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

September 23, 2014

Tom Moore
WRAP Air Quality Program Manager
WESTAR Council

Carson City, NV Meeting

WESTERN REGIONAL AIR PARTNERSHIP

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

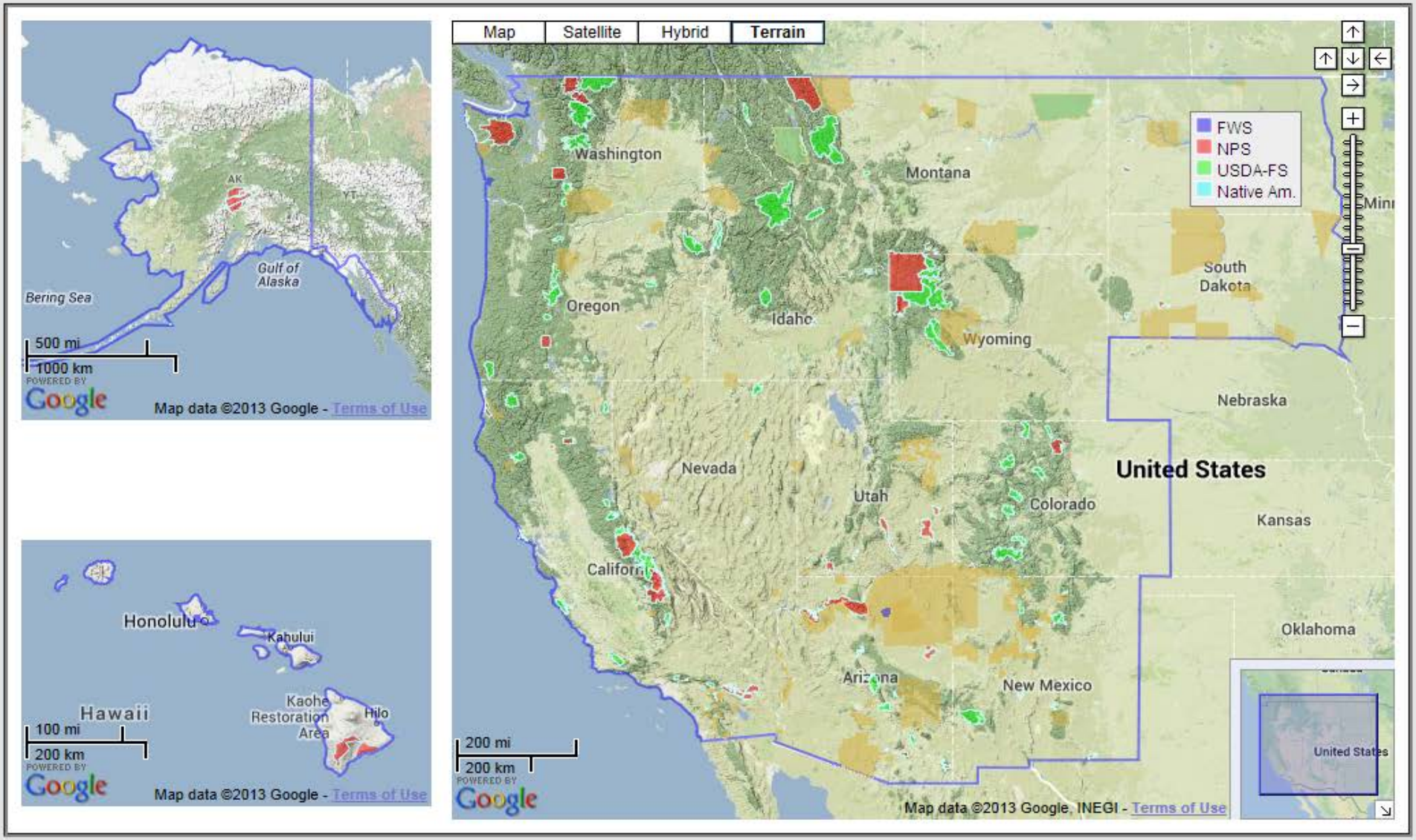
- Purposes:
  - Exchange information related to air pollution control;
  - Develop processes and procedures to meet air quality objectives and to protect the environmental resources;
  - Discuss air quality issues and report on the status of efforts undertaken to achieve air quality objectives;
  - Establish 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

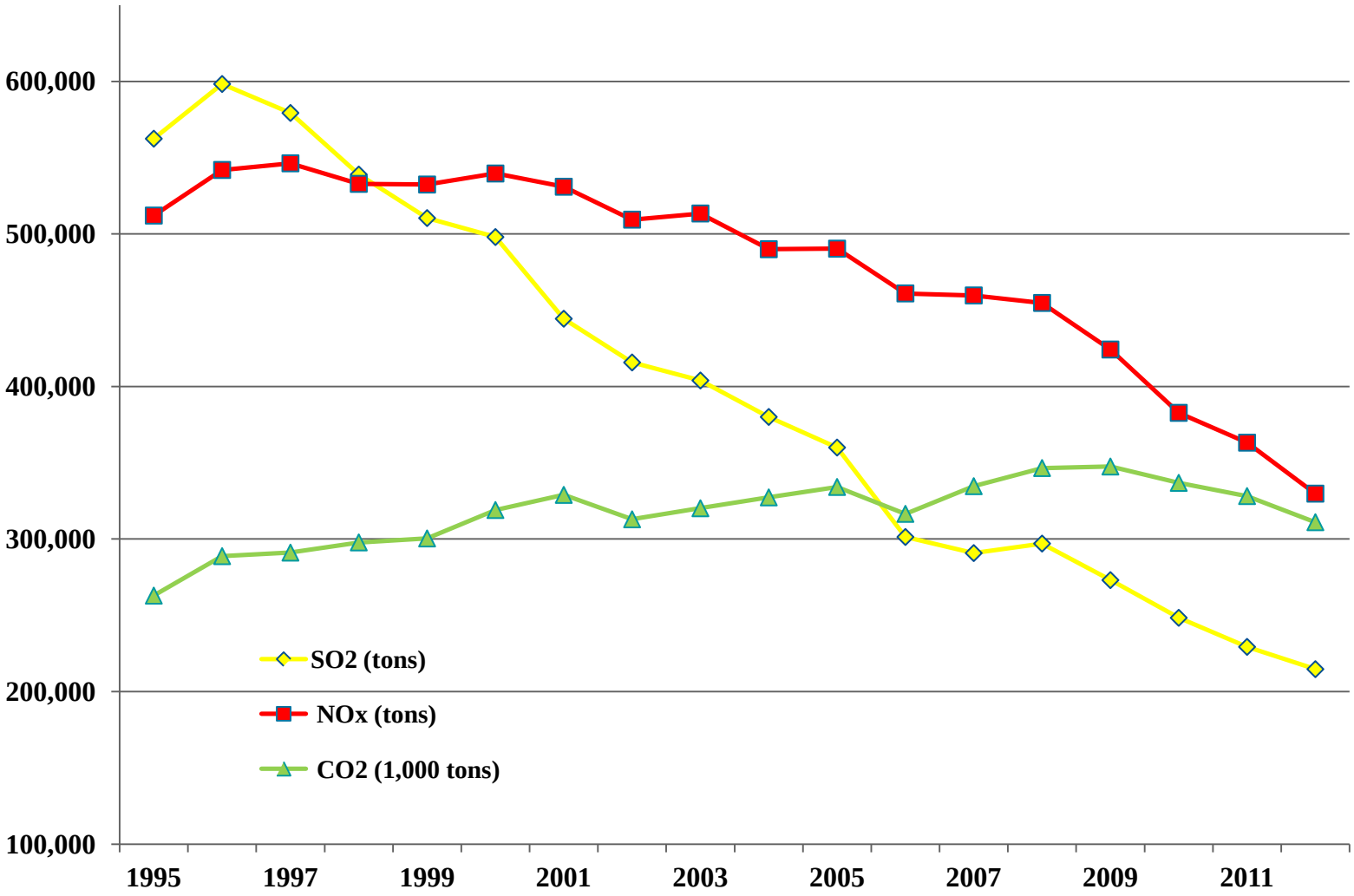
- NAAQS Implementation and Maintenance
  - Data for future infrastructure and transport SIPs
- Exceptional Events
  - Develop technical support data and analysis protocols
- Implementation of Regional Haze SIPs
  - Identify and execute technical work needed for 2018 plans
- Needs of sub-regional groups of states
  - Currently oil and gas
  - Similar efforts in past

Western ozone and PM precursors - key emissions sources

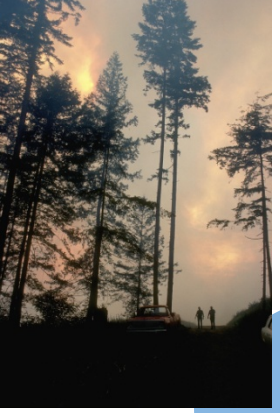
- Power plants decreasing markedly
- Mobile sources controlled and emission rates decreasing markedly through federal rules and state testing programs
- Fire activity and effects are huge, receiving intensive study
  - Deterministic & Empirical Assessment of Smoke's Contribution to Ozone (DEASCO$_3$)
  - 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
    - Just completed 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



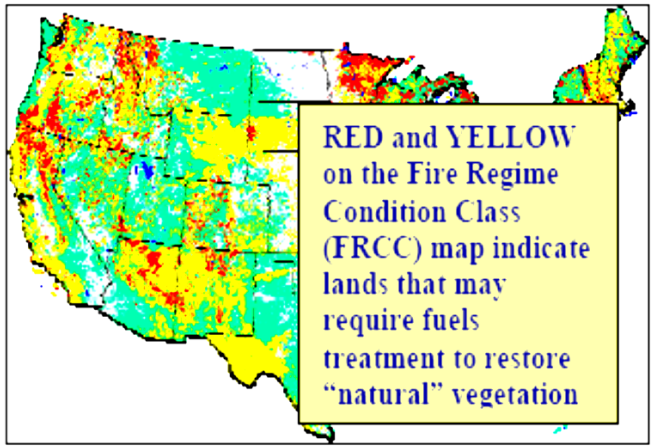
Data Source: EPA Clean Air Markets Division



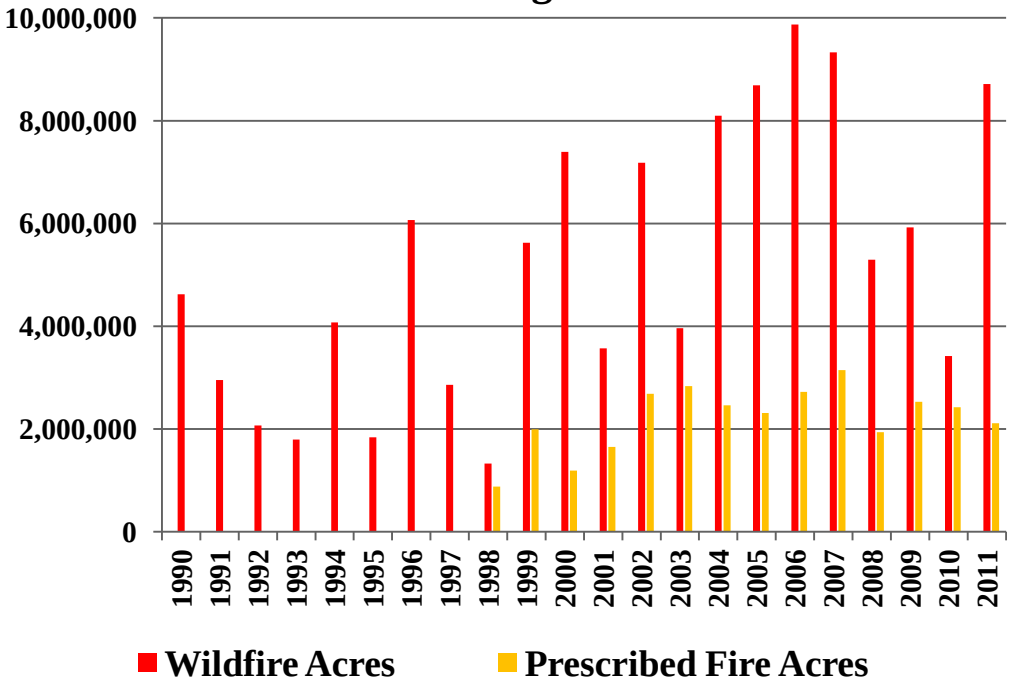
Fire

The Big Picture

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).



U.S. Wildfire and Prescribed Fires Acres Burned - 1990 through 2011



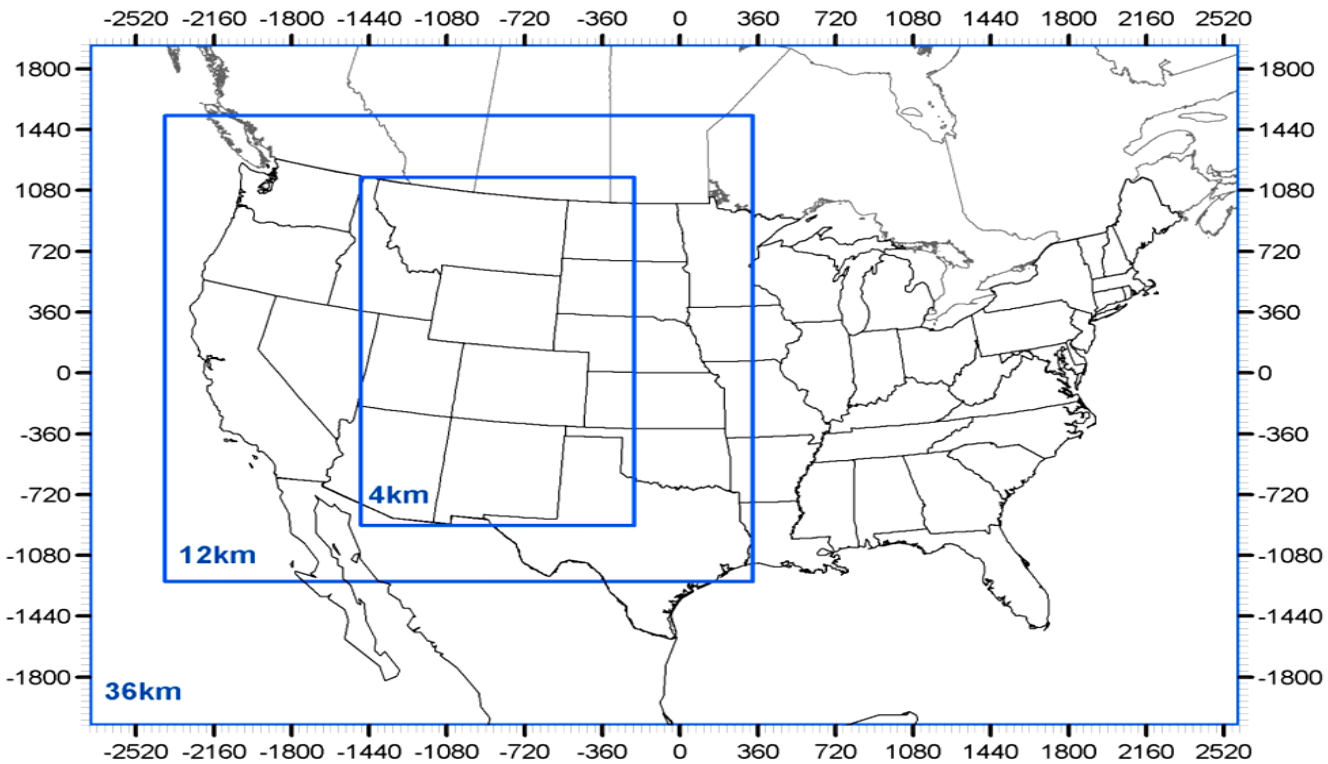
Western Regional Studies and Projects

West-Wide Jumpstart Air Quality Modeling Study

- 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
  - 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:

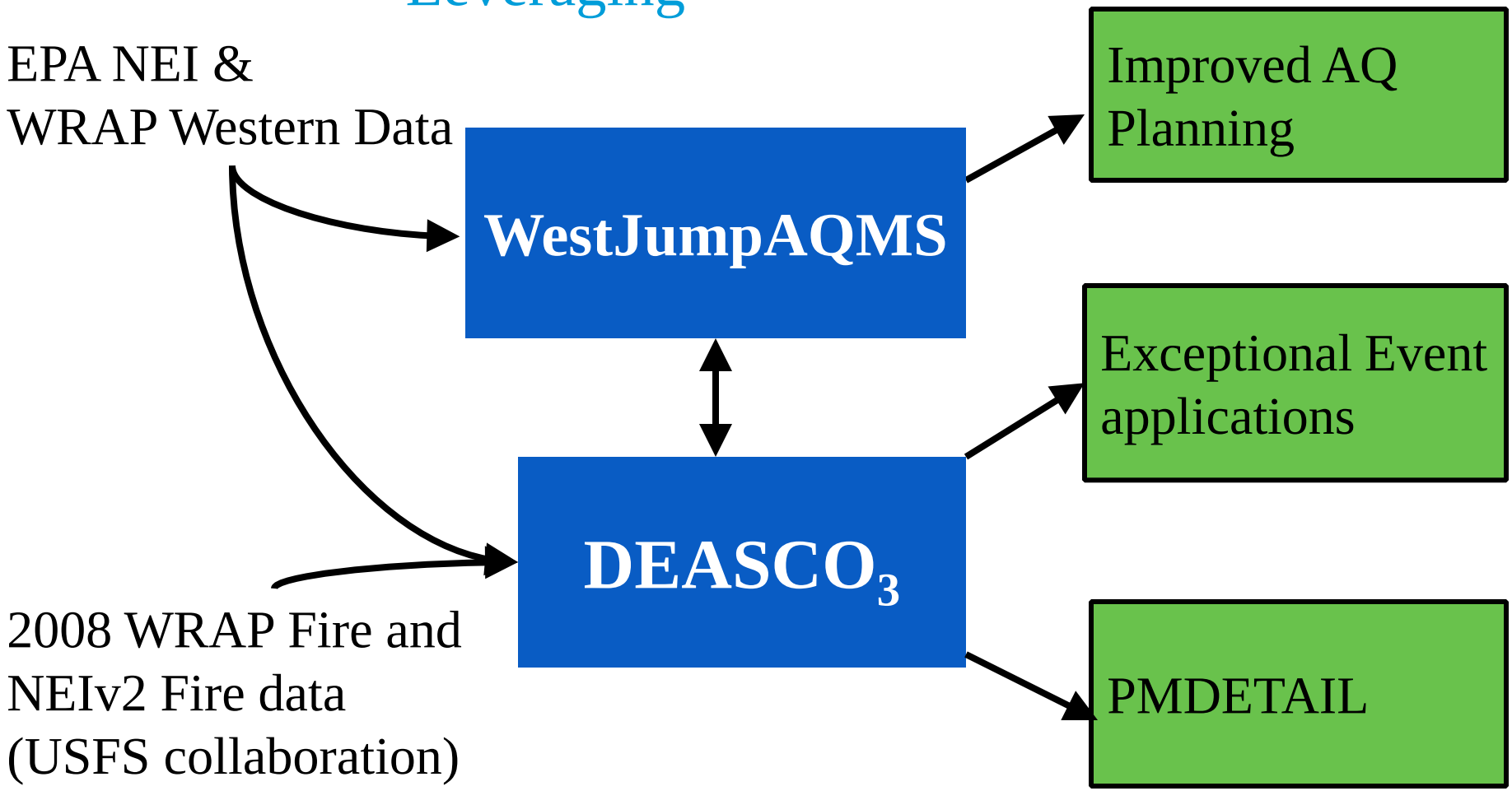
Prescribed and Other Fire Emissions: Particulate Matter Deterministic & Empirical Tagging & Assessment of Impacts on Levels (PMDETAIL)

Funding for both from FLM Joint Fire Sciences Program

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

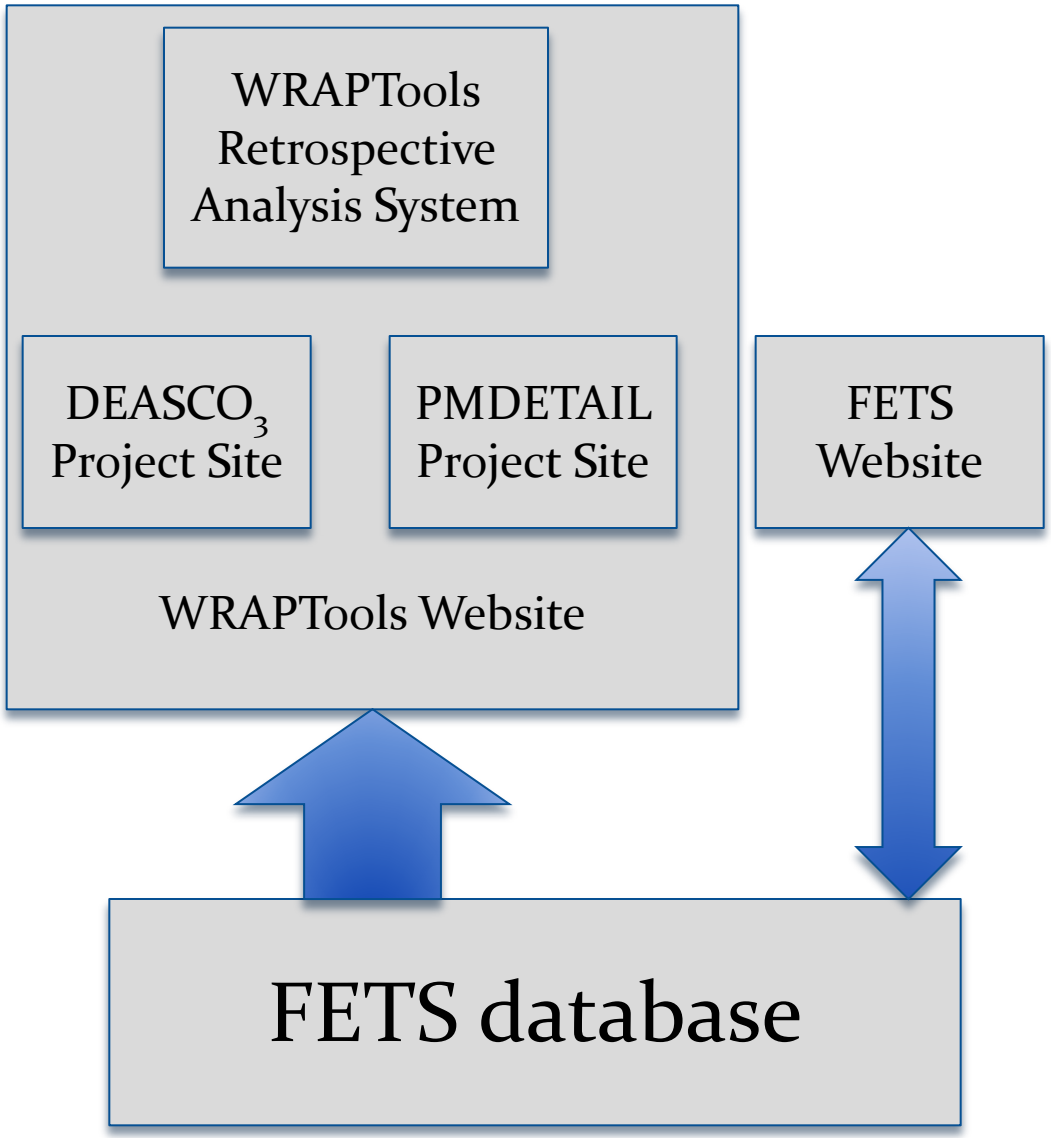
New proposal under JFSP review:
Contribution of Smoke Emissions to Secondary Organic Aerosols (SOA): Real-World Evaluation of Fire SOA Emissions Factors from Fires in a Data Management System (REFERS-DMS)

Leveraging


EPA NEI &
WRAP Western Data
WestJumpAQMS
DEASCO3
2008 WRAP Fire and
NEIv2 Fire data
(USFS collaboration)
Improved AQ
Planning
Exceptional Event
applications
PMDETAIL

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
- $DEASCO_3$
  - JFSP-funded project
  - DSS for Ozone impacts
  - Temporal analysis, area impacts
- PMDETAIL
  - JFSP-funded project
  - DSS for PM impacts
  - Temporal analysis, vulnerability matrix



WRAPTools Toolbar Approach

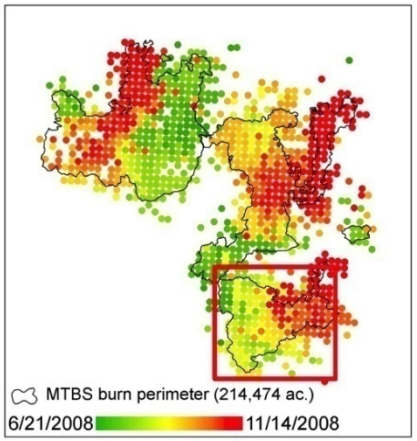
What questions do we need to address to perform retrospective case study analyses?

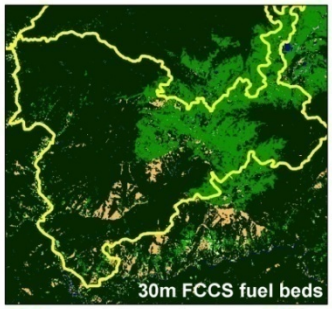
What data are available to us?

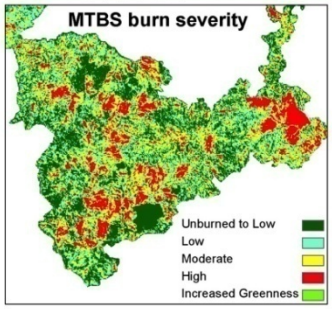
How do we organize results to accommodate differing analysis types?

- 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.

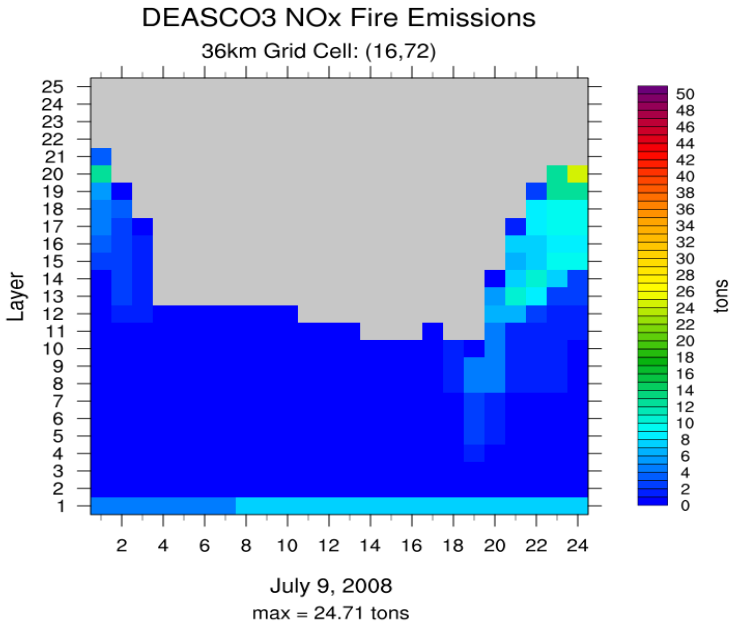
Smoke and Emissions Inventory Research



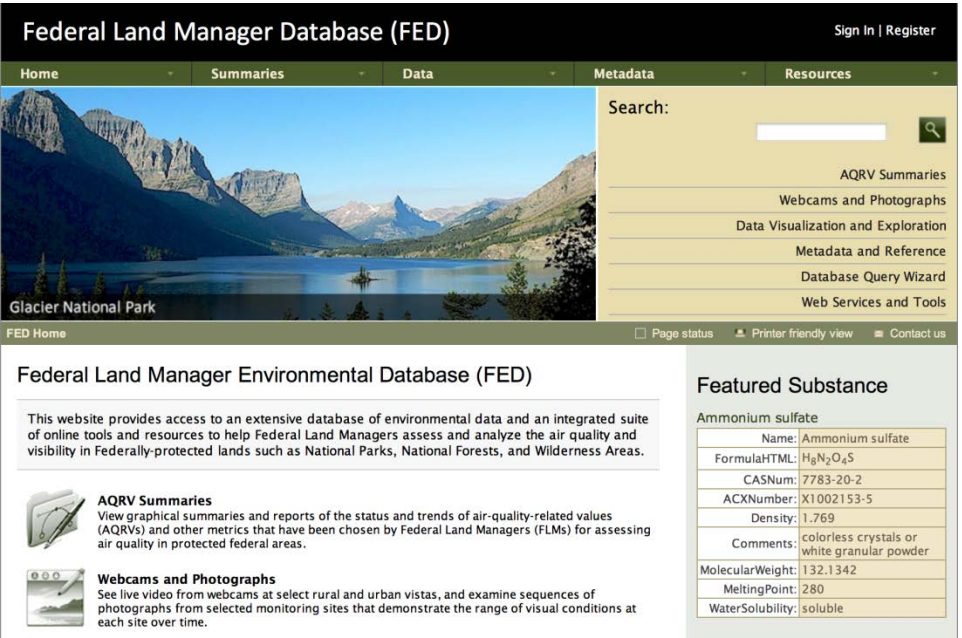




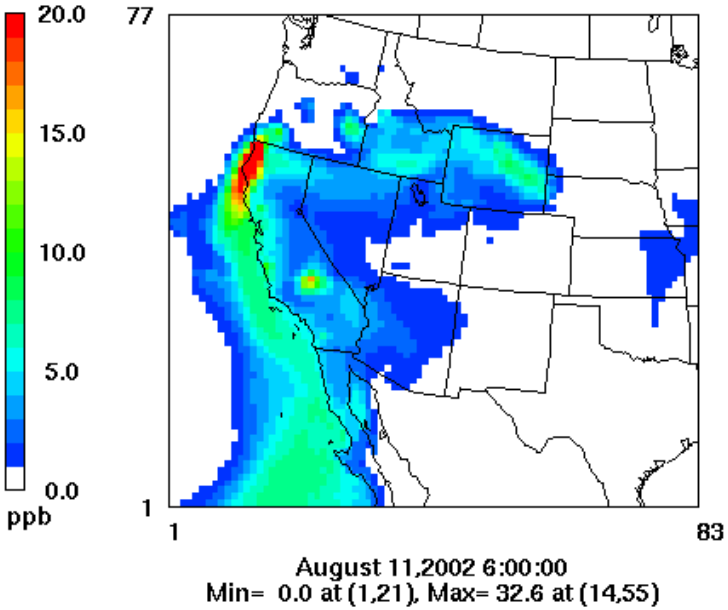
- Acres constrained by perimeter
- Daily growth & composite fuel loading
- Consumption scaled by severity



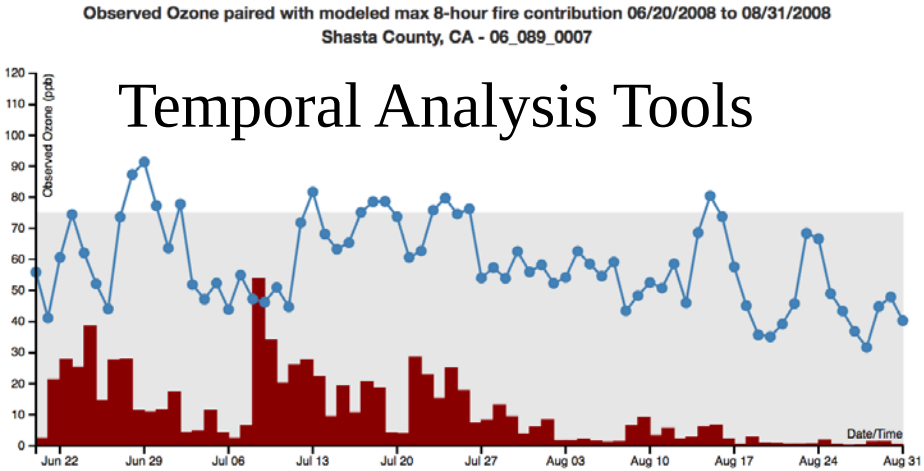
Smoke and Populations



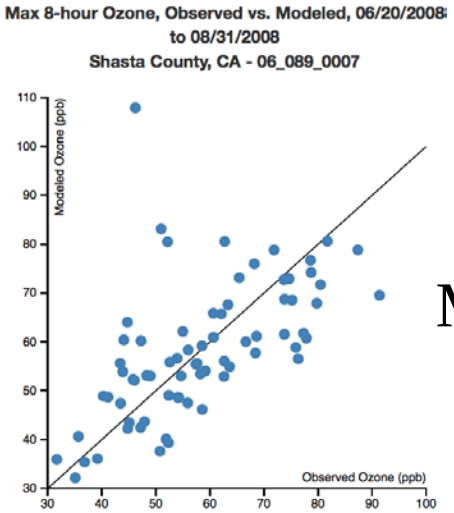
Fire and Smoke Model Evaluation



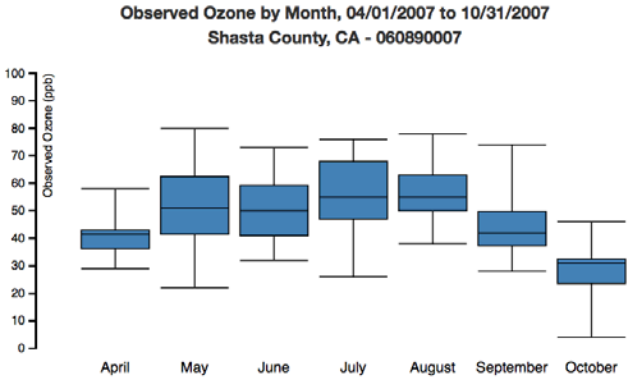
Temporal Analysis Tools



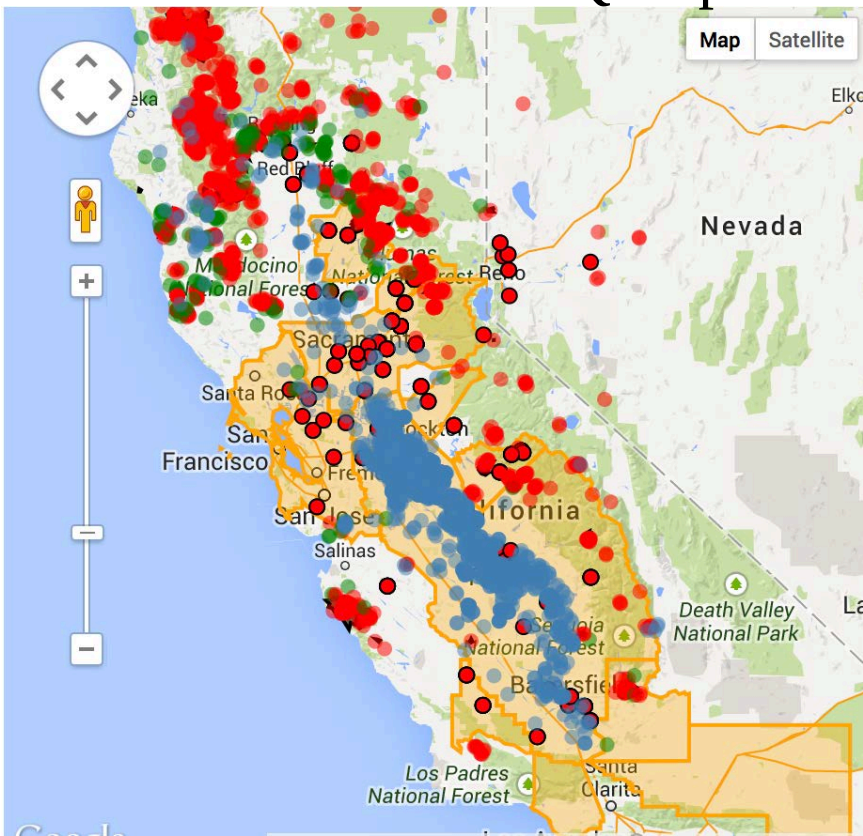
Model Evaluation



Fire Contributions to AQ Impacts



Inter-annual Observational Analysis



Area Impacts Analysis Tool

Number of days where planned fire caused an exceedance of 70ppb -- weight: 10

Number of days where planned fire caused an exceedance of 65ppb -- weight: 0

Number of days where planned fire caused an exceedance of 65ppb NAA ONLY -- weight: 2

Number of days where planned fire caused an exceedance of 70ppb NAA ONLY -- weight: 2

Number of 70+ ppb days where planned fire contributed > 1 ppb -- weight: 1.5

Number of 65+ ppb days where planned fire contributed > 1ppb -- weight: 1.25

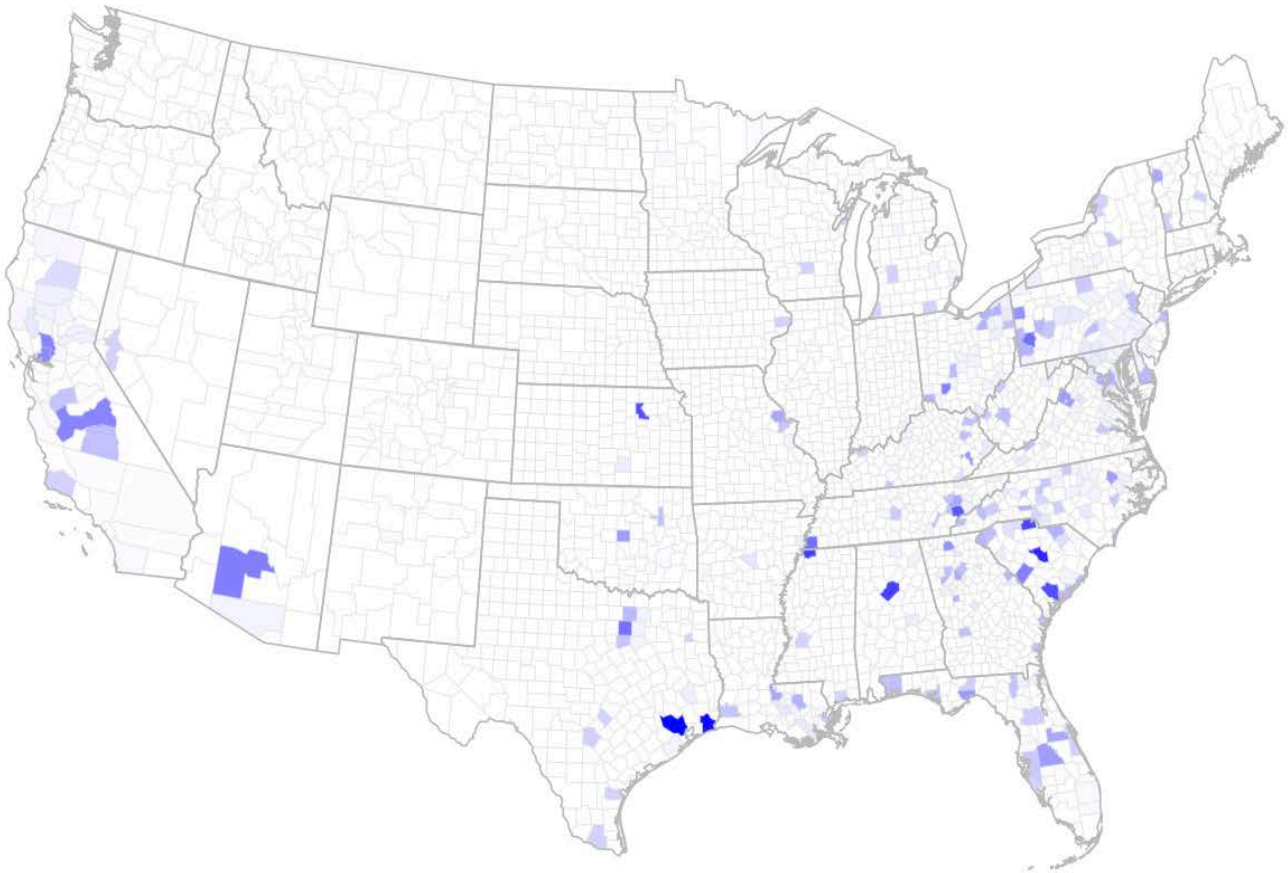
Tons consumed from planned fires near NAA during the ozone season -- weight: 1

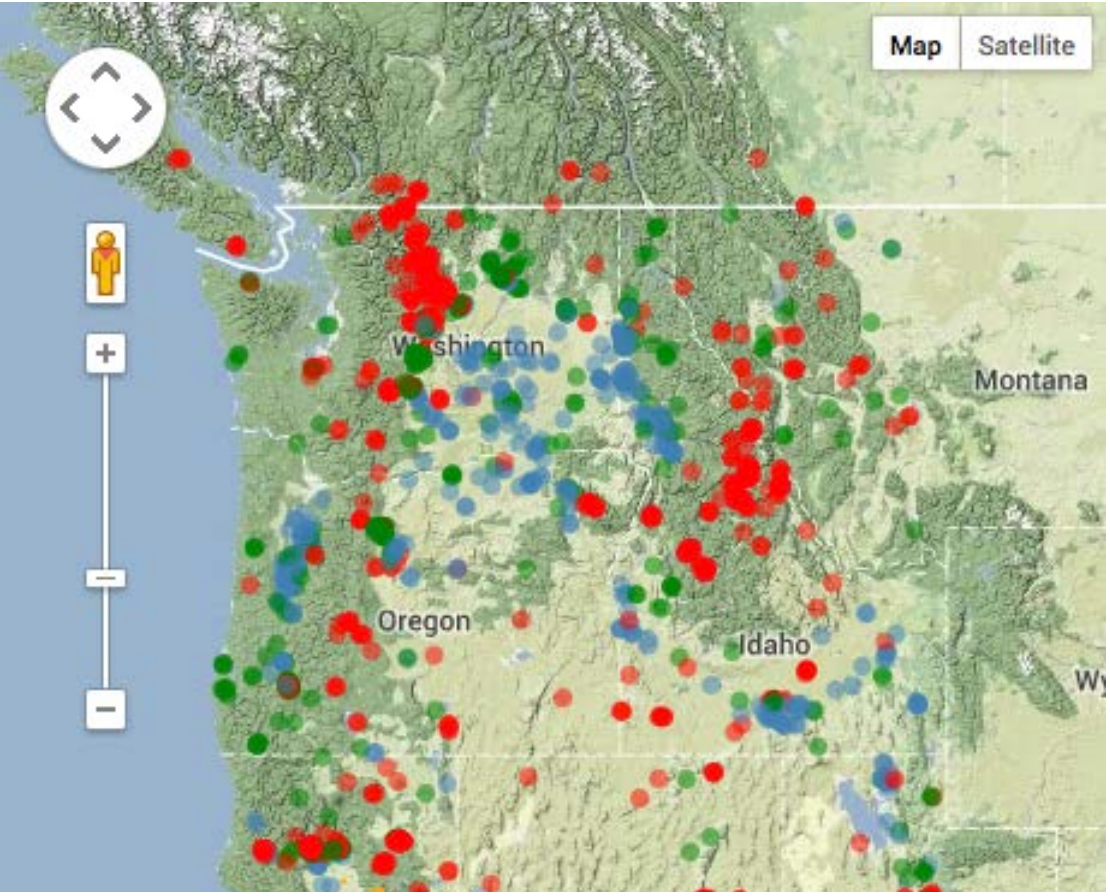
Tons consumed from planned fires near NAA during the ozone shoulder season -- weight: 1

Average tons consumed prior to exceedance -- weight: 1

Number of 65+ days -- weight: 0.01

Number of 70+ days -- weight: 0.01

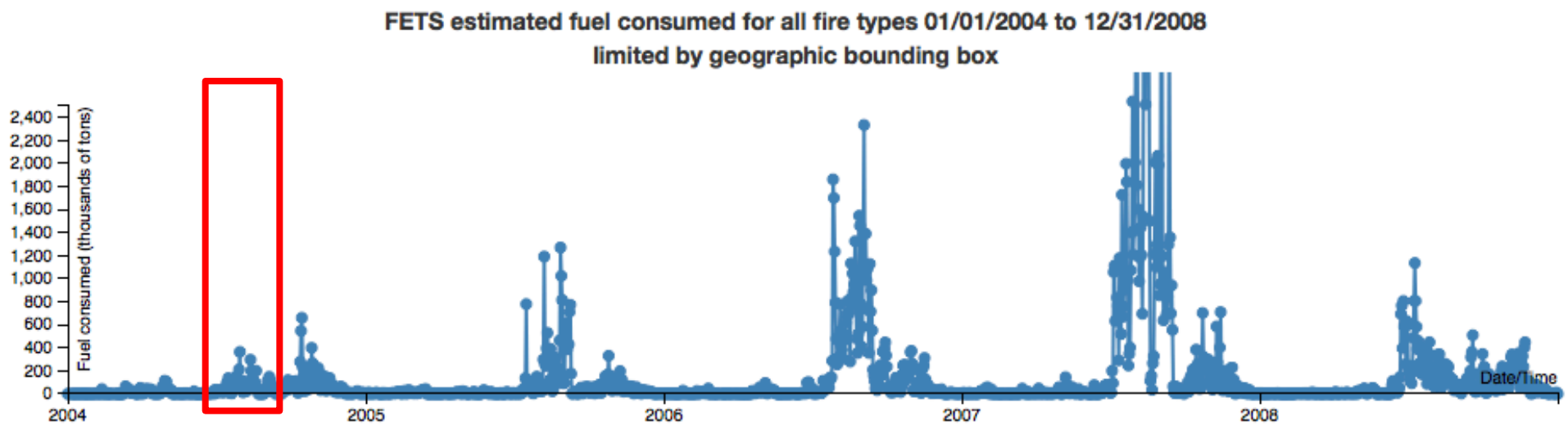


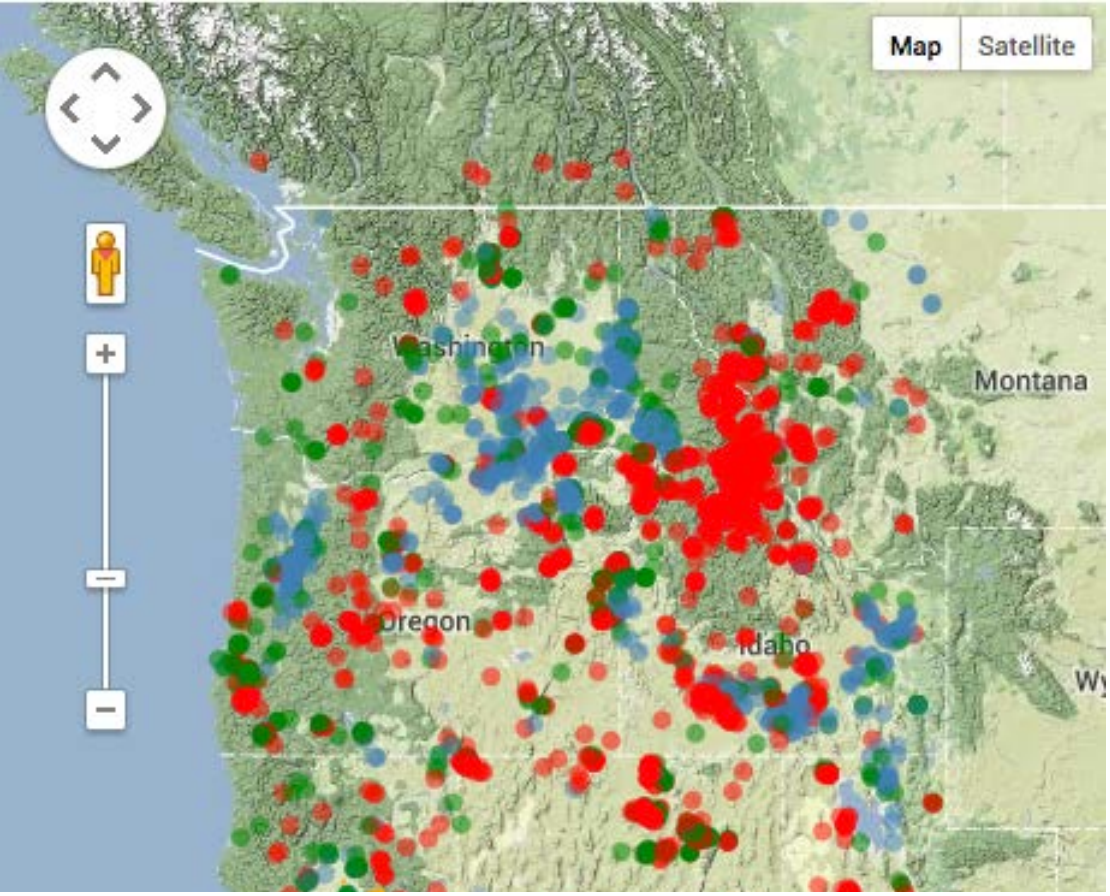


2004

6/20 – 8/31

Limited by bounding box





2005

6/20 – 8/31

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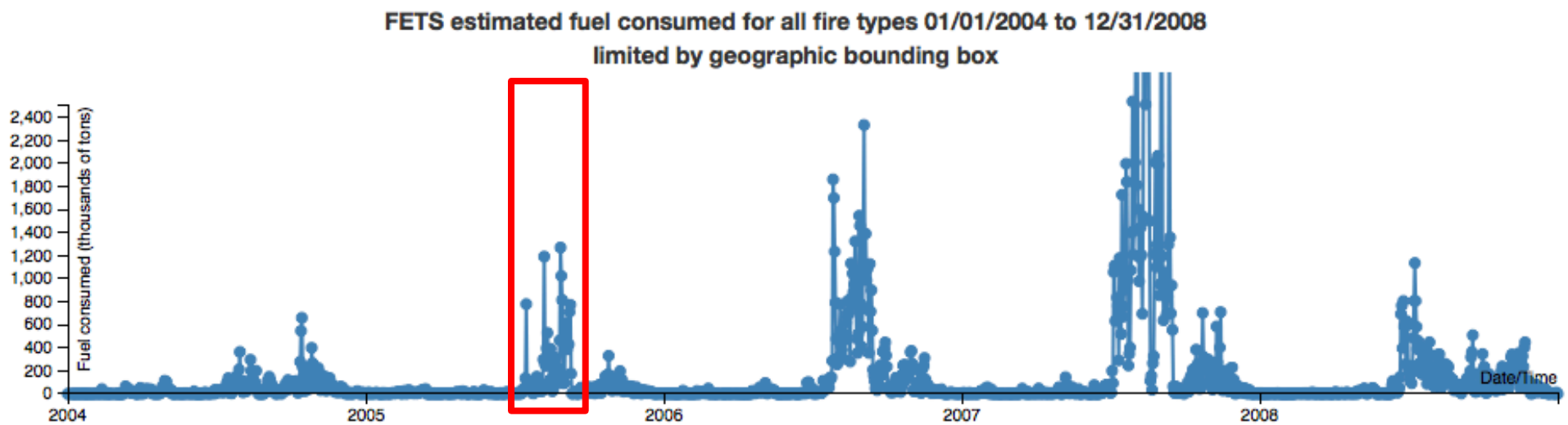

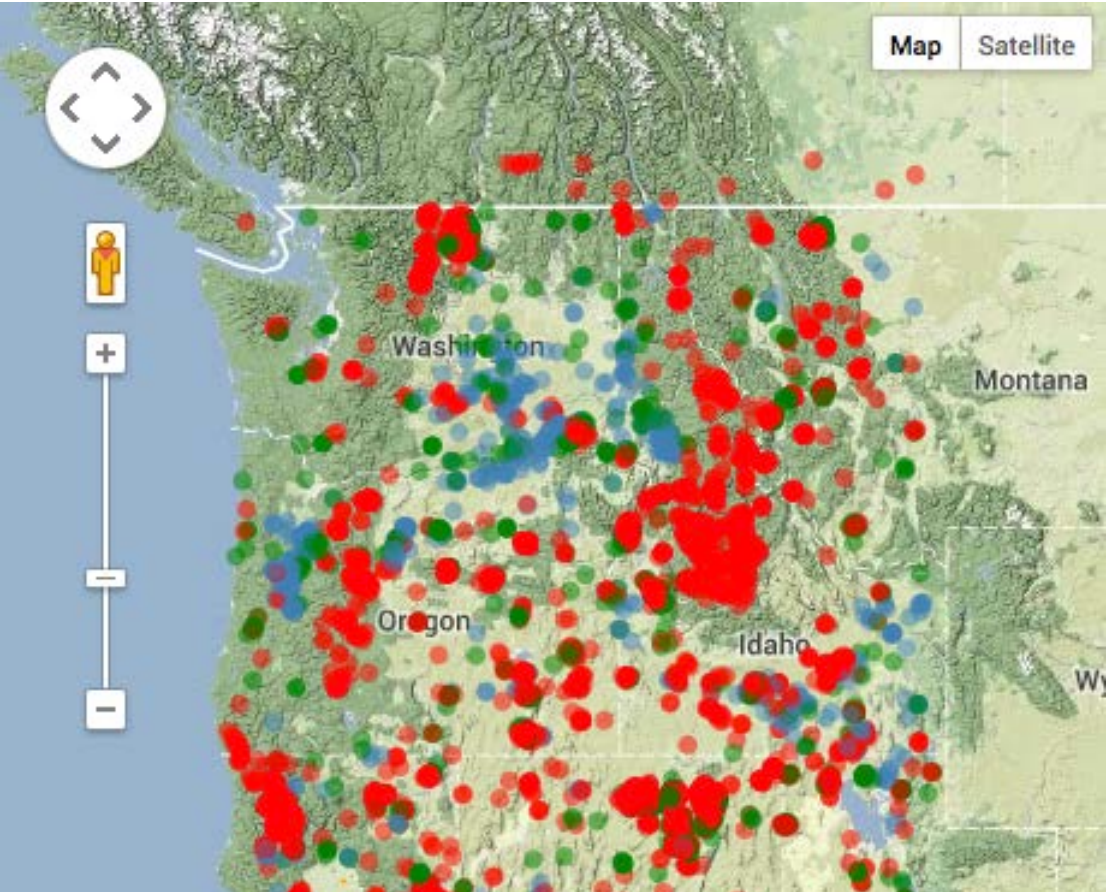

2006

6/20 – 8/31

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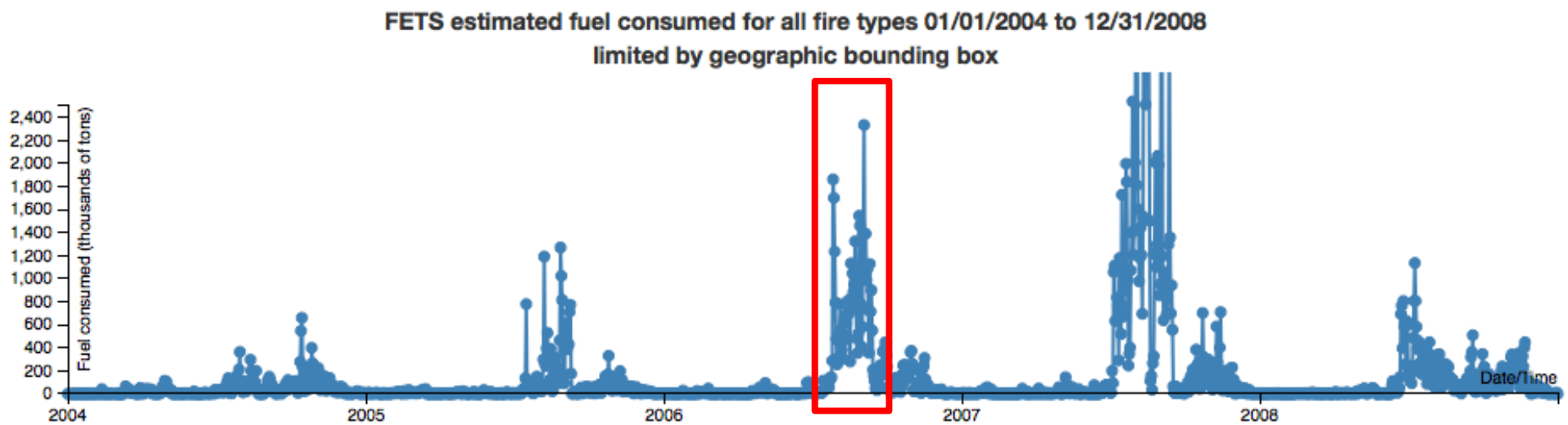

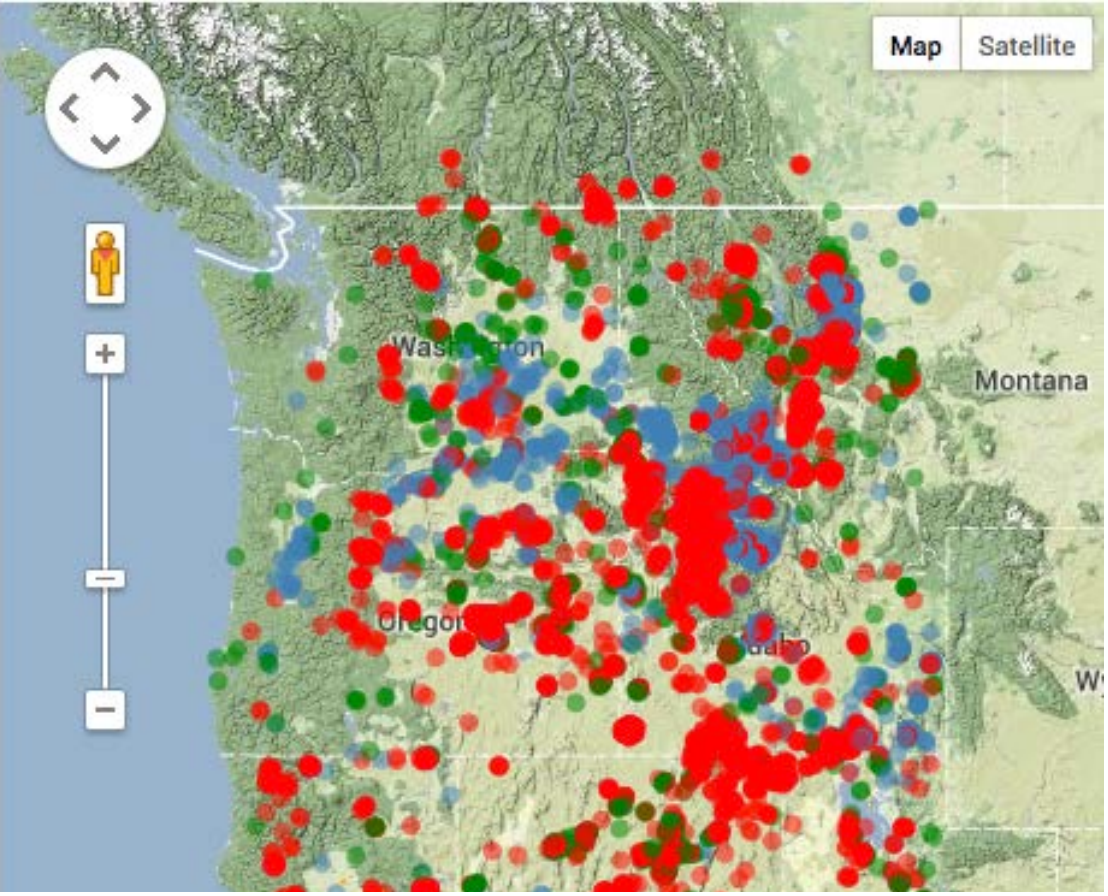

2007

6/20 – 8/31

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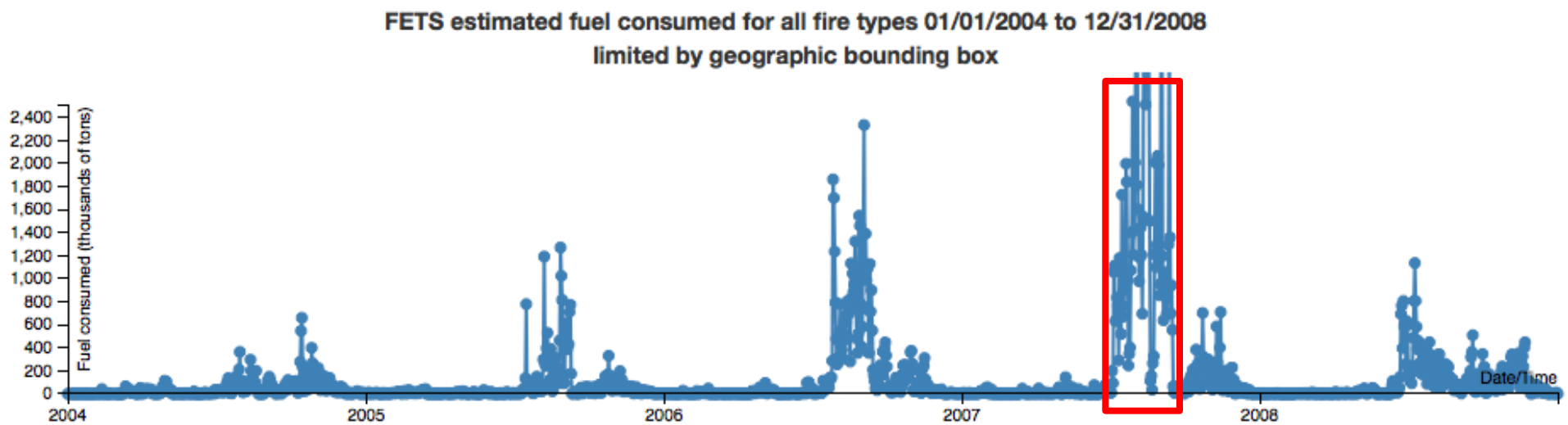

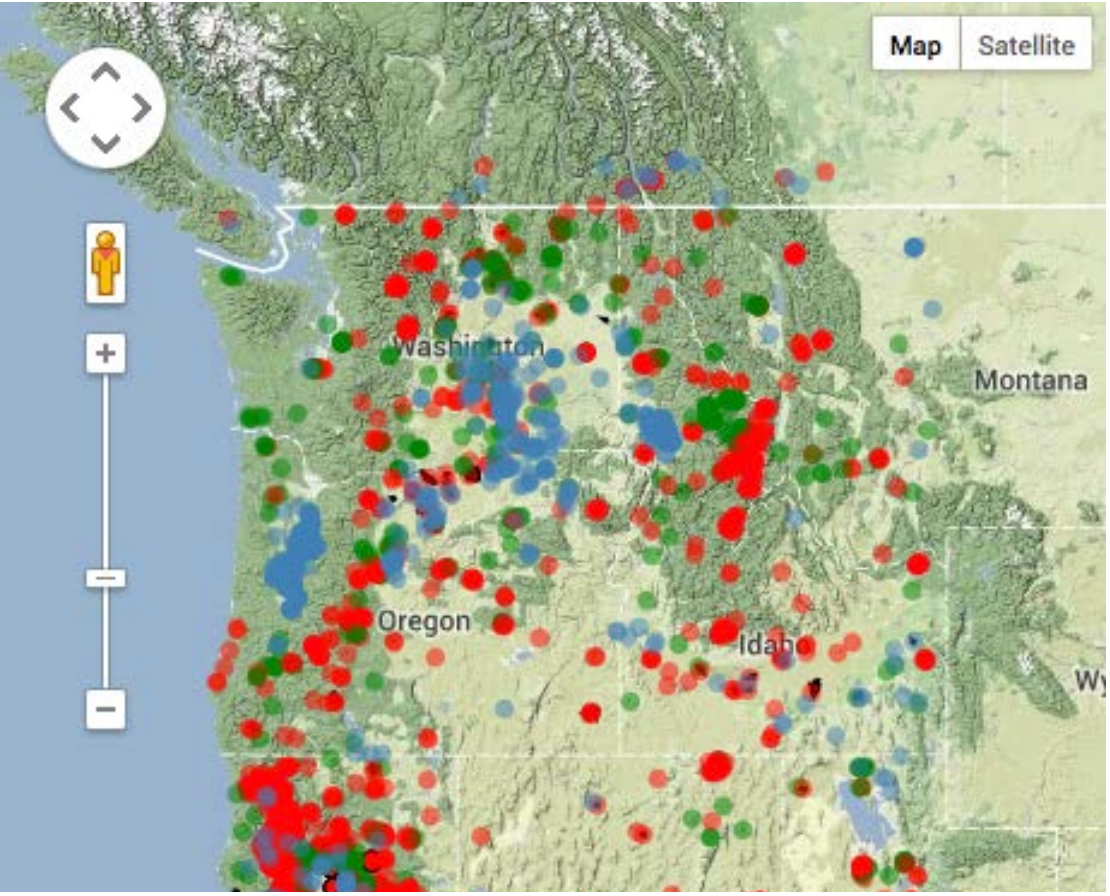

2008

6/20 – 8/31

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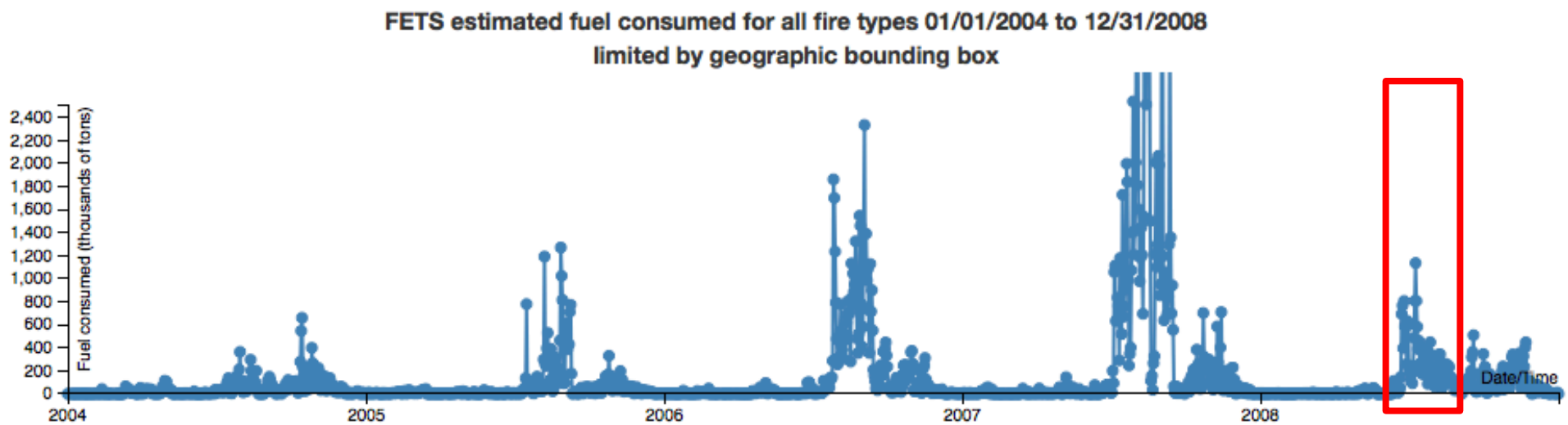
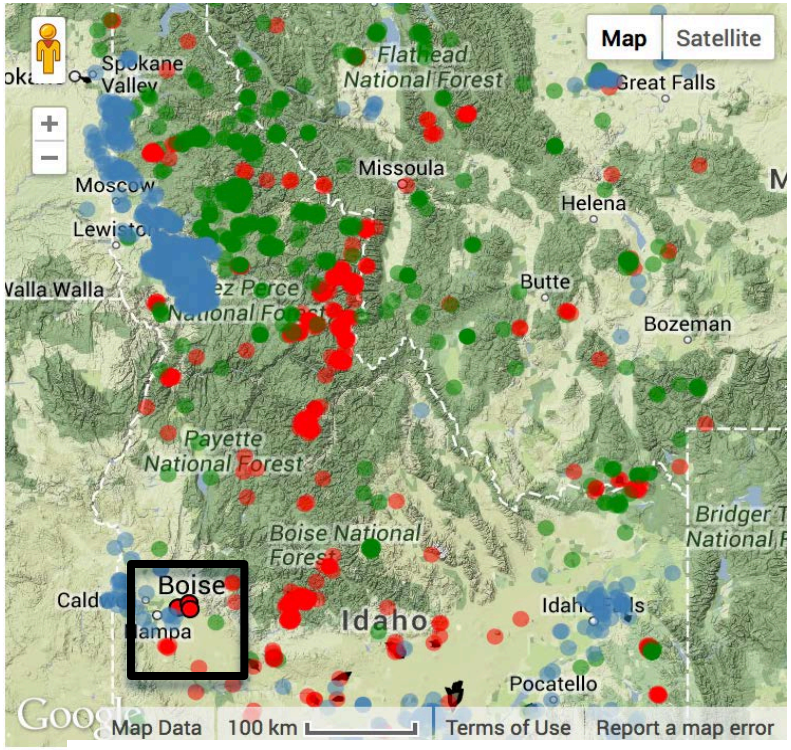
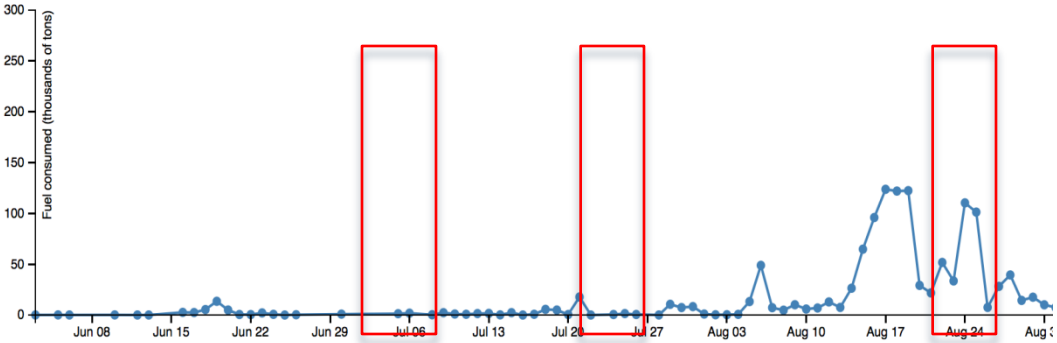


Elevated Ozone due to Fire: Idaho - 2008 Case Study

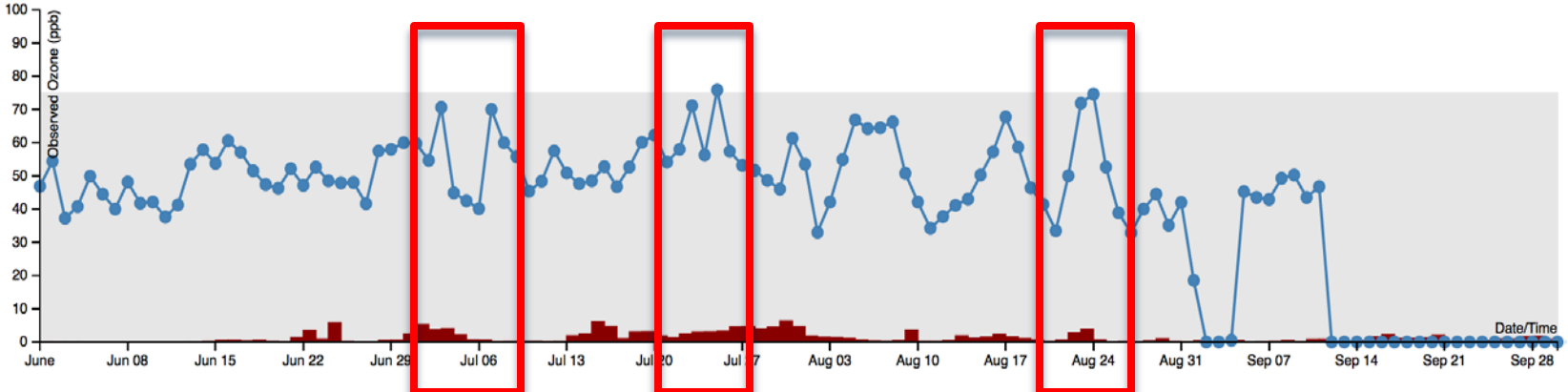


Jun 1 – Sep 30, 2008, O_3 > 70ppb
Fire contr. ≥ 1ppb, model error ≤ 25%

- 3 periods of elevated O_3
- Each period shows fire contribution > 3ppb
- Only late August period has nearby fire activity
- Earlier contr. from long-range transport (NorCal complexes)



Observed Ozone paired with modeled max 8-hour fire contribution 06/01/2008 to 09/30/2008
Ada County, ID - 16_001_0019



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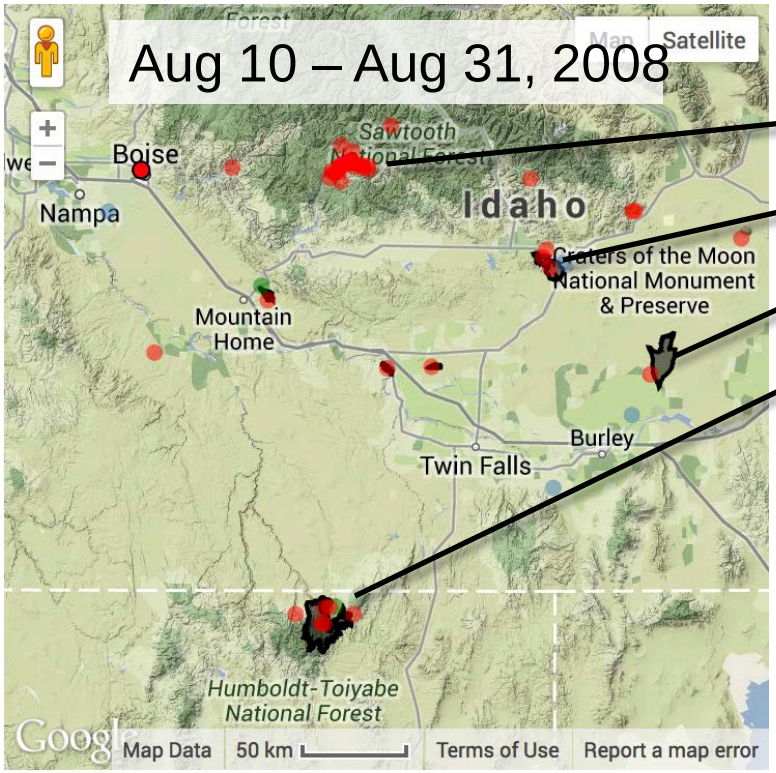
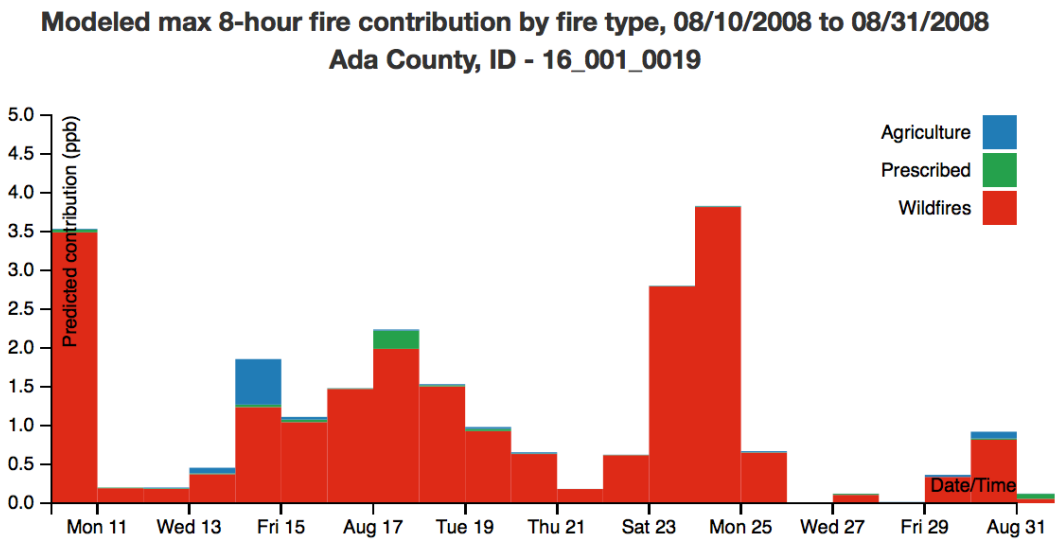
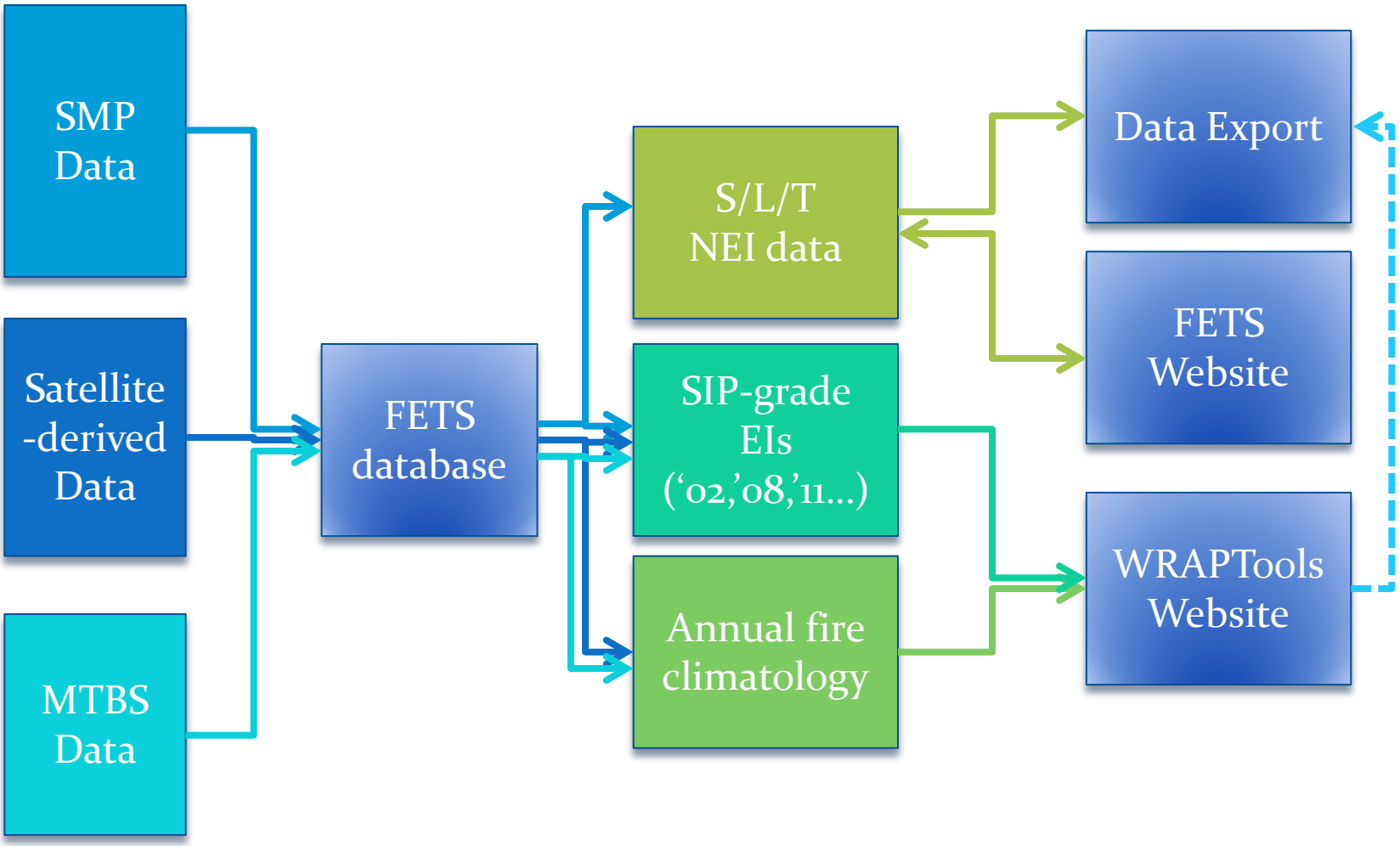


South Barker
Nature
North Minidoka
East Slide Rock Ridge



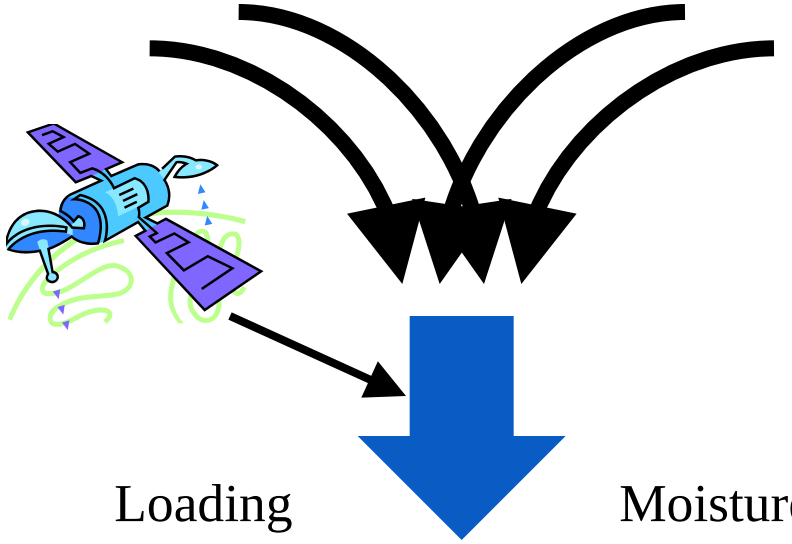
Where do your data go, how are they used?



User-supplied data maintain their identity throughout the system

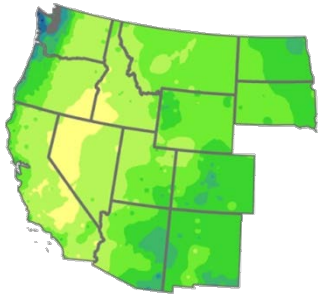
Track activity and emissions

Fire Activity Data (acres/day)



Loading

Moisture



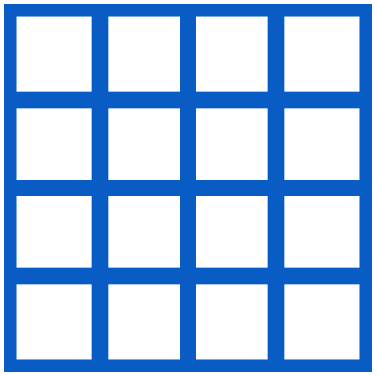
Emissions Model

FETS

DEASCO$_3$ & PMDETAIL

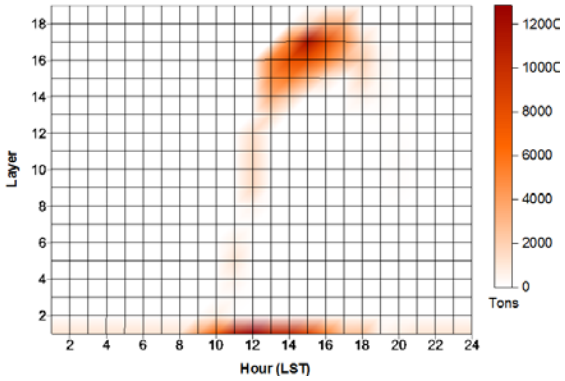
Determine source impact / contribution

distribute emissions



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

Exceptional Events Support

The following case studies are related to the Exceptional Events Support analysis type. To begin click on one of the case studies to review it, or select **Start a New Analysis** to begin creating your own study.

The purpose of this analysis tool is to assist with understanding whether fire might have contributed to an ozone exceedance; and assist with knowing what kind of information might be helpful to a state for preparing an Exceptional Event demonstration package(s) for air quality excursions affected by fire and smoke. The effects of wildland fire on ozone are complex, and meeting the exceptional events requirement is difficult for most if not all fire occurrences. This is, in part, because wildland fires occur at the same time of high ozone caused by anthropogenic emissions. Thus, separating the contribution of wildland fire from anthropogenic emissions is challenging: the but-for test. Yet, EPA requires this for their concurrence. Using the combination of observed ozone and CMAX model output, this tool examines selected cases—planned, unplanned, and combinations of the two—fires contribution to ozone impacts.

Exceptional Events Support Overview

A State Exceptional Event demonstration package must provide evidence that:

A. The event affects air quality, is not reasonably controllable or preventable, and is an event caused by human activity that is unlikely to recur at a particular location or a natural event;
B. There is a clear causal relationship between the measurement under consideration and the event that is claimed to have affected the air quality in the area;
C. The event is associated with a measured concentration in excess of normal historical fluctuations, including background; and
D. There would have been no exceedance or violation but for the event.

States are responsible for demonstrating to EPA that unplanned fires or certain planned fires were responsible for an exceedance of the ozone standard at a particular monitoring site or group of sites. In attempting to make this demonstration, a state may request certain information from land managers. This might include: the smoke emissions; particulate monitoring particular to the fire or photographs; the timing of the burn along with how it was distributed through the day in terms of combustion and smoldering; and to what extent smoke management regulations were complied with

Review a Related Analysis

Title	Sections
Biscuit Wildfire	10
Chatfield, CO July 2004-2007	16
Chatfield, CO July 2008	12
Evans Road Wildfire (Pocosin NWR) / Peat burning	12
Fall burning in southern Louisiana, 2008	9
Flint Hills	8
McNally Wildfire	6
Missionary Ridge & Hayman Wildfires	7
Northern California Wildfires, 2008	17

edit list

These are the current analyses associated with Exceptional Events Support. To review an

Particulate Matter Deterministic & Empirical Tagging & Assessment of Impacts on Levels (PMDETAIL)

- 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 impacts of prescribed and other fire sources on $PM_{2.5}$ levels across the continental U.S.
  - Develop new fire inventories and computational modules for chemical transport models to simulate atmospheric transformations
  - 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 used for regulatory purposes, while PMCAMx is its research version developed by the CMU team.
  - Leverages and significant extends emission inventory development and CAMx modeling from Deterministic and Empirical Assessment of Smoke's Contribution to Ozone ($DEASCO_3$) study completed in 2013.

FETS, Present and Future

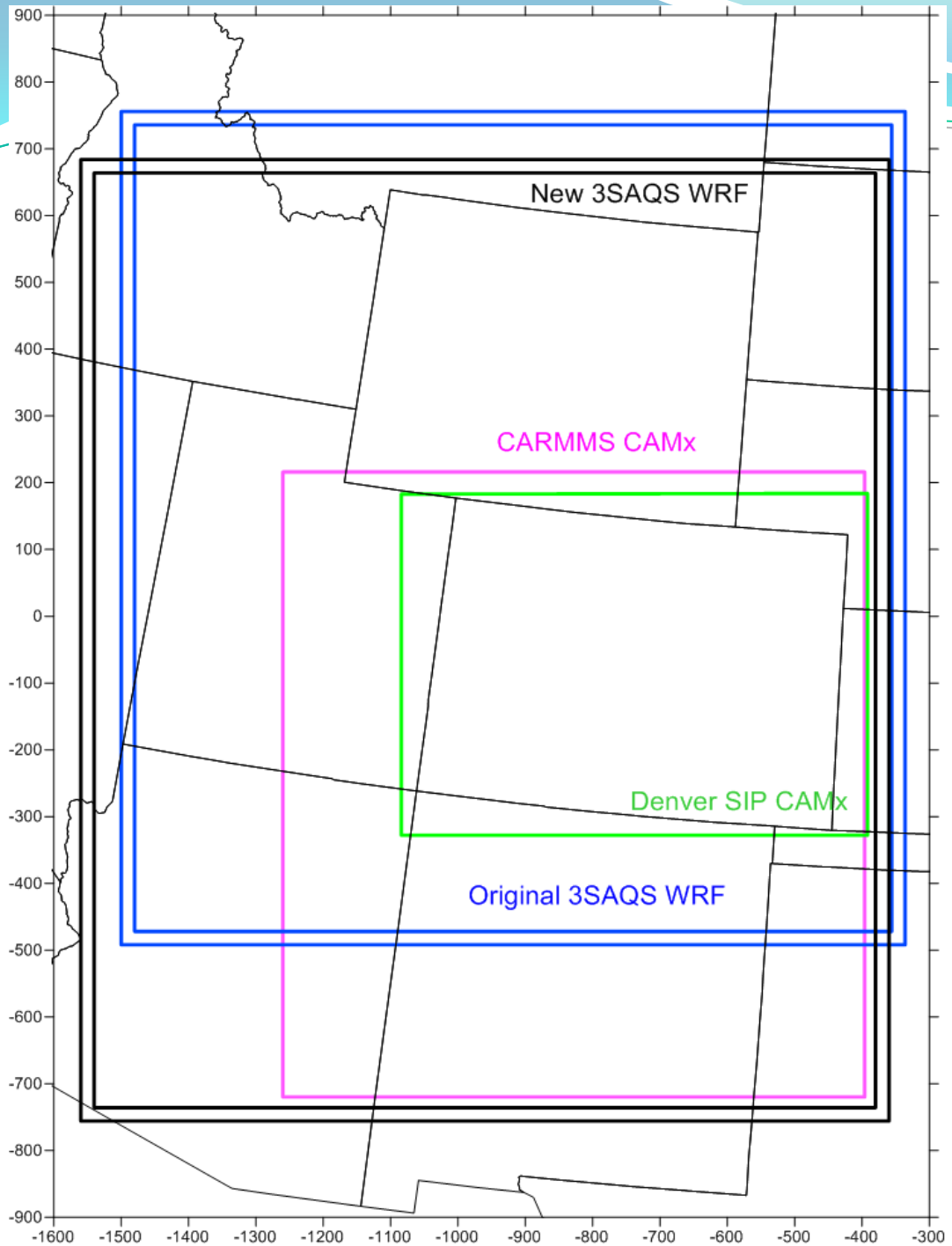
- Developed and on-line in 2007
- Continuing processing / addition of each year's data from SMPs
  - Continuing to add new SMPs
  - Exploring additional sources of daily wildfire incidence data
- Leveraged JFSP projects have covered very limited FETS maintenance support
- Datasets from JFSP projects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

Regional Haze: Reasonable Progress Reports + July 2018 SIP

- 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
  - Progress report 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
- Regional technical support for July 2018 SIPs in WRAP Work Plan

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, nested into 12km western US and 36km North American domains

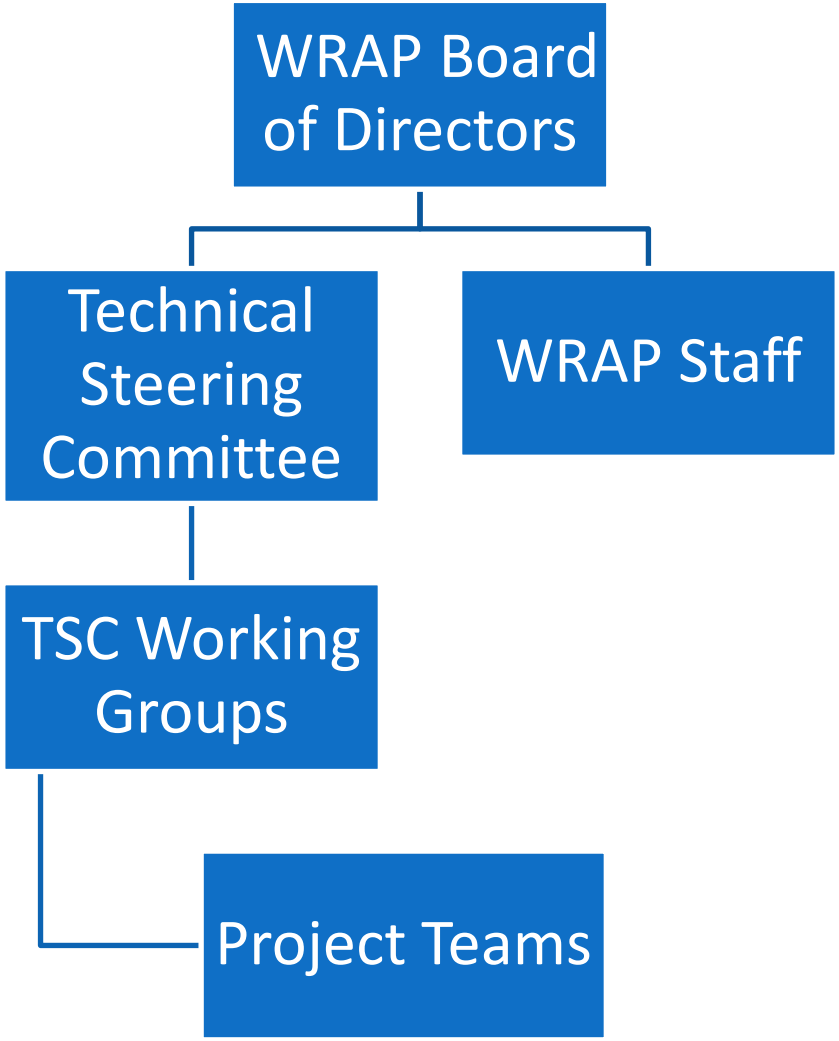
3-State Air Quality Study - Objectives

- 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

WRAP Work Plan - organizational structure



Attributes of WRAP Regional Analysis and Planning Support Activities

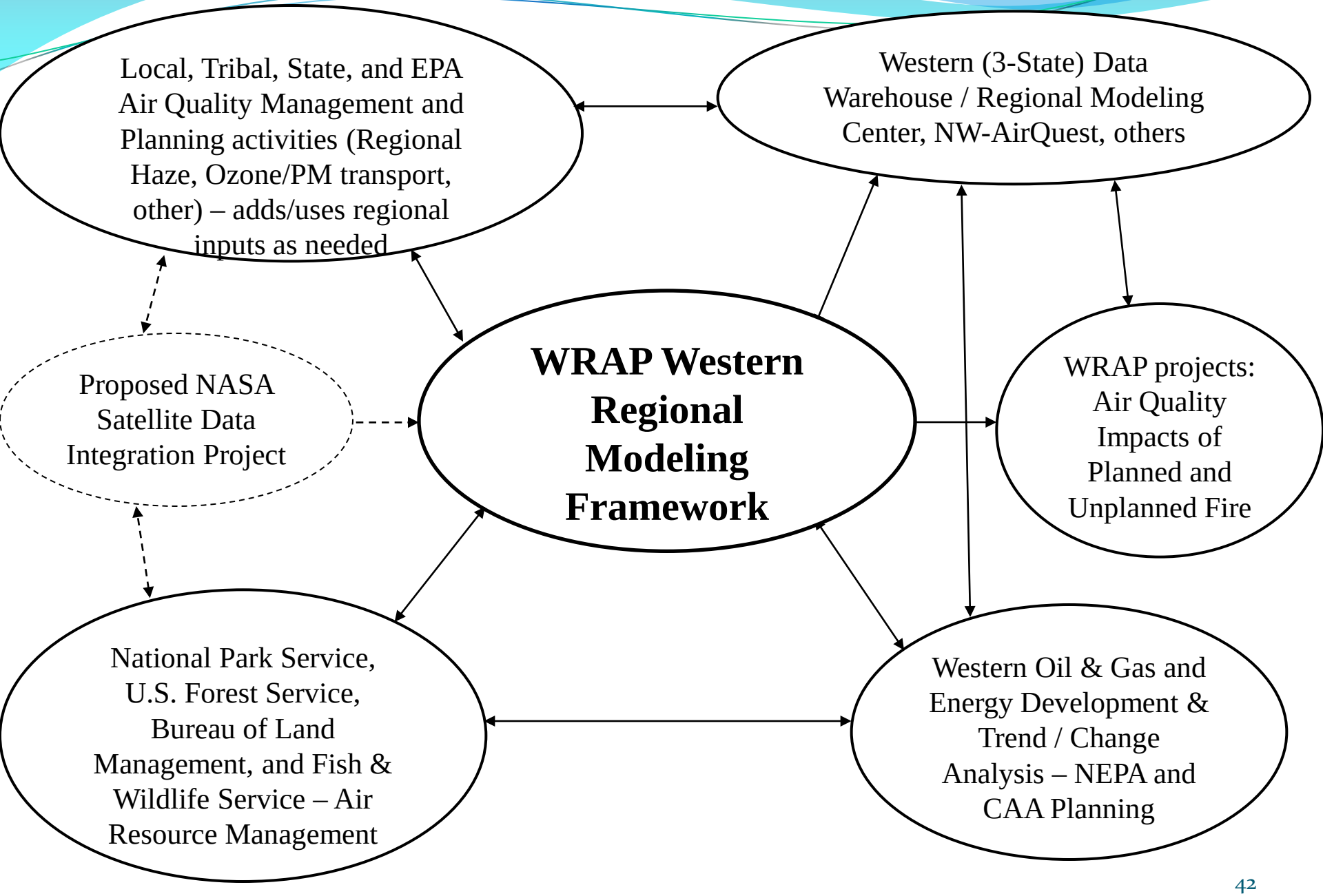
Desirable Capabilities
Remote sensing/Satellite data,
Improved technical resolution for international transport,
Efficient regional data and decision support systems, et cetera

Necessary Regional Activities
Regional Haze Planning Support,
Tracking and Analysis of Controls, et cetera

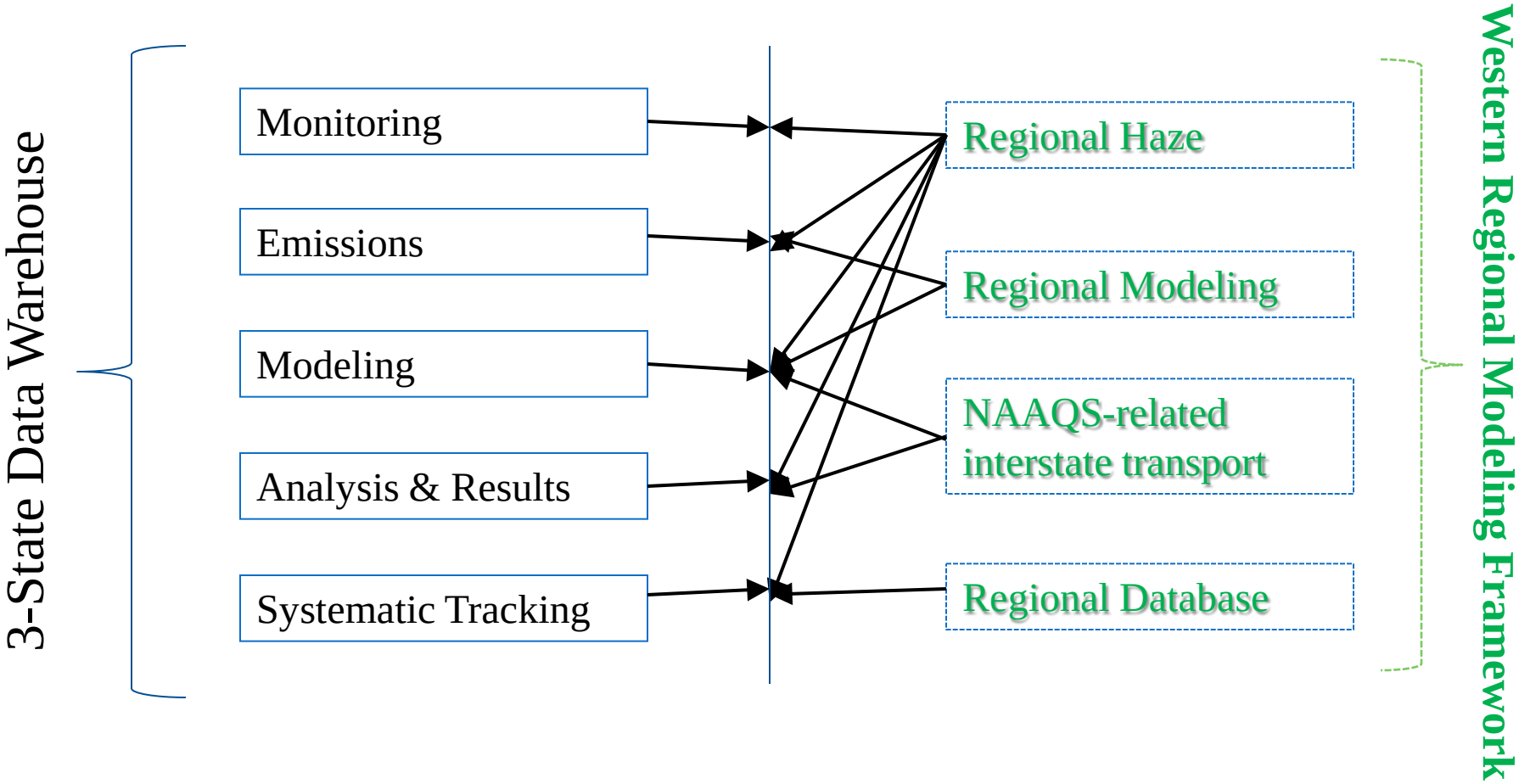
Required Foundational Activities
(Western Regional Modeling Framework,
Tracking and Projection of Regional Emissions,
Preparation/delivery of ready-to-use Datasets, e.g., Monitoring, Meteorology, et cetera

Coordination with western air agencies ensures that the WRAP serves as a resource and repository for federal, state, tribal and local air planning activities.

WRAP members and relationship to regional technical activities



3-State Data Warehouse **Western Regional Modeling Framework (future)**



WRAP 2014-18 Integrated Work Plan – development, review , and adoption process

- All materials at: 2014-18 Integrated Work Plan
- Led by Technical Steering Committee
- Review Draft released week of Sept. 8th
- WRAP-wide review call on Thursday Sept. 25th
- Comments through October 24th
- Board review and adoption steps in Nov. and Dec.

Thanks –

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Western States Air Resources Council (WESTAR)

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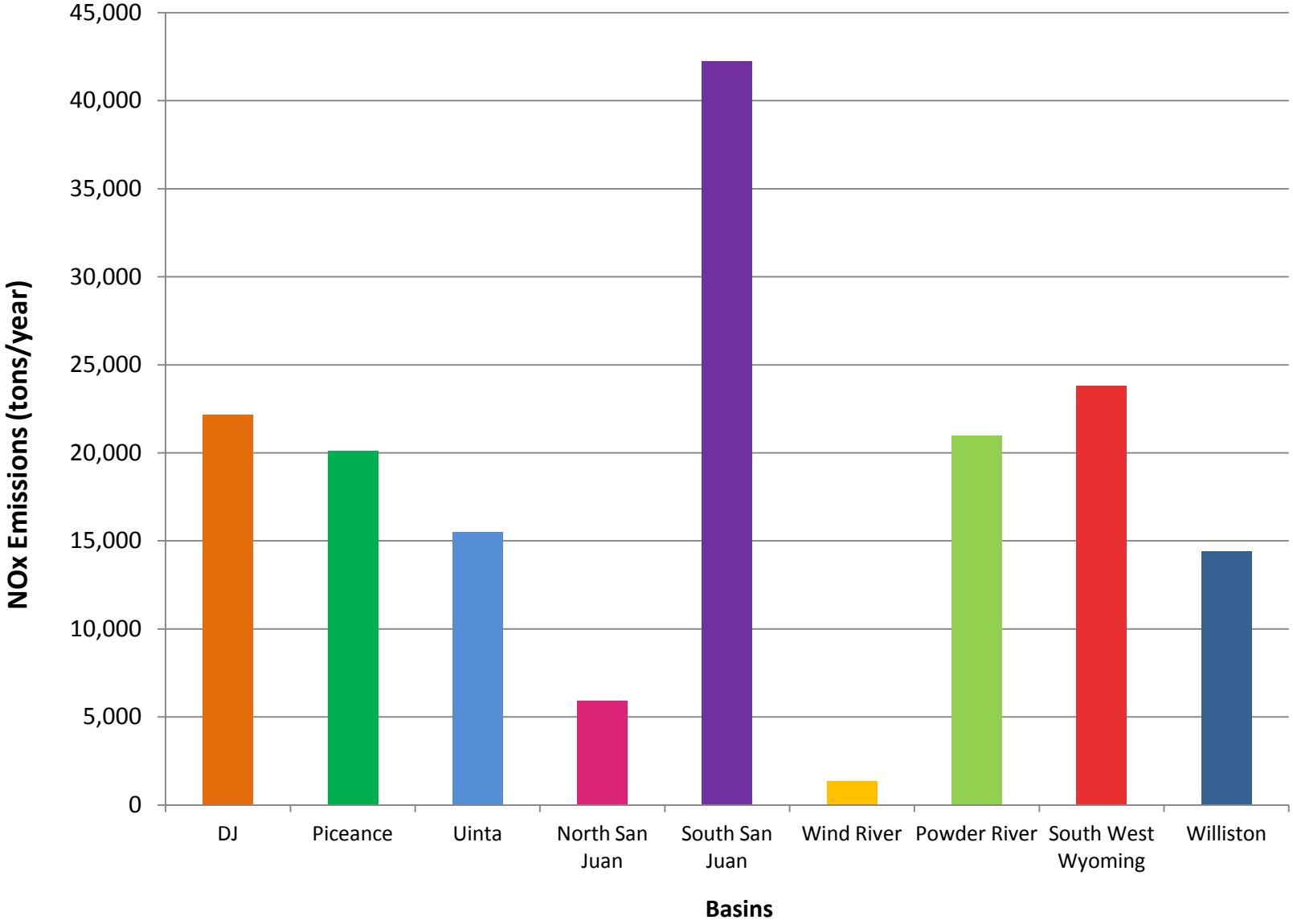
Western Regional Air Partnership | www.wrapair2.org

Oil & Gas slides

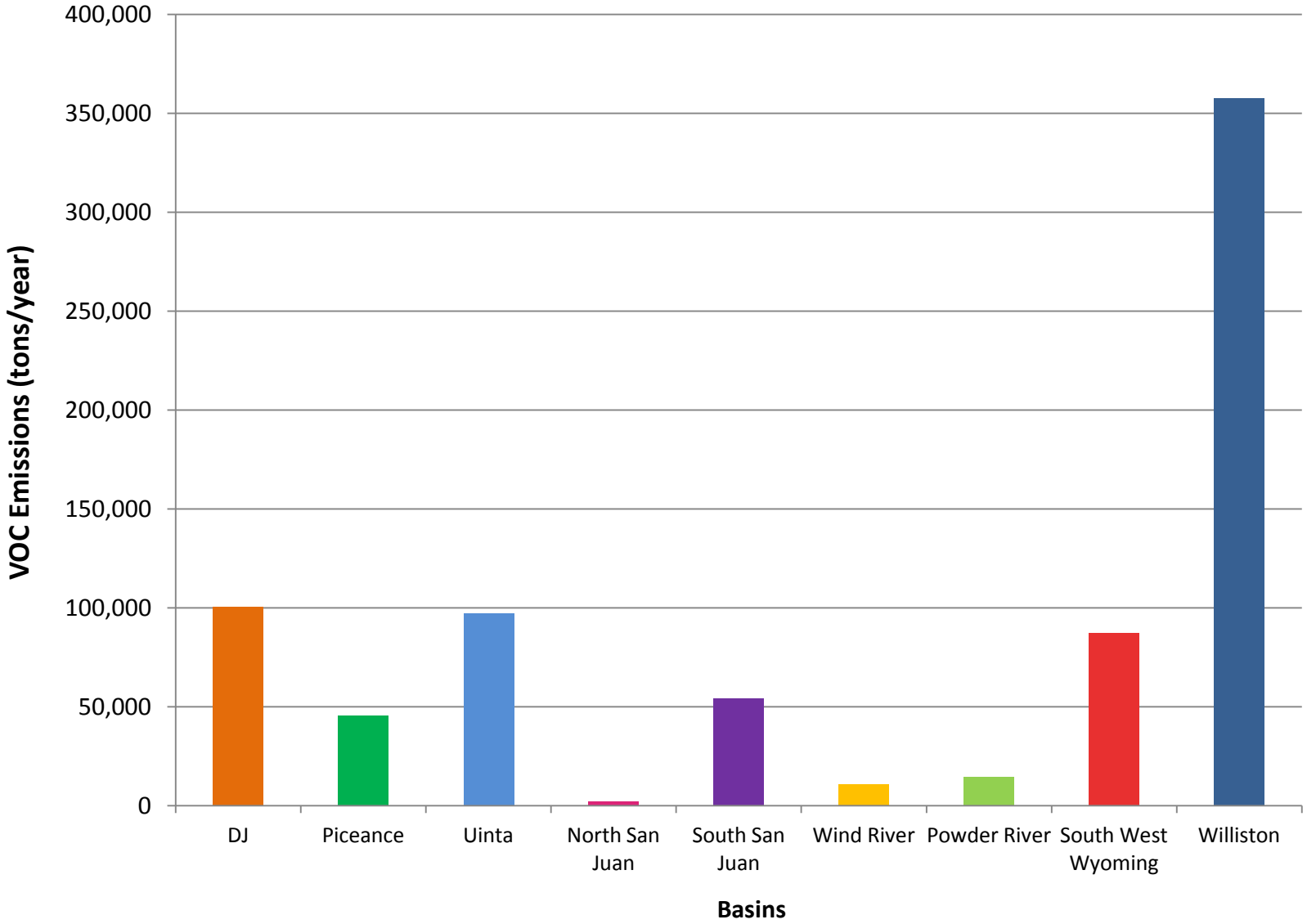
Oil & Gas: Emissions Inventories and Control Analysis

- 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

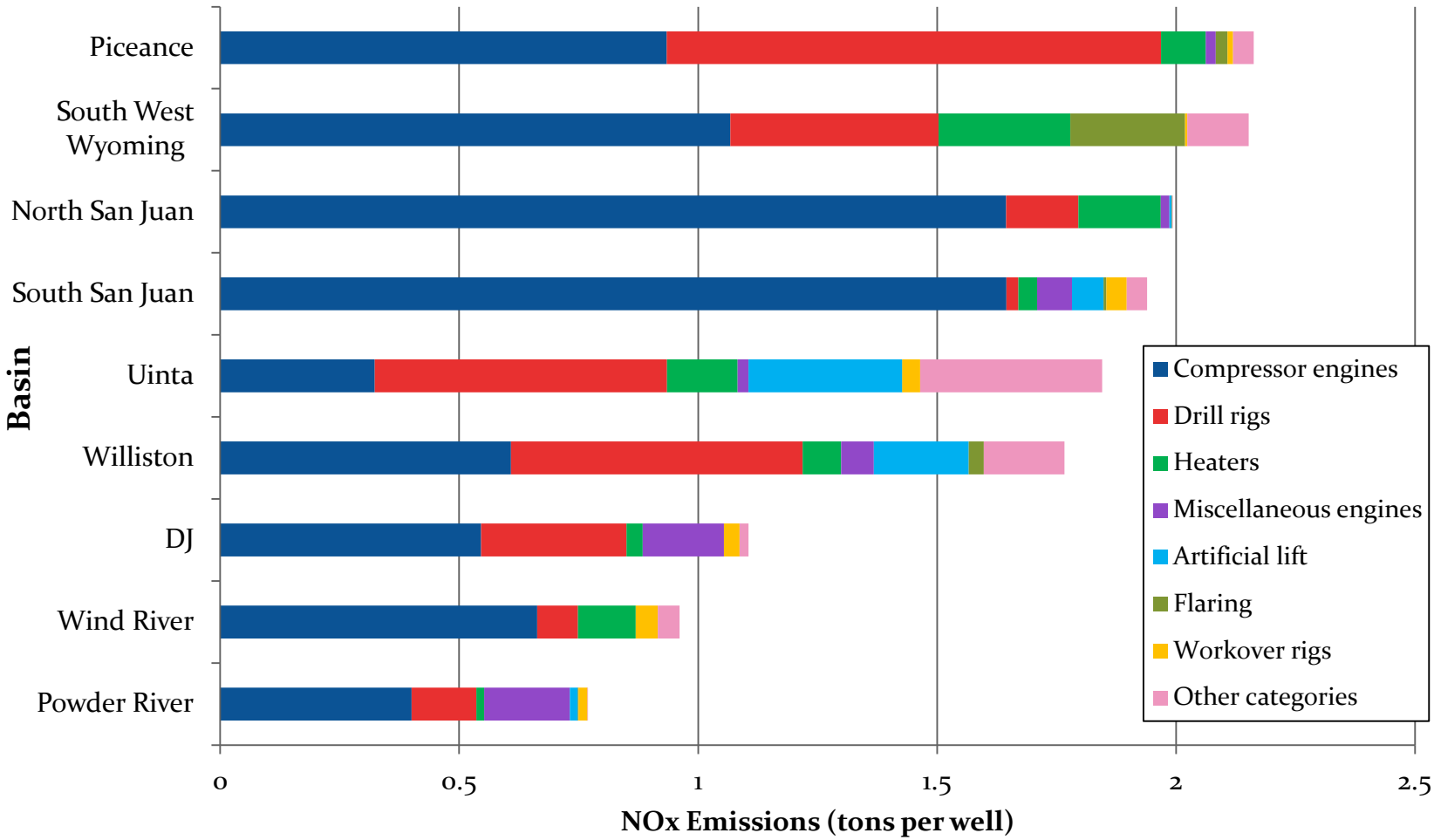
Cross-Basin – NOx Emissions



Cross-Basin – VOC Emissions

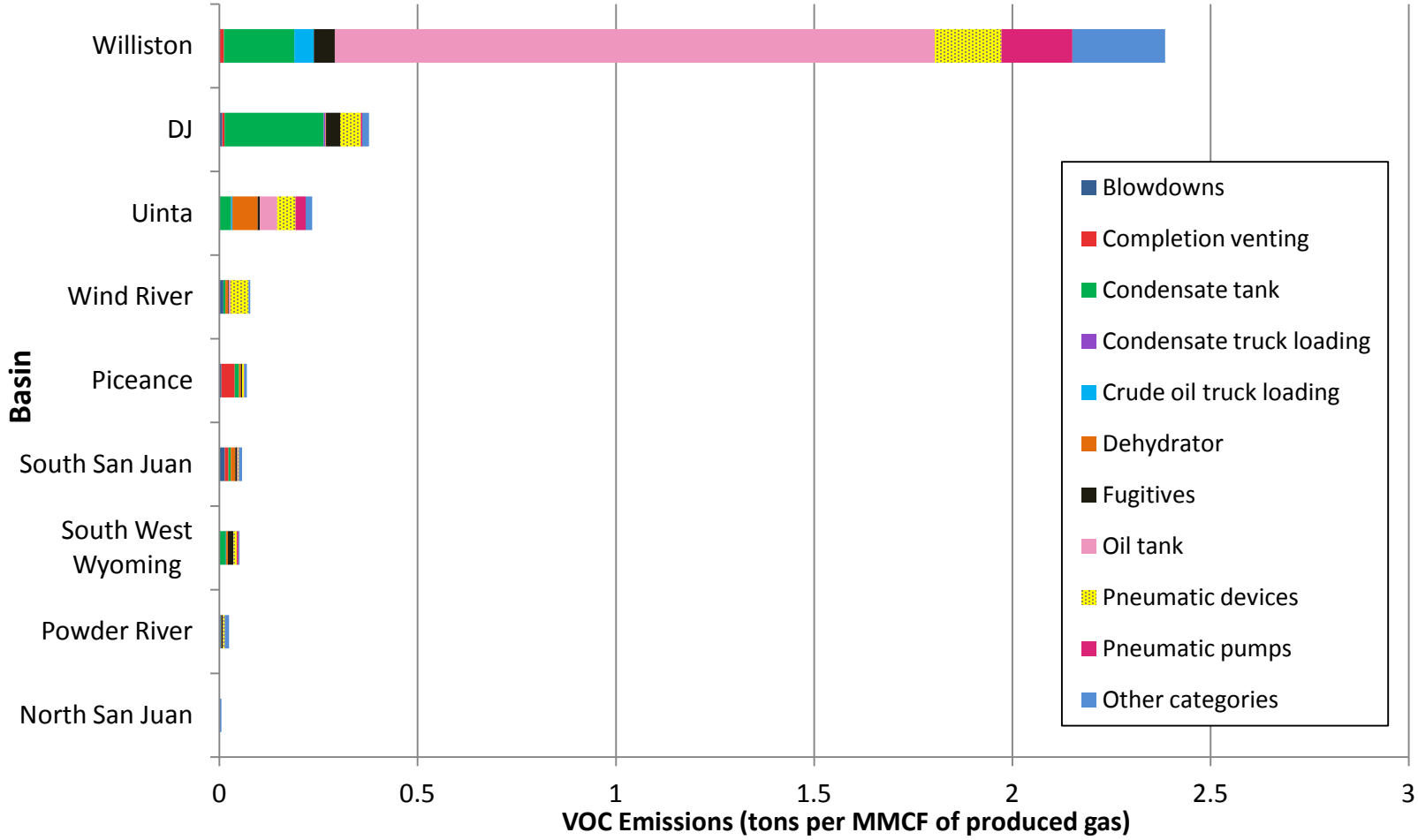


Cross-Basin – Per-Well NOx Emissions



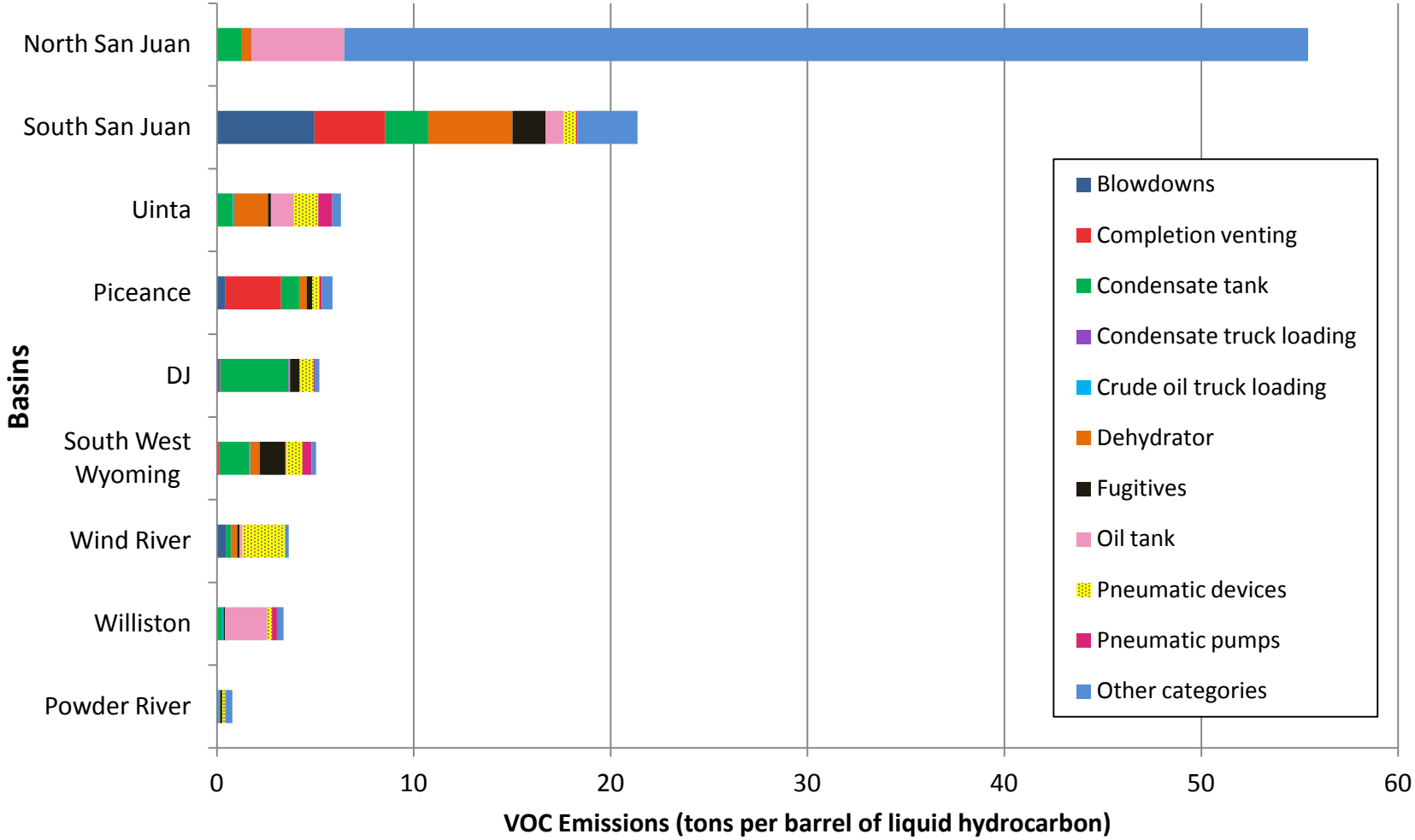
Per well NOx emissions relatively consistent across basins – differences mainly due to usage of compression and centralized vs. wellhead compression

Cross-Basin – Per-Unit-Gas-Production VOC Emissions



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

Cross-Basin – Per-Unit-Liquid-Production VOC Emissions



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

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

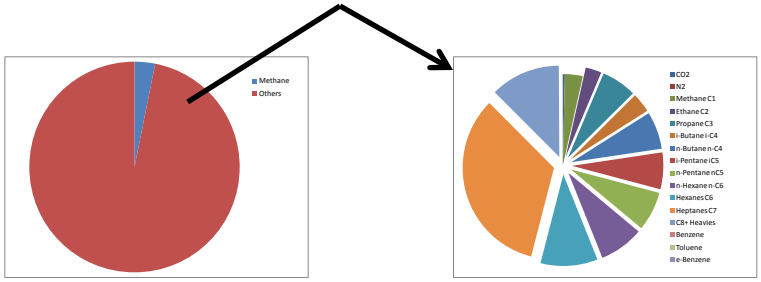
Issues / New Concepts – Non-routine events, Skewness

- 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

Conventional Gas
(Vented/Fugitive Sources)



Flash Gas
(Condensate and Oil Tanks)

- **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**