Bioavailable Fe Supply to the North Atlantic

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Wind-borne dust directly influences climate by supplying iron (Fe), which limits phytoplankton productivity in high-nutrient, low-chlorophyll (HNLC) areas of the ocean. These areas are remote from Fe sourced by rivers, shelf sediment recycling, glaciers and hydrothermal activity; thus, atmospheric deposition dominates. Atmospheric dust supplies Fe as fine-grained (oxyhydr)oxides that are potentially bioavailable along with a variety of other Fe-bearing minerals (e.g. illite, smectite and chlorite) that are more refractory.

The influence of dust on climate remains poorly constrained, however, in part because dust Fe speciation and mineralogy are rarely quantified. Within this framework, we analyzed four North Atlantic IODP cores from proximal to distal sites across the North Atlantic relative to Saharan dust sources that deliver Fe that can become bioavailable for phytoplankton for photosynthesis and for nitrogen assimilation by bacteria.

We observe a fractional solubility loss of 0.4-7% between proximal and distal sites for the most reactive fractions. These fractions require their reactivity to be enhanced by cloud processing during long-range transport in order for Fe to be lost to the water column and made bioavailable. If widely relevant, our findings suggest that dust-driven primary production might be greatest far downwind from dust source regions, allowing us to predict and explain past patterns of productivity in terms of both Fe source region and key distance-dependent transport processes.