

Interactive comment on “Land-use and land-cover change carbon emissions between 1901 and 2012 constrained by biomass observations” by Wei Li et al.

Anonymous Referee #2

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This study's main aim is to reduce uncertainty on the magnitude of land use change emissions over the past century or so by constraining estimates from individual models with the use of remotely sensed biomass. The idea is that uncertainty in model-derived LUC emissions is partly due to uncertainty in the biomass state at the beginning of the model simulation period, which is partially fitting because much of the LUC emissions derives from the live biomass itself. While the basic concept is good, the study adopts an odd approach that seems poorly guided by logic. The study also fails to fully evidence uncertainty reduction. Furthermore, it misses an equally large if not larger concern about across-model spread in biomass and how that contributes to uncertainty in LUC emissions. These and other concerns are elaborated upon below. These

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concerns notwithstanding, the study has significant merit overall, and involves several powerful new datasets on land use change and biomass, that if properly incorporated, could serve to significantly advance understanding of land change emissions.

1) A logic concern: The approach oddly ignores the vast discrepancy across models with regard to their estimates of biomass. One could directly use remotely sensed biomass in the 2000s to more directly evaluate which models match the data. Instead the authors do some contortions: (1) convert present-day observed biomass to year 1901 biomass based on year-2000 biomass versus year-1901 biomass, wherein even the use of a regression seems incorrect, and then (2) applies the expected year 1901 biomass according to observations in a regression equation of across-model LUC emissions versus each model's initial biomass estimate to derive a sort of model-guided distribution of inferred LUC emissions. This is a strange approach. In a sense, it estimates the LUC emissions we would expect, on average according to models, given an initial year-1901 biomass that has been estimated from contemporary observations and then adjusted to remove intervening effects of growth and mortality. It is rather indirect. It does not reduce across-model spread in mean emissions estimates, nor does it evaluate models against biomass observations. The method should really be improved with something more direct.

2) A logic concern: The approach seems to suggest that we should trust each model's relation between LUC emissions and biomass, and that all of the spread or uncertainty is due solely to model error in biomass. However, there are several other causes of across model spread in LUC emissions estimates and these get ignored in the present approach.

3) A logic concern: Regarding the alleged reduction in cumulative LULCC emissions, it seems to be the trivial and obvious result of replacing the across-model spread with results from a regression of across-model results. Of course this reduces uncertainty, but it needs to do so based on additional information or understanding and the only additional information comes from an odd and flawed use of biomass observations as

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a sort of indirect constraint.

4) A technical concern: Regarding the use of regression to estimate biomass in 1901 consistent with year 2000 observations of biomass, regression seems to be the wrong tool here. Instead of an across-model regression, it would seem more appropriate to use an across-model mean delta biomass (2000 minus 1901 biomass change). The regression equation has an intercept that does not have a proper meaning in this case.

5) An interpretation concern: The across method spread (method A, B and C) in the constrained emissions estimates is still rather large but this is largely ignored in the presentation with a preference to show uncertainty reduction relative to the initial across-model spread in singular estimates. This leads to the next point.

6) An interpretation concern: The new uncertainty is inadequately compared to the original across-model spread in cumulative LULCC emissions. Here are some concerns and suggestions for how this could be corrected. (a) Figure 6: Use boxplots for all bars, or bars for the TRENDY estimates. Mixing these two display approaches in the figure adds confusion and obfuscates the main comparison of interest. Also make the use of error bars or percentile whisker's consistent across the TRENDY to constrained estimates. These changes will allow readers to clearly see the degree to which uncertainty reduction has been achieved with the constraint. Right now we can't see that. (b) Figure 3: Add the probability density function of the unconstrained TRENDY model cumulative LULCC emissions to each panel's right-side graph. This could have a light shaded red for each model's distribution, and a dark, thick red line for a Bayesian combination across the models. (c) Table 3 and Figure 5: Mixing an uncertainty spread shown as min/max, or range, for the TRENDY results compared to a 1 stdev spread for this study's inferred estimates inhibits a clear comparison of uncertainties across these two approaches. This needs to be corrected.

7) Model output data concern: TRENDY V2 LUC simulations had a problem with the fluxes for the final decade simulated. This study probably needs to switch to use of V4,

or maybe to shorten the study to exclude the period that was in error. Please check with your co-author Stephen Sitch with any questions.

8) Additional details:

Clarify in the methods how effects of LUC on biomass up to the time of observation (year 2000s) were accounted for in the inference of year 1901 biomass. The methods were not clear on this point.

Figure 4 should probably be presented before Figure 3 based on the methodological flow for the study.

Figure 4: explain in the figure caption that both biomass terms are from TRENDY, not the remote sensing

Remove the junk text after the citations (1.2 Subsection, 1.2.1 Subsection)...

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