MARAMA’s Speciation Trends Network (STN) Project

The Joint MARAMA/NESCAUM Monitoring Meeting

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Goal of the STN Project

…gain an understanding of the nature and extent of PM$_{2.5}$ pollution in the MARAMA Region…
Specific Objectives of the Project

- Identify the 20 “cleanest” and “dirtiest” PM$_{2.5}$ episodes during the 2000-2003 period
- Determine the composition of the PM$_{2.5}$ mass during these episodes
- Explore how composition varies by season and location
- Provide basic meteorological information about episodes (surface observation maps and back trajectories) (This is an optional task)
- Provide STN data to our members in a “user friendly” format
A Look at FRM Time Series Revealed Episodic Behavior…

Average FRM Measurements for 9 MARAMA Cities, Jul-Sep, 2001
Episodic Behavior Occurs Regardless of Season…

Average FRM Measurements for 9 MARAMA Cities, Oct-Dec, 2001
Episodes can be Selected by Severity and Duration

Average FRM Measurements for 9 MARAMA Cities, Jul-Sep, 2001
Collaborating on the Episodes

- We realize modelers and data analysts around the region are analyzing various episodes.
- We would like to collaborate with you!
- Please let us know which episodes you would like us to analyze.
Calculating the Mass of PM$_{2.5}$ Species using STN Data is Challenging...
Source of the STN Data

- State and local agencies
- EPA Region 3
- STN files posted on the Internet at:

http://www.epa.gov/ttn/airs/airsaqs/detaildata/downloadaqsaqsdatal.html
Analyzing STN Data

- We were aware of some of the QA and uncertainty issues associated with STN data.

- So, we held some conference calls with EPA, RTI and others to explore these issues.

- Some of the issues discussed were:
  - Blank corrections
  - Minimum Detection Limits (MDLs)
  - Missing and flagged data
  - Methods for reconstructing PM mass
### STN Data & STN Blanks in the MARAMA Region

<table>
<thead>
<tr>
<th></th>
<th>Measurements (µg/m³)</th>
<th>Blank Values (µg/m³)</th>
<th>% Avg. Blank to Avg. Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Max.</td>
<td>Min.</td>
</tr>
<tr>
<td>Ammonium</td>
<td>2.02</td>
<td>13.8</td>
<td>0.029</td>
</tr>
<tr>
<td>Elemental Carbon</td>
<td>0.75</td>
<td>8.93</td>
<td>0.24</td>
</tr>
<tr>
<td>Nitrate</td>
<td>1.69</td>
<td>19.2</td>
<td>0.05</td>
</tr>
<tr>
<td>Organic Carbon</td>
<td>4.68</td>
<td>73.9</td>
<td>0.02</td>
</tr>
<tr>
<td>Potassium</td>
<td>0.96</td>
<td>3.43</td>
<td>0.03</td>
</tr>
<tr>
<td>Sodium</td>
<td>0.172</td>
<td>3.84</td>
<td>0.03</td>
</tr>
<tr>
<td>Sulfate</td>
<td>5.16</td>
<td>35.9</td>
<td>0.023</td>
</tr>
<tr>
<td>Total PM2.5 Mass</td>
<td>14.2</td>
<td>239</td>
<td>0.69</td>
</tr>
</tbody>
</table>
Many researchers have identified the need to blank correct STN organic carbon (OC) measurements. We have briefly examined two approaches:
- Averaging blank data for specific sites, and
- The regression technique suggested by Tolocka et al.
OC Blank Corrections: The “Averaging the Blanks” Approach

OC Blank Time Series, Lawrenceville, PA (AIRS 420030008)

Possible Outlier
OC Blank Corrections: The Regression Approach

OC Mass vs. Total PM2.5 Mass, Lawrenceville, PA (AIRS 420030008)

$y = 0.1501x + 1.9687$

$R^2 = 0.5015$
# OC Blank Corrections: Comparison of the Two Approaches

<table>
<thead>
<tr>
<th>AIRS#</th>
<th>Site</th>
<th>State</th>
<th>Regression</th>
<th>Average OC Blank</th>
</tr>
</thead>
<tbody>
<tr>
<td>420030008</td>
<td>Lawrenceville</td>
<td>Allegheny Co.</td>
<td>Intercept</td>
<td>1.97</td>
</tr>
<tr>
<td>371190041</td>
<td>Mecklenburg</td>
<td>NC</td>
<td>Intercept</td>
<td>2.23</td>
</tr>
<tr>
<td>371070004</td>
<td>Lenoir</td>
<td>NC</td>
<td>Intercept</td>
<td>0.25</td>
</tr>
<tr>
<td>340390004</td>
<td>Union</td>
<td>NJ</td>
<td>Intercept</td>
<td>2.45</td>
</tr>
<tr>
<td>420010001</td>
<td>Arendtsville</td>
<td>PA</td>
<td>Intercept</td>
<td>1.56</td>
</tr>
<tr>
<td>420270100</td>
<td>State College</td>
<td>PA</td>
<td>Intercept</td>
<td>1.40</td>
</tr>
<tr>
<td><strong>Averages</strong></td>
<td></td>
<td></td>
<td><strong>Regression</strong></td>
<td><strong>1.64</strong></td>
</tr>
</tbody>
</table>

Outliers have not been removed.
An Important Issue Associated with Reconstructing PM$_{2.5}$ Mass

DRI “Traditional” Reconstructed Mass Equation

1. Unidentified = Measured Mass - Reconstructed Mass
2. Geological = AVERAGE (AlO+AlO2)+SiO2+CaO+AVERAGE(FeO+FeO2) = 1.89*Al + 2.4*Si + 1.4*Ca + 1.43*Fe
3. Organics = 1.4*OC [Used to be 1.2*OC, can be 2.1*OC]
4. Soot = EC
5. Nitrate = Nitrate
6. Sulfate = Sulfate
7. Ammonium = Ammonium
8. Salt = 1.65*Cl (XRF)
9. Trace Elem. = SUM (XRF Measured Species) - (Al+Si+Ca+Fe+S+Cl)
10. Reconstructed Mass = SUM (Items 2-9)
Some Questions Regarding OC Mass

- Is it important to blank correct OC mass data if the OC reconstruction factor is so poorly known?
- How can we estimate the OC factor for a site?
  - If the OC factor varies by season and is a function of weather conditions and emissions, can an average factor for a site be developed?
  - Can PAMS data or other data provide an estimate of the OC factor?
  - Can we “back out” the OC mass if other mass constituents are adequately known?
Deliverables from the MARAMA STN Project
Deliverables

- Excel datasets for each STN monitor in the MARAMA Region, arranged in date order, a column for each analyte.
- A report summarizing the analysis of the data.
Deliverables

- What should be included in the analysis and the final report?
- How should results be presented?
Episode Analysis

Average FRM Measurements for 9 MARAMA Cities, Jul-Sep, 2001

Concentration (ug/m³)

PM2.5 Species, 8/2-12/01, Baltimore, MD (AIRS 240053001)
Weather Maps and Back Trajectories

Surface observations with fronts and pressures

HYPLIT back trajectories

HYPLIT model output courtesy of Bill Ryan, Penn State University
**Time Series**

Time series plots showing how analytes vary over time.

Lawrenceville, PA time series courtesy of Jason Maranche, Allegheny County Health Department
PM$_{2.5}$ Composition by Region and Season

Sample figure from “Particulate Matter Science for Policy Makers – A NARSTO Assessment”
We value your input!