Methane emissions from a palsa-mire underlayed by sporadic permafrost under rapid degradation

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Abisko area:

- located in north Sweden, in sub-Arctic climate [1],
- wind is channeled by surrounding mountains, two main wind directions are observed (east and west) fig1,
- palsa mire (west wind) dominated by tiny ericacious woody plants, drained,
- fen (east wind) dominated by Eriophorum angustifolium and Carex rostrata with some Esquisetum spp, totally thawed,
- mean annual temperature for 21st century is exceeding 0 ºC [1],

Goal:

- estimating methane fluxes based on two main wind directions, west (palsa mire) and east (fen),
- checking different gap filling method,

Motivation:

- Main wind directions are connected with different types of wetland - palsa mire and fen. Them are exposed to the same environmental factors but reacts in different way.
- Annual methane budget has to calculated for both sites separately

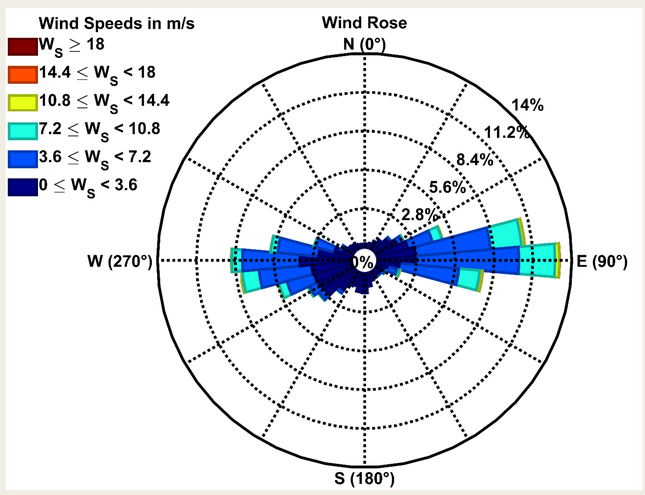

Fig1. Wind rose from Abisko-Stordalen ICOS station

Time series fluxes, temperature and water table level

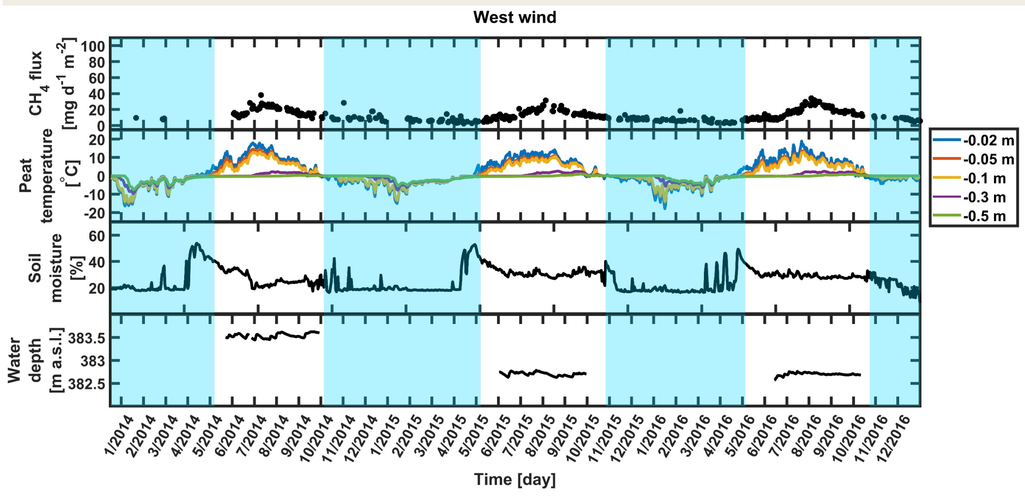

Fig2. Time series of daily mean values from western part of peatland. Shaded light blue area is frozen period.

- Fluxes and environmental variables divided by two main wind directions
- Daily pattern on methane fluxes haven't been observed,
- Daily mean values calculated for more than 10 points per day.

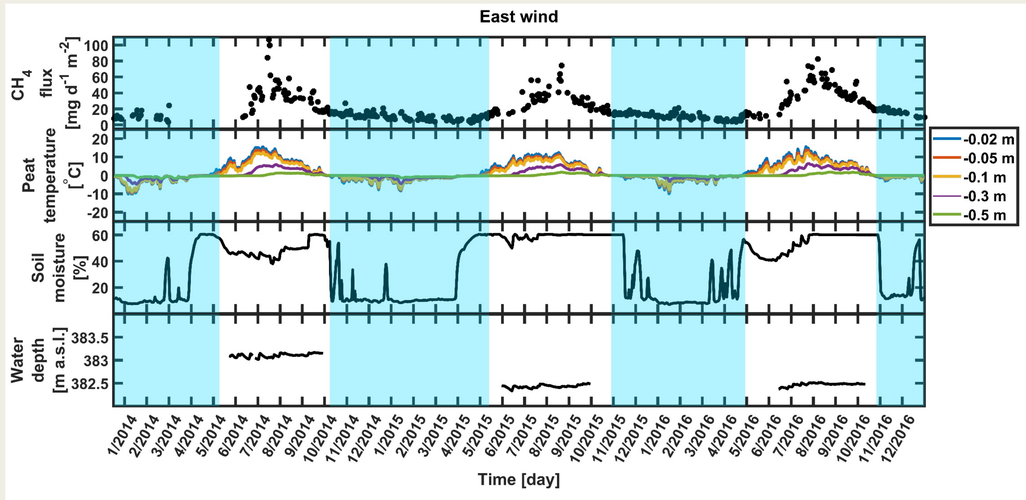

Fig3. Time series of daily mean values from eastern part of peatland. Shaded light blue area is frozen period.

Maximum of methane fluxes has been observed at the beginning of August.
Methane fluxes during frozen periods were positive.
Pulse of methane flux hasn't been observed after snow melt event and before freeze in.
Thawed layer depth is by around 20 cm deeper on the fen than on the palsa mire.

Different gap filling method

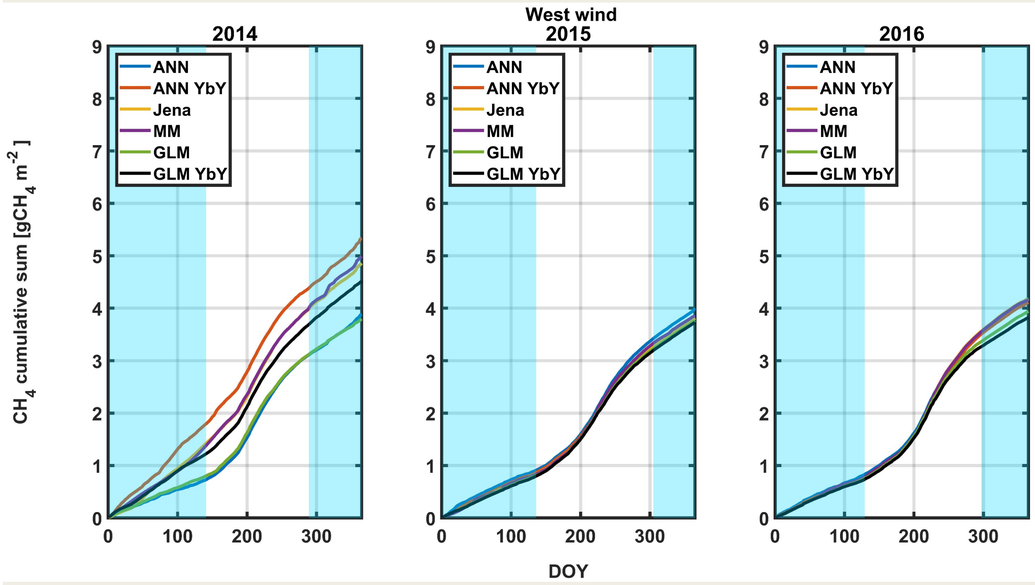

Fig4. Cumulative sum of methane fluxes for years 2014-2016 for western winds calculated with different gap filling method. ANN - artificial neural network for all years, ANN YbY - artificial neural network each year separately, Jena - Jena online gap filling tool, MM - moving mean with 5 day moving window, GLM- general linear model for all years, GLM YbY - general linear model for each year separately. Shaded light blue area is frozen period.

- Gap filling method have been used separately for both wind directions,
- Jena online tool [2] have been used on half hour dataset,
- Others method have been applied on daily mean values,
- Unrealistic values produces by gap filling tool has been removed. Gaps after this process have been filled by linear interpolation.

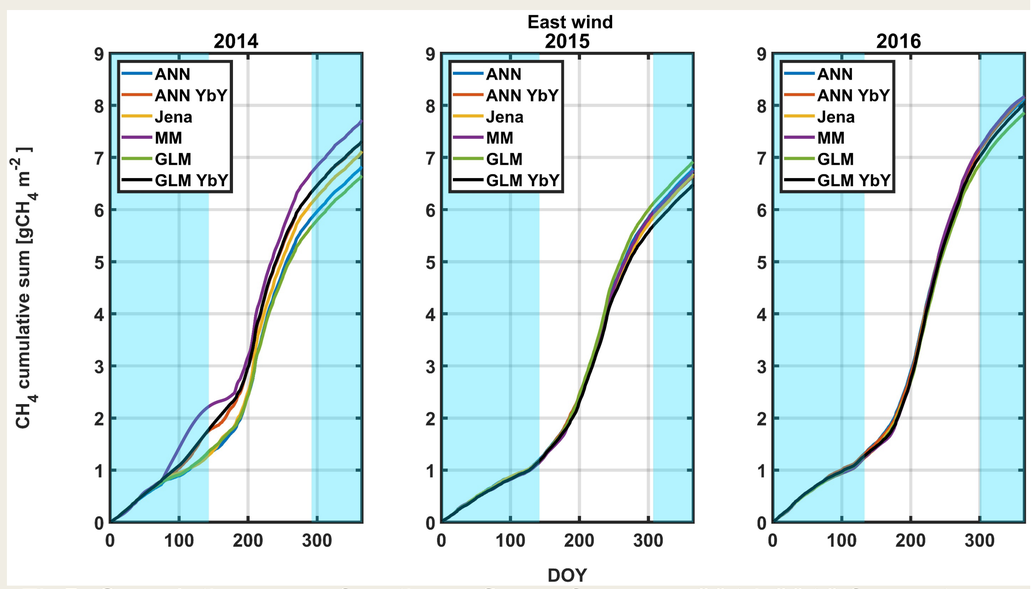

Fig5. Cumulative sum of methane fluxes for years 2014-2016 for eastern winds calculated with different gap filling method. ANN - artificial neural network for all years, ANN YbY - artificial neural network each year separately, Jena - Jena online gap filling tool, MM - moving mean with 5 day moving window, GLM- general linear model for all years, GLM YbY - general linear model for each year separately. Shaded light blue area is frozen period.

Summary

- west wind area (palsa mire) emits significantly less methane than east wind area (fen)
- methane emission from frozen period has significant contribution in annual budget and it couldn't be omitted,
- all gap filling methods are affected by length of the gaps,
- gap filling methods performed better during unfrozen periods where measured fluxes are higher

Fig6. Photography of Abisko-Stordalen ICOS station

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[1] Callaghan, T. V., Bergholm, F., Christensen, T. R., Jonasson, C., Kokfelt, U., and Johansson, M. (2010), A new climate era in the sub-Arctic: Accelerating climate changes and multiple impacts, Geophys. Res. Lett., 37, L14705, doi:10.1029/2009GL042064
[2] Wutzler T, Lucas-Moffat A, Migliavacca M, Knauer J, Sickel K, Sigut, Menzer O & Reichstein M (2018) Basic and extensible post-processing of eddy covariance flux data with REddyProc. Biogeosciences, Copernicus, 15, doi: 10.5194/bg-15-5015-2018