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Mineral particle size as a control on aerosol iron solubility

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Atmospheric transport of mineral aerosol is the dominant source of nutrient iron to vast areas of the world ocean. The solubility of aerosol iron is a major uncertainty in the biogeochemical cycle of this key micronutrient and, through iron's role as a limiting nutrient for phytoplankton growth, the carbon cycle and its influence on global climate. Previous studies have reported widely different values for this solubility (0.01 – 80%) and proposed several chemical or photochemical mechanisms by which solubility might be enhanced during transport through the atmosphere. There is currently a fundamental lack of understanding of the magnitude of aerosol iron solubility and the processes that affect it. Here we show that the primary control on aerosol iron solubility is in fact the surface area to volume ratio of mineral aerosol particles and that this ratio changes during atmospheric transport due to preferential removal of larger particles. This important result indicates that aerosol iron solubility is not fixed, but will change predictably with gradients in dust concentration, both spatially and over time (e.g. glacial – interglacial timescales). Thus gradients in soluble iron inputs to the ocean are likely to be rather lower than the observed very strong spatial and temporal gradients in dust inputs, since fractional soluble iron inputs will be lower at high dust concentrations and *vice versa*.