Enhanced Sulfate Formation through Synergistic Effects of Chlorine Chemistry and Photosensitization in Atmospheric Particles

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Abstract

Numerous studies have demonstrated that organic photosensitizers from biomass burning can generate oxidants to effectively convert inorganic/organic precursors into secondary aerosols. Particulate chloride ions can be internally mixed with organic photosensitizers in biomass burning particles. In this study, we further investigate the impact of the interaction of chlorine chemistry and photosensitization on the oxidative potential of aerosols by utilizing SO_2 oxidation to form sulfate as an indicator. Mixed particles of chloride with glyoxal and its reaction products of ammonia of imidazole-2-carboxaldehyde (IC) were studied. Premixed NH_4Cl + glyoxal particles have a 4~5 times higher sulfate formation rate than premixed NaCl + glyoxal, particularly at low relative humidity, suggesting the role of photosensitization. Furthermore, the addition of IC resulted in ~73-fold increase in sulfate production rate compared to NH_4Cl alone. No noticeable sulfate formation was observed in the presence of IC alone, likely due to the high particle acidity in this study (i.e., pH = 2). Furthermore, kinetic analysis of these particle results yields a reaction rate constant of chloride ions with the triplet state of IC, $^3IC^*$, ~3 orders of magnitude higher than previously reported values in bulk solution. These results underscore the significance of the synergetic effect of chlorine chemistry and photosensitization in promoting sulfate formation in particles.

Early Career Scientist

YES, I am an early career scientist.

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