Role of acid mobilization in association of smaller particle size with higher iron solubility

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Iron (Fe) is an essential nutrient for phytoplankton. Iron-containing soil dust mobilized from arid regions supplies the majority of iron to the oceans, but primarily presents in an insoluble form. Since most aquatic organisms can take up iron only in the dissolved form, a key flux is the amount of soluble iron in terms of the biogeochemical response to atmospheric deposition. Atmospheric processing of mineral aerosols by anthropogenic pollutants may transform insoluble iron into soluble forms. We discuss the effect of the acid mobilization on a relationship between aerosol iron solubility and mineral particle size in an aerosol chemistry transport model [1]. The iron solubility from onboard cruise measurements [2, 3] over the Atlantic and Pacific Oceans in 2001 is used to evaluate the model performance in simulating soluble iron.

The association of smaller size with higher solubility as a role of the acid mobilization considerably improves the results of soluble iron in terms of ratio of fine to total particles, compared to constant iron solubility. The improvement of model-observation agreement provides strong evidence for faster iron dissolution in fine particles by anthropogenic pollutants. Accurate simulation of the ratio of fine to total aerosols of soluble iron has important implications with regards to the ocean fertilization because of a longer residence time of smaller particles, which supply nutrients to more remote ocean biome. The model reveals higher concentration of soluble iron in the coarse mode than that in the fine mode over the Southern Ocean except downwind regions of Australian dust, in contrast to the Northern Ocean. These results suggest that dust does not efficiently transport soluble iron to significant portions of the Southern Ocean. This corroborates hypothesis that phytoplankton blooms are not sustained by the supply of iron to surface waters from dust deposition in the Southern Ocean [4] except the Australian sector [5].

[1] A. Ito & Y. Feng (2010), *Atmos. Chem. Phys.* 10, 9237-9250. [2] Y. Chen & R. L. Siefert (2003), *J. Geophys. Res.* 108, 4774. [3] A. R. Baker et al. (2006), *Mar. Chem.* 98, 43-58. [4] S. Blain et al. (2007), *Nature* 446, 1070-1074. [5] E. Brévière et al. (2006), *Tellus* 58B, 438-446.