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Global distribution of nickel sources and sinks as seen from a diagnostic model

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Nickel is known to be a micronutrient for phytoplankton in the oceans. While it generally has a ‘nutrient-type’ profile, there remain uncertainties about the biological and abiotic processes responsible for cycling Ni, for example whether Ni is incorporated into diatom frustules and whether Ni in the surface oligotrophic gyres is bioavailable. We have applied a diagnostic modeling technique to evaluate the 3D spatial distribution of Ni sources and sinks in the global ocean. In contrast to a prognostic model, where specific biogeochemical processes are encoded, the diagnostic approach couples global OCIM circulation and a global Ni climatology in order to determine the location of Ni sources and sinks, without invoking explicit biogeochemistry [1]. First we predicted a global Ni climatology using various machine learning techniques, finding that simple multiple linear regression is the optimal approach. Ni fluxes were then diagnosed with a nutrient-restoring technique. We find that Ni uptake in the surface oceans is spatially co-located with P uptake and not with Si uptake, suggesting that Ni is not incorporated into diatom frustules despite the global similarity between Si and Ni distributions. We also find that Ni/P uptake ratios increase as Ni is depleted, providing evidence against a pool of non-bioavailable Ni in the surface ocean. Ni regeneration is deeper than P but shallower than Si, suggesting a decoupling between regeneration of biogenic Ni and P from sinking particles.

[1] Roshan, S., DeVries, T. & Wu, J. Constraining the Global Ocean Cu Cycle With a Data-Assimilated Diagnostic Model. *Global Biogeochem. Cycles* 34, e2020GB006741 (2020).