Development of a model of nitrous oxide in the western North Pacific

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Nitrous oxide (N_2O) is a greenhouse gas that also destroys the stratospheric ozone. It is important to estimate accurately the global N_2O budget in order to better understand the factors that influence atmospheric N_2O concentrations, to develop global warming countermeasures, and to protect the ozone layer. Previous models have indirectly predicted marine N_2O emissions from the apparent oxygen utilization, based on the observed inverse relationship between the dissolved oxygen and N_2O concentrations in the ocean. However, different microbes with distinctive substrates and enzymes mediate N_2O production and consumption processes. The accurate estimation of past, current and future marine N_2O emissions requires a model including these processes explicitly. In this study, a 1D marine ecosystem model that incorporates N_2O production processes (i.e., ammonium oxidation during nitrification and nitrite reduction during nitrifier denitrification) was developed. We applied this model to the JAMSTEC time-series subarctic and subtropical sites (K2 and S1) in the western north Pacific. The model was validated with observed nitrogen concentration and successfully simulated the higher N_2O concentration, the higher N_2O production rates, and the higher nitrification rates at K2 compared with S1. The annual mean N_2O emission fluxes were estimated to be 42 mgN m^{-2} yr^{-1} at K2 and 3 mgN m^{-2} yr^{-1} at S1. Using this model, we conducted two case studies: 1) estimating the ratio of N_2O emission flux by in-situ biological N_2O production to total flux, 2) estimating the ratio of N_2O production by ammonium oxidation to that by nitrite reduction. The results of case studies estimated the ratio of N_2O emission flux by in-situ biological N_2O production to be ~68% at K2 and ~100% at S1. It is also suggested that N_2O was mainly produced via ammonium oxidation at K2 but was produced via both ammonium oxidation and nitrite reduction at S1. Beman et al. (2010) suggested that ocean acidification could reduce nitrification rates and therefore affect oceanic N_2O production. In this presentation, we will also show the model results in the case of ocean acidification.

