Emissions Processing For Long-term Regional Air Quality Modeling

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Abstract

This presentation describes our experiences in creating emission inputs to perform a retrospective 1988 - 2005 regional air quality simulation over the Northeastern U.S. using the SMOKE/MM5/CMAQ modeling system. The approach involved use of inventories from various sources such as the summary files generated from the EPA's national emissions inventory (NEI) database for criteria air pollutants for the years 1990 and 1996 through 2001, EPA's 2001 CAIR modeling inventory, and the inventories prepared for recent air quality modeling under the umbrella of the Ozone Transport Commission (OTC) for 2002 and 2009. We discuss our approach for creating the final CMAQ-ready database for area, nonroad, mobile and point source emissions and present an analysis of sector- and state level emissions over time. We also show preliminary results from CMAQ air quality modeling using this emissions database.

Introduction

- Typically, grid based air quality models are employed to assess air pollution and control strategies for time periods ranging from several days to a year depending on the pollutant.
- Recently there has been increased interest in exploring the potential benefits of performing longer-term air quality simulations to assess trends in air pollution and to examine the link between air pollution and human health.
- Such studies would require long-term meteorological and emission inventory databases.
- Toward this end it is desirable to have a consistent source of long-term emission inventory data.
- Utilized county/SCC based emissions summaries available from EPA[1] for 1990 and 1996 through 2001, which were analyzed and augmented with additional databases to perform long-term modeling.

[1] http://www.epa.gov/ttn/chief/net/critsummary.html

Emission Inventory Source

Area and Nonroad

Inventory Year(s)	Source
1988 - 1990	Converted county/SCC level 1990 summary files to IDA format.
1991 - 1995	Developed county and pollutant specific projection factors using the 1990 and 1996 SCC level summaries. The projection factor for each pollutant/county for each year between 1990 and 1996 was linearly interpolated from the 1990 and 1996 projection factors.
1996 - 2000	Converted county/SCC level 1996 to 2000 summary files to IDA format.
2001	Used EPAs 2001 CAIR Inventory.
2002 - 2005	Used OTCs 2002 BaseB modeling inventory for 2002 and interpolated inventories for 2003-2005 from 2002 and 2009 OTC BaseB inventories.

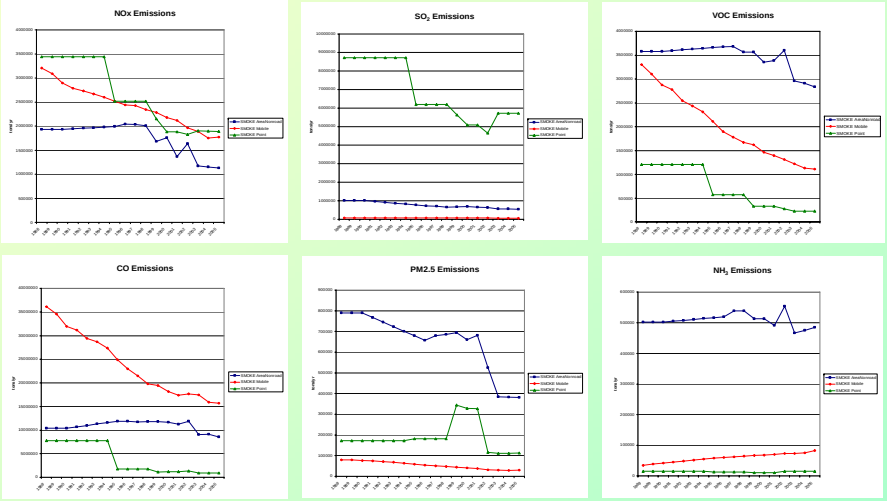
Point

Inventory Year(s)	Source
1988 - 1994	Created a growth and control matrix and applied it to the 1996 NET v3.11 point source IDA format file. This approach was necessary because the SCC/county level summaries from the trends files would not have facility or stack information and the facility summaries did not have stack and SCC information.
1995 - 1998	Used the 1996 NET v3.11 point source inventory in IDA format.
1999	Used the 1999 NEI v3 point source inventory in IDA format.
2000 - 2001	Used EPAs 2001 CAIR Inventory and hourly CEM data.
2002 - 2005	Used OTCs 2002 BaseB modeling inventory for 2002 and interpolated inventories for 2003-2005 from 2002 and 2009 OTC BaseB inventories. Also used hourly CEM data.

Mobile

Inventory Year(s)	Source
1988 - 2001	Used year-specific county/SCC level VMT from Access database and matched against speed information from 1999 NEI inventory file to create a year-specific VMT/speed inventory. This was used as input to Mobile6 which is then run with year-specific emission factors.
2002 – 2005	Used the 2002 OTC BaseB modeling inventory for 2002 and interpolated inventories for 2003 – 2005 based on 2002 and 2009 OTC BaseB inventories.

Emission Summary (Domain-Wide)



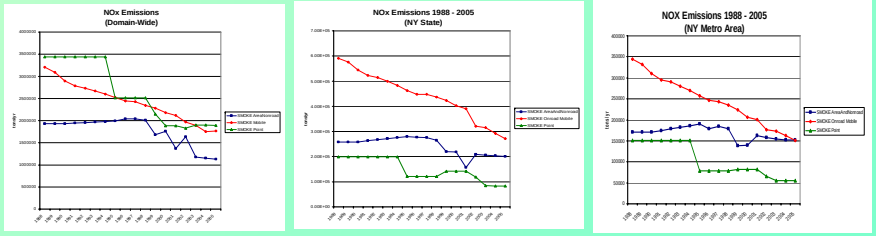
- NO_X emissions are dominated by mobile and point sources, SO_2 emissions are dominated by point sources (primarily EGU's), VOC emissions originate from mobile and area sources and mobile sources are the major source for CO emissions.
- Substantial reductions in SO_2 emissions from power plants starting in 1995. Continuous reductions of NO_X and VOC emissions, to a large extent driven by mobile source reductions.
- Large temporal variations in some pollutants over time may be a result of the use of differing data sources. (Point source $PM_{2.5}$ spike in 1999-2001)

Annual total anthropogenic emissions over the 12 km modeling domain processed by SMOKE for 1988 and 2005. All emissions are shown in kilotons.

		NO_x	VOC	CO	SO_2	NH_3	$PM_{2.5}$
Area + Nonroad	1988	1,933	3,581	10,379	1,018	502	790
	2005	1,132	2,835	8,554	546	485	382
Mobile	1988	3,207	3,300	36,090	66	34	80
	2005	1,769	1,114	15,657	45	83	30
Point	1988	3,443	1,209	7,743	8,725	15	172
	2005	1,892	229	915	5,728	15	113

Substantial decrease in all pollutants for all sectors, except mobile source NH_3 seen from 1988 to 2005

Emission Summary (Regional)



General emission trends are consistent across different regions, although the relative importance of different source categories varies spatially.

Model Configuration

Meteorology: MM5: 36 km/12 km modeling with data assimilation.

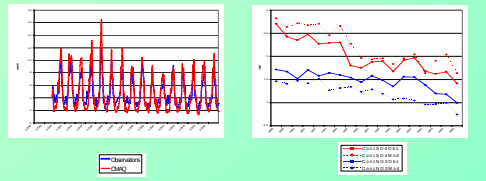
Emissions: Processed with SMOKE, MOBILE6 using annual county-level VMT and BEIS3.12 using MM5 temperature, radiation and precipitation.

Air Quality: CMAQ 4.5.1, 36 km Eastern U.S. / 12 km NYS and surrounding states: full gas phase and aerosol modules.

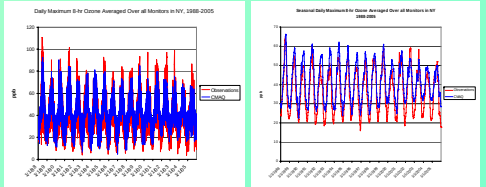
Preliminary Model Results

CMAQ and Observed Seasonal SO_4 Concentrations at 8 Rural CASTNet Sites

CMAQ and Observed Annual Average Precipitation-Weighted Rainwater Concentrations at NADP Monitors



- Comparison against long-term records of weekly dry-deposition $PM_{2.5}$ sulfate measurements at eight rural CASTNet sites in the modeling domain generally shows good agreement
- CMAQ appears to capture the effect of SO_2 & NO_X emission reductions on sulfate and nitrate wet deposition.



- Model generally performs well for 8-hour ozone and captures a decrease in annual variability over time.
- For any given year, model seems to underestimate high values and overestimate low values.
- Overall decline in emission over the time period reflected in lower ozone concentrations from 1988 to 2005

Summary

- Long-term simulations for ozone and $PM_{2.5}$ over the Northeastern U.S. have been performed with the MM5/SMOKE/CMAQ system
- Assembled a long-term emissions inventory database from EPA county/scc level summary files and other available inventories
- Overall decline in emissions from all source categories seen in aggregation of various inventories despite some variability induced by different data sources.
- For $PM_{2.5}$, comparison against the limited measurements available during the simulation time period shows good model performance for SO_4
- Comparisons of simulated SO_4 concentrations and wet deposition against limited available measurements indicate that CMAQ captures the effect of the Title IV SO_2 reductions

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