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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Tracking city CO_2 emissions from space using a high resolution inverse modeling approach: A case study for Berlin, Germany" *by* D. Pillai et al.

Anonymous Referee #2

Received and published: 29 March 2016

Review of the manuscript "Tracking city CO2 emissions from space using a high resolution Inverse modeling approach: A case study for Berlin, Germany" by Pillai et al.

This study presents the performance assessment of the CarbonSat instrument (which mission unfortunately has not been selected by ESA for the Earth Explorer 8 opportunity) for detection and quantification of the CO2 and CH4 city-emissions globally. Although CarbonSat was not selected, there is a clear need for such a mission specially designed and optimized to getting high resolution images of CO2 and CH4 from emission hot spots. From this perspective the synthetic data experiment like presented in this study is essential for further missions.

The authors estimate the utility of such potential instrument to disentangle anthro-

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pogenic from natural emissions of greenhouse gases given systematic and random measurement errors. This work continues the study of Buchwitz et al. (2013) but with more sophisticated setup. Using Bayesian inversion method the typical expected range of errors for anthropogenic emissions was derived under different scenarios and test cases.

The paper is well written, structured and I recommend the paper to be published at ACP subject to very small revisions listed below.

P3 L10: "The goal swath width is 500 km, but a smaller swath width will likely be implemented to limit cost (ESA, 2015). " Here and elsewhere in the text, check the consistency with the fact that CarbonSat was not selected.

P3 L17: "...Buchwitz et al. (2013a)... " I could not find Buchwitz et al. (2013b) in references (which is also cited further in the manuscript). I supposed you mean the paper: "Carbon Monitoring Satellite (CarbonSat): assessment of scattering related atmospheric CO2 and CH4 retrieval errors and first results on implications for inferring city CO2 emissions" Buchwitz et al. AMTD, 2013 Please, confirm.

P4 L10: "41 vertical levels" Please, indicate the model top at hPa

P4 L26: "An overview of the flux optimization is shown in Fig. 2." I think the reference to Pillai et. al. 2012 is enough. As well as for P11 L19-20, "As can be seen in Fig. 2". I suggest to remove Fig. 2

P5 L11: "Figure 4 shows..." I suggest to keep consistency between figures and use a) b) c) etc. for different panels throughout the paper.

As remark, I suggest to add more clarifications in sections 2.2 and 3.2. At this shape it's hard to get into details of the inversion system. It would be useful to add dimensions for every component of the system. For example the way of constructing Jacobian K, which is sensitivity to parameters lambda (F perturbed = Fdlamda?) showing the dimensions may improve the readability for the reader.

P6 L16: "Eq. (4)" -> "Eq. (6)"

P8 L8: "Any error correlations are neglected, hence Sprior is set to be a diagonal matrix" - is the measurement error covariance matrix also diagonal? If so, add few words about this assumption, especially for CarbonSat-like XCO2 observations.

P10 L6: "...typically differs... " - Typically for Berlin region or in general?

P10 L16-17: "In general, we find that the two different swath widths have a negligible impact on the daily SE of the retrieved emissions" - Please, rephrase this sentence as in conclusion section.

P12 L25-26: "Furthermore, the systematic errors of the retrieved emission fluxes for both swath widths are found to be lower than the systematic error of the prior fluxes (estimated based on “true” fluxes) except for a very few cases,..." Please, rephrase this sentence.

P12 L12: "...in the target region is notably different." - Here need to add ref. to the figure 6 in the end of the sentence. Otherwise this figure is not mentioned in the paper at all.

P15 L22-23: "By showing that the systemic error of the retrieved fluxes is lower than that of the prior fluxes (estimated based on true fluxes) in most of the cases," – please, consider to rephrase this sentence

Also, as a comment to section 4.3 I think there might be effect of ignoring transport model uncertainty giving less weight to the prior fluxes.

As for section 5 - Discussion, I agree with Referee #1 about introduction and discussion of the "clean pixel method" here. From my point of view it disturbs the logic of the paper and I suggest to remove this paragraph.

reference:

M. Buchwitz, M. Reuter, H. Bovensmann, D. Pillai, J. Heymann, O. Schneising, V.

Rozanov, T. Krings, J. P. Burrows, H. Boesch, C. Gerbig, Y. Meijer, and A. LÂÍoscher: Carbon Monitoring Satellite (CarbonSat): assessment of scattering related atmospheric CO2 and CH4 retrieval errors and first results on implications for inferring city CO2 emissions. Atmos. Meas. Tech. Discuss., 6, 4769–4850, 2013, www.atmos-meas-tech-discuss.net/6/4769/2013/, doi:10.5194/amtd-6-4769-2013

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