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## Role of Oxalic acid on Fractional Solubility of Aerosol Iron over Coastal Ocean: Evidence from compound-specific stable carbon isotopic composition and diagnostic mass ratios

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Atmospheric transport and the subsequent air-to-sea deposition of water-soluble iron ( $Fe_{ws}$ ), an essential micronutrient for the phytoplankton growth, have a profound influence on the biogeochemical cycles of carbon and nitrogen. Sources of  $Fe_{ws}$  include contributions from poorly soluble natural mineral dust and highly soluble anthropogenic aerosols from biomass burning emissions and fossil-fuel combustion in the continental outflows. Apart from the source/emission contributions, atmospheric processing of aerosol iron ( $Fe_{Tot}$ ) by inorganic acidic species (e.g., non-sea-salt or  $nss-SO_4^{2-}$  and  $NO_3^-$ ) and/or organic acids also affect the supply of  $Fe_{ws}$  to the surface waters that are downwind of pollution sources. Among these, the least understood process is the oxalic acid-mediated photochemical cycling of  $Fe_{ws}$ . Laboratory studies have clearly demonstrated an enhancement in the fractional solubility of aerosol iron (i.e.,  $Fe_{ws}(\%) = Fe_{ws}/Fe_{Tot} \times 100$ ) via the oxalic acid complexation with  $Fe_{Tot}$  and subsequent photochemical reduction process. However, lacking support from the field measurements limits our ability to incorporate the proposed mechanism in the current biogeochemistry models. This study is designed with the overarching goal of investigating the role of oxalic acid on the  $Fe_{ws}(\%)$  over a coastal ocean (i.e., the Bay of Bengal: BoB) influenced by the atmospheric outflow from the Indo-Gangetic Plain (IGP) and South-east Asia (SEA) during the winter season. We analysed 31  $PM_{2.5}$  samples for the mass concentrations of  $Fe_{Tot}$ ,  $Fe_{ws}$  and other chemical composition including  $nss-SO_4^{2-}$ ,  $NO_3^-$ , oxalic acid and related polar compounds as well as stable carbon isotopic composition of oxalic acid ( $\delta^{13}C_{oxalic}$ ). Strong positive linear relationship of oxalic acid with  $Fe_{Tot}$  and significant inverse linear relationship between  $\delta^{13}C_{oxalic}$  and  $Fe_{ws}$  over the BoB clearly emphasize the role of oxalic acid on the  $Fe_{ws}(\%)$ . These findings comply with the notion that oxalic acid formed from the precursor water-soluble organic acids in the deliquescent aerosols, is complexed with aerosol-Fe and undergoes through successive photochemical reactions, contributing to an overall increase in the  $Fe_{ws}(\%)$ .

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