

Atmos. Meas. Tech. Discuss., referee comment RC2
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Comment on amt-2021-31

Anonymous Referee #2

Referee comment on "Synergetic use of IASI profile and TROPOMI total-column level 2 methane retrieval products" by Matthias Schneider et al., Atmos. Meas. Tech. Discuss., <https://doi.org/10.5194/amt-2021-31-RC2>, 2021

The authors propose to combine independent retrievals of CH₄ from TROPOMI and IASI, which are in differing orbits, using well-known optimal estimation techniques. They compare the combined and individual L2 retrievals to a number of independent measurements while accounting for the individual sensitivities of the retrievals. Those comparisons are interesting as they show the strengths and weaknesses of IASI and TROPOMI.

They describe in detail the method to combine a column retrieval and a profile retrieval using optimal estimation techniques. This extends previous approaches, e.g., Luo et al, 2013, with a useful twist that could be applicable to other instrument combinations.

The value of this combined product, however, is not entirely clear. The theoretical analysis presented in the appendix neglects the fact that IASI is in a morning orbit and TROPOMI is in an afternoon orbit. The coincidence criterion that they propose is reasonable for evaluating L2 products against independent data but it is not adequate for actually combining data.

For this study, they need to directly account for the dislocation error, which could be modeled as a covariance. This could be done in a simulation context using, for example, CAMS methane (<https://atmosphere.copernicus.eu/charts/cams/methane-forecasts>).

This is important in part because the paper neglects a key question: who would want to use this data? Most scientists aren't interested in CH₄ concentrations, they are interested in the fluxes that produce them. Given their characterization, IASI and TROPOMI can be used in this context. Models can readily account for the differences in time of day and how winds may shift the origins of morning and afternoon air parcels. The proposed method would improve DOFS but potentially at the expense of the anomalies that a model

would exploit infer fluxes. They need to address this issue.

The paper asserts that a linear optimal estimation combination of L2 products is equivalent to a non-linear combination of L1B products. They never show this. Rather they depend on the mild non-linearity assumption in Rodgers, 2000. However, they never show that this assumption is valid for their problem. They could demonstrate it by showing in a simulation environment where they combine the L1B data in a multi-spectral retrieval and compare it to the equivalent L2 combination.

The authors are impressively unaware of the literature on combining satellite data for composition. They don't discuss the landmark Landgraf and Hasekamp (2007) or Worden et al, 2007 papers. In addition to Cuesta, there are a number of papers by Fu et al, 2013, 2018 that solve this problem with L1B data. Luo et al, 2013 demonstrate a similar approach for combining TES and MLS L2 data for CO. The authors are encouraged to familiarize themselves with the literature and cite appropriately.

As noted by the authors, the value of this approach will be better realized with Sentinel 5, rather than IASI and TROPOMI. I would suggest orienting the paper more towards a proof-of-concept for S5 or similar configurations, e.g, the A-Train. Whether this approach is as good as a combined L1B retrieval with coincident measurements or separately assimilating L2 products remains to be seen. But, the current strategy with IASI and TROPOMI is not clear.

Additional comments are embedded in the supplement.

Please also note the supplement to this comment:

<https://amt.copernicus.org/preprints/amt-2021-31/amt-2021-31-RC2-supplement.pdf>