Using observations of Western U.S. wildfire smoke to improve fire emissions in air quality forecasting models

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Motivation

- Fire risk and property damage and loss of life due to fires are expected to continue to grow in the western U.S. along with population and longer, warmer, and drier fire seasons
- Air quality forecasts using regional chemical models provide key information for affected communities and smoke management efforts, yet many models fail to accurately predict ozone and particulate matter levels during fire events
- Large source of model uncertainty is satellite-based emissions, which for the Oct. 2017 Northern California fires range among inventories by factor of 83 (Fig. 1)

Results

Simulated trace gas mixing ratios and aerosol concentrations better correspond to observed values when FIREX-AQ EFs used (Figs. 4 and 5)

- Andreae (2019) EFs
- FIREX-AQ EFs

Questions

How does using reactive nitrogen, VOC, and aerosol EFs from 2019 NOAA/NASA Fire Influence on Regional and Global Environments Experiment – Air Quality (FIREX-AQ) campaign affect trace gases and aerosols in smoke plumes simulated by a regional chemical model?

How well does a burned-area-based plume injection scheme simulate injection heights observed during FIREX-AQ?

AirCraft and satellite observations and WRF-Chem simulations

WRF-Chem simulations:
Emission amounts from Brazilian Biomass Burning Emission Method (3BEM), based on MODIS/AVHRR satellite fire detections
Sensitivity tests:
(1) Gas and aerosol emission factors (EFs) from Andreae (2019)
(2) EFs from Andreae (2019) with updated reactive nitrogen, VOC, and aerosol EFs from FIREX-AQ aircraft observations

Conclusions

- Simulated trace gas mixing ratios and aerosol amounts better reproduce observations when EFs from FIREX-AQ used
- Burned-area plume injection scheme underestimate FIREX-AQ injection heights

Outlook

FIREX-AQ observations being explored to improve model representations of fire emissions and plume rise (including FRP-based approaches used in RRF-S-CMAQ and HRRR-Smoke/RAP-Chem), and chemistry

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References

- Andreae (2019)
- FIREX-AQ EFs
- Andreae (2019) EFs
- FIREX-AQ EFs