Air Pollutant Emissions Modeling and Analysis for the Three-State Air Quality Study

Z. Adelman, M. Omary, D. Yang
Center for Environmental Modeling for Policy Development
University of North Carolina – Institute for the Environment

R. Morris
ENVIRON International Corporation

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Presented at the 21st International Emission Inventory Conference
April 14-16, 2015 – San Diego, CA
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Western States Air Quality Study

• Assess environmental impacts related to oil and gas development and production
• Develop and distribute standardized and transparent databases and modeling platforms for National Environmental Policy Act (NEPA) Environmental Impact Assessments
• Federal and state cooperators
  – USFS, BLM, NPS, EPA Region 8, CDPHE, UTDEQ, WYDEQ
Project Timeline

**OCT 2012**
Pilot Project Start

**NOV-DEC 2012**
CO, UT, WY 2008 EI Analysis and Evaluation

**2012**
- CAMx 2008a
- 2008 EI Modeling
- 3SAQS Monitoring Network Report
- Final 2008 Emissions

**2013**
- EI Improvement Meetings With CO, UT, WY
- JAN 2013
- FEB-MAY 2012
  - 2008 EI Modeling
- FEB 2014
  - 3SAQS Monitoring Network Report
- JUL 2014
  - Final 2008 Emissions

**2014**
- Aug 2014
  - CAMx 2011a
  - CAMx 2008b, WRF 2011, Oil & Gas 2011a Emissions
- SEP 2014
  - SMOKE 2011a
- NOV 2014-APR 2015
  - CAMx 2011 Sensitivities
- OCT 2013
  - WRF 2011 Sensitivities
- MAR-JUN 2014
  - 2011 EI Modeling
- JUN 2012
  - Emissions VOC Reactivity Analysis
- Dec 2015 – Mar 2015
  - Additional MPE for Simulation Base11a
- AUG 2014
  - MPE
- OCT 2012
  - Pilot Project Start
Major Deliverables

• **Modeling Platforms**
  – Modeling input/output data, software, and scripts
  – 2008 version A and B
    • SMOKE and CAMx
    • Base and Future Year (2020)
  – 2011 version A
    • WRF, SMOKE, and CAMx
    • Base and Future Year (2020)
  – 2104 in development

• **Emissions**
  – 2011 O&G inventory
  – Data updates for 3-state sources
    • Fusion of NEI and 3-state inventories

• **Monitoring Network Assessment**
Major Deliverables

• Key Analysis Products
  – Inventory comparisons
  – VOC reactivity analysis
  – Model performance evaluations
    • CAMx 2008
    • WRF 2011
    • CAMx 2011
  – Methane inventory analysis

• Modeling Sensitivities
  – Boundary conditions
  – US background air quality
  – Ammonia emissions
  – Oil and gas emissions
  – Winter ozone
Key Findings: Emissions

- New 2011 O&G EI
- 2008 > 2011 > 2020
  - Trends vary by state/sector/pollutant
  - General decrease in emissions through time
  - Exception is VOC from O&G sources
Key Findings: Emissions

• Collaboration with CO, UT, WY state DAQs to obtain data, review emissions, and get feedback on protocols/evaluations

• Updates to key sectors/pollutants
  – Agricultural NH3 – point CAFO locations used to improve the spatial allocation of livestock emissions
  – On-road mobile – link-based VMT from CO used to improve spatial allocation of on-road mobile sources in CO
  – Review of 3SAQS updates to temporal and chemical speciation profiles for nonroad and nonpoint sources
  – Updated oil and gas source inventories for base and future years
Oil and Gas Emissions Development Activities

- 2011 base year inventories developed for all major basins in the 3 states
  - Uinta (UT)
  - Piceance (CO)
  - D-J (CO)
  - All Wyoming Basins (WY)
  - Raton Basin (CO/NM)
  - Paradox Basin (UT)
  - South San Juan Basin (NM)
- 2020 projections developed for all basins
- 2011/2020 emissions processed through SMOKE and model-ready
Example Processed and Gridded O&G Emissions

June 2011 gridded oil and gas emissions in 4-km modeling domain
Key Findings: Emissions

- **2020 – 2011 Emissions**
  - Mostly decreases for all sectors/pollutants/states except O&G VOC/TOG
  - Plots show differences by state (CO, UT, WY)
Emissions Modeling Report

- Detailed description of 3SAQS 2008 and 2011 emissions modeling platforms
  - Data sources
  - Data preparation
  - Modeling
- Summaries by state (and county for 2011)
- Inventory comparisons
  - 2008 vs 2011
  - Base vs future
- Analysis of the inventory changes from 2008 to 2011
- Available on the Data Warehouse
Key Findings: Emissions

• Methane
  – 3SAQS one of the first U.S. regional CTM studies to look at active methane emissions
  – Tracer for important regional emissions sectors (O&G and ag)
  – O&G is the largest source in the current inventory
  – Missing significant agricultural sources: enteric fermentation and livestock
Key Findings: Emissions

- **Emissions Reactivity**
  - Reactivity-based analysis of inventories focuses on sources with greatest ozone formation potential
  - Different sources are dominant using reactivity weighting vs. mass-based analysis
  - Reactivity analysis is dependent on validity of inventory and chemical speciation
Key Findings: Emissions

Emissions Reactivity

RTOG = TOG * Profile Total MIR
RTOG/TOG = Relative emission reactivity
3SAQS Base 2011a MPE

- 2-slide summary of 2011a MPE
- Summer O₃ OK
- Too little winter O₃
- Too much NO₂

All AQS and CASTNet sites 4-km domain

Colorado AQS NO₂

Myton, UT MDA8
3SAQS Base 2011a MPE

- High seasonal PM$_{2.5}$ bias
- PM performance issues with all species
- Wet deposition too low
Garfield County, CO VOCs

- 4 Locations in Garfield County with speciated VOC measurements in 2011 ([monitor map](#))
  - Parachute (PACO) – small urban location, close to O&G development/production; transportation hub
  - Rifle (RICO) – urban center, close to O&G development/production; industrial hub
  - Bell-Melton (BRCO) – rural site, near O&G development locations
  - Battlement Mesa (BMCO) – rural site, near large natural gas development locations
Formaldehyde
Garfield County, CO Oil and Gas Formaldehyde Sources
http://views.cira.colostate.edu/tsdw

The Western Air Quality Data Warehouse provides air quality data and analysis tools to support regulatory, research, and academic applications. Available datasets include emissions inventories, meteorological data, monitoring data, and air quality modeling platforms. Available modeling platforms support consistent photochemical grid modeling for National Environmental Policy Act projects and other modeling studies.

**GET DATA**

Access a wide variety of monitored, modeled, emissions, and met data.

**DOCUMENT NEEDS REVIEW**

- WSAQS Weather Research Forecast (WRF) Winter Modeling Workplan
- 3SAQS WRF 2011 Meteorological Model Performance Evaluation

**DATA & METADATA**

- Data
- Studies
- Documents
- Literature

**PROJECTS & PLANNING**

- Projects
- Meetings
- News