Using SOAS and related field study data for scientific and regulatory modeling

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Outline

1. Single source secondary impact assessments for permit (PSD/NSR) related programs

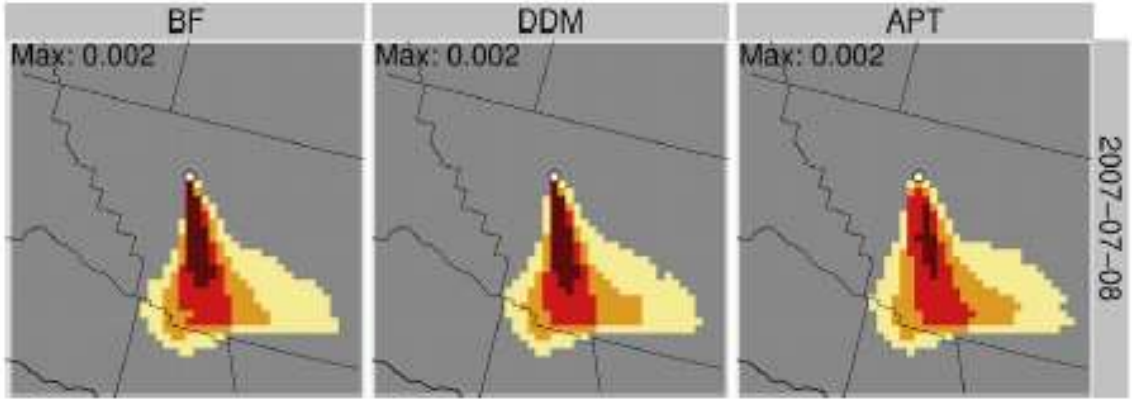
2. Wild, prescribed, and agricultural fires

Motivation: Single Source Secondary Impacts

- Sierra Club Petition Grant – Ozone and secondary PM2.5 assessments for PSD program
  - In January 2012, the EPA granted a petition submitted by the Sierra Club; Agency committed to engage in rulemaking to evaluate updates to Appendix W to 40 CFR 51, and, as appropriate, incorporate new analytical techniques or models for ozone and secondary PM2.5 for new and modified sources
- EPA's Guideline on Air Quality Models published as Appendix W to 40 CFR Part 51
  - Originally published in 1978, it addresses the regulatory application of air quality models for assessing criteria pollutants and ensures consistent analyses under the CAA
  - Primary pollutants modeled with AERMOD
- Proposed Rulemaking, "Revision to the Guideline on Air Quality Models," May 2015
  - Incorporate new analytical techniques to address ozone and secondary PM2.5
  - Final Rulemaking, "Revision to the Guideline on Air Quality Models," late 2016

Single Source Application & Evaluation

- Multiple studies modeling single source O3 and secondary PM2.5 with multiple photochemical grid model approaches (bottom and right)
- In-plume measurements of TVA power plant in 1999 used to evaluate O3 single source estimates (right)
- Need for additional O3 evaluations and for the first time to include secondary PM2.5 assessment



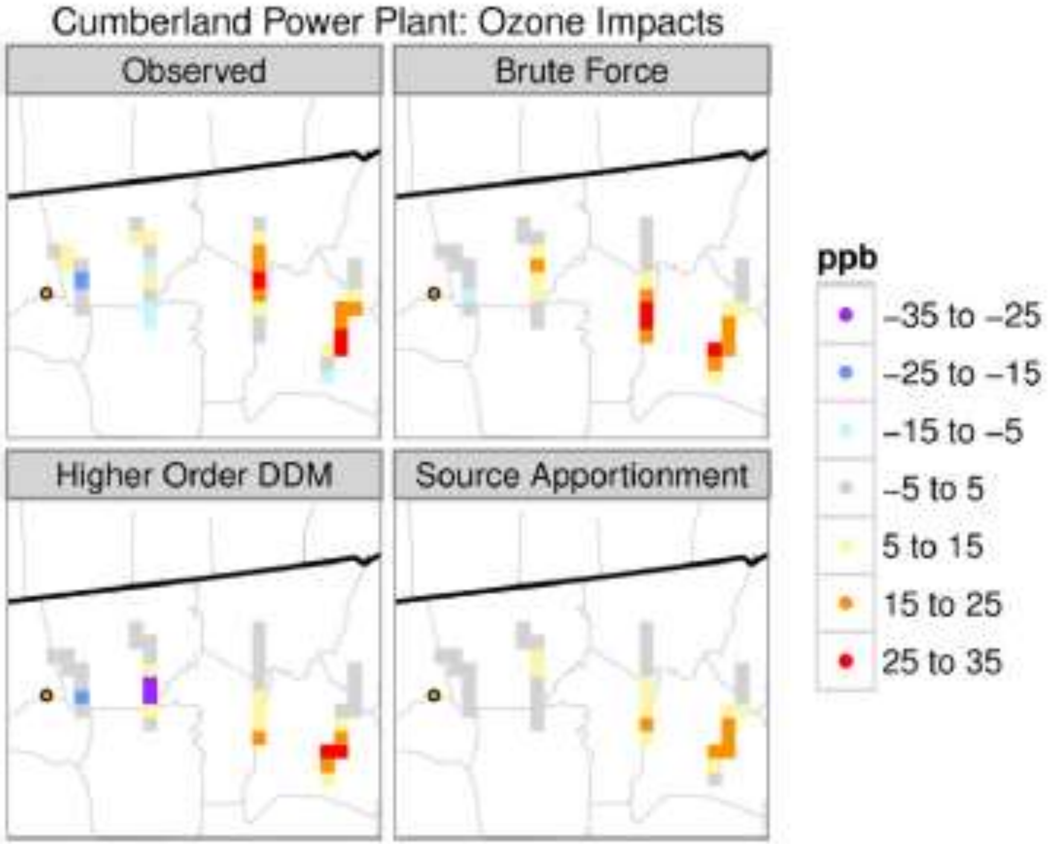
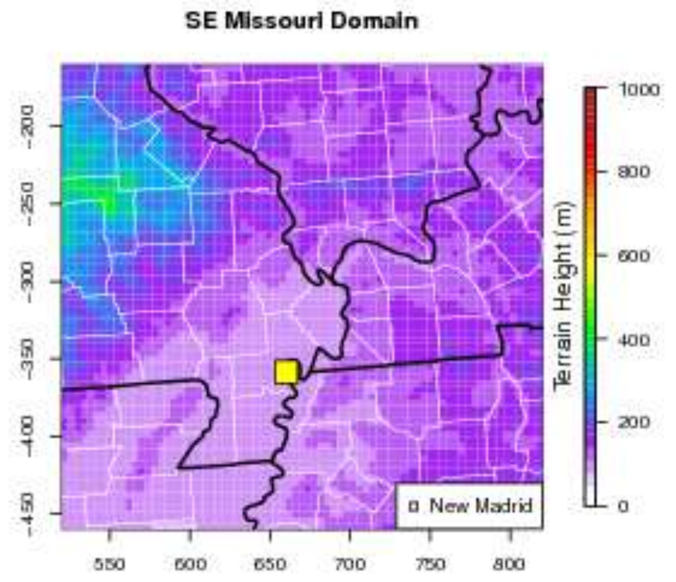
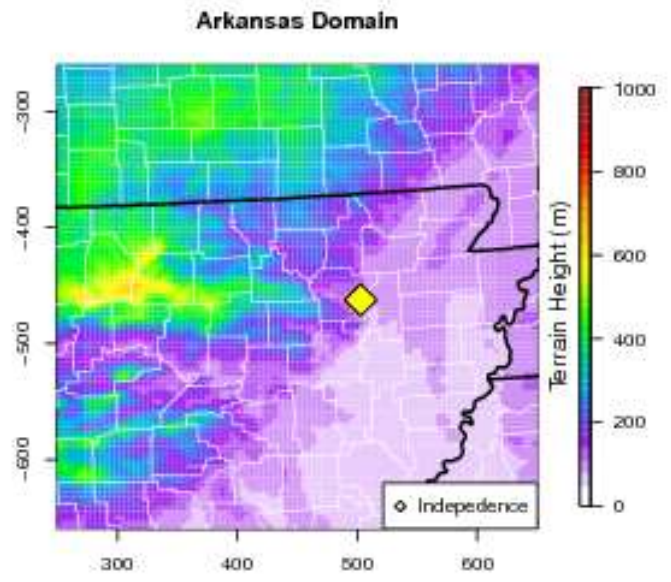


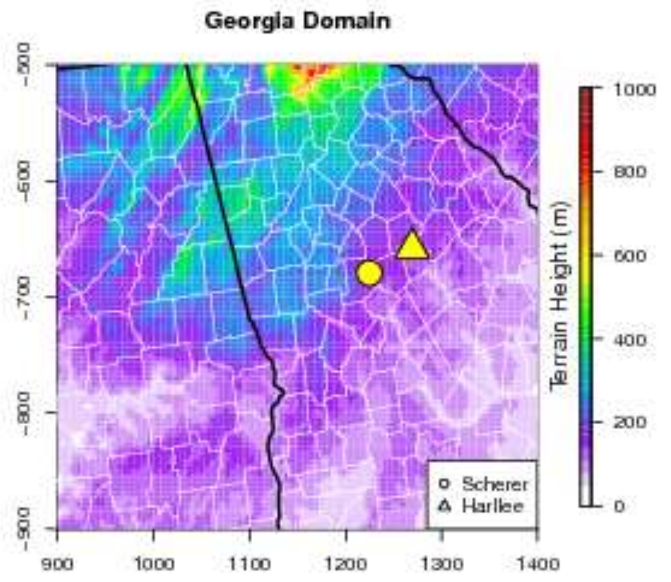
Fig. 4. Spatial plots of observed and measured O_3 mixing ratios. Modeled source impact shown using source apportionment, HDDM, and brute force difference. Observations are aggregated to match model grid structure.

O3 & PM2.5 Plume Evaluations

- In-plume transect measurements made as part of 2013 SENEX field campaign allows for additional single source model evaluation for O3 and a new opportunity to secondary PM2.5 evaluation
- Identified 5 flight-days that have plume transects related to 4 specific facilities
- Modeled single source impacts using photochemical grid model (CMAQ) using multiple approaches for isolating source impacts: brute-force zero out, source apportionment, & advanced plume treatment (with brute-force zero out)







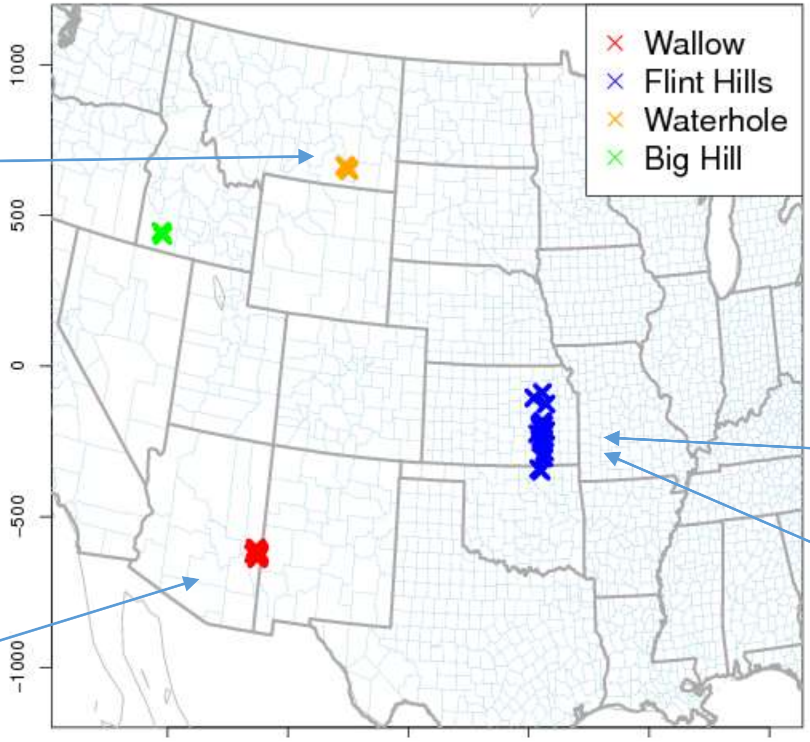
Motivation: Fires

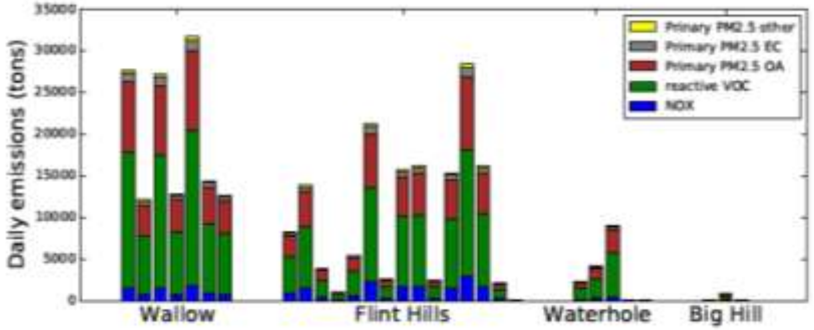
- Wildfire, prescribed fires, and agricultural fires routinely part of regulatory photochemical grid modeling for O3/PM/haze/toxics
  - Some projects have tracked the collective contribution from wildland fires to differentiate those impacts from other sources (e.g. transport rules, sector modeling to support benefit per ton health impacts)
- Assessing the impacts of fires (as a specific category or part of the collective "background") and specific fire events is becoming increasingly of interest to the air quality management community which will challenge our application of models to estimate impacts related to these sources
- Better characterization of fires in our regulatory modeling system is important for upcoming (1) regulatory needs such as Regional Haze Rule, Exceptional Events demonstrations, PM NAAQS review, O3 NAAQS review, and (2) other needs such as matching model predictions of fires with health effect information
- Critically important to understand whether our model estimates of O3/PM/haze/toxics from fires are over or understated given increased interest in regulatory and health exposure assessments

Initial Air Quality Modeling Project

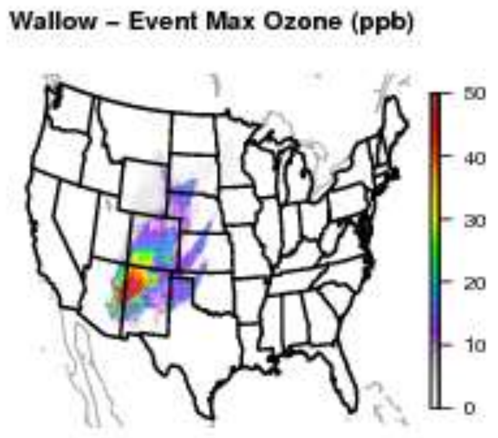
- To better understand the impacts of specific fires (rather than collectively) on model estimated O3 and PM2.5, the Community Multiscale Air Quality (CMAQ) photochemical transport model was applied using multiple source attribution approaches
- This project provided the first opportunity to relate emissions from specific fire events to downwind primary and secondary pollutant (O3, PM2.5) impacts
- Better understanding these relationships provides a technically credible way to support the use of simpler screening approaches for regulatory needs such as the Wildfire/O3 Exceptional Events Guidance
    - How much O3 forms from different sized fires? Are both NOX and VOC important or just NOX? How useful are simple tools like HYSPLIT trajectories or Q/D ratios? Can we clearly show multiple simple tools need to be employed when not using a refined modeling system?
- The following slides outline the photochemical model work done for specific fire events to support CMAQ source apportionment evaluation and subsequently to support Wildfire/Ozone Exceptional Event Guidance; the work also includes an assessment of fire related PM2.5 impacts

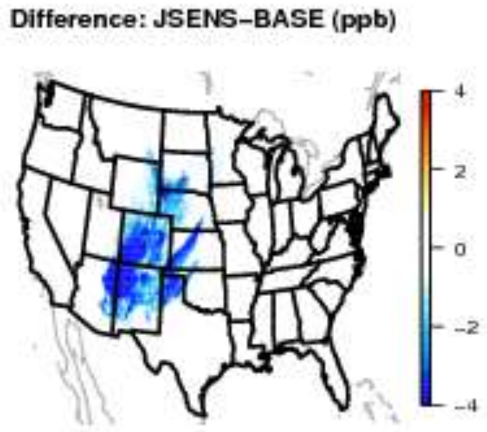
- Annual 2011 photochemical grid model (CMAQ) simulation at 12 km grid resolution
- Tracked Wallow, Flint Hills, Waterhole, and Big Hill fire contribution to modeled O3, CO, NOX, VOC, NH3, and speciated PM2.5 with multiple approaches

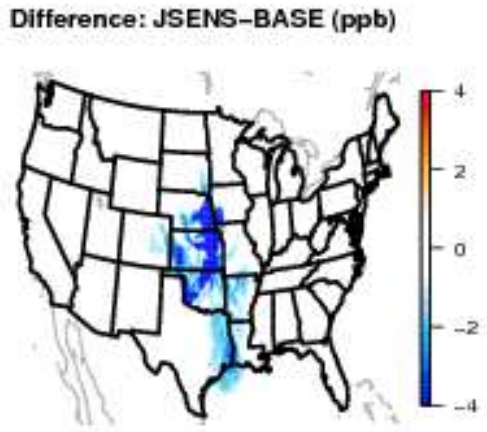




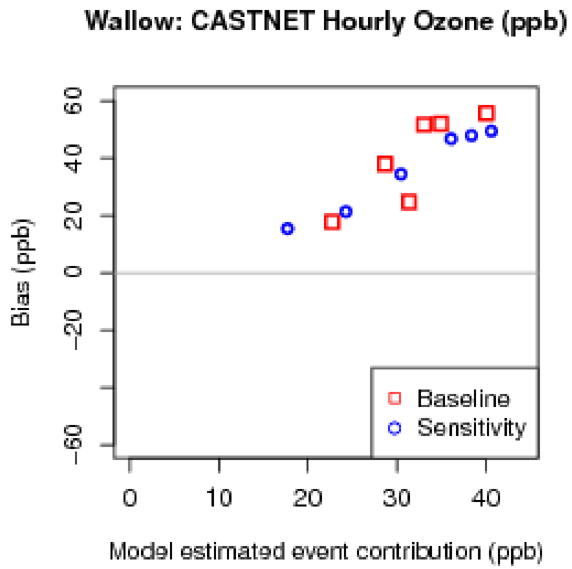
Ozone

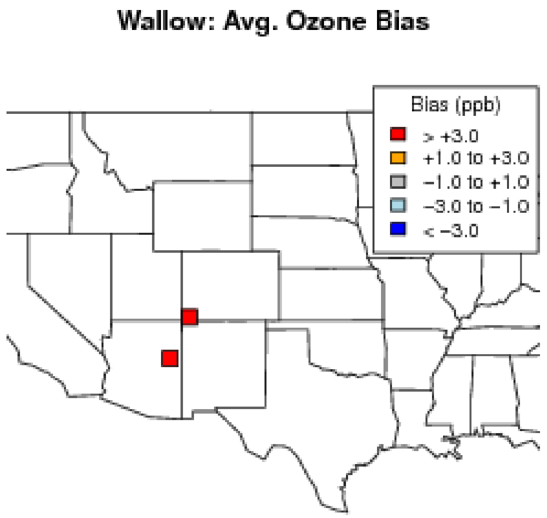






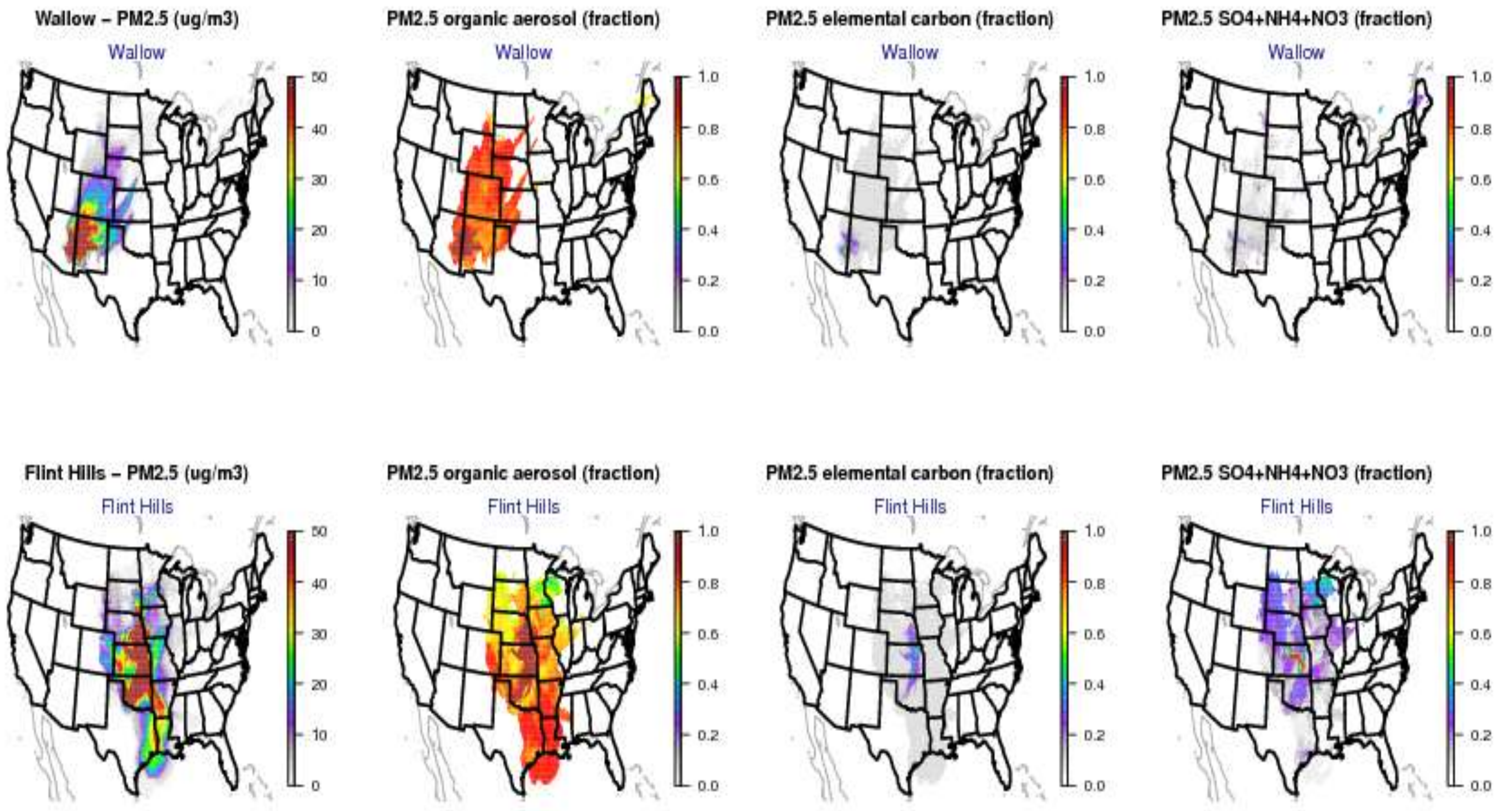
- Downwind maximum hourly O3 impacts by distance from the fire event (left) and difference with additional light attenuation
- Some constraint may be possible comparing model predictions with rural ambient measurements (CASTNET and IMPROVE) where the model estimates a large contribution from the fire event
- Many limitations using routine surface networks for evaluation
- **Best approach would be modeling field studies designed to capture wildfire O3/PM impacts**

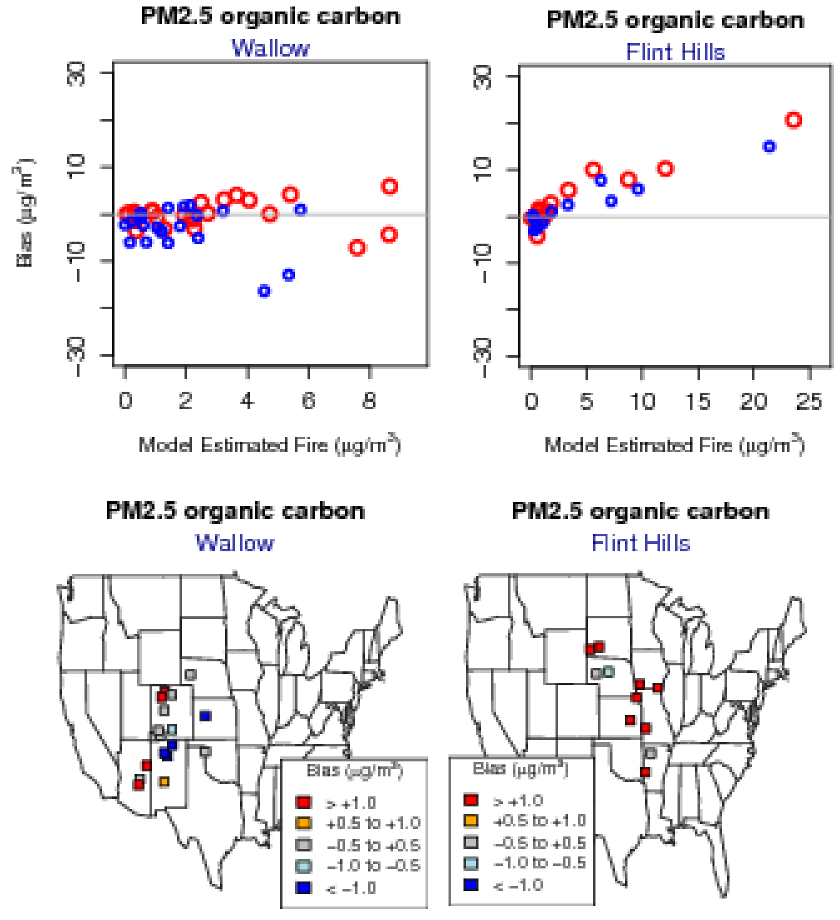




PM2.5

- Downwind maximum hourly total PM2.5 impacts (left panels)
- Speciated PM2.5 impacts shown as fraction of total (left panels): POA largest component
- Average Model Bias (model-obs) at IMRPOVE sites over days with modeled fire impacts (right)





Volatility Basis Set Approach

- Using the default VBS implemention in CMAQ and CAMx based on Koo et al 2014
- Working to better understand how fires are represented in this system
- Open to other approaches

Koo, B., Knipping, E., Yarwood, G., 2014. An Improved Volatility Basis Set for Modeling Organic Aerosol in Both CAMx and CMAQ, Air Pollution Modeling and its Application XXIII. Springer, pp. 103-108.

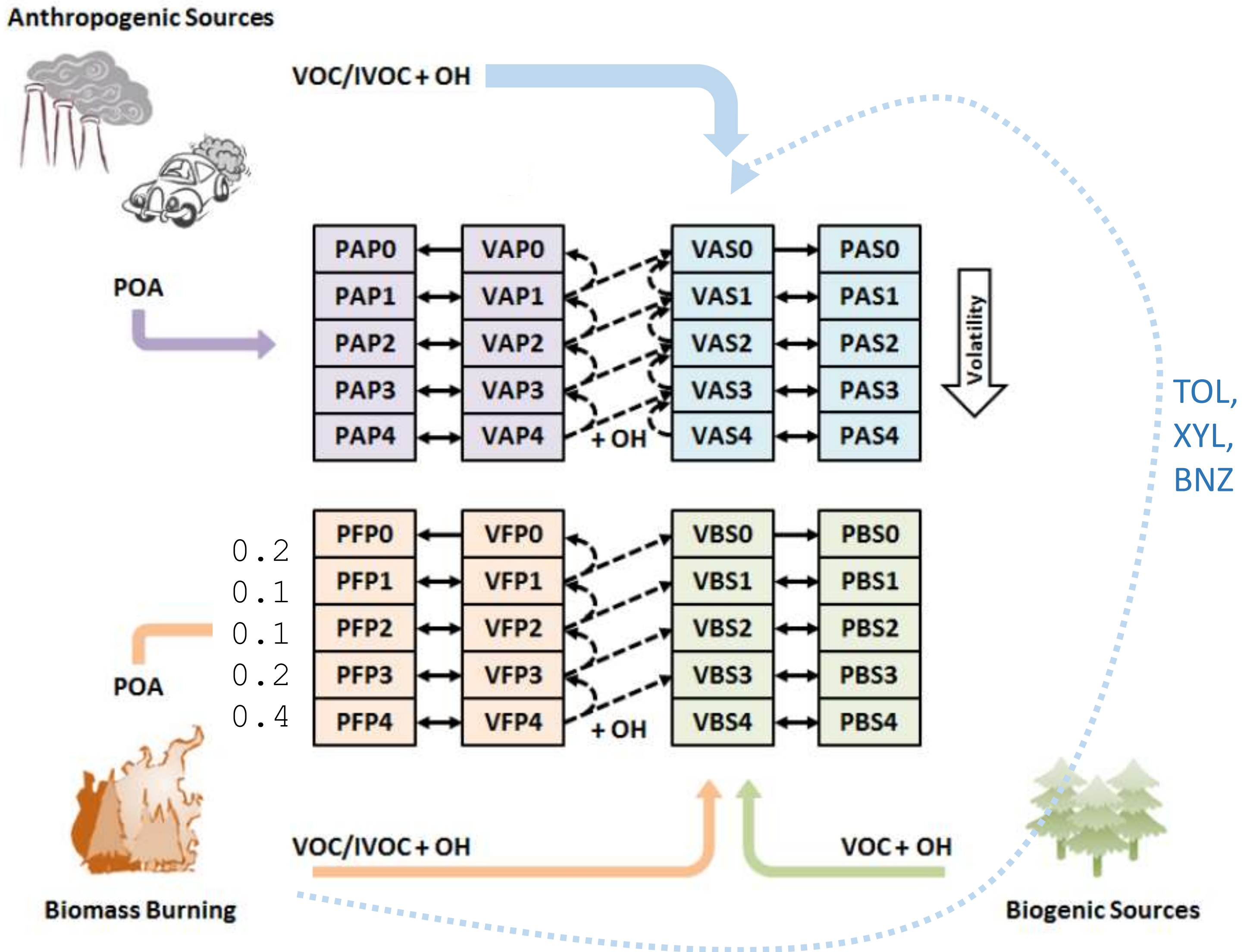
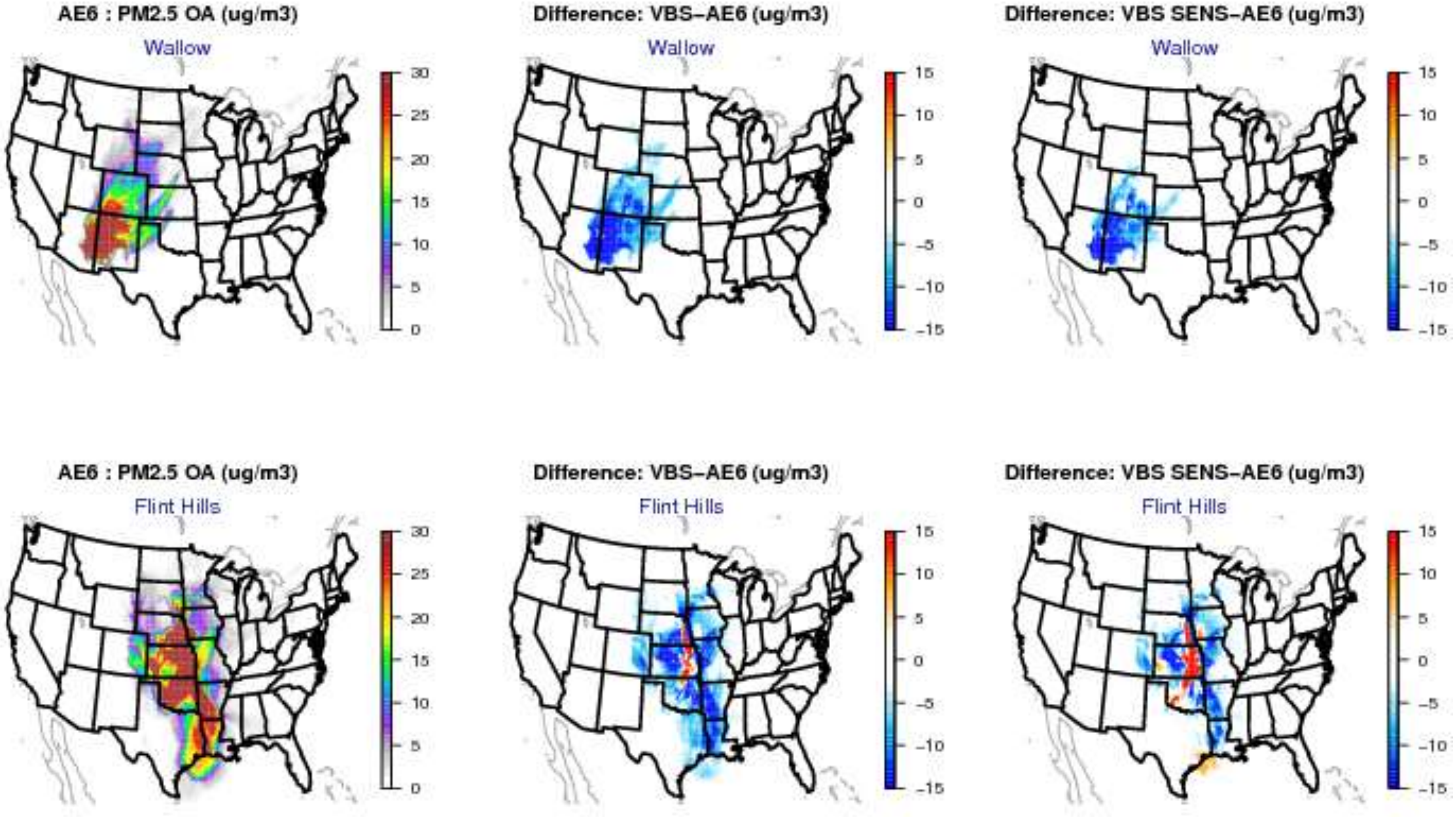


Figure 5-2. Schematic diagram of the CAMx VBS module. The model VBS species name consists of 4 characters that indicate the phase (P – particle; V – vapor), the source (A – anthropogenic; B – biogenic; F – fire), the formation (P – primary; S – secondary), and the volatility bin number. The solid and dashed arrows represent gas-aerosol partitioning and chemical aging, respectively. The thick colored arrows represent POA emissions or oxidation of SOA precursors. *CAMx v6.2 manual; www.camx.com

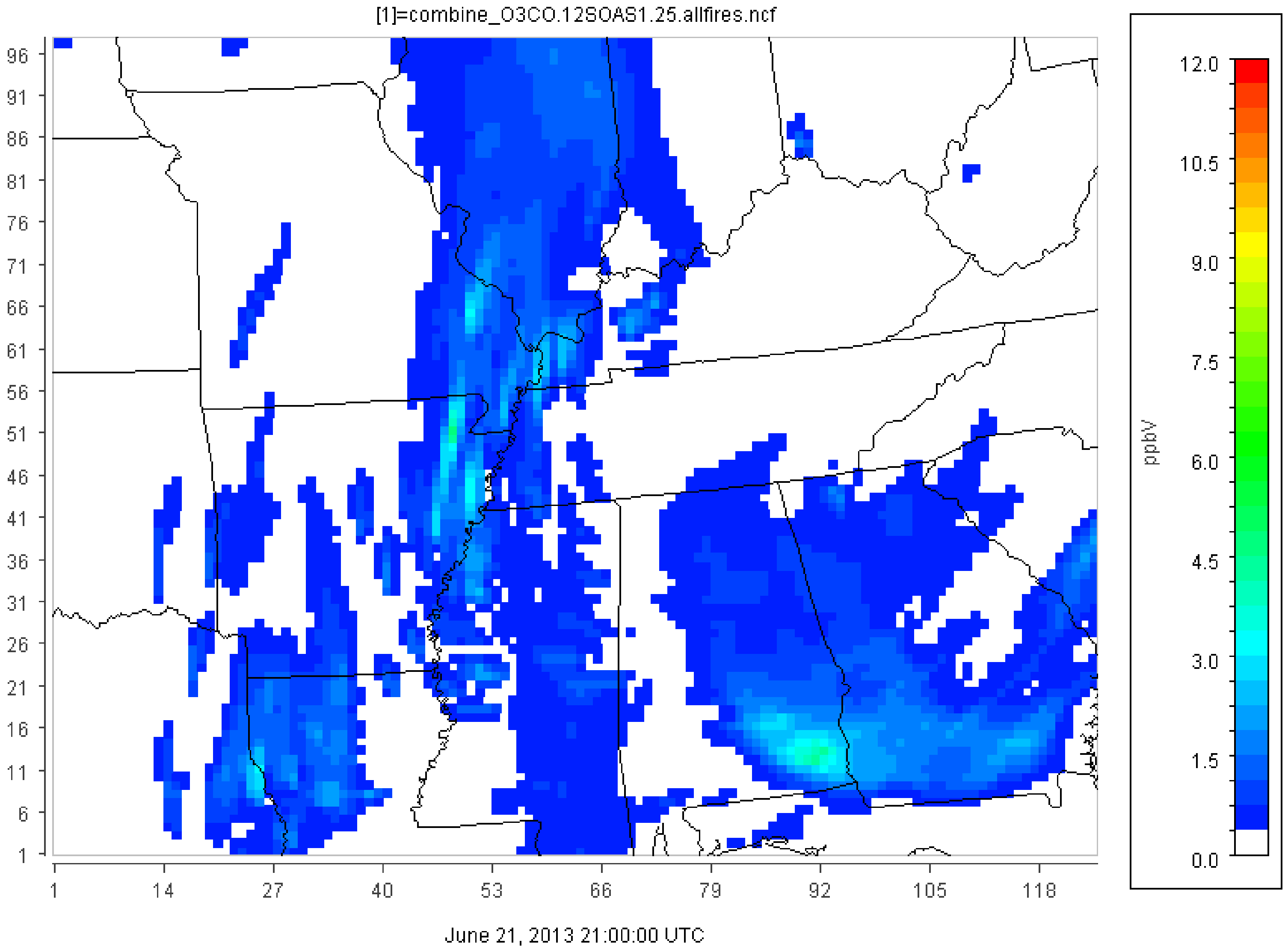
PM2.5 OA

- Exploring alternative approaches for treating POA as semi-volatile (VBS) rather than non-volatile (current AE6 approach)
- Hourly maximum PM2.5 organic aerosol (left) and difference between baseline (AE6) and VBS (middle and right)



Hourly modeled O3 contribution from fires during the 2013 SOAS field study period

- 2013 field campaigns SOAS, SENEX, SEAC4RS provide information specific to biomass burning regionally and for specific events
- Provides a better opportunity for modeled fire evaluation while waiting for future fire specific field campaigns such as FASMEE, FIREX, and FIREchem



Other ongoing and long term fire related modeling projects

- AgBurn 2013: Science to Support Smoke Management Agricultural Field Burning
  - FY2013 ORD Regional and Applied Research Effort (RARE) with Region 10
  - August 18-26, 2013 agricultural fires in western Idaho and southeast Washington
- Fire and Smoke Model Evaluation Experiment (FASMEE): local to regional scale prescribed burn field campaigns coordinated by the Joint Fire Science Program; modeling being done both to inform field study planning (Phase 1) and also after field study for development of smoke and fire models (www.fasmee.net)
  - FASMEE is currently in Phase 1 which will lead to a detailed experimental design. Phase 2 will be the field campaign measurements which are currently planned for summer 2018-2020 (location in western US and southeast US)
- FIREX: Local to regional scale field campaign focused on western U.S. fires being planned by NOAA for 2017 and 2018
- FIREchem: Regional to super-regional field campaign being planned by NASA to compliment the FIREX campaign (same time period as FIREX)

Other planned uses of SOAS/SENEX/SEAC4RS

- Biogenics evaluation for SE US
  - Expand on California & Ozarks evaluations
- Contribution to regional formaldehyde
- Ammonia evaluation
- Contribution to regional SOA
- Support mobile source sector assessments
- Mercury evaluation

Geosci. Model Dev. Discuss., 8, 8117–8154, 2015
www.geosci-model-dev-discuss.net/8/8117/2015/
doi:10.5194/gmdd-8-8117-2015

Geoscientific Model Development Discussions

This discussion paper is/has been under review for the journal Geoscientific Model Development (GMD). Please refer to the corresponding final paper in GMD if available.

Evaluation of improved land use and canopy representation in BEIS v3.61 with biogenic VOC measurements in California

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