



A study of the marine nitrogen cycle using an ecosystem model including nitrogen isotopes

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We have developed an ecosystem model including two nitrogen isotopes (^{14}N and ^{15}N), and validated this model using an actual data set. A study of nitrogen isotopic ratios ($\delta^{15}\text{N}$) using a marine ecosystem model is thought to be most helpful in quantitatively understanding the marine nitrogen cycle. Also, the model study may indicate a new potential of $\delta^{15}\text{N}$ as a tracer. This model has six compartments: phytoplankton, zooplankton, particulate organic nitrogen, dissolved organic nitrogen, nitrate and ammonium in a two-box model, and has biological processes with/without isotopic fractionation. We have applied this model to the Sea of Okhotsk, and successfully reproduced the $\delta^{15}\text{N}$ of nitrate measured in seawater and the seasonal variations in $\delta^{15}\text{N}$ of sinking particles obtained from sediment trap experiments. Simulated $\delta^{15}\text{N}$ of phytoplankton are determined by $\delta^{15}\text{N}$ of nitrate and ammonium, and the nitrogen f-ratio, defined as a ratio of nitrate assimilation by phytoplankton to total nitrogenous nutrient assimilation. Detailed considerations for biological processes in the spring and autumn blooms have proved that there is a significant difference between $\delta^{15}\text{N}$ values of phytoplankton, which assimilates only nitrate, and only ammonium, respectively. We suggest that observations of $\delta^{15}\text{N}$ of phytoplankton, nitrate and ammonium in the spring and autumn blooms may indicate the ratios of nutrient selectivity by phytoplankton. In winter, most of the biogeochemical fluxes decrease rapidly, but nitrification flux decreases much more slowly than the other biogeochemical fluxes. Therefore $\delta^{15}\text{N}$ and concentration of ammonium reflects almost only on nitrification. The nitrification rate can be parameterized with observations of $\delta^{15}\text{N}$ of ammonium in winter and a sensitive study varying the parameter of nitrification rate.