

Iron cycling in the North Pacific in an ocean ecosystem model

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Iron plays an important role in the control of primary production and carbon cycle in the ocean. Mineral dust has been considered as a major source of iron in the ocean. Recent observation studies suggest that sedimentary iron is recognized as another important iron source, especially in the western North Pacific. We examine transport processes of iron from the Sea of Okhotsk into the North Pacific by numerical simulation.

The global ocean general circulation model (POP, Parallel Ocean Program) with the BEC (Biogeochemical Elemental Cycling) model with a resolution of 1.125 degree in longitude and roughly 0.5 degree in latitude is used for the investigation. We modify the bottom topography and forcing data around the sea of Okhotsk on the current POP configuration. The modified POP acceptably reproduces the physical fields in the Sea of Okhotsk: the dense shelf water is formed in the northern continental shelf, a cyclonic gyre with southward western boundary current develops in the central basin and water is exchanged through the straits between the Kuril Islands. Sedimentary iron mainly supplied in the northern continental shelf of the Sea of Okhotsk is transported by the physical processes in the depth below subsurface and is exported to the North Pacific. The BEC model includes four functional-type group of phytoplankton (diatom, coccolithophores, diazotrophs and picophytoplankton) and five limiting nutrients (nitrate, ammonium, phosphate, silicate and dissolved iron). Both mineral dust and sedimentary sources are considered in our control simulation.

We carry out the model integrations with the different scavenging parameters. The model with lower scavenging parameters simulates higher dissolved iron concentrations in the western subarctic Pacific than in the eastern part below intermediate depth. Dissolved iron exported from the Sea of Okhotsk likely contributes to form the horizontal difference of the dissolved iron distribution in the western North Pacific. Simulated dissolved iron concentrations in the intermediate water of the North Pacific show higher in the west than the east with two high concentration cores in the latitudinal cross section of 165 degree E. These features are consistent with the observed data.

Sensitivity experiments only giving either mineral dust or sedimentary sources of iron show that the observed features are better simulated by considering sedimentary iron. Furthermore, sedimentary iron contributes oceanic primary production comparably with mineral dust in the western North Pacific.

Keywords: Ocean ecosystem model, Iron, North Pacific, Sea of Okhotsk, Mineral dust, Sediment