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Fluxes of N_2O and CH_4 from forest and grassland lysimeter soils in response to simulated climate change

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Central Europe is expected to be exposed to altered temperature and hydrological conditions, which will affect the vulnerability of nitrogen and carbon cycling in soils and thus production and fluxes of climate relevant trace gases. However, knowledge of the response of greenhouse gas fluxes to climate change is limited so far, but will be an important basis for future climate projections.

Here we present preliminary results of an ongoing lysimeter field study which aims to assess the impact of simulated climate change on N_2O and CH_4 fluxes from a forest and a fertilized grassland soil. The lysimeters are part of the Germany-wide research infrastructure TERENO, which investigates feedbacks of climate change to the pedosphere on a long-term scale. Lysimeters (A = $1m^2$) were established in 2010 at high elevated sites (HE, 500 and 600 m.a.s.l.) and subsequently transferred along an altitudinal gradient to a low elevated site (LE, 100 m.a.s.l.) within the Eifel / Lower Rhine Valley Observatory in Western Germany, thereby resulting in a temperature increase of 2.3 K whereas precipitation decreased by 160 mm during the present study period. Systematic monitoring of soil-atmosphere exchange of N_2O and CH_4 based on weekly manual closed chamber measurements at HE and LE sites has started in August 2013. Furthermore, we routinely determine dissolved N_2O and CH_4 concentrations in the seepage water using a headspace equilibration technique and record water discharge in order to quantify leaching losses of both greenhouse gases.

Cumulative N_2O fluxes clearly responded to simulated climate change conditions and increased by 250 % and 600 % for the forest and the grassland soil, respectively. This difference between the HE and LE sites was mainly caused by an exceptionally heavy precipitation event in July 2014 which turned the LE site sustainably to a consistently higher emission level. Nonetheless, emissions remained rather small and ranged between 20 and 40 μg m^{-2} h^{-1}. In terms of CH_4, the forest soil exhibits a consistent uptake. Climate change conditions almost doubled the CH_4 sink strength from -0.14 to -0.27 g C m^{-2} $year^{-1}$. In contrast, the grassland soil was a net source of CH_4 which appeared to be mainly related to emission peaks responding to organic fertilization and periods with high soil moisture. However, the net source strength was so far not significantly affected by simulated climate change.

In conclusion, our preliminary results provide evidence that climate change will considerably affect N_2O emissions from both soils as well as CH_4 uptake by the forest soil. However, comparatively small fluxes of both trace gases suggest that N_2O and CH_4 fluxes of the investigated soils will be of minor importance for the net greenhouse gas balance of our sites. Our data further highlight the need for long-term flux measurements, in particular to account for the impact of short-term events and interannual variability.