

Atmos. Meas. Tech. Discuss., referee comment RC1  
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## Comment on amt-2021-392

Anonymous Referee #1

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Referee comment on "The surface longwave cloud radiative effect derived from space lidar observations" by Assia Arouf et al., Atmos. Meas. Tech. Discuss.,  
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Arouf et al are interested in the surface cloud radiative effect (CRE) in the terrestrial spectrum. They aim at retrieving this quantify from satellite observations and propose that cloud observations from a spaceborne lidar are the best-suited observations for this. The key ingredient is a series of radiative transfer modelling on the basis of which Arouf et al. demonstrate a linear relationship between the mean altitude of clouds as retrieved from the lidar, the surface terrestrial-spectrum CRE, conditioned on surface elevation as well as humidity and temperature profiles. This allows for a simple linear transformation of the retrieved altitude to obtain surface CRE. The dataset produced this way compares favourably to other satellite-retrieved datasets as well as to surface observations at three sites.

The study in general is written in very good English language. It is in parts a bit lengthy and I propose some cuts to make it better readable.

I have two main remarks that could be answered by additional discussion, as well as quite a number of specific remarks.

### Main remarks

- For the LW CRE at the surface, it is crucial to estimate the cloud-base height correctly. The authors do not dwell on this problem very much, they basically just use what is readily available. There are, however, several approaches to retrieve it. One such

approach uses CALIPSO (Mülmenstädt et al. 2018, doi: 10.5194/essd-10-2279-2018)

- There is no discussion of the reasons for the linear relationship between  $Z_{T,Opaque}$  and CRE. Can the authors produce some arguments on why this is the case, e.g. in the sense of what Corti and Peter (ACP 2009) did for TOA CRE?

### **Specific remarks**

I29 "captures"

I66 "ideal" and "everywhere" are a bit overdoing the statement. For the "everywhere" in particular, current lidar and radar are questionable due to the lack of swath.

I108 the optical depth is not measured but retrieved

I200 "does not contribute" should be revised to be more quantitative. Why would an optical thickness of 5 in the green be exactly the threshold below which also no infrared radiation escapes the cloud?

I210 Well, CloudSat is also not optimal to detect cloud base in particular if it is liquid-water cloud

I212 What could be cases in which  $Z_{T\_Opaque}$  is a better estimator of  $Z_{Base}$  than  $Z_{FA}$ ?  $Z_{FA}$  is below  $Z_{T\_Opaque}$  so it should always be better, or am I mistaken?

I217 Why is this simpler? And what was the difference between the two choices?

I244 This is unclear. Is CRE computed at some aggregate scale? Because for each satellite footprint, there is either an opaque or thin cloud, and the CRE for the other type is zero. If it is aggregated in space or time, this should be stated here.

I269 Really theoretical or rather empirical?

I373 This point of missed multi-layer situations seems important enough to merit a broader discussion. How often may such systematic mistakes by CALIPSO-GOCCP occur?

I401 This idea can be tested, by comparing the humidity profiles used in the retrieval with the ones for these particular cases (e.g. from the reanalysis).

I460 The authors provide the spatial scale, but should also note what is the temporal averaging. Or are these instantaneous values at time of satellite overpass?

I470 "months"

I476 Besides the biases, it would be useful to also report the other scalar quality indicators, RMSE and correlation coefficients, perhaps in a table.

I486 Is there any reference or evidence to substantiate this claim?

I498 How is this possible? The idea that it is due to humidity profiles is not plausible, since the same humidity profiles are used in both retrievals.

I527 This section in my opinion is not very instructive, and there is room for making the paper more concise by dropping Fig. 15 and the corresponding text.

I551 "suggest"

I570 before it was noted only for a specific location

I597 It is overstated to say that CALIPSO "measures well" opacity – there are only two coarse classes distinguished.

I830 I find the right-hand-side panel (Opaque cloud) a bit misleading, as the altitude Z\_FA

is just slightly above  $Z_{\text{Base}}$ . However, it often is quite near  $Z_{\text{Top}}$ , since it is at 5 optical depths (line 95).

1840 To me this sketch isn't very helpful. I don't quite get the "actual" in the rectangular clouds in (A) and (B), from the caption I would rather understand, these are the fluxes computed by the radiative transfer modelling. Also, I don't see why the powerpoint-cloud-shaped-clouds and the rectangular carry different information with respect to the radiation arrows. Why do the arrows in (C) from the rectangular cloud end above the surface?

1898 I propose a different colour scale that does not suggest a division into two subsets.

1929 The mean biases lack units.