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Balance between nitrogen assimilation and dissimilation in tidal mudflat sediment: A stable isotope labeling study

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Due to intense nitrogen cycling, coastal sediments largely control nutrient export from the coastal region to the adjacent ocean, particularly in a shallow and eutrophic region like the Southern North Sea. Relevant benthic processes include both assimilatory and dissimilatory pathways, but most studies on benthic nitrogen cycling generally deal with either of those and usually focus on only one or two specific processes. As a consequence, the integrated fate of nitrogen in sediments and the associated balance between assimilatory versus dissimilatory processes has remained unstudied. We conducted a 15N-labeling experiment in which 15N-labeled ammonium and nitrate were added to tidal flat sediment. Analysis of 15N in bulk- and KCl-extracted sediment and ammonium, nitrate, and N2 in pore water allowed us to quantify all major assimilatory and dissimilatory processes in the sediment.

Results showed that, barring considerable denitrification, assimilatory processes clearly dominated nitrogen turnover, with comparable impact of bacteria and benthic microalgae, whereas nitrification and dissimilatory nitrate reduction to ammonium (DNRA) were found to be of subordinate role. By combining data with a zero-dimensional N-cycle model, it became apparent that physical processes that cannot be deduced from flux rates alone also play a significant role in sedimentary nitrogen cycling. These findings further underscore the force of combined approaches that integrate observational and modeling results.