Mercury Transport and Deposition in the Ohio River Valley Region: Measurements at a Rural Super site in Athens, Ohio

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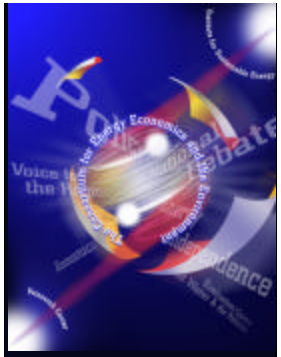
Project Objectives

- Measure atmospheric concentrations of Mercury (Hg^0, RGM and Hg_p), Arsenic, Fine particulate matter and criteria pollutants
- Regional model validation
- Source characterization
- Characterize diurnal, seasonal, and annual levels of Hg, Arsenic, and $PM_{2.5.}$
- Enable coal-based power plants to develop cost-effective emission control strategies to reduce air pollution.



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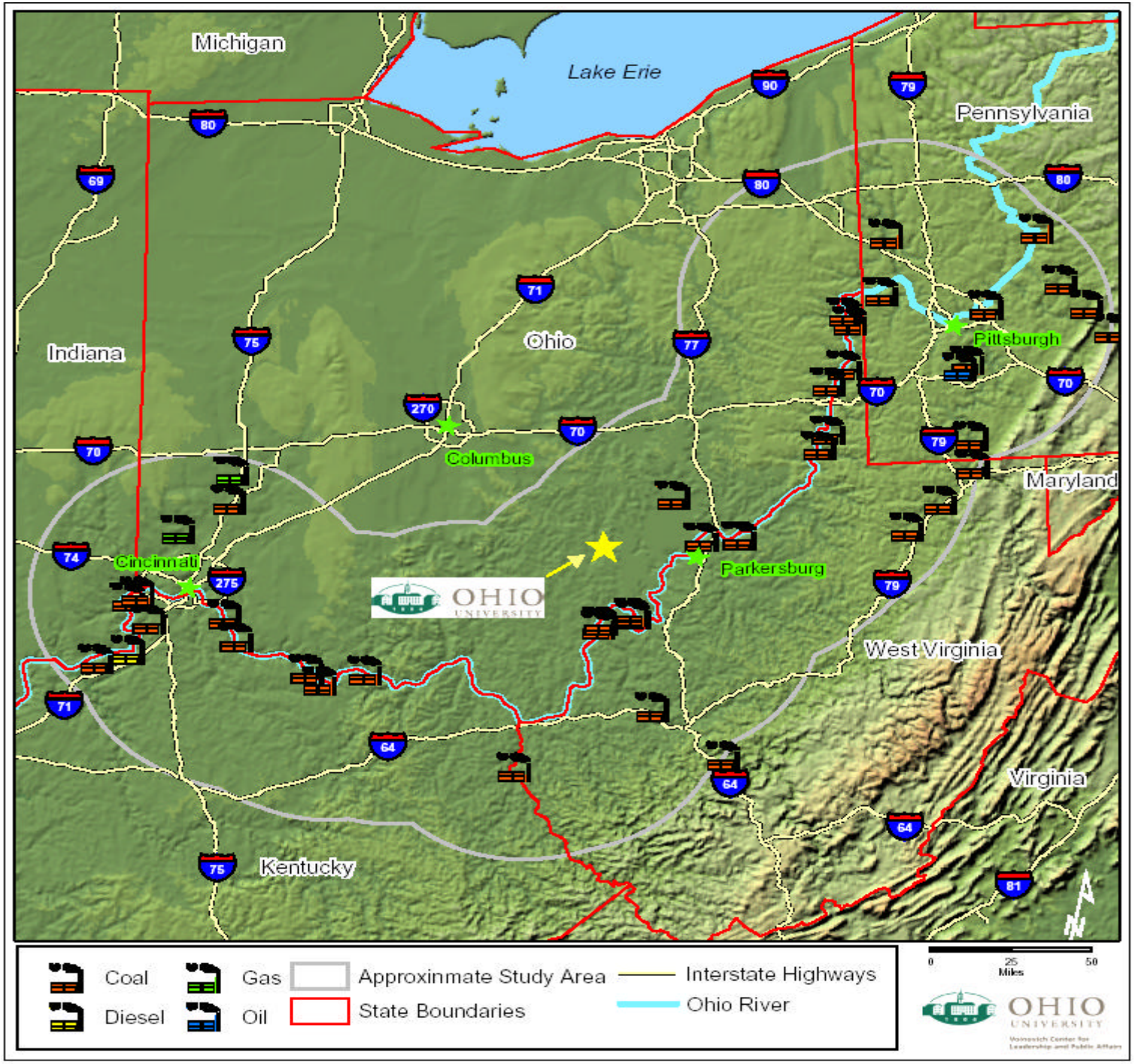

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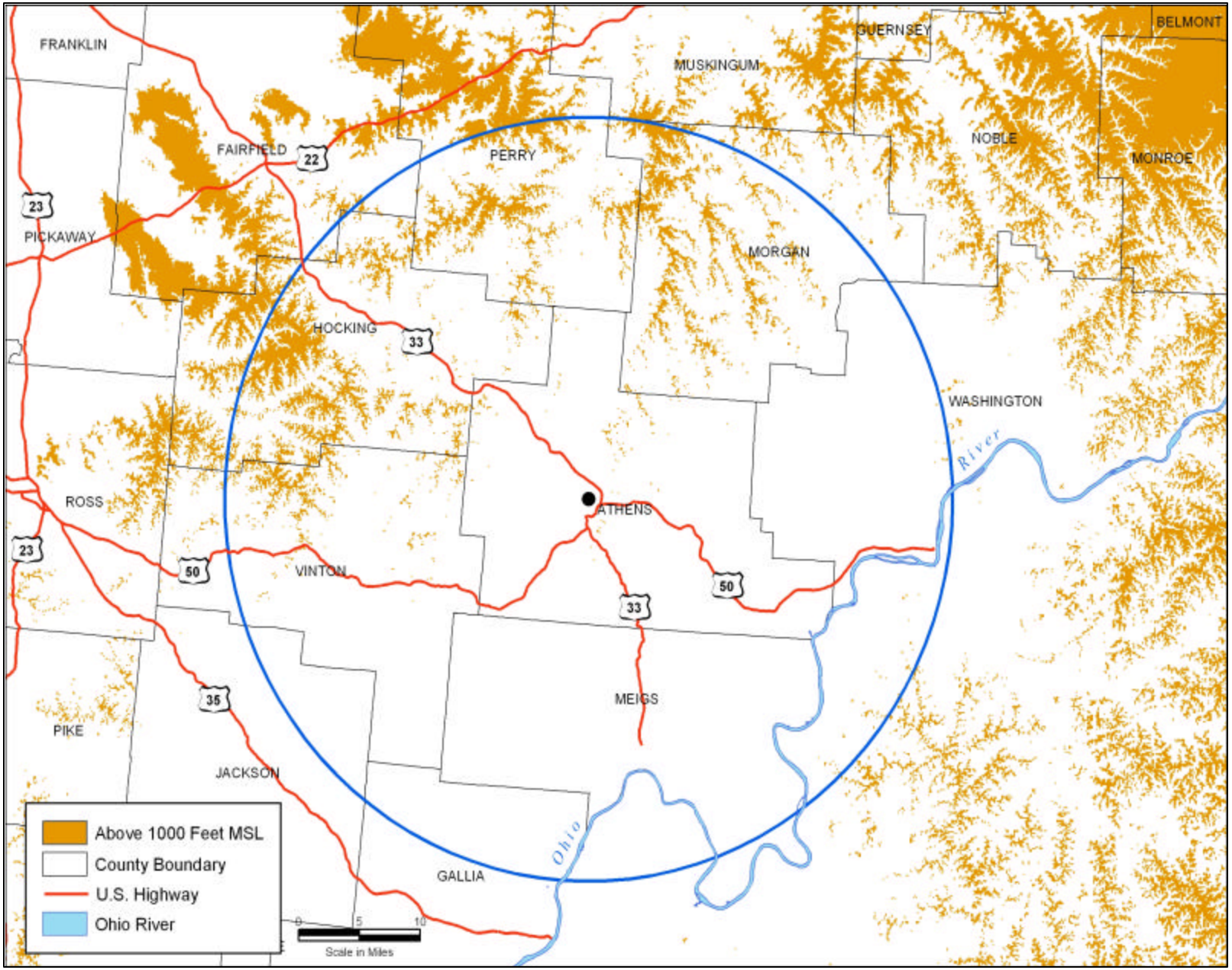

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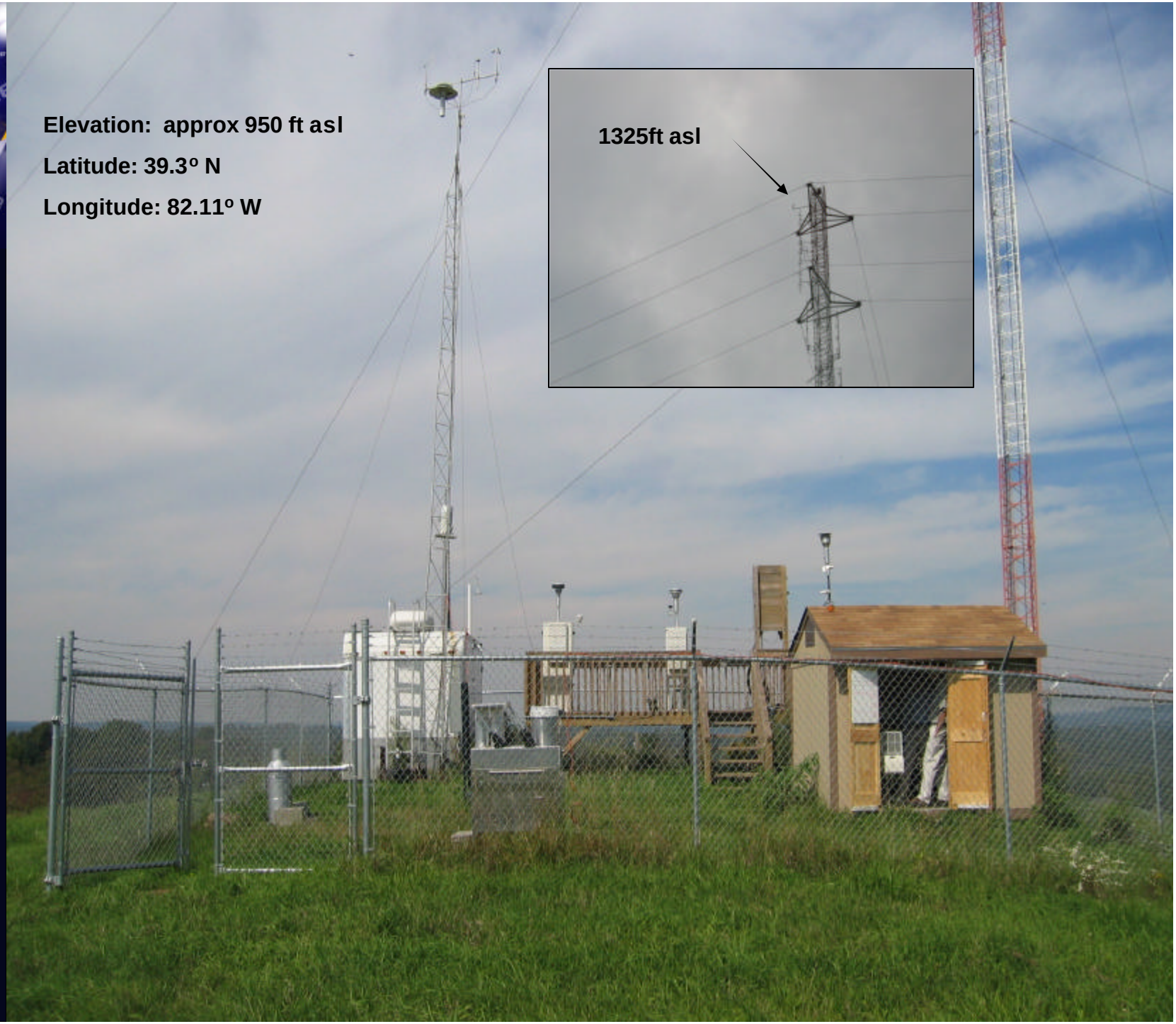

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Measurements

Species of Concern	Observed	Resolution
Mercury	Hg^0, RGM, Hg_p	60 min
Wet Deposition	Total Mercury	1 week
Gases	SO_2, NO_x, CO, O_3	1 min
Fine Particulate	$PM_{2.5}$ & Speciation	3 days
Met (approx 100m)	WS, WD	1 min
Met (10 m)	WS, WD, Temp, BP, RH, Precip.	1 min
Ammonia	NH_3, HNO_3, SO_2, $SO4^{2-}$, NO^{3-}, NH^{4+} , $PM_{2.5}$	6 days

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Why Mercury is a concern?

- Speciation
  - Elemental mercury (Hg^0): long range transport, stable in the atmosphere, ng/m^3
  - Reactive Gaseous Mercury (RGM/Hg^{2+}): Local deposition, soluble in water, pg/m^3
  - Particulate mercury (Hg_p): Local deposition, associate with fine PM, pg/m^3

- Health effects
  - Neuro toxin affecting infants

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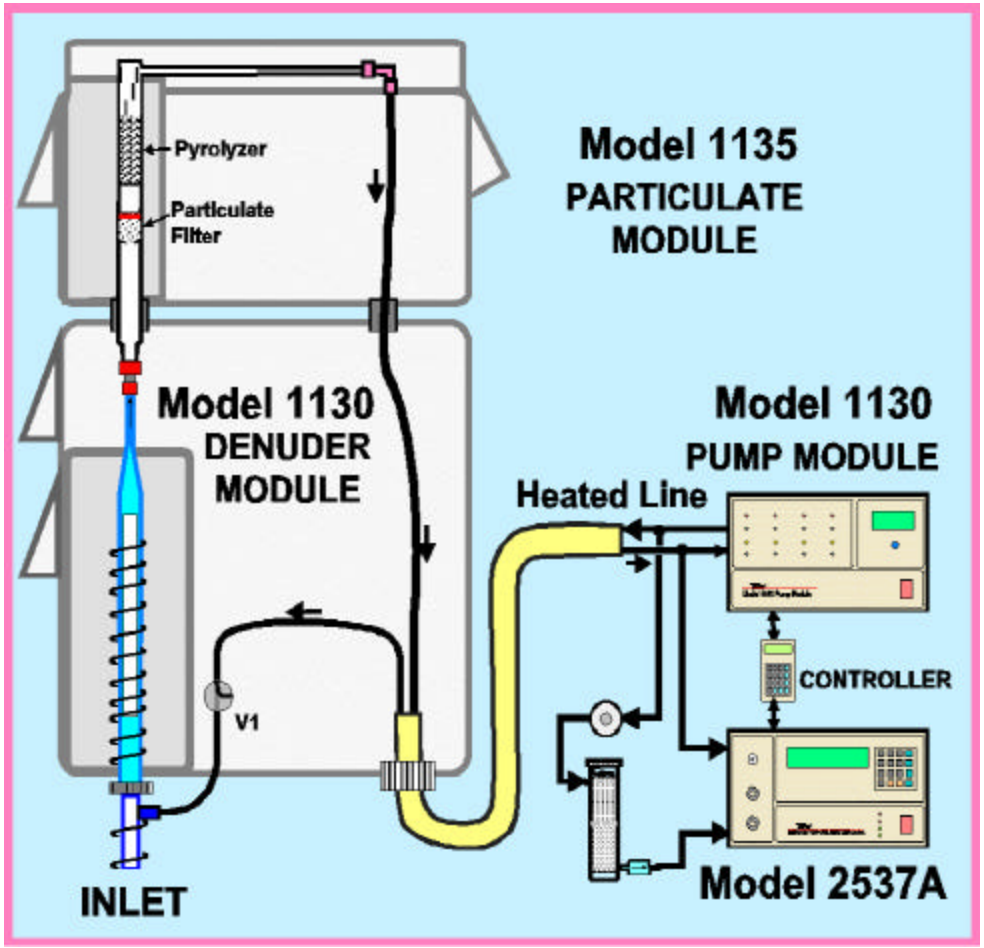
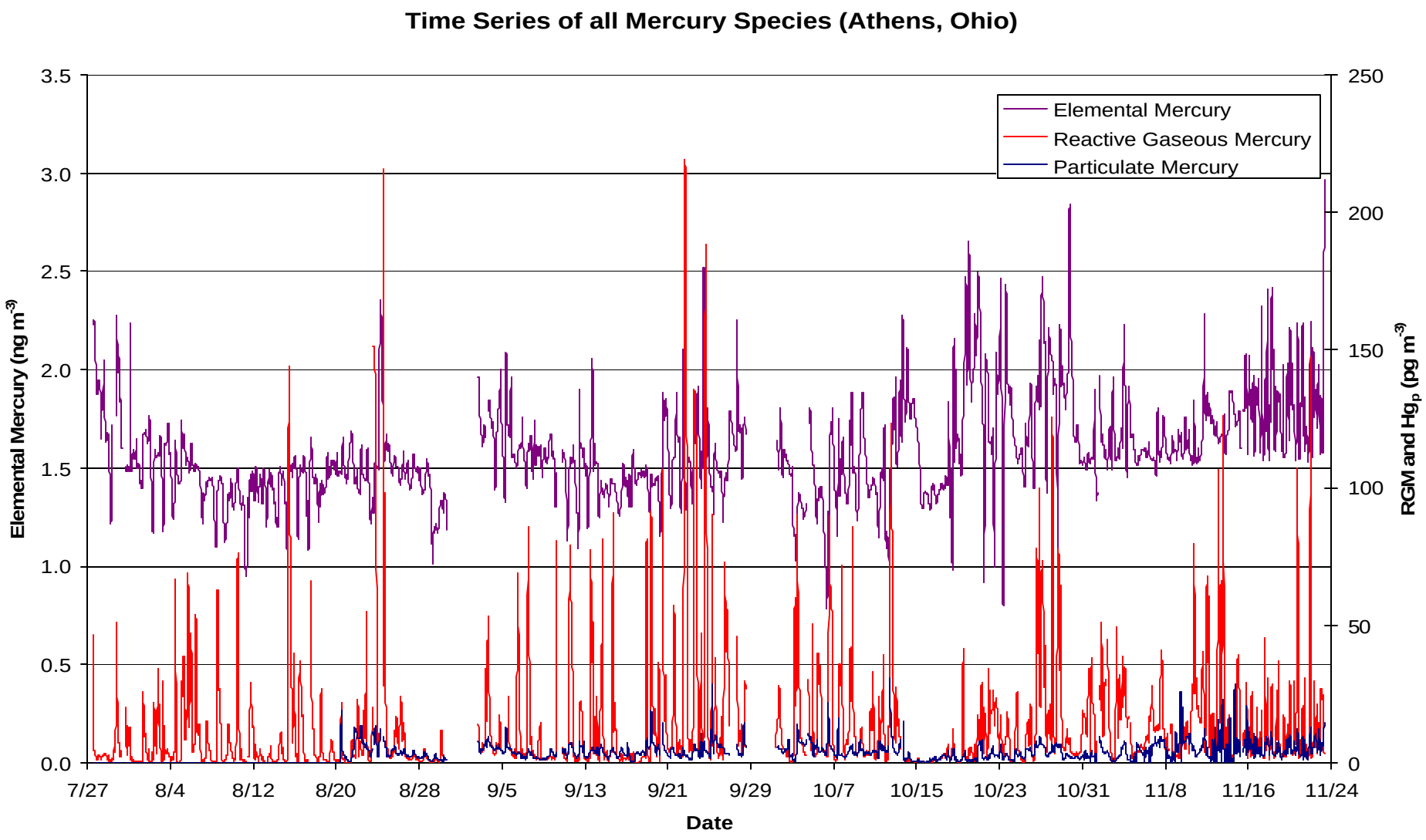
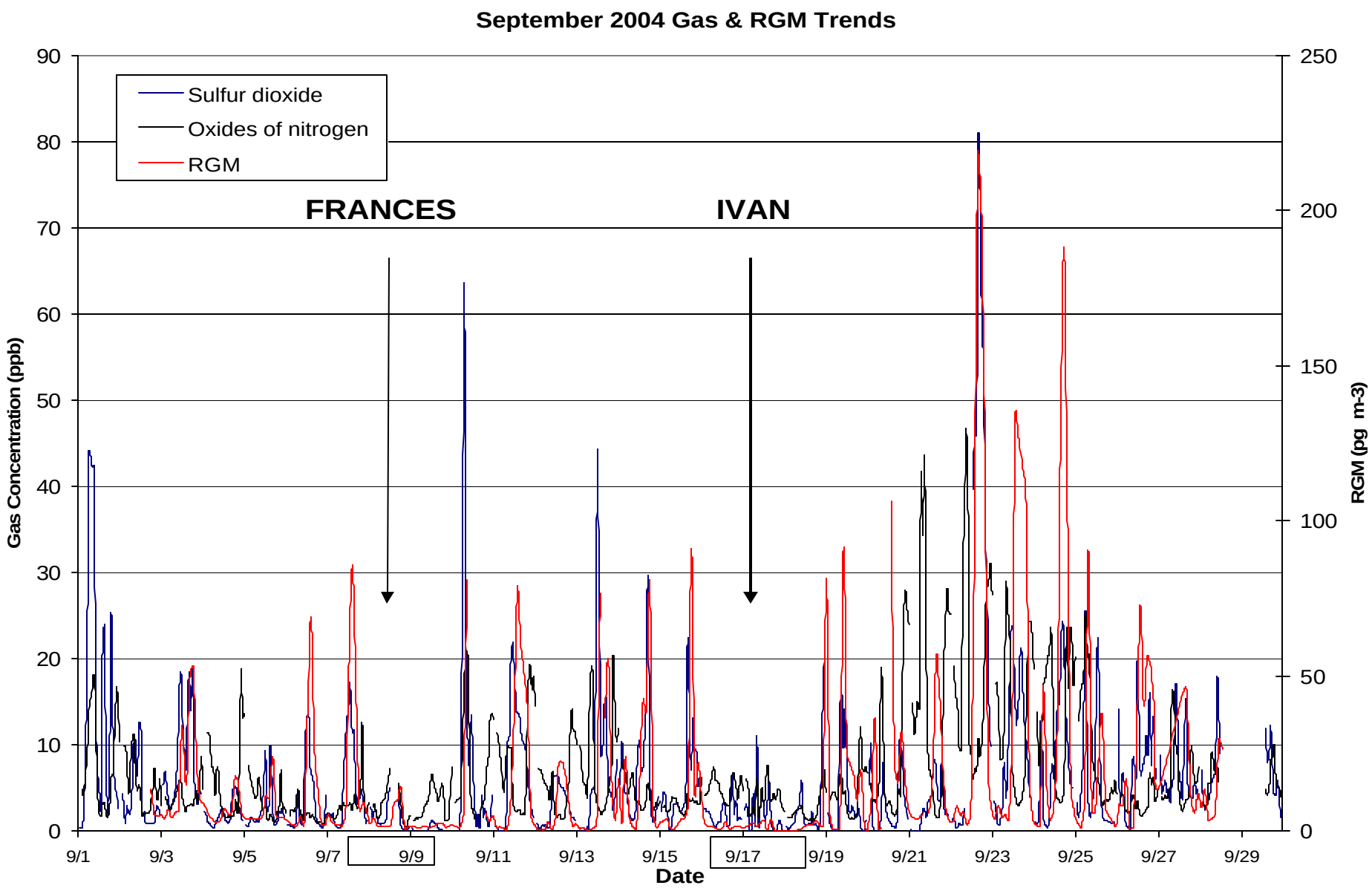
TEKRAN

- Semi – continuous
- 2537A (CVAFS) analyzer
- KCl-coated annular denuder
- Quartz filter




Time Series of all Mercury Species (Athens, Ohio)
Elemental Mercury
Reactive Gaseous Mercury
Particulate Mercury
Elemental Mercury (ng m-3)
RGM and Hgp (pg m-3)
Date
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
250
200
150
100
50
0
7/27
8/4
8/12
8/20
8/28
9/5
9/13
9/21
9/29
10/7
10/15
10/23
10/31
11/8
11/16
11/24


September 2004 Gas & RGM Trends
Sulfur dioxide
Oxides of nitrogen
RGM
FRANCES
IVAN
Gas Concentration (ppb)
RGM (pg m-3)
Date
0
10
20
30
40
50
60
70
80
90
0
50
100
150
200
250
9/1
9/3
9/5
9/7
9/9
9/11
9/13
9/15
9/17
9/19
9/21
9/23
9/25
9/27
9/29

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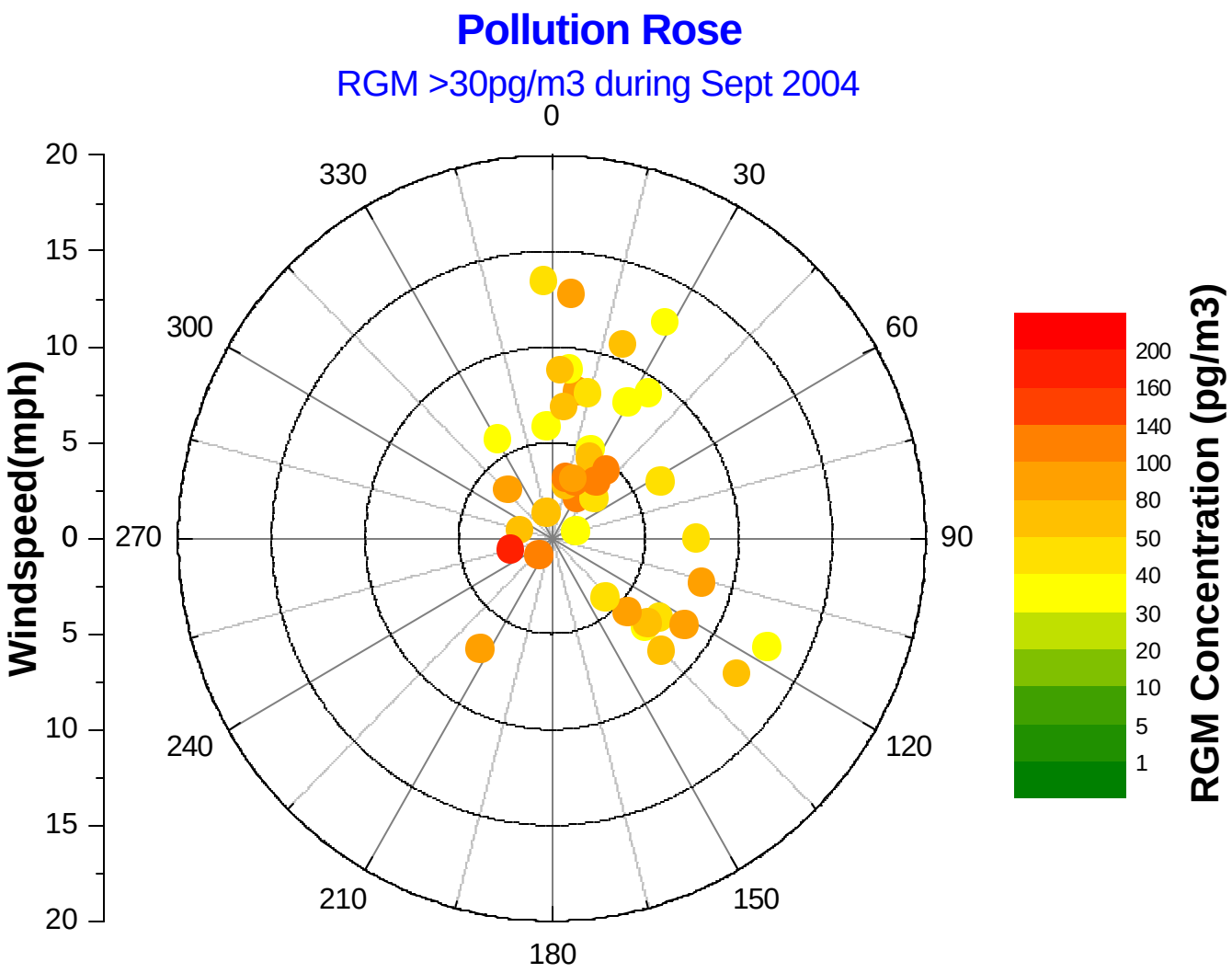

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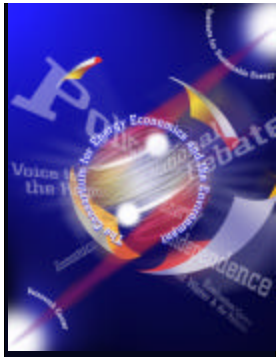
Wet Deposition sampler

- Mercury Deposition Network (MDN)
- Associated with both rain and snow events
- Glassware is changed once every week
- Analyzed for total mercury content



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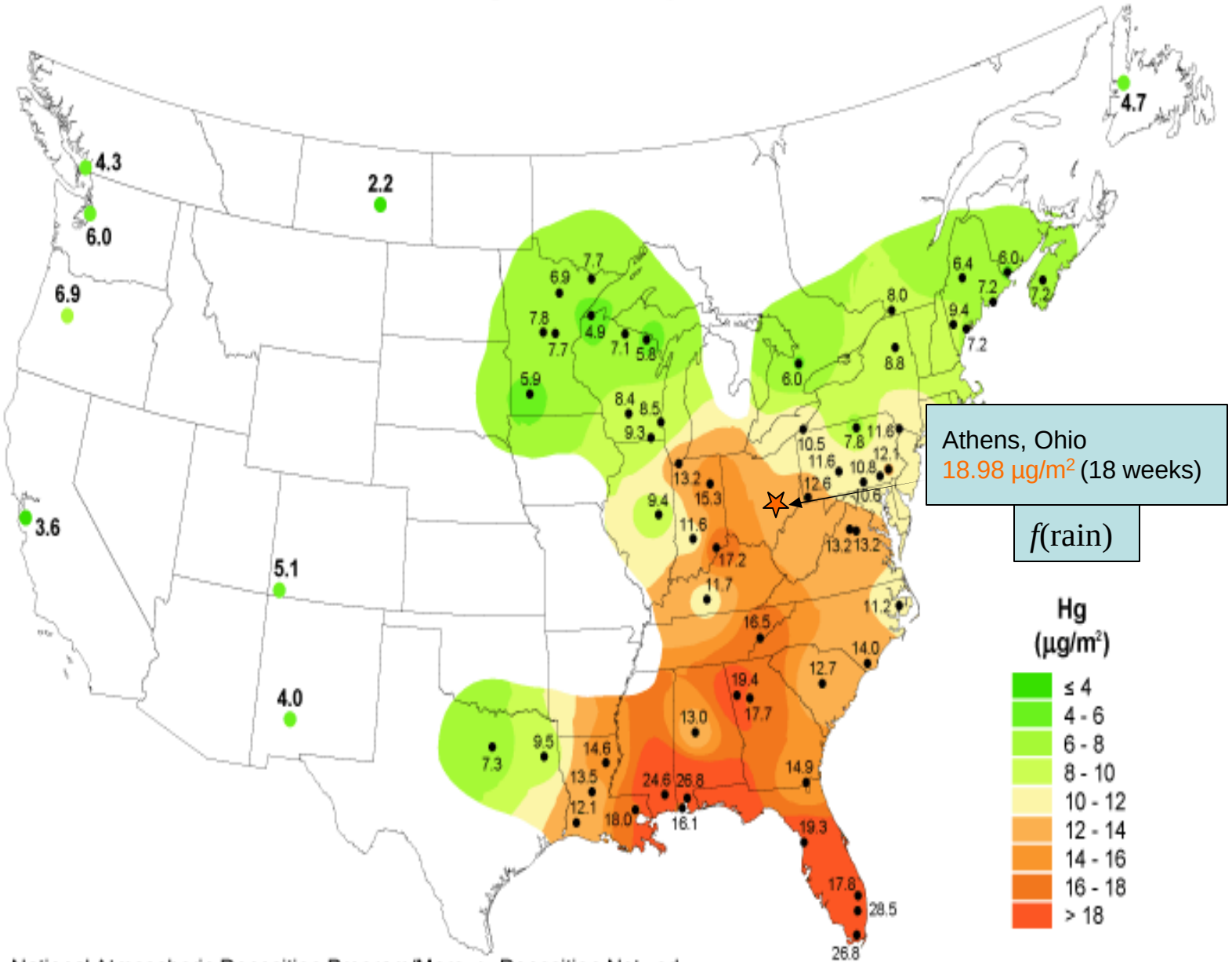
Total Mercury Wet Deposition, 2003



National Atmospheric Deposition Program/Mercury Deposition Network

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Conditional Probability Function (CPF)

$$\mathrm{CPF}_{??} = \frac{m_{\Delta q}}{n_{\Delta q}}$$

$m_{??}$ = number of occurrences from wind sector ?? above the threshold criterion

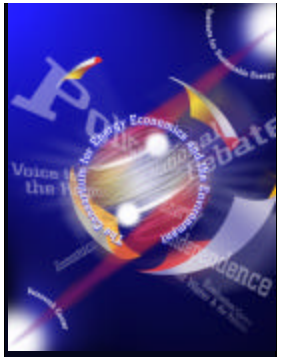
$n_{??}$ = total number of observations from the same wind sector

<u>References</u>

•Bilkis A. Begum, Eugene Kim, Swapan K. Biswas, Philip K. Hopke., Atmospheric Environment 38(2004) 3025-3038

•Eugene Kim, Philip K. Hopke., Atmospheric Environment 38(2004) 4667-4673

•Eugene Kim, Philip K. Hopke, Eric S. Edgerton., Atmospheric Environment 38(2004) 3349-3362



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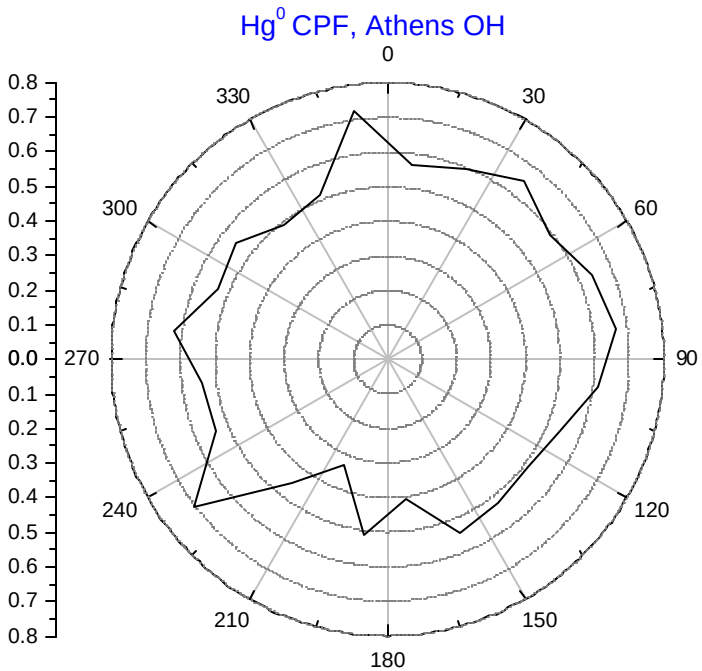
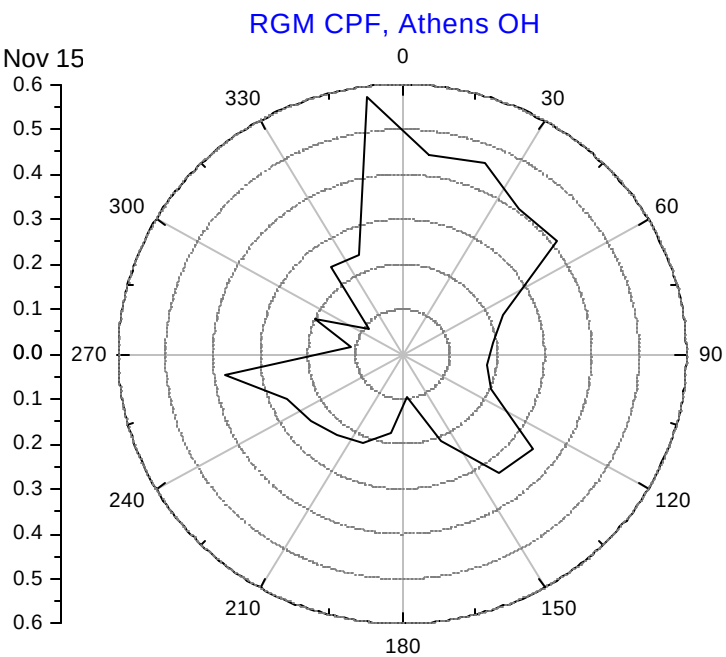
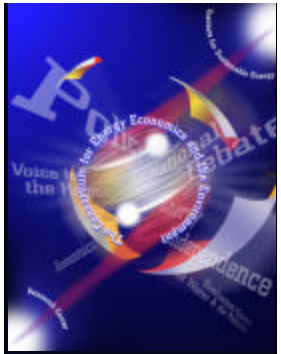


Data from July 27 till Nov 15



Data from July 27 till Nov 15, 2004



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Potential Source Contribution Function (PSCF)

- PSCF has been used for air pollution source apportionment and source-receptor relationship studies.
- If a backward trajectory endpoint lies in the *ij*th cell, the air parcel assumes to collect PM emitted in the cell and transports along the trajectory to the monitoring site.
- $PSCF_{ij}$ is the conditional probability that an air parcel that passed through the *ij*th cell has a high concentration upon arrival at the monitoring site

$$PSCF_{ij} = \frac{m_{ij}}{n_{ij}}$$

n_{ij}: total number of end points that fall in the *ij*th cell

m_{ij}: number of end points that exceeded the threshold criterion

(in this study, average concentration of PM was used for the threshold criterion)

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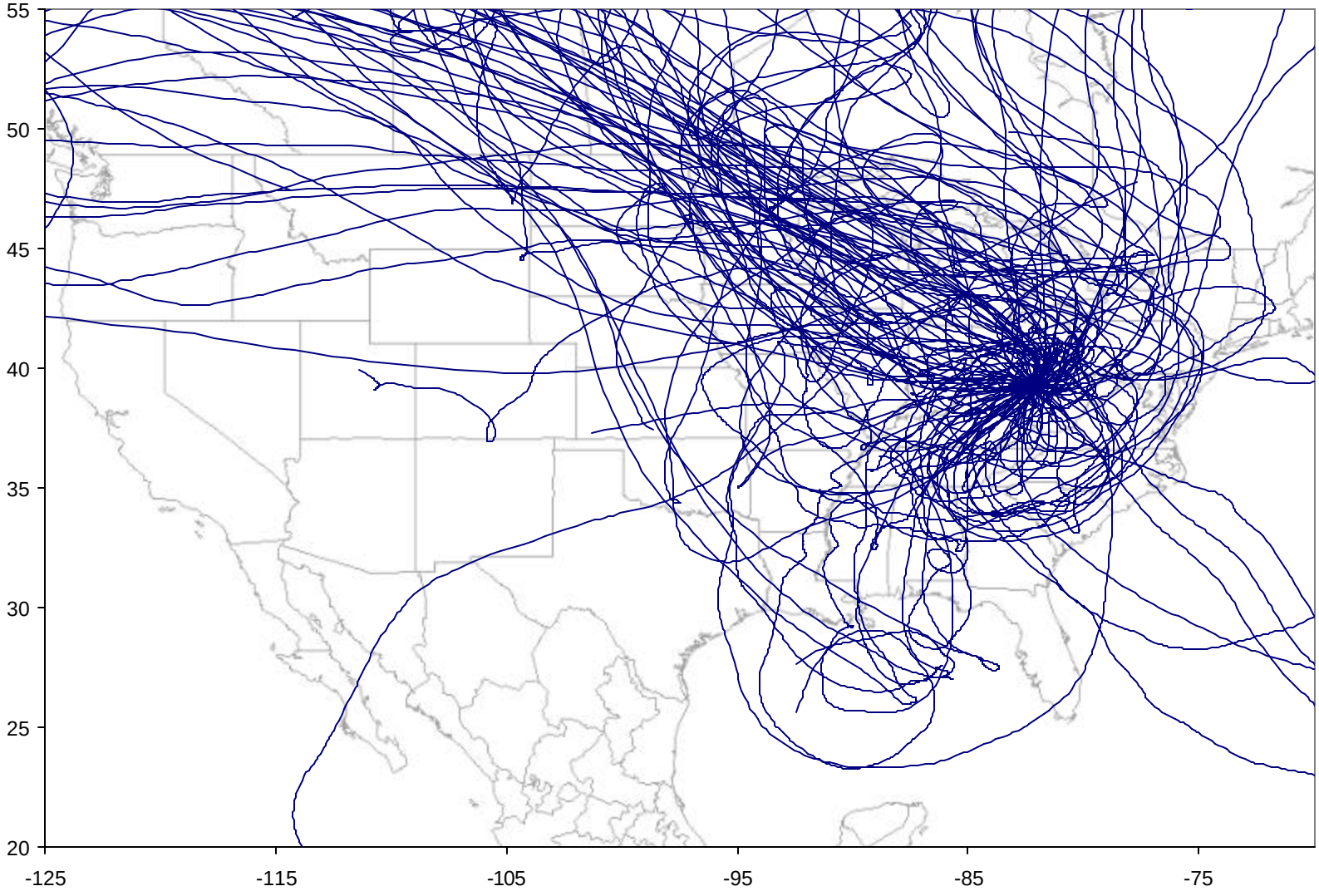
5-Days Backward Trajectories for Hg^0 (July 27 to Nov. 15, 2004)



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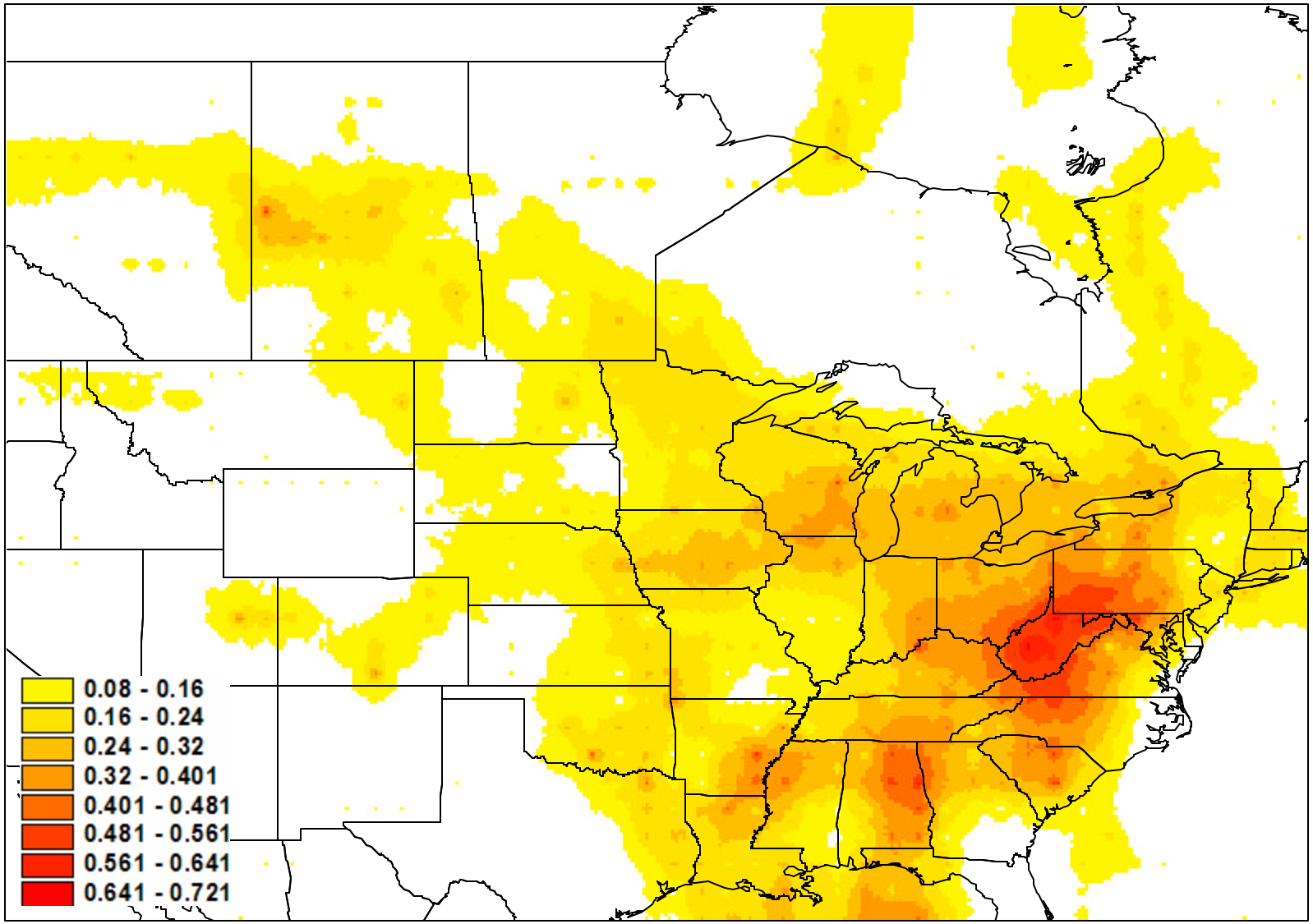
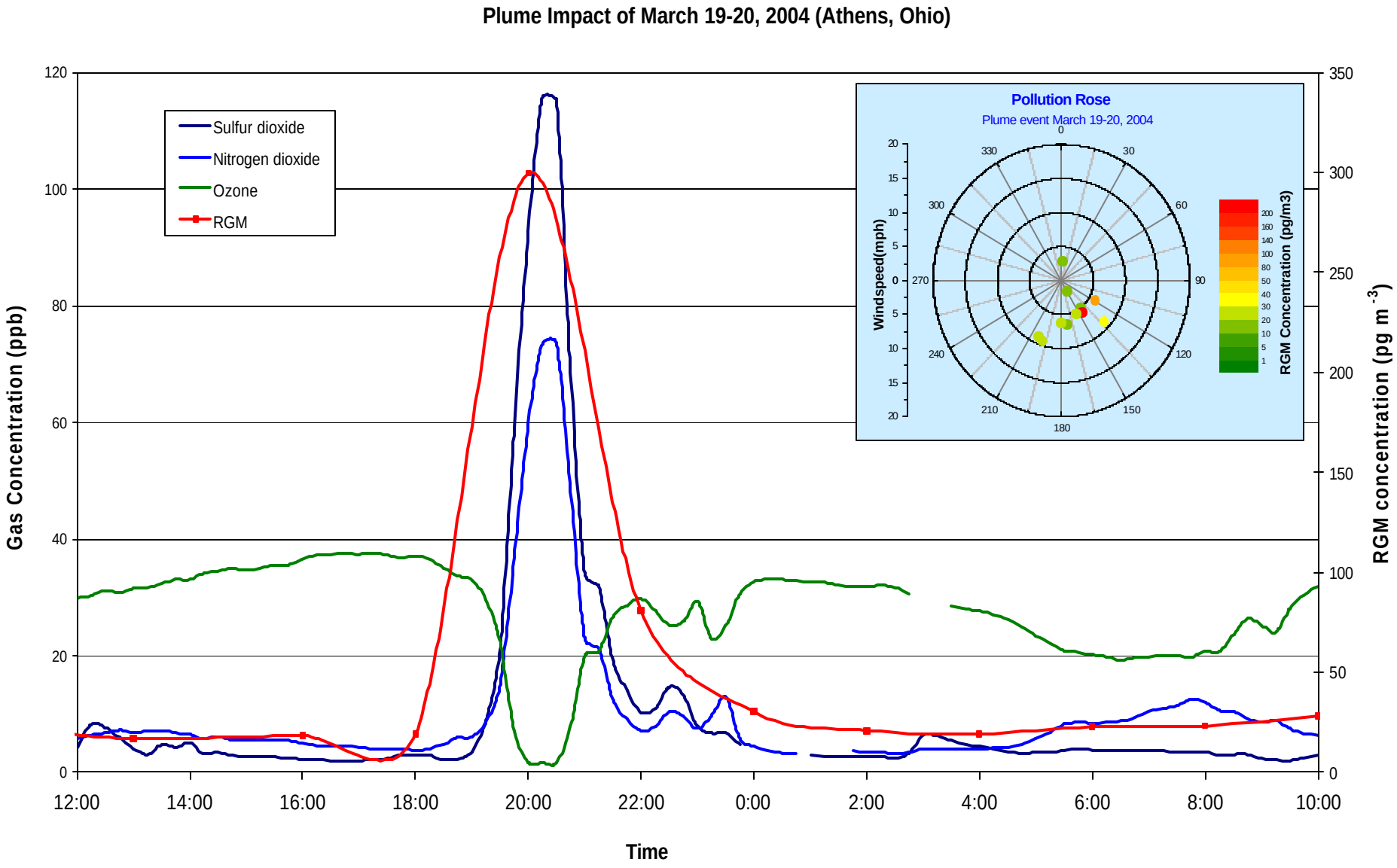
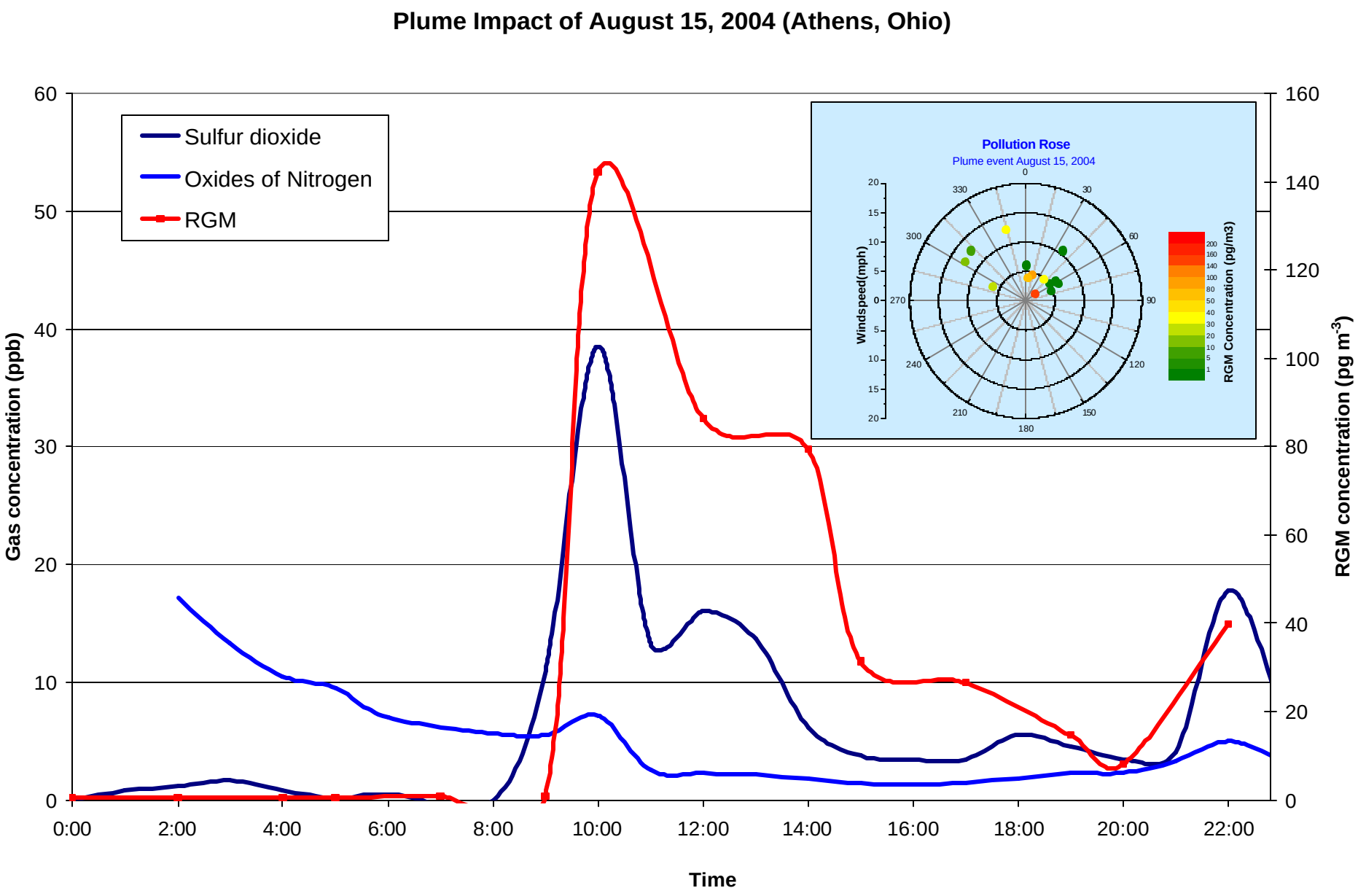
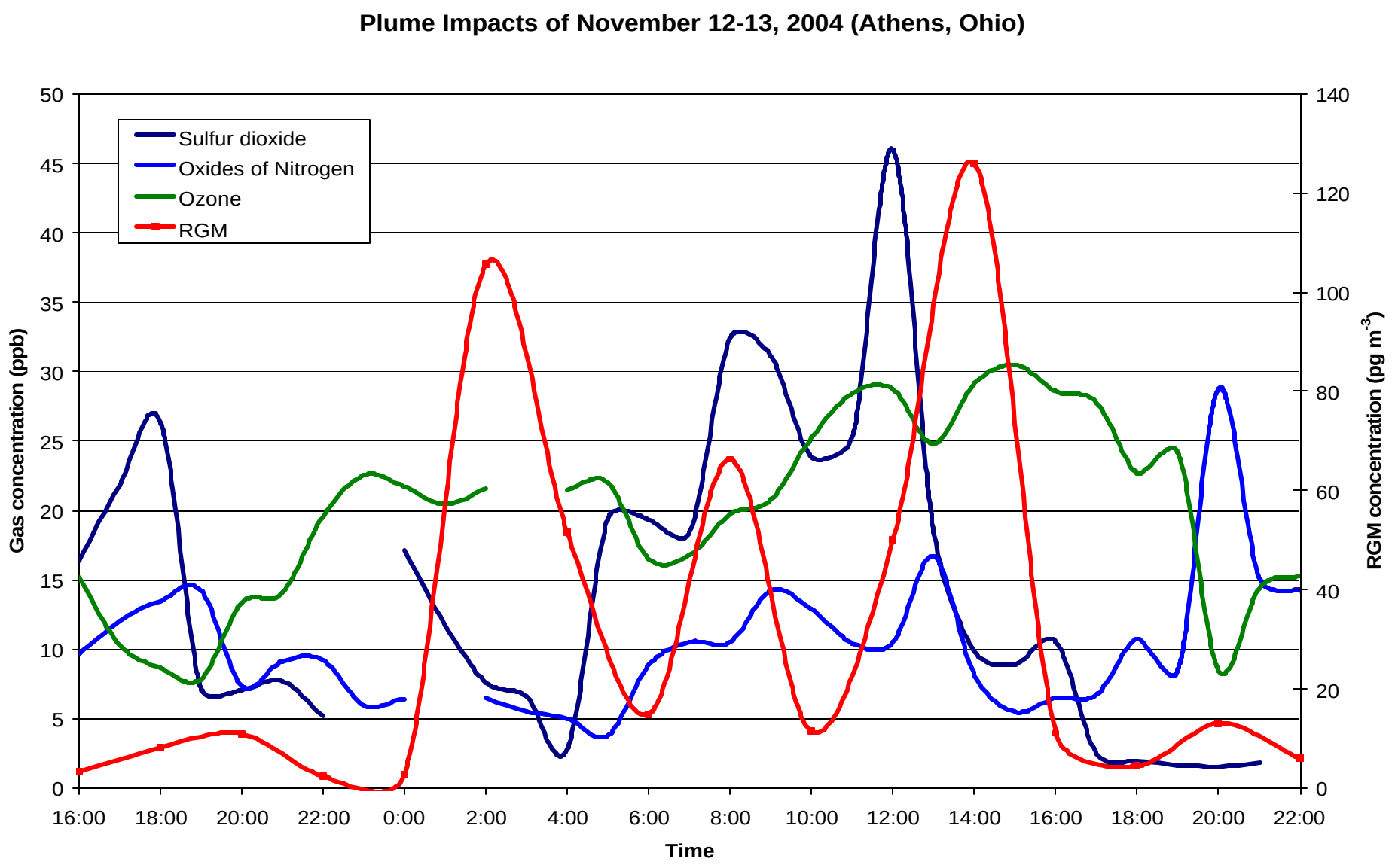
Potential Source Contribution Function (PSCF for Hg^0)




Plume Impact of March 19-20, 2004 (Athens, Ohio)
Sulfur dioxide
Nitrogen dioxide
Ozone
RGM
Gas Concentration (ppb)
RGM concentration (pg m -3)
Time
12:00
14:00
16:00
18:00
20:00
22:00
0:00
2:00
4:00
6:00
8:00
10:00
Pollution Rose
Plume event March 19-20, 2004
Windspeed(mph)
RGM Concentration (pg/m3)


Plume Impact of August 15, 2004 (Athens, Ohio)
Sulfur dioxide
Oxides of Nitrogen
RGM
Gas concentration (ppb)
RGM concentration (pg m-3)
Time
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
Pollution Rose
Plume event August 15, 2004
Windspeed(mph)
RGM Concentration (pg/m3)


Plume Impacts of November 12-13, 2004 (Athens, Ohio)
Sulfur dioxide
Oxides of Nitrogen
Ozone
RGM
Gas concentration (ppb)
RGM concentration (pg m-3)
Time
0
5
10
15
20
25
30
35
40
45
50
0
20
40
60
80
100
120
140
16:00
18:00
20:00
22:00
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00

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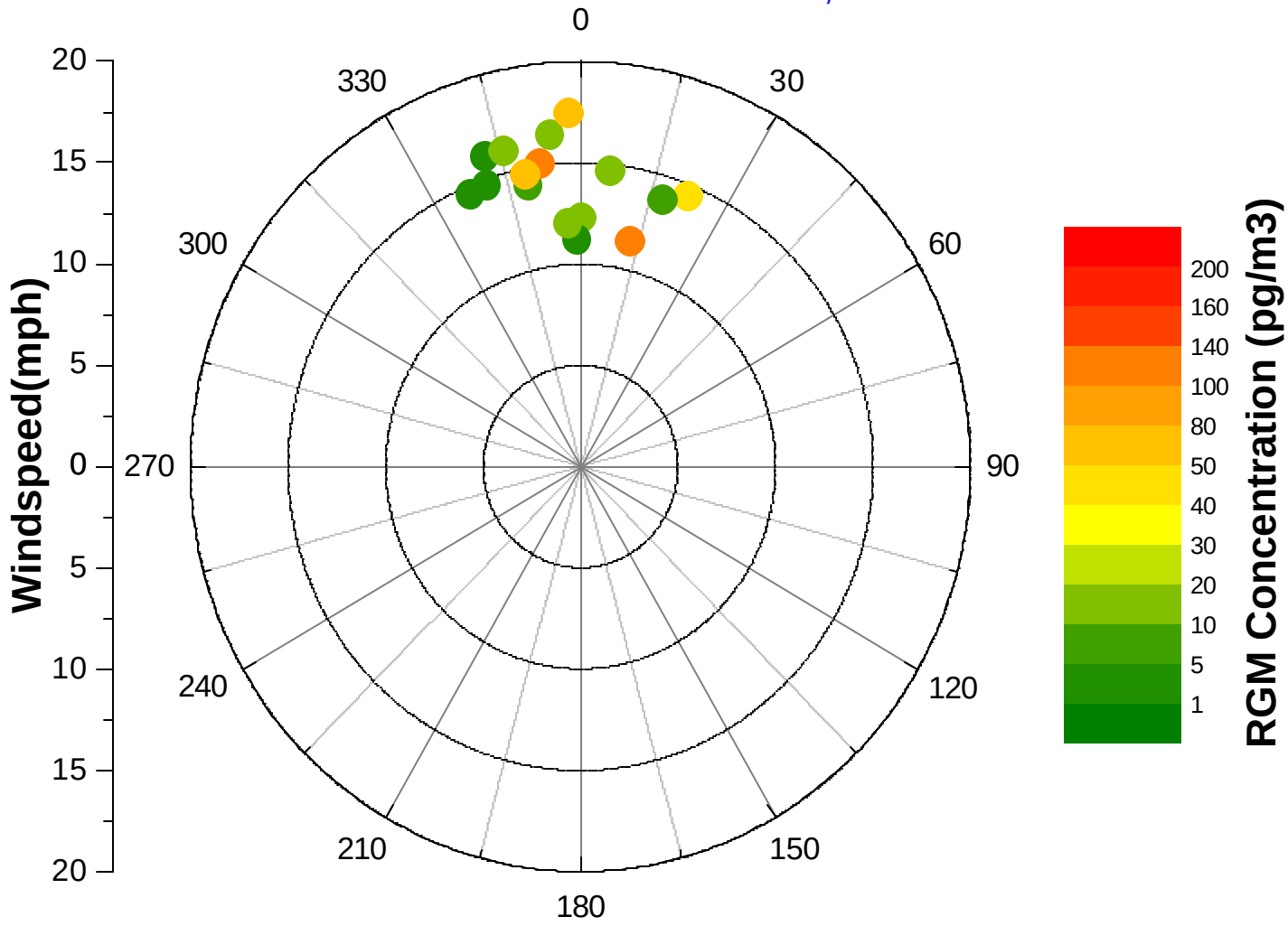
Pollution Rose

Plume event November 12-13, 2004



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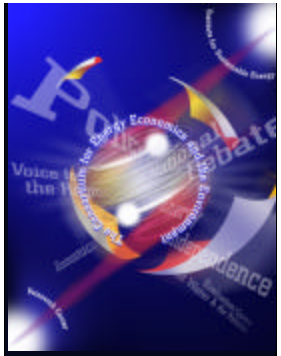
Future Plans

- Source characterization (point vs. urban)
  - NO_y
  - Trace level CO
- Regional haze assessment
  - EC/OC
  - Haze camera
  - Nephleometer
- Trace metals
  - Modify wet deposition collection



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Questions?