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Interactive comment on "First tomographic observations of gravity waves by the infrared limb imager GLORIA" *by* Isabell Krisch et al.

Anonymous Referee #3

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This paper reports on first measurements obtained with a novel observation technique: limb imaging. This technique is applied here to obtain unprecedented observations of gravity waves in the lower stratosphere during one winter flight of the airborne GLORIA instrument above Iceland. The limb imaging technique and the associated tomographic retrieval allows the authors to provide for the first time an observational 3D view of a mountain wave packet over an extended mountain ridge, as well as to fully characterize the wave packet in terms of amplitude, horizontal and vertical wavelengths, as well as momentum flux.
The precise characterization of the gravity-wave packet enabled by GLORIA is further used to identify the wave source and to trace its forward propagation in the stratosphere, which convincingly underlines the significance of oblique wave propagation in

the atmosphere, a common defficiency of current gravity-wave drag parameterizations.

This article therefore provides a very clear demonstration of limb imaging capabilities for gravity-wave studies, and I support its publication with only minor revisions, which are detailed hereinunder.

Minor comments

- p4, l5: Could you be more specific here regarding the "regularization term" or provide a reference where the use of this term is better detailed?
- p4, l7: Similarly, could you be more specific on the smoothing you are using in the raw ECMWF fields?
- Section 2.2
  - Could you please state the airplane altitude during GLORIA measurements?
  - One primary goal of the article is to show how GLORIA observations can be used to accurately retrieve gravity-wave fluctuations. I am therefore surprised that you did not try to show comparisons between the retrieved 3D temperature field and in-situ observations performed by the airplane before the hexagonal path or with the dropsonde measurements, as well as with the resolved gravity-wave structures in the ECMWF analyses. In my opinion, such comparison should further support the capabilities of GLORIA, and perhaps also provide an additional way of characterizing the instrument performances.
- p7, l10: It may be worth stating that Equation (2) actually only applies in the so-called mid-frequency approximation, where "pseudo-momentum" and "momen-

tum fluxes" are stricly equivalent. Otherwise, the sentence here may be slightly confusing.
I furthermore wonder whether this approximation is really valid in this case study. The ratio of horizontal/vertical wavelengths seems to imply relatively long waves, for which inertial effects in Equation (2) could not be totally neglected.

- Section 3.1, last paragraph: this comparison looks somewhat biased to me: if I have well understood, the GWMF for the Iceland case study are in one hand estimated from GLORIA observations, while in the other hand they are compared to a distribution of GWMF computed with ECMWF operational analyses. There is actually no garanty that ECMWF analyses accurately resolve such mountain wave events, and e.g. Jewtoukoff et al. (2015) have reported a significant underestimation of GWMF in ECMWF operational analyses.

References

Jewtoukoff, V., A. Hertzog, R. Plougonven, A. de la Camara, and F. Lott, Comparison of gravity waves in the southern hemisphere derived from balloon observations and the ECMWF analyses, *J. Atmos. Sci.*, **72**, 3449-3468, 2015.

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