Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2017-115-RC2, 2017

Atmospheric Measurement Techniques Discussions

Interactive comment on "Link between the Outgoing Longwave Radiation and the altitude where the space-borne lidar beam is fully attenuated" *by* Thibault Vaillant de Guélis et al.

Anonymous Referee #3

Received and published: 6 July 2017

General

The authors present a methodology to estimate the outgoing longwave radiation (OLR) at the global scale from cloud products derived with the help of long-term space-borne measurements with the lidar CALIOP onboard CALIPSO. The major information comes from the opacity altitude of the atmosphere, i.e. the altitude at which the laser beam is fully attenuated due to clouds, and the geometrical cloud top height, which together allow the estimation of the radiative temperature of the cloud. It is shown that the latter one is linearly related to the OLR. Non-opaque (thin) clouds are treated in terms of top and base heights together with their emissivity, which is estimated from the lidar attenuated scattering ratio below the cloud under consideration of a constant multiple-scattering factor. For opaque clouds, a very good correlation between the derived OLR and the one measured by CERES is found, whereas a systematic deviation is seen for thin clouds. Despite some possible explanations the reason for the deviation in the case of thin clouds does not finally become clear.

In general, the paper presents an interesting approach to study longwave radiation effects of clouds at the global scale. The paper deserves publication, but has the potential to be improved both in terms of scientific contents as well as style of presentation. I recommend publication after consideration of the comments below.

Major

My major concerns are related to the rather simplified approach of using only two cloud scenarios, namely single-layer thin and opaque clouds. I would at least expect an extended sensitivity study regarding more realistic scenes in the very beginning. Justifying the approach before the presentation and discussion of results would be much more satisfying for the reader than the currently provided discussion of limitations in Sec. 6 (where several questions are tackled which the reader has already in mind when reading the major part of the paper). In particular, the following cases need to be considered in the evaluation and discussion of obtained results throughout the paper, starting already in Sec. 2.1 and Fig. 1.

1) Multi-layer clouds: The discussion related to multi-layer clouds is not sufficient. The authors have added a very short paragraph in Sec. 2.1 (lines 176-179) during the technical revision of the paper. However, this explanation deals with thin clouds only. The more common feature is the appearance of thin, high cirrus clouds over mid-level or low-level opaque clouds. It is well known that retrievals from passive sensors locate the radiative cloud top height (or radiative temperature) in between the cloud layers in such cases, and that the location will depend on the optical thickness of the upper “thin” cloud. This fact is obviously not covered by the presented approach, since it

considers only the geometrical properties of cloud top height and opacity altitude for the calculation of the radiative temperature. Although some discussion is provided in Sec. 6.2, no substantial investigation of the related consequences for the approach is given.

2) Broken clouds: The authors find a high amount of “thin clouds” in the lower troposphere at temperatures above 0 °C, i.e. liquid clouds (Fig. 4). Usually, liquid clouds are not penetrated by lidar, even if they are geometrically thin (thickness of a few hundred meters). Those occasions of “thin clouds” might often be related to broken opaque clouds partly hit and partly missed by the lidar beam, thus leading to signals from the cloud and from the atmosphere and surface below the cloud in the same profile, so that the cloud appears to be transparent. The effect may be due to broken clouds within a single laser footprint, but can also result from averaging of laser shots over cloudy and clear atmospheric volumes before further retrievals are applied. From the description in Sec. 2.1, it does not become clear how averaging of lidar profiles is done, what exactly is meant with “each atmospheric single column” (line 127), which basic products (single shot, 1-km averages, 5-km averages) are used, and how the averaging to the 2°x2° grid is performed. It should be studied which differences in the results are expected when sub-scale broken opaque clouds instead of thin clouds appear. It would be interesting to see whether the worse correlation between calculated and measured OLR found for thin clouds could be explained in this way. In this context, also the discussion in Sec. 6.2 is insufficient.

Minor

Abstract: The abstract doesn’t say anything about the retrievals for thin clouds.

Line 185, should be: “Flux observations collocated with lidar cloud observations”

Line 290, regarding the “second mode”: What does “more diffuse” mean? What about altocumulus, altostratus clouds?

Line 300, “cloud emissivity of the cloud”: correct to either “cloud emissivity” or “emissivity of the cloud”.

Lines 331-332, “in spite of significant differences in the atmospheric temperature and humidity profiles”: What does “significant” mean? How are these differences considered/validated in the calculations?

Line 372, “The evaluation . . . is only using observation from January 2008”: This explanation should be given in the beginning of the discussion of Fig. 6.

Lines 405-415: Explain the units to be applied in the equations.

Lines 556 and 561, “decreases. . .from. . .”, “reduces. . .from. . .”: The meaning of the sentences with the word “from” is unclear.

There a many language/grammar/punctuation errors, which cannot be listed in detail here. The manuscript needs careful copy editing.

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2017-115, 2017.