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

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Tom Moore
WRAP Air Quality Program Manager
WESTAR Council
California Desert Air Working Group WRAP Workshop
Pala, CA
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
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 (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)
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

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

- Wildfire Acres
- Prescribed Fire Acres
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
  - 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 used by EPA contractor for 2011 NEI
    - Will be applied in 2014 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

Emissions Model

Determine source impact / contribution

distribute emissions

DEASCO$_3$ & PMDETAIL

Chemical Profiles

loft emissions
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\textsubscript{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

Federal Land Manager Database (FED)

Federal Land Manager Environmental Database (FED)

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

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

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

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

July 9, 2008
max = 24.71 tons

Fire and Smoke Model Evaluation

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

Featured Substance
Ammonium sulfate
- Name: Ammonium sulfate
- Formula: H4N2O4S
- CAS Number: 7783-20-2
- ACN Number: 6100213-5
- Density: 1.769
- Comments: colorless crystals or white granular powder
- Molecular Weight: 132.342
- Melting Point: 280
- Water Solubility: Soluble
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 > 1 ppb -- 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
Limited by bounding box
2007

6/20 – 8/31
Limited by bounding box
Limited by bounding box

FETS estimated fuel consumed for all fire types 01/01/2004 to 12/31/2008
limited by geographic bounding box

2008
6/20 – 8/31
Elevated Ozone due to Fire: Idaho - 2008 Case Study

Jun 1 – Sep 30, 2008, O₃ > 70ppb
Fire contr. ≥ 1ppb, model error ≤ 25%

- 3 periods of elevated O₃
- Each period shows fire contribution > 3ppb
- Only late August period has nearby fire activity
- Earlier contr. from long-range transport (NorCal complexes)
Elevated Ozone due to Fire: Idaho - 2008 Case Study

Aug 10 – Aug 31, 2008

- South Barker Nature
- North Minidoka
- East Slide Rock Ridge
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

<table>
<thead>
<tr>
<th>Title</th>
<th>Sections</th>
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<tbody>
<tr>
<td>Biscuit Wildfire</td>
<td>10</td>
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<tr>
<td>Chatfield, CO July 2004-2007</td>
<td>16</td>
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<tr>
<td>Chatfield, CO July 2008</td>
<td>12</td>
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<tr>
<td>Evans Road Wildfire (Pocosin NWR) / Peat burning</td>
<td>12</td>
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<tr>
<td>Fall burning in southern Louisiana, 2008</td>
<td>9</td>
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<tr>
<td>Flint Hills</td>
<td>8</td>
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<tr>
<td>McNally Wildfire</td>
<td>6</td>
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<tr>
<td>Missionary Ridge &amp; Hayman Wildfires</td>
<td>7</td>
</tr>
<tr>
<td>Northern California Wildfires, 2008</td>
<td>17</td>
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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](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
  - Western 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 Western 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

- WRAP Board of Directors
  - Technical Steering Committee
  - WRAP Staff
  - TSC Working Groups
  - Project Teams
- WRAP Staff
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

Local, Tribal, State, and EPA Air Quality Management and Planning activities (Regional Haze, Ozone/PM transport, other) – adds/uses regional inputs as needed

Western (3-State) Data Warehouse / Regional Modeling Center, NW-AirQuest, others

WRAP Western Regional Modeling Framework

Proposed NASA Satellite Data Integration Project


WRAP projects:
- Air Quality Impacts of Planned and Unplanned Fire
- Western Oil & Gas and Energy Development & Trend / Change Analysis – NEPA and CAA Planning

Western Oil & Gas and Energy Development & Trend / Change Analysis – NEPA and CAA Planning
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
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 Oct. 2nd
- Comments through October
- Board review and adoption steps in Nov. and Dec.
Thanks –

Tom Moore, WRAP Air Quality Program Manager
Western States Air Resources Council (WESTAR)

e: tmoore@westar.org | o: 970.491.8837

Western Regional Air Partnership | www.wrapair2.org
Leveraging EPA NEI & WRAP Western Data

- 2008 WRAP Fire and NEIv2 Fire data (USFS collaboration)

- WestJumpAQMS

- DEASCO$_3$

- Improved AQ Planning

- Exceptional Event applications

- PMDETAIL
Where do your data go, how are they used?

User-supplied data maintain their identity throughout the system.
Completed DEASCO$_3$ project - purpose & goals

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

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

- [https://pmdetail.wraptools.org/](https://pmdetail.wraptools.org/)

- 3-year project, JFSP-funded
  - Completion target Sept. 2015
  - Team = WESTAR/WRAP, Air Sciences, ENVIRON, CMU, and CSU

- Study Objectives
  - Quantify 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
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

<table>
<thead>
<tr>
<th>Basins</th>
<th>NOx Emissions (tons/year)</th>
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<tbody>
<tr>
<td>DJ</td>
<td>22,500</td>
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<tr>
<td>Piceance</td>
<td>19,000</td>
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<tr>
<td>Uinta</td>
<td>15,000</td>
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<tr>
<td>North San Juan</td>
<td>5,000</td>
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<tr>
<td>South San Juan</td>
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<tr>
<td>Wind River</td>
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<tr>
<td>Powder River</td>
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<tr>
<td>South West Wyoming</td>
<td>23,000</td>
</tr>
<tr>
<td>Williston</td>
<td>12,000</td>
</tr>
</tbody>
</table>
Cross-Basin – VOC Emissions

Basins

VOC Emissions (tons/year)

Williston

South West Wyoming

Powder River

Wind River

South San Juan

North San Juan

Uinta

Piceance

DJ
Per well NOx emissions relatively consistent across basins – differences mainly due to usage of compression and centralized vs. wellhead compression.
Per unit gas production VOC emissions vary widely across basins – differences due to levels of liquid hydrocarbon production (oil and condensate) and VOC content of produced gas.
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
Midstream sources

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

- Pipeline blowdowns
- Spills/upsets
- Maintenance activities

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

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

New factor data

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

Uncertainty

• Uncertainties not quantitatively estimated in most inventories
• Large data sets needed to estimate uncertainty
• Helpful in identifying poorly-characterized sources, and estimating uncertainty in AQ modeling