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The Arctic Oscillation and Polar Night Jet Oscillation seen in a Perpetual February Simulation (Extended Abstract)

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Introduction

The annular mode in the Northern Hemisphere (NH) extratropical circulation, which has an equivalent barotropic structure from the surface to the lower stratosphere, is called the Arctic Oscillation (AO) by Thompson and Wallace (1998). The AO is the leading empirical orthogonal function (EOF) mode of the sea level pressure field, and it can be seen throughout the year. It is more dominant in winter, especially in middle and late winter. It is characterized as a seesaw pattern of mass between the the Arctic region and the midlatitude belt. It is also a seesaw of the mean zonal wind between the region poleward of 40N and that equatorward of it.

In this study, an Analysis of the simulated AO is made, to confirm that the AO is an atmospheric internal mode, and for studying the transition mechanism to the high/low polarity of the AO. Moreover, the relation between the AO and the Polar Night Jet Oscillation (PJO) is studied. Most of this study is found in Yamazaki and Shinya (1999).

Model and experiments

The seasonal and perpetual February runs were made by using the Center for Climate System Research/National Institute for Environmental Studies (CCSR/NIES) atmospheric general circulation model (AGCM). In the seasonal run, the climatological sea surface temperature (SST) is specified. In the perpetual February run, the sun and the SST are fixed at the mid-February conditions. February is chosen because the AO is dominant in February.

Simulated annular mode

In both runs, the AO signature is dominant and more dominant than the observation. Its magnitude is similar to the observed one. Thus, it is confirmed that the AO is an internal mode of the atmosphere. The result of the perpetual February run is used for the following analysis. In the run, the dominant mode in daily mean fields is also the AO. Therefore, the daily AO index can be defined. The auto correlation of the daily AO index shows the red noise feature, of which e-folding time is about 16 days. Using the data, a composite analysis of the transition to the high/low polarity of the AO index is made.

Because the AO is the annular mode, the change of the zonal mean zonal wind is analyzed.

Based upon the transformed Eulerian mean equation for the mean zonal wind, it is investigated which term is responsible for the transition. The results indicate that the wave forcing term contributes to the transition and the term of the residual meridional circulation acts to restore the transition. A decomposition of the wave forcing to zonal wave component indicates that planetary-scale wavenumber 2 and 3 contribute most to the transition. The synoptic-scale waves contribute partly to the low-latitude wind change. In summary, the AO is dominant due to the feedback between the zonal mean zonal wind and the planetary-scale waves and this idea is consistent with the observational study by Ohhashi and Yamazaki (1999).

The AO index at each level

To investigate the relation between the stratosphere and troposphere, the AO* index is defined at each level. For simplicity, the AO* index is defined as difference of the zonal mean zonal wind between 58N and 30N.

The frequency distribution (and the probability density function; PDF) of the daily AO* index at 850 hPa has a single peak, but the distribution near the peak is flatter than the normal distribution. However, the PDF of the 31-day running mean AO* index at 850 hPa shows a bimodal distribution. This suggests that the existence of two flow regimes, *i.e.*, the high AO and low AO state.

The relationship between the polar night jet oscillation and the AO

During winter in the Northern Hemisphere, the strength and location of polar night jet in the stratosphere vacillates with intra-seasonal time scale (the polar night jet oscillation (PJO)). It is observed that the anomaly of the stratospheric circulation propagates downward into the troposphere (Baldwin and Dunkerton, 1999, Kuroda and Kodera, 1999).

In the perpetual February run, a slowly propagating stratosphere-troposphere coupled mode is detected in the 31-day running mean zonal wind field. The variation is not regular, but its oscillation period is 4-6 months. The anomaly of the zonal-mean zonal wind first appears in the subtropical stratosphere and propagates poleward. Once the anomaly reaches high latitude, it becomes large and propagates into the stratosphere. Lag-correlation analysis of the AO* index also confirmed the downward propagation in the low-passed field.

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