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Interactive comment on "Objective evaluation of surface- and satellite-driven CO_2 atmospheric inversions" *by* Frédéric Chevallier et al.

Anonymous Referee #3

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The authors of this paper aim at evaluating whether airborne CO2 measurements made in the free troposphere can distinguish six flux inversion results that are based on two different transport model versions and three independent CO2 datasets. The three CO2 datasets used here are a selection of surface-based CO2 measurements and column-mean CO2 concentrations retrieved from GOSAT and OCO-2 satellite observations. The authors presented the evaluation result in terms of the mean of differences between the airborne measurement and corresponding modeled posterior concentration at each airborne site.

Specific comments:

1. The authors achieved their goal of distinguishing the six independent flux inversion results with the free troposphere airborne CO2 measurements, but they go further to

address the relative merits and demerits of using GOSAT and OCO-2 retrieval datasets based on their evaluation results. The current design/setup of the experiment, however, is too limited to discuss that topic; the two satellite retrieval datasets were evaluated over different time periods and with different amounts of airborne observations at different locations/sites. Indeed, the authors acknowledge in the conclusion chapter that the current experiment can be expanded to 1) cover longer periods in which both satellite retrieval datasets overlap, 2) understand the impact of differences among multiple GOSAT/OCO-2 retrieval algorithms available, 3) test out other approaches to handle the dense OCO-2 retrievals, and 4) assess the impact of OCO-2/GOSAT differences in data density, data precision, and quality in CO2 retrieving and bias correction. Items 2-4 are particularly essential topics that need to be explored. I would encourage the authors to go to that depth, if they are to touch on the merit/demerit topic.

2. I am left with questions regarding gaps found between the time series of annual fluxes by GOSAT and OCO-2 presented on Figures 2 through 4. In 2015, the only year the flux estimates by the two satellites overlap, larger gaps are found in the time series for Northern and Southern Africa, Eurasian Boreal, Australia, and South American Tropical (lager than those of N. American Boreal/Temperate, Eurasian Temperate). These are regions where surface-based CO2 measurement sites are sparse, as indicated in Chevallier 2018, and also where evaluation by the airborne CO2 measurement is limited (Figure 9; most of the airborne evaluation is concentrated over N. America). South American airborne sites are among the very few sites that are found over those regions under-sampled by surface measurement networks. At these site, CO2 biases are shown to be larger both in the OCO-2 and GOSAT cases (>0.6 ppm; INPE (Figure 8) and RBA-B (Figure 7) sites). Do both the OCO-2 and GOSAT CO2 biases have the same signs (+/-) at these South American sites? Can this help explain the gaps in the regional flux time series? Do the flux gaps fall within the range of flux uncertainties? What are other reasons that may explain these gaps? What Figures 2 through 4 show poses readers a question of whether column-mean CO2 retrievals from multiple satellite missions can be mixed in CO2 source-sink studies. I think these are worth

discussing in depth in this paper.

Minor comments:

1. Figure 2 caption: Please explain in the main text what “edge effects” are.

2. Figure 7: The SURF values are shown in red color in the bar chart, but blue color is used for SURF circles indicating >0.15 ppm differences. Should this be in red??

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