Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., referee comment RC1
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Comment on amt-2021-93

Anonymous Referee #1

Referee comment on "Using vertical phase differences to better resolve 3D gravity wave structure" by Corwin J. Wright et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-93-RC1, 2021

The authors of "Using Vertical Phase Differences to Better Resolve 3D Gravity Wave Structure" present an improved analysis algorithm applied to AIRS data analyzed for stratospheric gravity waves that affects the retrieval of vertical wavelength. Compared to 3-d Stockwell transforms previously developed by the authors, the resolution of the vertical wavelength is improved by the new method, with the greatest improvement for larger wavelengths. The new method relies on analysis of phase differences between vertical levels, and thus represents a clever and data-based interpolation technique. It is very well presented and explained, extensively validated for test cases and the superiority and science gain is showcased for three different types of real-world gravity waves. The presentation and figures are extensive and high-quality.

The task is challenging, as very few independent measurement points in the vertical are available, and the new methods main advantage is for long wavelengths. However, the GW spectrum of vertical wavelengths extends well below 10 km, and the limitation of the instrument to wavelengths above 10 km cannot be overcome by data analysis. It could however be acknowledged that this limitation still holds, and that other remote-sensing techniques exist that indeed yield much higher vertical resolution (the statement in p. 2, l. 32).

Your focus is entirely on gravity waves, with a tendency to "extremely vertically long waves" (p. 1, l. 13). Can you comment on the discrimination of other types of waves like planetary waves and tides in AIRS data, are these of no relevance, or is there danger of confusion? On the same note, you state that GW with 70 km vertical wavelength transport significant moentum to the upper atmosphere (p. 1, l. 18), but don't add a citation. In lidar analysis, GW vertical wavelenghts are often only analyzed below 20 km vertical wavelength (to avoid named confusion with tides and planetary waves) and the majority of gravity waves observed has 5-15 km vertical wavelengths.

When you sketched your algorithm (p. 6, l. 117), I wondered if the presence of monochromatic waves is a requirement. Would it give meaningful results in more complex environments, like a superposition of waves with different wavelengths, or is it required that it is indeed one and the same wave contained in both levels? And is this the usual case in AIRS data, or do you usually see more complex patterns than the examples selected?

Have you considered comparing the three cases to reanalysis data, e.g. ERA5? Your method incorporates smoothing in the vertical, and I wonder if there is substantial variation in the vertical that is not resolved by AIRS and your method, and what it means for the interpretation of your results.

You stress the applicability of the method to other types of datasets with similar scale relations - besides the atmosphere, can you think of an example? (p. 3, l. 49)

In p. 5, Fig 2 you said the level-to-level spacing is 3 km, but you show 7 km-space levels in the figure, which is not a multiple?

In p. 5, l. 210 you mean that there is, although you have corrected the retrieved amplitude (as stated in l. 163), still a factor 2.5 is missing? You gave a number of reasons, but it still seems large?

Maybe you can reformulate the sentence in p. 4, l. 90, e.g. what do you mean by "discrete orthonormal approach". The sentence just wasn't very clear to me.

Technical corrections:

p. 1, l. 1 "Atmospheric gravity waves… are a dynamical process" - I am not a native speaker, is it correct to say that a wave is a process? I would rather say that i.e. the transport of momentum or the breaking of a wave is a process.

p. 2, Fig. 1 please add the information that perturbations in temperature are shown (I know, it is obvious, and it says "K", but still, for the readers that are not too familiar with gravity waves)

p. 3, l. 55, "hgh" -> "high"

p. 5, Fig. 2 "The left column shows three…"

p. 7, l. 150 please give numbers for the step (2 x 3 = 6 km?, or 2 x 7 = 14 km?), for the minimum vertical wavelength resolved, and the actual vertical resolution

p. 8, l. 186 "using one granule or another"?

p. 8, l. 187 "the median value" do you mean the median value of retrieved vertical wavelength?

p. 9, Fig. 4 add commas and "and" in "wave amplitude T', (g-l) vertical wavelength lambda_z, (m-r)…, and (s-x)…", same in p. 12, Fig. 6

p. 11 l. 241 "case that is"?

p. 11, l. 246 please check this sentence again, what are "non-input fields", can't you omit "data" in "< 2.7 K data"

p. 12, Fig. 6 caption: "box-car smoothed by 3 voxels": in the text it was 5x5 voxels?

p. 17, l. 355, "almost"

p. 18, l. 382 "3SDST" -> "3DST"