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Experimental approach to study the climate effects from drained peatland restauration

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Introduction

Northern European peatlands have accumulated considerable of organic amounts carbon during the Holocene. During the last 200 years, peatlands have been drained to increase their productivity, which mobilised the organic carbon. Now, drained peatlands are being restored, to stop peat degradation, but what are the effects of peatland restauration on their greenhouse gas (GHG) budgets?

The Norwegian Environment Agency is establishing a paired field experiment, where GHG fluxes are being monitored in two peatland sites, one of which shall be restored by filling the drainage ditches. In this first phase of the experiment, we examine the comparability of the two sites.

Materials and methods

In spring 2019, two sites in a drained ombrotrophic bog in Norway (close to Trysil, Innlandet, M1, 61.105N-12.255E, 685 m a.s.l. and M2 61.111N and 12.251, 640 m a.s.l.) were equipped with eddy covariance stations, including a Gill HS-50 ultrasonic anemometer, an enclosed path LI7200 CO_2 and H_2O sensor and an open path LI-7700 CH_4 analyser (Fig. 1 a). The measurement height (z_m) is at 2.8 m, keeping the size of the flux footprint small. The turbulence data was processed with LI-COR's EddyPro software, using basic settings, because the software did otherwise not run stable. The flux footprint was calculated with the model FFP (Kljun et al., 2015).

The peat depth varies between 1 and 2 m with the tendency of a deeper peat layer in M2, i.e. the lower site that is located on a saddle compared to the higher site M1 that is closer to the mountain ridge.

Results and discussion

Fig. 1 b and 1c show the horizontal distribution of surface types around the towers and the footprint climatology during summer 2019. Due to the low z_m the main area of influence (70%) is within 50 m radius from the stations. This area is mainly covered by wetland and ditches. While the CO_2 fluxes (FCO_2) are remarkably similar between the two sites the methane fluxes (FCH_4) in M2 tend to be higher (Fig. 2). Despite a gap, it can be seen that the flux magnitudes are higher in summer than in winter and that this seasonality is similar between the two sites and the two GHGs.

From October, the sites were covered by snow and the soil temperatures approached 0 °C. In this period, the CH_4 flux varied around 0 mg CH_4-C m^{-2} d^{-1} at M1, while at the site M2 it varied around 10 mg CH_4-C m^{-2} d^{-1}.

a) b) c)

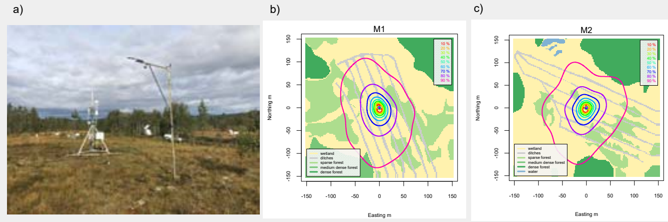

Fig. 1: a) station M1, b) and c) map with footprint climatology (Kljun et al. 2015).

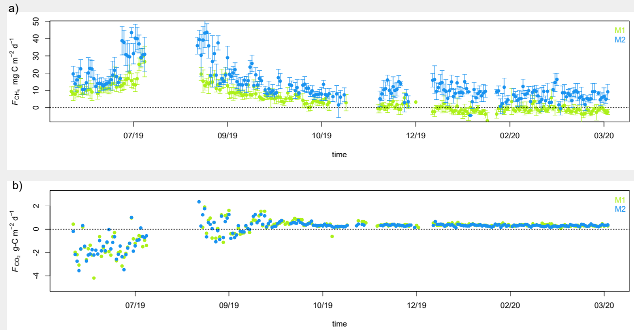

Fig. 2: Daily fluxes of a) methane and b) carbon dioxide.

The footprint model was used to calculate the relative source contribution (rSC) for the land-cover types as seen in Fig. 1 b and 1 c for every single flux value. With this data, it was examined, whether the fluxes depended on the land cover distribution. From all comparisons (four land cover types, FCO_2 and FCH_4, in sites M1 and M2), only the FCH_4 at site M2 showed a systematic variation with the rSC from the drainage ditches.

a) b)

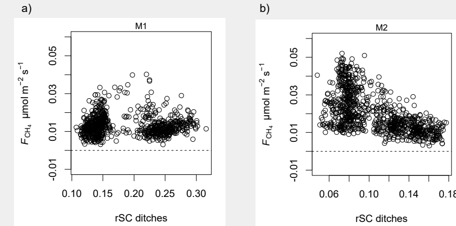

Fig. 3: Relationship between relative source contribution (rSC) and methane flux in a) M1 and b) M2 in summer 2019.

The flux was the lower, the higher the rSC of the ditches, were the water table is likely lower. This indicates a likely increase of methane fluxes after the ditches will be filled. The true area of influence from the ditches might be higher.

Conclusions

Experiments to demonstrate short and long-term effects of changed peatland management require reference sites and tests, whether and how a pair of sites is comparable. In flux sites, horizontal heterogeneity might affect the comparability of the sites. The results from this study showed that some site traits might be directly comparable (FCO_2), while for other traits, changes of the relationships between sites (FCH_4) might be needed to be used to show management effects.

Acknowledgements

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References

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