

Data-Driven Modelling and Comparative Analysis of CO₂ Exchanges in Dutch Peatlands via Eddy-Covariance

A Study of Ground Calibrated Models vs. Airborne Measurements

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The Peat Emissions - A very dutch issue

A few (Peat) Facts about NL & NOBV

- Farming on peatlands requires drainage: peat oxidation, subsidence, CO₂ emissions
- 11% of agriculture area, 25% of agriculture carbon emissions, 3 % of national GHG emissions
- Eutrophic Peat; heavily loaded in nutrients
- NOBV created in 2019 by Ministry of Agriculture
- NL-Climate Agreement: reduction target 1 Mt/y in 2030 from peatland
- 3M : Measure, Model and Mitigate



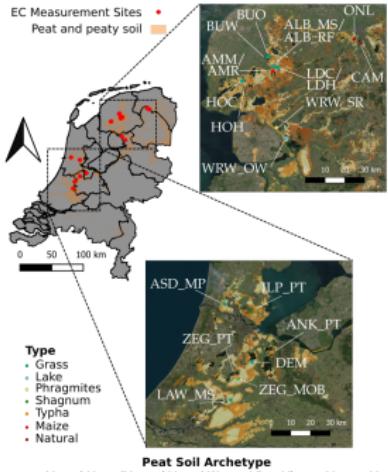
Ground Eddy-Covariance Measurements

■ Permanent CO₂/CH₄ EC Fluxes

- Pasture elevated water table 3 x
- Pasture 'control' 1x
- Paludiculture (typha, moss) 3x
- Natural wetland reeds 1 x
- Restored Semi-Natural Grassland 1 x
- Open water (shallow lake) 1 x

■ Mobile EC CO₂/CH₄ fluxes

- Pasture elevated water table/rough 7 x
- Pasture 'control' 6 x
- Crop (maize & Hemp) low water table 2x
- Natural young wetlands 2x

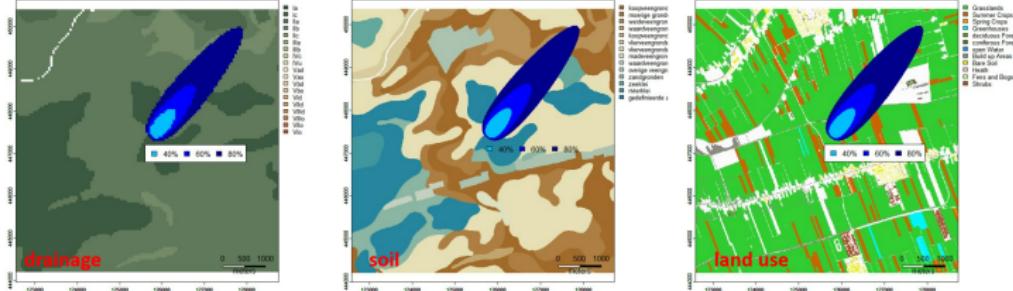


Airborne Eddy-Covariance Measurements

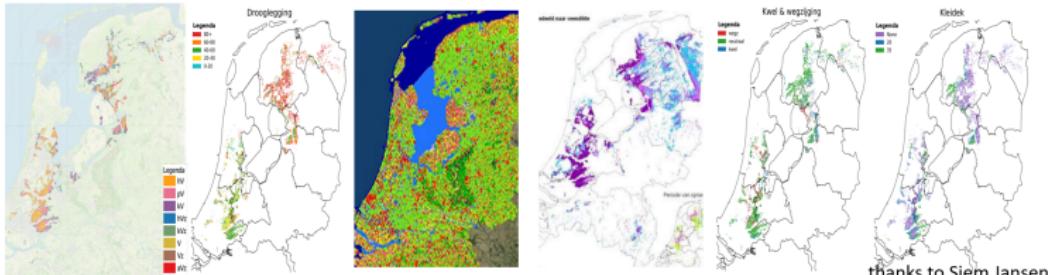
- PH-WUR -
SkyArrow 650
TCNS ERA
- turbulent fluxes (H ,
 LE , CO_2 , τ)
- Q_{net} , PAR $\uparrow\downarrow$, T_{sfc}
- CH4, N2O (Licor
7810/15/20,
Aircore)
- nominal altitude 60
m
- airspeed 100 km/hr



Footprint Analysis and Spatial Covariates

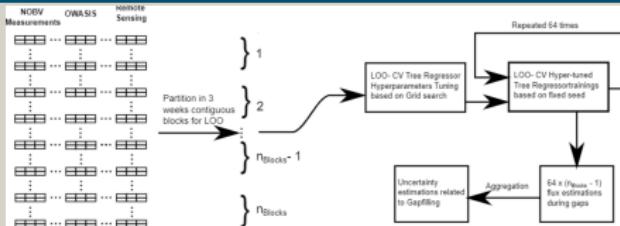


- Soil x Drainage x Land use x Peat depth x Seepage x Clay cover
- 2-10 3-5 5-12 3-cts 3 3
- combinations: 1000's



Machine-Learning and Data-Processing

Ground EC - Gap-Filling



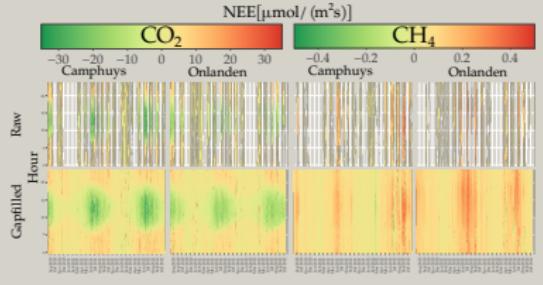
- Mobile Tower provide intermittent data, requiring a ML method to fill the gaps
- Multiple ML Methods Tested : ANN, Boosted Regression Trees, RandomForest

Airborne EC

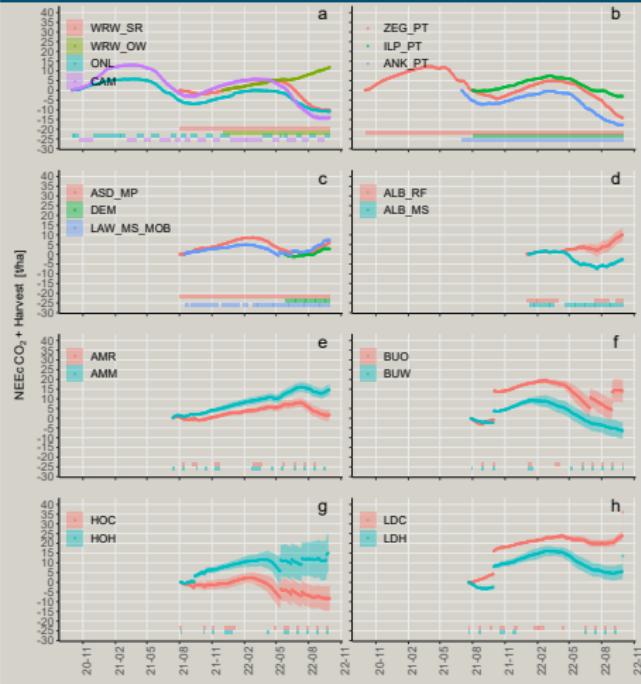
- MODIS NDVI Products
- In addition to measured, OWASIS Variables (model describing soil hydrology daily at a 250m) , product from Hydrologic Society.
- Variable Selection based on XGBoost and Sequential Backward Floating Selection.
- Interpretation based on Shapley Values

EC Tower - Annual Budgets and Seasonality

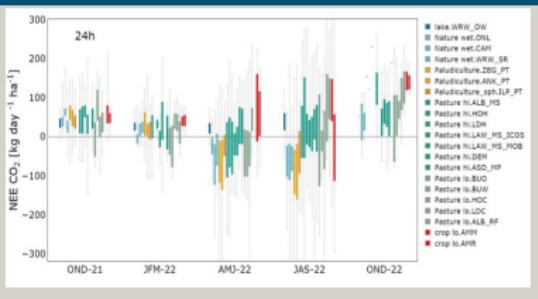
Mobile Tower - Gap-filling



Cumulative Curves - NEE CO₂

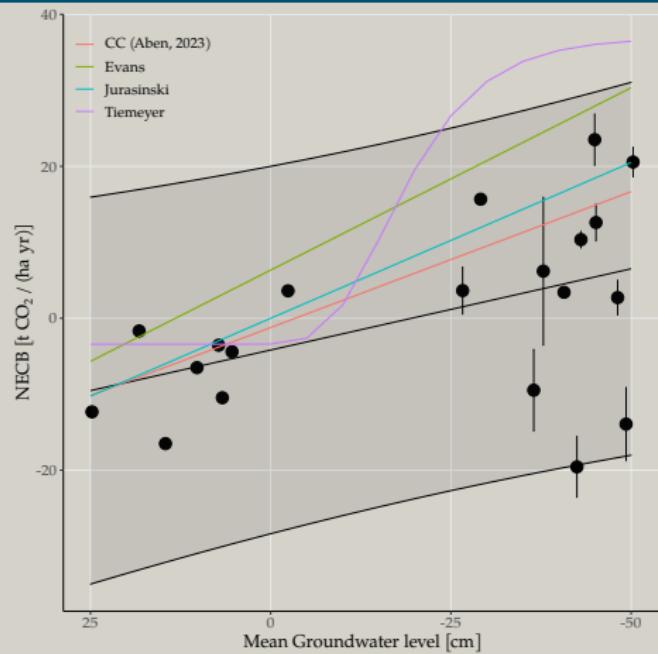


Site Category Effect



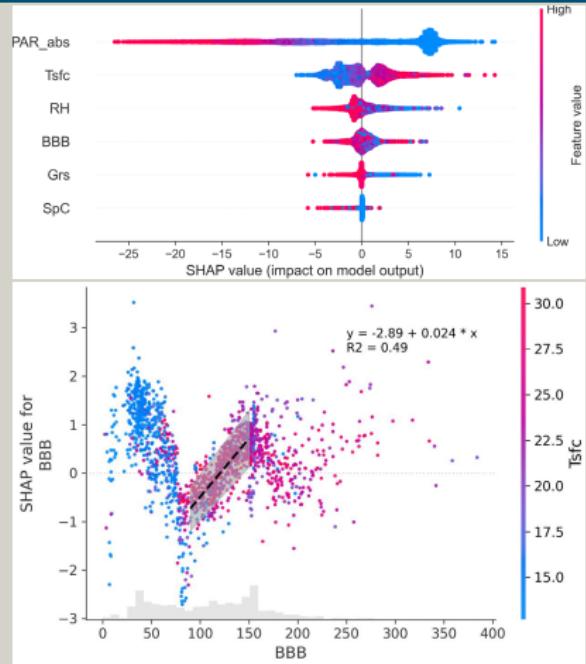
Water Table effect

Ground EC



Slope 22 tCO₂/(yr ha m_{bgl})

Airborne EC -



Slope 33 tCO₂/(yr ha m_{bgl})

Conclusion/Perspectives of improvements

- The more data on parcel hydrology at a large scale, the better
- Farm management increase budget variability
- Similar groundwater sensitivity despite different methods

Future improvements

- Synergies with NOBV partners producing hydrology products
- More spatial datasets available at the parcel level
- More extended ML/Deep-learning models
- More intensive use of the footprints at site level for ground EC
- Extensive fusion of the datasets of Ground EC and Airborne EC

PhD/Post-doc Positions Incoming...



WAGENINGEN
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Natuuronderzoeksprogramma
Broekgassen Veenwouden



Ministerie van Landbouw,
Natuur en Voedselvoorziening



Natuurmonumenten

HydroLogic EGU

Thanks for your attention, and stay tuned...



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Slides



NOBV Website



Research Group

