

## Answers to referee #2

RC2: 'Comment on amt-2022-301', Anonymous Referee #2

### *General comments*

The authors present a simple yet elegant concept for building full three-dimensional atmospheric profiles. The exposition is detailed but very clear (with a few minor comments that I will address shortly). The benefits to the EarthCARE mission are obvious and immediate, yet the authors are not blind to the limitations of the proposed approach (just to give one example, the discussion of Figs. 7 and 9 contains a fair appraisal of the algorithm's estimated error). It is clear that this manuscript does not constitute a full demonstration of the algorithm's performance, but I also appreciate that this was not possible within the scope of this submission, and the authors do include a reference to another contribution (that I have not reviewed). Technically, the paper appears sound, even though I do not feel fully qualified to review all technical details (especially appendix B).

### **Thank you for your compliments!**

I would rate the manuscript length as being perhaps on the longish side, but without being excessive.

### **Specific comments**

The term "assessment domain" (line 54) and the processor designations ACM-RT and ACMB-DF (lines 74 and 75) have not been formally introduced before first use. However, this may be resolved at the time of publication (I did not check the referenced publications).

**At the beginning of the second paragraph in the Introduction, "assessment domain" is now defined more fully. ACM-RT now has a citation attached to it. Since publication time of the paper that describes and applies EarthCARE's radiative closure assessment is highly uncertain, we just mention that ACMB-DF is, in essence, the radiative closure assessment.**

What is not immediately clear in the main body of the text, is whether the SCA works with one channel at a time, or with a combination of channels. Although this is addressed in the appendix (it is able to use any conceivable, weighted combination), I would suggest explicitly adding this to the main text to improve linear reading, as I believe this influences the interpretation of the results. (Otherwise, I cannot explain the increased error when moving away from the ground track.)

**We mention this now at the beginning of section 3.1.**

Formula (1) uses a minimum, whereas I would have naïvely expected a maximum over the domain, to ensure all values remain bounded by above. Could the authors explain this?

**You're right, it should be  $\max\{\dots\}$ .**

The discussion in 3.1 mention the increasing RMSE with increasing across-track distance from the ground track (visible in Fig. 7). My interpretation is that, with increasing across-track distance, meteorological conditions start to differ more, and it becomes increasingly difficult to match the ensemble of MSI radiances with satisfying accuracy. I think the text would benefit from a brief explanation by the authors.

**What you've described is true, especially out toward the edges of the MSI swath; i.e., up to 130 km off-nadir. But Fig. 7 only goes out +/-20 km so meteorological changes are not too pronounced. Note that  $\partial RMSE / \partial x$ , where  $x$  is distance from nadir, maximizes for very small  $x$ . This is "not" due to meteorological changes, but rather the algorithm being supplied with incomplete information from the ranges that are searched along-track. The other side of this issue is searching along-track too far from nadir and running the risk of exactly the issue you raised... hence, the reason why we are likely to limit the search to ~200 km.**

The role of Lambda in Appendix A (line 345) appears to be a selector for suitable donor/acceptor pairs. I take it that any such pairs with F exactly equal to zero disqualify immediately for the selection in formula (15), because they would otherwise falsify the ranking? This is not stated explicitly in the text.

**Good point! We were trying to express the algorithm symbolically in a new way by using lambda (this is not in previous presentations). Lambda is supposed to *exclude* columns from the list of potential donors, not make them the *most appropriate*! Moreover, it can be removed from the summation, too. We think this works... lambda is either 1 (usable) or -1 (unusable). Then, just above (14) it is noted that only  $F \geq 0$  are considered.**

Appendix B felt quite technical, and I admit that I could not fully grasp the technical details.

**We agree. It wasn't easy translating what is a fairly simple algorithm/code into text. We felt, however, that it should be presented at least once, and that an Appendix was the appropriate place to do so.**

Figure 5 does not mention or show  $m\_buffer$  (across-track) or clouds, is this the figure that was intended to be shown?

**You are right, it doesn't. We have redrafted the figure, and now it indicates  $m\_buffer$ .**

In Figure 6, I would suggest adding a marginal (side) plot to the left of the left half of channel 1, plotting channel 1 nadir radiance as a function of latitude (and similarly for channel 4), to assist the reader in assessing the working of the algorithm. For the case shown, I would expect a relatively flat and relatively low nadir radiance profile between ~10 and 13 degrees N, which would explain the gradual failure of the algorithm in matching the high off-nadir radiances, and the visible "banding" in the reconstructed radiances.

**Note that nadir is the line labelled "GT", so there are no errors along it. We have, however, added plots, that we believe the Reviewer is suggesting, that correspond to transects running along the centres of these domains, which are 40 km east of nadir. We consider this to be a distance well beyond where the SCA is expected to be needed most. These plots show closely what the Reviewer described.**

### *Suggested technical corrections*

What follows is a list of suggestions that I would humbly propose. Please note that I am not a native speaker, so I respectfully defer to the editor and authors for any final decision.

- 14 (abstract) "out to ~15 km on both sides of nadir": suggest adding "along-track" explicitly for clarity

**Actually, it's "across-track", but you're right in that it did lack clarity.**

- 48-49 possible grammar mistake in "The extreme case is use"

**Right, it should be "... is to use..."**

- 66 typo in "retrieved"

**Got it.**

- 83 possible missing article in "At its core is definition of D"

**We think it is correct, but we modified to "... is the definition...", which we think is still correct.**

- 114-115 possible redundancy in "adverse effects near the perimeter of D are affected by [...]"

**We like what we have.**

- 119 possible grammar mistake in "Buffer-zone also accommodate"

**Should be plural; "Buffer-zones..."**

- 130 semicolon where a comma was expected

- 133 semicolon where a comma was expected

**Right... not sure how semicolons got, and remained, there.**

- 195 symbol ( $\mu$ ) appears to be missing in wavelength units (twice)

**Fixed, but not sure why it didn't come through in the original???**

- 213 possible typo in "where"

**Got it... should have been "were".**

- 214 suggest adding a comma after "and for each array"

**Added.**

- 254 text unclear in "[values] get reduced by at least a factor of 10 when for averages [...]"

**The word "when" has been deleted.**

- 309-310 a verb appears to be missing in the subsentence spanning these 2 lines

**It was incorrect, and it has been improved.**

- 317 possible typo in "cost-effect"

**Has been corrected to "... cost-effective...".**