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Atmospheric Chemistry and Physics Discussions

Interactive comment on "A new classification of satellite derived liquid water cloud regimes at cloud scale" *by* Claudia Unglaub et al.

Claudia Unglaub et al.

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We would like to thank the reviewer for the effort in helping us improve the manuscript. Below we respond point-by-point to the comments.

General comments:
This study proposes a new classification of liquid water clouds based on cloud-top height and cloud-base height, the former and latter being employed to quantify cloud heterogeneity and cloud altitude, respectively. The authors employ their newly developed retrieval for cloud-base height at cloud scale. The total six cloud categories are defined as a result from three cloud-base height intervals and two intervals of

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Discussion paper

cloud-top horizontal variability. It is then shown that the climatology of their occurrence is reasonable on the global scale, and two basic cloud properties (liquid water path and cloud droplet number concentration) are also documented to show some interesting differences between the categories defined. I think that the authors' analysis is a meaningful addition to current knowledge of satellite-based analysis of cloud regimes, particularly given that this study's approach of classification is based on cloud geometrical information and thus independent of cloud microphysical/optical properties. This will enable more meaningful investigation of cloud microphysical/optical properties for different cloud regimes as a function of environmental factors such as aerosol and stability conditions. I only have a couple of minor comments described below in an attempt to make the authors' analysis more sounding before the paper will be published in Atmos. Chem. Phys.
We thank the reviewer for this thoughtful and constructive statement.

Specific comments:
Overall: It would be beneficial to readers if quantitative information about retrieval uncertainty of cloud-base height and cloud-top height is provided so that readers can evaluate how robust the statistics shown in the manuscript (e.g. RFOs of different categories and PDFs of cloud properties) are.
This is a very good point and a very useful addition. Cloud base height was examined in detail by Mülmenstädt et al. (ESSD 2018), and we added a statement to the description of the data.

Line 165-170, Figure 4 and Table 1: The authors argue here that characteristics of Nd and L (in both PDFs and mean/median values) for six cloud categories show some signatures of different cloud behaviors between over continent and ocean. I would recommend the authors to separate the analysis into continent and ocean to more clearly see land-ocean differences in Nd and L in each category, facilitating

the authors' interpretation and also eliminating the effect of background aerosol differences between land and ocean on cloud characteristics.
We thank the reviewer for this very useful suggestion, and now show and discuss the characteristics separately for land and ocean in an Appendix, in conjunction with the discussion of Tropics vs. extratropics as suggested by reviewer 2.

Technical comments:
Figure 1 right panel: The color bar appears to show relative scale of variability, but the text (Line 114) states that "Cloud top height variability is defined here as the average absolute deviation". Can you clarify?
We thank the reviewer for this attentive reading of the text. Indeed, it is the relative deviation.

Figure 2: Please add labels for horizontal axes, i.e. "cloud base height (m)" for left panel and "cloud-top height variability (%)" for right panel. It would also be helpful for readers if characters such as "low", "middle" and "high" are added to the corresponding ranges of cloud-base height on left panel and those such as "stratiform" and "cumuliform" are added to the corresponding range of cloud-top height variability on right panel.
The figure is revised as suggested.

Line 153: "their response to perturbations": "perturbations" of what?
We thought specifically of aerosols and add this here.

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