Annual greenhouse gas fluxes from drained transitional bog and raised bog forest soils with different tree species composition

Joosep Truupõld, Reti Ranniku, Muhammad Kamil Sardar Ali, Ülo Mander, Thomas Schindler, Kaido Soosaar

Department of Geography, Institute of Ecology & Earth Sciences, University of Tartu, 46 Vanemuise, 51014 Tartu, Estonia

Aim

This study aims to estimate the magnitude and temporal variability of soil GHG fluxes in three drained transitional bog forests (DTBF) in southeastern Estonia with different tree compositions, dominated respectively by Downy Birch (Betula pubescens), Norway Spruce (Picea abies) and Scots Pine (Pinus sylvestris), in addition to one drained raised bog forest (DBF) dominated by Scots Pine.

Methods

To estimate soil N_2O and CH_4 fluxes, gas concentration samples were collected at 20-minute intervals during an hour-long session using manual static chambers (n=6) and were analyzed with Shimadzu GC-2014 gas chromatography. Soil environmental parameters (water table depth, soil temperature and moisture) were measured simultaneously with GHG measurements at each site. Ongoing sampling campaigns run twice a month since April 2022.

Conclusions

- Drained transitional bogs were annual net sinks of CH_4, while the only drained raised bog was a net source
- The nitrogen rich spruce site was a significant N_2O source
- Both CH_4 and N_2O fluxes had high seasonal variability
- CH_4 fluxes best correlatde with water level and soil temperature
- N_2O fluxes correlated with WL at the DBF site, but no other significant correlations occured

Next step

- N-C budget
  - Forest above-ground biomass, below-ground biomass
- Analysis and modelling of soil heterotrophic respiration
- Continue manual measurements for a second year to account for possible interannual variability

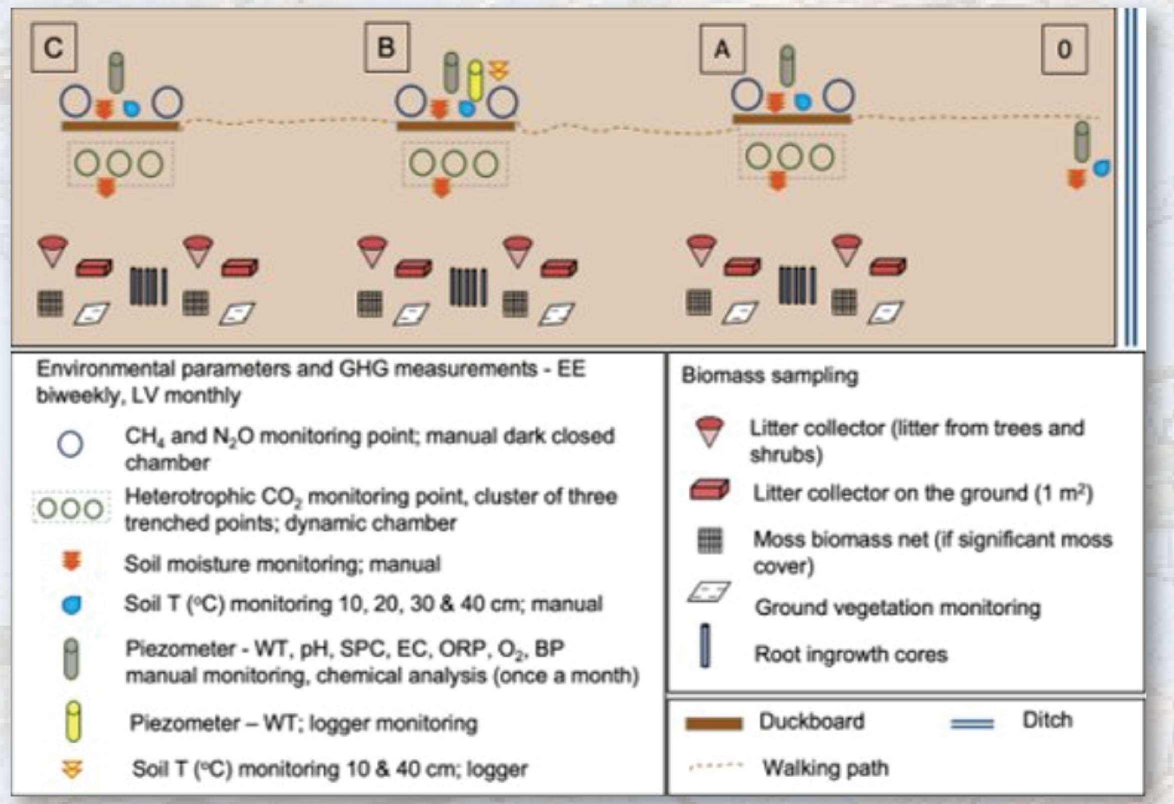


Fig. 1. Study site with three subsites for GHG and environmental parameter data collection. (figure modified from Jauhiainen et al. (2019))

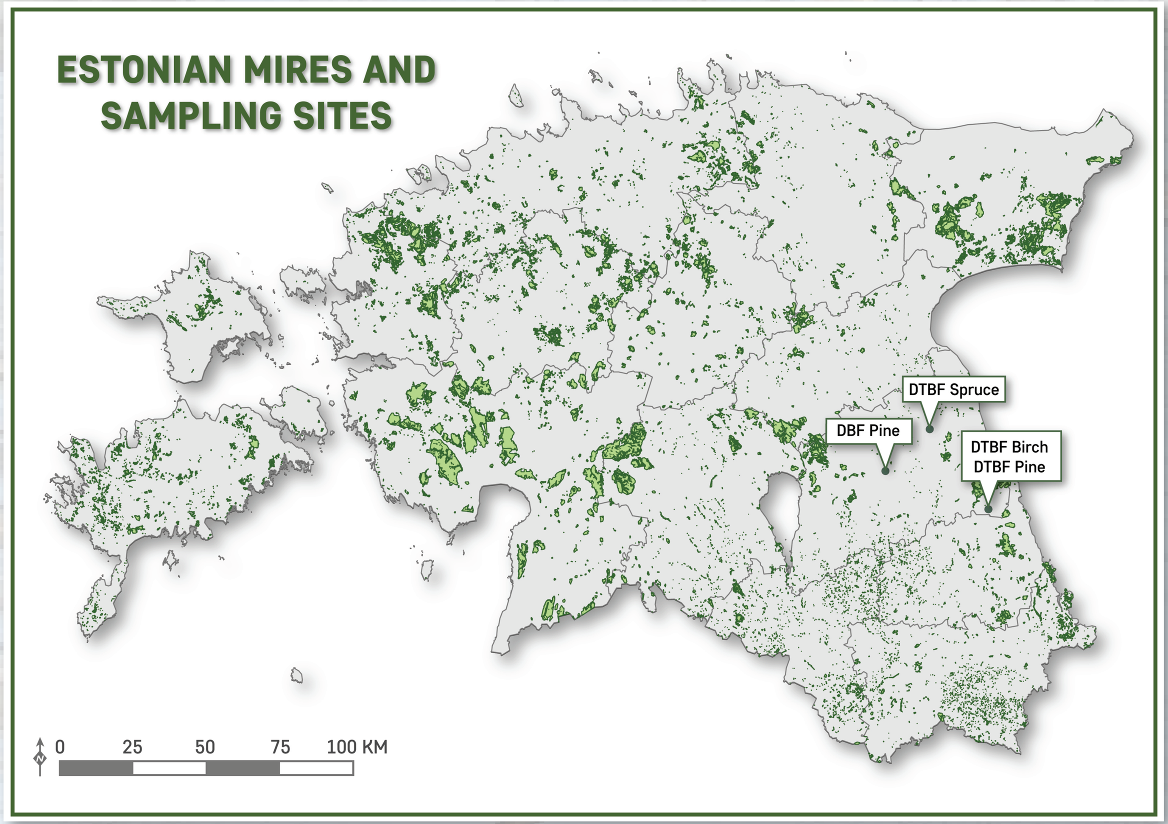
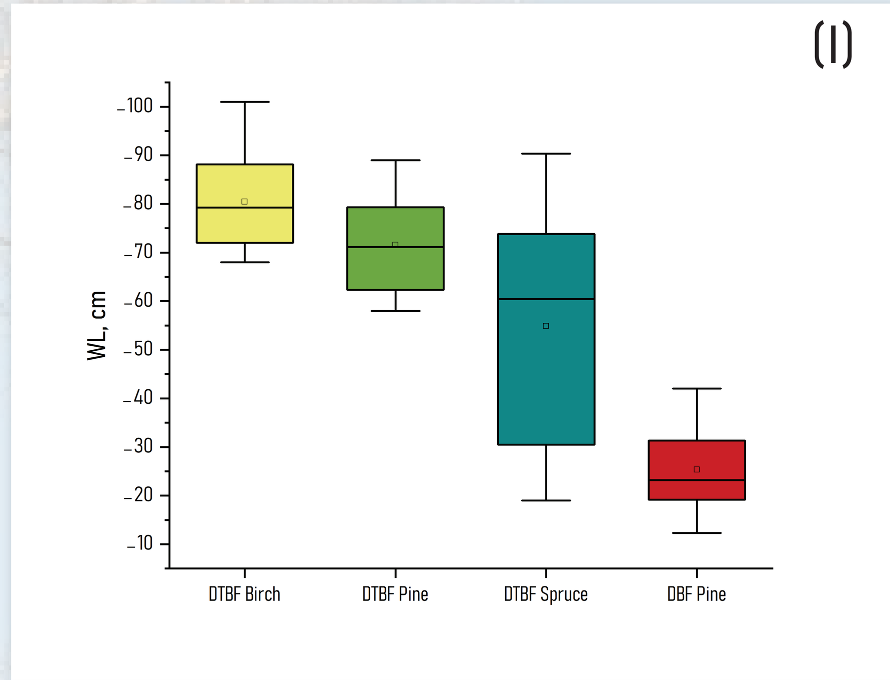


Table 1. Annual CH_4 and N_2O fluxes per site.

	CH_4-C (kg C ha y^{-1})	SE	N_2O-N (kg N ha y^{-1})	SE
DTBF Birch	-7.607	0.017	0.354	0.007
DTBF Pine	-5.840	0.011	0.511	0.007
DTBF Spruce	-5.198	0.012	1.810	0.033
DBF Pine	3.066	0.053	-0.039	0.001



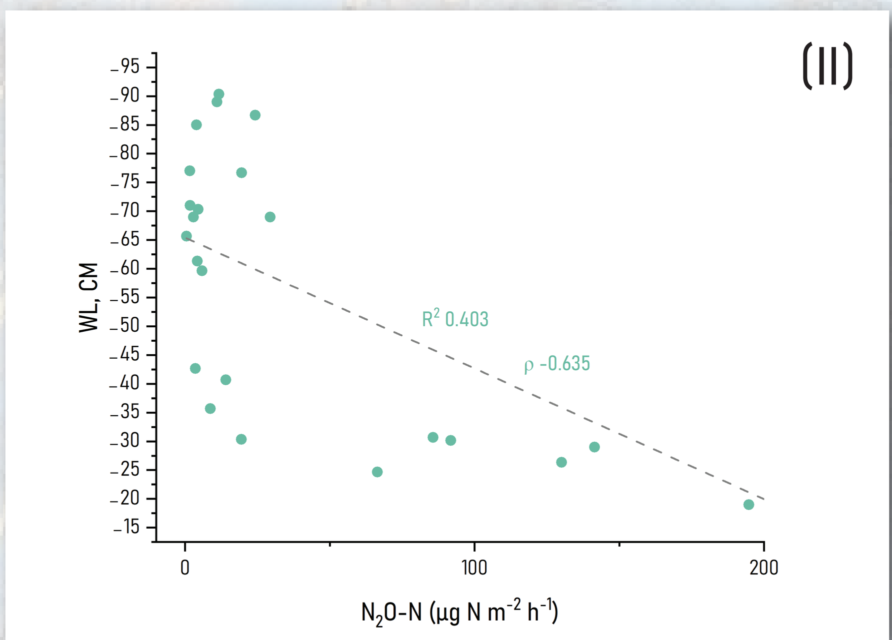


Fig. 2. (I) Annual variability water level per site (median values, 25th and 75th percentiles, minimum and maximum values) and (II) correlation between water level and N_2O at DBF Pine site.

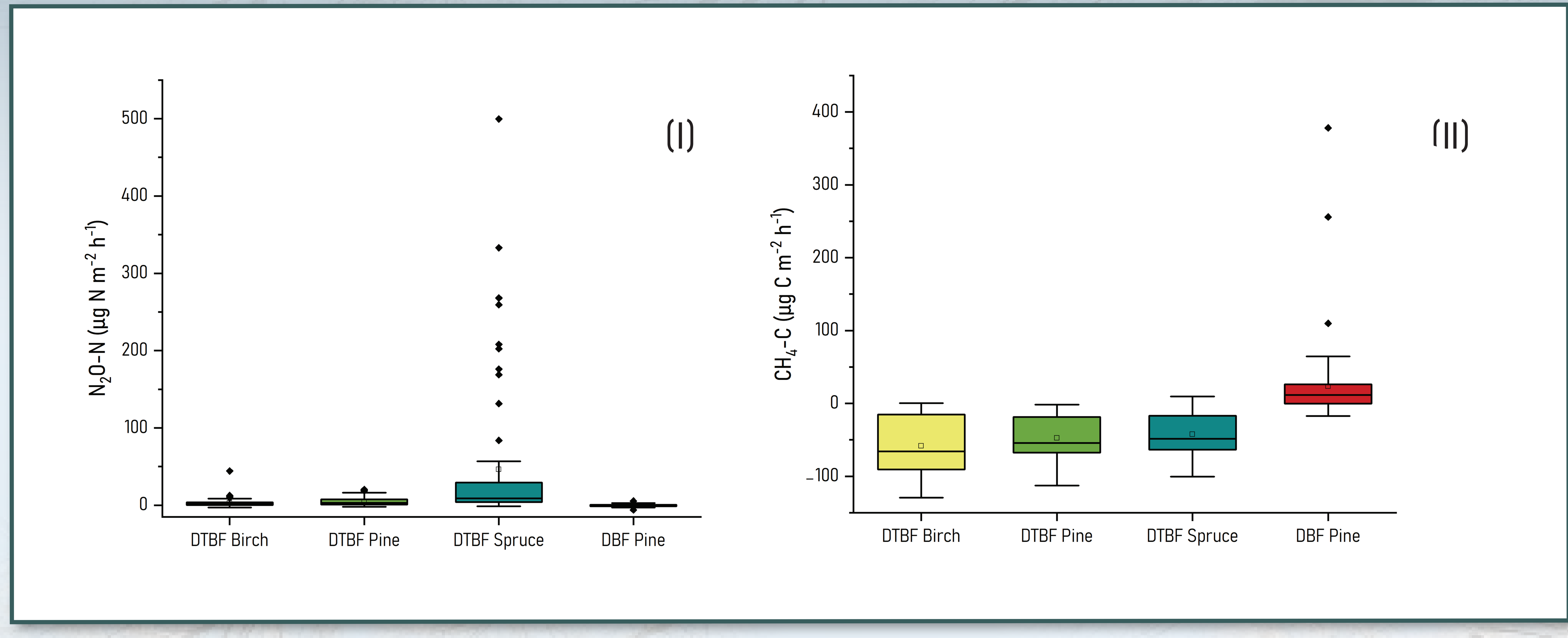


Fig. 5. Variation of annual (I) N_2O and (II)CH_4 fluxes per site (median values, 25th and 75th percentiles, minimum and maximum values).

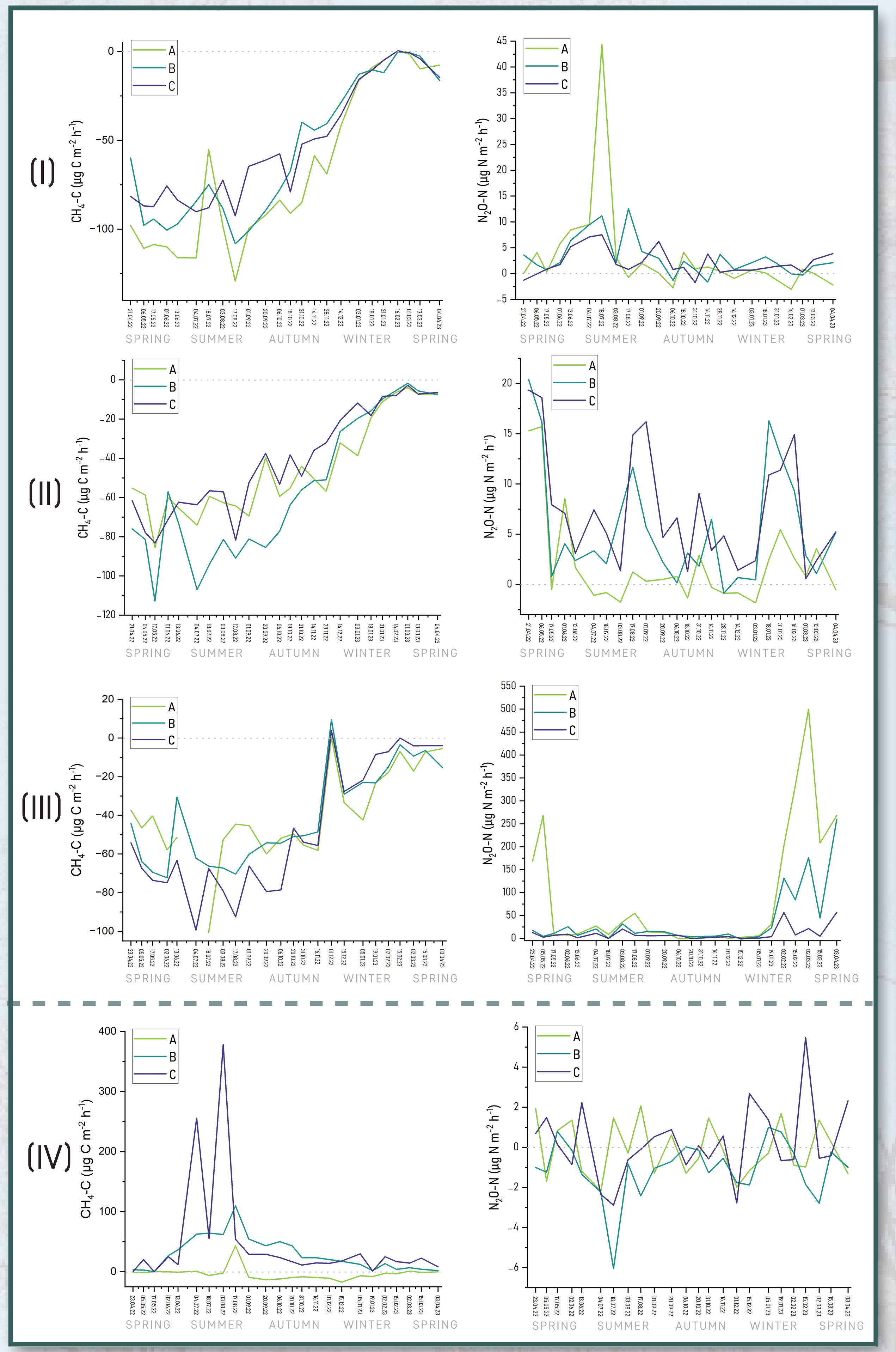


Fig. 3. Time series of (left) CH_4 fluxes and (right) N_2O fluxes per each sites' subsite. Row (I) DTBF Birch, row (II) DTBF Pine, row (III) DTBF Spruce, row (IV) DBF Pine.

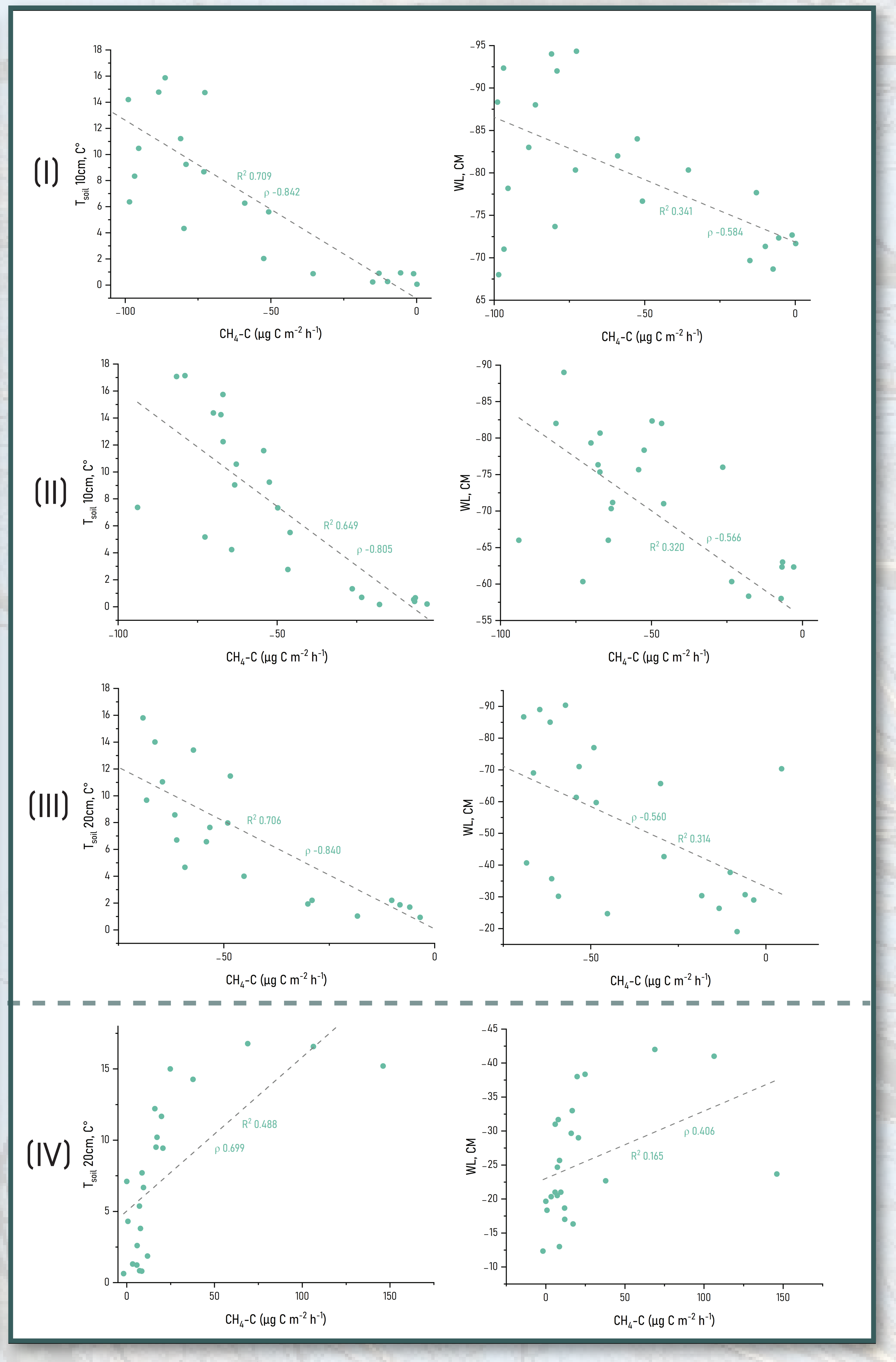


Fig. 4. Correlation (left) between soil temperature and CH_4 fluxes and (right) between water level and CH_4 fluxes. Row (I) DTBF Birch, row (II) DTBF Pine, row (III) DTBF Spruce, row (IV) DBF Pine.