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Interactive comment on "Relation Between the Interannual Variability in the Stratospheric Rossby Wave Forcing and Zonal Mean Fields Suggesting an Interhemispheric Link in the Stratosphere" *by* Yuki Matsushita et al.

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Response to the comments from Reviewer #2

We greatly appreciate the reviewer for his/her critical reading and constructive comments. We have revised our manuscript as much as possible following his/her comments. Our response to each comment is described as follows:

1) *The analysis focuses on JJA time period. How about boreal winter (DJF)? The same proposed mechanism should apply to the boreal winter too. I don't see any discussion*

of the stratospheric interhemispheric coupling in the text.

Following the reviewer's suggestion, we have newly performed the analyses for the boreal winter (DJF). As a result, it is indicated that the interhemispheric link and cross-equatorial flow in the boreal winter is associated with the wave forcing in the NH stratosphere as well, while the latitudinal extent to the summer hemisphere is limited compared to that in the austral winter. Due to significantly large amplitude of planetary waves in the NH winter, which sometimes causes the breakdown of the polar vortex, a linear relation is unlikely obtained between the wave forcing and mean fields in the NH winter. We have newly added Sect.4.3 on the results for the boreal winter and have added figures as Fig. 9 in the revised manuscript.

2) *Figures 5(a-c) show that the width of the small meridional gradient of absolute angular momentum around the equator varies along with wave forcing. It is not clear how significant this width variation–between 35 and 40 km the variation on each side is about 3 degrees latitude–for interhemispheric coupling. Is there any quantitative justification that this is (or is not) significant for the coupling?*

In order to clarify the relation between meridional gradient of absolute angular momentum ($\bar{M}_y$) around the equator and cross-equatorial flow, we define the region of 10°S–10°N, 35–45 km as Region B, and examine $\bar{M}$ averaged over Region B (hereafter referred to as $\left[\bar{M}\right]_B$). The correlation between $\left[\nabla \cdot F\right]_A$ and $\left[\bar{M}\right]_B$ is significantly positive (0.49), which is consistent with the results of the composite analyses (Figure 5 in the revised manuscript). The correlation between the interannual variability of $\left[\bar{M}\right]_B$ and $\bar{v}^*$ is significantly highly positive in the region of the cross-equatorial flow as seen in Fig. 4b. Thus, when the absolute angular momentum at the Region B is small, the southward cross-equatorial flow through the Region B is strong. We have added a paragraph and a figure (Fig. 6 in the revised manuscript) on the $\bar{M}_y$ around the equator to Sect.3.

And related to my question 1, are the absolute angular momentum and its meridional

gradient similar during boreal winter?

The correlation of $\bar{u}$ and extratropical stratospheric wave forcing in DJF, shown in Fig. 9a, is significantly positive and higher than 0.4 at 50–55 km and 30°S–30°N, and the correlation of $\bar{v}^*$ is also significant at 50–55 km and 20°S–30°N. At the equator, $\bar{u}$, and thus absolute angular momentum, is small when the Rossby wave forcing in the boreal winter stratosphere is strong in DJF as in JJA, although the altitudes where these variabilities are observed is different from that of JJA.

3)*Figure 6 shows that the wave forcing is not always correlated with the solar activity. On the other hand, it seems over some time periods the forcing has a period of 2-3 years. And it is conceivable that the equatorial dynamical state (including the angular momentum/gradient) could be affected by QBO (probably comparable to solar impact, if not stronger). I wonder if this impact has been looked at in the analysis.*

Following the reviewer's suggestion, we have newly performed the analyses focusing on the relation of our results with the QBO. We used $\bar{u}$ at the equator and 30 hPa as a proxy of the QBO phase and made a new plot showing the correlation of the QBO phase and the wave forcing (Figure 8 in the revised manuscript). The correlation between $[\nabla \cdot F]_A$ and $\bar{u}$ at the equator and at 30 hPa is small and is not significant (-0.14). Since the reason why the correlation between the QBO and the wave forcing in Region A is insignificant is out of the scope of this study, we only note here that the height region for the wave forcing in the present study (namely, Region A) is located at a much higher altitude than that were focused in the previous studies (e.g., Baldwin and Dunkerton, 1998; Salby et al., 2011). We have added a figure (Figure 8) and a paragraph on this point to Sect. 4.2.

4)*Page 7 line 197: "deflected from the midlatitudes". Please clarify whether the waves are deflected toward higher or lower latitudes.*

We have revised the phrase as follows: "deflected from the midlatitudes to higher latitudes"

References:

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