N_2O flux response to meteorological solicitations and farming practices in a sugar beet crop

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EXPERIMENTAL SET-UP

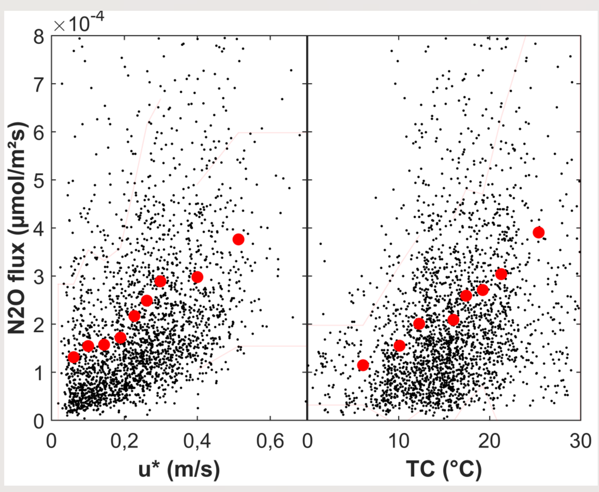
Ecosystem :
- Production crop - Sugar beet (2016)

Measurements :
- Wind velocity (Gill HS-50)
- N_2O mixing ratio (Aerodyne Research Inc. QCLaser)
- Meteorological and soil conditions (half-hourly monitoring)

EC data processed with EddyPro® (LI-COR software)

EC DATA TREATMENT / N_2O specifics

- **Quality of timeseries following Vickers & Mahrt, 1997**
  - ⇨ Most test parameters need to be adjusted specifically for N_2O timeseries
  - ⇨ The test for skewness and kurtosis was not relevant
- **Timelags assessed by searching for covariance maximum**
  - ⇨ Method suitable during peaks *and* periods of background flux
- **Stationarity and turbulence by Foken & Wishura (1996)**
  - ⇨ Quality classes (Mauder & Foken, 2004), level 2 discarded
  - ⇨ Stationarity test suitable for our dataset (no moving hotspot)
- **Influence of friction velocity**
  - ⇨ Selection of data to minimize the influence of N_2O flux drivers (fertlization, SWC,…)
  - ⇨ Still, difficult to untie the influence of u* and temperature
  - ⇨ Use of CO_2 fluxes to assess the u* threshold.



EVALUATION OF UNCERTAINTIES

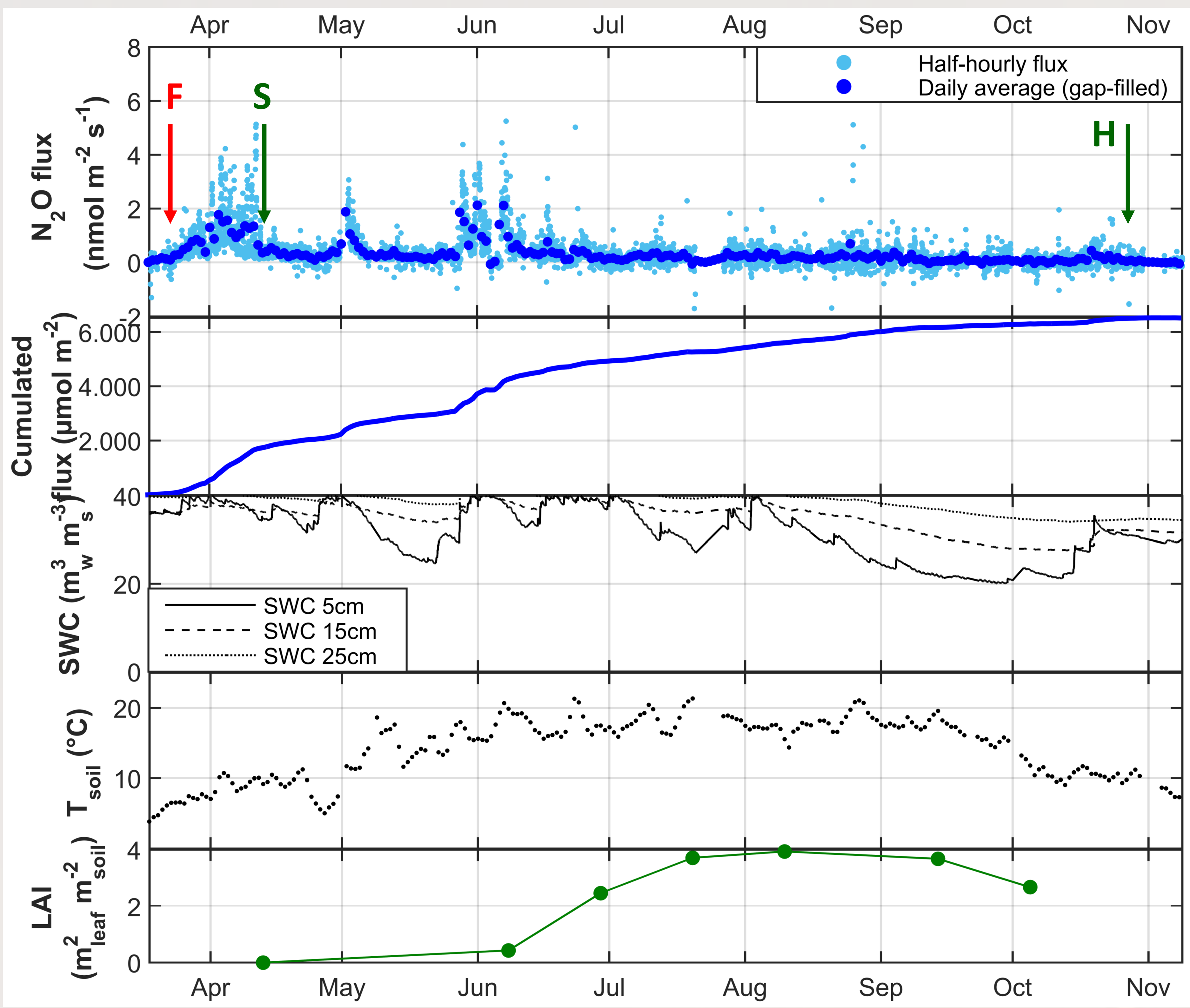
- **Total Random Error (TRE)**
  - ⇨ Estimated by the RMSD from zero of the covariance function at a far away lag (e.g. 200 s) following Langford et al., 2015.
  - ⇨ We considered the TRE dependent from half-hour to half-hour and independent from day to day in error propagation.

Period of time	Absolute / Relative TRE
30 min	0.11 [nmol m^{-2} s^{-1}] / 30 %
Daily integral	9.5 [µmol m^{-2}] / 30 %
Crop budget (219 days)	138.3 [µmol m^{-2}] / **2 %**

- **Sensitivity to spectral correction**
  - ⇨ The uncertainty lies in the choice of the method and in the choice of thresholds for "good half-hours".
  - ⇨ N_2O budget over the crop season varied **from 6 to 8%.**
- **Sensitivity to u* filtering**
  - ⇨ Lowest and highest thresholds determined on a past sugar beet crop (Moureaux et al., 2006).
  - ⇨ Variation of **8.2%** in the N_2O budget over the crop season.
- **Sensitivity to gap-filling**
  - ⇨ Gap-filling was performed at a daily scale using a rectangular moving mean if less than 30 half-hours available in a day.
  - ⇨ Changing the 30 half-hours threshold from two reasonable limits changed the crop budget by **less than 2.4%.**

► How to combine such uncertainties?
These uncertainties were estimated separately but need to be combined to give a unique estimate of the error on the crop budget. The question on the combination method remains.

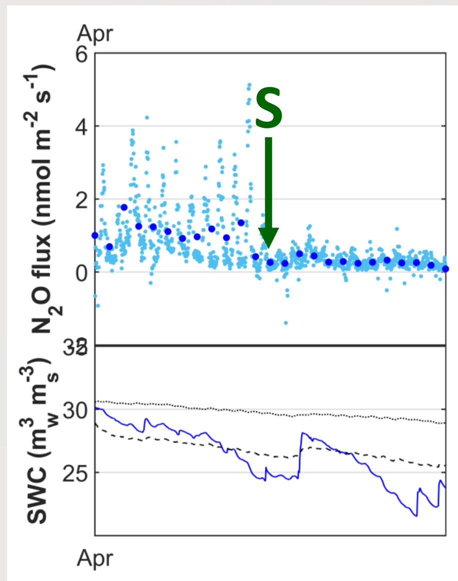
RESULTS – Dynamics from fertilization (F) to harvest (H)



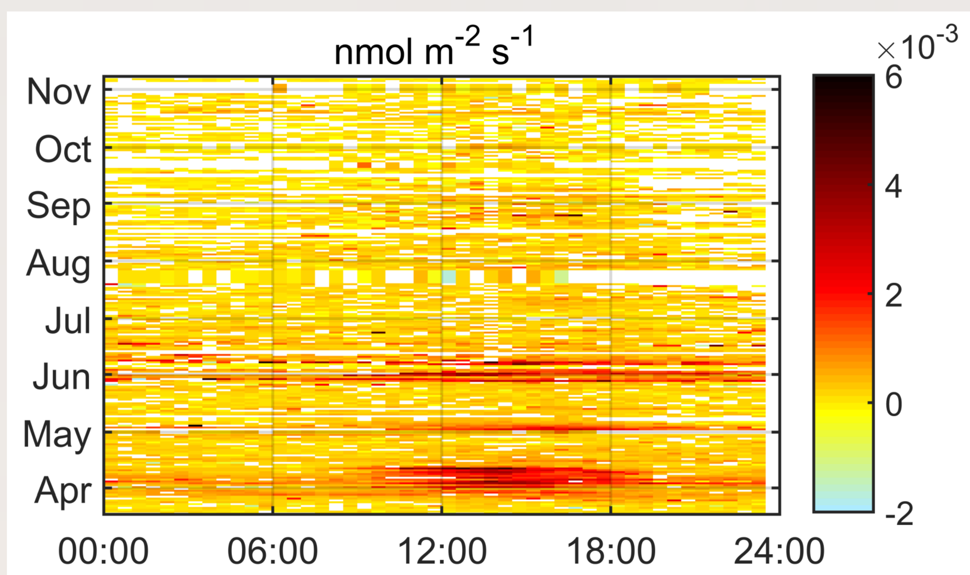
- **Cumulated emissions from fertilization to harvest : ~ 6500 µmol N_2O m^{-2}.**
  - ⇨ This represents a **1.4% loss of N inputs** via N_2O emissions, which is in agreement with IPCC 2006 estimates of emission factor for managed soils (1%).
  - ⇨ When converted to CO_2-eq, it corresponds to **30% of the mean annual NBP** of the experimental site (Buysse et al., 2017).

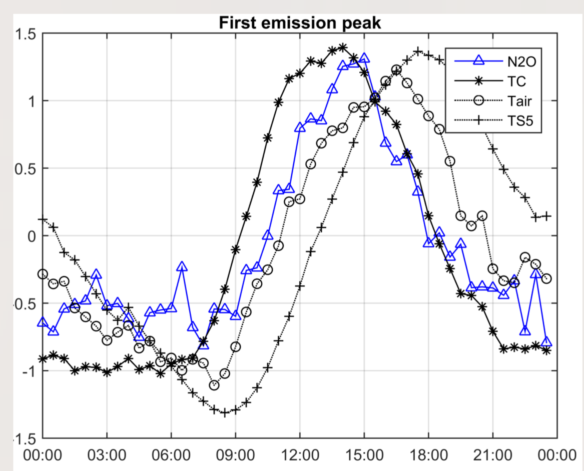
Influence of weather and farming practices

- **30 % of N_2O fluxes were emitted between fertilizer and sowing (S)**
  - ⇨ Favorable conditions for N_2O production with fertilization (136.5 kg N ha^{-1}) and precipitation (SWC ~ 40%)
- **The first emission burst was inhibited after sowing (significant decrease of 70%)**
  - ⇨ This suggest that the preparation of seedbed, by disturbing the top soil layer, relocated active micro-organisms at a greater depth which decreased N_2O production.



Daily variability of N_2O fluxes





Daily cycle following the surface temperature (TC)

- **The three episodes of emission peak show different daily patterns**

❶ During the first emission burst, **correlation between N_2O and CO_2 fluxes** (R^2 = 0.53) and clear **diurnal pattern.**

❷ During the second peak, no correlation with CO_2 fluxes and a **less distinct** diurnal pattern.

❸ During the third peak, **important emissions during the day *and* during the night**.

- **During the background period, night fluxes significantly lower**