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**Glacial northern hemisphere atmospheric circulation and the impacts on proxy
data: a model intercomparison**

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Glacial NH atmospheric circulation and the impacts on proxy data: a model intercomparison

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OUTLINE

- ⊕ **Introduction (Model Analysis);**
- ⊕ Atmospheric circulation variability;
- ⊕ Paleoclimate implication (impact on proxy).



WHAT DID I DO? and WHY?

- ⊕ Model intercomparison of NH (20°-90°N) atmospheric variability in two fundamentally different climate states

PI & LGM

Period	<u>Orbital Parameters</u>	<u>GHGs</u>	<u>Vegetation</u>	<u>Ice Sheet</u>
PI Pre-industrial	1950	1750 AD	Modern	Modern
LGM Last Glacial Max.	21 ka	21 Ka	Modern	ICE-5G



WHAT DID I DO? and WHY?

- ⊕ Model intercomparison of NH (20°-90°N) atmospheric variability in two fundamentally different climate states

PI & LGM



Amplitude of past climate variability
Common/fundamental features across climates
(NAO: still first mode of variability in LGM?)

- ⊕ atmospheric circulation \neq in the LGM



1. the variability recorded in the proxy data is representative of the variability at the larger scale?
2. changes in the general circulation make the proxy data more or less meaningful in describing the large-scale variability?

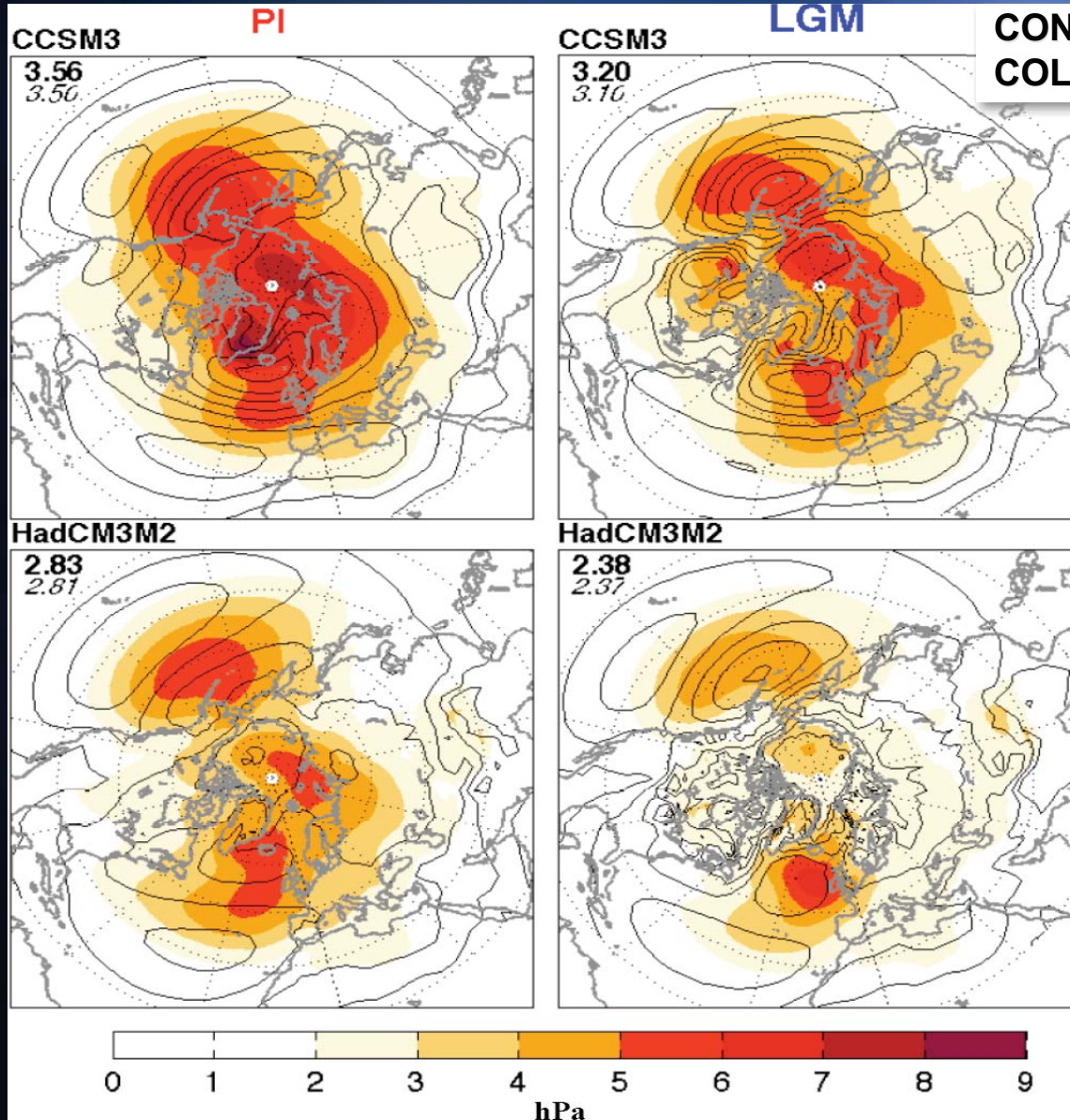


OUTLINE

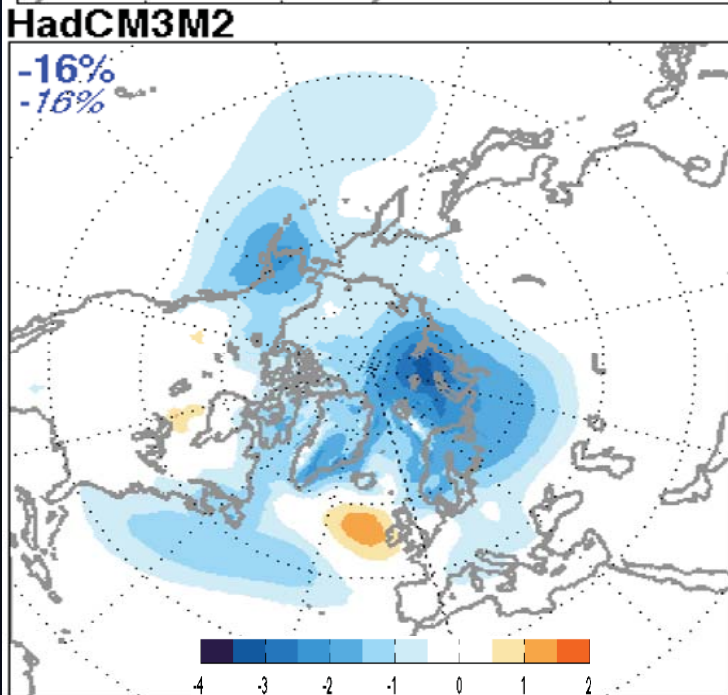
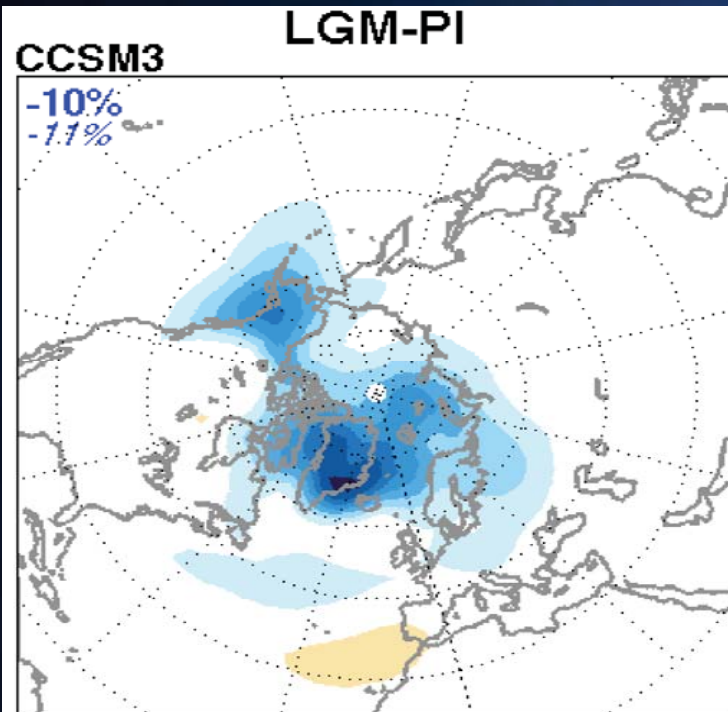
- ⊕ What I did (Model Analysis);
- ⊕ Atmospheric circulation variability;
- ⊕ Paleoclimate implication (impact on proxy).



SPATIAL PATTERN OF VARIABILITY



CONTOURS: SLP climatology
COLORS: Annual SLP standard deviation (σ)



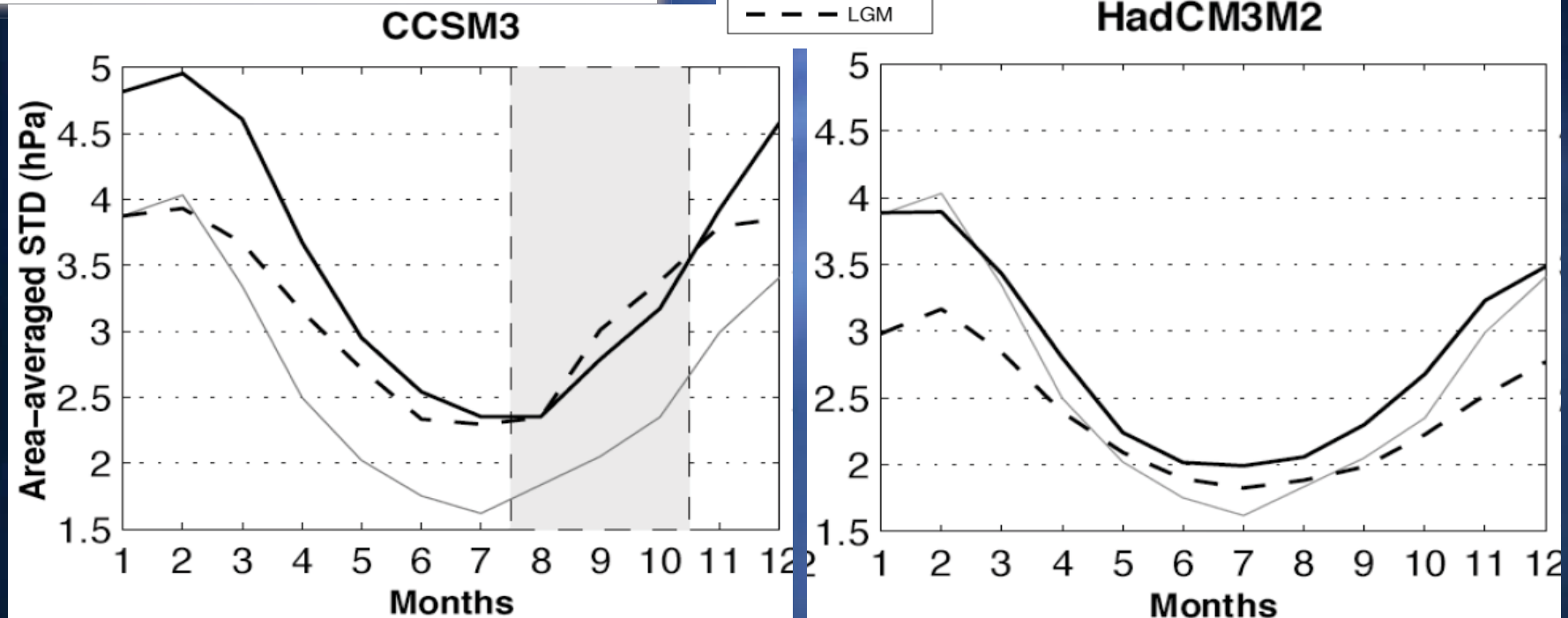
Drop in annual SLP standard deviation (σ)
in the LGM (up to 16%)



SEASONAL CYCLE OF VARIABILITY

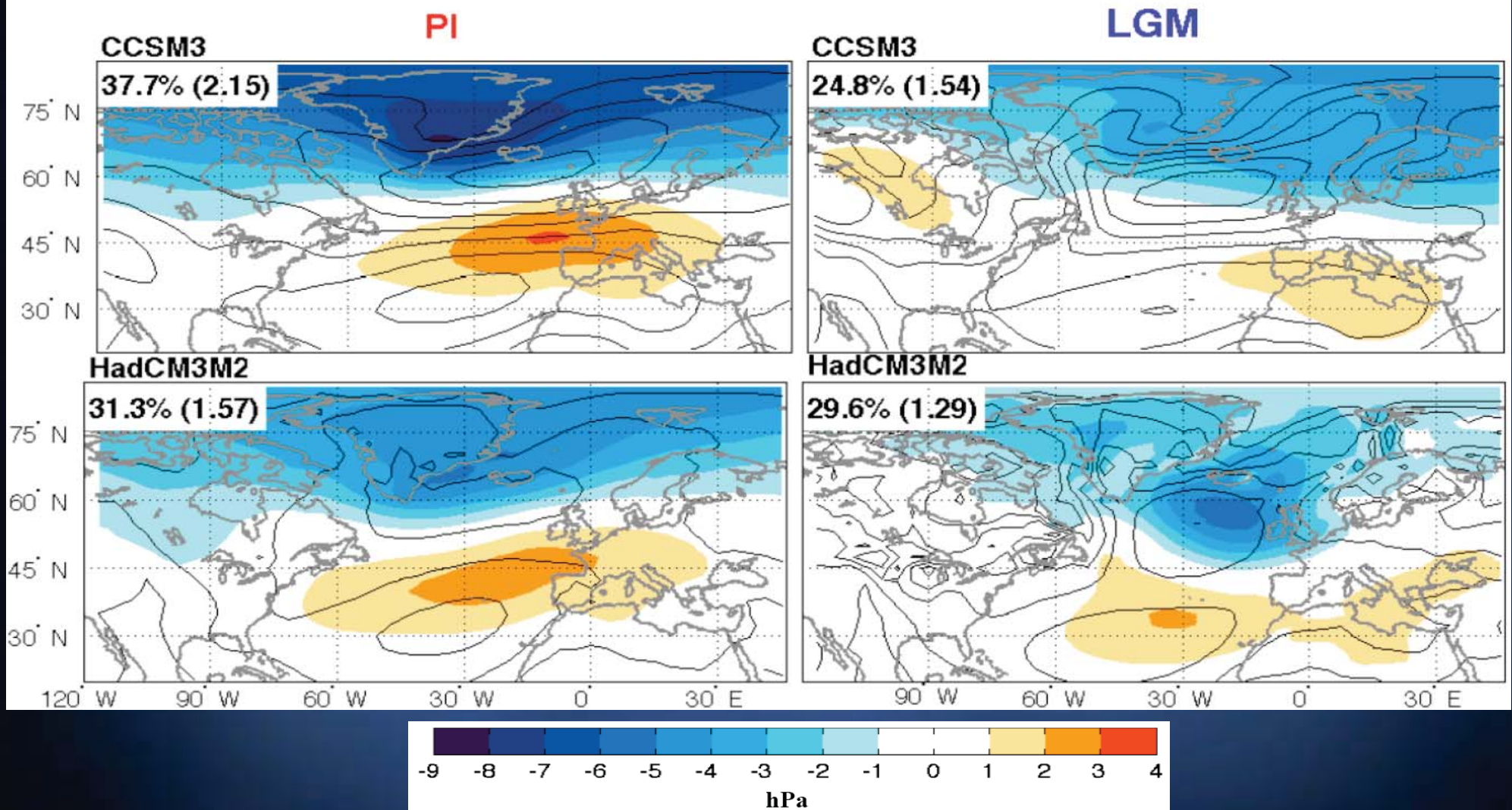
Monthly SLP standard deviation (σ)

— ERA40
— PI
- - LGM



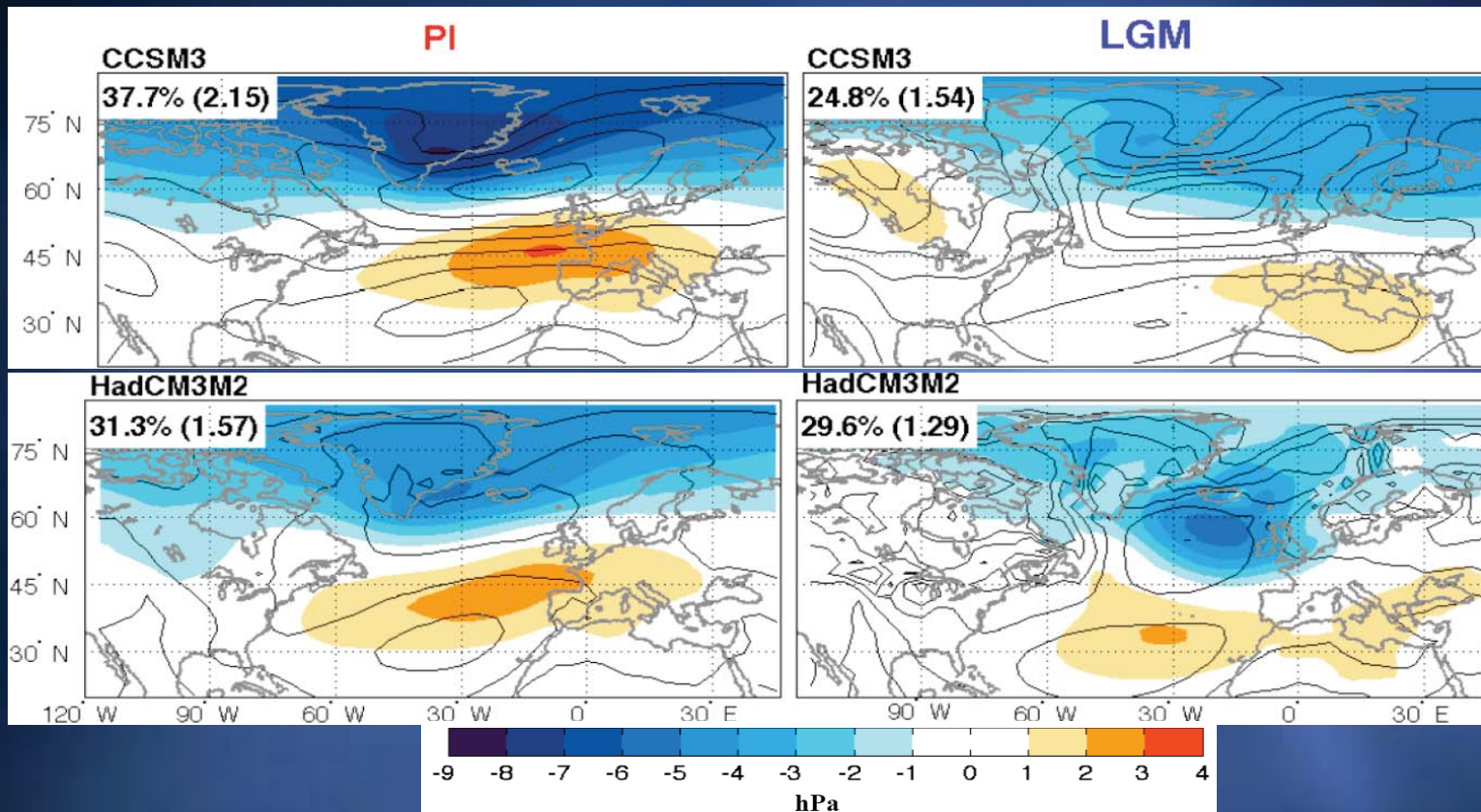
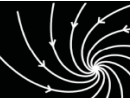
Reduction in seasonality of SLP standard deviation
from 19 to 38% in LGM

SLP EOF1 (averaged all months)



CONTOURS: SLP climatology
COLORS: EOF1 of monthly SLP anomalies (hPa / standard deviation of PC)

SLP EOF1 (averaged all months)



NAO-like feature is the dominant mode of variability in both climates:

- ⊕ It explains less total variance (λ) in LGM;
- ⊕ Centres of action are weaker.



OUTLINE

- ⊕ Introduction (Model Analysis);
- ⊕ Atmospheric circulation variability;
- ⊕ **Paleoclimate implication** (impact on proxy).



PALEOIMPLICATION

changes in the mean circulation, in the variability of the mean circulation and its seasonality



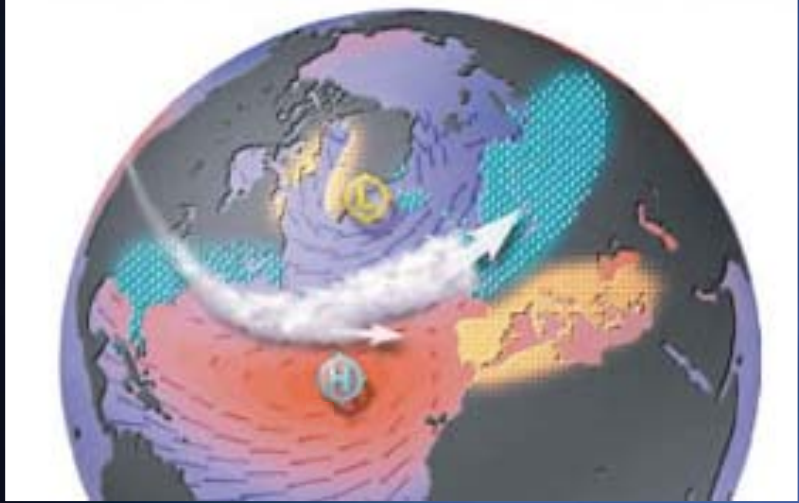
affect the signal recorded in the proxies



Modify capability of a particular location in recording atmospheric variability

3. PALEOIMPLICATION

NAO⁺: Positive Phase of the NAO

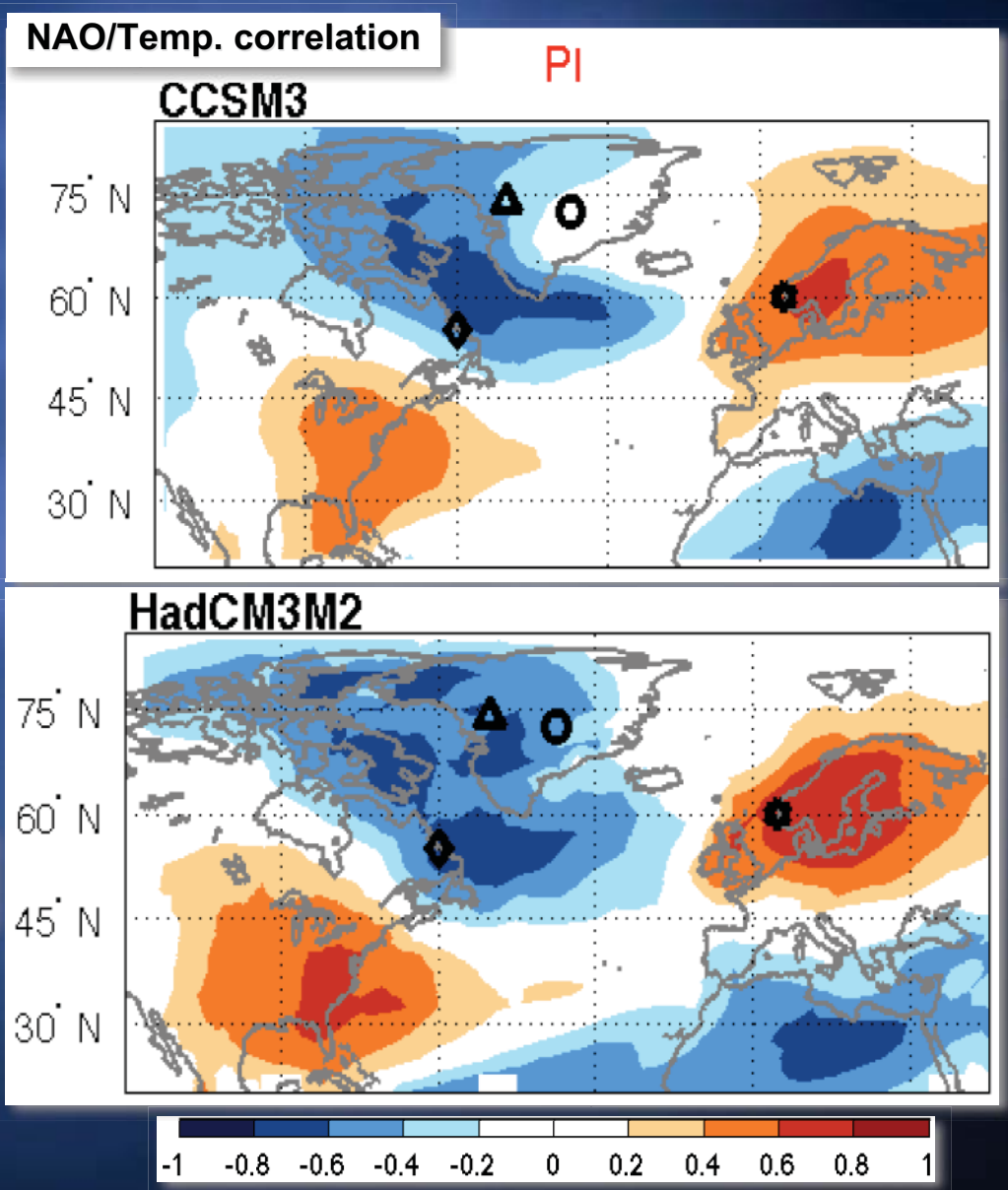


PI

GrIS inverse relationship with NAO-like pattern

Able to capture NAO signal

NAO is the driver of the atmospheric circulation



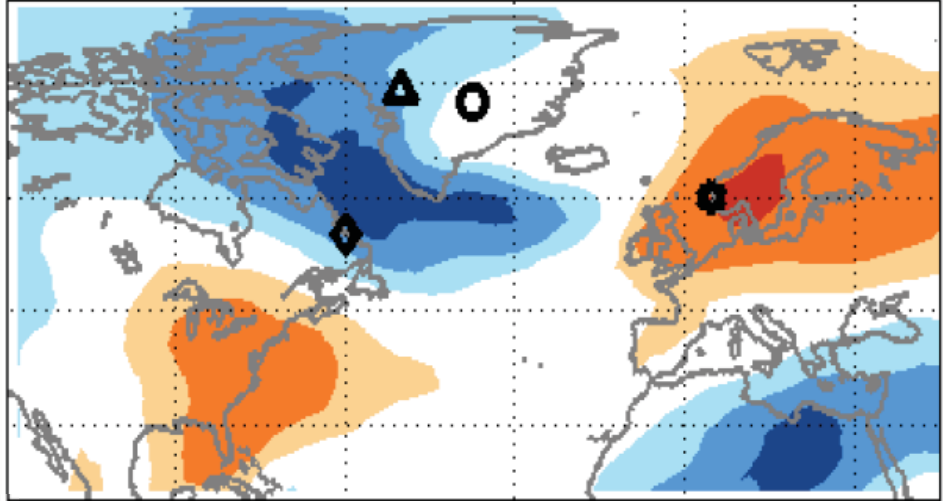
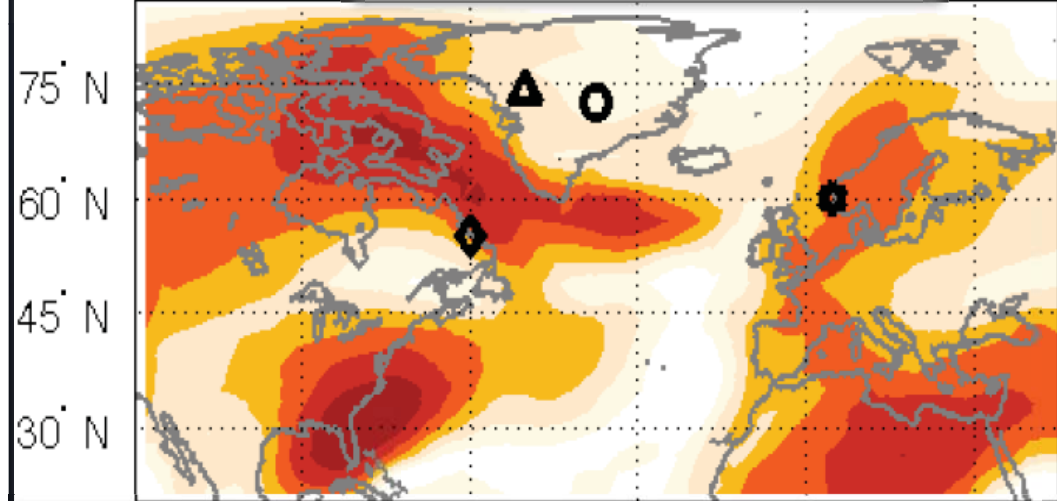
3. PALEOIMPLICATION

Area-weighted 1-point temp. correlation

NAO/Temp. correlation

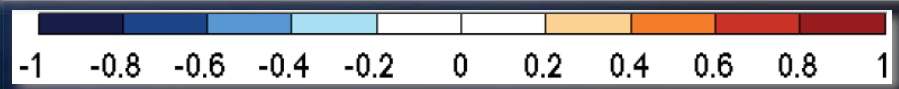
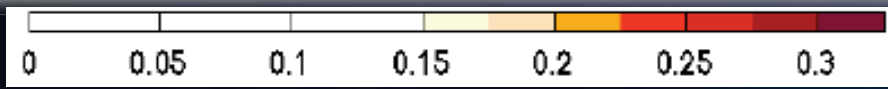
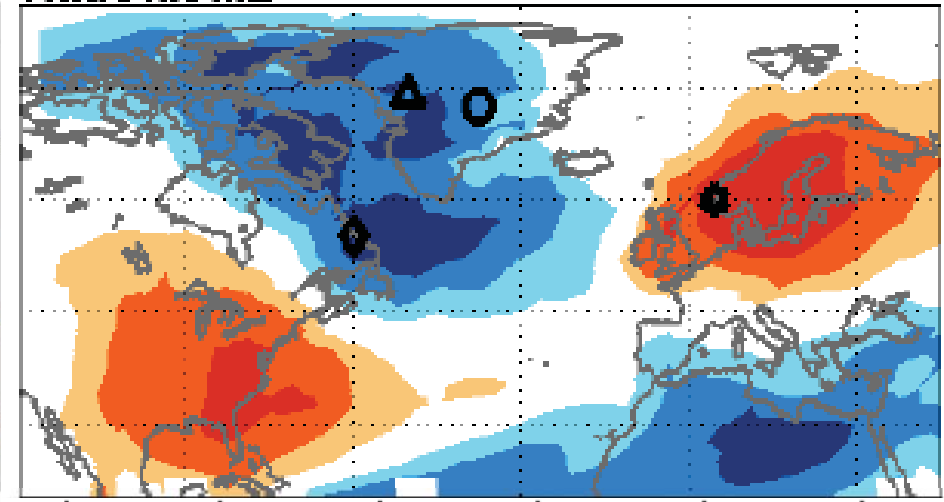
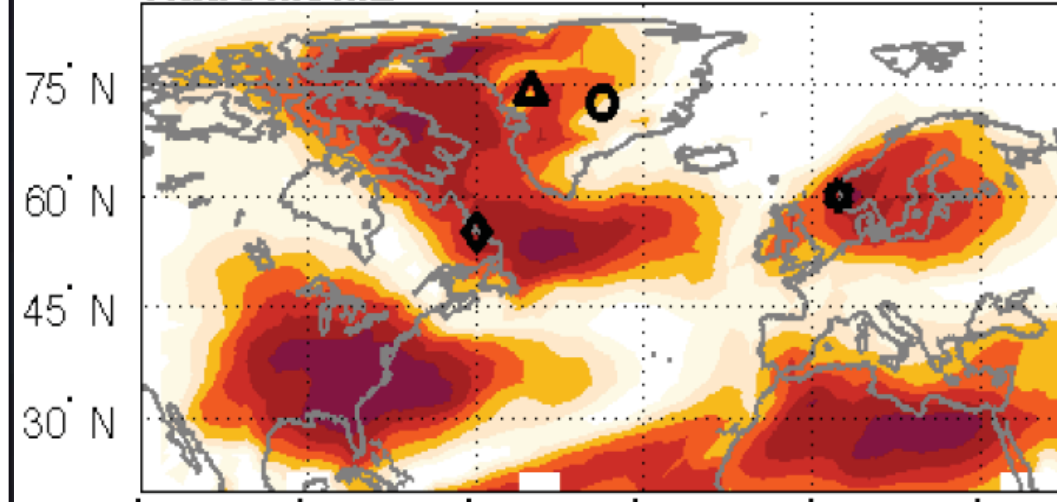
CCSM3

CCSM3



HadCM3M2

HadCM3M2



3. PALEOIMPLICATION

LGM 2 behaviors

CCSM3

the NAO-like imprint can be recorded by proxies in the GrIS



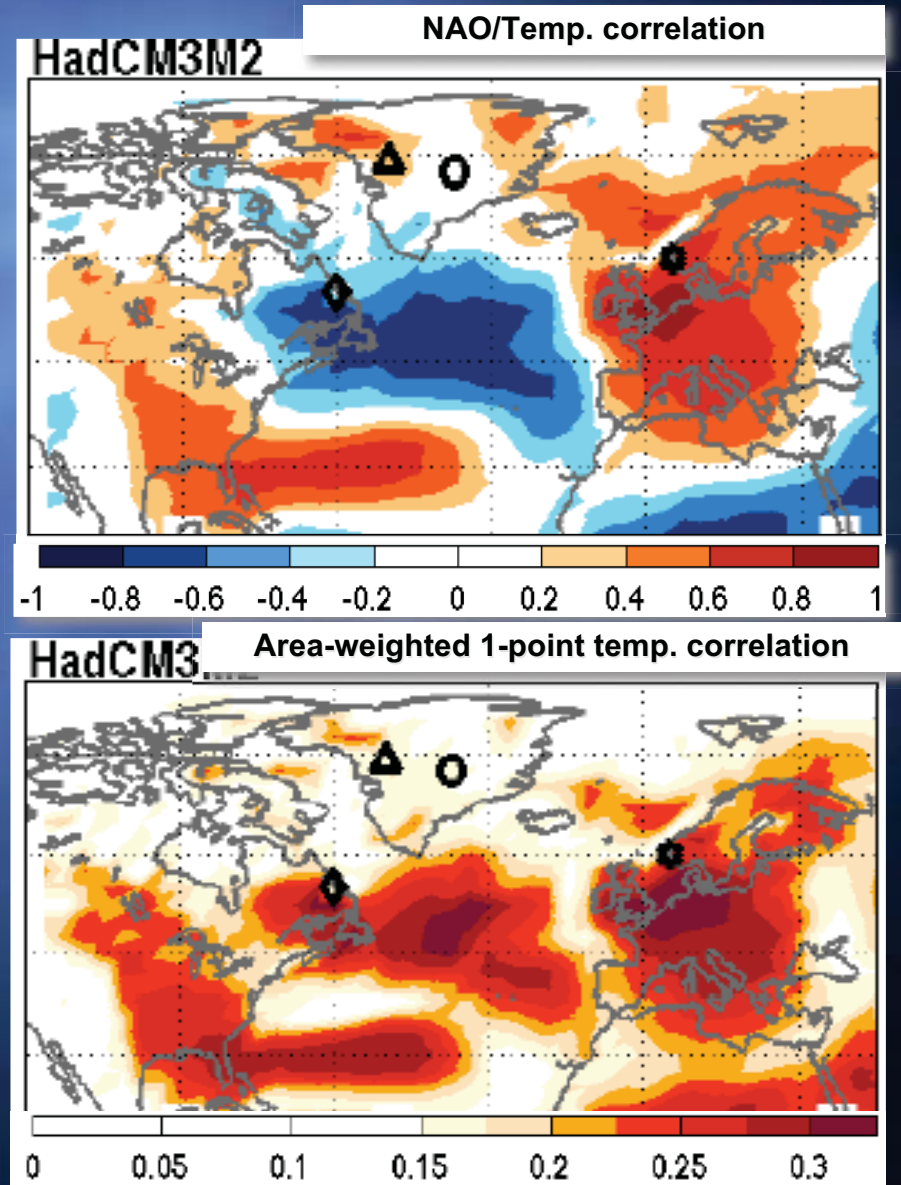
NAO not a dominant role on the temperature and precipitation variability

HadCM3M2

NAO-like response



Correlation patterns strongly shifted south





Concluding remarks

- ⊕ SLP mean state shifted south;
- ⊕ SLP interannual variability & its seasonal cycle are damped in LGM;



- ⊕ Large Laurentide ice sheet → upstream-blocking situation
- ⊕ Lower GHGs concentrations
- ⊕ Changes in surface properties (snow cover & sea ice)

Stronger jet

Less variable



Concluding remarks

- ⊕ SLP mean state shifted south;
- ⊕ SLP interannual variability & its seasonal cycle are damped in LGM;



⊕ shift south of temperature/precipitation pattern of correlation



repercussion on what a single location is able to record in different climate states;

⊕ NAO not the principal driver of the temp./prec. variability



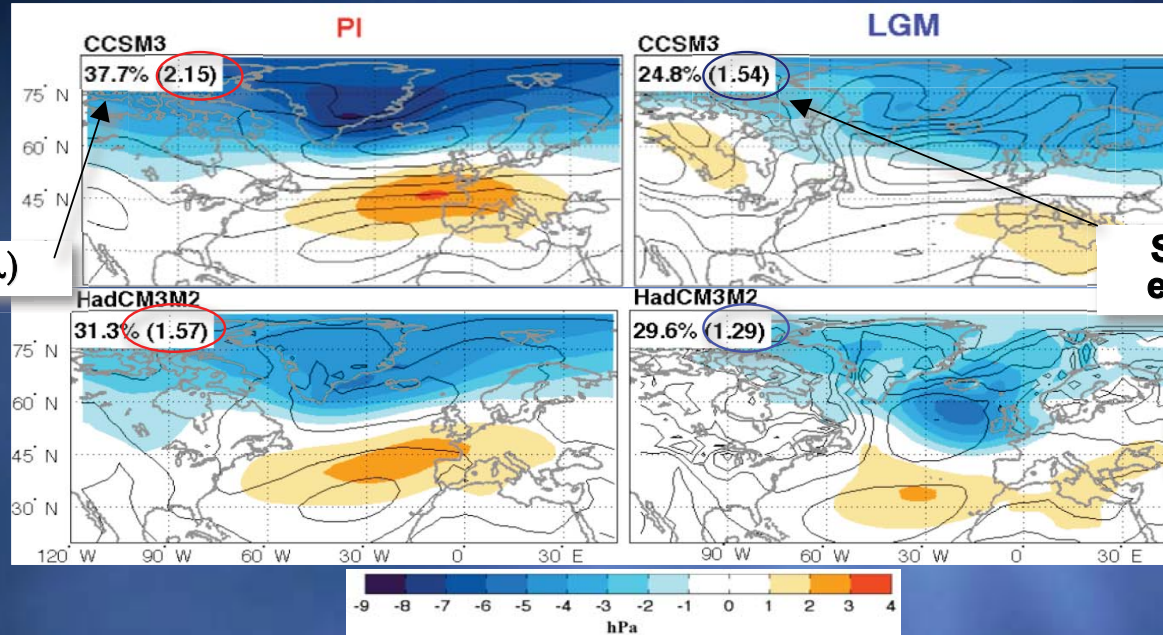
NAO-index reconstruction not sufficient.



Grazie!
QUESTIONS?

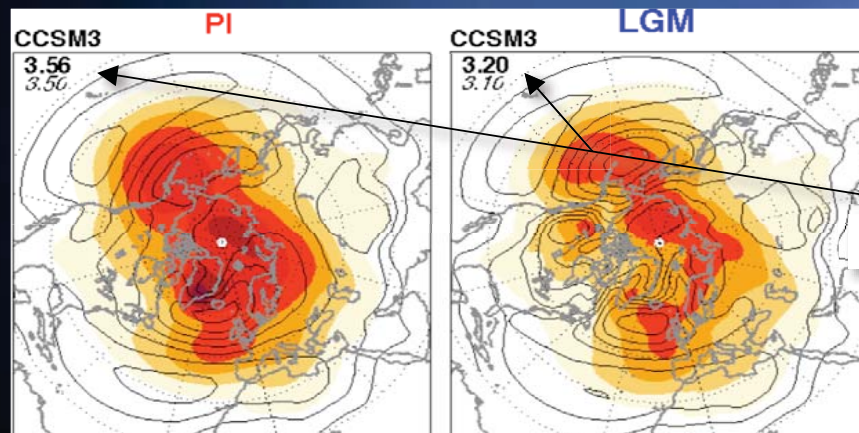
SLP EOF1 (averaged all months)

Explained variance (λ)

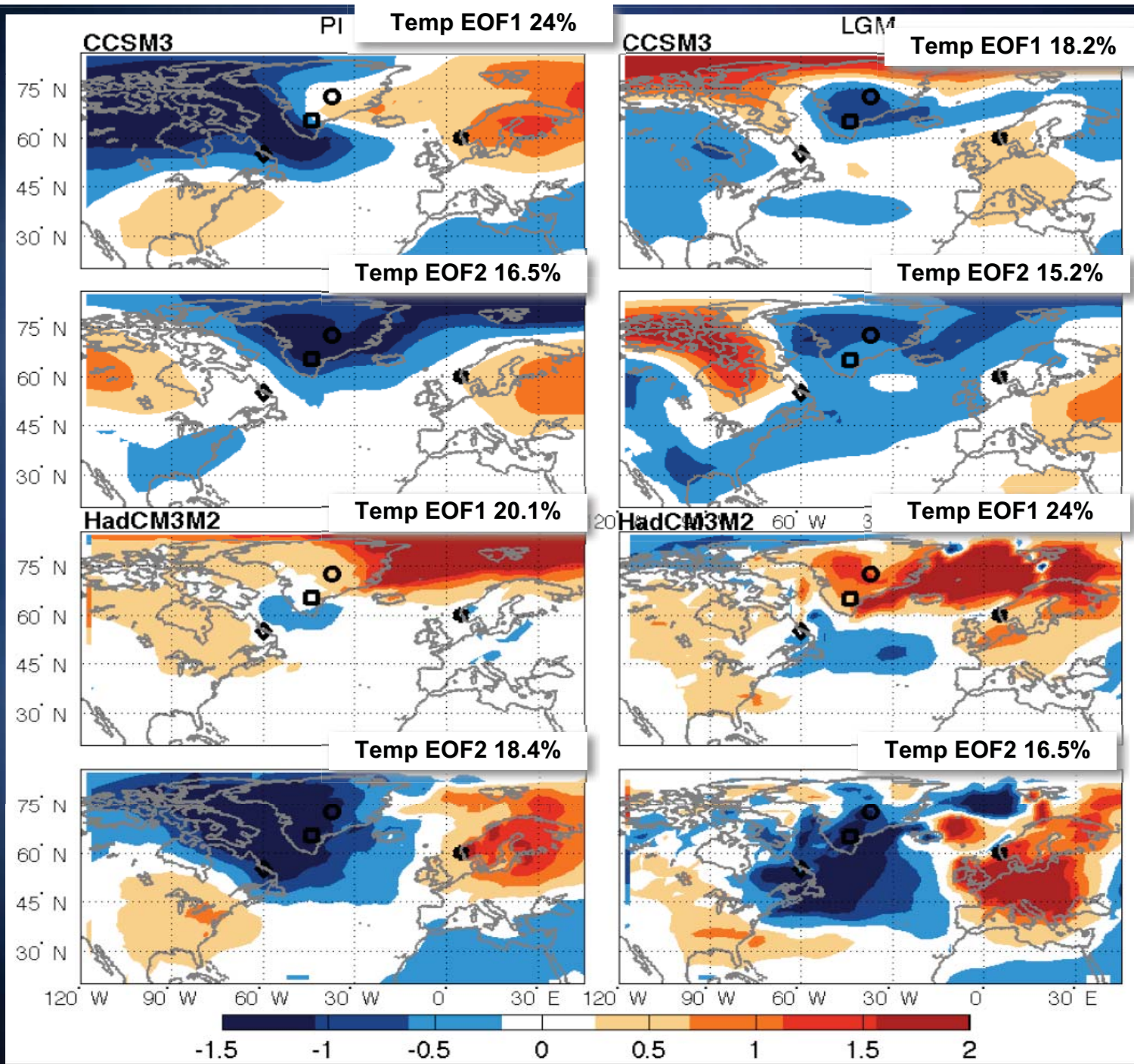


Standard deviation (σ) explained by the EOF1

$$\sigma_{NA} \cdot \sqrt{\lambda}$$

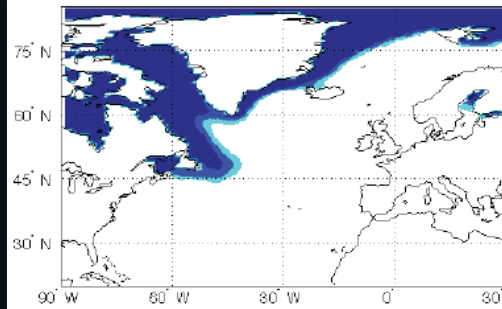


Area-averaged σ_{NH} & σ_{NA}

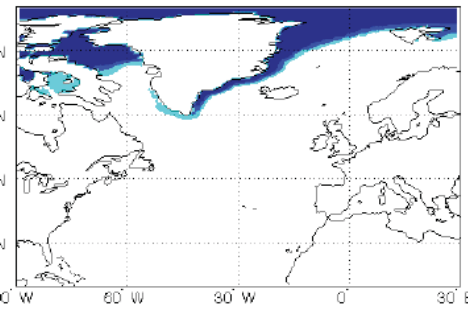


SEA ICE COVER percentage (%) PRESENT

MARCH, CCSM

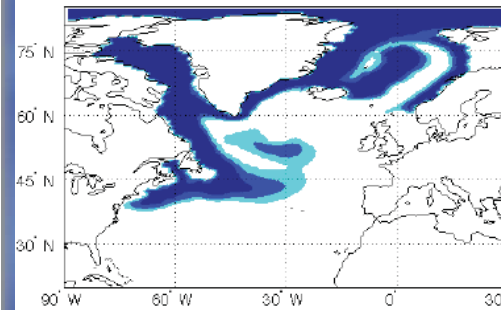


SEPTEMBER, CCSM

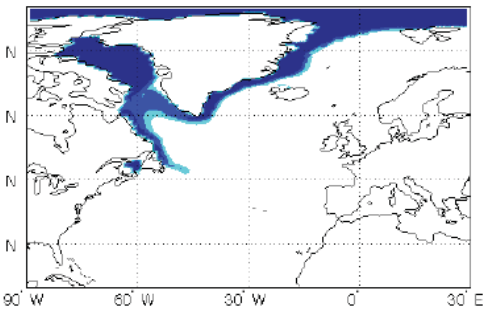


SEA ICE COVER percentage (%) LGM

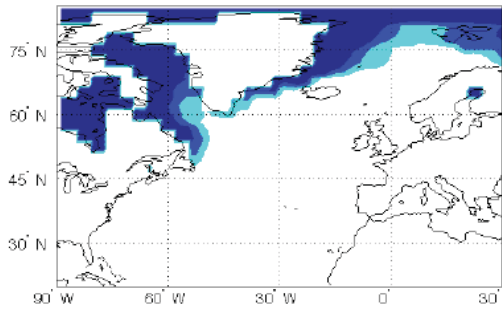
MARCH, CCSM



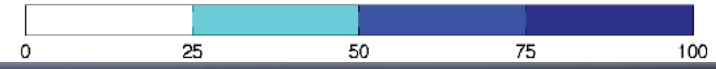
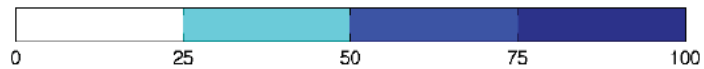
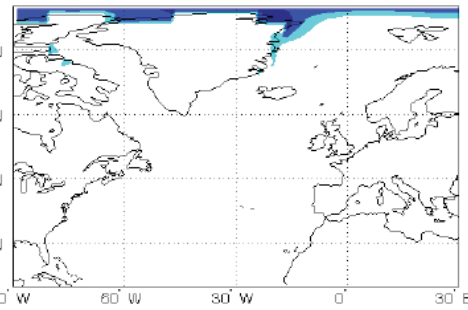
SEPTEMBER, CCSM



MARCH, HadCM3M2

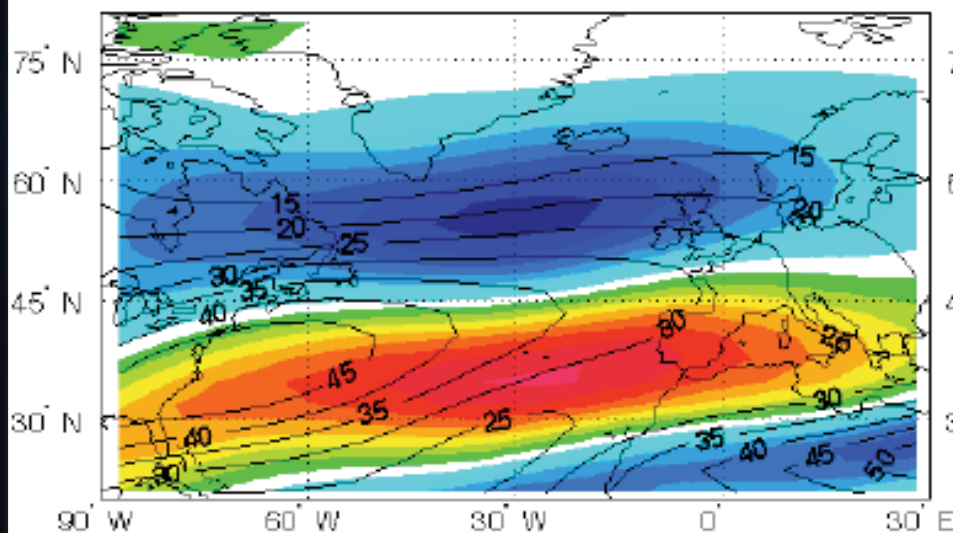


SEPTEMBER, HadCM3M2



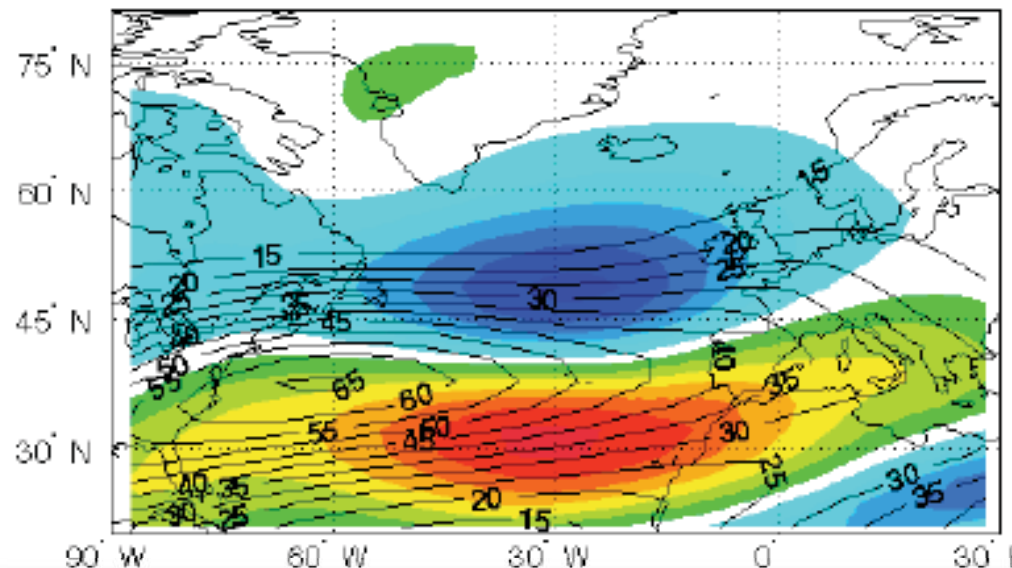
Averaged U200 + EOFs (m/s) DJFM PRESENT

EOF1, var. expl. 0.33, CCSM

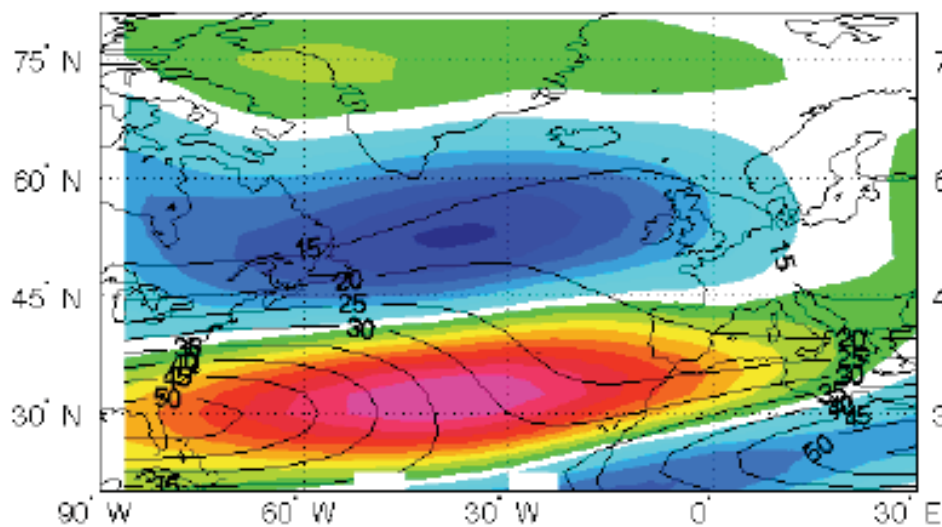


Averaged U200 + EOFs (m/s) DJFM LGM

EOF1, var. expl. 0.28, CCSM



EOF1, var. expl. 0.32, HadCM3M2



EOF1, var. expl. 0.39, HadCM3M2

