH DIVISION



- CO-LOCATE SAMPLING EQUIPMENT
- SHARE DATA
- TRADE SAMPLES FOR ANALYSIS
- CO-AUTHOR MANUSCRIPTS DESCRIBING OUR JOINT RESULTS



# **NETL's ambient air monitoring equipment**

**PM<sub>2.5</sub> Partisol®- Plus FRM Sequential Air Sampler (R&P),  
ENVIROcheck Model 107M Environmental Particulate  
Monitoring System (Grimm),**

**PM<sub>2.5</sub> DustTrack Aerosol Monitor (TSI),**

**PM<sub>2.5</sub> TEOM® Ambient Particulate Monitor equipped with  
an AccuSampler (R&P),**

**PM<sub>2.5</sub> RASS 2.5-400 Speciation Sampler (Andersen),**

**PAS 2000 Real-time PAH Monitor (EcoChem Analytics),**

**Seven Day Pollen and Mold Spore Trap (Burkard),**

**Continuous Gas Monitors -- SO<sub>2</sub>, O<sub>3</sub>, CO, NO<sub>x</sub>, NO<sub>y</sub>, NH<sub>3</sub>,  
H<sub>2</sub>S (API) and Peroxide (Kok),**

**PM<sub>2.5</sub> PCBOSS Sampler (BYU),**

**High Volume Samplers (BYU and NETL),**

**PM<sub>2.5</sub> 5400 Ambient Carbon Particulate Monitor (R&P),**

**Highly Instrumented Meteorological Tower  
(Climatronics)**

**and PM<sub>2.5</sub> 8400N Continuous Nitrate Analyzer (R&P).**



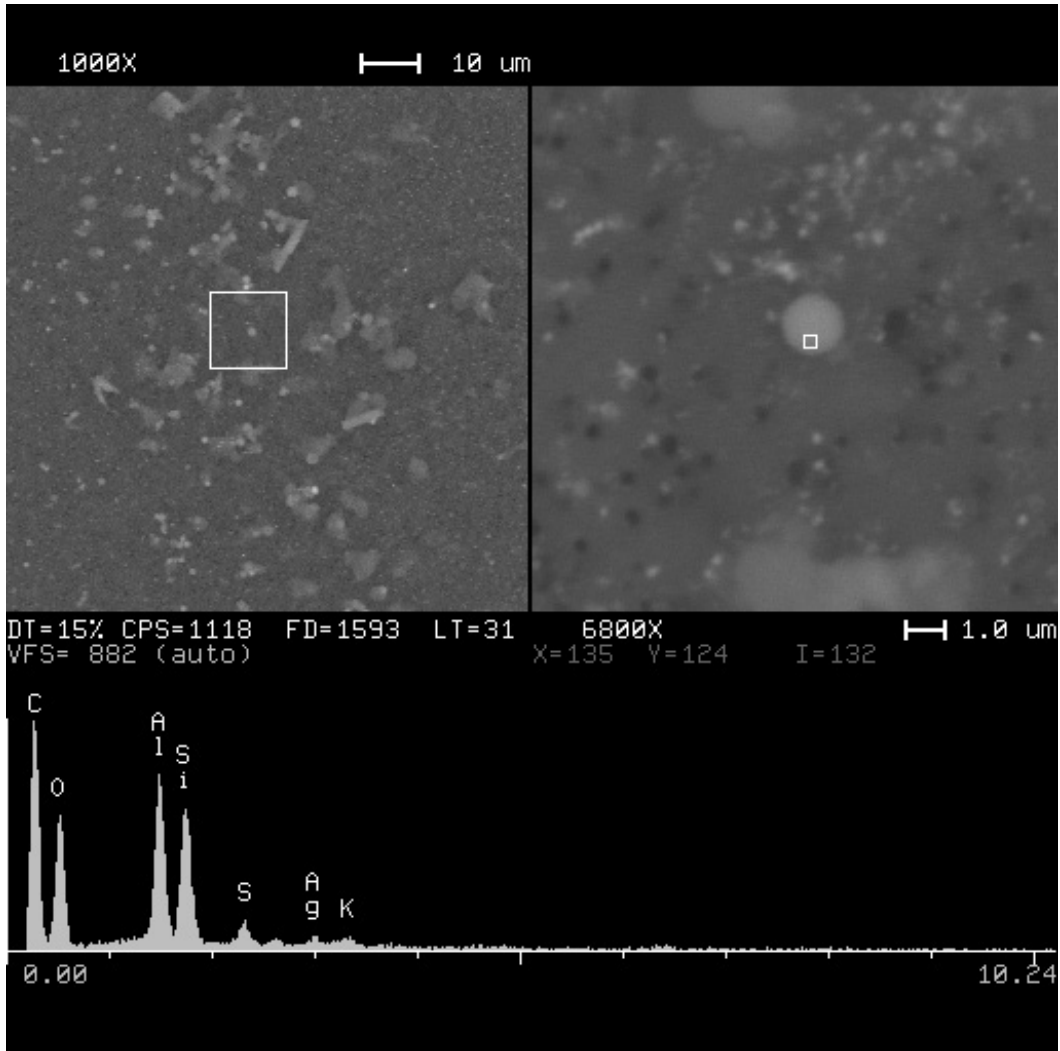
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# **EXPERIMENTAL APPROACH TO OBJECTIVE ONE**

**In order to provide insight into the degree to which coal-fired electric power generating stations directly contribute to the primary particulate matter load in Pittsburgh's ambient air, spherical aluminosilicate (SAS) particles, a somewhat unique emission from high temperature coal combustion, will be quantitatively determined. The total primary and secondary particle load will be measured and the number of SAS particles will be determined, allowing an estimate of the direct contribution that coal-fired electric power generating stations make to the total primary particle load. It is thought that this information will provide insight into the potential impacts that the new National Ambient Air Quality Standards (NAAQS) may have on coal-based power systems. The SAS particles will be determined using two methods-- a method described by Eatough et al. and by an SEM/EDX counting technique using R. J. Lee's personal SEM. Values from the two methods will be compared.**



# SEM/EDS of SAS



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# **EXPERIMENTAL APPROACH TO OBJECTIVE TWO**

**The EPA has developed a suite of 33 hazardous air pollutants (HAPs) including trace metals, semi-volatile organics, and volatile organics that it is interested in monitoring in ambient air. A Particle Concentrator-BYU Organic Sampling System (PC-BOSS) has recently been added to the NETL sampling station. These samples will be recovered and sent to BYU. BYU will perform functional group analysis for -NO<sub>x</sub> containing semi-volatile compounds. These potentially highly carcinogenic -NO<sub>x</sub> containing semi-volatile compounds are classified as “polycyclic organic matter (POM)” in the official EPA list of 33 HAPs.**





# BYU PC-BOSS



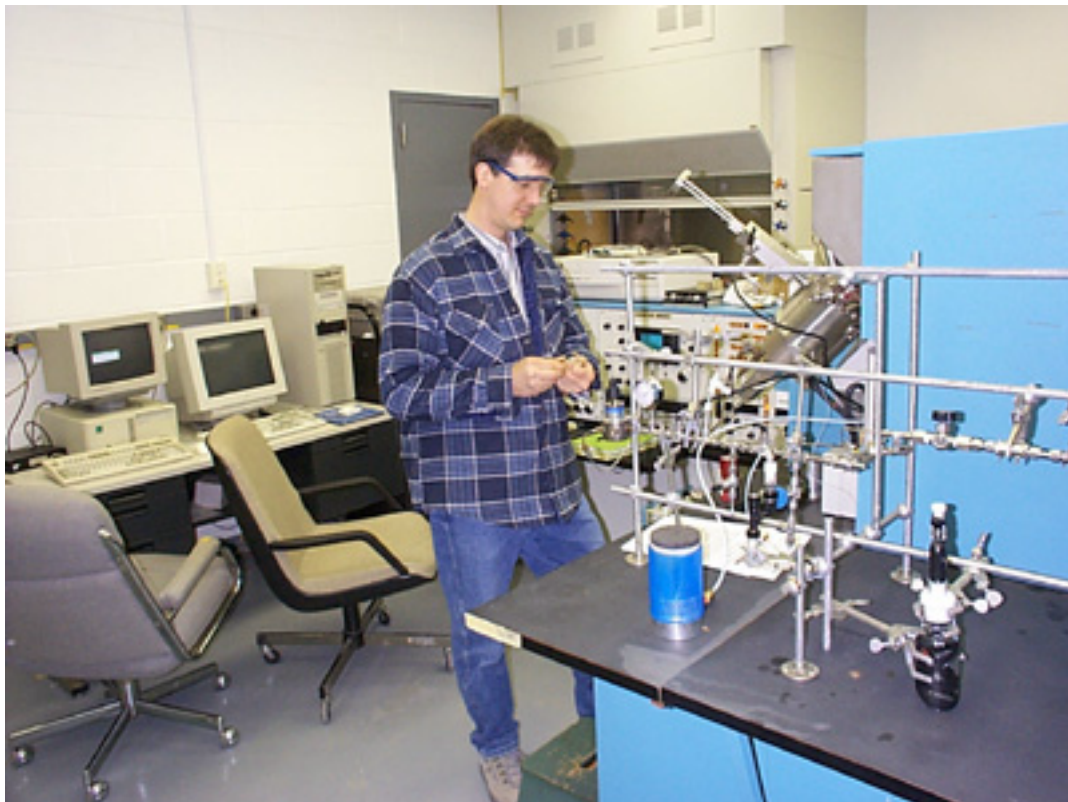


# **EXPERIMENTAL APPROACH TO OBJECTIVE TWO CONTINUED**

**NETL - OST will provide advanced state-of-the-art characterization of the organic components, potential HAPs, on the particles in order to comply with the NRC recommendation to obtain better chemical characterization of the ambient fine particles especially with respect to the organic components. This characterization will include Raman microscopy, ion chromatography (IC) and inductively coupled plasma (ICP) analysis of the water soluble components, followed by thermal extraction and analysis by HRMS and GC-MS. Specifically, Raman microscopy will be performed before and after aqueous extraction by Chemlcon. They have built a Raman spectral library of common materials that we expect to find on the filters such as ammonium sulfate, ammonium bisulfate, and ammonium nitrate, common crustal minerals, tire particles, soot particles, leaves, etc. In addition to providing analysis of inorganic components of the fine particles, Raman can also potentially provide organic functional group maps of the particle surfaces.**



# High - Resolution Mass Spectrometer



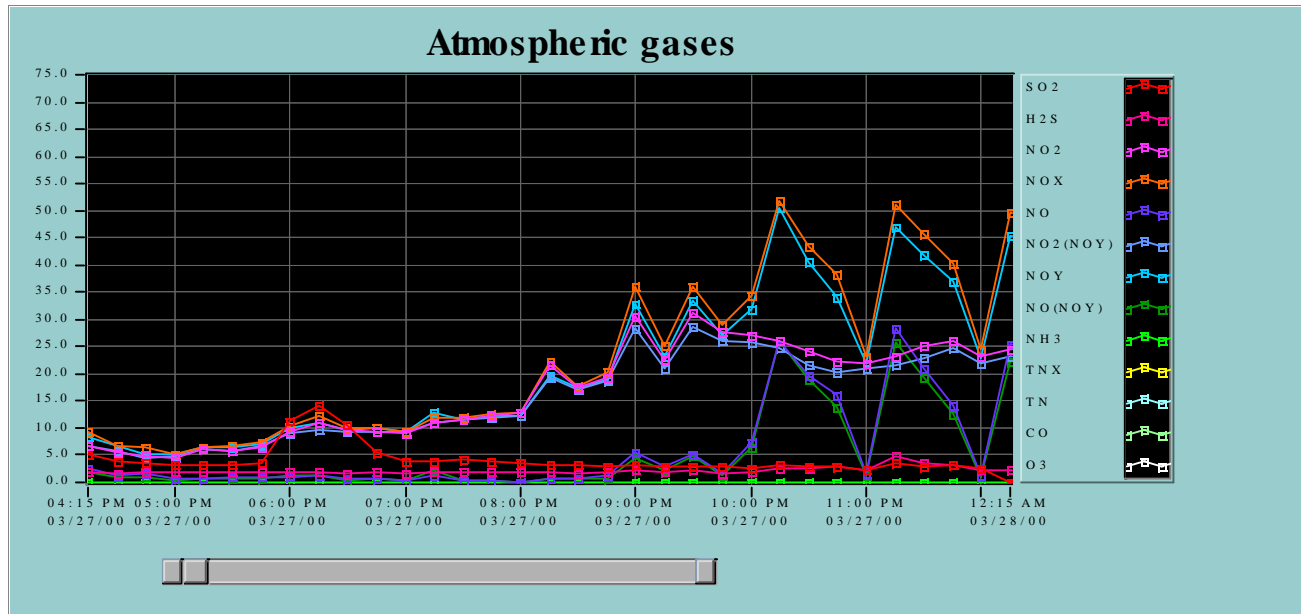
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# EXPERIMENTAL APPROACH TO OBJECTIVE THREE

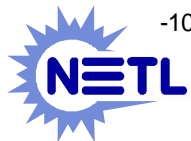
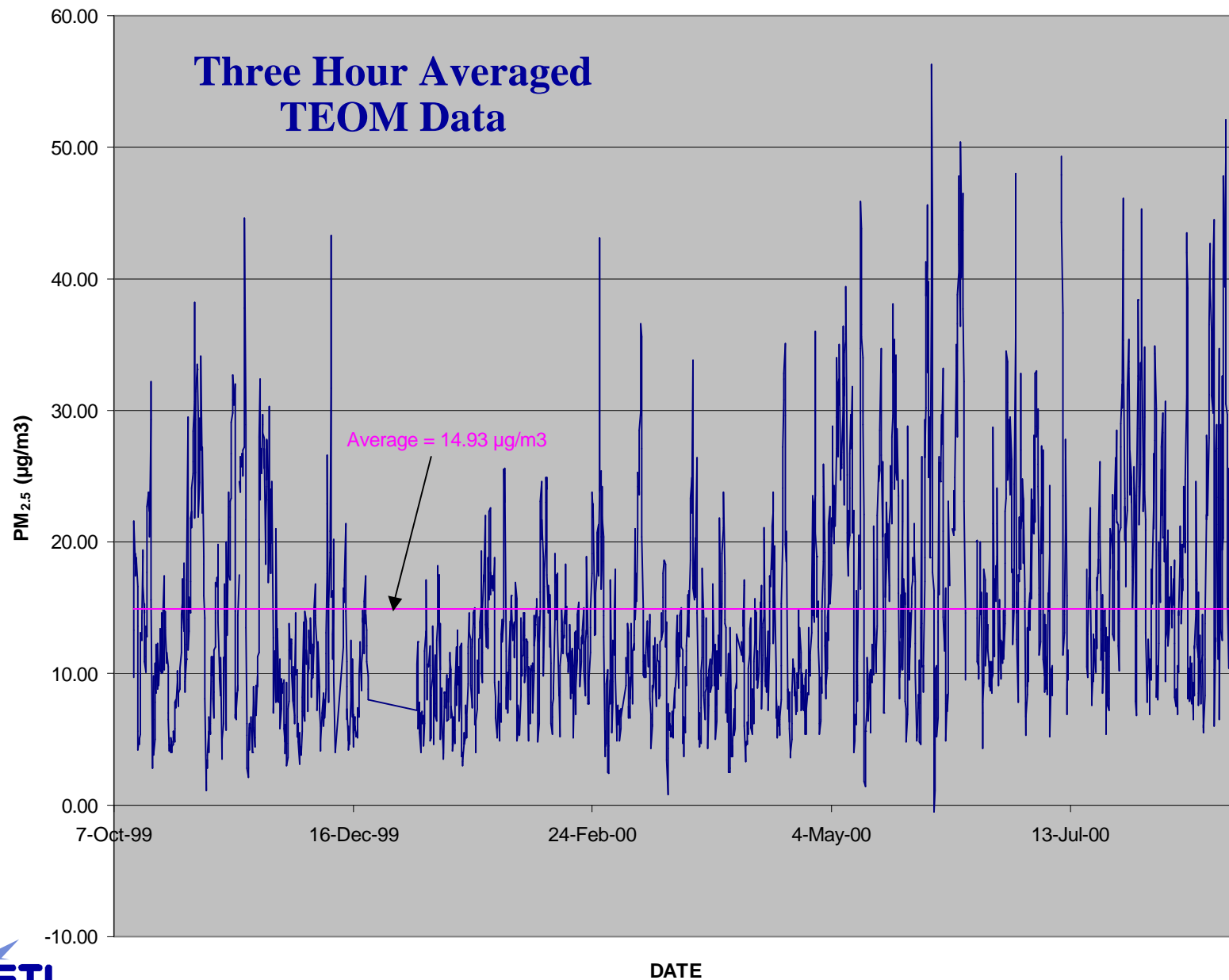
In order to provide insight into the formation and atmospheric chemistry of secondary  $PM_{2.5}$  formed from reaction of  $SO_x$ ,  $NO_x$  and  $NH_3$  these gases will be continuously monitored as will the sulfate and nitrate content of the air. The sulfate and nitrate values will come from analysis of the denuders used in the Andersen RASS. A bank of continuous gas monitors housed in the indoor facility at the monitoring station provides the concentration of  $O_3$ ,  $SO_2$ ,  $NH_3$ ,  $NO_y$ ,  $NO_x$ ,  $CO$ ,  $H_2S$  on a continuous basis. Thus, we will search for relationships between the concentration of  $SO_2$  and the nitrogen oxides ( $NO_y$ ,  $NO_x$ ) with the sulfate and nitrate concentration. The data will be evaluated for the effect of  $O_3$  and UV intensity on any relationship.



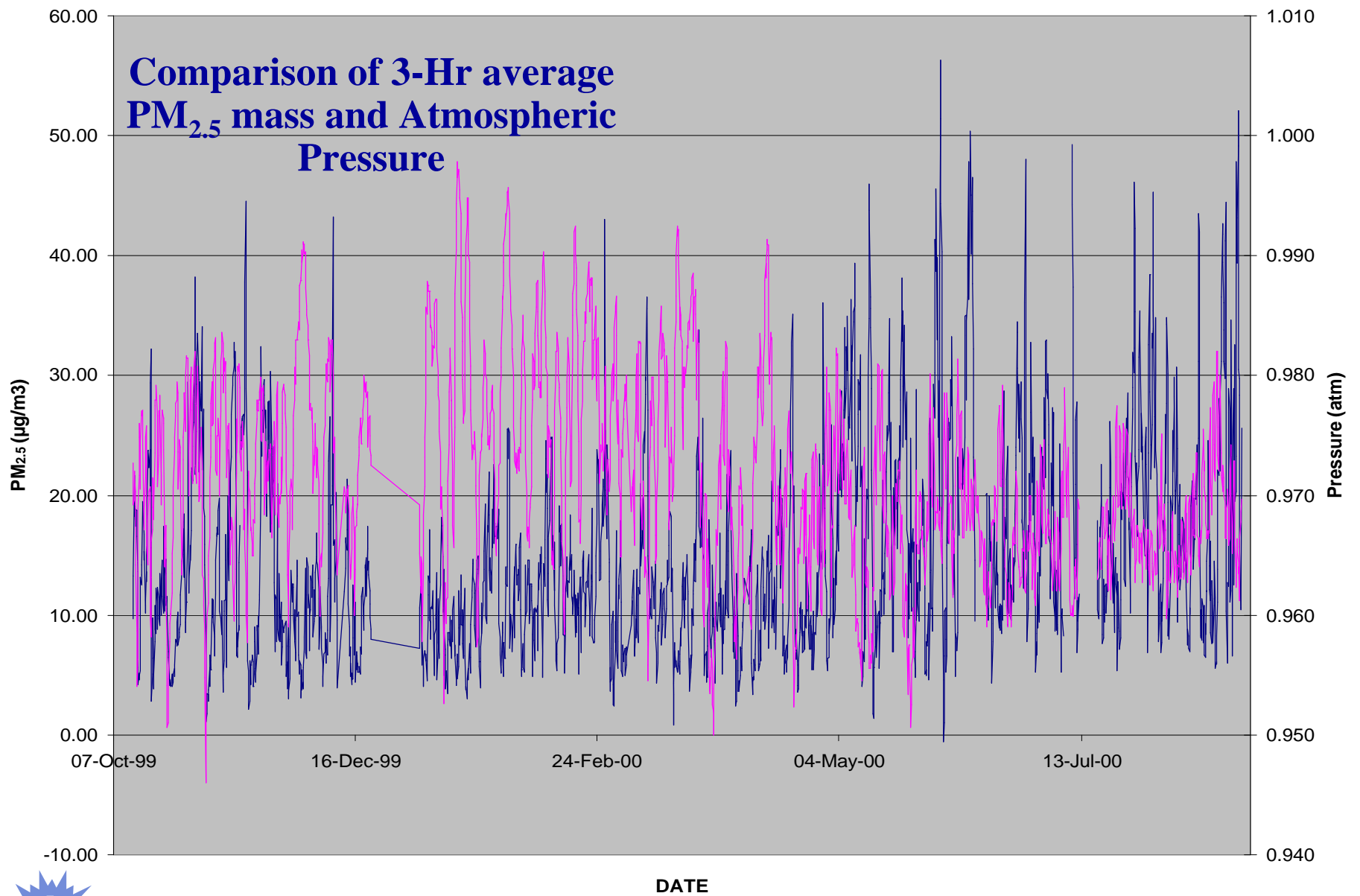
# CONTINUOUS EMISSION MONITORS



## Three Hour Averaged TEOM Data



# Comparison of 3-Hr average PM<sub>2.5</sub> mass and Atmospheric Pressure



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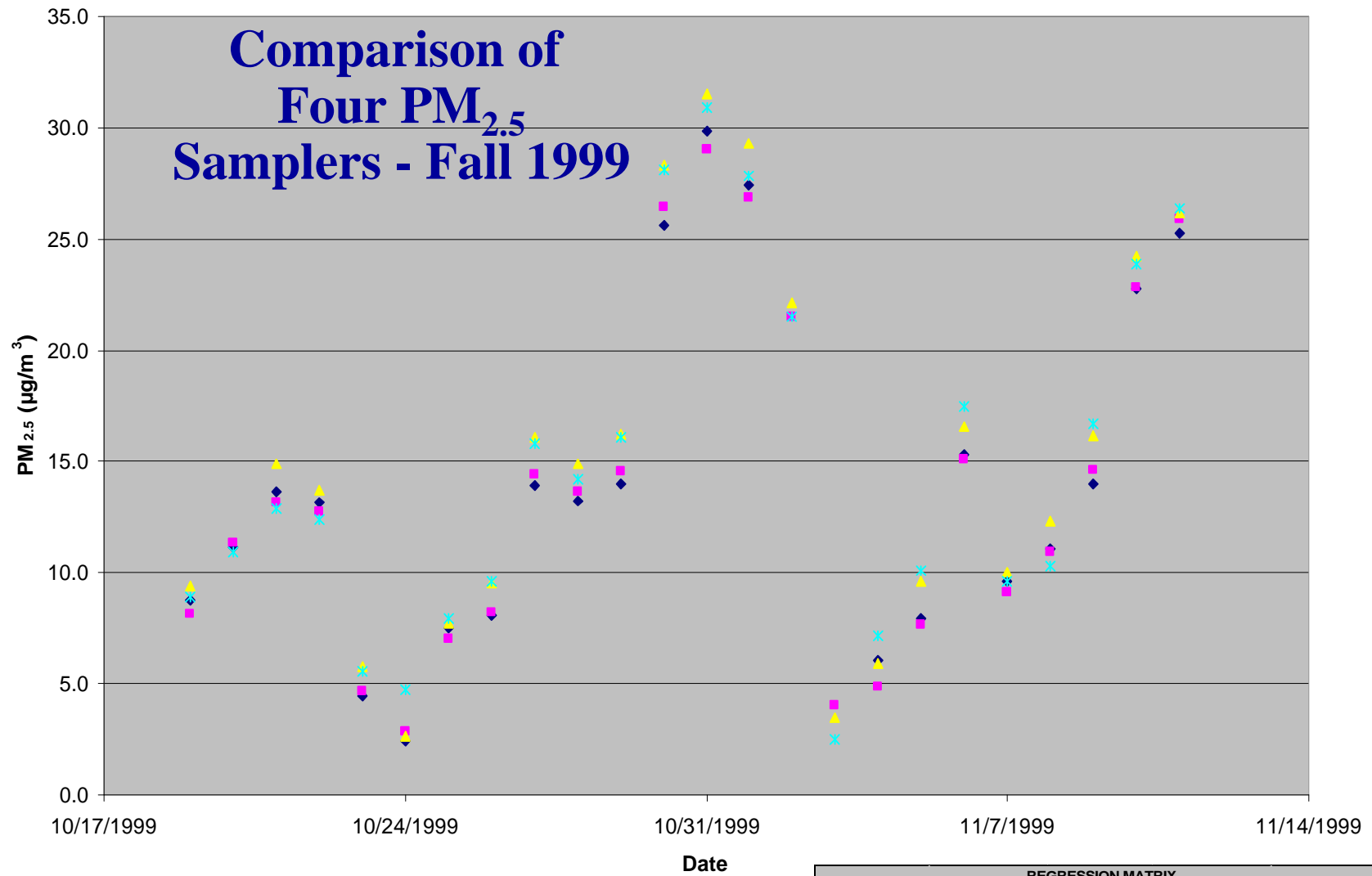
# **EXPERIMENTAL APPROACH TO OBJECTIVE FOUR**

**In order to provide insight into the variation of fine particulate matter over the US it is worthwhile to develop an understanding of how it varies over a small geographic area, in this case South Park Township. The masses determined by NETL's FRM as well as Consol's and one from the Allegheny County Health Department (ACHD) will be compared when they are co-located at NETL and when scattered over South Park Township. This will allow development of a clear picture of the variation of fine particulate matter over a small geographic area.**





# Comparison of Four PM<sub>2.5</sub> Samplers - Fall 1999



◆ NETL    ■ ACHD    ▲ CONSOL    ✕ NETL TEOM

REGRESSION MATRIX				
	NETL FRM	ACHD FRM	CONSOL FRM	NETL TEOM
NETL FRM	1.0000			
ACHD FRM	0.9976	1.0000		
CONSOL FRM	0.9969	0.9971	1.0000	
NETL TEOM	0.9902	0.9914	0.9935	1.0000



# “HYSPLIT” Backward Trajectories for NETL PM<sub>2.5</sub> Site



NOAA Air Resources Laboratory

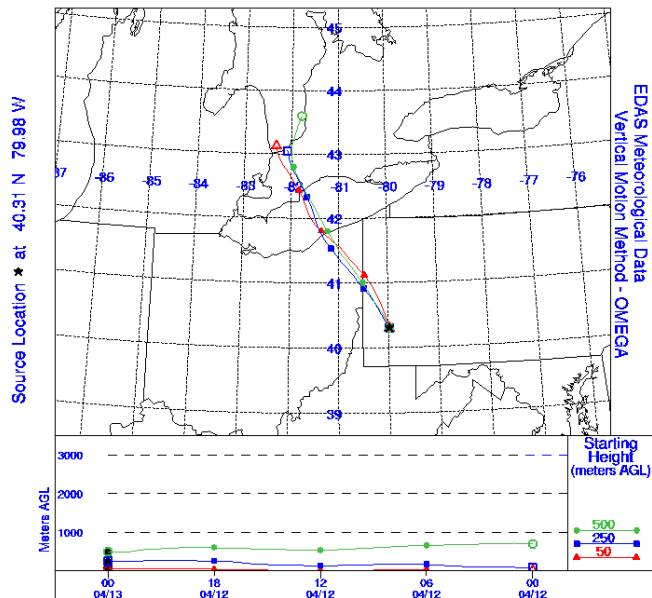
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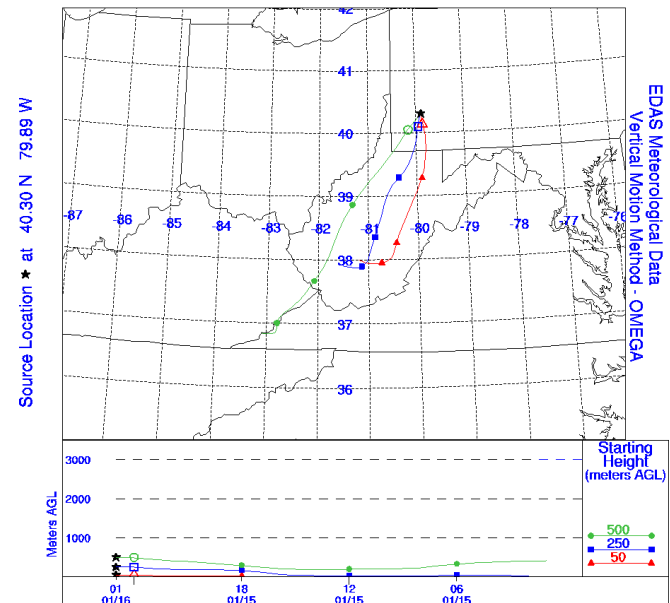
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Backward Trajectories Ending- 00 UTC 13 APR 00



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Backward Trajectories Ending- 01 UTC 16 JAN 00



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# **EXPERIMENTAL APPROACH TO OBJECTIVE FIVE**

**In order to study the seasonal variation in fine particles at NETL, we propose to sample intensively in one month/30 day periods seasonally. In a more limited fashion, diurnal variation studies will be done during the off-seasonal periods.**

## **SAMPLING SCHEDULE**

- Fall -- Monday, October 16th to Thursday, November 9th - 24 days.**
- Winter -- Thursday, January 20th to Monday, February 14th - 25 days.**
- Spring -- Monday, April 24th to Thursday, May 18th - 24 days.**
- Summer -- Monday, July 31st to Thursday, August 24th - 24 days.**

