Evaluating models for the simulation of sustainable agricultural systems

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1 Motivation

- The effects of management on **productivity and greenhouse gas (GHG) emissions** needs to be quantified in order to assess sustainable management practices
- Process-based models are useful tools to to quantify these effects in croplands and grasslands
- Further, models are important for up-scaling yields and GHG-exchange beyond the field scale
- However, accurate simulations of GHG exchange, in particular nitrous oxide (N_2O) fluxes, are still a challenge, highlighting the necessity of model evaluation and improvement

2 Objectives

- Evaluation of biogeochemical models for biomass yields and N_2O emissions from an intensively managed grassland in Switzerland
- Estimation of the accuracy of N_2O simulations compared to IPCC Tier 1 approach
- Investigation of the accuracy of driver variables for N_2O production ("Are models right for the right reasons?")
- Highlighting key aspects of model improvement

3 Material and Methods

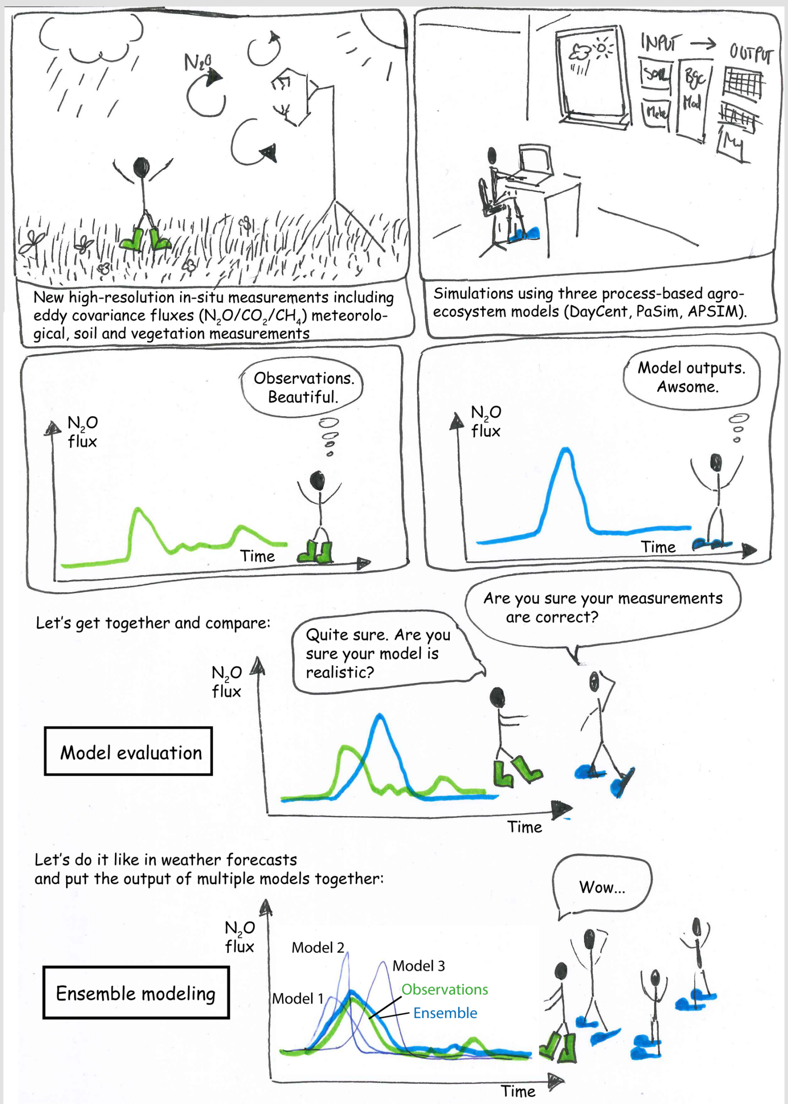

Fig. 1. Multi-model validation using observational data from the site Chamau

4 Preliminary Results

- All models estimated annual N_2O emissions more accurately than the commonly applied IPCC (Tier 1) approach.
- Models performing best in the estimation of annual N_2O emission (DayCent in two variants) were outperformed by other models that performed best on the prediction of daily N_2O emissions (APSIM in two variants).

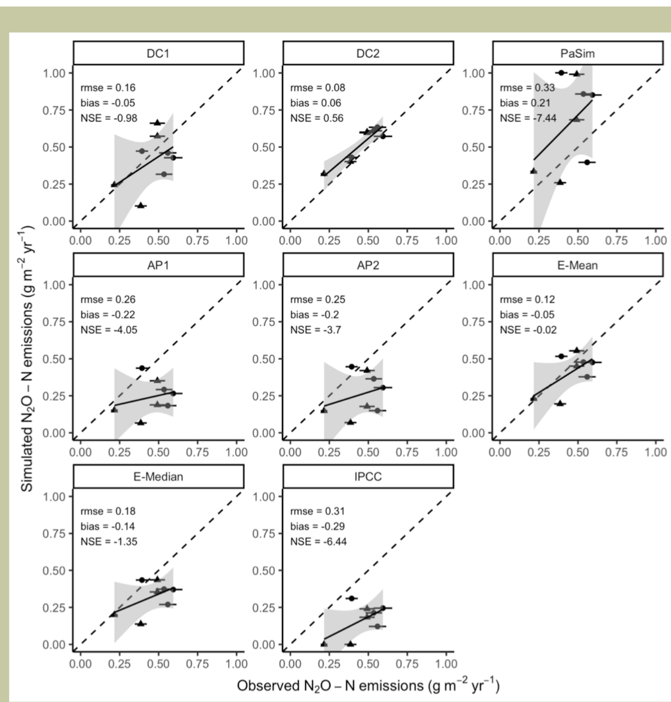

Fig. 2. Annual values of observed (horizontal axis) versus simulated N_2O emissions (vertical axis) for models DayCent (DC1, DC2), PaSim, APSIM (AP1, AP2), the ensemble median (E-Median), the ensemble mean (E-Mean), and for the IPCC estimate in parcel A (circles) and parcel B (triangles). The dashed lines indicate the 1:1-lines, and the solid lines display the linear regression line between observed and simulated N_2O emissions.

- The ensemble mean achieved better performance on the daily time-scale than all individual models.

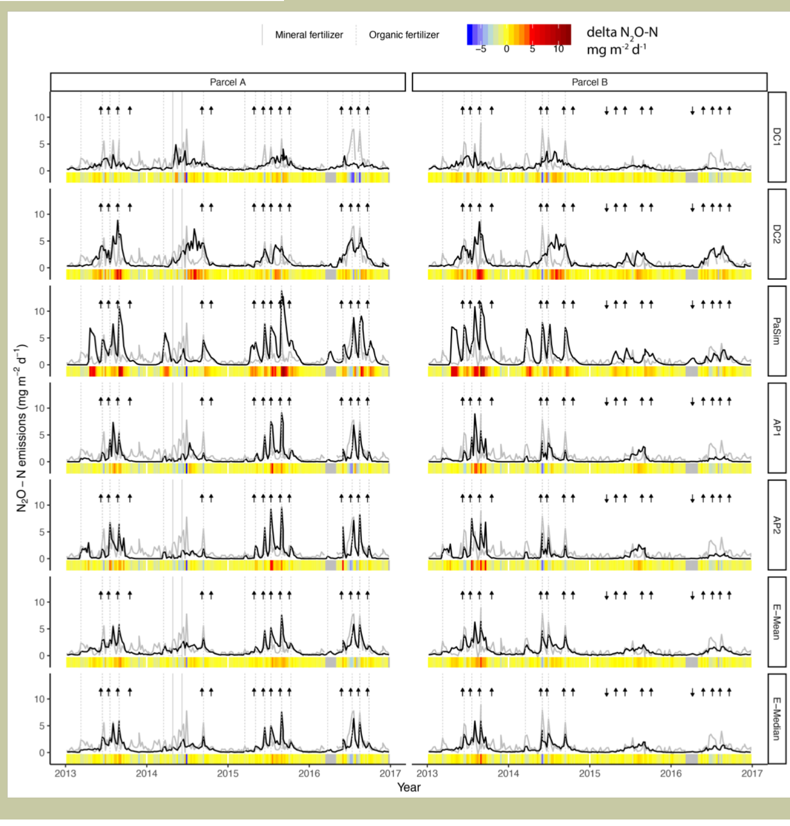

Fig. 3. Weekly averages of simulated (black) and observed (grey) N_2O fluxes for Parcel A (left) and Parcel B (right) by several models and the multi-model ensemble (top to bottom); Upward arrows indicate harvest and downward arrows indicate over-sowing. Grazing periods are shown as black bars. The weekly bias in N_2O fluxes (ΔN_2O) is displayed as colored bar, with red indicating an overestimation, blue an underestimation by the respective model, and yellow a bias close to zero (see legend). A grey colored bar indicates periods of missing data.

5 Conclusions

- The multi-model ensemble simulated the impact of management strategies on yields and N_2O emissions more accurately compared to individual models.
- Therefore, using an ensemble of several (>3) models is highly beneficial to reduce uncertainties when evaluating the sustainability of agricultural systems.

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