Comment on amt-2022-197
Anonymous Referee #2


The Authors discuss the application of the RemoTeC algorithm to four years of TROPOMI methane retrievals over the ocean, and present an extensive validation against TCCON observation and GOSAT retrievals carried out using the same algorithm. The results show that the retrieval product is compliant with mission requirements. The performance of the algorithm on challenging scenes, such as scenes with significant dust aerosol loads, is also discussed.

I think the paper is very well written and fits the scope of AMT, and I recommend publication with only minor corrections, as outlined below:

- P2, L33. You can also mention that OCO-2 has a much narrower swath than TROPOMI and GOSAT has no swath, which is the main reason why their coverage is much poorer than that of TROPOMI.

- P2, L45. "the latter poses" --> "these pose"

- P2, L46, "most extensively has been analysed" --> "has been analysed most extensively"

- P2, L49-50, "direct reflection of the solar backscattered light". Is it really backscattered light? Isn't it direct light?

- P2, L50 (and several other instances). You often use the word "backscattering" throughout the paper (e.g., "diffuse backscattering"), but is it really justified? If the
instrument is looking at sun glint angles, I do not think it is ever looking in the backscattering direction (scattering angle of 180°). Wouldn't it be better to say "scattering"?

- P3, L64, "is for most of the scenes underestimated" -> "is underestimated for most of the scenes"

- P4, eq. 1. I think this formulation is only valid if the measurement error covariance is diagonal. If you assume it is, explicitly say so when you explain the meaning of each term. If it is not, then \( Sy^{(-1/2)} \) is not uniquely defined, and it would be more correct to write the first term on the right hand side as

\[(F(x)-y) Sy^{(-1)} (F(x)-y)\]

- P4, L97-99. Also point out that \( y \) is the vector containing the observations and \( F(x) \) is the output of the forward model in response to the state vector \( x \).

- P5, L125. Can you briefly summarize what the "small area approximation" does, or at least add a reference? It may not be clear to the occasional reader.

- P5, L145, "tendency of increase" -> "increasing trend"?

- P10, fig. 4. It may be good to report absolute bias, standard deviation and number of data points in each figure. Otherwise the figures look purely "illustrative".

- P14, L253-254. "First, VIIRS data is used ..., and we apply a threshold... then AOT is used...". I would advise to either use first or third person throughout.

- P20, L392, "solar backscattering from surface reflection". Is this not just "direct reflection of sunlight from the surface"?

- P20, L406, "atmospheric backscatter" -> "atmospheric scattering", "surface reflection over water surfaces" -> "reflection from water surfaces"