Permafrost methane emissions
Detailed site-level evaluation

Model: Sarah Chadburn (Leeds,Exeter), Eleanor Burke, Nic Gedney (Met Office), Eddy Comyn-Platt (CEH). *Observations:* Annett Bartsch (Vienna, Austria), Julia Boike, Torsten Sachs (AWI Potsdam, Germany), Thomas Friborg, Mathilde Jammett (Copenhagen), Christina Biasi, Maija Marushchak (Finland), Han Dolman, Frans-Jan Parmentier (Tromsø, Norway).
(+ other CLIFFTOP folks, Yao Gao (Finnish Met Institute), potentially others!)

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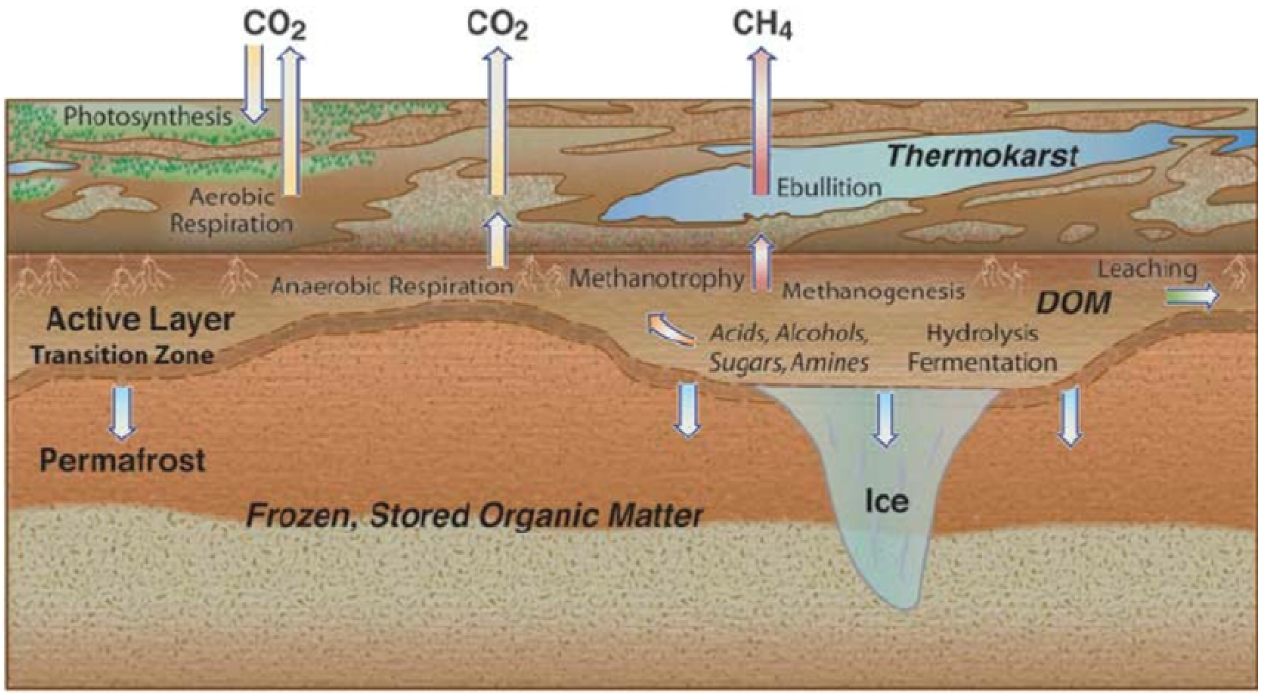
JULES meeting 2017

High-latitude carbon-cycle feedbacks

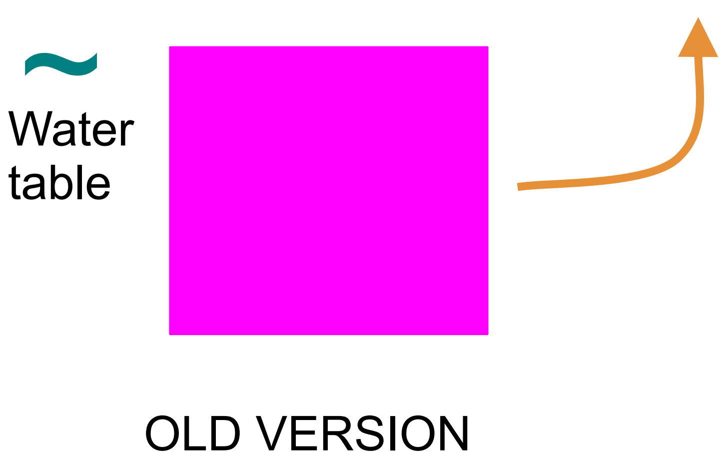
- Permafrost: ground that is continuously frozen.
- Carbon stored in permafrost may be released under climate warming = *Permafrost carbon feedback.*
- Is it released as carbon dioxide (CO2) or methane (CH4)?

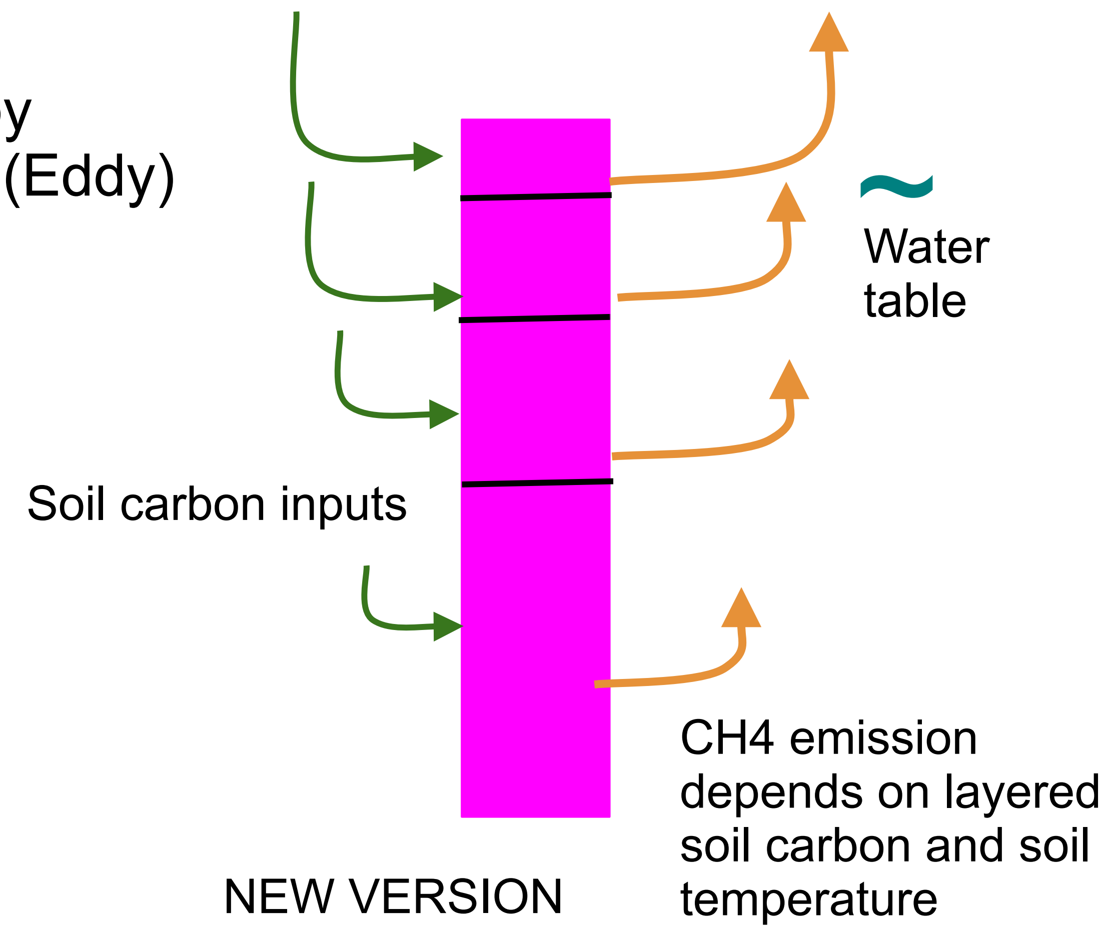


- Accounting for CH4 can increase global warming potential by 35-48%
- CH4 feedback depends on whether the ground gets *wetter* or *drier.*

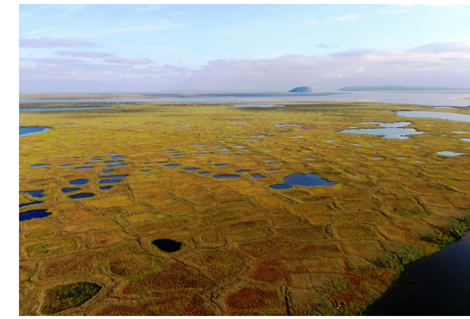
Methane and permafrost in JULES

- CLIFFTOP: NERC 1.5/2ºC project
- Model development to link methane emissions with permafrost carbon.
- CH4 parameters constrained by observed Q10 and global total (Eddy)





Arctic Evaluation Sites

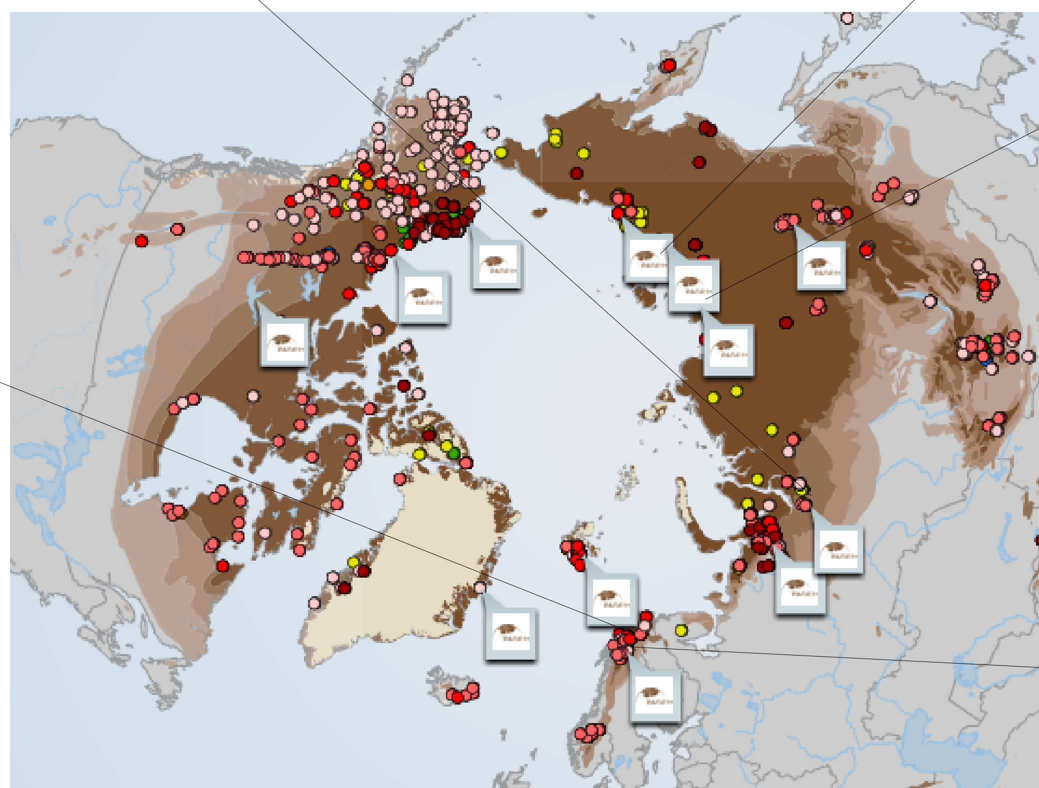


Seida

Kytalyk

Samoylov

Lompolojankka



Abisko

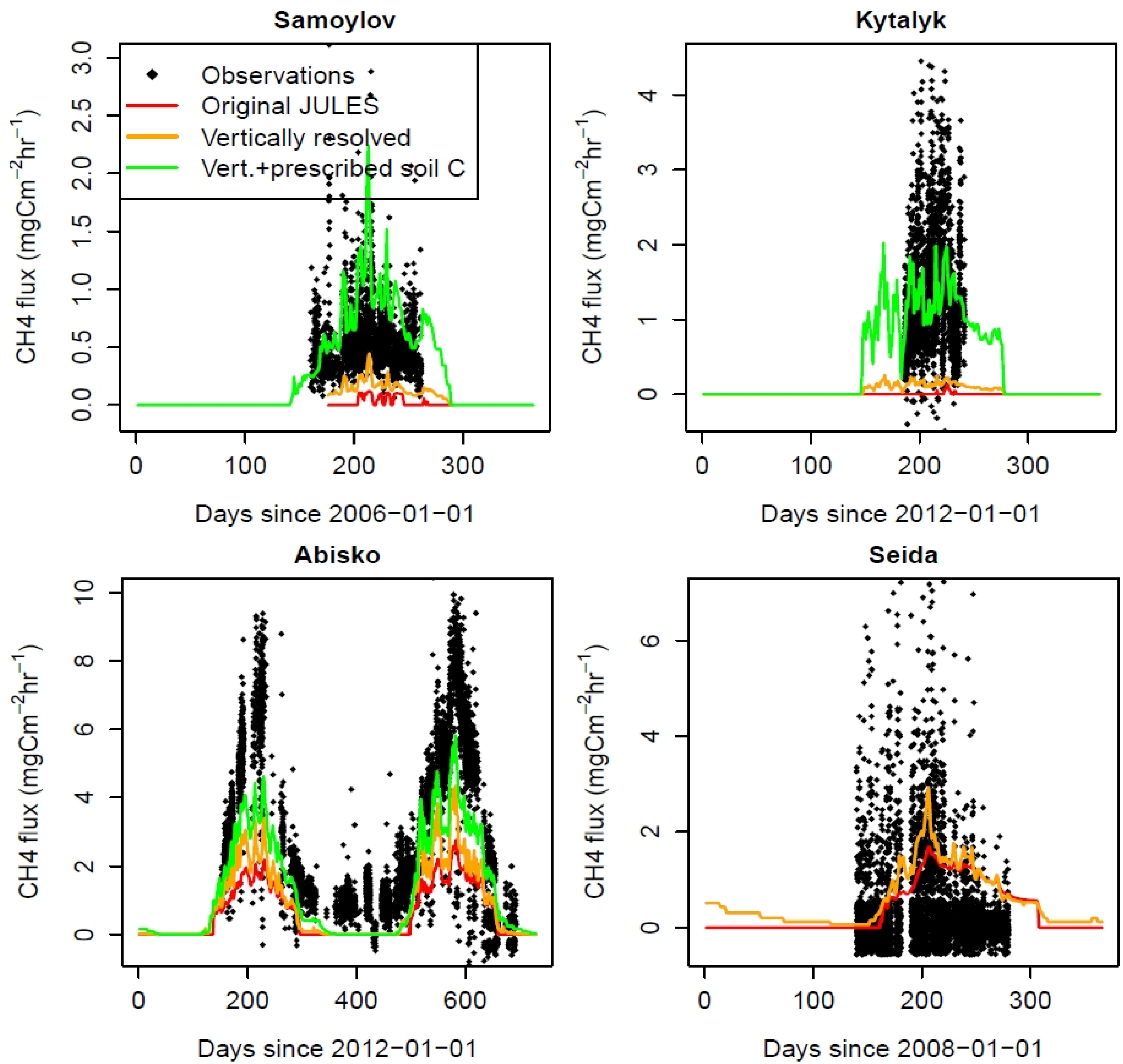
Methane fluxes

Observations from eddy covariance.

Model results: Methane flux per m2 of wetlands.

JULES calculation based on soil carbon and soil temperature.

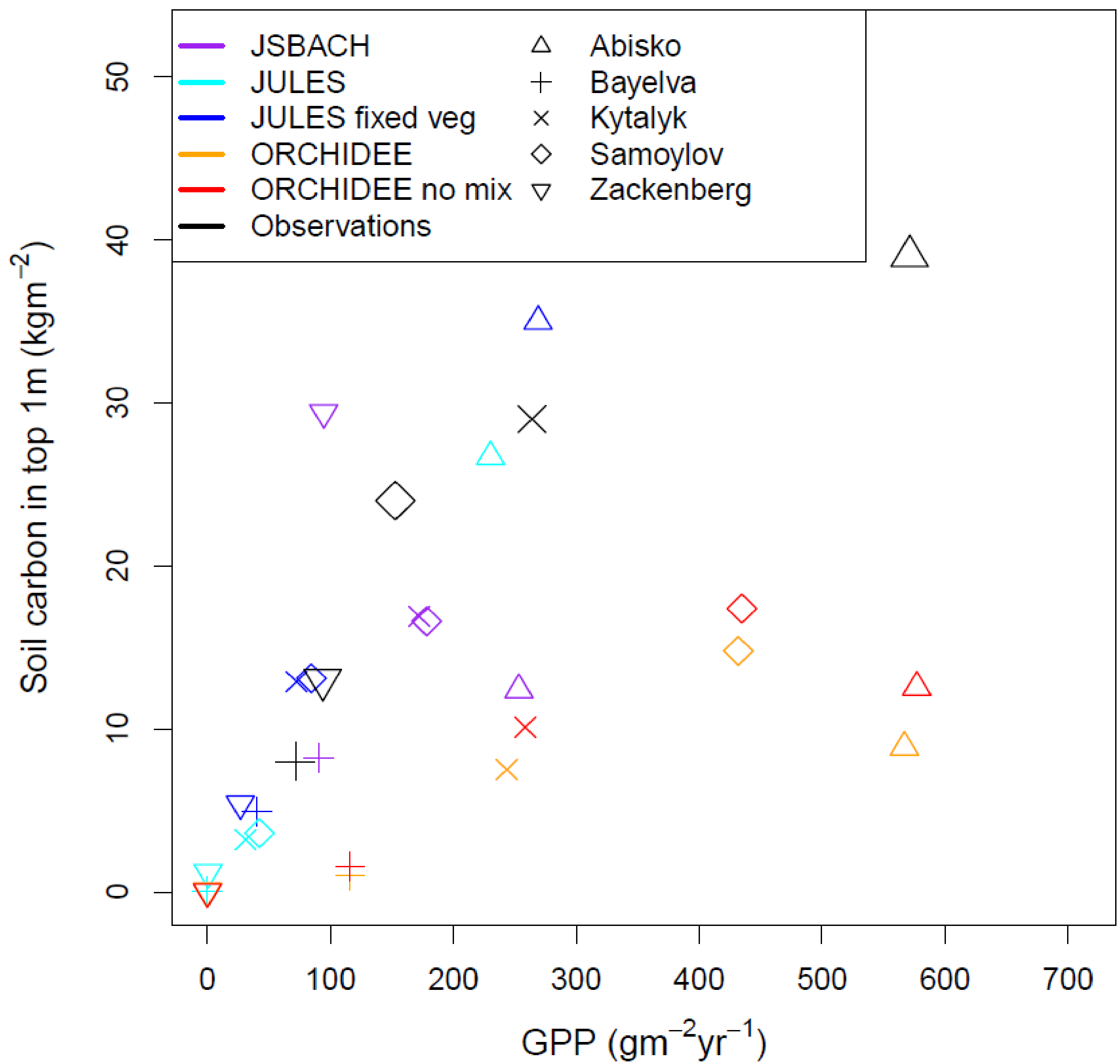
Largest bias is from *too little soil carbon*



Lack of soil carbon in Arctic is due to lack of vegetation

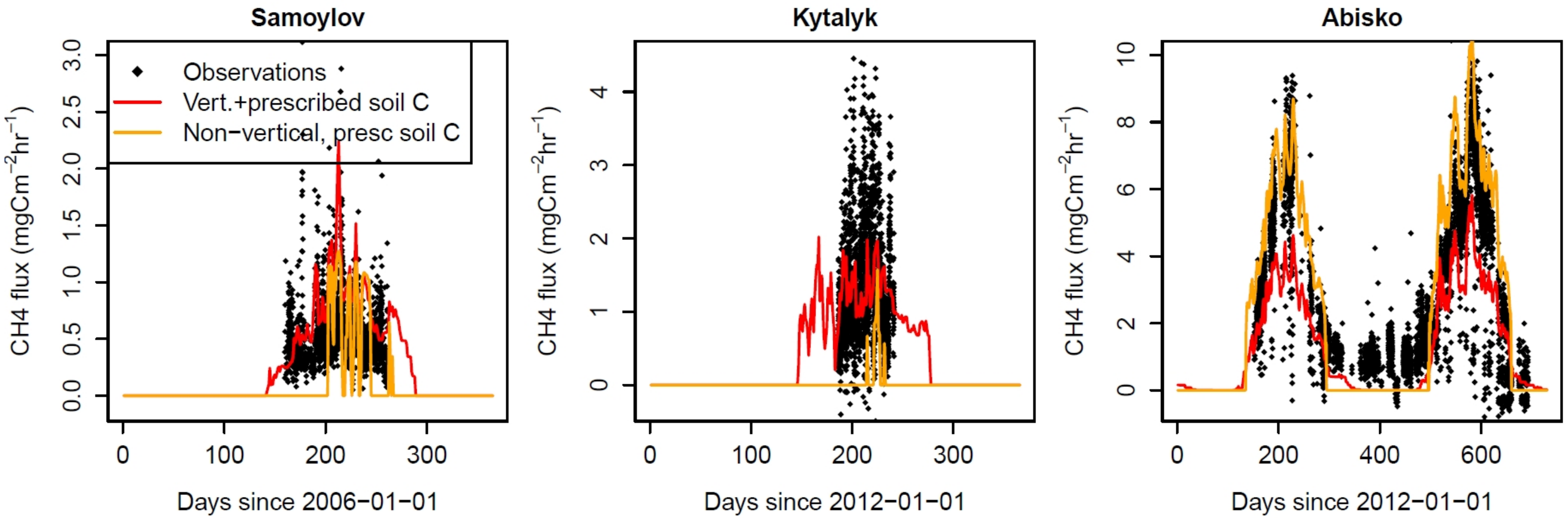
JULES layered soil carbon gives realistic quantity of soil carbon relative to GPP

(NB Nitrogen is another issue – see next talk)



Soil temperature dependence

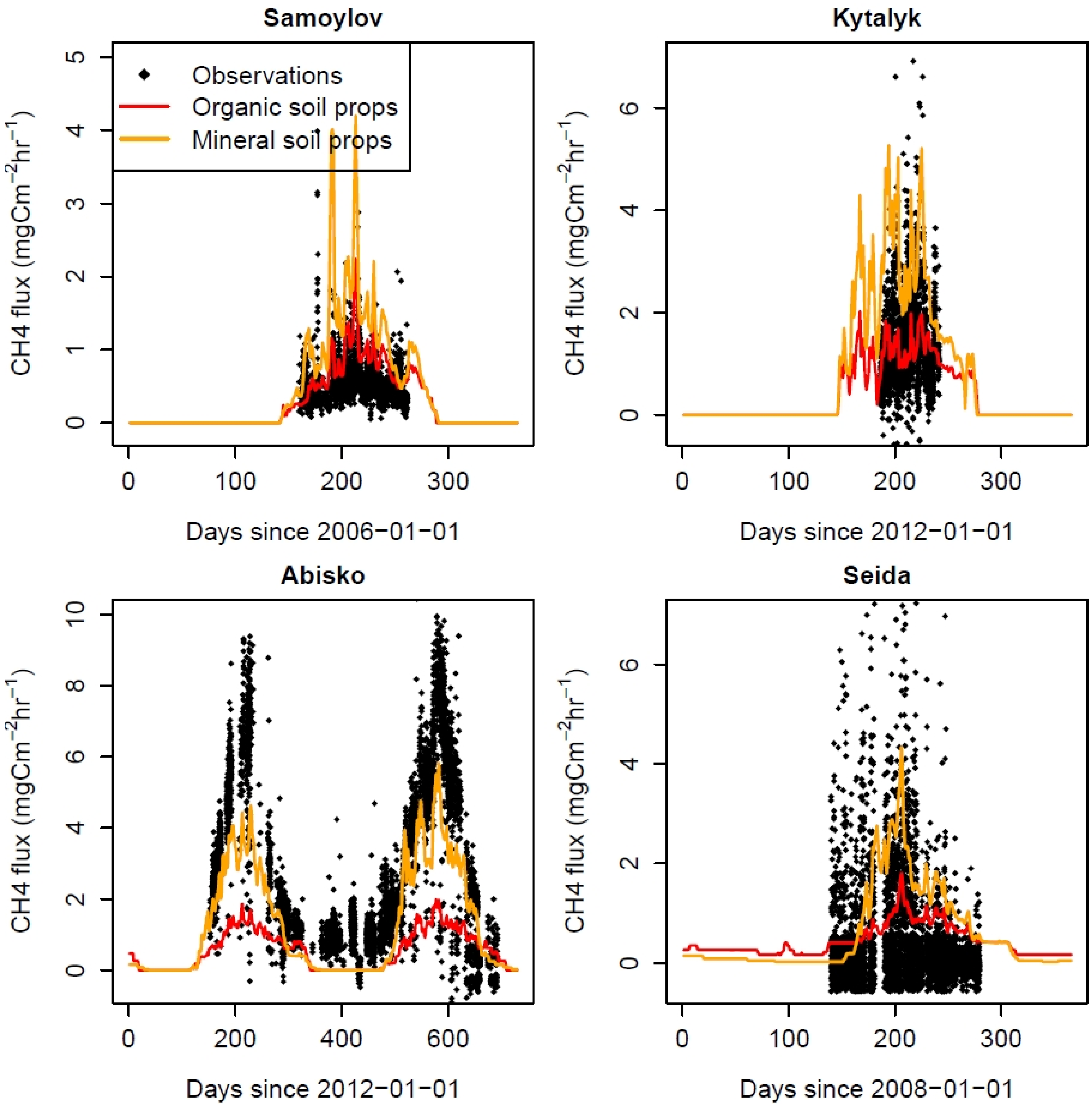
Layered soil temperature calculation is really useful for very cold sites.



Impact of soil properties – mineral vs organic soil

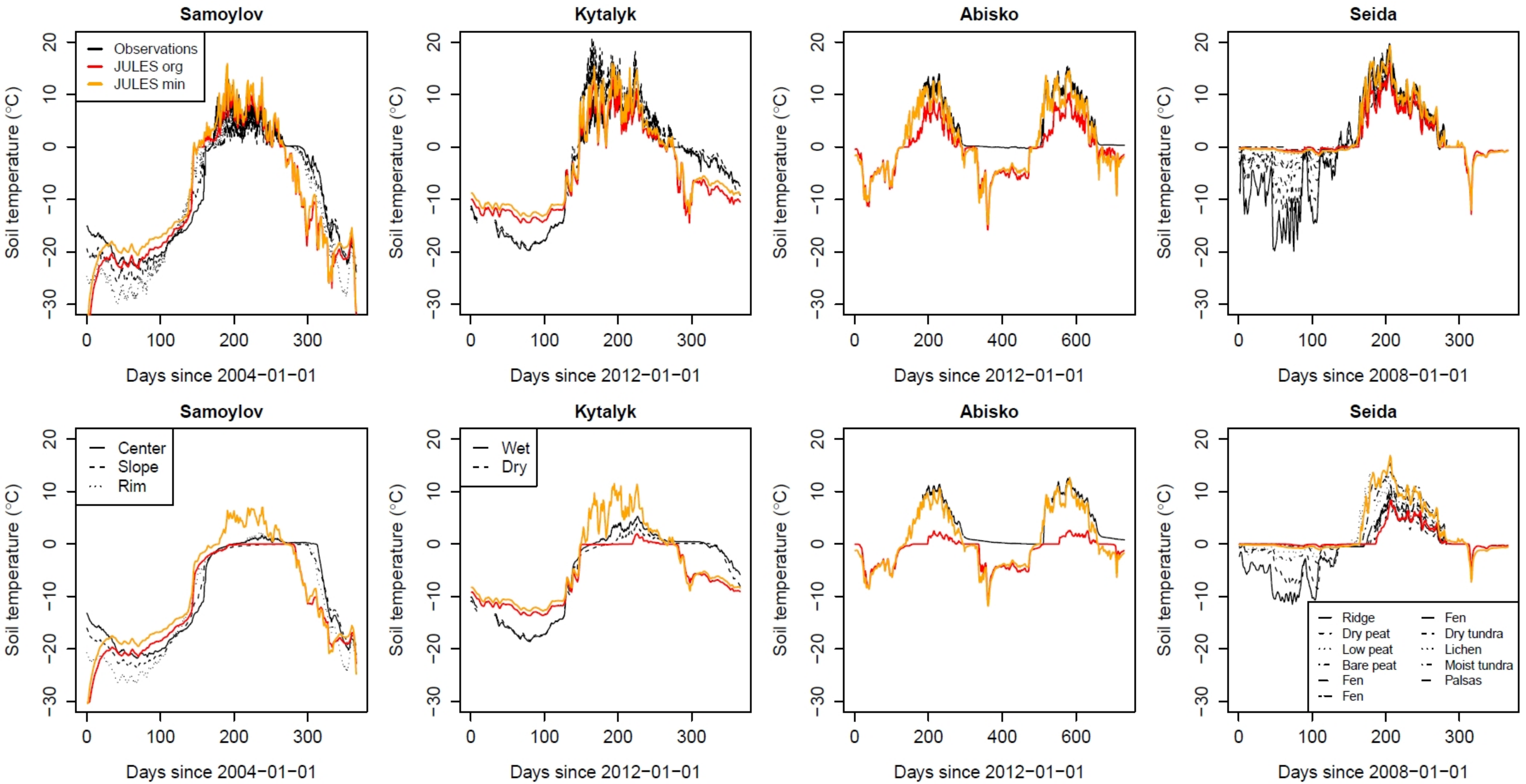
Changing soil properties has large impact on CH4 emissions.

Important to have realistic properties including organic soils.



Soil temperature

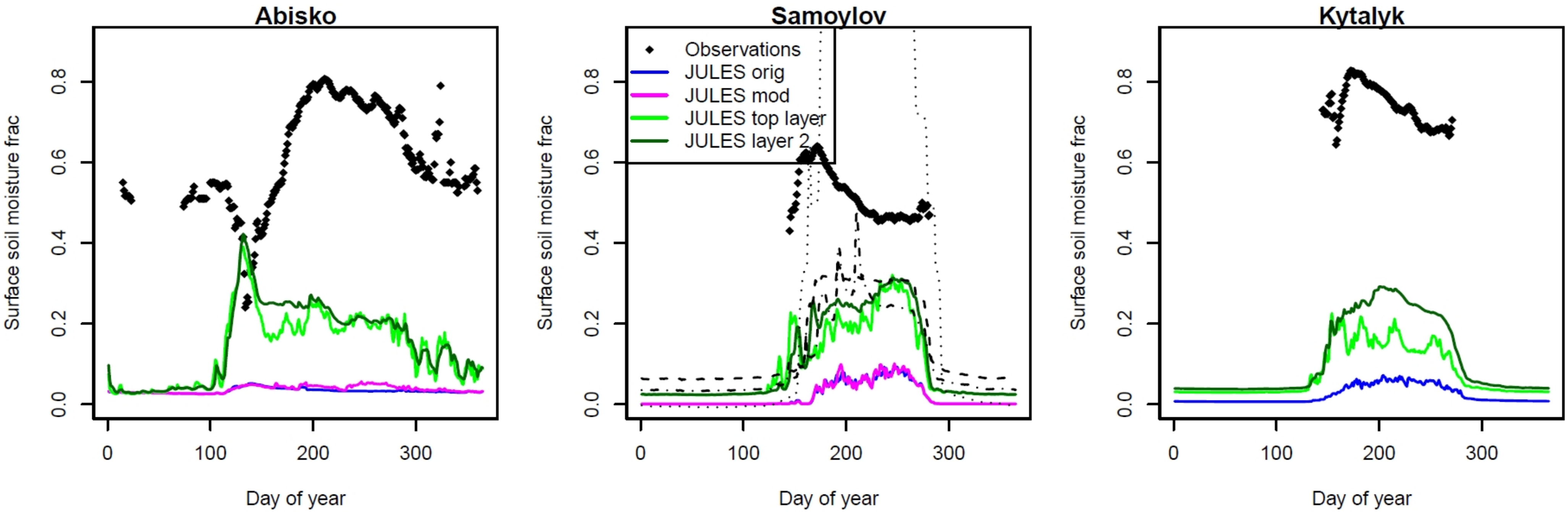
We seem to be getting the right CH4 emissions for the right reasons – suggests global soil temperatures are reasonable?!



Conclusions Part 1

- Methane model with globally constrained parameters gives realistic emissions per m^2 of wetland. :)
- Very sensitive to soil temperatures/soil properties.
- Soil carbon bias (due to lack of vegetation) is the biggest issue.
- When soil temperature and carbon are correct: Emissions still a little too small for permafrost sites (parameters constrained by global totals).

Wetlands



Satellite surface soil moisture data (ASCAT)

Soil is too dry.

- So far I have factored out wetland area, but this is the big issue for CH4 emissions.
- Possible reasons why soil is too dry: issues with soil_sat_down? Snow doesn't infiltrate in spring? Other possibilities? JPEG?

Conclusions Part 2

Two main issues for cold-region sites:

- 1. Vegetation (not enough).
- 2. Hydrology (not enough water).

Immediate future plans:

- Constrain depth dependence of CH_4 emission model using observed soil temperatures and CH_4 emissions?
- More work on hydrology, for organic and/or frozen soils.

Thank you for listening!

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