Development of a Local-Scale Emissions Inventory for the Cleveland Multiple Air Pollutant Study

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Presentation Outline

• Project background
• Emissions inventory development
  – Overview
  – Development steps
  – Emissions modeling
• Summary of results
• Questions and discussion
The Cleveland Multiple Air Pollutant Study (CMAPS) is a year-long measurement and modeling study designed to investigate sources of air pollution in the Cleveland metropolitan area.

**Partners include**

- EPA Office of Research and Development (ORD)
- Cleveland Division of Air Quality (CDAQ)
- Akron Region Air Quality Management District
- Ohio EPA
- Contractors (Alion and Sonoma Technology)
CMAPS Background (2 of 4)

Technical Approach

- Year-long (9/2009–9/2010) PM and Hg measurements at 1 background and 3 urban sites
- Two intensive monitoring periods (9/2009 & 2/2010) to measure additional pollutants (CO, SO₂, BC, NH₃, etc.)
- Intensive periods include the placement of passive monitoring devices at 20 fire stations
- Meteorological measurements collected at a site in Industrial Valley
Technical Approach

- Receptor modeling with Chemical Mass Balance (CMB), Positive Matrix Factorization (PMF), and Unmix
- Photochemical grid modeling with WRF and CMAQ

CMAQ Emissions Inputs

- Update the 2005 NEI to make the inventory more representative of the CMAPS study period, capturing effects of recent economic downturn
- Focus on key sources in Cleveland and the region (e.g., industrial sources, power plants, on-road mobile sources)
CMAPS Background (4 of 4)

SO$_2$ pollution roses show impact of power plants and industrial sources

NO$_2$ pollution rose shows impact of roadways and industrial sources
Point sources

- 21 key Cleveland facilities
  - Identified by CDAQ and EPA
  - Invited to March meeting at CDAQ
  - Follow-up survey by phone and email
  - Data collected from 17 of 21 facilities
Point sources

- Regional power plants
  - Focus on OH and western parts of PA and WV (52 facilities)
  - Obtained monthly $\text{SO}_2/\text{NO}_x$ emissions and heat input for 2009 and 1st quarter of 2010 from EPA’s Clean Air Markets Division (CAMD) database
Point sources

- Regional power plants
  - Scaled emissions for Hg and other pollutants on the basis of heat input
  - Reduced Hg$^{2+}$ emissions by 95% for units with wet FGD systems installed since 2005
On-road mobile sources

- Acquired 2009 travel demand model outputs from the Northeast Ohio Areawide Coordinating Agency (NOACA)
- Used TDM VMT data to update MOVES county database and develop 4-km spatial allocation factors (SAFs)
- Updated MOVES met data for Cuyahoga County
- Ran MOVES for all counties in the 4-km modeling domain
Non-road mobile sources

- Analyzed 2005 NEI to determine key sources (marine vessels, construction equipment, locomotives)
- Contacted Port of Cleveland, railroads, and Cleveland Planning Department
- Only port data was obtained in time for use in developing EI

<table>
<thead>
<tr>
<th>Source</th>
<th>NOx</th>
<th>SO2</th>
<th>PM2.5</th>
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<tbody>
<tr>
<td>Commercial equipment</td>
<td>4,322</td>
<td>634</td>
<td>155</td>
</tr>
<tr>
<td>Recreational boats</td>
<td>2,819</td>
<td>404</td>
<td>75</td>
</tr>
<tr>
<td>Industrial equipment</td>
<td>2,631</td>
<td>170</td>
<td>66</td>
</tr>
<tr>
<td>Locomotives</td>
<td>2,395</td>
<td>177</td>
<td>87</td>
</tr>
<tr>
<td>Construction and mining</td>
<td>1,142</td>
<td>117</td>
<td>75</td>
</tr>
<tr>
<td>Commercial marine vessels</td>
<td>1,009</td>
<td>76</td>
<td>179</td>
</tr>
<tr>
<td>Other</td>
<td>61</td>
<td>77</td>
<td>0</td>
</tr>
</tbody>
</table>

Percentage of non-road emissions:
- NOx: 40%
- SO2: 60%
- PM2.5: 20%
Non-road mobile sources

- During 2009, vessel traffic at the Port of Cleveland was at a 50-year low (91% lower than in 2005)
- 2005 emissions scaled based on vessel calls
- Monthly emissions profile developed from 2009 vessel call data
Starting point

EPA’s 2005-based modeling platform, version 4

- Adjusted 2005 emissions for point, on-road, and non-road sources to account for 2009/2010 activity levels
- Verified the location of key point sources using Google Earth
- Re-projected EPA’s default 4-km surrogates to match the CMAPS modeling domain
- Developed spatial allocation factors (SAFs) for on-road mobile sources based on NOACA’s travel demand model (TDM) outputs
- Development of 1-km surrogates is pending
Emissions Modeling (2 of 2)

- Developed day-specific emissions files for August 2009 and February 2010 for key point sources
- Developed monthly profiles for power plants and commercial marine vessels
- Updated SMOKE’s inventory tables and speciation profiles to include the full range of species to be modeled by EPA

Ran SMOKE to produce CMAQ-ready emissions files for the CMAPS 4-km domain for:

- July 21–August 31, 2009
- January 22–March 2, 2010
Summary of Results (1 of 9)

Key facilities in Cleveland

- August 2009 emissions 39-90% lower than 2005 levels (steel mill and power plant not active in August)
- February 2009 emissions comparable to 2005 levels (±30%)
Regional power plants

- SO₂, NOₓ, and Hg²⁺ emissions during the two intensive months 37%–58% lower than 2005 levels
Summary of Results (3 of 9)

On-road mobile sources

• Significant reductions in CO, SO₂, and VOC compared to 2005 National Emissions Inventory (NEI)

• Slight decrease in NOₓ and actual increases in PM

• Consistent with other comparisons of MOBILE6 and MOVES
Summary of Results (4 of 9)

Port of Cleveland

- Significant reductions in vessel calls, cargo tonnage between 2005 and 2009
- Emission reductions of 77% for NO\textsubscript{x}, 34% for SO\textsubscript{2}, and 62% for PM\textsubscript{2.5}
- No vessel calls at port in winter months (Jan–Mar)
Summary of Results (5 of 9)

Daily NO\textsubscript{x} emissions for August 2009 and February 2010
Summary of Results (6 of 9)

Daily SO$_2$ emissions for August 2009 and February 2010
Summary of Results (7 of 9)

Daily PM$_{2.5}$ emissions for August 2009 and February 2010
Summary of Results (8 of 9)

Emissions density plots for August 1, 2010
Recap and next steps

• Updated Cleveland emissions inventory was developed for point sources, on-road mobile sources, and commercial marine vessels.

• CMAQ-ready inputs for 4-km modeling domain were prepared for August 2009 and February 2010.

• 1-km domain for metropolitan Cleveland may be required to resolve local-scale pollutant gradients.
Questions and Discussion

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