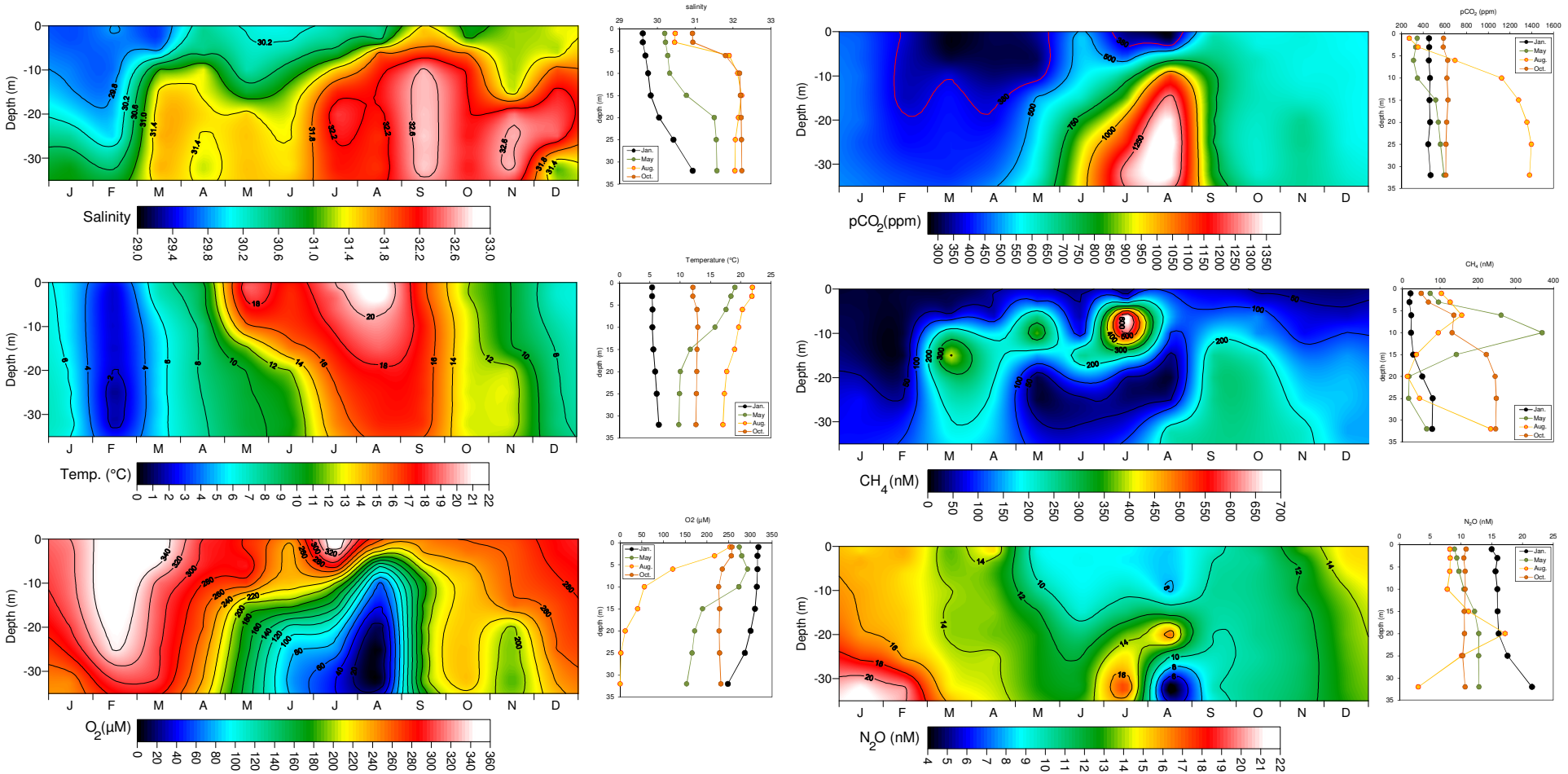
CO_2, CH_4 and N_2O dynamics and fluxes in the brackish Lake Grevelingen (The Netherlands)

Borges A.V.[1,*], Filip Meysman[2], and Jérôme Harlay [1]

[1] ULg (BE) [2] NIOZ * alberto.borges@ulg.ac.be



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 km^2, 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. 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 (pCO_2), and concentrations of CH_4 and N_2O obtained throughout the water column. The water column was isothermal in winter, stratification settled in spring, was maximal in summer (August), and vertical mixing occurred in fall. Overall, salinity increased from surface to depth, ranged from 29.57 to 31.57 in surface waters and from 30.55 to 32.74 in bottom waters, and was minimal in winter and maximal in summer. O_2 in surface waters from 367 to 361 µM, and was always lower in bottom waters than in surface water waters. This pattern was very faint in Winter and very marked in August when anoxia occurred below 22 m. pCO_2 in surface waters ranged from 270 to 650 ppm, and 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 due to a summer-time bloom, as also evidenced by O_2. pCO_2 was vertically virtually homogeneous in winter and fall, and showed the strongest vertical gradient during the anoxic event in August. CH_4 values were minimal in winter (~20 nM) and as stratification developed during spring and summer a distinct maximum of CH_4 (up to 730 nM) developed at the pycnocline (5 to 10 m). N_2O showed little seasonal variations and only a very faint increase with depth, except in August when bottom waters became anoxic. At this time, N_2O shown a maximum (~22 nM) at the oxycline (probably related to enhanced N_2O production by nitrification at low O_2 concentrations), and decreased in the anoxic layer (~3 nM) (probably related to denitrification).