Nitrous oxide cycling in oxygen minimum zones

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Regions of the ocean where coastal upwelling and oxygen minimum zones (OMZ) occur are major oceanic sources of nitrous oxide (N_2O) emissions to the atmosphere. The depth distribution of N_2O in OMZs characteristically exhibits two maxima, one above and one below the undersaturated anoxic core. Although likely more variable and dynamic than is apparent from measurements made on infrequent research cruises, these features are consistent and stable over time. Microbial nitrification and denitrification are both implicated in N_2O cycling, but their distributions and relative contributions to net production are not well constrained. Using a suite of ^{15}N-tracers, we performed incubation experiments to directly measure the rates and pathways of N_2O consumption and production in the two OMZs of the Eastern Tropical Pacific Ocean. Not surprisingly, we find that both nitrification and denitrification contribute to net N_2O production. Rates of N_2O production from nitrite and nitrate within the anoxic depths far exceed the production of N_2O from ammonium in the oxygenated surface layer. Consumption rates of N_2O are very high in the anoxic core of the OMZ as well, however, such that rapid turnover rates maintain low concentrations. The oxycline overlying the OMZ is a particularly dynamic depth interval for both production and consumption, suggesting that uncoupling of the two processes due to differential dependence on or tolerance of oxygen is a critical factor in determining the net oceanic N_2O flux to the atmosphere.