

Comment on **essd-2022-15**

Anonymous Referee #2

Referee comment on "A 10-year global monthly averaged terrestrial net ecosystem exchange dataset inferred from the ACOS GOSAT v9 XCO₂ retrievals (GCAS2021)" by Fei Jiang et al., Earth Syst. Sci. Data Discuss., <https://doi.org/10.5194/essd-2022-15-RC2>, 2022

The authors provide a detailed description of their new GCAS2021 dataset for monthly global NEE data over 10 years from 2010-2019, which were inferred by using their data assimilate system GCASv2 to assimilate the latest GOSAT XCO₂ retrievals of version 9. The manuscript is well written, easy to understand while clearly covering important aspects of the dataset, from their inversion method to the comprehensive evaluation using independent data etc. The resulting dataset is meaningful, and easy to use. Together with other top-down and bottom-up NEE /NBE data, it can be used to improve our understanding of terrestrial biosphere-atmosphere carbon exchange, although (just like other NEE/NBE datasets) there are still some open questions on its reliability, particularly over regions poorly covered by GOSAT observations. Hence I recommend it for publication after minor correction.

Major comments:

1 As shown in Figure 6, discrepancies from other top-down inversions (such as CMS or CT2019b) are quite significant over tropical regions, and also over South America temperate and South Africa. As mentioned by the authors, it could be caused by different observation coverages.

To help the reader understand the impacts of poor (GOSAT) observation coverage over regions (like the Tropical South America etc) on the top-down flux inversion, I suggest the authors include a simple comparison with their own and other groups' inversions based on the denser OCO-2 XCO₂ data for 2015-2019. Such comparisons may also help answer the question whether the high net flux in 2019 (Table 1) is realistic.

2 I'd like to see more details on the assumption of the a priori error covariance, and like to know how the authors aggregated posterior error across different assimilation windows to calculate the uncertainty for annual flux.

Table 1 shows that assimilation of GOSAT XCO₂ has reduced the uncertainty of the global annual NEE total by about 16% (i.e., from 0.6 PgC/yr to about 0.5 PgC/yr), which seems lower than other literatures. I am not sure whether the temporal error correlations between assimilation windows have been taken into account in the calculation of those annual uncertainties.

Minor comments:

1 Line 31, Page 1: 'We believe that this dataset will contribute to regional or national-scale carbon cycle and carbon neutrality assessment ...',

I think this dataset can be very useful, particularly when combined with other top-down and bottom-up results. But for me, the above statement is a bit too strong, considering the significant discrepancies with other datasets over several regions critical for global carbon cycle. I also don't see direct comparisons/evaluation at national scale. I think further assessment are needed, and at this moment, it is better to say "this dataset can contribute to ..."

2 Line 73, Page 3: 'data are now available'

Change to 'data is now available...' (to be consistent with line 74 ', which spans...')

3 Line 135, Page 5: '... the product of CT2017...',

'CT2017' has not been mentioned before. Should it be 'CT2019B' instead ?

4 Line 150, Page 5: Equation 1.

Please define i and N . It is a bit confusing as the gridded product was at a horizontal resolution of 1×1 , but the transport model was run at 1.9×2.5 .

5 Line 239, Page 9: '...which also shown'

Should be '...which also showed'

6 Line 251, Page 9: '...shown that'

Should be '...showed that '

7 Line 262, Page 9 & Figure 6 Caption

Please use 'TRANSCOM' or 'TRANSCOM 3' consistently

8 Line 315, Page 8 & Table 1.

It is better to include prior estimates for comparison. Also, why were the CMS and CT2019B results not included in this table ?

9 Table 1:

Table 1 shows a high net flux of 6.08 PgC/yr during 2019, which is higher than 2015 (5.95 PgC/yr). It seems inconsistent with NOAA atmospheric CO₂ growth rates derived from the in-situ network (i.e., 2.57 ppm/yr (2019) vs 2.96 ppm/yr (2015)). Also, to my knowledge, some inversions based on OCO-2 XCO₂ data or based on the surface in situ network showed significantly lower net global fluxes (upto 1 PgC/yr). Some discussions

may be needed.

10. Line 425, Page 15: ' In the Amazon basin, the simulated, CO2 profiles also agree well with the observations...'

I think the results (Figure 12) actually suggest there could be systematic bias in the posterior fluxes over Amazon basin.