Nitrous oxide emissions using quantum cascade laser spectrometry over a production crop: preliminary results

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1. Global objectives

- ❑ Eddy covariance measurement of N_2O fluxes over a production crop field
- ❑ Analysis and identification of N_2O fluxes drivers

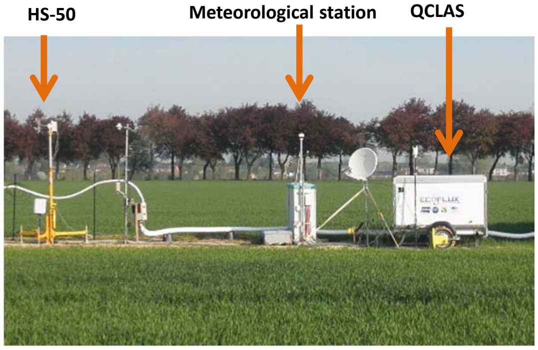
2. Material and Methods

The measurement campaign was carried out at the Lonzée Terrestrial Observatory (50°33'08'' N , 4°44'42'' E , Belgium). The site is a production cropland (four year rotation). In 2013, the crop was winter wheat. The measurement campaign covered, not continuously, the period from 16th April to 7th June 2013.

The data was collected on an half-hourly basis by the ECOFLUX station, developed by the « Groupe de Spectrométrie Moléculaire et Atmosphérique » (GSMA) from University of Reims, comprising:

- ❑ A sonic anemometer, type Gill HS50 for wind components and temperature measurements
- ❑ A Quantum Cascade Laser Spectrometer (QCLAS) for CO_2, H_2O and N_2O measurements at a sampling rate of 5 Hz

Standard meteorological measurements were performed by the micro-meteorological in-situ station.

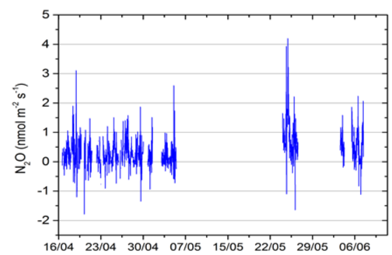


The N_2O fluxes were computed by the Eddy Covariance technique using the EDDYSOFT software suite (Max-Planck-Institut für Biogeochemie).

The N_2O detection limit of the ECOFLUX station was estimated 0.15 ~ 0.2 nmol m^{-2} s^{-1} or 5 ~ 6 ng N m^{-2} s^{-1}.

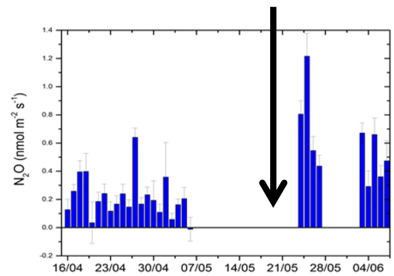
3. Results

Temporal variation



Half-hour N_2O fluxes (nmol m^{-2} s^{-1}) for full measurement period

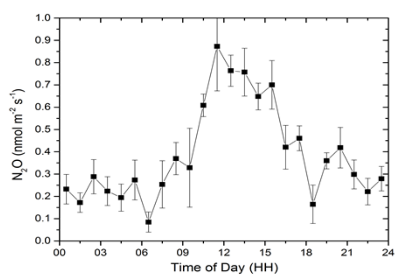
Fertilization (20/05)

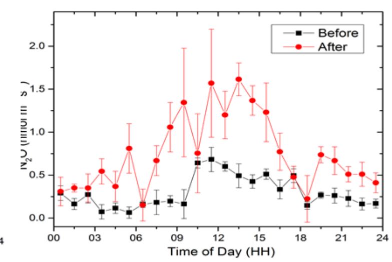


Average Daily N_2O fluxes (nmol m^{-2} s^{-1})

- ❑ Most of observed fluxes were above the detection limit of the QCLAS
- ❑ Significant increase in N_2O fluxes were observed after fertilization. The daily average for full period before fertilization was multiplied by a factor 2.6
- ❑ The N_2O fluxes were between -2.5 and 4.5 nmol m^{-2} s^{-1} (-70 to 126 ng N m^{-2} s^{-1})
- ❑ Negative fluxes occurred during periods of a few consecutives half-hours though daily average flux is positive
- ❑ Daily average reached 1.2 nmol m^{-2} s^{-1} (34 ng N m^{-2} s^{-1})

Daily cycle



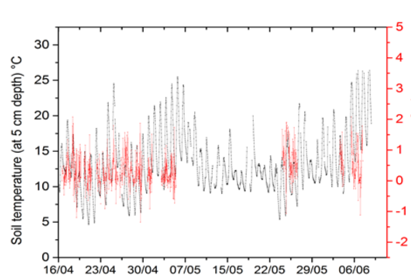


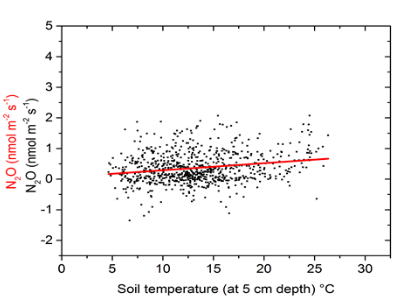
Daily cycle of N_2O fluxes. Each point is average over 1 hour and then averaged over selected windows.

Left – Full measurement period , Right – Full period before fertilization and full period after fertilization

- ❑ A clear daily cycle identified for background N_2O emissions with the maximum emissions occurs between 12:00h and 15:00h
- ❑ The daily cycle was observed using several windows specially after the fertilization event (20/05)
- ❑ After fertilization, the maximum reached was multiplied by a factor 2.5

Environmental drivers





Left – Evolution Half-hour N_2O fluxes (nmol m^{-2} s^{-1}) and soil temperature (at 5 cm depth), Right – Fluxes and soil temperature relation

- ❑ Several environmental variables were analyzed
- ❑ Only soil temperature (at 5 cm depth) showed a significant dependency
- ❑ No clear relations between N_2O fluxes and other climatic variables were identified at present

4. Conclusions

- ❑ Significant background N_2O emissions were measured during the full period
- ❑ The daily average flux was positive, thus the field is a net emitter of N_2O
- ❑ During periods of a couple of hours (up to 4 ~ 5 hours), the ecosystem behaves as a sink, i.e. negative fluxes were observed
- ❑ A clear daily cycle was observed with the maximum emission occurring at day time between 12:00h and 15:00h
- ❑ A significant N_2O background flux – soil temperature relationship was observed. No clear relations with other environmental variables were found at present

Acknowledgements
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