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

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WESTAR Council

Tribal Air Program Meeting - EPA Region 8
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
  - 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 (PMDETAI)
  - 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)
Western Regional Studies and Projects
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
  - FLM Joint Fire Science Program projects enable continuing operation of WRAP’s Fire Emissions Tracking System (http://www.wrapfets.org/)
  - 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 (DEASCO$_3$) – 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/

*New proposal under JFSP review:*
Track activity and emissions

Fire Activity Data (acres/day)

Loading Moisture

Distribute emissions

DEASCO₃ & PMDETAIL

Emissions Model

Chemical Profiles

loft emissions
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)
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
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
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
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
West-wide Jumpstart Air Quality Modeling Study
Final Project Report and Modeling Results

March 26, 2014

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Technical Project Team
ENVIRON, Alpine Geophysics, Univ. of North Carolina

Funding from State of NM, BP, and National BLM Air Program

Oversight by western states, local air agencies, federal land managers, EPA regional and national offices
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](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
Introduction

- West-wide Jump-start Air Quality Modeling Study (WestJumpAQMS) was initiated in late 2010 to:
  - Develop the next generation of regional air quality modeling databases for ozone, PM$_{2.5}$, visibility and deposition planning in the western U.S.
  - Provide information on the role of interstate and international transport to ozone and PM$_{2.5}$ under current and potential future NAAQS
  - Assess contributions of major source categories (e.g., point, O&G, mobile, et cetera) to air quality in the West
  - Provide detailed information to the community
Overview of Approach

- 2008 Modeling Database
  - 36 km CONUS
  - 12 km WESTUS
  - 4 km IMWD
- WRF meteorological; CAMx photochemical; SMOKE emissions models
- 2008 WRAP Phase III O&G emissions
- 2008 NEI emissions
- Model Evaluation
- Sensitivity Tests

- State-Specific and Source Category-Specific Ozone and PM$_{2.5}$ Source Apportionment Modeling
WestJumpAQMS Products

- Final Report
  - 15 Electronic Appendices
  - Response-to-Comments
- Ammonia Emissions Recommendations Memo
- Modeling Protocol
  - Response-to-Comments
- WRF Application/Evaluation Report
  - Evaluation down to individual monitoring site
  - Response-to-Comments

- 16 Technical Memorandums on Emissions
  1. Point Sources
  2. Area + Non-Road
  3. On-Road Mobile
  4a-e. Oil and Gas (5 geographic areas)
  5. Fire (WF, Rx & Ag)
  6. Fugitive Dust
  7. Off-Shore Shipping
  8. Ammonia
  9. Biogenic
  11. Mexico/Canada
  12. Sea Salt and Lightning
  13. Emissions Modeling Parameters

All information on WestJumpAQMS website
WestJumpAQMS Progress Webinars

- **June 20, 2013**: 2008 Database Development
- **July 26, 2013**: State-Specific Source Apportionment
- **August 29, 2013**: Source Category-Specific Source Apportionment
- Interactive agenda from WestJumpAQMS Final Project Report meeting, Denver, CO – September 25, 2013

**Presentations and all project materials at:**
http://www.wrapair2.org/WestJumpAQMS.aspx
Ozone, PM, Deposition, and Visibility Source Apportionment Resources from WestJumpAQMS

- Appendices A through I address Ozone

- Appendix J: Source Category-Specific Contributions to Annual PM\textsubscript{2.5} Design Values at Monitoring Sites in the 12 km WESTUS Domain using MATS (XLSX 2MB)

- Appendix K: Source Category-Specific Contributions to Modeled Annual PM\textsubscript{2.5} Concentrations (µg/m\textsuperscript{3}) at Monitoring Sites in the 12 km WESTUS Domain (XLSX 4MB)

- Appendix L: Source Category-Specific Contributions to 24-Hour PM\textsubscript{2.5} Design Values at Monitoring Sites in the 12 km WESTUS Domain using MATS (XLSX 2MB)

- Appendix M: Source Category-Specific Contributions to Ten Highest Modeled 24-Hour PM\textsubscript{2.5} Concentrations (µg/m\textsuperscript{3}) at Monitoring Sites in the 12 km WESTUS Domain (XLSX 10MB)

- Appendix N: Annual Sulfur and Nitrogen Wet and Dry Deposition at IMPROVE Monitors by Species (XLSX 1MB)

- Appendix O: Western State-Specific Modeled Contributions to Visibility Impairment at IMPROVE Monitoring Sites for Modeled Worst (W20) and Best (B20) 20% Days during 2008 (ZIP 46MB)
Ozone Attainment Test Software – Unmonitored Area Analysis with Design Value (2006-2010) ≥ 76 ppb

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

Min(107,1) = 70.00, Max(45.67) = 113.30
Attainment Test Software – Unmonitored Area Analysis with Design Value (2006-2010) $\geq 65$ ppb

Min(177,1) = 65.00, Max(45,67) = 113.30
Ozone Attainment Test Software – Unmonitored Area Analysis with Design Value (2006-2010) ≥ 60 ppb

2008

Min(45,2) = 60.00, Max(45,67) = 113.30 ppb
State-Specific Ozone Source Apportionment

**Purpose**: To provide information on the role of ozone transport to exceedances of the current and potential future ozone NAAQS in the western U.S.

**Approach**: Analyze ozone apportionment several ways:

1. Upwind state contribution to downwind state nonattainment using Cross State Air Pollution Rule (CSAPR-type) approach
   - Use EPA method for projecting ozone Design Values (RRFs)
2. State contributions to modeled high ozone DMAX8 ozone at monitors in 12 km WESTUS domain
   - Spatial extent of modeled state contributions to 1stmax and 4thmax DMAX8 ozone greater than current and potential future NAAQS
   - Source category analysis (Natural, Fires & Anthropogenic)
3. Detailed Source Category-Specific Source Apportionment
   - 6 key source categories across 4 states in intermountain West
   - 2-way nesting between model domains
State-Specific Ozone Source Apportionment

- 2008 36/12 km Base
- 17 Western States
  - Plus EasternUS, Can, Mex & Off-Shore
- 5 Source Categories
  - Natural (Biogenics+Lightning+WBDust+SeaSalt)
  - WF, Rx and Ag Fires
  - Anthropogenic
- 107 Source Groups (21 x 5 + 2)
  - 4 Extra Species for each Group
    - 428 additional species
    - Standard Model = 70 species
    - Computationally Demanding
CSAPR-Type Analysis for Current (76 ppb) NAAQS

- CSAPR looked at contributions to:
  - Average Design Value = Average of DVs from 2006-2010
  - Max Design Values = Max DVs from 2006-2010

- 136 ozone monitors in 12 km WESTUS domain with Average Design Value exceeding NAAQS
  - 86 sites (63%) in California

- For 17 upwind western states examine 2008 contribution to DMAX8 ozone Design Value in downwind states
  - CSAPR used a 1% NAAQS significance threshold (≥0.76 ppb)

- This analysis is for 2008 and is not a regulatory analysis that would have to examine a future year
Arizona CSAPR-Type Ozone Analysis for 76 ppb NAAQS (from WestJumpAQMS Appendix A)

Arizona Ozone Contributions

[Graph showing contributions to top 5 states surrounding Arizona with bar heights indicating values and states listed nearby.]

Downwind State Design Values

[Graph showing contributions to top 5 states surrounding Arizona with bar heights indicating values and states listed nearby.]

Background:
- 76 ppb
- 70 ppb
- 65 ppb
- 60 ppb
Arizona CSAPR-Type Ozone Analysis for 65 ppb NAAQS (from WestJumpAQMS Appendix A)

Arizona Ozone Contributions

ARIZONA’s Contributions to Top 5 States Surrounding ARIZONA, where DV is at or above 65.0 ppb Threshold

- [ppb]
- Average: 67.00
- Maximum: 71.00

NM_San Juan1005
TX_El Paso0029
CO_Montezuma0101
NV_Clark0601
UT_Weber1003

Downwind State Design Values

States’ Contributions to Top 5 States Surrounding ARIZONA, where DV is at or above 70.0 ppb Threshold

- [ppb]
- Average: 67.00
- Maximum: 80.00

NM_San Juan1005
TX_El Paso0029
CO_Montezuma0101
NV_Clark0601
UT_Weber1003
Spatial Distribution of State Ozone Contributions

- Spatial distribution of state’s ozone contribution to DMAX8 ozone concentrations greater than or equal to:
  - 76 ppb (current NAAQS)
  - 70 ppb; 65 ppb and 60 ppb (potential future NAAQS)
  - 0 ppb (highest contribution in year)

- Two types of metrics:
  1. Maximum modeled contribution to Highest and 4th Highest DMAX8 ozone (from WestJumpAQMS Appendix C)
  2. Attainment Test Unmonitored Areas projection contribution to 8-hour ozone design value

- Examples for Colorado next:
  - Maximum contribution to highest DMAX8 ever and design value
  - Maximum contribution to 4th high DMAX8 for 76 and 65 ppb
2008 Colorado 8-Hour Ozone Contribution

Highest Modeled Contribution
(actual 2008 emissions)

Attainment Test Design Value Contribution
(EPA and states have used both a 3-year average or an average of three 3-year averages)

Contrib. to CAMx Daily Max 8-Hour Ozone >= 0 ppb
CO Anthropogenic Max Contribution

Max(144,110) = 29.18

Min(3,1) = 0.00, Max(142,107) = 17.60
Colorado Max Contribution to 4th High DMAX8 Ozone

**Contrib. to CAMx Daily Max 8-Hour Ozone >= 76 ppb**
CO Anthropogenic 4th Highest Contribution

Max(142,109) = 24.25

**Contrib. to CAMx Daily Max 8-Hour Ozone >= 65 ppb**
CO Anthropogenic 4th Highest Contribution

Max(142,109) = 24.25
“Other Sources” Max Contrib. 4th High DMAX8 Ozone

Boundary Conditions

- Wildfire
  - Contrib. to CAMx Daily Max 8-Hour Ozone >= 0 ppb
  - Contrib. to CAMx Daily Max 8-Hour Ozone >= 0 ppb
  - Max(129.53) = 60.13

Natural

- Prescribed Fire
  - Contrib. to CAMx Daily Max 8-Hour Ozone >= 0 ppb
  - Contrib. to CAMx Daily Max 8-Hour Ozone >= 0 ppb
  - Max(116.41) = 6.16

Anthropogenic

- Agricultural Fire
  - Contrib. to CAMx Daily Max 8-Hour Ozone >= 0 ppb
  - Contrib. to CAMx Daily Max 8-Hour Ozone >= 0 ppb
  - Max(79.51) = 3.15
Northern California Wildfires June-July 2008
Denver Ozone Monitors July 2008
Pilot Study - Detailed Source Category-Specific Ozone Source Apportionment

• Six Source Categories:
  • Natural (Biogenic, Lightning, Sea Salt & WBD)
  • Fires (WF, Rx, & Ag)
  • Upstream Oil and Gas (O&G)
  • Point Sources (EGU & Non-EGU)
  • Mobile Sources (on-road, non-road & CMV)
  • Remainder (Area/Non-Point)

• Ozone Apportionment
  • May-Aug 2008
  • 36/12/4 km Domains
  • 4 States (CO, NM, UT & WY)
Pilot Study - Ozone Source Category-Specific Source Apportionment

4 km Detailed Source Apportionment Domain

36/12/4 km Two-Way Grid Nesting

(Results in Appendix I on WestJumpAQMS webpage)
Detailed Pilot Study: 2008 4\textsuperscript{th} Highest Modeled Contribution to Ozone (from WestJumpAQMS Appendix I)

Example: Colorado\_JeffersonCounty0006

Rank (4) 07/15/08; Model = 75.0 ppb; Obs = 77.8 ppb; Bias = -3.5%; BC = 40.4 ppb (53.9%)
WestJumpAQMS Benefited From

- WRAP Regional Modeling Center (2002 Platform)
- Four Corners Air Quality Task Force (2005 Platform)
  - NEPA O&G EIS using PGM for far-field AQ/AQRV
- Denver Ozone SIP Modeling and Follow-On
- 2008 National Emissions Inventory (2008 NEIv2.0)
  - Cornerstone to 2008 emissions
- WRAP Phase III O&G Emissions Study
  - Projected to 2008 plus add Permian Basin
- WESTAR-funded MEGAN Biogenic Emissions Enhancement Study
- DEASCO$_3$ 2008 Fire Emissions
Benefited from WestJumpAQMS (so far)

- Colorado Air Resource Management Study (CARMMS)
  - 2008 4 km Modeling Platform

- Deterministic & Empirical Assessment of Smoke’s Contribution to Ozone (DEASCO$_3$)
  - 2008 36/12 km Modeling Platform

- PMDETAIL -- Smoke contributions to PM

- Three-State Data Warehouse (3SDW) and Three-State Air Quality Study (3SAQS)
  - 2008 36/12/4 km Modeling Platform; Test database for 3SDW

- Additional Follow-On Studies
  - NPS, BLM, etc.
Thanks –

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