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Variability of dissolved Fe bioavailability in the Pacific Ocean as revealed by photochemical reactivity

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The bioavailability of iron to marine phytoplankton depends on its chemical form. While most dissolved iron in seawater is complexed with dissolved organic matter (natural organic ligands), iron in surface seawater is partially reduced to Fe(II) through photochemical reactions during the daytime, resulting in high bioavailability. This study reports that the bioavailability of iron in the surface waters of the North Pacific varies with ocean region. Filtered seawater samples were collected from 10 m depth in the North Pacific at 25 sites during the GEOTRACES GP02 and GP22 cruises, then frozen and brought back to a land-based laboratory. After thawing in the dark, the samples were adjusted to the local seawater temperature and exposed to simulated sunlight. Changes in Fe(II) concentrations were investigated using luminol chemiluminescence. The maximum concentration of Fe(II) produced by light exposure was high in the mid-latitude region of the western Pacific Ocean between 25°N and 44°N but low in the tropical and subtropical regions from the equator to 20°N. High values were also observed in the eastern Pacific Ocean, east of 140°W at 47°N latitude. This trend does not necessarily coincide with the distribution of dissolved total iron concentrations, which reflects that the photochemical reactivity of iron organic complexes depends on the type of organic ligands in seawater. However, no clear relationship has been found between photochemical reactivity and the concentration and conditional stability constants of the organic ligands determined using the CLE-ACSV method. In the western mid-latitude region, the Oyashio and Kuroshio transition zones, highly photochemically reactive organic ligands, such as saccharides and marine biogenic substances, may be the main organic ligands in the surface seawater.