Emissions Inventory Development and Processing for the Seasonal Model for Regional Air Quality

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Introduction

- **Background:** SMRAQ project, domain, models, automation methods for processing and QA
- **Methods:** Initial inventory, inventory issues, processing issues
- **Results:** Temporal analysis over season, limitations, comparison of point sources with CEM data
- **Conclusions**

BACKGROUND

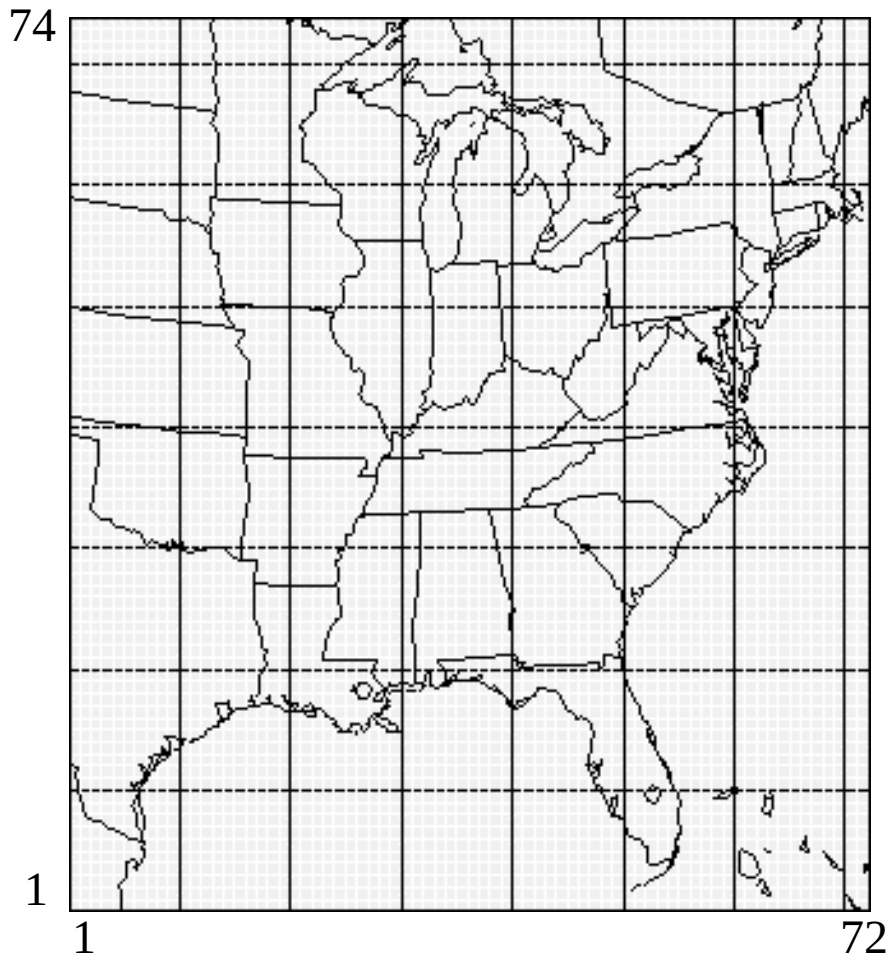
SMRAQ Project

- **Mission**
  - Investigate the scientific issues for simulating air quality on a seasonal basis
  - Develop, evaluate, and apply a seasonal air quality modeling system for the Eastern US
  - Explore the seasonal and episodic responses of ozone concentrations to control strategies
- **Episode**
  - May 15 to September 13, 1995

BACKGROUND

SMRAQ Domain

- 72 x 74 36km^2 Lambert projection
- Vertical resolution: 22 layers (12 used for emissions)



BACKGROUND

SMRAQ Models

- **Models**
  - Meteorology: Penn State/NCAR Mesoscale Modeling System, Version 1 (MM5)
  - Emissions: Sparse Matrix Operator Kernel Emissions (SMOKE)
  - Air Quality: Multiscale Air Quality Simulation Platform (MAQSIP)
- **SMOKE**
  - Developed to demonstrate matrix-vector multiplication for efficient emission processing
  - Reproduces the core functions of emission processing
  - Driver for Mobile5a or Mobile5b
  - Modified version of BEIS2

BACKGROUND

SMRAQ Emissions automation

- Used the Environmental Decision Support System (EDSS) Study Planner for automation
- Four plans
  - Point-source inventory growth (once per inventory)
  - Inventory import (once per inventory)
  - Monthly point-source adjustments based on CEM data
  - Meteorology-dependent steps (5-day periods)
- QA: state and county totals, other totals, plots
  - Built into the plans using UNIX scripts and automatically started when the outputs were available from SMOKE
- Resources
  - IBM 590 Workstation, 256 MB RAM, 45 GB local disk space, and remote file storage using a Cray data migration facility

METHODS

Initial SMRAQ Inventory

- **Original SMRAQ plan: use 1995 Ozone Transport Assessment Group (OTAG) inventory from 5/96**
- **Several changes made:**
  - **Area sources: corrected GA and FL off-road data. Added sources in OH, WI, and duplicates deleted in MI**
  - **Biogenic sources: obtained land use specifically for our grid**
  - **Mobile sources: VMT corrections in PA, new NC VMT mix, and updates to average speed**
  - **Point sources: 27/38 states had changes to stack parameters, facility locations, temporal profiles, and emissions data. SMRAQ did not use hour-specific data**

METHODS

Emission Inventory Issues

- **Considered improving monthly variation for anthropogenic source categories**
  - **Area sources: No reliable monthly data available. Used average-summer-weekday emissions from updated OTAG inventory**
  - **Mobile sources: Considered 1995 Traffic Volume Trends report from the USDOT. Variations too small to warrant extra effort**
  - **Point sources:**
    - **Projected from 1990 to 1995 using 1990 & 1995 fuel use**
    - **Checked projection with average-daily CEM data by month**

METHODS

Emission Processing Issues (1)

- **Relationship between meteorology and emissions**
  - For plume rise, biogenic emissions, mobile emissions
  - Coastal, mobile-source, artificial emissions reduction: impact was less than 5%
  - Appropriate height of temperatures from MM5 (used T_g)
- **Temporal considerations and adjustments**
  - Reid's Vapor Pressure of motor vehicle fuels (not modified)
  - Treatment of holidays (used Sunday for May 29, Jul 4, Sep 4)
  - Time zones (modified SMOKE so that weekly/monthly profile applications consider time zones as well)
  - Correct "weekday-Saturday-Sunday" approach (for multiple time zones, must include Monday as well)

METHODS

Emission Processing Issues (2)

- **Model science and corrections**
  - **Compared results from Mobile5a to Mobile5b for the SMRAQ domain. For a 4-day test case, domain-total differences:**
    - **CO: Mobile5b was 2.8% - 5.2% greater**
    - **$NO_{x:}$: Mobile5b was 1.7% - 2.8% greater**
    - **VOC: Mobile5b was 0.3% - 1.2% smaller**
    - **Local differences could be much greater**
  - **Corrected the plume rise algorithm**
    - **Error found in original RADM code**
    - **Other changes to keep consistent with Models-3**
  - **Biogenic changes (previous presentation)**

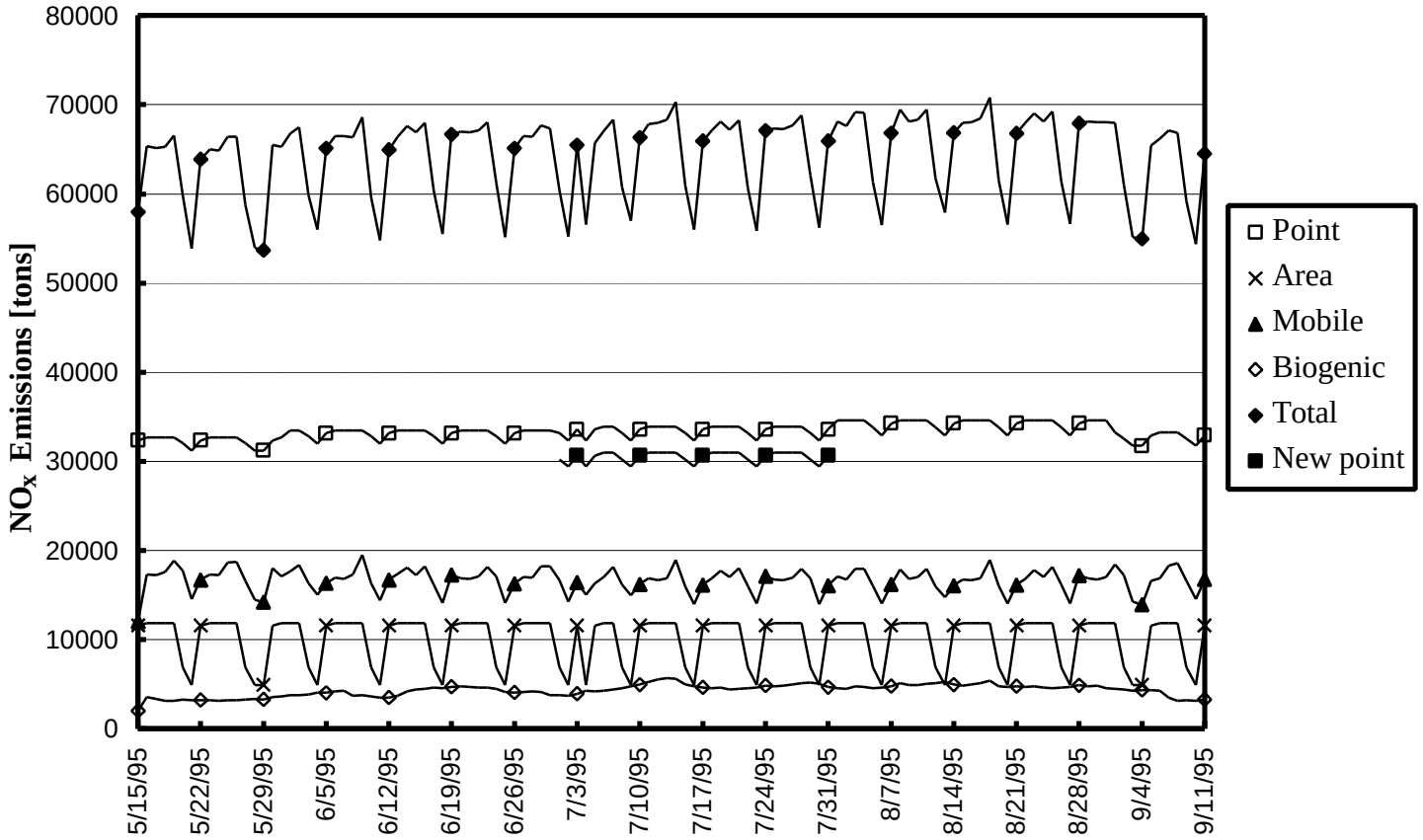
RESULTS

Performance

- **Seasonal processing wall-clock computer time: 95 hours including 66 QA hours**
- **Each 5-day period: 3.8 hours wall-clock computer time (2.6 hours QA)**
- **One person, 1.5 hours/day average for 33 days:**
  - **Monitor runs,**
  - **Check disk usage**
  - **File compression**
  - **Remote storage**

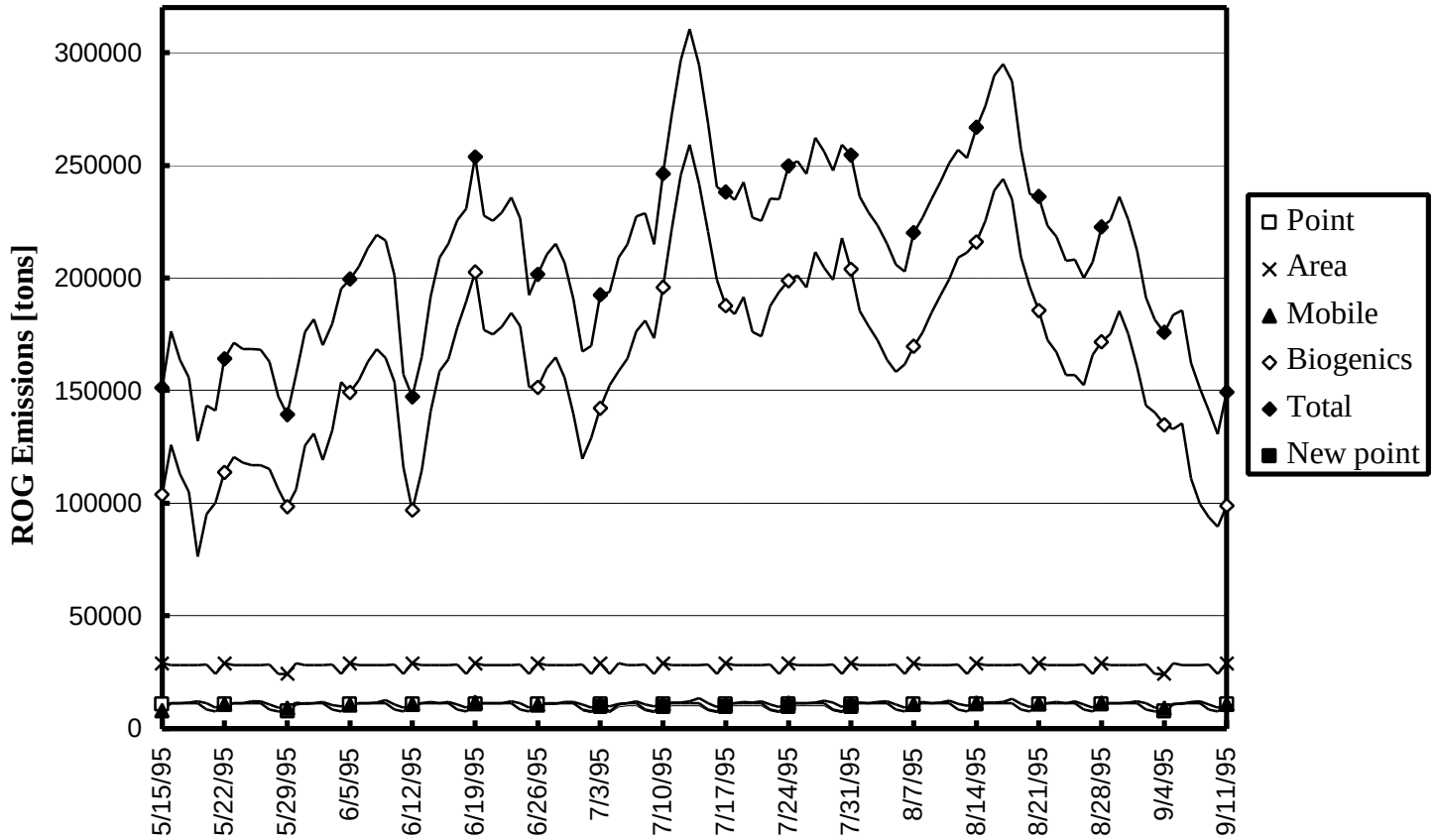
RESULTS

Seasonal NO_x Emissions



RESULTS

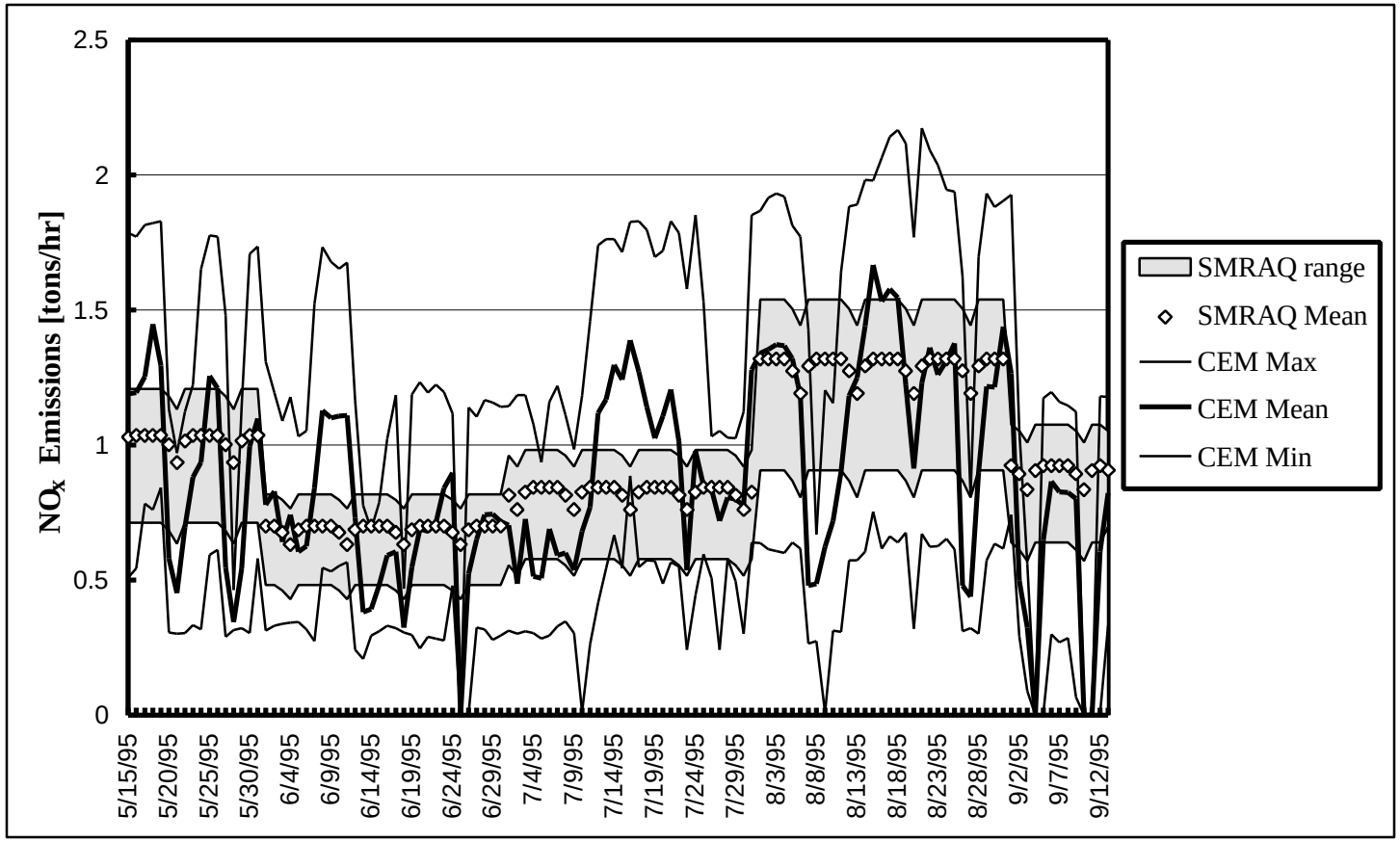
Seasonal ROG Emissions



RESULTS

Point-source Comparison to CEM

CP&L H.F. Lee plant



Conclusions

- EDSS-Study Planner plans and QA scripts: benefits worth the costs
- To further improve emissions preparation timeliness and quality: inventory development
- Guidance for seasonal modeling
- Monthly and week-to-week variations
  - Utility emission variations not captured well
  - Future investigations: shortcomings for all source categories?
  - Are these important?
  - To address, must modify inventory development and processing
- Emission factor models should expect MM5