Photochemistry of Typical Anthropogenic Pollutants at the Air-Sea Interface as an Alternative Source of Organic Sulfur in the Marine Atmosphere

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Abstract

Sea surface chemistry directly affects air-sea interaction. Hitherto, there is still a lack of research on the impact and related mechanisms of anthropogenic pollutants on the air-sea interface. Polycyclic aromatic hydrocarbons (PAHs) and sulfur dioxide (SO_2) are common anthropogenic pollutants in the coastal seawater and atmosphere, respectively. Dimethyl sulfoxide (DMSO), as a ubiquitous organic sulfur (OS) compound in the ocean, is the main compound in the marine sulfur cycle. In this study, the mixed aqueous solution of typical PAHs and DMSO (PAHs/DMSO) including pyrene, fluoranthene and phenanthrene was used to be the proxy sea surface microlayer containing organic matter. The laboratory experiments on the photochemical reaction of PAHs/DMSO and its heterogeneous photochemical reaction with SO_2 were carried out in the presence of simulated sunlight irradiation, separately. (1) Excited triplet states of PAHs (^{3}PAHs*) can undergo interfacial photochemical reactions with DMSO, generating a large amount of gaseous and aqueous OS products containing 6 SOA precursors including methanesulfonic acid and methanesulfinic acid, thereby promoting the formation of SOA and enhancing the formation potential of cloud condensation nodules in aerosol particles. (2) In the presence of SO_2 upon irradiation of aqueous solutions containing PAHs/DMSO, a myriad of gaseous and aqueous OS compounds was detected, among which aqueous OS can form surfactant films, thereby interfering with the normal air-sea exchange processes; The tentative reaction mechanisms proposed in this study for DMSO degradation triggered by ^{3}PAHs*, and light-induced heterogeneous reactions of SO_2 with either DMSO or PAHs/DMSO in the sea surface microlayer, are potential sources and new formation mechanisms for atmospheric OS generation in coastal areas, which can fill the gap of existing sea-air exchange and atmospheric models, and provide new insights into chemistry occurring at the sea surface.

Early Career Scientist

NO, I am not an early career scientist.

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