Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2017-80-AC1, 2017
© Author(s) 2017. This work is distributed under
the Creative Commons Attribution 3.0 License.

Atmospheric Measurement Techniques Discussions

Interactive comment on "The potential of satellite spectro-imagery for monitoring CO_2 emissions from large cities" *by* Grégoire Broquet et al.

Grégoire Broquet et al.

gregoire.broquet@lsce.ipsl.fr

Received and published: 16 December 2017

See a better presentation of the answers in the supplementary document.

Reviewer:

The authors report an observation simulation study of uncertainty reductions obtained using simulated CarbonSat observations of fossil fuel co2 emissions from the Paris, France urban area. In the absense of correlated (bias) errors, the authors estimate that a 50% reduction in uncertainty relative to the assumed prior uncertainty is obtained. The authors also include detailed estimates of the effect of bias errors. General comments: The problem is reasonably well conceived, the methods are sufficient to provide useful information. The results are useful in showing that use of CarbonSat

Printer-friendly version

Discussion paper

data in regional CO2 inversions would reduce uncertainty in urban fossil fuel emissions. The paper would be useful contribution to AMT and could be published with revisions.

Authors:

We thank the referee for this review and for his general assessment of the paper. Please find between his comments ("Reviewer") our answers and indications of how we improved the manuscript in line with them ("Authors").

Reviewer:

That said, the paper covers a lot of material and lacks clarity in some of the figures and description.

Authors:

Regarding the extent of the manuscript, we feel that a critical asset of our study flows from the various sensitivity tests that have been conducted, and from the series of messages that they bring individually or altogether. Therefore, we think that all the aspects and sensitivity tests that have been covered are important and that it was critical to analyze and discuss all of them in a single paper rather than to fragment them between different publications. We have improved or added some figures and legends according to the following comments from the referee.

Reviewer:

In particular, authors might add separate figures showing: 1) the predicted fossil and NEE signals within the modeling domain for one of the OSSE configurations

Authors:

An illustration of the response functions to hourly emissions from Paris and to hourly NEE in the modeling domain (see section 2.5.4) and of their aggregation into response functions for 6-hour emissions and NEE is now provided in the supplementary material

CC BY

(as the new Figure S4). This figure is now referred to in section 2.5.4 and in section 3.1.

Reviewer:

2) the pattern of sampling for each of the different OSSE configurations (TH-CS, TH-LS, SIM- CS from Table 1.)

Authors:

The subfigures corresponding to TH-CS and TH-LS with and without perturbations associated with the measurement noise are now provided in the supplementary material (as the new Figure S1) and referred to in section 2.3. SIM-CS is illustrated in what used to be Figures S1 and S2 which are now Figures S2 and S3, and which have been referred to by section 2.3. We agree that such figures help understanding section 2.

Reviewer:

The figures showing model results need better captions that describe that each panel shows points representing results for each of the 20 model days included in the OSSE (assuming I understand the figures correctly).

Authors:

The reviewer understanding is correct, and this point has been clarified in the legends of the figures.

Reviewer:

The assumption of relatively weak positive NEE for the October period doesn't allow consideration of other seasons. For example, strong NEE uptake in the growing season would result in potentially uncertain drawdown in XCO2 that could mask the fossil signal. This mentioned and potentially estimated numerically to provide a better sense of the seasonal cycle in CO2 sensing.

CC BY

Authors:

This is very difficult to quantify (even in terms of order of magnitude) without re-running the whole set of experiments with new NEE estimates. Our study shows some indices that the system does not fully separate the CO2 emission plume from the rest of the XCO2 scene, but it is difficult to anticipate how much this problem would impact the emission inversion if the amplitude of the NEE was much larger. We cannot extrapolate intuitively the low posterior correlations between uncertainties in the inverted NEE and uncertainties in the inverted emissions obtained in October to another month and then convert it into a level of error in the emission inversions due to problems of separations from the NEE for this other month. This topic was discussed in section 2.9, before the correlations between the posterior uncertainties in the NEE and the emissions were analyzed, and briefly reminded in section 5. We have now extended the corresponding text in section 5 to better address this specific point.

Reviewer:

The methods description of systematic biases is so terse as to be unclear how large are the resulting signal (ppm) biases. It would be helpful to have some additional figure or table to illustrate this before launching into results.

Authors:

What used to be Figure S1, which is now Figure S2, provides an extensive illustration of the values taken by the systematic errors and of their spatial patterns. We have now added a practical description of these errors in section 2.8.3.

Reviewer:

Last, I have not assessed the accuracy of the bias simulations so cannot comment on those results.

Authors:

CC BY

These bias simulations have been generated and presented by Buchwitz et al. (2013). We can only refer to this publication for such a concern (which is regularly done in our paper). A few words have been added to say it more explicitly.

Reviewer:

Specific comments: abstract: The abstract should state the assumed prior model uncertainties (50% on all fluxes) before stating the uncertainty reductions provided by the observations.

Authors:

We have included this information.

Reviewer:

page 7, Eq (1) & (2): The OSSE is estimating scaling factors for hourly (in a band of 6 hours) fossil fuel and NEE using maps of XCO2 covering the entire model domain. This effectively assumes that prior modeled fluxes do not contain significant correlated spatial errors. This should be identified as a limitation of the study and perhaps addressed by comparing with modeled XCO2 signals obtained from a different prior model for emission (e.g., spatially uniform fluxes

Authors:

We do such an investigation with series of exp Bdist in sections 2.8.2, 4.1.1 and 4.3. The uncertainty in the spatial distribution of the emissions is also analyzed through the experiments TH-sect corresponding to section 3.3.

Reviewer:

or a different flux models like EDGAR, GEIA, etc.).

Authors:

This topic and the extent to which we have investigated it were already discussed in

CC BY

section 5. We have now added some indications regarding the type of computations (the use of alternative inventories such as in Staufer et al. 2016) that could be conducted to refine such an investigation even though it was out of the scope of this paper to provide a precise assessment of the impact of all of sources of uncertainties.

Reviewer:

page 11, line 23: What is the justification for assuming prior uncertainties for all fossil fuel and NEE sectors are equal to 50% ? This seems a rather weak constraint relative to uncertainties typically assumed for fossil fuel emissions, though perhaps not so far off for NEE.

Authors:

This was discussed in section 5. There is very little information on the accuracy of city emission inventories at the hourly temporal scale. Most uncertainty estimates are made at the annual or monthly scales. The relative uncertainties for the hourly time scale could be much larger since the diurnal cycle is unknown. In addition, most inventories with temporal profiles are periodical with typical diurnal cycles for typical months, while weather patterns and specific events may have a large impact on the instantaneous emissions. Lastly, for cities other than Paris where there is a lack of information on the fossil fuel consumption, like in developing countries, the uncertainty may be much larger. This discussion has been extended to include NEE and further strengthen the justification for the fossil fuel emissions.

Reviewer:

Fig. 1: The figure axes or caption need to indicate units (degrees?)âĂĺ

Authors:

This has been done.

Please also note the supplement to this comment:

CC BY

https://www.atmos-meas-tech-discuss.net/amt-2017-80/amt-2017-80-AC1-supplement.pdf

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2017-80, 2017.

Printer-friendly version

Discussion paper

CC BY