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Oxygen, a regulating factor for nitrogen cycling in continental shelf sediments?

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Oxygen is a fundamental parameter in regulating the cycling of carbon and nitrogen in continental shelf seas. Recent studies and models have shown that some regions of coastal seas are prone to a lack of oxygen and under such conditions, the dynamics of the nitrogen cycle could be altered. We measured rates of denitrification, anaerobic ammonium oxidation (anammox), oxygen uptake, nutrient exchange and pore water profiles of oxygen in sediments of the southern North Sea experimentally exposed to different oxygen saturations. The incubation of sediment at 33% (of air-saturation) for oxygen reduced the penetration and consumption of oxygen by the sediment by of approximately 50%, with a new steady state being reached after approximately 75 min. The rates of the various processes showed strong seasonality over the survey period (2007-2008), with denitrification ranging from 0.6 to 21.2 μmol N m^{-2} h^{-1}, anammox 0.2 to 4.4 μmol N m^{-2} h^{-1} and oxygen uptake 46.5 to 631.8 μmol O_2 m^{-2} h^{-1}. At the reduced saturation for oxygen ($\sim$ 33%), denitrification increased significantly (30%) while anammox remained constant. On average anammox accounted for 14-28% of the total production of di-nitrogen (N_2) gas. Under ambient oxygen saturation, the rates of oxygen uptake and total production of N_2 were positively correlated with each other (r = 0.73, p = 0.01, n = 230). The increase in denitrification was coupled to a change in NO_3^- flux. Under ambient oxygen there was a net release of 10.5 μmol NO_3^- m^{-2} h^{-1} from the sediment to the water column, whereas under reduced oxygen, the sediments became a sink for NO_3^- (-1.2 μmol NO_3^- m^{-2} h^{-1}) from the overlaying water. These results suggest that facultative denitrifying bacteria were able to exploit the newly extended suboxic sediment layer, while the monophyletic group of anammox bacteria were not as flexible.