Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., referee comment RC2
https://doi.org/10.5194/amt-2021-134-RC2, 2021


# Comment on amt-2021-134

Anonymous Referee #2

Referee comment on "Gravity wave instability structures and turbulence from more than 1.5 years of OH* airglow imager observations in Slovenia" by René Sedlak et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-134-RC2, 2021

General comments:

This paper deals with the analysis of wave and vortex signatures in ground-based OH Meinel emission imaging measurements from a central European site. The OH imager used has a high spatial resolution with a pixel width of about 24 m. Wave characteristics are extracted using a 2D-FFT. Eddy diffusion coefficients and energy dissipation rates are calculated from individual rotating vortices based on a concept by Prölss. In my opinion the manuscript is of interest to the scientific community and should eventually be published. I do have, however, several general and specific comment that I ask the authors to consider.

The general comments are:

- I have some concerns about the concept of Prölss (see also the specific comments at the end). The idea is that the mixing occurs at time scales of half a rotation of the cylinder. This time directly affects the derived eddy diffusion coefficient. However, the rotation will not be over after half a rotation but will continue and the vortex will disintegrate into smaller vortices etc. It may well by that the assumption that the mixing occurs at time scales of half a rotation leads to a systematic underestimation of the effective mixing time and hence to an overestimation of the eddy diffusion coefficients. This may also explain why your values of K are systematically larger than

the literature values cited.

- Please show a sample 2-D FFT spectrum.

Specific comments:

Line 37: “Furthermore, gravity wave generation is not restricted to the ground”

Perhaps it’s better to write “not restricted to the troposphere”, as many GWs propagating to the middle atmosphere are not excited at the ground.

Line 68: “These include ..”

What does "these" refer to? I think it refers to "remote sensing measurements" two sentences before this one? Please rephrase or change order of sentences.

Line 74: “Proceedings”

I think this is not the most suitable word here. Do you mean “improvements” or “progress”?

Line 104: “automatic measurements with focus on the OH* airglow”

What does this mean (i.e. “with focus on”)? Has a filter been used to remove the O2 singlet delta emission?

Lines 103, 264, 279 and several others: Please add comma before “e.g.” (in AE also behind it)

Line 124: “Due to the small FOV of FAIM 3 we renounce the application of a star removal algorithm”

Please comment briefly on the effect of stars on the results.

Line 128: “A fitted linear intensity gradient”

This fitting is done before the FFT, right?

Line 136: “Wave structures with horizontal wavelengths of half the FOV size still showed a strong bias toward phases 0 or pi”

Is there a simple reason for this behavior for long wavelengths?

Line 166: “Ca. 63 % of the observed wave events have a period longer than the respective BV period and will be referred to as gravity wave events in the following.”

What about the remaining signatures? What are they? Probably Doppler-shifted GWs?

Line 168: here you distinguish between waves and gravity waves. See my previous comment.

Line 184: “Unless the rotational axis is aligned perpendicular to the image plane, the three-dimensional vortex rotation manifests as more than one coherent structure that is moving against or overtaking each other”

I read this sentence several times, but didn’t really understand it. The grammar (singular/plural) is also not fully correct (“that is moving against or overtaking each other”).

Line 207: “The circumferential velocity is determined by reading the distance a patch on the rotating cylinder surface covers within an episode of at least ten images”

I guess the resulting velocity also depends on where on the cylinder the patch is relative to the observer. A patch appearing on one side of the cylinder will have a lower apparent speed as a patch viewed a quarter of a cycle later. Is this geometric effect considered?

Line 239: “a reduced aperture angle of 6.2 FWHM”

I don’t fully understand this statement. Is something missing here? Perhaps a degree sign?

Page 8, last paragraph: If understand correctly, then completely different spatial scales are compared here, right? Several hundred km (spectrometer) vs. a few km (FAIM). Perhaps this can/should be mentioned explicitly.

Line 252: “The directions of propagation are quite uniformly distributed over all quadrants as can be seen in Figure 2.”

Well, looking at the figure, I disagree.

Line 293: “In principal” -> “In principle”

Line 309: “The here-presented values of K exhibit a magnitude of 10^3 – 10^4 m²s^-1, which partly agrees with recent results, although some of our values are higher.”

Your values are 2 orders of magnitude larger than the ones published by Lübken. This is quite a large difference. The Liu values are an order of magnitude smaller. Potential reasons should be discussed.

Regarding the Prölss-concept to derive K: I'm not sure, whether this concept applicable to measurements capturing the rotating structures at different stages of the evolution of the structures? The cascade will go from a large eddy to many smaller eddies and I'm not sure what effect is makes, if the structure is analyzed at different times?

Line 330: "Given that our analyzed episodes are typical representatives of turbulent wave breaking, dynamical heating by gravity wave dissipation would deliver the same effect within few minutes as does chemical heating during an entire day."

One should keep in mind that the chemical heating is quasi-global and not intermittent in space and time, whereas the dynamical heating is probably quite local. The heating rates only apply to the air volumes affected by the turbulent motion. It would be interesting to estimate what fraction of the global MLT region experiences events (and how many) on a given day.

Line 393: "We find an isotropic distribution of directions of propagation"

Looking at the figures, it is not really isotropic, is it?

Line 347: "and agree mostly with earlier results from rocket and lidar measurements and simulations."

I disagree. The Lübken values are 2 orders of magnitude smaller (rocket) and the cited lidar values one order of magnitude. Please revise this statement.

Appendix A: I checked the derivation and it seems to be OK. But I have one general question: The model assumes that the mixing occurs on time scales of one half rotation. However, the rotation will go on and after one full cycle the original state is reached again (assuming a rigid cylinder). And this will go on several more cycles until the vortex disintegrates to smaller vortices. In reality this is of course much more difficult, but I think the model may underestimate the effective mixing time and hence overestimate the turbulent diffusion coefficient. Perhaps this is the reason why your estimates are larger than the other ones?

And a minor comment on the appendix: The term “side gas” is quite unusual and I don’t know what it means to be honest. Is this a problem with the translation from German? I suggest to use another term.