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

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Received and published: 26 June 2019

The authors investigate the potential of upcoming space-based imaging spectrometers with low spectral and high spatial resolution to detect and quantify methane plumes. The manuscript is very interesting, well written and the scientific methods and assumptions are clearly outlined and (mostly) valid. Therefore, I recommend accepting the manuscript for publication after including the following minor corrections.

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Discussion paper

1 General comments

(1) The authors use the (relative) root mean square error (RMSE) for evaluating the precision of the methane retrieval. However, the RMSE is the sum of accuracy (mean bias) and precision (variance)

$$RMSE = \sqrt{MB^2 + Variance}$$

and thus the analysis of the precision is potentially biased by the mean bias the retrieval. The mean bias might be caused by the strong dependency surface reflectance as discussed by the authors that apparently results in increased XCH4 as seen in Figure 3. Consequently, the author should not use the term "precision" as synonym for the RMSE as done in the text and in Figs. 4 and 5. The authors also need to check how much the computed RMSE is affected by a mean bias and variance and revise their results, discussions and conclusions accordingly. Using the variance will make the results better comparable with the a posteriori retrieval noise (second method), even if the latter is of course not affected by other (random) error terms in the retrieval.

(2) The authors consider SNR of the instruments and other errors included in the EeteS simulator, but assume precise knowledge of wavelength positions. However, inaccurate spectral calibration is a potentially large error source not considered in the study. A further potential error source for the CH4 retrieval are radiometric calibration errors that can result in (systematic) high-frequency patterns in the spectra. The latter could in particular be a problem for instruments where the main application is not influenced by such high-frequency patterns. The authors should therefore discuss these limitations in their study and mention possible recommendation for the instrument developers, e.g. characterization in the lab, to make their instrument more suitable for measuring methane.

2 Specific comments

- P3, L61 and P10, L266: Please provide (rough) numbers of "most" and "majority of anthropogenic point sources".

- P6, L146f: Please specify what you did here. Applying a Gaussian filter with 10.0 nm FWHM to AVIRIS-NG spectra with 5.0 nm FWHM would result in a spectral resolution of 11.2 nm FWM.

- P7, L183ff: Since this seems to be the first time that Legendre polynomials have been used in a DOAS analysis, it is probably worthwhile to provide some additional information here.

- P7, L190f: Please explain why you are testing separated convolutions <*>. I assume this is due to the following inequality: <I0 · exp(-tau) > ≠ <I0>·<exp(-tau) > (Frankenberg et al. 2005, Eq. 16). Frankenberg, C., Platt, U., and Wagner, T.: Iterative maximum a posteriori (IMAP)-DOAS for retrieval of strongly absorbing trace gases: Model studies for CH4 and CO2 retrieval from near infrared spectra of SCIAMACHY onboard ENVISAT, Atmos. Chem. Phys., 5, 9-22, https://doi.org/10.5194/acp-5-9-2005, 2005.

3 Technical corrections

- P8, L223f: Please add parenthesizes, e.g.: (8.2 ± 0.7)

- P11 L312: Varon et al., 2018 -> Varon et al., 2018a

- Table 1: It might be better to use the term "undefined" (or something else) instead of "TBD" which is quite ambiguous.

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- Figure 5 (right): Please add the missing numbers on the colorbar.

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