Comment on amt-2022-82
Joern Ungermann (Referee)


GENERAL COMMENTS

The paper compares two different methods of fusing the measurements of the IASI-NG and FORUM satellites to derive atmospheric states. One operating on level 1 data, one operating on level 2 data. It is found that both methods deliver (under reasonable assumptions) equivalent results. Such, the method simpler to implement can be chosen.

The topic fits the journal well.

The paper is concise and well written. I recommend publication after addressing the comments below.

MAJOR COMMENTS

lines 327ff

The test profiles for the perfectly co-located measurements are generated using a (fixed) a priori profile perturbed by random vectors according to the CM 0.5 S_m. This is strange as the matrix S_m was designed to represent the typical differences between two mis-aligned FORUM and IASI-NG profiles, not to represent
the typical variability of Antarctic profiles in general in this season. I would assume that such neighboring profiles exhibit - on average - only small differences whereas Antarctic profiles exhibit a large variety of shapes.

I would have expected a much larger variety of profiles here based on a different CM matrix. Such more diverse profiles could then be perturbed using 0.5 S_m to generate the two differing profiles for the second part of the study.

Please adapt the study or elaborate why the current choice sufficiently captures the required variability of atmospheric states. I do not expect a different outcome, but the examination of 900 probably very similar profiles seems questionable.

SPECIFIC COMMENTS

It would be interesting to note how exactly the modification is performed. I would assume by an additional factor in front of the a priori precision matrix as described by Rodgers or with, e.g., a factor and an identity matrix as is often used in numerical libraries?

Is the emissivity linearly interpolated between the grid points? Please specify.

This paragraph sounds as if there are different S_a matrices being used depending on the use case, if only w.r.t. to the surface emissivity. This should be taken up in the mathematical notation (e.g. with an i index).
It is surprising that the nadir sounders seem to replicate the true profile near-perfectly (on average). Due to the spatial smoothing of the true profile, I would have expected, e.g., systematic discrepancies close to the local extrema of the temperature and water vapour profiles. I.e. there should be a difference between true and retrieved profiles, simply due to the lower spatial resolution of the retrieval result. Or was the true profile folded with an averaging kernel as well to compared within the same spaces? Is there another explanation for the excellent performance?

Data Availability
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Is the test data set too big (or restricted by licenses) to be placed on, e.g., Zenodo?

MINOR REMARKS
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errors -> error

It’d be helpful to associate the terms with the mathematical notation in the text. I.e. CMs $S_i$ and AKMs $A_i$.

convergence -> $x_i$
This notation does not express properly, that $T(p_k)$ expresses a subvector $T(p_1)$ to $T(p_n)$.
Perhaps $\{T(p_k)\}_{k=1..61}$ ? Why $T$ and not consistently $x_T$ ?