5.084 New perspectives for the air-sea interactions of bioactive trace metals: Applying X-ray spectroscopy and geochemical modeling to size-fractionated marine aerosols.

Early Career Scientist

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Abstract:

Air-sea interactions of bioactive trace metals (BTMs, e.g.: Fe, Zn, and Cu) in marine aerosols have great impacts on carbon/sulfur cycles and global climate via the promotion of primary productions in the surface ocean. Although dissolved BTMs in the surface ocean act as nutrients for microorganisms, little is known about the factors controlling BTMs solubility in marine aerosols. One of the reasons for the uncertainties in controlling the BTMs solubility is a lack of speciated BTMs data. We applied X-ray spectroscopy to directly determine BTMs analysis in size-fractionated aerosols without any sample treatments including solvent-extraction. Furthermore, we utilized a geochemical model for the BTMs speciation in marine aerosols for the first time. We found excellent agreement between the X-ray spectroscopy and the geochemical model. This is the critical methodological development in speciating BTMs in marine aerosol because this model is able to calculate BTMs species based only on the concentrations and stability constants. In addition, we revealed that the formation of Fe(III)-organic complexes with siderophore (Fe(III)-siderophore) plays an important role in controlling atmospheric Fe solubility. Siderophore is the representative of Fe-ligand in seawater and Fe(III)-siderophore has substantially high solubility. The X-ray microscope indicated that Fe(III)-siderophore was formed by heterogeneous reactions of Fe with siderophore in sea spray aerosol. Therefore, the air-sea interactions of BTMs are important in the promotion of primary productions via atmospheric deposition as well as the control of atmospheric BTMs solubility. We believe that further applications of this novel method to other BTMs drastically develop our understanding of air-sea interactions of BTMs and its impacts on climate regulation.