

Interactive comment on “Towards space-borne monitoring of localized CO₂ emissions: an instrument concept and first performance assessment” by Johan Strandgren et al.

Anonymous Referee #1

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Manuscript “Towards space-borne monitoring of localized CO₂ emissions: an instrument concept and first performance assessment” of Strandgren et al. highlights the importance of global observations to detect and quantify emissions of localized CO₂ emission sources such as coal-fired power plants. They presents a concept for satellites to conduct these observations in the future. They explain the proposed satellite/instrument concept and show global and city-scale assessment results based on simulations. The manuscript is well written and presents interesting new results. I recommend publication in Atmos. Meas. Tech. after the comments listed below have been carefully addressed by the authors.

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General comments

Detection of an emission plume is not the same as accurate quantification of emissions and the paper including the abstract must make clear what exactly is meant here. Abstract, line 6 following: Sentences: “. . . the goal is to reliably estimate the CO₂ emissions from localized sources down to a source strength of approx. 1 MtCO₂/yr,” and “Resolving CO₂ plumes also from medium-sized power plants (1-10 MtCO₂/yr) is of key importance for independent quantification of CO₂ emissions from the coal-fired power plant sector.”. What does “to reliably estimate the CO₂ emissions from localized sources” mean? Please clarify already in the abstract. Is 1 MtCO₂/yr the expected 1-sigma uncertainty / detection limit ? If yes, this would mean that the 1-sigma uncertainties of the medium-sized power plants are in the range 10%-100%. Is this good enough? Or is this just good enough for detection of medium-sized emission sources but not for accurate quantification? In this context: Is it good enough if errors are larger than 4 ppm in 32% of all cases?

Specific comments

Page 4, line3: Sentence “With such a dense spatial sampling, . . .”. This seems to refer to “spatial resolution” mentioned in the sentence before but resolution is not sampling.

Page 4, line 6: Sentence “Wilzewski et al. (2019) recently demonstrated . . .” This statement is too strong as the cited paper is still in review.

Page 5, line 9: Is there a reason why “a local equatorial crossing time at 13:00” has been selected?

Table 1: Please add Adet (detector area) as this is used in several equations. Is the aperture circular so that the aperture area can be computed given the listed diameter? Please add the missing information.

Figure 4 (a): The dotted vertical line is at $x=0.1$ and the label refers to Albedo=0.1 whereas the x-axis annotation lists Albedo times $\cos(\text{SZA})/\text{PI}$. If this is not correct then

please correct this.

Page 9, bottom: Please add a reference for the statement that the SWIR-1 albedo is higher than the SWIR-2 albedo. Is this always the case?

Section 4.2, Fig.9, Fig.10: Is the retrieval using the true CO₂ profile? If not: are the reported errors including the smoothing error? Do Figs. 9(b) and 10(top) only show noise or are there also systematic XCO₂ biases? If yes, where are the biases coming from? Is the bias correlated with the emission plume (e.g., due to aerosols)? Please show retrieved minus true also for Fig. 10. I would expect to see an aerosol-related XCO₂ bias correlated with the emission plume.

Typos etc.

Page 12, line 4: Strange sentence: “For the SWIR-2 set-up it is only retrievals over scenes ...”. Probably “it is” needs to be removed.

Page 12, line 14: Add “nm” after “1.29”.

Page 14, line 2: “Which effect that is dominating ...”: delete “that”.

Page 14: “... the Hestia Project was gridded ...”. Replace by “... the Hestia Project data set was gridded ...” or equivalent.

Various places including References: Check CO₂ etc and use subscripts where needed, e.g., for CO₂ and CH₄.

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