4.1 Improving prediction of aerosol and ozone formation from wildfire emissions in the western U.S.

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In 2017, wildfires burned one of the largest areas on record in the western U.S. 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 utilizing regional chemical models provide key information for affected communities and firefighting efforts, yet many models fail to accurately predict ozone and particulate matter levels during fire events. This study examines fire case studies from recent years for which in-situ observations are available, including smoke transported across the U.S. and to Europe from numerous wildfires in the Pacific Northwest in Sept. 2017, and the Santa Rosa fires in Oct. 2017. We conduct meteorology-chemistry simulations with WRF-Chem and evaluate the model against aircraft, ground-based, and satellite observations of aerosols, trace gases, and radiation. Next, we include fire diurnal cycle information obtained from Geostationary Operational Environmental Satellite (GOES)-16 Fire Radiative Power (FRP) observations in FRP-based emissions estimates, compare the FRP-based emissions with bottom-up approaches, and evaluate the sensitivity of air quality prediction to the emissions. We also develop a meteorology-driven fire emissions parameterization for WRF-Chem. We use the simulations to identify dominant ozone and aerosol formation chemical pathways and missing mechanisms in the model. Finally, we discuss plans for modeling analysis for the 2018 NSF Western wildfire Experiment for Cloud chemistry, Aerosol absorption and Nitrogen (WE-CAN) and CU Trace Gas Emission Fluxes from Biomass Burning Sources (BB-FLUX) and 2019 NOAA-NASA Fire Influence on Regional and Global Environments Experiment – Air Quality (Fire-X-AQ) field campaigns. This study will help to focus and prioritize measurements collected in the upcoming field experiments. The field observations will be used to constrain model parameterizations of emissions, plume rise, chemistry, and aerosol-cloud and aerosol-radiation interactions.