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Modelling temperature controls on dissolved iron fluxes and marine iron distributions

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Sedimentary iron dissolution and scavenging are key processes that determine the distribution of the essential micronutrient iron within the ocean and consequently the extent of iron limitation of primary productivity. Reductive dissolution dominates iron release across continental shelves and in oxygen minimum zones. Global models typically link this flux to bottom water oxygen and carbon oxidation at the sediment-water interface based on observation-derived parametrisations. The amount of sediment-derived iron that reaches the euphotic zone and is then available for phytoplankton uptake is sensitive to scavenging parametrisations. However, the role of temperature in regulating reaction kinetics at the sediment-water boundary and scavenging rates has not been extensively explored in global ocean models.

Herein, we implement and evaluate the role of temperature-driven reaction kinetics on sedimentary dissolution processes and scavenging in a state-of-the-art iron biogeochemical model within the University of Victoria Earth System Climate Model (UVic ESCM). Model configurations are constrained using multiple observational datasets, including dissolved iron concentrations, iron isotopic compositions, and other biogeochemical tracer distributions. This provides observational constraints on sedimentary iron release and a basis to explore how temperature-driven changes in sedimentary iron supply and scavenging may influence marine productivity and the biological carbon pump.

Our results indicate that temperature can influence the spatial distribution of sediment-water iron and scavenging fluxes, with potential consequences for marine iron distributions and residence times as well as marine primary productivity. Accounting for temperature-dependent reaction kinetics may therefore improve predictions of iron and productivity under future climate scenarios.