The Records of Dust Iron Provenance in Marine Cores and Its Potential to Affect Ocean Productivity

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Changes in bioavailable dust-borne iron (Fe) supply to the iron-limited ocean may influence climate by modulating phytoplankton growth and CO_2 fixation into organic matter that is exported to the deep ocean. The chemical form (speciation) of Fe impacts its bioavailability, and glacial weathering produces highly bioavailable Fe minerals in modern dust sources. In this work, we will discuss several independent methods of differentiating the source, speciation and the reactivity of sedimentary Fe delivered from dust to the Southern Ocean. A suite of high-resolution records of Fe speciation and sediment mineralogy is obtained with X-ray absorption spectroscopy and diffraction to establish the variation in dust-borne Fe species reaching the iron-limited Southern Ocean on glacial-interglacial timescales is unknown, and its impact on the bioavailable iron supply over geologic time has not been quantified. We show that changes in speciation are more significant variables to overall productivity than is overall Fe flux. We show that the Fe(II) content, as a percentage of total dust-borne Fe, increases from 5-10% in interglacial periods to 25-45% in glacial periods due to the increased input of primary rock flour from glaciers. Consequently, the highly bioavailable Fe(II) flux increases by a factor of 15-20 in glacial periods compared to the current interglacial.