

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

March 26, 2014

Tom Moore
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WESTAR Council

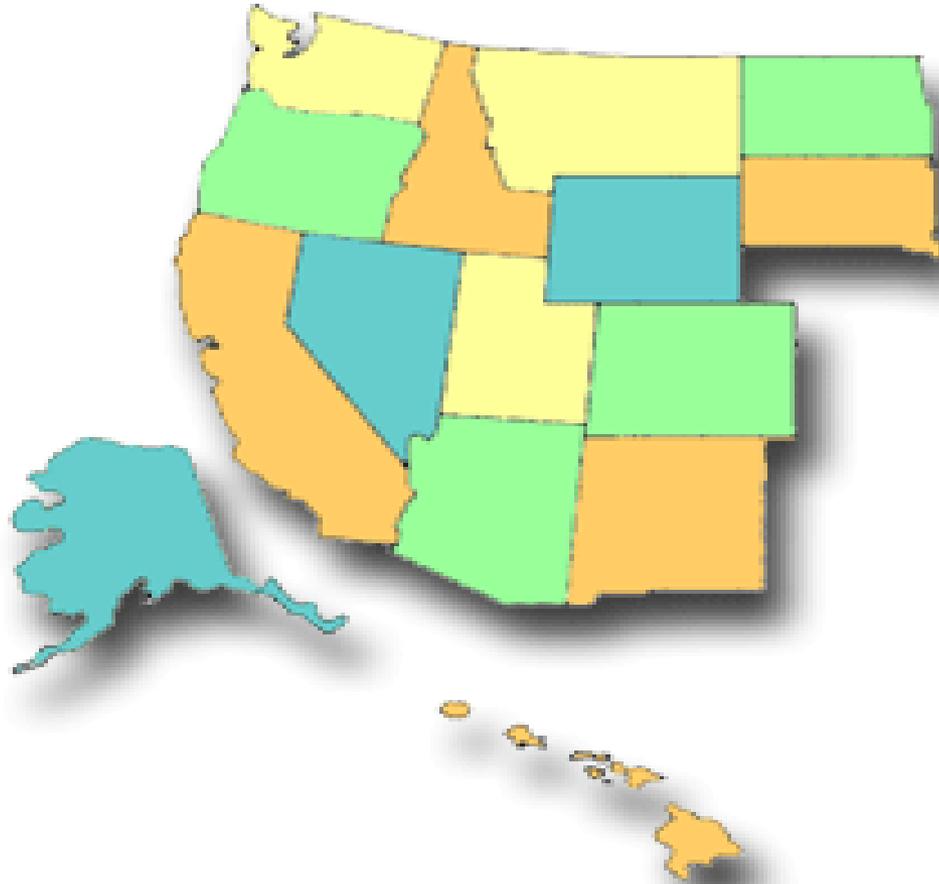
Tribal Air Program Meeting - EPA Region 8



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
- 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.

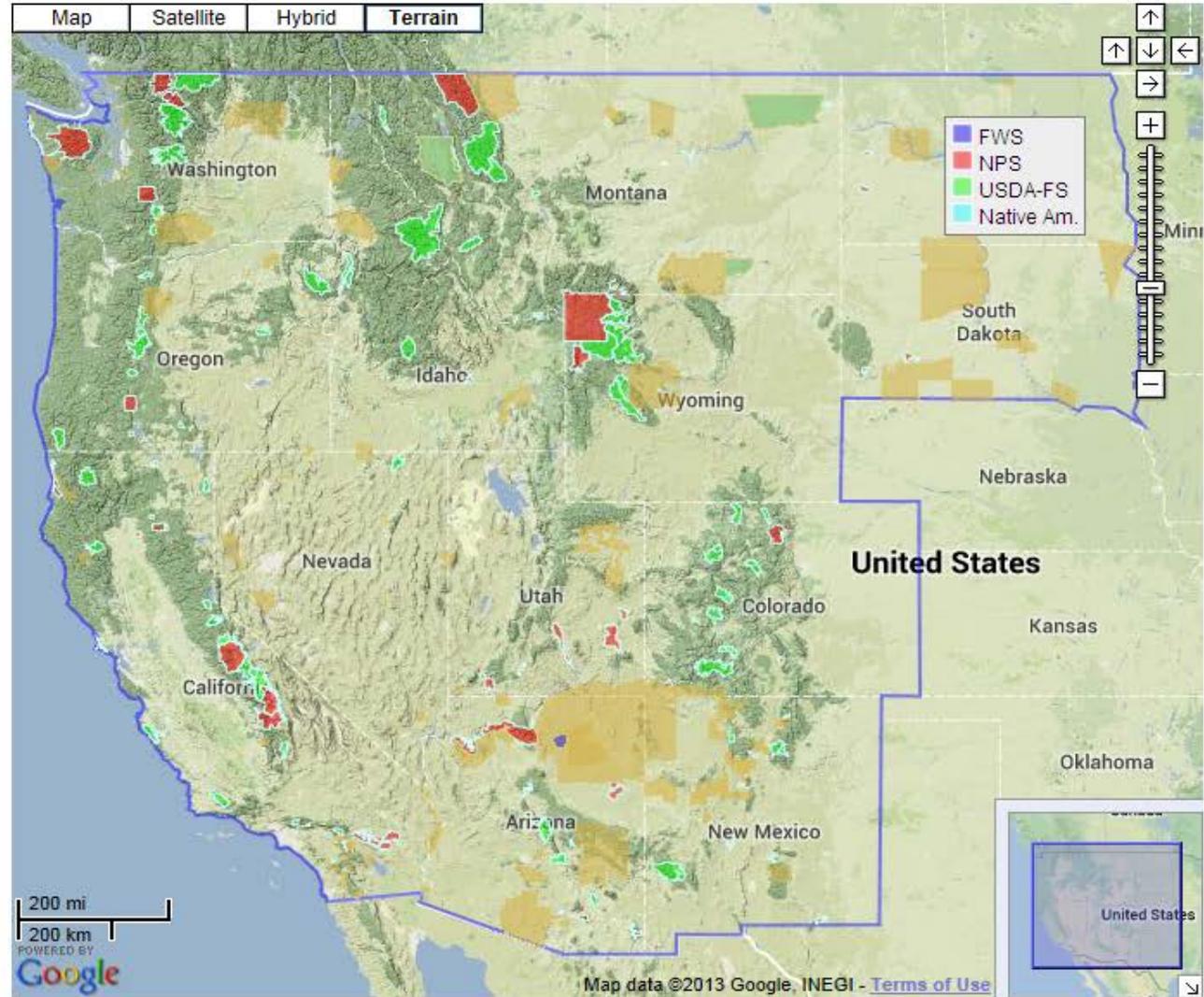
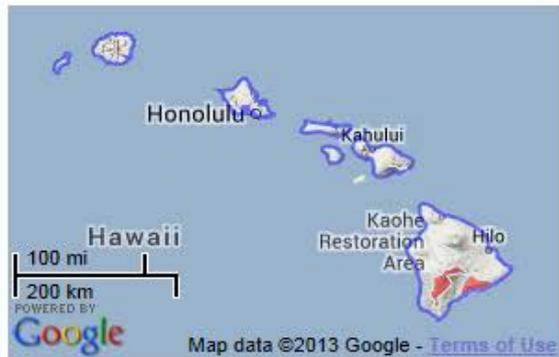
WESTAR / WRAP geographic region



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

WRAP Region Areas and Points of Interest



- 15 states, federal land managers and EPA, tribes, and local air districts
- Regional analyses for Western sources and air quality impacts

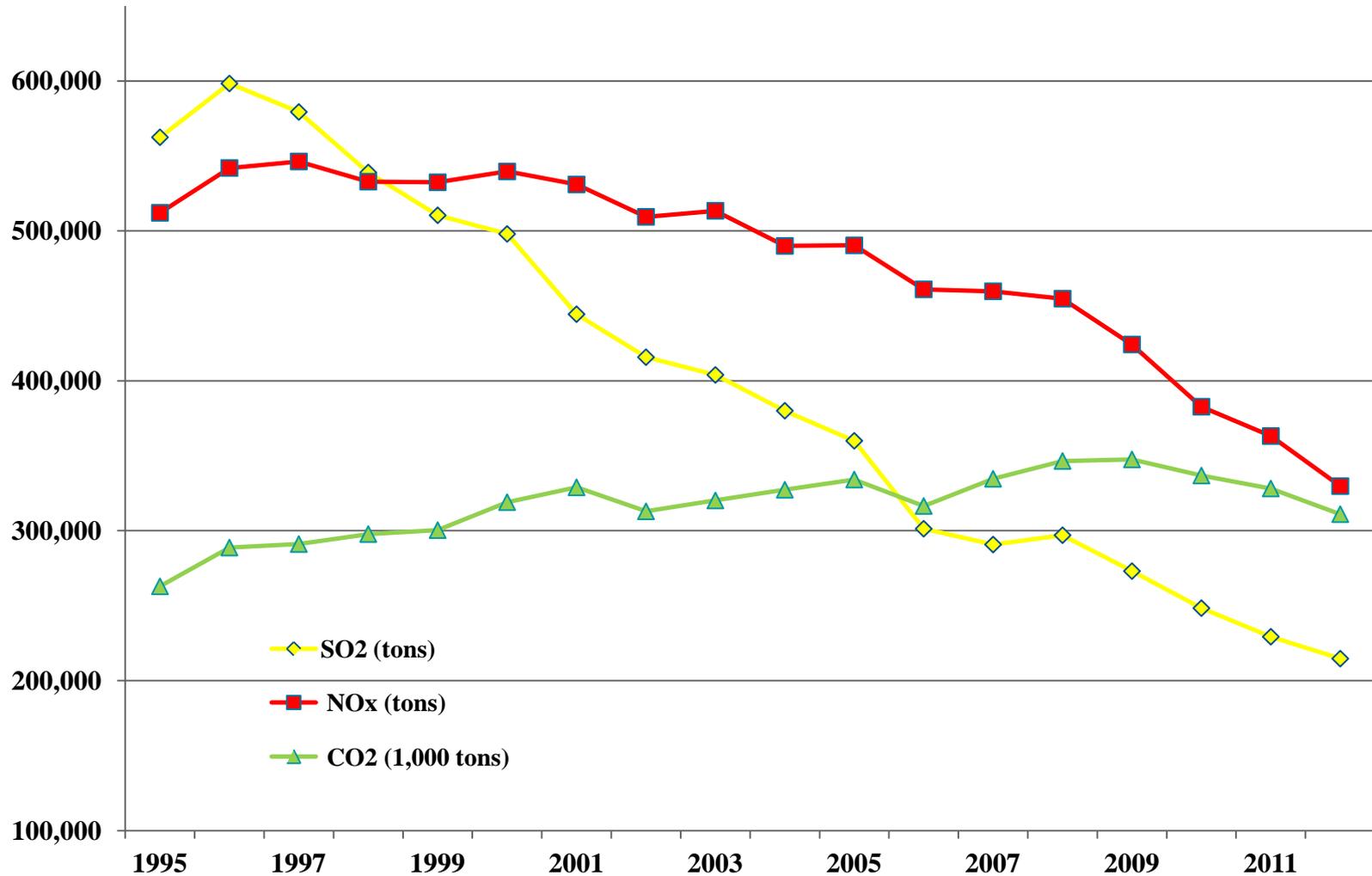
WRAP, continued

- 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

Power Plant Emissions Trends – Western Interconnect



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 ([DEASCO₃](#))
 - 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](#))



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 (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/>**

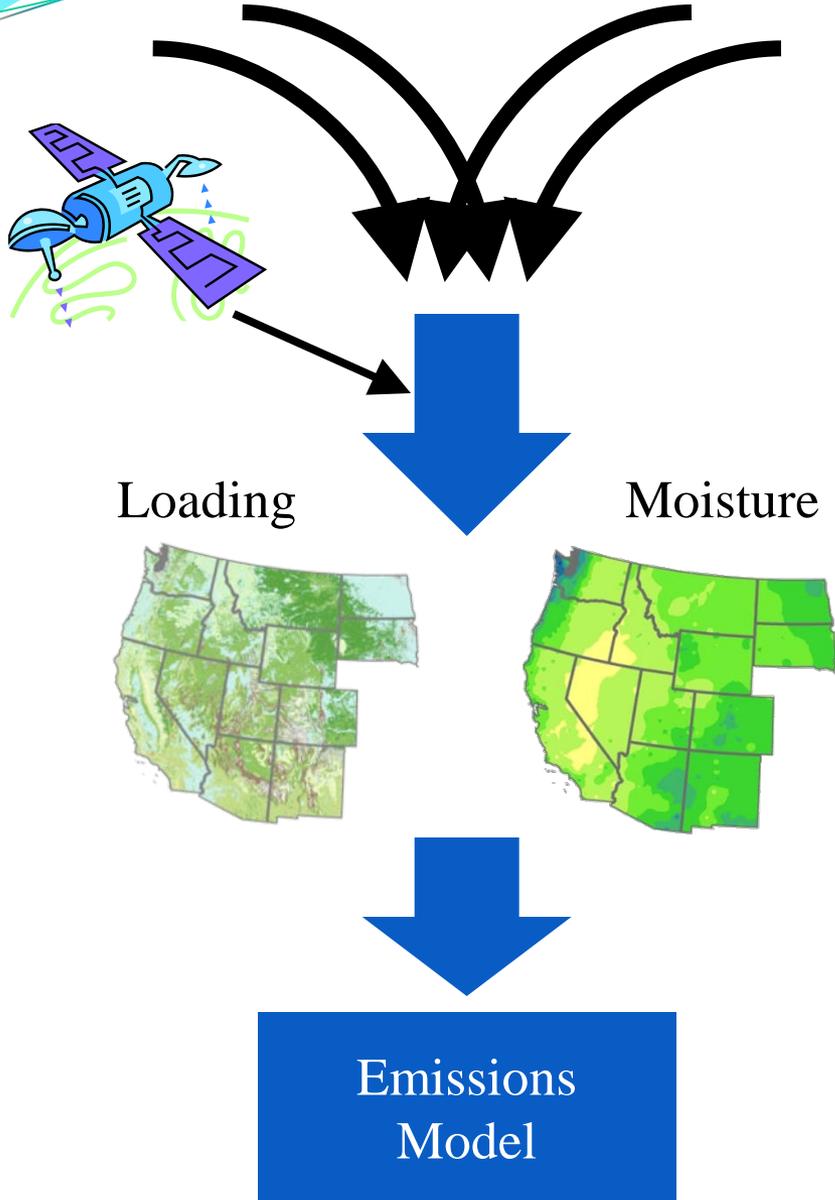
New proposal under JFSP review:

Contribution of Smoke Emissions to Secondary Organic Aerosols (SOA): Real-World Evaluation of Fire SOA Emissions Factors from Fires in a Data Management System (REFERS-DMS)

Track activity and emissions

Determine source impact / contribution

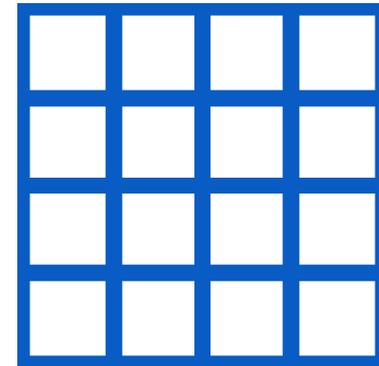
Fire Activity Data (acres/day)



FETS

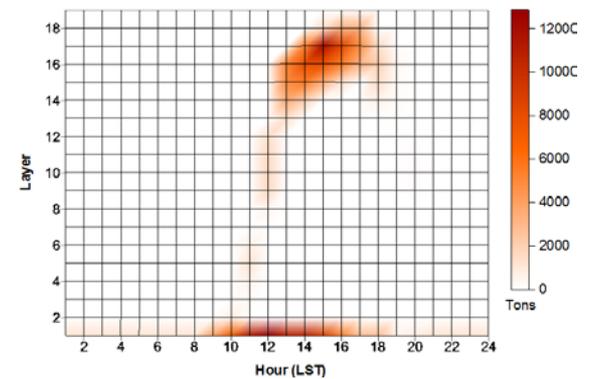
DEASCO₃ & PMDETAIL

distribute emissions



Chemical Profiles

loft emissions



Leveraging

EPA NEI &
WRAP Western Data

WestJumpAQMS

Improved AQ
Planning



DEASCO₃

Exceptional Event
applications

2008 WRAP Fire and
NEIv2 Fire data
(USFS collaboration)

PMDETAIL

Completed DEASCO₃ 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

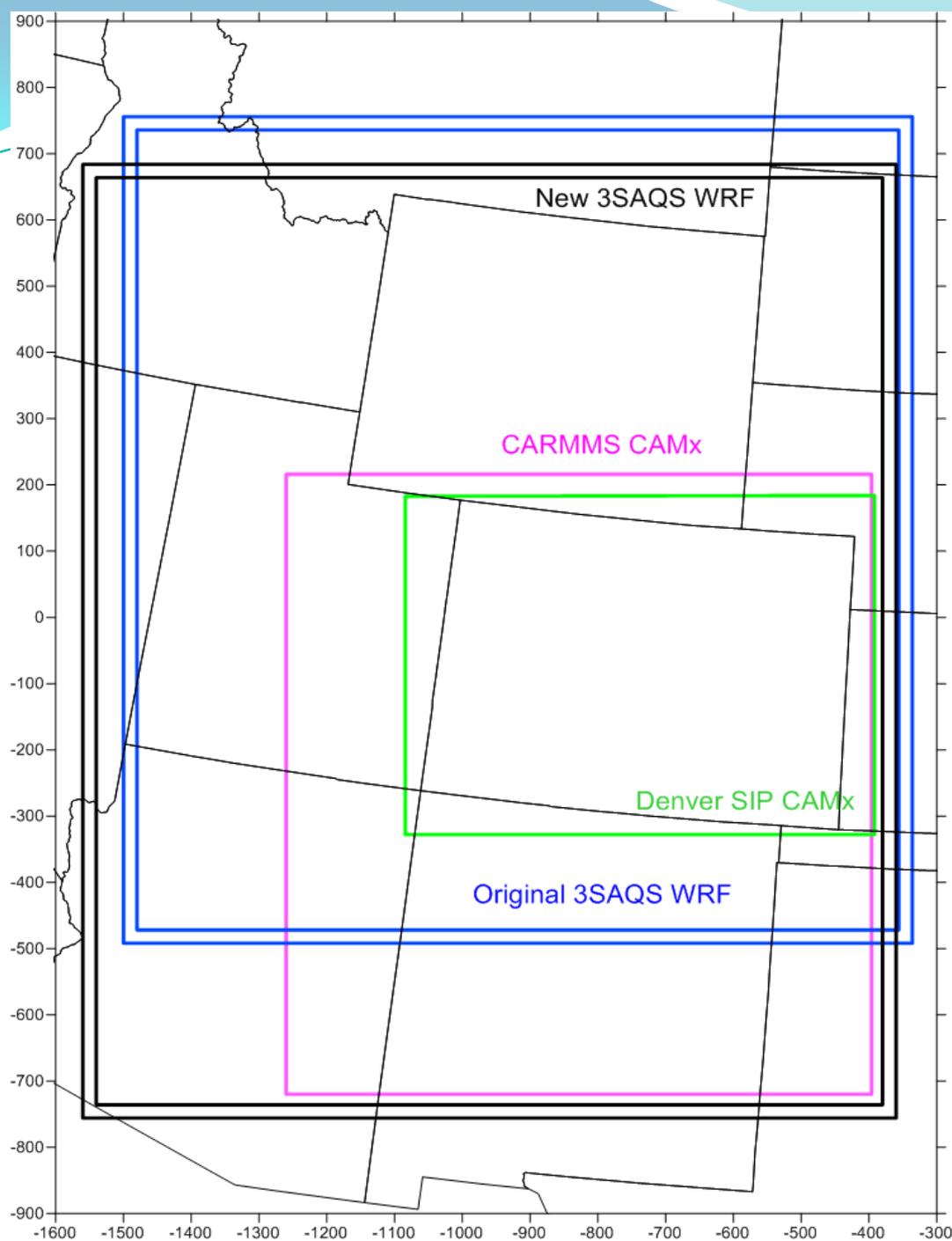
(funding by Western Energy Alliance , EPA, States of WY and ND, BLM)

- 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

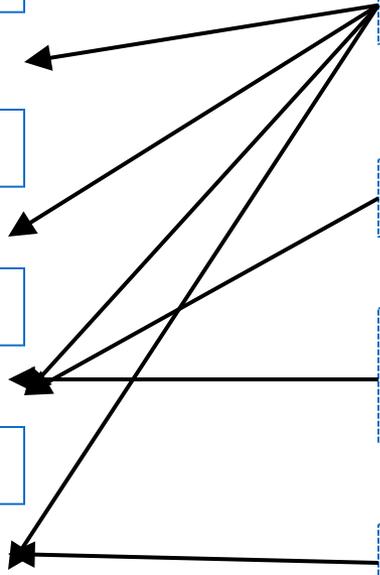
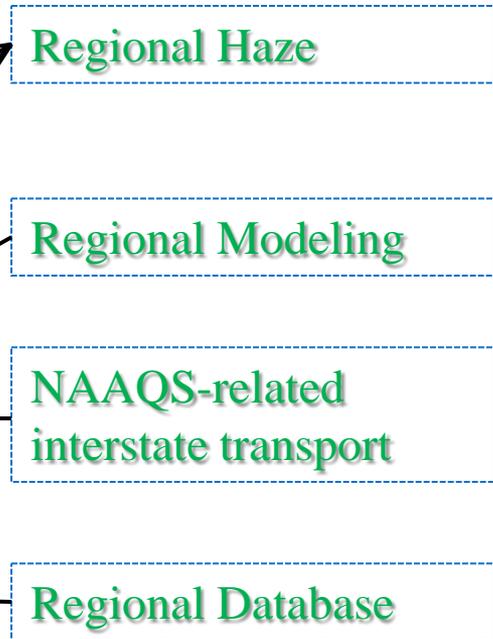
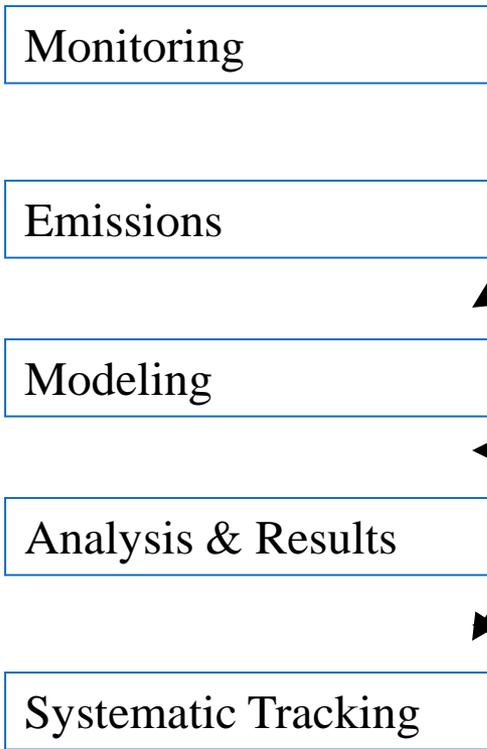
Opportunities for Data Warehouse and Applying Regional Modeling Results from Western Regional Technical Studies

- 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

Western Regional Modeling Framework (future)

3-State Data Warehouse



Western Regional Modeling Framework

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



March 26, 2014

Tom Moore

WRAP Air Quality Program Manager

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

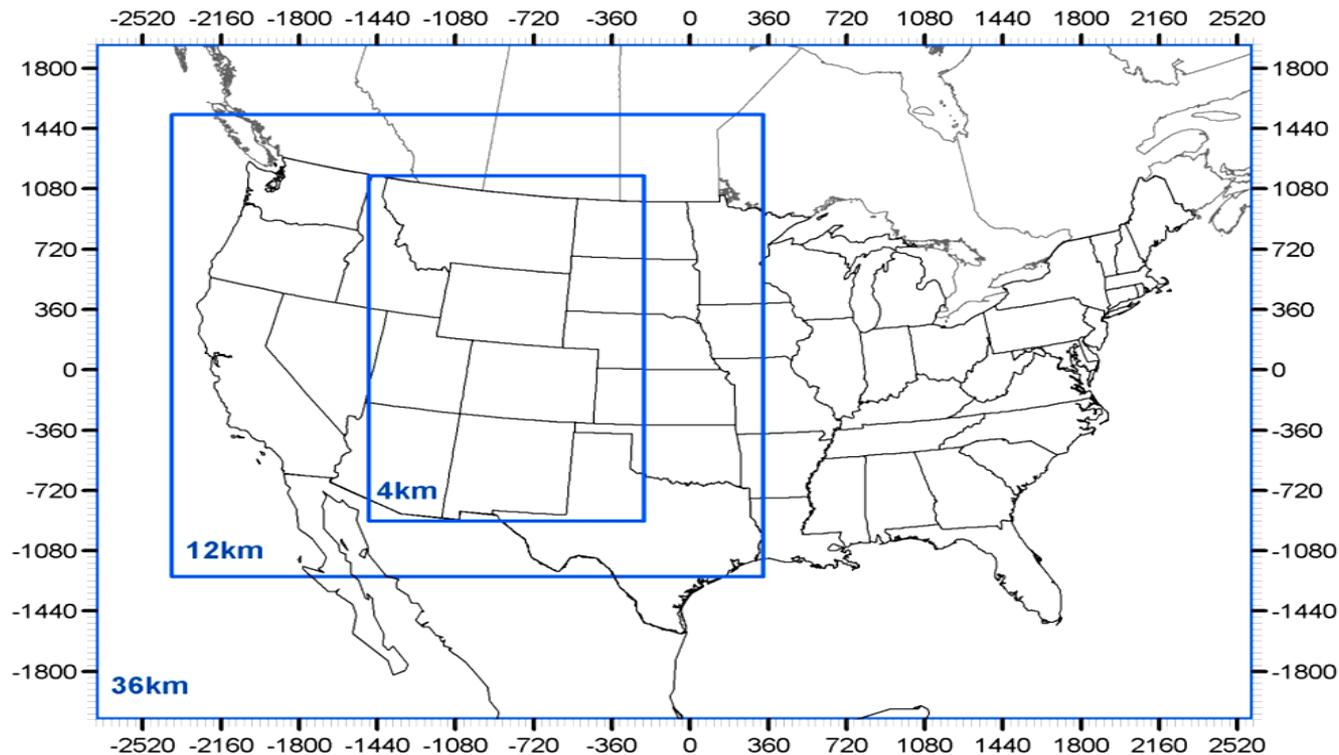


West-Wide Jumpstart Air Quality Modeling Study

(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>
 - 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)

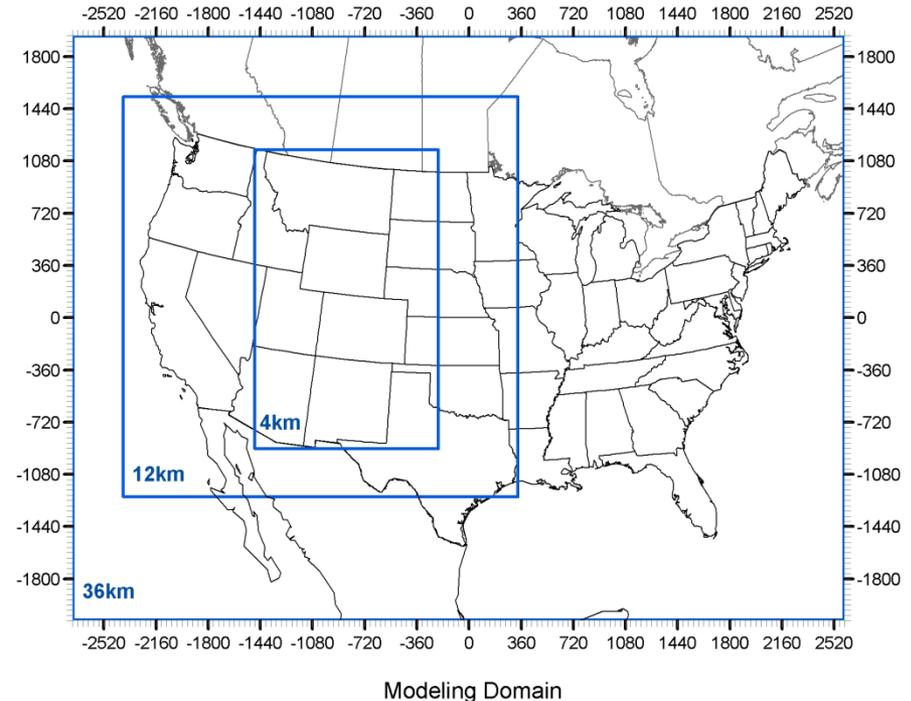
* includes buffer cells

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

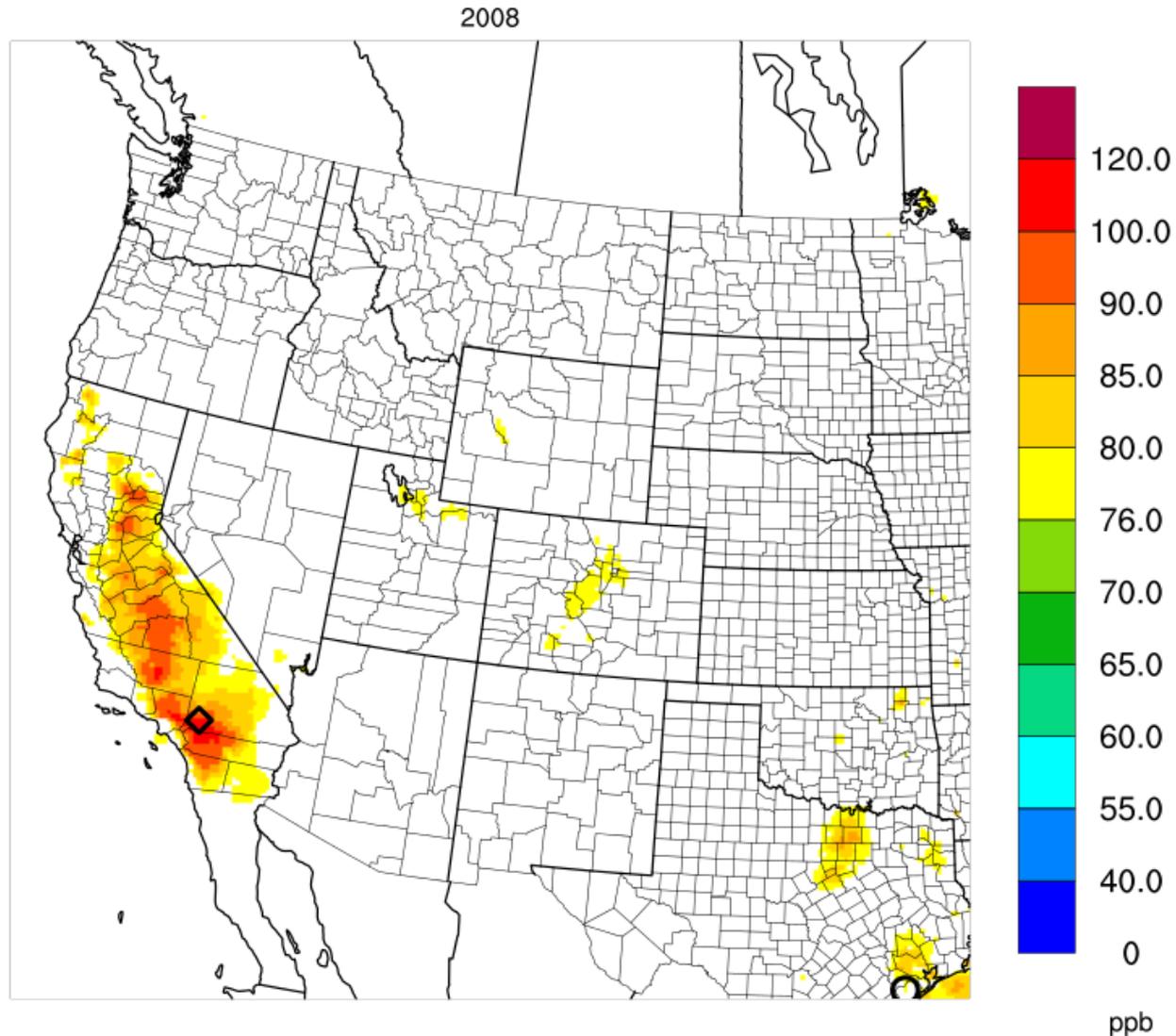
WestJumpAQMS Progress Webinars

- 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

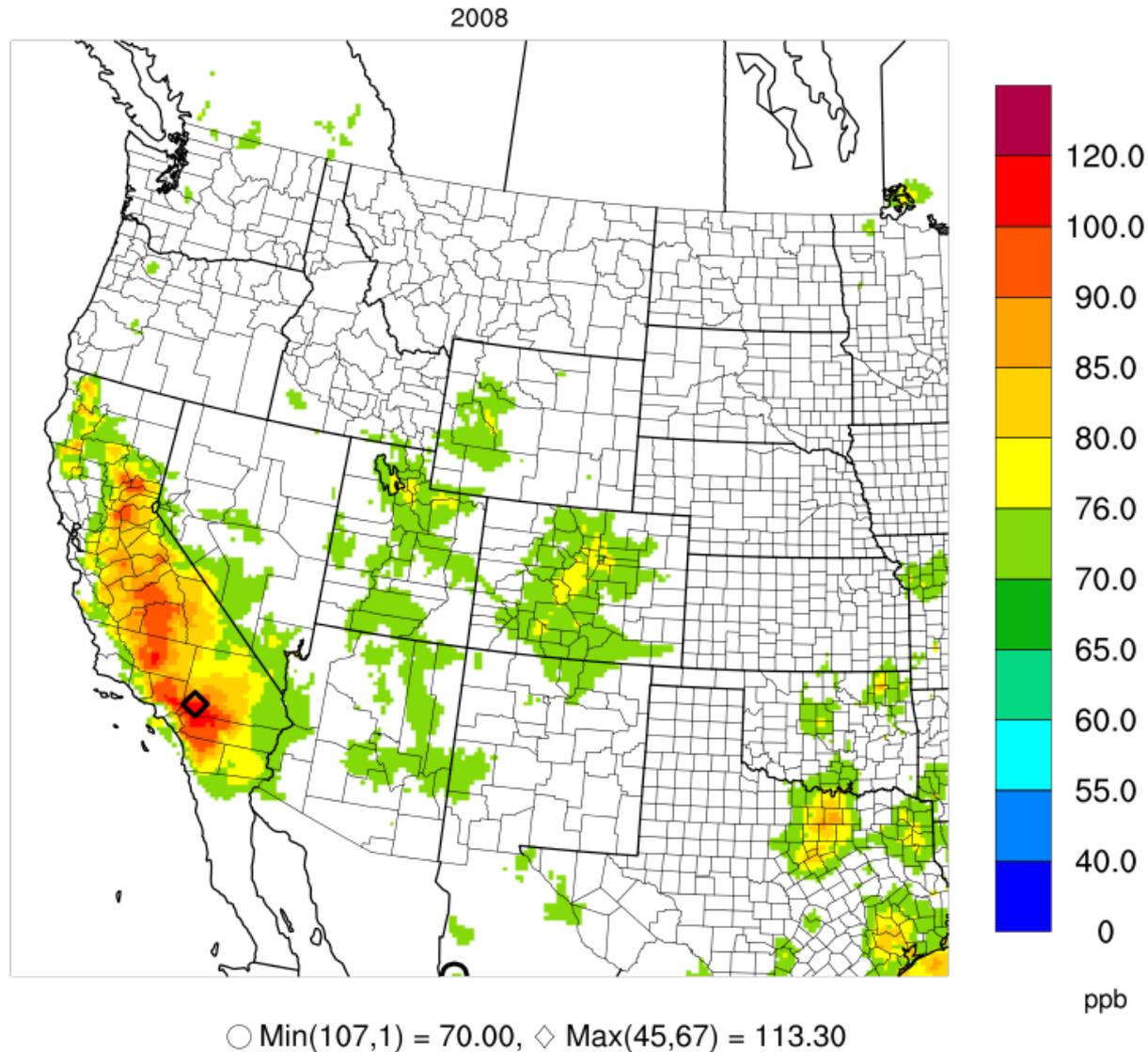
- Appendices A through I address Ozone
- Appendix J: Source Category-Specific Contributions to Annual PM_{2.5} Design Values at Monitoring Sites in the 12 km WESTUS Domain using MATS ([XLSX](#) 2MB)
- Appendix K: Source Category-Specific Contributions to Modeled Annual PM_{2.5} Concentrations (µg/m³) at Monitoring Sites in the 12 km WESTUS Domain ([XLSX](#) 4MB)
- Appendix L: Source Category-Specific Contributions to 24-Hour PM_{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_{2.5} Concentrations (µg/m³) 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



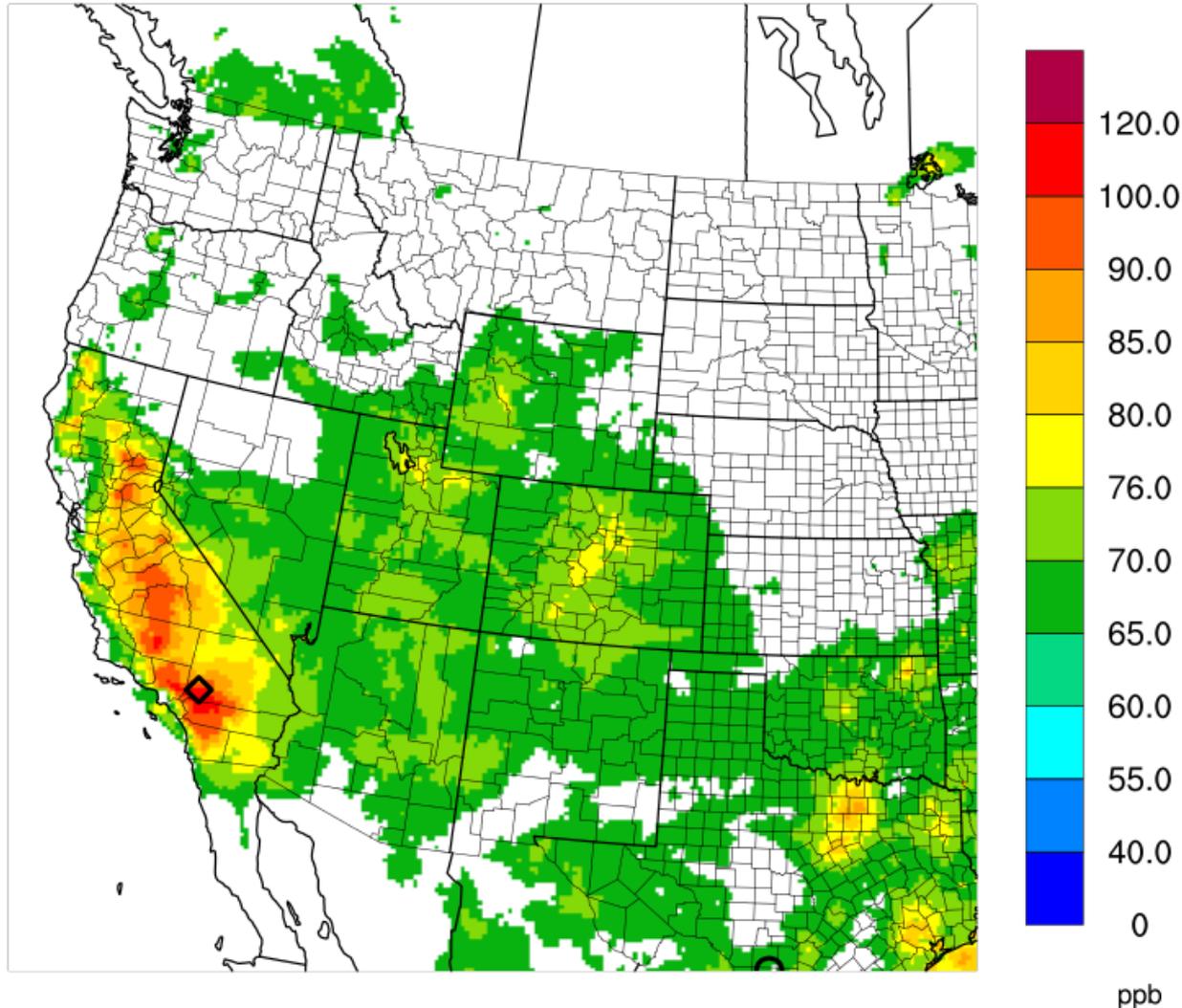
○ Min(210,3) = 76.00, ◇ Max(45,67) = 113.30

Ozone Attainment Test Software – Unmonitored Area Analysis with Design Value (2006-2010) ≥ 70 ppb



Attainment Test Software – Unmonitored Area Analysis with Design Value (2006-2010) ≥ 65 ppb

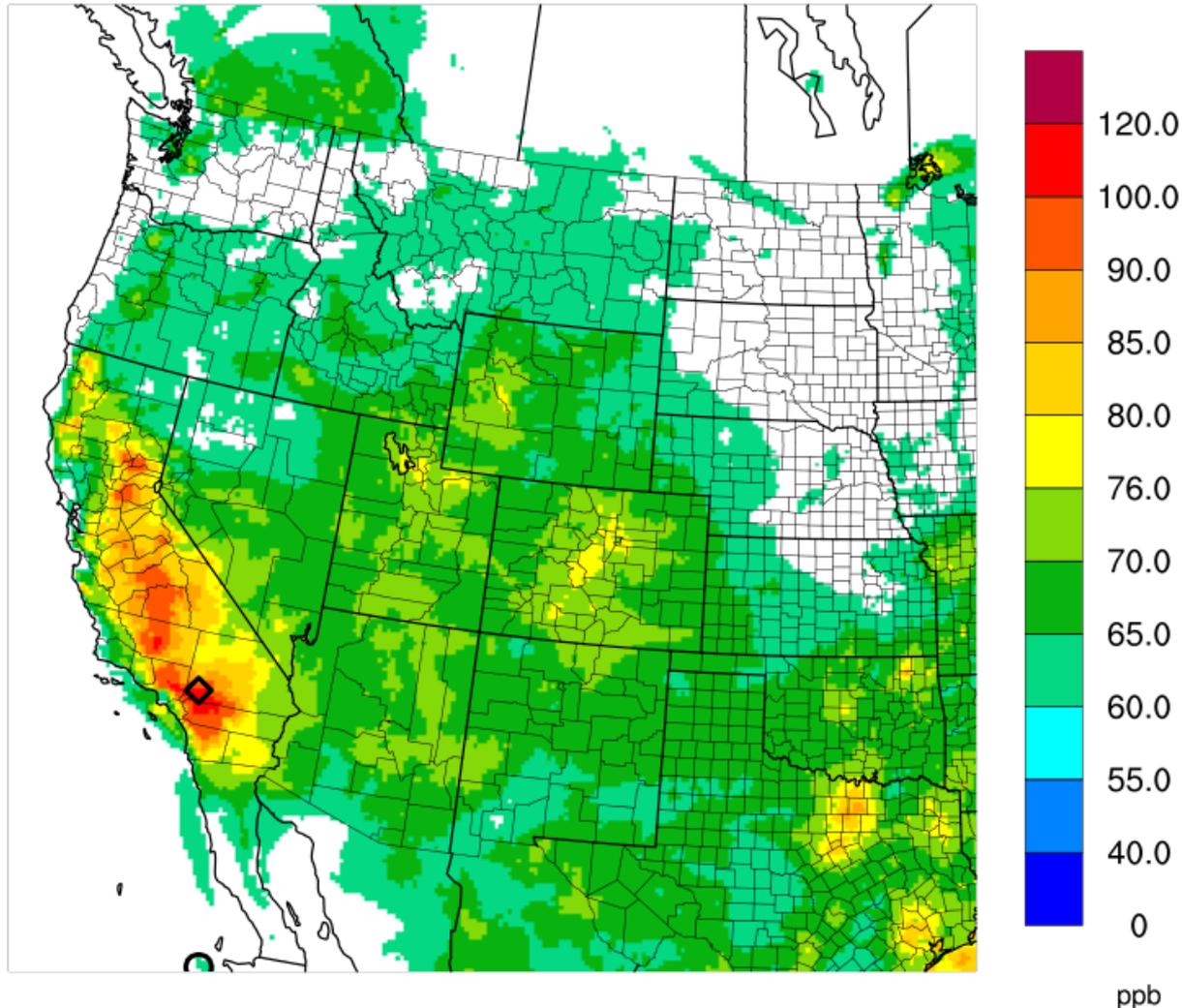
2008



○ 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



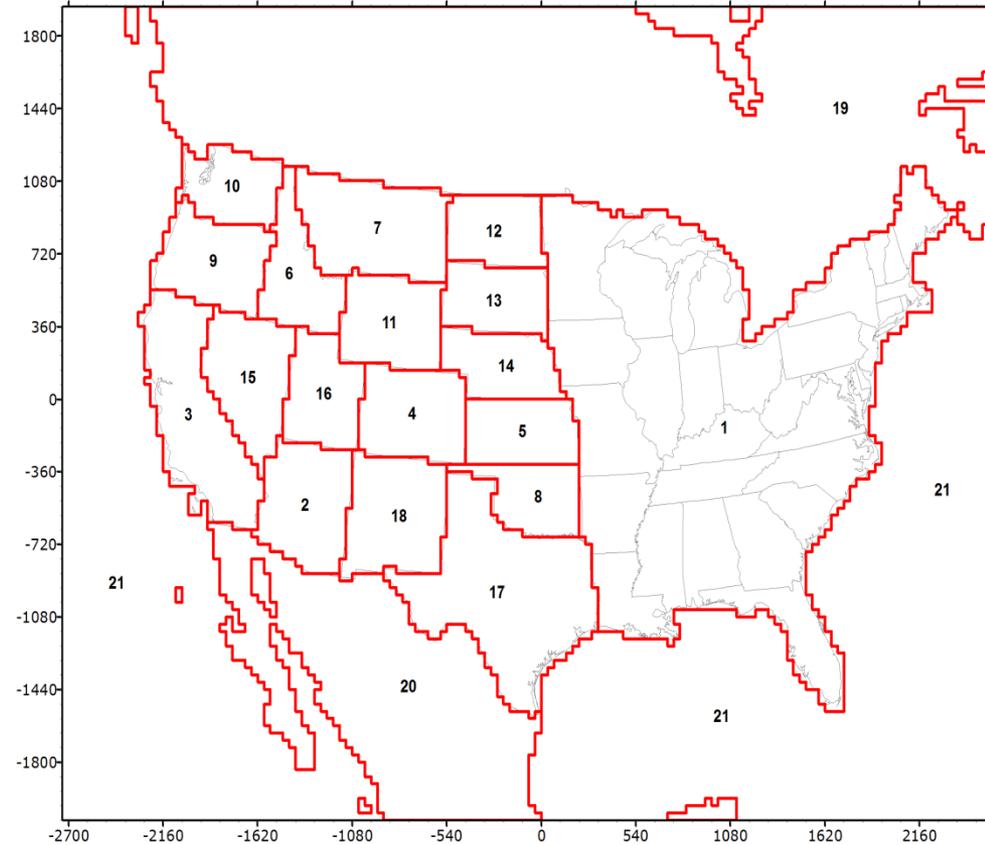
○ Min(45,2) = 60.00, ◇ Max(45,67) = 113.30

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

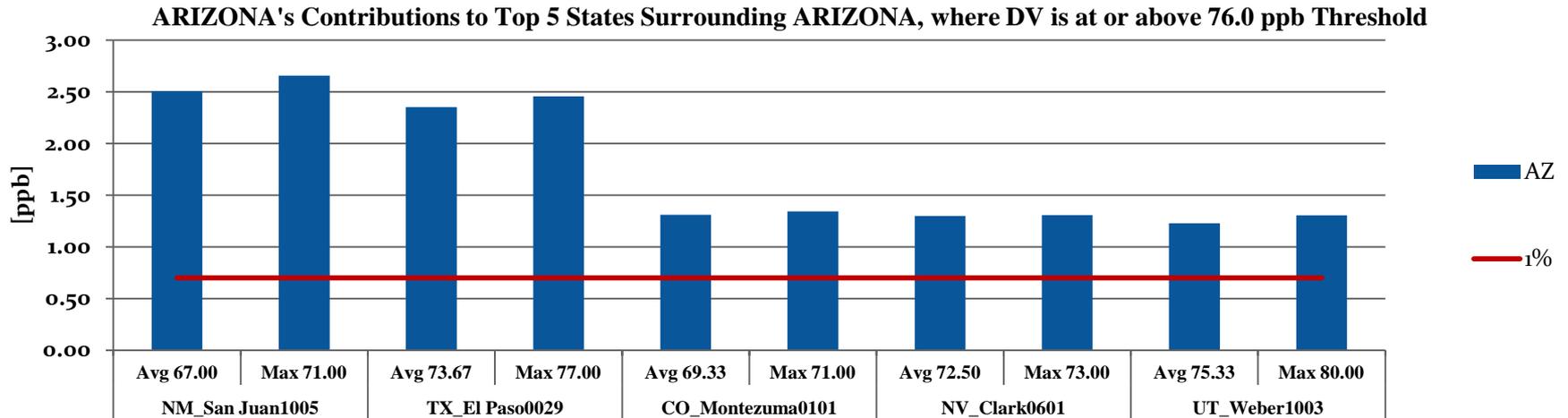


CSAPR-Type Analysis for Current (76 ppb) NAAQS

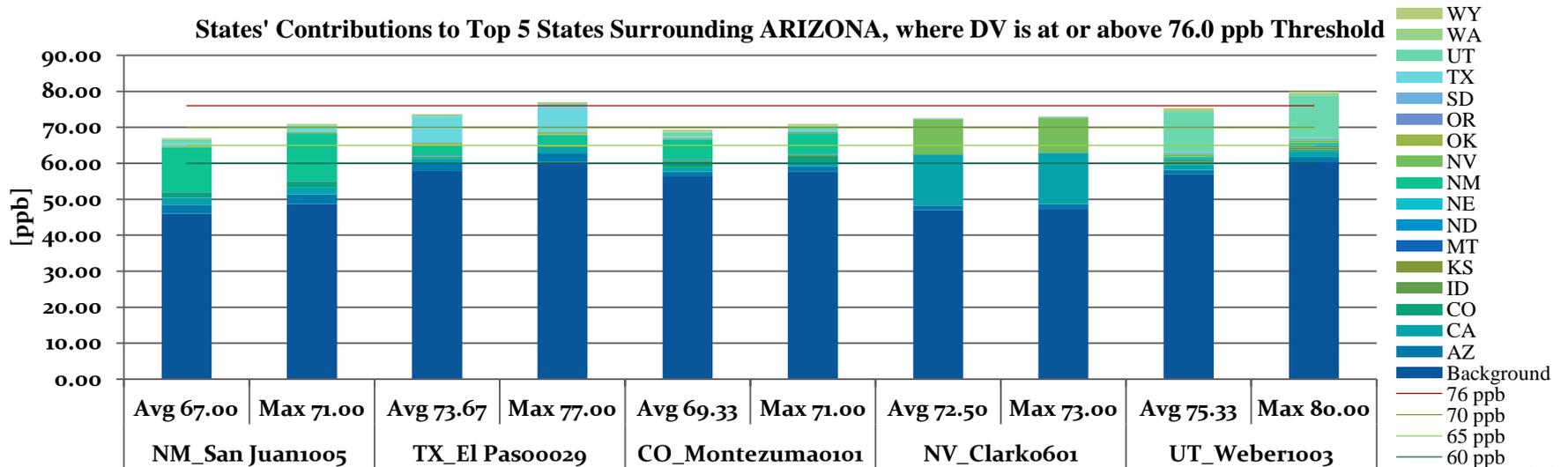
- CSAPR looked at contributions to:
 - Average Design Value = Average of DVs from 2006-2010
 - Max Design Values = Max DVs from 2006-2010
- 136 ozone monitors in 12 km WESTUS domain with Average Design Value exceeding NAAQS
 - 86 sites (63%) in California
- For 17 upwind western states examine 2008 contribution 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

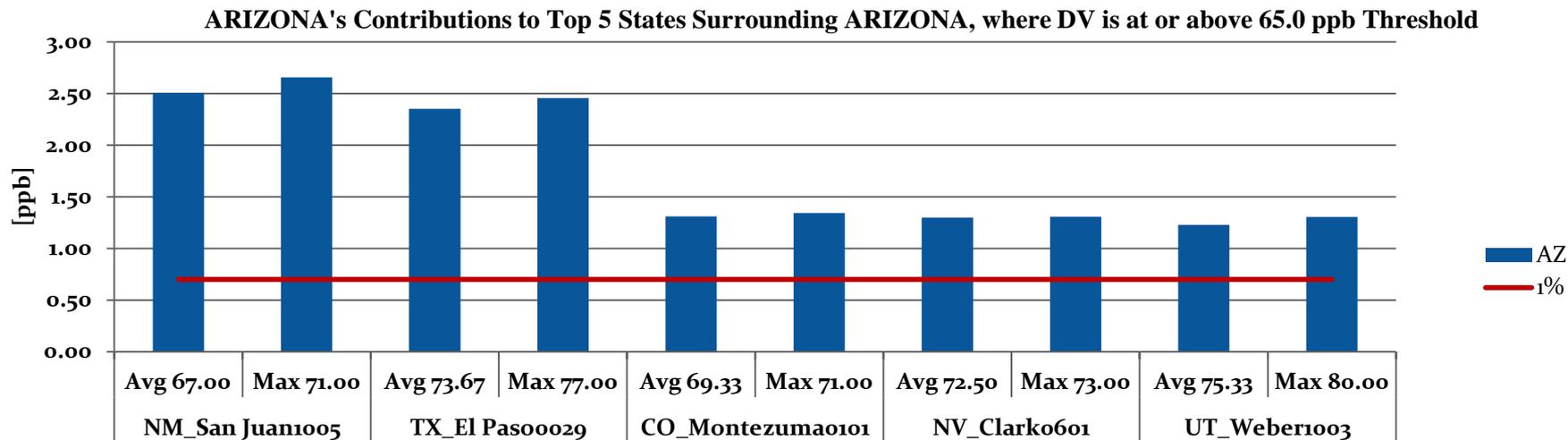


Downwind State Design Values

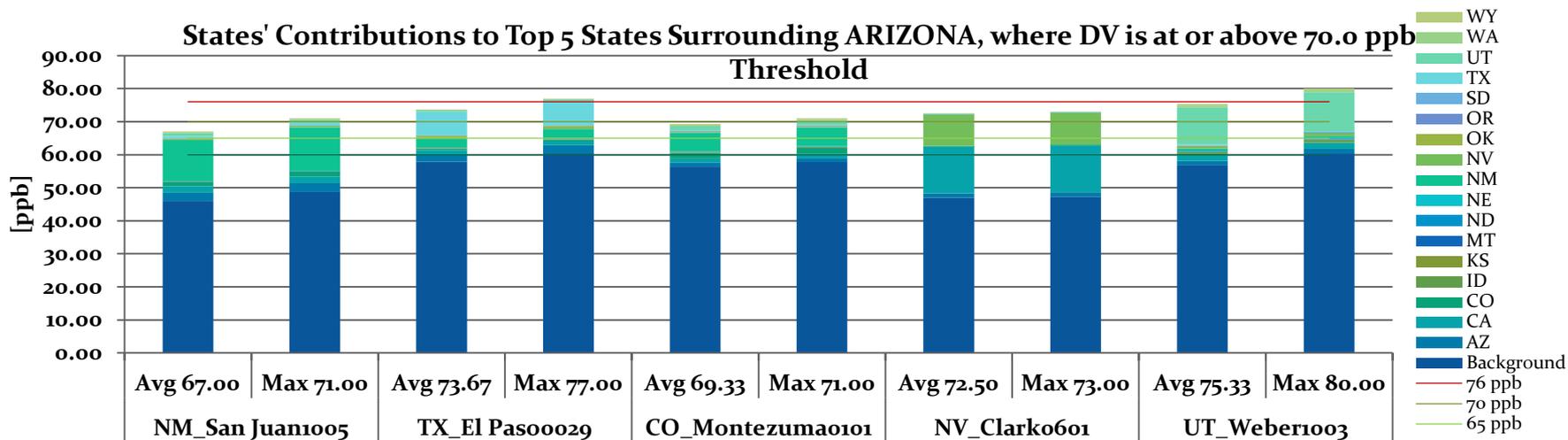


Arizona CSAPR-Type Ozone Analysis for 65 ppb NAAQS (from WestJumpAQMS Appendix A)

Arizona Ozone Contributions



Downwind State Design Values



Spatial Distribution of State Ozone Contributions

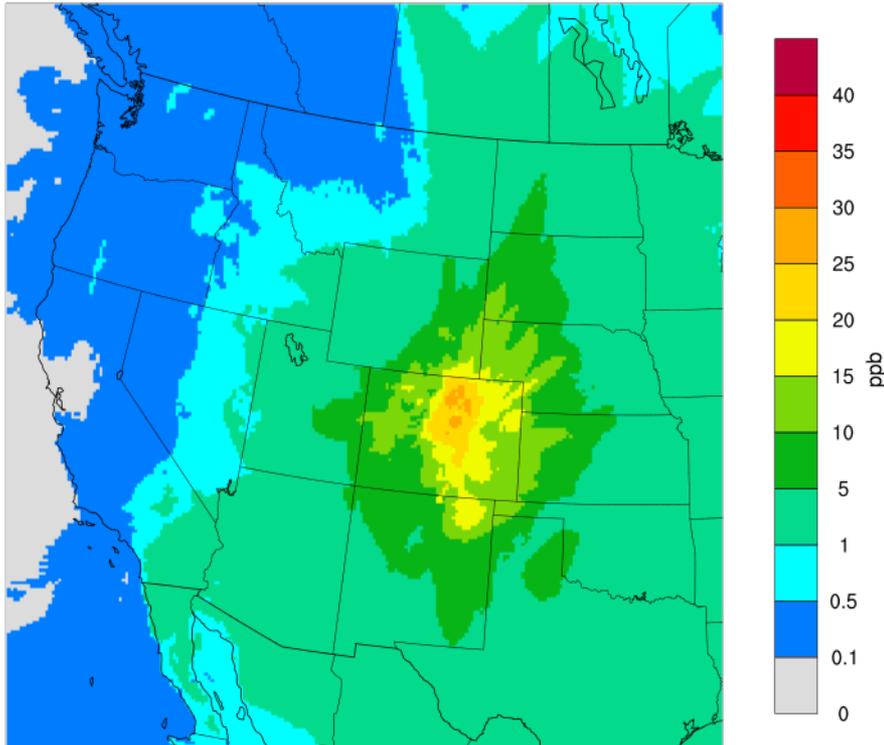
- Spatial distribution of state's ozone contribution to DMAX8 ozone concentrations greater than or equal to:
 - 76 ppb (current NAAQS)
 - 70 ppb; 65 ppb and 60 ppb (potential future NAAQS)
 - 0 ppb (highest contribution in year)
- Two types of metrics:
 1. Maximum modeled contribution to Highest and 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)

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



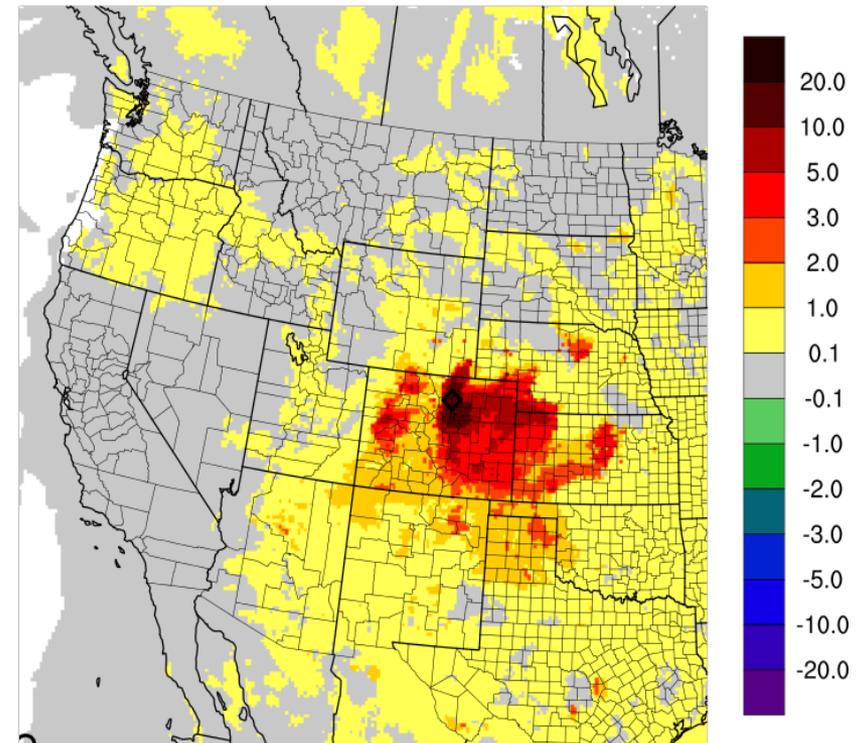
Max(144,110) = 29.18

Attainment Test Design Value Contribution

(EPA and states have used both a 3-year average or an average of three 3-year averages)

CO

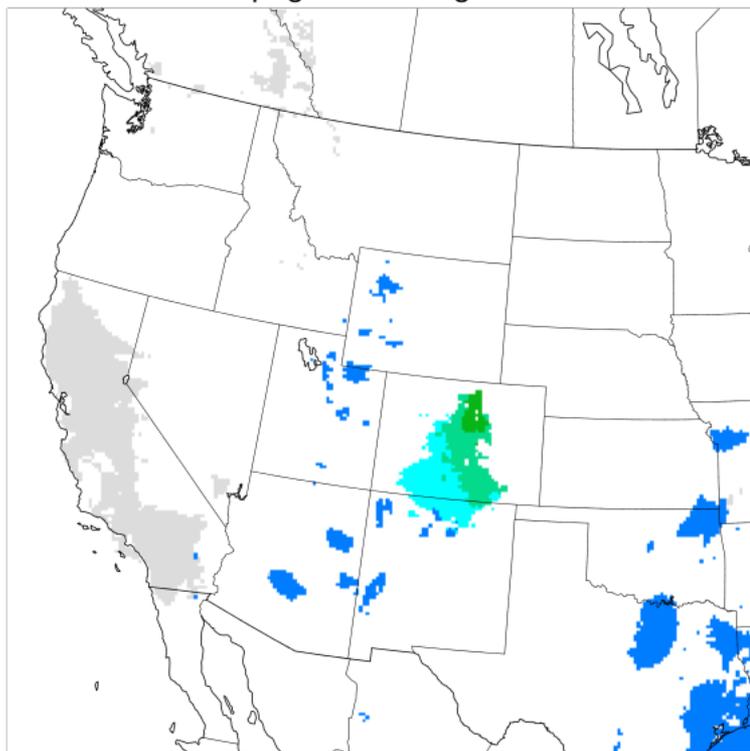
2008



○ Min(3,1) = 0.00, ◇ Max(142,107) = 17.60

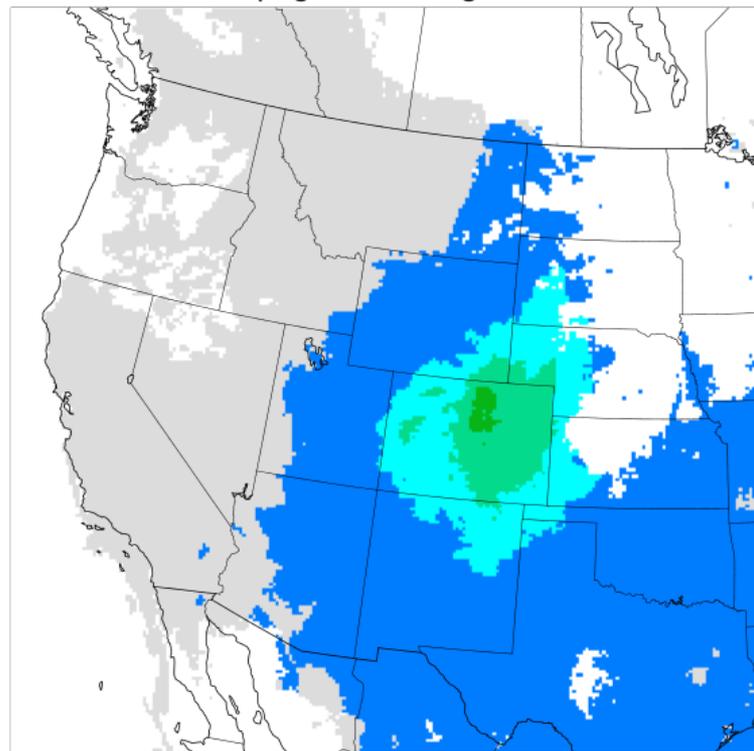
Colorado Max Contribution to 4th High DMAX8 Ozone

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

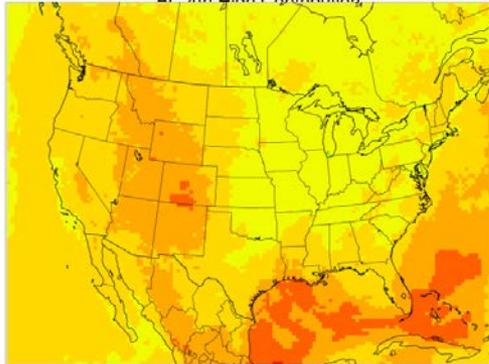
“Other Sources” Max Contrib. 4th High DMAX8 Ozone

Boundary Conditions

Natural

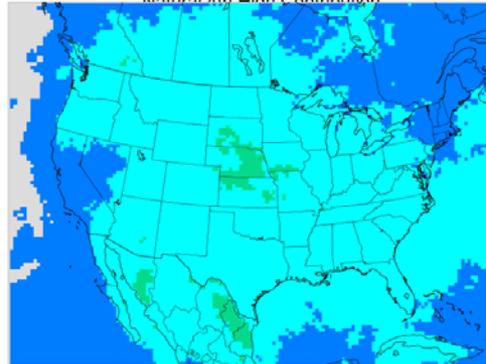
Anthropogenic

Contrib. to CAMx Daily Max 8-Hour Ozone ≥ 0 ppb
BC 4th High Contribution



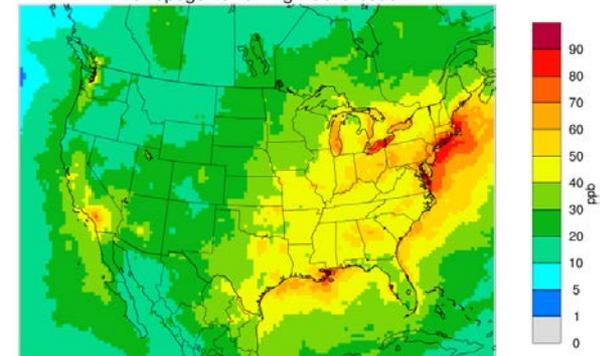
Max(82,2) = 80.37

Contrib. to CAMx Daily Max 8-Hour Ozone ≥ 0 ppb
Natural 4th High Contribution



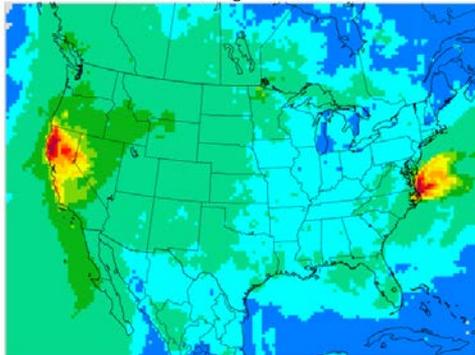
Max(70,11) = 12.84

Contrib. to CAMx Daily Max 8-Hour Ozone ≥ 0 ppb
Anthropogenic 4th High Contribution



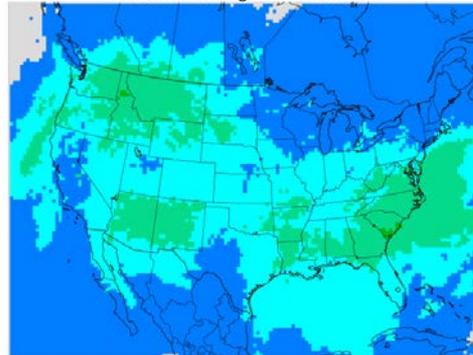
Max(133,70) = 110.89

Contrib. to CAMx Daily Max 8-Hour Ozone ≥ 0 ppb
Wildfires 4th Highest Contribution



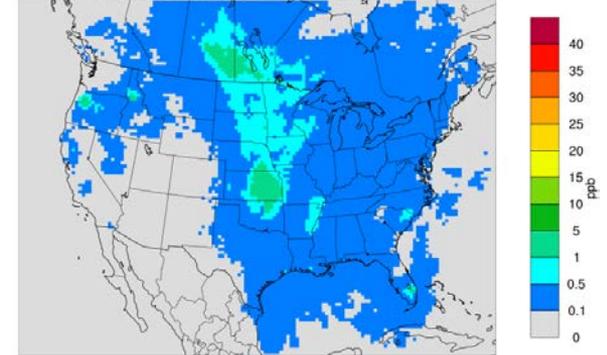
Max(129,53) = 60.13

Contrib. to CAMx Daily Max 8-Hour Ozone ≥ 0 ppb
Rx Burns 4th Highest Contribution



Max(116,41) = 6.16

Contrib. to CAMx Daily Max 8-Hour Ozone ≥ 0 ppb
Agricultural Burns 4th Highest Contribution



Max(79,51) = 3.15

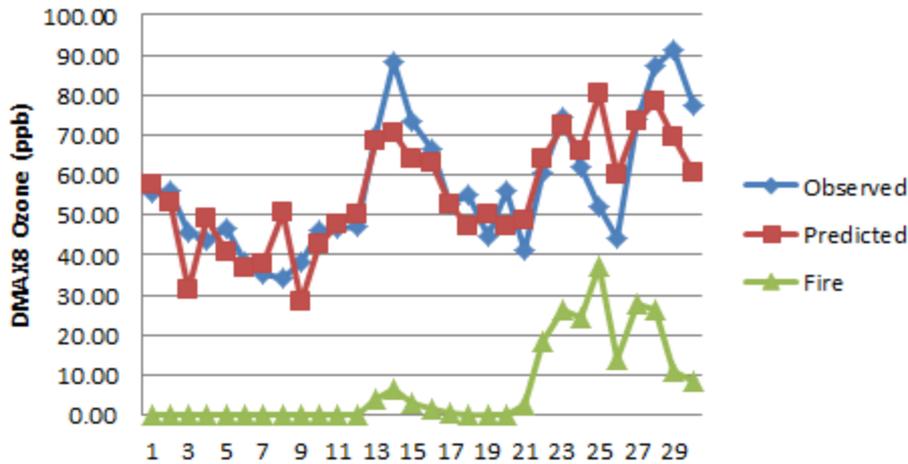
Wildfire

Prescribed Fire

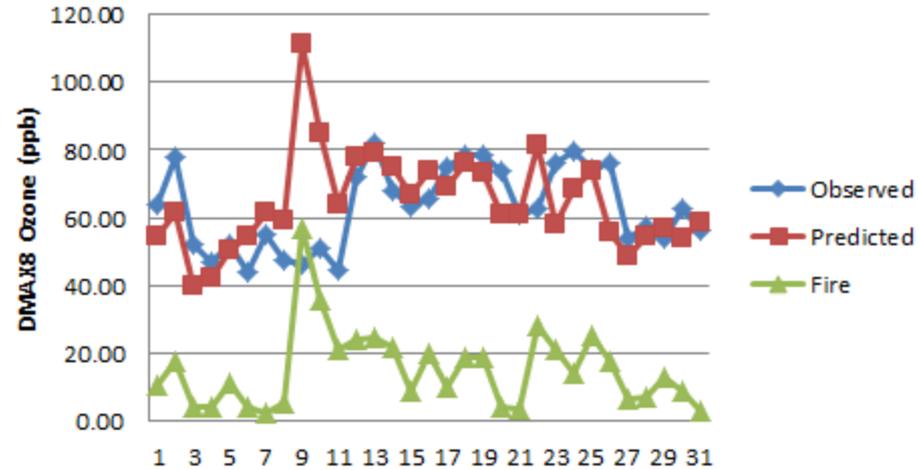
Agricultural Fire

Northern California Wildfires June-July 2008

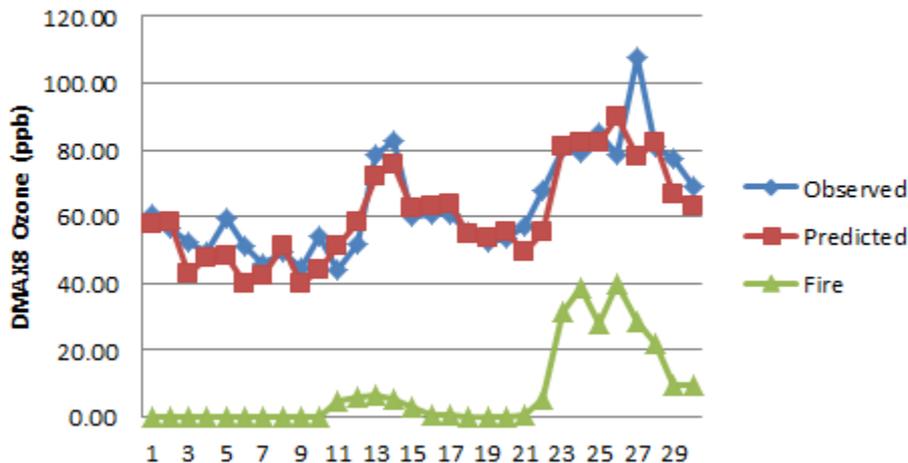
June Base08c DMAX8 Ozone Shasta 0007



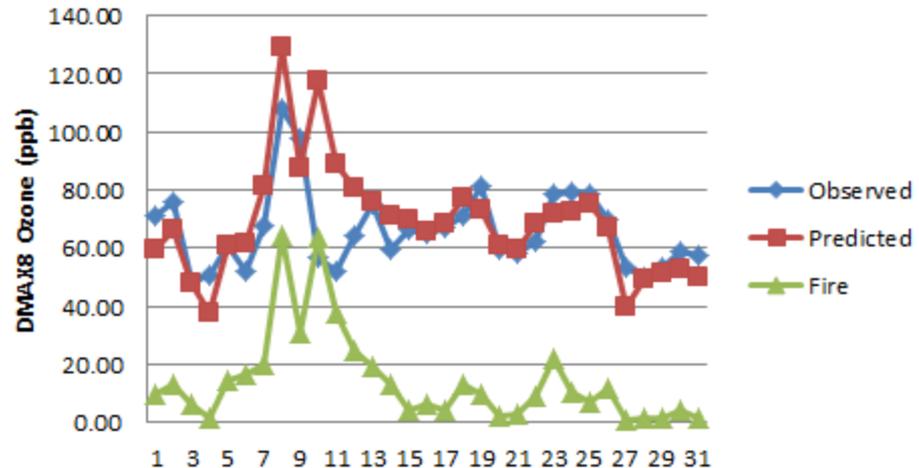
July Base08c DMAX8 Ozone Shasta 0007



June Base08c DMAX8 Ozone Butte 0007

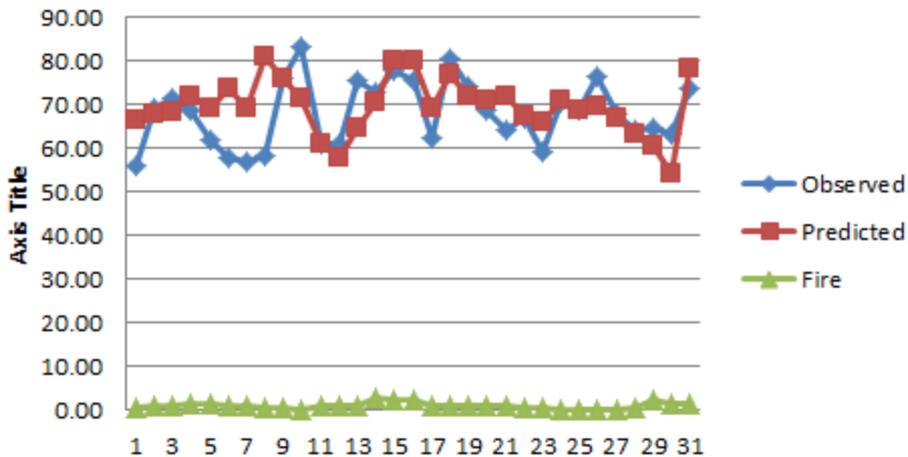


July Base08c DMAX8 Ozone Butte 0007

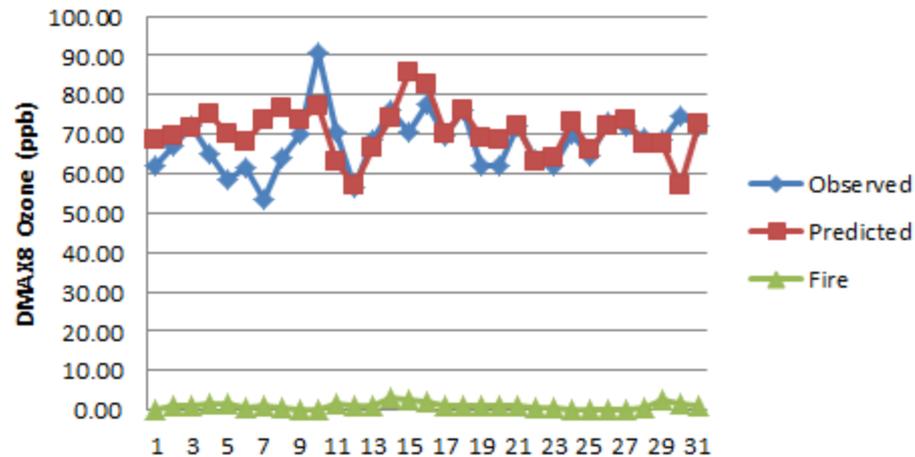


Denver Ozone Monitors July 2008

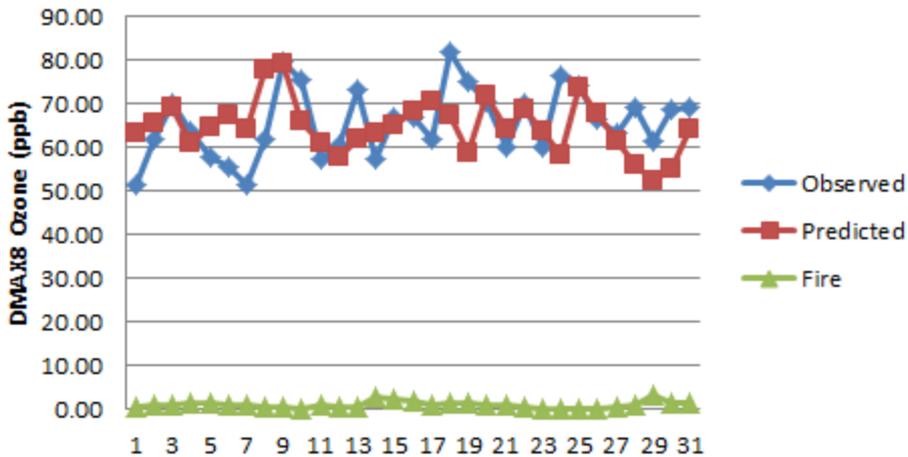
Jul DMAX8 Ozone Rocky Flats No



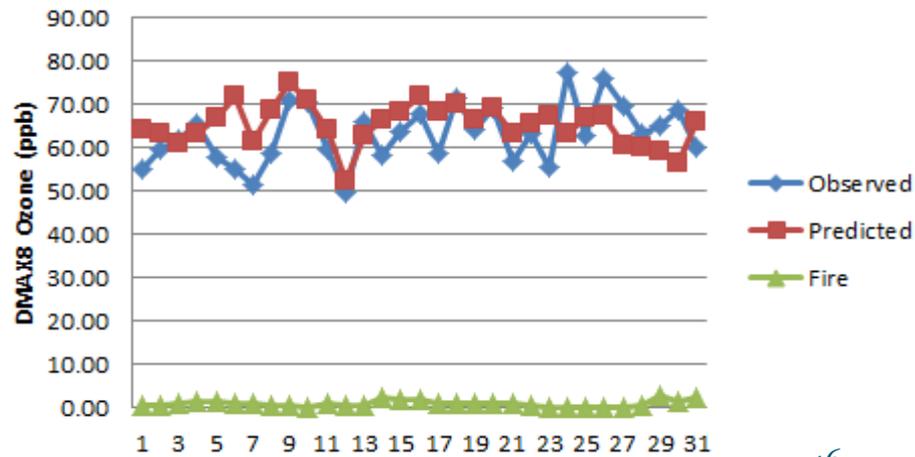
Jul Base08c DMAX8 Ozone Chatfield



Jul Base08c DMAX8 Fort Collins West



Jul Base08c DMAX8 Greeley



Pilot Study - Detailed Source Category-Specific Ozone Source Apportionment

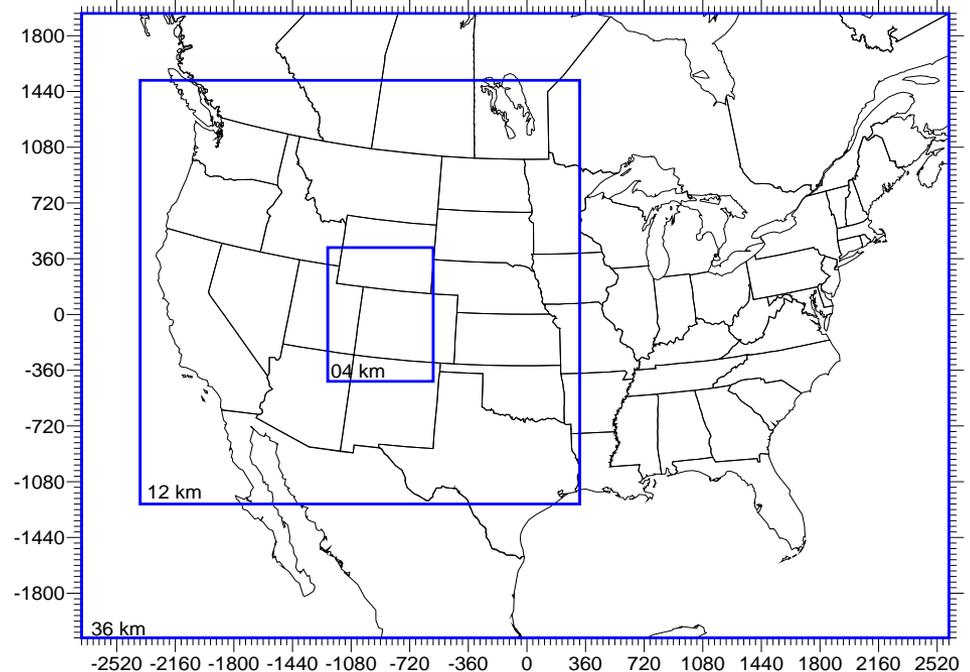
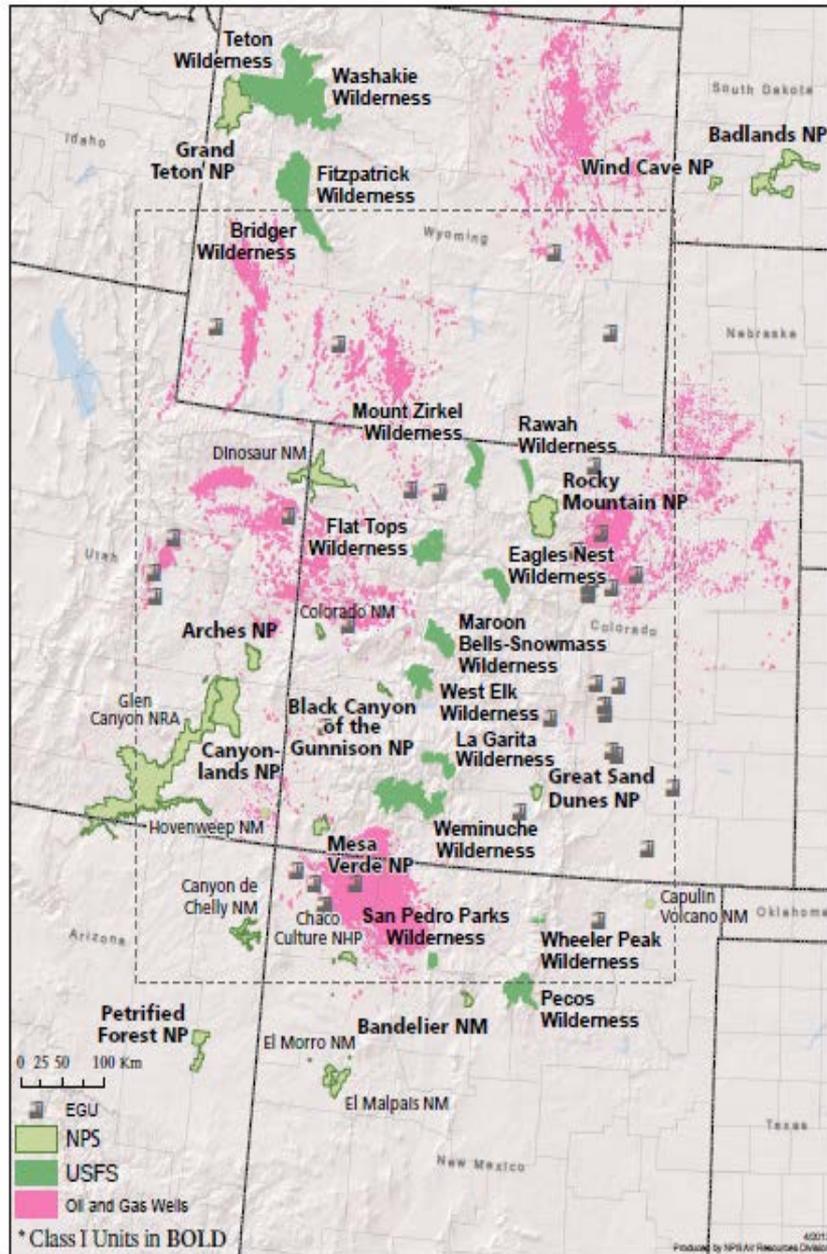
- Six Source Categories:
 - Natural (Biogenic, Lightning, Sea Salt & WBD)
 - Fires (WF, Rx, & Ag)
 - Upstream Oil and Gas (O&G)
 - Point Sources (EGU & Non-EGU)
 - Mobile Sources (on-road, non-road & CMV)
 - Remainder (Area/Non-Point)
- Ozone Apportionment
 - May-Aug 2008
 - 36/12/4 km Domains
 - 4 States (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)



CAMx Modeling Domain

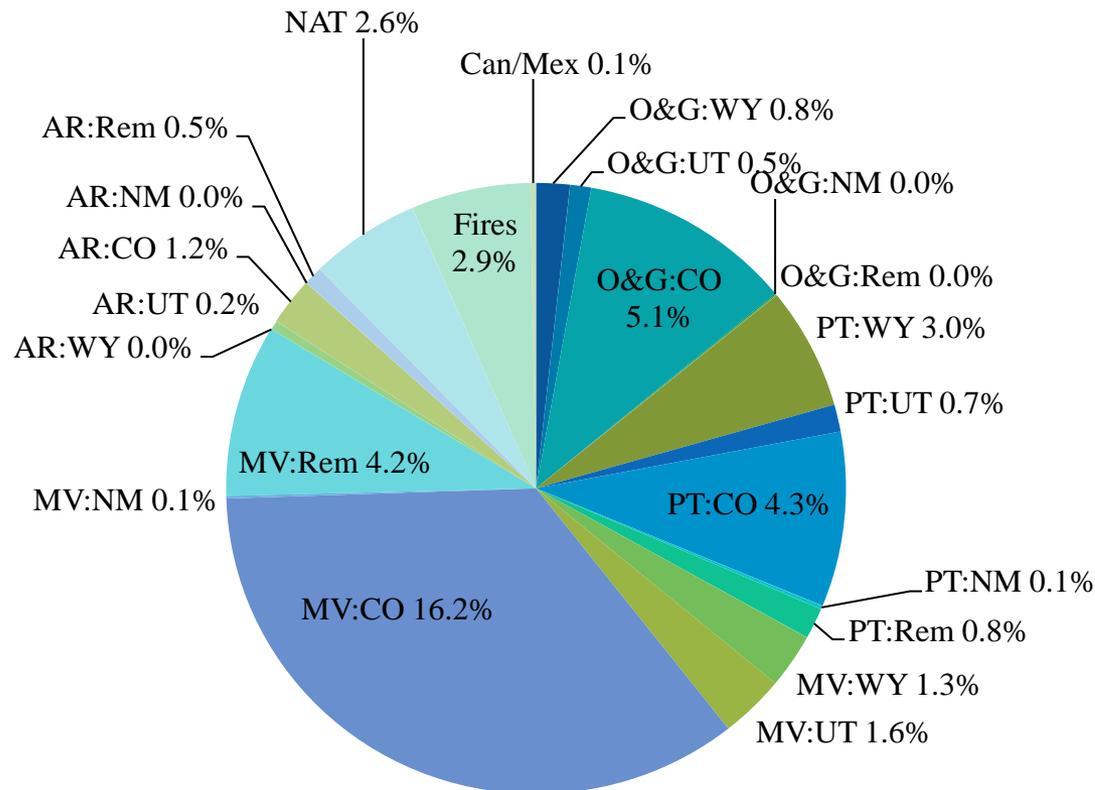
36 km : 148 x 112 (-2736, -2088) to (2592, 1944)
 12 km* : 227 x 230 (-2388, -1236) to (336, 1524)
 04 km* : 164 x 218 (-1228, -436) to (-572, 436)

* includes buffer cells

Detailed Pilot Study: 2008 4th 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)
- Continental Divide-Creston EIS (2005/2006 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
- DEASCO₃ 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 (DEASCO₃)
 - 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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