Western Air Quality Studies,
3-State Air Quality Pilot Study / Data Warehouse, and
Western Regional Modeling Framework

April 16, 2014

Tom Moore
WRAP Air Quality Program Manager
WESTAR Council

Salt Lake City, Utah Meeting
Regional Organizations

- **WESTAR = Western States Air Resources Council**
  - 15 state air agencies are voting members, ex-officio membership includes FLMs, also open to local air agencies and tribes, EPA active participant but not a member
  - Incorporated non-profit, offices in Seattle, Portland, and Fort Collins
  - [www.westar.org](http://www.westar.org)

- **Purposes:**
  - Exchange information related to air pollution control;
  - Develop processes and procedures to meet air quality objectives and to protect the environmental resources;
  - Discuss air quality issues and report on the status of efforts undertaken to achieve air quality objectives;
  - Establish work groups, task forces, as needed; and
  - Adopt resolutions and policy statements for implementation by Council members.
WESTAR / WRAP geographic region
Organizations, continued

- WRAP = Western Regional Air Partnership
  - [www.wrapair2.org](http://www.wrapair2.org)
  - Same 15-state region as WESTAR
  - Virtual organization, not incorporated
  - 60+ member agencies include 15 state air agencies, NPS, FWS, BLM, USFS, EPA, and interested tribes and local air agencies/districts in the WRAP region
  - Board has State and Tribal co-chairs, with representatives across states, tribes, federal, and local agencies.
  - Formed in 1997 to implement Grand Canyon Visibility Transport Commission recommendations
    - Led Regional Haze planning effort 1997-2009 for the West
    - 75% of Class I areas in the WRAP region
- 15 states, federal land managers and EPA, tribes, and local air districts
- Regional analyses for Western sources and air quality impacts
WRAP, continued

- Since 2010, WRAP working as regional technical center to support and coordinate Regional Analysis and Planning
- Develop and facilitate use of improved, consistent, comparable, transparent, and reproducible western air quality data
  - Interconnected series of regional technical projects
- Management of ongoing emissions and modeling studies
  - Reviewed / coordinated with federal agencies, states, locals, tribes
  - External review by, and outreach to, industry and environmental groups
- Staff work for WESTAR - report to WRAP and WESTAR Boards, and WESTAR Executive Director
WRAP regional technical support

• NAAQS Implementation and Maintenance
  • Data for future infrastructure and transport SIPs

• Exceptional Events
  • Develop technical support data and analysis protocols

• Implementation of Regional Haze SIPs
  • Identify and execute technical work needed for 2018 plans

• Needs of sub-regional groups of states
  • Currently oil and gas
  • Similar efforts in past
Western ozone and PM precursors - key emissions sources

- Power plants decreasing markedly
- Mobile sources controlled and emission rates decreasing markedly through federal rules and state testing programs
- Fire activity and effects are huge, receiving intensive study
  - Deterministic & Empirical Assessment of Smoke’s Contribution to Ozone (DEASCO$_3$)
  - Prescribed and Other Fire Emissions: Particulate Matter Deterministic & Empirical Tagging & Assessment of Impacts on Levels (PMDETAIL)
  - Others…
- Biogenics (natural plant sources)
- Oil and gas (WRAP emissions inventories)
  - Emissions Inventories for Intermountain Basins with significant production
    - Currently completing ND-MT Williston and MT North Central (Great Plains) Basins
    - Coordination for 3-State Air Quality Study
- All sources studied in comprehensive regional modeling analysis
  - 2008 base year - West-wide Jumpstart Air Quality Modeling Study (WestJumpAQMS)
Power Plant Emissions Trends – Western Interconnect

Data Source: EPA Clean Air Markets Division
The quantity of forest fuels and composition of vegetation in the wildlands of the Western U.S. motivate the land managers to increase the application of prescribed fire to the landscape (from 650,000 acres in 2002 to a projection of up to 3.6 MM acres in 2018).
Western Regional Studies and Projects
West-Wide Jumpstart Air Quality Modeling Study
(funding by State of NM, BP, and BLM national air program)

- Regional results provide data and context for state and federal planning
  - Uses most current transport and background studies
  - Meteorological and emissions modeling
    - Regionally consistent, High resolution, Comprehensive
  - Photochemical modeling
    - 2008 base case model performance evaluation with Ozone / PM source apportionment
  - Most up-to-date and complete characterization of Western U.S. air quality available

- Study completed September 2013
  - Emissions and Modeling data foundation of 3-State Data Warehouse
  - All materials at: http://www.wrapair2.org/WestJumpAQMS.aspx
  - Advances goal to provide a regional modeling framework
WestJumpAQMS Area

Modeling Domain

36km: 148 x 112 (-2736, -2088) to (2592, 1944)
12km*: 227 x 230 (-2388, -1236) to (336, 1542)
04km*: 317 x 515 (-1480, -904) to (-212, 1156)

* includes buffer cells
Tracking and Managing Smoke

- Significant impacts to both local and regional air quality
  - Large summer wildfires
  - Prescribed and agricultural burns in spring and fall

- States & tribes manage both planned burns & wildfire impacts
  - Used daily by western states, tribes, and federal agencies to track planned fire and manage smoke
  - FETS
    - Used by states and OAQPS to evaluate 2008 NEI
    - Fire activity and emissions data being sent to EPA for 2011 NEI
Fire’s Effects on Elevated Regional Ozone & PM

Deterministic & Empirical Assessment of Smoke’s Contribution to Ozone (DEASCO₃) – completed Summer 2013

and leveraged companion study underway:

Prescribed and Other Fire Emissions: Particulate Matter Deterministic & Empirical Tagging & Assessment of Impacts on Levels (PMDETAIL)

Funding for both from FLM Joint Fire Sciences Program

Both projects, analysis toolbox / data, and FETS access at: http://wraptools.org/

Leveraging

EPA NEI & WRAP Western Data

WestJumpAQMS

DEASCO$_3$

Improved AQ Planning

Exceptional Event applications

PMDETAIL

2008 WRAP Fire and NEIv2 Fire data (USFS collaboration)
WRAP Fire Tools Landscape

- **Fire Emissions Tracking System**
  - Gathering daily WF and S/L/T data
  - QA/QC and reporting tools for activity, emissions, NEI

- **DEASCO₃**
  - JFSP-funded project
  - DSS for Ozone impacts
  - Temporal analysis, area impacts

- **PMDETAIL**
  - JFSP-funded project
  - DSS for PM impacts
  - Temporal analysis, vulnerability matrix

**Diagram:**
- WRAPTools Retrospective Analysis System
- DEASCO₃ Project Site
- PMDETAIL Project Site
- WRAPTools Website
- FETS Website
- FETS database
WRAPTools Toolbar Approach

What questions do we need to address to perform retrospective case study analyses?
What data are available to us?
How do we organize results to accommodate differing analysis types?

• Start with basic criteria from user: time, space
• Build a set of modular tools that produce analysis results
• Build a one-page “workspace” and plug in tool results, commentary.
Smoke and Emissions Inventory Research

- Acres constrained by perimeter
- Daily growth & composite fuel loading
- Consumption scaled by severity

Smoke and Populations

Federal Land Manager Database (FED)

Federal Land Manager Environmental Database (FED)

This website provides access to an extensive database of environmental data and an integrated suite of online tools and resources to help Federal Land Managers assess and analyze the air quality and visibility in Federally-protected lands such as National Parks, National Forests, and Wilderness Areas.

AQVR Summaries
View graphical summaries and reports of the status and trends of air-quality-related values (AQVRs) and other metrics that have been chosen by Federal Land Managers (FLMs) for assessing air quality in protected federal areas.

Webcams and Photographs
See live video from webcams at select rural and urban vistas, and examine sequences of photographs from selected monitoring sites that demonstrate the range of visual conditions at each site over time.

Featured Substance
Ammonium sulfate
Name: Ammonium sulfate
Formula/HTML: $\text{NH}_4\text{SO}_4$
CAS Number: 7783-20-2
ACI Number: K100213-5
Density: 1.769
Comments: colorless crystals or white granular powder
Molecular Weight: 132.1342
Melt/Freeze Point: 280
Water Solubility: soluble

Fire and Smoke Model Validation

DEASCO3 NOx Fire Emissions
36km Grid Cell: (16,72)

July 9, 2008
max = 24.71 tons

August 11, 2002 6:00:00
Min= 0.0 at (1,21), Max= 32.6 at (14,55)
Temporal Analysis Tools

Model Validation

Fire Contributions to AQ Impacts

Inter-annual Observational Analysis
Prescribed fires' influence on ozone formation - MT Case Study

This case study was developed by looking at areas with large amounts of prescribed burning and coincident prescribed fire-caused ozone predicted by CAMx modeling in 2008. Idaho and western Montana have an active prescribed fire season in the fall, as can be seen in the map below that covers a two-week period in October, 2008. One ozone monitor location still active during this time period in 2008 was shown to have a significant amount of predicted ozone formation caused by prescribed fire. However, observed ozone at this site was quite low, and closer examination of the model performance shows consistent over-prediction of total ozone, shown below. Despite the model over-prediction, estimated values with up to 5ppb of prescribed fire-caused ozone are still well below the current or any potential near-term new standard. So, while there is evidence that prescribed burning in this area at this time can influence ozone concentrations, it is not enough to be a concern in the context of fire planning or SIP development.

Oct 12 - 25, 2008
Observed Ozone paired with modeled max 8-hour fire contribution 10/01/2008 to 10/31/2008
Flathead County, MT - GLR468

![Graph showing observed ozone levels over time]

FETS Summary Fire Statistics 10/12/2008 to 10/25/2008

<table>
<thead>
<tr>
<th>Emissions Totals</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total NOx</td>
<td>1478.1</td>
</tr>
<tr>
<td>Total VOC</td>
<td>1745.4</td>
</tr>
<tr>
<td>Total PM2.5</td>
<td>4217.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>Tons Consumed</th>
<th>Acres Burned</th>
<th>Tons NOx</th>
<th>Tons PM2.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wildfire</td>
<td>16419</td>
<td>1180</td>
<td>51.0</td>
<td>141.8</td>
</tr>
<tr>
<td>Prescribed Fire</td>
<td>453523</td>
<td>18703</td>
<td>1407.5</td>
<td>4032.5</td>
</tr>
<tr>
<td>Agricultural Fire</td>
<td>6344</td>
<td>3428</td>
<td>19.7</td>
<td>42.8</td>
</tr>
</tbody>
</table>

Max 8-hour Ozone, Observed vs. Modeled, 10/12/2008 to 10/25/2008
Flathead County, MT - GLR468

![Graph showing correlation between observed and modeled ozone levels]
**Gnarl Ridge Report**

Gnarl Ridge Fire 2008

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### FETS Summary Fire Statistics 08/01/2008 to 09/30/2008

<table>
<thead>
<tr>
<th>Emissions Totals</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total NOₓ</td>
<td>325.0</td>
</tr>
<tr>
<td>Total VOC</td>
<td>375.2</td>
</tr>
<tr>
<td>Total PM₂₅</td>
<td>865.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Tons Consumed</th>
<th>Acres Burned</th>
<th>Tons NOₓ</th>
<th>Tons PM₂₅</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wildfire</td>
<td>104,711</td>
<td>3,417</td>
<td>325.0</td>
<td>865.5</td>
</tr>
</tbody>
</table>

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**FETS estimated fuel consumed for all fire types 08/01/2008 to 09/30/2008**

limited by geographic bounding box

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Ozone monitor locations with max 8-hr observed ozone between 40 and 75 ppb, with a modeled fire contribution of at least 6 ppb, from 2008-08-01 to 2008-09-30. Ozone and predicted fire contribution from the FINN model. Non-attainment areas are shown as orange polygons and MTBS areas as red polygons. Ozone stations are shown in red with a black border; fire activity is shown in blue (agriculture), green (prescribed) and red (wildfires).
2004

6/20 – 8/31

Limited by bounding box
2005

6/20 – 8/31

Limited by bounding box
2006

6/20 – 8/31

Limited by bounding box
2007
6/20 – 8/31
Limited by bounding box
Where do your data go, how are they used?

SMP Data

Satellite-derived Data

MTBS Data

FETS database

S/L/T NEI data

SIP-grade EIs ('02,'08,'11...)

Annual fire climatology

Data Export

FETS Website

WRAPTools Website

User-supplied data maintain their identity throughout the system
Track activity and emissions

Fire Activity Data (acres/day)

Loading Moisture

Emissions Model

Distribute emissions

DEASCO3 & PMDETAIL

Chemical Profiles

loft emissions
Completed DEASCO$_3$ project - purpose & goals

- Assess fire’s impact on elevated ozone episodes with retrospective studies
  - Studies of fire and ozone in 2002 through 2008
  - Tools and data at: http://deasco3.wraptools.org/

- Outcomes
  - Support future collaborative FLM-state ozone air quality planning
  - Developed “lessons learned”, basic analysis rules for fire-ozone episodes, and online tools for FLM-state air quality planning
  - Through WRAP FETS, prepared and implemented planning-grade fire emissions inventories in FETS suitable for SIP work by states & FLMs
  - Published data and analysis results in transparent and reproducible formats
  - Collaboration involved EPA western RO and FLM staff, leverages WestJumpAQMS
  - Products for FLMs and states to use in SIP process and Exceptional Events demonstrations
Particulate Matter Deterministic & Empirical Tagging & Assessment of Impacts on Levels (PMDETAIL)

- [https://pmdetail.wraptools.org/](https://pmdetail.wraptools.org/)
- 3-year project, JFSP-funded
  - Completion target Sept. 2015
  - Team = WESTAR/WRAP, Air Sciences, ENVIRON, CMU, and CSU

**Study Objectives**

- Quantify the impact of prescribed and other fire sources on particulate matter (characterized as PM$_{2.5}$ and PM$_{10}$) levels across the continental U.S.
- Develop new fire emissions inventories and computational modules for chemical transport models to simulate the atmospheric transformations of these emissions
- CAMx and PMCAMx models and inventories will be evaluated against field measurements for 2002, 2008, and 2011.
  - CAMx is a publicly available chemical transport model (CTM) used for regulatory purposes, while PMCAMx is its research version developed by the CMU team.
- Based on leveraging and significant extending emission inventory development and CAMx modeling from the Deterministic and Empirical Assessment of Smoke's Contribution to Ozone (DEASCO$_3$) study completed in 2013.
FETS, Present and Future

- Developed and on-line in 2007
- Continuing processing / addition of each year’s data from SMPs
  - Continuing to add new SMPs
  - Exploring additional sources of daily wildfire incidence data
- Leveraged JFSP projects have covered very limited FETS maintenance support
- Datasets from JFSP projects and ongoing FETS data collection converging on WRAPTools ([https://wraptools.org/](https://wraptools.org/))
- High-priority, critical infrastructure maintenance tasks underway
- Outreach process to WRAP region SMPs to assess needs for additional functionality and identify collaboration activities
Regional Haze: Reasonable Progress Reports (EPA grant funds for contractor support)

• WRAP produced a comprehensive, regionally-consistent technical report – completed Summer 2013
  • Regional, state, and Class I area reports
  • Technical analyses required by Regional Haze Rule
  • Western states will use as a common basis in preparing individual SIP revisions
  • SIP revisions are due in the 2013-15 timeframe

• WRAP providing western 2008 emissions data
  • Leveraged from WestJumpAQMS
  • States will use to evaluate changes in monitored visibility

• Project reports at: [http://www.wrapair2.org/reghaze.aspx](http://www.wrapair2.org/reghaze.aspx)
Oil & Gas: Emissions Inventories and Control Analysis
(funding by Western Energy Alliance, EPA, States of WY and ND, BLM)

- Key source for Ozone / PM standards, & Regional Haze
- Exploration and production activity continue to increase
- Data in use current OAQPS national & western modeling work
  - Significant funding and involvement by industry
  - Open review and discussion process with all interested stakeholders
- Linkages
  - WestJumpAQMS
  - 3-State Air Quality Study
  - O&G EI project funded by BLM MT-Dakotas office
    - 2011 base & projection years’ EI for Williston & Montana Great Plains Basins
Cross-Basin – VOC Emissions

![Bar chart showing VOC emissions by basin](image-url)
Per well NOx emissions relatively consistent across basins – differences mainly due to usage of compression and centralized vs. wellhead compression.
Per unit gas production VOC emissions vary widely across basins – differences due to levels of liquid hydrocarbon production (oil and condensate) and VOC content of produced gas.
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Issues – Missing Categories

Produced water (evaporation) ponds

- Emission factors uncertain and highly dependent on composition, production type
- Seasonal/diurnal variations
- See for example Utah State University work to characterize emissions in Uinta Basin
Issues – Missing Categories

Field gathering pipelines

- Lack of data on extent of pipeline infrastructure within fields
- Pipeline companies historically not part of the inventory process
Issues – Missing Categories

Midstream sources

- Midstream sources not always captured in inventories – state reporting thresholds
- Midstream sources on tribal lands
- Midstream companies historically not part of the inventory process
Issues / New Concepts – Non-routine events, Skewness

- Pipeline blowdowns
- Spills/upsets
- Maintenance activities

- Poorly performing and “non-average” sources could have significantly higher emissions than estimated in inventories
- Analogous to “smoking vehicles” in mobile source inventories
- Statistical sampling/monitoring of sources needed to develop methods to represent this in inventories
- See for example NOAA monitoring in Uinta Basin and CDPHE capture efficiency adjustments
Issues and New Concepts – Gas Compositions

- Gas compositions in Phase III use a basin-average approach
- Variability within a basin by production type (field to field)
- Variability within the production/gathering system
- More data needed – field or formation level approach for basins?
Issues and New Concepts – Factors and Uncertainty

New factor data

- Fugitive emissions
- Venting from well completions
- Water tanks / evap ponds

Uncertainty

- Uncertainties not quantitatively estimated in most inventories
- Large data sets needed to estimate uncertainty
- Helpful in identifying poorly-characterized sources, and estimating uncertainty in AQ modeling
Federal Leadership Forum / 3-State Air Quality Study
(funded by BLM, USFS, EPA, others in-kind)

- Steering committee of WY, CO, UT, EPA, BLM, NPS, and USFS
- Implementation of 3-State and national MOUs’ objectives
- Planning for air quality impacts of energy development
  - Ozone focus, additional rural monitoring stations in oil & gas basins
  - Wintertime ozone nonattainment areas
  - Integrates results from WestJumpAQMS and Oil & Gas projects
  - Data warehouse to support future air quality modeling and other analyses
3SAQS 4km Modeling Domain – discussed and recommended at Oct. 31-Nov. 1 Technical Committee Workshop
3-State Air Quality Study - Objectives

- Facilitate more complete and consistent AQ Analysis for NEPA and other AQ decisions
- Improve timeliness and collaboration
- Reduce duplication of AQ analysis resulting in lower costs
- Improvements include or will include:
  - Six new monitoring sites
  - More region-specific modeled emissions
  - More current base case and better future case air quality modeling
  - A data warehouse to contain all this improved information and future data for access by agencies and those they approve to use it
Opportunities for Data Warehouse and Applying Regional Modeling Results from Western Regional Technical Studies

- Leveraged studies address both regulatory planning needs and fill gaps where data are needed
  - Working for the users of the data

- Tracking key western source categories / source areas
  - Regionally consistent, comparable, transparent, and reproducible

- Modeling analyses of Ozone and PM background and transport on a routine basis and during elevated episodes
  - NEPA air quality studies
  - Background data for SIP planning
  - Impacts of fire on ozone and PM across West

- Better oil & gas, fire, biogenics emissions data
  - Improves assessment of natural vs. anthropogenic contributions

- Next Step – develop Western Air Quality Modeling Framework concept paper
3-State Data Warehouse

- Monitoring
- Emissions
- Modeling
- Analysis & Results
- Systematic Tracking

Western Regional Modeling Framework

(future)

- Regional Haze
- Regional Modeling
- NAAQS-related interstate transport
- Regional Database

Western Regional Modeling Framework
Thanks –

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Western Regional Air Partnership | www.wrapair2.org