Rewet or not – insights on spatiotemporal patterns of greenhouse gas fluxes from soils in a rewetted Danish forested wetland

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Previously drained forested wetlands around the world are being restored for biodiversity, but our knowledge on the impact of restored hydrology on the total greenhouse gas (GHG) budget in these systems remains fragmented. Whereas the reduction in the net CO$_2$ emission upon rewetting is well documented, the magnitude of the effect on the microbial production of CH$_4$ and N$_2$O is much more uncertain. This is partly because GHG fluxes, especially for CH$_4$ and N$_2$O, exhibit a highly dynamic spatiotemporal variation tied to the soil hydrological regime. To capture this variation properly a high number of flux measurements in time and space is needed, but many field studies are still highly limited in terms of their spatio-temporal coverage. This hiatus of field data is a primary source of uncertainty in model projections of impacts on the GHG budgets when restoring natural hydrology in drained wetlands.

We use a novel automatic chamber measurement system (SkyLine2D) connected to a Picarro G2508 analyzer for CO$_2$, CH$_4$ and N$_2$O flux measurements in a rewetted Danish forest wetland. With this system, we wish to resolve the little known spatio-temporal patterns of these GHGs and their relationship with environmental drivers such as soil moisture, water table, temperature, and soil carbon content. A total of 30 measurement plots, each measured 5 times per day over a period approaching 1 year (> 40,000 measurements), were placed along a 30 meter transect covering a soil hydrological gradient including well-drained, waterlogged and open water conditions. The gradient also spans a soil carbon gradient increasing from well-drained mineral soils, over gleysols to waterlogged histosols.

Based on the novel, high-frequency flux data of CO$_2$, CH$_4$ and N$_2$O we will present a detailed analysis of the relationship with soil hydrology and temperature over periods spanning from hours to months. The data produced by this gradient approach combined with automated measurements represents an important step towards developing improved ecosystems models that can better predict the GHG effect of rewetting previously drained wetlands.