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Upscaling N_2O emissions from field to farm scale with ecosystem flux measurements and remote sensing

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Motivation

Nitrous oxide (N_2O) is together with carbon dioxide (CO_2) and methane (CH_4) among the most important greenhouse gases (GHG).

Soil microclimate, plant performance, microbial activity and fertilization are the main drivers of soil N_2O emissions.

In this project we investigate the crop rotation of a dairy farm in Switzerland

and model N_2O emissions at farm level. The aim is to develop site-specific management recommendations to reduce N_2O emissions from agriculture.

Measuring high resolution GHG fluxes at field scale

GHG fluxes between the biosphere and atmosphere are measured with the eddy covariance (EC) method (Fig. 1) and provide continuous fluxes (Fig. 2) at one field (FOR) of the crop rotation.

These measurements are combined with a meteorological station and soil sensors as well as manual vegetation and soil measurements.

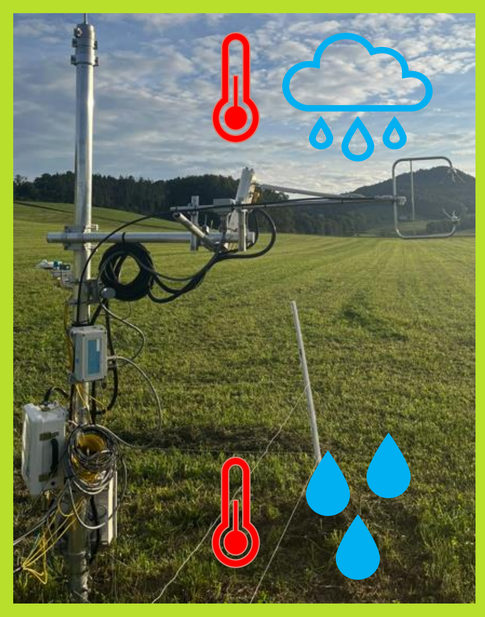


Fig. 1: Fully equipped eddy covariance station.

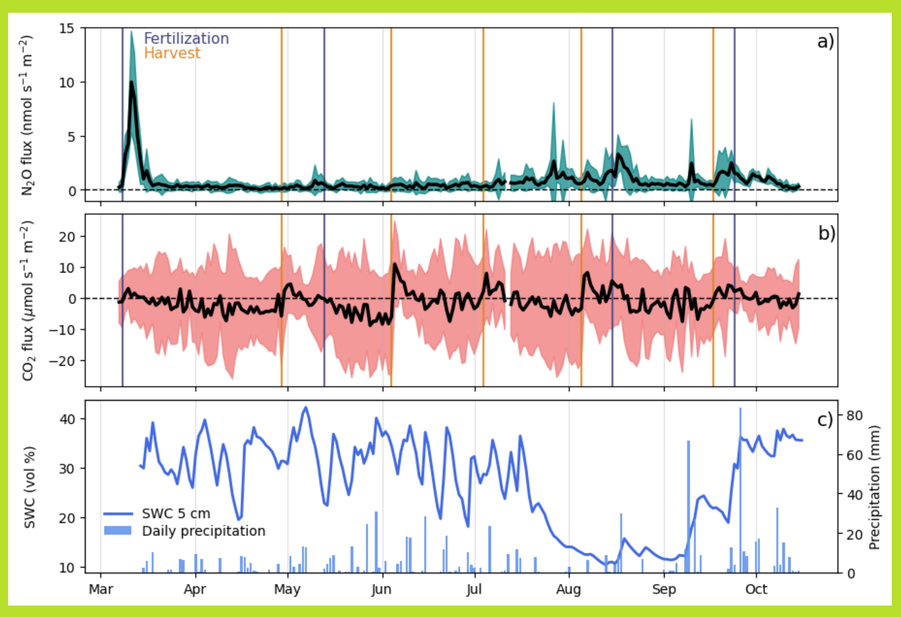


Fig. 2: Daily average (± stdev) a) N_2O b) CO_2 fluxes in temporary grassland 2024 (grass-legume mixture). Negative and positive values indicate ecosystem uptake and release, respectively. c) Daily average soil water content (SWC) and cumulative precipitation.

Additional field measurements

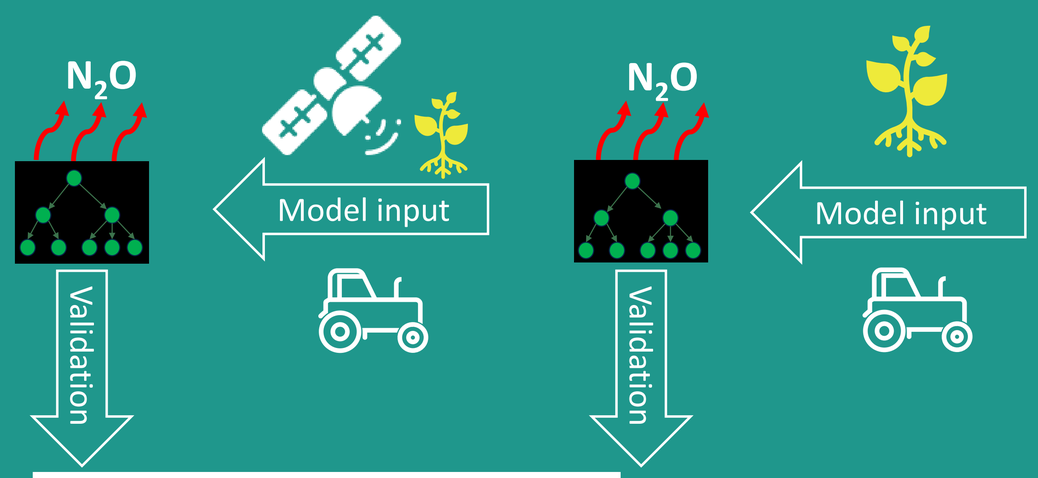
Soil sensors are installed in a second field (FO2) at the same stage of the crop rotation. We also carry out manual soil and vegetation measurements.

This will improve the robustness of the model used for upscaling.

Model N_2O emissions with field data

An empirical model will be built from the data measured at the two fields (FOR and FO2) and validated with gas chamber measurements (Fig. 3).

In a next step, vegetation measurements will be replaced with remote sensing products and the model will be again validated with chamber measurements.



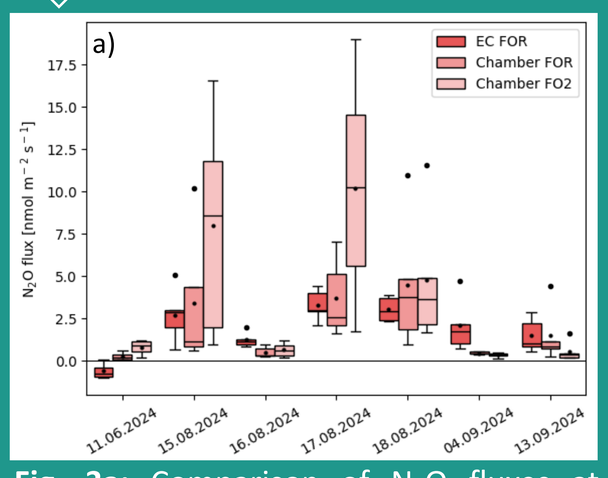


Fig. 3a: Comparison of N_2O fluxes at FOR and FO2 using eddy covariance and (b) chambers. Five chambers were installed per field. EC data shows five 30-minute averages per date, matched to chamber measurement times.

Build final model for farm upscale

To model N_2O emissions at farm level, field management and remote sensing products for each specific field will be used to capture field heterogeneity.

Predicted N_2O fluxes will be discussed with the farmer to develop site-specific management recommendations.

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