GREENHOUSE GAS EMISSIONS FROM DRAINED HEMIBOREAL PEATLAND FOREST SOILS IN ESTONIA

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INTRODUCTION

Peatlands are the largest long-term carbon (C) store, covering only ~3% of the earth's surface yet account for approximately one-third of all carbon storage, and therefore important for the global C cycle. Water saturation is a key control on oxygen availability in peat and on plant community composition and excess soil wetness is necessary for long-term peat development.

Northern peatlands constitute most of the global peatland area and boreal regions have historically experienced long winter & wet summer seasons. Changes in winter weather could have a cumulative effect on peat hydrology and in extremely dry periods the stored carbon losses to the atmosphere due to intensified peat decomposition.

Peatlands have been drained for forestry (ca. ~15 Mha) in the temperate and boreal regions for production of tree biomass. Drainage has fundamental impacts on the hydrological and biogeochemical processes of peatlands:

- Drainage promotes the oxidation of the stored organic material and enhance decomposition turning peatland from C sink into emitter of CO_2.
- Mineralization of nutrients from peat is increased, and emission of N_2O occur due to favorable conditions for nitrification.
- Lower water levels and soil water content in drained organic soils lead to reduced CH_4 emission, while oxidation may increase.

Moreover, any changes together with the predicted global warming may result in significant variation of GHG fluxes.

OBJECTIVES

Our aim is to determine the GHG fluxes and factors regulating the temporal and spatial variation in GHG fluxes at the soil surface in drained forested sites.

1) *Downy Birch* 2) *Black Alder* 3) *Norway Spruce* 4) *Scots Pine* Forests drainage ditch

METHODS

We are conducting a two-year long study on drained nutrient-rich organic soils with different tree species and fen (wetland) as a reference site in central Estonia. GHGs exchange measured twice per month along with auxiliary soil and environmental parameters from Jan-2021 till date.

- Manual static chamber method and GC analysis (CH_4 and N_2O)
- Dynamic closed chamber with EGM (CO_2 heterotrophic respiration)
- Soil temperature profile (10-20-30-40 cm) and soil moisture (5 cm)
- Water chemical parameters (specific conductance, pH and O_2 conc.)
- Automatic logger for ground water level, soil temperature, moisture (hourly)

RESULTS

Our preliminary results shows that all drained forest sites were annual emitters of CO_2 and N_2O while consumed CH_4 during the first year Jan- Dec 2021.

- The annual mean CO_2 emission (heterotrophic respiration) was 716 ± 47.9 mg m^{-2} h^{-1}, and highest during the summer with temporal variability associated with temperature and soil water content within site.
- Most of the sites had relatively high N_2O fluxes (mean = 48.5 ± 7 µg m^{-2} h^{-1}), which were controlled by soil temperature and peaks in emission occurred during the spring (freeze-thaw) period.
- Overall forest soils were annual CH_4 sinks (mean = −58.6 ± 2.5 µg m^{-2} h^{-1}), and significantly correlated with ground water levels in terms of spatial variation among the sites.

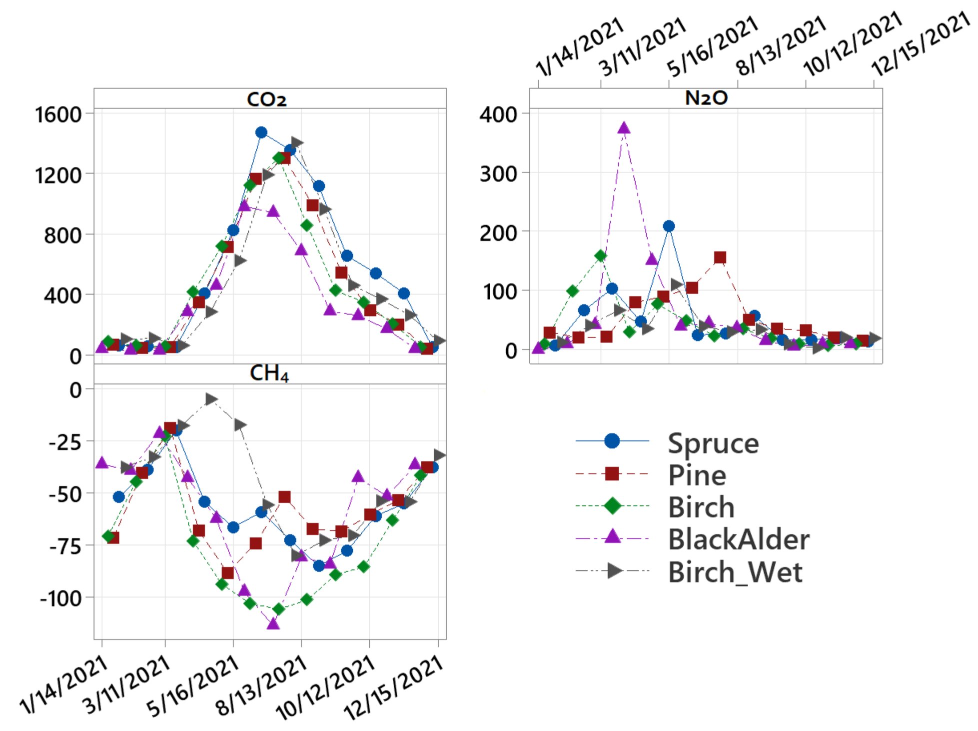

Fig. 1. Annual variation of GHG fluxes. Dots represent monthly mean of each study site

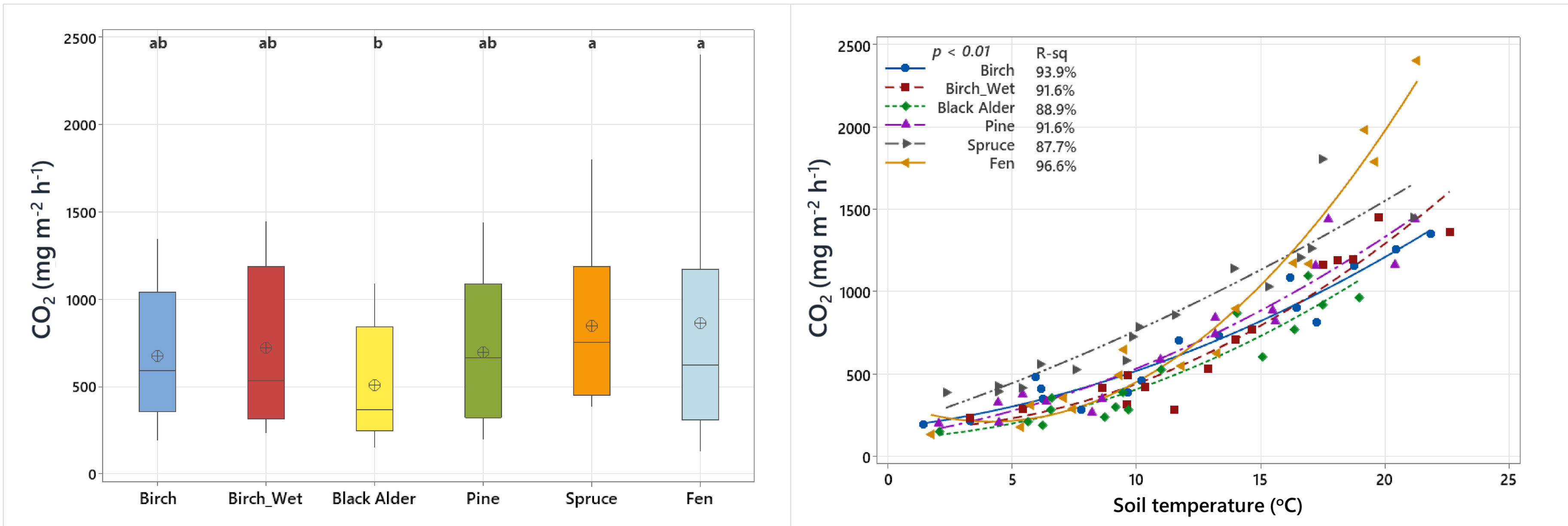

Fig. 2. Average CO_2 flux and relationship with soil temperature at 10 cm depth.

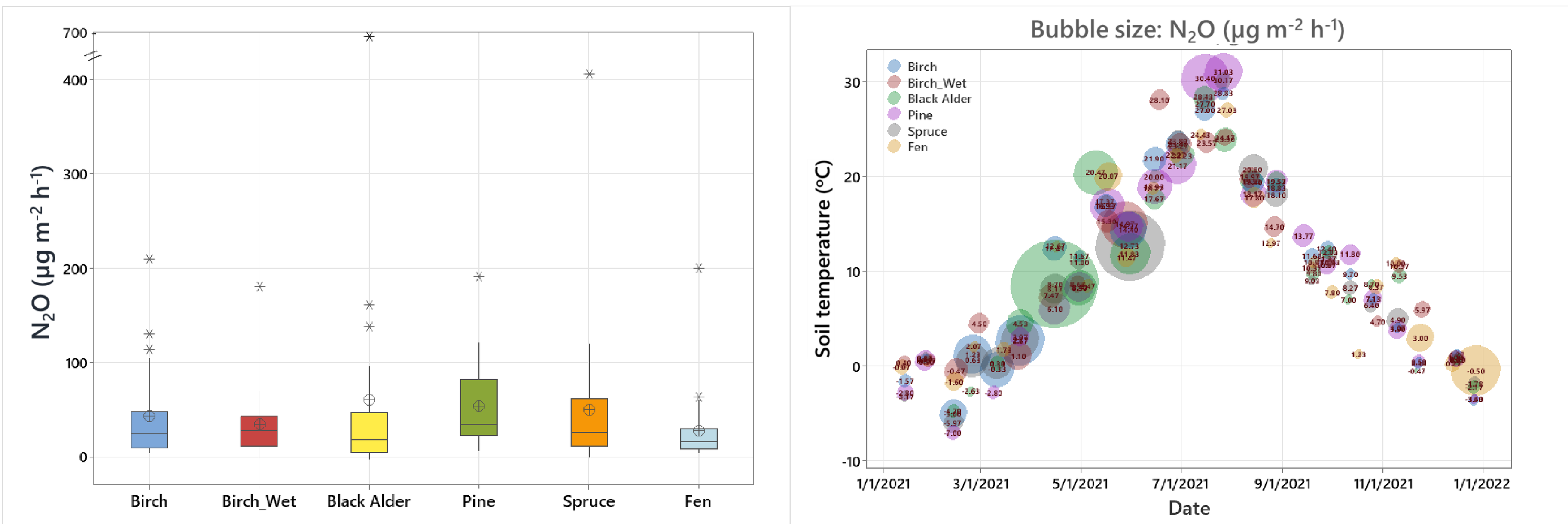

Fig.3. Average N_2O flux and relationship with soil temperature at 5cm depth.

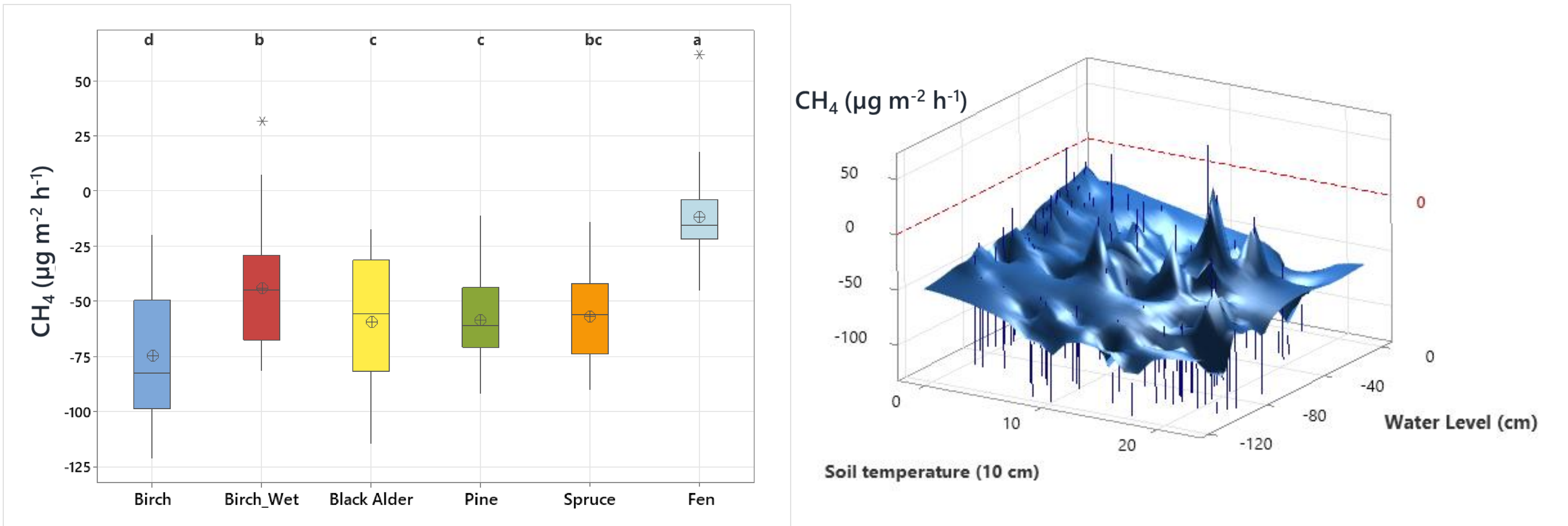

Fig.4. Average CH_4 flux and relationship with soil temperature and ground water level.

CONCLUSIONS

GHG fluxes have large seasonal and spatial variabilities.

Forestry drainage increased heterotrophic respiration in the soil. CO_2 emissions were similar across different forest species, the rates were increased with higher temperatures during the vegetation period.

Nutrient-rich soils produced high N_2O due to increased mineralization rates, the fluxes were controlled by soil temperature.

Drained forest soils consumed more CH_4 than fen as a result of aerated surface layer and CH_4 fluctuated with ground water level.

Furthermore, soil microbes, ground vegetation cover and litter horizon will be investigated as factors influencing soil atmospheric gas exchange in the future.

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