EGUsphere, referee comment RC2
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Comment on egusphere-2022-924

Luis Guanter (Referee)

Referee comment on "Using a deep neural network to detect methane point sources and quantify emissions from PRISMA hyperspectral satellite images" by Peter Joyce et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-924-RC2, 2022

The manuscript by Joyce et al. presents an AI-based framework to detect and quantify methane emissions with the PRISMA satellite mission. This data processing formalism is proposed as an alternative to the methods currently used with PRISMA for the same purpose. These typically consist of (i) a data-driven retrieval to derive methane concentration enhancement maps, (ii) plume detection through visual inspection, and (iii) emission rate quantification using IME-based methods. The proposed AI-based formalism helps to circumvent and automate some of those steps, which can be very useful considering the recent increase in the volume of available spaceborne imaging spectroscopy data with the advent of EnMAP and EMIT.

I think the topic fits well in AMTD and is definitely of interest to the growing community dealing with high resolution methane mapping. The manuscript is well written and presented. I generally recommend publication, but I would like to request the authors to address the points below in their revision of the manuscript.

1) Testing on real data: I understand that the proposed methodology is expected to be globally applicable. PRISMA scenes from a wide range of site conditions are actually used for algorithm training (Table S1). However, only results from real plumes in Turkmenistan are presented. Turkmenistan is considered an optimal study region for plume detection, since surfaces are typically bright and homogeneous, and plumes are large. For the readers to get a better impression of the method's performance, it would be great to see how the it works in other sites. In particular, the authors could use the PRISMA scenes and plume detections in the Permian Basin and the Shanxi region reported by Guanter et al. (2021), to which we gave access to the authors. Why were results from those sites not included?

2) Overall presentation of results: I feel that a stronger effort could be done in the analysis and presentation of results from real data. For example, by providing more information on the comparison between the proposed AI-based method and that of the

existing “clustering and thresholding” methods. One could show the potential and limitations of each method, or where the AI-based method does not outperform the supervised method. Also, it would be useful to see more concentration enhancement maps, especially for the plumes which where not detected by the method. Detecting 14 out of 21 plumes with flux rates >1 t/h in Turkmenistan doesn’t sound that impressive, and it would be good if this could be discussed further.

Other points:

L21: “order of km2” the sources or the plumes? I guess the latter?

L29: what is a F1-score?

L20: (line numbering restarted in p4): regarding PRISMA CO2 retrievals, this https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2020AV000350 could be cited

L45: Section 2.2: could you introduce here what this retrieval step is needed for? Not clear to me until much later in the document

L57: among data-driven retrieval methods, I think matched-filter retrievals are used in more studies so far than the PCA-based retrievals. Any reason why you chose the latter?

L74 (p7): I think the per-column processing is actually more important because of striping (column-wise changes in the instrument’s radiometric response)

L74 (p11, line numbering restarted again): There is no Sec 2.4.1.

Fig. 6: 3 of the plumes / emission rates selected for this figure are actually huge. Consider to use more normal cases of 1-3 t/h?

The authors might like to discuss this recent preprint on the same topic https://res.cloudinary.com/diywkbi34/image/upload/v1669115401/Marketing/COP27/Kayrros%20Science_%20Detecting%20Methane%20Plumes%20using%20PRISMA:%20Deep%20Learning%20Model%20and%20Data%20Augmentation.pdf