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Persistently high CH_4 emissions 10 years after restoration: The necessity for long-term observations when measuring GHG emissions of transitional systems

Danica Antonijevic, Shrijana Vaidya, Claudia Vincenz, Nicole Jurisch, Nathalia Pehle, Elisa Albiac Borraz, Bertram Gusovius, Matthias Lück, Jürgen Augustin, and Mathias Hoffmann
Leibniz-Zentrum für Agrarlandschaftsforschung (ZALF) e. V., Working Group: Isotope Biogeochemistry & Gas Fluxes, Müncheberg, Germany (danica.antonijevic@zalf.de)

When drained for e.g. agricultural use, natural peatlands turn from a net C sink to a net C source. It is therefore suggested that restoration of peatlands, despite of increasing CH_4 emissions, holds the potential to mitigate climate change by reducing their overall global warming potential. The time span required for this transition, however, is fairly unknown. Moreover, greenhouse gas emission measurements from peatlands are often limited to a couple of years only. This is problematic in so far, as most peatland ecosystems are in transitional stage due to restoration related disturbances (e.g. enhanced water table) and global climate change. This might affect GHG emissions in one way or another which emphasizes the necessity of longer-term observations to avoid misinterpretations and premature conclusions.
Exemplary for that, we present 14 consecutive years of CH_4 flux measurements following restoration at a formerly long-term drained fen grassland within the Peene river catchment (near the town of Zarnekow: 53.52ºN, 12.52ºE). Restoration of peatland was done by simply opening the dike. Thus, no water table management was established and water table was strongly fluctuating. CH_4 flux measurements were conducted at two sites (restored vs. non-restored) using non-flow-through non-steady-state (NFT-NSS) opaque chambers.
Throughout the 14 years study period, distinct stages of an ecosystems transition, differing in their impact on measured CH_4 emissions, were observed. During the first two years of the measurement period directly following restoration in autumn 2004, an eutrophic shallow lake was formed. This development was accompanied by a fast vegetation shift from dying off cultivated grasses to submerged hydrophytes and helophytes and evidenced substantially increased CH_4 emissions. Since 2008, helophytes have gradually spread from the shore line into the established shallow lake especially during drying years. This process was only periodically delayed by exceptional inundation, such as in 2011, 2012 and 2015, and finally resulted in coverage of the measurement site in 2016 and 2017. While, especially the period between 2009 and 2015 showed exceptionally high CH_4 emissions, these decreased significantly after helophytes were established at the measurement site. Hence, CH_4 emissions only decreased after ten years transition following restoration and potentially reaching a new steady state.