Effects of benthic-pelagic coupling on primary production in the South China Sea and the model-assessment of denitrification rates

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Abstract

The primary production in the South China Sea (SCS) has been assessed by a coupled physical-biogeochemical model with a simple NPZD ecosystem. In recent years there have been an increasing number of observations in the SCS that may be used to check the validity of the previous approach. The coupled model of the SCS mentioned above uses the simplest bottom boundary condition of an inert benthic layer. This scheme was checked against observations at the South-East Asia Time-series Study (SEATS) Station in the northern SCS and in the Gulf of Thailand. Numerical experiments with or without active benthic processes were carried out in this study. Additional experiments were performed with different parameters used for these processes. The observed values of the vertically integrated primary production (IPP) in the Gulf of Thailand clearly demonstrate the importance of the benthic-pelagic coupling to the nutrient cycle. Without benthic nutrient regeneration the model grossly underestimates primary production due to failure to build up the nutrient reserve in the Gulf. On the other hand, a fully regenerated flux of particulate organic nitrogen at the seafloor without denitrification produces too strong a primary productivity. The improved model uses a higher upper limit for the chlorophyll-to-phytoplankton ratio of 3.5 g Chl/mol N and adopts benthic processes of a coupled nitrification-denitrification scheme with denitrification consuming 14% of the detritus flux at the bottom. The model predicts a mean annual IPP value of 406 mgC mmgC $m^{-2}d^{-1}$ for the SCS, which may be broken down as 390 mgC $m^{-2}d^{-1}$ for the basin region (>200 m) and 429 mgC $m^{-2}d^{-1}$ for the shelf region (<200 m). The modeled monthly mean IPP values for the shelf and basin regions compare favorably with observed mean values in different seasons. The model also predicts a mean nitrogen removal flux of 0.16 mmol N $m^{-2}d^{-1}$ during denitrification for the shelf region.