

Atmos. Meas. Tech. Discuss., referee comment RC2
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Comment on amt-2022-102

Anonymous Referee #2

Referee comment on "On the influence of underlying elevation data on Sentinel-5 Precursor TROPOMI satellite methane retrievals over Greenland" by Jonas Hachmeister et al., Atmos. Meas. Tech. Discuss., <https://doi.org/10.5194/amt-2022-102-RC2>, 2022

General comments

Hachmeister et al. present a topography correction for S5P TROPOMI methane retrievals, and show evidence of significant improvements of the product due to this correction. Their focus region is Greenland where the coasts have significant altitude variability in small (sub-TROPOMI-pixel level) spatial scales and also temporal variability due to the melting of the ice sheet. They propose to replace an obsolete elevation model GMTED2010 with elevation derived from ICESat-2 data. Methane anomalies over Greenland are shown to be correlated with both altitude and altitude difference (defined as old minus new elevation model), highlighting the sensitivity of the retrieval to surface pressure (and thus altitude). The spurious methane anomalies over Greenland coasts largely disappear when accounting for the updated elevation model.

This paper highlights the significance of updated input data for space-based retrievals of atmospheric composition, and is well-suited for the scope of AMT. The study is presented in a concise manner and the message it delivers is important for the atmospheric retrieval community. As for applied studies using satellite data (such as greenhouse gases source-sink analysis), it is important to reduce systematic errors in order to improve the reliability of the results derived using these data. I recommend publishing the paper in AMT after considering my minor comments and corrections below (in addition to those from Reviewer 1).

Specific comments

Title: Have you considered including "TROPOMI" in the title? I'm suggesting it for an improved visibility through search engines etc.

Introduction: This section is completely missing the motivation for the need to address the elevation (or surface pressure) sensitivity of the retrieval and thus an improved elevation model. Since this is the content of the paper, I propose to introduce the topic in the introduction. Other high-latitude retrieval challenges have been mentioned (dark surfaces); perhaps also mention the elevation sensitivity there (I would also recommend mentioning the solar zenith angle limitations at high latitudes), and then add a paragraph, perhaps after the 3rd paragraph in introduction, about what you are addressing in this paper, along with relevant background on GMTED2010 (complementing the request by Reviewer 1 here). Applicable text has already been written in several other parts of the manuscript.

Sect. 2.1.2 (and also 2.1.1 as applicable): I suggest to add information on the filtering (quality-screening) of the data, in particular because in e.g. Fig. 10 caption you refer to an updated quality filtering. You also most likely quality-screen the data before gridding so it is important to mention the qa_value criteria in 2.1.1 also.

Sect. 2.1.2: This is more of a question than a comment or suggestion: could steep elevation changes (especially at high latitudes where the SZA are large) also have an effect on the retrievals through casting shadows? Likely this is much less significant; I was just looking at Fig. 2 where one can see different XCH₄ anomalies in the northern coast of Greenland compared to elsewhere in the coast.

Sect. 3.1: For the calculation of the 7-day methane anomaly, could you please specify how you do the gridding; is it only based on the centre coordinates of each pixel?

Sect. 4.5 and Conclusions: I assume that the "preliminary version of the updated WFMD product" is indeed a preliminary reprocessing of the WFMD retrieval (i.e. considers also the updated reference spectra corresponding to the updated elevation information) and not limited to postprocessing corrections based on the linear relationship shown in the paper. Could you please specify this part in the paper?

Conclusions: Is the updated DEM recommended also for the retrievals of other atmospheric gases? Please specify.

Technical corrections

Line 19: as up-to-date as possible

Line 21: introduced in

Line 36: spatio-temporal

Line 55: the Earth's

Line 55: SWIR wavelengths

Line 66 (also elsewhere): the word 'data' is plural so please change 'data has' --> 'data have' (and correspondingly also elsewhere in the text)

Lines 75-77: WFM-DOAS; please harmonise with the rest of the manuscript (either use WFM-DOAS or WFMD systematically)

Lines 95-96: remove the spaces between number and % symbol; 1 % --> 1%

Line 101: just --> only

Line 136: 7-days --> 7 days

Sect. 3.2 and Figs 6 & 7: Ambiguous use of p.

Line 155: don't effect --> do not affect

Line 195: is no longer --> are no longer

Line 206: where --> were

Appendix A is not referred to in the main text, please add.

Line 252: don't --> do not

Line 253: Fig 7 --> Fig. 7

Line 262: due melting --> due to the melting

Figs. 6 & 7: please include 'a' also for the top row figures