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Isotopic constraints on the fate of anthropogenic nitrogen delivered to the coastal ocean via the Mississippi-Atchafalaya River Basin

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Human activities, such as agricultural practices and fossil fuel combustion, have significantly altered the global nitrogen (N) cycle. The current rate of anthropogenic N production has doubled the amount of natural fixed N globally. Excess N in coastal waters can lead to detrimental effects on the ecosystem, such as eutrophication, hypoxia, fish kills, and habitat loss. The northern gulf coast has been profoundly impacted by excess anthropogenic N inputs from the Mississippi-Atchafalaya River Basin (MARB), resulting in coastal hypoxia and harmful algal blooms in recent decades. However, the fate of anthropogenic N in the northern gulf is uncertain. Specifically, it is unclear how much of the riverine N is transferred to the open waters and how it affects the ecosystem and productivity there. Given that the riverine N input from the MARB has a higher $^{15}N/^{14}N$ ratio compared to the open ocean N source in the gulf, natural-abundance N isotope analyses provide a valuable tool for assessing the impact of riverine N on the open ocean. In this study, we present a 40-year N isotope record ($\delta^{15}N$) using a *Siderastrea siderea* coral colony obtained from the Dry Tortugas National Park, Florida, along with modern seawater nitrate isotopes ($\delta^{15}N$ and $\delta^{18}O$) collected during five cruises in the northern gulf. From 1972 to 2012, despite the increase in the coastal hypoxic zone area and harmful algal blooms in the gulf, there was only a minor increase (<0.3‰) in the annual mean coral skeletal $\delta^{15}N$ values. Additionally, nitrate $\delta^{15}N$ exhibits a minimum at ~200 m in the northern gulf, consistent with the patterns observed in the open waters of the gulf. This minimum has been previously interpreted as stemming from N_2 fixation in the (sub)tropical Atlantic and subsequent water transport. Both the historical coral $\delta^{15}N$ record and modern nitrate isotope data imply that that the MARB N inputs may be largely removed in coastal areas by sedimentary denitrification/anaerobic ammonium oxidation and organic N burial, limiting their impact on the open ocean.