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Stronger increase of CH_4 efflux on drained compared with rewetted sites on organic soils after severe prolonged precipitation

Gerald Jurasinski (1), Vytas Huth (1), Mathias Hofmann (2), Anke Guenther (1), and Jürgen Augustin (2)

(1) Landscape Ecology, University of Rostock, Rostock, Germany, (2) Institute of Landscape Biogeochemistry, Leibniz Centre for Agricultural Landscape Research, Müncheberg, Germany

As a result of global warming, the frequency of climate extremes is expected to increase, leading to warmer winters and hotter summers in the long-term. Although a change in annual sums of precipitation for northern countries remains uncertain, global warming promotes the occurrence of heavy precipitation events in this region. The summer of 2011 in northern Germany saw exceptionally strong precipitation that lead to prolonged freshwater flooding in many low-lying areas. With access to manual chamber GHG time series for 2011 this gave us the opportunity to measure the effect of heavy precipitation on CH_4 effluxes under high summer temperatures.

Here, we present CH_4 efflux data measured with manual closed chambers during the growing season (April-October) 2011 in eight different study sites on organic soils with 2 to 5 measurement plots. The study sites spread across an area of more than 25,000km^2. They stretch over an approximate distance along the climatic gradient from East to West of more than 300km and were affected by different intensities of the monsoon-type precipitation events in June and July 2011. The plots span land-use types from former high-intensity grassland to nature conservation areas and different hydrological regimes from drained over rewetted to inundated. The different site conditions are reflected in the vegetation composition from communities typical for intensive grassland use to emergent macrophytes and open water bodies. We estimated the local severity of the monsoon-type precipitation compared to long-term averages using data of the German Weather Service network. We assessed the response of CH_4 emissions to the local changes in water table following the extreme event by comparing the total fluxes based on all gathered data to the ones that were estimated based on data without the measurements during flooding and to data series were the flood fluxes were substituted by average fluxes during non-flood times.

Our results show that the most responsive sites are those with easily decomposable grassland vegetation not adapted to inundation. These sites may reach annual CH_4 emissions typical for rewetted or pristine peatlands showing the sensitivity to single measurement years and extreme climatic events. Communities of rewetted sites responded less to the flooding whereas inundated sites did show almost no response of CH_4 emissions to the extreme event suggesting that higher overall CH_4 emissions following rewetting measures are partly compensated by lower climate vulnerability. Extreme event years, which are predicted to increase under global warming, may, thus, become more important for CH_4 estimates from non-flooded sites. Since long-term field trials monitoring CH_4 fluxes on organic soils are scarce, meta-analyses usually incorporate data from field trials which rarely exceed two years of duration. In the light of our findings this may become insufficient for deriving reliable emission factors in the future.