

Interactive comment on “A Global Synthesis Inversion Analysis of Recent Variability in CO₂ Fluxes Using GOSAT and In Situ Observations” by James S. Wang et al.

Anonymous Referee #2

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General comments

This paper describes an impact of satellite observation data on carbon cycle inversion by using multiple settings (observation data sets and prior flux uncertainties) of high-resolution batch Bayesian inversion. The new results are well considered (ex. inversion bias can vary with data coverage). I consider this article should be acceptable after some minor revisions for publications for ACP. One important issue is that the number of observation sites (87 sites (only 10 continuous sites for in situ inversion) is considered insufficient to constrain 108 regional CO₂ flux. The inversion results (chi-squared value, dipole behavior, mismatch against independent observation, etc.) show

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this issue. One option to avoid this issue is to add observation sites (JR station data and amazonica aircraft data) for in situ inversion. The other issue is inadequate description of satellite retrieval bias. I consider the difference between in situ inversion and GOSAT inversion comes from not only satellite sampling bias but also satellite retrieval bias. The authors should discuss retrieval bias of satellite from validation of multiple inversion results and show some choices. Because modification of satellite biases (sampling and retrieval) is significantly important to the future use of satellite observation data in carbon cycle analysis.

Specific comments

Line 38: The authors should also mention the influence of satellite observation errors on this sentence.

Line 54: At 2010, a relatively high temperatures around eastern North America event (all year round) occurred. This event might have affected greater uptake over the region.

Line 68: The authors should refer to the high precision feature of observation data in this sentence.

Line 178: In the experimental settings, natural (biosphere and ocean) net sink is too small comparing with current knowledge. This means that it is necessary to redistribute a large amount of CO₂ flux by inversion. Errors tend to occur due to transport model, observation data and inversion settings. The author should mention about it.

Line 204: 87 sites seem to be insufficient comparing with 108 regions (numbers of continuous sites are only 10 and geographically unevenly distributed). The authors should use more observation sites to constrain these regional CO₂ flux.

Line 226: The minimum value (0.01ppm) of the standard deviation of the observations within a particular looks too small. The authors should clarify the reason.

Line 307: The authors should show a thickness of the lowest model layer.

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Line 308: The authors should show numbers of dimensions of matrix (especially GOSAT and in situ + GOSAT inversion).

Line 392: The authors should also mention the bias of satellite observation.

Line 398: The authors should discuss the reason why chi-square of GOSAT inversions is almost same.

Line 422-425: The authors need multifaceted discussions. It is difficult for this inversion setting (PCTM horizontal resolution (about 200km) and 8 day mean flux) to reproduce CO₂ concentrations near surface at regions where vegetation activities are active like tropical rainforests.

Line 434-437: The authors should show the usefulness of increasing the number of observation data.

Line 448-453: The authors should show degrees of freedom for signal and noise for in situ + GOSAT inversion as previous paragraph.

Line 537: The authors should unify expression (prior/in situ/GOSAT) for N. Pacific and N. Atlantic.

Line 572: The lack of ocean observations at southern high latitudes brings analysis results closer to a priori information. The authors should consider satellite retrieval bias.

Line 577-579: 67ppm difference seems too large. The author should identify and remove the cause observation data from inversion.

Line 586-588: In general, current transport models could not well reproduce tropopause. The authors should use only tropospheric HIPPO data in figure 10 (c,f) for discussion.

Line 642-643: It seems that the figure and explanation sentences do not match, so more detailed explanation is needed.

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Line 644: The larger anti-correlations is visible among land area (Bor. N. America and Temp. N. America, Trop. America and Temp. S. America, N. Africa and S. Africa, Temp. Asia and Trop. Asia). The authors should discuss such anti-correlations.

Line 756: A decreased sink in parts of North America (Eurasia) almost matches high temperature anomaly area at 2010 summer. The authors should mention this point in this paragraph. Amazonica aircraft data also could constrain tropical America CO₂ flux. <https://www.ncdc.noaa.gov/sotc/global/201007>

Line 767: Measurements from the JR-STATION are significantly important to constrain Eurasia CO₂ flux. The authors should include these data to inversion.

Line 860: The author should consider possibility of using CONTRAIL dataset.

Line 863: Satellite retrieval bias also reflected in this paragraph.

Line 889-891: GOSAT TIR retrieval also could provide high latitude winter observation. The authors should mention it.

Figure 1: The authors should show validation sites (JR stations, HIPPO and amazonica aircraft).

Figure 5: The authors should show Tropical America to discuss validation against amazon aircraft data.

Figure 6: The number of observation sites should be shown in the bottom of the figures to know how much the region was constrained.

Figure 10 and 13: The authors should remove or mention outlier (stratospheric observation data?) in the figure. The authors should show from (a) to (f) in the figure.

Figure 11: The GOSAT inversion seems to enhance dipole phenomena comparing with the in situ inversion. The authors should explain it.

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