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Fe(III) Complexing Organic Ligands and Their Regulation of Ecosystem Response to Atmospheric Iron Enrichment of High Nitrate Low Chlorophyll Waters

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Mesoscale iron enrichment studies now have been performed repeatedly in the subarctic Pacific, equatorial Pacific, and Southern Ocean, each time enhancing the growth of phytoplankton. Although all these studies had very similar experimental designs, the magnitude of the diatom growth response varied dramatically. For example, growth in the SEEDS and SEEDS II iron enrichment experiments, conducted at very nearly the same location in western subarctic Pacific, differed by almost an order of magnitude. Deckboard incubation experiments conducted during SEEDS II demonstrated that diatom growth remained iron-limited in the fertilized patch even though total dissolved iron concentrations ($>$ 0.5 nM) were several times higher than ambient levels. This outcome reflects the negative influence of strong Fe(III)-complexing organic ligands on diatom growth. Our experiments show that the combination of Fe and Cu additions generated more growth than either metal added alone, consistent with a current model that diatoms can utilize strongly complexed Fe(III) if Cu supplies are adequate. These findings have implications for the inverse relationship observed between mixing depth and bloom size generated from artificial iron enrichments. This relationship is attributed mainly to physical effects (temperature, light, mixing), but instead it may be controlled by the inorganic:organic ratio of dissolved iron speciation in the fertilized patch. If so, most atmospheric iron deposition events to HNLC waters may have little impact on diatom growth and export production; a view that challenges current paradigms.