

We thank all reviewers for their comments. Our detailed response is provided below (in blue). We hope we have clarified all the issues raised. The main modifications to the manuscript made in response to the comments received was the addition of a new Table (Table 3) which provides an overview of the main methodological changes that have taken place between each carbon budgets published so far. We also added a column to Table 5 to specify the changes in the models that have taken place since the last published version of the carbon budget. Finally we provided the data for the carbon budget from year 1750, as shown used in the manuscript.

Compared to the version submitted to ESSDD, we modified the LUC CO<sub>2</sub> emissions. The submitted emissions were from an update of the Bookkeeping method published in last year's carbon budget. This update is no longer included in the revised paper, which uses the same LUC emissions published last year. This is because the underlying paper describing the update, in review at the time of submission, is not yet published. We revised all figures, tables and text accordingly. The largest change is the revision of the cumulative emissions, which have gone down from 590±75 PgC to 570±70 PgC. We also added one DGVM (ORCHIDEE, already published last year but not available at the time of submission) and made a small correction to one ocean model. The changes in the DGVM ensemble and ocean model have minor impact on the manuscript.

#### **Interactive comment on “Global carbon budget 2013” by C. Le Quéré et al.**

##### **M. Heimann (Referee)**

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The authors present an update of the global carbon budget based on a revised synthesis of existing datasets of fossil fuel CO<sub>2</sub> emissions, emissions from changes in land use, atmospheric CO<sub>2</sub> increase, ocean CO<sub>2</sub> uptake and changes in the net budget of land carbon inferred from the global budget equation as a residual. The applied methodology is essentially the same as in the previous assessment published in 2013. The main difference is the addition of the new estimates for the year 2012 and some- what revised numbers of the CO<sub>2</sub> emissions from changes in land use, primarily after 1982. The manuscripts includes a new section providing a brief discussion of non- CO<sub>2</sub> carbon emissions (primarily CH<sub>4</sub> and CO) which are deemed small in the global context, as well as a brief description of the carbon transfers from land to ocean and atmosphere through the hydrological cycle. However, these new elements are not considered to affect the global budget numbers; primarily because they are small and thus within the uncertainties of the budget terms. Furthermore, new observation based global estimates of the ocean sink are included, as well as the results from a new crop of dynamic global vegetation models. This auxiliary information is included as a plausibility check on the global annual budget and its temporal variability, but it is not used to correct the global budget numbers determined with the base methodology.

Major comments:

- 1) As in my review to the previous paper (Le Quere et al., 2013), I am not happy with the nomenclature. The text refers to the “anthropogenic budget”, even though climate related natural variability clearly is also reflected in the presented budget numbers; especially on shorter time scales. In some places climate and other changes are added as a qualifier, but the text would gain by being more precise here. A case in point: take Table 7 labelled “Anthropogenic CO2 budget” which clearly includes these other terms. Why is the decadal land sink maximal in the 1990’s? This is clearly not an “anthropogenic” effect. Why not consistently throughout the text simply refer to the “global carbon budget” and use the term “anthropogenic” only where appropriate (e.g. for the FF and the LU terms)?

We have removed the term ‘anthropogenic’ from the introduction and all instances where it was associated with the partitioning of carbon between the atmosphere, land and oceans. We kept ‘anthropogenic’ in relation to emissions only, and in the section on the Land-ocean aquatic continuum where the text specifically refers to the human-driven component of the LAOC.

- 2) The dataset associated with this manuscript only contains estimates for the period 1959-2012. However, at several locations in the text and e.g. Figure 2, as well as the reported cumulative emissions since 1750 refer to data that are not available in the excel spreadsheet. E.g. the LU emissions prior to 1959 are discussed in the text; they appear to have changed, however, they are not included in the dataset and the given reference is a manuscript that is not yet been published. Either the budget estimates prior to 1959 should be included, or the referring text bits removed.

We will provide the carbon budget data from 1750 in the spreadsheet. We have requested permissions from the various authors and they all agreed.

- 3) The main group of authors of this manuscript have published in the framework of the Global Carbon Project each year an updated version of the global carbon budget. These previous updates are referenced in the text, as well as in the data excel spreadsheet. However, it would be very useful for the uninitiated reader if the major changes in methodology of each update were summarised, perhaps in a Table. E.g. earlier versions of the budget included the additive bias correction of the ocean sink trend as compared to the multiplicative method in this and the previous version. The difference in the reported ocean sink in the 1960’s is substantial but difficult for the non-specialist to pull out of the various publications in different journals.

As suggested we have now included a Table which highlights the main changes for each of the eight carbon budget releases (new Table 3).

- 4) The present document contains a completely different group of DGVMs as auxiliary information for the plausibility check on the terrestrial sink as compared to the variant reported in 2013. Why did the authors now choose different models? Are the model results of last year no longer valid? This new choice of models needs to be explained, and why the models of last year are now no longer considered state-of-the-art.

We have included a column in Table 5 (now Table 6) that explains the main changes since last year’s

publication. We also added text in section 2.2.3 to indicating that the models used are not all the same as the models used in 2012. The text is as follows: “We use only models that have estimated LUC CO<sub>2</sub> emissions and the terrestrial residual sink following the Trendy protocol (see Section 2.5.2), thus providing better consistency in the assessment of the causes of carbon fluxes on land. Models use their latest configurations, summarised in Tables 5 & 6.

- 5) Uncertainties of FF emissions: Guan et al., 2012 come up with a systematic uncertainty for the Chinese emissions alone of 0.4 PgC/yr. Does this not imply somewhat less optimistic uncertainties for the FF emissions than reported here (1sigma on global emissions = 0.4 PgC/yr).

We use an uncertainty of 15-20% for China for the 95% level ( $\pm 0.4-0.5$  PgC/y), or 7-10% for  $\pm 1$  sigma ( $\pm 0.2-0.26$  PgC/y) as assessed by Gregg et al. 2008. The range of 0.4 PgC/yr found by Guan et al between emissions estimates using the national and provincial statistics lies almost exactly on both sides of our own estimate for China (so a distance of 0.2 PgC/y). We find the Guan paper alone does not provide a compelling enough argument to increase our uncertainty estimate for China. More work including all sources of uncertainties would need to be done for this.

- 6) p. 694: the proper reference to the ppm to PgC conversion number is Prather et al., 2012; Joos et al only cite it. This needs to be changed also in Table 1.

Changed to ‘Prather et al., 2012’ as suggested, also changed in Table.