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Interactive comment on "Earth system feedbacks following large-scale tropical forest restoration" *by* Alexander Koch et al.

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We thank reviewer 2 for their comments and kind suggestions. Our replies (standard font) to the comments (italics) are below.

1. *For the title of the paper, I would actually prefer something like "Effects of Earth System feedbacks on the potential mitigation of large-scale tropical forest restoration", but this is just a suggestion. I think it highlights better the advantage of this work over the previous studies.*

We thank the reviewer for this suggestion. Title changed.

2. *The abstract points in the end three key points. I think the first one, "carbon benefit of restoration is CO2 -scenario dependent", is really not surprising. Differences on the*

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CO2 atmospheric concentration should affect the carbon benefit of restoring part of deforested tropical land. Also, the paper does not address different CO2 scenarios to claim this result. I think one key message that should be highlighted in the end of the abstract is the estimate that the expected benefit of restoring a large part of the tropics would actually be largely limited (maybe in half or even more?) by negative feedbacks in the Earth System."

We have removed the point about scenario dependence and adjusted the abstract to include the point about the limiting carbon cycle responses. The sentence in line 13ff now reads: "Comparing our results with previous modelling studies we identify two model-independent key points: (i) in a world where emission reductions follow the Paris Agreement, restoration is best deployed immediately, (ii) the global carbon cycle response to reduced emissions limits the efficacy of negative emissions technologies by more than half."

The abstract length is now 295 words.

3. *Methods: Why did you skip a section 2. Methods ? I think the structure should simply follow 1.Introduction, 2.Methods, 2.1 HadGEM-ES, ... 3.Results, 4.Discussion, etc. But, apart from this, I think you need to explain better what is the restore simulation. What does it mean to 'stop anthropogenic land use' in the Discussion model? Does that mean that all of the existing crop areas in the model are abandoned or only all NEW crop areas (which would be informed, maybe yearly, by RCP 2.6 transitions from vegetated area to cropland...)? Please clarify."*

We apologize for the omission of a clear Methods section header and have now added section 2 Methods. The "restor" (now called "esmrcp26restor") involves that all currently existing land use area is abandoned and no future land use takes places. We have now clarified this in line 49 "all current and future anthropogenic land use in the tropics [. . .] is stopped. . ." and in line 111 "abandoning all present-day and future land use areas led to an increase" as well as line 115 "current anthropogenic land use of

1529 Mha".

4. *It would be nice also to describe in more detail how the inter-PFT competition happens in the model. What factors will provide advantage to one or other PFT in the dynamics of succession?*

The following has been added to line 71ff: "The share of each PFT of a grid cell depends firstly on a grass-shrub-tree hierarchy where shrub PFTs dominate grasses and tree PFTs dominate grasses and shrub, and secondly on a species competition approach (Lotka-Volterra) that determines the share between two PFTs of the same type (e.g. broadleaf and needleleaf) depending on height (Cox, 2001)."

5. *Section 1.3 (which I think could actually be section 2.3, given a new section 2.Methods is added): I think this section is difficult to understand as it is. Is this included in the text to present the approach used to convert the information obtained by the model (land surface sink) to infer the impact on atmospheric CO2 concentration? Please improve this section to clarify.*

Section 1.3 describes the biomass scaling we discussed in section 4.1 (now section 5.1) and was accidentally left in this place from an earlier version of the manuscript. It has now been placed in section 5.1 "Restoration timescales and carbon uptake", line 316 where more context is provided. We apologize for this mistake.

Minor comments 1. *line 112: "In the control simulation (control), broadleaf forest declined globally by 107 Mha from 2006–2100 CE and by 213 Mha in the tropics." So, the first number is 107 Mha outside the tropics, and the global area of broadleaf forest decline was actually 320 Mha ?*

Broadleaf forest declined globally by 107 Mha from 2006–2100 CE, driven by a decline of 213 Mha in the tropics that is somewhat offset by an 106 Mha increase in the extratropics. We added this clarification to line 112.

2. *line 122: "The spatial pattern of land cover change shows that the largest change,*

786 Mha, is new broadleaf trees, mostly located on ...", I suggest "The spatial pattern of land cover change shows that the largest change that the restoration scenario indicates, 786 Mha, is the growth of new broadleaf trees, mostly located on . . ."

Changed to reviewers suggestion.

3. *line 140 "... resulting in an emission reduction of 9.6 Pg C from halting deforestation alone." I think you could rewrite to ".. resulting in the prevention of 9.6 PgC of emissions from halting deforestation alone. "*

Changed to reviewers suggestion.

4. *legend of Figure 2. Modelled global carbon emissions . . .*

The figure shows global, tropical, and extra-tropical emissions, we have therefore chosen the figure title to simply state "Modelled carbon emissions..".

5. *Figure 3 and Figure 2A are the same? Or fig 2A is for the tropics only?*

Figure 2 shows all fluxes into the atmosphere including land use emissions in Figure 2A. We clarified this by adding "Modelled carbon emissions and fluxes 2006–2100 CE into the atmosphere" to the Figure 2 caption. We assume the reviewer is referring to Figure 3C. There FWP represents the carbon flux from the cut down woody biomass into the wood product pools while EDEFOR is the flux from the wood product pools to the atmosphere (i.e. land use emssions). We have clarified this relationship in line 78.

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