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Component: Fire Emissions and Atmospheric Aging (FEAA)

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Title: Chemical Aging of Emissions in Sagebrush Fire Scenarios

The sagebrush ecosystem is dominant across the western United States, particularly in Nevada, which —along with its neighboring states— faces the highest wildfire potential in the nation. Despite their extensive coverage and importance, a critical gap remains in characterizing the emissions, chemistry, microphysics, and atmospheric properties of biomass burning organic aerosols (OA), leaving uncertainties in our understanding of wildfire impacts in the sagebrush ecosystem. In addition, while mid- and long-distance plume aging has been relatively well characterized, uncertainties remain regarding the complex physicochemical evolution of wildfire OA near the fire. This near-fire period — within approximately the first 30 minutes of plume development and prior to buoyancy neutralization—is especially critical, as emissions undergo rapid transformations over short temporal scales.

At DRI, controlled small-scale burn experiments have been conducted during the fire season under comparable fuel conditions to wildland burns. These experiments were designed to address critical gaps by providing detailed measurements of gas-phase emission factors and comprehensive chemical speciation from local brush types, characteristic of Nevada's shrubland ecosystems.

In this study, we integrated biomass burning emission factors from different fuel types collected at the DRI Burning Facility into the process-level kinetic model SOM-TOMAS (Statistical Oxidation Model–Two Moment Aerosol Sectional model). This model simulates multigenerational gas- and particle-phase chemistry, thermodynamic properties, and phase-state–influenced kinetic gas/particle partitioning of OA. The model was used to assess OA production from key measured gas-phase precursors for different local brush types and quantify changes in the reactivity and chemical properties of emissions as they age and are transported in prescribed fire scenarios, with a focus on the near-fire environment. This study aims to enhance our understanding of near-field photochemical processes that influence wildfire OA transformation in sagebrush fires provides critical insights into the impacts of these fires on air quality in such prevalent ecosystems.