

Spatiotemporal distribution of anthropogenic nitrogen and internal nitrogen dynamics in the Southern Ocean

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The oceanic external nitrogen (N_{ex}) deposition to the global ocean is expected to rise significantly owing to human activities. The Southern Ocean (SO) is an important pathway, which brings external influences into the ocean. It touches the borders of several developing countries that emit a large amount of anthropogenic nitrogen. To comprehend the dynamics of N_{ex} in the SO, We developed a new method to assess the change in the oceanic uptake of N_{ex} (ΔN_{ex}) in the entire SO. We obtained the spatiotemporal distribution of ΔN_{ex} in the SO by applying this method to a high-resolution grid data constructed using ship-based observations. During the 1990s to the 2010s, N_{ex} increased significantly by $67 \pm 1 \text{ Tg-N year}^{-1}$ in the SO. By comparing this with the rate of N_{ex} deposition to the ocean, the SO has received $\sim 70\%$ of N_{ex} deposition to the global ocean, indicating that it is the largest uptake region of anthropogenic nitrogen into the ocean interior. Additionally, in order to comprehensively understand the impact of natural nitrogen dynamics on N_{ex} transportation in the ocean interior, We have also quantified the nitrogen budget over the 110°E line using the chemical tracer N_2^* . The natural nitrogen balance of SO was found to be controlled primarily by physical processes, rather than being consumed by living organisms. As a result, N_{ex} is also possibly spreading from the SO to the global ocean through transportation of water mass.

Keywords: Southern Ocean, Anthropogenic nitrogen, Decadal variation, Nitrogen budget