Estimation of sedimentary iron flux to the world ocean

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Iron is an important nutrient in marine biogeochemical cycles because it limits primary production in high-nutrient, low-chlorophyll areas. Iron cycle is implemented in the most marine biogeochemical cycle models used for future climate projection lead by IPCC. It has been revealed that the deposition of aerosols, release of iron from seabed sediments and hydrothermal vents are the major iron sources to the ocean. These exogenous iron inputs are considered in marine biogeochemical cycle models as the boundary conditions, but the magnitude and distribution of the fluxes are vary significantly among the models (Tagliabue et al., 2016). The sedimentary iron flux showed the largest dispersion among the exogenous inputs, it varies two-orders of magnitudes (0.6-196 Gmol/yr; Tagliabue et al., 2016), being a cause of the large discrepancy of simulated dissolved iron distributions among the models. Consequently, to construct a more precise sedimentary-iron flux dataset and standardize it are urgent need to reduce model uncertainty.

This study proposes new datasets of the sedimentary iron flux for the global ocean (Fig 1). We used formulae presented by Moore and Braucher (2008) where sedimentary iron flux is proportional to the particulate organic carbon (POC) flux reaching to the seabed sediment. This formulation is based on an empirical relationship observed in flux chamber data off the coast of California (Elrod et al., 2004). Moore and Braucher (2008) used the POC flux simulated in their model (BEC). In this study, we instead used the POC flux estimated from satellite data to prevent from two potential problems using the simulated POC flux: 1) coarse-resolution global models usually underestimate the POC flux in the coastal areas where the sedimentary iron fluxes are particularly large, and 2) using simulated POC flux is a cause of inter-model discrepancy of the sedimentary iron flux because the simulated POC fluxes are always different among the models. Our approach therefore can provide more proper sedimentary-iron estimate with model independent manner.

In addition to this standard dataset (hereafter STD dataset), we propose another dataset that is corrected from the STD dataset considering the bottom water properties. The reason of the proportionality between sedimentary iron and POC fluxes is considered that remineralization of organic matter in sediment consumes dissolved oxygen and reduces iron to more soluble Fe(II). The reduced iron is oxidized rapidly when it reaches to oxic bottom water, but the oxidation rates depend on bottom water properties such as temperature, salinity, dissolved oxygen and pH. We estimated the oxidation rates using an empirical relationship (Tagliabue et al., 2011) and the GLODAP v2 dataset (Lauvset et al., 2016 and Key et al., 2015). The obtained oxidation rates were then normalized by the value off the coast of California where the proportional constant between the sedimentary iron and POC fluxes is observed. The resultant non-dimension factors were multiplied to the STD dataset (hereafter FCT dataset).
Both the STD and FCT datasets showed larger sedimentary iron flux (200, 321 Gmol/yr in the global sum) than the previous estimates. The larger fluxes are attributed mainly to increase the fluxes in the shelf regions. The FCT dataset predicted larger fluxes in deep-sea sediments and shelf areas in high latitudes than the STD dataset reflecting slow oxidation rates due to low bottom-water temperatures. In addition to the magnitudes, the horizontal distributions are significantly altered from the fluxes estimated by Moore

and Braucher (2008). The fluxes are increased mainly in the Pacific and Arctic Oceans where the shelf areas are extensive. Simulated results put these datasets into a marine biogeochemical cycle model will be presented in this talk.

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