Climate variability and prediction in high latitudes, CL4.15, EGU2020, 8 May 2020

Internal variability of the Arctic Oscillation and its projections

Annalisa Cherchi[1], Paolo Oliveri[2], Aarnout van Delden[3]

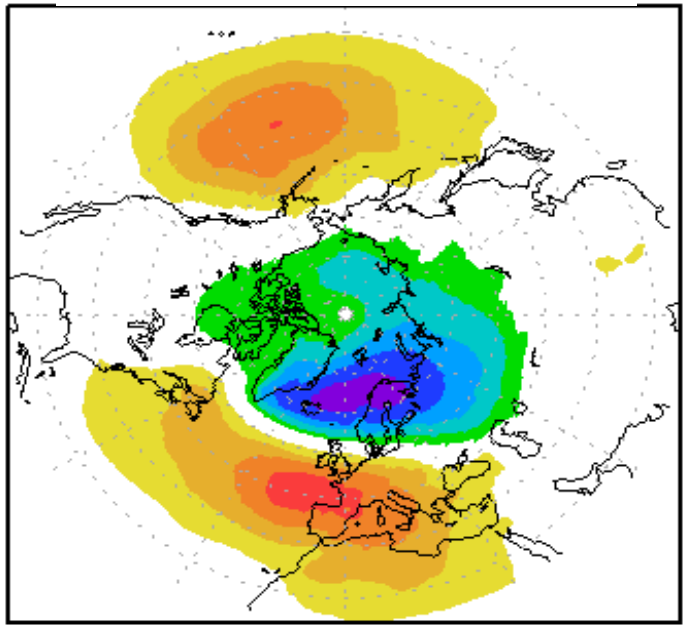
[1] Istituto di Scienze dell'Atmosfera e del Clima, ISAC-CNR, Bologna, Italy

[2]Istituto Nazionale di Geofisica e Vulcanologia, Bologna, Italy

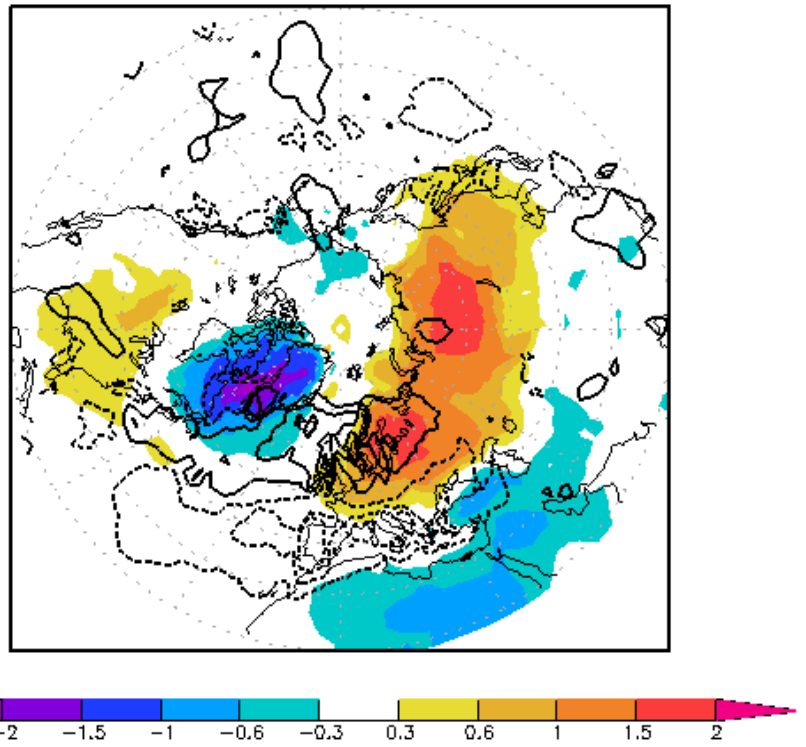
[3]Institute for Marine and Atmospheric Research Utrecht, Utrecht, The Netherlands

Arctic Oscillation (AO): EOF1 of DJF SLP in Northern Hemisphere & teleconnections

ERA-Interim (1980-2005)

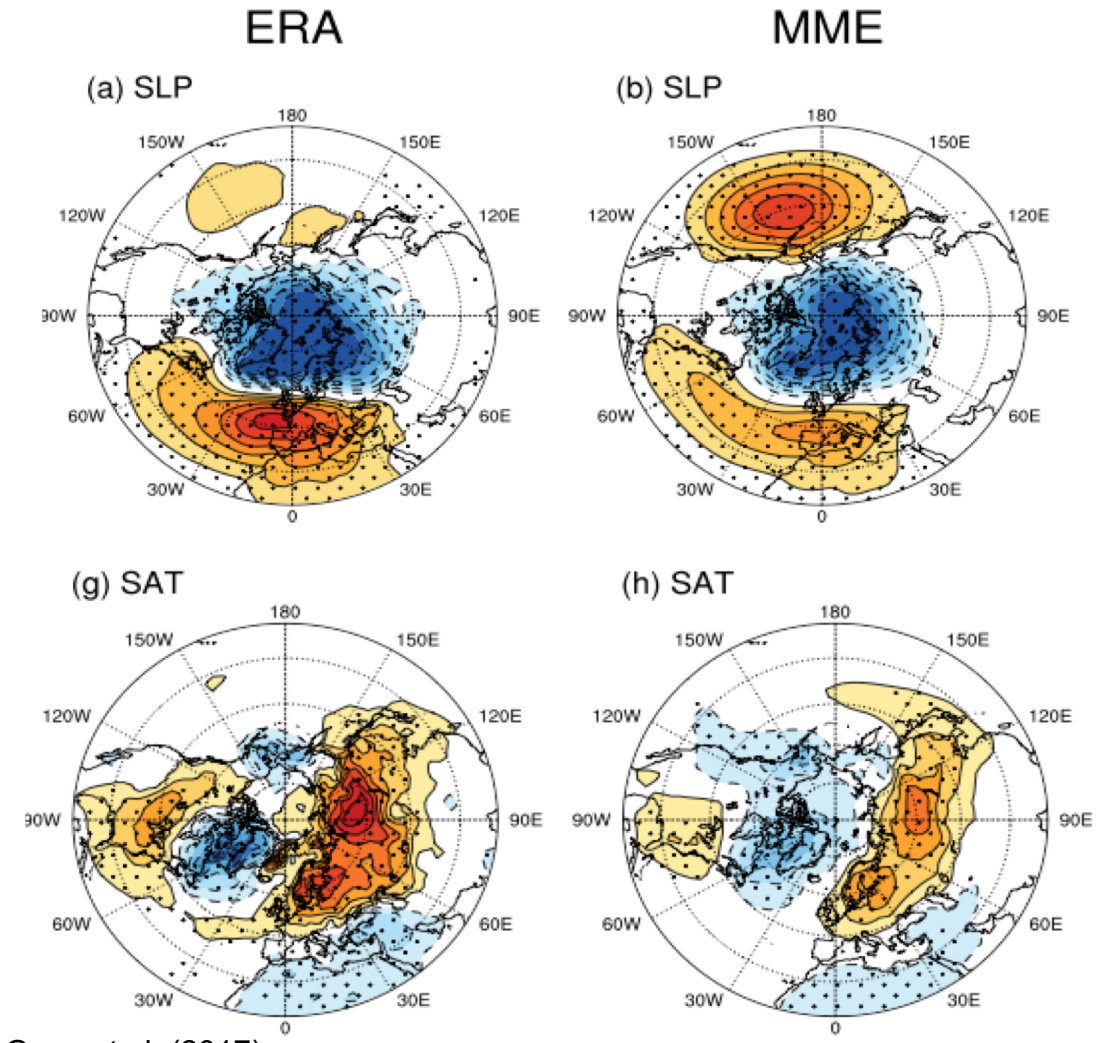


Regression PC1 vs PRECIP & T2M
(GPCP & ERA-Interim 1980-2005)



Main features: dipoles of warming/cooling in North America and Europe/Asia & wet conditions in North Europe & dry over Mediterranean (effects larger in Atlantic than in Pacific sector)

How do models represent the Arctic Oscillation?



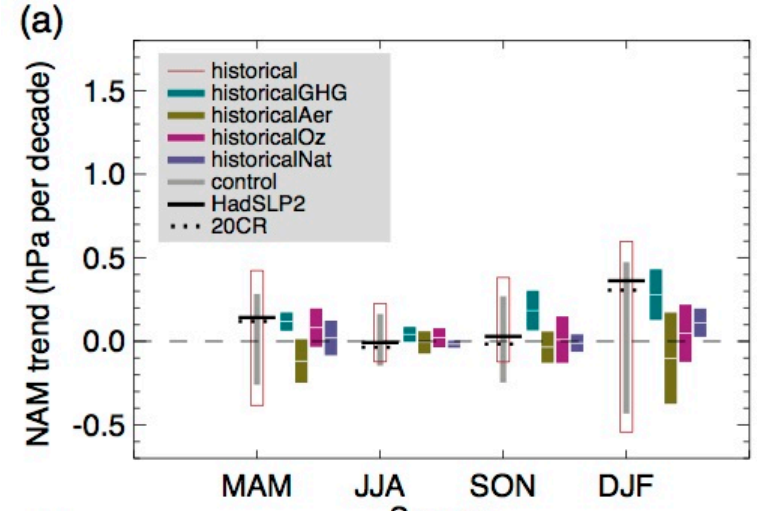
Gong et al. (2017)

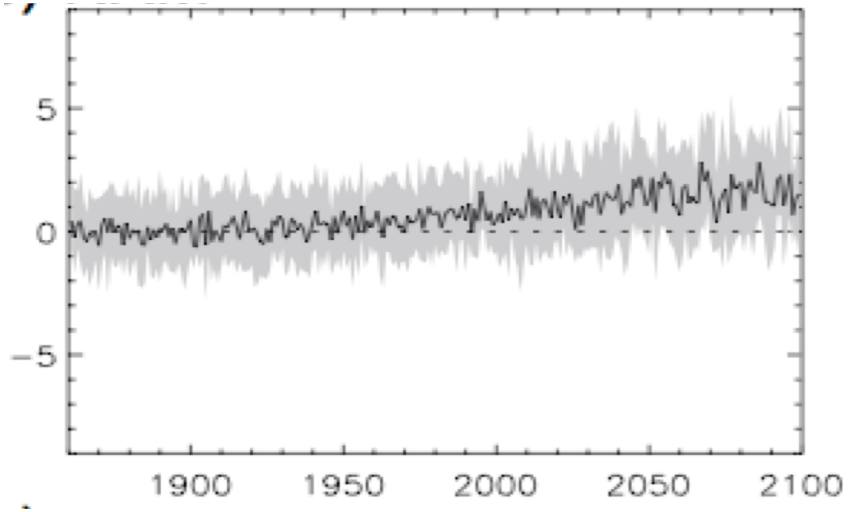
Model biases:
Pacific (Atlantic) center excessively strong (weak)

AO-related SAT anomalies are generally weak over Eurasian continent and North America (because of excessively strong linkage between AO and North Pacific Mode)

All CMIP5 models tend to overestimate the intensity of the AO pattern (Zuo et al., 2013)

Changes in Arctic Oscillation: CMIP5 simulations – IPCC AR5 (2013)





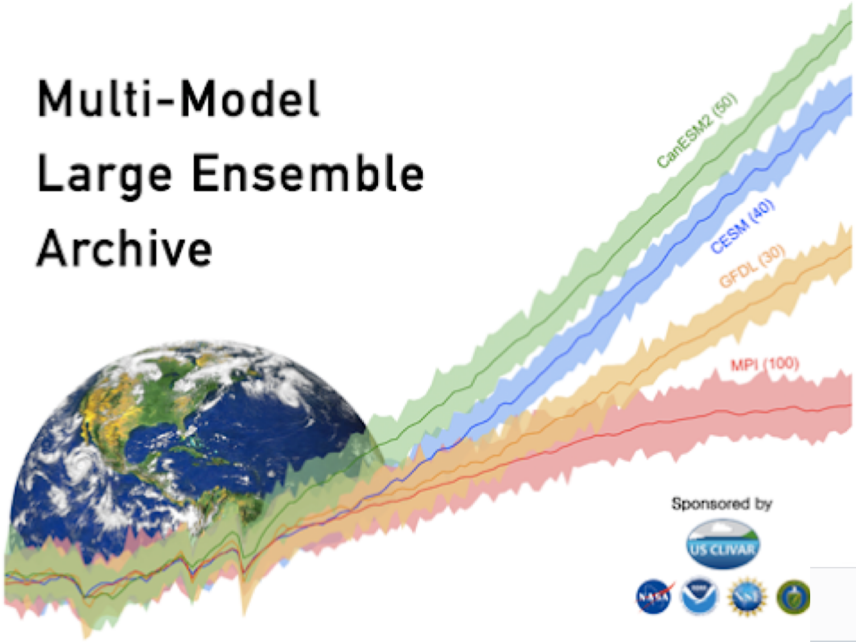
For AO observed trend (1951-2011) in DJF captured with GHG-only forcing included.

When all forcing are included the response is not consistent.

The change is “mitigated” mostly by the effects of the aerosols

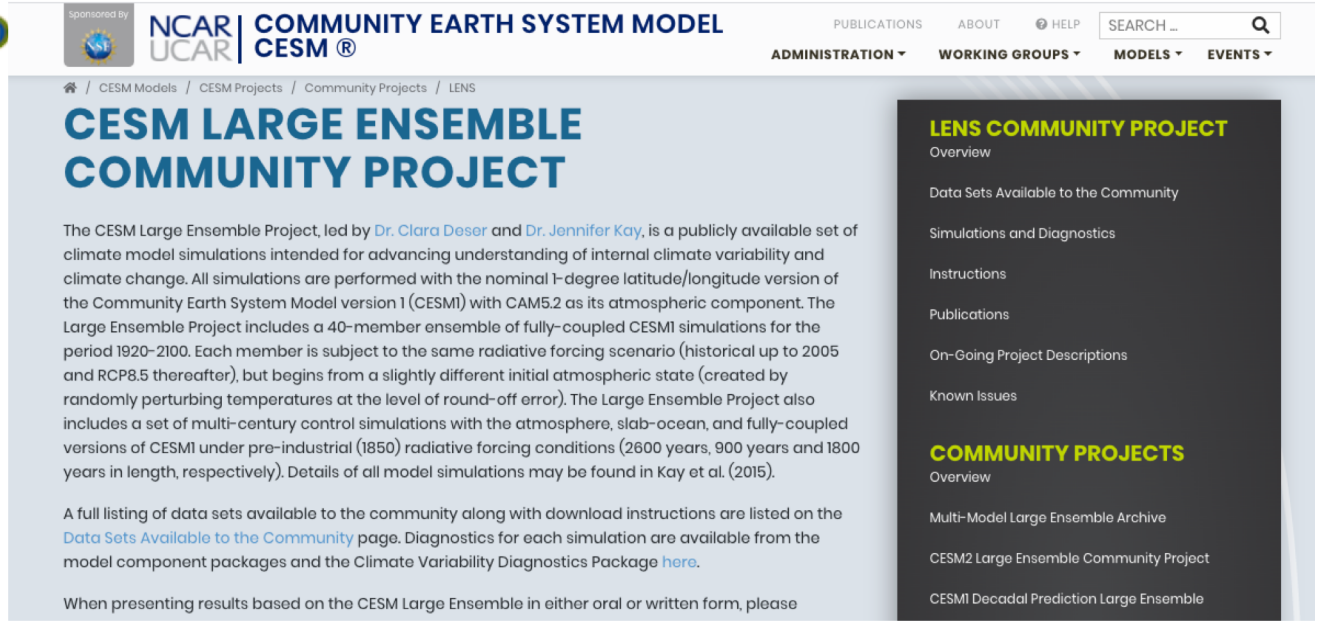
AO projected to increase (but the spread is large)

(also Gillett and Fyfe, 2013)

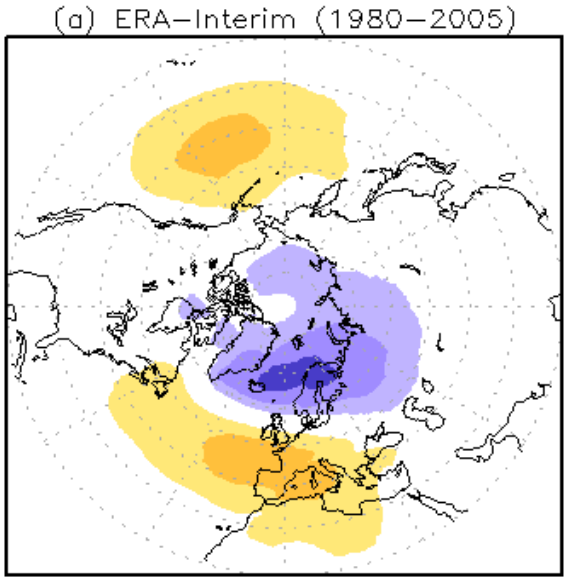


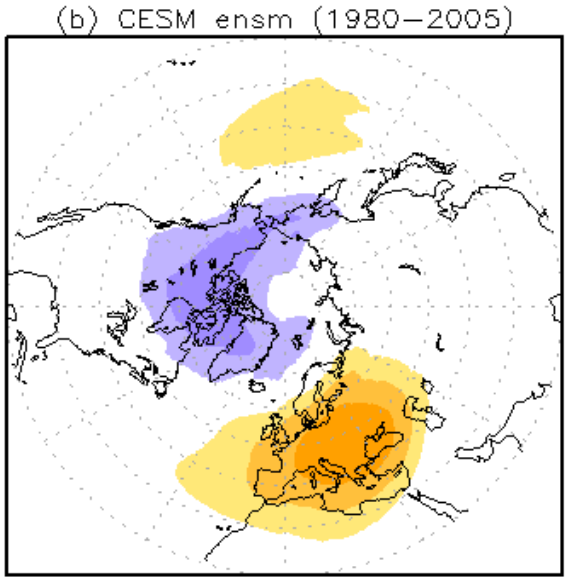
CESM-LE: 40 members, 1920-2100 (RCP8.5)

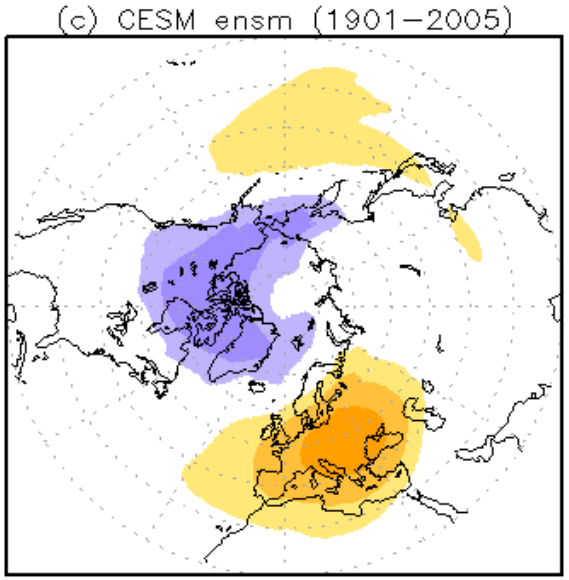
Kay et al., 2015

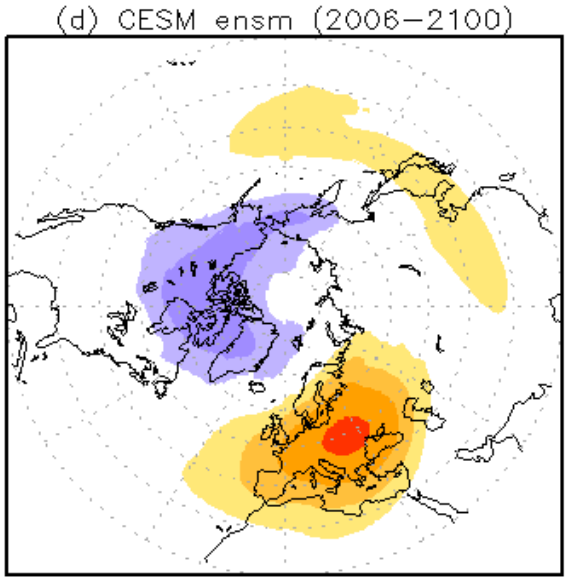


How do CESM-LE simulate the AO mode and how it project it into the future:









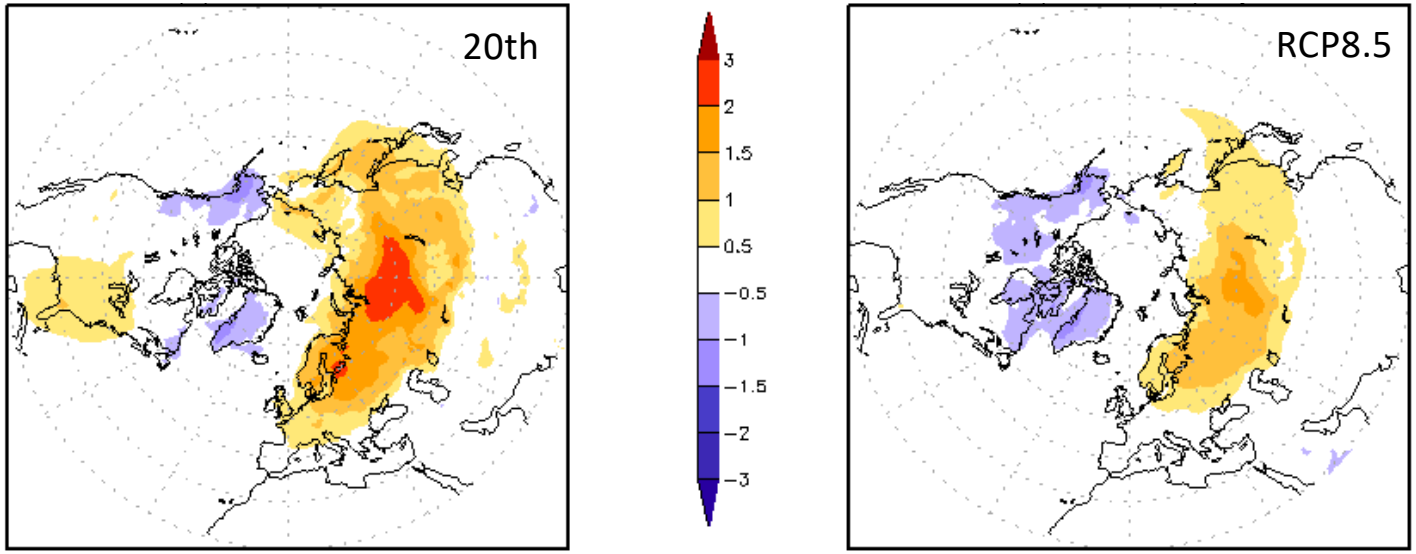
CESM-LE has a realistic representation of the AO mode (it seems not to have the common bias of overestimating the Pacific lobe)
The pattern is almost unchanged in projections as compared to present-climate

How do CESM-LE simulate and project in the future the AO mode fingerprints for temperature and precipitation:

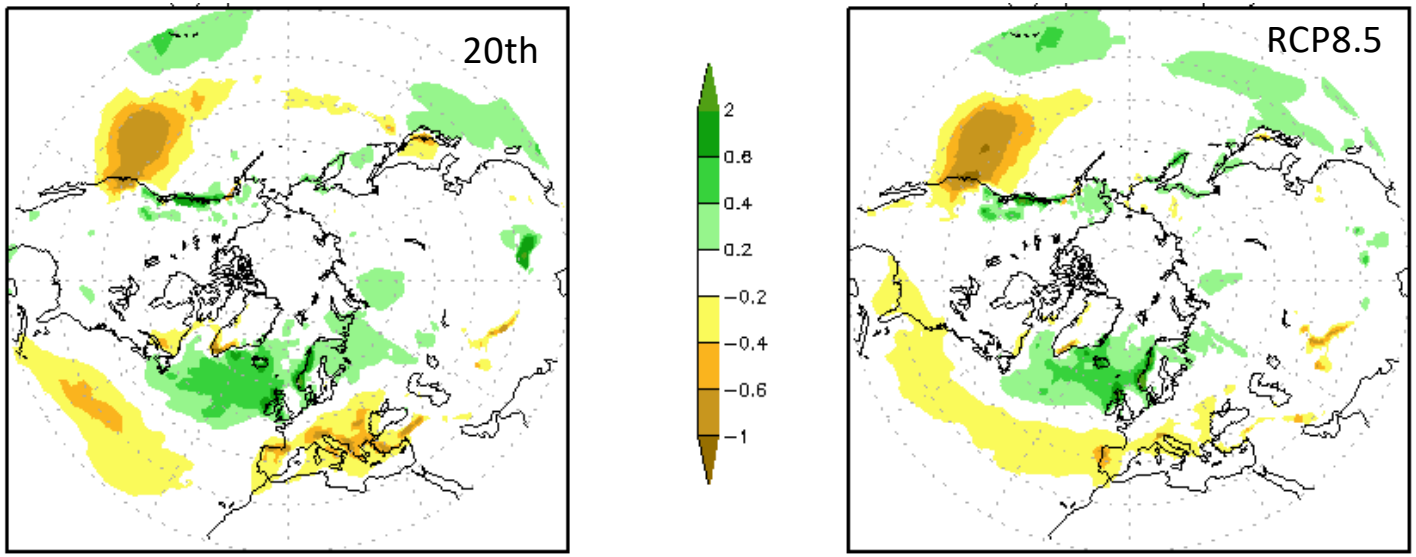
CESM-LE has a realistic representation of the AO mode fingerprints on temperature and precipitation

In the projections the temperature anomalies are reduced in intensity and disappeared from eastern US. Precipitation fingerprints are "confirmed".

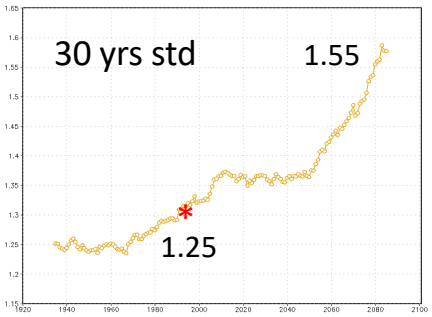
2m temperature (°C)



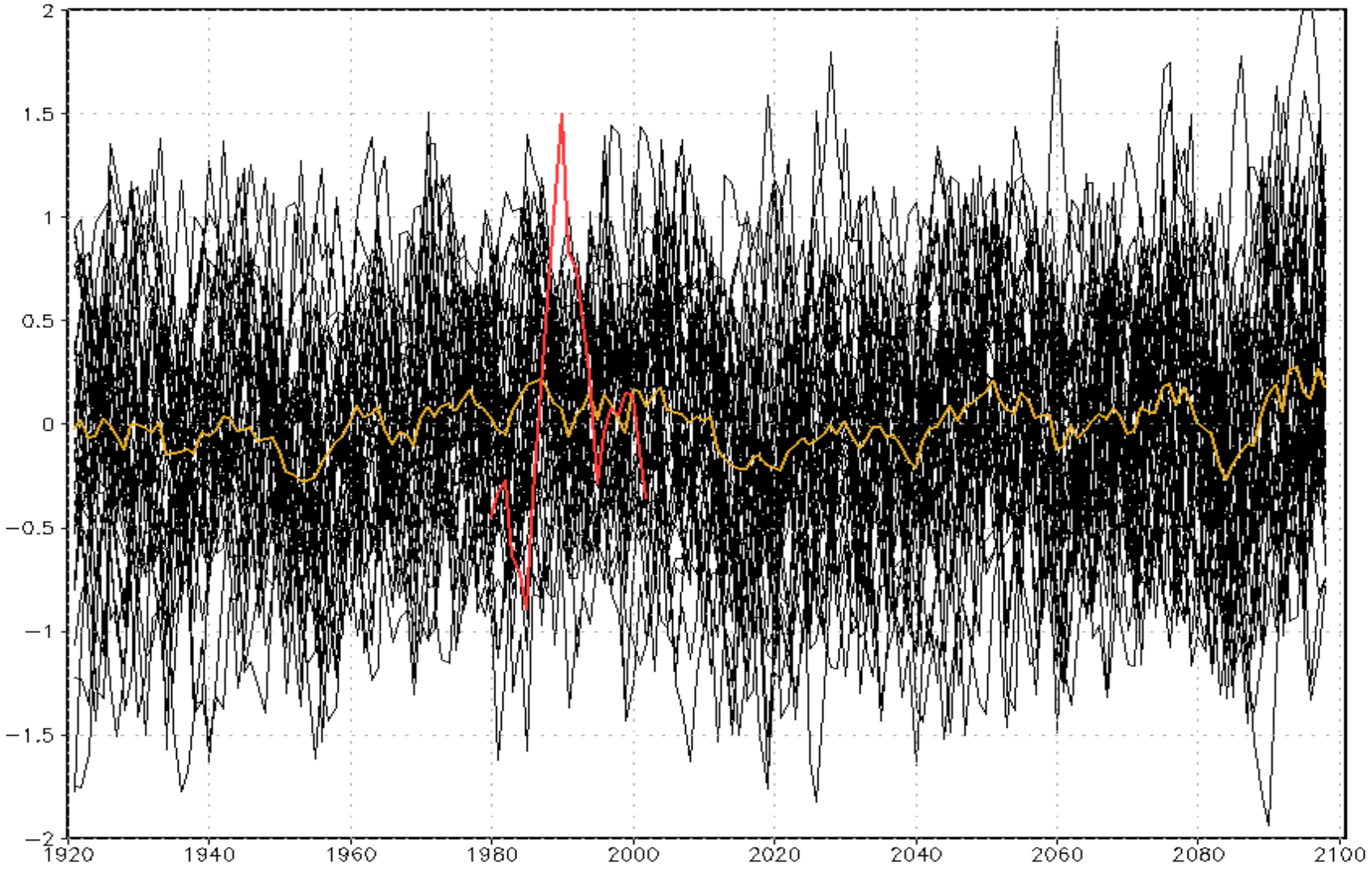
precipitation (mm/d)



AO index (5-yrs running mean): observations (red), ensemble mean (yellow) and members spread (black)



Hard to identify a trend (in projections) of the AO index, and for the whole period of analysis the members' spread is quite large



Preliminary conclusions:
CESM-LE has a realistic representation of the AO mode (it seems not to have the common bias of overestimating the Pacific lobe of the mode)

Projected fingerprints of AO in terms of near-surface temperature & precipitation

Hard to identify a trend (in projections) of the AO index, but the ensemble mean of the modes evidence some long-timescale variability (once interannual variability is filtered)

Members' spread is large but the amplitude seems to increase in the projections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