What controls the subsurface extrema of dissolved iron in the upper ocean thermocline?

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Recent GEOTRACES transects revealed basin-scale patterns of dissolved iron (dFe) in all major ocean basins, providing a unique opportunity to test our models and understanding of the dFe cycling. Subsurface dFe maxima in the upper ocean thermocline are observed along many transects, which can play an important role in regulating marine productivity due to their proximity to the surface euphotic layer. In this study, a suite of numerical sensitivity experiments is performed in an ocean biogeochemistry model to examine the mechanisms controlling the formation and maintenance of the observed subsurface dFe maxima. The model includes the Fe cycling with three external dFe sources (dust deposition, continental shelves, and hydrothermal vents), two classes of organic ligands parameterized as functions of dissolved organic matter and remineralization, and a particle dependent parameterization of scavenging. The model reproduces some observed features of the subsurface dFe maxima, and the sensitivity experiments suggest that the subsurface dFe maxima under high-dust regions of the Indian and Atlantic basins are formed by the release of scavenged Fe from sinking particles. In low-dust regions of the Pacific basin, the subsurface dFe maxima are sustained by inputs either from low-oxygen continental shelves or from hydrothermal vents. In all cases, ligands produced by the remineralization of organic particles protect dFe from being scavenged, maintaining the subsurface elevated dFe.