Interpreting the oceanic silicon stable isotope distribution: Insights from ocean GCMs

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Diatoms fractionate the stable isotopes of silicon (Si) when they take up silicic acid in order to form their opaline frustules. This produces a signal of surface-ocean Si consumption in the stable isotope composition of silicic acid in seawater (expressed as δ^{30}Si), as well as a complementary signal of regeneration in the ocean interior, such that the oceanic δ^{30}Si distribution can be used to study the marine Si cycle.

As the volume of available marine δ^{30}Si data has grown, it has become increasingly clear that its distribution is strongly influenced by the ocean's physical circulation at spatial scales ranging from the regional to the near-global. This influence implies that the observed marine δ^{30}Si distribution bears information on marine Si cycling that is integrated over some spatial and temporal scales. How can such data be best interpreted?

In the context of ocean general circulation (GCM) simulations, we explore how the interactions between the ocean's physical circulation and biological Si uptake at its sunlit surface shape the interior δ^{30}Si distribution. To do this, we apply a number of diagnostics only available in the modelling framework, such as a separation between the preformed and regenerated components of Si, and the explicit tracing of Si pools sourced from high-latitude ocean regions where Si cycling is particularly vigorous. The mechanistic insights gained from these diagnostics give us a better understanding of what we can learn about the cycling of Si from the observational δ^{30}Si dataset. Particular attention will be paid to the role of the Southern Ocean in global marine Si cycling, as well as the basin-scale transport of isotopic signals created in the high-latitude surface ocean.