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Long-term ocean oxygen depletion caused by decomposition of submarine methane hydrate

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Ocean oxygen depletion associated with global warming significantly affects macrofauna and ocean biogeochemical cycles over thousands of years. Methane released from the decomposition of submarine methane hydrates accelerates oxygen depletion via oxidation in seawater; however, the global impact of this process is yet to be quantitatively investigated. We have projected the potential impact of oxygen depletion due to methane hydrate decomposition via numerical modeling. We find that the global methane hydrate inventory decreases by approximately 70% under four times CO_2 concentration and is accompanied by significant global oxygen depletion on a timescale of thousands of years. In particular, we demonstrate the great expansion of suboxic and hypoxic regions, having adverse impact on marine organisms and ocean biogeochemical cycles. The expansion induced by methane release is half (same) of that induced by oxygen solubility decrease due to seawater warming, under the condition that half (all) the methane decomposed into free gas is released from the seafloor to the ocean. This is because methane hydrate decomposition primarily occurs in the Pacific Ocean, where present-day seawater has low oxygen concentration. Consequently, severe oxygen depletion occurs in this region, particularly in so-called oxygen minimum zones. Besides the decrease in oxygen solubility and reduced ventilation associated with global warming, the process described in this study is also important in oxygen depletion.