

We thank the reviewers and editors for their constructive comments on our manuscript. The manuscript is revised thoroughly by considering all the comments. Besides, Figures 2, 4, 5, 6, 7, 9, 10, and 11 have been updated to make the results clearer. The reference format has also been updated. Our responses to every comment are listed below with blue.

Response to Anonymous Referee 1

1) There are too many grammar mistakes and some of the sentences are difficult to understand. I have list some of them in the detailed list. I did not list all the errors. The language need to be polished more.

The manuscript is polished by the EditSprings English editing service before the resubmission, and more detailed descriptions are added in the revision.

2) The figures are not explained well. Especially Figures 4-7 and 9-11, the i and j figures need to be better explained. I have a hard time following the discussion of these figures. More descriptions on the analysis results are added in the revision.

Specific comments:

Line 94-95, Further research by Palo et al. (2007). Also this sentence is confusing. Do you mean eastward Q2DW was produced by the nonlinear interaction?

Yes, that is correct. I have revised the following sentence in the manuscript to reflect this: " Beyond the knowledge about nonlinear interactions between migrating tides and Q2DWs (Palo et al., 1999), further investigation has confirmed that E2 Q2DW is coupled by nonlinear planetary wave and tides in the mesosphere and lower thermosphere (Palo et al., 2007)." Meanwhile, we need to explain that E2 generation may be caused by the nonlinear interactions of MLT region, or it may be caused by the instability of polar region. E2 occurs at different altitudes and latitudes in these two modes.

Line 113, This sentence is confusing. How can 'propagation height' be limited to high latitudes? Do you mean eastward waves are limited?

The text has been corrected as follows: "Lu et al. (2013) found that eastward planetary wave propagation is limited to the winter high latitudes probably because the negative refractive indices equatorward of $\sim 45^{\circ}\text{S}$ result in evanescent wave characteristics."

Figure 1, please specify what the white areas represent, missing data, data too small, etc., either in the caption or the text. Without this information, I can not follow the discussion involved these figures.

White areas in Figure 1 represent small signals (corresponds to the right color bar). This is made clear in the revision.

Line 215-216, First, please describe what are showed in Figure 3. Second, please specify why these latitude bands are chosen for these waves. I assume that these are where the peaks are found in Figure 2, but please state it clearly in the paper.

Figure 3 shows the span of period for every planetary wave mode. And the latitudes and altitudes chosen in Figure 3 are where the corresponding wave peak. These two

points are made clear in the revision.

Line 228-229, Please justify the statement ‘the PWs E1-E4 have similar phase speeds’ by, for instance, explaining how the phase speeds are calculated, and specifying what are values of the phase speeds.

The calculation of phase speed has been added in the revision. And the values of the phase speed are also clearly stated in the revision.

$$c = -v_0 \cos\left(\frac{\varphi\pi}{180}\right) / sT$$

where c is the phase speed; v_0 is the equatorial linear velocity; φ is the latitude; s is the zonal wavenumber and T is the wave period.

Line 230-232, Please explain more detailly what are shown in each figure of Figure 4. Specifically, what are ‘temperature structure’? From the context I can guess it’s the amplitude of the wave in temperature, but it should be clearly stated in the paper, instead of leaving it for the readers to figure out.

Temperature structure means the vertical and latitudinal distribution of the wave amplitude in temperature for the eastward waves. Every figure is stated more clearly in the revision.

Figures 4-8, and 9-11, Please explain what the filled colors in figures i and j are. Without this information, I can not follow the discussion associated with these figures.

Figure i and j are exhibited to show the propagation and amplification of every wave (below). The blue shaded region represent instability, and the red arrow represent EP flux. The green line represents critical layers. Regions enclosed by orange solid lines are characterized by the positive refractive index. More descriptions on the analysis results are added in the revision.

Technical comments.

Line 25-26: seasonal variations of the critical layers generated by the background wind
Revised in the revision.

Line 45: ‘The seasonal variations’ to ‘Seasonal variations’
Revised in the revision.

Line 54: ‘a maximum amplitude’ to ‘amplitudes’
Revised in the revision.

Line 58: ‘the W3’ to ‘W3’
Revised in the revision.

Line 59: delete ‘those of’
Revised in the revision.

Line 62: citation format needs correction, ‘the wave’ to ‘wave’
Revised in the revision.

Line 67: ‘confused’ to ‘indistinguishable’, ‘during the SSWs period’ to ‘during SSWs’
Revised in the revision.

Line 68-69: to 'Then periods of W3, W4 and W2 vary between, respectively'
Revised in the revision.

Line 71, Than the tropics?
No. W2 can be observed in global satellite datasets, showing weaker amplitude than W3 and W4 in the NH and SH. This is stated more clearly in the revision.

Line 72, 'dominated' to 'modulated'
Revised in the revision.

Line 76, 'the SSWs period' to 'the SSWs'. Revise all the terms in the manuscript
Revised in the revision.

Line 81, It should be 'planetary waves' or 'planetary wave activities'
Revised in the revision.

Line 82, change to ' with periods of nearly 2 and 4 days'
Revised in the revision.

Line 86-88, 'In addition, planetary waves ofhave been found to have the same phase speeds as...'
Revised in the revision.

Line 109, 'proposed' to 'found'
Revised in the revision.

Line 120, 'eastward propagation wave' to 'eastward propagating wave'
Revised in the revision.

Line 127, 'In Section 2, ...',
Revised in the revision.

Line 132, 'Section 3.3 compares and analyzes ..'
Revised in the revision.

Line 136, Any reasons for choosing these windows (i.e.,10, 6, 4, 4 days)?
We chose analysis windows that are ~2-3 times as long as the wave periods without other specific reasons.

Line 144, 'amplitude of wave (not wavenumber)'
Revised in the revision.

Line 170-176, These definitions of terms should be moved after Eq.2. Also when defining the terms of an equation with 'where', the first letter should not be capitalized, and it should not be a new paragraph (for example Line 182, 187)
Revised in the revision.

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Response to Anonymous Referee 2

Specific comments

Due to the extensivity and focus of the study, I would appreciate an adoption of Open Science approaches to allow reproduce the extensive analysis in this study (e.g. Laken, 2016). In particular, I would recommend any kind of willingness of the authors to publish the code allowing to reproduce the figures in the paper. There are multiple ways how to proceed, either to allow the access upon request or via portals allowing to assign Digital Object Identifier (DOI) to the research outputs, e.g. ZENODO. I think it could enhance the quality and reliability of this publication. In the end, this publication might be motivating for future middle atmosphere studies.

Code and data availability All the MATLAB codes and data used for analysis of this study are available at <http://hdl.pid21.cn/21.86116.7/04.99.01293>.

Authors should consider using a diverging colormap in Figure 2 to clearly differentiate between positive and negative values (Zeller and Rogers, 2020).

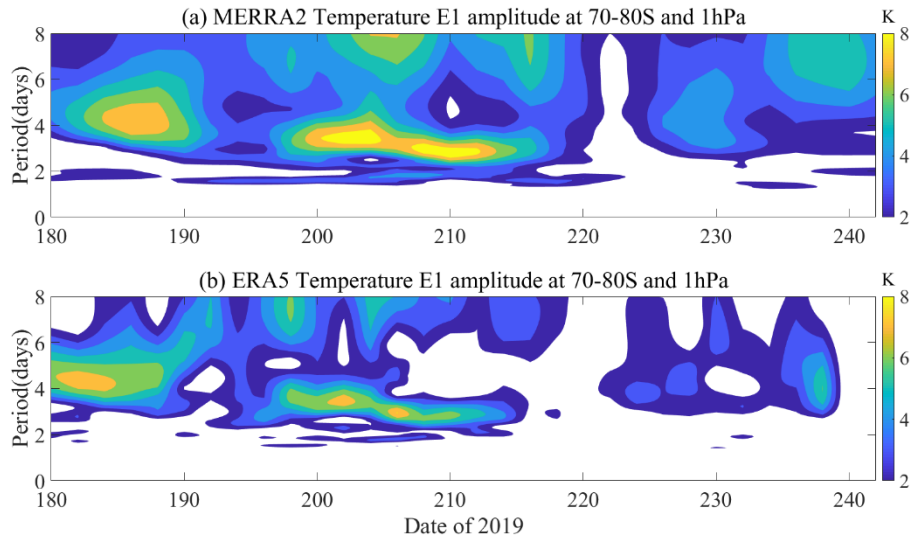
The eastward and westward winds are distinguished by dotted and solid lines, respectively.

To improve Figure 4 and its successors deserve improvements in terms of description and graphical representations of EP fluxes. The size of the arrows may need to be increased. Using vector figures instead of raster ones may help to differentiate details as well.

More descriptions on the analysis results are added in the revision. The red arrows for EP flux have also been redrawn.

Is there any reason why only one year was analysed? Would you expect any differences between reanalysis datasets in terms of your results? The same one-year analysis may be done based on the ERA5 reanalysis.

We present the E1, E2, E3 and E4 events in 2019 because the amplitudes and periods of these four events are typical. Different reanalysis datasets may cause differences for amplitude, because different reanalysis datasets (ERA5, etc.) are based on different data and algorithms, but the final results for our research should be similar. Thus the results do not change much even if ERA5 reanalysis data were applied to our study.



Technical comments

158 switch position of “long-term” and “observed”
 Revised in the revision.

References

- Laken, B. A. (2016). Can Open Science save us from a solar-driven monsoon? *Journal of Space Weather and Space Climate*, 6, A11. <http://doi.org/10.1051/swsc/2016005>
- Zeller, S., and D. Rogers (2020), Visualizing science: How color determines what we see, *Eos*, 101, <https://doi.org/10.1029/2020EO144330>. Published on 21 May 2020.