Biogeochemical modeling to investigate the impacts of ocean acidification and hypoxia in Tokyo Bay, Japan

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Abstract

There is growing concern in recent years that, like global warming, ocean acidification primarily caused by excessive anthropogenic CO_2 may adversely affect calcifying organisms. Similarly, hypoxia, the long-term decline in dissolved oxygen (DO) concentrations in seawater, has also been linked to global warming and ocean acidification. The combined effects of these concurrent phenomena on various species and life-stages of marine organisms are complex and need further elucidation. This study aims to develop an approach to help evaluate and predict the combined effects of ocean acidification and hypoxia on calcifying organisms for Tokyo Bay. The Coastal and Regional Ocean COmmunity (CROCO) modeling system (Jullien et al., 2019) was used to couple the Regional Ocean Modeling System (ROMS) (Shchepetkin and McWilliams, 2005) with the Pelagic Interactions Scheme for Carbon and Ecosystem Studies (PISCES) model (Aumont and Bopp, 2006), to simulate physical and biogeochemical processes in the highly eutrophic Tokyo Bay. The model grid resolution was ~1 km with bathymetry derived from the ~500 m General Bathymetric Chart of the Oceans (GEBCO). While mostly reproducing the general trends in observed physical parameters, the simulations failed to properly capture the relatively low pH levels and omega aragonite saturation states detected by the continuous monitoring sensors, especially in deeper waters. Trends in DO were generally well-reproduced, except for the summer season in near-bottom waters. River nutrient inputs may be still greatly underestimated, and biogeochemical initial and boundary condition settings need to be improved. Overall, this study stresses the importance of having model setups capable of incorporating both local and regional factors affecting ocean acidification and hypoxia as potentially useful tools in the determination of necessary mitigation and adaptation measures.