Atmospheric Measurement Techniques Discussions

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Comment on amt-2022-304

Anonymous Referee #2

Referee comment on "Broadband radiative quantities for the EarthCARE mission: the ACM-COM and ACM-RT products" by Jason N. S. Cole et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2022-304-RC2, 2023

The manuscript presents the broadband radiative transfer (RT) algorism for the EarthCARE mission. The 1D and 3D RT schemes are implemented. Because the 3D RT scheme will be used operationally in the satellite mission for the first time, the authors presented in this manuscript how 3D RT is important in to achieve the mission's goal for the accuracy in radiative flux. The manuscript is generally well written. I recommend this paper is published after some revisions. Below are my specific comments and questions.

General comments

- In the manuscript, the authors used several technical terms specific to the EarthCARE project, such as "joint standard grid (JSG) column". Although they are shown with references, many of which are in the EarthCARE special issue, and they are unknown for the readers. It is helpful for the readers to be with some (even short) explanations (e.g., what to do for what purpose).
- This is a similar issue as above. I miss the algorithm description of the "observed" radiative fluxes from BBR. Because the BBR actually measures the broadband radiances, the "observed" radiative fluxes would be some estimates. There is a citation to a manuscript that has not yet been published, but I could not find any further information about the paper. A brief explanation is required in the manuscript. Is the observed radiative flux accurate enough to compare with simulated radiative fluxes? As for radiative closure analysis, I support the usefulness of BBR multiangle radiance (instead of radiative fluxes).
- If local positive and negative 3D-1D flux differences are well cancelled in larger scales, 1D flux is enough to explain larger scale average. Averaging-scale dependence is interesting to see. Is there any plan to study that aspect in the future radiative closure studies?
- I have a question regarding the 3D radiative effect: Why the goal of the EarthCARE mission is set at local (of ~100 km^2 domain) radiative flux accuracy? I completely agree that 3D RT is required to simulate BBR radiances and to obtain the radiative closure, while the local radiative flux at TOA (~20 km height) is not directly measured.

What is the benefit to obtain local 3D flux? Is CRE evaluated for 3D RT as well? If so, it would be interesting to see how CRE is different from 1D RT counterpart.

- Why the size of "assessment domain" was chosen as 5´21 km?
- The radiative flux distribution will be different by the reference height, which was set at 20 km in the manuscript. Many of readers should not be aware of the importance of the reference height. Can the authors add some explanation of the reason for their choice of the reference height?
- Results are probably obtained from synthetic multi-sensor measurements made from GEM. This point should be clarified. In Fig. 3, retrievals are significantly different from the reference (GEM) profile. There are several possible reasons for the discrepancies in this type of experiment. The synthesis measurements are probably superimposed by measurement noise, inversion algorithm should be built on several assumptions and prior information, and the simulation may not be perfect. Please explain the reason of deviation from the reference.

Specific or typographic comments/questions

Eq. (8): Is this the (modified) Gamma distribution? Is there a reference?

Fig. 5: SW and LW CREs are usually radiative flux anomaly due to the presence of cloud in the net downward flux at the TOA, and SW and LW CREs are negative and positive, respectively. The authors seem to use unusual definition of the SW and LW CREs. Please give the definition specifically.

There are many uses of a word "get", which may be rewritten with more specific word (e.g., "become" and "obtain").

L419: "W/m2" could be "W m^{-2}"