

Atmos. Chem. Phys. Discuss., referee comment RC2
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Comment on acp-2022-572

Anonymous Referee #1

Referee comment on "Signatures of gravity wave-induced instabilities in balloon lidar soundings of polar mesospheric clouds" by Natalie Kaifler et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-572-RC2>, 2022

The paper presents high quality Rayleigh lidar measurements of the PMC during a high latitude balloon mission. The work reveals vast variations of the PMC and their implications of highly active small-scale dynamic activities in the mesosphere at high latitudes. The results of the PMC gradients in vertical and temporal dimensions, including the categorization of the PMCs, provide more ammunition to tackle the complex gravity wave dynamic topics. The description and figures are reasonably clear and clean, although there are some parts in the manuscript need to be clarified. My recommendation is accepted but with minor revisions.

Line 36, "By means of..." I think the author is trying to say that GW or other small-scale dynamics changes the altitudes of ice particles and their surrounding temperatures. Please consider to revise.

Line 60, How can the lidar measure the PMC brightness? The lidar measures the strength of the lidar echoes, so it is easy to understand the lidar can measure the "density" and thickness of the layer. But does the brightness also depend upon the size of the ice particle, which the lidar cannot measure? Please clarify?

Line 88, it would be helpful to describe how this b is defined based on the lidar measurement. I know it is articulated in the other papers, but I think it can make the paper more reader friendly.

Line 104, "Notable is the bright ...", this sentence reads a bit strange. Also, I think the "brightness" above is referring to the lidar's echo strength.

Line 127-128, this sentence seems to be incomplete. Please consider to revise.

Line 134, 135, the ν and η parameters are not defined. What are they?

Figure 2. The differences between the reconstructed results and the observations are quite noticeable, may need some explanations. In addition, the distinction in Figure 2c may need more discussion.

Line 181-182, it may be a good idea to address how these results of category reflect Fritts' assessment of GW activities and forcing.

Line 202-204, what is "high definition of the layer edges"? In addition, "Second, due to..." this sentence reads funny. Please consider to revise.

Line 207, it may be helpful to show some PMC images that are associated with the discussion here to provide the direct evidence of your argument.

Line 218, I am not sure the feature can indicate "instability dynamics", without the in situ temperature and horizontal wind information, just physical form of the lidar echoes may implicate some instabilities, but not enough to draw this conclusion. The same can be said for the conclusion, the first sentence in the Conclusion. These results may be the indirect evidences of the atmospheric instability.