An update on the Arctic 2k Hydroclimate efforts

Hans Linderholm
and the Arctic 2k group

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UNIVERSITY OF GOTHENBURG

Gothenburg University Laboratory for Dendrochronology (GULD)

RCG
Regional Climate Group - Göteborg University

Talk outline

- Background
- Arctic hydroclimate proxies
- Proxies vs models
- Summary

Changes in hydroclimate will have impacts on the Arctic environment

- Changes in ecosystem productivity
- Alterations in ecosystem biophysical properties, biogeochemical cycling and chemical transport
- Altered landscapes, successional trajectories and creation of new habitats
- Altered seasonality and phenological mismatches
- Gains or losses of species and implications for trophic interactions

Wrona et al. 2016 (JGR)

- Increased winter precipitation may increase the CH_4 source strength of Arctic tundra

Blanc-Betes et al. 2016 (GCB)

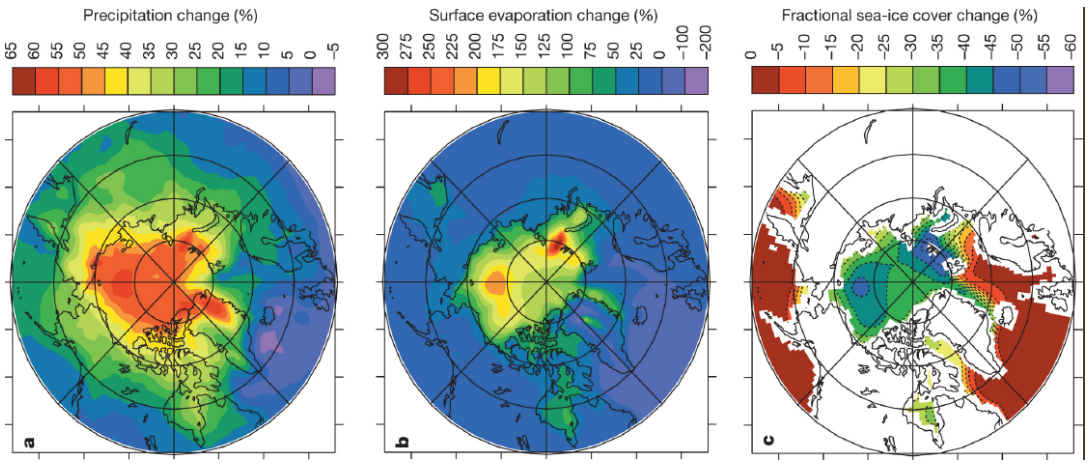
Changes in the Arctic will also affect lower latitude hydroclimate

- Changes in autumn-winter snow cover affects the general atmospheric circulation (e.g. the jet stream)

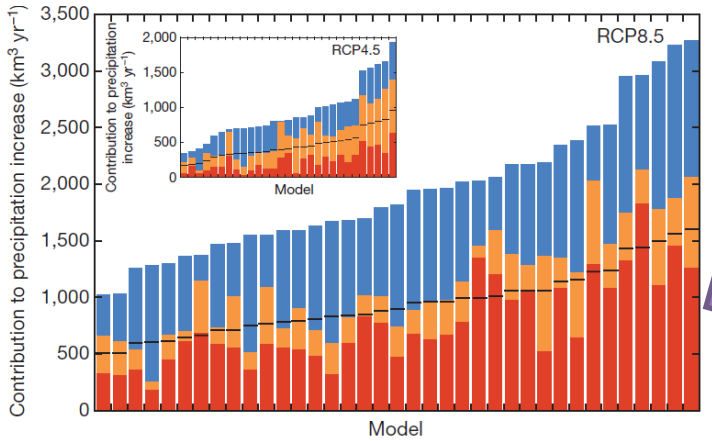
- Links between sea-ice variability and the summer NAO
→ affecting hydroclimate in the North Atlantic Region

- Increased freshwater input in North Atlantic may impact the AMO

The future?



Simulated (CMIP5 models, RCP8.5) annual mean 21st-century precipitation, surface evaporation, and sea-ice cover changes in the Arctic region. (difference between the means over 2091–2100 and 2006–2015)



Transport (remote origin)

Evaporation unrelated to sea ice

Evaporation due to sea-ice retreat

Bintanja and Selten, 2014 (Nature)

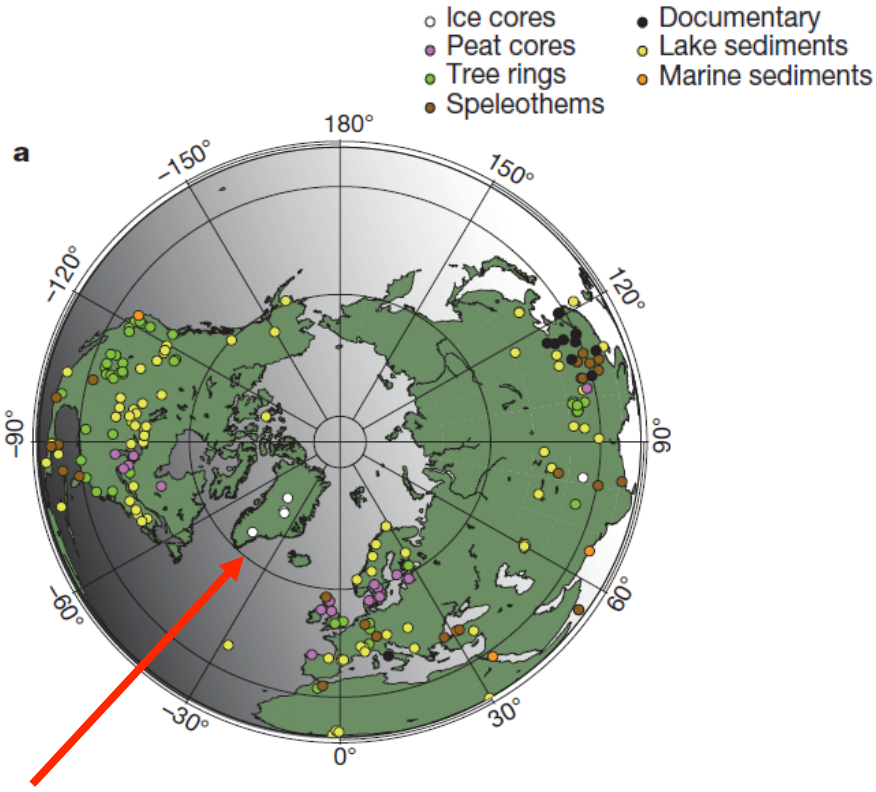
But how well do climate models represent hydroclimate in the Arctic and how much do we know about spatiotemporal variations in the region?

"… much work remains before we can model hydroclimate variability accurately, and highlights the importance of using palaeoclimate data to place recent and predicted hydroclimate changes in a millennium-long context"

Ljungqvist et al. 2016

Arctic hydroclimate proxies

The Arctic 2k hydroclimate effort
What do we have?

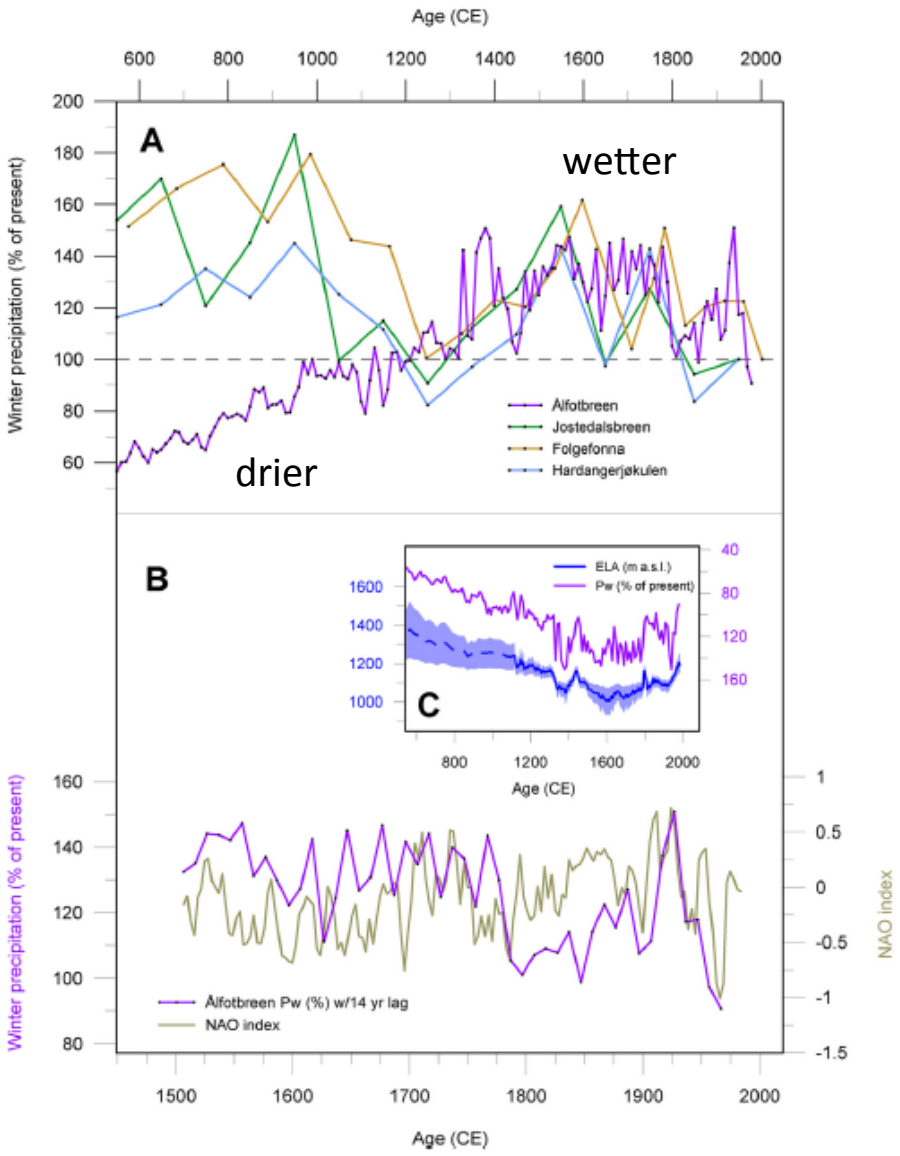


In Fredrik's paper for >60N:

10 lake sediment records
1 tree-ring record
2 peat records
5 ice core records

Some more data is currently available in the PAGES2k database, and there is data out there that has yet not been included. Also, exciting results have recently been, or are about to be, published.

Here follows some examples of the latter…



Lake sediments

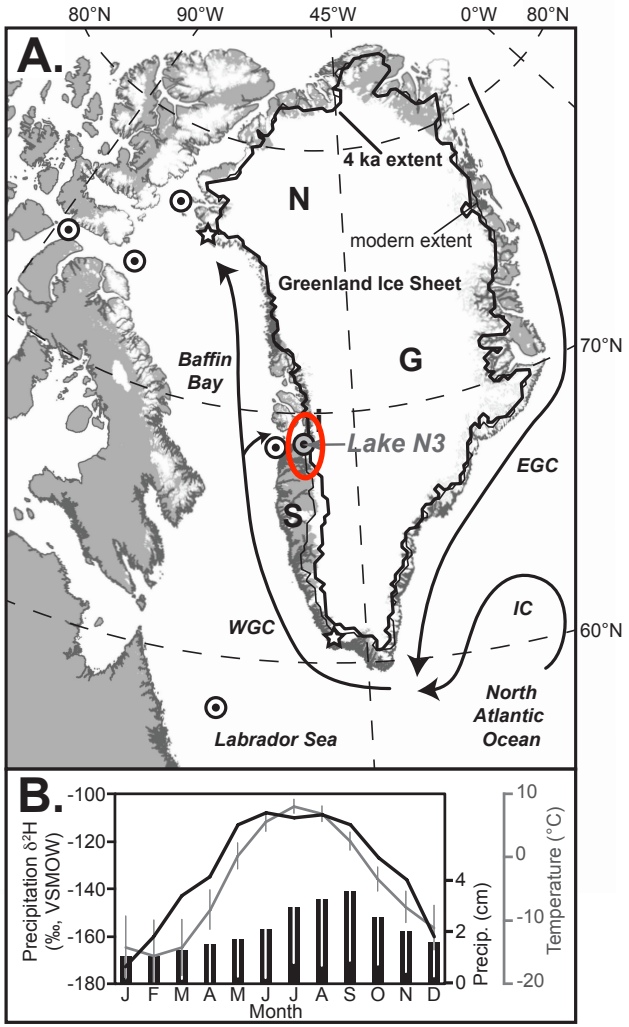
Reconstructions of equilibrium-line-altitude (ELA) variations from glaciers sensitive to changes in winter precipitation (Pw) provide an potential to quantify past winter climate.

ELA and summer T are reconstructed from lake sediments → Pw can be attained

- High-resolution Pw reconstruction
- Differences in Pw patterns along the coast of Norway

Gjerde et al. 2016 (QSR)

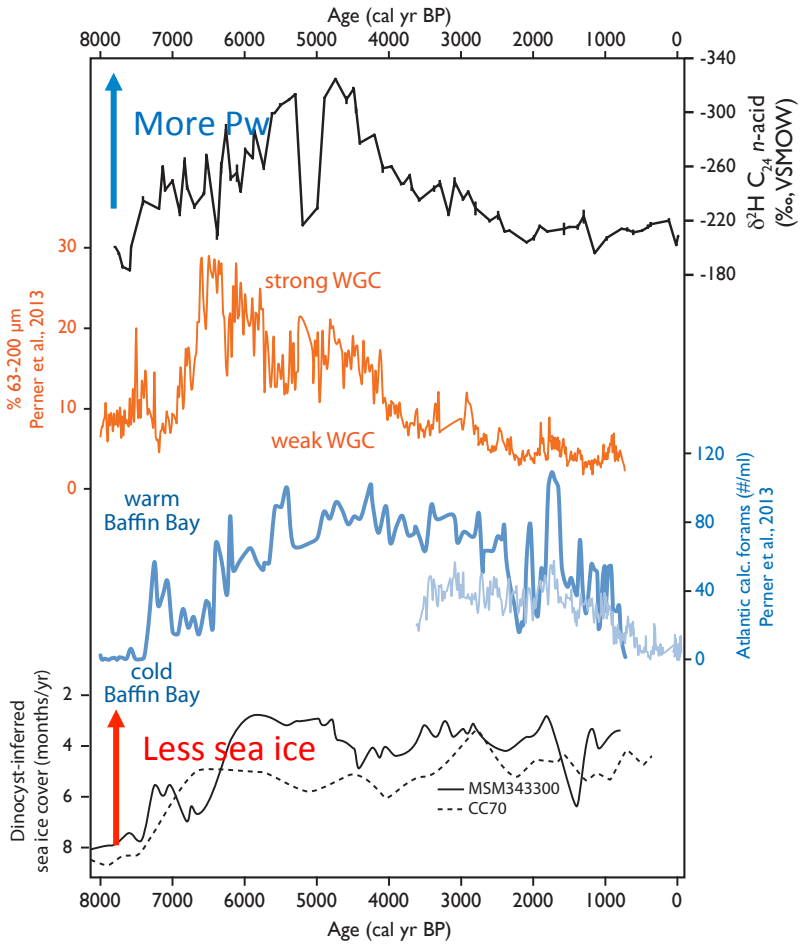
Biomarkers: Aquatic plant leaf waxes



Hydrogen isotopes ratios (δ^2H) of lipid biomarkers from Lake N3 on western Greenland were used to reconstruct Holocene precipitation seasonality and temperture.

Thomas et al. 2016 (GRL)

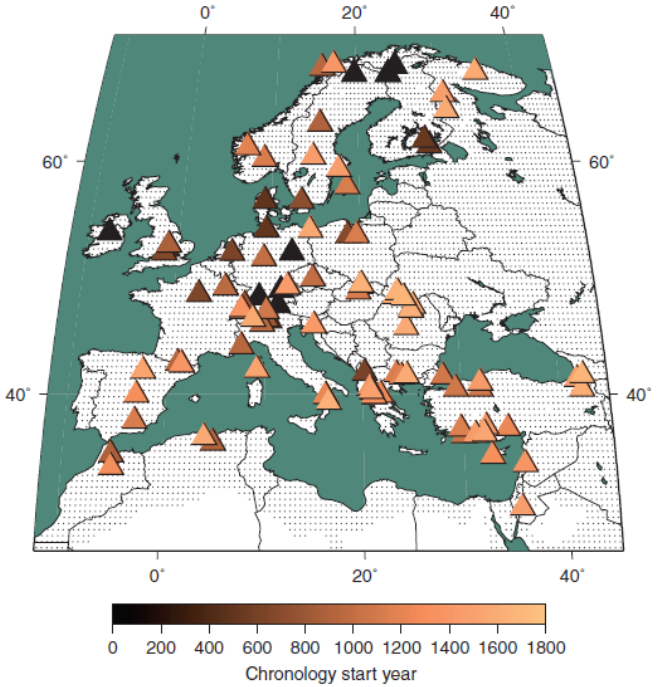
Biomarkers: Aquatic leaf waxes



Aquatic leaf waxes become depleted during the middle Holocene, when the West Greenland Current (WGC) was at maximum strength and temperature and regional sea ice was at a minimum. This supports model results that *warmer conditions and loss of sea ice may cause increased snowfall in the Arctic*.

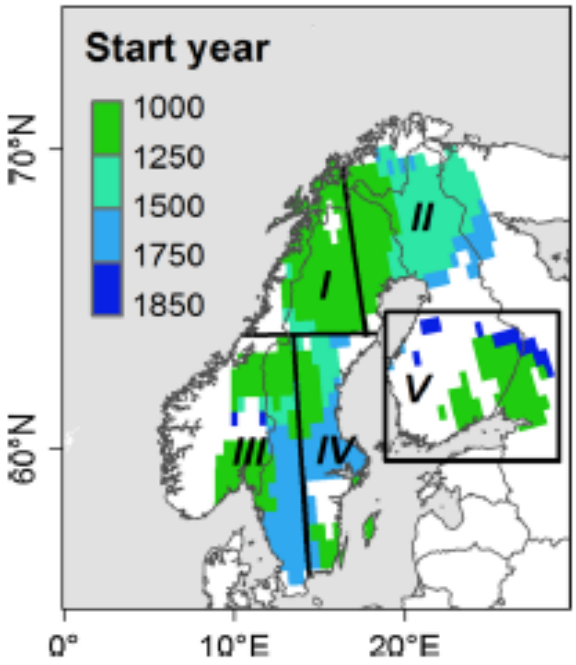
Thomas et al. 2016 (GRL)

Tree-ring data: Hydroclimate atlases



OWDA (JJA scPDSI)

Cook et al. 2015 (Sci. Adv.)

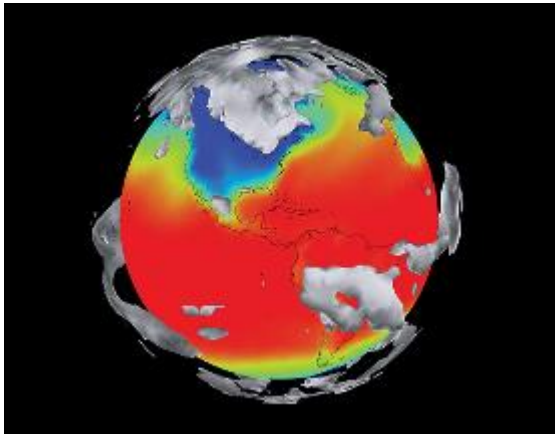


FEDA (JJA SPEI)

Seftigen et al. 2015 (Clim. Dyn.)

Both atlases provide annual maps of hydroclimate variability across their domains. Makes regional comparisons possible

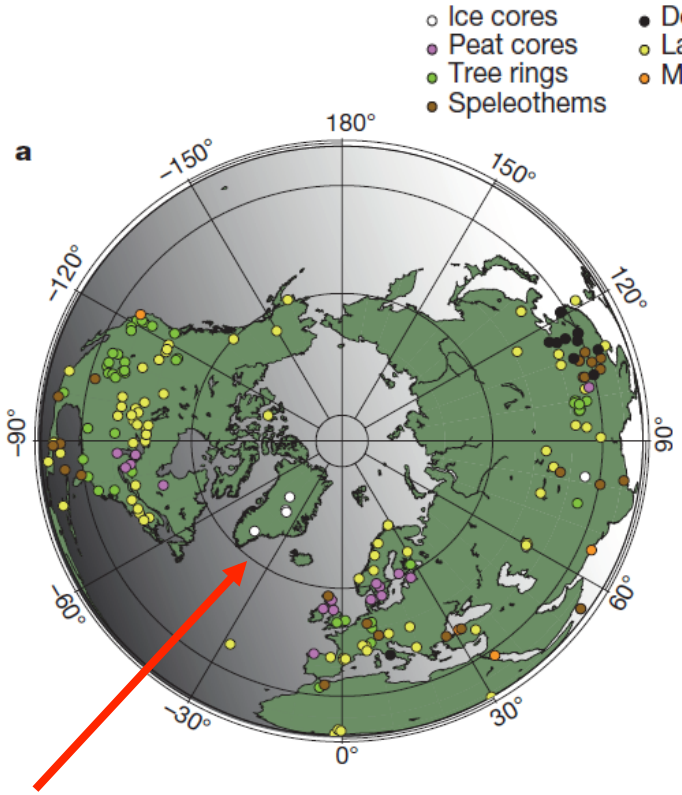
Proxies vs. Models



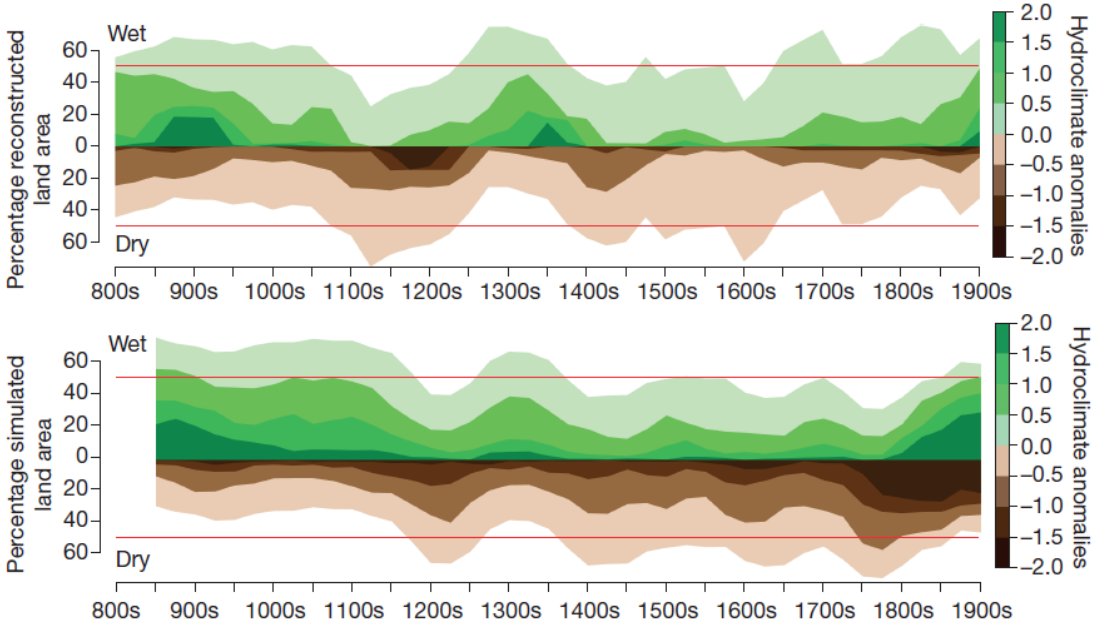
Credit: PNNL

A new reconstruction of NH hyrdoclimate

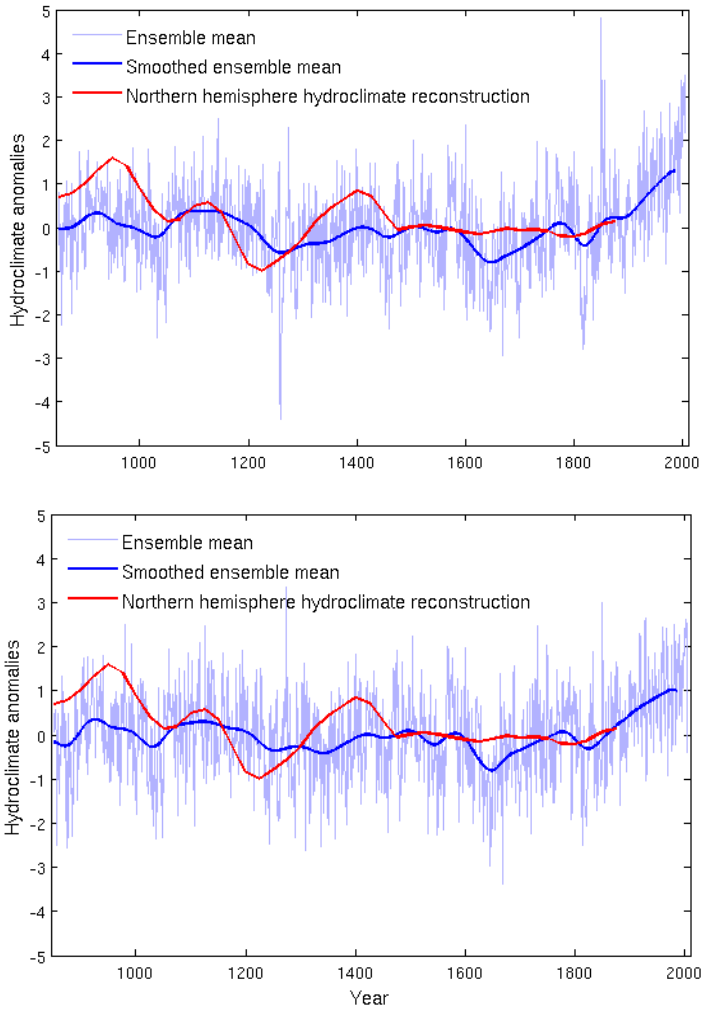
Ljungqvist et al. 2016 (Nature)



Proxies vs. models

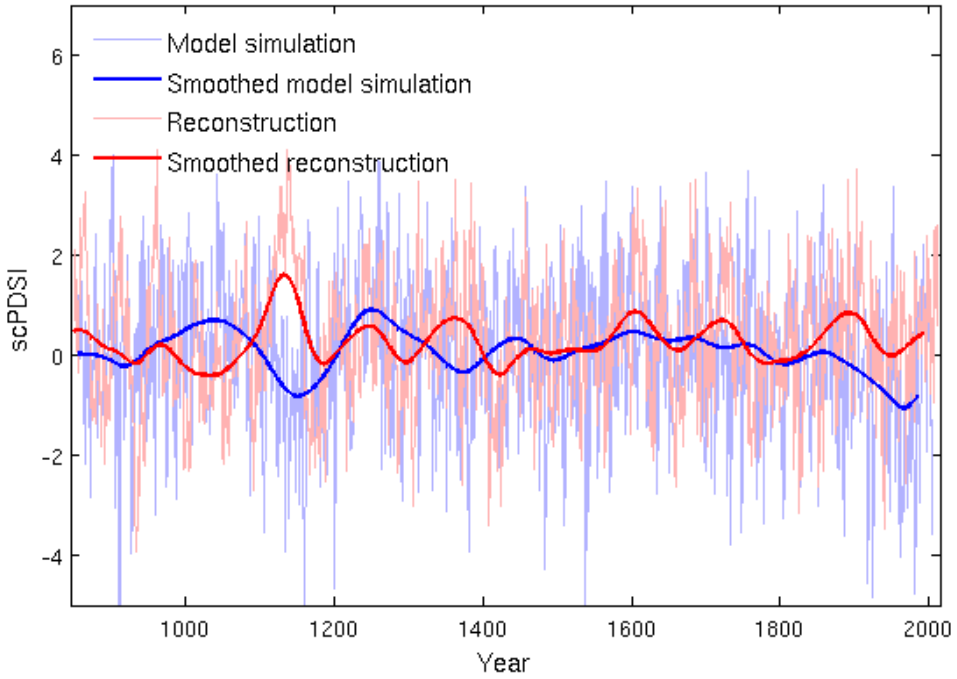


Focusing on the Arctic (>60°N)



Ljungqvist et al. 2016 annual precipitation 60-80N for whole NH vs. PMIP3 ensemble mean (4 models, CSIRO-Mk3L-1-2, HadCM3, IPSL-CM5A-LR & MPI-ESM-P)

Ljungqvist et al. 2016 annual precipitation 60-80N recon vs. PMIP3 for 65W-45E ensemble mean (same models as above)



Comparison of from OWDA and the MPI-ESM-P JJA scPDSI for the region 60-71N, 11-45E

Summary

- The Arctic is indeed a key area when it comes to the impact of hydroclimate related changes

- Low number of hydroclimate proxies available at present (but more are coming)

- Field reconstruction for the whole Arctic not feasible. Possibly selected regions (e.g. North Atlantic region)

- An extended hydroclimate proxy network will enable further investigations not only of spatiotemporal hydroclimate variability in a long-term context, but also the mechanisms behind inferred changes.

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