Working toward better characterization of wildland fire impacts on air quality

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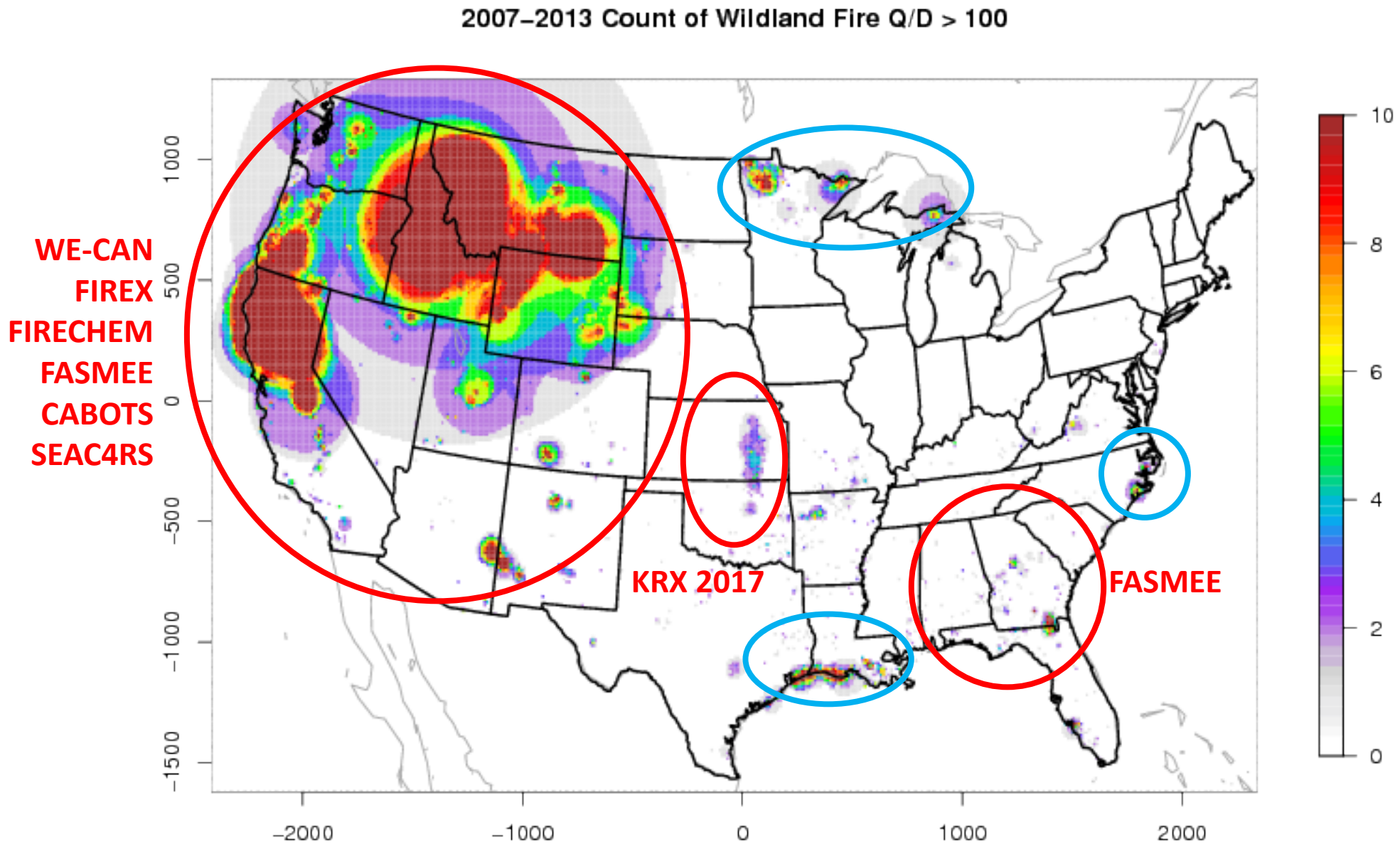
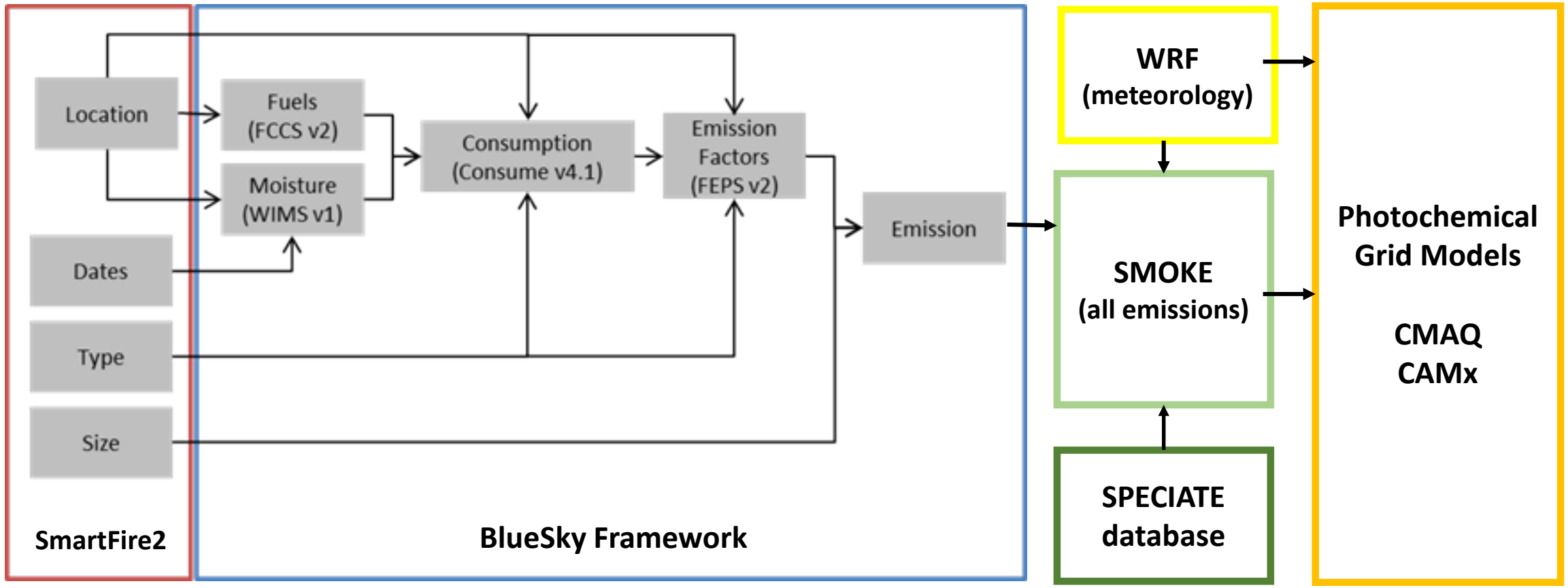

2007–2013 Count of Wildland Fire Q/D > 100
WE-CAN
FIREX
FIRECHEM
FASMEE
CABOTS
SEAC4RS
KRX 2017
FASMEE
1000
500
0
−500
−1000
−1500
−2000
−1000
0
1000
2000
10
8
6
4
2
0

Motivation

- Current and future human health impacts from wildland fires
- O_3 and PM National Ambient Air Quality Standards (NAAQS)
  - Exceptional Event demonstrations (e.g., Flint Hills impacts on O_3 in Kansas City)
- Regional Haze Rule
- National Air Toxics Assessment
- Exposure and health impact assessments
- Understand how well our regulatory modeling system (SMARTFIRE2, BLUESKY, SMOKE, CMAQ) represents wild and prescribed fires to best inform regulatory assessments—includes warm and cold seasons, large and small wildland fire

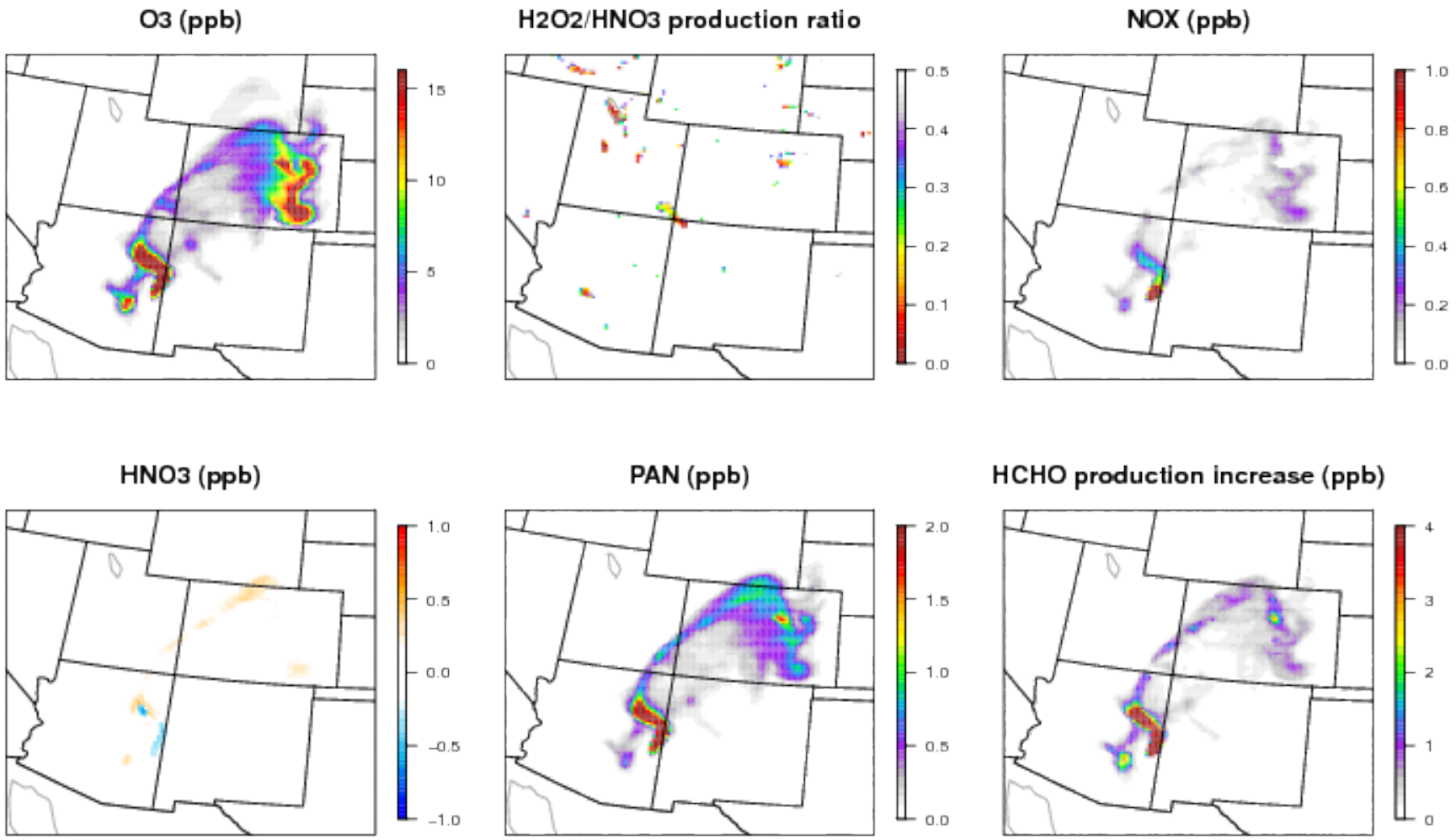
Regulatory Modeling System for Wildland Fire

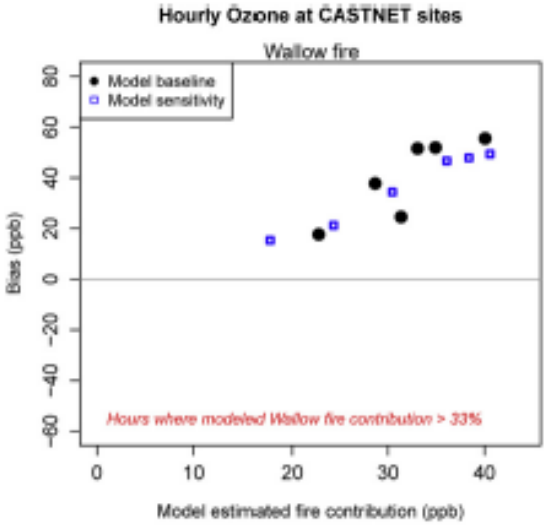


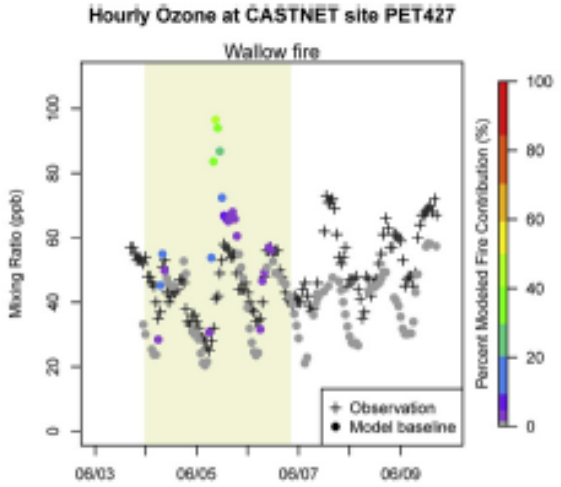
*2014 TSD documentation on estimating WLF emissions for the NEI

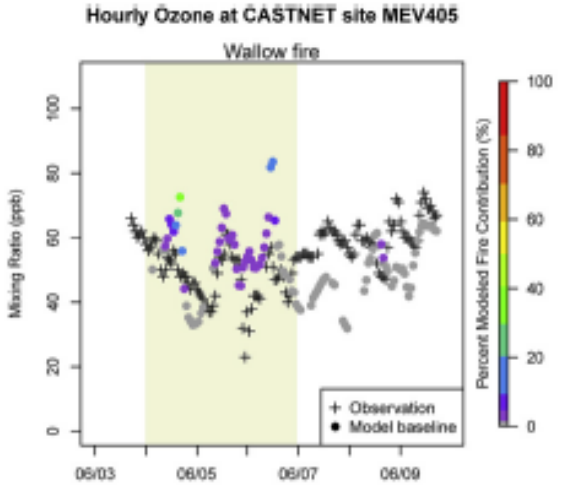
Ozone

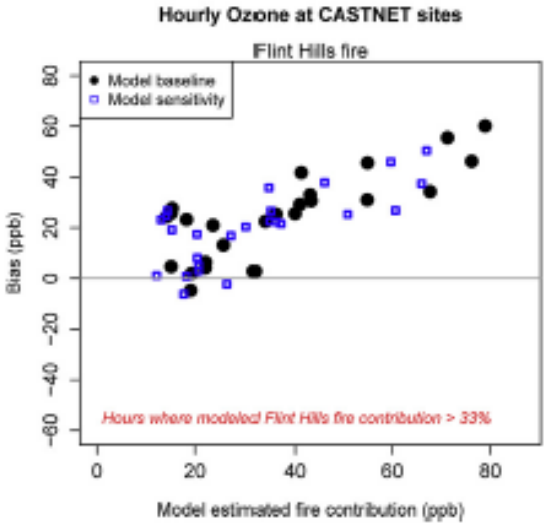
- Modeled impacts of Wallow fire shown for June 5, 2011 at 2pm LST
- NO_X and VOC emissions from wildfires important
- PAN and aldehydes important in local to regional scale O_3 production

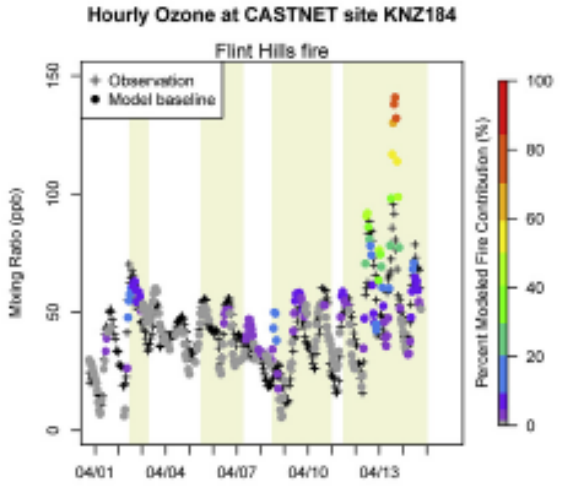


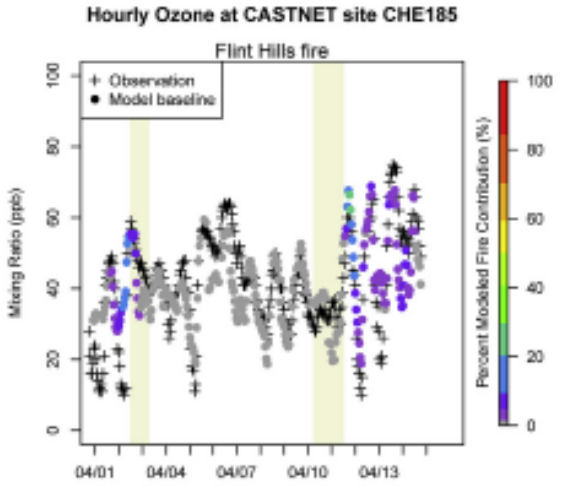










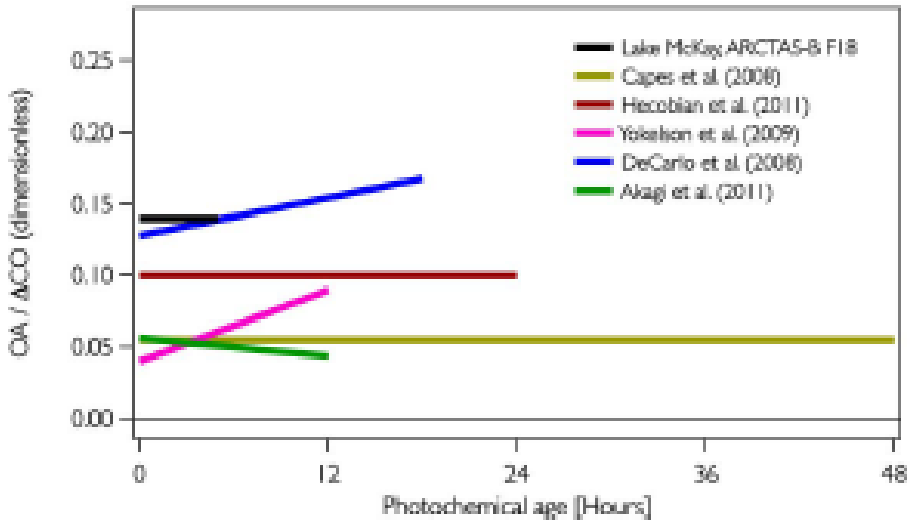


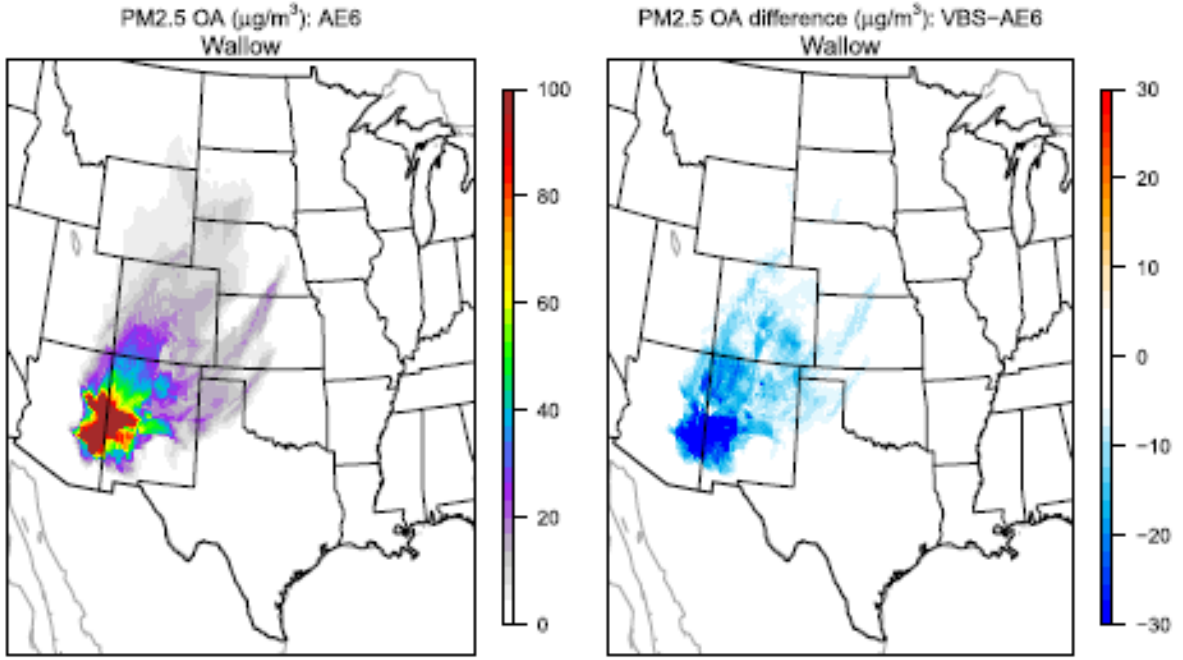
- Hourly modeled fire contribution paired with bulk model O3 bias at rural CASTNET monitors.
- The shaded areas of the time series plots indicate days with possible Wallow or Flint Hills fire impacts based on HMS data.
- The model sensitivity is a simulation where solar radiation and photolysis rates are more aggressively attenuated by modeled organic aerosol.
- Baker, K.R., Woody, M., Tonnesen, G., Hutzell, W., Pye, H., Beaver, M., Pouliot, G., Pierce, T., 2016. Contribution of regional-scale fire events to ozone and PM 2.5 air quality estimated by photochemical modeling approaches. Atmospheric Environment 140, 539-554.

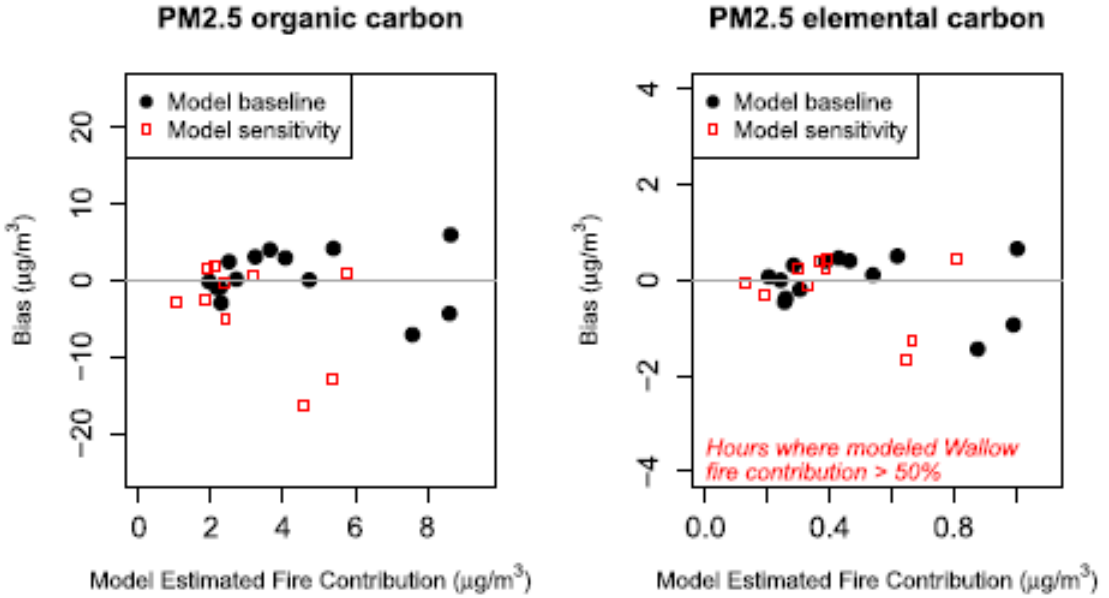
PM2.5

- PM2.5 largely in the form of organic aerosol (OA)
- Disagreement about secondary OA formation from wildland fires within the scientific community

M. J. Cubison et al.: Effects of aging on organic aerosol







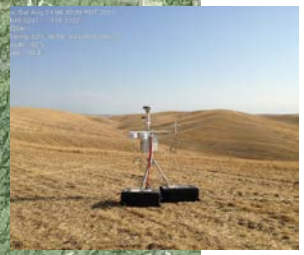
What are outstanding needs for local to regional scale O_3 and PM wildland fire modeling?

- How can current and planned satellite products be improved for detection and areal extent of fires? Help with plume rise and temporal allocation?
- Improved region specific fuel type and fuel amount characterization
- Fire emissions needed by fire type, fuel type, and combustion component (flaming to residual smoldering) for O_3 and PM2.5 precursors
- Improved temporal allocation of emissions for wild and prescribed fires
- Plume rise/vertical allocation for flaming and residual smoldering emissions during day and night time
- Near-fire and downwind O_3 and $PM_{2.5}$ chemistry during day and night
- Optical properties of smoke are not well characterized meaning photochemistry may be overstated near large fires
- Approaches for projecting future year wild fires

Field study nexus with model evaluation needs

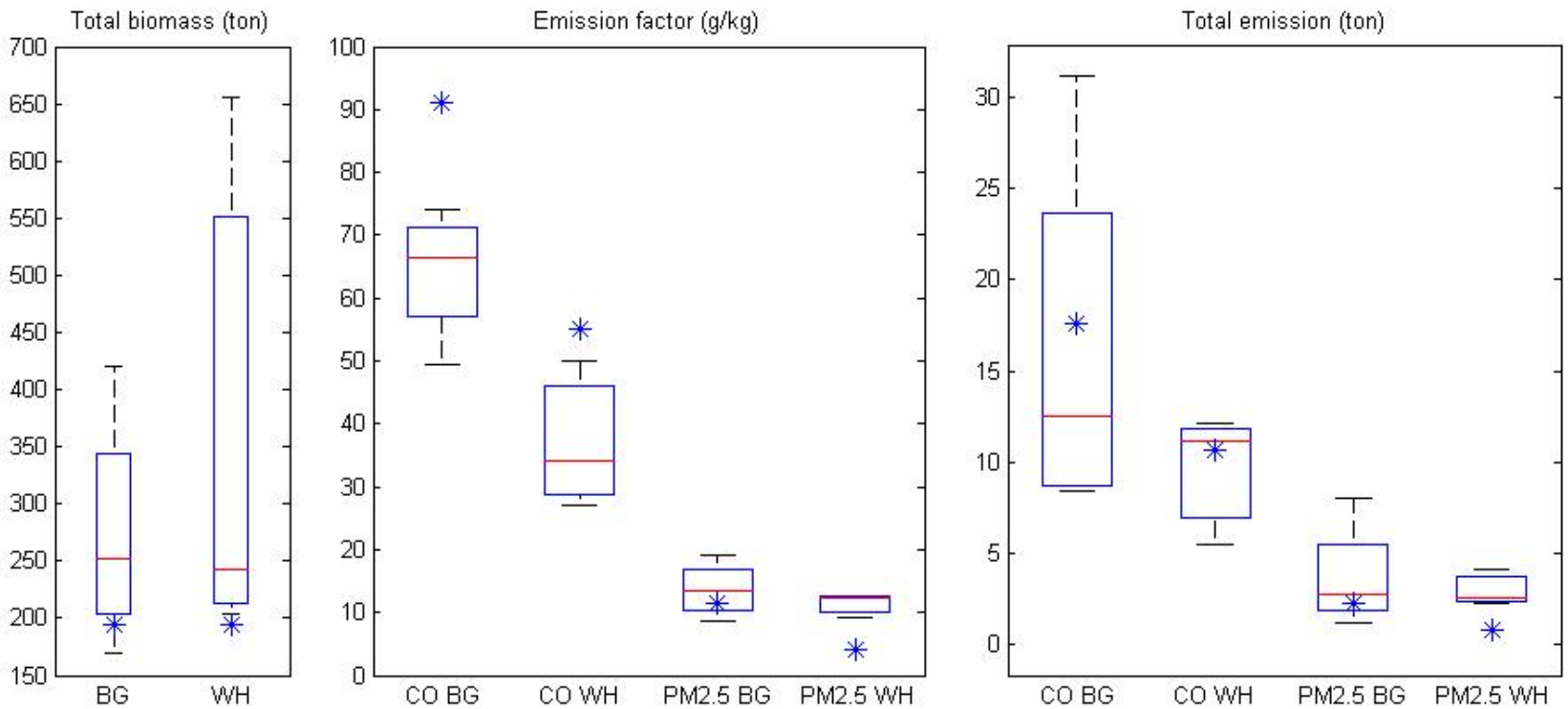
Fuels	Emissions	Near-fire plume rise	Near-fire chemistry	Regional scale plume transport	Regional scale chemistry
WA/ID 2013 cropland					
				SEAC4RS/SENEX 2013	
				CABOTS 2016	
FIREX 2016			??		
Konza Prairie 2017 grassland					
??	??		WE-CAN 2018 western US		
FASMEE 2019 western US			FIREX 2019 western US		
				FIRECHEM 2019	
FASMEE 2021 western US					
FASMEE 2022 southeast US					

August 2013 Washington/Idaho Field Study



Emissions

- Compare emission factors estimated by recent National Emission Inventory approach with measured emission factors from field study



Plume Rise

- Color-filled contours of CO concentration due to fire emissions on Aug. 20 (a, b, and c) and on Aug. 24 (d, e, and f). The plume edge is the 20 ppb contour line.
- Shown with ceilometer detected boundary layer height (red), model input boundary layer height (black), and lidar estimated plume top (blue).

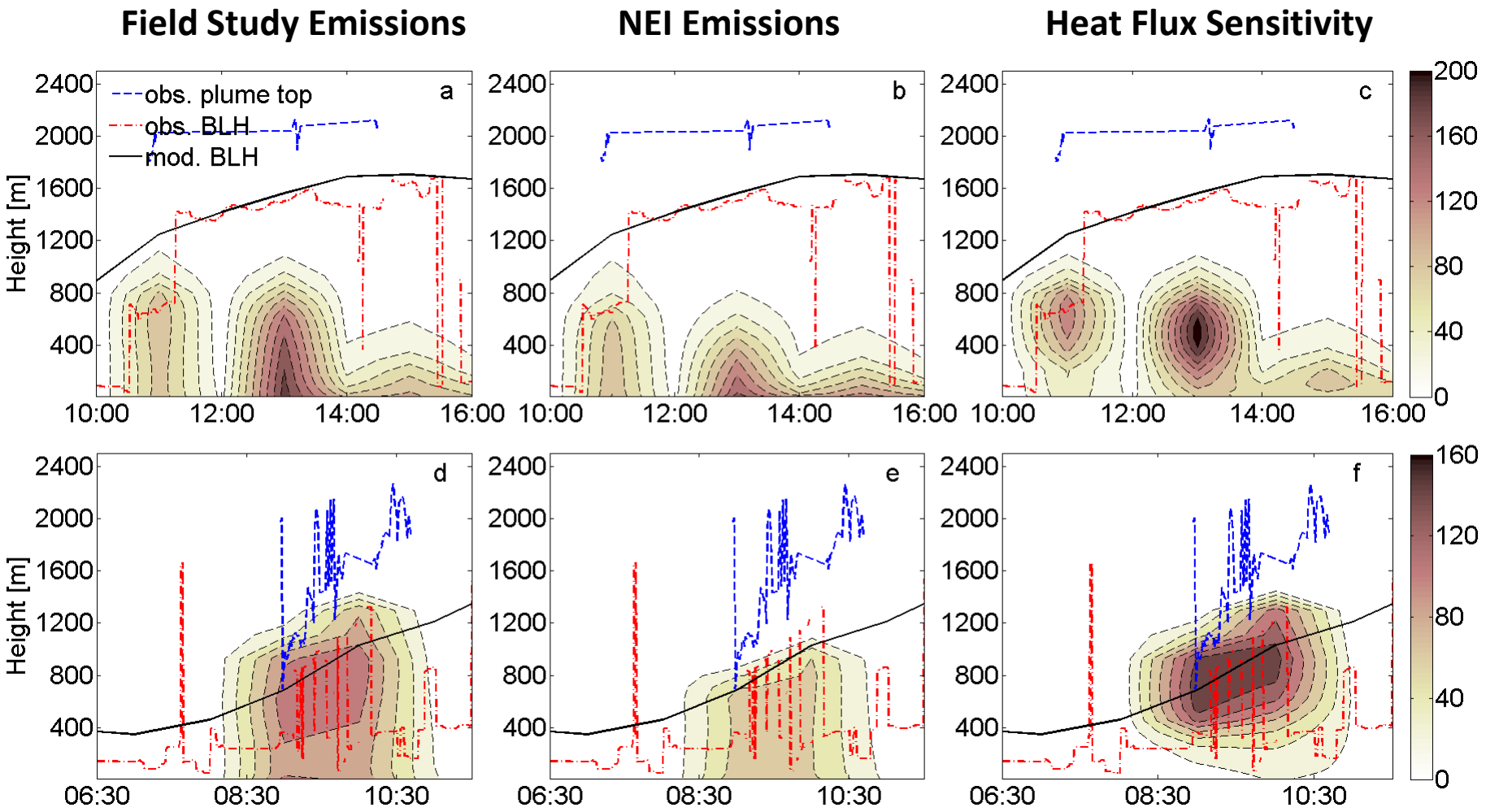
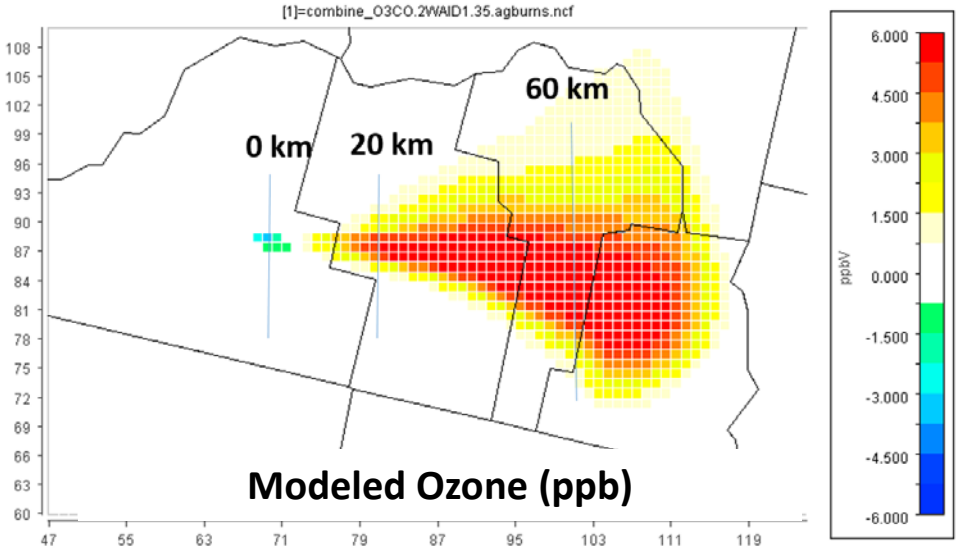


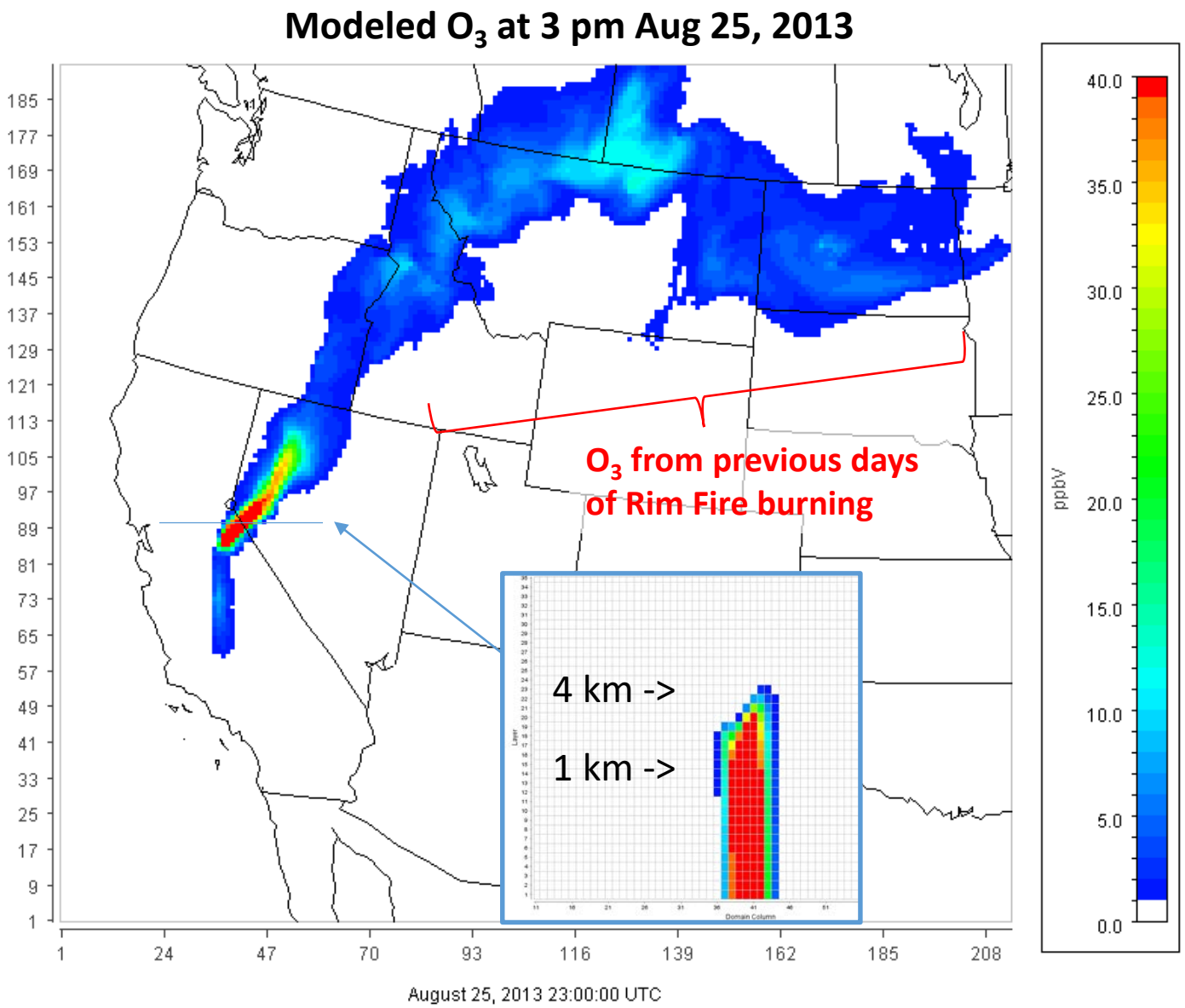
Figure courtesy of L. Zhou

Plume Chemistry

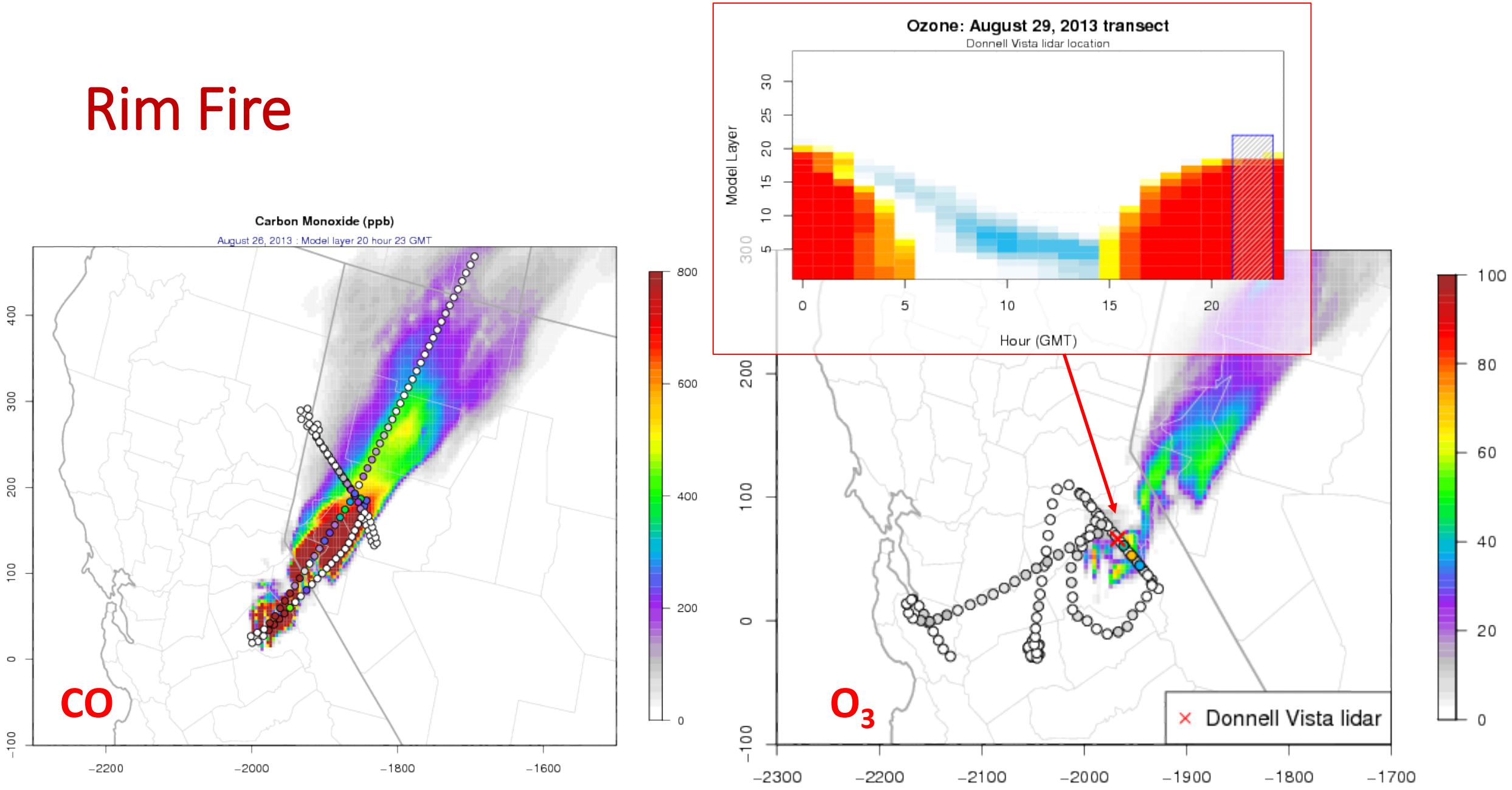
- Cropland fires in the Pacific Northwest are a concern for local to regional scale air quality
- Data collected as part of that study useful toward evaluating cropland emissions modeling approach; photochemical model plume rise and near-fire plume transport
- The field study provided no information to evaluate plume chemical evolution or regional plume transport



- **2013 Rim Fire** in central California well studied and characterized
- Using aircraft measurements from the 2013 SEAC4RS and NASA-AJAX flights for model evaluation
- Lidar plume measurements
- Satellite AOD
- Routine surface networks



Rim Fire



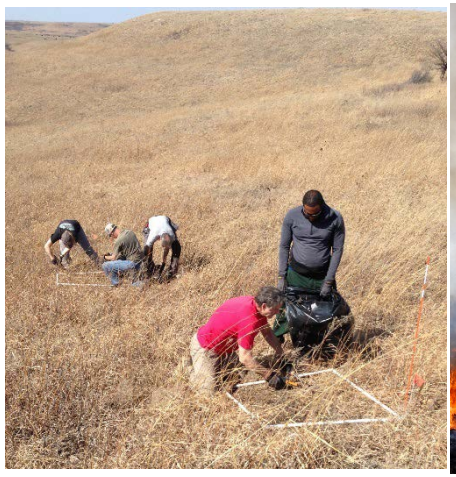
CO data from SEAC4RS and O3 from AJAX

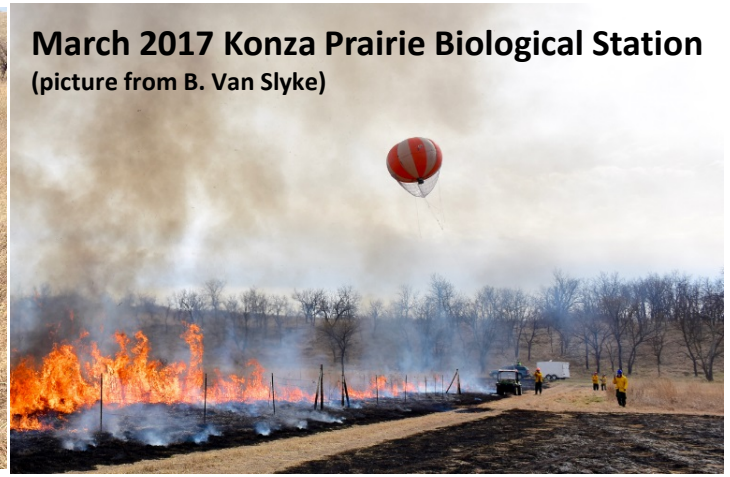
Grassland Prescribed Burning in the Flint Hills

March 16, 2017 – 200 acre burn @ Konza Prairie Biological Station, KS

Konza Prairie Biological Station 2017

- Annual grass/rangeland prescribed burning in Flint Hills region of central Kansas intended to minimize invasive woody species on the prairie and stimulate new grass growth for cattle grazing
- This practice can lead to elevated O_3 and PM regionally
  - Kansas developed an exceptional event demonstration for O_3 impacts in Kansas City & Wichita from Flint Hills burning in 2011
- Field work at Konza Prairie Biological Station conducted to evaluate and improve emission estimates (March 2017)
  - Also working to better understand plume rise and dispersion to improve air quality model representation of these fires

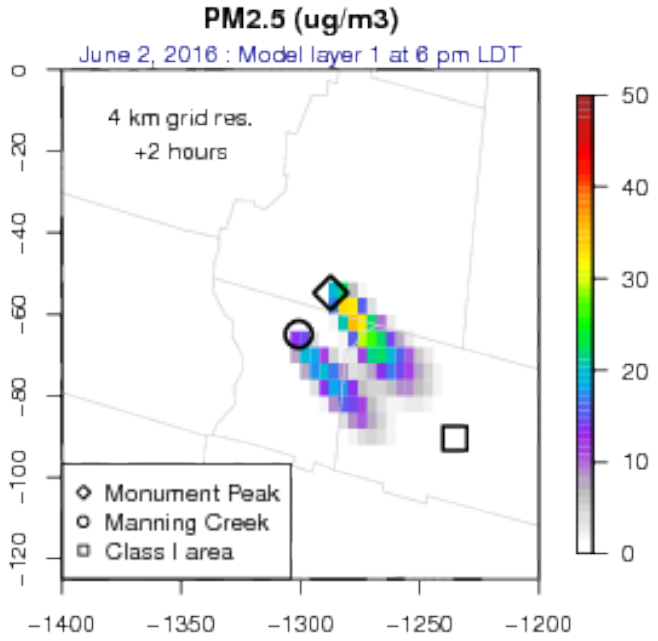


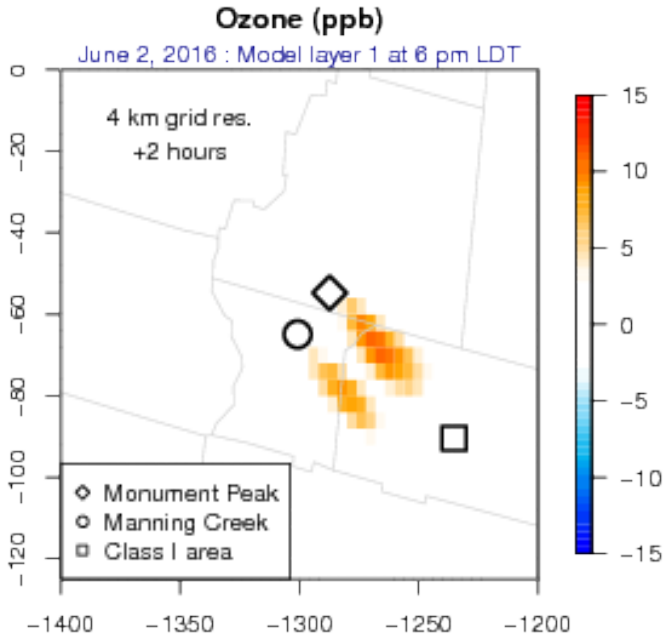


March 2017 Konza Prairie Biological Station
(picture from B. Van Slyke)

FASMEE – Fishlake NF

- Modeled actual burn unit at Fishlake NF June 2016: Monument Peak
- Modeled a burn unit that may be used for FASMEE: Manning Creek
- 4 km CMAQ simulations using BlueSky emissions





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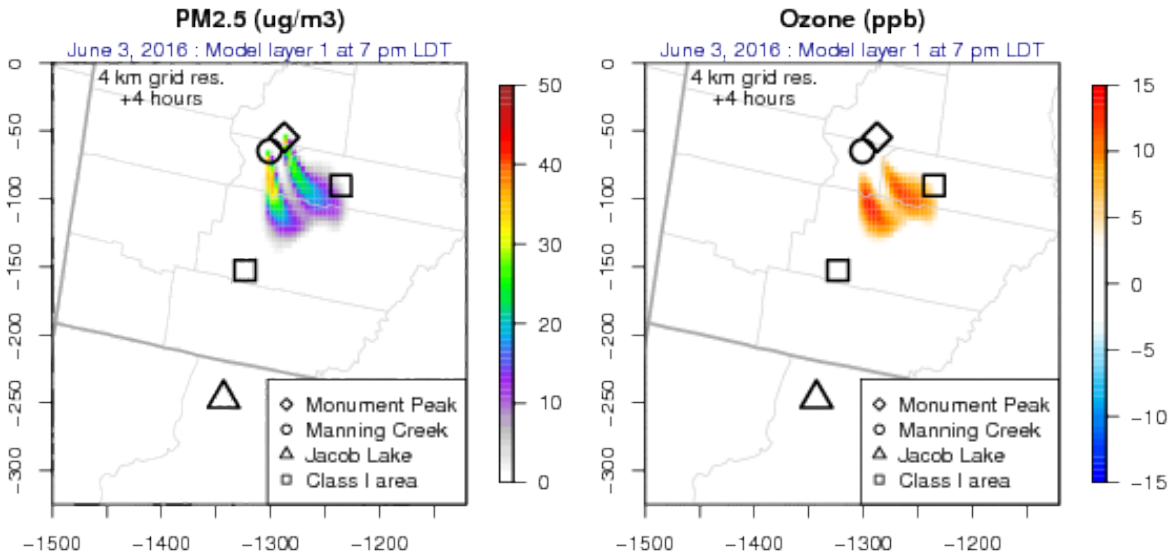
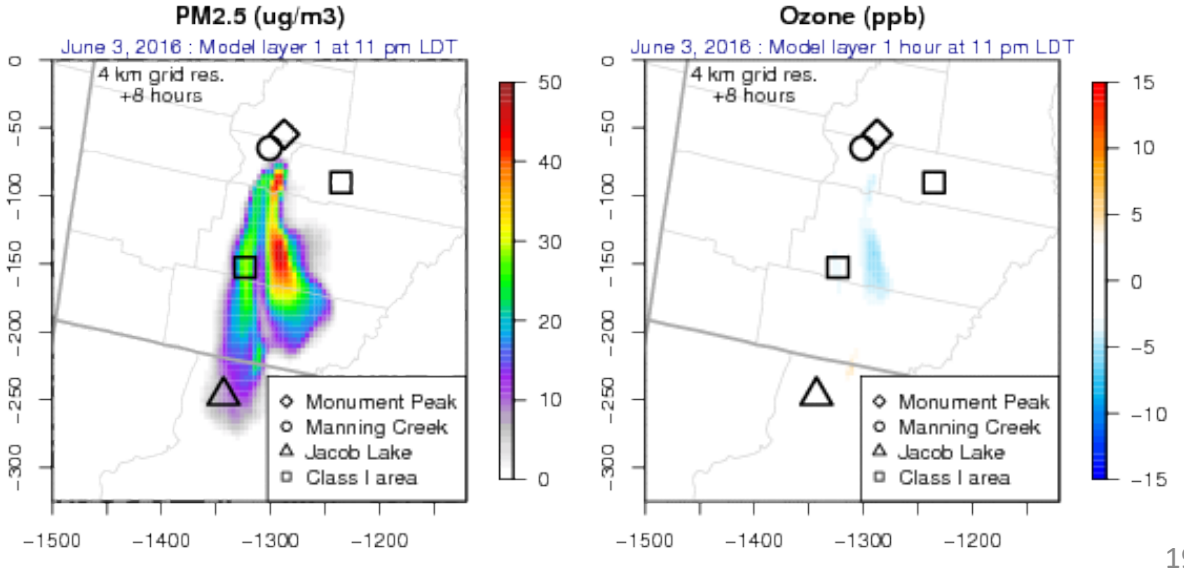
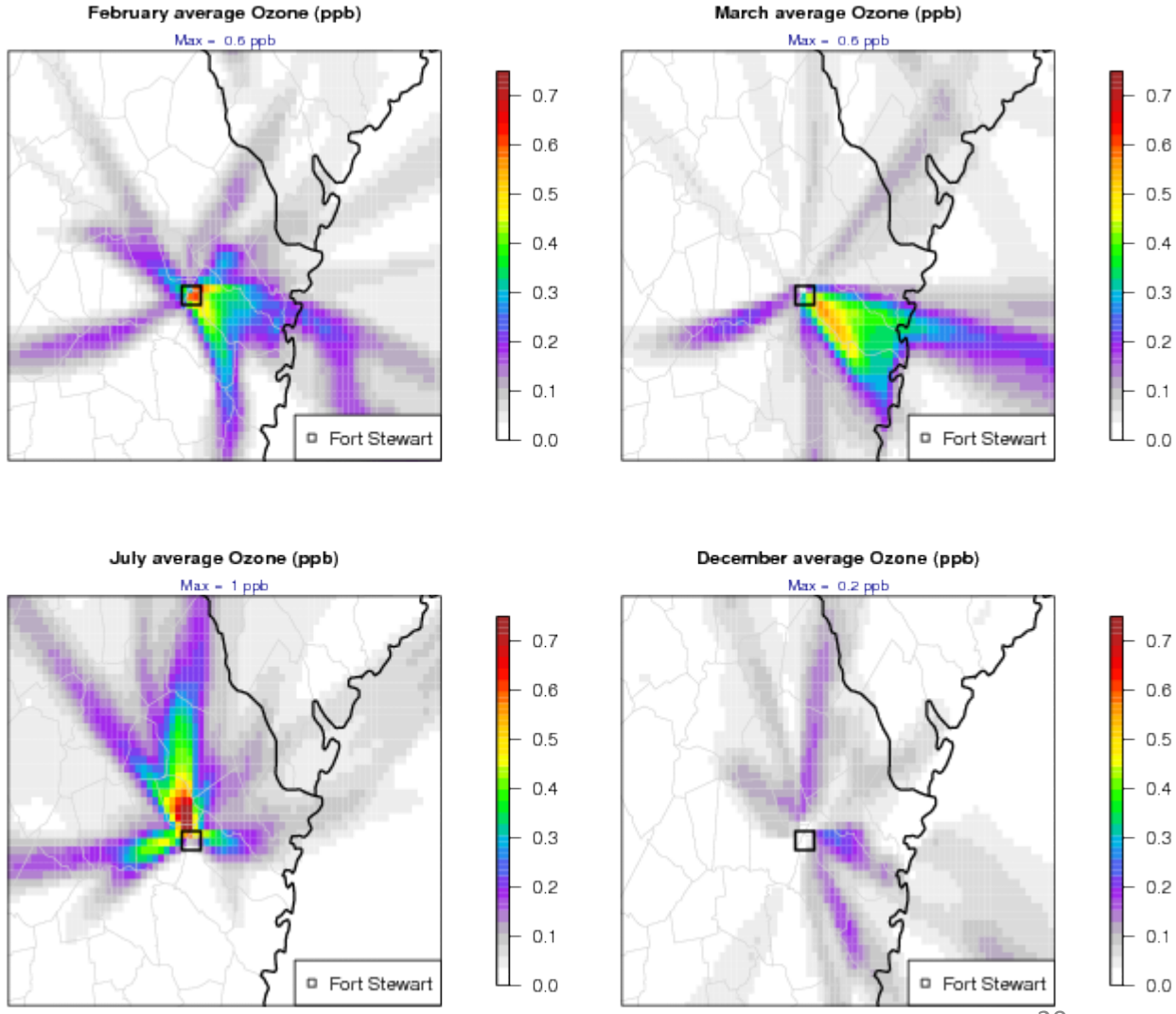




FASMEE – Hypothetical burn at Fort Stewart, GA

- How much O_3 could form from a typical burn unit at Fort Stewart in different seasons to inform study plan choices?
- Monthly average O_3 from a burn unit being held by Fort Stewart for FASMEE shown at right
- The same prescribed burn is simulated on each day of 2013
- Minimal O_3 chemistry in late fall 2013 (Nov & Dec)
- FASMEE study at Fort Stewart planned for 2022



Planning field work for southeast U.S. in early 2019

26 acre prescribed burn at Ichauway (J.W. Jones Ecological Research Center) April 11, 2017

Additional interests in wildland fire

- **Toxicology studies** are ongoing to differentiate how wildland fire smoke impacts human health compared with a typical urban environment
- **Health communication** information "Wildfire Smoke: A Guide for Public Health Officials" is available at the AIRNOW wildland fire site
- **Smoke Sense App** development - intended to understand effective health risk communication strategies for people impacted by wildfire smoke
- **Wildland Fire Sensors Challenge** - intended to stimulate development of low-cost, light-weight, accurate, and easily deployable sensor technology for first responders and public health agencies during wildland fires
  - https://www.challenge.gov/challenge/wildland-fire-sensors-challenge
- Working toward a **comprehensive survey/inventory of EPA research** related to wildland fire (wildland fire research prospectus)