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Reassessing the Zn Cycle from the Global Ocean to the North Pacific Using Tracer-Constrained Circulation Fields

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Zinc (Zn) plays a crucial role in biological processes and is biogeochemically important. In the global ocean, Zn and silicon (Si) exhibit a strong correlation, maintaining a relatively consistent ratio. However, some GEOTRACES data have reported that this coupling is disrupted in the North Pacific.

Our previous study suggested that this Zn-Si decoupling could be attributed either to Zn inputs from the continental shelf or to differences in the regeneration processes of Zn and Si. The conclusion varied depending on the circulation fields used in the model experiments. The two different circulation fields used in simulations had distinct characteristics, particularly in terms of particulate organic carbon (POC) export flux and water mass age in the North Pacific. These differences influenced the reproducibility of regenerated tracer concentrations, which in turn affected the interpretation of the Zn-Si decoupling factors.

A key limitation of the previous study was the inadequate reproduction of realistic regenerated Zn concentrations in the subarctic North Pacific, where Zn-Si decoupling is most pronounced. As a result, it was difficult to determine the key constraints on the factors driving the decoupling.

In this study, we improve the fidelity of the circulation fields using an inverse approach with phosphate (P) and Si distributions as well as temperature, salinity, and $\Delta^{14}C$. By using these refined circulation fields, we aim to quantitatively constrain the factors contributing to Zn-Si decoupling in the North Pacific. Furthermore, we discuss the role of reversible scavenging and the influence of continental shelf processes on Zn distribution.