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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Gradients of Column CO_2 across North America from the NOAA Global Greenhouse Gas Reference Network" *by* Xin Lan et al.

Anonymous Referee #2

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Review of "Gradients of Column CO2 across North America from theÂăNOAA Global Greenhouse Gas Reference Network" by Lan et al

General Comments

In this paper, the authors use regional observations of vertical profiles of CO2 to demonstrate how vertical information shows the impacts of local emissions and transport on the atmospheric column of CO2. This is an extremely important article given the application of satellite data to the task of estimating regional fluxes. In general, the analysis is excellent and the conclusions are appropriate, and I recommend publication after a few changes to address the concerns below.

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Discussion paper

Throughout the paper, the expression “drawdown” is used when what the authors really mean is “negative anomalies”. Âă This is an important conceptual difference, since the entire point of the paper is to determine the information content of column averages on fluxes versus transport. Given the discussion of meteorological phenomena such as the sea breeze and the resulting difficulty in interpretation of anomalies, it’s important to not mislead the reader with this phrasing.

Additionally, the reader might be lead to the somewhat implicit conclusion that XCO2 can’t serve as a constraint on surface fluxes, but this might be an artifact of the multi-month averaging that is used in the analysis in later sections. At least some discussion of the ability of models such as CT to capture transient features needs to be put forth, because these transient spatial gradients could indeed be attributed to fluxes given sufficient accuracy and adequate transport modeling, as has been shown in numerous OSSEs (Liu et al [2014], Miller et al [2007], Rayner and O’Brien [2001], to name just a few). Connecting the analysis in this paper to those earlier studies is critical to readers trying to assess the conclusions of inversion work with OCO-2 and GOSAT.

Specific comments:

Figure 2: Are there statistics of goodness of fit? ÂăThese two examples may not be representative.

Line 207: Can you explain the word “random” here? ÂăIf all of the profiles are given the same weight in the sampling distribution, then this isn’t really a measure of uncertainty, but rather a weighted standard deviation that would be extremely sensitive to the 100 particles you selected. ÂăIf there were a “prior” uncertainty placed on each profile, how was that done?

Line 216: ÂăThere is also some increase due to the shallow PBL alone. ÂăIt would be good to know what fraction is from the enhancement is due just to boundary layer dynamics. ÂăSimilarly for the summer.

Line 228: The PBL height is different at different locations, and through different seasons. ÂăHow much is the chosen division of the atmosphere mis-attributing boundary layer into the free troposphere, and vice versa? ÂăThis might be a small detail, but it does impact the conclusions later about the seasonal strength of sources and sinks by region.

Line 257: "The SE region also demonstrates a less pronounced seasonal cycle with weaker summer drawdown compared with other northern regions, which may due to the sea-breeze influence in summer within PBL." Is this a statement about the actual impact of the sea breeze on the fluxes, or is it an assertion that we can't interpret the column due to the meteorology?

Figure 4: It would be useful to have a fifth panel that shows full column XCO2 with the CT extension here, to re-inforce the assertion on line 249-250 about the information lost by considering the total column.Âă

Figure 9a: The multi-month average XCO2 gradients can easily miss transient features that could, in theory, be well captured by a regional transport model having spatial resolution that is sufficient to capture synoptic features such as fronts. These features could be attributed to fluxes under this assumption, provided biases are small. That doesn't discount this analysis, but it does imply the need to make assertions about the constraint of XCO2 on surface fluxes.

Fig 9b: This vertically averaged wind vector plot doesn't really match the spatial gradient well, in some cases actually being perpendicular to the field. ÂăIt would make more sense to use the potential temperature at 700mb, as did Keppel-Aleks et al in the reference you cite. ÂăAlternately, the 500mb geopotential height is a commonly used field for synoptic scale transport in NWP.

Figure 10: Can you show the same plots, but for the partial columns that are depicted in Figure 9c and d? That would really drive home the point about transport versus local fluxes.

Discussion of Reuter et al [2014]: Is it possible that the differences are due to the manner in which the anomalies are computed? Or are you asserting that the gradients are due to satellite measurement bias? Stating that they "should not be used" needs a bit more justification here.

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