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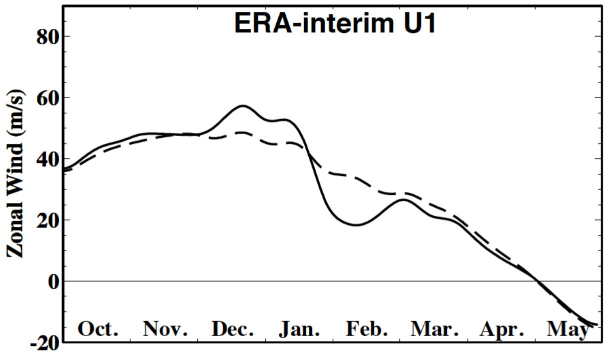

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Figure 1. Seasonal evolution of the zonal-mean zonal wind averaged over 50–70°N at 1 hPa from the ERA-interim. The solid and broken lines denote averages for QBO-W/S_{max} years and 1979–2006, respectively. All lines were smoothed by applying the 1:2:1 filter 60 times.

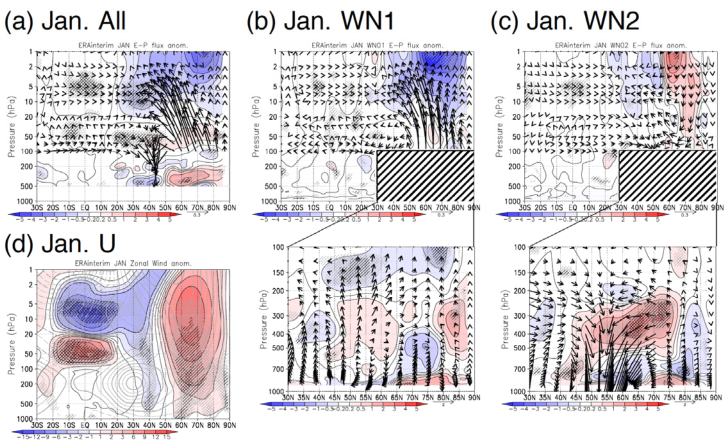

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Figure 2. (a) The longitude–height section of composite anomalies for QBO-W/S_{max} from the January mean E-P flux (vector) and its divergence (shading) from ERA-interim. (b–c) The same as (a), but for the (b) WN1 and (c) WN2 components. (d) The same as (a), but for the anomalies of the zonal-mean zonal wind.

- The combined influences of westerly phase of the QBO (QBO-W) and solar maximum (S_{max}) conditions on the Northern Hemisphere extratropical winter circulation are investigated using reanalysis data and CCSR/NIES Chemistry Climate Model (CCM) simulations.
- The composite analysis indicates strengthened polar vortex in December followed by weakened polar vortex in February–March for QBO-W during S_{max} (QBO-W/S_{max}) conditions (Fig. 1).
- In December, the dynamical processes related to the QBO-W and S_{max} may work in concert to maintain the stronger vortex during QBO-W/S_{max}.
- The amplification of tropospheric wavenumber 1 (WN1) wave in January during QBO-W/S_{max} results in the enhancement of upward WN1 propagation from troposphere into stratosphere, leading to the weakened polar vortex in February–March. Although wavenumber 2 (WN2) waves do not play a direct role in forcing the stratospheric vortex evolution, their tropospheric response to QBO-W/S_{max} conditions appears to be related to the maintenance of westerly wind anomaly in the high-latitude troposphere in January (Fig. 2).