Goldschmidt 2021 Abstract
https://doi.org/10.7185/gold2021.8079

Trace oxygen shifts nitrogen metabolism and stimulates nitrogen reduction in low-oxygen marine waters.

JULIA HUGGINS[1], CÉLINE MICHIELS[2], RACHEL SIMISTER[1] AND SEAN CROWE[1]

[1]University of British Columbia
[2]SRK consulting
Presenting Author: julia.a.huggins@gmail.com

The oceans are currently losing O_2, which may have dramatic effects on global climate and biodiversity. As the O_2 in marine environments is depleted to near anoxia, microorganisms transition from O_2-based to several possible NO_x^--based metabolisms: denitrification, anammox, and dissimilatory nitrite reduction to ammonium (DNRA). These three metabolisms have different geochemical outcomes, including nitrogen loss, carbon oxidation, and production of reduced compounds, which can, in turn, lead to changes in biological activity that may either exacerbate or mitigate O_2 loss. The net consequences of marine O_2-loss may therefore depend on which NO_x^--based metabolisms engage as O_2 is depleted. The regulation of NO_x^--based metabolisms under low O_2 has received little attention, however, because it is generally assumed that NO_x^--reduction only occurs in the absence of O_2. The threshold for anoxia is typically defined by an analytical detection limit of 1-2µM O_2, despite evidence that NO_x^- reduction occurs both above and below this limit. Here, we use stable nitrogen isotope (^{15}N) incubations of seawater collected from a model anoxic marine environment (Saanich Inlet, BC) to determine the rates and pathways of NO_x^--reduction under both anoxic conditions and within a high-resolution range of low O_2 conditions (0.1 – 10µM). We show that multiple pathways of NO_x^--reduction can co-occur in the presence of low O_2, and that these pathways have different activity thresholds between 4-8µM O_2. Furthermore, we demonstrate that rates of denitrification and DNRA are highest under very low O_2 concentrations (0.1-2µM) rather than fully anoxic conditions, which is a previously unrecognized interaction between O_2 and NO_x^--reduction. We also observed a trade-off between the rates of denitrification and DNRA across these very low O_2 concentrations, revealing interactions between competing pathways that would normally be overlooked in studies with low-resolution in O_2. The activity of NO_x^--reduction under environmental conditions that could support co-occuring N-oxidation raises the possibility of cryptic N-cycling and highlights the need for more complex process-rate measurements in ^{15}N incubations. These findings have implications for the biogeochemical models that predict microbial metabolic responses to ocean deoxygenation and their ecological impacts.