Impacts of observed changes in climate-related systems on northern peatland hydrology: first results from the ISIMIP peatland sector

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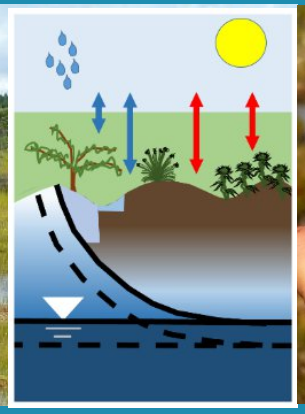
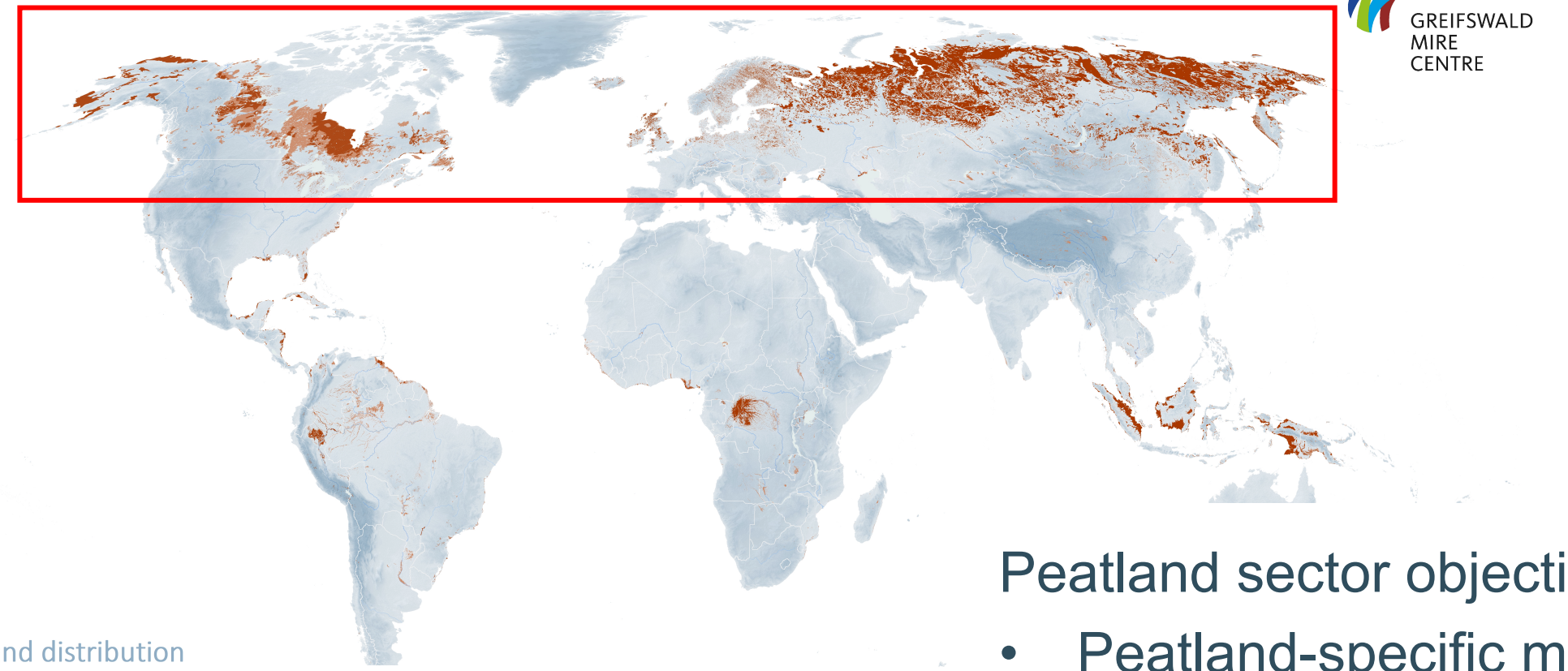


Peatland sector

This talk: Undrained northern peatlands only



GREIFSWALD MIRE CENTRE

~ 4 % of land surface

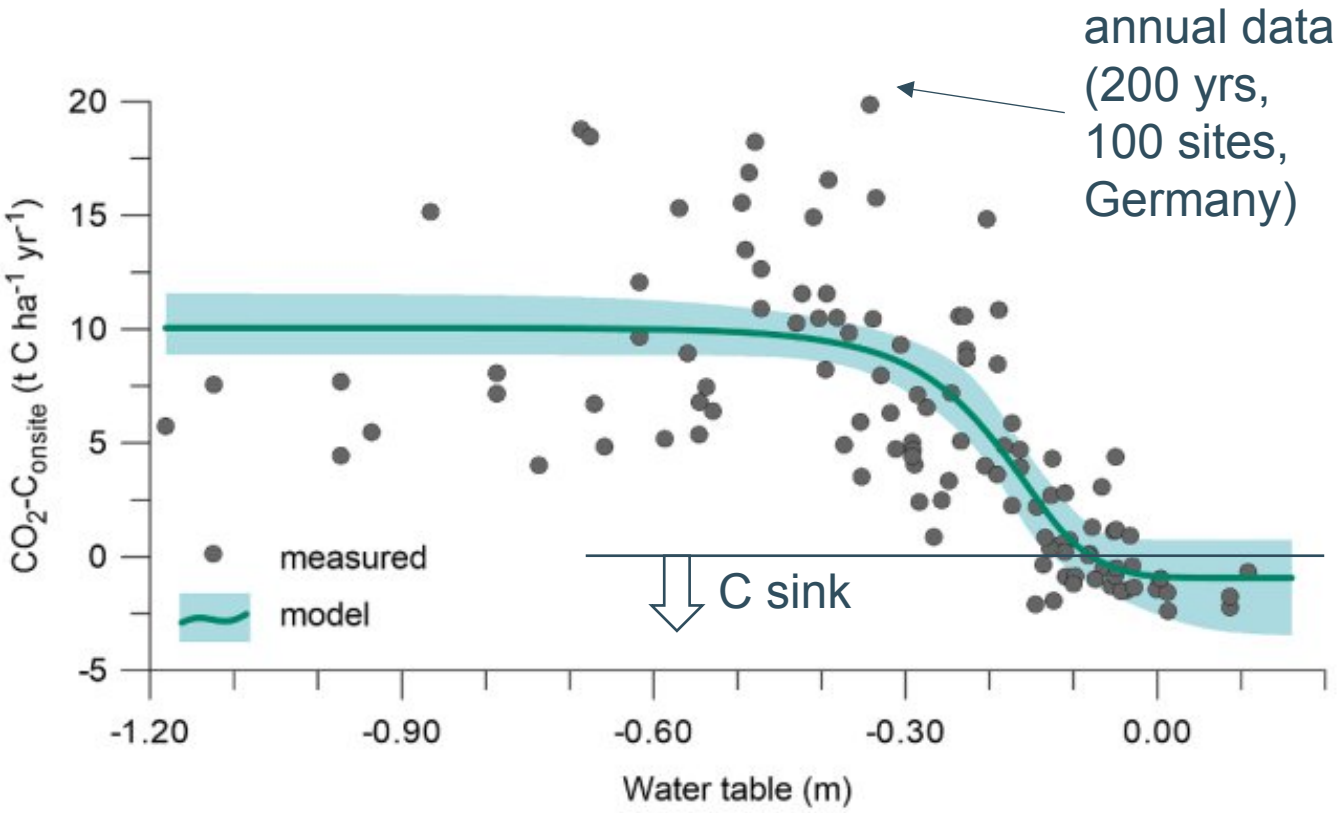
~ 30 % of global soil carbon

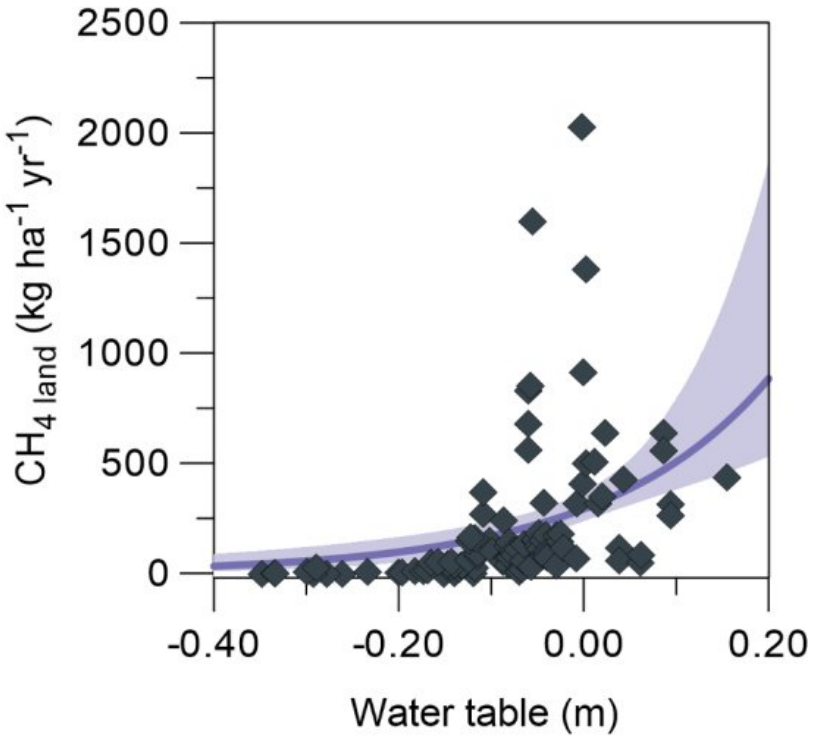
Peatland sector objectives:

- Peatland-specific modeling
- Performance assessment
- Attribution experiments

Groundwater table as first order control of climate impact

- Small changes in groundwater table ☾ Big impact on GHG emissions

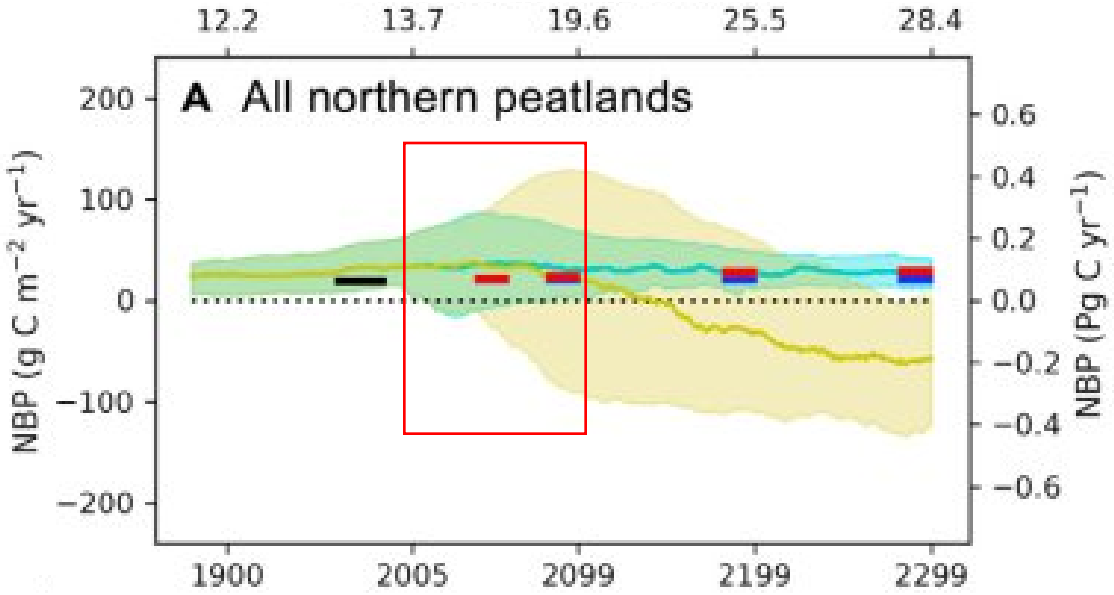


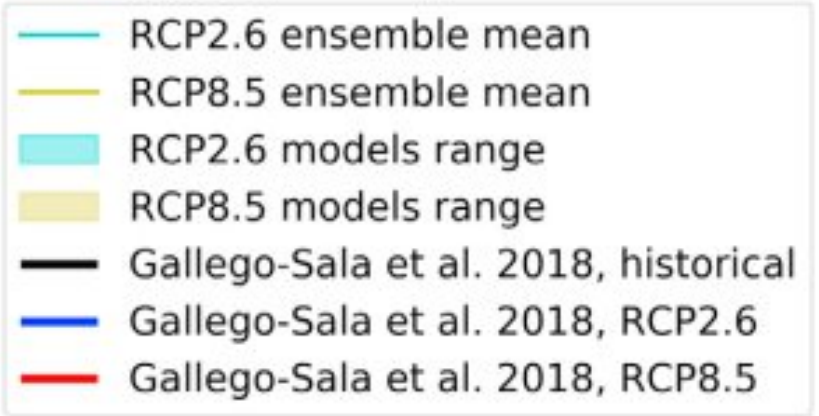


Tiemeyer et al., 2020, Ecological Indicators

Previous peat model intercomparison

- High ensemble spread in future projection of carbon balance





- Using ISIMIP attribution experiments to investigate reasons of different responses

- ORCHIDEE-PEAT
- LPJ-MPI
- LPX-Bern
- LPJ-GUESS
- LPJ-GUESS_dynP

Qiu et al., 2022, One Earth

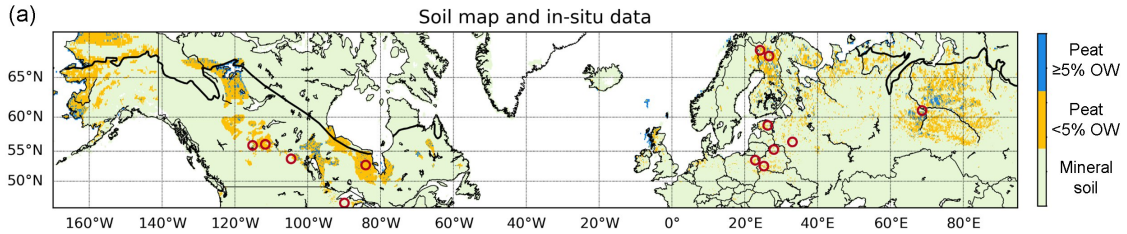
Status of simulations

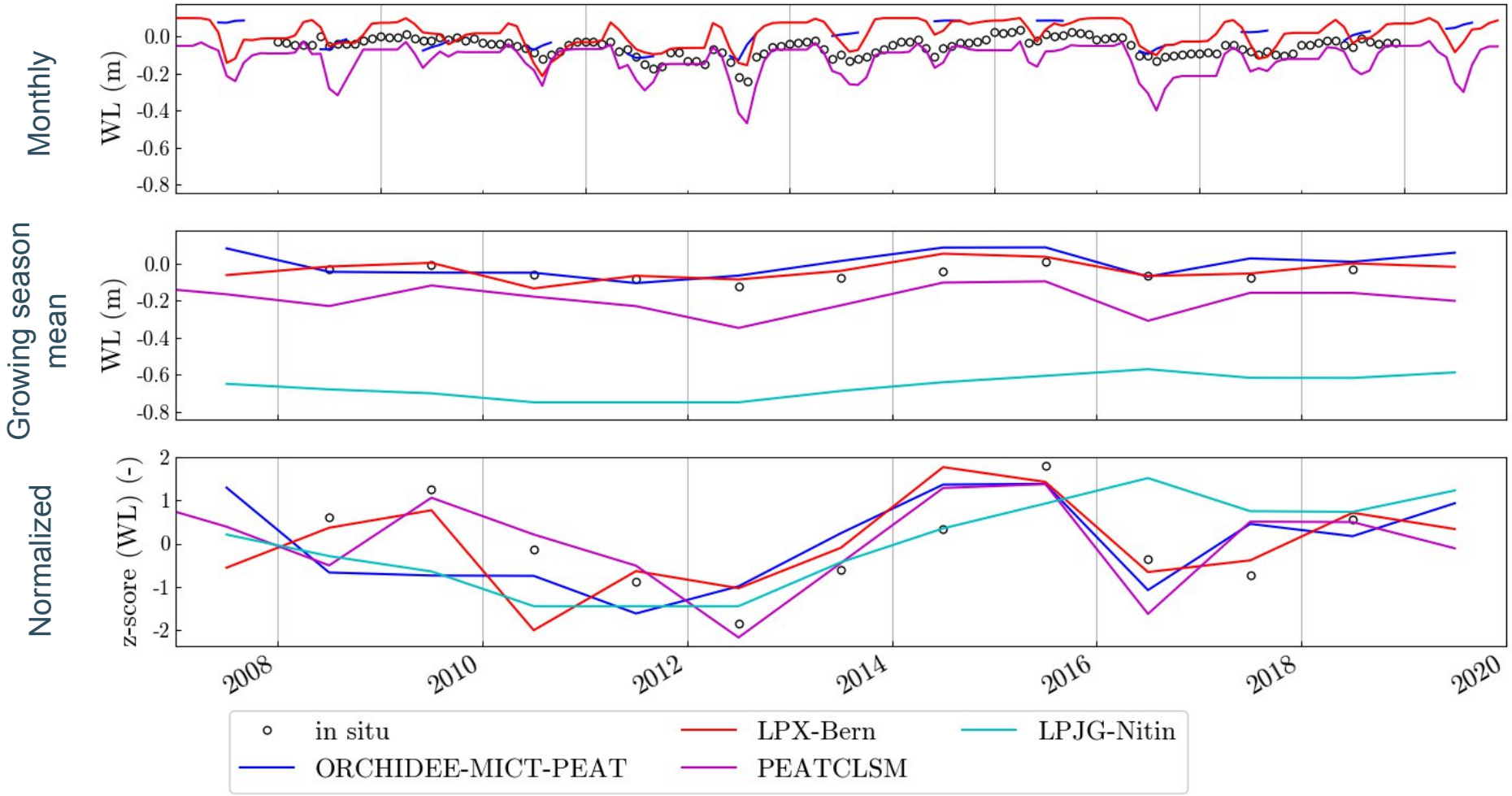
MODELS	ISIMIP3a		ISIMIP3b
	obslim obslim_1901co2	counterclim (default and 1901CO2)	pre-industrial control (RCP 2.6/ 8.5/ CO2 sensitivity RCP8.5
ORCHIDEE-MICT-PEAT	completed	completed	
LPX-Bern	completed	completed	
LPJ-GUESS_dynP	completed	in progress	
PEATCLSM	partly	pending	
LPJ-GUESS	in progress	pending	
JULES-PEAT	planned	planned	
CLASSIC	?	?	
JSBACH-HIMMELI	?	?	
CLM5 (peat?)	?	?	
ECOSYS	?	?	

Performance assessment

(Undrained peatlands only)

- Example: Western Siberian Lowlands

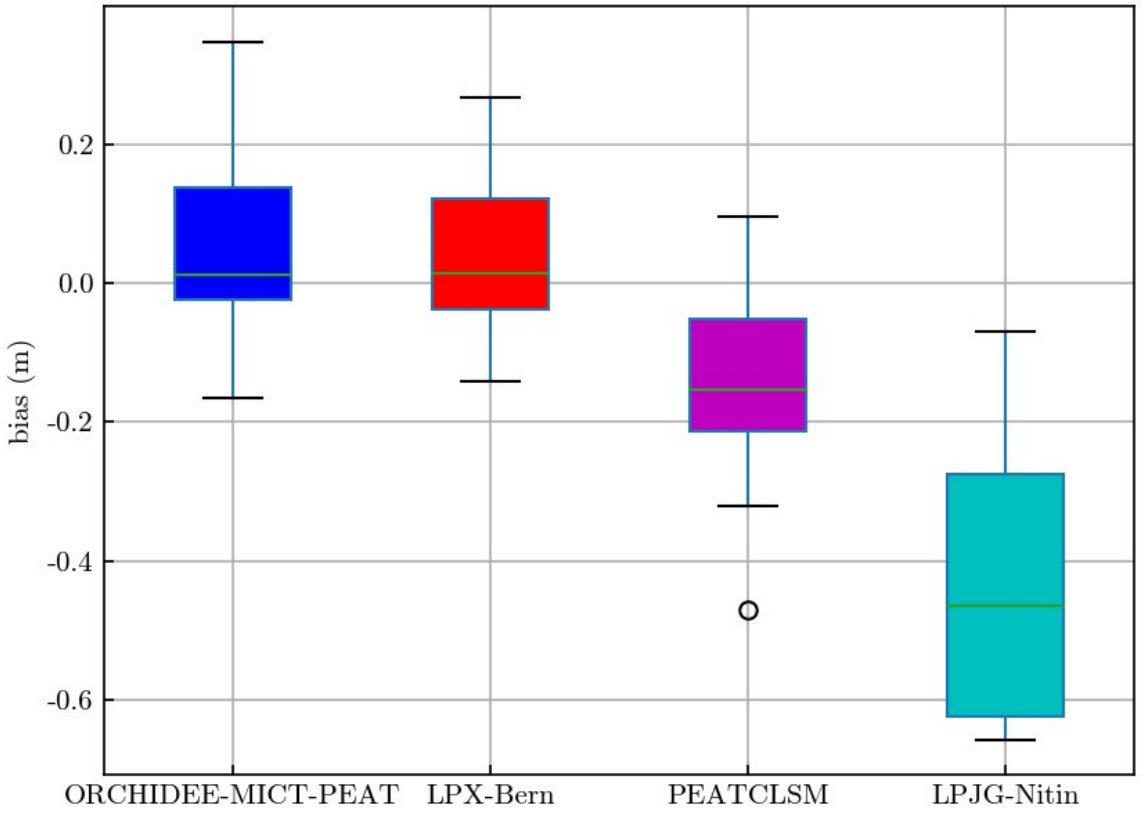


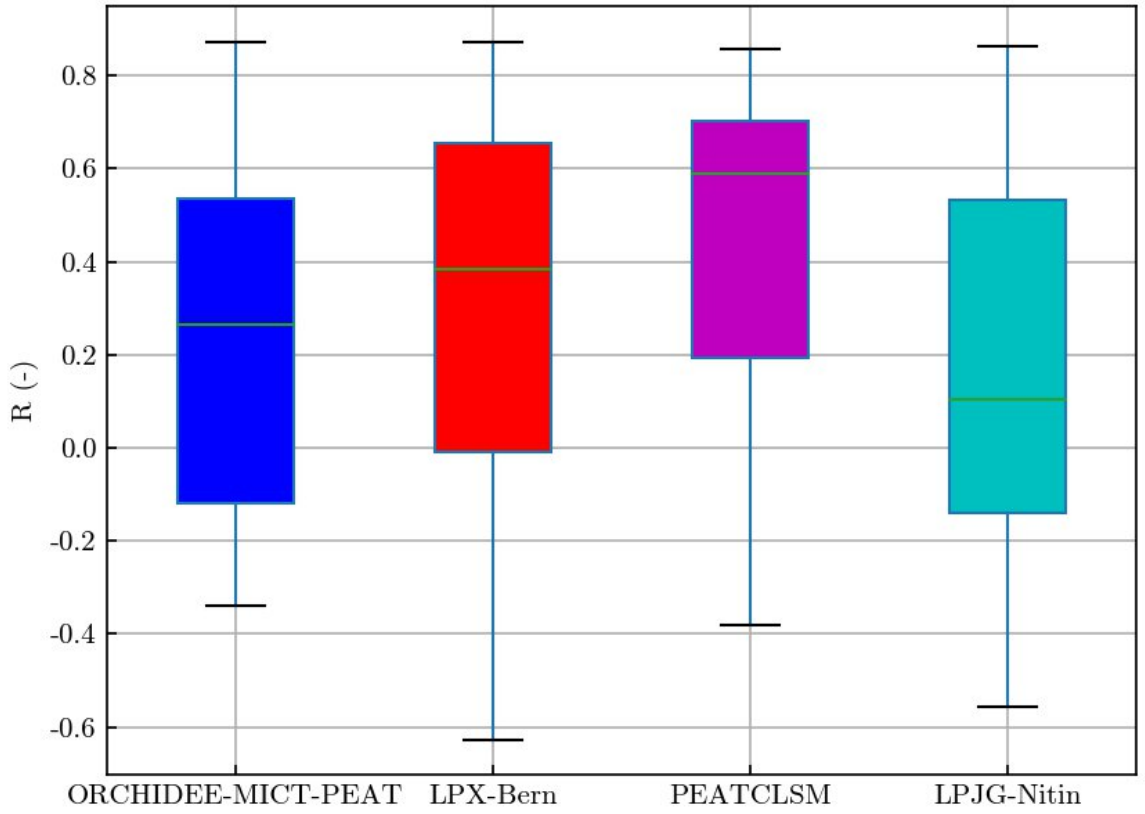


~ 44 undrained peatlands with in situ water level data, after cross-masking with model output ☾ only 6 left (~ 20 monitoring well)

Performance assessment
(Undrained peatlands only)

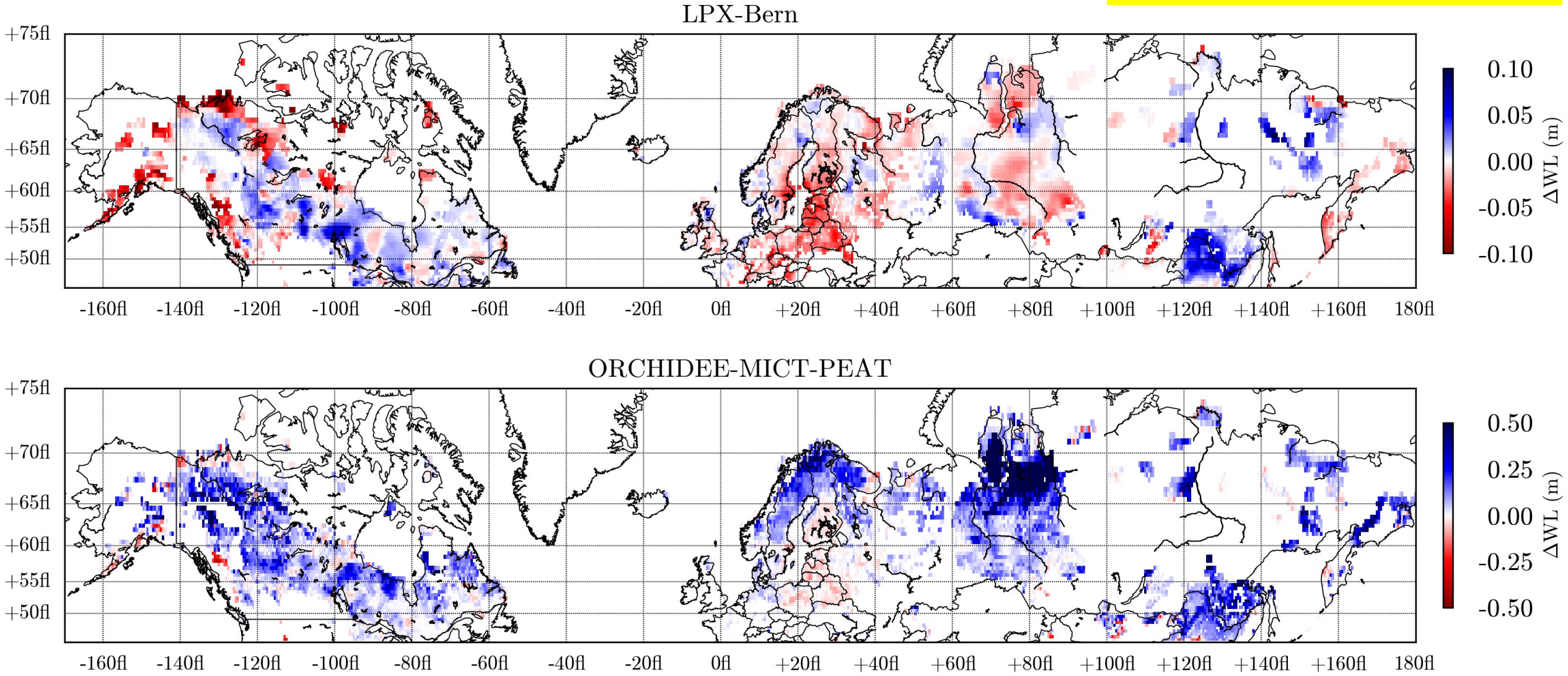
- For groundwater table depth, growing season mean





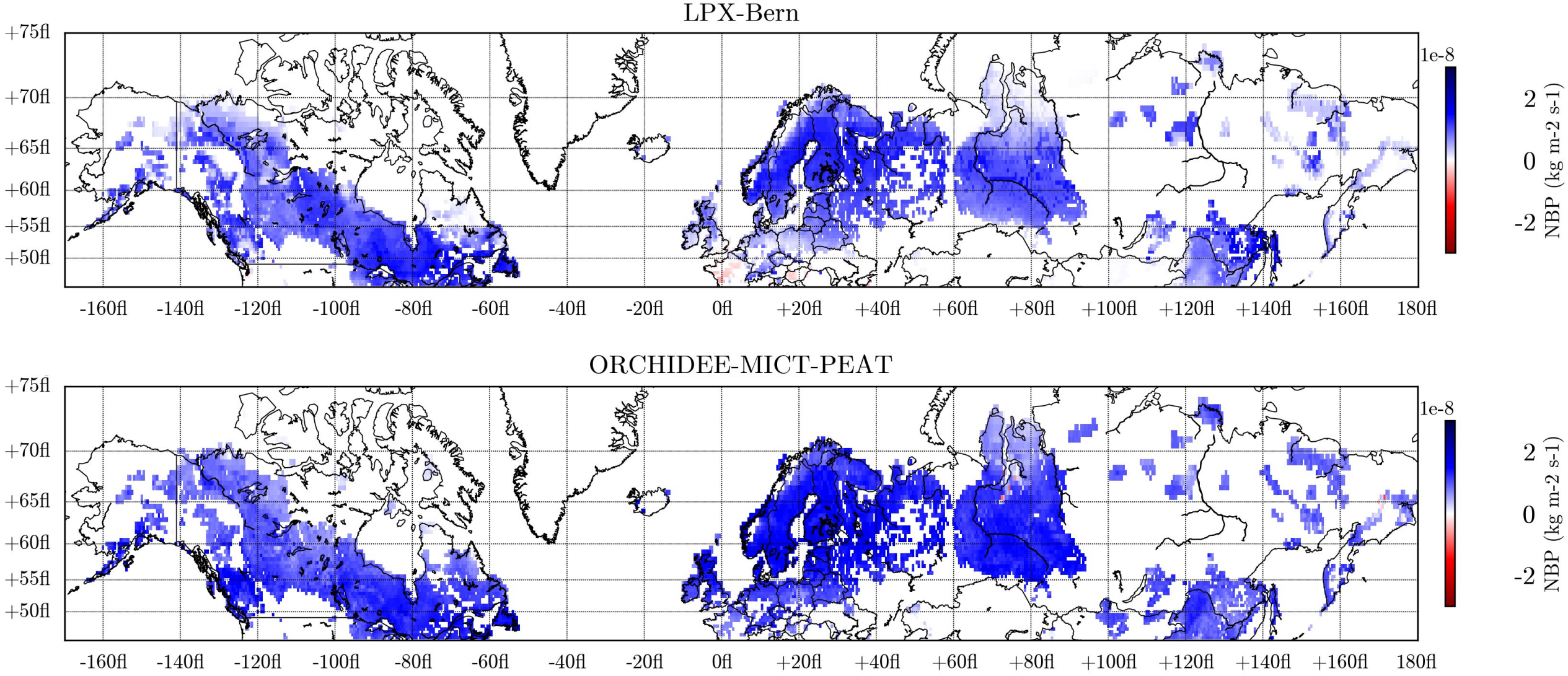
Change in growing season mean water level (1980-2019, obsclim – counterclim)

Spatial variability of climate impact on peatland hydrology



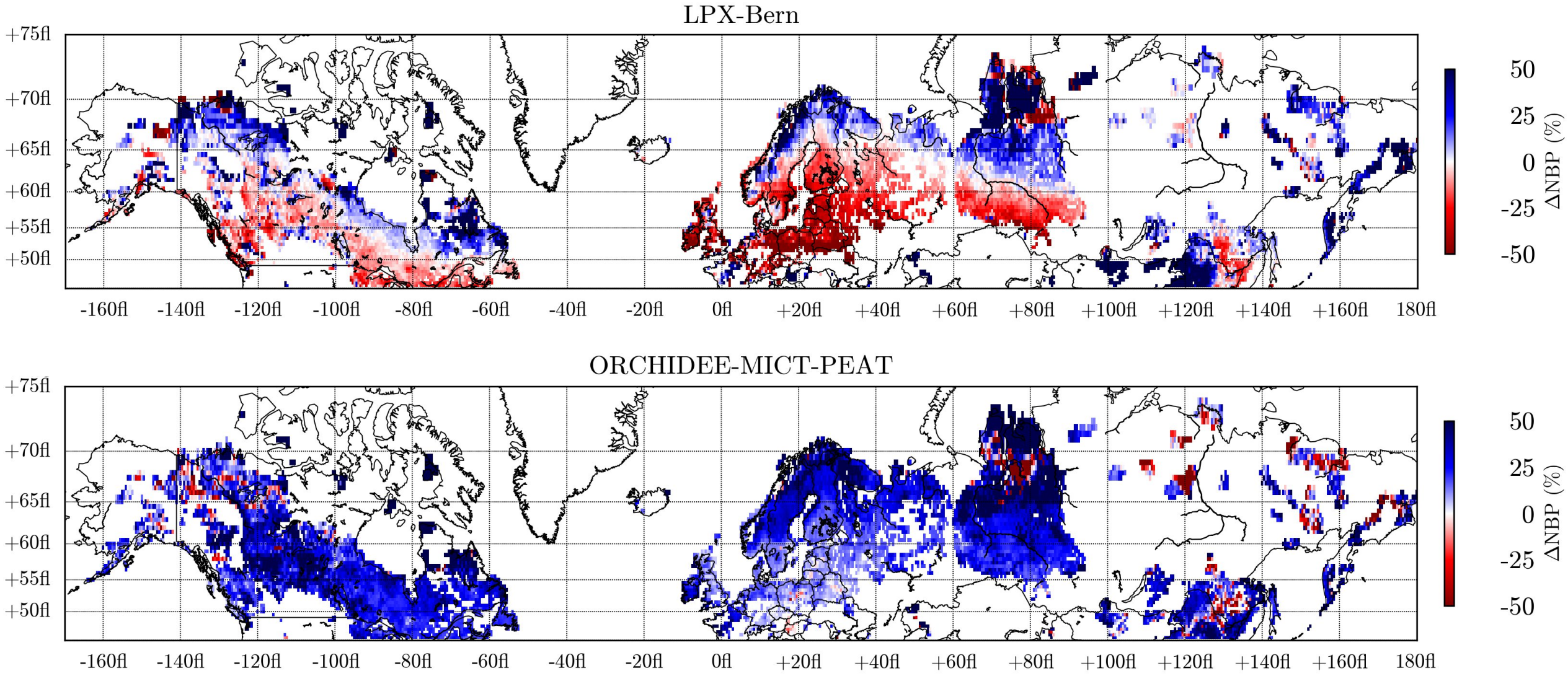
Carbon sink function (1901-2019 mean, obsclim)

High agreement



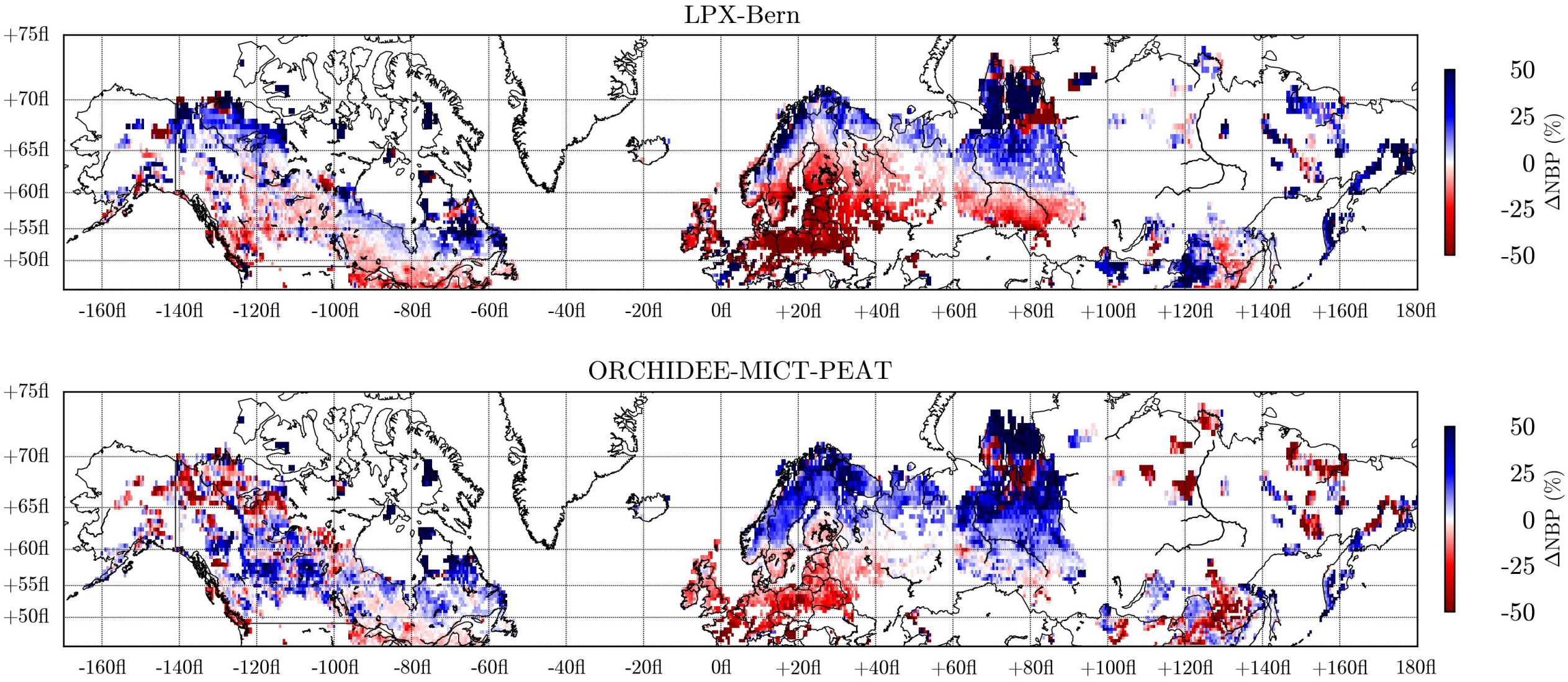
Change in carbon sink function (1980-2019, obsclim – counterclim)

High discrepancy



Change in carbon sink function (1980-2019, obsclim1901co2 – counterclim)

Higher agreement
w/o CO2 sensitivity



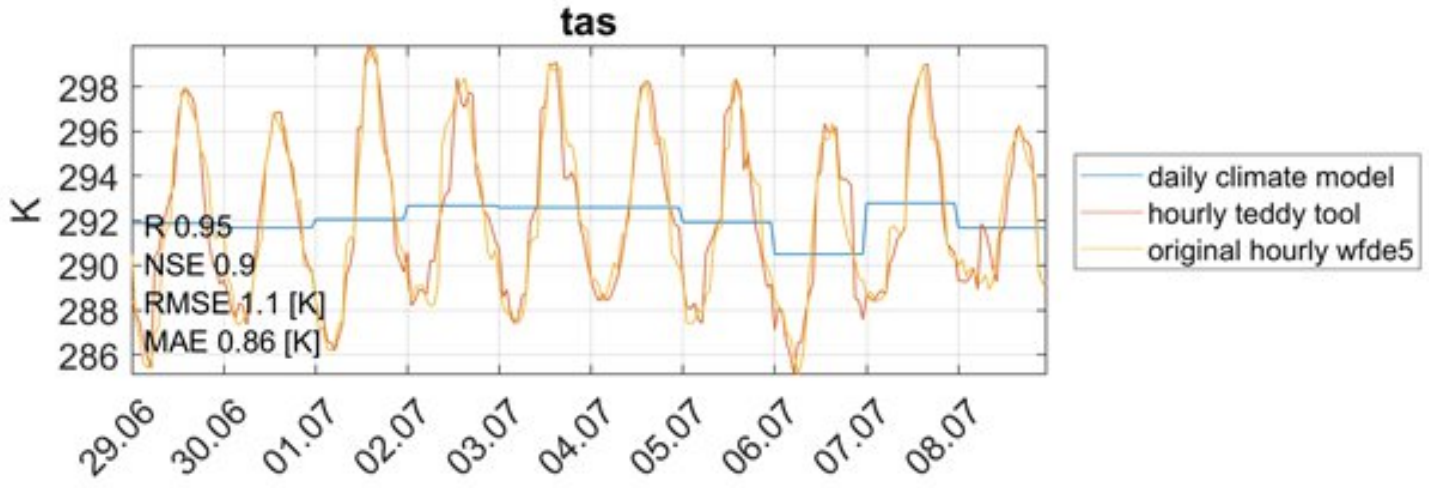
First conclusions

- First insights from performance assessment
- Substantial changes in carbon sink function due to changes in climate-related systems
- Models show different responses to changes in climate-related systems (strong differences in CO_2 fertilization impact)
- Involvement of more peatland models needed (ongoing)
- Long-term plan: Integration of drainage and rewetting into ISIMIP runs, including the tropics

Extra slides

Temporal downscaling of daily forcing data

- ORCHIDEE, PEATCLSM, CLM etc. use different approaches to downscale daily ISIMIP climate forcing data
- A common dataset, e.g. generated with ‘Teddy tool’ that is consistent with bias adjustment procedure in ISIMIP on the basis of WFDE5, would be useful



Zabel and Poschlod, 2023, GMD

Paper plans

Paper #1 (Michel Bechtold et al.) | Peatland hydrology with 3a output:

- Detailed assessment and interpretation of performances differences
- Climate change impact attribution

Paper #2 (Noah, Angela, Sarah et al.) | Peatland carbon cycle 3a/3b output:

- Details to be worked out

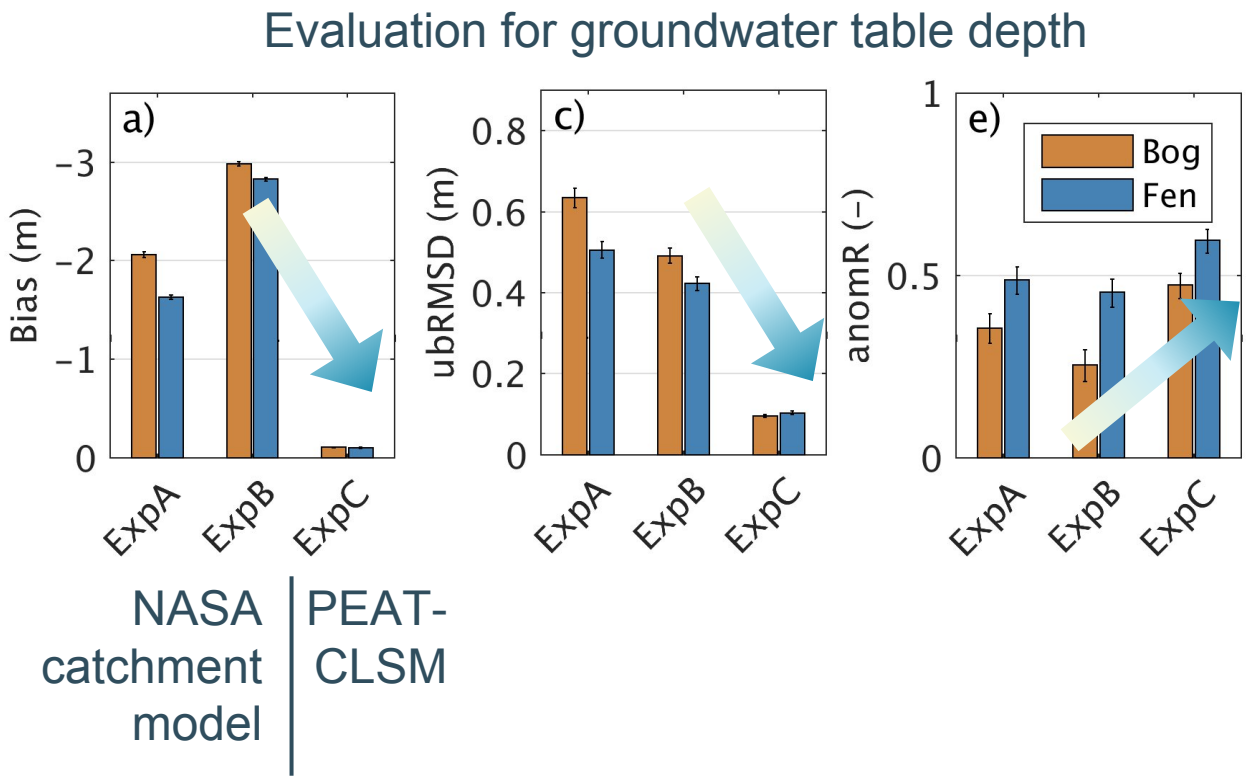
Paper #3 (Chunjing Qiu et al.) | CO2 fertilization paper 3a/3b output:

- Poorly studied for peatland ecosystems
- C vs. CN models
- Climate sensitivity RCP2.6 with RCP8.5 CO2 (2nd priority) needed

more?

Peatland-specific models with drastic improvements

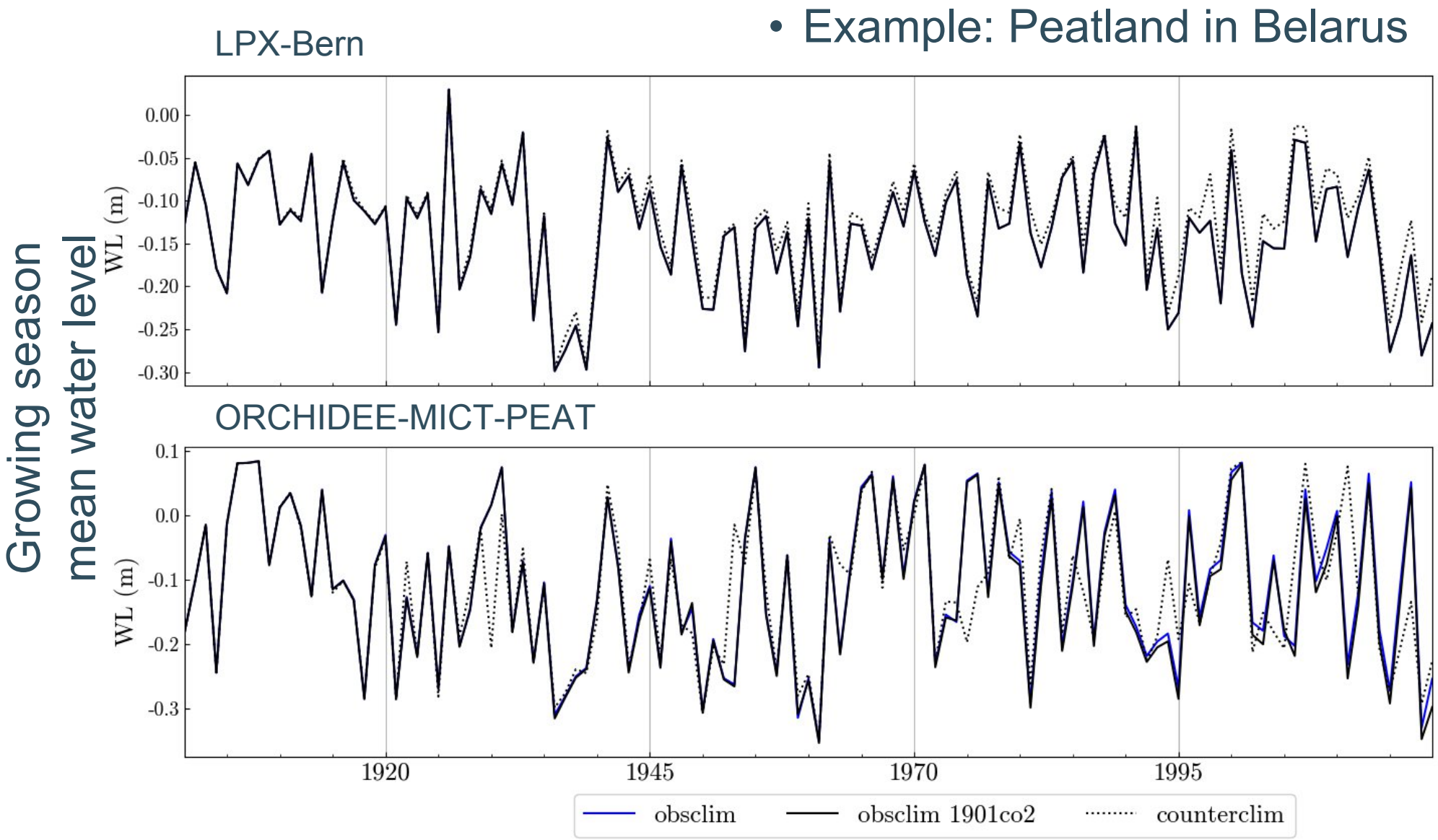
- Groundwater table depth from 44 different northern peatlands
- Also reduction of bias in evaporation (not shown)



Bechtold et al., 2019, JAMES

Attribution experiments (water cycle)

- Example: Peatland in Belarus



- systematically drier
- no impact of CO2

- interannual drier/wetter
- CO2 impact (carbon-water cycle interaction)