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Interactive comment on "Carbon Monitoring System Flux Net Biosphere Exchange 2020 (CMS-Flux NBE 2020)" *by* Junjie Liu et al.

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This article documents the land biosphere prior and the optimized land biosphere and ocean posterior fluxes resulting from a 2010-2018 inversion using the Carbon Monitoring System (CMS) modelling system. The observational inputs are restricted to satellite measurements of XCO2, based on GOSAT for 2010-2014 and OCO-2 from 2015-2018.

My first hesitation is based on the appropriateness of publishing optimized fluxes in ESSD. These are not measurements, but rather, by definition, a model-based interpretation of measurements. In the description of the Aims and Scope of the journal it states that: "Any interpretation of data is outside the scope of regular articles." On some level

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this is a philosophical distinction, and it seems this article has made it through the first quick review process, so I have to assume that the editor does not see a major problem here.

My next hesitation is on the criterion of "Completeness". This is one of the categories reviewers are asked to assess, stating that: "A data set or collection must not be split intentionally, for example, to increase the possible number of publications. It should contain all data that can be reviewed without unnecessary increase of workload and can be reused in another context by a reader."

The current paper seems to be a classic case of withholding part of the dataset to release it in a future publication. The modelling system used has been well-documented in its ability to (quoting from the Introduction): "resolve regional fluxes, and also disentangle net biosphere exchange (NBE) into constituent carbon fluxes including plant gross primary productivity (GPP) and biomass burning through solar-induced fluorescence and carbon monoxide proxies, respectively (Bowman 53 et al, 2017, Liu et al., 2017)." So is that what is reported here? No, they have decided to only report NBE, stating that" Subsequent papers will present the partitioning of the NBE into constituent gross fluxes." This seems like a clear infringement of the "Completeness" criterion. My recommendation would be to include the optimized GPP, biomass burning, and respiration fluxes in the same data release, and have an accompanying analysis paper (in another journal) that goes into the interpretation of the retrieved signals. One of the unique strengths of the CMS is its partitioning of the net land biosphere fluxes, which most modellers do not claim to be able to do with any confidence. It is this partitioning that would make the resultant fluxes more interesting for comparison against other approaches.

Finally, my third hesitation is related to the data quality. This is not related to anything that the authors themselves have done wrong, but there are (still) clear limitations to using only satellite data in an inversion. This has been well documented in the literature (e.g. Basu et al., 2013; Chevallier et al., 2014), and leads to an unexpectedly

high source in northern Africa (and perhaps a too-large sink in Europe) that is hard to reconcile with bottom-up fluxes and inversions based on surface/in-situ measurements. The magnitude of this potential bias has decreased in more recent retrieval versions but has not disappeared.

This discrepancy is clearly seen in the limited validation that is presented here, when the optimized concentrations are compared to the Atlantic ATom-1 and -2 flights. At least this inconsistency with independent data is documented: hopefully potential users of this dataset will not assume that their model is wrong simply because it disagrees with the CMS fluxes. One potential improvement here would be to include also fluxes optimized based on surface-based measurements, to give some idea of the uncertainty in the fluxes as a result of the choice of input data. (The estimated fluxes will most likely not agree within the stated uncertainties.)

This is downplayed by comparing the global land biosphere budget to widely accepted values from the Global Carbon Project (Friedlingstein et al., 2019), rather than the regional breakdown. Comparing to Figure 8 of Friedlingstein et al. (2019) it seems that the tropics are a more substantial source and the extratropics a more substantial sink than is seen within the spread of inverse models included in the GCP analysis.

Another potential limitation to the usefulness of the data is the underwhelming resolution. Monthly fluxes at 4 x 5 degree resolution are no longer really state-of-the-art. One of the arguments for using satellite measurements is the higher spatial resolution of the signals that can be resolved compared to the rather sparse surface-based network. This dataset is not exploiting to this strength.

Based on these concerns, I would not recommend publishing this paper in ESSD in its current form.

Other comments:

Regarding the completeness of the dataset presented, I had some minor concerns.

I tried to check the availability of the datasets linked to here, and found that I was not sure which version of the ECCO-Darwin fluxes had been used: the data portal lists several different options. I was not even entirely sure if the ocean fluxes had been optimized, but the netCDF gridded fluxes describe the ocean fluxes as "posterior ocean fluxes,2010-2014 constrained by GOSAT, 2015-2018 constrained by OCO2", so I assume that they are not identical to the prior. In any case, this could be clarified. Similarly, the paper mentions that FLUXCOM-GPP is one of the inputs to CARDAMOM, but there is more than one version of this product as well. Even CARDAMOM comes in different flavours, I believe, based on the documentation in the cited papers. For completeness it would be suitable to include all the prior and posterior fluxes in the dataset - including the anthropogenic fluxes which are not optimised. Only then can the full budget be assessed.

I do not see the purpose of providing the monthly fluxes (with uncertainty) at 13 different FLUXNET sites. As far as I can tell, these are extracted directly from the model, and do not represent additional downscaling or enhanced temporal resolution. The benefit of this (and the rationale for the selection of these specific sites) is not clear to me. The measured monthly mean NBE at these sites is not included for comparison, nor is any validation using FLUXNET sites provided in the manuscript. It seems redundant.

I was surprised by the choice of the masks used for aggregation of fluxes. If two masks are included, why not include the broadly-applied TransCom mask? The benefit of such a common mask is the ease of comparison. Yes, a user may apply his or her own mask to the data, but it really does not add much in terms of space (22 regions with monthly resolution), and would facilitate comparison with already available model output. This is likely of more general application than the two custom masks given here.

Minor/typographical comments:

L29: “from Greenhouse” -> “from the Greenhouse”

L30: remove “the” before NASA

L49: Crowell et al. 2019 is an odd choice as an example of inversions based on surface CO2 observations, as this was explicitly not the focus of the publication.

L55: The NBE are far -> NBE is far

L108: suggest " North America (NA)" -> "North American" (abbreviation is established elsewhere, and adjectival form fits better here)

L122: Section 8 is -> Section 8 describes the

L128: "that no" -> "no"

L151: its -> their

L161: from2010 (missing space)

L169: CARDAMON -> CARDAMOM

L184: by ACOS -> by the ACOS

L185: maximize -> maximizes

L193: land nadir good quality observations -> land nadir observations flagged as being of good quality

L221: of OCO-2 -> of the OCO-2

L272: over Pacific, and -> over the Pacific, but

L277: its -> their

L279: each nine -> each of nine

L283: fractions sampled at ith aircraft locations -> fraction sampled at the ith aircraft location

L285: of mean -> of the mean

L287: either posterior fluxes or transport -> either the posterior fluxes or the transport

L288: posterior fluxes -> the posterior fluxes (twice)

L315: of RMSE to posterior flux using GEOS-Chem -> of the RMSE to the posterior flux using the GEOS-Chem âĂĺ L342: Please rewrite the first sentence.

L355 & L366: by NOAA -> by the NOAA

L360: of posterior -> of the posterior

L371: calculate -> calculated

L375: with GCP -> with the GCP (or, “with the range estimated by the GCP,”)

L382: shows large -> shows that large

L382: Southern -> the Southern

L383: eastern -> the eastern

L409: or weakly -> or are weakly

L410: during 2015 -> during the 2015

L415: Pouter -> Poulter

L416: capitalisation weird in “tropical south America Savanna”âĂĺ L440: above planetary -> above the planetary

L446: used NOAA -> used the NOAA

L448: is equal or above -> is greater than or equal toâĂĺ L450 & L482 & L497: Southern Ocean -> the Southern Ocean (as an aside: the weaker seasonality certainly plays a role, but this was also a “problem region” in comparison to Atom-1 measurements, so perhaps there is something else going on there. . .)

Figure 2: It is really difficult to tell the regions apart on this map. The blues in North America, for instance, really blend together.

Figure 9: This figure seems unnecessarily cramped. Perhaps split it into two? For instance, I could barely tell that the bars were really blue without zooming way in, as they are so tiny.

General figure comment: Something is a bit off with the rendering of the digits in your colour bars, making the bottom bar of “2”s disappear and making a gap in the bottom of round digits.

L466: from Monte -> from the Monte

L478: What is meant here? “either transport or low of posterior flux uncertainty estimates”: Perhaps, “either transport errors or too low values for posterior flux uncertainties”?

L480: of flight -> of the flight

L493: defined -> as defined

L496: These -> The, also, specify which ratio you mean “between RMSE and RMSEMC“

L500: Pacific -> the Pacific

L503: these -> the

L504: with 4° x 5° resolution transport model -> using a transport model with only 4° x 5° resolutionâĂĺ

L513-515: A bit awkward, please rephrase.

L516: indicates small -> indicates a small

L518: of posterior -> of the posterior

L533: to FLUXSAT -> to the FLUXSAT

L541: “needs caution” -> perhaps better: “calls for caution”?

L556: by GCP -> by the GCP

L562: atmospheric -> the atmospheric

L563: level -> levels

L576: provide support the monitoring of the regional contributions to the changes inÂăatmospheric. . . I'm not sure about this, perhaps: "support the monitoring of the regional (biospheric) contributions to changes in atmospheric. . ."?

L580 & L582: data is -> data are

L582: ensemble posterior -> ensemble of posterior

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