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Internal variability of the Arctic Oscillation and its projections

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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?



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)

NCAR COMMUNITY EARTH SYSTEM MODEL

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CESM LARGE ENSEMBLE COMMUNITY PROJECT

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The CESM Large Ensemble Project, led by Dr. Clara Deser and Dr. Jennifer Kay, is a publicly available set of climate model simulations intended for advancing understanding of internal climate variability and climate change. All simulations are performed with the nominal I-degree latitude/longitude version of the Community Earth System Model version 1 (CESMI) with CAM5.2 as its atmospheric component. The Large Ensemble Project includes a 40-member ensemble of fully-coupled CESMI simulations for the period 1920-2100. Each member is subject to the same radiative forcing scenario (historical up to 2005 and RCP8.5 thereafter), but begins from a slightly different initial atmospheric state (created by randomly perturbing temperatures at the level of round-off error). The Large Ensemble Project also includes a set of multi-century control simulations with the atmosphere, slab-ocean, and fully-coupled versions of CESMI under pre-industrial (1850) radiative forcing conditions (2600 years, 900 years and 1800 years in length, respectively). Details of all model simulations may be found in Kay et al. (2015).

A full listing of data sets available to the community along with download instructions are listed on the Data Sets Available to the Community page. Diagnostics for each simulation are available from the model component packages and the Climate Variability Diagnostics Package here.

When presenting results based on the CESM Large Ensemble in either oral or written form, please



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".







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



