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Interactive comment on “Asymmetry and uncertainties in biogeophysical climate–vegetation feedback over a range of CO₂ forcings” by M. Willeit et al.

Anonymous Referee #2

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This study addresses three issues of the vegetation feedback:

- a) The uncertainty of the simulated vegetation feedback is determined by using a single model multi-physics ensemble. The authors contrast the uncertainty in the impact of changes in plant physiology to the uncertainty in the impact of vegetation shifts. This approach allows to identify the main source of uncertainties in the vegetation feedback.
- b) The asymmetry of the vegetation feedback is assessed by analysing the vegetation feedback for enhancing and reducing atmospheric CO₂. The impact of changes in plant physiology and the impact of vegetation shifts are shown separately.
- c) The strength and the zonal distribution of the vegetation feedback is considered

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relative to other feedbacks such as cloud, lapse rate, and ice albedo feedback.

All three issues are relevant when dealing with the vegetation feedback. The large spread of the vegetation feedback determined in different studies makes a clear estimation on the uncertainty of the vegetation feedback essential. The vegetation feedback has been assessed for enhanced atmospheric CO₂ in previous studies, while contrasting the vegetation feedback for halving and doubling CO₂ is new. Studies which compare the vegetation feedback with other feedbacks are rare and needed, when discussing the impact of vegetation dynamics in climate change.

However, I am not convinced about merging these three issues to one study. To merge the asymmetry and uncertainty of the vegetation feedback could be reasonable, even though it might be challenging to motivate and structure such a study. A connection between asymmetry, uncertainty, and a comparison of the vegetation feedback to other feedbacks is difficult for me to see. Addressing too much issues in one study arises the risk of lacking a main aim leading to a list of results without relevance. I have the impression that this manuscript contains too much issues and the main results are buried under the large amount of results.

I recommend to exclude the comparison of the vegetation feedback to other feedbacks and to focus on the asymmetry and uncertainty of the vegetation feedback. The motivation to address the asymmetry and the uncertainty of the vegetation feedback should be described more carefully in the introduction. The structure of the results section could be improved to illustrate the main results clearly.

Comments on the content and structure of the manuscript

Abstract

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1. Results on uncertainties and asymmetry are presented in a clear and brief way in the 2nd paragraph 7 to 14. The mechanisms which drive asymmetry are specified in the last paragraph. It might be clearer to describe the asymmetry and the driving mechanisms together.

2. In the 3rd paragraph (line 10 to 18), findings on the vegetation feedback related to other feedbacks follow. The connection to the asymmetry and uncertainty remains unclear.

3. I guess with term 'Charney feedback' in line 16/17 refers to the feedbacks introduced in Charney et al. (1979). The term Charney feedback might be mixed up with the 'Charney effect' introduced by Charney (1975), which is suggested to amplify Sahelian droughts. Using the term 'fast feedbacks' such as the authors use it in line 17 avoids possible confusion.

Introduction

4. The introduction includes a broad review of recent studies on vegetation climate interactions and emphasises the spread in the results which motivates a study on the uncertainties of the vegetation feedback. A motivation for a study on the asymmetric behaviour of the vegetation feedback is lacking.

5. In the introduction, the connection between the different issues should to the specified.

6. In the methodology section (12974/11-17), a motivation for using a single-model multi-physics approach is given. Why not mentioning this motivation in the introduction?

7. The paragraph 12972/8-21 interrupts the motivation for assessing the uncertainty of vegetation feedbacks. A motivation for connecting a comparison of the vegetation feedback to other feedbacks with an estimation of the uncertainties of the vegetation

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feedback is missing.

Results

8. What causes the warming named in 12981/18? Is the albedo lower due to a smaller cloud cover? Or does a weaker latent heat flux cause the warming?

9. 12983/23 to 12984/2: I have the impression that the results from the physiological changes and vegetation shifts are repeated. Is this paragraph necessary?

10. 12984/10 How does a smaller desert in central Asia cause warming?

11. Results on the uncertainty of the vegetation feedback get lost in the analysis of the asymmetry. To display the results clearer, the uncertainty analysis should be separated from the asymmetry analysis. Further, the uncertainty analysis should be more detailed, because this is one major topic of this study.

12. The structure for the asymmetry analysis is not clear. I have the feeling that in the part from 12984/3 to 12986/7 the author lists results rather than illustrates the asymmetric behaviour of the vegetation feedback. There are relevant results, but the reader needs to organise the results herself/himself to get a picture of the asymmetry. Maybe it would be more convenient to discuss the results for vegetation feedback for $1/2 \text{ CO}_2$ and $2 \cdot \text{CO}_2$ separately.

13. The sentences in 12986/20-25 gives a good explanation for the asymmetry. Wouldn't it make sense to provide this explanation already in 3.2.3?

14. Section 3.3: As already mentioned, the relevance of the comparison of the vegetation feedback to other feedbacks in a study on uncertainties and asymmetries is difficult to see for me.

Comments on the language

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12968/9: '-0.1-0.2' should be '-0.1 to 0.2' to avoid confusion.

12969/14: 'and' is missing, '...the surface, and the exchange...'

12969/21: 'act' should be 'acts'.

12970/5: The subject to the verb 'reduce' is missing.

12973/20 - 12980/15: Tense not consistent in the methodology section. For instance, it is 'we consider' (12974/17), but 'we included' (12974/19) or it is 'satisfied' (12977/26), but 'constitute' (12977/26).

12974/16: It might help the reader to refer to table 1 and table 2 already in this paragraph.

12975/18: 'to' is missing in 'assigned to'.

12979/16-19: This part is a repetition of 12979/5-7.

12981/11: Why is 'prescribed' in brackets?

12982/4: This sentence is confusing, because it looks like the closing stomata enhances evapotranspiration.

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12982/6: 'Betts et al.,1997' shouldn't be in brackets.

12983/4: 'increase' should be 'decrease'.

12983/9: One sentence can't be one paragraph. Is the sentence really necessary?

12984/3-5: This part seems to be longer than necessary. Is the first sentence needed? The second sentence expresses the same information as the third sentence.

12984/4: 'acts' should be 'act'.

12984/12: Vegetation dynamics enhance the uncertainty relative to what? I guess relative to the physiological effect of vegetation.

12984/12: 'enhances' should be 'enhance'.

12984/14-17: 'into account' should be after 'under higher CO₂'.

12984/21: '-0.1-0.3' should be '-0.1 to 0.3' to avoid confusion.

12984/21: Why is the temperature difference due to dynamic vegetation for doubling CO₂ here -0.1 to 0.3 K and 0.1 to 0.2 K in the abstract?

12984/28: 'most relevant' should be 'largest'.

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12985/22: Figure 10 might be denoted earlier to illustrate the method.

12985/26: 'correlation' needs to be shifted: '...highest correlation between...'

12985/27: 'to' should be 'of' in '...sign of the correlation...'

12986/4-5: It should be 'albedo effect' and 'evapotranspiration effect'.

12985/11 - 12986/7: Subdividing the paragraph makes structure clearer.

12988/11: Is 0.5°C the ensemble mean?

Figures

Figure 1a): The label of the axes are not intuitive.

Figure 6): The colour for RPL-R and RPLV-R is hard to distinguish.

Figure 12), caption: It should be '...ensemble are plotted...'

Figure 9): Just as an idea, might it be possible to merge a) and c) as well as b) and d) by hatching the uncertainty over the temperature difference? This would facilitate the evaluation of temperature changes.

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Figure 10): Using the same size and layout as for figure 9 makes a comparison of the two figures easier. The annual mean should be separated as in figure 9.

Best wishes

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