Mobile Eddy-Covariance tower network in the Dutch peatlands
Data-driven gapfilling creating site-specific Ecosystem Response Functions

1 Introduction

Background: Peat soil degradation in the Netherlands contributes 4.6-7 Mt CO₂ annually, around 3% of national greenhouse gases (GHG) emissions, and the government aims to reduce these by 25% by 2030.

The Dutch National Research Programme on Greenhouse Gases in Peatlands (NOBV), a research consortium aims to study peat degradation in the Dutch grassland and its mitigation.

Mobile Eddy-Covariance: Eddy-Covariance (EC) is used by NOBV to monitor the CO₂ and CH₄ fluxes on 20 different sites. Mobile EC towers are used in 10 locations in Fryslân and Drenthe.

Small EC towers are relocated between sites every 3 weeks allowing to explore a more diverse range of soil profiles, land use and mitigation techniques. Each site is equipped with a weather station, soil moisture and groundwater are monitored in most of them. However, the interminability of measurements requires robust gap-filling methods to construct annual GHG budgets.

2 Objectives & Methodology

Objectives:
- Develop a ML framework adapted to the mobile EC specificities
- Estimate the uncertainty introduced by the gap-filling algorithm and focus on the model interpretability.
- Partition the fluxes in order to isolate the peat-degradation related ones.
- Develop a data-driven bottom-up model based on Eddy-Covariance Measurements

Methodology:
- EC Data are prefiltered to ensure data quality.
- Tree regressors (Random Forest and Gradient Boosted Trees) were selected
- Besides NOBV measurements, other external data sources including remote sensing (NDVI/FAPAR timeseries) and the outputs of OWSASIS (proxies of groundwater table depth and top-soil moisture at a daily rate and moderate resolution).
- Gapfilled signals are partitioned through day partitioning, manure inputs/harvest are collected via the each parcel managers.

3 Results - Gap-filling

Cumulative NEE curves for CO₂ between October 2020 and October 2022. In dual comparisons, the blue curves denote where mitigation measures are implemented, while the red curve refers to a control site. Rectangles below some subfigures allow to distinguish measurement periods from gapfilled ones.

4 Results annual NECB

Relationship between mean groundwater depth and NECB in the different sites. Left - NECB data and site typology and right-comparison with other models (EC: this study, CC: chamber data). Bottom - Annual total NEE dependent on the start date for integration

5 Conclusion

- Maize crops on peat tend to be outliers
- The natural area and paludiculture shows lower emissions and the best described by ML, also submitted to the lower anthropic disturbance, while intensive grassland showed the highest uncertainty and dispersion.
- The impact of mitigation measurements is limited but this trend needs longer measurement.
- The sensitivity of NECB to Mean Groundwater depth is consistent with literature.

Slopes of EC and CC are comparable for studied areas, intermediate.
- Optional cutting points for NECB are located in Jan/Feb

Further Research Plans:
- Replacing the tree regressors by a Deep-learning, testing specialized architectures, able to take into account measurement uncertainties estimated via EC computation tools.
- Include landscape flux footprint to consider the potential surroundings heterogeneities (ditches, wet vegetation surrounding grassland...).
- Use a more related EC signals, e.g. energy fluxes
- Make use of Mowing/Grazing detection based on. Remote Sensing as additional data
- Develop a data-driven bottom-up model based on EC Measurements

E-mail Abstract Digital version Bibliography NOBV Website