Interactive comment on “Potential of next-generation imaging spectrometers to detect and quantify methane point sources from space” by Daniel H. Cusworth et al.

Anonymous Referee #1

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This paper analyzes the potential to observe atmospheric methane plume from space with the objective of estimating the emission rate. It is based on both radiative transfer simulation and retrievals as well as an analysis of airborne observations. The focus is on spatial observations that would have a spectral resolution lower than that of instrument designed for atmospheric sensing, compensated by a high spatial resolution. The paper concludes that this class of instruments would permit to detect and quantify methane emission for sources down to the range 100 kg/h.

The paper deals with a technical subject that may interest a wide community in preparation for the launch of several space instrument in the forthcoming year. It is therefore a welcome addition to the literature on the subject. The paper is mostly clear and the figure are of high quality. There are nevertheless a few methods that are unclear as well as statements that appear overly optimistic:

- In section 4.1, one discusses the results presented in Figure 3. Although one can “see” the plume in the retrieved images (center and right) for the homogeneous scene when one knows it is there, I am not convinced that an uneducated guest would detect the plume without a significant number of false detections. It seems rather clear that, if the source was 100 kg/h (and not 500 and 900 kg/h) as in the simulated images, the signal would be hardly distinguishable for the noise. Thus, the claim that one would be able to detect and quantify plumes from 100 kg/h source is definitely not founded.

- Lines 229-230, it is said that “8% precision [...] should enable EnMAP to successfully quantify 500 kg/h point sources in a single pass.” There is no attempt at estimating sources in this section, so that there is no ground for this claim. Lines 235, it is said that, for a 900 kg/h source, the plume is “well defined against the background” which is an overstatement.

- Line 284 “but a source rate can still be estimated successfully with EnMAP”. There is no ground in the paper for that statement.

- Line 323: “Nevertheless, the results do confirm that EnMAP should be able to detect plumes and quantify source rates down to ∼100 kg/h”. The analysis of the airborne data show overestimates by a factor up to 3 (mean 2). How can one see that as a confirmation that the source can be quantified?

- In the conclusion it is said that the space measurements can be used to “detect and quantify plumes of magnitude ∼100 kg/h over relatively bright surfaces”. Yet, the simulations have been performed with larger sources (factor 5 to 9). In addition, it is rather ambiguous whether the objective is to quantify the plume (and what that really means) or to quantify the source that generate it. This should be clarified.

In addition, one major source of uncertainty for instrument with a “low” spectral res-
olution is the knowledge of the instrument response function. I understand that the authors have assumed that this response function is perfectly known. It would be nice to add a sensitivity test to analyze the impact of some uncertainty on this important parameter. To the very least, they should mention and discuss the potential impact.

Also, the paper uses a method for plume mask through “median and Gaussian filters” which is not described. Some sentences do describe the principle of the method would be useful.

In conclusion, this paper has the potential to be published in AMT, but there is a strong need to justify better, or to remove, several strong statements. See also a few comments directly on the pdf.

Please also note the supplement to this comment: https://www.atmos-meas-tech-discuss.net/amt-2019-202/amt-2019-202-RC1-supplement.pdf