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Oxidative Aging and Secondary Organic Aerosol Formation from Simulated Wildfire Emissions

[Hennigan, C. J.](#); [Miracolo, M. A.](#); [Engelhart, G. J.](#); [May, A. A.](#); [Wold, C. E.](#); [Hao, W. M.](#); [Lee, T.](#); [Sullivan, A. P.](#); [Gilman, J. B.](#); [Kuster, W. C.](#); [de Gouw, J. A.](#); [Collett, J. L.](#); [Kreidenweis, S. M.](#); [Robinson, A. L.](#)
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Wildfires are a significant fraction of global biomass burning and a major source of trace gas and particle emissions in the atmosphere. Understanding the air quality and climate implications of wildfires is difficult since the emissions undergo complex transformations due to aging processes during transport away from the source. As part of the third Fire Lab at Missoula Experiment (FLAME III), we investigated the oxidative aging of smoke from combustion of 12 different types of vegetation commonly burned in North American wildfires. In these photochemical chamber experiments, we quantified the evolution of reactive trace gases and particles, with a focus on the chemistry contributing to changes in the organic aerosol (OA) concentration. Factors such as precursor VOC concentrations, oxidant exposure, and the role of NO_x were considered. The results illustrate the complex and variable nature of biomass burning emissions, since none of these factors alone account for the wide range of OA enhancements that were observed. For example, in some experiments, a net decrease of up to 30% in the OA concentration was observed, while in others, the OA concentration increased by a factor of three over the course of aging due to secondary OA (SOA) production. Despite this variability, all experiments showed significant physical (e.g., changes in aerosol volatility) and chemical (e.g., changes in oxidation) transformations in the OA due to oxidation. Overall, the results demonstrate that traditional definitions of POA and SOA continue to blur in many systems, and that processes like partitioning and heterogeneous chemistry can have the most significant effect on the evolution of biomass burning aerosol.

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