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The role of the Arabian Sea in the global ocean nitrogen cycle

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The Arabian Sea covers only a small area of the world oceans, but has a significant influence on the global cycle of nitrogen. It is one of the three oceanic regions where a mid water oxygen minimum zone has been observed. Under hypoxic conditions the oxygen source used by bacteria to reduce organic matter is nitrate. This leads to the progressive reduction of biologically available nitrogen to elemental nitrogen, the denitrification. The depletion of nitrate, a macro nutrient, affects the biological production, in turn the carbon cycle and, thus, the global climate. In order to preserve the observed global ratio of P to N, the opposite process, the nitrogen fixation, occurring in surface waters, should balance on long times scales the oceanic loss of nitrogen. To date, the oceanic budget of fixed nitrogen is still poorly understood. Neither reliable estimates of the magnitude of the nitrate loss during denitrification in the Arabian Sea and in the world oceans nor knowledge about climate induced variations in the nitrogen cycle are available.

This study aims to simulate the global nitrogen cycle with special emphasis on the Arabian Sea. The modelling approach, based on the isotopic signature of nitrate, permits to evaluate the transformations between N-species within the cycle. Therefore, the hypotheses formulated in literature on the occurrence of different mechanisms and their relative rates can be tested. Particular focus is on crucial processes as the denitrification and nitrification. The consideration of the almost parallel isotopic fractionation of oxygen, which is fixed in nitrate, gives additional insight into the rate of nitrification. The study concentrates furthermore on potential climate feedbacks of the nitrogen cycle. The modelling tool is the ocean general circulation model MPIOM (1°x1°, 40 vertical levels) with the biogeochemistry submodel HAMOCC5.1 embedded. Such an instrument offers the unique opportunity of tracking single processes and addressing open scientific questions, as on the quantitative budget of the marine nitrogen cycle. Results show the sensitivity of the isotopic composition of nitrate to the different processes. Simulated global sources and sinks of the nitrogen cycle are presented and discussed.