Biogeosciences Discuss., referee comment RC1
https://doi.org/10.5194/bg-2022-88-RC1, 2022

Referee comment on bg-2022-88

Anonymous Referee #1

Referee comment on "Sensitivity of land-type variations across Canada using S-5p products" by Saheba Bhatnagar et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2022-88-RC1, 2022

Bhatnagar et al., used the official operational methane data product from Sentinel-5-Presursor (S-5p) to detect land types in Canada using a machine learning algorithm. Their analysis shows (see Abstract) "unique sensitivity to certain land types". They found (see Abstract) that "the areal extent of six land types (marsh, swamp, forest, grassland, cropland, and barren-land)" can be identified "with high overall accuracy by analysing S-5p data over Canada utilising" their classification-segmentation algorithm. For this purpose, they analysed retrieved methane and retrieved surface albedo individually and in combination. They summarized their results as follow: "Monthly and yearly inventory maps were created, which can be used to validate or complement global models where data from other sources are missing and may help in further constraining the methane budget".

General:

I am very surprised by this study. I don't think that the interpretation w.r.t. methane is correct. It is shown in several recent papers that the operational S-5p methane data product suffers from albedo related methane biases, e.g., Barré et al. (2021), Hachmeister et al., (2022), Lorente et al., (2022) explaining, for example, that the locally elevated methane feature discussed in Froitzheim et al., (2021) is a surface albedo related retrieval artifact. The latest version of the scientific retrieval algorithm of SRON (Lorente et al., 2022) and Univ. Bremen (Schneising et al., 2022) are also addressing this albedo (or spectral surface reflectivity related) issue. Bhatnagar et al. are not citing these papers although they are highly relevant for their work. As surface reflectivity related issues are not mentioned in Bhatnagar et al., I assume that they are not aware of this issue.

As a consequence, it appears that Bhatnagar et al. is misinterpreting the albedo related methane bias as a geophysically interesting methane signal, which can be exploited to get land type information. While it may be true that land type information can be obtained by exploiting the albedo related bias (including possibly also real methane variations related to land type dependent methane emissions), I doubt that their results will helps to "further constraining the methane budget" (as written in their Abstract). I see this study as a detailed and interesting investigation of albedo related biases but not as a study that contributes directly to improving our knowledge on methane sources.

I recommend that the authors carefully study the listed references, cite them and modify the paper accordingly (especially the methane related interpretation and conclusions). I also strongly recommend to analyse in addition the latest versions of the two alternative scientific S-5p XCH4 data products, namely the one from SRON (Lorente et al., 2022) and the one Univ. Bremen (Schneising et al., 2022) to find out to what extent the conclusions are robust w.r.t. the used data product. I expect that such an analysis would result in significantly different conclusions.

Specific:

Line 47: Unclear for me why a few km resolution atmospheric data product of a long-lived gas can be used to better define the areal extent of different land use types (compared to few 10 m resolution sensors optimized for land applications).

Line 60 following: The cited reference for the operational algorithm is the pre-launch description and does not reflect the latest version. Please cite also the latest (relevant) ATBD and explicitly mention which version number of the data product has been used.

Line 65 following: The sparse TCCON network does not permit to validate the accuracy of spatial XCH4 maps and, therefore, the listed results in terms of systematic uncertainty may be too optimistic for the application addressed in this publication. I recommend to add this caveat.

Line 93: Please explain "producer accuracy" and "user accuracy".

Equation (2): Please explain all abbreviations (TP, FN, …).

Line 154: Please explain "kappa value".

Section 3.3: Please provide a more detailed explanation of the error metric (J, A, O, E) including how the results are to be interpreted when presenting Table 3.

Figure 2: Very nice and informative !

Figures 3, 5, 6: Please explain better the various curves shown in Figure 3 (how have they been computed, what do they show, interpretation for the purpose of the presented study; I recommend to use one or two cases (e.g., BOG and GRASSLAND) to explain as clearly as possible).

Typos etc.:

Line 50: Replace S5 by S-5p.

References:

Barré, J., Aben, I., Agustí-Panareda, A., Balsamo, G., Bousserez, N., Dueben, P., Engelen, R., Inness, A., Lorente, A., McNorton, J., Peuch, V.-H., Radnoti, G., and Ribas, R.: Systematic detection of local CH4 anomalies by combining satellite measurements with high-resolution forecasts, Atmos. Chem. Phys., 21, 5117–5136, https://doi.org/10.5194/acp-21-5117-2021, 2021.

Froitzheim, N., Majka, J., and Zastrozhnov, D.: Methane release from carbonate rock formations in the Siberian permafrost area during and after the 2020 heat wave, P. Natl. Acad. Sci. USA, 118, e2107632118, https://doi.org/10.1073/pnas.2107632118, 2021.

Hachmeister, J., Schneising, O., Buchwitz, M., Lorente, A., Borsdorff, T., Burrows, J. P., Notholt, J., and Buschmann, M.: On the influence of underlying elevation data on Sentinel-5 Precursor satellite methane retrievals over Greenland, Atmos. Meas. Tech., 15, 4063–4074, https://doi.org/10.5194/amt-15-4063-2022, 2022.

Lorente, A., Borsdorff, T., Butz, A., Hasekamp, O., aan de Brugh, J., Schneider, A., Wu, L., Hase, F., Kivi, R., Wunch, D., Pollard, D. F., Shiomi, K., Deutscher, N. M., Velazco, V. A., Roehl, C. M., Wennberg, P. O., Warneke, T., and Landgraf, J.: Methane retrieved from TROPOMI: improvement of the data product and validation of the first 2 years of measurements, Atmos. Meas. Tech., 14, 665–684, https://doi.org/10.5194/amt-14-665-2021, 2021.

Lorente, A., Borsdorff, T., Martinez-Velarte, M. C., and Landgraf, J.: Accounting for surface reflectance spectral features in TROPOMI methane retrievals, Atmos. Meas. Tech. Discuss. [preprint], https://doi.org/10.5194/amt-2022-255, in review, 2022.

Schneising, O., Buchwitz, M., Hachmeister, J., Vanselow, S., Reuter, M., Buschmann, M., Bovensmann, H., and Burrows, J. P.: Advances in retrieving methane and carbon monoxide from TROPOMI onboard Sentinel-5 Precursor, Atmos. Meas. Tech. Discuss. [preprint], https://doi.org/10.5194/amt-2022-258, in review, 2022.