BOREAL BOG INCUBATION'S GREENHOUSE GAS PRODUCTION INHIBITED BY NITROGEN ADDENDA

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MOTIVATION

Rising temperatures are projected to **increase decomposition in northern peatlands** and thus both:

- **Production of CO_2 and CH_4** , increasing radiative forcing
- **Release of nitrogen** bound in poorly decomposed organic matter into typically nutrient-limited systems

N serves as a nutrient and, when oxidized, as electron acceptor. Previous studies produced controversial results on the net effect of N availability [1-5].

Goal: Contribute to understanding the linked carbon and nitrogen cycle in peatlands, which is also relevant for thawing permafrost [6,7].

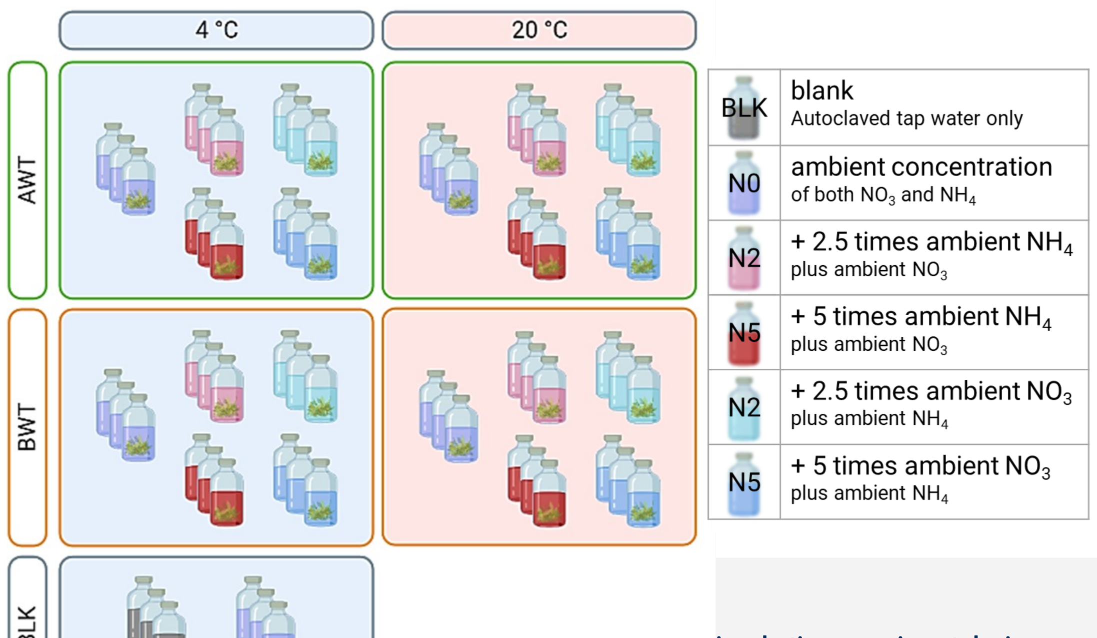
METHODS

Samples from Siikaneva bog, an ombrotrophic peatland in southern Finland were incubated in 120 ml glass vials under anoxic conditions. Peat from above the water table (AWT) and below (BWT) was incubated separately, and at both 4°C and 20° each. Inorganic N was added as solutions of NH_4Cl and $NaNO_3$ in sterilized tap water.

Drone image of the sample site
Lion Golde, Tabea Rettelbach
Vector Map: Openstreetmap contributors

From in situ porewater measurements of TDN (K. Jentzsch) and fractions of NH_4 and NO_3 [8], **target concentrations** of each N form were calculated as:

- **ambient (CTR)** 0.1 mg/l NH_4-N, 0.3 mg/l NO_3-N;
- **+ 2.5 * ambient (N2)**: 0.3 mg/l NH_4-N, 1.1 mg/l NO_3-N;
- **+ 5 * ambient (N5)**: 0.6 mg/l NH_4-N, 1.8 mg/l NO_3-N

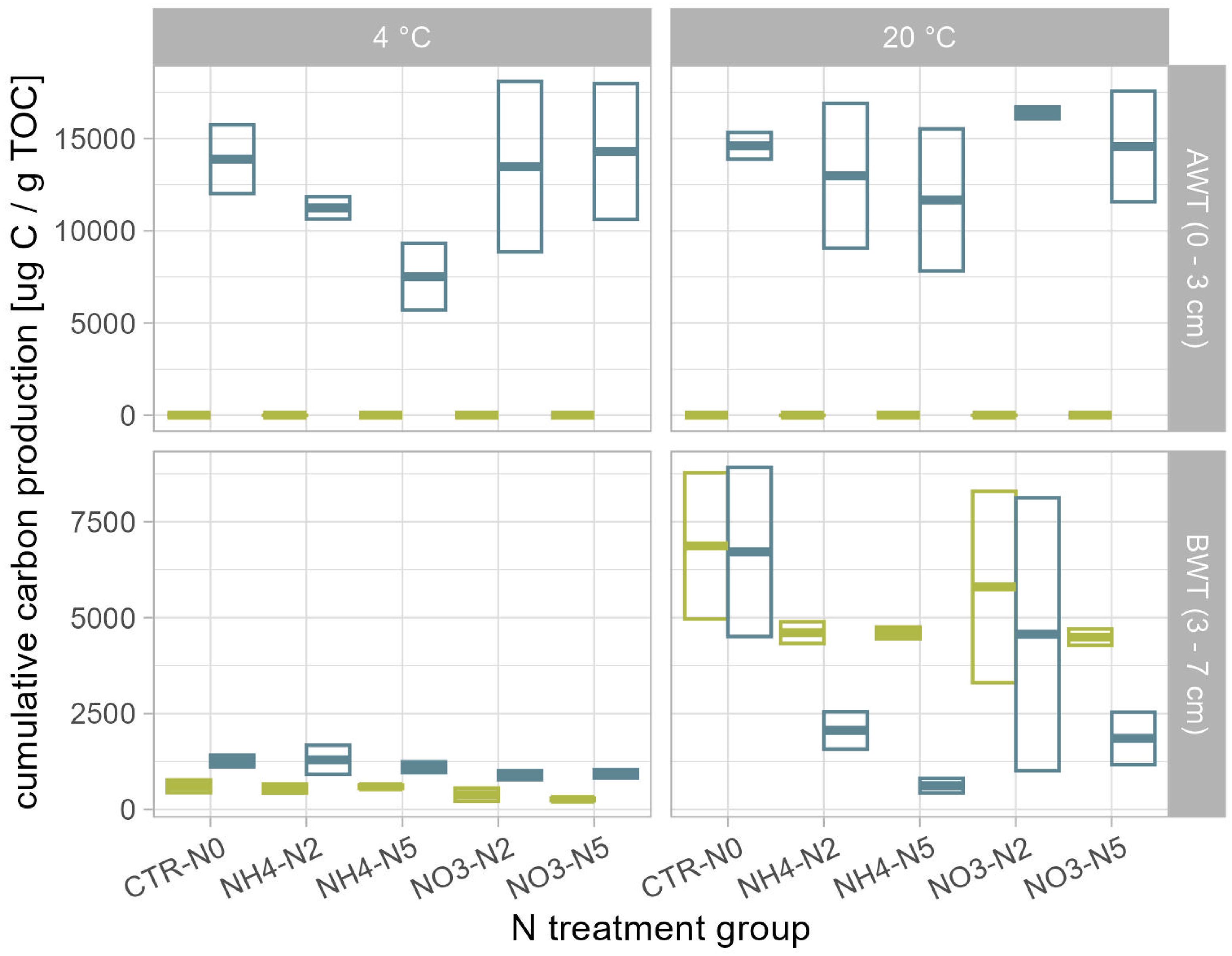


incubation experiment design
Figure created with biorender.com

CO_2 and CH_4 concentrations were determined from **headspace samples** with **gas chromatography**. Fluxes were calculated as differences of CO_2-C and CH_4-C contents over time between measurements after correcting for dissolved gas and losses through sampling.

RESULTS

Cumulative CH_4-C and CO_2-C production after 190 days of incubation



Cumulative C production
Standardized by g TOC after 190 days (mean ± standard deviation of three replicates).
Treatments are ordered by total amount of nitrogen added.

Peak production rates were reached in all treatments before day 60. Methane peak production occured later than for carbon dioxide, and delayed by nitrogen treatments.
The 20 °C control samples exhibited a higher CH_4-C production rate in the second half of the incubation, inverting the final ranking of CH_4-C production.

Main findings:

- **Available N did not limit microbial respiration (alone)**
- **Oxidation state of N addendum steers its effect on carbon mineralization**

Effects of temperature and depth:

- very **different microbial regimes** in above and below water tables samples expressed in lack of methane production in AWT.
- Temperature effect on C production was much larger in AWT compared to BWT samples.

Effects of N addenda:

- Trajectories of C production over time very similar between N treatments.
- Overall mainly **negative trend** of carbon production with increased N levels.
- No clear linear effect of total amount of N added.
- only two significantly different results within treatment sets (Kruskal-Wallis test): NH_4 addendum affected CO_2-C production in AWT at 4°C and BWT at 20°C.
- No significant effects on methanogenesis!

Quantified **sample properties** include (see tables below):

- water content, total organic and inorganic carbon, total nitrogen, bulk density (measured on peat samples)

	%H2O	%TC	%TOC	%TIC	%TN	C:N	dry BD
	%	%ww	%dw	%dw	%dw	%dw	g/cm3
AWT	97.3	42.0	41.9	0.1	0.6	70	0.021
BWT	96.8	42.9	42.8	0.1	0.8	54	0.034

- pH, electrical conductivity, dissolved organic carbon, total dissolved nitrogen (measured on water extracted with Rhizon samplers from frozen and thawed samples)

	pH	**EC** [µS/cm]	**DOC** [mg/l]	**TDN** [mg/l]
AWT	4.02	347	1130	23.8
_WT	4.04	119.1	457	5.72
BWT	4.03	64.6	186	3.28
tap water (lab)	7 - 8	554	---	---
tap water (report)	7.7	550 - 800	1.7	---

NEXT STEPS

- Do effects hold for shorter time frame around season length?
- Effects of N on date of max. respiration rate, C:N ratio, and coefficients of exponential fit to production rates after max. production
- Relative abundance of microbes (S. Liebner lab, GFZ) will help explain the microbial communities

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