

## ***Interactive comment on “A first year-long estimate of the Paris region fossil fuel CO<sub>2</sub> emissions based on atmospheric inversion” by Johannes Staufer et al.***

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Review of A first year-long estimate of the Paris region fossil fuel CO<sub>2</sub> emissions based on atmospheric inversion (Staufer et al)

This paper uses atmospheric CO<sub>2</sub> observations in a Bayesian inversion to evaluate urban CO<sub>2</sub> emissions for Paris. It builds on earlier work by Breon et al (2015) that first developed the inversion framework, using the innovative concept of inverting for differences between two observing sites (rather than absolute CO<sub>2</sub> mole fractions). This work expands the dataset to a full year, which allows meaningful evaluation of how well the framework works. The inversion framework already shows some useful outcomes that can inform/improve the bottom-up inventory priors. That is, the observations imply

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a stronger seasonal cycle in emissions than is represented in the bottom-up data products, and this stronger seasonal cycle is also consistent with expectations. They also discuss the challenges and limitations of their inversion framework. A major challenge is that the inversion result is still strongly dependent by the prior (bottom-up) emission estimate. They show that there is still much work to be done to provide detailed information from this type of regional inversion and they provide useful suggestions as to how the inversion could be improved.

This is a very nice paper and an excellent contribution to the (still very small) urban greenhouse gas literature. It is entirely appropriate for publication in ACP with some minor revisions as noted below.

General comments: There is very little attention paid to the contribution of the biosphere to the urban CO<sub>2</sub> observations and its contribution to uncertainties in the inversion. The biosphere fluxes used as priors are described only very briefly, but there is no information about the quality of that prior and how much biases and uncertainties in it might contribute to biases/uncertainties in the inversion. Some discussion of this is needed in the paper.

Specific comments: Pg 2 line 14. “two-month” not “two-months”

Pg 2 line 26. Presumably air parcels pass over the city, rather than through it?

Pg 3. Lines 24-29. This paragraph is hard to follow. It transitions abruptly from a description of preliminary tests to describing what is in specific sections of the paper.

Pg 3 section 2. It would be helpful if the inversion parameters were referred to by what they are, rather than by the algebra term in the equations. For the reader who is not a specialist in Bayesian inversions, it is hard to remember what  $y$ ,  $yo$ ,  $x$  etc are referring to.

Pg 5 lines 1-4. How good is C-TESSEL for the urban area? See also my general comment above.

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Pg 5 lines 15-18. What is the measurement quality for the 1 hour means that are used in the inversion?

Pg 6 lines 3-4. There are other studies that show that ATMs do poorly at night. It would be better to reference some work other from outside your own research group.

Pg 6 lines 30-32. The justification for discarding the GON-MON gradients needs to be given. Is it that the sites are too close together so that emissions are not large enough to create consistent enhancements? Or is there a major flaw in the methodology?

Pg 6 line 26. "BR2015" should be "Breon et al 2015" I think.

Pg 7 plines 10-14. One of the gradients had far more impact than the rest, so was excluded? This seems important - what is the justification for excluding it? How different was the inversion when this gradient was included?

Pg7 lines 20-31. There are a number of minor typos in this section.

Pg 7 llines 20-31. Ylag experiment. How does the ylag experiment account for the evolving boundary layer during the day?

Pg 8 lines 16-21. This paragraph should come before rather than after the preceding one.

Pg 8 lines 29-31. Are these the emissions that are in the model domain but outside Ile-de-France? Not clear.

Pg 10 line 1. (first sentence). Is the conclusion you state from your work or elsewhere? If the latter, please reference.

Pg 11 lines 17-19. Please reference the independent analysis that shows the temperature dependence.

Pg 11 lines 27-32. This paragraph seems spurious.

Pg 12 lines 22-24. Can a problem with a bias in one observation site during the month

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of December be ruled out as a cause of this December anomaly?

Pg 13 "r2" not "R2" in several places.

Pg 16 line 22. You have not demonstrated that GON-MON gradients are "not evidently related to the whole city emissions". See also my earlier comment.

Pg 16 lines 24-31. nd pg 17 lines 18-20. Have you tried inverting with the AIR-PARIF2010 prior? Does it pull the posterior values down even further? Or not? If every inversion pulls the values lower, does this imply a fundamental flaw in the inversion?

Pg 17 lines 1-2. "a large fraction of the Paris emissions are due to domestic and commercial heating". Add "believed to be" or something similar.

Pg 17 lines 29-31. This is a very awkward sentence.

Pg 18 lines 15-18. Be clear here that your inversion solves only for mid-pm observations, and your analysis does not exclude that the poor representation of the diurnal cycle could have a strong impact on nighttime emission estimates.

Pg 20 lines 13-15. Presumably actual nighttime measurements would be useful to constrain nighttime emissions as well!

Pg 20 line 18. The mention of Recife seems irrelevant.

Pg 20 line 25. What is GB?

Figure 3. Caption is inconsistent with labelling on graph (a, b, etc). Also, on the right hand panels, the numbers at the top are hard to follow (they are fine on the left panel).

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