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The N-isotope effect and fractionation of nitrification in the tidal influenced Elbe River estuary, Germany

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Estuaries act as a nutrient filter for coastal waters. The eutrophic Elbe River estuary is loaded with fertilizer-derived nitrogen, but management efforts have started to reduce this load effectively. However, an internal nitrate source in turn gained in importance and the estuary changed from a sink to a source of reactive nitrogen. Nitrification plays a key role in this estuarine nutrient regeneration but has to be quantified. The aim of our study was to assess the impact of nitrification on seasonal nitrogen loads and turnover using stable N- isotopes to identify the natural fractionation factor of nitrification.

Therefor we measured the dissolved inorganic nitrogen (ammonium, nitrite and nitrate), their stable isotope signatures and the *in-situ* nitrification rates in the tidal influenced part of the river during 9 cruises from August 2011 to August 2013. The DIN load was higher in winter than in summer, the main compound was nitrate. In summer concentrations of nitrate entering the estuary were between 50 and 100 μM and δ^{15}N and δ^{18}O were enriched to 15.5 to 21.5 ‰ and 7.5 to 11.5 ‰ respectively. Strong nitrification was found in the Hamburg port region. The nitrate concentrations increased significantly downstream after the port of Hamburg, along with a decrease of isotope values. Ammonium and nitrite peaked in the Hamburg port region with up to 25 μM and 12 μM, respectively. In July 2013, δ^{15}N of ammonium has shown a mean value of 16.2±3.3 ‰ and nitrite of -9.8±4.7 ‰The N-fractionation of nitrification in July 2013 was $^{15}\varepsilon_{nit}$ -10‰ the sub-process ammonia oxidation $^{15}\varepsilon_{amox}$-24‰ and the nitrite oxidation of $^{15}\varepsilon_{niox}$ 13‰ while fractionation was less pronounced during the other cruises Our data show that N-isotope fractionation generally confirmed culture experiments, but that it strongly depended on discharge, availability of substrate, temperature and the coupling of ammonia and nitrite oxidation.