Atmospheric deposition of iron from mineral aerosols to the ocean

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Atmospheric deposition of iron (Fe) from mineral aerosols to the ocean has been suggested to increase the amount of ocean uptake of CO_2 and emissions of marine biogenic aerosols. The marine organic material may be an important source of ice-nucleating particles in remote marine environment such as the Southern Ocean, North Pacific Ocean, and North Atlantic Ocean. Significant progress has been made in our understanding of atmospheric inputs of labile Fe from natural and anthropogenic sources to the surface oceans. Different emission sources and transformation processes affect aerosol Fe solubility. Mineral dust contains a small amount of labile Fe (e.g., ferrihydrite) on the surface (about 1% of Fe solubility) and thus may deliver insignificant labile Fe fluxes to the polar oceans in present days. However, about 10% of mean Fe solubility is measured for the Last Glacial Maximum (LGM) aerosols in Antarctica. If this value is applied to mineral dust during the LGM, the atmospheric input of labile Fe could be comparable to that provided by upwelling in present days. However, there are still large uncertainties regarding the relative importance of different sources of Fe and the effects of atmospheric aerosols on dissolved Fe in the ocean. Here, we use atmospheric chemistry transport model and ocean ecosystem model to investigate the effects of atmospheric deposition of Fe from mineral aerosols to dissolved Fe in the ocean, based on measurements in the North Atlantic. When a constant Fe solubility of 2% was used in the ocean model, the model overestimated the dissolved Fe concentration in the surface ocean downwind from the North African dust plume. Considering different degrees of atmospheric Fe processing reduced the overestimates. However, the atmospheric model underestimated labile Fe concentration over the Southern Ocean. Further investigation of the mechanisms of emissions, transport, and deposition of Fe-containing particles over the oceans is needed to improve our understanding of labile Fe supply to open ocean.