

Supplementary information for

Mechanistic understanding of nitrate reduction as the dominant production pathway of nitrous oxide in marine oxygen minimum zones

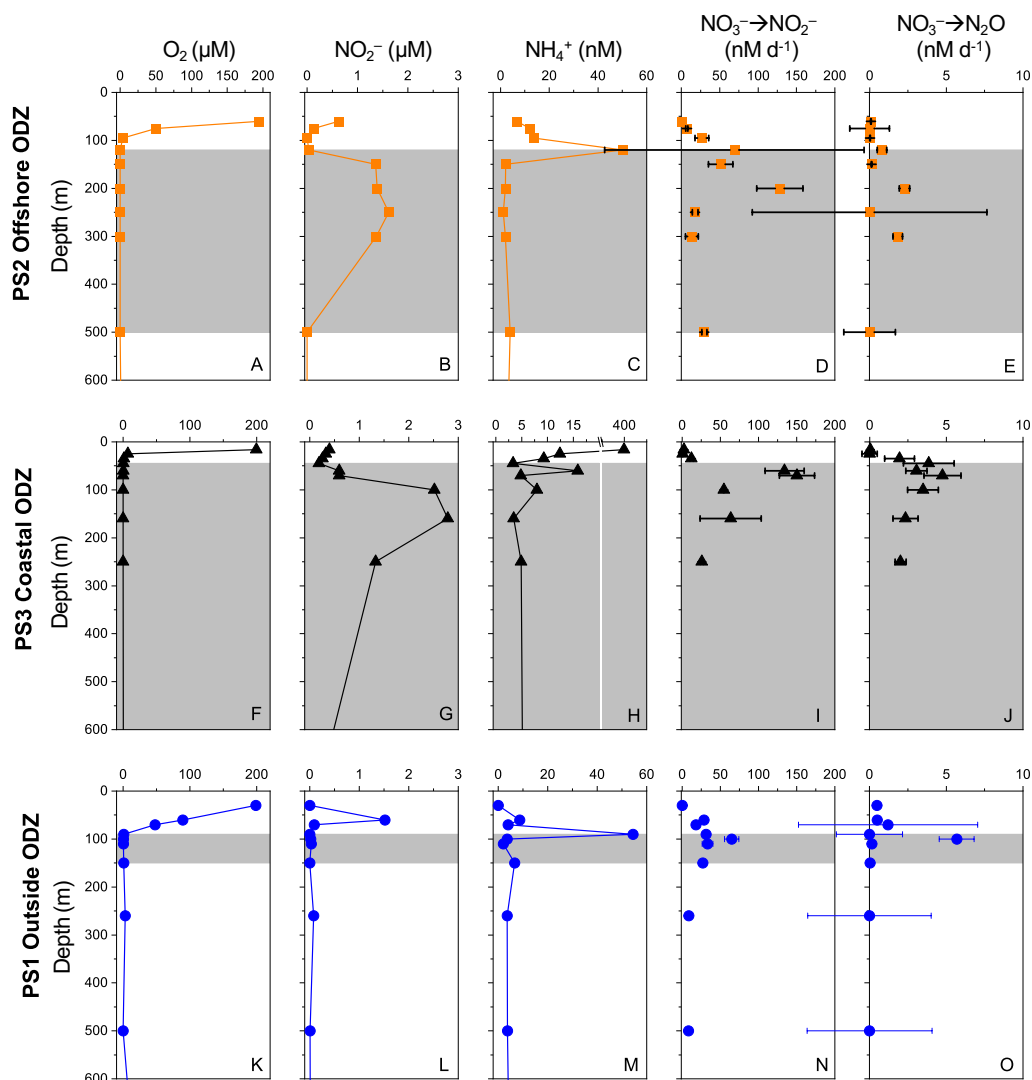


Figure S1 Depth profiles of O_2 (A, F, K), NO_2^- (B, G, L) and NH_4^+ (C, H, M) concentrations replotted from previous work^{1,2}, and $NO_3^- \rightarrow NO_2^-$ (D, I, N) and $NO_3^- \rightarrow N_2O$ (E, J, O) rates measured in this study at three stations in the ETNP OMZ. Error bars represent standard errors of linear regression slopes of estimated N_2O concentration accumulation over time. Station PS1 (K – O) is at the oceanic edge of the OMZ. The “anoxic” zone (grey shaded area) defined by oxygen concentration below the detection limit (2 μM) of the Seabird sensor extends only ~100 m, and the typical accumulation of nitrite to micromolar levels in the anoxic zone of an OMZ station, known as the secondary nitrite maximum (SNM), is absent at this station. Station PS2 (A-E) and Station PS3 (F – J) represent open-ocean and coastal OMZ stations, respectively.

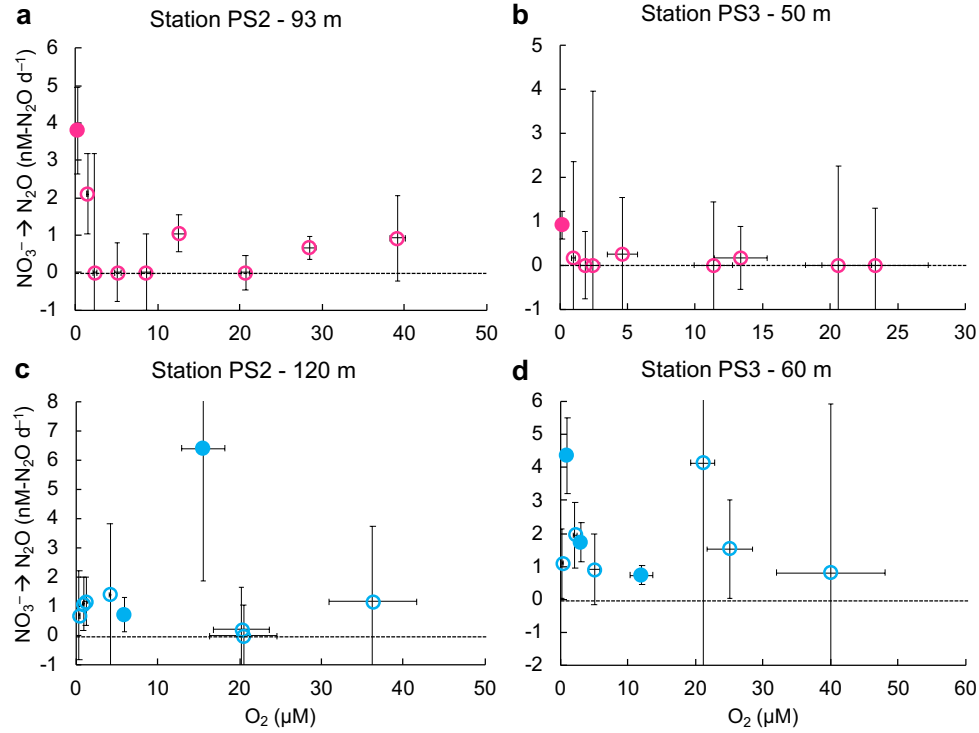


Figure S2 The response of $\text{NO}_3^- \rightarrow \text{N}_2\text{O}$ rates to oxygen additions in samples collected from oxycline depths (Panel **a**: 93 m at Station PS2 and Panel **b**: 50 m at Station PS3) and anoxic depths (Panel **c**: 120 m at Station PS2 and Panel **d**: 60 m at Station PS3). (**a-d**) Error bars are standard errors of linear regression slopes of estimated N_2O concentration accumulation over time in $^{15}\text{NO}_3^-$ incubation experiments. Note different scales used in the subplots. Filled circles indicate rates that are significantly larger than zero, and open circles indicate insignificant rates.

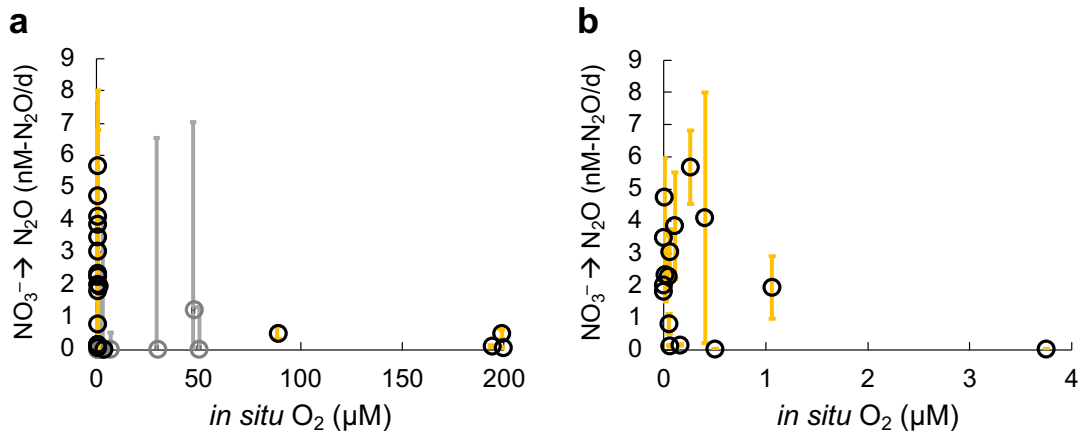


Figure S3 Rates of $\text{NO}_3^- \rightarrow \text{N}_2\text{O}$ from depth profiles (Fig. S2) against *in situ* O_2 concentrations at three stations. Rates significantly different from zero are shown as black circles with yellow error bars, and insignificant rates are indicated by grey circles with grey error bars. Error bars are standard errors of linear regression slopes of estimated N_2O concentration accumulation over time in $^{15}\text{NO}_3^-$ incubation experiments. Panel **b** is a zoom-in of panel **a**, with oxygen concentrations ranging from 0 to 4 μM .

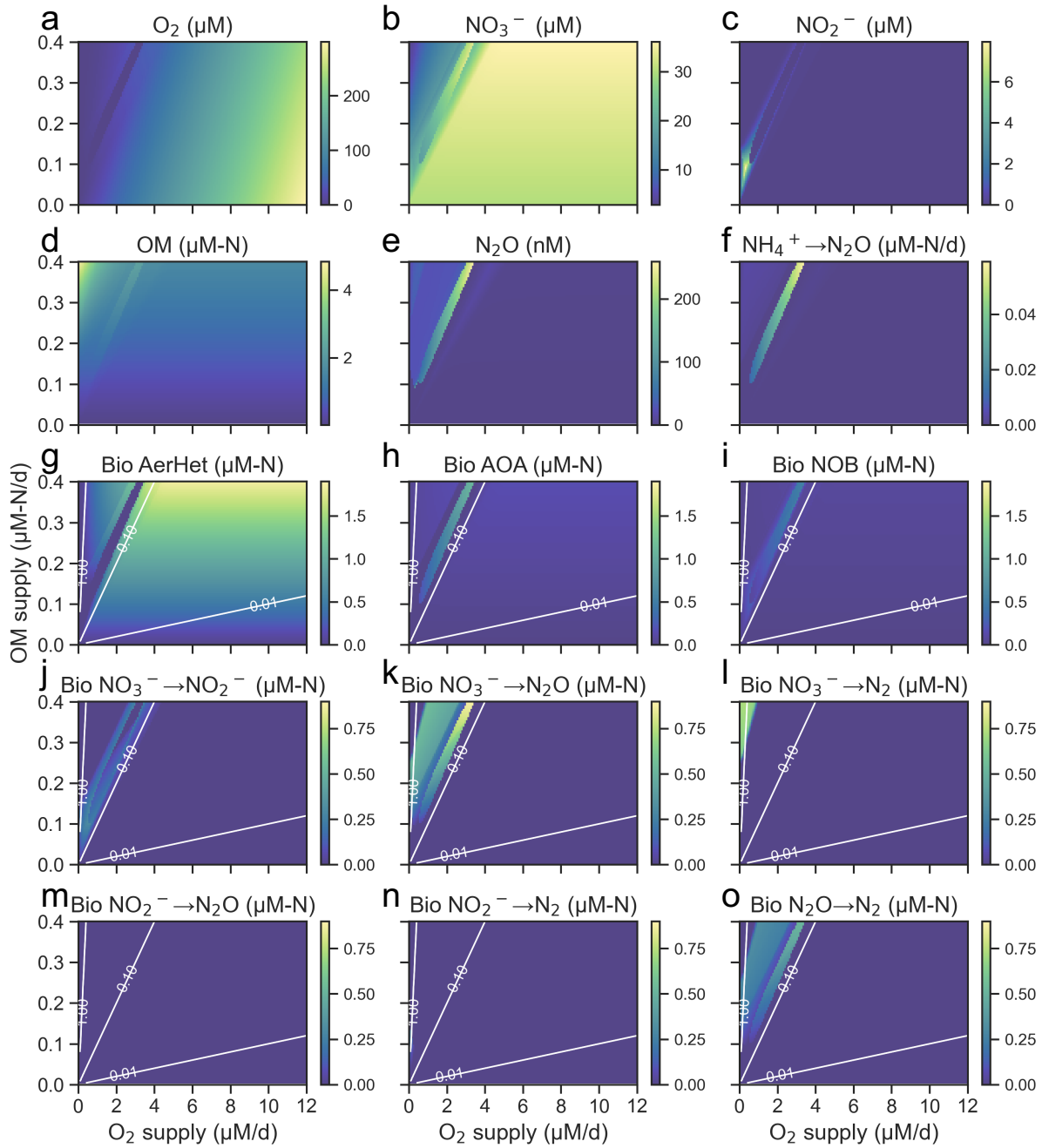
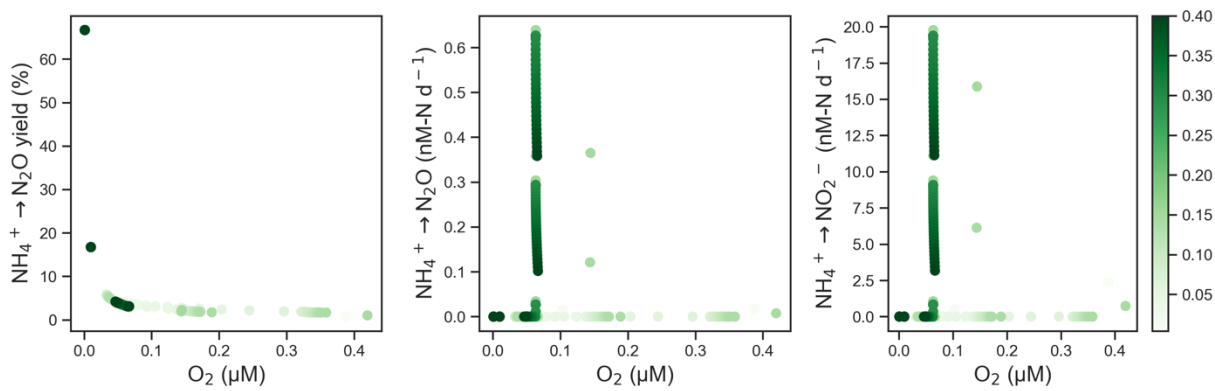


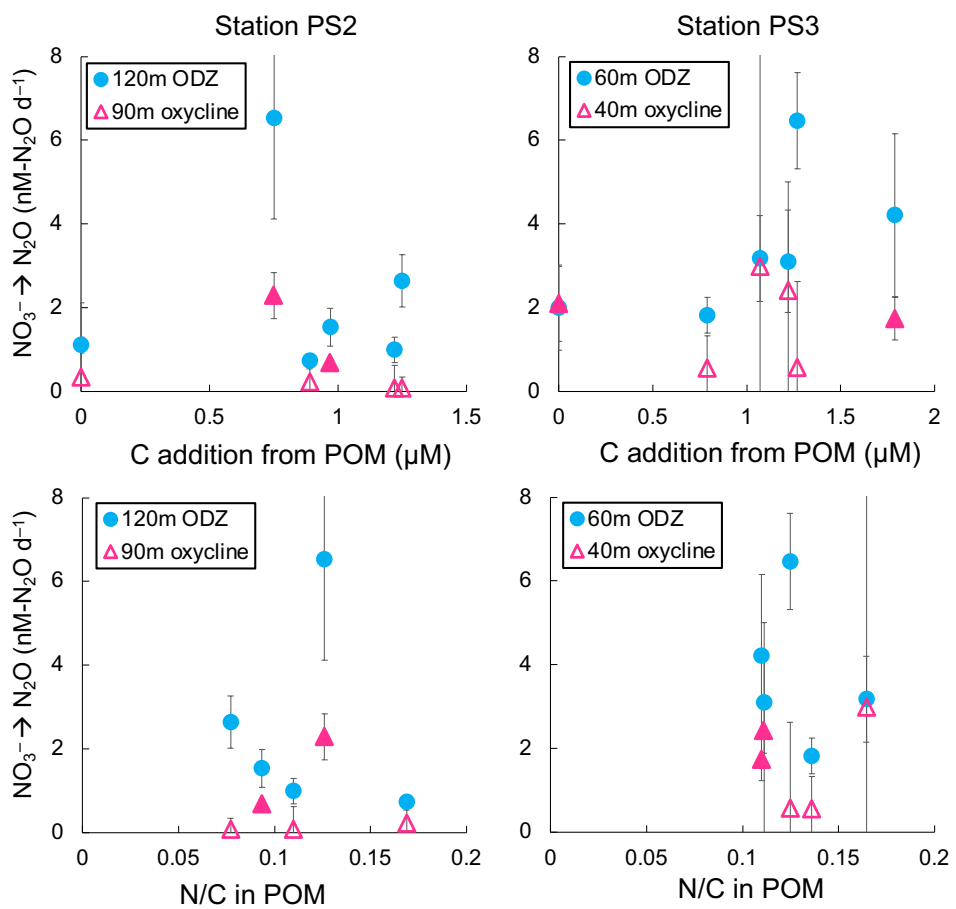
Figure S4 Nutrient concentrations (**a-e**), NH₄⁺→N₂O rates (**f**), and biomass (**g-o**) at quasi-equilibrium states from model simulations with different OM and O₂ supply rates. Bio AerHet stands for biomass of aerobic heterotrophs. White contour lines in **g-o** indicate the OM to O₂ supply ratio.

44
45



46
47
48
49
50
51
52

Figure S5 N_2O yield from NH_4^+ , $NH_4^+ \rightarrow NO_2^-$ rates and $NH_4^+ \rightarrow N_2O$ rates with different O_2 concentrations at quasi-equilibrium states from model simulations with different OM and O_2 supply rates.



53

Figure S6 The relationship between $\text{NO}_3^- \rightarrow \text{N}_2\text{O}$ rates and C concentrations and N:C ratios of added OM. Filled circles indicate rates that are significantly larger than zero, and open circles indicate insignificant rates. Error bars are standard errors of linear regressions.

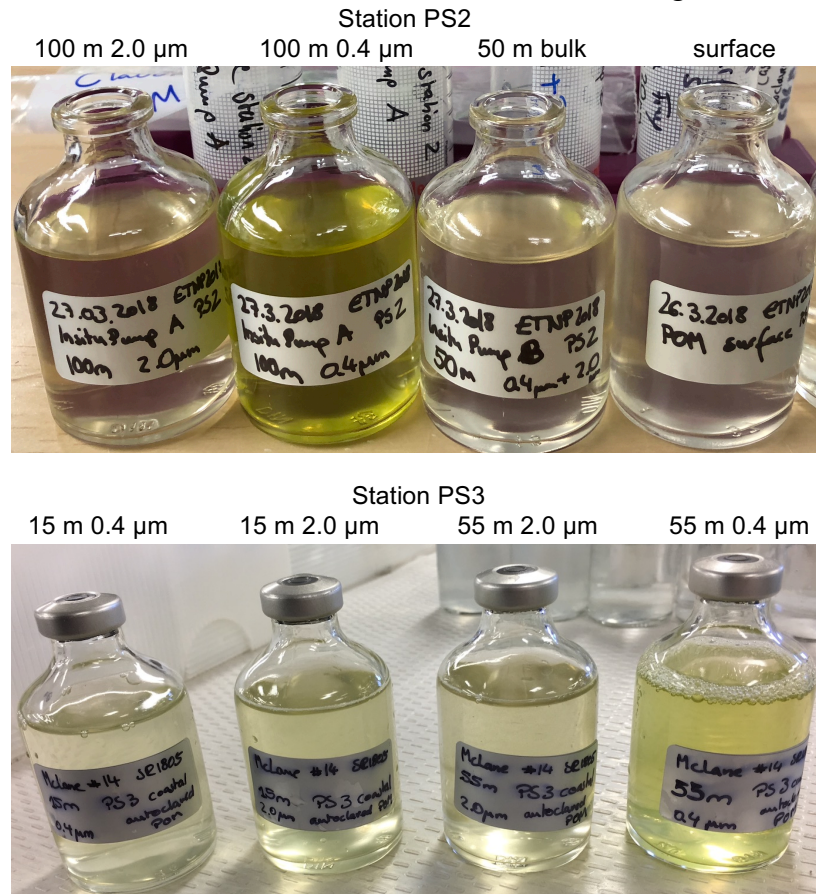


Figure S7 Photos of organic matter samples concentrated from seawater with an *in situ* pump (McLane), separated into different size classes (0.4 – 2µm; > 2µm, bulk refers to >0.4µm), with 53µm prefiltration.

References

1. Kelly, C. L., Travis, N. M., Baya, P. A. & Casciotti, K. L. Quantifying nitrous oxide cycling regimes in the Eastern tropical north pacific ocean with isotopomer analysis. *Global Biogeochem. Cycles* **35**, (2021).
2. Frey, C. *et al.* Kinetics of nitrous oxide production from ammonia oxidation in the Eastern Tropical North Pacific. *Limnol. Oceanogr.* (2022) doi:10.1002/lno.12283.