

## **Review of “A versatile spaceborne architecture 1 for immediate monitoring of the global methane pledge”**

### **Summary**

This paper proposes an interesting method to address the important issue of quantifying current methane emissions. The authors justifiably argue that no current satellite instrument provides both the coverage and the spatial resolution to accurately measure global methane concentrations; to address this lack they propose a two-step method that uses data from two very different instruments: the wide swath, coarse spatial resolution TROPOMI and narrow swath but very high spatial resolution PRISMA. The TROPOMI data are used to locate high methane emission regions and the methane hotspots within these regions, then the co-located PRISMA data are examined for the presence of plumes. Emissions over the hotspots and plumes are estimated by combining wind speed information with an integrated mass enhancement model.

The approach is demonstrated for short periods over five small regions and the results are compared with surveys over two other regions. The median and range of the plume emissions are qualitatively consistent with those obtained using data from another (non-specified) satellite instrument over the Permian basin, and much higher than those from an aircraft campaign over California. The hotspot and plume emissions are also compared with emissions from the EDGAR\_v6.0 inventory; the hotspot emissions were somewhat consistent with the inventory, while the plume emissions were much higher.

Summarizing the above, this is an interesting method with very interesting results. The authors evidently put a great deal of effort and enthusiasm into this work. However, the paper presents several problems, principally lack of detail on how some of the results were obtained. I have listed the main technical issues below, which need to be addressed before the paper can be published. An overarching issue is English language usage. Verb tenses are frequently used incorrectly (e.g, past or conditional future for present), and nouns and adjectives are interchanged. Before resubmitting the authors should have either a native English speaker or someone with excellent English revise the paper. I will be happy to provide more specific wording changes once this been done, if they are still necessary.

1. The method for identifying high emission areas and plumes appears to be visual identification. The authors do mention a Boolean mask for identifying the former, but no details are provided and the reader is left wondering what this means. This needs to be clarified. Such an intensive method is feasible for a small analysis, such as presented in figures 1-3, but obviously not for long term, global emission estimates. Here the authors suggest a machine learning approach for further applications of their method, which is a reasonable suggestion. However, this issue makes the year long results presented in S3 and S4 questionable. Were the TROPOMI maps obtained by applying the Sun oversampling method for an entire year over the original methane

concentrations? If so which wind fields were used to obtain the emissions, both for the regional and plume estimates? How were the PRISMA data averaged over the year? Given the variability in wind direction, I don't think it makes sense to look for plumes in averaged data. These plots need to either explained in much greater detail, or omitted entirely from the paper. If they are to be included, then the authors need to be clear which results (short term or annual) are used in all other plots.

2. The plume maps would be more interesting if the plume source were clearly marked .
3. How was the background vector used in equation 1 derived?
4. What does this sentence mean: methane enhancements detected in spectrometers generally exhibit sparsity, especially over low albedo surfaces.
5. Please define the co-location criteria between the TROPOMI and PRISMA datasets.
6. The section on comparing the TROPOMI/PRISMA results with the California and Permian surveys needs to provide more detail on those surveys (instrument, time of year, temporal and spatial extent). It also needs to emphasize that these comparisons are basically tests of reasonableness, not true quantitative comparisons.
7. The phrase "on a per column basis" is frequently used: what does this mean?
8. The detailed uncertainty analysis is confusing, disorganized and hard to follow. Please put some more thought in how to present this information.