High-resolution profiles and nitrogen isotope tracing reveal a dominant source of nitrous oxide and multiple pathways of nitrogen gas formation in the central Arabian Sea

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ABSTRACT: The oxygen minimum zone (OMZ) of the Arabian Sea is a significant source of nitrous oxide (N_2O), yet the metabolism responsible for N_2O production is unclear. High-resolution profiles identified peaks and troughs of N_2O and NO_2^- in the top 500 m of the water column. The first peak in N_2O was not in the oxycline, but deeper at the oxic-suboxic interface. Peaks and troughs were targeted with a suite of ^{15}N incubations ($^{15}NO_3^-$, $^{15}NO_2^-$, $^{15}NH_4^+$) to identify pathways of N_2O and N_2 formation. With $^{15}NO_2^-$, ^{15}N-N_2O was produced at all depths with a binomial distribution with respect to the NO_2^- pool. With $^{15}NO_3^-$, the ^{15}N was not binomially distributed. NO_3^- is first reduced to NO_2^- before reduction to N_2O, and NO_2^- -> N_2O is the dominant metabolism responsible for N_2O production. The N_2O produced from $^{15}NH_4^+$ represented 2-5% of that from $^{15}NO_2^-$ at the top of the OMZ. In addition, the production of $^{45}N_2O$, but no $^{46}N_2O$, at some depths with $^{15}NH_4^+$, suggested a novel source akin to *Nitrosomonas* spp. under O_2 limitation. Unlike N_2O, the production of N_2 with $^{15}NO_2^-$ or $^{15}NO_3^-$ was not binomially distributed and therefore was not entirely derived from the same source as N_2O. Although indicative of an alternative N_2 source to denitrification, the lack of significant production of labeled N_2 with $^{15}NH_4^+$ discounts anaerobic ammonium oxidation (anammox), as we understand it. Dissolved organic nitrogen or nitrate/nitrite reduction to ammonium are suggested as the additional sources of N in N_2 production.

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