Observation of iron solubilisation in anthropogenic aerosols

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Atmospheric deposition of aerosols to the surface ocean increases the availability of dissolved iron. This enhances primary production in high latitude and equatorial Pacific oceans where iron is limited and stimulates nitrogen fixation in much of the lower latitude oceans. Recent model studies have suggested an increase of dissolved iron into the oceans due to enhanced atmospheric acidity by anthropogenic emissions. However, no direct field evidence is available so far to confirm this hypothesis.

We carried out an observational study to evaluate this iron solubilisation hypothesis. The morphology, composition, and mixing state of individual iron-bearing particles collected over the Yellow Sea in June 2013 was investigated using a Transmission Electron Microscope coupled with an energy dispersive X-ray spectroscope. 14% of all analyzed particles ranging from 20-5000 nm contain iron, most of which as iron-rich spheres or fly ash within individual particles. The spheres and fly ash are most likely emitted from industrial processes and/or coal combustion. Less than 1.3% of the iron-bearing particles contain mineral dust. A majority of the iron-bearing particles larger than 300 nm were internally mixed with sulfate and sometimes both sulfate and organic matter. Elemental maps revealed that the iron was frequently present in the sulfur-containing matrix as well as the primarily emitted particles (as iron hotspots). This provides direct evidence on the release of soluble iron from primary anthropogenic iron-bearing particles through atmospheric processing.