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CO_2, CH4 and N2O dynamics and fluxes in the brackish Lake Grevelingen (The Netherlands)

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Lake Grevelingen in the South West Netherlands is a former estuary locked off from the sea by two dikes and a brackish lake since 1971 (salinities from 29 to 33 during our sampling). It is connected with the North Sea by sluices, has a surface area of 108 km2, a mean depth of 5.3 m, a maximum depth of 48 m, and about 60% of the area the depth is less than 5 m. In summer, anoxia occurs in bottom waters. From January 2012 to December 2012 a biogeochemical survey was conducted at monthly interval at a fixed station (35 m depth) at Den Osse. Here, we focus on the analysis of partial pressure of CO_2, and concentrations of CH4 and N2O obtained throughout the water column. pCO_2 followed a typical seasonal cycle for temperate coastal environments shifting from CO_2 over-saturation in winter to spring CO_2 under-saturation due to the spring phytoplankton bloom, and shifting back to over-saturation in fall. Unlike the adjacent Southern Bight of the North Sea and the adjacent Oosterschelde, CO_2 under-saturation prevailed in summer in Lake Grevelingen. CH4 values were minimal in winter ($\sim$20 nM) and as stratification developed during spring and summer a distinct maximum of CH4 (up to 730 nM) developed at the pycnocline (5 to 10 m). N2O showed little seasonal variations and only a very faint increase with depth, except in August when bottom waters became anoxic. At this time, N2O shown a maximum ($\sim$22 nM) at the oxycline (probably related to enhanced N2O production by nitrification at low O_2 concentrations), and decreased in the anoxic layer ($\sim$3 nM) (probably related to denitrification).