Application of Receptor Modeling to Trace the Sources of $PM_{2.5}$, Hg^0, PAH in New York State

Wei Liu[1], Philip K. Hopke[1], Youngji Han[1], Thomas M. Holsen[1], Scott Cybart[2], Kimberly Kozlowski[2] and Michael S. Milligan[2],

1. Clarkson University
2. SUNY at Fredonia

Outline

1. Objectives
2. Introduction
3. Experimental Methods
4. Results
5. Data Analysis
6. Conclusion
7. Future works
8. Acknowledgement

Objectives

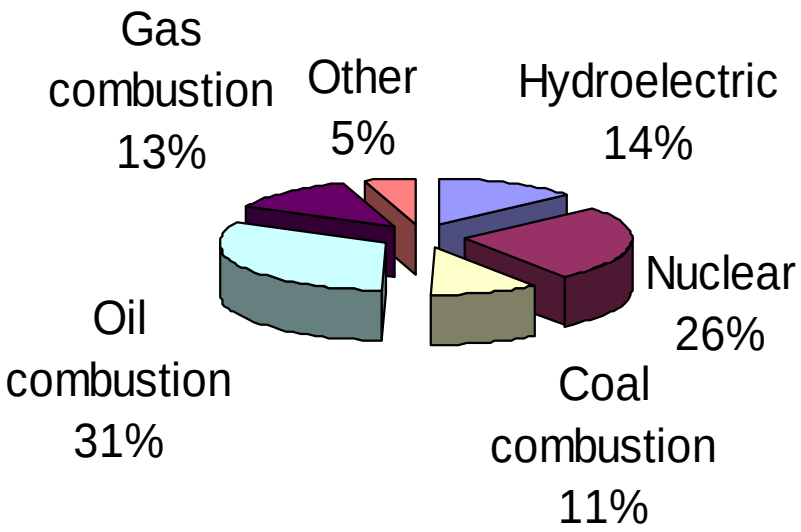
1. To measure the $PM_{2.5}$, vapor phase mercury, PAHs concentrations at two locations in New York state
2. To identify the source profiles and locations by using Receptor Modeling
3. To determine the impact of New York State coal power plant on air quality

Introduction

The present situation of New York power plants:

According to Department of Energy,the electricity generation status in NY is shown in Fig 1

Fig 1. Electricity generation status in NY



Experimental Method

Sampling

- Sampling site and sampling period

  Potsdam: airport;

  Stockton: SUNY Fredonia

- Sampling period:

  Daily from May through August in 2000, 2001

NY Power Plants and Study Sites

Sampling Site

Coal-Fired Power Plant

Oil-Fired Power Plant

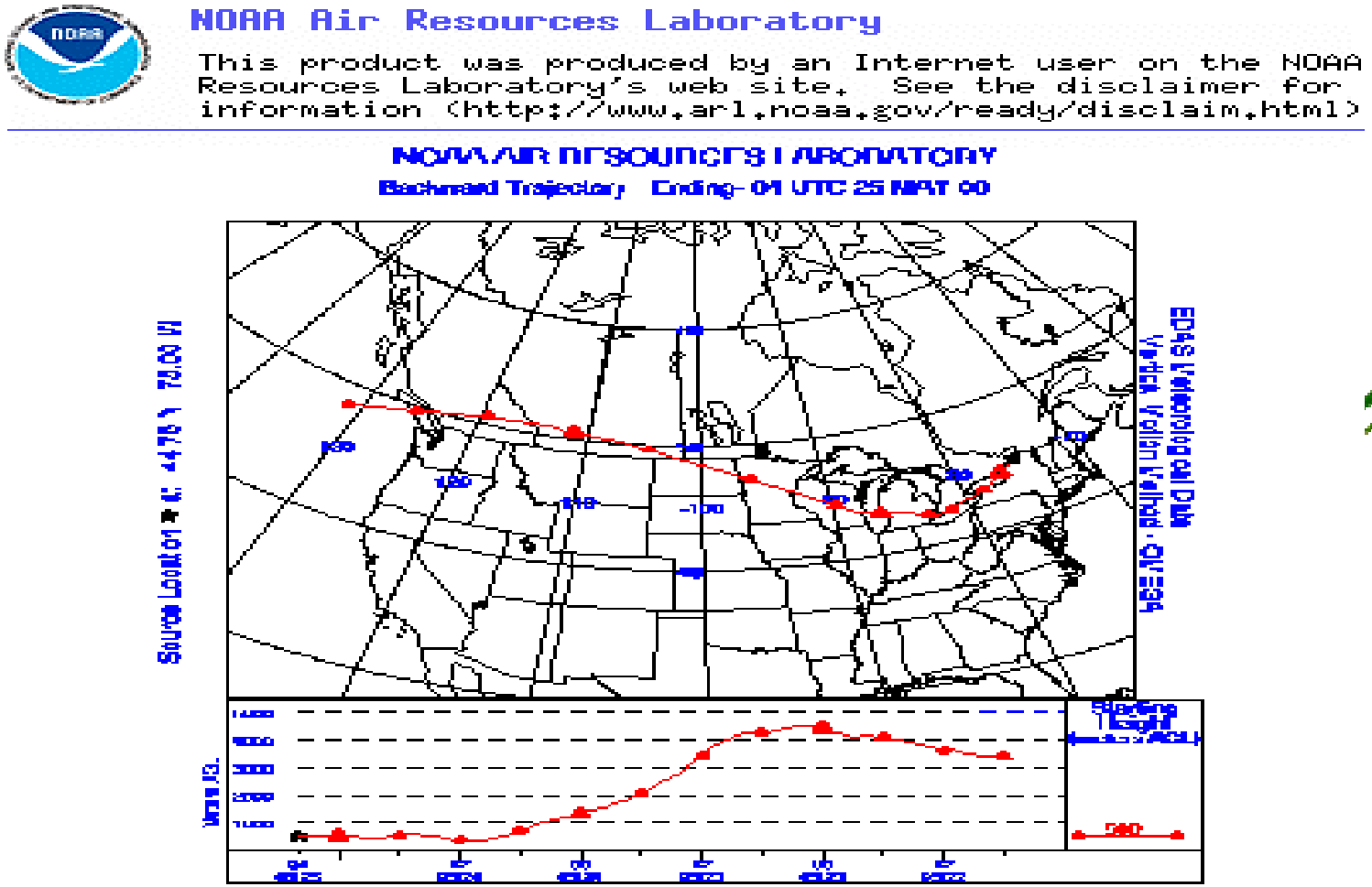
Samplers

1. $PM_{2.5}$ Speciation Sampler
   - Four sampling lines to independent filters (3 Teflo® filters, 1 Nylasorb® filter)
   - Mass, Black Carbon, Cations, Anions and trace elements
2. Hi-Volume Filter/PUF Sampler
3. Vapor Phase Mercury Sampler (gold wire)

Fig3 Study Sites at Potsdam, NY

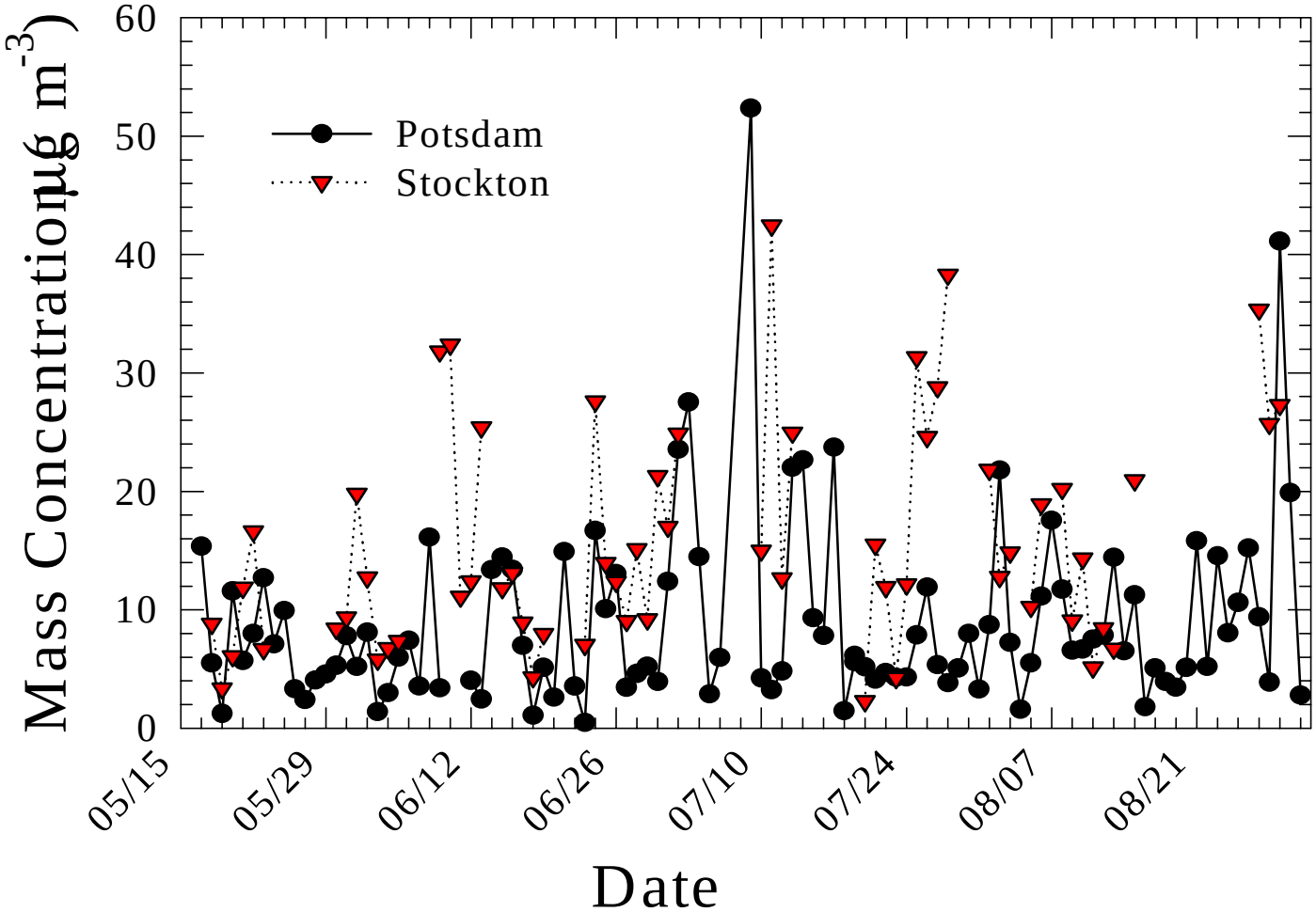
4. Back trajectory-NOAA HY-SPLIT model

Estimate where the air was prior to its arrival at the sampling site.



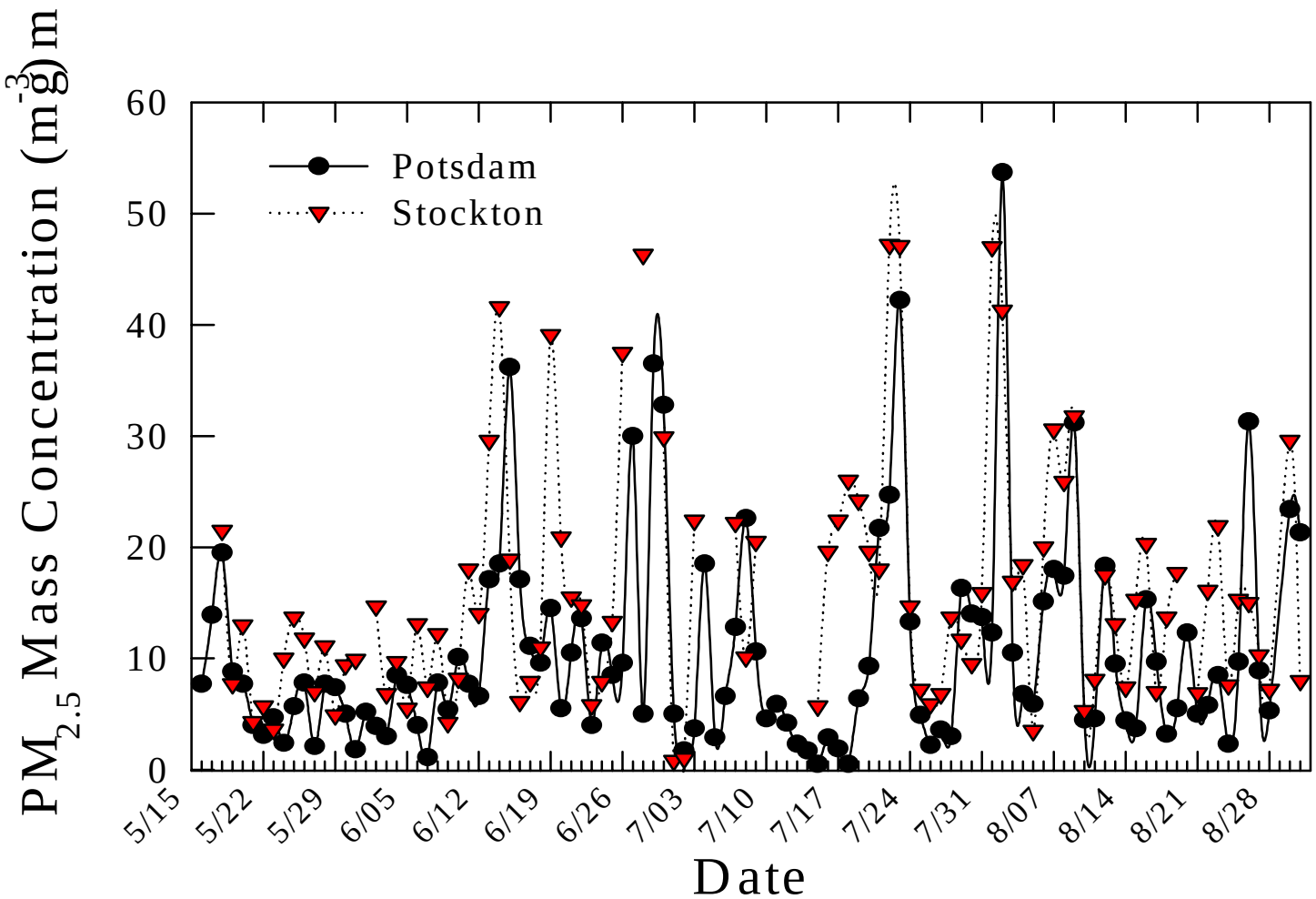
Results

Mass- 2000

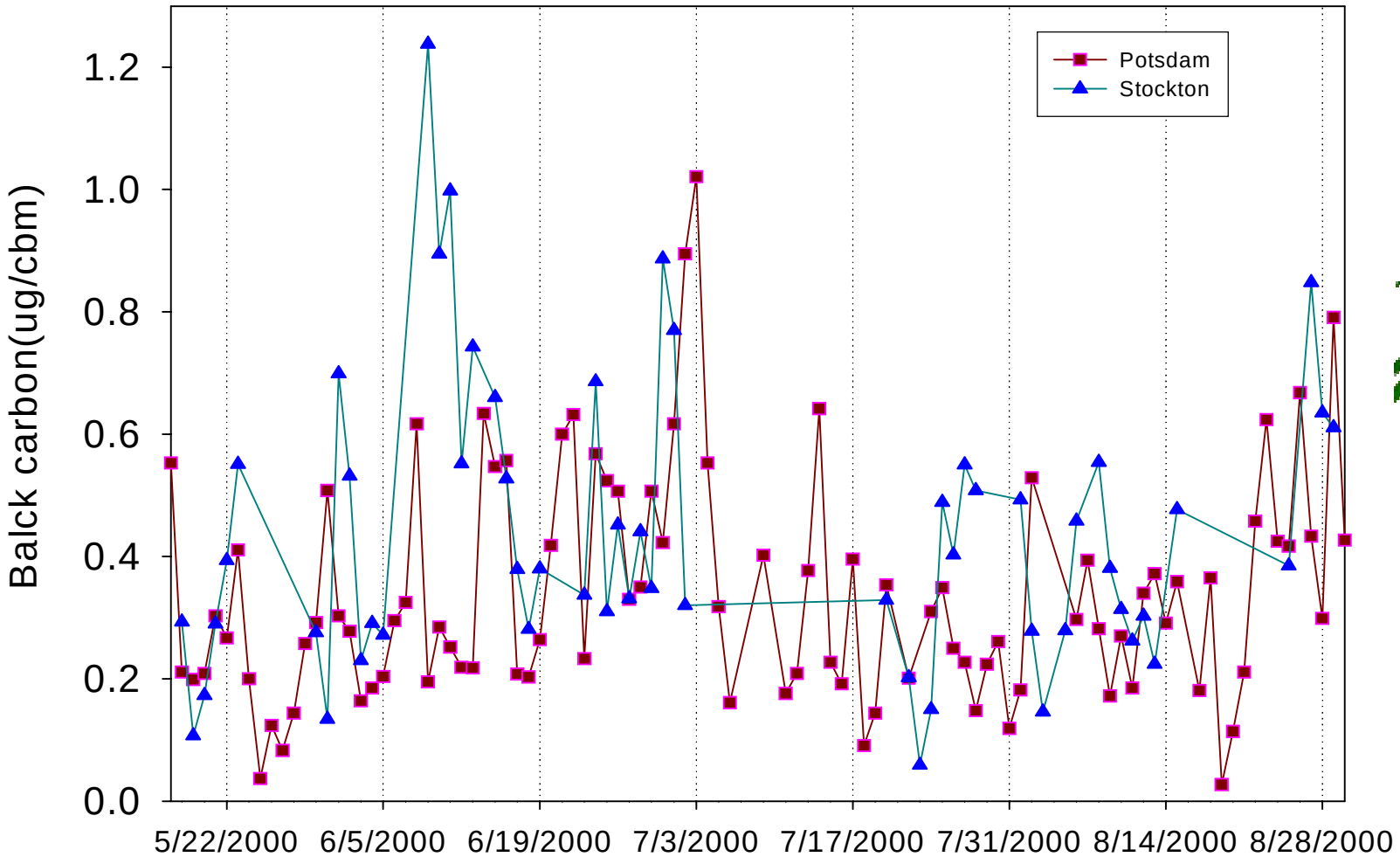


Results

Mass - 2001

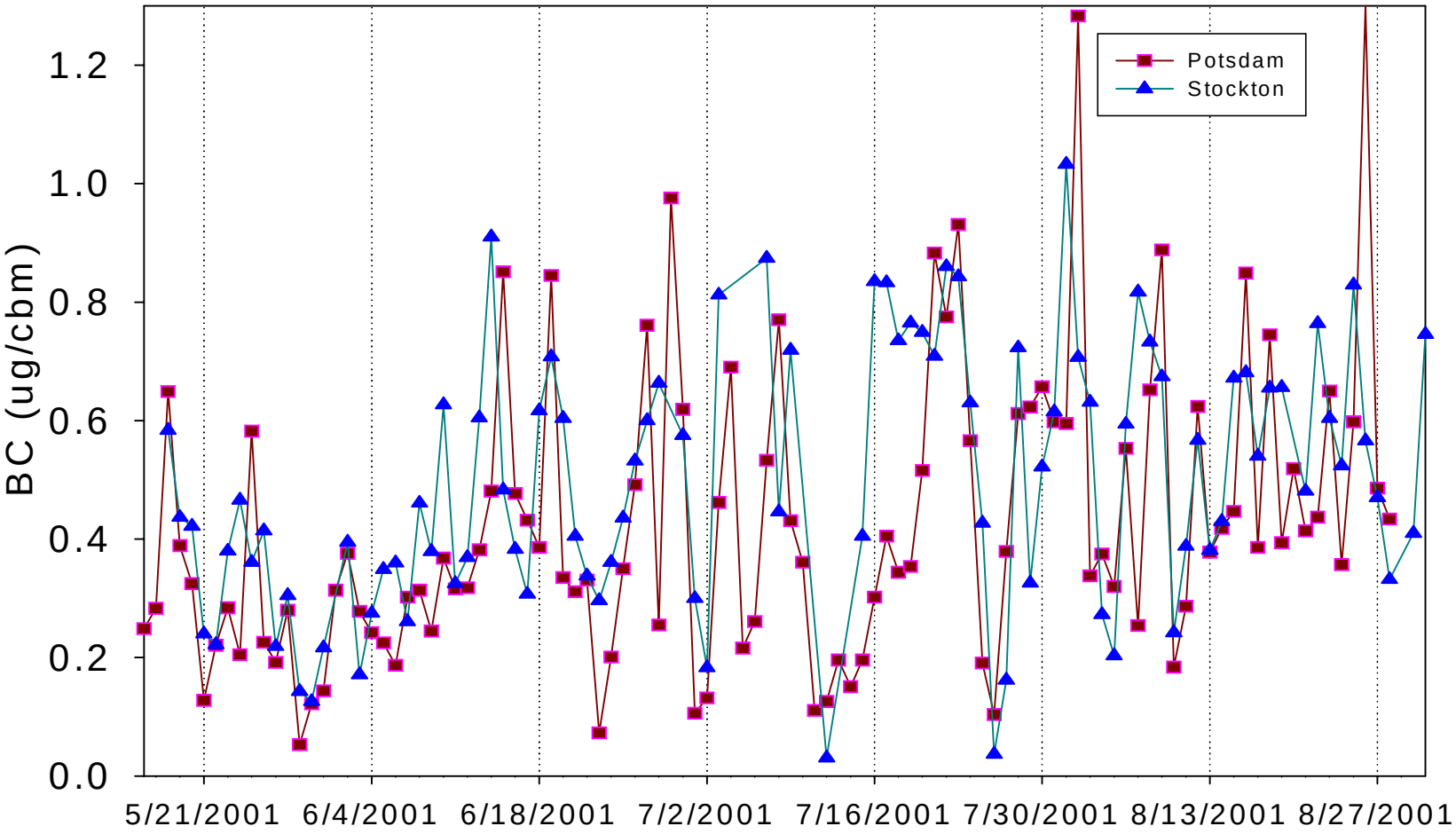


Results
Black carbon data 2000



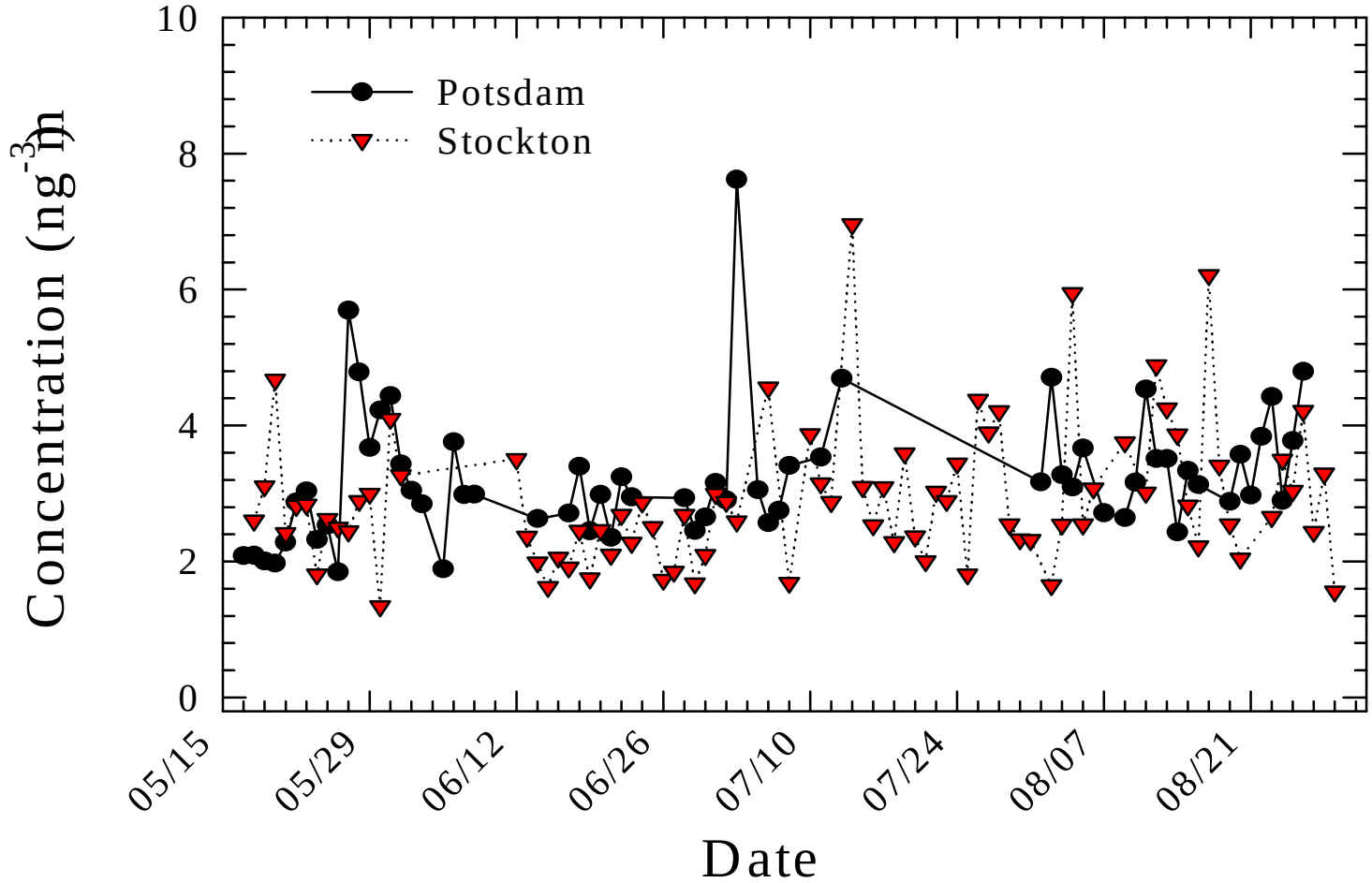
Results

Black carbon data 2001



Results

PAH data 2000



Data Analysis 1:
Positive Matrix Factorization

PRINCIPLE OF AEROSOL MASS BALANCE:

$$x_{ij} = \sum_{p=1}^{P} g_{ip} f_{pj}$$

$i = 1, \ldots, I$ samples

$j = 1, \ldots, J$ species

$p = 1, \ldots, P$ sources

$$X = GF$$

X: Elemental concentration of receptor sites.

G: Source contribution

F: Source profile

Positive Matrix Factorization

- The Objective Function, Q, is defined by

$$Q = \sum_{i=1}^{n} \sum_{j=1}^{m} \left[\frac{x_{ij} - \sum_{k=1}^{p} g_{ik} f_{kj}}{\sigma_{ij}} \right]^2$$

where s_{ij} is an estimate of the uncertainty in x_{ij}

Positive Matrix Factorization

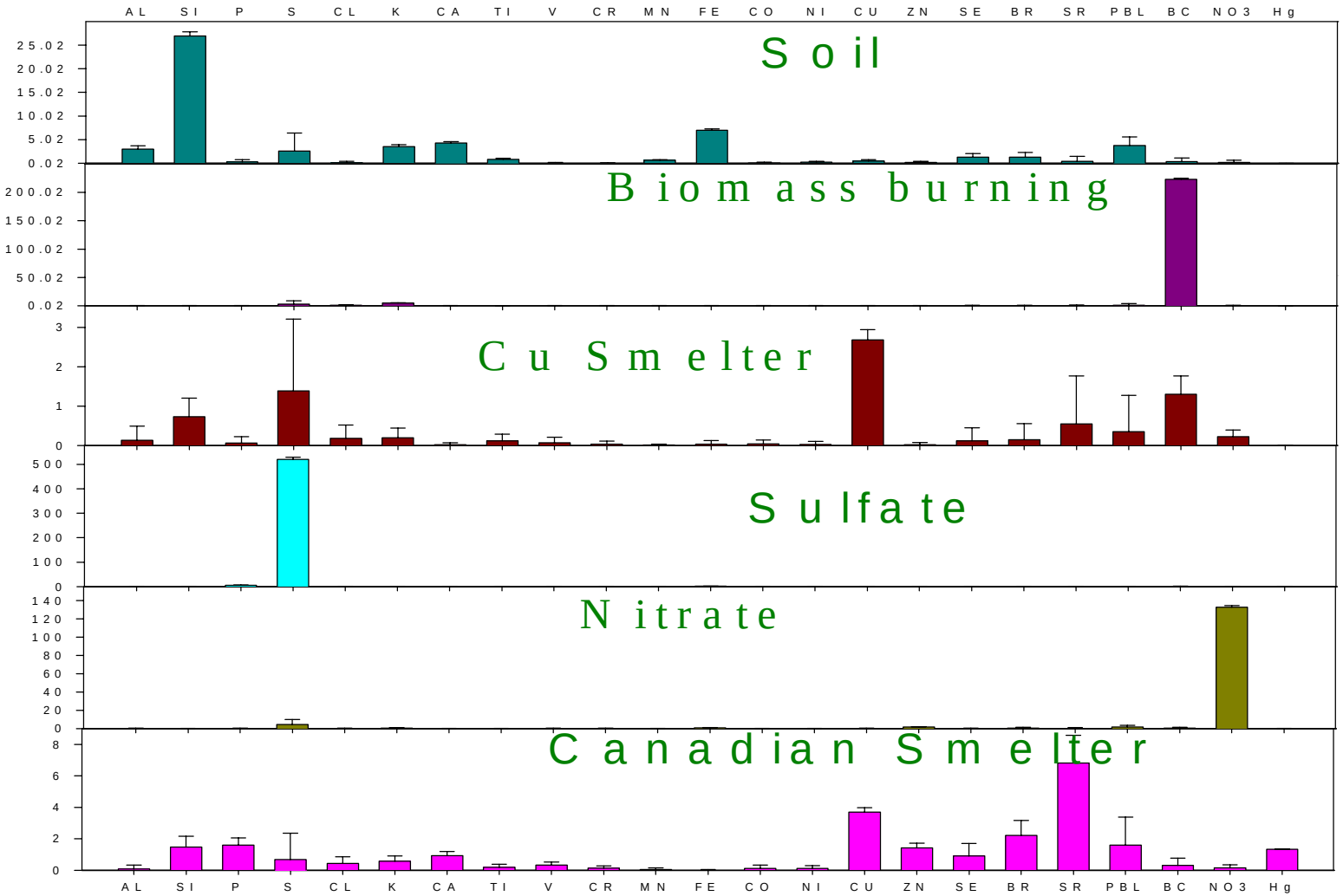
- Least squares approach to solving the factor analysis problem
- Individual data point weights
- Imposition of natural and other constraints.

Preliminary PMF Results

- Only the data from 2000 have been examined to date.
- Not yet included PAH data.

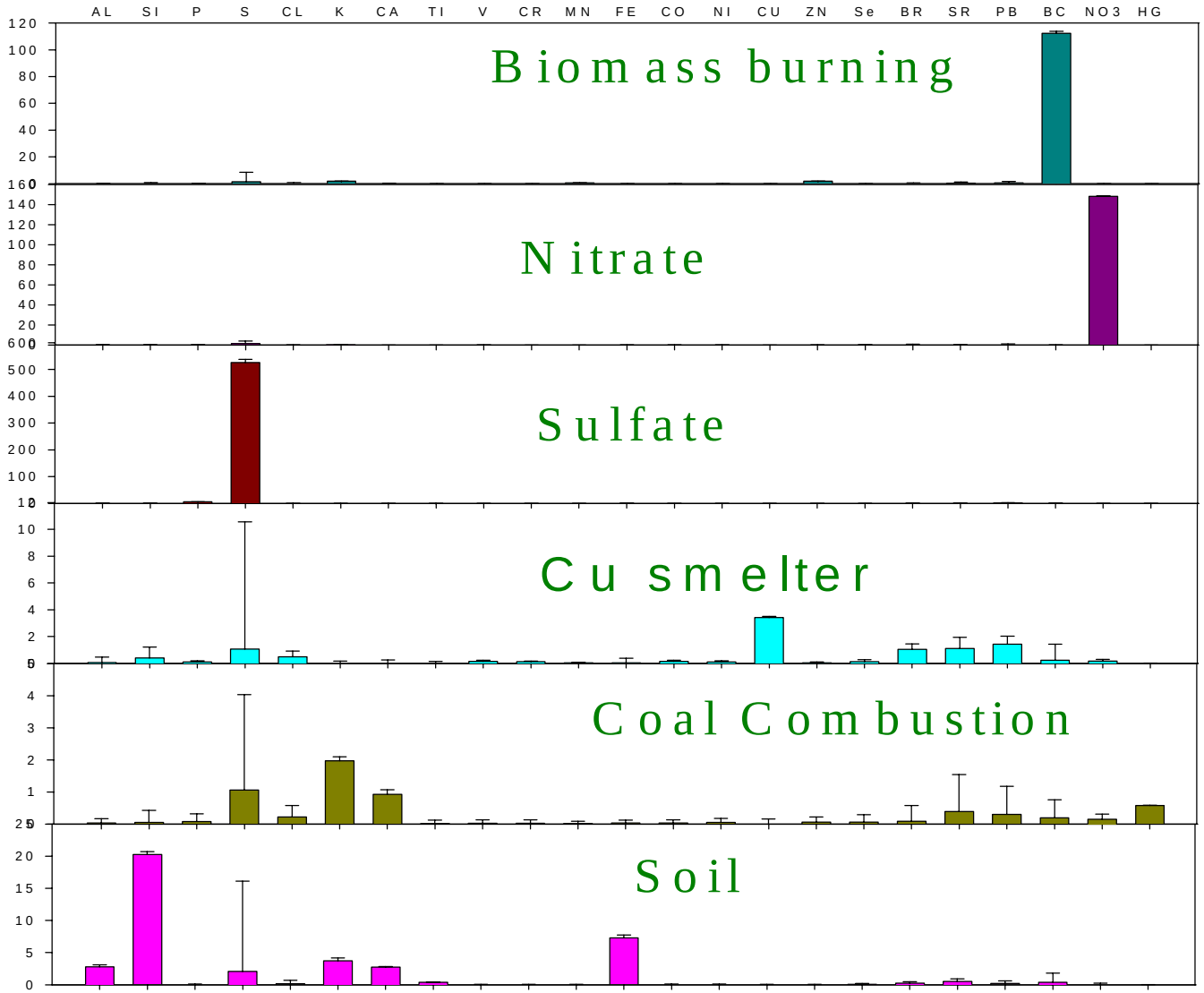
2. Source profiles

Potsdam : 6 factors

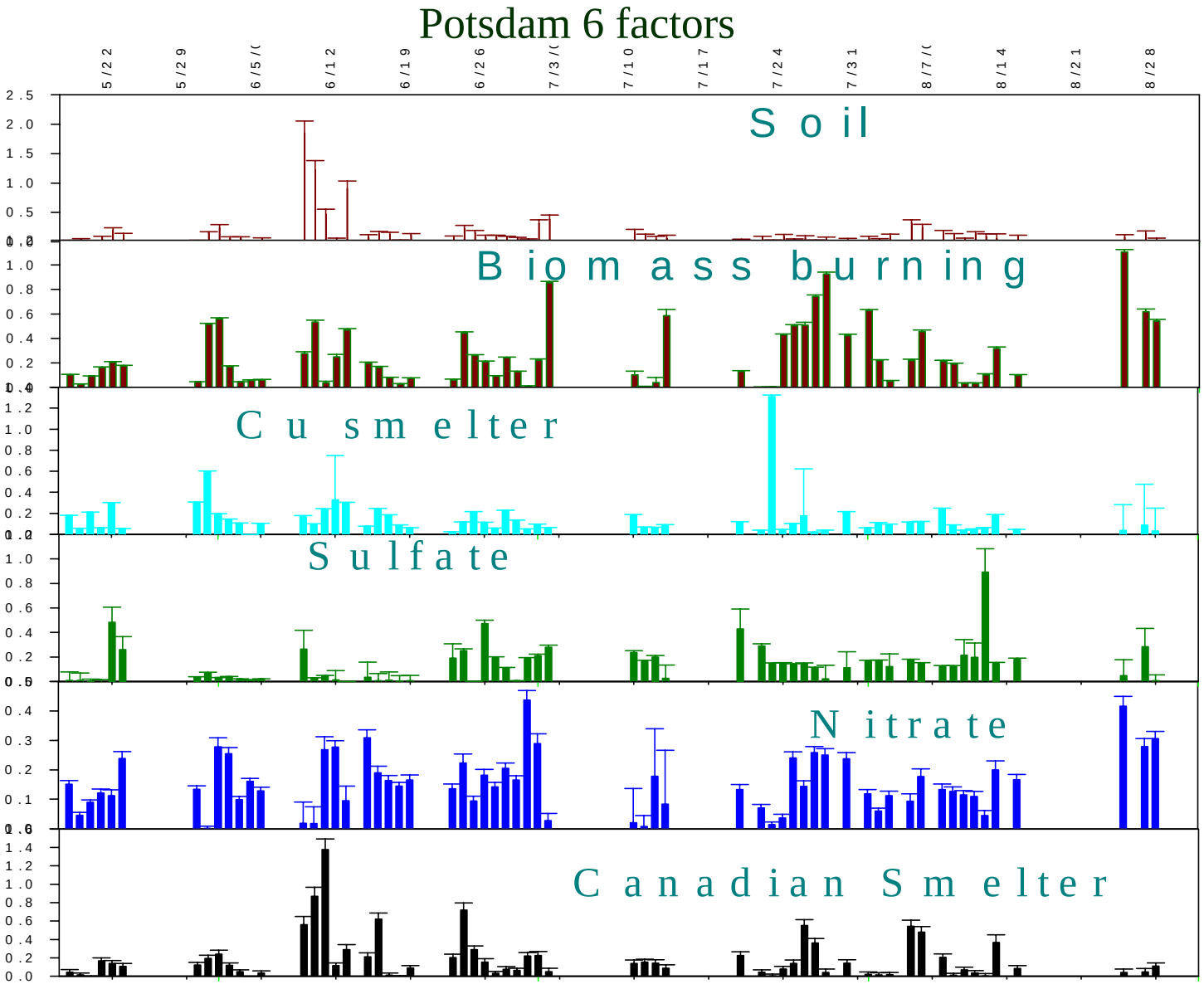


Source profiles

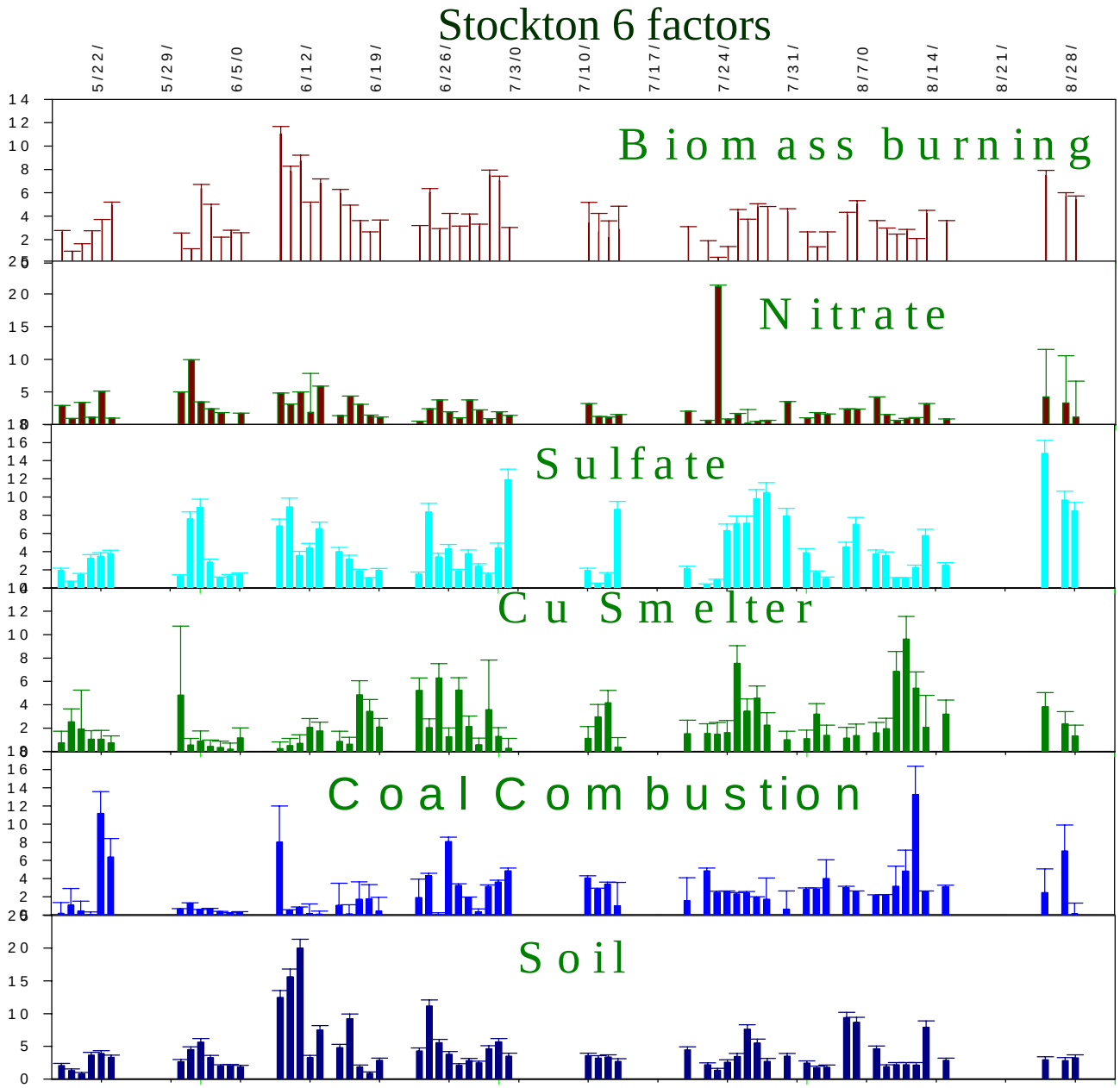
Stockton: 6 factors



2. Source Contribution



2. Source Contribution

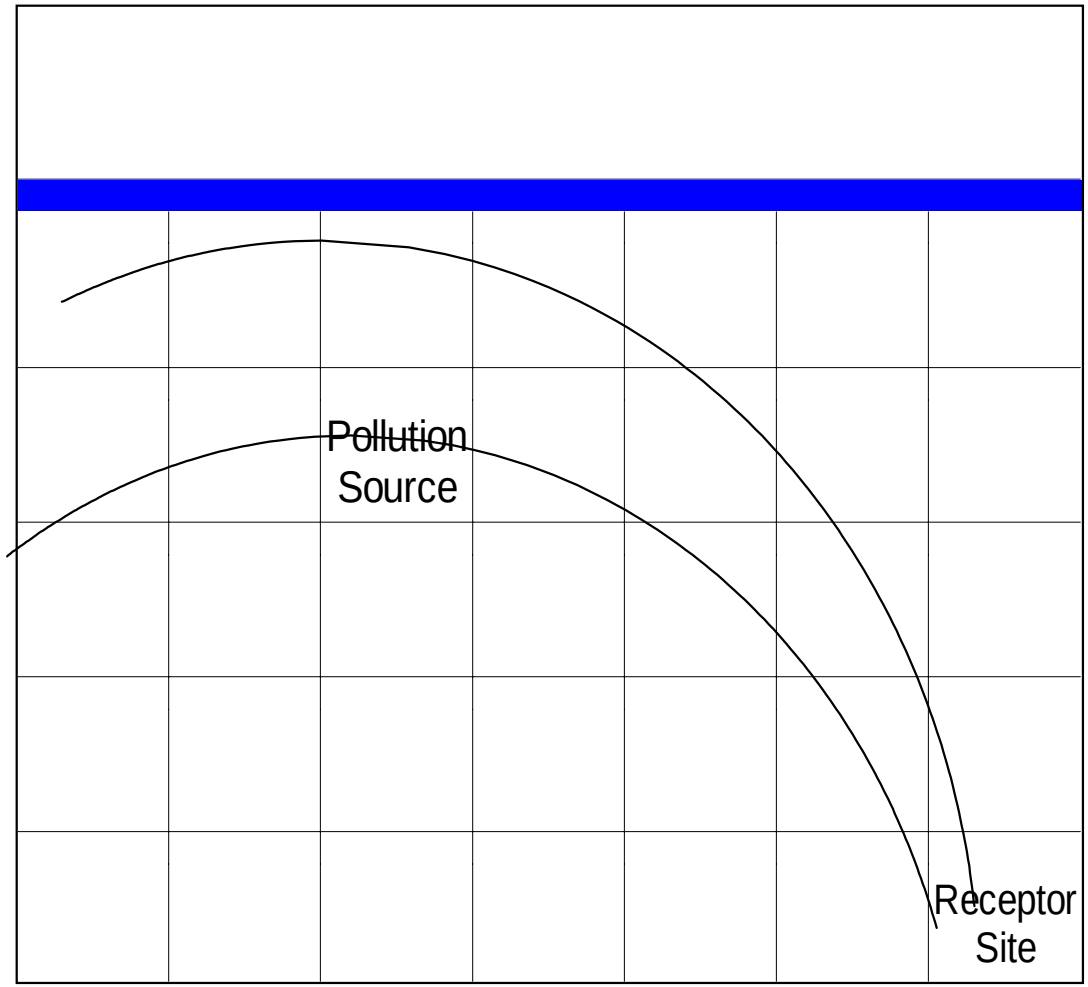


Data analysis 2:
Potential Source Contribution Function

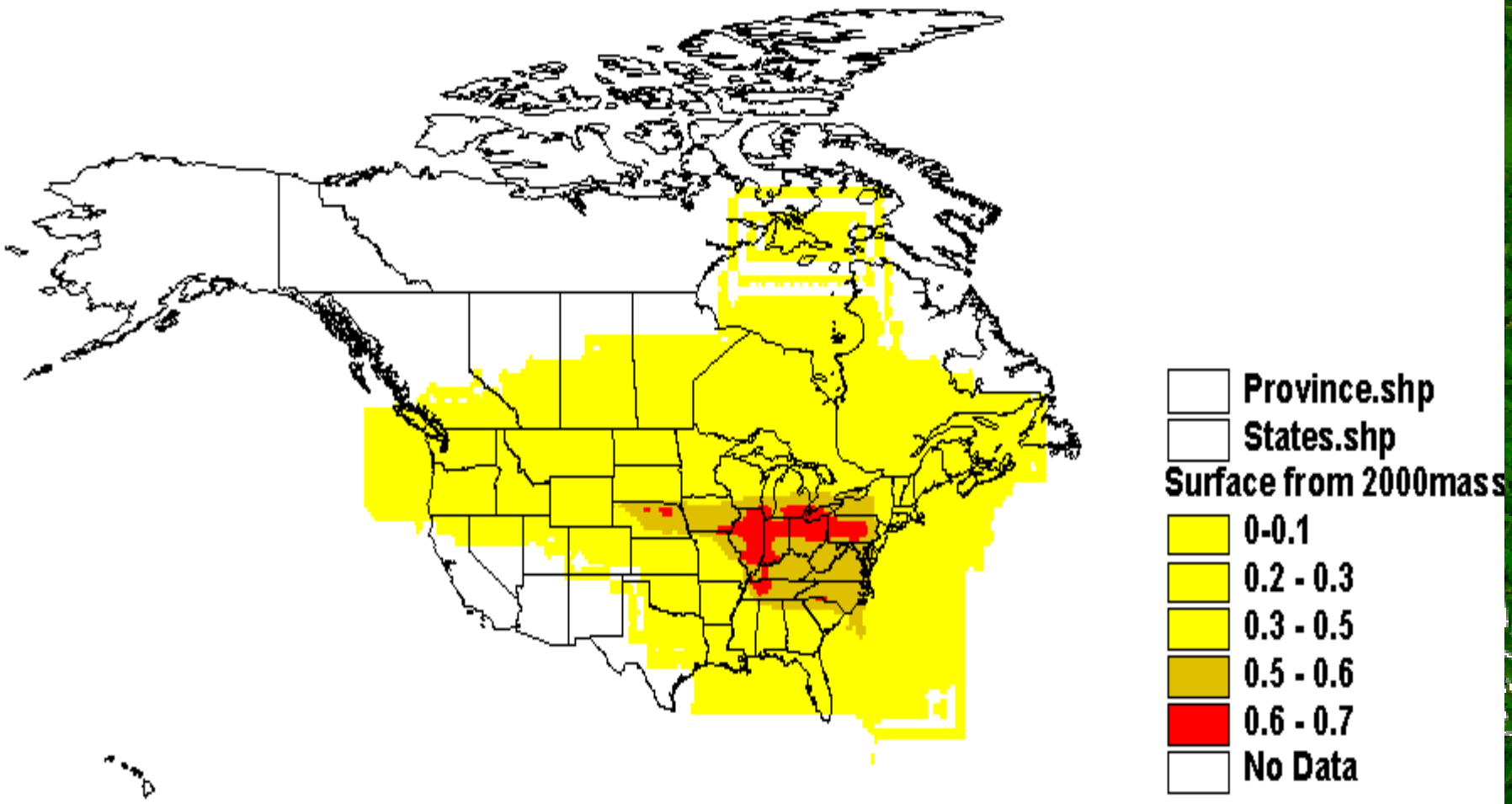
$PSCF_{ij} =$

$P[B_{ij}] / P[A_{ij}] =$

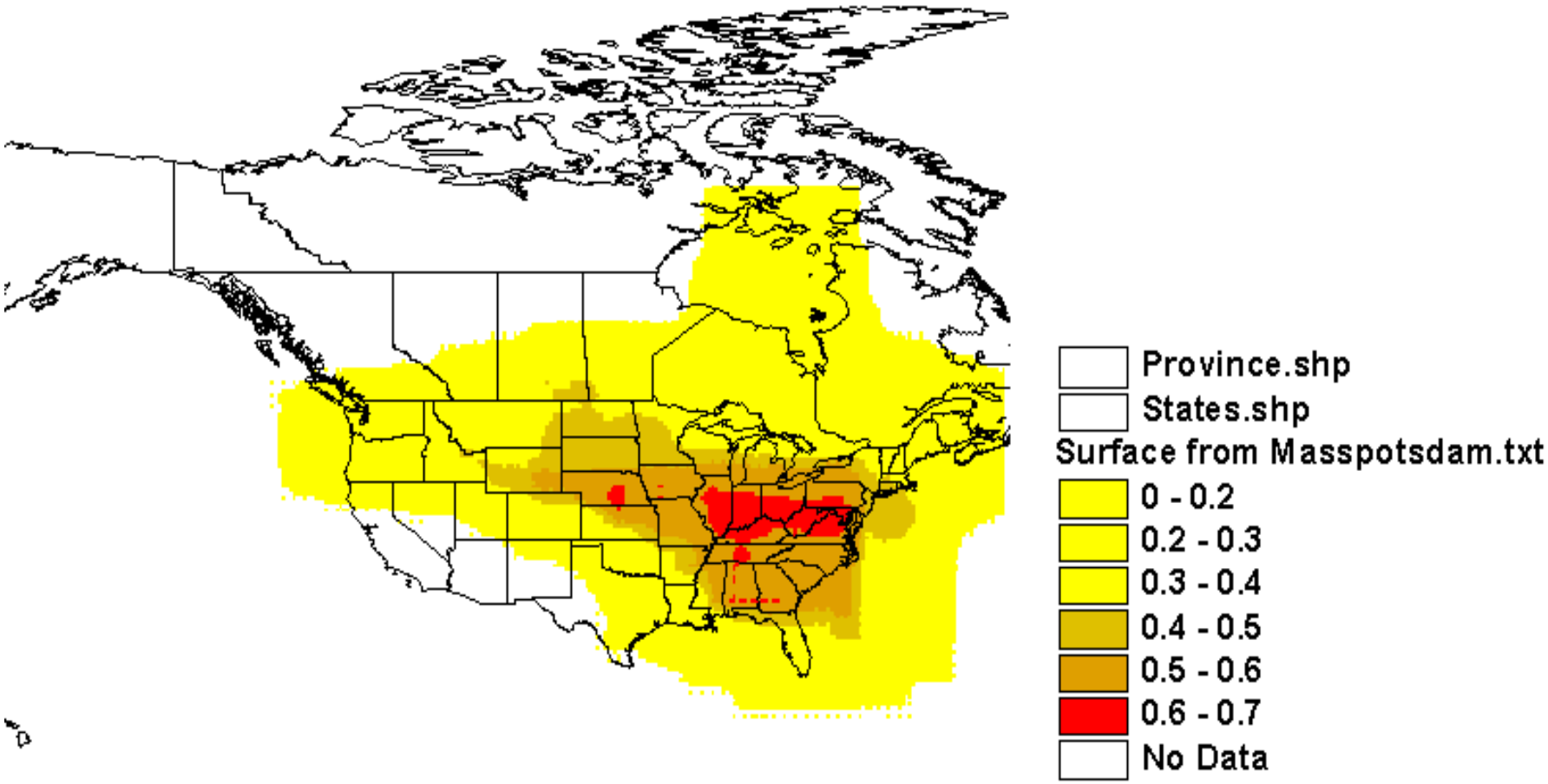
m_{ij} / n_{ij}



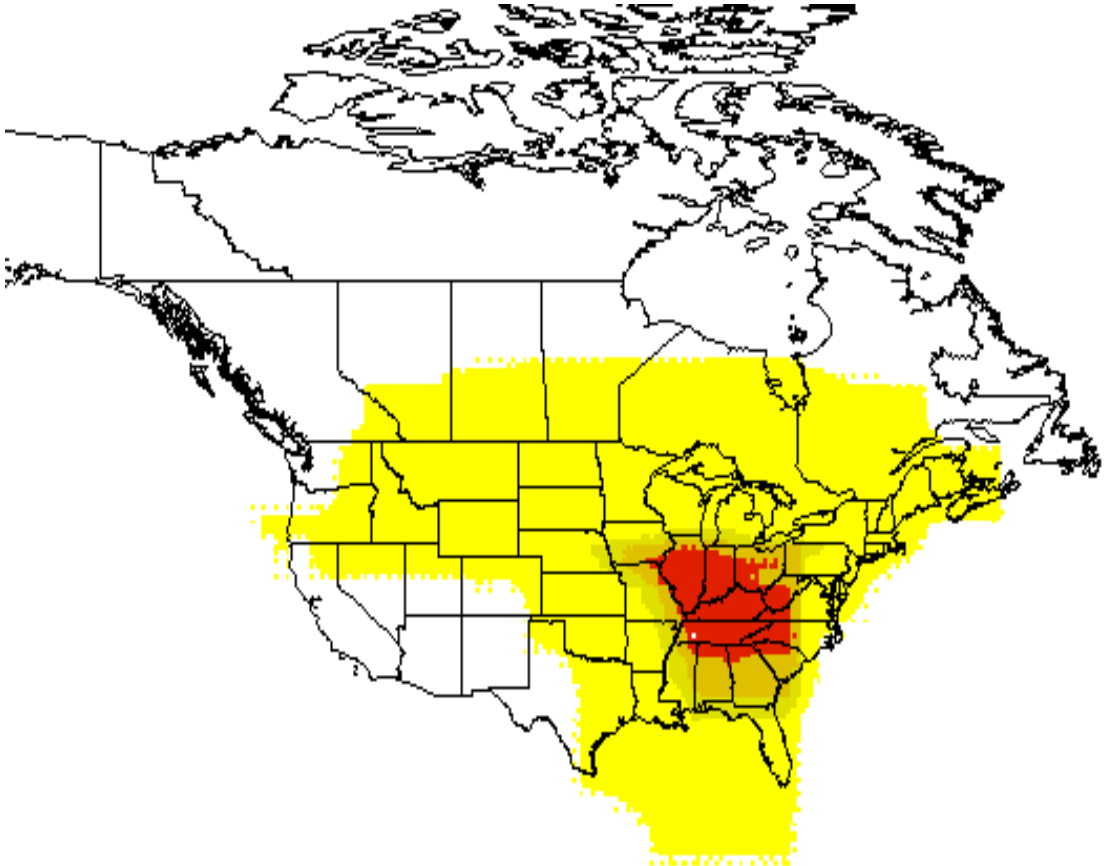
PSCF Results
Potsdam 2000mass



Potsdam 2000&20001mass

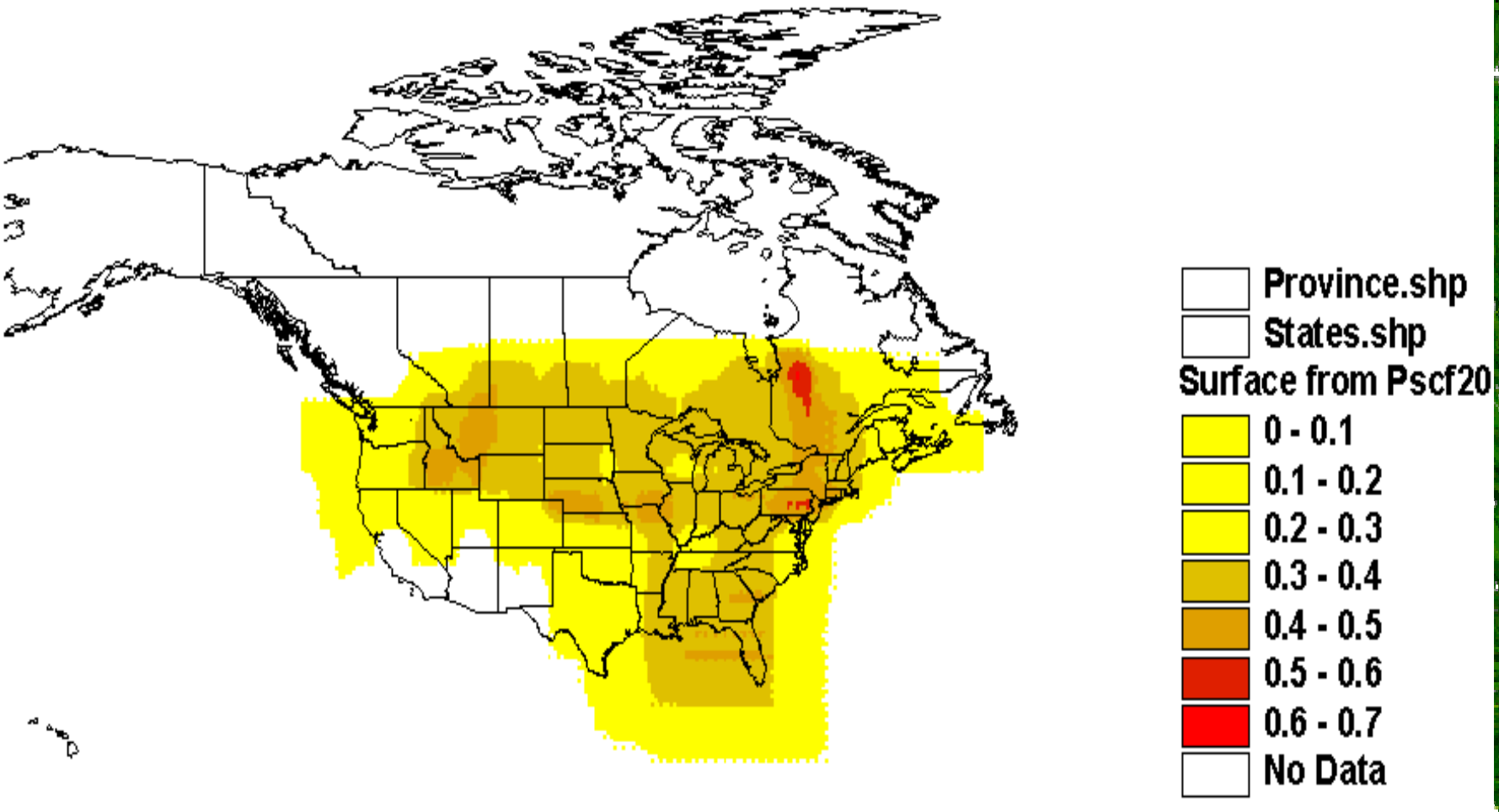


Stockton 2000 S



Province.shp
States.shp
Surface from Pscf5.txt
0 - 0.2
0.2 - 0.3
0.3 - 0.4
0.4 - 0.5
0.5 - 0.6
0.6 - 0.7
No Data

Stockton 2000Cu



Conclusion

- $PM_{2.5}$ mass and its chemical composition, Hg^0, PAHs were measured in two sites
- PMF was used to trace the source profiles and source contribution
- PSCF was used to trace the source location of some elements
- PMF combined with PSCF is useful in tracing air pollution sources

Future Works

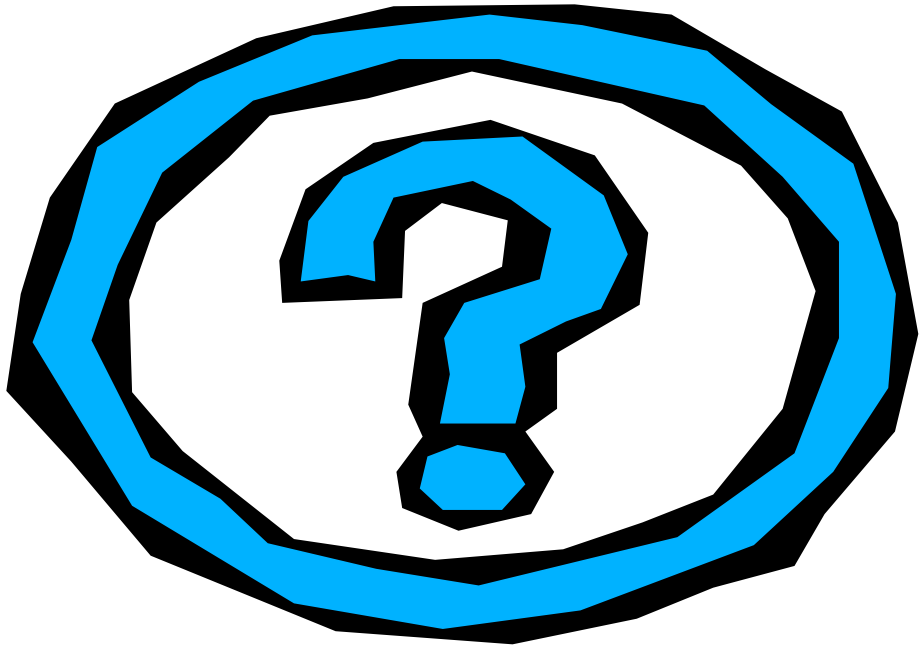
1. PMF with PAHs
2. PSCF to determine source locations from the source profiles determined by PMF
3. Mass apportionment

Ackowledgement

Thank NYSERDA for funding this project

Thank my advisor: Dr. Hopke. for the instruction and help in this project.

Thank Dr. Holsen for the instruction and help during my work.

Thank Young-ji Han for the help during my work.

Thanks to all of them who are helpful for my research:
Dr. Milligan, Scott Cybart, Mike Tambasco