North Atlantic Oscillation Controls on Water Isotope Proxies in the Iso2k Database and iCESM

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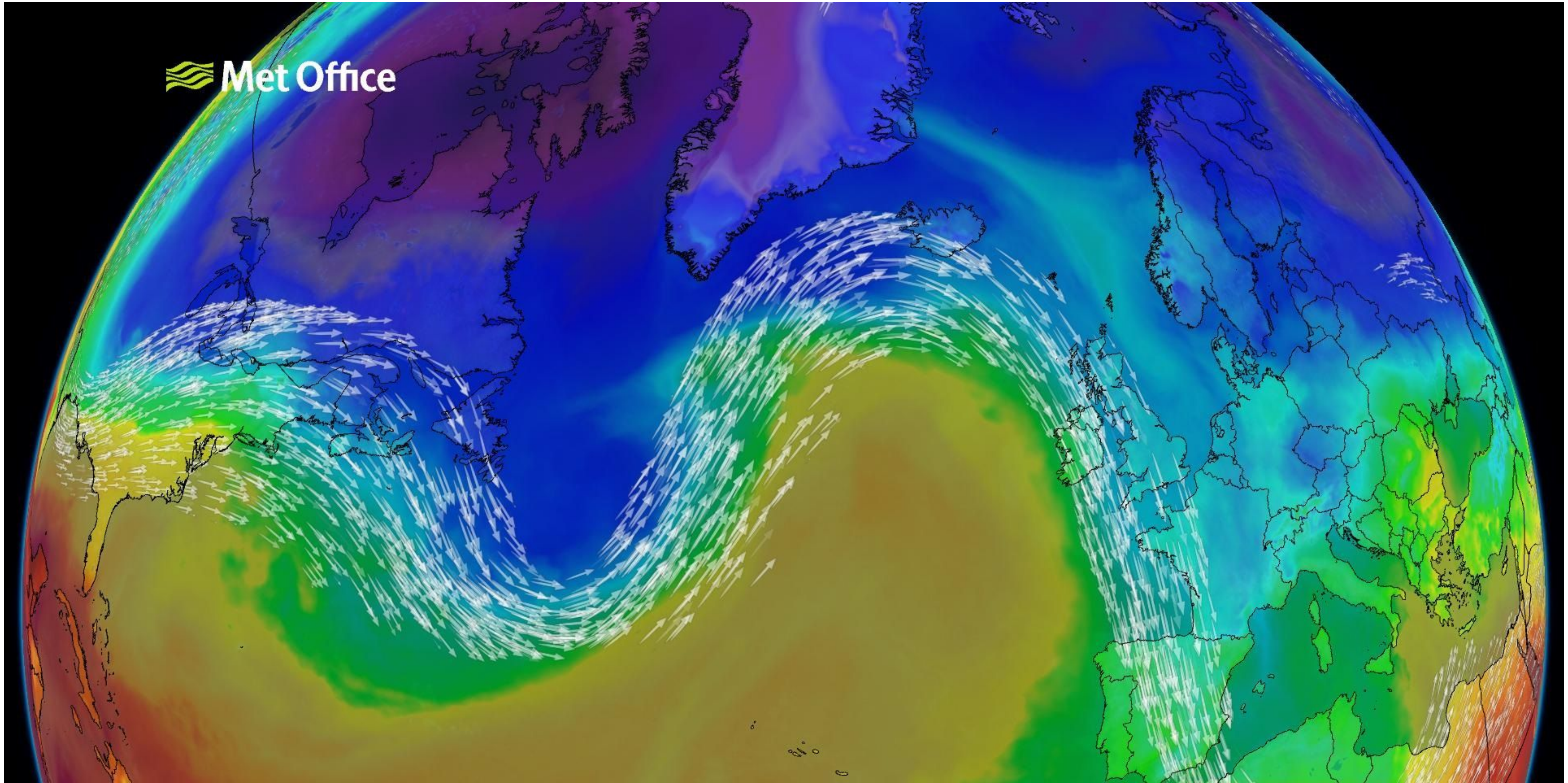
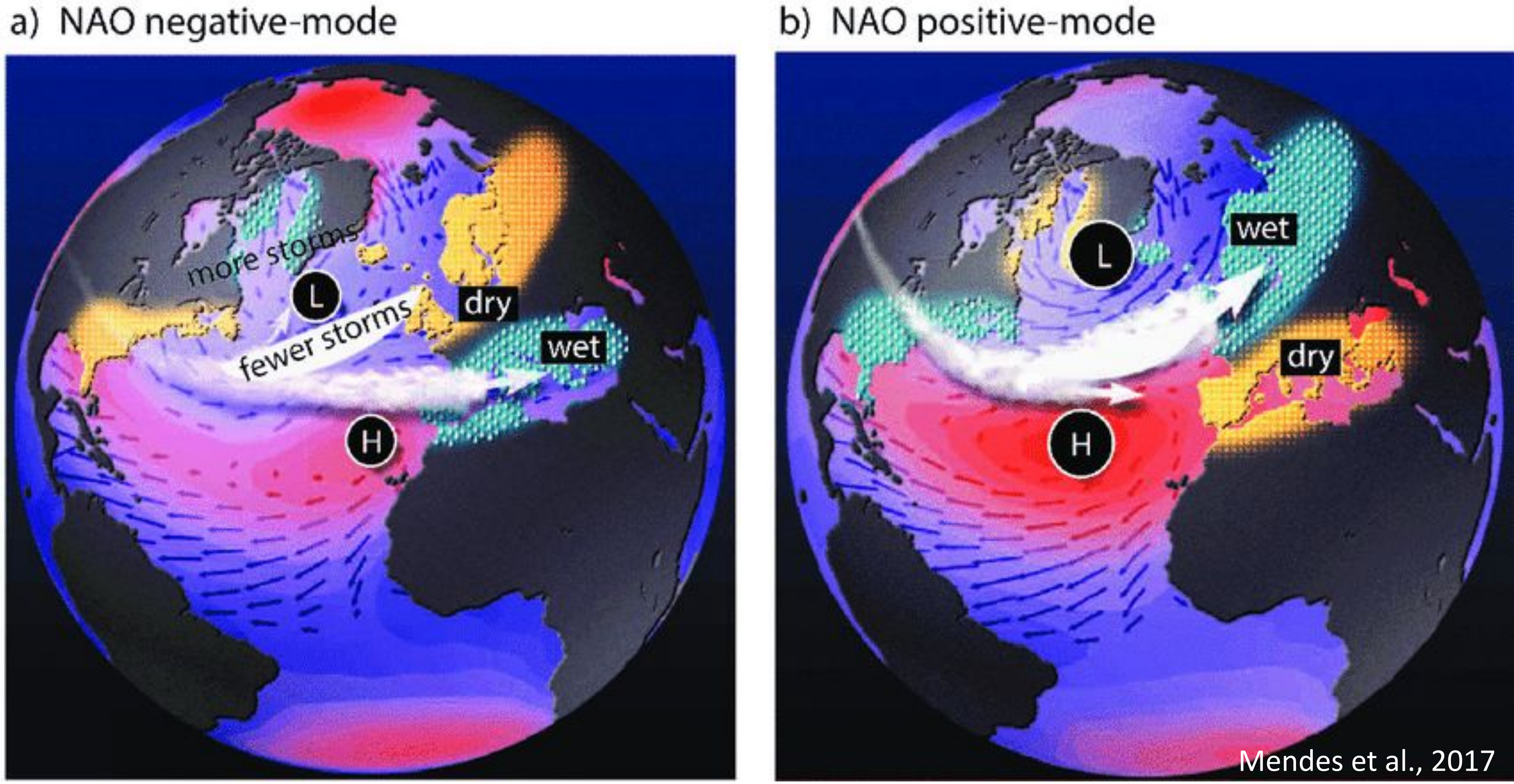
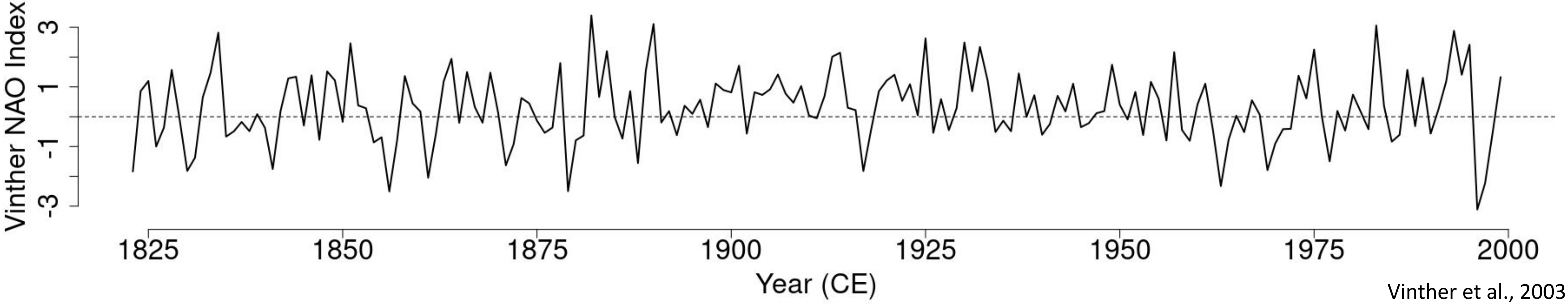


North Atlantic Oscillation (NAO):

- Azores High and Icelandic Low sea level pressure difference.
- Instrumental records extending through 1800’s CE.
- Influences temperature and precipitation by deflecting the jet stream.



Mendes et al., 2017



Vinther et al., 2003

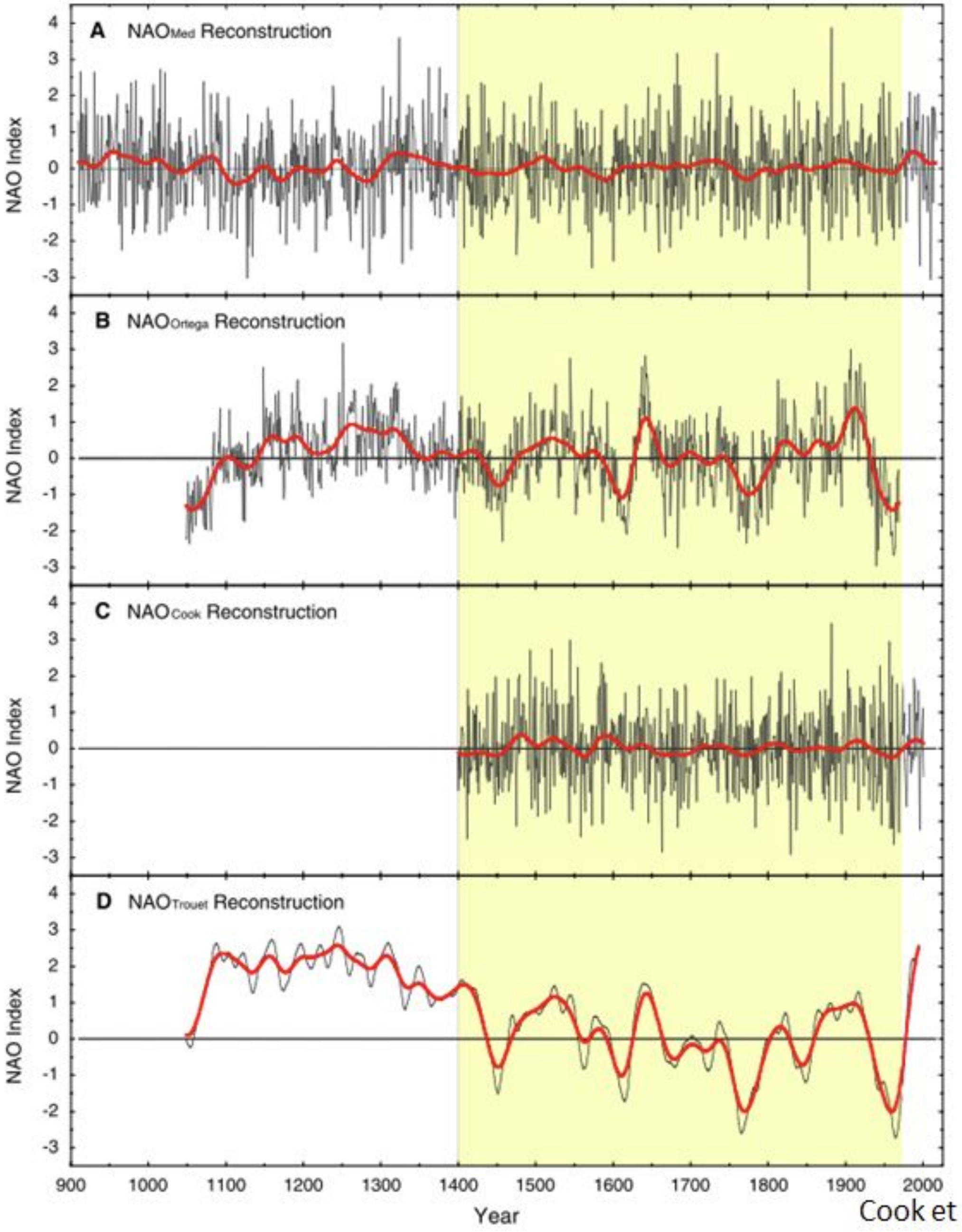
Existing reconstructions disagree on low-frequency variability

Cook et al., 2019:
96 tree-ring records

Ortega et al., 2015:
7 ice cores, 2 speleothems, 4 lake sediments, 36 tree rings

Cook et al., 2002
365 tree rings, 2 ice cores

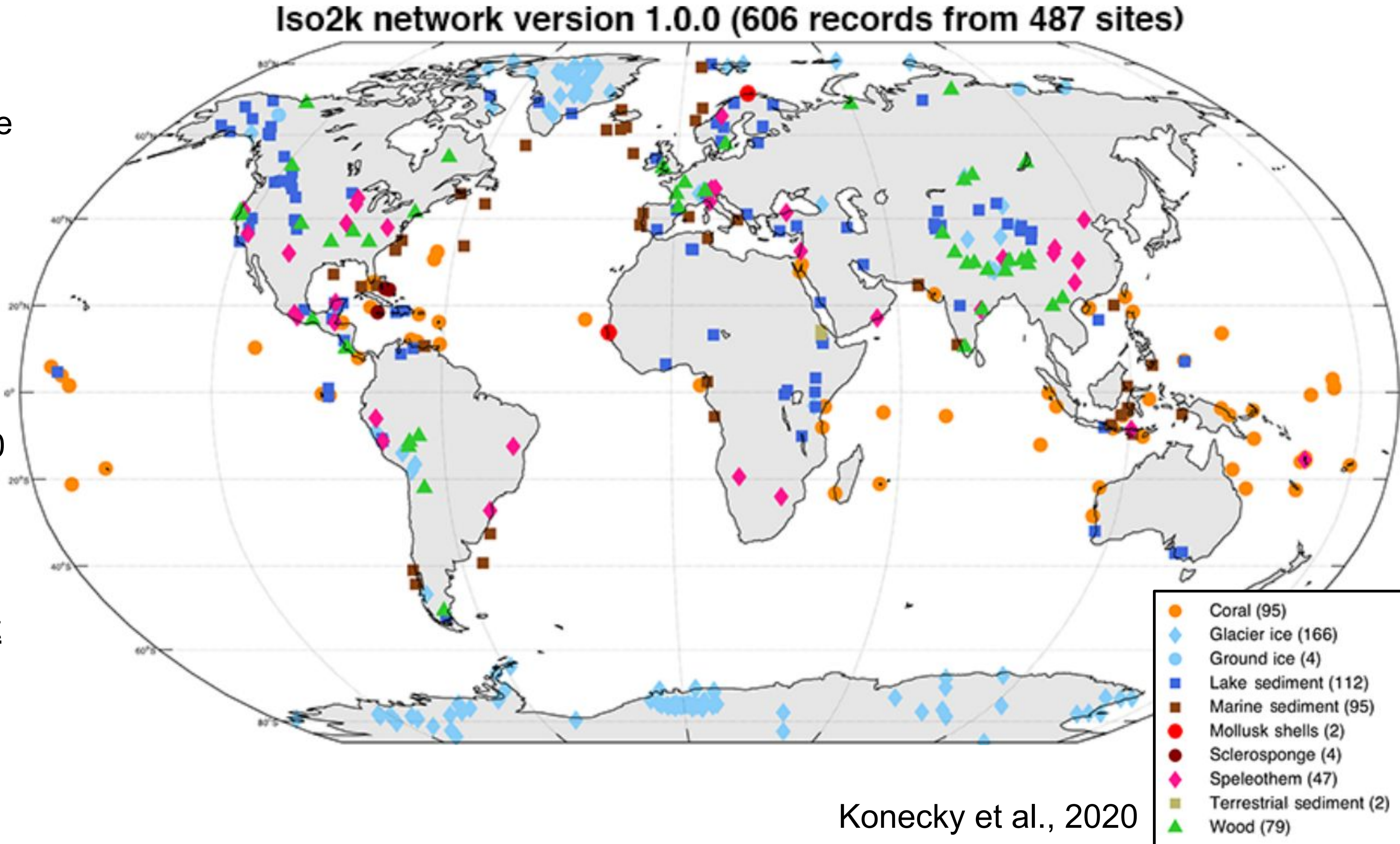
Trouet et al., 2009
10 Tree rings, 1 speleothem



Cook et al., 2019

Iso2k water isotope proxy database offers a new perspective on the NAO

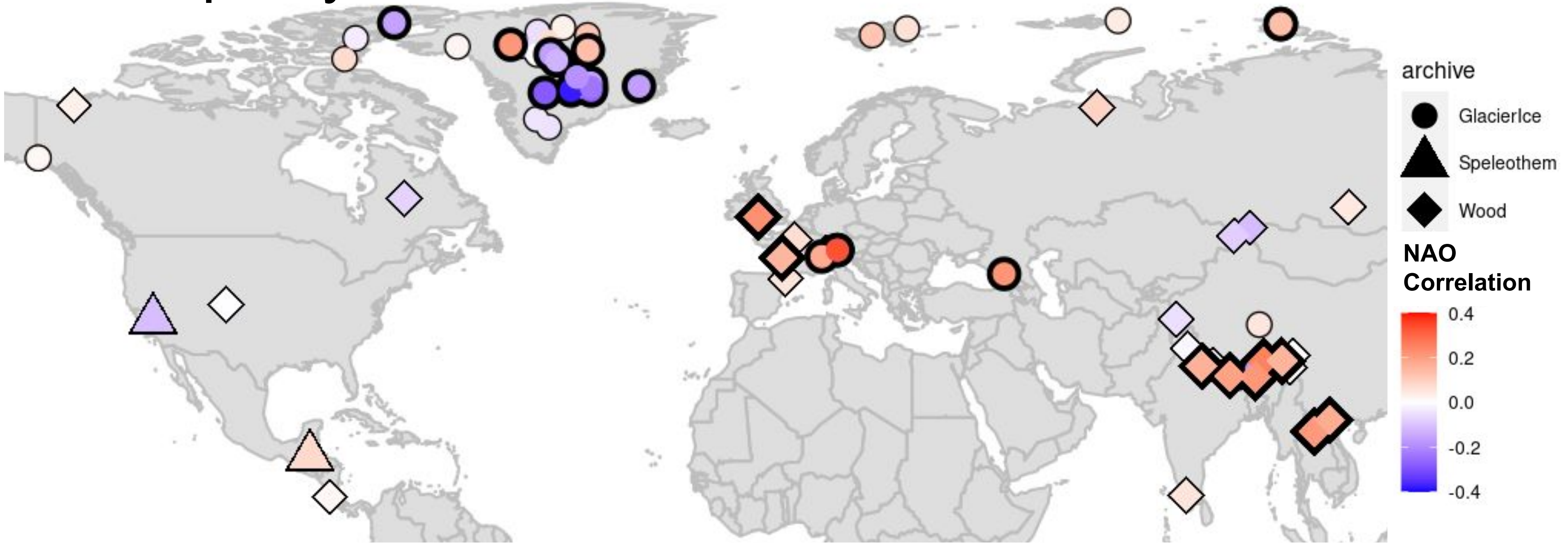
- Precipitation $\delta^{18}O$ is regionally more hydroclimate sensitive than precipitation amount.
- Paleoclimate records of δD and $\delta^{18}O$.
- Over 600 records spanning part of the Common Era (0-2000 CE).
- First global collection of water isotope records from <u>different archives.</u>

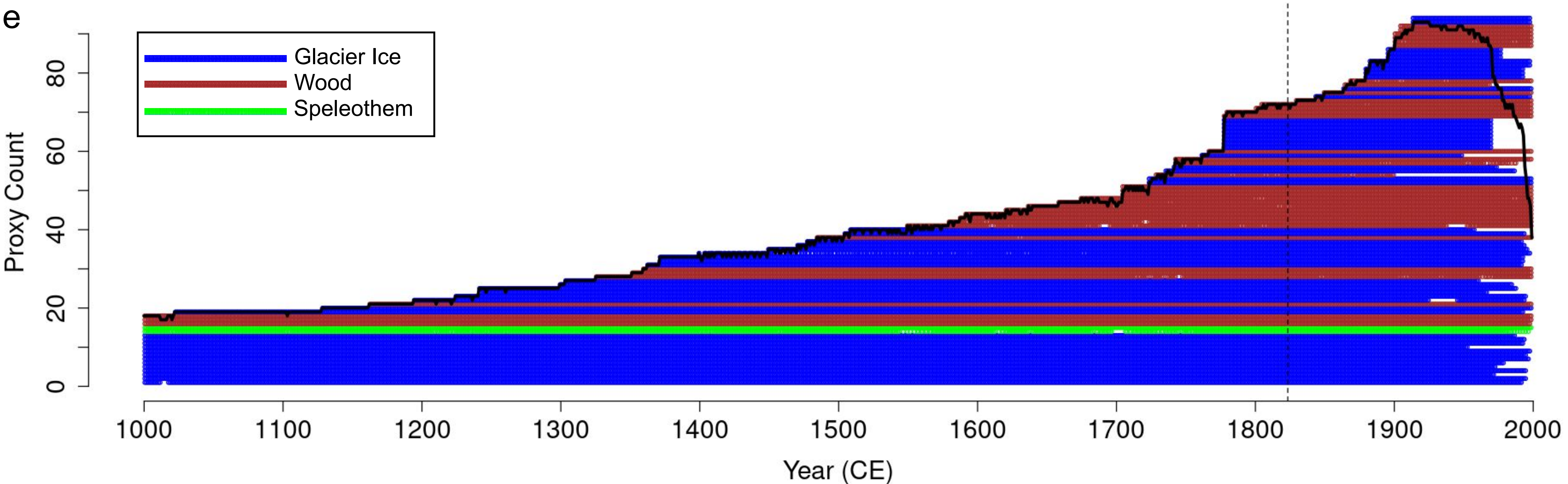


Konecky et al., 2020

NAO reconstruction uses proxy correlations with NAO index

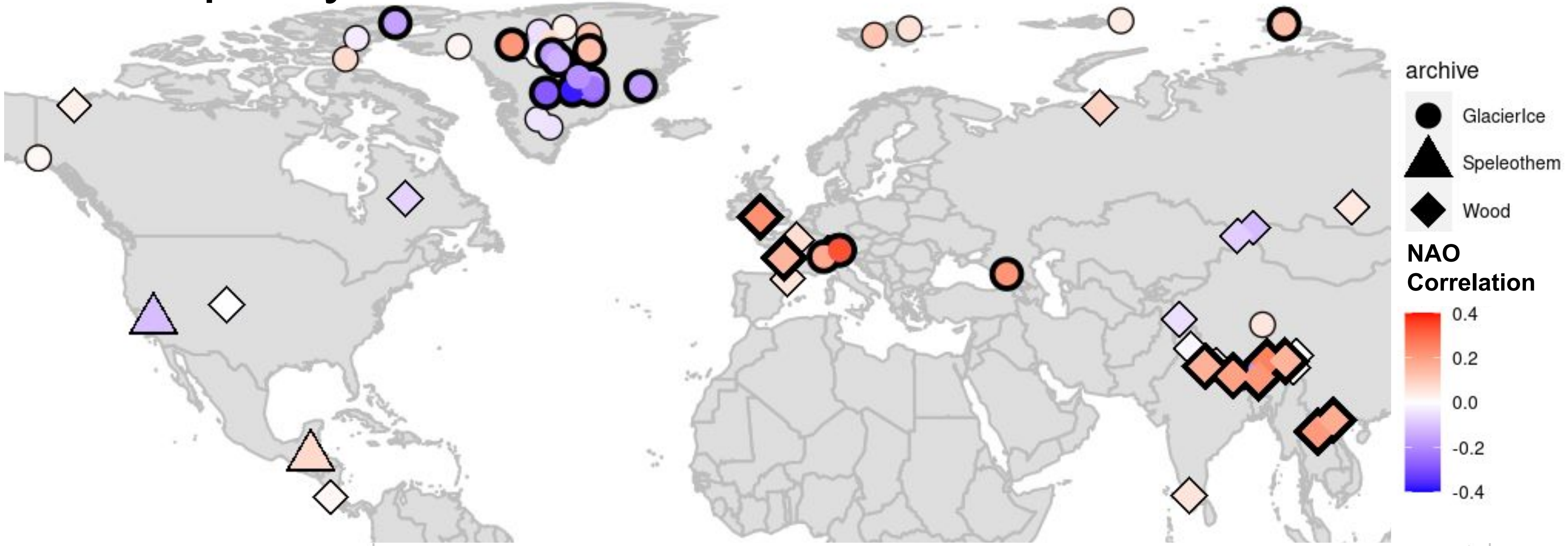
- Annually resolved northern hemisphere terrestrial records.
- 66% data coverage between 1820-2000 CE.
- Significant (**bold**) correlations have $p < 0.1$.
- Composite-plus-scale (CPS) reconstruction ensemble

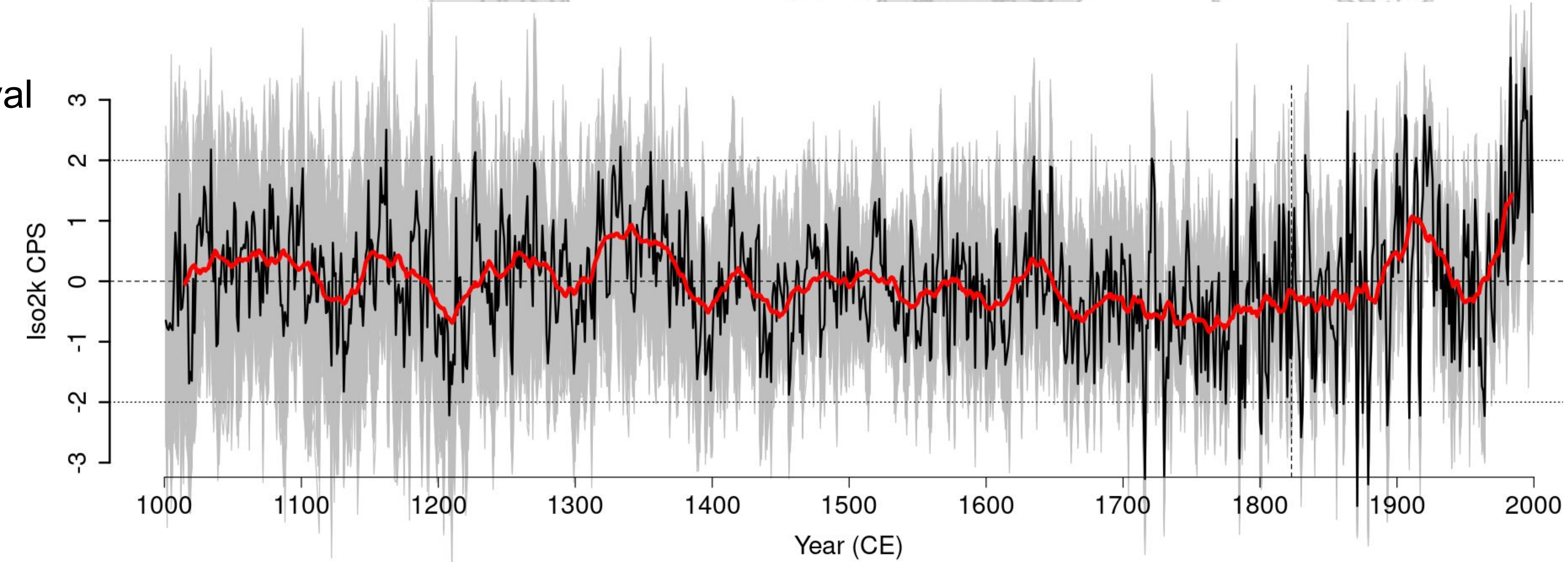




NAO reconstruction uses proxy correlations with NAO index

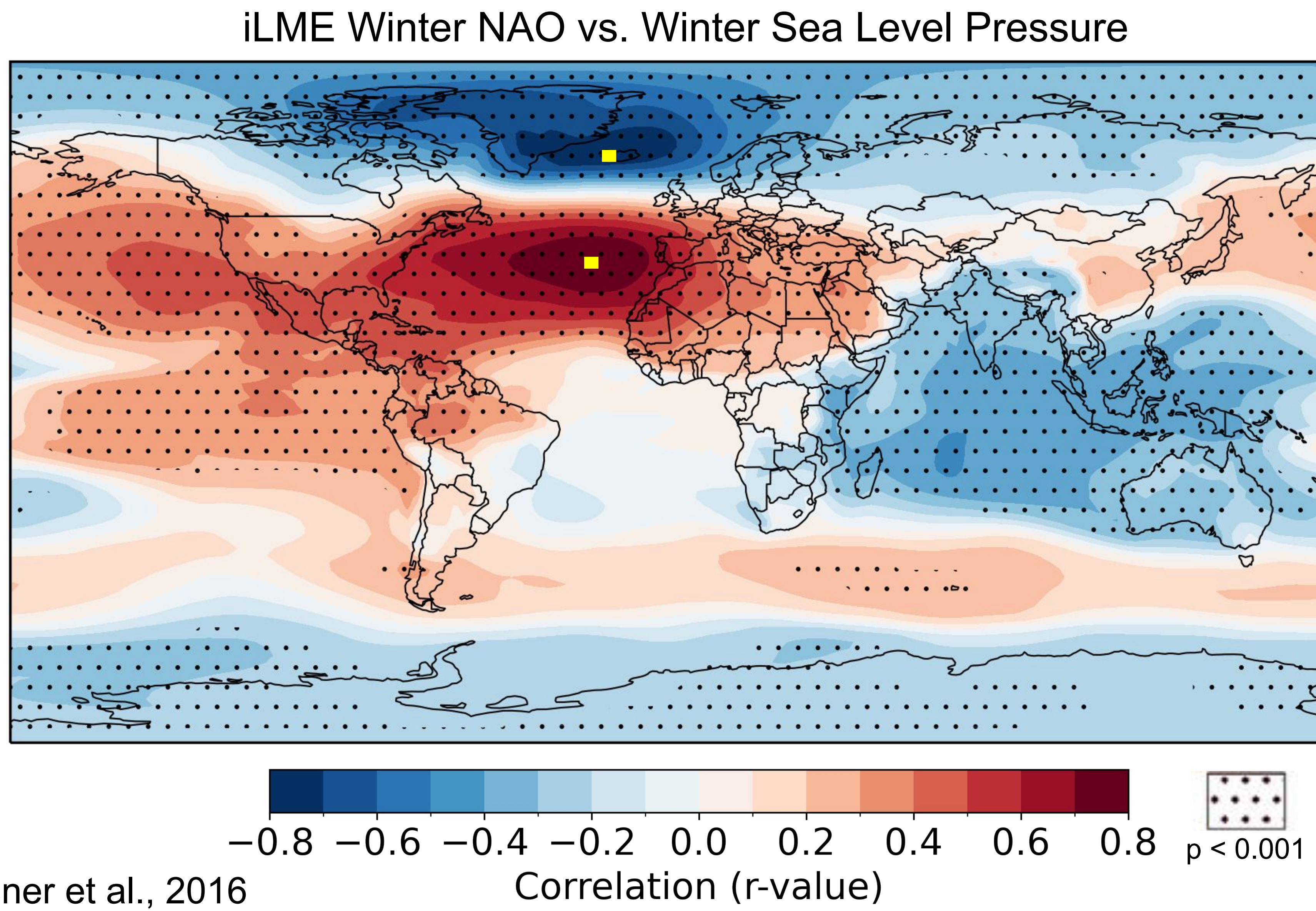
- Annually resolved northern hemisphere terrestrial records.
- 66% data coverage between 1820-2000 CE.
- Significant (**bold**) correlations have p < 0.1.
- Composite-plus-scale (CPS) reconstruction ensemble
    - 50% record removal per ensemble member
    - 30-year moving average (red line)





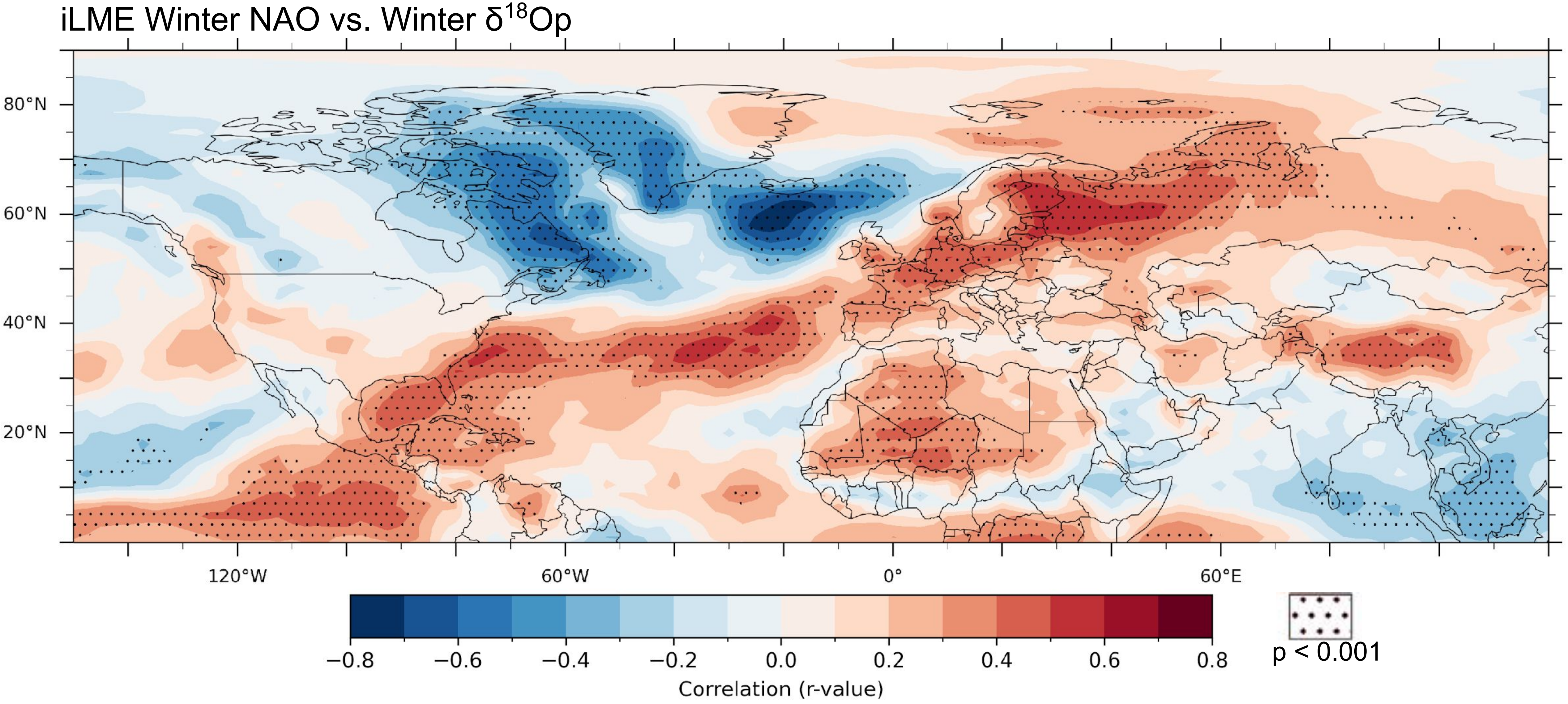
NAO index in the isotope-enabled Last Millennium Ensemble (iLME)

- Individual fully-forced members of iLME
- 1000-2005 model years
- Winter NAO: Difference between grid cells containing Reykjavik and Azores in DJF.
- Gridded correlation of model NAO index with DJF sea level pressure.
    - Significant SLP correlations extend far beyond the NAO centers of action.



Stevenson et al., 2019; Otto-Bliesner et al., 2016

NAO correlates with $\delta^{18}O$ of precipitation over Greenland and Europe



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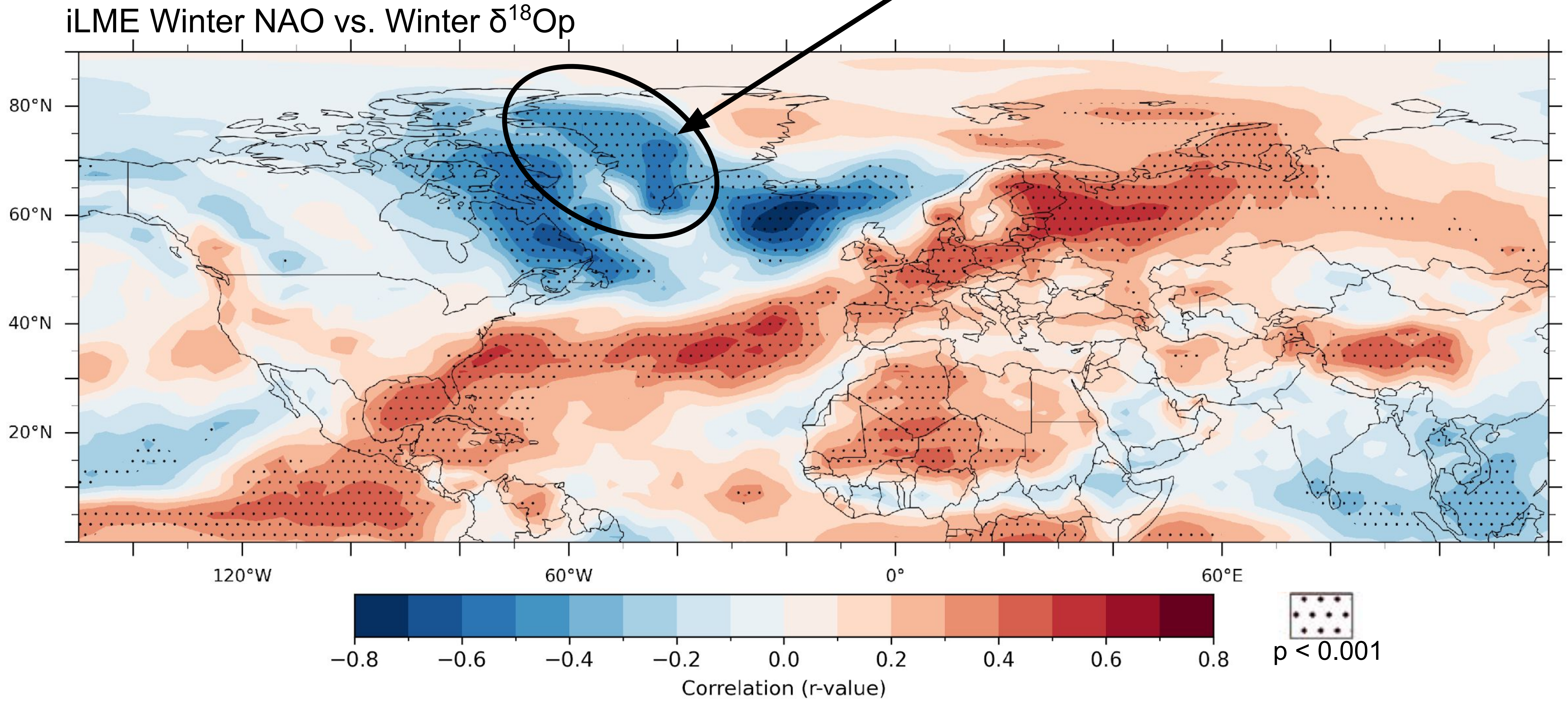

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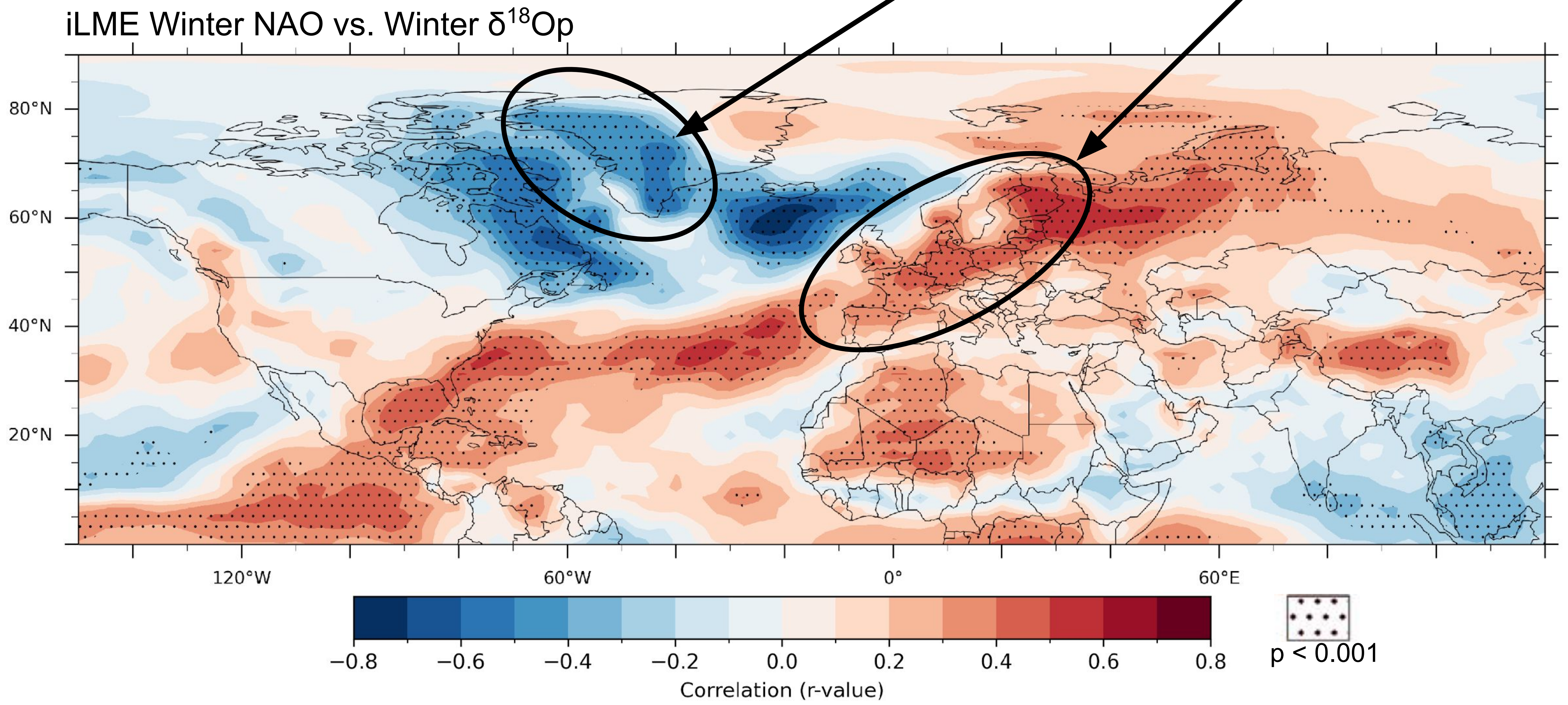
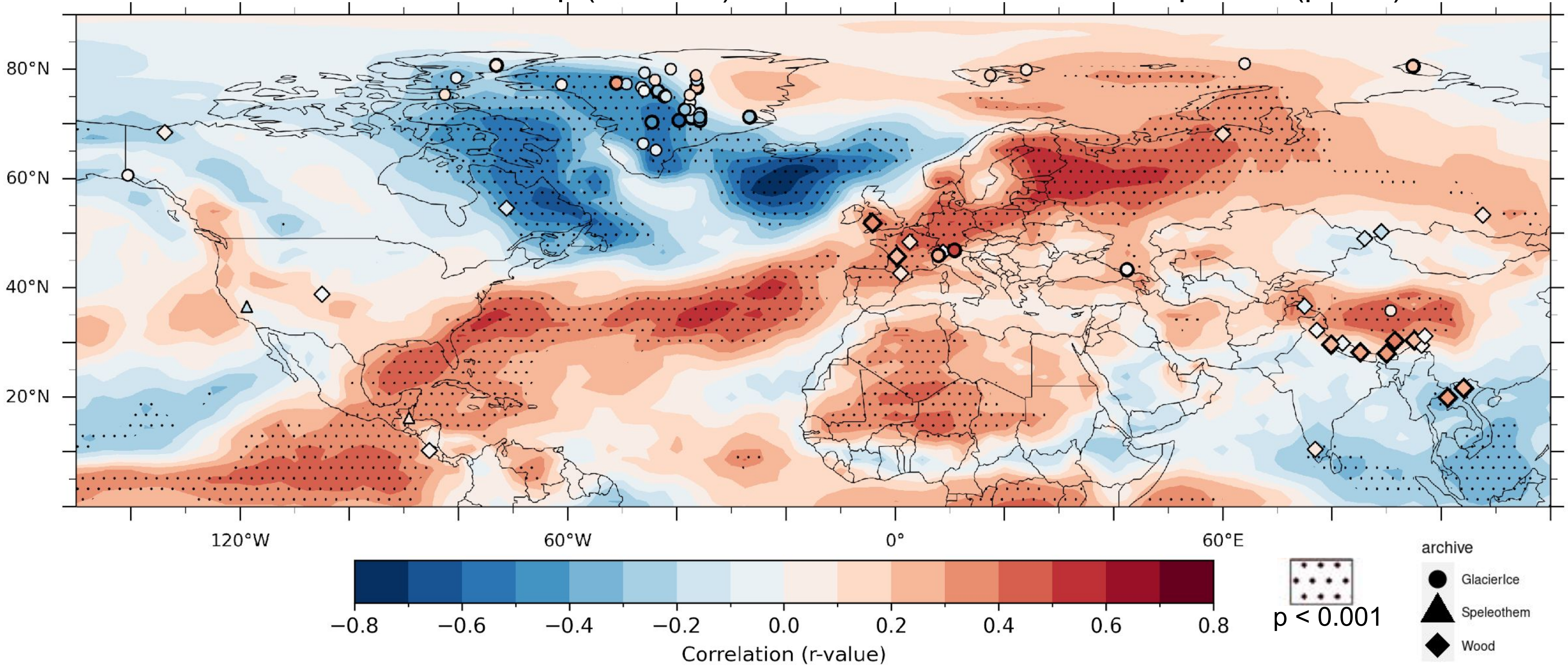
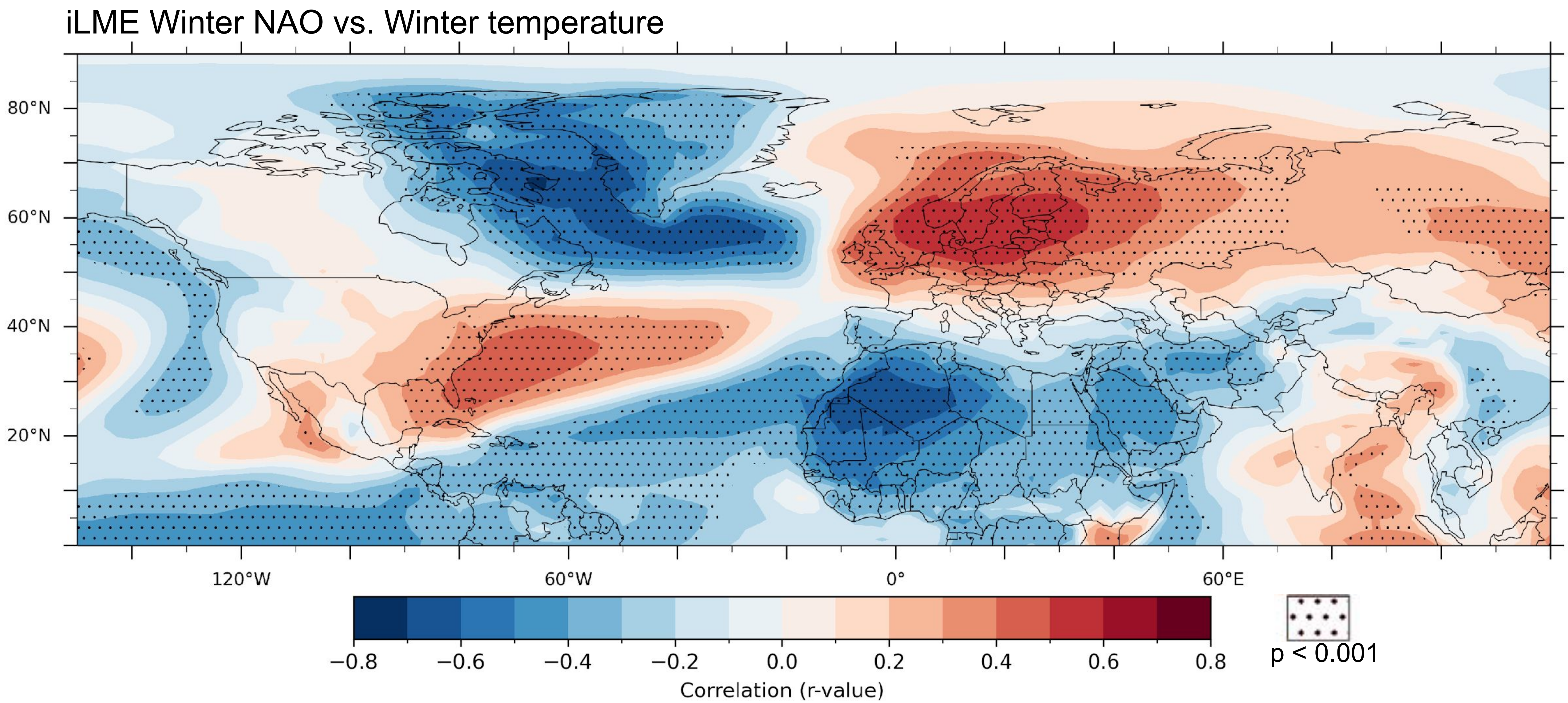


iLME $\delta^{18}O$ agrees with Iso2k proxy correlations

iLME Winter NAO vs. Winter $\delta^{18}Op$ (contours) + Instrumental NAO vs. Iso2k proxies (points)

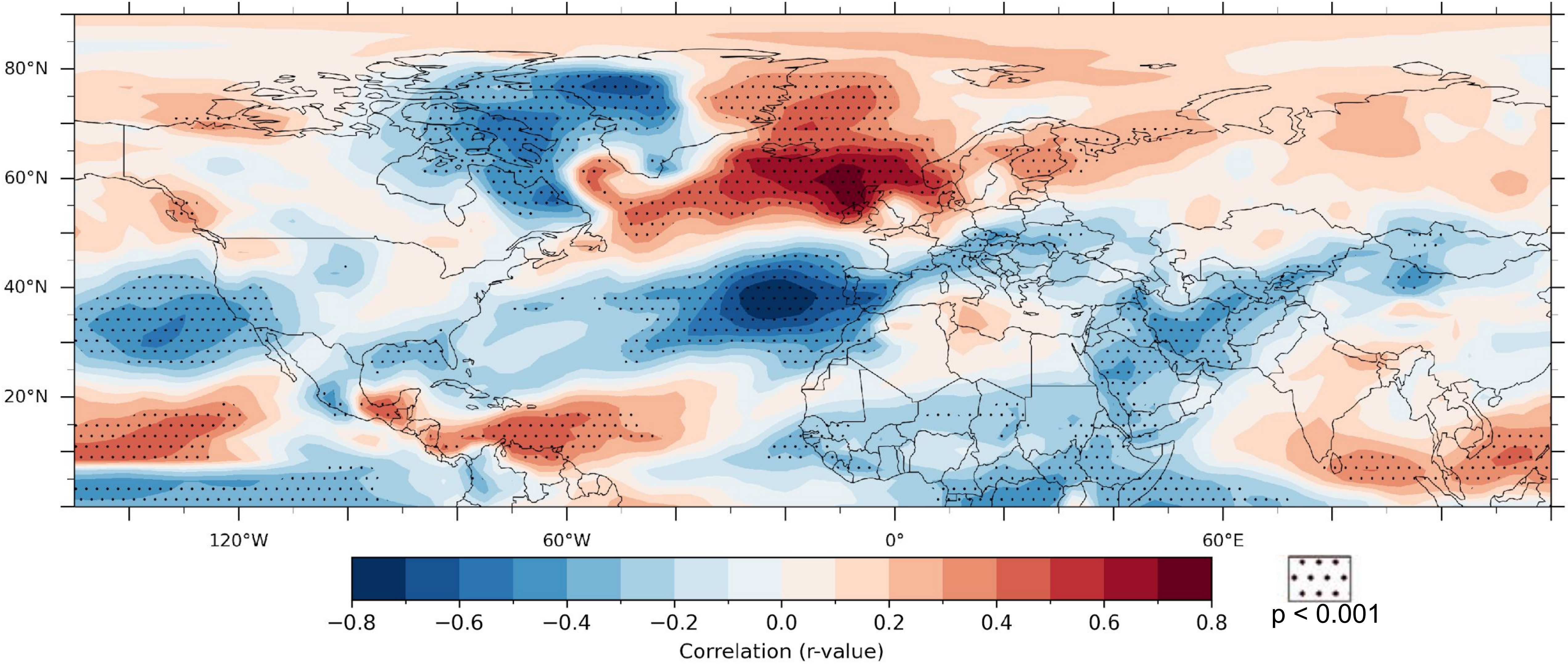


Temperature drives δ^{18}Op in Greenland and N. Europe

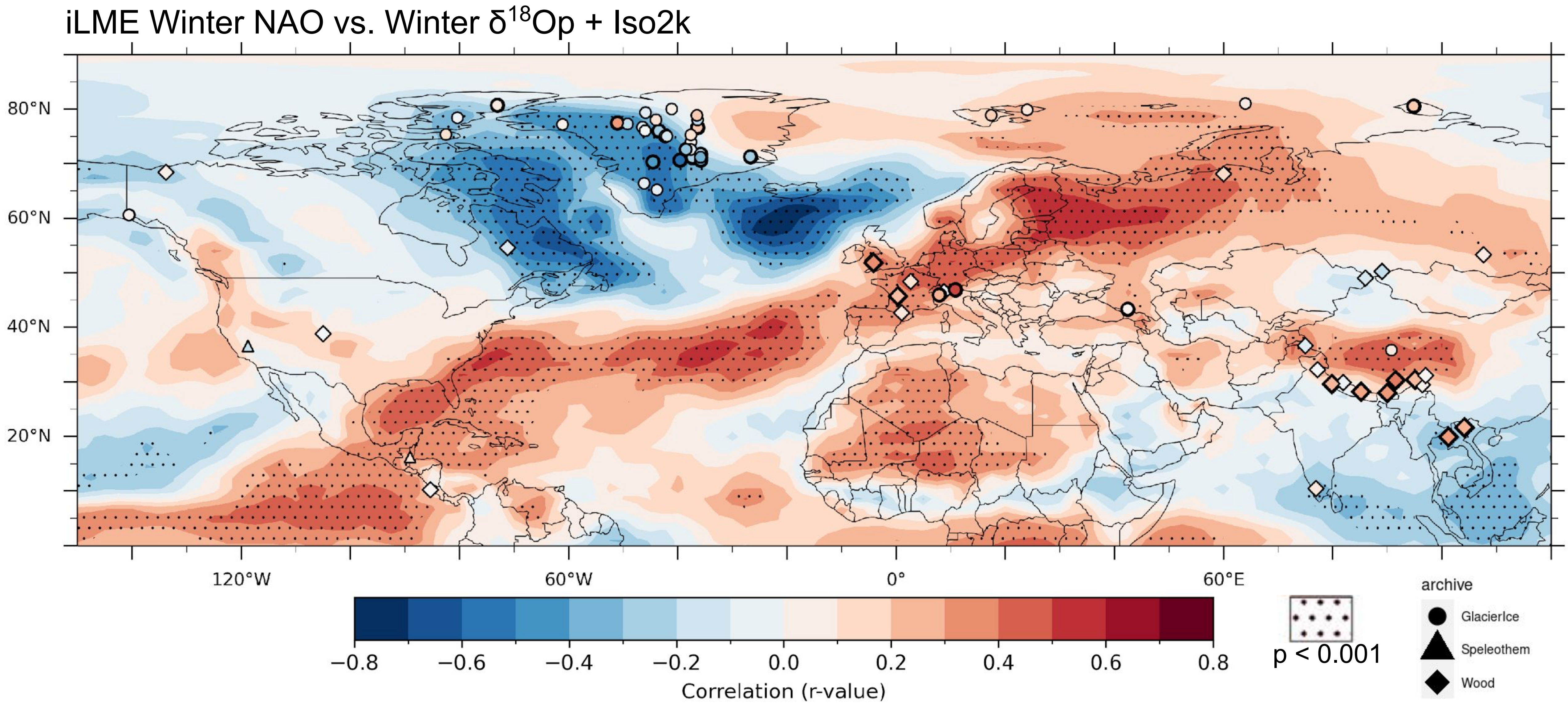


Precipitation drives δ^{18}Op over Iberian Peninsula and S. Europe

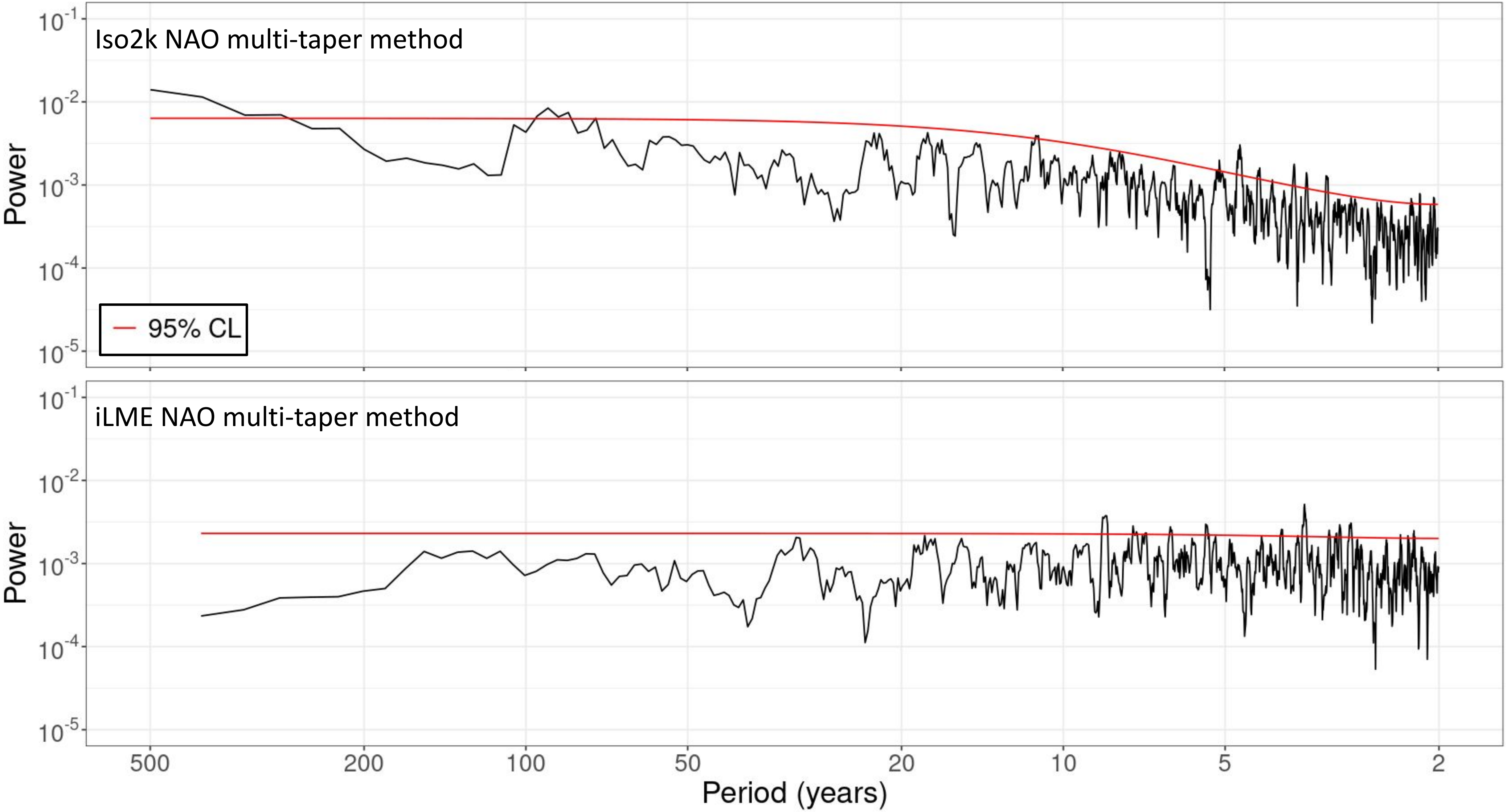
iLME Winter NAO vs. Winter precipitation



iLME δ18O agrees with Iso2k proxy correlations



Low frequency variability in the Iso2k NAO is absent from the iLME



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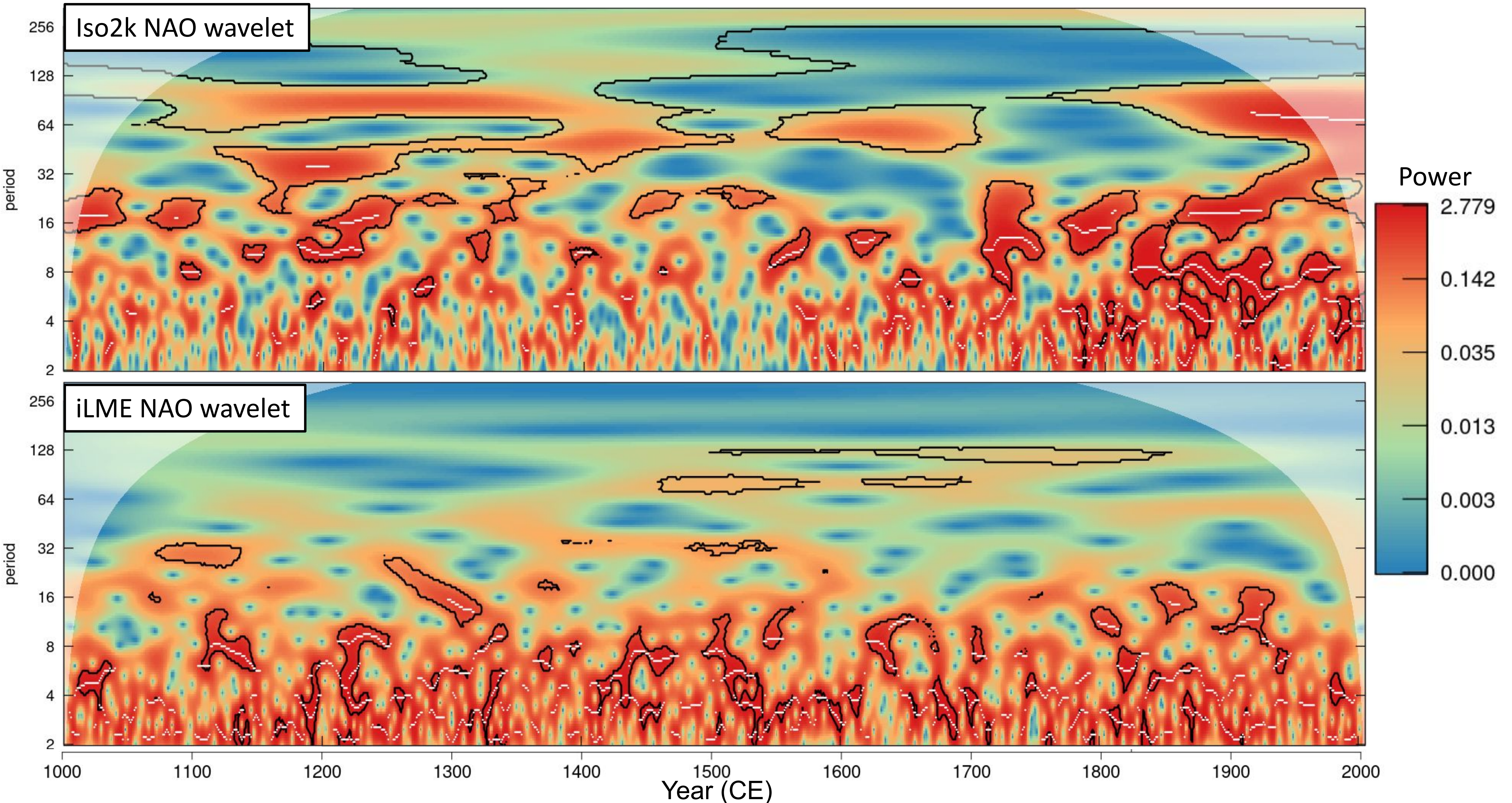

- Iso2k proxy records produce a new reconstruction of the NAO over the last millennium.
- $\delta^{18}O$ correlations with the NAO in the iLME resemble the Iso2k proxy correlations.
- NAO-correlated $\delta^{18}O$ drivers change from temperature to precipitation between Northern and Southern Europe.
- Evidence for multi-decadal to centennial variability in the proxy NAO reconstruction but absent from the iLME.

Questions?
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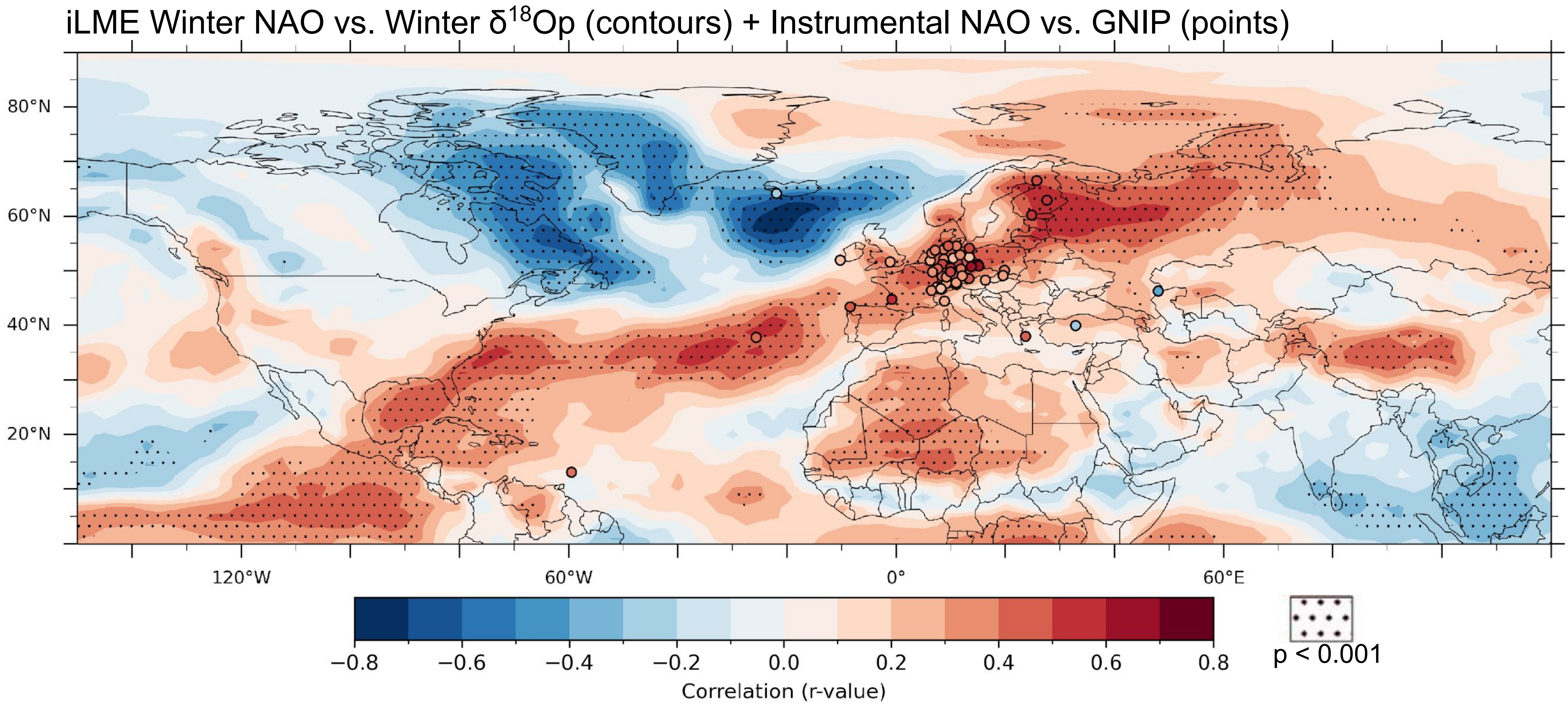
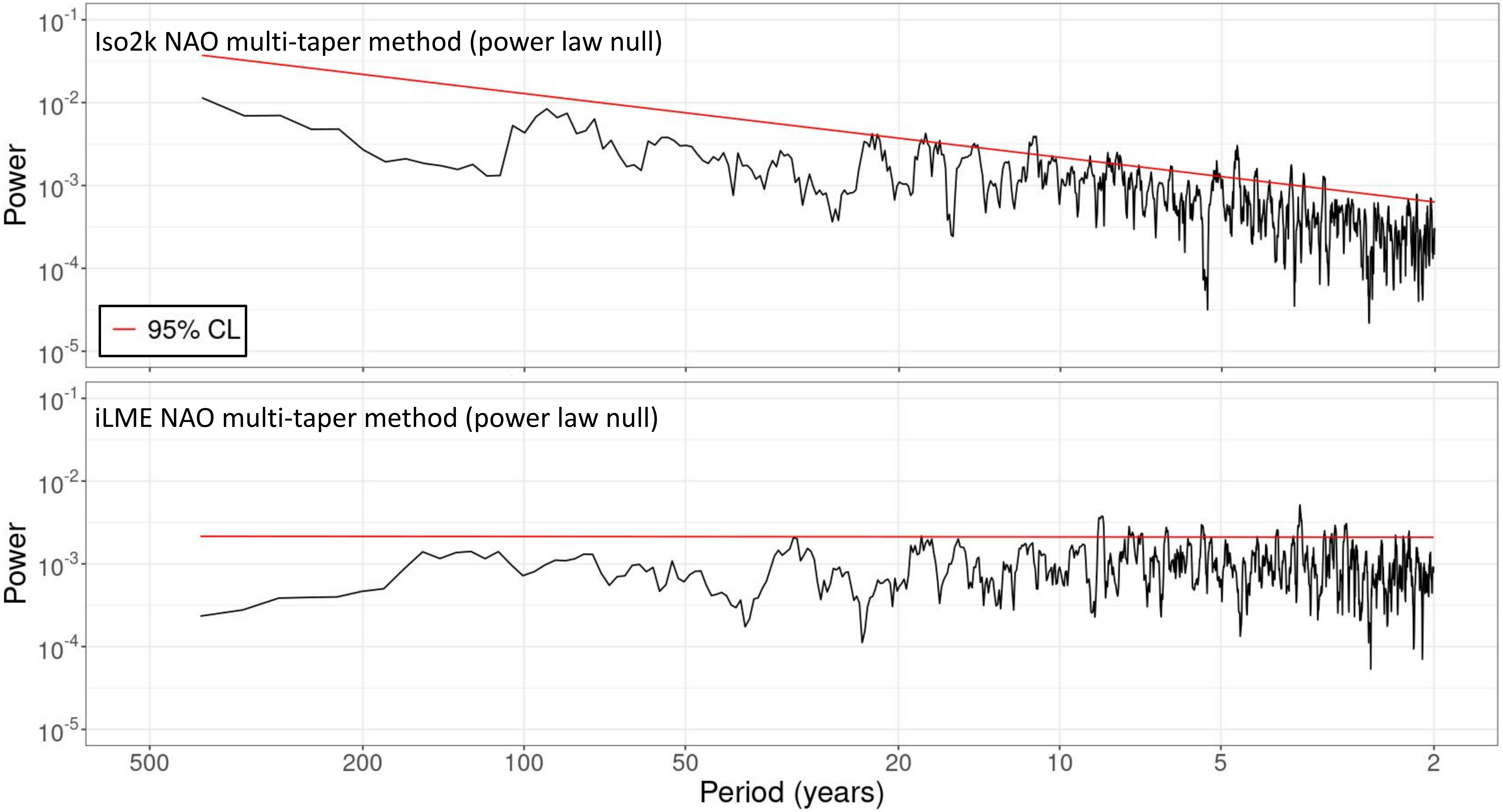
iLME $\delta^{18}O$ agrees with Global Network of Isotopes of Precipitation (GNIP)




Iso2k NAO multi-taper method (power law null)
95% CL
iLME NAO multi-taper method (power law null)
Power
Power
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
500
200
100
50
20
10
5
2
Period (years)

Regional NAO Correlations: