

Interactive comment on “Diurnal, synoptic and seasonal variability of atmospheric CO₂ in the Paris megacity area” by Irène Xueref-Remy et al.

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This paper describes a year-long series of in situ CO₂ measurements from sites in and around Paris. The paper focuses on how and why the CO₂ signals vary: the proximity to the city; height of the inlet above ground; variability in emission sources; wind direction and speed. They demonstrate that in many wind regimes, emissions from upwind sources can contribute as much or more CO₂ than local Paris emissions. They show that urban CO₂ variability is complex, implying that a strong understanding of these factors and the particular sampling network is needed to infer the emission flux from such measurements. Of particular note is that the Eiffel Tower sampling site is challenging to interpret since the inlet height is only sometimes within the boundary layer.

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This is a very nice, detailed examination of urban CO₂ source variability that will be useful for the existing and upcoming urban greenhouse gas researchers. This research area is still in its infancy, and this study gives a very good demonstration of how urban sampling networks should be designed and the types of problems that can be encountered. This paper is entirely appropriate for publication in ACP. I see no major issues with the paper, and recommend minor revisions for clarity and language usage.

Specific comments:

The authors should edit the full paper for correct English grammar. I point out some specific words in further comments, but there are many other cases where the grammar is comprehensible but incorrect.

Abstract page 1 line 31. “elevated” is used here and in other places through the paper to mean “sites where the inlet is well above ground level”. This is confusing though, because “elevated” is also commonly used to mean “the CO₂ is higher than background”. Perhaps “two sites with inlets high above ground level”?

Introduction pg 3 line 3 (and several other times in the paper). “conurbation” is not commonly used in English – I am a native speaker and had to look up the meaning. Perhaps “metropolitan area” would be a better choice.

Pg 5 ln 3-12. Are there any large point sources in the metropolitan area? You mention some in the next section, but it would be helpful to first give them in this section.

Pg 6 lines 13-31. Are there any emissions directly from the buildings you are sampling on top of?

Pg 7 line 16. You say that this station is ideally located, but don't give any justification as to why it is ideal.

Pg 8 ln 6-7. “Only the last calibration. . .” it is not clear what is meant by this sentence. Please clarify.

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Pg 8 In 16. Please give a reference for the ICOS procedure.

Pg 8 In 20. How were the very local influences (that were removed) identified?

Pg 8 In 26. Please reference the WMO-X2007 scale.

Pg 10 In 4. Please provide a link or reference for the Met Eireann met data.

Pg 10 In 23. What met dataset was used in HySplit?

Pg 11 In 11. I don't see the 1-sigma std devs on the plot. Did you mean to refer to figure 6 here?

Pg 11 In 15. Please provide references to previous work that has discussed the biosphere and vertical dilution impacts on CO₂.

Pg 12 In 2. "During daytime. . ." do you mean mid-afternoon?

Pg 12 In 3. "significant positive gradient". Perhaps "enhancement" would be a better word. (Also used elsewhere in the paper).

Pg 12 In 12-14. Why does the lack of diurnal cycle at MHD make it a poor choice for background? If you are interested in examining the urban anthropogenic CO₂ source, then this is probably correct, but if you are interested in the diurnal variability of the continental biosphere signal, then it might be a good choice. Please explain/clarify.

Pg 12 In 22-23. Can you give an estimate of the magnitude of the biospheric flux through the seasons. It would be helpful to know how large it might be relative to the fossil fuel flux (even though the biosphere flux might be poorly constrained).

Pg 13 In 14. I think you mean figure 5 and 6, not figure 7.

Pg 15 In 5-11. I don't see what this discussion of the vertical gradients adds to the paper. It could either be cut out, or a sentence added to explain why it is useful.

Pg 15 In 13-26. The AIRPARIF inventory, I believe, is fossil fuel CO₂ flux only, whereas you measure total CO₂ (both fossil and bio). Could it be that the smaller week-

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day/weekend differences in your observation be due to the fact that biospheric fluxes are constant through weekdays and weekends? I.e. the difference between weekdays and weekends would be proportionally smaller in the total CO₂ observations than in the inventory, if there is a large (and constant) biosphere flux. Could this also explain why the GIF signal is more consistent between weekdays and weekends? I.e. perhaps the biosphere contribution is relatively more important at GIF than the urban sites?

Pg 15 In 28. Does this seasonal cycle include all or only some hours of the day?

Pg 16 In 5-9. Please reference previous work that has discussed this phenomenon of seasonality in BL height, biosphere emissions and fossil fuel emissions. See for example: Denning, A. S., P. J. Rayner, R. M. Law and K. R. Gurney (1995). Atmospheric tracer transport model intercomparison project (TransCom). IGBP/GAIM report series report #4. D. Sahagian. Turnbull, J. C., P. J. Rayner, J. B. Miller, T. Naegler, P. Ciais and A. Cozic (2009). "On the use of ¹⁴CO₂ as a tracer for fossil fuel CO₂: quantifying uncertainties using an atmospheric transport model." *Journal of Geophysical Research* 114, D22302.

Pg 16 In 17-21. Indeed, the CO₂ signals are higher in the winter, but the standard deviations do not seem to be higher in winter. Elsewhere in the paper, the higher standard deviations are used to identify higher anthropogenic emissions. Please justify why this is not the case here.

Pg 17 In 5-10. I don't think you can conclude that fossil fuel emissions are lower in summer from this dataset, since photosynthetic drawdown confounds the signal so strongly.

Pg 17 In 21-24. Please explain and/or reference how the seasonal adjustment was performed. Reference previous work that discusses relationship between concentration and wind speed/ventilation.

Pg 18 In 20-22. Please clarify what the relationship is that justifies using the different

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wind speed regimes to identify local and remote emissions. Another sentence or two would help to follow the logic of doing this.

Pg 18 In 25-29. Please expand this explanation a little more and/or reference the method, particularly for the square root transformation that has been applied.

Pg 20 In 1-23. Exactly how close are MON and GON to CDG airport? Are there any other industrial or commercial facilities that could be causing this signal? In section 2.1.1. You stated that airport emissions are 4% of the total, whereas industrial emissions are 14%, so industrial emissions are potentially more important. Are CDG emissions large enough to plausibly explain the signal at both sites?

Pg 20 In 22-23. How would carbon isotopes and specific emission tracers help to discriminate between airport and traffic emissions? Does jetfuel have a different isotopic signature than petrol/diesel?

Pg 21 In 3-11. See also previous comment – are the CDG emissions large enough at night and close enough to plausibly influence the GON site so strongly?

It would be helpful to include Figure S2 in the main paper, since that shows the actual CO₂ data which is the main focus of the paper. If there is a limitation on the number of figures, Figures 3 and 4 could move to the supplementary material (since the wind directions are also shown in figure S2).

Figure 5 is essentially repeated in figure 6. Could these two figures be combined?

Figure 9a and b could be combined by plotting 9a as an 8th panel in figure 9b.

Tables are mentioned in the text in a different order than the order of their numbering.

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