Global distribution of decoupling between silicate and nitrate in the ocean

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The biological productivity of the ocean has a significant impact on controlling atmospheric CO_2 level. The surface layer of the Southern Ocean (SO) serves as the major source of nutrients for primary production in global low-latitude surface waters with the formation of the Intermediate Water (IW) *[Sarmiento et al., 2004; Palter et al., 2010]*. The high downward export flux of biogenic silica from the surface SO results in a much greater decrease gradient of dissolved silica (Si) which decoupled from that of nitrate (N) along the northward transportation of IW, thus limiting biological productivity in most of the global surface ocean. Due to the sparseness of extensive time-series observation of nutrients across the global ocean, especially in the SO, such decoupling between Si and N is still understood in a very vague way. Recently, parameterization technique has proven to be a good solution to the problem of insufficient ocean observation *[Pan et al., 2020; Pan et al., 2022]*. Here we attempt to quantify the seasonal downward export fluxes of Si and N from surface as well as the upward resupply fluxes by using neural network parameterizations and biogeochemical Argo float (BGC-Argo), and to directly estimate this decoupling between Si and N over the global surface ocean. We found a contrast downward export ratio of Si and N (Si/N) between the SO of 8:1 and the North Atlantic of 0.1:1. IW-derived water masses with Si/N $\geq$ 1 are found in the major global upwelling regions, such as the equatorial Pacific and the Subarctic Pacific. Lower Si/N in these regions (~2:1) than that in the SO is probably due to the deficiency of Si or the supply of terrestrial-origin iron. The imbalance between the downward export and the upward resupply allows us to identify the main regions of Si removal from the surface that result in the meridional descending gradient of Si in the global ocean. Our results have important implications for our understanding of the nutrient dynamics of the global surface ocean and future climate change.

References

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