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Isotope investigations of nitrification dynamics in the Elbe River and in pure cultures of nitrifying bacteria

Juliane Jacob, Tina Sanders, and Kirstin Dähnke
Helmholtz-Center Geesthacht, Germany, Institute for Coastal Research

Since the onset of industrialisation, the nutrient input to aquatic systems is significally enhanced. This leads to high nitrogen loads in rivers, which drain densely populated catchments, and an increased eutrophication pressure on coastal water bodies. Along the river – estuary – continuum, nitrogen processing in aquatic environments has the potential to alter river loads significantly. Especially nitrification, the stepwise oxidation of ammonium to nitrite and further to nitrate, is important, because it can create additional nitrate from freshly remineralized organic matter, but also represents the link to subsequent removal via denitrification.

Stable isotopes are a valuable tool to track overlapping source and sink processes in natural environments: Changes in stable isotope ratios can be attributed to the corresponding turnover processes, if the corresponding isotope effects are carefully assessed. However, the data base on N and O isotope fractionation in natural environments and during specific turnover processes is scarce. Thus we aimed to better understand the isotope dynamics of nitrification, assigning specific fractionation factors to environmentally relevant bacterial species.

Besides N and O isotope analyses of river nitrate over an annual cycle, we performed incubation experiments with pure cultures and river water.

Biweekly water samples from the Elbe River (Northern Germany) were taken to analyse, among other parameters, the seasonal variations of δ^{15}N and δ^{18}O in nitrate, corresponding nitrification rates and isotope effects during nitrification. While changes in δ^{15}N and δ^{18}O suggest phytoplankton assimilation as the main turnover process, incubations of river water reveal the relevance of nutrient regeneration via nitrification, which increase 15-fold with the onset of spring. In these incubations, we analysed rates of ammonium and nitrite oxidation and the corresponding isotope fractionation factors.

Additional experiments with newly isolated *nitrospina 347* and *nitrospira ecomaris 2.1* cultures confirm the suggested inverse isotope fractionation during nitrite oxidation, but also suggest that the precise fractionation factor crucially depends on the culturing conditions.