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Comment on acp-2020-1252

Anonymous Referee #2

Referee comment on "Satellite retrieval of cloud base height and geometric thickness of low-level cloud based on CALIPSO" by Xin Lu et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2020-1252-RC2, 2021

Lu et al. "Satellite retrieval of cloud base height and geometric thickness of lowlevel cloud based on CALIPSO"

This study proposes a method to retrieve the cloud base height from CALIPSO observations, from which cloud thickness is further derived. It also shows the statistical results of cloud macrophysical properties based on their retrievals. In principle, the study are interesting, while I have some concerns as listed below. Thus, I would recommend its acceptance for publication after necessary modifications.

General comment:

- While this study shows the cloud base properties from CALIPSO, the representation of the statistical properties should be discussed. Particularly, only partial clouds over the world have been retrieved with the proposed method, how could people use the statistical information obtained to represent all cloud properties? In addition, the cloud bases along with the statistical values from CALIPSO should be evaluated with the CloudSat. Particularly, using only two ground station observation (also not long-term observations) to evaluate the performance of the method seems to me not sufficient.
- How do you consider the clouds with multiple layers? Particularly, there are considerable amount of multiple layer clouds on the globe. How do you consider the time representation error and sample representation errors when you do the statistics for only partial clouds that you can retrieve?

Detailed comments

L39-40, As I know, these two references are about the aerosol-cloud interactions. The importance of cloud boundaries to the cloud microphysical properties are mainly for the remote sensing of retrievals, such as the various retrieval methods indicated in Zhao et al. (2012, doi:10.1029/2011JD016792) along a lot of recent retrieval algorithms.

Line 41-42, this sentence has two verbs and should be rephrased. In addition, the finding that aerosols which can serve as CCN change the radiation balance by modifying the cloud properties was provided long time ago. In addition to the recent reference by Rosenfeld et al. (2019), other studies particularly those important are recommended, such as Twomey et al. (1977, DOIï¼□10.1175/1520-0469(1977)034<1149:TIOPOT>2.0.CO;2), Albrecht (1989, doi:10.1126/science.245.4923.1227), and Garrett and Zhao (2006, doi:10.1038/nature04636).

Line 46-49, a transition sentence from adiabatic fraction to cloud base is necessary.

Line 50, why? For radar-based cloud retrieval, I do not think CTH is crucial unless the retrieval method is based on MWR LWP (to adjust).

Line 59-60, how about the satellite radar observations, such as CloudSat?

Line 82-84, it is not always this case, depending on the amount of aerosols. This case is particularly significant over East Asia, South Asia and desert regions.

Data part, what are the potential uncertainties for the data used in this study?

Line 109-110. This sentence is too redundant. You can simply use "The retrieval algorithm is validated using the ground-based ceilometer observations."

Line 110-111, do you have any reference or support that much of the low-level cloud occurs over the ocean, while it might be true?

Section 2, in addition to the ground-site observation based evaluation, why do not the authors evaluate the retrieval results using CloudSat observations, which can give the performance globally?

Line 114-119 and Figure 1, by selecting so large domain, it would assume the cloud base

heights vary little within this region. It might be not the truth sometimes. Have you checked the horizontal variation of cloud base heights using other observations such as CloudSat, and thin clouds with CalipSo?

Line 125-126. Sine this assumption is a key basis of this study, the authors need approve its reliability based on further in-detail analysis using observations, such as what I mentioned above.

Line 135-139. The question is that clouds can form via various mechanisms, the mixing of cold and warm air masses, the surface heating, the fronts, the radiative cooling, and so on. Based on the point mentioned here, could all cloud bases be determined? If yes, may you please explain more? If not, how many clouds (in fraction) globally could be determined with this method?

Section 3.2, I am not sure if this section is necessary or not. To me, most of the information here are redundant information, which have been introduced earlier.

Figure 4 and corresponding analysis, As I know, there are long-term observations of clouds over the Azores site, why do not the authors use long-term observations to evaluate the performance of the retrieval algorithm? Anyway, the sample number seems too small to me in current Figure 4.

Section 3.4.1 Are you sure with the method, all multi-layer clouds can be excluded.

Lines 260-270, with these limitations, I wonder how many cloud samples have been removed and how many cloud samples are kept. In addition, the CALIPSO not continuously observe the clouds at a fixed location (coarse time resolution). How could these sample limitation, time limitation affect the statistical results obtained in later analysis (Section 5).

Line 291, “indicates” -> “indicate”

Line 294, do you have a reference to support this claim that there are more scenes with lots of optical thicker clouds and multilayer clouds over land.

Line 297-300, personally, I think the CTHs are particularly large over the Tibetan Plateau region, which is worthy to mention. Also, you may compare your statistical findings (actually only partial of clouds existing) with those from MODIS (polar-orbiting satellite)

and Himawari (such as Yang et al. 2020, doi: 10.1016/j.atmosres.2020.104927).