Geophysical Research Abstracts
Vol. 21, EGU2019-14582, 2019
EGU General Assembly 2019

Using the physical-biogeochemical coupled ROMS-CoSiNE model to simulate the intermediate oxygen minimum water in the South China Sea

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Dissolved Oxygen (DO) is essential for many marine species. Its variation affects the marine ecosystem significantly. The DO content is regulated by both the physical and biogeochemical processes. The WOA2013v2 climatological dataset shows that the DO in the surface layer of the South China Sea (SCS) is approximately equivalent to that in the West Pacific (WP) ocean. However, the DO in the intermediate SCS water is much lower than that in the intermediate WP water. Precise simulation of that phenomenon by the numerical model would benefit the research of the ecosystem dynamics in the marginal sea.

The biogeochemical model CoSiNE (Chai et al., 2002) was coupled with the ocean circulation model ROMS. The physical model was driven by the climatological monthly averaged forcings. The biogeochemical initial condition and boundary conditions were provided by the CoSiNE-Pacific model's monthly averaged output (Xiu & Chai, 2011). One can refer to Zhou et al. (2017) for the parameterization of the CoSiNE model. The hydrological model as well as the ecological model was validated by the observations and the peer model output.

The yearly-averaged DO from the WOA2013v2 dataset at the meridional transect shows that there is a DO minimum in the intermediate water of the SCS. In the intermediate layer, the water in the southern SCS has lower DO than that in the northern SCS. That three-layer DO structure has been qualitatively reproduced by the present model, despite some quantitative difference especially on the minimum value. The reproduction of the phenomenon is significant for the further research on the DO dynamics that is regulated by both the physical and the biogeochemical processes. On that the basis, the research on the variation of the intermediate DO minimum water in the context of the global climate change can be advanced.

The preliminary discussion on the formation of the intermediate DO minimum water is as follows: The DO in the euphotic zone can be supplemented by the air-sea exchange, mixing and diffusion processes, the photosynthesis and other biogeochemical processes despite of the depletion processes. On the contrast, the DO in the water beneath the euphotic zone is mainly gradually depleted by the decomposition processes as well as other biogeochemical processes. Generally, the circulation system in the SCS has a sandwich structure (Liu & Gan, 2017). The Kuroshio Current intrudes the SCS at the surface and the bottom from the Luzon strait in the north. The surface and bottom water are then squeezed out to the WP from the intermediate layer. Therefore, the intermediate water in the SCS has the longest residence time counting from the entrance of the WP water at the Luzon strait. Beneath the euphotic zone, the more residence time, the more DO is depleted. That plausibly explains why the intermediate water in the SCS has the lower DO than that in the WP intermediate water and the surface and bottom layers in the SCS.