

## A tropospheric pathway of the stratospheric QBO impact on the boreal winter polar vortex

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The quasi-biennial oscillation (QBO) is quasi-periodic oscillation of the tropical zonal wind in the stratosphere. When the tropical lower stratospheric wind is easterly (westerly), the winter Northern Hemisphere (NH) stratospheric polar vortex tends to be weak (strong). This relation is known as Holton-Tan relationship. Several mechanisms for this relationship have been proposed, especially linking the tropics with high-latitudes through stratospheric pathway. Although QBO impacts on the troposphere have been extensively discussed, a tropospheric pathway of the Holton-Tan relationship has not been explored previously. We here propose a tropospheric pathway of the QBO impact, which may partly account for the Holton-Tan relationship in early winter, especially in the November-December period. The study is based on analyses on observational data and results from a simple linear model and atmospheric general circulation model (AGCM) simulations. The mechanism is summarized as follows: the easterly phase of the QBO is accompanied with colder temperature in the tropical tropopause layer, which enhances convective activity over the tropical western Pacific and suppresses over the Indian Ocean, thus enhancing the Walker circulation. This convection anomaly generates Rossby wave train, propagating into the mid-latitude troposphere, which constructively interferences with the climatological stationary waves, especially in wavenumber 1, resulting in enhanced upward propagation of the planetary wave and a weakened polar vortex.

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