Evaluation of Fire Emissions Inventory Improvements Using an Atmospheric Dispersion Model

Klara Kjome Fischer[1], Sam Faulstich[2], Heather Holmes[2]

[1]Department of Geology, Carleton College; [2]Department of Chemical Engineering, University of Utah

I. Introduction

- PM2.5, released by wildfires in the form of smoke, poses significant health risks to people downwind
- Fire emissions inventories (FEIs) provide estimates of fire emissions for smoke transport modeling
- FEIs rely on satellite fire detections often resulting in missing data
- **Our objective is to evaluate FEI improvements for daily smoke transport modeling in the western U.S. for three representative fire years (2013, 2016, 2018).**

II. Methods

- Fire emissions using the Wildland Fire Emissions Inventory System (WFEIS) with FEI improvements from Faulstich et al., (*in review*)[1]
  - **MODIS:** WFEIS Moderate Resolution Imaging Spectroradiometer satellite (MODIS) for daily temporal resolution (Fig. 1)
  - **MODIS+MTBS:** WFEIS MODIS incorporating Monitoring Trends In Burn Severity (MTBS) burned area measurements for increased spatial resolution—helpful for small fires (Fig. 1)
  - **MODIS+MTBS+CC:** WFEIS MODIS + MTBS incorporating cloud-cover interpolation to better model smoke when fire is obscured from MODIS
- Atmospheric dispersion modeling using FEI inputs
  - Hybrid Single-Particle Lagrangian Integrated Trajectory model (HYSPLIT)
  - North American Mesoscale (NAM) model to drive HYSPLIT (3-hr, 12km)
  - Forward trajectory run for each fire individually
- Data analyzed and plotted using R
  - Daily average for each unique location and fire
  - Data summed over four layers, with the vertical layer sum and surface layer used for data analysis

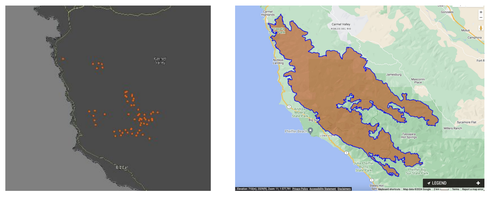

Fig. 1 – 2016 Soberanes Fire (left) MODIS thermal anomalies and (right) MTBS burned area estimate

III. Results

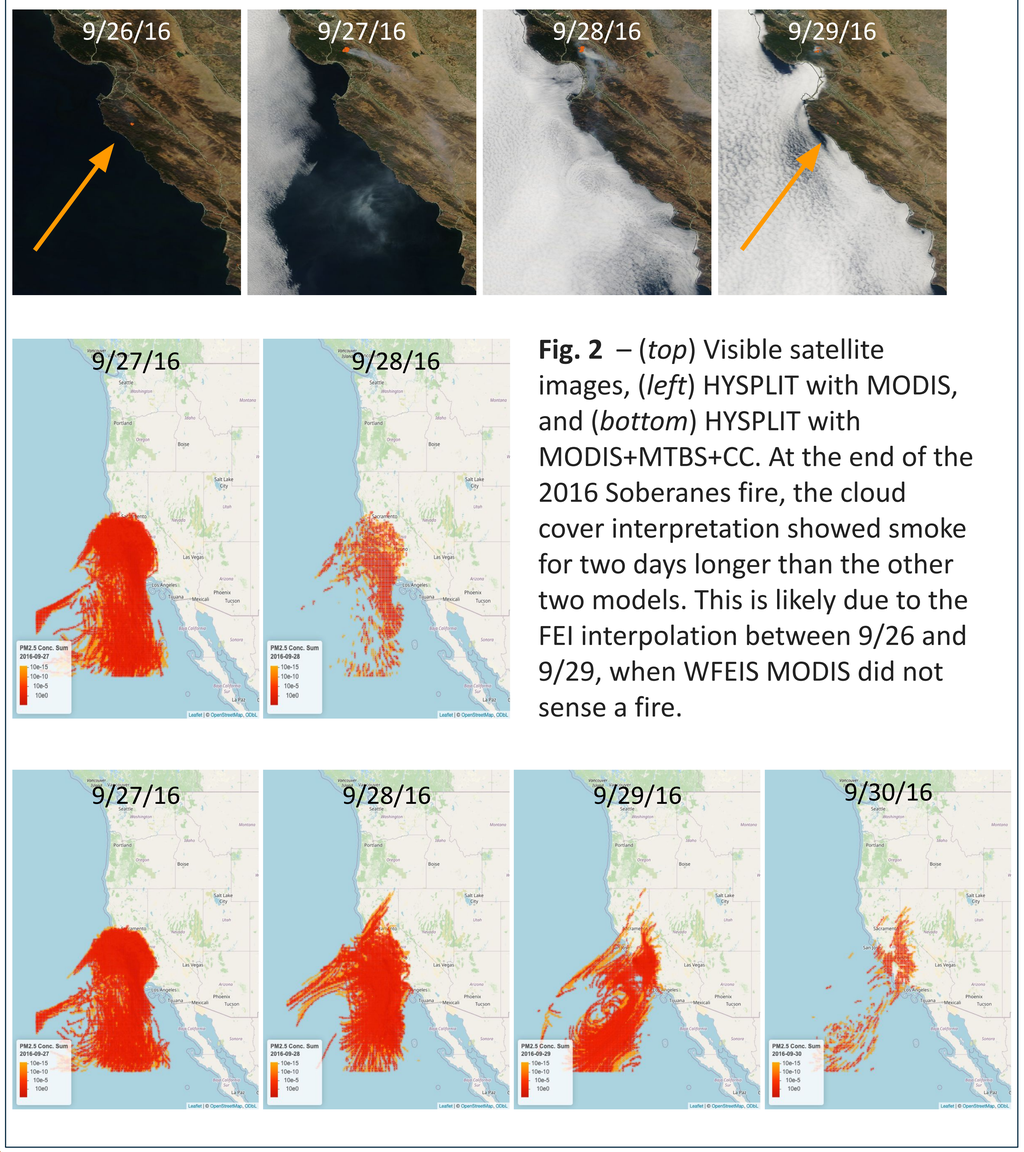

Fig. 2 – (*top*) Visible satellite images, (*left*) HYSPLIT with MODIS, and (*bottom*) HYSPLIT with MODIS+MTBS+CC. At the end of the 2016 Soberanes fire, the cloud cover interpretation showed smoke for two days longer than the other two models. This is likely due to the FEI interpolation between 9/26 and 9/29, when WFEIS MODIS did not sense a fire.

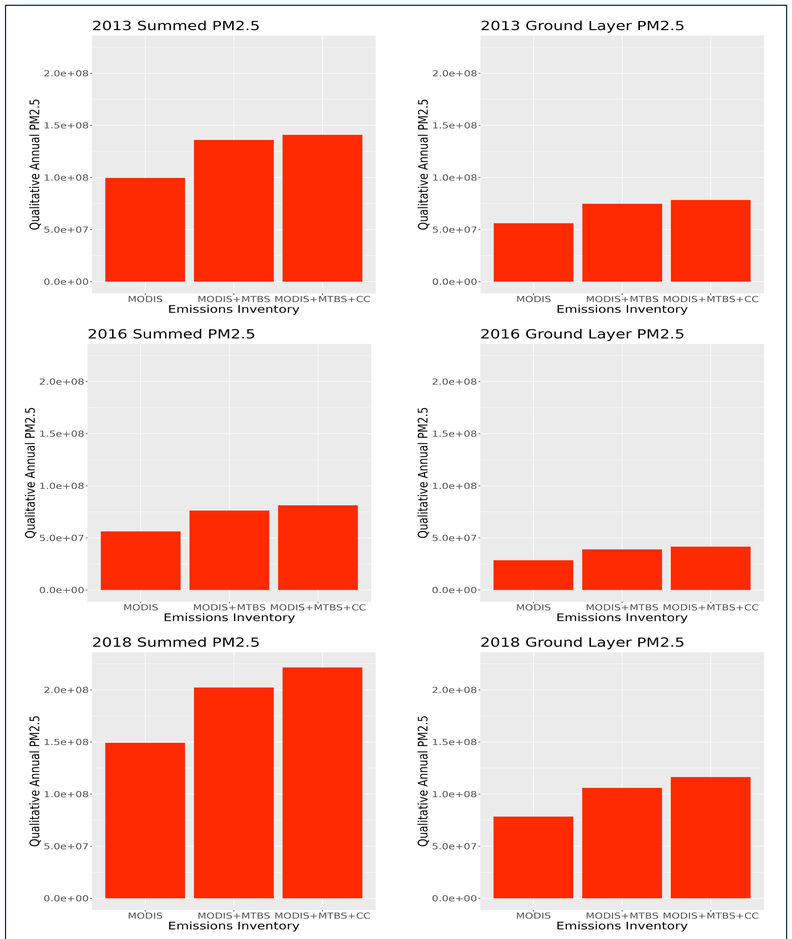

Fig. 3 – Annual PM2.5 concentrations estimated by HYSPLIT for each FEI improvement by year (*top*) 2013, (*middle*) 2016, and (*bottom*) 2018 for the (*left*) vertically summed and (*right*) surface concentrations. MTBS adds significantly to MODIS likely because of small fires. The CC interpolation also increases MODIS+MTBS but with less than half of the MTBS effect.

IV. Conclusions

- FEI improvements from Faulstich et al., (*in review*)[1] produced demonstrably different distributions and concentrations of smoke from HYSPLIT
- Leveraging the increased spatial resolution of MTBS likely accounts for more small fires than MODIS alone
- The gap filling method (MOBIS+MTBS+CC) increased the overall modeled PM2.5 concentrations, adding in missing fire days
- Satellite smoke observations offer unclear results, more analysis is needed to fully evaluate the FEI-HYSPLIT models

References and Acknowledgements

[1]Faulstich, S., Strickland, M., & Holmes, H. Enhancing Fire Emissions Inventories for Acute Health Effects Studies: Integrating High Spatial and Temporal Resolution Data, *in review*.

This work was done as part of the Research Experience in ALpine Meteorology (REALM) at the University of Utah Department of Atmospheric Sciences, which is sponsored by the National Science Foundation (NSF) Research Experiences for Undergraduates Program, award #2244272. The support and resources from the Center for High Performance Computing at the University of Utah are gratefully acknowledged.

Klara Kjome Fischer
Carleton College Geology
kjomek@carleton.edu