

## ***Interactive comment on “Regional feedbacks under changing climate and land-use conditions” by L. Batlle Bayer et al.***

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### REVIEWER #1

Comment 1: Although this is not obvious from the title and abstract, this paper should be considered a review paper since it does not present new results or analysis. Instead, the conclusions are based only on previously published literature.

Response 1: Indeed, the paper could be considered a review as it gives an overview of potential feedbacks at the regional scale based on published studies. However, these feedbacks are placed in a conceptual framework that assists to decide the type of modeling studies that are needed to study the representative processes. We changed the title into “A framework. . .” to better illustrate the goal of the paper, and adjusted the

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introduction section accordingly.

Comment 2: This review is very broad in scope, namely it investigates the role of terrestrial-climate feedbacks (both biogeophysical and biogeochemical) at regional and global scales.

Response 2: First we introduce both biogeochemical and biogeophysical feedbacks, but we discuss mainly on biogeophysical feedbacks, since we focus at land use change related aspects at the regional scale, including responses and feedbacks during drought and heat wave events. This was also highlighted in the introduction.

To better distinguish spatial scales within the framework, we modified the diagram (Fig.2): local (solid lines) and regional/global (dotted lines) processes. Relevant feedback loops require consistence across scales, as is explained in the figure caption of that diagram.

One feedback loop that was originally discussed (the carbon cycle-climate feedback for Sub-Saharan Africa) has been removed, as it does not comply with the required consistence in spatial scale.

Comment 3: I would like to stress the fact that there are already published reviews on these topics, in particular: Bonan, Science, 2008 (land cover change) Seneviratne, et al., Earth- Science Reviews, 2010 (soil moisture feedbacks) Arneth et al., Nature Geoscience, 2010 (terrestrial biogeochemical feedbacks). The present work somehow tries to cover these different aspects all at once, but I am unable to conclude that it provides the sort of novel perspective or argument on these issues.

Response 3: The novelty is to present soil, vegetation and physical/chemical processes and interactions that take place at various spatiotemporal scales in a single diagram, and thus to be able to explore feedbacks at a range of scale and across the disciplinary domains as covered by Bonan, Seneviratne and Arneth.

Comment 4: The main deficiency of the paper is the lack of quantitative arguments to

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support its conclusions. The authors compare different feedback loop mechanisms in 3 different regions and make statements about which feedback process is supposed to be the most important for a given region. However, no quantitative tool is proposed to help comparing these feedbacks and give an objective basis to judge whether one feedback process has more strength than another. (Note that for instance in Arneeth et al. (2010) different biogeochemical feedbacks are compared quantitatively in terms of their radiative effect).

Response 4: Indeed, we do not show quantitative analysis since the aim of the paper is to explore potential feedbacks and to propose experimental designs for future research. This objective has been explained clearer in the introduction. The discussion of the proposed experimental designs has been included in a separate section (#4) rather than included in the general conclusion section of the paper.

Comment 5: In addition to the lack of quantitative arguments, the comparison is also confused by putting at the same level mechanisms acting on different spatiotemporal scales. For instance, the carbon cycle-climate feedback is of global importance and impact the climate over very long time scales. The soil moisture feedback, on the other hand, has a local effect and impacts the climate over short time scale in particular in the context of drought and heat waves. The paper does not clarify this issue of time/space scale which again means that the common basis to compare the feedback processes is missing.

Response 5: We also realized the confusion that could emerge about spatiotemporal scale. As mentioned before, the feedback diagram was adjusted to address this spatial scale issue explicitly. Also, in section 3 a paragraph was added to discuss scale issues when using the framework. Furthermore, we discuss how local feedbacks can have an impact on feedbacks at larger scale. In section 4-paragraph 1, we also propose a cross-linking approach to deal with these scale issues.

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Comment 1: A novel aspect of the manuscript is the use of state diagrams for each region that outline the role of drivers of land surface changes and consequences for climate.

Many thanks.

Comment 2: The paper clearly illustrates the complexity of land-atmosphere feedbacks for earth system modelling but it could be strengthened by building on the state diagrams to: 1) assess uncertainty 2) distinguish between local and global feedbacks (and short to long timescales) 3) better quantify the role of feedbacks in forcing units (i.e.,  $Wm^{-2}$ ) 4) discuss challenges and solutions for improving earth system models.

Response 2.1: We have added more explicitly in the text, both in the introduction and in the added section 4, the issue about uncertainty of feedback modeling, in particular for biogeophysical feedbacks. We added a reference to a recent paper by Pitman et al. (2011), in which they quantify the impact of LULCC on regional-scale climate in United States, Eurasia and Asia.

Response 2.2: Changes in the framework (Fig.2) have been included to better distinguish between global/regional and local interactions and feedbacks (see comment to reviewer 1).

Response 2.3: We do not attempt to quantify feedbacks but rather to highlight potential feedbacks that need future research and to raise the issue about adding the human dimensions when analyzing terrestrial ecosystems-climate feedbacks.

Response 2.4: This issue has been added in section 4.

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