Multi-millennium changes in dissolved oxygen due to global warming: Results from GCM and offline biogeochemical model

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Global warming is expected to globally decrease ocean oxygen concentrations by sea surface warming and ocean circulation change. Oxygen reduction is expected to persist for a thousand years or more, even after atmospheric carbon dioxide stops rising. However, long-term changes in ocean oxygen and circulation are still unclear. In this study, we simulate multimillennium changes in ocean circulation and oxygen under doubling and quadrupling of atmospheric carbon dioxide, using GCM (MIROC) and an offline biogeochemical model. In the first 500 years, global oxygen concentration decreases, consistent with previous studies. Thereafter, however, the oxygen concentration in the deep ocean globally recovers and overshoots at the end of the simulations, despite surface oxygen decrease and weaker AMOC. This is because, after the initial cessation, the recovery and overshooting of deep ocean convection in the Weddell Sea enhance ventilation and supply oxygen-rich surface waters to deep ocean. Another contributor to deep ocean oxygenation is seawater warming, which reduces the export production and shifts the organic matter remineralization to the upper water column. Our results indicate that the change in ocean circulation in the Southern Ocean potentially drives millennial-scale oxygenation in deep ocean, which is opposite to the centennial-scale global oxygen reduction and general expectation. In presentation, we will discuss the mechanism of response of deep ocean convection in the Weddell Sea and show the volume changes of hypoxic waters.