

First Assessment of Greenhouse Gas Emissions in Austrian Peatlands under Different Land Management Intensities

Lanthaler, B.^{1,2}, Maier, A.¹, Glatzel, S.^{1,2}

¹ Working group Geoecology, Department of Geography and Regional Research, Faculty of Earth Sciences, Geography and Astronomy, University of Vienna, Vienna, Austria

² Vienna International School of Earth and Space Sciences, University of Vienna, Vienna, Austria

Background

- Austrian peatlands cover 44.000 ha. (Egger et al., 2025)
- More than 2/3 are used for agriculture, predominantly grassland. (APCC, 2024)
- CO₂ and CH₄ fluxes have been measured only for a near-natural bog. (Drollinger et al., 2019)
- Currently, no reliable estimate of greenhouse gas (GHG) emissions from Austrian peatlands under different land management is available.

Research questions

- To what degree do different land use intensities affect the emission of CO₂, CH₄ and N₂O in Austrian peatlands?
- Which are the main factors controlling the fluxes of each gas?
- To what extent does a reduced management intensity affect the yearly GHG balance?

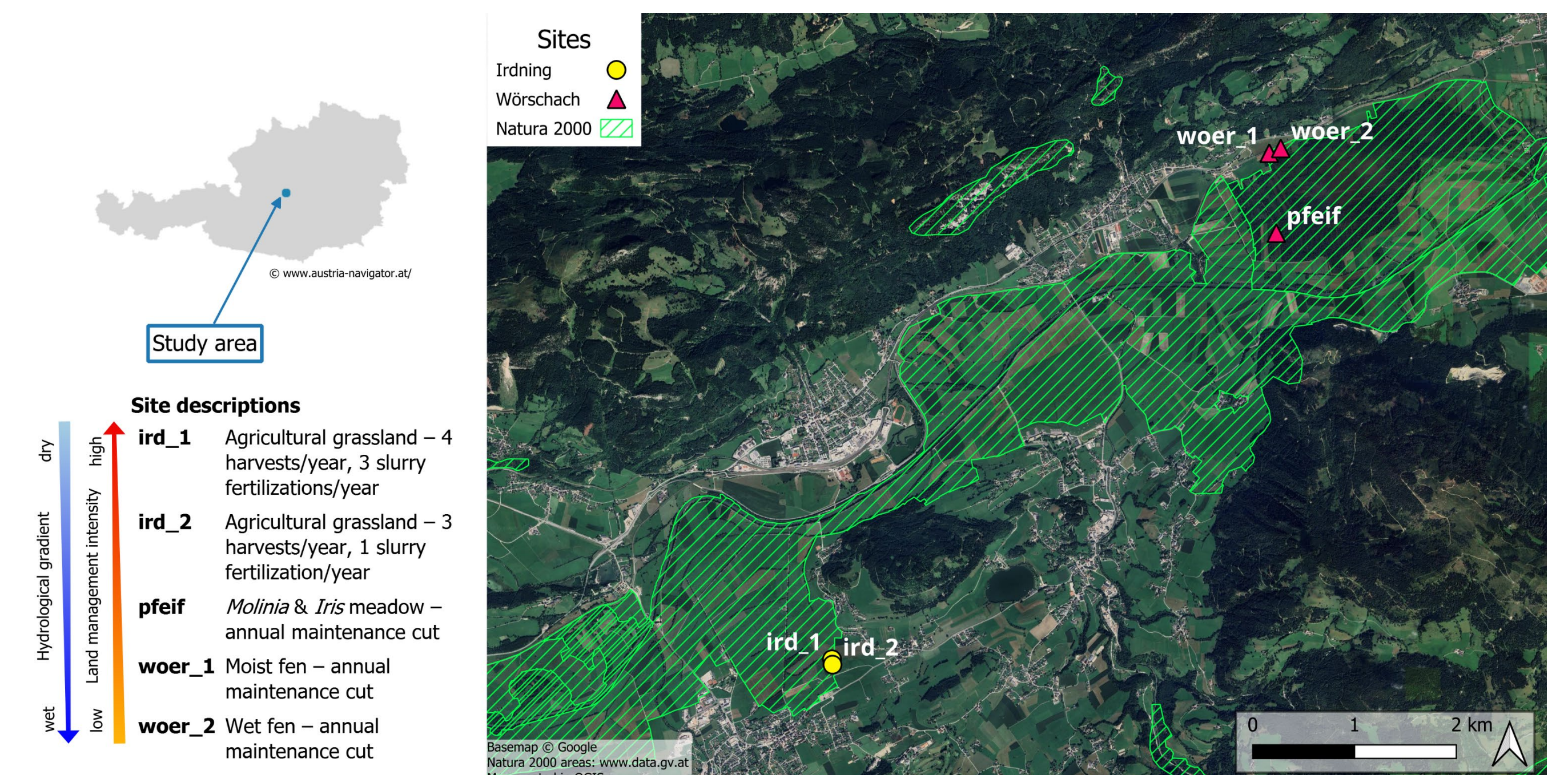
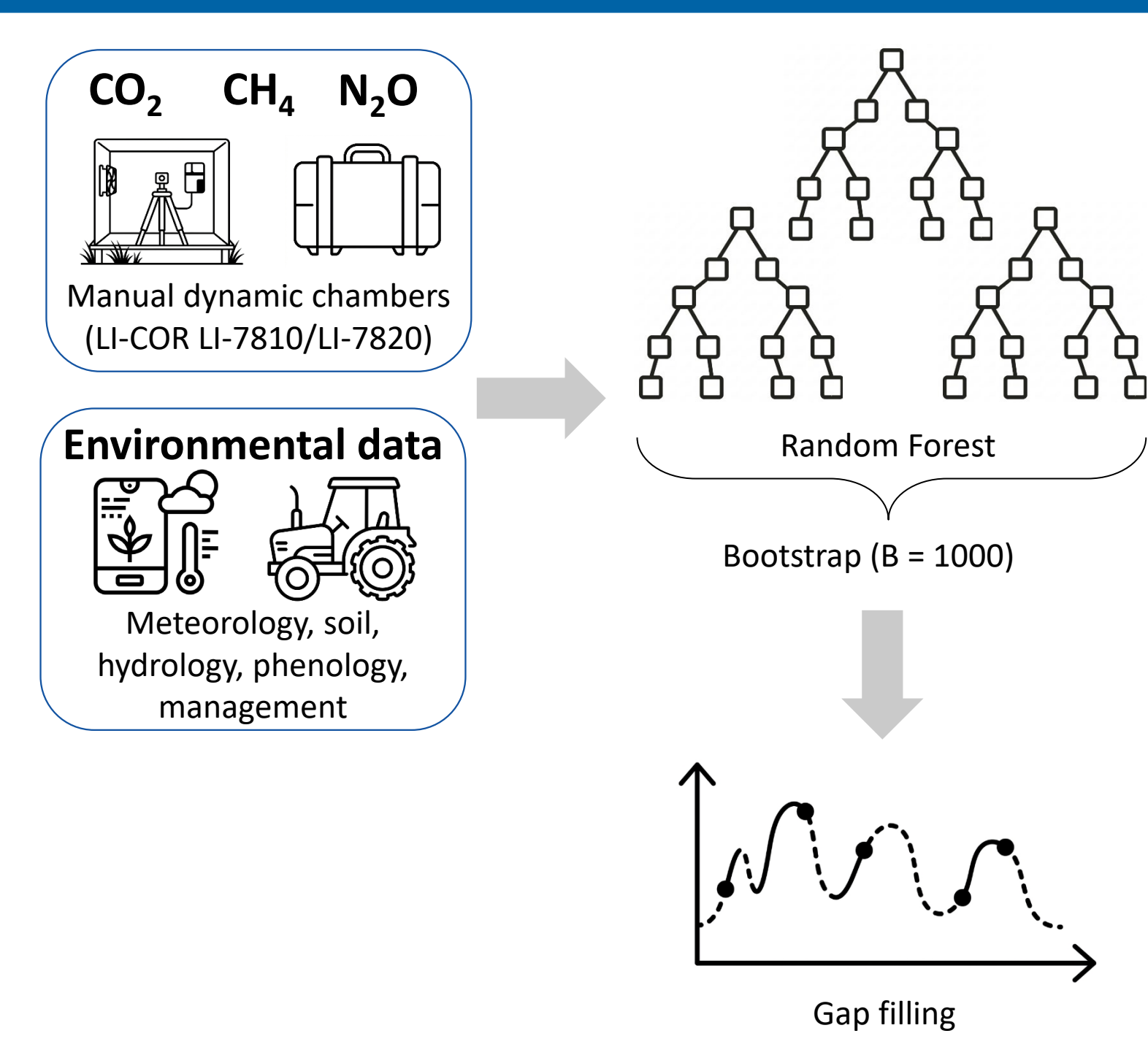


Figure 1: Study sites in the Irdninger and Wörschacher Moor, Styria (AT)

Methods



Key findings

CO₂ fluxes:

- Decreasing R_{ECCO} along hydrological and management gradient
- All sites acted as net CO₂ sources across the studied gradient, with only the wettest site approaching carbon neutrality (NEE ≈ -0.3 t CO₂ ha⁻¹ y⁻¹).
- R_{ECCO} mainly driven by water table depth (WTD), soil temperature (surface and -10 cm), air temperature and harvest events
- GPP mainly driven by light availability (PAR) and harvest events

CH₄ fluxes:

- CH₄ emissions gradually increasing with decreasing WTD
- Visible trend linked to growing season and soil temperature

N₂O fluxes:

- N₂O emissions only in fertilized grassland sites
- Emission peaks following fertilization and freeze-thaw events

Results

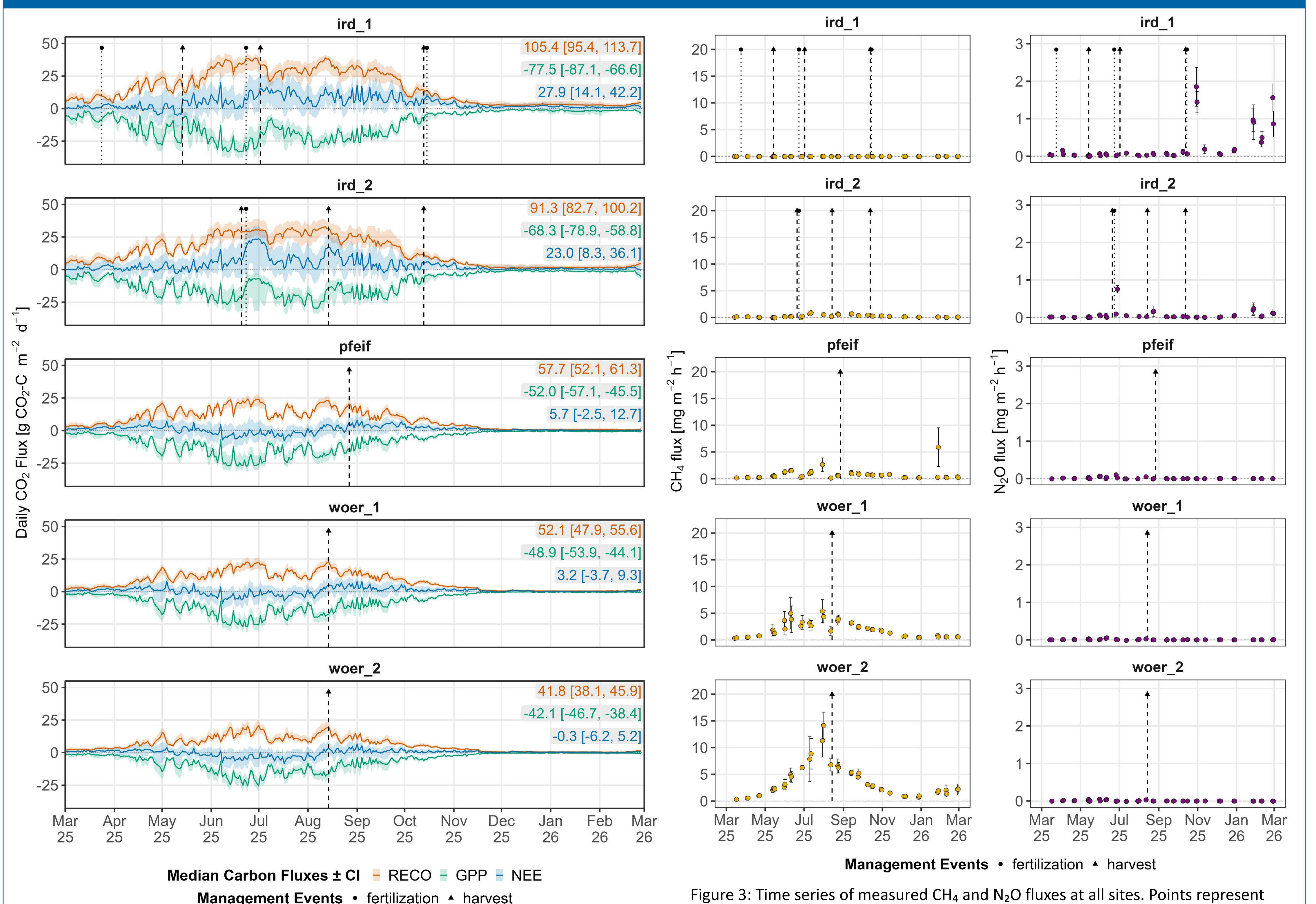


Figure 2: Time series of modelled daily CO₂ fluxes. Lines represent the median flux and shaded areas the 95% confidence interval obtained by bootstrapping. Annual sums per site are shown in the upper right corner of each panel [tCO₂ ha⁻¹ yr⁻¹]. Atmospheric sign convention: positive = ecosystem release to the atmosphere; negative = ecosystem uptake from the atmosphere

Future steps

- Test different additional machine learning algorithms (e.g. Neural Networks) to further improve CO₂ model
- Extend the machine learning framework to CH₄ and N₂O fluxes
- Derive net C Balance and total GHG emissions for all sites

Figure 3: Time series of measured CH₄ and N₂O fluxes at all sites. Points represent mean value of spatial and temporal replicates.

References:

- APCC. (2024). APCC Special Report: Landnutzung und Klimawandel in Österreich (R. Jandl, U. Tappeiner, C. B. Foldal, & K. Erb, Eds. 1. ed.). Springer Spektrum Berlin, Heidelberg. <https://doi.org/https://doi.org/10.1007/978-3-662-67864-0>
- Drollinger, S., Maier, A., & Glatzel, S. (2019). Interannual and seasonal variability in carbon dioxide and methane fluxes of a pine peat bog in the Eastern Alps, Austria. *Agricultural and Forest Meteorology*, 275, 69-78. <https://doi.org/10.1016/j.agrformet.2019.05.015>
- Egger, G., Rehberger, O., & Kudrnovsky, H. (2025). Moortinventar Österreich - Ergebnisse des Projekts zur Aktualisierung des Österreichischen Moorschutzkatalogs – Modul II.

