Greenhouse Gas Fluxes From Nutrient-rich Organic In Estonia and Latvia

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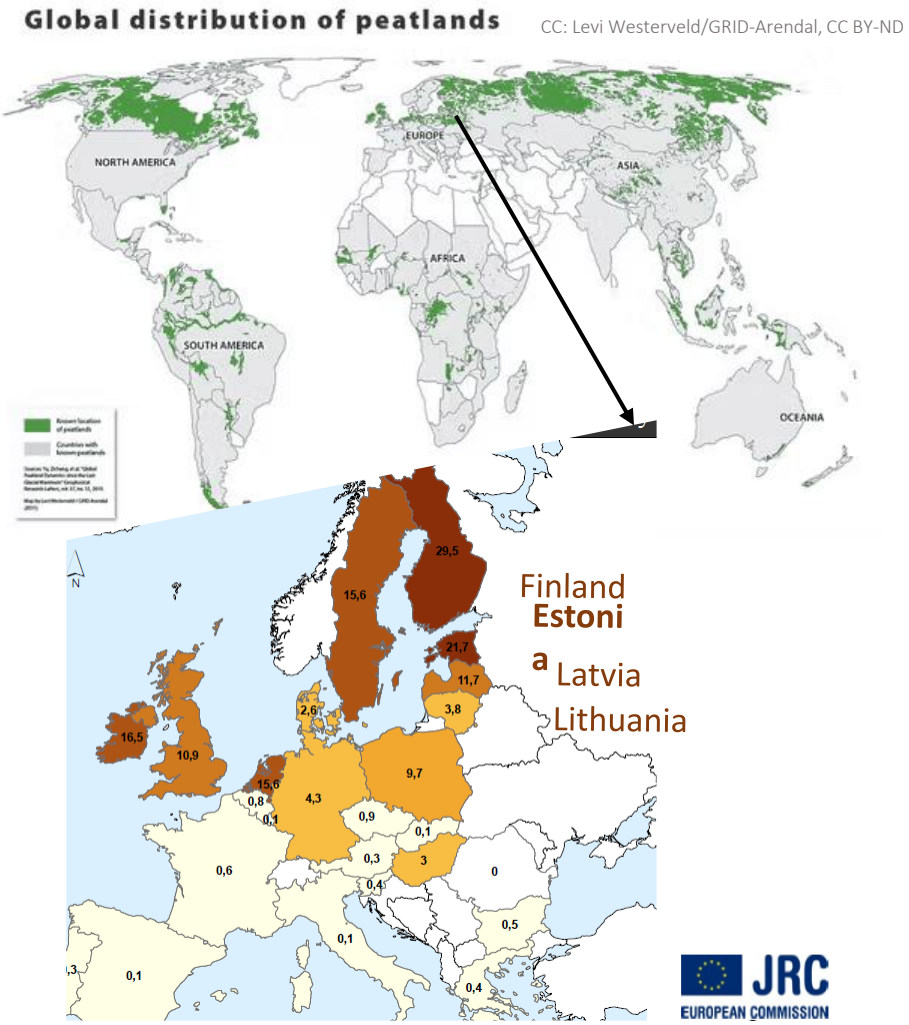
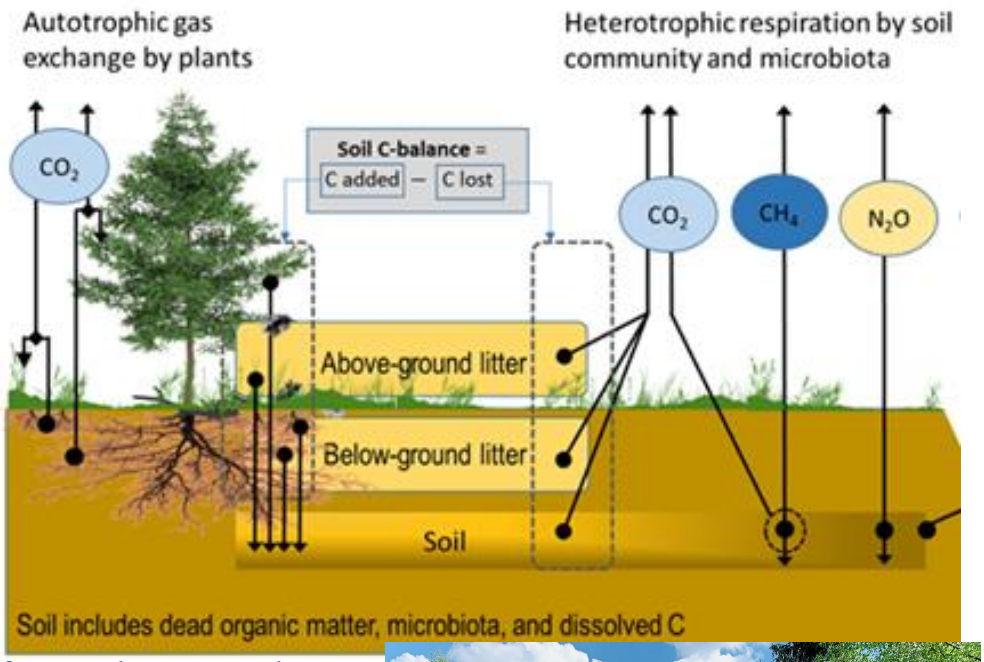
Background

- Peatlands occupy 4 million km^2 store >25% global soil carbon
- C-reservoir are affected anthropogenic activities i.e., peat extraction, drainage
- ~10% global peatland area drained (0.3% of global area)
- Accounting for ~5% of anthropogenic GHG emissions.



Peatlands drained for cultivation and peat extraction

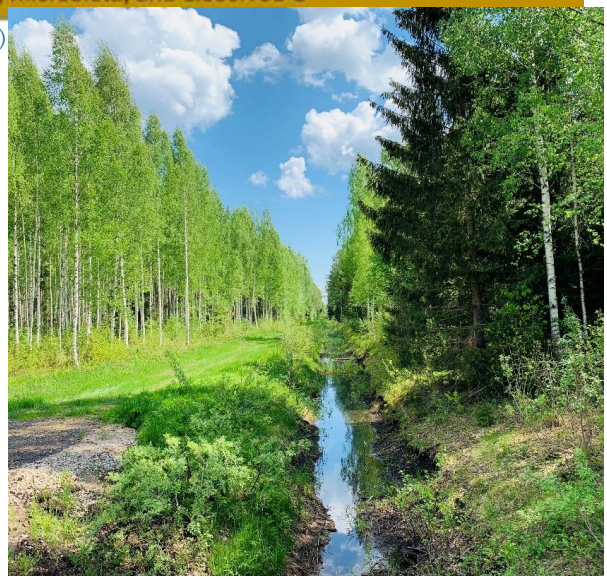
- Increased peat mineralization
- Water level fluctuation
- GHG emissions



modified from Jauhiainen et al. (2019)

<u>Research question:</u>

- **How drainage will impact GHG emissions forest land on nutrient-rich organic soils**
- C and N budget
- Emission factors



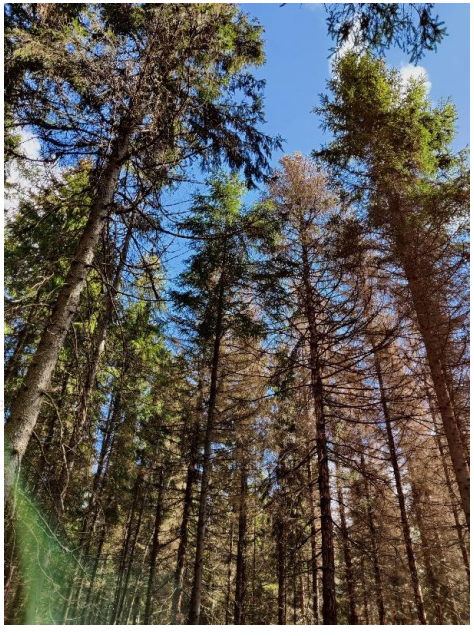
Study Areas

Estonia and Latvia (hemiboreal zone)

Drained nutrient-rich organic soil

Mature forest types:

(Downy birch, Norway spruce, Scots pine, black alder)



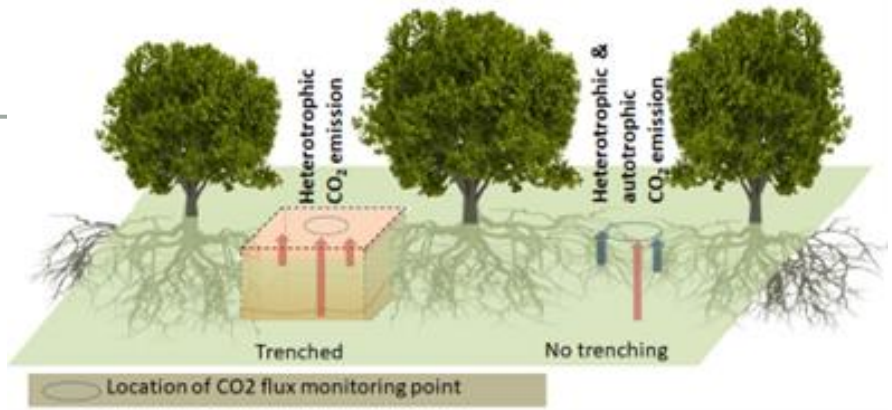
Study Sites

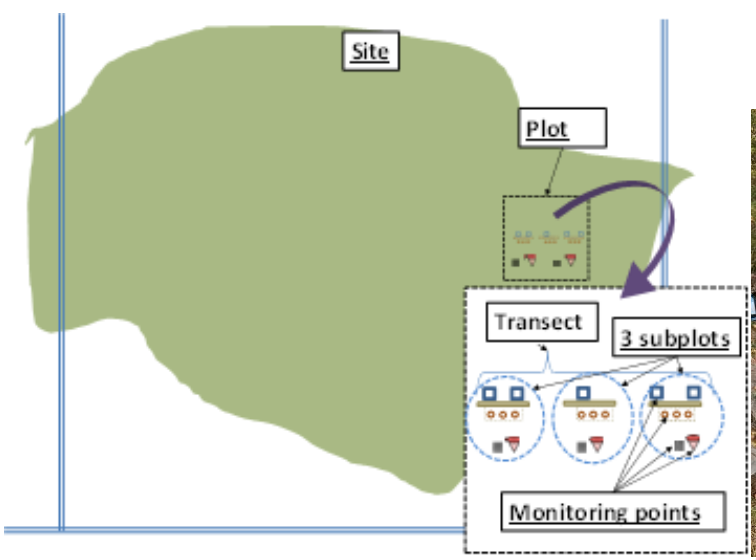
Estonia; 5
Latvia; 10

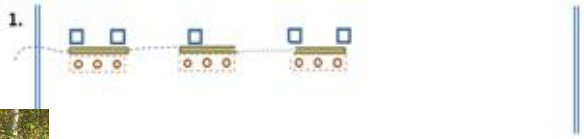
Dominant species	Common name, Site ID		Peat depth (cm)	Water table regime	Stand age
Black alder	Karevere	EEC108	20-30cm	Drained site	Mature stand
	Birzgale	LVC109	>50 cm	Drained (Wet)	mature stand
Birch	Laeva	EEC106	60-70 cm	Drained site	20-40
	Ulila	EEC109	50-70 cm	Drained site	younger stand
	S-99-9	LVC108	>50 cm	Drained site	24
	Pļaviņas	LVC115	>50 cm	Drained site	mature stand
	Smiltenes Melnalkšņi	LVC111	100 cm+	Drained (Wet)	mature stand
Spruce	Laeva	EEC104	>50cm	Drained site	43-65
	Ropaži	LVC104	30+ cm	Drained site	mature stand
	Viesīte otrais	LVC106	40 cm	Drained site	mature stand
	Tālākā daļa	LVC113	>50 cm	Drained site	48
Pine	Laeva	EEC105	>50cm	Drained site	40-60
	Olaine	LVC107	>21cm	Drained site	120
	S-193-27	LVC116	60 cm	Drained site	141
	Iecava	LVC110	>21 cm	Drained (Wet)	mature stand

Site description

- Dark Chamber method: CH_4 & N_2O flux monitoring points, n = 6
- Dynamic Chamber: CO_2 Heterotrophic respiration







1. Transect oriented subplots from ditch to mid-field.
2. & 3. Subplots accounting mid-field conditions.

GHG monitoring point (frame)
Heterotrophic CO2 monitoring point (trenched)
Duckboard
Path
Ditch

Methods

GHG flux measurements: twice per month, Jan 2021 – Dec 2022

- Manual static closed dark chamber method for CH_4, N_2O, analysis by GC
- Dynamic chamber (with EGM-5) for heterotrophic respiration (CO_2)
- Soil chemical analysis

Auxiliary parameters: Tsoil, Tair, soil water content, soil moisture, water chemistry



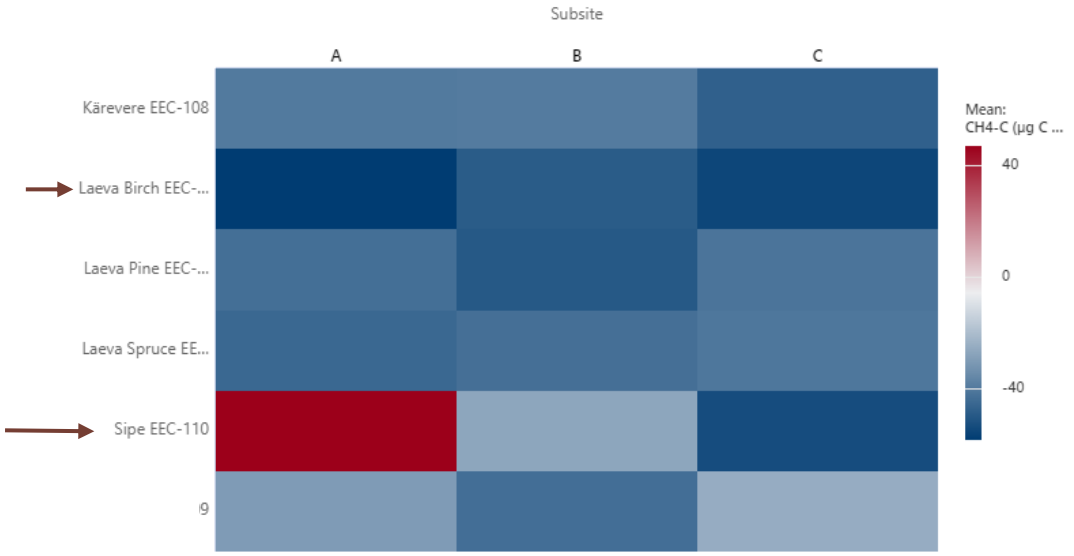


Heterotrophic respiration (CO_2) data is not presented

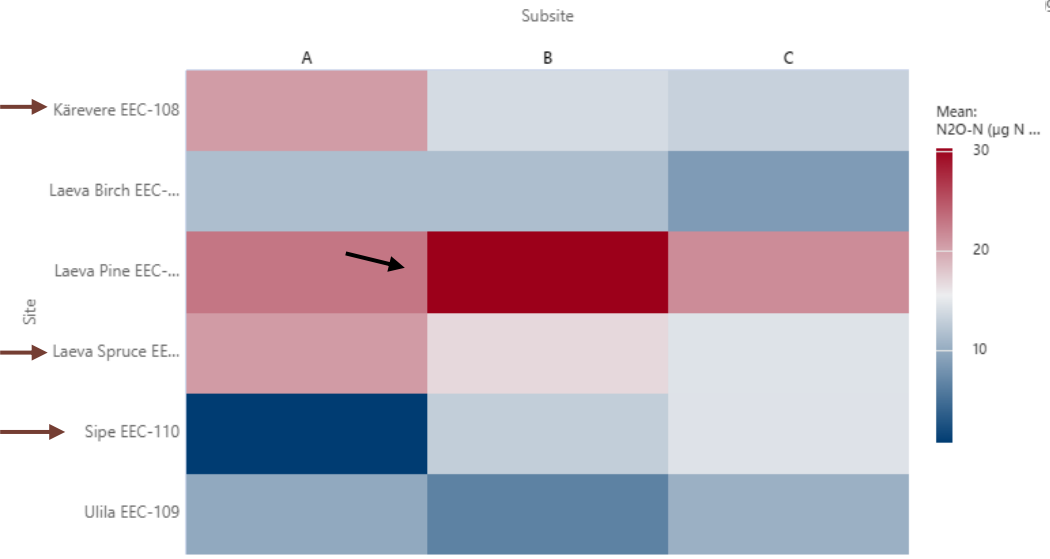
Forest subsites Estonia

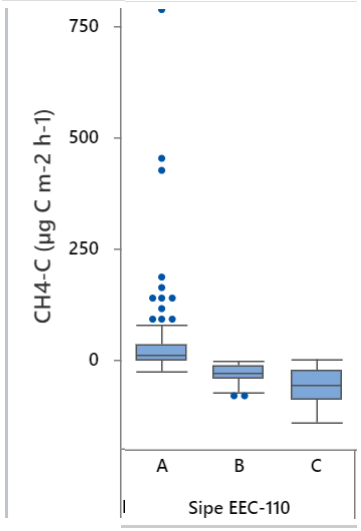
Effect of drainage ditch on overall fluxes
A, B and C

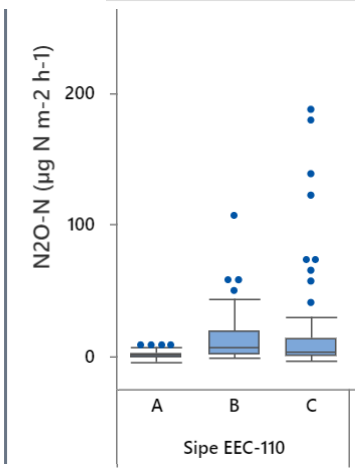
CH_4 (μ g m^{-1} h^{-1})



N_2O (μ g m^{-1} h^{-1})

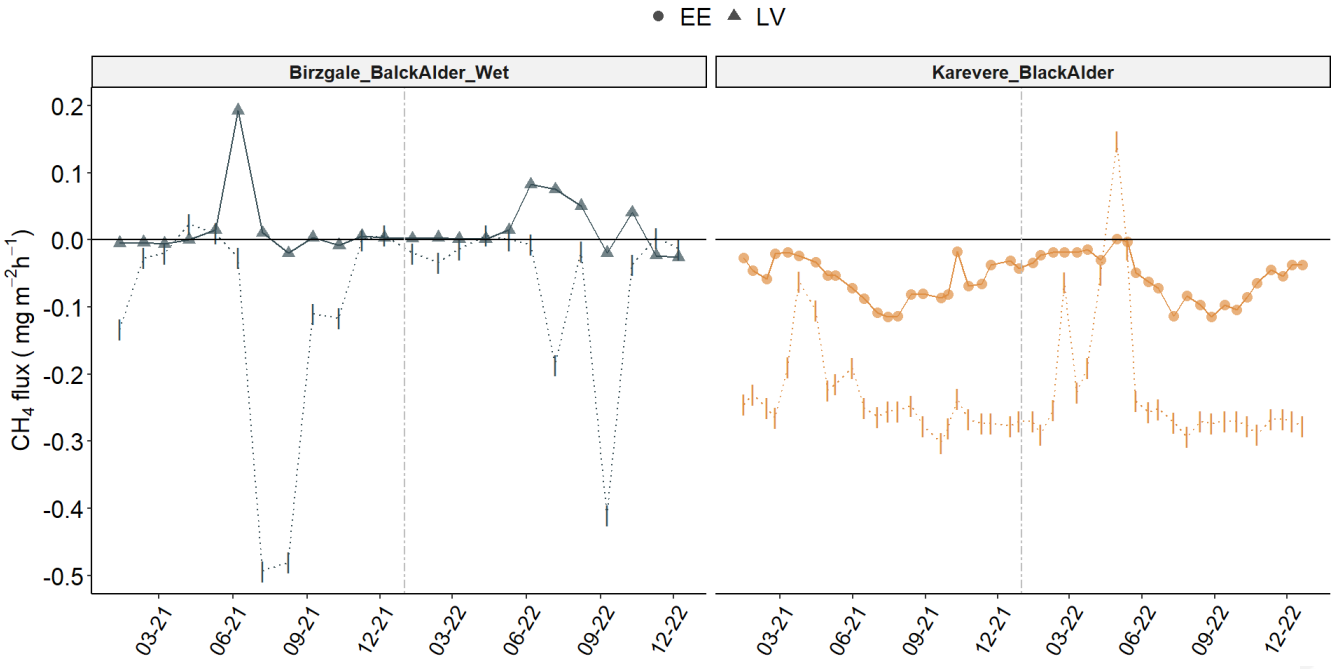


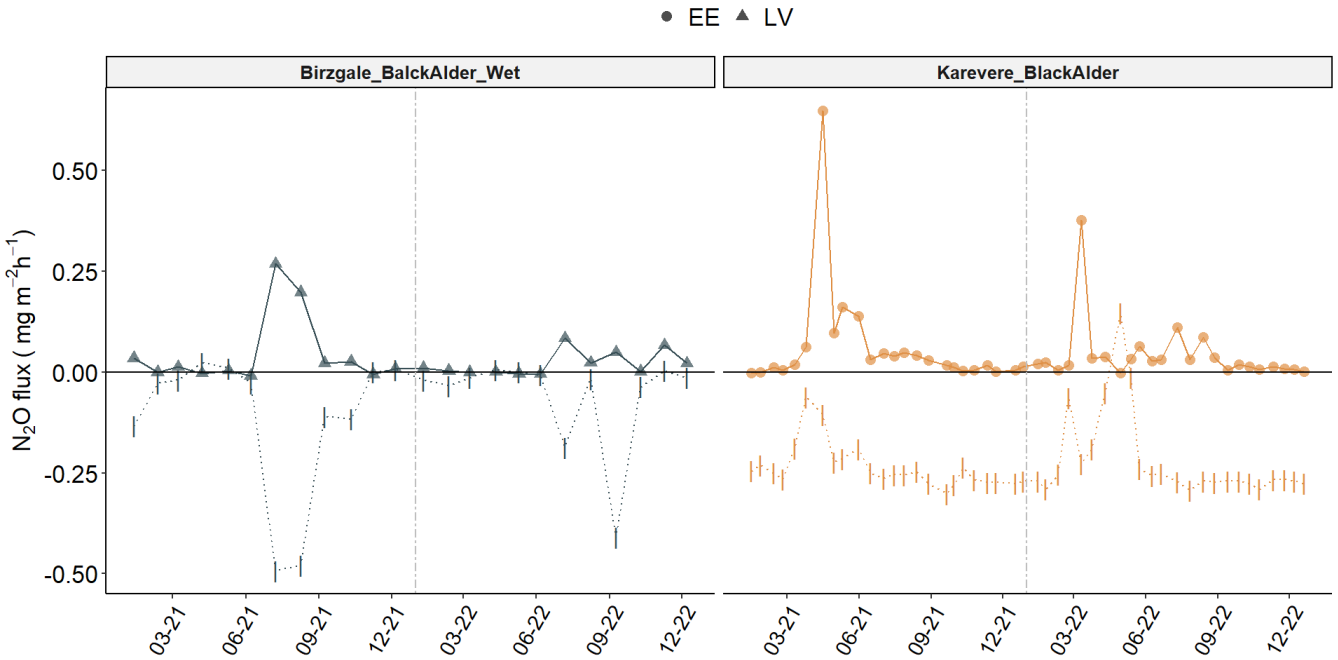




Results

Time series of CH_4, N_2O fluxes and Ground water level (2021- 2022)





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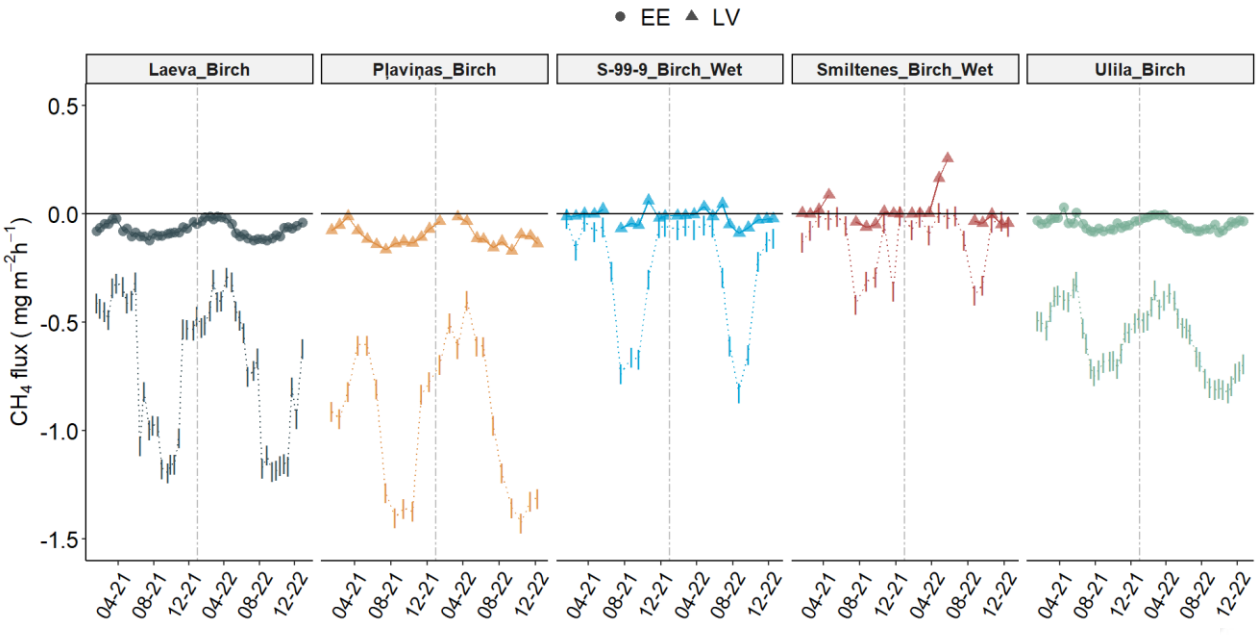

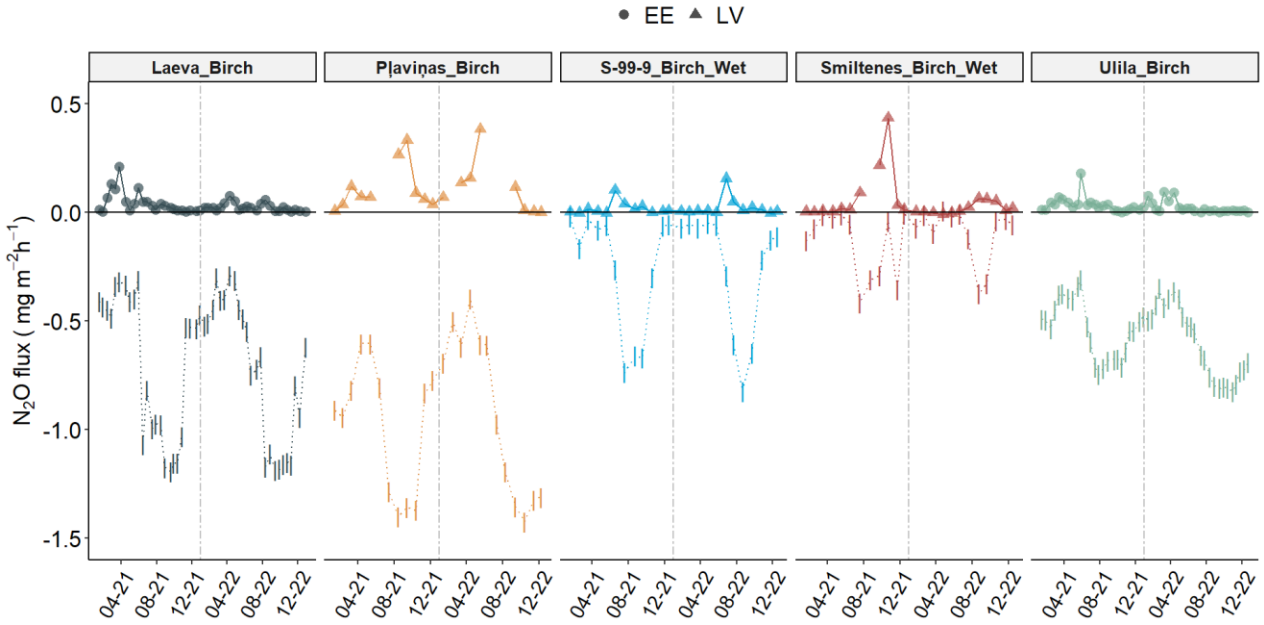

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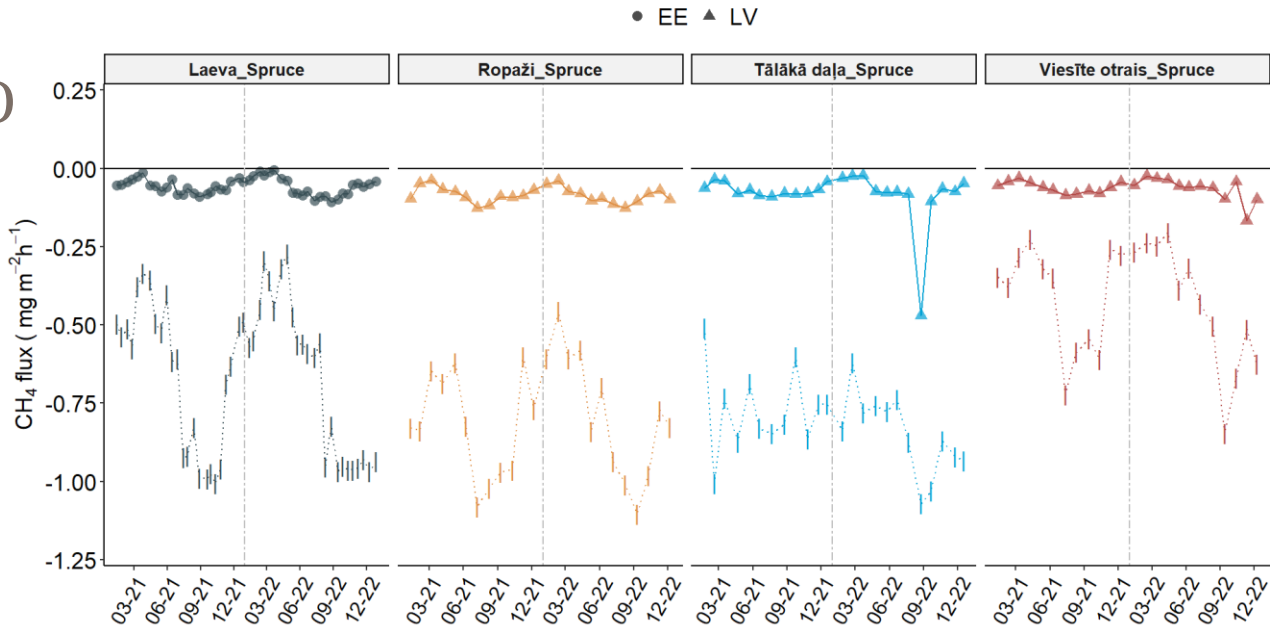

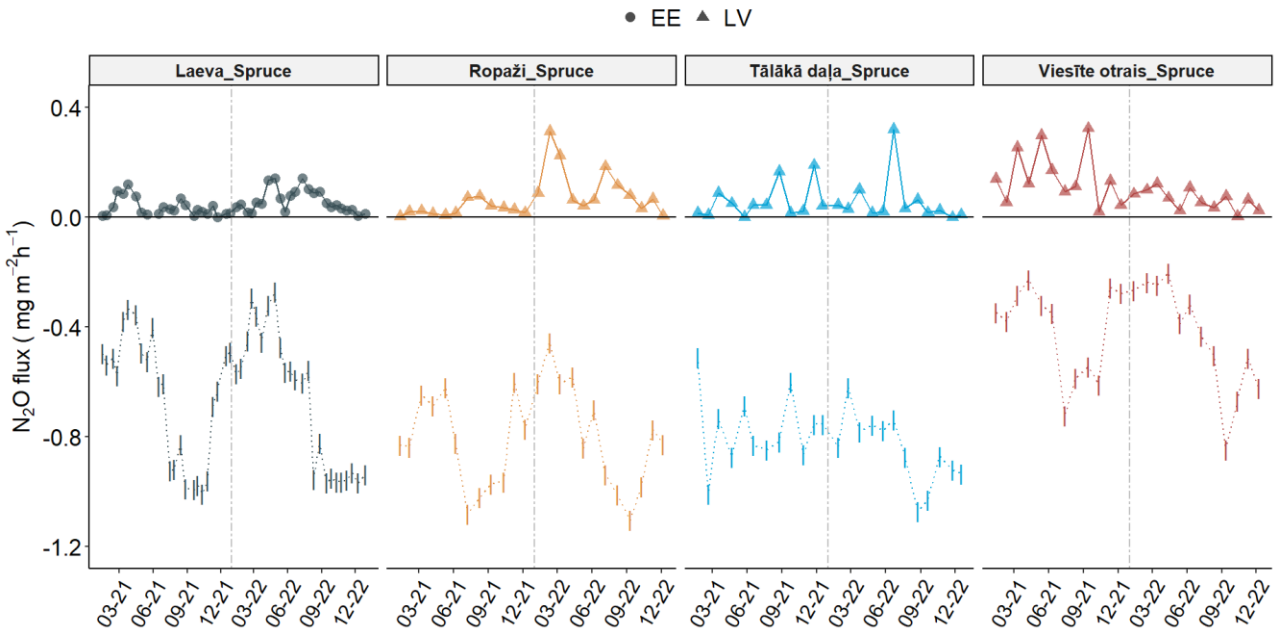

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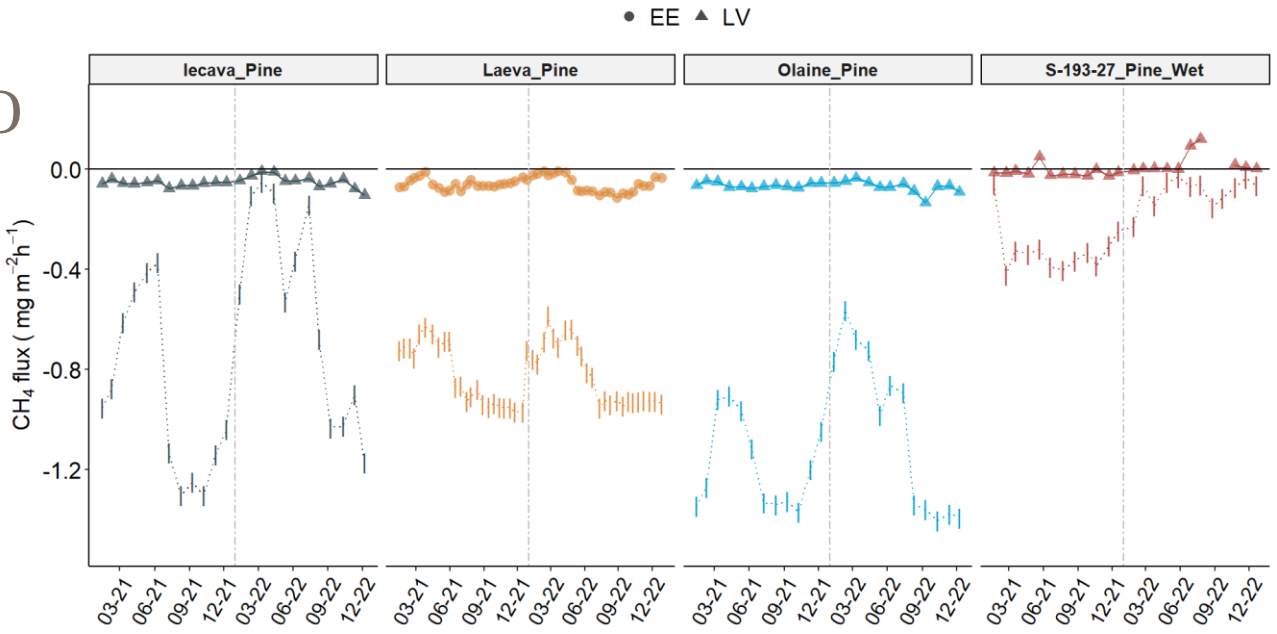
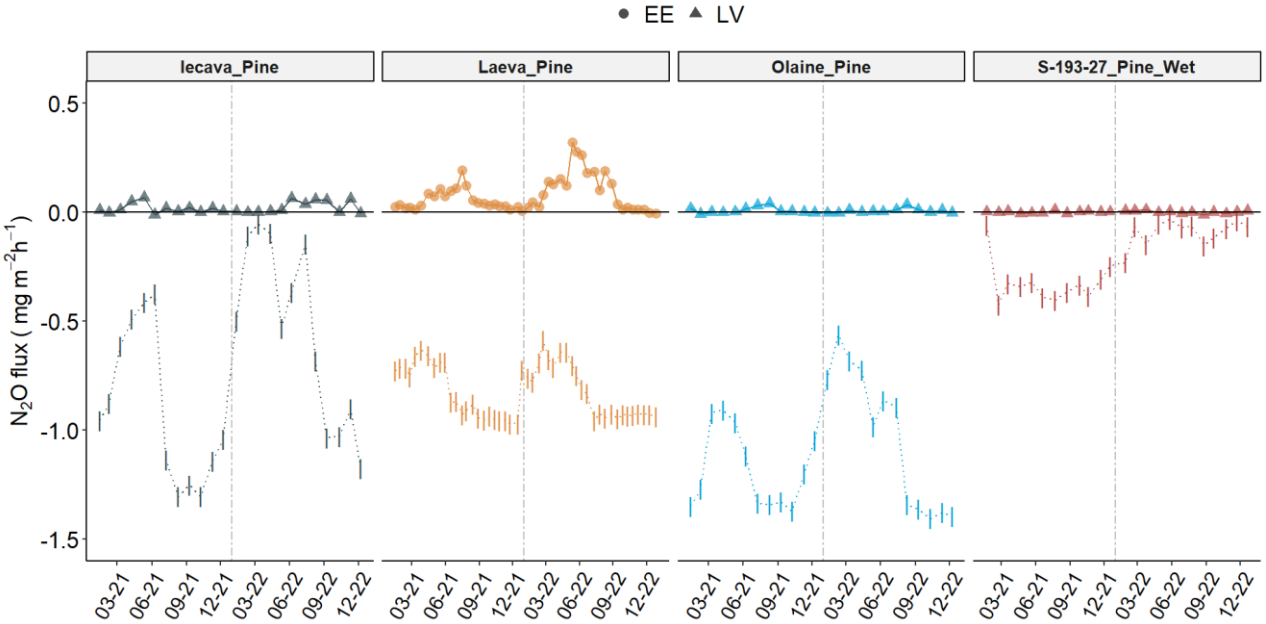
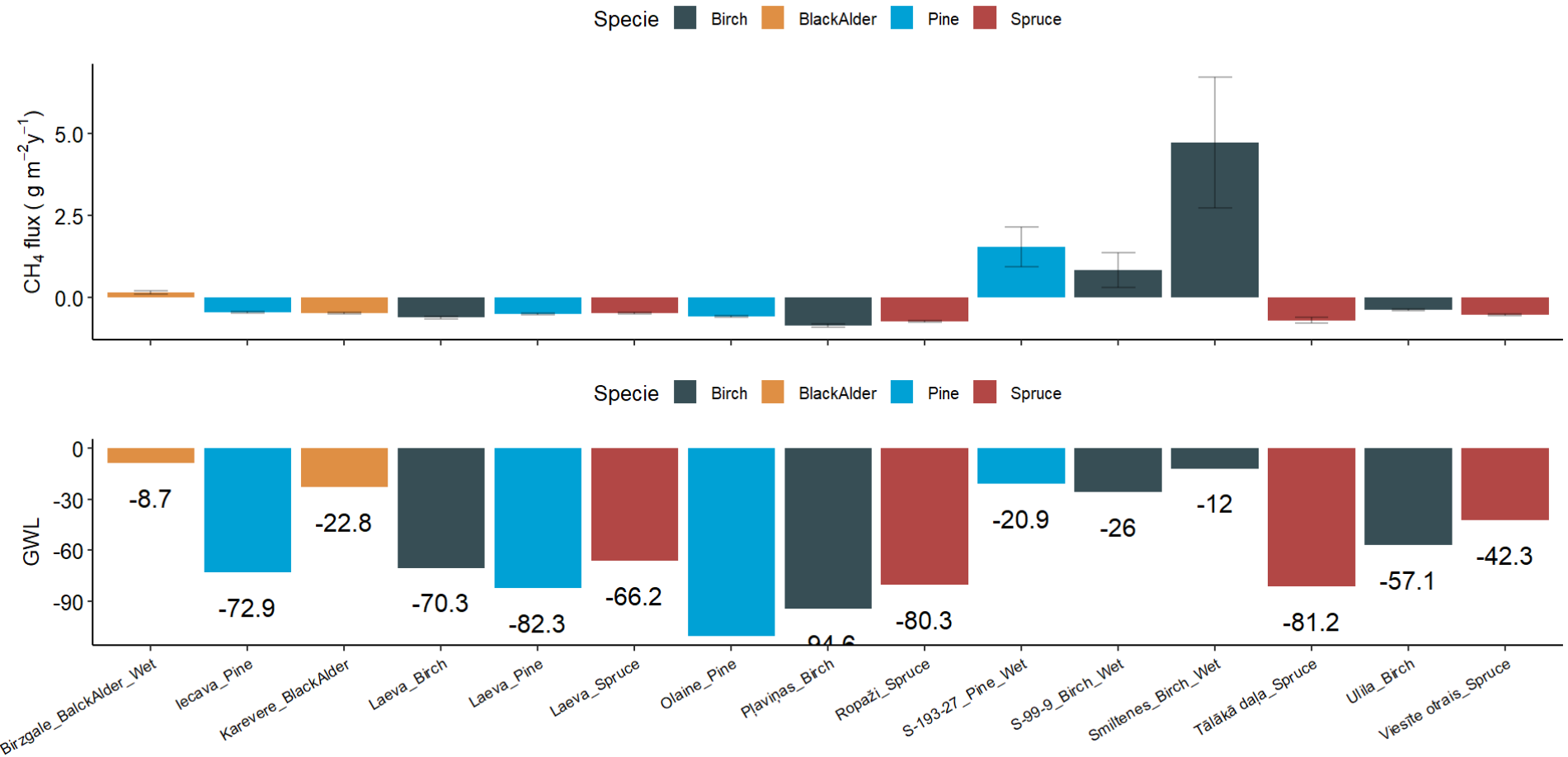




Results

Annual CH_4 fluxes and Ground water level (m)

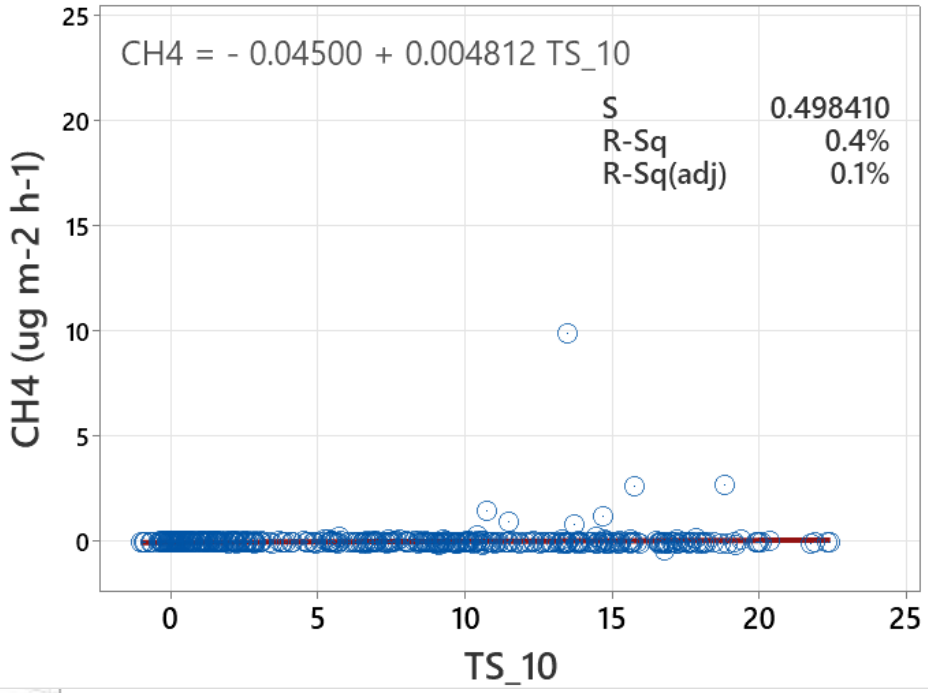


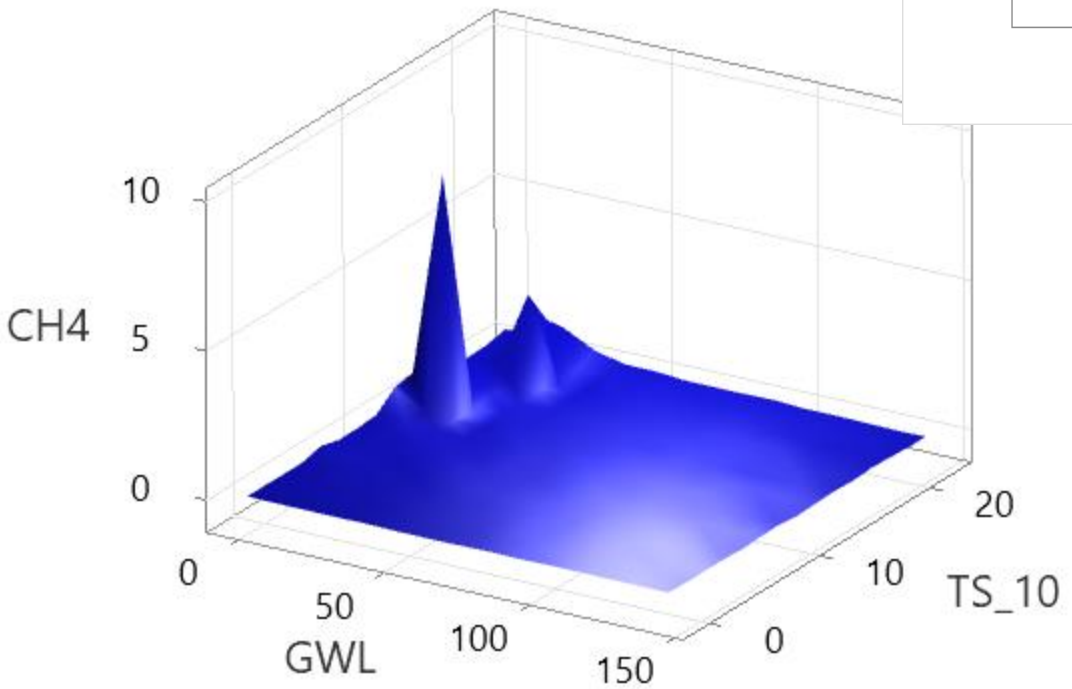
Results

Relationship of CH_4 flux

Soil temperature at 10cm

Ground water level

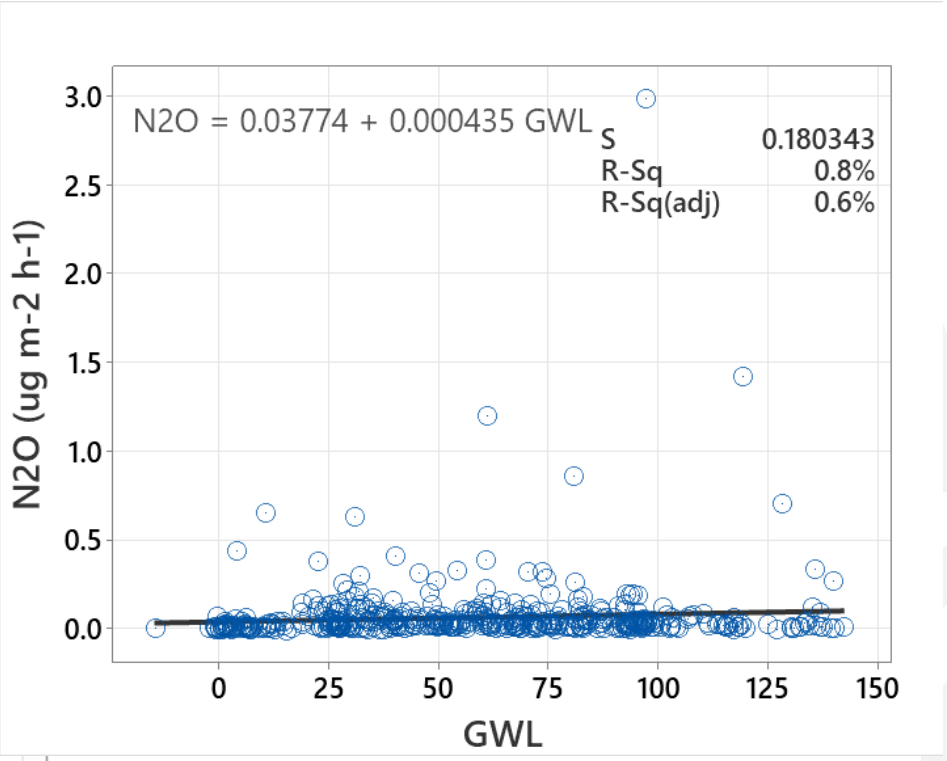


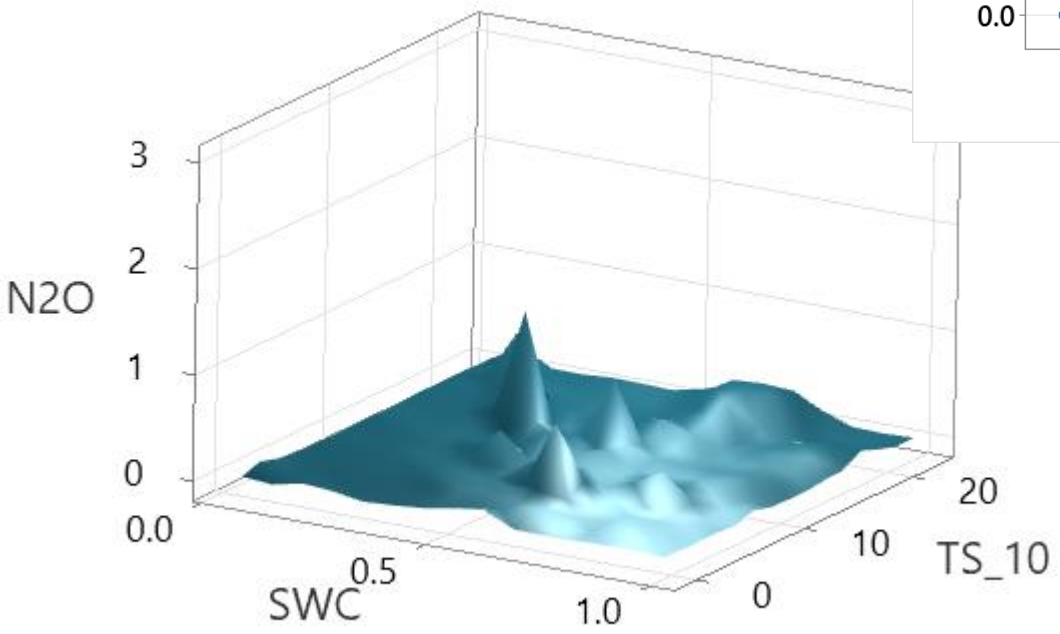


Results

Relationship of N_2O flux

Ground water level
Soil moisture at 10cm

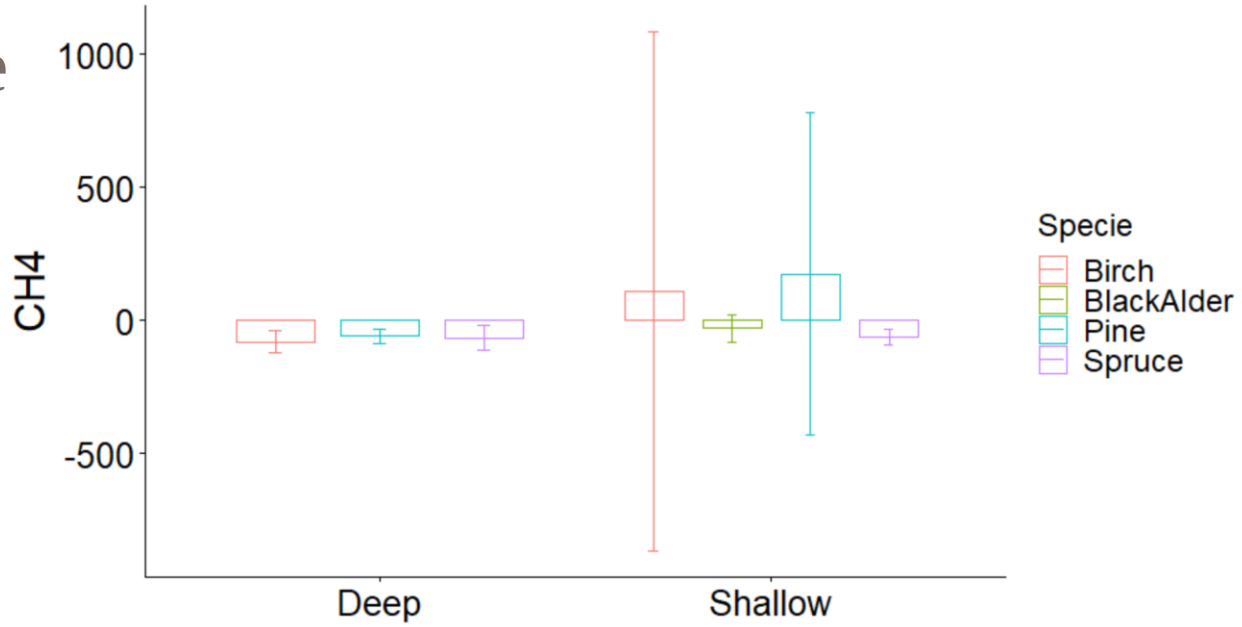


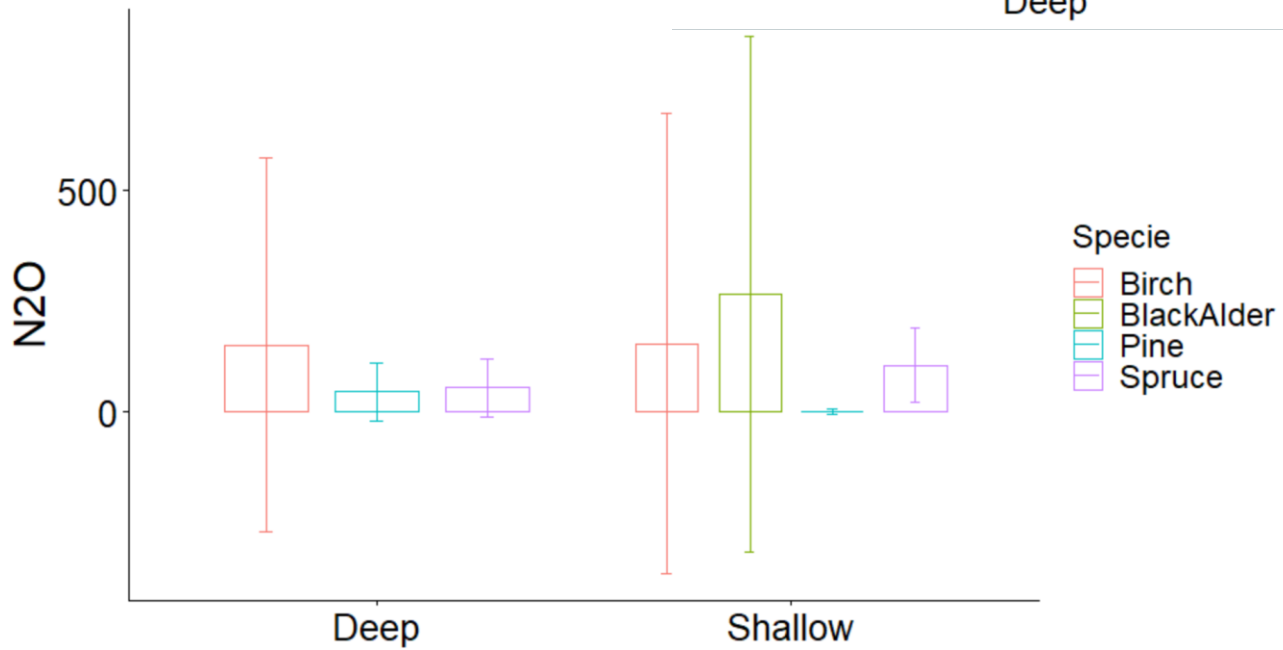


Results

Fluxes from Drainage

Deep drained:
Water level > 30 cm
Shallow drained:
Water level < 30 cm

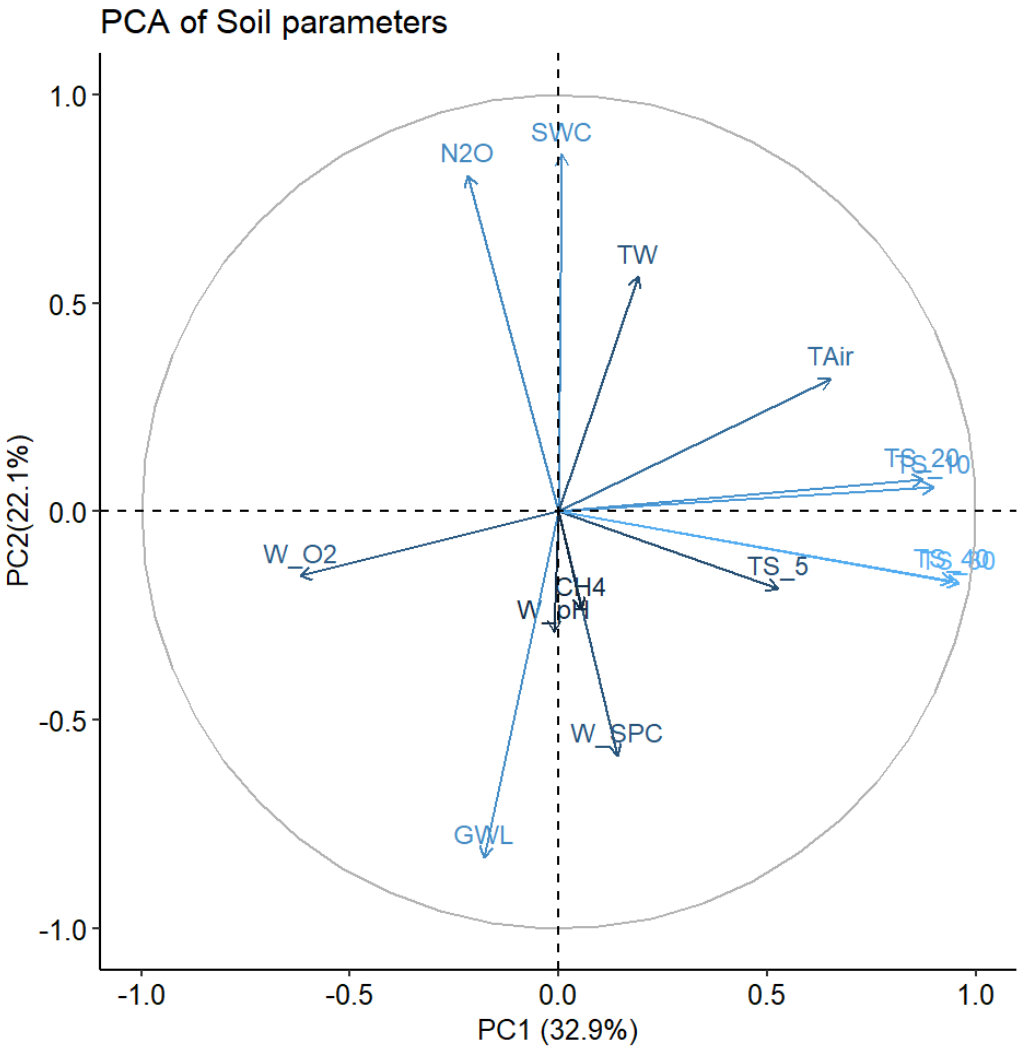




Results

Gas fluxes and soil parameters

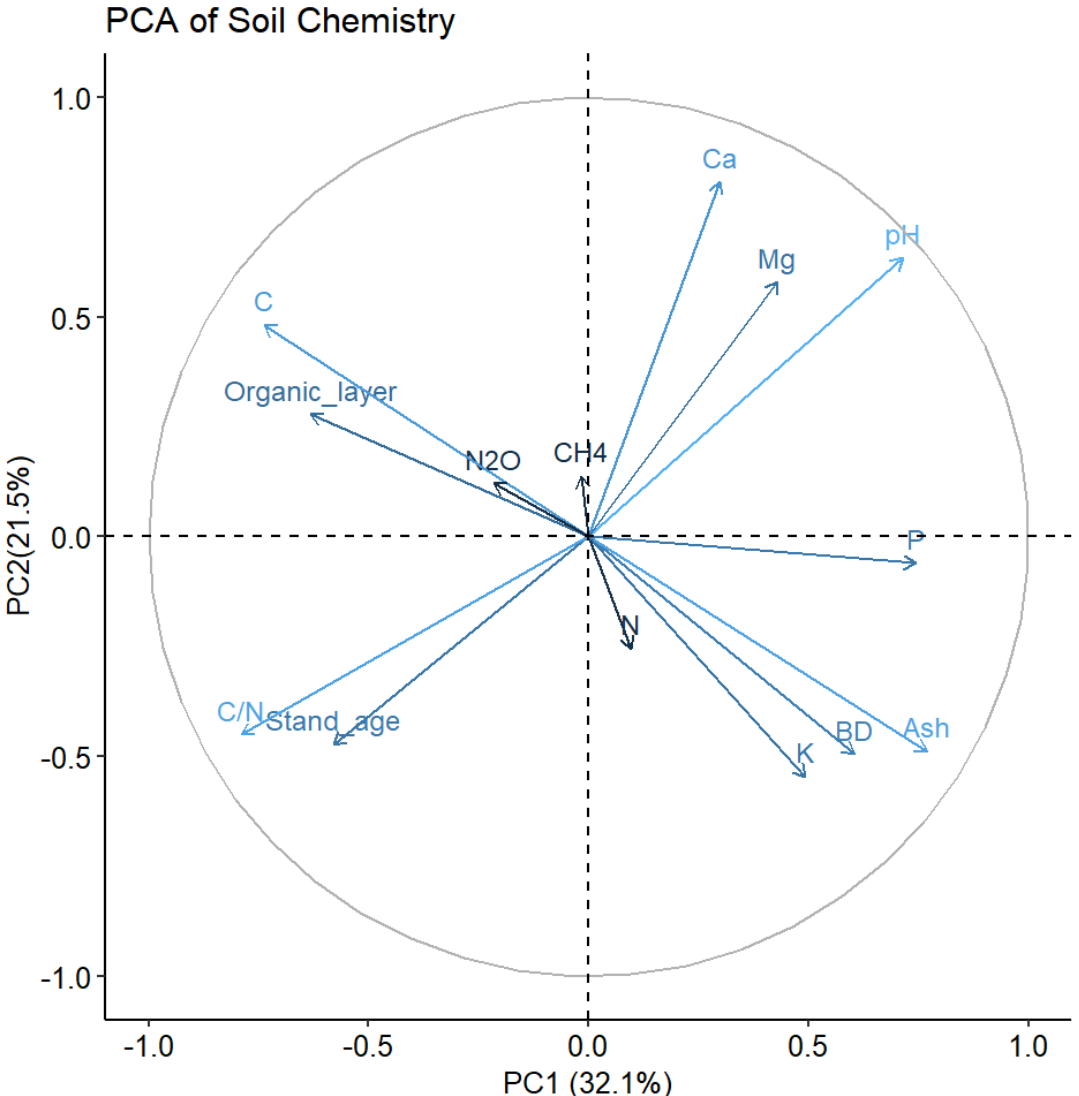
- Soil temperature (^{O}C)
  - 5, 10, 20, 30, 40 cm
- Soil moisture ($m^3\ m^{-3}$)
- Water table depth (m)
- Water parameters
  - O_2 content (%)
  - pH
  - Conductivity dsm^{-1}



Results

Gas fluxes and soil chemistry (10 cm)

- Organic layer depth
- Soil pH
- Carbon
- Nitrogen
- C/N ratio
- Calcium
- Magnesium
- Potassium
- Ash content
- Phosphorous

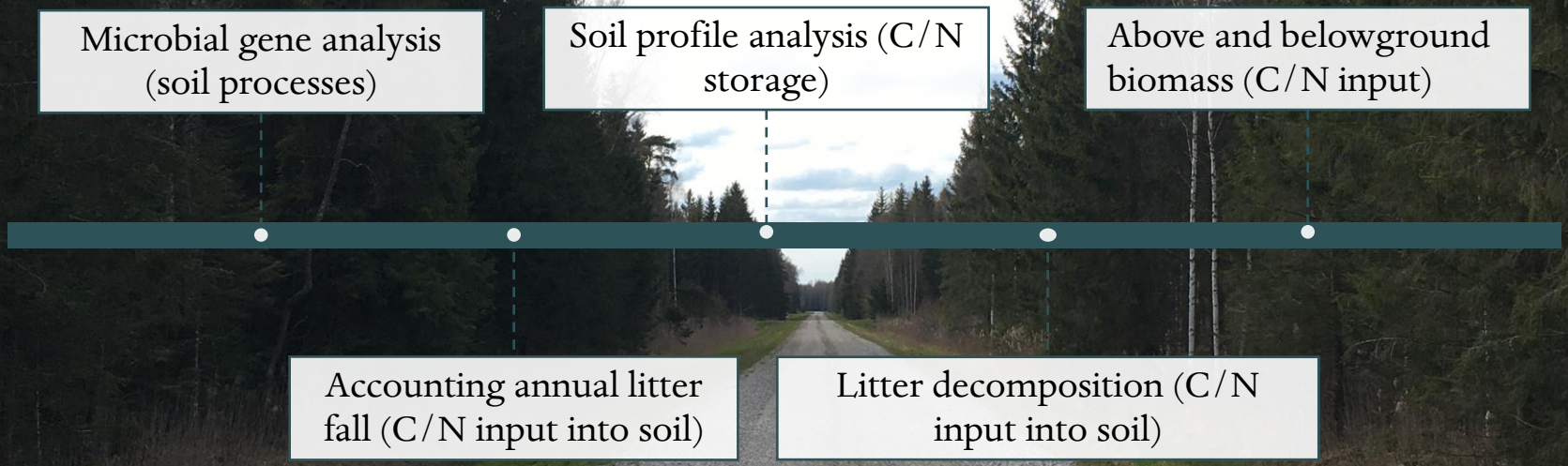


Results

Emission factors calculated from different forest species

Dominant species	Common name, Site ID		Peat depth (cm)	Water table regime	N2O (kg ha-1 yr-1)	CH4 (kg ha-1 yr-1)
Black alder	Karevere	EEC108	20-30cm	Drained site	4.58	-5.01
	Birzgale	LVC109	>50 cm	Drained (Wet)	3.02	1.45
Birch	Laeva	EEC106	60-70 cm	Drained site	4.86	-5.12
	Ulila	EEC109	50-70 cm	Drained site	2.51	-3.91
	S-99-9	LVC108	>50 cm	Drained site	1.76	8.36
	Pļaviņas	LVC115	>50 cm	Drained site	**33.90**	-8.60
	Smiltenes Melnalkšņi	LVC111	100 cm+	Drained (Wet)	6.28	**48.12**
Spruce	Laeva	EEC104	>50cm	Drained site	6.03	-7.54
	Ropaži	LVC104	30+ cm	Drained site	2.97	-6.39
	Viesīte otrais	LVC106	40 cm	Drained site	9.39	-5.60
	Tālākā daļa	LVC113	>50 cm	Drained site	5.04	-7.29
Pine	Laeva	EEC105	>50cm	Drained site	6.99	-5.34
	Olaine	LVC107	>21cm	Drained site	0.62	-6.09
	S-193-27	LVC116	60 cm	Drained site	0.02	**15.58**
	Iecava	LVC110	>21 cm	Drained (Wet)	1.76	-4.78
				IPCC (Tier1)	**2.5 (–0.6, –5.7)**	**8.8 (–1.8, –19.2)**

Next steps


Microbial gene analysis (soil processes)
Soil profile analysis (C/N storage)
Above and belowground biomass (C/N input)
Accounting annual litter fall (C/N input into soil)
Litter decomposition (C/N input into soil)

Preliminary Conclusion

- Drained organic soils act as soil CH_4 sinks, fluctuated by ground water level.
- High emissions of CH_4 occurs under anaerobic conditions, when the ground water level is close to the surface.
- N_2O fluxes are controlled by soil nutrient status
- High emission of N_2O occurred during the spring-thaw period as well during summer in some sites.
- Furthermore, detailed physiochemical soil and water parameters, peat characteristics, and tree litter fall will be investigated as factors influencing soil atmospheric gas exchange.

Thank you

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