Biomass Burning Organic Aerosol as a Pool of Reactive Triplet Molecules to Drive Multiphase Reactions

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Abstract

Massive biomass-burning organic aerosols (BBOA) have been emitted to the atmosphere due to intensified wildfire events in recent years. While the light-absorbing properties and lifetime of BBOA, as well as their impacts on radiative balance, have been extensively explored, the multiphase photochemistry of BBOA is less studied. In this study, we demonstrated the remarkable photochemical reactivity of BBOA, evidenced by the efficient oxidation of SO_2 to sulfate under light exposure and N_2 conditions. Triplet states were identified as the primary drivers of sulfate formation, with triplet concentrations in BBOA exceeding those found in ambient particle extracts due to the abundance of photosensitizers in BBOA. Additionally, the photosensitized sulfate formation rate in BBOA was 4 orders of magnitude higher than the modeled value based on kinetic parameters for bulk solutions, likely due to accelerated photosensitized reactions at the interfacial layers of BBOA. Moreover, the photosensitized sulfate formation rate was doubled in air over that in N_2, highlighting the critical role of oxygen. Control experiments suggest that the reactive singlet oxygen ($^1O_2$) is likely the main contributor to the enhanced sulfate formation in air. This study highlights the significant role of BBOA in triggering multiphase photochemical reactions that generate secondary pollutants, in addition to their direct contributions to global warming through light absorption.

Early Career Scientist

YES, I am an early career scientist.

IGAC Activities

BBURNED: Biomass Burning Uncertainty: ReactioNs, Emissions and Dynamics, ACAM: Atmospheric Chemistry and the Asian Monsoon

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