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Atmos. Chem. Phys. Discuss., referee comment RC3
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Comment on acp-2021-160

Anonymous Referee #3

Referee comment on "Propagation paths and source distributions of resolved gravity waves in ECMWF-IFS analysis fields around the southern polar night jet" by Cornelia Strube et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-160-RC3, 2021

REVIEW OF Strube et al.: Propagation paths... (ACP160)

** Summary

The authors study the propagation of gravity waves in ECMWF-IFS analyses for an event (31 July / 01 August 2014) during the DEEPWAVE campaign. They apply established methods and concepts. I am missing a dedicated discussion of achievements with respect to former publications. Further, the appendix needs thorough correction. Thats why I recommend major revision.

** Major ccomments

Paramount importance: In line 496 ff you write about the "paramount importance of the relative wave direction for the distance..." in contrast to the wave-refraction effects. Do you mean those waves in Fig. 8 which travel more than 4000 km which are opposite to the wind? This needs to be elaborated and made more pronounced.

Long waves: You show long waves travel long - as may be verified with the ratio of horizontal and vertical group velocities. Jiang et al. (2019) show similar effects as well as Ehard et al. (2017). This needs to be included in the discussion. Are these long-travelling waves the "paramount" waves oriented against the wind?

Mountain-wave directions: In the appendix you show that ground-based (apparent) group

velocity is perpendicular to the wavenumber vector respectively parallel to the phase lines (or the mountain ridge). Can this detail be used to interprete the wave propagation? What was your intention to show Fig. A1 when you do not refer to it in the main text?

225 Degree: What is the reason for the major wave orientation seen in Fig. 9? It is not apparent in Jiang et al. (2019), but is also present in Ehard et al. (2017). They argue it is a refraction effect. Please, dicuss this issue.

Appendix: This part of the paper has to be rewritten because it contains a number of mistakes. For example, equation (A1) is wrong because phase velocity is the ratio of frequency and wavenumber and it is NOT parallel to the wavenumber vector (k, l). In the text, you write in line 595 that the phase and group veocity are equal but you do not give a dispersion relation. For mid-frequency waves with

$$\hat{\omega} = N k_h / m$$

it is definitely NOT. While eq. (A2,A3) is formally correct for such waves, it might be easily extended for arbitrary wavenumbers (k, l) and winds (u, v). Also figure A1 needs revision: there should be intrinsic (flow-relative) group velocity instead of "horizontal phase speed vector" because the vector addition is fo the group velocity. Further, I suggest to extend the consideration with a decomposition of the group velocity in a component parallel and perpendicular to the wavenumber.

** Technical comments

Abstract: Please, specify the event you analyzed.

L201: Do you refer to Fig. 2b? Please, specify.

L207: May be, "localized" or "confined" is a better word than "restricted"?

L318: "through" --> "of"

L321 (Eq. 6): The formula is corrupted - please, indicate the time derivatives correctly - either with "\partial" or subscripts.

L546: You write "apparent contradiction" while you refer to different situations. I suggest to write "There are different situations..." or "There is not a universal picture..."

Fig. 4: Please, change positions of "Right column: ..." and "Left column: ..."

** References

Ehard, B., B. Kaifler, A. Dörnbrack, P. Preusse, S. D. Eckermann, M. Bramberger, S. Gisinger, N. Kaifler, B. Liley, J. Wagner & M. Rapp, 2017: Horizontal propagation of large-amplitude mountain waves into the polar night jet. J. Geophys. Res. Atmos. 122, 3: 1423-1436, doi:10.1002/2016jd025621.

Jiang, Q., J. D. Doyle, S. D. Eckermann & B. P. Williams, 2019: Stratospheric Trailing Gravity Waves from New Zealand. J. Atmos. Sci. 76, 6: 1565-1586, doi:10.1175/jas-d-18-0290.1.