Quasi-Biweekly Oscillation over the Western North Pacific in Boreal Winter and Its Influence on the North American Temperature

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Abstract

This study investigates the characteristics and climate impacts of the quasi-biweekly oscillation (QBWO) over the western North Pacific (WNP) in boreal winter based on observational and reanalysis data and numerical experiments with a simplified model. The wintertime convection over the WNP is dominated by significant biweekly variability with a 10-20-day period, which explains about 66% of the intraseasonal variability. Its leading mode on the biweekly timescale is a northwestward-propagating convection dipole over the WNP, which oscillates over a period of about 12 days. When the convection-active center of this QBWO is located to the east of the Philippines, it can generate an anticyclonic vorticity source to the south of Japan via inducing upper-tropospheric divergence and excite a Rossby wave train propagating towards North America along the Pacific rim. The resultant lower-tropospheric circulation facilitates cold advection and leads to cold anomalies over central North America in the following week. This result highlights a cause-effect relationship between the WNP convection and the North American climate on the quasi-biweekly timescale and may provide some prediction potential for the North American climate.

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Motivation

1. Insufficient knowledge of wintertime QBWO over the WNP and its climate influences

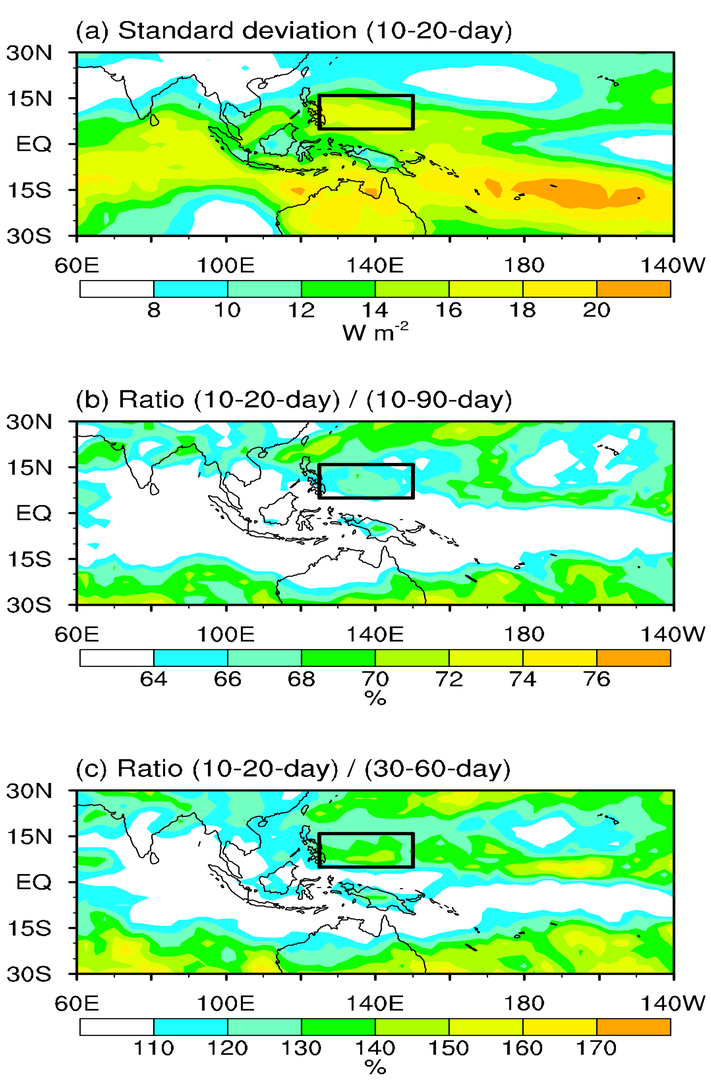
2. Unclear understanding of the tropical-extratropical connection on the quasi-biweekly timescale

Data and Methods

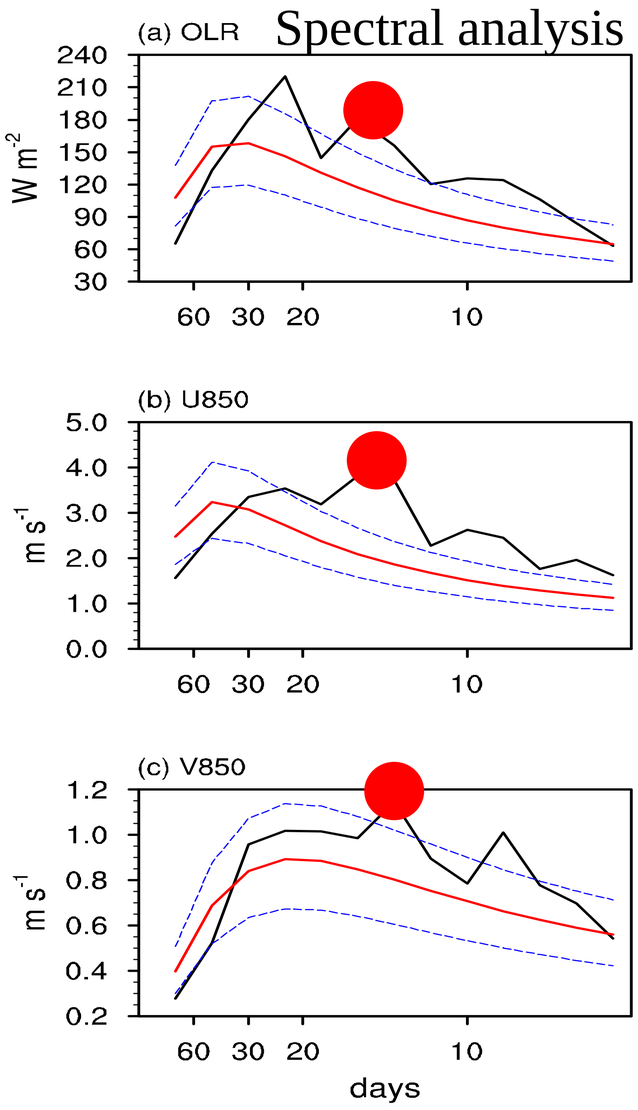
1. Data: NOAA OLR & ERA5 reanalysis (DJF)
2. Filter: a 10–20-day Butterworth filter
3. RWS:

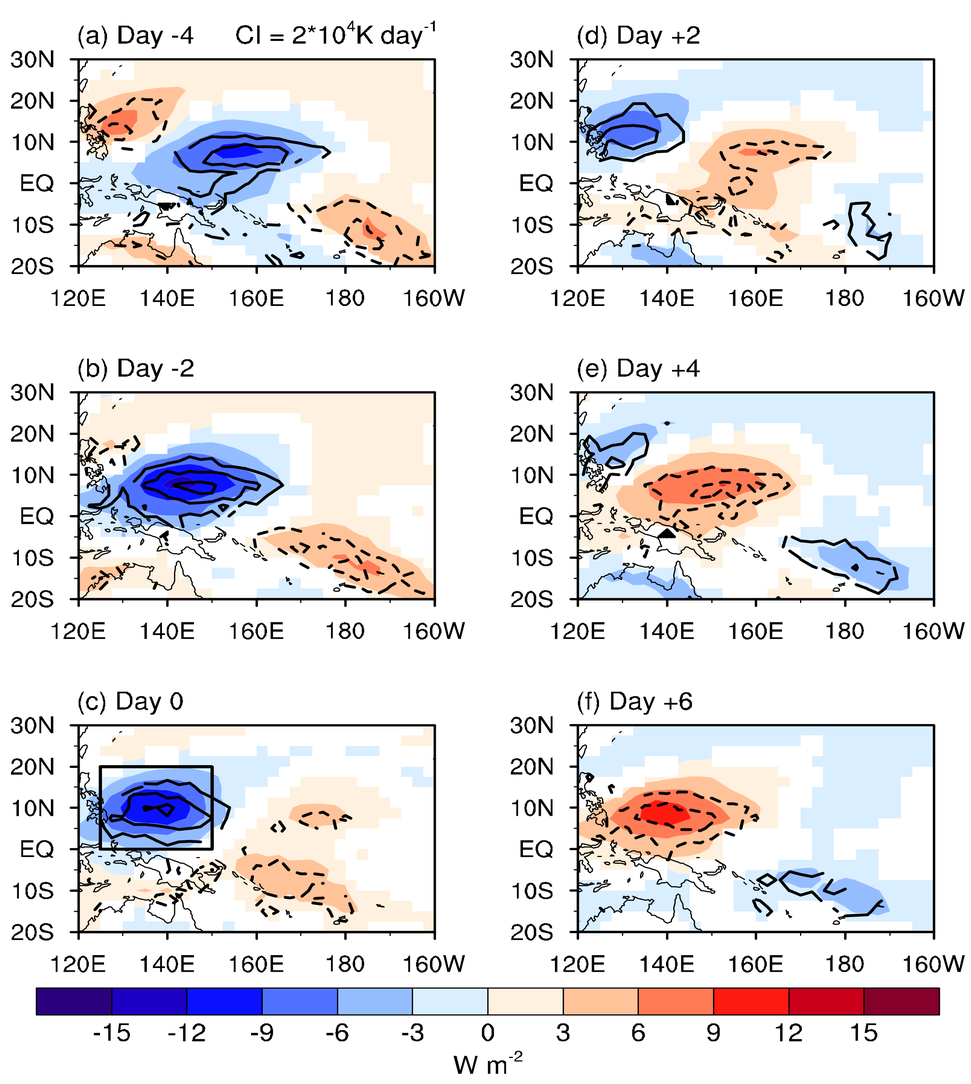
$$S = -\overline{\overline{\nu_\chi}}\nabla\zeta' - \zeta'\nabla\cdot\overline{\overline{\nu_\chi}} - \overline{\nu_\chi}'\nabla\overline{\zeta} - \overline{\zeta}\nabla\cdot\overline{\nu_\chi}'$$
$$\equiv S_1 + S_2 + S_3 + S_4$$

The importance and characteristics of QBWO over the WNP



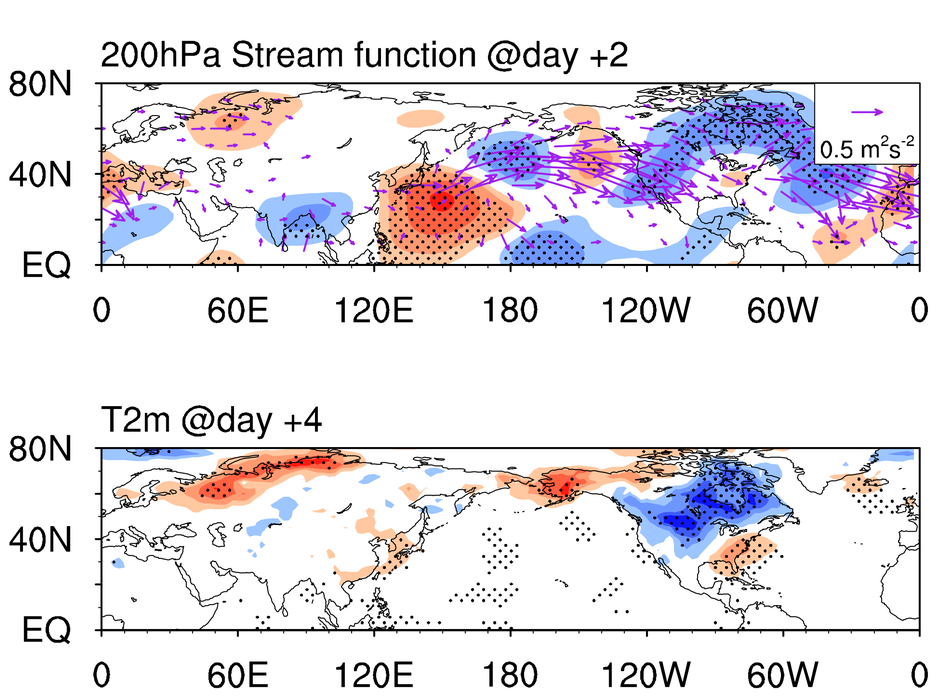
Spectral analysis

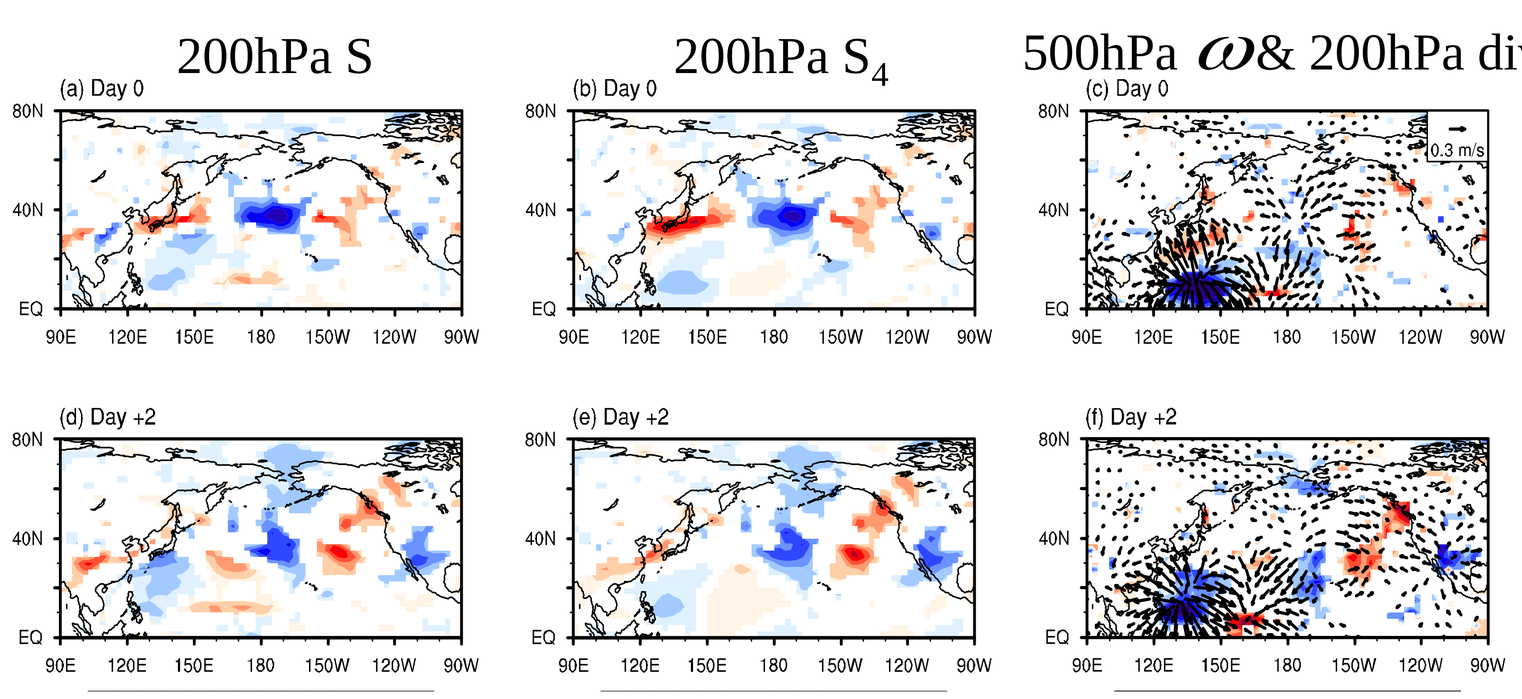




- ✓ The wintertime convection over the WNP is dominated by significant biweekly variability with a 10–20-day period.
- ✓ Its activity on the biweekly timescale is a northwestward-propagating convection dipole over the WNP, which oscillates over a period of about 12 days.

Impact of QBWO over the WNP on the North American temperature





- ✓ QBWO over the WNP on day 0 → anticyclonic vorticity source via upper-level divergence → a poleward propagating Rossby wave on day +2 along the North Pacific rim
- ✓ Low-level circulation of the Rossby wave activity → meridional cold advection → cold anomalies over central North America in the following week