Responses to Report #1

General

Almost all of my concerns and remarks were taken into account in the text properly, including new figure and corresponding text. The paper provides now a useful overview of methods for inversion of local CO2 emissions from satellite images.

We thank the reviewer once again for the positive feedback and the careful examination of the manuscript

Technical corrections

Line 149: Check language ('Worth mentioning ...').

As suggested by the reviewer, we corrected and rephrased several sentences of the text:

Line 149: “Of mention is that…” => “It is worth mentioning that …”

Line 164: “Of particular note the fact …” => “It is worth emphasizing the fact…”

Line 426: “Note that…” => “It is worth mentioning that …”

Line 809: “biassed” => “biased”

Line 1000: “Note that the” => “Notably, the …”

Line 1296: “Note that as sink terms …” => “Sink terms…”

Line 998: Disentangle characters!

As mentioned, we disentangle in the text all the numbers followed by the character “%”

Line 1072: Which journal?

The reference is indeed outdated. We correct to:

Dumont Le Brazidec, J., Vanderbecken, P., Farchi, A., Broquet, G., Kuhlmann, G., & Bocquet, M.: Deep learning applied to CO_2 power plant emissions quantification using simulated satellite images. *Geoscientific Model Development*, *17*(5), 1995-2014. 2024.

There are still some '.' left in the units of Fig. 5 (right axis), Fig. A2 (16 X in legends) and Fig. A9 (axes and caption + typo in right legend). Please correct.

Corresponding figures were corrected as suggested by the reviewer

Fig. 1 is dizzy, improve quality.

As suggested, we improve the quality

Response to Report #2

I highly appreciate that the authors did investigate the performance of the divergence method on single day basis in great detail, and I am excited to see that the results are quite promising. And I agree with the authors that "further investigation is required" here.

We thank S. Beirle for his positive and constructive feedbacks, and for having pointed out the interest of applying the divergence method on single day basis, which led us to strengthen our study.

There is only one aspect I would like to point out: As written in my review, "The authors find the divergence method to show poorest performance for the quantification of CO2 emissions. However, I suspect that this result is partly due to the way the retrieval was done. In particular, the divergence method was treated quite differently, and - if I understood correctly - uses a different data selection than the other methods: The quantification of emissions from methods (1) to (4) require the identification of a plume. I.e. these methods are only applied to favourable conditions which are close to steady state - which is more or less assumed in all approaches. In contrast, the divergence method was applied to a temporal mean flux which probably contains unfavourable conditions as well - please clarify.

We agree with the reviewer that via different selection processes, the other methods identify favorable cases for which they provide emission estimates (typically when the plume detection step is successful). These favorable cases generally correspond to scenes where the plumes can be distinguished from the background variations, and primarily depend on factors such as the wind conditions, the background field, or the amplitudes of the emissions. They do not necessarily correspond to steady-state conditions. However, they probably correspond to conditions which could also favour the application of the divergence method.

In response, the authors extended the conclusions. However, I think that this is an important aspect in order to understand the poor performance of the divergence method that also needs to be discussed in the main part. Thus I would propose to - state that the application of the divergence to annual means implies that the input data sample is different that for the other methods, which were only applied when a plume could be identified (e.g. in line 106 or line 298, might also be a footnote) - remind the reader about this difference in data sample when presenting the poor performance of the divergence method: for the other methods, steady state is more or less fulfilled (otherwise there would be no clear plume), but for the annual mean, also non-steady-state cases are averaged in. I think it is important to point out that the poor results of the divergence method are probably not caused by the method itself, but by the selection of input data.

Following the reviewer suggestion, we emphasized in the new version of the manuscript that our implementation of the divergence method computes the annual means without any selection of the overpasses, while the other methods have internal checks which leads to a selection of favorable overpasses when estimating the annual means. This point is mentioned at the beginning of the section analyzing the results in terms of annual estimates (Section 4.1.):

As noted earlier (Sect. 2.1.5), the Div method computes the annual emission estimate for a given source by averaging the divergence map from all available overpasses in 2015. However, the other methods select overpasses for which they succeed to detect plumes,

likely increasing the reliability of their estimates. These selections generally corresponds to conditions — in terms of wind, of background variability or of emission strength — that should be favorable to all methods, including the Div method. The lack of selection and thus the use of unfavourable overpasses when applying the Div method may therefore hamper the comparison between the annual estimates of the Div method and that from the other methods.

We also rewrite the description of the divergence results in the conclusion section:

The relatively weak performance of the Div method could be explained by the fact that this method was originally developed for the estimation of NO_x emissions and the fields of this chemical species are generally characterized by stronger divergence peaks than for CO_2 fields. Its performance may also be hindered by the fact that our implementation of this method does not select the overpasses from which the annual divergence maps are derived (see Sect. 4.1). Further investigation is needed to determine whether the filtering of overpasses which could be favorable to the method could strongly increase the accuracy of its annual estimates.