

### RC3 Michio Kawamiya

#### General comment

The Global Carbon Program (GCP) annually publishes a detailed analysis of the global carbon cycle budget using simulation model results, observational and statistical data. This manuscript is the latest edition of such analysis, and many parts of the methodology have been thoroughly reviewed in previous editions. The manuscript is deemed acceptable assuming that the authors provide appropriate responses to these comments.

#### Specific comments

II.214-216: In line 190, the authors excluded cement carbonation. It is not quite clear whether the “total anthropogenic emissions” include cement carbonation or not. Please clarify.

*We now always included cement carbonation in the global EFOS estimate*

section 2.5: The authors mention several times on emissions from peat fire, but not on those from natural and anthropogenic biomass burning. How are they treated in this estimate?

*Natural wildfires are part of the natural sink terms (SLAND) as estimated by the DGVMs, as was mentioned in I. 878. However, not all DGVMs simulate fires, so our confidence in assessing this specific contribution would be low. Note that there is the FireMIP activity that assesses DGVMs wildfires. Anthropogenic biomass burning is included in the processes covered by the bookkeeping models.*

Some of the DGVMs list in Table A1 are not DGVMs in its narrow sense, i.e., models that predict the distribution of plant types. VIST, for example, deals with biomass variation with a fixed distribution of plant types. Note somewhere that the term “DGVMs” in this manuscript simply means vegetation models. Also, it would be more user-friendly if Table 4 is referred to in addition to Table A1.

*Yes the reviewer is correct that there is no one single definition of DGVM. The term is now used as generic, encompassing sense. For example, a model with seasonal phenology could be considered “dynamic vegetation”. Furthermore we impose changing vegetation fractions (via LUH2), so vegetation fractions are dynamic in a sense. Hence to avoid confusion we would like to keep the use of DGVM, but we added the following sentence to Table A1. “Here we use the term “DGVM” in the broadest sense in terms of global vegetation models which are able to dynamically adjust to imposed LULCC.”*

I.562: ONI index -> The acronym ONI includes the word “index”. Please just say “ONI” instead of “ONI index”. There are a few other places where the same expression is used. I am afraid that the authors are well aware of this, but I presume many of the readers will feel uncomfortable with this expression.

*Thank you, corrected now.*

I. 891: This sentence says that 30% is from LUC and 79% is from fossil fuel. The sum exceeds 100%.

*Typo, sorry, It is 30% and 70%. Corrected now.*

I. 976: The text says “one new model is included” but Table 4 shows there are two models that are new this year. Perhaps the authors meant something like “one of the new models bears an estimate higher than the average”?

*Good catch, thank you. Rephrased to: “because two new models are included (CESM2, MRI)”. Both new models have higher than average CO2 uptake.*

II.1034-1035: “This suggests... by the ocean.” This sentence casts doubt on the scheme adopted in the manuscript to calculate ocean uptake as an average between GOBM estimates and observation-based products. Isn’t it more suitable to put some weight on the observation-based products when the authors are so sure that GOBMs underestimate the uptake? Explanation from the authors on this point would be appreciated.

*This is an excellent question. The GOBMs likely underestimate the CO2 uptake by about 10% (this number was now added to the text). However, the pCO2-based data-products have large uncertainties, too; see discussion in sections 3.5.2 and 3.7.3, and Table 10. In fact, these may be even larger than the 10% underestimation by the GOBMs, but this is work in progress. We will be able to give more information on this in the next year. In view of the uncertainties in both data streams, taking the average of both ensembles seems the best approach at present.*

II. 1398-1399: It is stated that the importance of ELUC is increasing, but given the fact that the fraction of ELUC to the entire GHGs emission is decreasing, the statement sounds somewhat contra-intuitive. Explanation on this point would be appreciated.

*That sentence refers to the climate mitigation discussions, where land based mitigations are gaining more and more interest (despite the fact that ELUC is getting smaller relative to EFOS as mentioned by the reviewer).*