

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

Anonymous Referee #2

Received and published: 6 January 2021

The manuscript in discussion can provide an important contribution to a recent debate in the scientific community about the potential of a large-scale tropical forest restoration. There are available studies using different approaches to estimate a potential amount of carbon that could be taken up by the land surface mitigating at least partially the impacts of anthropogenic emissions of greenhouse gases. However, very few studies are able to estimate possible feedback mechanisms in the Earth System that could affect this potential mitigation. This manuscript uses the HadGEM2 Earth System model to simulate how much carbon would be taken up by the land surface after stopping deforestation in the tropics and allowing the model to ‘freely’ regrow the natural vegetation in the areas previously destined for crop use, and compares this restoration simulation with a standard RCP2.6 control simulation (in which a scenario

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of deforestation is still allowed, albeit with a reducing trend). The difference between these two runs of the model would represent a ‘more realistic’ maximum potential of climate mitigation by the restoration of natural vegetation in the tropics, since the feedbacks of the Earth System that can hamper this potential are now represented in the coupled model. The results are valuable to be published, but some few corrections are important in the manuscript to improve the understanding of what the model really represents and of what are the implications for the biogeophysical and biogeochemical feedbacks in discussion.

1 Major comments

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.
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 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
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

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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.

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?
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.

2 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 ?
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 ...
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. "

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4. legend of Figure 2. Modelled **global** carbon emissions ...
5. Figure 3 and Figure 2A are the same? Or fig 2A is for the tropics only?