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Lakes as components in the greenhouse gas balance - regional implications as exemplified for Lake Neusiedl (Austria)

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Inland surface waters and associated wetlands must not be neglected when global greenhouse gas emissions are balanced. Natural lakes, rivers and hydroelectric reservoirs are parts of the surface water system where outgassing of CO_2 or CH4 enhances the carbon flux to the atmosphere. For lakes, the carbon emission estimates vary over several orders of magnitude, depending on the age of the lake, depth, area, volume, temperature, input of organic carbon and residence time. Nitrogen input into lakes may be caused by wet atmospheric deposition, by surface runoff from agricultural areas and by wastewater inputs into the tributaries. In most cases, denitrification of nitrate is the dominating source of N2O; only in the case of high ammonium loads and oxygen availability nitrification and subsequent denitrification to N2O and N2 play a major role. Focusing on Lake Neusiedl (Austria) as case study, this study aims at illuminating the regional role of a shallow steppe lake as greenhouse gas emitter and at analyzing the local physico-chemical conditions affecting the emission of CO_2, CH4 and N2O.
The uniqueness of this lake with regard to its shallowness, salinity and sediment depth required the performance of separate measurement campaigns instead of applying general lake greenhouse gas flux rates. For the period of 9 months (based on 6 observation episodes in spring, summer, and autumn), the greenhouse gas emissions of the lake consisted of about 75700 t CO_2, 1006 t CH4, and 18 t N2O. Presumably because of significant sulphate concentrations in the lake water (0.3-0.4 g/l) and high pH (8.5-9) the C emissions were not dominated by CH4 but by CO_2. Approximately one third of the methane and carbon dioxide emissions originated in the pelagic zone and two thirds in the reed belt whereas nitrous oxide emissions were similar in these two zones. An estimate of ebullitive emissions resulted in additional 1765 t CH4 that predominantly originated in or near the reed belt from spring to autumn. A set-off of these emissions as forest carbon sink would require an area of 319 km^2 forest, roughly equaling the total area of the lake.