

Reply to comments by Anonymous Referee #1

on the manuscript "Estimation of cloud optical thickness, single scattering albedo and effective droplet radius using shortwave radiative closure study in Payerne" by Aebe et al., submitted to Atmospheric Measurement Techniques.

We thank the referee for the constructive comments that contributed to the improvement of the manuscript. Detailed answers to the comments are given below (bold: referee comment, regular font: author's response, italic: changes in the manuscript).

The study presents a method for estimating the cloud optical thickness, single scattering albedo and effective droplet radius from downward shortwave radiation simulations and measurements during days with low clouds (stratus-altostratus) and high clouds (cirrus-cirrostratus) in Payerne, Switzerland in the period 2013-2017. The authors have done a good job to describe their analysis, and demonstrate their findings in a good way. Results from their method are tested against other methods and good correlations are revealed. The study is suitable for publication in AMT, the manuscript is well written, the findings are well described and in general I find a good paper. I recommend publication after a few clarifications.

Comment 1: Table 1: The table refers to 739 out of 1827 days during the period 2013-2017. Maybe it escaped my sight but I couldn't find out what happened with the remaining days. Can you explain what happens with the remaining 3/5 of the period, e.g. no available sky camera measurements, different cloud types than the ones investigated?

The parameter "number of days" defines the number of days during which the total number of measurements of one specific sky condition is found, e.g. for Ci-Cs, the 206 measurements are found at 48 different days and for Cf, the 13,240 measurements are found at 379 different days. It is also possible that at the same day cloud-free and Ci-Cs measurements are available for example. At all other days, there was either another cloud class present than the ones considered, or the cloud fraction criterion was not fulfilled.

To clarify, we changed p. 6, l. 151f:

Table 1 summarises the number of measurements in total and the number of days during which they are found, the cloud fractions considered and the occurrences throughout the year per cloud class separately.

Comment 2: I am confused with the use of terms COT and COT_DSR. From the abstract I understand that COT is the cloud optical thickness calculated from modelled downward shortwave radiation, and that COT_DSR is the cloud optical thickness derived from measured downward shortwave radiation. However in section 3.2, I read that the total DSR and its components, direct and diffuse radiation, are derived from libRadtran, and that the lookup tables, used to estimate the COT_DSR, contain simulated radiation values. I cannot figure out how the ground-based radiation measurements are used to derive the COT_DSR. Please clarify.

The COT_{DSR} values are retrieved by combining DSR measurements with simulations of a RTM. To make it more clear, we rewrote Section 3.2. Additionally, we slightly changed the descriptions of the retrieval of COT_{DSR} at various places. One example of the changes is:

p. 3, l. 74ff:

In the current study we estimate cloud optical thickness for stratus-altostratus (St-As) and cirrus-cirrostratus (Ci-Cs) using broadband shortwave radiation measurements, a RTM and ancillary ground- and satellite-based data from the BSRN station in Payerne, Switzerland, by performing a radiative closure study. This allows determining COT by minimization of the difference between modelled and measured DSR values. The COT values determined with this method are abbreviated with COT_{DSR} .

Throughout the manuscript we also used more consistently the term COT_{DSR} and added some more times COT_{MODIS} , $COT_{Barnard}$ or COT_{PFR} instead of only using COT. We hope that this leads to less confusion.

Comment 3: In the same motif. Lines 234-235: What is the ‘effective COT_{DSR} ’? Do you mean that a modelled COT is used as input to derive the measured COT_{DSR} ? Line 251: It reads ‘ COT_{DSR} the cloud optical thickness’. Is this derived from radiation measurements? Line 256: It reads ‘These two variables are estimated from a LUT, which was generated using a radiative transfer model’. So, is COT_{DSR} derived from simulated radiation values and not from measured ones?

l. 234-234: we deleted the term effective.

Otherwise, we changed the description of the COT_{DSR} retrieval (Section 3.2, p. 9, l. 244ff) to make the method more clear (see also the answer to comment 2).

Comment 4: Line 310: it reads ‘6.80 COT’. Is it ‘6.80 of COT’ or is it just ‘6.80’ and COT is a typo error?

Thanks for this comment, it was indeed a typo and we changed the sentence to:

p. 11, l. 314f:

The retrieval *method of the COT values for St-As conditions presented here has a U_c of 6.8.*