A Seasonal Perspective on Regional Air Quality in Central California

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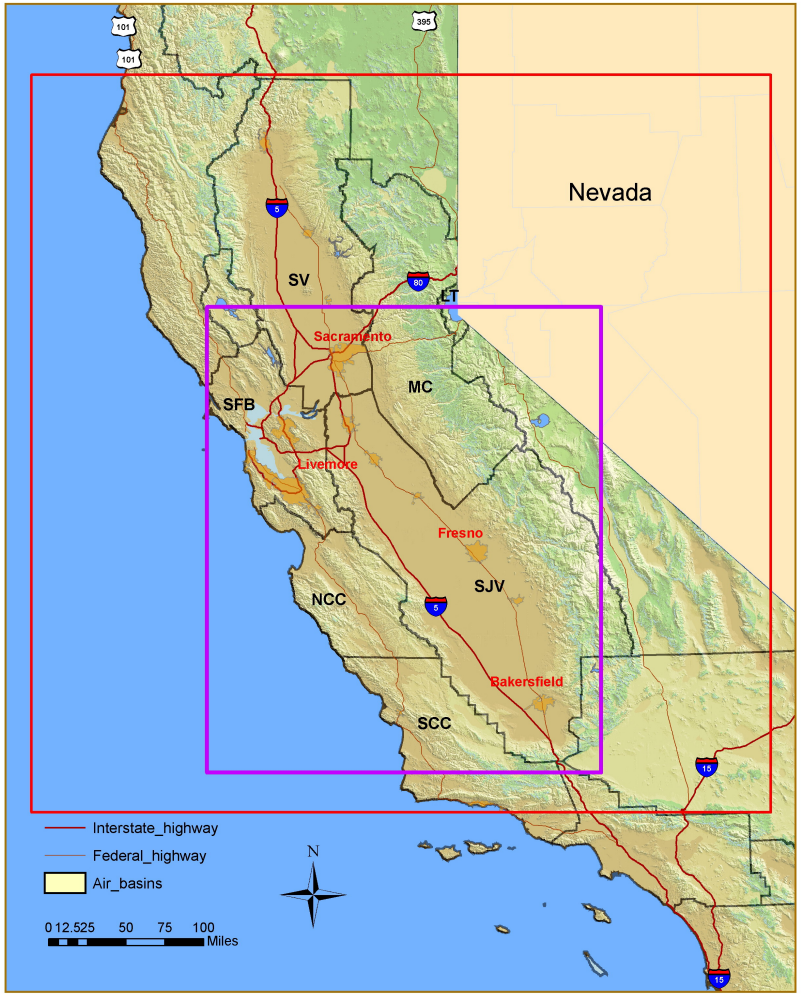
Air Quality Study Domain



Community Multiscale Air Quality (CMAQ) model applied to Central California for summer 2000 conditions

Phase 1: 15 days and 96x117 purple domain
Phase 2: 4 months and 190x190 red domain

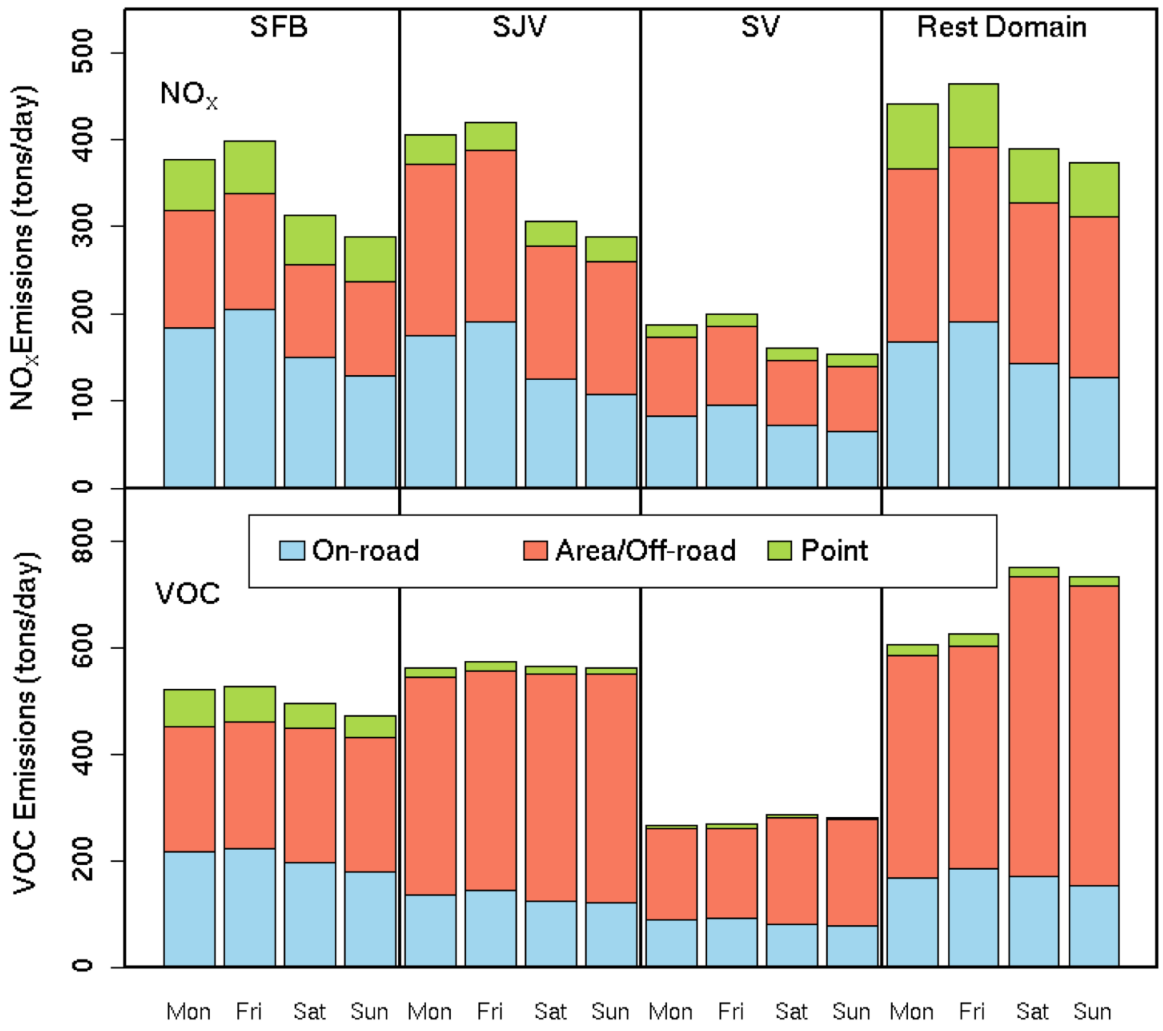
Day-specific meteorology (MM5 model)

Day-specific biogenic & forest fire emissions

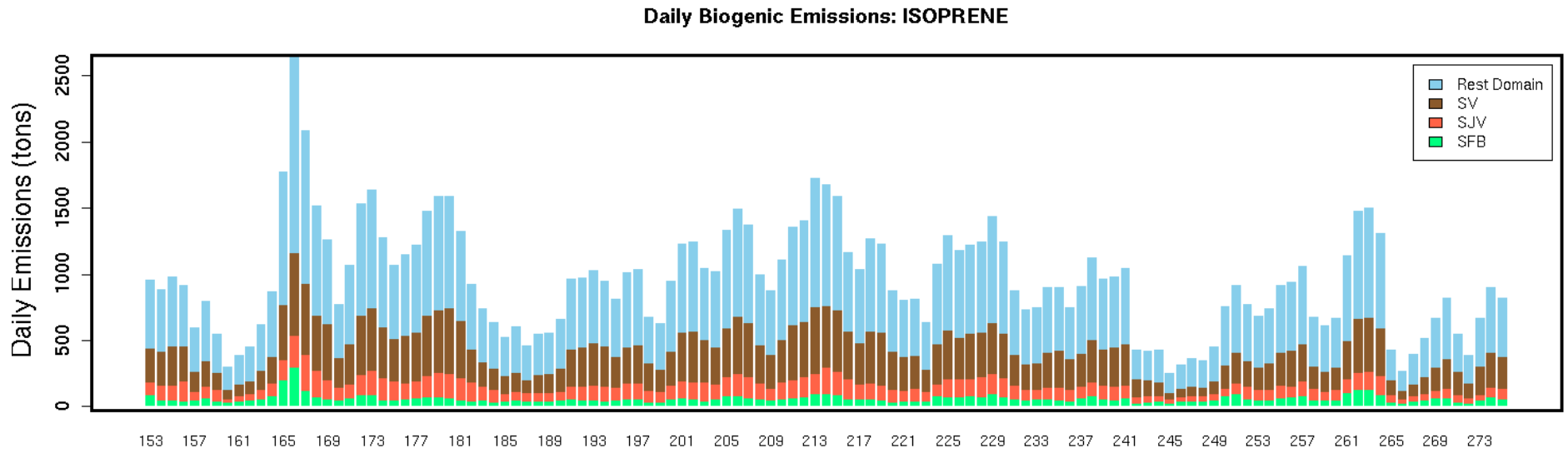
Weekday/weekend anthropogenic emissions

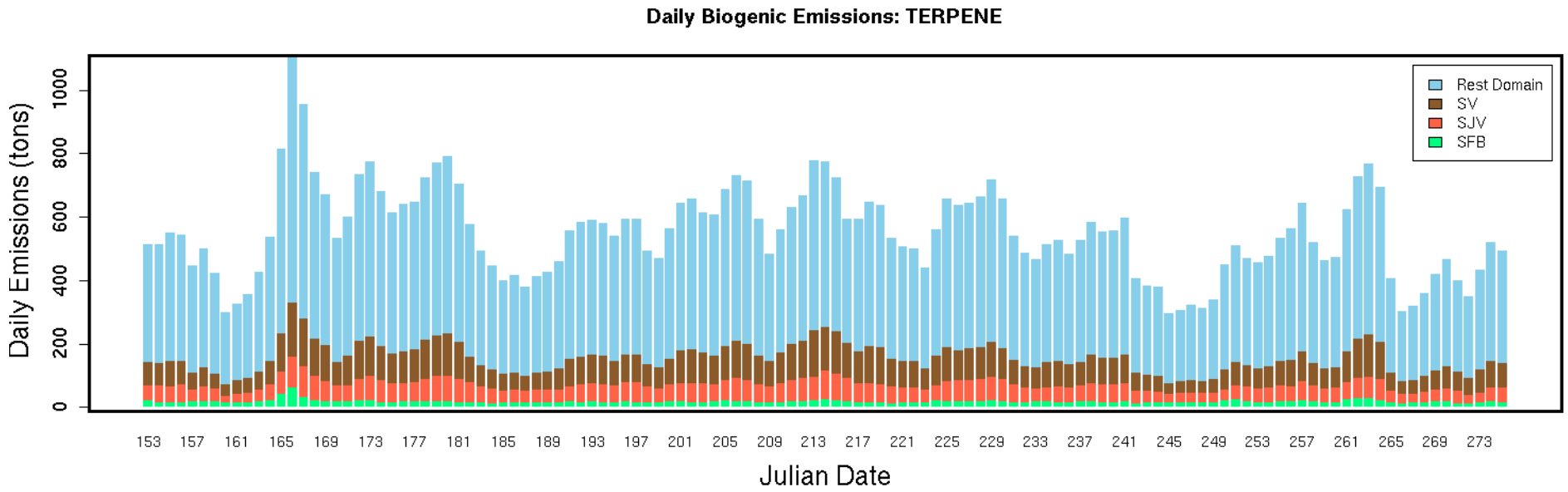
SAPRC99 chemical mechanism

Anthropogenic Emissions

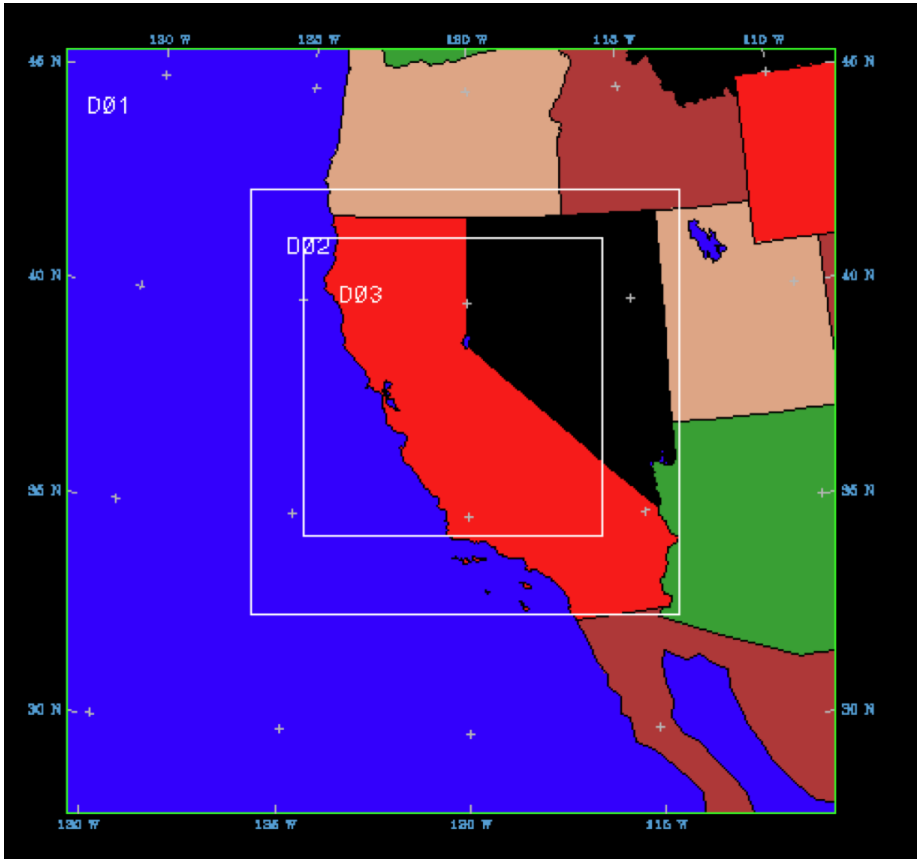


Biogenic VOC Emissions





MM5 Meteorological Model



Prognostic met model with
36-12-4 km one-way nested grid

50 vertical layers

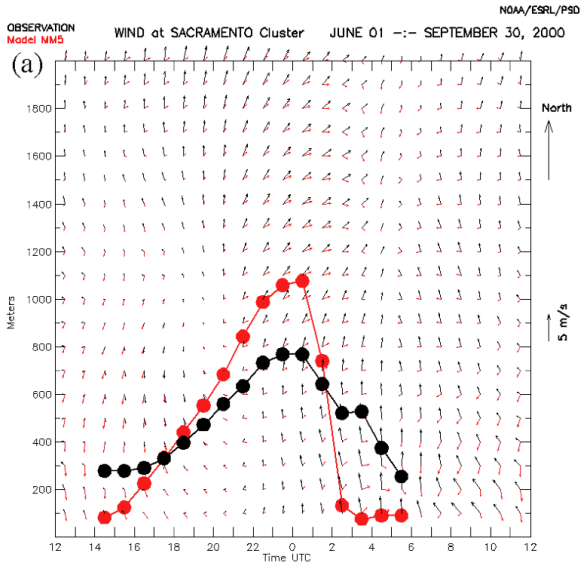
BC/IC: 6-h NCEP Eta analyses

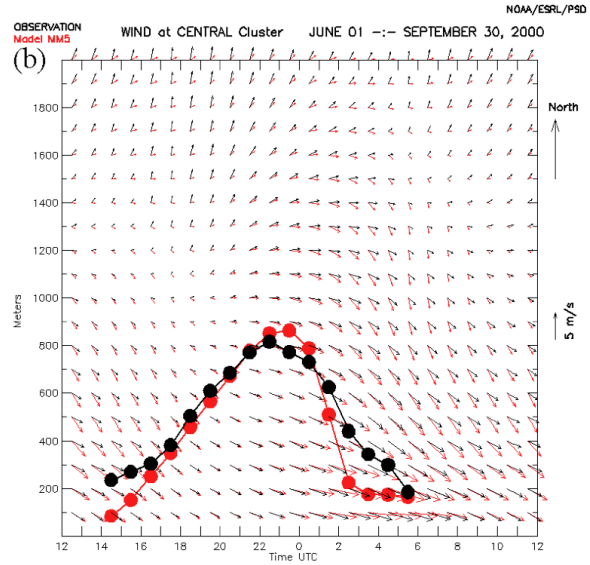
Results from innermost
(4 km) grid used to drive
air quality model

Simulated all of summer 2000;
MM5 reinitialized every 5 days

Run <u>without</u> assimilation of radar
wind profiler data

MM5 Model Evaluation: Winds & PBL Height



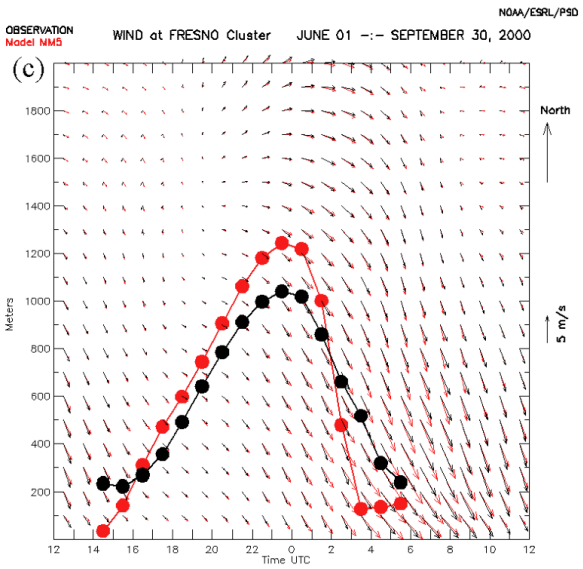


Observed in black
MM5 model in red

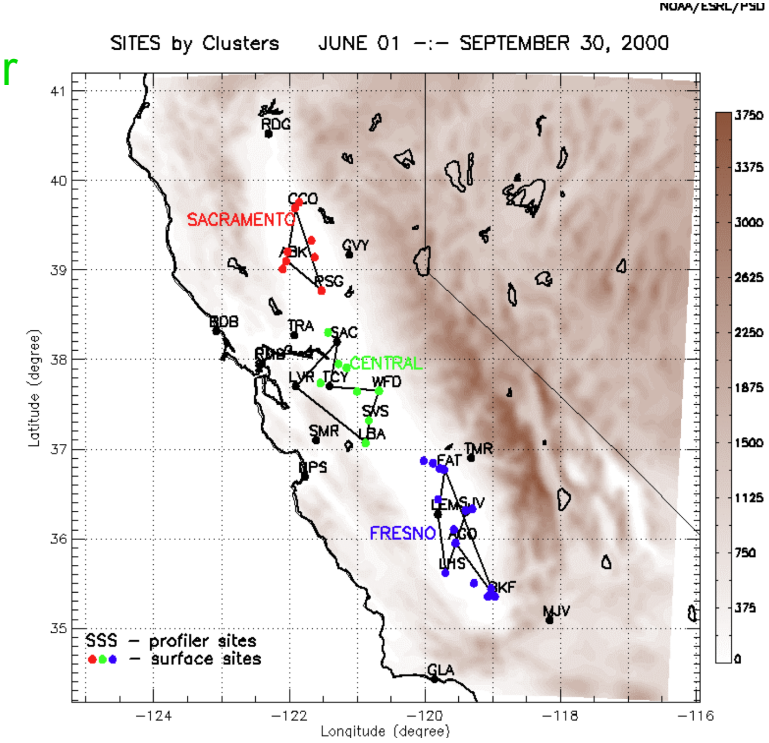
Also note: MM5 under-predicts surface T by 2-3°C

Sacramento Cluster

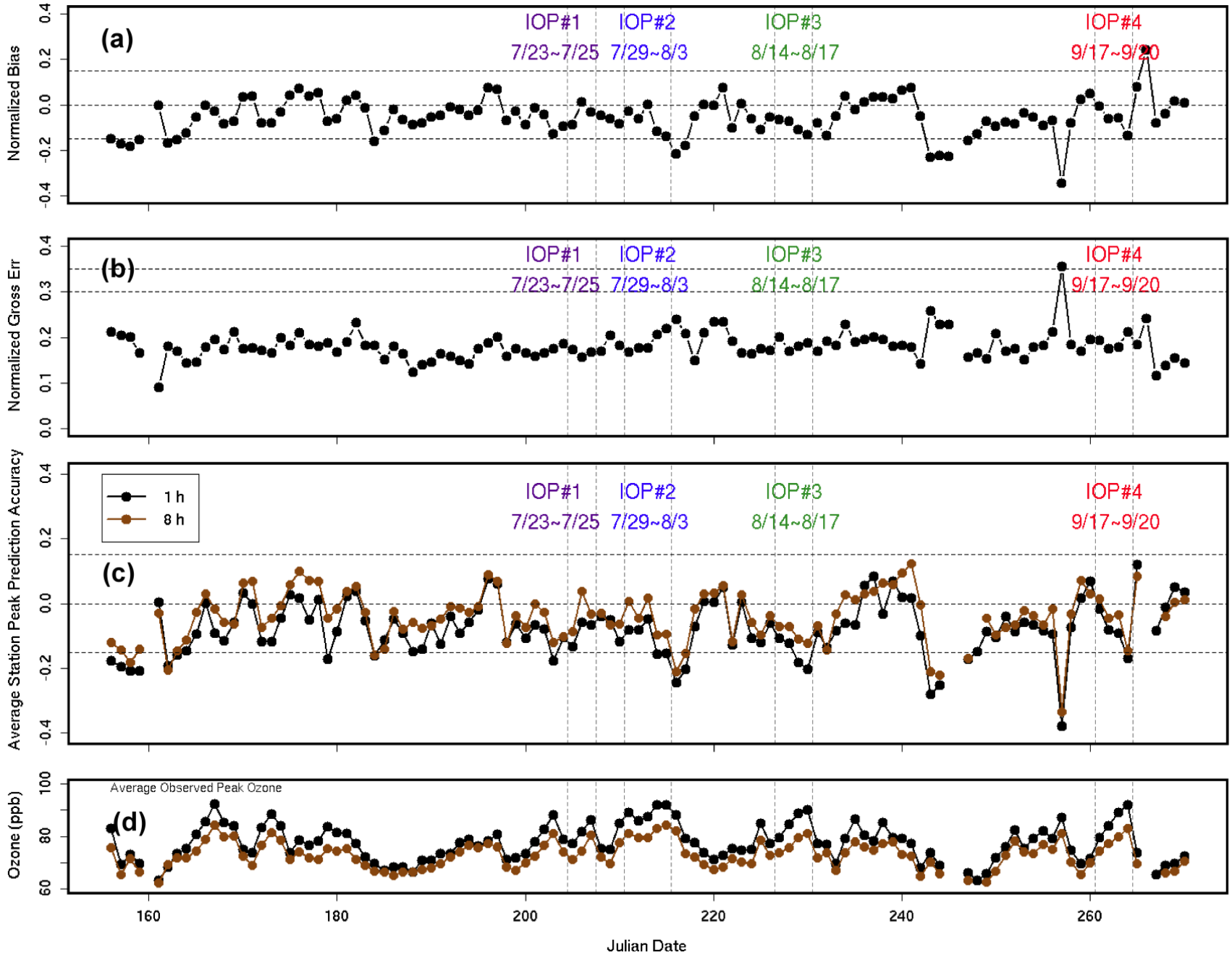
Central Cluster

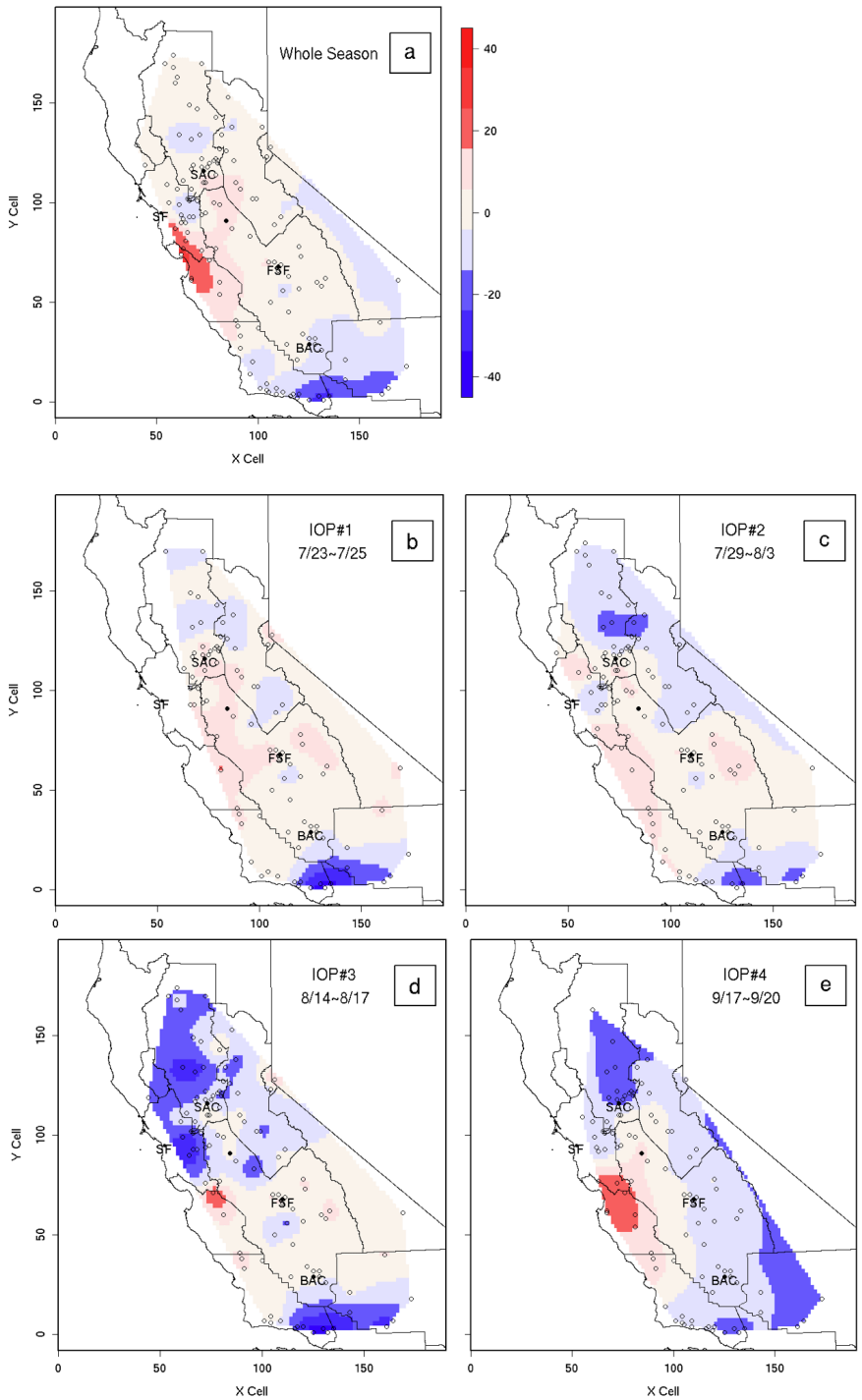


Fresno Cluster



Air Quality Model Evaluation: Ozone





Spatial distribution of normalized bias for ozone (a=whole summer b-e=individual IOP)

Coastal areas where observed ozone below 60 ppb cutoff left unshaded (though O_3 over-predicted along the coast)

Coastal O_3 esp sensitive to strength and timing of sea breeze

Network of wind profilers sparse in coastal areas (most of the profilers were sited in the Central Valley)

Difficult to model coastal stratus and its radiative effects

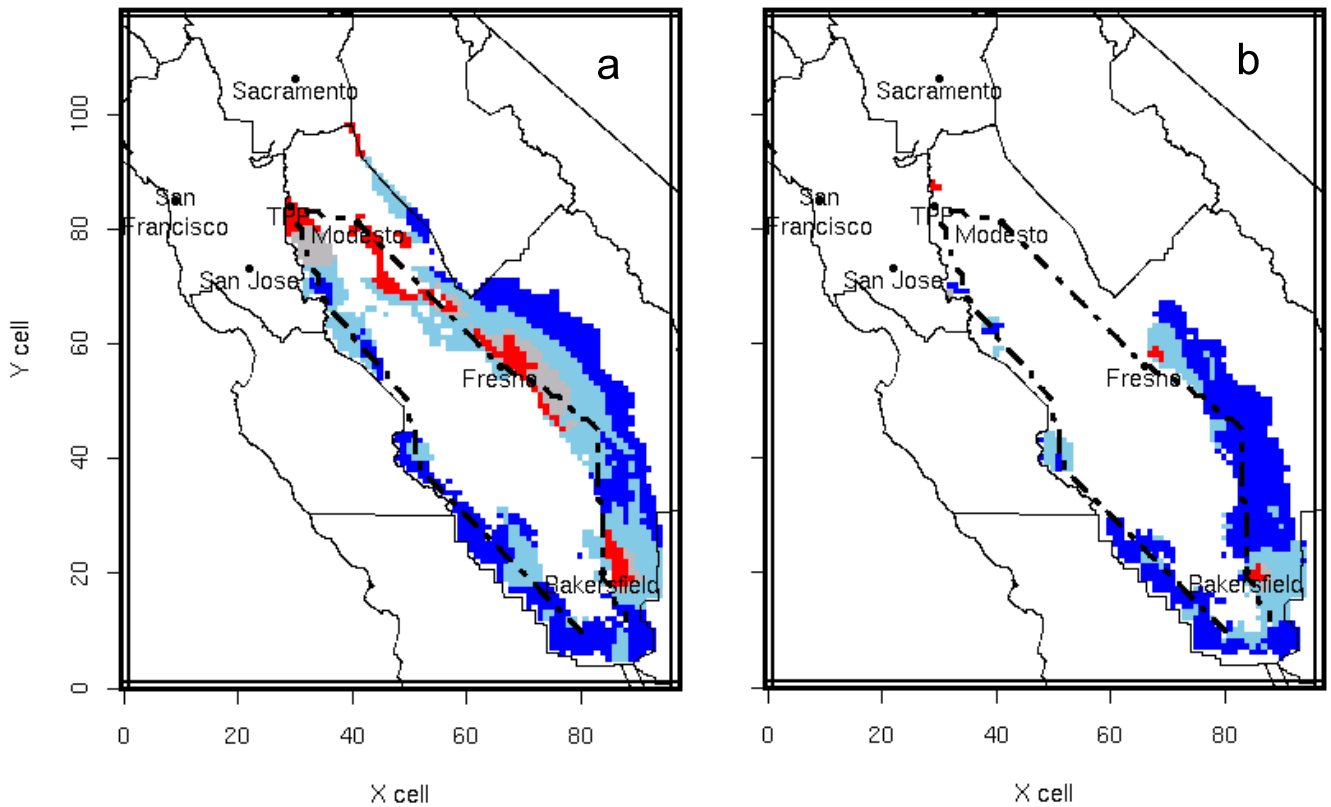
Model Evaluation for Ozone Precursors

	Normalized Bias	Normalized Gross Error
Daytime NO_y (cutoff = 5 ppb)	+32%	72%
NMHC (cutoff = 35 ppbC)	+23%	63%
CO (cutoff = 100 ppb)	-17%	45%

Evaluation contrained by precision of CO data (0.1-1 ppm) and sparseness of observed NMHC and NOy data

Significant under- and over-predictions for all precursors

Ozone Sensitivity Analysis



Weekdays

Weekends

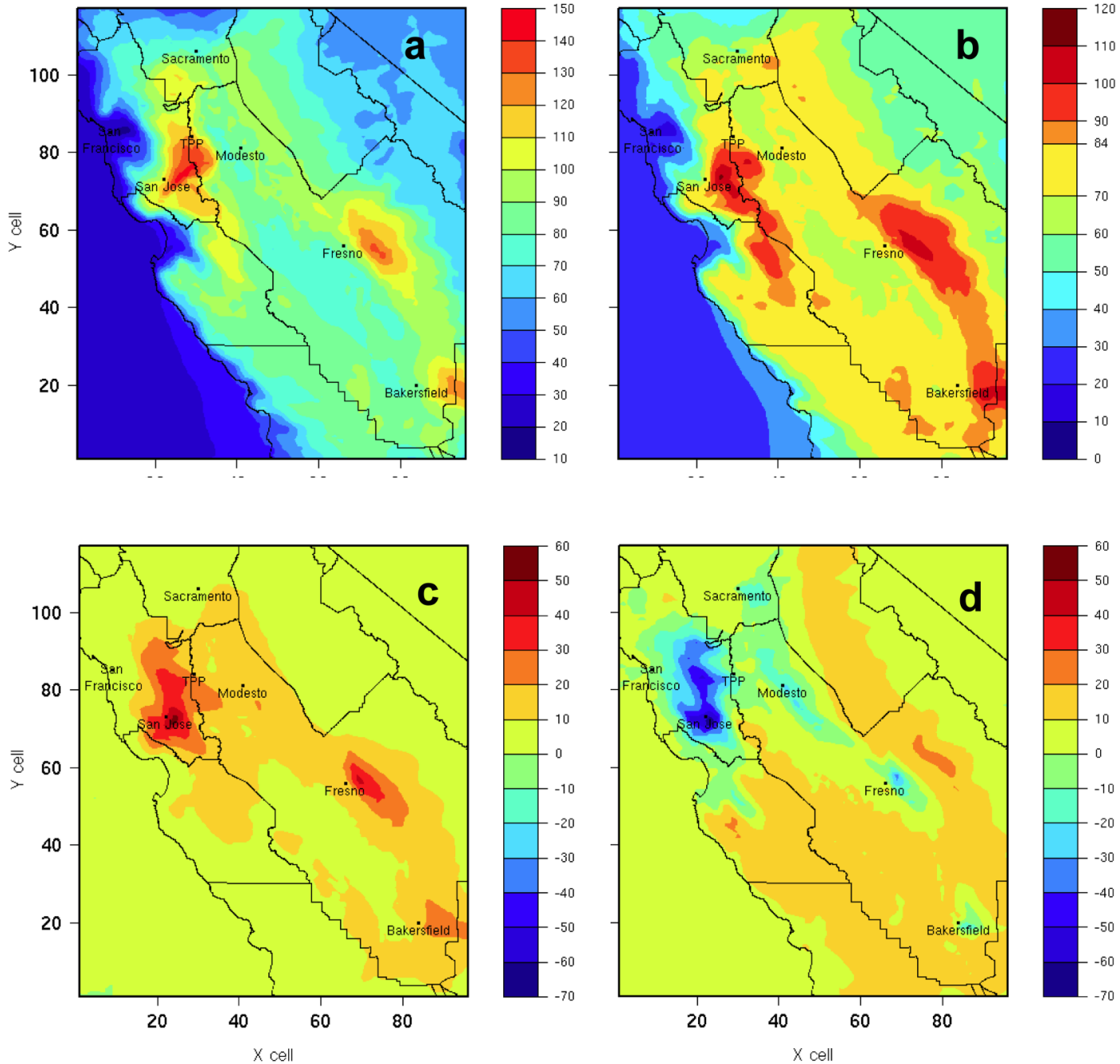
Red = VOC control (NOx disbenefit),
Lt Blue = VOC or NOx control both beneficial
Dk Blue = NOx control (VOC control ineffective)

1-h O3

8-h O3

AVOC sens

NOx sens



Meteorology Discussion

- Summer average meteorology in Central Valley represented well by MM5 model
  - surface T under-predicted by 2-3°C
- CCOS profiler network too sparse to assess met fields in the SF Bay area
- IOP4 (9/17-20) had significant MM5 model performance issues, especially in Sacramento Valley
  - Assimilation of profiler data recommended

Air Quality Discussion

- Model performance for ozone comparable for summer 2000 season as seen in past episodic modeling studies
- Ozone over-predicted near the coast
- Ozone precursor predictions hard to evaluate (sparse obs data esp for VOC)
- Ozone control regimes in Central California vary spatially and with prevailing meteorology

References

- Jin et al. (2008). Direct Sensitivity Analysis of Ozone Formation and Transport in California's San Joaquin Valley. *ES&T* **42**, 3683-3689.

- Tonse et al. (2008). A Process-Analysis Based Study of the Ozone Weekend Effect. *Atmos. Environ.* **42**, 7728-7736.

- Jin et al. (2010). Seasonal versus Episodic Performance Evaluation for an Eulerian Photochemical Air Quality Model. *JGR*, accepted for publication.