Western Regional Analysis for Ozone Standard Planning

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Tom Moore
WRAP Air Quality Program Manager
WESTAR Council

Fish Camp, CA
Topics

- Overview of WESTAR and WRAP regional organizations
- Key issues and areas of focus
- Ozone analysis: Results from recent projects and studies
Overview of WESTAR and WRAP

- **Purpose**
  - Service organizations
  - Assist members in achieving their air quality management goals

- **WESTAR**
  - Training
  - Provide a forum for discussion
  - Inform policy-related discussions
  - [www.westar.org](http://www.westar.org)

- **WRAP - provides technical support (esp. regional)**
  - Virtual organization, not incorporated
  - 65+ 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 representatives across states, tribes, federal, and local agencies.
  - [www.wrapair2.org](http://www.wrapair2.org)
- 15 states, federal land managers and EPA, tribes, and local air districts
- Regional analyses for Western sources and air quality impacts
Overview of WRAP

- Since 2010, WRAP working as regional technical center to support and coordinate Regional Analysis and Planning
- Develop and facilitate use of western air quality data:
  - Make improvements, ensure consistency and comparability
  - Increase transparency and access
  - Track trends for better, reproducible analyses
  - Regional emissions and modeling studies
- National Ozone and PM Ambient Air Standards Implementation and Maintenance – transport and background
- Exceptional Events
- Implementation of Regional Haze SIPs
- Needs of sub-regional groups of states
  - Currently oil and gas, fire
  - Similar efforts in past – dust, BART, other topics
Western Electrical Interconnect

WECC
Existing Transmission System

- 230 kV HVAC
- 345 kV HVAC
- 500 kV HVAC
- ± 500 kV HVDC
Western Interconnect Fossil Fuel Power Plant Emissions

1996 through 2014 data from EPA data for fossil fuel-fired electrical generating units in the 11-state Western Interconnect

* Additional NOx reductions estimate - BART controls from Regional Haze baseline planning

** Further NOx reductions from applying maximum post-combustion controls to all remaining units
Smoke/Fire & the Ozone and PM NAAQS, Regional Haze Rule

Technical Products for air quality planning & management as required by the Clean Air Act

Future emissions, efforts to avert emissions & health/visibility impacts, & adapt to a changing/varying climate

Fire

The Big Picture

U.S. Wildfire and Prescribed Fires Acres Burned - 1990 through 2014

Data from National Interagency Fire Center, no prescribed fire data before 1998
2007
6/21 – 9/21
Limited by bounding box

Source: WRAP Fire Tools
2008
6/21 – 9/21
Limited by bounding box

Source: WRAP Fire Tools
2011
6/21 – 9/21
Limited by bounding box

*Obtained additional small wildfire data for this inventory

Source: WRAP Fire Tools
Example Oil & Gas Study: Williston Basin 2011 Baseline Results

NOx Emissions By Source Category

- **Basin-wide NOx Emissions (tons/year):** 29,404

- **Source:** BLM/WRAP Oil and Gas Inventory project
Numerous U.S. sources will continue to contribute to air quality impacts across the West

Some are further controllable

Others are less controllable, quasi-natural, and/or less well-understood - these may grow within the CAA planning timeframes
EPA national Ozone Standard

- Measured at ground station sites, highest 8-hour average each day

- 4th highest values each year are averaged over specific 3-year periods to determine compliance (e.g., 2007-09, 2008-10)
  - Statistic is called a “Design Value” for that site for that time period

- Current Ozone health standard level is 75 ppb

- EPA proposed a revised Ozone health standard in a range of 65 to 70 ppb

- EPA proposed a secondary Ozone standard for ecosystem protection at the same range
  - Proxy for a growing season / daylight hours-weighted cumulative metric
Counties with Monitors Violating Primary 8-Hour Ground-Level Ozone Standard (0.075 ppb)

(Based on 2011-2013 Air Quality Data)

http://www.epa.gov/airquality/greenbook/map8hr_2008.html
What are (some of) the sources and control issues in the West related to new Ozone standard(s)?

- Urban and rural reactivity
- Transport and formation – how much / how important?
- Public lands with large biogenic emissions and fire activity
  - How to characterize for effects of drought and climate variation?
- Federal and state mobile fuel and tailpipe controls
- Upstream Gas NSPS rules in place in 2015
  - Industry practices changing rapidly, e.g., green completions
- Point sources (dominated by EGUs for $\text{SO}_2$, $\text{NO}_x$)
  - Significant $\text{NO}_x$ BART by ~2018
  - Less coal-fired electricity supply due to climate change rule?
  - 17+ million acres of public lands leased in last 5 years for O&G exploration and production
3-year Average 4th Highest 8-Hour Ozone value by County 2011-2013

AQS Federal Reference Method data from the monitoring site in each County with the highest Ozone values
Average Annual Count of Days with 8-Hour Ozone Averages >60 ppb for Rural/Class I Monitoring Sites – 2004 through 2013

AQS Federal Reference Method data from rural or Class I area monitoring sites
3-year Average 4th Highest 8-Hour Ozone Design Value for Selected Urban Counties currently in Attainment – 2011 through 2013

AQS Federal Reference Method data from the monitoring site in each County with the highest Ozone values
Source Regions used in the State-Specific APCA ozone and PSAT particulate matter 2008 source apportionment modeling for WestJumpAQMS.

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

Source: WestJumpAQMS
Ozone Modeled Attainment Test Software – Unmonitored Area Analysis with Design Value (2006-2010) ≥ 76 ppb

Source: WestJumpAQMS

○ Min(210,3) = 76.00, ◇ Max(45,67) = 113.30
Ozone Modeled Attainment Test Software – Unmonitored Area Analysis with Design Value (2006-2010) ≥ 70 ppb

Source: WestJumpAQMS

Min(107,1) = 70.00, Max(45,67) = 113.30
Ozone Modeled Attainment Test Software – Unmonitored Area Analysis with Design Value (2006-2010) ≥ 65 ppb

Source: WestJumpAQMS

Min(177,1) = 65.00, Max(45,67) = 113.30
Regional modeling of U.S. sources for air quality planning, to identify sources and assess controls for contributing sources, will continue within the West.

Inter-jurisdictional transport contributions are more important with more stringent standards and air quality goals.

The process for analyzing emissions controls is well-established, practiced by all air regulatory agencies, and EPA will need to work with western air agencies to develop methodologies and a system for this round of analysis.
Contributions to Ozone at Rocky Mountain National Park

Contributions to MDA8 Ozone [ppb] at CO_Larimer0007

- O&G:NM 0.0%
- O&G:CO 0.0%
- O&G:UT 0.0%
- O&G:WY 0.2%
- PT:CO 0.0%
- PT:WY 0.3%
- PT:UT 0.1%
- PT:NM 0.0%
- MV:WY 0.4%
- MV:UT 0.2%
- MV:CO 0.0%
- MV:NM 0.0%
- PT:Rem 0.9%
- MV:Rem 4.6%
- Can/Mex 1.8%
- NAT 2.7%
- AR:Rem 0.7%
- AR:NM 0.0%
- AR:CO 0.0%
- AR:UT 0.0%
- AR:WY 0.0%

Rank (10) 05/01/08; Model = 68.8 ppb; Obs = 69.9 ppb; Bias = -1.6%; BC = 60.4 ppb (87.9%)

Source: WestJumpAQMS
State Contributions to Modeled DMAX8 Ozone Days

**Highest** Modeled DMAX8 Day at “Reno3” on State Street, Reno

### High Day Contributions to MDA8 Ozone [ppb]

<table>
<thead>
<tr>
<th>Source: WestJumpAQMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site: NV_Washoe0016</td>
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<tr>
<td>Rank: 1 - 10 Jul, 2008</td>
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<tr>
<td>Total Ozone = 103.4 ppb</td>
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<tr>
<td>BC Ozone = 44.2 ppb (42.8%)</td>
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</table>

- **AZ**: 0.01 ppb, 0.01%
- **CA**: 5.09 ppb, 4.92%
- **CO**: 0.00 ppb, 0.00%
- **KS**: 0.00 ppb, 0.00%
- **ID**: 0.01 ppb, 0.01%
- **MT**: 0.00 ppb, 0.00%
- **OK**: 0.00 ppb, 0.00%
- **OR**: 1.43 ppb, 1.38%
- **WA**: 0.54 ppb, 0.52%
- **WY**: 0.00 ppb, 0.00%
- **NE**: 0.00 ppb, 0.00%
- **NV**: 0.16 ppb, 0.15%
- **UT**: 0.01 ppb, 0.01%
- **TX**: 0.00 ppb, 0.00%
- **NM**: 0.00 ppb, 0.00%
- **Eastern**: 0.00 ppb, 0.00%
- **Canada**: 0.02 ppb, 0.02%
- **Mexico**: 0.00 ppb, 0.00%
- **Ocean**: 0.04 ppb, 0.04%
- **Natural**: 2.25 ppb, 2.17%
- **Wild Fire**: 49.60 ppb, 47%
- **Rx Fire**: 0.00 ppb, 0.00%
- **AG Fire**: 0.00 ppb, 0.00%
State Contributions to Modeled DMAX8 Ozone Days

4th Highest Modeled DMAX8 Day at “Reno3” on State Street, Reno

High Day Contributions to MDA8 Ozone [ppb]

Source: WestJumpAQMS
State Contributions to Modeled DMAX8 Ozone Days

10th Highest Modeled DMAX8 Day at “Reno3” on State Street, Reno

High Day Contributions to MDA8 Ozone [ppb]

Site: NV_Washoe0016
Rank: 10 - 03 May, 2008
Total Ozone = 70.3 ppb
BC Ozone = 61.4 ppb (87.4%)

Source: WestJumpAQMS
Contributions to 2008 Ozone at Tuscan Buttes

Top 10 MDA8 Ozone and Its Contributions at CA_Tehama0004

Source: WestJumpAQMS
Five Ozone Planning Needs

1. Ozone NAAQS planning – requires photochemical modeling for SIP attainment demonstrations for nonattainment areas.

2. Ozone transport SIPs – photochemical source apportionment modeling can be used to quantify U.S. Ozone transport between states and jurisdictions.

3. Identification of Ozone exceptional events caused by stratospheric intrusion and wildfires – requires observations & data analysis, supplemented with global/regional scale photochemical models and regression models.

4. Identification of international transport of Ozone for §179B demonstrations: requires nested global and regional scale photochemical modeling to evaluate international transport of Ozone.

5. Identification of §182 Rural Transport Areas – combination of data analysis and photochemical modeling.

In the West under CAA, whom to do which?

- Alone or together?
- States/Locals
- Regional
- Federal
Uncertainty in model estimates of U.S. Background

CAMx simulations for 2007 and 2008 at Canyonlands National Park – Eastern UT


WRAP 2008 CAMx model: BC contributions of 50-72 ppb, much larger than OAQPS modeling.

Same methodology - reasons for modeled differences are not fully understood
O$_3$ in upper free troposphere is determined primarily by transport from boundaries

O$_3$ animation in Layer 21 (6-7 km) June 22 through July 4, 2008

Layer 21  1000*O3a

CAMx v5.41 Mech6 CF westjump.3612K.25L.base08b
a=epa.36km.chain

June 22,2008 1:00:00
Min=  0 at (1,1), Max= 104 at (77,95)
Background / Boundary Conditions evaluations:

- MOZART
- GEOS-Chem
- (now adding AM3)

Observations vs. Boundary Condition / Background Monthly Mean MDA8 Ozone

Animations of Modeled Daily Max Concentrations
- Background contribution
- Difference plots for background minus U.S. sources
  - O3, NOx, CO, PM2.5

Animations of Daily Max Concentrations for O3 and Dust Boundary Tracers

Boundary conditions plots:
- O3, Ox (O3+NO+NO2+PAN)
- Coarse Dust (CCRS), Fine PM (FPRM+FCRS)

http://views.cira.colostate.edu/tsdw/
Applications of global model data as regional modeling boundary conditions need to be codified between the science and regulatory communities.

Current, clear, and unambiguous scientific findings are needed about uncertainty, assessment methods, and applications of global modeling products as boundary conditions and to clarify transport within the U.S.

Resources and usable tools for applying data and knowledge from global models and observational studies across the West are likely beyond the scope of most/many air regulatory agencies – how will that work be done and when, and whom will be responsible for communicating those results?
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<th>WRF Layer</th>
<th>Sigma</th>
<th>Pressure (mb)</th>
<th>Height (m)</th>
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<th>CAMx Layer</th>
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37 Vertical layer interface definition for WRF simulations (left most columns), and approach for reducing to 25 vertical layers for CAMx/CMAQ by collapsing multiple WRF layers (right columns).
CAMx (Version 5.41) and CMAQ (Version 5.0.1) model configurations for WestJumpAQMS

<table>
<thead>
<tr>
<th>Science Options</th>
<th>Configuration</th>
<th>Details</th>
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<td>Model Codes</td>
<td>CAMx V5.41 – November 2012 Release</td>
<td>CAMx V6.00 was released in May 2013</td>
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<td>CMAQ V5.0.1 – July 2012 Release</td>
<td>CMAQ V5.0.1 is latest version</td>
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<td>Horizontal Grid Mesh</td>
<td>36/12/4 km</td>
<td>Many CAMx runs done using just 36/12 km grids</td>
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<td>36 km grid</td>
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<td>12 km grid</td>
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<td>4 km grid</td>
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<td>Vertical Grid Mesh</td>
<td>25 vertical layers, defined by WRF</td>
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<td>Grid Interaction</td>
<td>36/12/4 km two-way nesting for CAMx</td>
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<td>Initial Conditions</td>
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<td>Boundary Conditions</td>
<td>36 km from global chemistry model</td>
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<td>Sub-grid-scale Plumes</td>
<td>Plume-in-Grid not used, waiting for improvements in CAMx V6.1</td>
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<td>WRFCAMx and MCIP 4.1</td>
<td>Compatible with CAMx V5.4 and CMAQ V5.0.1</td>
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<td>Vertical Diffusion</td>
<td>CMAQ-like in WRFZCAMx</td>
<td>ACM2 for CMAQ V5.0.1</td>
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<td>Diffusivity Lower Limit</td>
<td>$K_{z_{min}} = 0.1$ to 1.0 m²/s or 2.0 m²/s</td>
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<td>Deposition Schemes</td>
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<td>M3Dry Pleim dry deposition (CMAQ)</td>
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</tr>
<tr>
<td>Wet Deposition</td>
<td>CAMx and CMAQ-specific formulation</td>
<td>rain/snow/graupel/virga</td>
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<tr>
<td>Numerics</td>
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<tr>
<td>Gas Phase Chemistry Solver</td>
<td>Euler Backward Iterative (EBI) -- Fast Solver</td>
<td>EBI implemented in both CAMx and CMAQ</td>
</tr>
<tr>
<td>Vertical Advection Scheme</td>
<td>Implicit scheme w/ vertical velocity update (CAMx)</td>
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<tr>
<td></td>
<td>New vertical velocity scheme (CMAQ)</td>
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<tr>
<td>Horizontal Advection Scheme</td>
<td>Piecewise Parabolic Method (PPM) scheme</td>
<td>PPM in both CAMx and CMAQ</td>
</tr>
<tr>
<td>Integration Time Step</td>
<td>Wind speed dependent</td>
<td>~0.1-1 min (4 km), 1-5 min (1-km), 5-15 min (36 km)</td>
</tr>
</tbody>
</table>