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Biogeosciences Discussions

Interactive comment on "The African contribution to the global climate-carbon cycle feedback of the 21st century" *by* P. Friedlingstein et al.

P. Friedlingstein et al.

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Response to reviewers H. Dolman Referee #1 This is a pretty well written paper addressing the issue of potential feedbacks of the carbon cycle on 21-st century climate in Africa. The authors use one of the few coupled systems, IPSC-CM4-LOOP, with the vegetation model ORCHIDEE. They find a small contribution of the African biosphere to the feedback of about 26 Gt C or 6 ppmv. This is in the smaller range of the C4MIP models, as was the global contribution of this model configuration. This result is worth publishing, but I find the paper a bit shallow in its precise treatment of the causes. I have the feeling the authors felt the same and have therefore included the IMOGEN results as compensation. This unfortunately brings in an additional objective in the paper of comparing the HDCM3 climate with IPSC model which confuses the reader towards the end even more. I suggest to take out this bit (p 4853 l21-27 and p 4854).

Response : As both reviewers suggested removing the section on IMOGEN, we did follow these recommendations. We only keep one short paragraph in the discussion about the uncertainty arising from climate projections.

As a remedy against the perceived lackluster analysis of I would also like to see a more detailed analysis of the contribution of different African vegetation types, biomes to the feedback, so that a more coherent picture can be given of what type contributes how much, and importantly how that differs between vegetation types.

Response : Following the reviewer suggestion, we added a section where we analyze the model results per biomes (forest, savannah, grassland) over Africa. Figure 4 now shows changes in NEP for each biome. We also calculate the specific vulnerability of each biome to climate change and their respective contribution to the climate-carbon feedback

Anonymous Referee #2 General comments The manuscript tries to identify the African contributions to the global climate-carbon cycle feedback using a global land surface model coupled with an atmosphere ocean general circulation model (IPSL-CM4-LOOP). The authors found great contributions of the African ecosystem to net ecosystem productivity induces by rainfall reduction, but only small contributions of the African rainforest to the positive climate-carbon cycle feedback. The analysis is of high scientific relevance, and well-written. In order to understand the role of the different ecosystems to the climate carbon feedback and the impact of climate change on the carbon cycle of the African continent it needs some more investigation. It is not explained why both experiments react so divers in terms of the carbon fluxes and stocks in different regions (Fig. 3).

Response: We added a section describing in more details the regional patterns of changes. In particular, as mentioned above, we now discuss the results per biome.

It is also not clear how different the climate systems of these two experiments are. I would expect changes at least due to differences in water fluxes. Are there no changes

in the UNC experiment to the climate in 1860?

Response: In the UNC simulations, CO2 is kept at its preindustrial value for radiative calculations, hence it does not induces any climate change. However, the biophysical effect of stomatal closure due to atmospheric CO2 increase is present in the UNC simulations as the surface model (ORCHIDEE) does see the CO2 increase. Hence the climate of the UNC simulation is not strictly constant; it does show a slight warming across the simulation. This is now explained in the text.

The discussion contains a long paragraph about the IMOGEN experiment. This appears a bit displaced here. This needs a different study or it could be explicated in the result capture. In general I have noticed that the theme is not comprehensively discussed. In the introduction you find only one sentence about the African biomes. And the discussion part is filled with the Amazon forest and the IMOGEN project.

Response: This has been removed now

Specific comments p. 4850, para. 1: Please explain the method of this two runs more detailed to avoid misunderstanding. I’m not sure if the UNC experiment includes climate change or is only the carbon-climate feedback missing.

Response: Explained above and clarified in the text

p. 4851, para. 2: The carbon sensitivity describes how much carbon the biosphere releases respectively uptakes. The indicator suggests that the carbon balance changes linear with temperature change, but these changes are more abrupt.

Response: Indeed these changes do not have to be linear, we use gamma as a diagnostic t a given time of the carbon lost/gain per unit of climate change. Gamma is certainly not constant in time (as can be seen from Figure 2 in Friedlingstein et al, 2006). For most models, including the IPSL model, gamma gets more negative for larger warming, showing indeed non linearities in the land response to climate change.

p. 4852, para. 1: Could you show why climate change is the main driver? In most

studies CO2 fertilization plays an important role. The COU run shows an enhancement of 14 GtC/yr and UNC only 2 GtC/yr less. Regarding this the fertilization part must amount to 12 Gt/yr.

Response : Actually there was a small mistake in the original version, over Africa, GPP increases by 15 GtC/yr thanks to the CO2 fertilization, but looses 1GtC/yr because of the climate change. We rewrote that section accordingly, reinforcing the statement about the dominant role of CO2 fertilization.

p. 4853, para. 2 and p. 4855: This study emphasises the minor contribution of the African ecosystem to the global carbon cycle, but here is shown that the local changes are very great. That means major changes occur in the African biosphere due to climate changes and in the same order as in Amazon forest. It is only owing to the small area of the rainforest that the global contribution of the African rainforest are so small. That is known

Response: It is of course known that the area of the African rainforest is smaller than the one in South America. This is why we propose to also estimate the area specific vulnerabilities (expressed in gC/°C/m2). As we now added these numbers for savannahs and grasslands, it further emphasizes the fundamental difference between ecosystem vulnerability and contribution to climate-carbon cycle feedback. This is now also clarified in the text.

Technical comments Fig. 1: Please use the same units in caption and figure.

Response: Done, thank you

Fig. 3: What does relative mean if your units are gC/m2?

Response: By relative we meant the difference between two simulations (COU – UNC). This is clarified now

Fig. 4 and 5: Please use the same units in caption and figure. Captions have not the same letter size.

Response: Done, thank you

Interactive comment on Biogeosciences Discuss., 5, 4847, 2008.