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Agroscope

Quantification of N_2O fluxes and EF values in a pasture using chamber and eddy-covariance technique

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Motivation

❖ In Swiss agriculture nitrous oxide (N_2O) is generated by applications of fertilizers, indirect N_2O emissions, storage of farmyard fertilizer, animal excreta.

❖ Especially pastoral land is are a dominant source for N_2O due to various nitrogen inputs. Urine and dung patches are spatial hot spots for N_2O and contribute to its spatial-temporal variability. This implicates a challenge for the quantification of N_2O emissions.

❖ Switzerland uses IPCC global default Emission Factor (EF) values to quantify N_2O emissions

EF_3 = 2 % for grazing based N inputs
EF_1 = 1 % for fertilizer

❖ For the use of Tier 2 approach and the employment of country-specific EFs, country-specific data need to be collected. Particularly, measurement data from urine and dung patches are rare in Switzerland.

From 2020-2023 we measure N_2O emissions from a pasture in relation to possible drivers in order to give suggestions for EF values used in the Swiss greenhouse gas inventory

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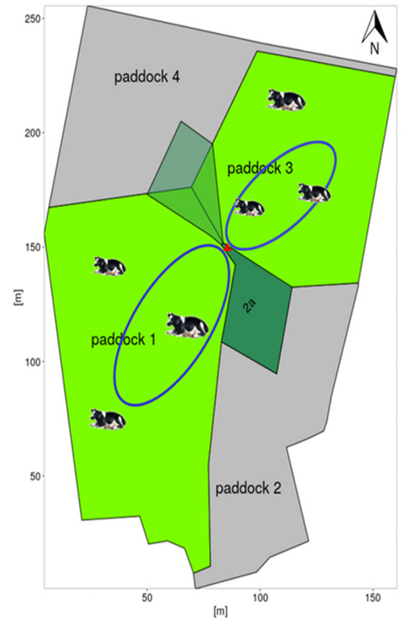
Field site and Methods

❖ Experimental pasture field of 2.6 ha located in Kt. Thurgau of Switzerland; 539 m a.s.l.; 1124 mm precipitation yr^{-1}

❖ Pasture field consists of four paddocks with a net equal management of grazing, mowing and fertilizer applications



Field scale measurements from a real pasture:

An Eddy covariance tower is located in the middle of field recording since Mai 2020. N_2O fluxes measured by QCL originate from paddock 1 & 3 according to the main wind directions (NE, SW).

Small scale measurements from artificial applications:

Performed in a fenced subarea of the same field using a fast-box chamber[1,2]

→ Three applications were performed in 2020:

July: 2 L (10 g N L^{-1}) of synthetic urine[3]

August: 2 L (10 g N L-1) of synthetic urine; 1 L & 2 L of real cattle urine

September: 1 L & 2 L (10 g N L-1) of synthetic urine

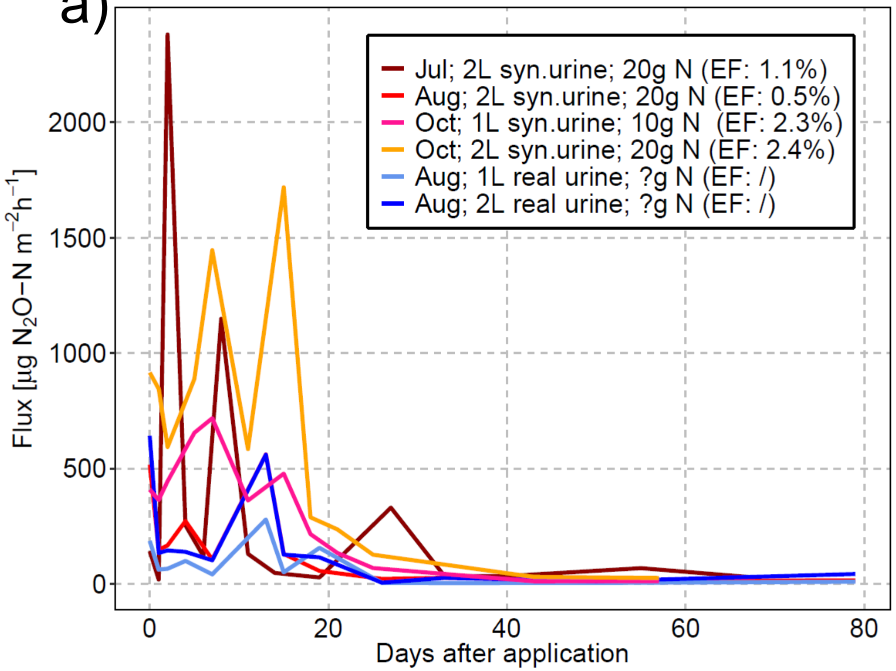
[1] Hensen A., Groot T.T, van den Bulk W.C.M., Vermeulen A.T., Olesen J.E. , Schelde K.:Dairy farm CH4 and N2O emissions, from one square metre to the full farm scale. Agric. Ecosyst. Environ., 112 (2–3), 146-152, 2006.

[2] Voglmeier K., Six J., Jocher M., Ammann C.: Grazing-related nitrous oxide emissions: From patch scale to field scale. Biogeosciences, 16, 1685-1703, 2019.

[3] Kool D.M., Hoffland E., Sander A., van Groeningen J.W.: What artificial urine composition is adequate for simulating soil N2O fluxes and mineral N dynamics? Soil Biol Biochem 7, 1757-1763, 2006.

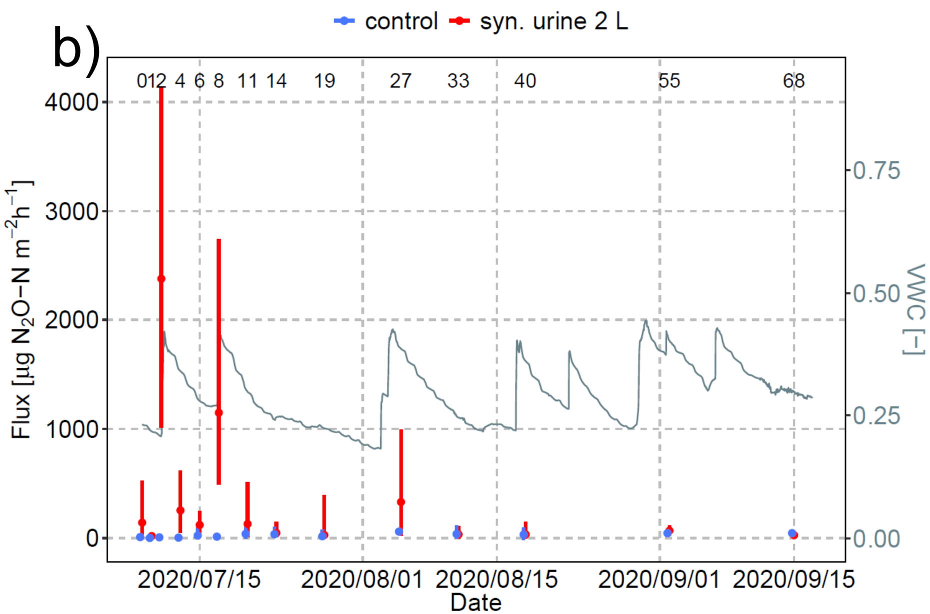
Results of first small scale measurements

a)



- Linear interpolated N_2O fluxes of artificially applied urine patches in Jul, Aug and Oct
- Elevated N_2O fluxes of 280-2400 µg m^{-2} h^{-1} (maximum) after urine application deceasing to background level within 19-43 days
- EFs for 2 L of syn.urine vary (0.5-2.4 %)
- EFs for syn.urine applied in two different amounts give similar EFs

b)



- Fluxes of syn. urine applied in July together with the control fluxes (without excreta application)
- Lower N_2O emissions on the day of application compared to the Aug and Oct applications in a)
- N_2O peaks occur after rain events

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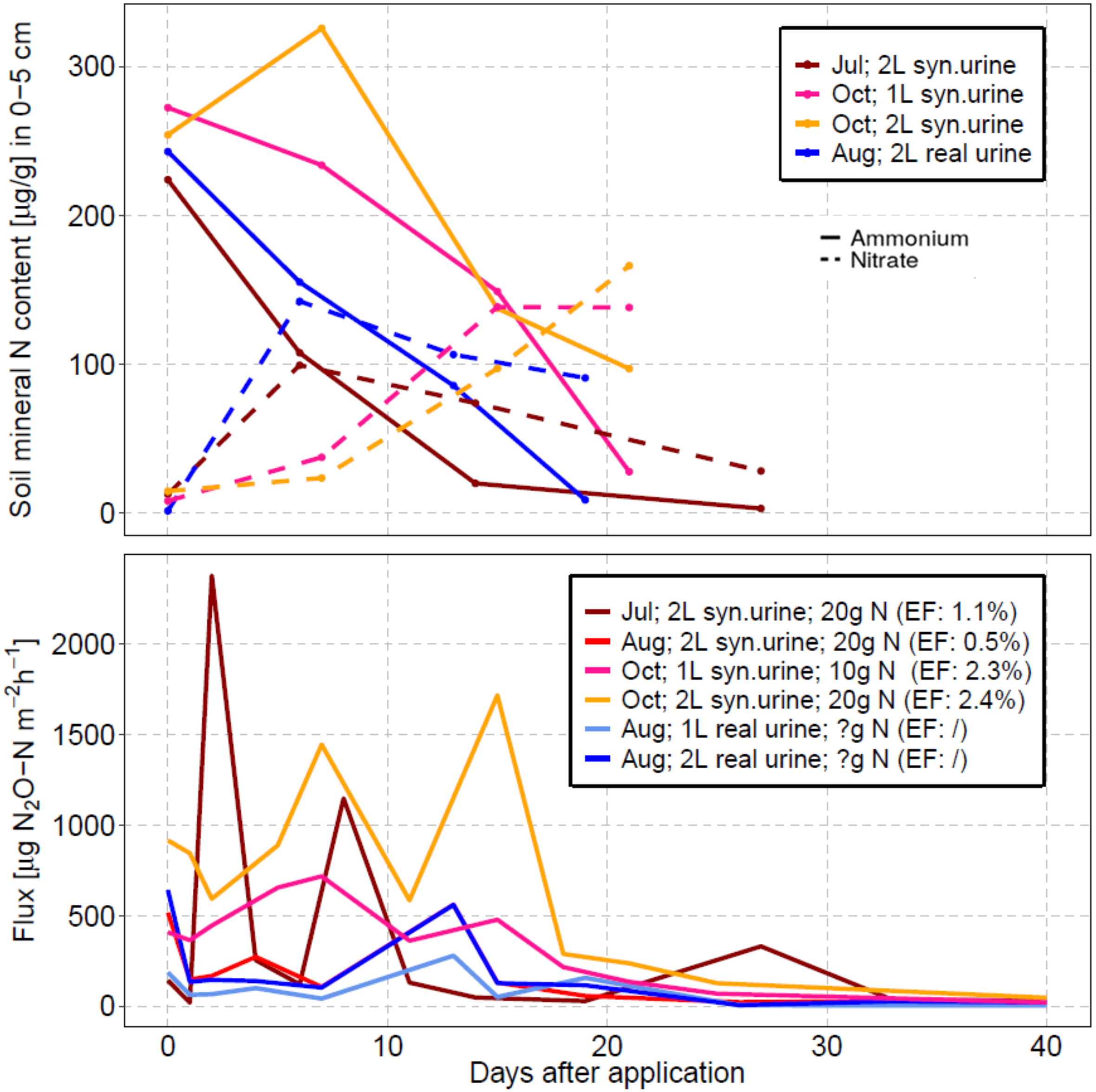
Results of first small scale measurements



- Soil mineral N samples were taken weekly after urine application
- Soil NO_3- content is still elevated three weeks after application

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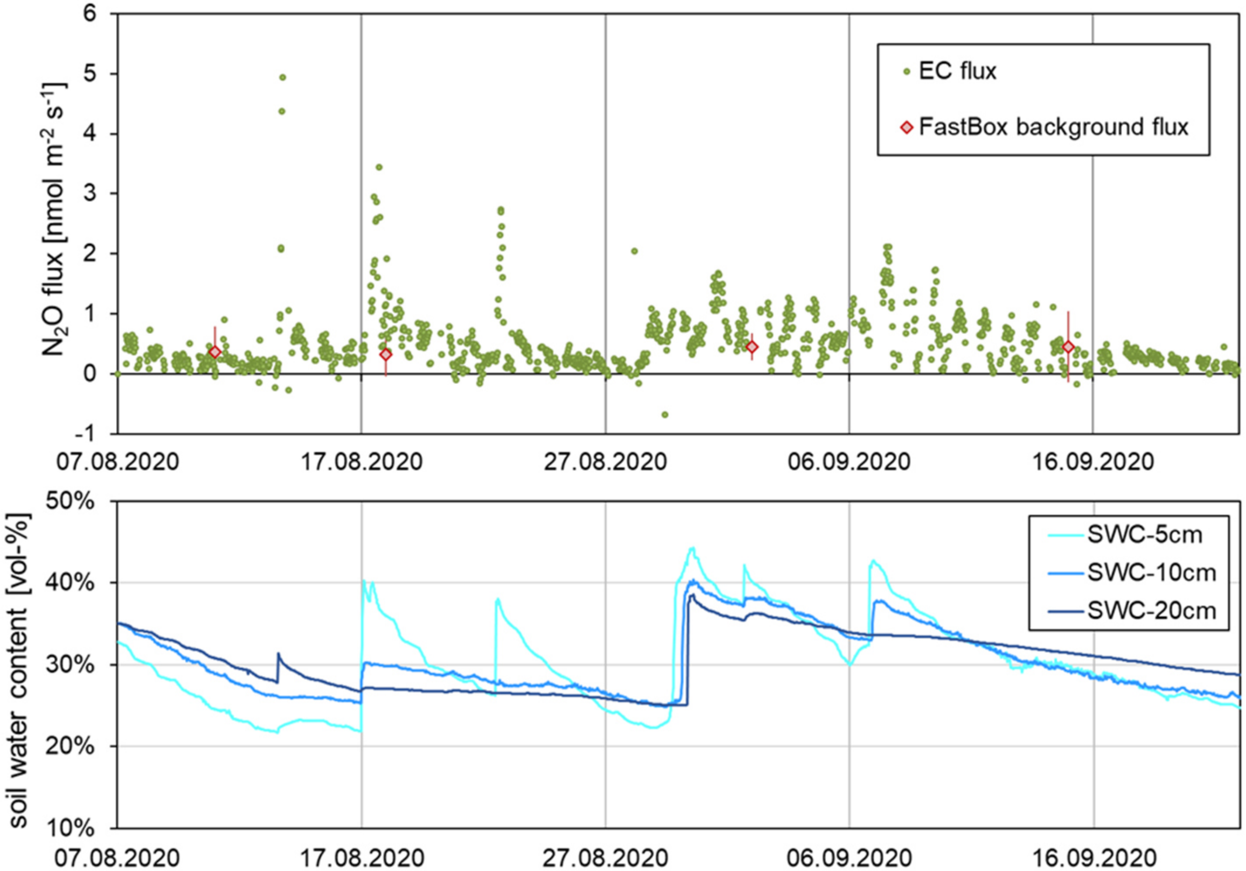
First field-scale EC fluxes

- EC fluxes during grazing periods show a considerable temporal variability, partly depending on soil water content
- Peak EC fluxes are more than 10 times higher than background (control) measurements by the FastBox



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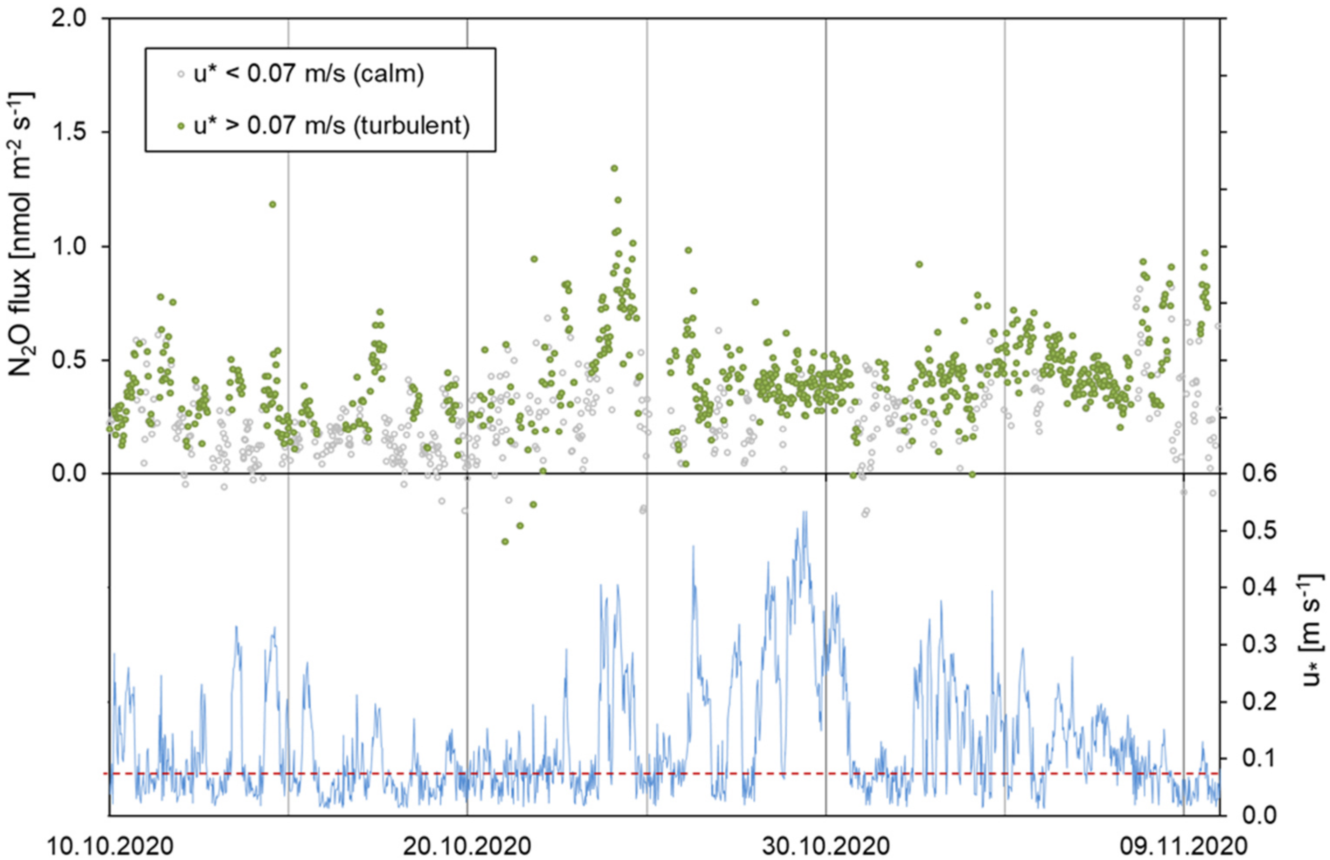
First field-scale EC fluxes

- EC fluxes were filtered for low u_* conditions with a threshold of $u_* = 0.07$ m/s
- Without filtering, the average N_2O flux would be underestimated



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Preliminary conclusions

- Calculated mean EF (1.6 ± 0.9 %) of artificially applied cattle urine is in the range of the global EF (2 %) used in Swiss GHG inventory.
- Though, EFs of 2 L synthetic urine application in Jul, Aug and Oct vary indicating a seasonal variability, driven e.g. by soil water content.
- Our preliminary results can't confirm the hypothesis that EFs decrease with increasing urine volume.
- We suggest to take mineral N soil samples over a longer period than four weeks and more frequently in the first week as most of the urinary urea hydrolyses to NH_4+ within the first days.
- Further artificial application of urine and dung will be carried out and upscaled to the field scale for reconciliation of patch-scale and field-scale derived results.