Multidecadal Fluctuation of the Wintertime Arctic Oscillation Pattern and Its Implication

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Introduction and Objective

The wintertime Arctic Oscillation pattern
- The Arctic Oscillation (AO) is the most dominant low-frequency variability in the extratropical Northern Hemisphere and significantly influence the climate in the regional and hemispheric scales (e.g., Thompson and Wallace 1998, 2001; Wang and Chen 2010).
- Previous studies found that the AO pattern is non-stationary under certain specific conditions.
- However, it is remains unclear how the wintertime AO pattern itself changes with time.

Objective
- Investigate the plausible decadal changes in the pattern and teleconnections of the wintertime AO based on long-term observational and reanalysis data.
- Revisit the discussion on the nature of the AO from the perspective of the decadal changes of the wintertime AO pattern.

Data:
- Monthly mean SLP from HadSLP2r and SAT from HadCRUT4.
- To verify the robustness of the results, SLP and SAT from two analysis data (20CR-V2c and ERA-20C) are also employed.
- Few observations exist before 1920, thus the time period 1920–2010 is employed.
- Winter means are defined as the average of the monthly data over December to February.

Methods:
- The wintertime AO index is defined as the principal component of the first EOF of the winter mean SLP in the extratropical Northern Hemisphere.
- The North Atlantic Oscillation (NAO) and North Pacific mode (NPM) are defined as the first EOF modes of the winter mean SLP anomalies over the North Atlantic (20–80N, 90W–40E) and the North Pacific (20–65N, 120E–120W), respectively.
- Regression and correlation analysis were used and the significance of the results was evaluated with the two-tailed Student’s t-test.

Pattern and teleconnections of the AO are consistent among the three datasets

Time-varying AO pattern during the winters of 1920–2010

The stable similarity between the AO and NAO

The NAO is the fundamental mode over the North Atlantic

Revisiting the nature of the AO from the perspective of decadal change

The time-varying Pacific center of the AO and the North Pacific–North Atlantic coupling

Summary

- Intensity of AO’s Atlantic center is stable, but that of AO’s Pacific center has strong decadal fluctuations.
- The NPM and NAO are the inherent regional atmospheric modes because their centers are stable with time over the North Pacific and North Atlantic, respectively.
- AO’s Atlantic center always resembles the NAO over the North Atlantic, but AO’s Pacific center only resembles the NPM over the North Pacific when the NPM–NAO coupling is strong.
- AO seems to be fundamentally rooted in the variability over the N. Atlantic. The annular structure of the AO very likely arises from the coupling of the atmospheric modes between the N. Pacific and N. Atlantic.