Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2019-1119-RC2, 2020

Atmospheric Chemistry and Physics Discussions

Interactive comment on "A tropospheric pathway of the stratospheric quasi-biennial oscillation (QBO) impact on the boreal winter polar vortex" *by* Koji Yamazaki et al.

Anonymous Referee #2

Received and published: 29 January 2020

This paper presents the equatorial QBO influences on the Northern Hemisphere winter circulation. Many previous studies focused on the stratospheric pathways of this influences, while this manuscript proposes a possible mechanism for tropospheric pathways of this influences through the modulation of Rossby wave activities induced by the QBO-related convection over the tropical western Pacific and the Indian Ocean. This topic is interesting and valuable for this scientific area. However, there are some issues as mentioned below. For these reasons, I recommend minor revisions.

Minor comments:

(1) p.2, l.75: The definition of QBO is based on the absolute values of equatorial zonal

Printer-friendly version

Discussion paper

wind >3m/s. Please check another threshold and mention it.

(2) p.4, l.150: The difference between Fig. 5a and 5b indicates the influence of ENSO on the equatorial east Pacific as the downward around 150W with positive OLR in Fig. 3a. Is this interference from ENSO really ruled out in later analysis?

(3) p.5, l.l.165-170: Some references are needed for the constructive interference between the anomalous Rossby wave response and the background climatological stationary wave. Smith et al. (2010) showed the linear interference between these waves in their model. Using reanalysis data, Garfinkel et al. (2010) showed the constructive interference between the ENSO-related anomaly and climatology, and Yamashita et al. (2015) showed this interference between the QBO/solar-related anomaly and the climatology.

The constructive interference in Smith et al. (2010) is linear process, thus, it is reasonable that the constructive interference is reproduced with the LBM.

Garfinkel, C. I., D. L. Hartmann, and F. Sassi (2010), Tropospheric precursors of anomalous Northern Hemisphere stratospheric polar vortices, J. Climate, 23, 3282-3299.

Smith, K. L., C. G. Fletcher, and P. J. Kushner (2010), The role of linear interference in the annular mode response to extratropical surface forcing, J. Climate, 23, 6036-6050.

Yamashita, Y., H. Akiyoshi, T. G. Shepherd, and M. Takahashi (2015), The combined influences of westerly phase of the quasibiennial oscillation and 11-year solar maximum conditions on the Northern Hemisphere extratropical winter circulation, J. Meteor. Soc. Japan, 93, 629-644

(4) Some modifications of introduction are needed as mentioned below.

p.1, l.35: Holton and Tan, 1980, 1982 only show a plausible mechanism, as the latitudinal position of the zero-wind critical surface of stationary Rossby wave is primally controlled by the equatorial QBO. Recently, Watson and Gray (2014) posted this line

of discussion with their model.

Watson, P.A.G., and L.J. Gray (2014) How does the quasi-biennial oscillation affect the stratospheric polar vortex?, J. Atmos. Sci., 71, 391-409

p.1, l.35: "this critical latitude mechanism is not effective": The wave propagation change between the EQBO and WQBO is similar to the previous studies in high-latitudes and around equator in Naoe and Shibata (2010)'s results, in agreement with Holton-Tan relationship. In contrast, another propagation change, which is opposite to the critical line control, is analyzed in mid-latitudes by Naoe and Shibata (2010). White et al. (2015) suggested the enhanced upward wave propagation at midlatitudes due to the enhanced wave growth rather critical latitude mechanism, explaining the QBO-related change in mid-latitudes as well as the polar vortex change in high-latitudes.

White, I.P., H. Lu, N.J. Mitchell, and T. Phillips (2015), Dynamical response to the QBO in the northern winter stratosphere: Signatures in wave forcing and eddy fluxes of potential orticity. J.Atmos. Sci., 72, 4487-4507.

p.1, l.35: "The secondary circulation associated with the QBO in the subtropics": Naoe and Shibata (2010) and Yamashita et al. (2011) suggested the significance of the secondary circulation induced by the equatorial QBO in middle stratosphere rather lower stratosphere. In contrast, Garfinkel et al. (2012) and Lu et al. (2014) suggested the significance of the QBO-induced meridional circulation anomalies extend from the subtropics to the midlatitudes in relation to the midlatitudes change of Rossby waves due to the changes in index of refraction.

Other comments:

p.4, l.155: The middle tropospheric values of red lines (WQBO) are positive and the blue lines (EQBO) are negative in Fig. 6. Does it indicate the relatively large diabatic heating in the WQBO?

p.6, l.210: Fig. 9a shows the dipole pattern between mid-latitudes and Polar region,

while Fig. 12a shows the tri-pole pattern.

p.5, l.200: I suppose that “no interaction between the anomalous response and climatological fields” in terms of nonlinear processes, since the LBM model has the constructive interference for linear processes only.

p.6, l.215: I suppose that the constructive interference is valid, when the anomalous waves and climatological waves are in phase, as the description of wavenumber 1 field at p.5, l.170. But, their wavenumber 2 fields in Fig.8 are out of phase.

Typos: p.1, l.35: atmospheric general circulation models (AGCMs)

p.4, l.145: Fig. 4c, 5c -> Fig. 3c, 4c

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2019-1119, 2020.

Printer-friendly version

Discussion paper