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Towards better understanding of the response of Sphagnum peatland to increased temperature and reduced precipitation in Central Europe

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With respect to climate change peatlands are highly vulnerable ecosystems. Especially a potential drying in future might result in a major carbon source and release to the atmosphere. We carried out a field climate manipulation experiment at Rzecin peatland in western Poland to assess how increased temperature and reduced precipitation may impact carbon balance, vegetation, microbes and water chemistry of the *Sphagnum* peatland. Here, we present results of measurements conducted in two contrasting years (417 mm and 678 mm of precipitation in very dry 2015 and wet 2016, respectively). The experimental design consists of four treatments, each one replicated three times (control, CO; simulated warming, W; prolonged drought, D and warming & drought, W+D). Increased temperatures (T) during the year were achieved by infrared heaters (400W $\times$ 4 per site, approx. 60 W$\cdot$m^{-2} addition of LW radiation). Precipitation was reduced using an automatic curtain, covering the site during nighttime hours of the growth seasons. The manipulation experiment was successful during both years, increasing the air (30 cm height) and soil temperature (5 cm depth, sites W and D) by up to 0.2 ^{o}C and 1.0 ^{o}C, respectively. Precipitation was reduced to 37 % during both years. At W+D site the peat temperature was nearly two times higher than on W site indicating the impact of drought on T increase.

To study the C exchange we developed an automatic mobile platform for measuring CO_2/CH_4/H_2O fluxes (LGR) as well as $^{13}CO_2$ and $^{13}CH_4$ fluxes (PICARRO CRDS G2201-i). Measurements were performed, using dynamic ecosystem chambers (for NEE and Reco) and combined with simultaneous measurements of surface spectral properties. Flux calculation and gap filling was done according to Hoffmann et al. 2015.

Methane emissions were significantly higher on manipulated plots than on CO (25 gC$\cdot$m^{-2}yr^{-1}) during both years, but only in the very dry 2015, CH_4 fluxes were the highest on W+D site (33 gC gC$\cdot$m^{-2}yr^{-1}). Besides temperature, methane emissions were positively correlated with LAI of vascular plants, which was higher at the warmer sites during both years.

Despite of being a net sink for CO_2 during both years, the NEE was five times smaller for all sites (-100 gC$\cdot$m^{-2}yr^{-1}) during the dry 2015 year compared to 2016. The highest CO_2 emissions were measured for the site with increased temperature (W site, Reco 780 gC$\cdot$m^{-2}yr^{-1}). Temperature increase also provoked the productivity - GPP was the highest at W site. While the smallest CO_2 emissions and GPP were recorded on the site exposed to reduced precipitation. This emphasizes the importance of drought in inhibiting respiration and carbon uptake by plants. Despite of a higher productivity, NEE was smaller on W and W+D, due to higher CO_2 effluxes. As a result of the drier conditions in 2015, the GWP of all sites was positive, showing the highest values for the temperature increased sites. Compared to that, GWP was negative for all sites besides those exposed to drought during the more wet year 2016.

Different vegetation parameters further support the C exchange estimates. In general, warmer and drier conditions led to an increased LAI, whilst the site only exposed to drought exhibited the lowest NDVI. In addition, increased temperatures shifted the vegetation species composition by promoting vascular plants (mainly *Carex rostrata* and *C. limosa*), which correlates positively with nutrient (P_{tot}, Mn, F, Na, Zn) availability in the ground water.

We report short-term responses of peatland to increased temperature and reduced precipitation, showing that the combination of these to stressors are leading to very different scenarios, regardless of their individual impacts. Thus our results emphasize the need for long term records from full-factorial field manipulation sites on peatland response to climate changes.

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