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Ocean deoxygenation and the Marine N cycle: Perspectives from nitrate N stable isotope measurements

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Trends towards expansion and intensification of oxygen minimum zones of the eastern boundary currents in recent decades have been reported. One possible consequence is increased denitrification in these oxygen minimum zones (OMZ) and enhanced loss of fixed nitrogen in the ocean. We present global data set of stable N isotopes of dissolved nitrate ($\delta^{15}\text{N}_{\text{NO}_3}$) and N^* values to trace the impact of denitrification in various ocean basins in terms of N deficit and time scales of potential negative feedback through N fixation.

First, we trace the N deficit and the heavy N isotopes signatures generated in the OMZ all across the thermocline water of the Pacific Ocean. In contrast the Atlantic thermocline has lightest N isotope values and surplus N indicating the predominance of N-fixation over denitrification. Thus, the balance between denitrification and N fixation determines whether N or P is limiting nutrient in these ocean basin. This also indicates a relatively loose coupling between N-fixation and denitrification with in each of the ocean basins. Secondly N^* and N isotopes signatures of deep waters in each of the major ocean basin also reflect the balance between denitrification and N-fixation. Deep waters of the Pacific Ocean has the heaviest nitrate N isotope signatures and lowest N^* values where as the deep waters of the Atlantic has the lightest N isotope signatures and the highest N^* values. Deep waters with contrasting N^* and N isotope from various basins are mixed in the Southern Ocean but currently the balance of this mixing is in favour of denitrification leading to net deficit in N. This deficit is transferred to the thermoclines of the ocean through Upper Circumpolar Deep Water that upwells in the Southern Ocean and form intermediate and mode waters. Therefore, we suggest that ocean deoxygenation will deplete fixed N relative to P further enhancing N limitation in the ocean and this impact will be felt for thousands of years in the world ocean thermoclines on time scales of oceanic mixing time.