Answers to Referee #1

RC1: 'Comment on amt-2022-301', Anonymous Referee #1

The authors describe the scene construction algorithm (SCA) for EarthCARE Level-2 data products. The algorithm is based on earlier work by Barker et al. (2011, 2012) that uses spectral radiances to transfer cloud and aerosol vertical profiles derived over ground-track of active sensors to cross-track pixels. The manuscript includes descriptions of three stages of screening process and how to determine buffer zones. The authors define the error due to SCA as the domain averaged radiance difference between observed radiances and transplanted radiances, scaled by the mean flux over the ground-track portion of the domain. The authors show that the error due to SCA is well below 10 Wm-2, which is the error budget of EarthCARE including all algorithms.

The manuscript is well written and easy to follow. I only have minor comments.

Thank you for the compliment!

General comments

The paper does not discuss what channels/wavelengths are used for the scene construction algorithm and the total number of ks described on line 95. Channels used in the SCA are probably different for day and night. But do they also vary depending on scenes/locations? Some details are discussed in Barker et al. (2011). But it is not obvious from their paper which combination of cannels is used in the actual SCA. Could you include descriptions of channels/wavelengths used in the SCA?

You are right; we failed to mention what channels are used. They are now mentioned at the beginning of section 3.1. Four channels, i.e. 1 (0.67 µm), 4 (2.21 µm), 5 (8.80 µm), and 7 (12.00 µm), are used by the SCA algorithm during Sun-up periods. At nighttime, however, shortwave channels will not be used. This is stated following (1) (and following (13) in the Appendix). In addition, if a channels' value is zero or missing, it will not be by the SCA either.

One of conclusions is that the error by the SCA is less than 5 Wm-2 or 3 Wm-2. However, this is based on results using the Hawaii frame (line 276 to 280). Is this also true for other two frames used for testing?

On line 272 we stated that of the three frames, errors for the Hawaii frame are the largest.

Specific comments

Abstract

It is not described anywhere in the manuscript what four sub-algorithms are.

We changed the word "sub-algorithm" to "components". Their components are discussed in the 4 subsections in section 2.

The last sentence of the abstract and Section 3.3.

The direct way to show that the SCA helps more than hinder toward achieving the radiative closure goal of EarthCARE is to show that TOA flux error with and without the SCA. But this study did not address that. The SCA can help reducing the TOA flux error in two says. One way is by identifying clear-sky for the entire BBR footprint. If I look Figure 2 of Ham et al. (2015), nearly 30% of along-track clear-sky scenes contains up to 10% clouds. The SCA should reduce the TOA flux error identifying clouds present off-nadir. Second, the SCA can provide better off-nadir cloud information than no information. Top two plots of Figure 4 of Ham et al. (2015) show improvements of TOA fluxes (smaller differences between CERES-derived and computed fluxes) with the SCA. Also, the left plot of Figure 6 shows the improvement for almost all cloud types. If the authors prefer to estimate in their way, both effects together can be estimated by limiting the area of averaging radiance just over along-track in Eq. (5).

Your comments are all true, but we're not really concerned with modelling TOA fluxes in this report; that is the focus of a separate paper. For the case at hand, we're never sure how much modelled fluxes, based on SCA clouds, will be in error, but we can estimate bias errors likely to stem from the SCA process by checking known differences between "constructed" and "measured" radiances. Moreover, we tried to emphasize that the SCA is just a tool that helps facilitate radiative closure assessment. Ideally, this "facilitator" does not hinder assessments of the retrievals. When constructed and measured radiances don't (do) agree, we can assume that subsequent modelled broadband fluxes will be a poor (good) estimate of unmeasured real broadband fluxes.

Section 2.3

The authors describe three stages of screen processes. If a domain contains corrupted data are rejected (line 154), I am wondering what is the fraction of domains that pass this screen process. Do you have an estimate of how often domains are rejected? Could you include the number (yield) based on scenes the authors worked on so far? If active sensor retrievals systematically fail for certain type of clouds, such as deep convective clouds, then these clouds have never been included in the radiative closure assessment. Could you include author's thoughts/concerns that the closure is performed preferably toward certain cloud types?

Synthetic data used thus far are basically "perfect". Any corruption would be purposely imposed by us. Moreover, you're correct that if active sensors fail systematically for certain conditions, those conditions will not be assessed. We do not feel comfortable speculating in this paper about active sensor failure rates... those will possibly be addressed in other papers in this special issue.

One of variables used for screening is the solar zenith angle. Currently, the threshold of the solar zenith angle is 75 degrees. In addition, homogeneous land surface and standard deviation of surface elevations are used to screen scenes to be used for radiative closure. Can the authors estimate the faction of Ds that pass these screening process?

Screening success rates for the three frames used here are now included in Table 1.

Line 213. Could you explain what 2020 mean?

We have now added "inferred from measurements made during 2020".

Reference

Ham, S.H., S. Kato, H. W. Barker, F. G. Rose, and S. Sun-Mack, Improving the modeling of short-wave radiation through the use of a 3D scene construction algorithm, Q. J. R. Meteorol. Soc., (2015), DOI: 10.1002/qj.2491.

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