Reply to reviewer 2

Jonas Hachmeister

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We would like to thank the reviewer for their helpful comments. Below the specific comments are listed in **bold text**. Our replies are in standard black text and the changed passages from the paper are in blue.

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

We added 'TROPOMI' to the title of the paper which now reads:

On the influence of underlying elevation data on Sentinel-5 Precursor TROPOMI satellite methane retrievals over Greenland

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.

We added the challenges of high solar zenith angles and the sensitivity to elevation data to the introduction:
Additionally the high solar zenith angles provide challenging measurement conditions. Furthermore the satellite retrievals depend on knowledge of the surface elevation e.g. for the calculation of surface pressure. The exact use of elevation data depends on the retrieval algorithm, however both datasets we investigate in this paper report a 1% error in the retrieved XCH_4 (about 20 ppb) for a 1% error in the surface pressure. This could lead to problems due to the use of inaccurate elevation data.

We also added a paragraph explaining what is addressed in the paper:
In this paper we investigate noticeable features in the maps of retrieved XCH_4 over Greenland which can be seen both in the operational S5P XCH_4 product and the S5P WFMD product. For this we investigate the digital elevation model (DEM) used in both retrievals, namely the Global Multi-resolution Terrain Elevation Data (GMTED2010) and compare it to new elevation data from the ICESat-2 satellite mission.

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.

We added information on the quality screening to both sections.

Section 2.1.1:
The product includes a quality assurance value (qa) which is a continuous quality descriptor ranging from 0 (no data) to 1 (full quality data). As recommended in the product user guide [citation] we exclude data with qa$<$ 0.5.

Section 2.1.2:
In another post-processing step the data is quality filtered using a machine learning approach based on a random forest classifier [citation]. We use data with a quality flag qf= 0 (good) and don't include data with qf= 1 (potentially bad).

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.

Yes, this is indeed possible, however we assume these effects to be less significant. We note that the SZA is limited to 75° for the WFMD product and that the surface roughness is part of the product which can help with identifying the slopes, this would allow to filter the affected pixels. We have no definitive answer to these questions and plan to look into it in the future.

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?

Yes, the gridding is only based on the centre coordinate of each pixel. This information has been added to the manuscript.

We define the 7-day XCH_4 anomaly as follows: First we calculate the daily mean XCH_4 for every gridcell, where the gridding is based only on the centre coordinate 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?

This is correct. The linear relationship found in the paper is not used in the postprocessing. We specified this in the updated manuscript:

Finally, we present a preliminary version of an updated WFMD product which is reprocessed using the Greenland DEM [citation] from instead of GMTED2010. Furthermore the quality filter is refined using additional ocean data in the training of the random forest classifier (see [citation]) (18 million added scenes compared to v1.5 equally distributed over 30 days) to reduce scenes with residual cloudiness in particular over the Arctic ocean in summer.

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

Depending on the retrieval strategy of the target gas in question, inaccurate DEM data will impact the retrieved column of other products as well. We recommend the usage of up-to-date and precise DEMs in all algorithms which rely on elevation data. While the magnitude of the errors may vary (or not be significant at all), we advise to use the most accurate data available to ensure highest possible quality of the resulting data products.