Assessing the impact of anthropogenic N deposition on the North Atlantic in the Anthropocene: Evidence from Bermuda corals

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Human alteration of the global nitrogen cycle accelerated with the invention of the Haber-Bosch process (i.e. ammonia synthesis) in the 1910s. As of today, the rate of N fixation by humans (~200 Tg/yr) is similar to the global rate of natural N fixation (200-250 Tg/yr), with a substantial fraction of the human-fixed N entering the broader environment and altering terrestrial and coastal ocean ecosystems. Model results suggest that the open ocean might also be affected by the anthropogenic N through atmospheric transport and deposition. However, it remains challenging to assess the impacts of atmospheric anthropogenic N on the open ocean N cycle due to a lack of continuous atmospheric and oceanographic measurements. Here, we investigate the possibility of changes in the North Atlantic open ocean N cycle since 1780 AD using the nitrogen isotopes of the organic matter bound in the skeletal carbonate of corals from offshore Bermuda. The coral skeletal $\delta^{15}N$ record shows a gradual decrease from the early 20th century to the 1980s but the magnitude is small, <1.0‰. In contrast to nitrogen isotope records and nutrient data suggesting that the North Pacific N cycle has already been significantly altered by human activities [1-3], our data suggest that the North Atlantic N cycle has been minimally affected. Given that anthropogenic N emissions (NOx and ammonia) have been decreasing in North America since 1990s, we postulate that in the coming decades North Atlantic will remain largely unaffected by anthropogenic N, even as other drivers of environmental change intensify.

[1] Sherwood et al. (2014), *Nature*. **505**, 78–81.

[2] Kim et al. (2014), *Science*. **346**, 1102–1106.

[3] Deutsch et al. (2014), *Science*. **345**, 665–668.