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Temporal and spatial variability of methane emissions from a small northern boreal lake undergoing artificial water level fluctuation

Jonathan Schenk (1), Henrique O. Sawakuchi (2), Hjalmar Laudon (3), Jan Karlsson (2), and David Bastviken (1)

(1) Department of Thematic Studies - Environmental change, Linköping University, Linköping, Sweden (jonathan.schenk@liu.se), (2) Department of Ecology and Environmental Science, Umeå University, Umeå, Sweden, (3) Department of Forest Ecology and Management, Swedish University of Agricultural Sciences, Umeå, Sweden

It is now well-documented that methane (CH4) fluxes from lakes represent a major part of the global terrestrial emissions of this potent greenhouse gas. However, the current bottom-up estimations of total emissions at the global and regional scale are still poorly constrained. This situation is a consequence of the scarcity of measurements covering both the temporal and spatial variability of CH4 emissions, especially those occurring by bubbling. Such data sets are yet necessary to improve our understanding of the underlying processes governing the release of CH4 from lakes. In this study, we use a well-established method based on measurements with floating chambers to quantify CH4 emissions from a northern boreal lake surrounded by the boreal forest on one side and by a mire on the other side during the month of August 2017. At that time, the water level of the lake was artificially controlled, making it possible to investigate the effect of small hydrostatic pressure changes on CH4 emissions. The measurement frequency was refined with time, going from one sample taken in two days during the first two weeks to three samples per day during the last days of the campaign. Five transects of four chambers each were deployed in different regions of the lake to account for the spatial variability of CH4 fluxes. Weather measurements and water-related data are provided through an extensive monitoring program taking place in the lake's catchment area. The large number of samples collected throughout the campaign, in comparison with other similar studies, allows to quantify CH4 emissions at different spatial and temporal scales. Relationships between emissions and different environmental variables are investigated with a focus on potential explanatory variables for CH4 ebullition. This study implies that high frequency measurements are key for accurately distinguishing flux patterns and understanding their drivers.