

Interactive comment on “Systematic detection of local CH₄ emissions anomalies combining satellite measurements and high-resolution forecasts” by Jérôme Barré et al.

Anonymous Referee #1

Received and published: 30 September 2020

This manuscript introduces a method to systematically detect local CH₄ anomalies by combining total column CH₄ satellite observations from TROPOMI with high resolution CH₄ forecasts produced by CAMS. The manuscript is well written but it is at the edge of the scope of ACP, because it rather demonstrates the theoretical potential of the introduced technical method than having general implications for atmospheric science as it is not analysing how well the method can be applied globally (see general comments). However, as the editor has suggested to stay in ACP (instead of moving to AMT), I recommend publication after the following comments have been addressed.

General Comments

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My main criticism of this manuscript (in the sense of a publication in ACP) is its demonstration character with a lack of general implications for atmospheric science. The advantage is that the method can in principle be applied globally. However, it is not clear if the majority of the detected global anomaly candidates are due to actual unreported or over-reported sources or due to local systematic retrieval biases (e.g. as a consequence of small-scale albedo variations). The presented analysis of the method is limited to a few local case studies (e.g. confirmation of known underreported sources) and does not include an evaluation of the global capabilities to distinguish between missed sources and retrieval biases. Although this would be sufficient for an AMT publication, the global detection statistics and the impact of retrieval biases should be investigated further if possible to better fit the scope of ACP (see also specific comments).

Specific Comments

Page 2, Lines 56-59: There are also other relevant studies, e.g. Zhang et al. (2020) or Schneising et al. (2020).

Page 4, Lines 115-117: Is it advisable for the presented method to use a model in which satellite data have already been assimilated (IASI and TANSO)? The assimilated satellite data may already correct for under- or overestimations in the emission data bases to some extent and thus complicate the interpretation.

Page 5, Line 142: Why is Tours visible in Figure 5? What is the origin?

Page 6, Lines 161-163: Please give a reference for the TROPOMI averaging kernel function as a function of pressure.

Equation 6: What does the l_p stand for?

Page 8, Line 235: Should "positive" be "negative"?

Page 9, Lines 252-254: You have identified two candidates, which have not been investigated or documented yet: southern Nevada and northern Baja California. You conclude that the latter may be due to local albedo properties as you were not able to

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identify a responsible facility. What about the former (Nevada)? Is there are a source or local albedo variations?

Page 10, Line 284-287: "Consistent shapes over months" sounds longer than it actually is. Figure 12 only spans a time period of 6 weeks. The red Turkmenistan features in Figure 10 look similarly consistent over comparable periods. This exemplarily illustrates the difficulty of distinguishing between underreported sources and retrieval biases. Concerning persistent shapes over time, please also discuss the potential impact of temporally and spatially variable small-scale albedo features (e.g. due to snow).

Page 10, Lines 293-295: What is praised as an advantage here (does not only allow for the detection of anomalies but also has the potential of detecting local retrieval errors) is also the main problem: It is not clear if it is possible to reliably distinguish between the two cases in general and there is no global analysis performed to try to approach the answer quantitatively.

Figure 7: Please specify the time period. Is it 2019-07?

Figure 8: Please highlight the plot associated to the final choice of parameters (30 days, 2°) and describe in the caption.

Technical Corrections

Please replace CH4 by CH₄ in all instances.

Page 7, Line 193: Please delete "and": "... where d_m is the average departure ..."

Page 10, Line 315: Please delete "to": "... emission events could occur ..."

Caption of Figure 4: Is "next fluxes" correct or should it be "net fluxes"?

References

Zhang, Y., Gautam, R., Pandey, S., Omara, M., Maasackers, J. D., Sadavarte, P., Lyon, D., Nesser, H., Sulprizio, M. P., Varon, D. J., Zhang, R., Houweling, S., Zavala-Araiza,

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D., Alvarez, R. A., Lorente, A., Hamburg, S. P., Aben, I., and Jacob, D. J.: Quantifying methane emissions from the largest oil-producing basin in the United States from space, *Science Advances*, 6, <https://doi.org/10.1126/sciadv.aaz5120>, 2020.

Schneising, O., Buchwitz, M., Reuter, M., Vanselow, S., Bovensmann, H., and Burrows, J. P.: Remote sensing of methane leakage from natural gas and petroleum systems revisited, *Atmos. Chem. Phys.*, 20, 9169-9182, <https://doi.org/10.5194/acp-20-9169-2020>, 2020.

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