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Atmospheric Measurement Techniques Discussions

Interactive comment on "New perspectives on gravity wave remote sensing by spaceborne infrared limb imaging" *by* P. Preusse et al.

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We want to thank the reviewer for pointing out statements which need clarification. Please find our response to these points below, the technical corrections will be applied as suggested. The reviewer comment is highlighted in bold face, text alterations for the manuscript is given in italics.

p827, l6: Although I think I have understood it, the sentence is not very clear and should be rephrased.

We have reformulated the sentence:

Preusse et al. (2008) discuss which horizontal and vertical wavelengths of GWs are

important for driving the middle atmosphere. They also show the sub-ranges of this wavelength regime covered by the different spaceborne measurement techniques and review our current current knowledge of the relative importance of these sub-ranges.

p832, l6: I do not totally agree with the fact that GWs are primarily zonally propagating: for instance, convective sources that are expected to be very important in the tropics (and for which an ILI could provide very useful observations) tend to produce waves propagating in an almost isotropic way out of the clouds.

Convective wave sources are almost isotropic. However, wind shear between troposphere and stratosphere causes an anisotropy of the wave propagation direction in the stratosphere. This has been investigated in detail e.g. for typhoon generated gravity waves by S-Y Kim and coworkers for typhoon Ewinar (cf. her presentation at the AOGS conference 2008). In order to gain more statistical insight on this effect we have performed a ray-tracing experiment with isotropic launch into 256 equispaced launch directions. The launch spectrum, background atmosphere, etc. follow the set-up from Preusse et al. (2009). Despite the isotropic launch, we find a strong preference for zonal propagation in the winter polar jet and the summer subtropical jet. Only for the lower stratosphere at summer mid and high latitudes (above the wind reversal between tropospheric westerlies and stratospheric easterlies) a preference for meridional propagation is observed.

The statement is made to show that we have not picked an untypical case with untypical large effects. We have tried to further weaken by introducing "frequently": *However, the orientation shown is a rather typical one since preferentially zonal winds frequently result in a preferential south-to-north alignment of the wave fronts.*

- l16: I would like further precisions on the sensitivity diagram shown in Figure 2a: is it obtained by assuming a wave direction of propagation (as in the example) or is it obtained with a set of randomly oriented waves ? More generally, the authors should stress whether the wave orientation with respect to the

instrument LOS is an important factor in the instrument observational filter.

Thank you for the comment. This is an important point to clarify. The sensitivity diagram is estimated from full radiative transfer and retrieval simulations of entire profiles. They are determined for monochromatic waves in a 2D (altitude, along LOS) geometry and therefore the diagrams show the sensitivity for horizontal wavelengths along the direction of the LOS. For a wave which propagates into a different direction than the LOS, the projection onto the LOS causes a longer wavelength along LOS (cf. Preusse et al., 2002). Thus, for waves propagating into different directions the sensitivity limit actually shifts to shorter wavelengths of the atmospheric GWs. As long as we assume plane waves this can be calculated by simple geometric considerations. In case of convectively generated waves which have arc-shaped wave fronts realistic simulations have to be carried out. This will be done in future studies but exceeds the frame of the current paper.

Please note that we have introduced a new Figure 1, so Figure 2 in the discussion-manuscript is now Figure 3.

The sensitivity function is based on full radiative-transfer and retrieval simulations of monochromatic waves. The horizontal wavelength given is the wavelength projected on the line of sight $\lambda_{h,S}$, which is equal to or longer than the true atmospheric wavelength $\lambda_{h,GW}$ of the GW. For approximately plane wave fronts (as in Fig. 3) they are related by the angle α between horizontal wave vector and LOS:

$$\lambda_{h,S} = \lambda_{h,GW}/cos(\alpha) \quad (1)$$

- p833, l5: I have the same question than above on this sensitivity diagram.

The second diagram is also calculated for two-dimensional, monochromatic waves.

- l11 and 12: Can one really always estimate the horizontal wavelength from the across-track dimension ? For instance, what happens if: - the wave direction of propagation is parallel to the satellite track ? - the wave direction of propagation is perpendicular to the satellite track, but the horizontal wavelength is significantly longer than 320 km (the width of the across-track image) ? How do these cases impact the ILI sensitivity diagram ?

The sensitivity diagram shows only the observational filter due to radiative transfer and retrieval. If a wave is in the observable range, we will be able to analyze the vertical wave structure and phase from the vertical profiles. This can be used to estimate the horizontal wavelength also for waves with larger horizontal wavelength than the width of the image. For instance, a phase-difference method has been used by Ern et al. (2004) to estimate the horizontal wavelengths of GWs from profile pairs. The tropical distribution is consistent with scaling up to much longer horizontal wavelength than the profile distance. The zonal distribution of average horizontal wavelengths inferred in this way follows ω/f =1.4 (Preusse et al., 2006). Given the new quality of the imager data these methods can be further improved. It should be noted in this context that the momentum flux is inversely proportional to the horizontal wavelength. Inaccuracies for long horizontal waves are therefore less important.

- p844, l6-9: This is not really true: Hertzog et al. 2008 for instance used a wavelet analysis technique to identify the wave packets, and did not only extract the most significant wave.

This was meant in contrast to wave-spectra. In addition, though several waves may occur during one balloon flight, the technique is pushed to its limits when two or more waves occur simultaneously (cf. Figure 8 of Boccara et al., 2008). We have reformulated this sentence:

Accordingly, the separation of GWs from the background and their further analysis involves to describe the wind perturbations as a superposition of a few monochromatic *waves.*

Interactive comment on Atmos. Meas. Tech. Discuss., 2, 825, 2009.