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Evaluating the Impact of Changes in Oceanic Dissolved Oxygen on Marine Nitrous Oxide

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Emissions of the greenhouse gas nitrous-oxide (N2O) from oceanic oxygen minimum zones (OMZs) in the Equatorial Pacific and Northwest Indian Ocean are believed to provide a significant portion of the global oceanic flux to the atmosphere. Mechanisms of marine N2O production and consumption in these regions display significant sensitivity to ambient oxygen, with high yields at low oxygen levels (O_2 < 50 micromol/L), and N2O depletion via denitrification in anoxic zones. These OMZ regions display large gradients in sub-surface N2O, and high rates of N2O turnover that far exceed those observed in the open ocean. Recent studies have suggested that possible expansion of oceanic OMZs in a warming climate, could lead to significant changes in N2O emissions from these zones.

In this analysis we employ a global ocean biogeochemistry model (NEMO-PlankTOM), which includes representation of the marine N2O cycle, to explore the impact of changes in dissolved oxygen on the ocean-atmosphere N2O flux. We focus on the period 1960-2000, and evaluate the impact of estimated changes in ocean oxygen from two alternative sources : (a) the observationally-based upper-ocean oxygen distributions and trends of Stramma et al. [2012]; (b) simulated oxygen distributions and temporal variations from a set of CMIP5 Earth System models. We will inter-compare the oceanic N2O estimates derived from these alternative scenarios of ocean de-oxygenation. We will also discuss the implications of our results for the ability to reliably predict changes in N2O emissions under potential expansion of oceanic OMZs, particularly in view of the recently noted discrepancies between observed and modeled trends in oceanic oxygen by Stramma et al. [2012].