Application of OMI NO2 retrievals to the evaluation of NOx emissions from on-road mobile sources in the Great Lakes Region
Momei Qin1,* , Yongtao Hu1, M. Talat Odman1 and Armistead G. Russell1
1. Georgia Institute of Technology * Now at U.S. Environmental Protection Agency

Results and discussions

Tropospheric NO2 Columns in CMAQ vs. OMI

<table>
<thead>
<tr>
<th>Case</th>
<th>N</th>
<th>Mean Size</th>
<th>Mean Error</th>
<th>Fractional Bias</th>
<th>Fractional Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base</td>
<td>104829</td>
<td>-0.69</td>
<td>0.83</td>
<td>-65%</td>
<td>76%</td>
</tr>
<tr>
<td>50% NO2</td>
<td>104829</td>
<td>-0.68</td>
<td>0.78</td>
<td>-88%</td>
<td>77%</td>
</tr>
</tbody>
</table>

50% NOx emission reduction (US mobile)

- Reduced model-satellite differences in urban areas (i.e., Chicago, Detroit)
- No significant changes in evaluation statistics (MB, ME, r2) compared to the base case

Conclusions

- CMAQ shows low biases in NOx columns/surface concentrations against OMI retrievals/ground-based measurements in rural areas, with high biases in urban areas (not in all locations)
- Decreased emissions from on-road mobile sources in CMAQ reduce differences of CMAQ simulations with OMI retrievals & ground-based measurements at the high end of NOx columns/concentrations in urban areas
- Overestimation of NOx columns in CMAQ relative to OMI occurs in locations where other sources (e.g., EGU) dominate as well, which needs further investigation

Acknowledgements

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References

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Methodology

Model-satellite comparison

CMAQv5.1
- One-way nested: 12 km/4 km (Fig. 1)
- Period of interest: July 2011
- 2011 NEI with in-line calculations for BEIS and point sources
- CB05s1
- Two runs
  - Base case
  - 50% of NOx emissions from mobile sources
- NOx vertical columns calculated using the 4-km simulation between 13:00 and 16:00 EST

Source apportionment of NOx using Decoupled Direct Method (DDM)
- The first-order sensitivity (βx) of NOx concentration to NOx emission from an individual sector reflects contribution of the NOx emission source to overall NOx concentration (with c1c2 of -1):
  \[ C_{12} = C_E = \frac{E_E}{\sum E} = \frac{E_E}{C_E + \Delta C} \]
- On-road, pezu, nonroad, ptnonipm (point sources not included in EGU or oil/gas), c1c2 rail (C1 and C2 commercial marine emissions plus railroad emissions) and biess (i.e., NOx emission)
- Convert to contributions of NOx columns

Compared to ground-based measurements

- Significant underestimation of NOx surface concentrations at the low end in the CMAQ base case; mostly occurs in rural areas, with overestimation at urban & suburban sites at times (Fig. 5)

Conclusions

- CMAQ mostly underestimates NOx concentrations, regardless of location
- Reduction in NOx emissions decreases high biases of CMAQ NOx both in urban/suburban areas and at peaks (Fig. 6)
- Good agreement with measured NOx/NO during the surface during satellite pass-over time

Model-satellite Gap

Fig. 1 Modeling domains

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