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Discussions

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

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Dear Mr Christensen,

Thank you very much for these very helpful comments!

According to comment #1 we will include details on the smoothing filter used for the generation of the a-priori field as well as on the calculation of the occurrence probability (comment #3). Comment #2 is a valuable hint and we will change the determination of the resolution. Instead of the sphere in the horizontal and the FWHM of the row of the averaging kernel in the vertical, we will now use a 3D ellipsoid to

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estimate the resolutions in horizontal and vertical simultaneously. This new technique will account for the diagonal elements of the AVK matrix. However, applying the new method does not change the resulting resolution values. In the appendix we will clarify the sentence mentioned in comment #4.

A detailed list of all changes regarding these comments can be found below.

Again, thank you very much for helping us to present the theoretical background accurately and for improving the discussion and interpretation of results.

Sincerely, Isabell Krisch

Reviewer comment: What smoothing filter was used (type and fwhm) for the a-priori field generation?
Authors response: More details will be included in the text.
Text changes: This smoothing was done by applying a low-pass Fourier filter with cut-off wavenumber 18 in zonal direction. In height and latitude direction Savitzky-Golay (SG) filter (Savitzky and Golay, 1964) was applied with 4th order polynomials over 11 and 25 neighbouring points respectively. On the one hand, the so generated a-priori field improves the convergence speed of the iterative minimization, as this temperature structure is close to the true values due to the high quality of the ECMWF model. On the other hand, the smoothening ensures that any GW signature in the retrieval result does not stem from the used a priori data. If the a-priori data exerts any influence, it would dampen the GW structure.

Reviewer comment: Are you simply looking at the elements in the row of the AVK matrix corresponding to the grid points directly above the grid-point of the row, or are you collapsing (i.e. performing a summation) the two other dimensions (x,y) before this FWHM is calculated? If the first approach is used, some description of the elements located diagonally above and below the grid-point should be included, as these can (in principle at least) indicate information leakage from higher altitudes that the elements directly above.

Authors response: The determination technique for the resolution will be changed to a 3D ellipsoidal fit to include diagonal matrix elements. However, applying the new method, does not change the resulting resolution values.

Text changes: The horizontal and vertical resolutions can be defined by the axes of the smallest ellipsoid containing all elements of the averaging kernel larger than half the maximum. Accordingly, in the middle of the performed hexagonal flight path, the vertical resolution is around 200 m, the horizontal resolution around 20 km.

Reviewer comment: How are the GW located in the ECMWF data and how are the occurrence frequencies calculated? a bit more details on how this was done would be good to include.

Authors response: We will include the details on how the occurrence probabilities are determined in the manuscript.

Text changes: To classify this event, a comparison of all GW events in January 2016 has been performed in the 6-hourly operational analyses of ECMWF. First the temperature background was isolated, as described in Sec. 2.1 for the a-priori field, and subtracted from the original field. The remaining temperature residuals were analyzed for GWs using the 3D sinusoidal fit algorithm described above. The GWMFs for all cubes were calculated. The GWMFs from all 124 analyses fields were combined to obtain the probability of GW occurrence (Fig. 6*, former Fig. 5*). Here, all GWMF values were considered independent of the horizontal and vertical wavelengths. Removing wavelengths larger than 2.5 times the cube size in order to filter less significant fits (not shown) induced no major changes in the general shape

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of the distribution. This indicates that GW events with less certain fits do not bias the probability distribution. For the GW event over Iceland similar GWMF magnitudes were determined from the ECMWF analyses and from the GLORIA measurements. Thus, a comparison of the measurement results with the occurrence probability determined from the ECMWF analyses seems reasonable. According to Fig. 6 the measured GW event can be classified as a very strong case since the sum of all occurrence probabilities of stronger events is far below 1%.

Reviewer comment: What is meant by full height range of the S3D fitting volume? Does it refer to each individual fitting volume i.e. 160 km x 160 km x 3.6 km?
Authors response: The sentence will be restructured to clarify this point.
Text changes: In Fig. A1 left column the instantaneous value $\xi_{z=11.5}$ of the ray at the middle point of each fitting volume is compared to an average $\bar{\xi}$ of all values of the ray in the height range of the respective S3D fitting volume (comparable to the S3D fitting result).

References

Savitzky, A. and Golay, M. J. E.: Smoothing and Differentiation of Data by Simplified Least Squares Procedures., Analytical Chemistry, 36, 1627–1639, doi:10.1021/ac60214a047, http://dx.doi.org/10.1021/ac60214a047, 1964.

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