Towards operational quantification of GHG exchange in heterogeneous agricultural landscapes and experimental plots

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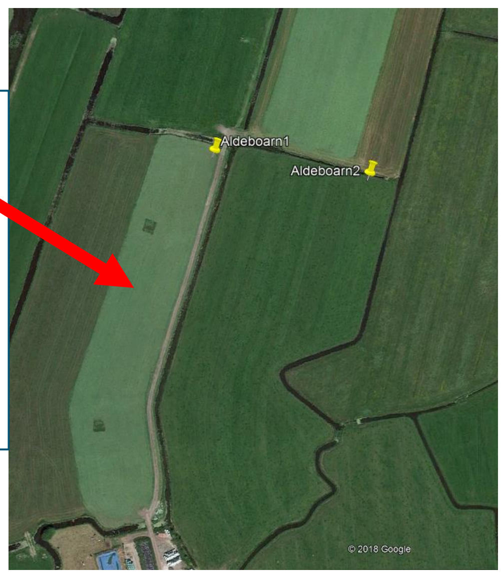
Why are we interested in this?

- Climate mitigation efforts and carbon market projects in the LULUCF sector rely on measuring, reporting and verifying (MRV).
- This requires emission registration techniques matching landscape patchiness.
- For mitigation measures applied in small pilots (sub-hectare to a few hectares) mobile automatic chambers and mobile EC-devices can contribute to low-cost emission registration.
- There is a large demand for techniques with an annual costs of 5,000-10,000 to monitor GHG emissions from a single pilot.

How to efficiently quantify GHG budgets at small scale?

- Eddy covariance needs minimum size & is expensive
- Chambers may not capture heterogeneity & is laborious

E.g.: Small peat meadow submerged drains plot to limit CO_2 emitted from oxidising peat



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Questions addressed here (preliminarily):

1. Can we get reliable Eddy Covariance (EC) flux with small footprints?

   Tested low measurement height at adjacent fields

2. How does EC compare with chamber measurements?

   Compared a few automatic chamber data sets with EC

3. Can we replace EC by measuring only **standard deviation** of [CO_2], [CH_4] or [H_2O] (& use cheaper instruments!) ?

   Analysed 1-year data on peat meadow, mimicking slow sensors

4. Can we get away with short EC campaigns with one roving system visiting several locations?

   Analysed subsets of 1-year data on peat meadow

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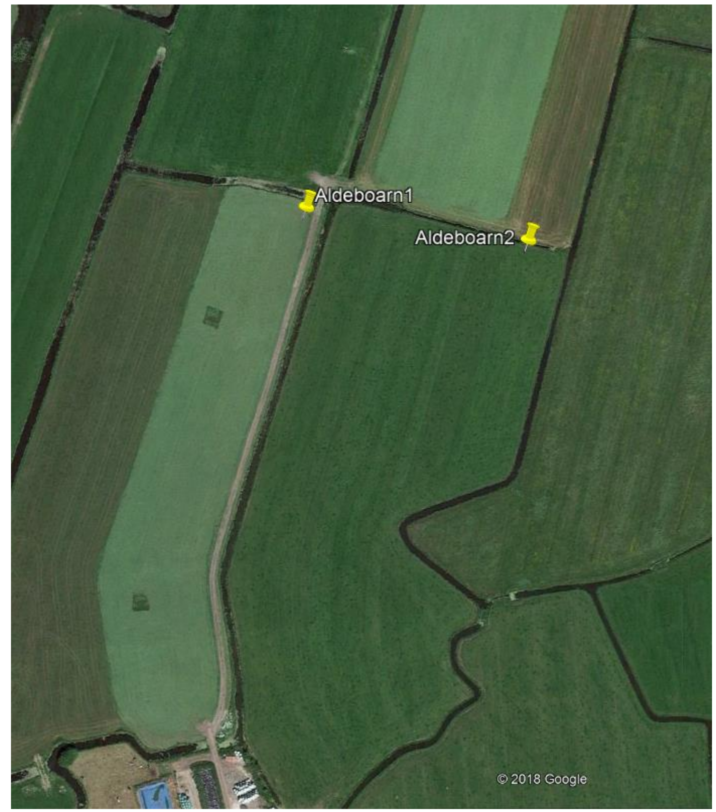
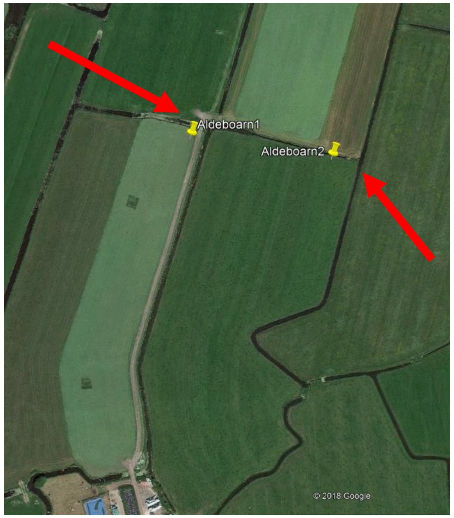
Pair of eddy covariance sets at 1 m height on peat meadows with and without submerged drains

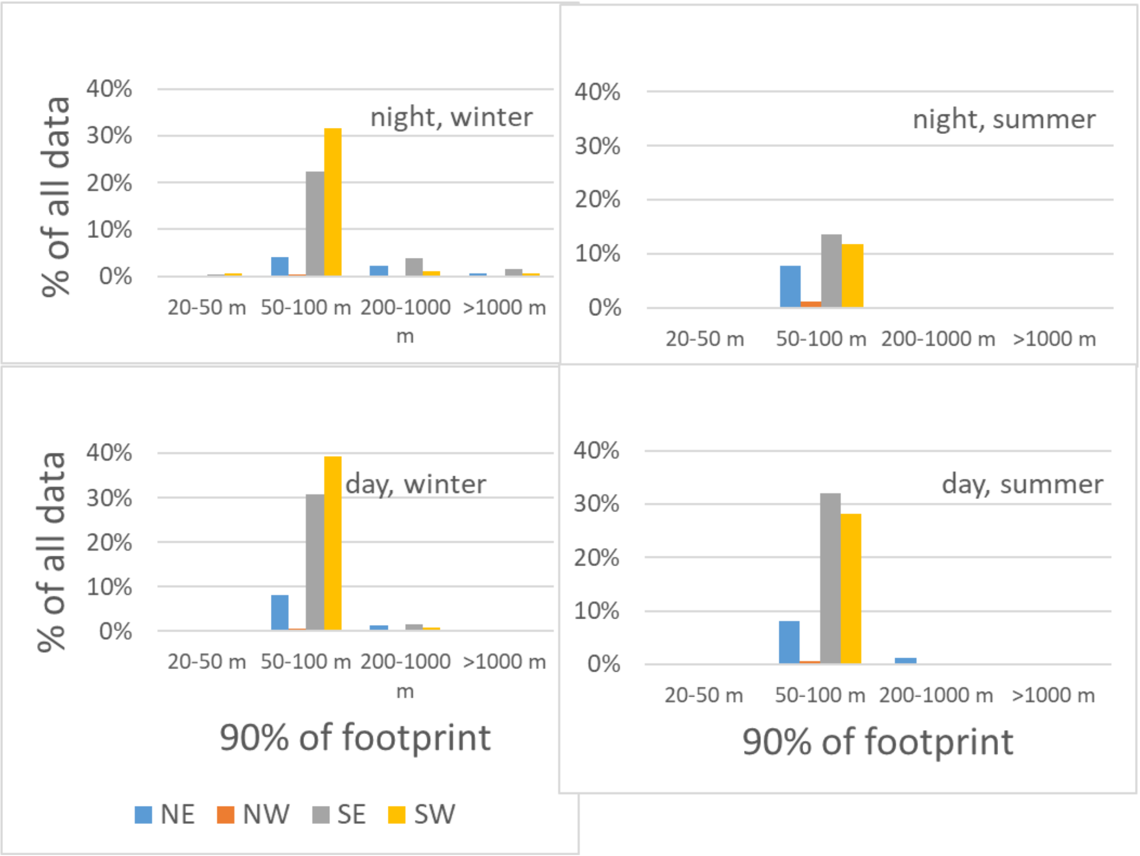


(Comparison phase. Later separated to one field each.)

1: Footprints almost always within field size of 100 m, but this forces to position mast in one corner of field; *Quality criteria are acceptable (not shown here)*

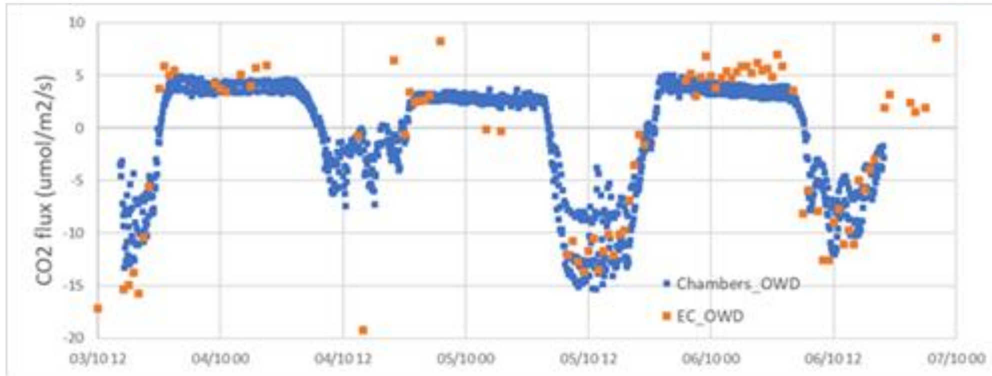
EC masts at NE side of 150 x 70 m fields, require SW winds



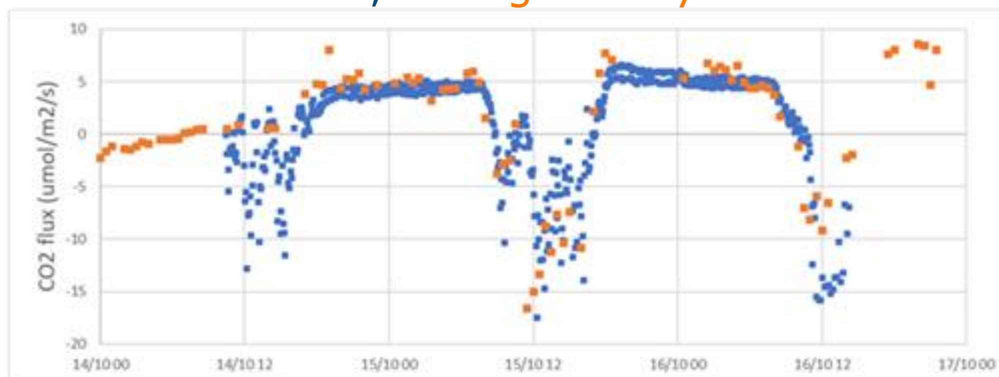


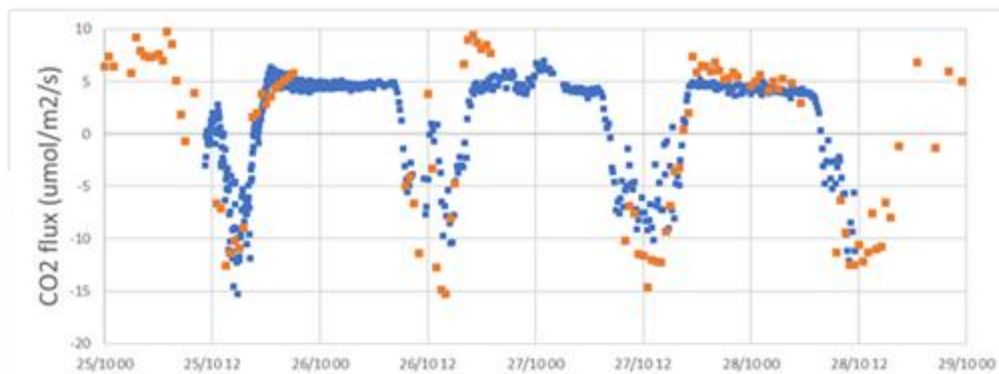
2: Eddy covariance and chambers compare well

- Chambers show heterogeneity
- Automatic chambers show very consistent data
- EC covers the whole footprint and is continuous
- EC gives more gaps (rain, poor turbulence, rejected wind direction)



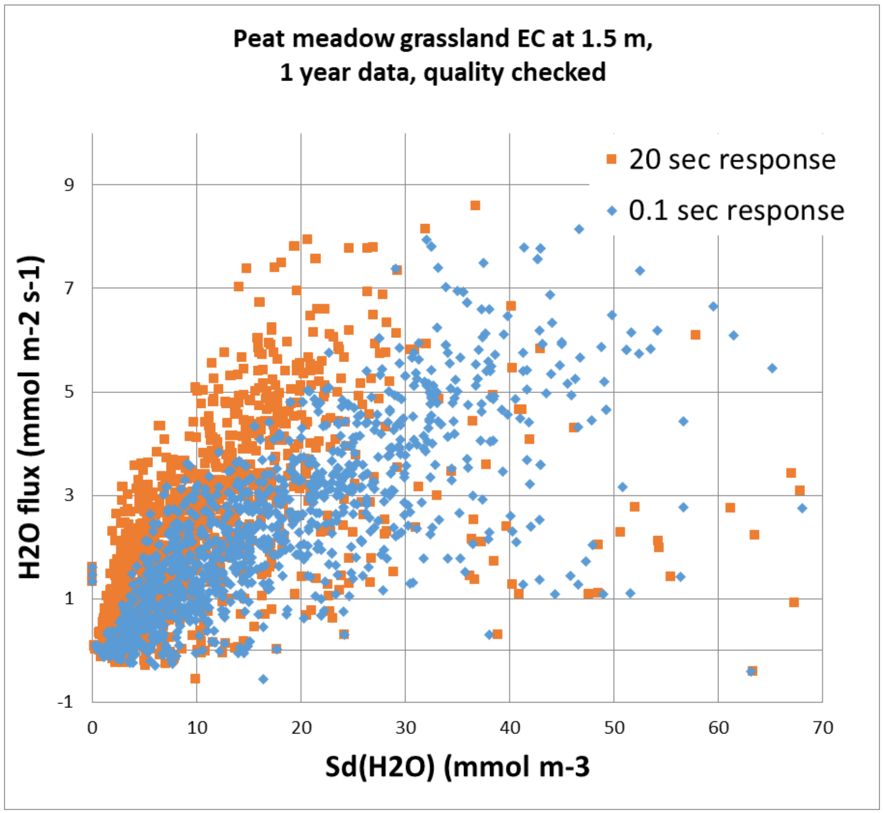
Blue: chambers; Orange: Eddy covariance

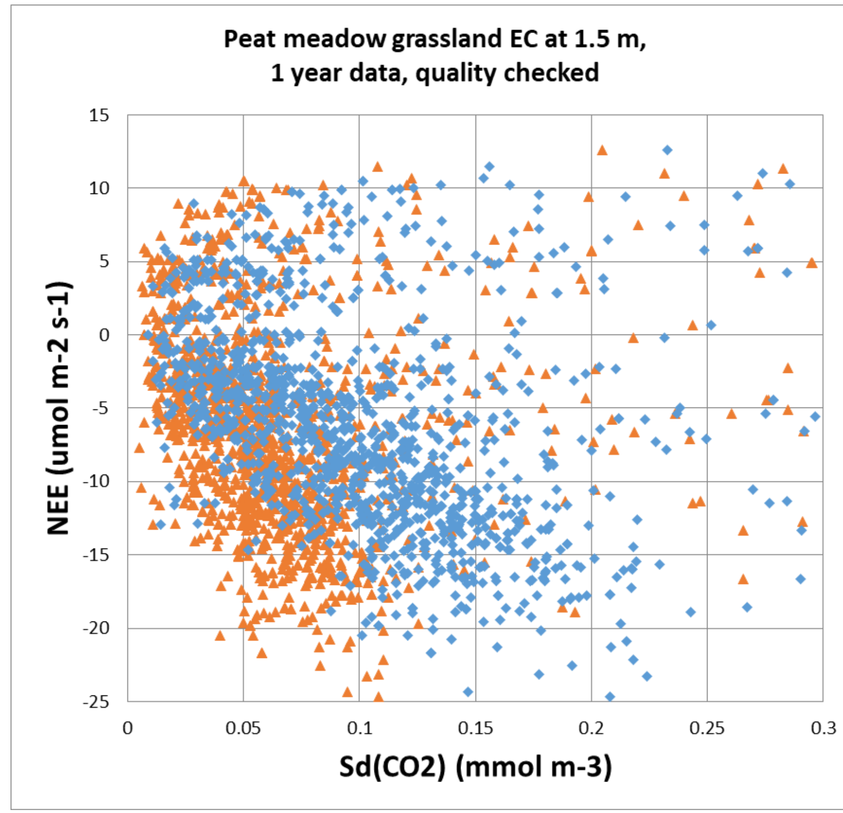




3: Eddy covariance correlates reasonably well with standard deviation of CO_2 or H_2O

Suggests we could use slow sensors (also for CH_4 and N_2O) to estimate MEAN fluxes but need extra information on e.g. sign of flux.





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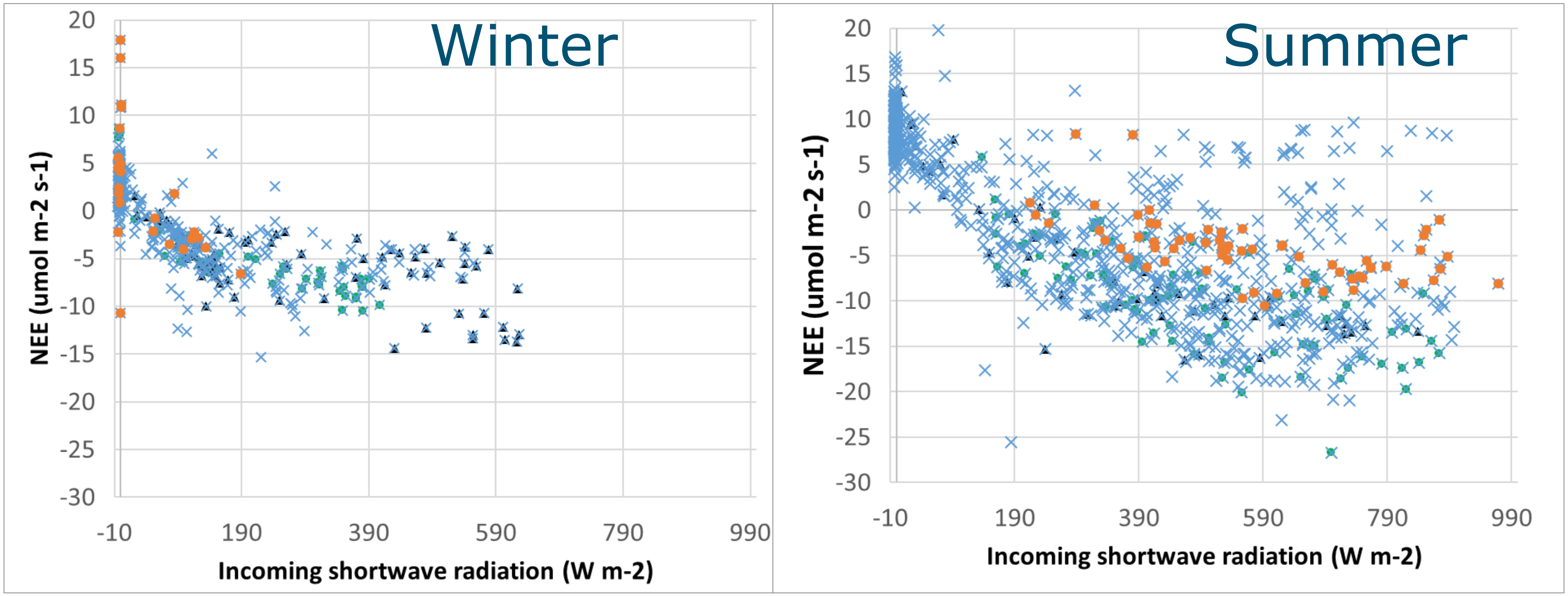
4: we need a few short campaigns per season to represent all data (for this grassland). Between seasons, other controls change



Light response of NEE for all data (blue X-es) versus three 10-day campaigns (other symbols) in Peat meadow grassland

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Conclusions

- 1: With low measurement height we can get acceptable and valid fluxes in small footprints
- 2: Eddy covariance and chambers compare well here
- 3: we may be able to rely on standard deviations of concentrations only, using slower sensors, to estimate fluxes of several inert scalars.
- 4: We only need a few short campaigns per season to represent all data, at least for simple vegetation cover

→ *For operational GHG flux monitoring, a combination of roving EC, fixed variance and meteo observations **may** be economical and sufficiently accurate*

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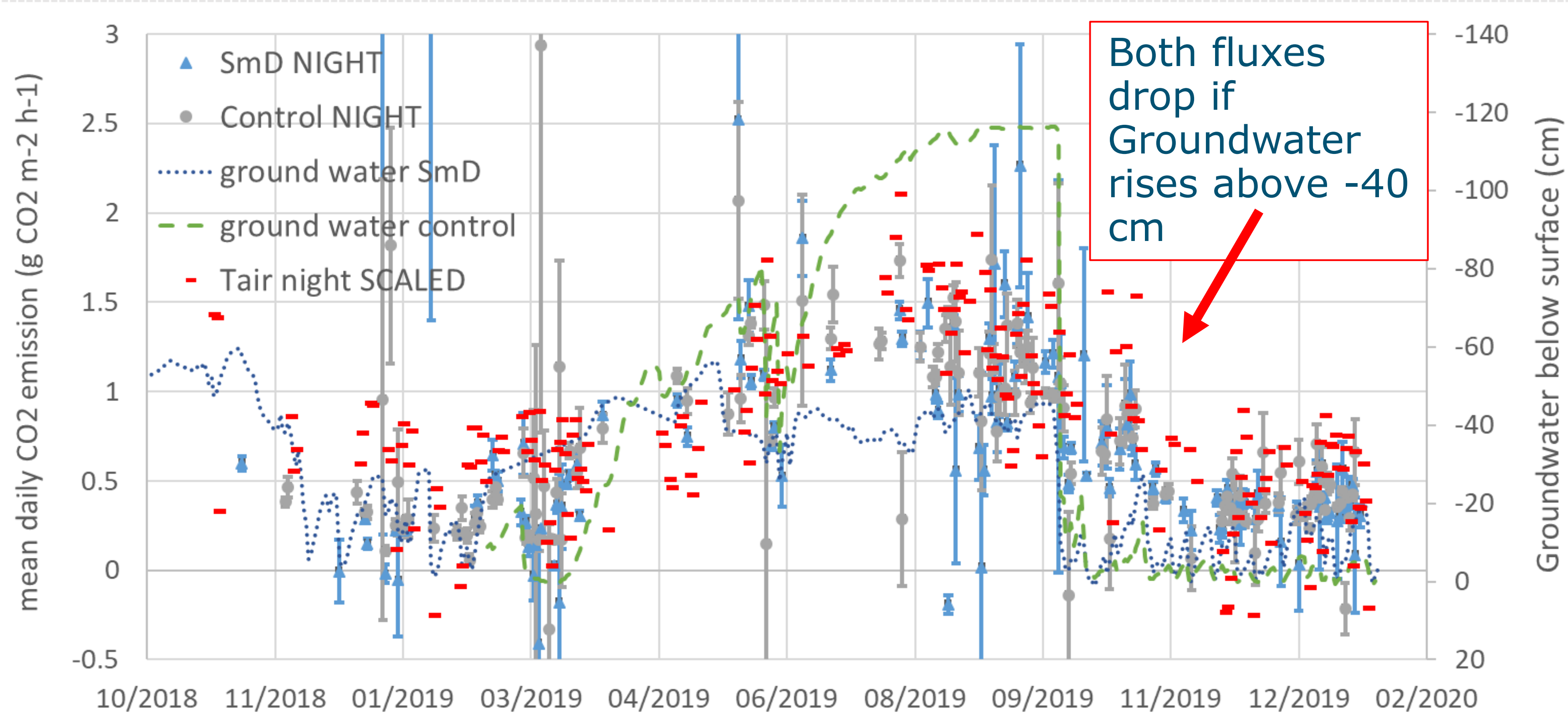
Still some work to do!

(additional material)

We find no difference in emissions between the peat soil treatments. But they do depend on ground water depth.



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