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Spatial and Temporal Variability of Nitrous Oxide Fluxes in a German Crop Rotation

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INTRODUCTION

- Nitrous oxide (N_2O) fluxes show **high temporal and spatial variability** → challenging its accurate quantification
- N_2O fluxes depend on numerous factors and their interactions (e.g. soil aeration, temperature, mineral nitrogen, easily available organic carbon, microbial activity) → making it difficult to identify the most important drivers

HYPOTHESES

- Management practices (i.e. **fertilization**) and **precipitation** result in **short-term N_2O peaks** which could be missed with discontinuous chamber measurements
- N_2O fluxes show a large **spatial variability** during emission peaks which is related to **variations in soil properties**

→ Combining **Eddy Covariance (EC)** and **chamber** measurements with soil analysis, climate and management data will help to accurately quantify N_2O fluxes and understand their drivers

PRELIMINARY RESULTS

100 Sampling points:

- **High spatial variability** of N_2O fluxes (COV* 245.97%)
- Soil nitrate (NO_3^-): 90 - 220 kg/ha
- Water fillled pore space (WFPS): 65% - 80%
- **No significant effects** of NO_3^-, WFPS or temperature on N_2O

8 Chambers:

*Coefficient of Variation

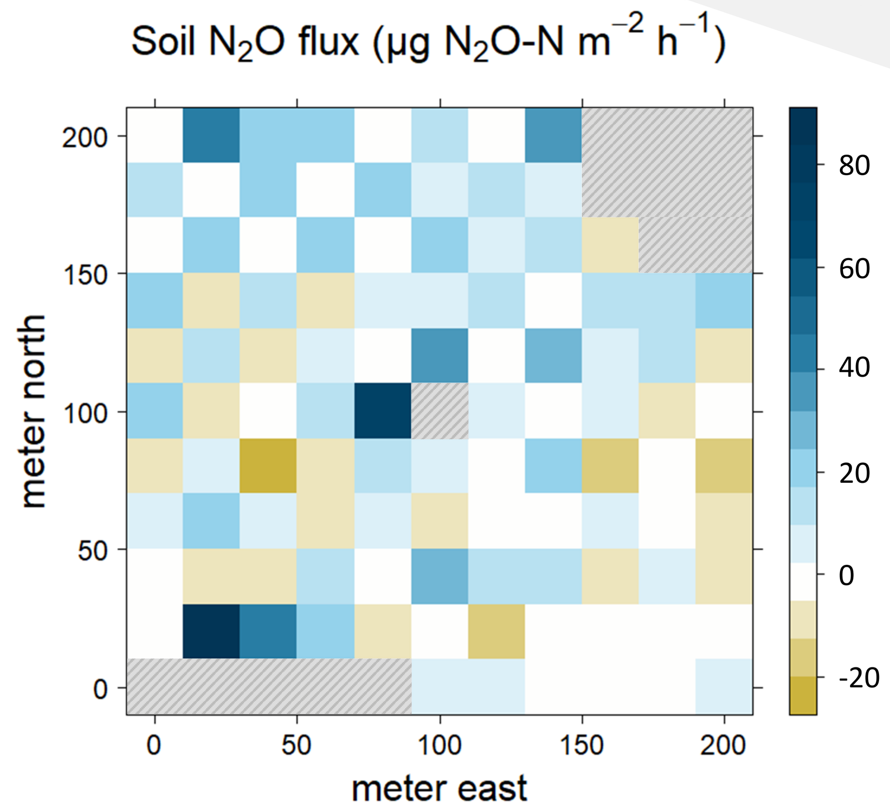
- **Increased N_2O fluxes after fertilization**
- Significant positive effect of NO_3^- and WFPS:

$$\log(N_2O) = 0.056 \times NO_3^* + 0.051 \times WFPS^* - 0.001 \times NO_3{:}WFPS^* + (1|chamber)$$

*$p < 0.05$, $R^2 = 0.54$

Preliminary EC-N_2O fluxes:

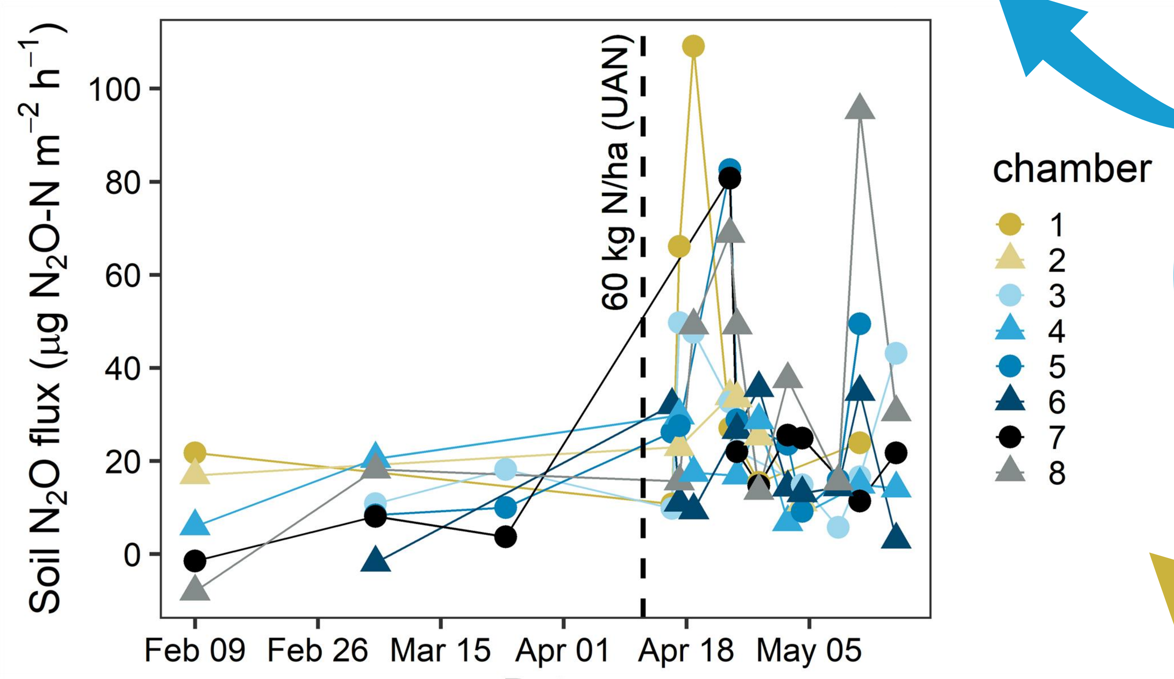
- **Short-term N_2O peak induced by** increasing temperature and 75 mm of **precipitation** after 5 dry weeks, while NO_3^- decreased to ~50 kg/ha 9 weeks after fertilization
- positive effect of 30-minute means of WFPS and soil temperature on EC-N_2O fluxes
- low signal-to-noise ratio is challenging the detection of small N_2O peaks

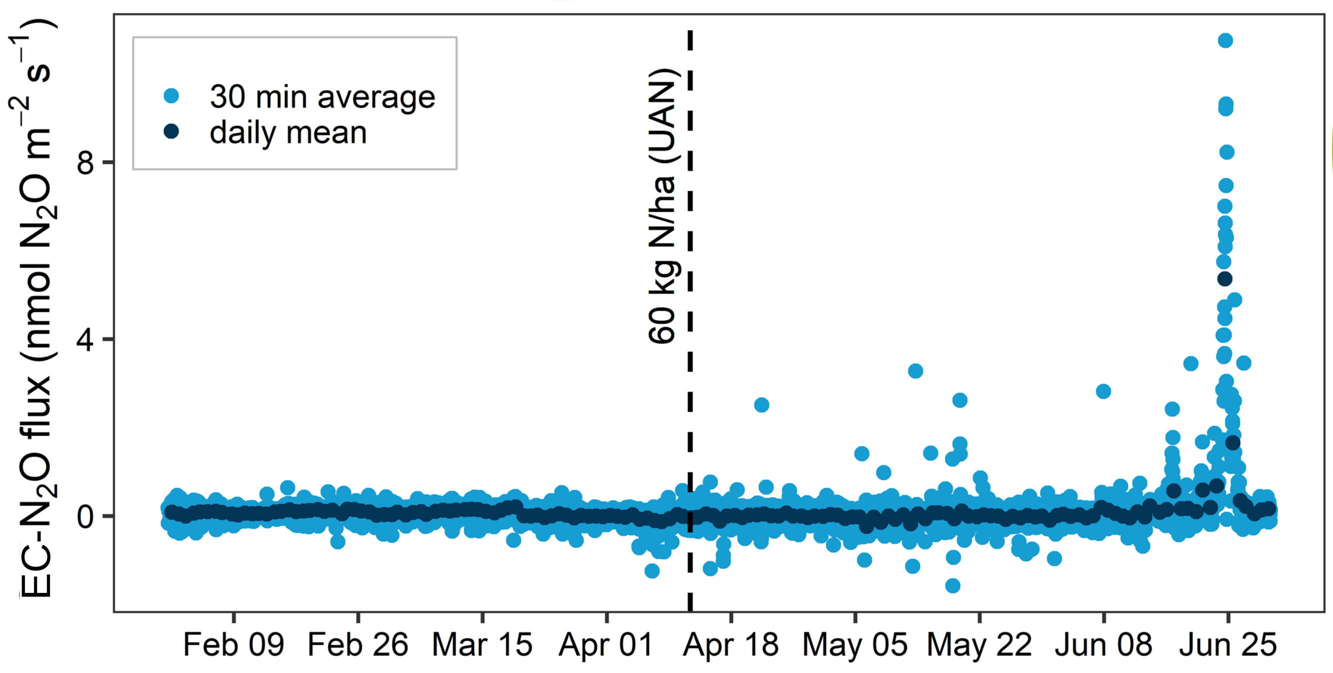


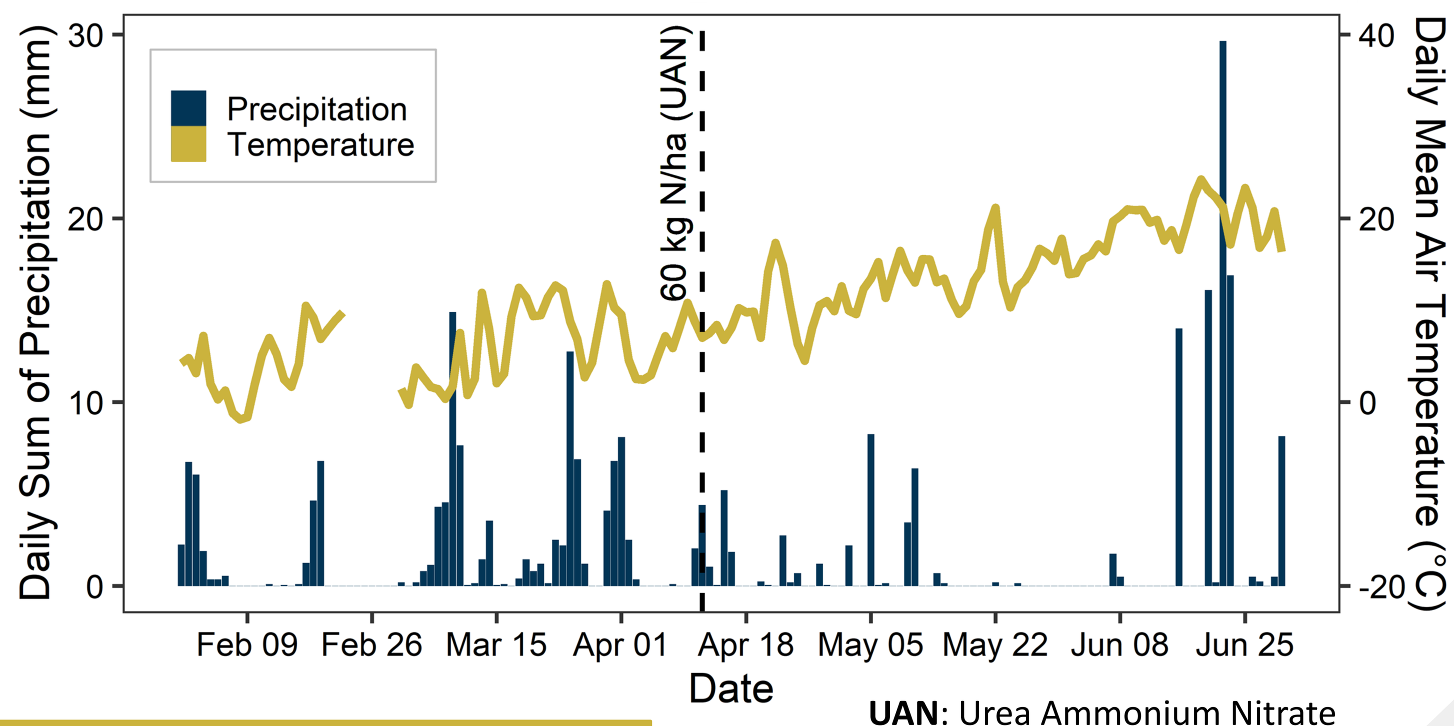
CONCLUSION

→ **N_2O peaks** appear after fertilization or meterological events, while the advantages of **both EC and chambers** is needed for detection

→ NO_3^- and WFPS **can** explain the **temporal variability** of chamber N_2O fluxes but **cannot** explain the high **spatial variability** after fertilization







UAN: Urea Ammonium Nitrate

OUTLOOK

- Analysing dissolved organic carbon (DOC) in all soil samples
- Measuring N_2O fluxes after harvest of the sugar beet + leaf incorporation and during winter wheat cultivation period
- Improving the mechanistic understanding using natural-abundance of N_2O isotopic species and analysis of gene abundance in the soil

MATERIAL & METHODS

- EC-Fluxtower on a 10 ha field with common agricultural practise, location 51.49°N, 9.93°E
- Sowing of sugar beets 2023-04-20 following white mustard as catch crop
- 8 static chambers (diameter 60 cm) located within the tower footprint, gas samples analyzed with gas chromatography, flux calculation with R package *gasfluxes*
- Soil samples (NO_3^-, NH_4^+, DOC) and soil moisture measurements next to each chamber
- 100 points measured with Licor-7820 on 2023-04-27, soil samples at every third point
- EC-tower with closed-path N_2O analyzer (LGR) and sonic anemometer (uSonic-3 MP Cage, METEK), flux calculation with EddyPro, tower equipped with soil moisture/temperature, air temperature and rain sensors

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