Responses to Anonymous Referee #2:

Comments from Referee:

In this paper, the authors introduced a new PDF (mPDF) for positive refractive indices as a function of zonal and meridional wavenumbers taking account of the fuzzy logic in order to assess the propagating property of planetary waves from the zonal-mean flow configuration. The correspondence to the meridional distribution of vertical component of EP flux is better for the obtained mPDF of the refractive index in comparison with the PDF derived by Li et al. (2007) taking account of only the sign of the refractive index. They also argued the dependence of the mPDF on the given meridional wavenumber of planetary waves. Hence, this paper proposed a valuable method to assess the propagating property of planetary waves and should eventually be published. However, there are some issues that need some minor clarification if the paper is to be read and understood by a wide audience.

Author's Response:

We would like to thank the referee for constructive comments that have lead to an improved manuscript.

Comments from Referee:

1. P. 32294, L. 14: Please clarify the definition of the meridional wavenumber. Specifically, how long is the meridional wave length corresponding to l=1 ?

Author's Response:

The zonal wavenumbers are defined as the number of wave cycles around a given latitude circle. The same definition method can be used for the meridional wavenumber. The wavenumbers (both meridional and zonal) can be calculated by the Fourier decomposition of geopotential height or streamfunction. An example of the length of an individual harmonic wave can be found in Wackter (1976). Table 1.1 of this research work shows the variation of wavelength with latitude for different zonal wavenumber. The same formula can be used to define the meridional wave length (except the meridional wave length does not depend on latitude). For l=1 the meridional wave length is approximately 40000 km.

Wackter, D., The Structure of Atmospheric Parameters in Wavenumber-Space, Colorado State University, 1976.

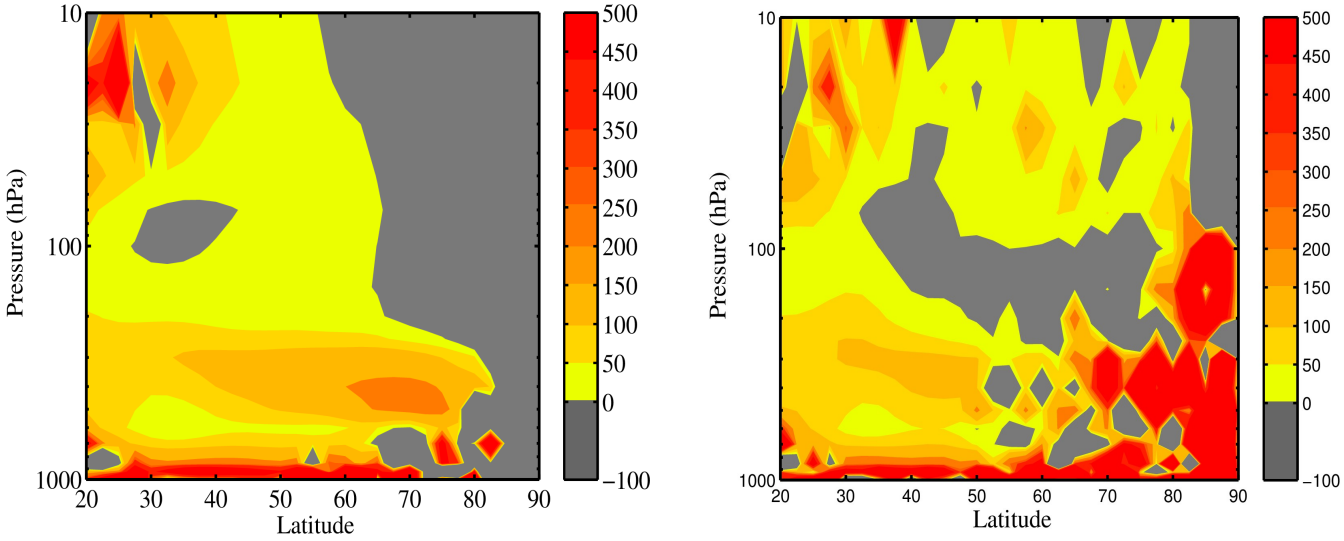
Comments from Referee:

2. P. 32294, L. 12: In this paper, the time mean refractive index squared (MRIS) is defined by the time average of the refractive index squared computed for the daily zonal-mean field. Hence, the meridional distribution of MRIS displays a noisy structure. However, if the refractive

index squared is computed for the time averaged zonal-mean field, it would have a well-defined structure in comparison with MRIS, and is more suitable to assess the propagating property of planetary waves. Please display the refractive index squared for the time averaged zonal-mean field, and argue the difference of its meridional structure from MRIS.

Author's Response:

On the left the time averaged zonal mean fields are used to calculate the refractive index squared (only for (k,l)=(1,1)). On the right the time mean of the rafractive index squared is shown. It is clear that the refractive index derived from the time averaged zonal mean fields has less noise than the time mean refractive index squared. We discuss this effect in more detail in the manuscript.



We added the figures and the following clarifying statements to the paper:

As shown in Fig. 2 and Fig. 3 the time mean refractive index has a noisy structure. One possibility to reduce the noise level is to calculate the refractive index of the time-mean zonal mean fields instead. However time-dependent Rossby waves propagate on the instantaneous atmospheric state and not on the time-averaged fields. Therefore we focus on an approach to reduce the level of noise in the time-averaged instantaneous refractive index.

Comments from Referee:

3. P. 32298, L.23 – P. 32299 L. 2: Fig. 5 shows that the planetary waves in the lower stratosphere just below 100 hPa easily propagate upward around the latitudinal bands from 50-70N. This is not well described by the meridional distribution of mPDF, which has a local minimum there as shown in Fig. 8 for (k,l)=(1,1). Moreover, mPDF has local maxima south of 40N and north of 80N. Please comment on this discrepancy.

Author's Response:

We added the following clarifying statements to the paper:

The maximum south of 40N at 100 hPa in the mPDF indicates that the region is favorable for wave propagation. In the same region, the vertical components of the EP fluxes have attenuated magnitudes. However as shown by Li et al (2007) the horizontal components of EP fluxes are large values in this region (Fig. 5 (e) in the study of Li et al (2007)). Since the current study concentrates only on the vertical wave propagation, not all aspects of the Fig. 5 can be directly compared with the Fig. 8.

Comments from Referee:

4. P. 32299, L. 25: I do not understand the logical connection of the sentence “and is not a function of the background zonal regime” with the previous sentence of “The critical strength depends on the scale of the wave”. What is the meaning of the “background zonal regime” ?

Author's Response:

The upward propagation of stationary planetary waves is possible when the mean zonal flow is positive and less than a critical value (Rossby critical velocity). The critical velocity does not depend on the mean zonal flow and is a function of the horizontal scale of the waves.

Comments from Referee:

5. P. 32300, L. 24: The authors insist that both WVR and SVR show similar patterns in comparison to the climatology (Fig. 8). However, there is no specific comment on this similarity. Please describe more specifically the similarity of both regimes to the climatology.

Author's Response:

In all cases (WVR, SVR and climatology) the most favorable propagation conditions are in the mid-latitude lower troposphere. In addition favorable conditions exist in the upper tropoosphere and lowermost stratosphere in the latitude region 20-40 N.

Comments from Referee:

6. P. 32302, L. 6 - L. 11: The authors insist that the newly developed diagnostic tool is capable of demonstrating the enhancing influence of positive vertical shear on the propagation of stationary Rossby waves from the troposphere to the stratosphere. However, I do not find any evidence in all the figures of this paper to support this conclusion. Please specify the evidence related to this conclusion.

Author's Response:

In Fig. 1(b) southward of 40N in the middle-lower stratosphere, the vertical shear of the mean zonal flow is negative and hence the theory suggests the impedence of the wave propagation. Fig. 4 is not consistent with this assumption while Fig. 8 shows that above 200 hPa south of 40N the probability of the wave propagation reduces significantly.

Referee's comment:

7. P. 32302 Conclusions: The authors should describe some implication for the better performance of mPDF in comparison with the PDF of Li et al. (2007) in Conclusion as follows: The better performance of the mPDF suggests that relatively small but positive numbers of the refractive index squared play an important role to offer an favorite propagating condition for planetary waves in the stratosphere.

The Authors response:

We have added the text as suggested by the referee.

Technical corrections:

Referee's comment:

1. P. 32290, L. 2: assess in a -> assess a

The Authors response:

It is now changed accordingly.

Referee's comment:

2. P. 32290, L. 2: framework the -> framework of the

The Authors response:

It is now changed accordingly.

Referee's comment:

3. P. 32293, L.26: Kalnay et al. (1996) -> (Kalnay et al. 1996)

4. P. 32294, L. 6: Andrews et al. (1987) -> (Andrews et al. 1987)

The Authors response:

It is now changed accordingly.

Referee's comment:

5. P. 32296, L. 7: refracted -> reflected?

The Authors response:

Refracted is an appropriate word in this sentence.

Referee's comment:

6. P. 32296, L. 20: MVF -> Membership Value Function (MVF). Please do not use an

abbreviation without the original unabbreviated term.

The Authors response:

It is now changed accordingly.

Referee's comment:

7. P. 32297, L.5: suggest -> suggests

The Authors response:

It is now changed accordingly.

Referee's comment:

8. P. 32299, L. 12: places which are -> places, which is?

The Authors response:

It is now changed accordingly.

Referee's comment:

9. P. 32299, L. 18, L. 19: The high value of mPDF does not necessarity correspond to a favorable condition of the upward propagation for planetary waves. It suggests a favorable condition for the propagation of planetary waves including the meridional direction.

The Authors response:

It is a correct point. The word upward is removed from P. 32299, L. 18, L. 19.

Referee's comment:

10. P. 32299, L. 29: “(3.3)” should be “(2,3)”?

The Authors response:

(3,3) is now changed to (2,3).

Referee's comment:

11. P. 32300, L. 4: “latitude” should be “altitudinal”?

The Authors response:

The word latitude is correct.

Referee's comment:

12. P. 32300, L. 5: “(3.3)” should be “(2,3)”?

The Authors response:

(3,3) is now changed to (2,3).

Referee's comment:

13. P. 32300, L. 15: SVR -> Strong Vortex Regime (SVR)

14. P. 32300, L. 15: WVR -> Weak Vortex Regime (WVR)

The Authors response:

It is now changed accordingly.

Referee's comment:

15. P. 32301, L. 6: “are found” -> “are found for WVR”?

The Authors response:

It is now changed accordingly.

Referee's comment:

16. P. 32301, L. 16: “this analyses” -> “these analyses”

The Authors response:

It is now changed accordingly.

Referee's comment:

17. P. 32301, L. 17: “wave-mean flow interaction” should be “propagating property of planetary waves”

The Authors response:

It is now changed accordingly.

Referee's comment:

18. P. 32302, L. 14: Please delete “therefore”.

The Authors response:

It is now deleted.

Referee's comment:

19. P. 32302, Eq. (A1): The denominator of the right hand side term should be “n”.

The Authors response:

The variable t is the time step and in the current study the daily mean values of the temperature and zonal wind are used in the calculations. Therefore the variable t is correct.