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Estimation of the denitrification in Baltic Sea deep water from gas tension measurements

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Denitrification is considered to be the most important process removing nitrogen in oceanic waters. 50-70% of marine denitrification occurs in organic rich sediments and oxygen depleted water bodies of continental shelf regions or marginal seas like the Baltic Sea, where a high percentage of riverine discharge of nitrogen is denitrified before entering the open ocean.

Measurements of the gas tension (= sum of the partial pressures of all dissolved gases in the water) provide a new experimental way for the quantification of denitrification by directly measuring the reaction product of this process. Continuous pumping of water from a defined depth trough the gas tension device with a pump-CTD allows getting integrated results.

Changes in N_2 concentrations were calculated from gas tension by subtracting the partial pressures of the most important other dissolved gases (O_2, Ar, CO_2, H_2S, water vapor). The p_{O2}, p_{CO2} and H_2S-concentrations were measured; other parameters (p_{Ar}, p_{H2O}, solubility coefficients) were obtained from temperature and salinity. The method allows the estimation of N_2-concentrations with a maximum error of 0.5%, corresponding to a standard error of 1.5 μmol L^{-1}.

Results of gas tension measurements and calculation of N_2 concentrations in the Gotland Basin deep water, central Baltic Sea, from 2008 and 2009 are presented. In the deep water below the permanent halocline the estimated N_2 partial pressure is continuously rising towards the oxygen depleted water layers. The calculated N_2 excess compared to equilibrium concentration reached values up to 20 μmol N_2 L^{-1} in the stagnant anoxic water layer, indicating a mean N release of 10 μmol N L^{-1} y^{-1} after 4 years of stagnation.

The increase of total dissolved inorganic nitrogen (due to the N_2 excess and formation of ammonium in the deep water) in relation to nitrogen background values was compared with the increase of total inorganic carbon due to mineralization processes. The resulting C:N ratios were close to the Redfield value.