The New Ozone Standard

Preliminary Screening Modeling by the OTC

There is Hope !!!

MARAMA Meeting, September 28, 2010
Participants in this Effort

- NJDEP/ORC
- UMD/MDE
- NYSDEC
- MARAMA
- OTC
- Collaboration with EPA
Topics Covered

• The Screening Modeling
  – Model set-up and performance
    • Discussed earlier
  – Sensitivity Runs
    • 2 across the board runs
    • 1 OTC Strategy Run (National and local controls being pursued by OTC)

• The critical role of federal measures
Modeling Approach

• 2007 Meteorology replicated by WRF
• Man-made Proxy Emissions:
  – Actual 2007 for point and non-road sources within MANE-VU
  – Other point sources from EPA CHIEF 2005 Platform
  – Remaining source sector emissions were interpolated from 2002 and 2009 inventories from 2002 SIP platform
• 2007 Natural emissions based on MEGAN
• Photochemical model – CMAQv4.7 with CB5 chemistry
• Modeling domain: 12 km Eastern U.S.
• Boundary conditions always kept at “clean” background levels
• Modeling period: April 1 – October 31 for base case
Domain-wide NOx Emissions*
2007 Proxy Inventory

*Tons per Year

- Area
- Onroad
- Nonroad
- Non-EGU Point
- EGU Point

*Includes MOVES adjustments to MOBILE6 emissions
• MOVES emissions are 60-80 % higher than Mobile-6
• MOVES emissions based on EPA provided data to approximate MOVES model output
Domain-Wide VOC Emissions

2007 Proxy Inventory

Major Source Sector:
- Biogenic
- Total Anthropogenic
- Area
- Nonroad
- Mobile
- Point
• Man-made VOC emissions are dominant in urban areas
• Natural VOC emissions are dominant in forested areas, especially in the south
Model Performance

*Discussed in Previous Presentation*
## Summary Model Performance Statistics for Daily Maximum 8-hour Ozone

<table>
<thead>
<tr>
<th>Region</th>
<th>Data Pairs</th>
<th>Mean Observed</th>
<th>Mean Model</th>
<th>Mean Bias (ppb)</th>
<th>Mean Error (ppb)</th>
<th>Normalized Mean Bias (Percent)</th>
<th>Normalized Mean Error (Percent)</th>
<th>Root Mean Square Error (ppb)</th>
<th>Correlation Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domain-wide</td>
<td>115,712</td>
<td>49.7</td>
<td>51.9</td>
<td>2.2</td>
<td>9.5</td>
<td>4.4</td>
<td>19.2</td>
<td>12.4</td>
<td>0.7</td>
</tr>
<tr>
<td>OTC States</td>
<td>39,320</td>
<td>47.6</td>
<td>52.7</td>
<td>5.0</td>
<td>10.3</td>
<td>10.6</td>
<td>21.5</td>
<td>13.4</td>
<td>0.73</td>
</tr>
</tbody>
</table>

- Model performance is within the range of previous studies
Very Preliminary Screening Modeling

• Very rough, preliminary OTC “Screening” modeling – Many thanks to NYDEC and UMD
• From a 2007 Base
• Three scenarios
  – A lower bound - 50% NOx and 30% VOC cuts across all states and all sectors in domain
  – An upper bound - 70% NOx and 30% VOC cuts across all states and all sectors in domain
  – OTC Strategy Run
    • Tried to mimic federal rules and local controls being pursued by the OTC
      – “Top 6” Federal Measures across domain
        » 65% cut to stationary NOx
        » 75% cut to on-road mobile NOx
          (includes post-2007 Tier II benefits)
        » 35% cut to area NOx
        » 30% VOC
        » In total about a 55% NOx and 30% VOC run
      – Additional 5% NOx in all OTC states
The Priority Source Categories for Federal Rules

- EGUs
- Tougher On-Road Vehicle Standards
- ICI Boilers
- Cement Kilns
- Marine Engines
- Locomotives

? Represent ...
  - 75 % of the NOx left to regulate
  - 85 % of the SO2 left to regulate
  - 75 of the 2005 Hg emissions
• “Scenario 3” approximates an overall 55% NOx reduction
• Includes MOVES adjustments to MOBILE6 emissions
All screening runs reduce VOC emissions by 30%.
Includes MOVES adjustments to MOBILE6 emissions
Results

N50V30, N70V30, and “Scenario 3” Simulations

June 1 – August 31
• Ozone reductions from “Scenario 3” run fall between those from the across-the-board reduction simulations
• NO\textsubscript{x} focused emission reductions show less benefit for urban core areas
Differences in Relative Ozone Reductions

N70V30 Minus N50V30

Scenario 3 Minus N50V30

For most of the OTR, “Scenario 3” provides more than 50% of the additional benefit of N70/V30 compared to N50/V30.
• In N50/V30 across-the-board reductions, hot spots remain in urban areas
• Hot spots are further reduced in “Scenario 3” and N70/V30 reduction scenarios
• In N50/V30 across-the-board reductions, hot spots remain in urban areas
• Hot spots are further reduced in “Scenario 3” and N70/V30 reduction scenarios
### Results for Potential Nonattainment Levels
*Inside the OTR*

#### Monitors Above Potential Levels of the New Standard

<table>
<thead>
<tr>
<th></th>
<th>Base Case</th>
<th>N50/V30</th>
<th>N70/V30</th>
<th>“Scenario 3”</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>.080 ppm</strong></td>
<td>69 (36%)</td>
<td>1 (1%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td><strong>.070 ppm</strong></td>
<td>167 (86%)</td>
<td>16 (8%)</td>
<td>1 (0%)</td>
<td>1 (0%)</td>
</tr>
<tr>
<td><strong>.065 ppm</strong></td>
<td>186 (96%)</td>
<td>55 (29%)</td>
<td>4 (2%)</td>
<td>12 (6%)</td>
</tr>
<tr>
<td><strong>.060 ppm</strong></td>
<td>191 (98%)</td>
<td>101 (53%)</td>
<td>15 (8%)</td>
<td>29 (15%)</td>
</tr>
<tr>
<td>Monitors in OTR</td>
<td>194</td>
<td>190</td>
<td>190</td>
<td>190</td>
</tr>
</tbody>
</table>
## Results – Toughest Monitors in the East

<table>
<thead>
<tr>
<th>NON ATTAINMENT AREAS</th>
<th>Monitored Design Value</th>
<th>After 50% NOx &amp; 30% VOC Run</th>
<th>After 70% NOx &amp; 30% VOC Run</th>
<th>After OTC Strategy Run</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>New York</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Bayonne</td>
<td>85</td>
<td>81</td>
<td>74</td>
<td>78</td>
</tr>
<tr>
<td>- NYC/Queens</td>
<td>77</td>
<td>72</td>
<td>67</td>
<td>69</td>
</tr>
<tr>
<td><strong>Philadelphia</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Camden</td>
<td>88</td>
<td>75</td>
<td>65</td>
<td>68</td>
</tr>
<tr>
<td>- Bristol</td>
<td>90</td>
<td>76</td>
<td>64</td>
<td>67</td>
</tr>
<tr>
<td><strong>Cleveland/A/L</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mayfield</td>
<td>79</td>
<td>74</td>
<td>64</td>
<td>71</td>
</tr>
<tr>
<td>- Eastlake</td>
<td>79</td>
<td>72</td>
<td>62</td>
<td>69</td>
</tr>
<tr>
<td><strong>Columbus</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Albany HS</td>
<td>84</td>
<td>71</td>
<td>62</td>
<td>67</td>
</tr>
<tr>
<td><strong>Washington</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- River Terrace</td>
<td>83</td>
<td>70</td>
<td>59</td>
<td>62</td>
</tr>
<tr>
<td><strong>Baltimore</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Edgewood</td>
<td>91</td>
<td>68</td>
<td>55</td>
<td>59</td>
</tr>
</tbody>
</table>
Results for Potential Nonattainment Levels

*OTC Strategy Run/Domain-wide*

The modeling looked at 309 specific monitoring sites. After the OTC Strategy Run:

- 99% are below a 70 ppb standard
- 94% are below a 65 ppb standard
- 80% are below a 60 ppb standard
Preliminary Conclusions

• There is hope !!!
• An aggressive suite of local controls in combination with an equally aggressive package of national controls to reduce transport takes us a long way to meeting the new ozone standard
Additional Weight-of-Evidence on Why Federal Measures Will Help

• The Priority Source Sectors
  – EGUs
  – Tougher On-Road Vehicle Standards
  – ICI Boilers
  – Cement Kilns
  – Marine Engines
  – Locomotives
• The 75/85/75 argument
• Pushing very good controls and a multi-pollutant approach
• Why? ... What’s Our Logic?
Understanding How Transport Really Works

Ozone as an Example

The Transport Cloud ... or the Elevated Ozone Reservoir

- Every bad ozone day, in the morning hours, a large cloud or reservoir of ozone sits above Maryland and the Mid-Atlantic area waiting to mix down.
  - Based upon real, measured data
  - Ozone levels in the reservoir are routinely measured at 60 to 100 ppb.
  - In the morning, ozone levels at the surface are very low (10 to 20 ppb).
- Around 10:00 or 11:00 – when the nocturnal inversion breaks down - the ozone (and any precursors) in the reservoir mix down to the surface and degrade air quality.

Source: Maryland Department of the Environment & Howard University
The Transport Cloud
A Regional Cloud of Pollution - Crashing Down to Earth

Aloft Ozone Reservoir (June 13, 2008)

1. Elevated Reservoir Before Inversion Break
2. Inversion Breaks The Regional Signal
3. Local and Regional Pollution Combined

Measured ozone at aloft monitors in the 60 to 90 ppb range all night long.

All monitors, ground level and aloft, record ozone levels that are almost identical to what was measured all night long at the aloft monitors.

Source: Maryland Department of the Environment
How Do We Reduce the Transport Cloud?

• The NOx SIP Call as an example
  – OTAG collaboration in late 90’s
  – EPA finalizes SIP Call in 1998
  – Very significant regional NOx reductions across the East in the 2003/2004 timeframe
  – Dramatic drops in ozone levels

• Similar story for SO2 controls and PM
**Controls From the NOx SIP Call**

- **77.8% of Units Installed between 2003-2007**

**Phase I**
- Minimal SCR Units
- Expect Minimal NO\textsubscript{x} Reductions

**Phase II**
- Large Number of SCR Units Installed
- Expect SIGNIFICANT NO\textsubscript{x} Reductions Especially after 2003-2004
- Air Quality should decrease dramatically

Data courtesy of The Institute of Clean Air Companies (ICAC).
Regional NOx Emission Reductions

- Dramatic regional NOx emission reductions in the 2003/2004 time frame
- NOx reductions from Tier II/LEV II standards also – very gradually - occurring in this same period

*NOx Reductions at NOx Budget Program Sources*

Thanks: EPA Clean Air Markets
Reducing O3 in the Transport Cloud

Average ozone levels in the elevated reservoir before 2004

Average ozone levels in the elevated reservoir after 2004

Approximately 25% Decrease in Ozone Concentrations

Pre/Post NOx SIP Call Benefits
Methodist Hill, PA (2218 Feet above MSL, May-September)

Graph generated by Maryland Department of the Environment

Time (EST)
Reducing Regional NOx Emissions Works

The 6 Priority Categories Represent About 75% of the NOx Left to Regulate
The Fine Particle/SO2 Story

• Similar to Ozone
  – Regional reservoir of SO2 and PM dominates the East’s problem
  – Summertime SO2 “westerly” transport dominates Mid-Atlantic PM levels and acts pretty much like Ozone for westerly transport

• However ...
  – More complex chemistry
  – Different behavior at night

• Little debate over the regional nature of SO2 piece of the PM problems in the East
Eastern State - SO$_2$ Controls

- Some controls driven by Title IV
- Some controls driven by early CAIR

Source: EPA Clean Air Markets
SO2 Emission Reductions

Thanks: EPA Clean Air Markets
Reducing Regional SO2 Emissions Works

The 6 Priority Categories Represent About 85% of the NOx Left to Regulate
What Has This Meant to Maryland?

1-Hour Ozone

8-Hour Ozone

Annual Fine Particulate

Daily Fine Particulate

*2008 data are preliminary.
Just a Little on the Mercury Story

• Another Major Issue to the States
  – Joint effort between state water and air programs

• 319 G Process initiated by Northeast states just beginning

• Moving towards 4 State/Federal Partnership efforts
  – National and local controls
  – Product stewardship
  – Global/International efforts
  – Communications
Clearly a National Problem

Status of Mercury 303(d) Listings and TMDLs
May 2010

Thanks: EPA 319G Meeting

The 6 Priority Categories Represent About 75% of the 2005 national Hg emissions.

- Coal-fired utility boilers: 50.9%
- Boilers & process heaters: 15.3%
- Portland cement: 7.3%
- Electric arc furnaces: 7.1%
- Hazardous waste incineration: 4%
- Municipal waste combustion: 2%
- Gold mining: 2.4%
- Chlor-alkali plants: 1.1%
- Mobile sources: 1.1%
- Hospital/medical/infectious waste incineration: 0.3%
- Other: 8.2%

103 short tons

Thanks: EPA 319G Meeting
Very Significant Benefits

• Many lives to be saved
  – EPA has estimated the improvements in public health resulting from just the 2004 NOx SIP Call
    • Thousands of lives to be saved
    • Significant health benefits to asthmatics and other individuals with lung disease

• Dramatically help states with old and new Ozone, PM, NO2 and SO2 SIPs

• Multiple other benefits
  – Haze/Visibility, Chesapeake Bay, Mercury, other toxics, etc.
Next Steps

• Continue to develop and adopt new local control programs for the OTR
• Continue to work with EPA and push for very deep, multi-pollutant reductions from priority source sectors
• Continue to refine and improve inventories and modeling