Sensitivity of biogenic volatile organic compounds (BVOCs) to land surface processes and vegetation distributions in California

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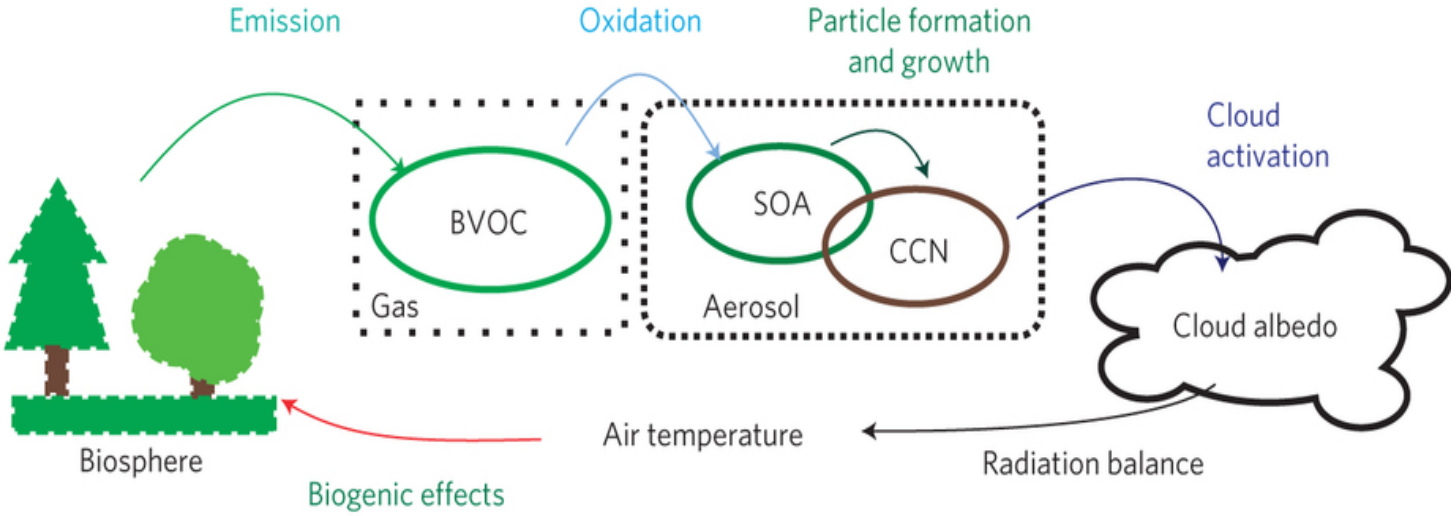
Biogenic VOC (BVOCs)

- **Biogenic volatile organic compounds (VOCs) play an important role in atmospheric chemistry, and therefore can significantly affect ozone and secondary organic aerosol (SOA) formation and ultimately air quality and climate.**



Paasonen et al. [2013]

Biogenic VOC (BVOCs)

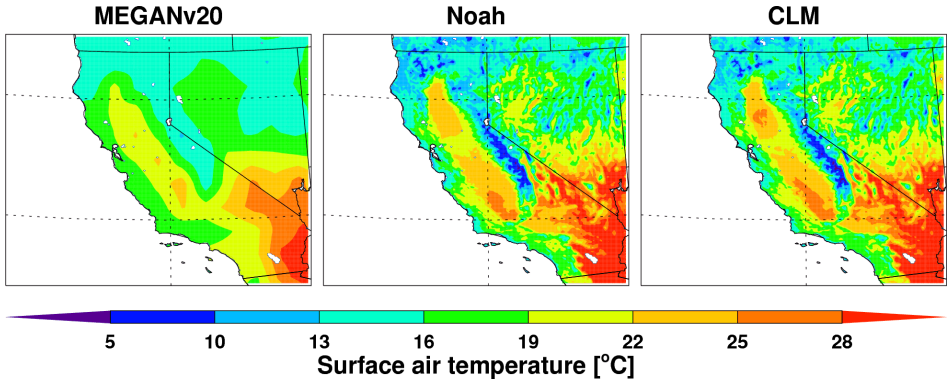
- Biogenic volatile organic compounds (VOCs) play an important role in atmospheric chemistry, and therefore can significantly affect ozone and secondary organic aerosol (SOA) formation and ultimately air quality and climate.
- Large uncertainties in estimating VOCs still remain due to many factors, including that of biogenic emissions associated with, e.g., land-surface processes, vegetation distributions
- California continues to be a nonattainment state for O_3 and PM standards partly due to the local natural emissions including biogenic VOCs (BVOCs) that still have large modeling uncertainties due to the region's large topographic and vegetation variations

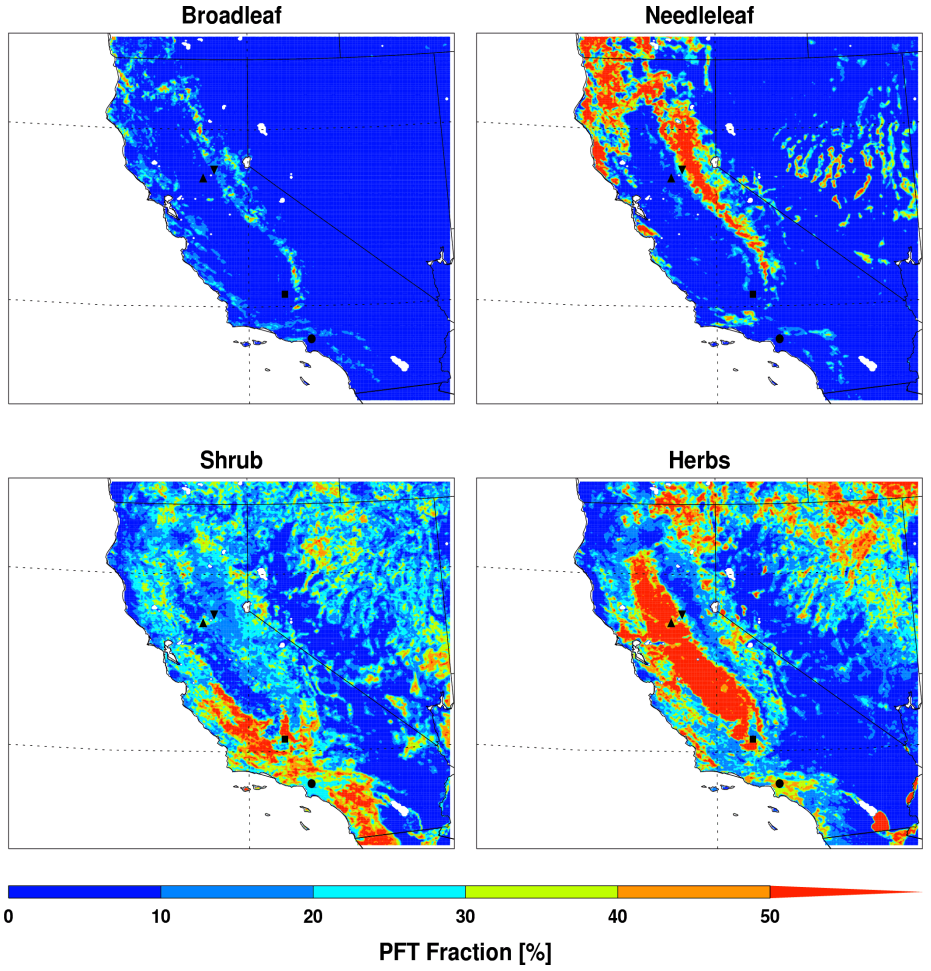
Scientific Objectives

- **Sensitivity of BVOCs to land surface processes and vegetation distributions in California**
  - Land surface processes (Noah and CLM)
  - Vegetation distributions

Model development

- **Current issue/incompleteness in MEGAN in WRF-Chem**

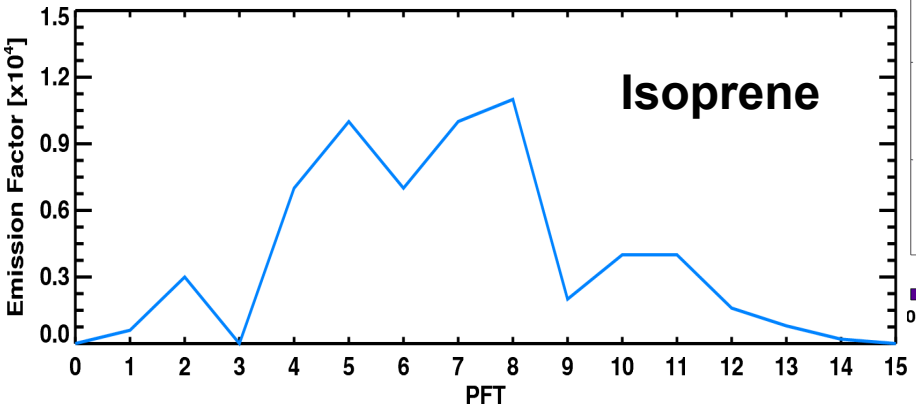


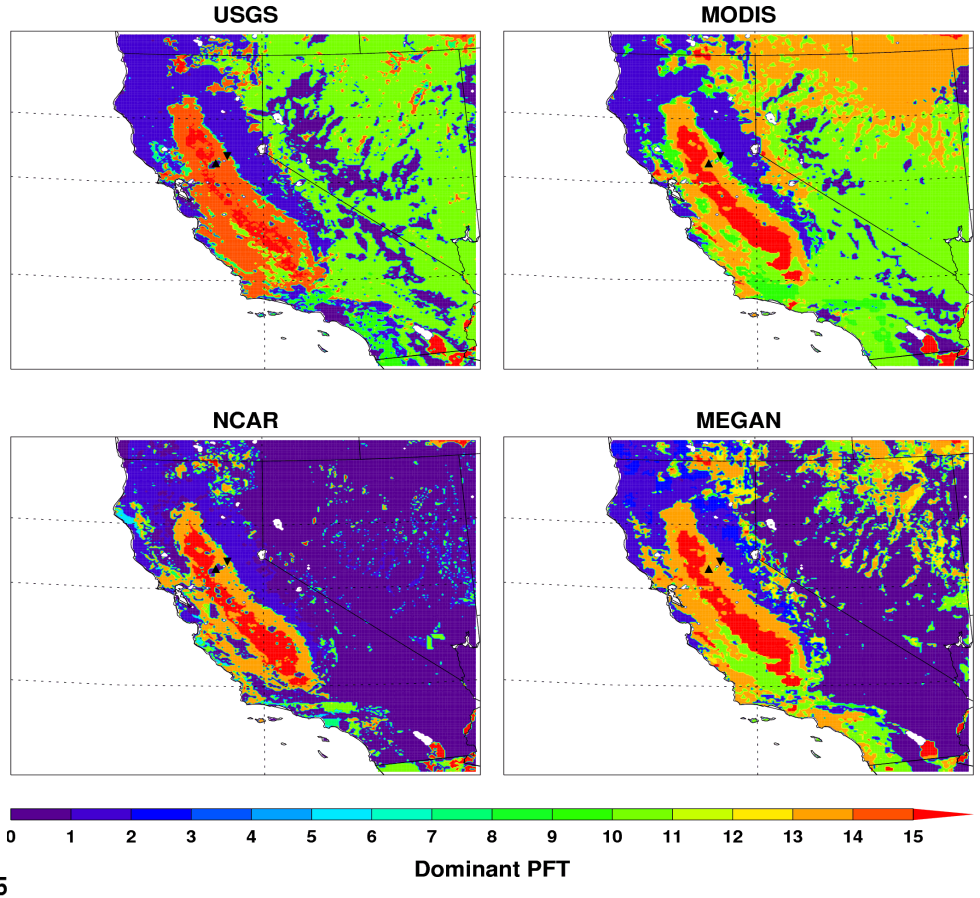


- Climatology temperature without temporal variability
- Four vegetation types for BVOCs emission
- Inconsistent vegetation distribution with land surface model

Model development

- **New coupling of MEGAN in WRF-Chem (CLM only)** **This is the newer version of MEGAN**
- Model simulated temperature
- 16 vegetation types for BVOCs, consistent with CLM
- Sub-grid variability of vegetation distribution





WRF-Chem (v3.5.1)

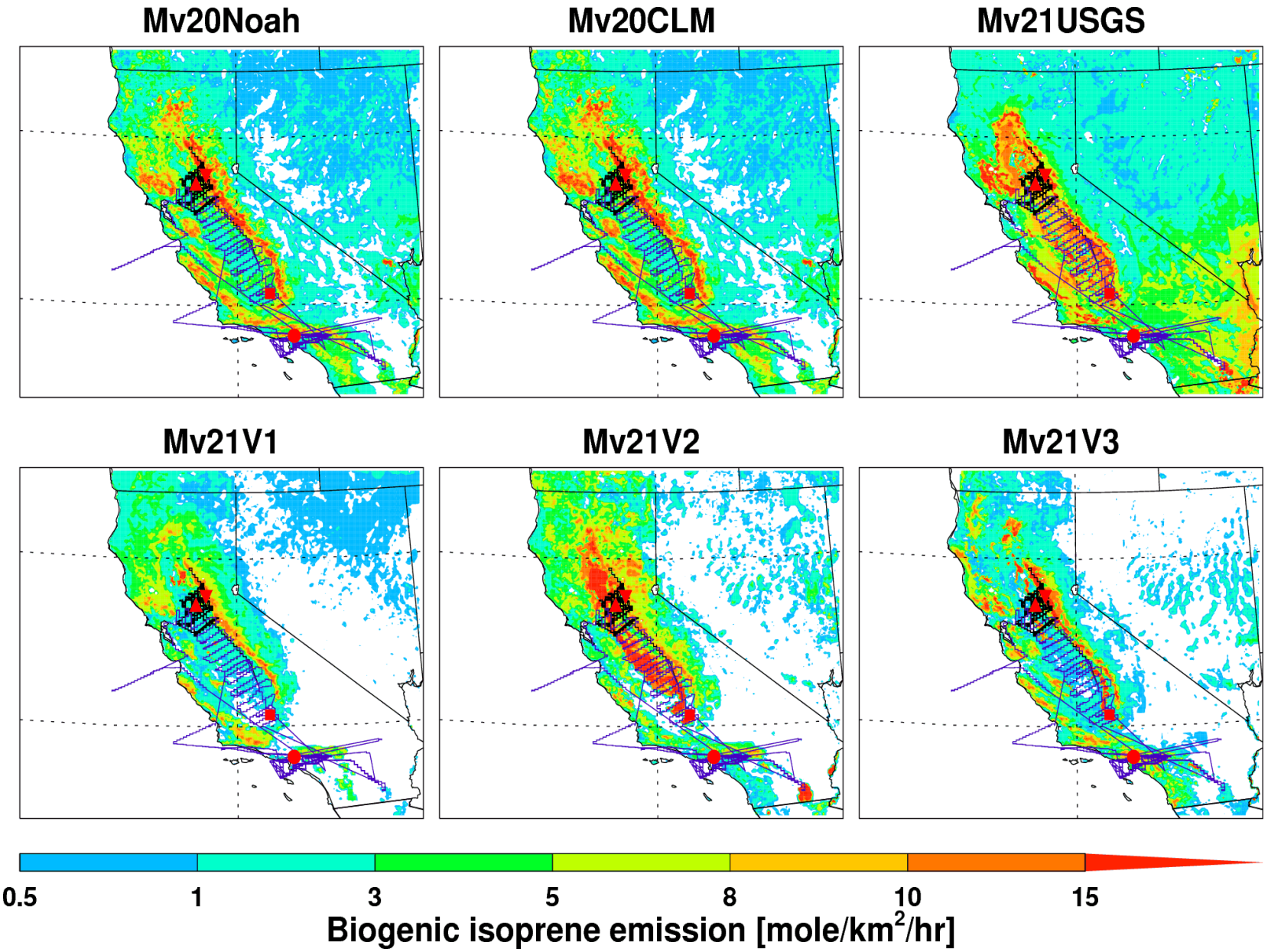
- SAPRC99 gas chemistry mechanism
- Noah and CLM4.0 land surface model
- Vegetation cover datasets from USGS, MODIS, NCAR, and MEGAN
- MEGAN biogenic emission schemes
- RRTMG SW and LW radiation scheme; Morrison 2-moment microphysics; Kain-Fritsch cumulus parameterizations for tracer transport and wet-scavenging; YSU PBL scheme.

Experiments

- 4 km horizontal resolution over California;
- Meteorology driven and nudged to NARR reanalysis for June 2010
- NEI05 and CARB08 anthropogenic and GFEDv3 biomass burning emissions for June 2010
- 4 Vegetation datasets
- Experiments listed as following:

	Surface scheme	BVOC scheme	Plant Function Type Dataset				
			USGS/VEG-M	USGS	VEG1	VEG2	VEG3
WRF-Chem	CLM4.0	MEGANv2.0	Mv20CLM	-	-	-	-
		MEGANv2.1	-	Mv21USGS	Mv21V1	Mv21V2	Mv21V3
	Noah	MEGANv2.0	Mv20Noah	-	-	-	-

Biogenic isoprene emission



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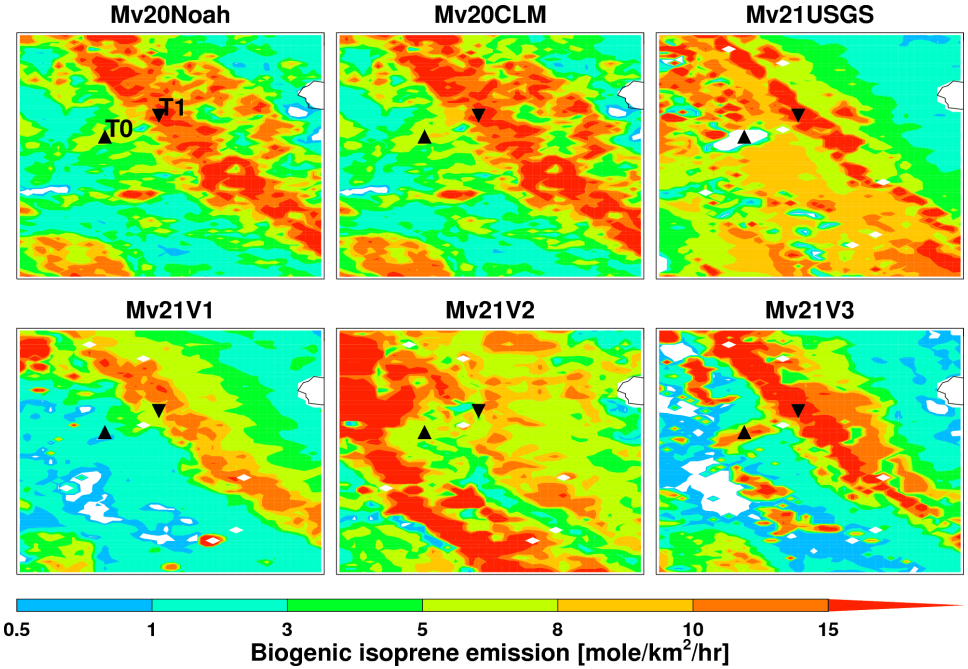
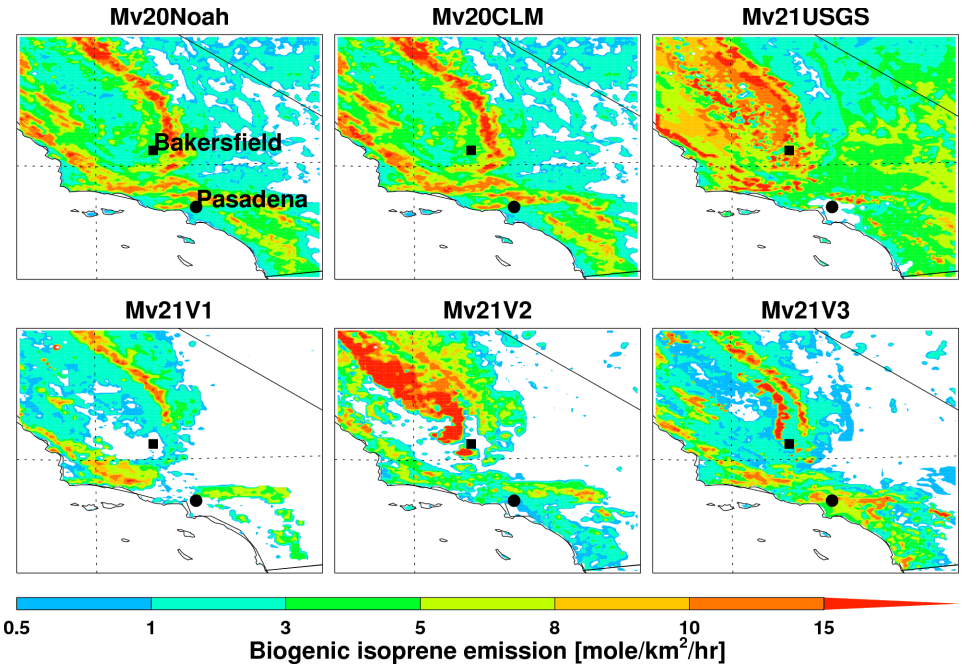


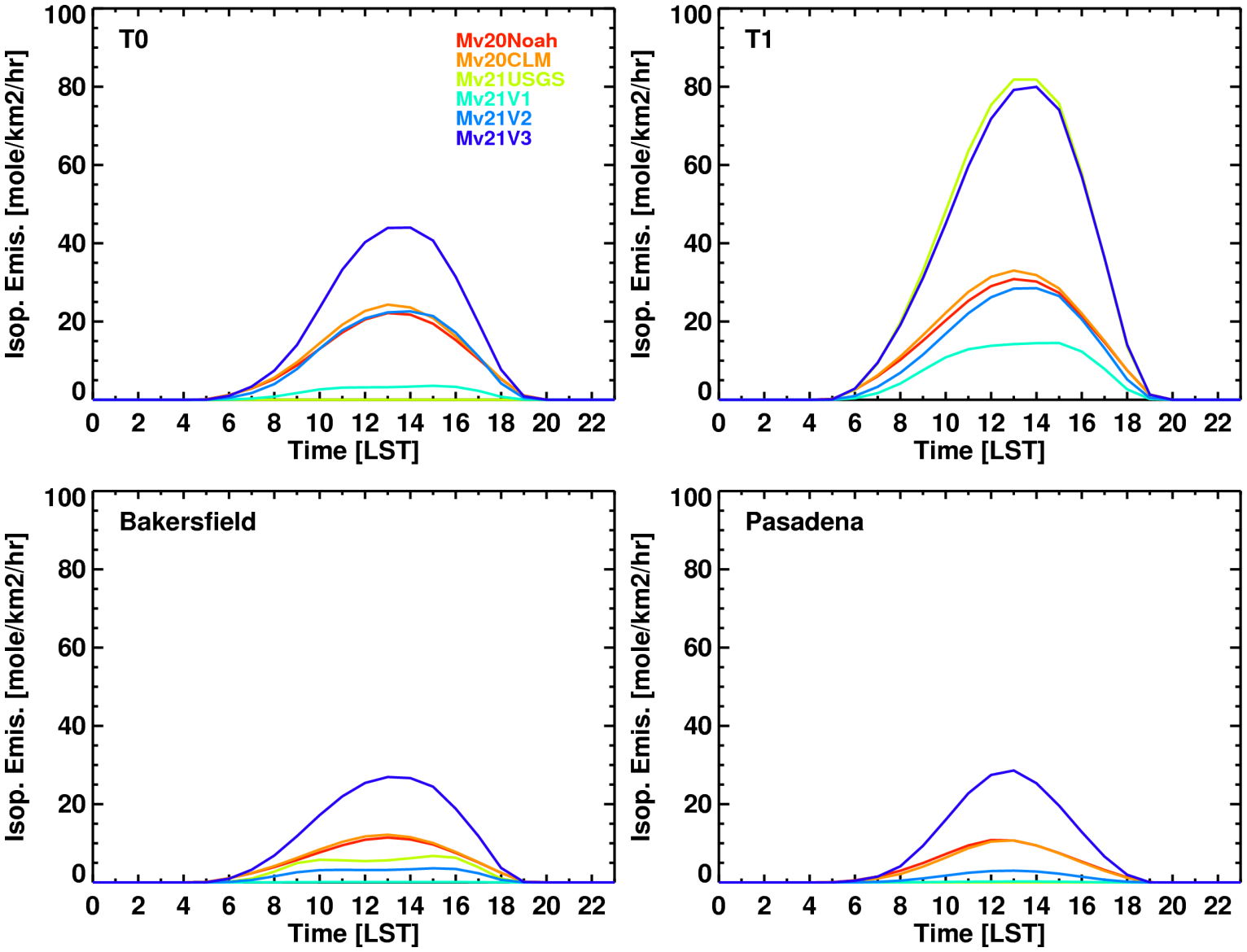
North California



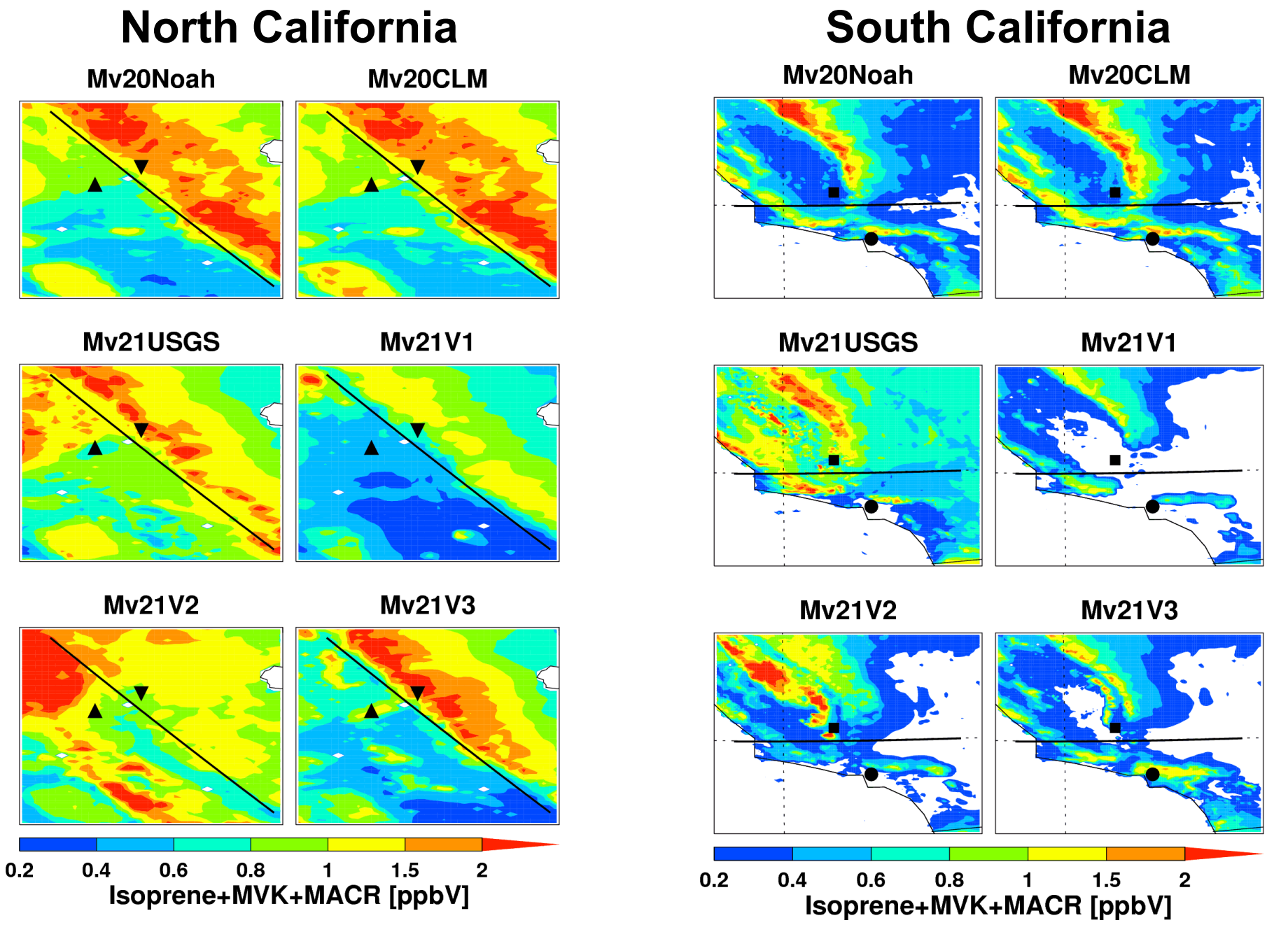
South California

Biogenic isoprene emission

Four observation sites



Biogenic isoprene+MVK+MACR mixing ratios



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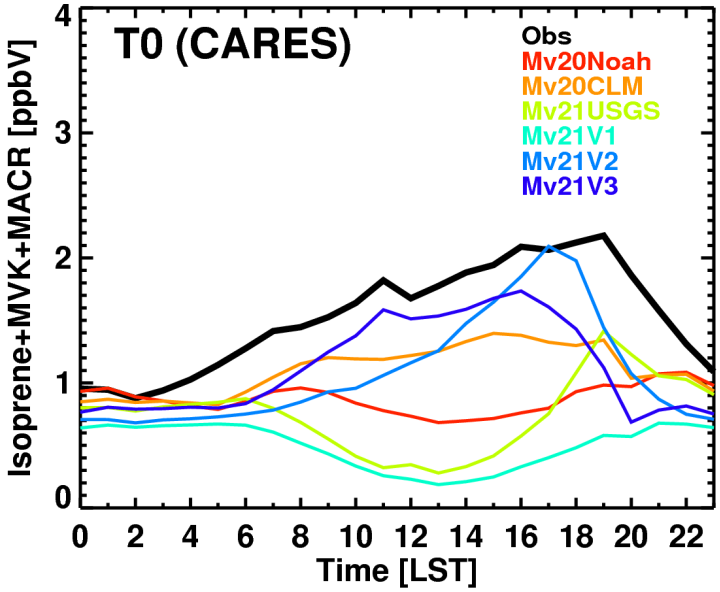

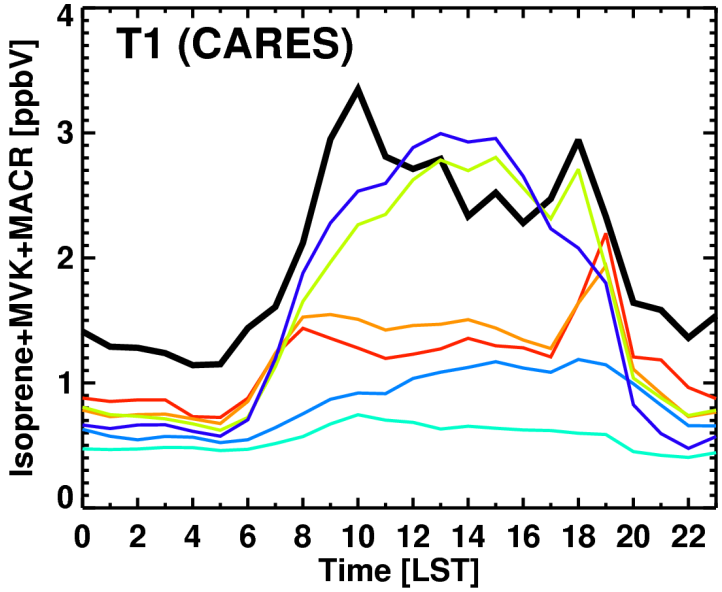

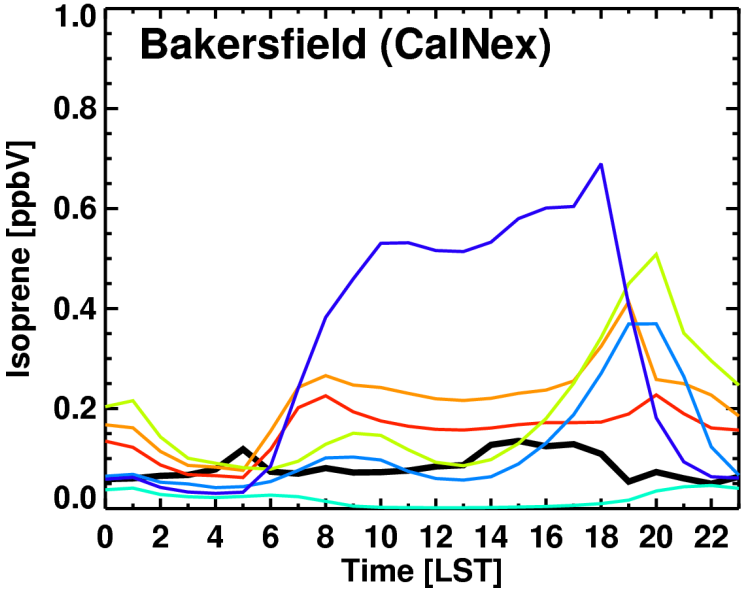

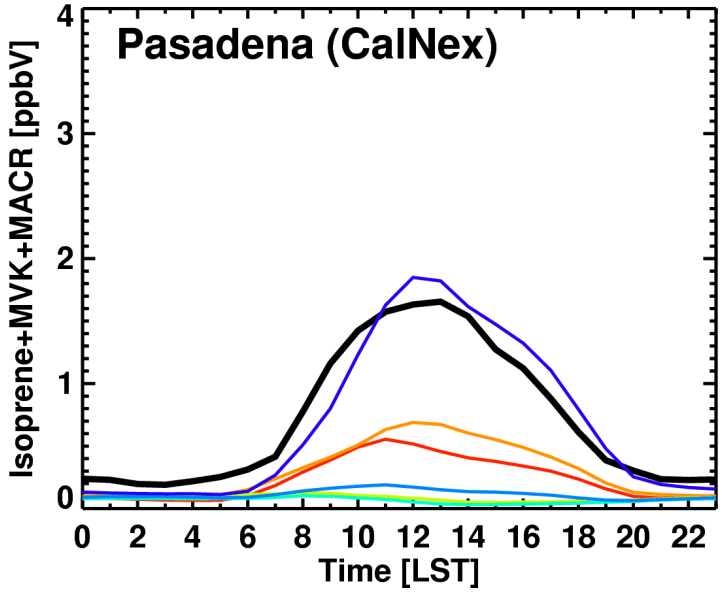

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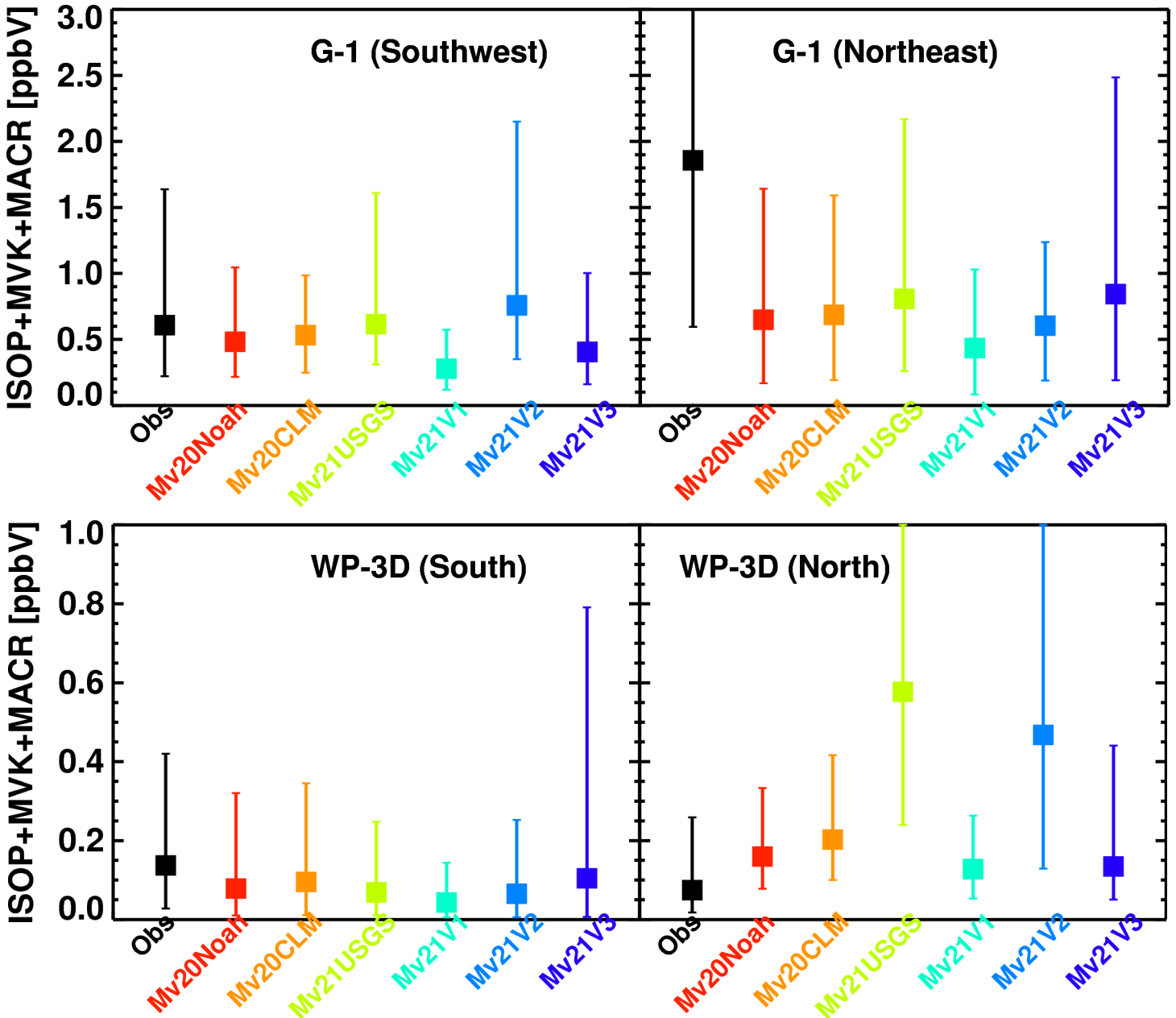

Summary

- Coupled modeling system with appropriate vegetation distribution can reasonably simulate BVOCs.
- Emissions of biogenic isoprene along the foothills of the Sierra Nevada may be underestimated due to the biases in emission factors.
- The difference in vegetation distributions over the Central Valley results in large variance in biogenic isoprene emissions.
- The impact of vegetation distributions on simulating BVOCs is larger than that of land surface processes over California
- This study implies that, effort is needed to obtain appropriate land cover datasets for models in terms of simulating BVOCs and consequently SOA formation.
- Biogenic monoterpene emissions are also significantly affected (not shown in this presentation)