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Comment on acp-2020-1289

Anonymous Referee #2

Referee comment on "Orographically induced spontaneous imbalance within the jet causing a large-scale gravity wave event" by Markus Geldenhuys et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2020-1289-RC2, 2021

The manuscript describes a case study of a low-frequency gravity wave observed in the upper troposphere, lower stratosphere
with an innovative airborne instrument, GLORIA. The analysis of the wave and its context from observations, reanalyses and ray-tracing is
complemented by a couple of numerical simulations which demonstrate the key but indirect role of orography in the generation of the waves. The evolution of the jet differs slightly when the orography of Greenland is smoothed, and the imbalance which generatees the waves is no longer present, or no longer sufficient to generate large amplitude inertia-gravity waves. This constitutes a very interesting, well-written and well-argued study, illustrating the complexity of the sources of gravity waves. There is one suggestion, below, which the authors may consider, and a number of minor points to improve the presentation. Once these points are taken into account, I recommend publication.

Major point

The authors have access in the simulations to all variables. The wave they are describing is a low frequency wave, as discussed for instance in the comments of the hodograph. A very good variable for capturing the signature and life cycle of this wave in the simulations would be the divergence of the horizontal velocity field. The signature of balanced motions is weak in this field, and waves with short vertical wavelengths come out conspicuously. The investigation of the divergence could in particular bring insights on the generation of the wave
(in complement to the ray-tracing), and also importantly on whether traces of an analogous wave are present in the T21 run.

Minor points

l26 Earths -> Earth's

l30 for fronts, rather than a reference to a study of the parameterization of waves from fronts, reference to a study or to studies of the process itself, ie of emission by fronts, would be more appropriate. Here are some suggestions

l50-56: De la Camara et al 2016 also obtained improvements after modifications of their NOGWD scheme. It is mentionned at the end of Garcia et al 2017 that the improvement can be obtained by enhancing the NOGD too.

l76: is the acronym PGGS explained somewhere? Is there a reference describing it?

l113-115: does the irregular grid have disadvantages? It is indicated that it allows to reduce the computation time. How important is this? Naively, one imagines that such calculation is done just once, so that computational expensiveness may be secondary, so long as it remains within reasonable bounds.

l113-115: It is pointed out that this is the very first irregular grid retrieval. Is it possibel to quantify error bounds relative to the retrieval used usually?

Some of uncertainties are discussed in lines 122-125; this is interesting. Perhaps a figure illustrating the sensitivity of retrievals to different choices could be shown in an appendix or as a supplementary material, so the interested reader may have an idea of the more robust features and the less reliable features of the retrieval.

l138: 'groundbased is too long for a subscript; a suggestion would be to write ω_{gd} and explain in the text that this corresponds to 'ground-based'.

l138 Place the footnote after the word 'density' rather than after the parentheses which contains a mathematical formulation; there is no ambiguity because it would not really make sense to consider the fifth power of the expression... but still, it would be simpler to have the footnote after a word.

l139: 'taken into account': given the uncertainties on the damping due to turbulence or to the dissipation of waves in general, it would be worthwhile describing the assumptions used to account for these processes. Sensitivity to the choices made there could also be welcome, when results are presented.

l142: what other indications of potential sources are there? Reaching the ground... For waves emanating from couvective regions, is the WKB condition violated?

l163: it would be useful to include a standard reference on the Savitsky-Golay filter, even if it seems classical.

l173: the footnote is not well placed

l182-183: 'the divergence of the jet': what exactly does this designate? This is ambiguous.

l190: the waves observed have a wavelength ~2 km. Should this read 'wavelengths < 4km'rather than '> 4km'? The following sentence causes confusion.

l219: 'despite the expected increase': on such short vertical scales the increase is not expected to appear clearly, relative to all other causes of variation; the observations do not scan a range much larger than the vertical wavelength...

l224-225: could this assertion be more physically justified? What foes this criterion correspond to, and what are the other possible causes?

l275: the beginning of the section could use a sentence of paragraph explaining the purpose of the simulations.

Figure 11: more informative than the wind barbs given that the panels are small and that only a limited number of wind barbs can fit, the authors should consider plotting geopotential; the pressure level to which this corresponds should be indicated in the caption.

About the summary: the summary is a bit abrupt, and acronyms (GLORIA, GROGRAT) are used directly. It depends on the editorial instructions, but it may be worth reintroducing them for hasty readers.

l367: the horizontal phase speed is an important quantity, and the range given is very wide. The uncertainty in the estimate of this important quantity is worth a comment.

l372-373: this is an important issue currently; reference to previous work highlighting this issue would be relevant, eg Sato et al (2012)

l380: 'For coherency'? Perhaps state explicitly the goal of the simulations, the hypothesis that is tested with these simulations.

l392: 'the jet, which depends heavily on the orography': the formulation is ambiguous... the dynamic of the jet is influenced by the orography?

references

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