

Atmos. Chem. Phys. Discuss., referee comment RC1
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Comment on acp-2022-572

Anonymous Referee #2

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-RC1>, 2022

Overall comment:

The manuscript applies a two-dimensional gradient analysis to assess small-scale variabilities inside polar mesospheric clouds. The study is of high quality and provides initial insights into a novel dataset. Polar mesospheric cloud profiles are classified according to their brightness and gravity wave activity. In addition, certain frequently occurring patterns are identified and described.

Specific comments:

p. 1, l. 14/15: correct spelling "a unique"

p. 2, l. 34: missing word: should be "strong gravity wave activity" in the beginning of the line

p. 2, l. 44: I suggest formulating the connection between the sentence starting with "At timescales of minutes," and the previous sentences better. The connection content wise is clear, but in the current wording I am not sure if "the PMC layer" in l. 44 refers to the specific case from the previously mentioned study or is meant as a more general statement.

p. 3, l. 75: The lidar beam was tilted 28 degrees off-zenith, however, the abstract's first sentence tells about "near-vertical" profiles. Is 28 degrees off-zenith still considered near-vertical or does the statement in the abstract refer to profiles already converted from slant range to vertical range (if the latter, why "near" vertical)?

p. 5, l. 113/4: How long are the times of below-threshold or no PMC detections? Are they short enough so that linear interpolation is preferred to skipping these times?

p. 5, l. 110-131: I find the use of the term "high frequency" slightly unclear from reading this paragraph. I get that the focus spectral range is 5-62 min (corresponding to frequencies lower than the buoyancy period since the buoyancy period is below 5 min in the mesopause region). From the statement about Fig. 2b (l. 129) I also understand that exactly this range is called "high frequency" (both lower and higher frequencies are omitted in the blue curve). What is then meant by "retain high-frequency gravity waves above the buoyancy frequency only" (l. 116/7)? Please clarify. Confusion might just arise from shifting between the use of frequency/period and the meaning of above/below in terms of numbers.

p. 5, l. 133: correct spelling "independent"

p. 5, l. 139: The potential of emerging/fading in just 35s challenges the role of PMC particles as passive tracers. Can you quantify how rare such extremely large gradients are and such keep up the assumption of PMC particles being passive tracers at minute scales cited earlier (Fritts et al., 1993; Dong et al., 2021)?

p. 6, Fig. 2bc: Consider adding a legend in addition to the information given in the caption.

p. 7, Fig. 3a: There is an oscillation at the very top of the distribution around zero (solid line). Do you have an idea where this comes from and whether it can be considered an artefact or real?

p. 8, Fig. 4: I suggest renaming the title of the x-axis to " σ (number of standard deviations)", so that there is a connection between the use of " σ " in the caption and the figure itself.

p. 8, l. 166: In my opinion the reader could benefit from a brief introduction of the structure of the Discussion chapter here. The chapter refers first to a number of already picked and published case studies from the dataset before putting the remaining cases into four groups. This division into already looked at and remaining events feels somehow

arbitrary (though understandable for practical reasons) and needs introduction.

p. 9, Table 3: Could you in the text (around l. 180) elaborate on how the mean category is calculated based on P_{GW} and P_{β} ? Also, I guess the times on 10 July should be UT as well?

p. 9, l. 175: Please clarify what "such events" refers to.

p. 11, l. 219-221: After reading about the helpfulness of associate data described here (wind, imagery) I am left with the question to what degree this kind of data is available or not (wind no, image yes?). Probably a further interpretation is beyond the scope of this study, but the reader would appreciate a short note.

p. 11, l. 222: correct spelling: ... activity ... "reduces" PMC brightness ...

p. 11, l. 230/1: Is there any possibility to state already how the bright band in imagery relates to the transition that defines the described third category? Can you from the coincidence conclude that this sudden increase in thickness of the band visible in the lidar must have occurred on a scale of several hundred kilometres as this is the scale of the band on the image? This might of course be part of the announced future study, but I am missing some kind of interpretation here once the image is already mentioned.

p. 12, l. 245: Please clarify if the number of 20% refers to group 4 only or group 2 and 4 together. Is this result comparable to the occurrences in Schäfer et al., 2020?

p. 15, l. 259: correct spelling "behaviour"

Side notes concerning references:

For several references the doi-links as url are not given correctly and one can therefore not click on them from the bibliography directly.

p. 17, l. 320: For the reference Geach et al., 2020, I suggest giving the doi of the finally

published article (<https://doi.org/10.1029/2020JD033038>) and not the given doi linking to the manuscript in an open archive.