Response to Reviewer #1

In this study, the authors analyze three DGVM-derived fLULCC estimations for twelve models within 18 regions and quantify their differences as well as climate- and CO2-induced components. Results showed a global fLULCC of 2.0 ± 0.6 PgC per year for 2009–2018, of which ~40% are attributable to the LASC. Regional hotspots of high cumulative and annual LASC values are found in the USA, China, Brazil, Equatorial Africa and Southeast Asia, mainly due to deforestation for cropland. Distinct negative LASC estimates, in Europe (early reforestation) and from 2000 onward in the Ukraine (recultivation of post-Soviet abandoned agricultural land), indicate that fLULCC estimates in these regions are lower in transient DGVM- compared to bookkeeping-approaches. By unraveling spatio-temporal variability in three alternative DGVM-derived fLULCC estimates, our results call for a harmonized attribution of model-derived fLULCC. This study proposes an approach that bridges bookkeeping and DGVM approaches for fLULCC estimation by adopting a mean DGVM-ensemble LASC for a defined reference period. I would recommend this work for publication with few minor modifications.

Thank you very much for the review and the recommendation for publication.

Specific comment:

Line 130: More introduction about" gridded output" is needed. For example, the resolution of these data. Monthly data or Annual data?

Thank you for this comment. We will add columns with information on the spatial and temporal resolution of output provided for each model to Table 1 and slightly modify the referencing text and table caption.

Line 140: All abbreviations must be explained. For example, HYDE and FAO.

Thank you, we will add the full names for HYDE and FAO at their first occurrence and slightly modify the respective sentence. Similarly, we will add the full name for RECCAP2 at first occurrence and to the caption of Figure A2. We could not find any other abbreviations that were not introduced.

Line 154: 'the amount of precipitation in the Poyang Lake Basin' was not consistent with the caption.

We are sorry, we can't relate this comment to our manuscript. Please specify.

Line 166: Descriptions of three alternative fLULCC are not clear in the current version.

Thank you, to ease the understanding of the different alternative f_{LULCC} estimates, we will change the description in the methods section, assemble each equation within one line and add colored labels referring to the different f_{LULCC} estimates into Figures 1, 3 and 5. Our suggestion for clarification:

NEW – 'We infer the three different DGVM-based f_{LULCC}s each from the differences in NBP of a simulation with and one without LULCCs (Eq. 1 to 3, see Table 1 for description of simulations S0 to

S6 and Fig. 1 for a schematic of resulting carbon fluxes). For example, we derive the f_{LULCC} under transient environmental conditions by subtracting NBP in S3 from NBP in S2 (Eq. 1). Using yearly aggregated NBP values, f_{LULCC} is derived for each DGVM, time step and grid cell under transient (subscript *trans*), constant pre-industrial (*pi*), and constant present-day (*pd*) environmental conditions from the TRENDY v8 simulations as follows:'

NEW – 'Here, a lower NBP in the simulation including LULCC (S3 to S5) compared to the one excluding LULCC (control, S0 to S2) represents a net flux of CO_2 out of the terrestrial biosphere into the atmosphere (emissions) due to LULCC causing a reduced C uptake or C losses.'

Line 385: I have some serious concern about the assumption that the last 100 years due to climate change – clarify it?

We are not sure we interpret the comment correctly (the sentence seems incomplete), but we will add a reference to Section 2.2.2 to explain better which climate (changes) our simulations capture. Due to the definition of the DGVM forcing within TRENDY v8, the climate of the first decades of the 20th century is recycled to infer earlier climatic conditions. This is a common procedure in model protocols since the trends in the physical climate before the 20th century are small (for information on TRENDY forcings for climate see CRU JRA data e.g. in Harris et al. 2014 and for CO_2 e.g. Joos and Spahni 2008). Because of this setup, the influence of climate change on NBP, and consequently C fluxes, as derived in this study depicts roughly the last hundred years, starting with the earliest decade of the 20th century. The validity of this approach is highlighted e.g. by proxy-based temperature reconstructions as published in Hegerl et al. (2019, *Environmental Research Letters*). To clarify, we will add the mentioned reference, modify the explanation given in Section 2.2.2 and suggest text changes as follows:

NEW - 'Note, within the TRENDY v8 simulations, pre-industrial and present-day climate forcing is defined as a recycling of climates in the earliest decades of the 20th and 21st century, respectively (see Sect. 1). Consequently, the climate change impact derived in this study roughly represents the last hundred years, which seems a reasonable approximation of the history, given that for example proxy-based temperature reconstructions cannot detect a warming earlier than the beginning of 20th century (Hegerl et al., 2019).'

NEW - 'The latter is highlighted by the simultaneous peak in EED which in essence is the intersection of LULCCs with the difference in standing biomass and actual soil C stocks due to altered environmental conditions over the last hundred years (under pre-industrial vs present-day environmental conditions; compare Fig. 2a with Fig. 2b and Sect. 2.2.2)'

Eq 1,2,3: I really had difficulty in understanding these equations. I suggest the authors made them easy to follow in the revised manuscript.

See answer to earlier comment. We will improve the description for the alternative f_{LULCC} estimations by adding references to new Table 1 and Figure 1, additional labels and modified caption in Figure 1 (see next comment), assembling all equations within one line and by text modifications in the methods section (2.2.1).

Figure 1 box 4 presents fLULCC differences, but no information about different line.

We apologize as we forgot to name the assignment of line colors for the differences of the three f_{LULCC} estimates in Figure 1. We will change the caption of Figure 1 as follows:

NEW - '[…] higher f_{LULCC} (box 3: red line (present-day) higher than blue line (pre-industrial); yellow line (transient) increasing with time). […] the Loss of Additional Sink Capacity (LASC; green line; Eq. 4), Environmental Equilibrium Difference (EED; purple line; Eq. 5) and `Present-day' vs `Transient' environmental conditions Difference (PTD; orange line; Eq. 6).'

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In addition to changes resulting from the reviewer comments, we suggest the following changes:

- change to capitalized journal abbreviations in references and added doi that where missing

- add new Table 3 with overview of different estimates

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New reference:

Hegerl, G. C., Brönnimann, S., Cowan, T., Friedman, A. R., Hawkins, E., Iles, C., Müller, W., Schurer, A., and Undorf, S.: Causes of climate change over the historical record, ENVIRON RES LETT, 14, 123 006, https://doi.org/10.1088/1748-9326/ab4557, 2019.