

Increased tropical South Pacific western boundary current transport over the past century

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Supplementary discussion for *Increased tropical South Pacific western boundary current transport over the past century*

Nitrogen isotope dynamics in the western tropical South Pacific

Based on measurements by Lehmann 2018¹, the nitrate concentration in the mixed layer of the Solomon Sea is near zero, so the primary nitrogen source for biological uptake in the euphotic zone is provided by vertical mixing of thermocline nitrate, probably with some contribution from local N₂ fixation and/or dissolved organic nitrogen. While there have been very limited measurements of the Solomon Sea thermocline nitrate $\delta^{15}\text{N}$ changes on seasonal or longer time scales, we could derive some information based on the spatial changes of the thermocline nitrate $\delta^{15}\text{N}$ in the western tropical South Pacific. The upper thermocline water or the subsurface water in the western tropical South Pacific (0 – 10°S) is primarily composed of South Pacific Tropical Water (SPTW), which is centered between 100 and 250 m, and originates in the oligotrophic subtropical South Pacific gyre due to high evaporation and consequent subduction of surface water^{2, 3}. The nitrate $\delta^{15}\text{N}$ of the SPTW in the Solomon Sea is measured to be about 7.5‰, but it increases towards the equator. Paired $\delta^{15}\text{N}$ and $\delta^{18}\text{O}$ analyses of the nitrate in the western tropical South Pacific indicates contribution from the sinking and remineralization of high- $\delta^{15}\text{N}$ particles in SPTW, transmitting the high- $\delta^{15}\text{N}$ signals from the suspended PON from the surface into the subsurface dissolved nitrate pool. In-situ N₂ fixation imprint in thermocline nitrate pool is absent suggesting a dominance of equatorial sourced N in the Solomon Sea. But influence from subtropical N₂ fixation could be brought into the Solomon Sea through increase in the western boundary current transport, and lowers the $\delta^{15}\text{N}$ of the upper thermocline nitrate when the equatorward transport is strong.

Recent observations on the upper ocean current system in the Solomon Sea based on direct glider measurements suggest two branches of the equatorward flow, the shallower interior branch controlled by tropical winds, and the western boundary current transport remotely controlled by subtropical winds in the South Pacific⁴. Although the shallow interior branch dominates changes on annual transport, the western boundary current transport is more likely to influence the nitrate $\delta^{15}\text{N}$ changes in the Solomon Sea. This is because, first of all, the shallow interior flow occurs mostly in the upper 200 m, where nitrate concentration is low, while the western boundary current flow occurs in the upper 1000 m, centered above 500 m, thus is more likely to cause changes in the thermocline nitrate. And secondly, the shallow interior flow mostly brings in waters from east of the Solomon Islands, thus are similar to the tropical waters in terms of nitrate $\delta^{15}\text{N}$. But the western boundary current transport brings in subtropical waters, which are isotopically lighter comparing to the Solomon Sea thermocline nitrate. Our CS- $\delta^{15}\text{N}$ data is consistent with the above argument by showing smaller annual changes comparing to interannual changes, and a lagged response to changes in the tropical winds (Extended Data Fig. 3; Extended Data Fig. 5). Our results thus argue that the upper ocean nitrate $\delta^{15}\text{N}$ in the Solomon Sea is more sensitive to the western boundary current transport that is likely remotely forced by the subtropical wind in the South Pacific.

References:

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