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A time series of N speciation and N isotope fractionation during nitrification in a eutrophic coastal embayment

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In aquatic environments, processes and conditions affecting distribution and isotopic compositions of nitrogen (N) compounds are complex and highly variable in both space and time. Verification studies that can be used to test understanding of mechanisms through comparison of both N species concentrations and N isotopic signals with microbial N sources and sinks are rare. A particularly effective approach is to exploit naturally occurring "experiments", in which temporally changing physical and hydrochemical conditions drive changes in N cycling that can be followed through observation of temporal changes in N concentrations and isotopic ratios. Here, we present an annual cycle of physicochemical parameters and N isotopic data obtained in the frame of the Bedford Basin Time Series, a coastal monitoring program in the Northwestern Atlantic near Halifax, Canada.
During spring and early summer, high export production and remineralization of phytoplankton-derived organic matter resulted in increasing levels of particulate N and accumulation of ammonium in the basin bottom waters (60 m). Elevated bottom water nitrate concentrations as well as an increase in δ15N ammonium and a corresponding decrease in δ15N nitrate clearly indicated active ammonium and nitrite oxidation. In mid-summer, inflow of more saline Scotian Shelf water into the basin was observed, whereupon nitrifying activity markedly increased. Decreasing surface productivity in autumn was followed by a decline in subsurface ammonium concentrations and a complete oxidation of the ammonium pool to nitrate. The N isotopic compositions of ammonium, nitrite, and nitrate followed a Rayleigh-type fractionation, with a fractionation factor for ammonium oxidation of $\sim$19 ‰