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Climate of the Past Discussions

Interactive comment on “Detecting vegetation-precipitation feedbacks in mid-Holocene North Africa from two climate models” *by* Y. Wang et al.

Y. Wang et al.

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Interactive comment on "Detecting vegetation-precipitation feedbacks in mid-Holocene North Africa from two climate models" by Y. Wang et al.

Anonymous Referee #2

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The paper deals with the simulation of the vegetation-precipitation feedback during 6 ka simulated by two different climate models (but using the same vegetation model). The most important result is a negative relation between vegetation and precipitation at (semi)-annual timescales caused by the competition between transpiration and ground evaporation.

Although there are many vegetation studies for 6 ka, it is (to my knowledge) the first time that the influence of transpiration and soil evaporation is separated, which makes the paper innovative. The paper is well written, short, clear and to the point, which I like. However, the paper might be too short. I miss some information about the models and the explanation of the results could be more detailed. Furthermore, the authors could show some more pictures. After these additions I recommend publishing in Climate of the Past.

Response: We have extended the model description section in our revised paper to provide more detailed information about two climate models. We also provided more explanation to our results in our revised paper. Accordingly, more plots have been added in our revised paper. However, we still suggest readers to review the corresponding reference papers to get further detailed information there about the two climate models.

General comments.

1. Section 2.1. The model description is too short. At least a description of LPJ should be added (vegetation types; how do climate parameters (precipitation, temperature, ...) determine vegetation types; how does vegetation influence climate etc. etc.). Furthermore, because the results depend on the soil characteristics, a more extensive description of the soil modules should be included. It is not sufficient to say that "CCSM2 has ten soil layers while FOAM only has two layers (P 964, lines 15/16)". More information is needed about the water holding capacity of the soils, the (moisture) transport between the soil layers, how is runoff computed etc. etc.

Response: As we mentioned before, we have revised our paper so that the model description section is in more details. We also provided more references regarding the soil component in CCSM2, including the water holding capacity of the soils, the moisture transport between the soil layers, and how is the runoff computed. For example, In the CCSM2, soil texture varies by grid cell and with depth (Oleson et al., 2004). The data comes from the IGBP soil dataset (Global Soil Data Task 2000). Soil colors are from Zeng et al. (2002). This explains why vegetation and soils at 6K in the CCSM2 tend to have little albedo difference and sometimes in a direction opposite of the expected (Levis et al. 2004a). In the FOAM, soil texture is fixed for the integration. In substituting the original FOAM land component with the LPJ-based one, we retain the original FOAM surface/soil diffusive temperature calculation scheme that assumes 4-soil layers, but replaces the simple, single layer (bucket) soil water component with the 2-layer soil water scheme of LPJ (Sitch et al. 2003). Local runoff calculated when the soil water of a layer exceeds water holding capacity is used as input into the river routing scheme for freshwater discharge into the oceans. The zonal distribution of average runoff predicted by LPJ also compares favorably to a 1o x 1o gridded dataset of observed runoff (see Fig. 8 in Stich et al., 2003). However, since the coupling between two climate models and LPJ has been published in great details in Gallimore et al. (2005) and Levis et al. (2004a), we still want readers to go to these published references for more detailed information about two climate models, including coupling between vegetation module and physical climate components. All references are listed in our revised paper.

2. Figures 1B and 1F show quite large differences between CCSM and FOAM although they both use LPJ. I guess this is caused by different temperature and precipitation patterns in both models. This should be explained, especially because the differences between figures 1C and 1G can (partly) be explained by the grass fractions shown in figures 1B and 1F.

Response: We agree that the simulated vegetation difference is largely controlled by the different temperature and precipitation patterns in the two climate models at 6K. In reference Gallimore et al (2005) and Levis et al (2004a), the simulated difference of vegetation patterns has been explored in details there. We have added two more figures on the different precipitation and soil moisture patterns between CCSM and

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FOAM.

3. Runoff is not mentioned throughout the whole text. However, runoff is very important for the moisture availability for vegetation and runoff also (partly) determines soil wetness. Especially soil wetness could strongly influence the main results of the paper. A description of the computation of runoff in both models should be added (see also general comment 1) but also a discussion of the role of runoff should be included.

Response: In FOAM-LPJ, local runoff calculated when the soil water of a layer exceeds water holding capacity is used as input into the river routing scheme for freshwater discharge into the oceans. The zonal distribution of average runoff predicted by LPJ also compares favorably to a 1o x 1o gridded dataset of observed runoff (see Fig. 8 in Stich et al., 2003). We do not see any significant feedbacks between total vegetation and runoff in our climate models. We have discussed the role of runoff in our revised paper.

4. To my knowledge there is no restriction on the number of pictures in CP(D). I suggest that the authors include some additional graphics to support some results mentioned in the text. First of all I think that a picture of soil wetness and albedo for 6 ka and pre-industrial is necessary because they (largely) explain the differences in feedback between 6 ka and pre-industrial (page 967, line 1). Further figure suggestions are: temperature and/or precipitation patterns for 6 ka (see also general comment 2); similar pictures as figure 2 but for the pre-industrial runs; inclusion of area-averaged feedback parameters for the pre-industrial runs in figure 3.

Response: Unfortunately, our model output (history files) does not contain surface albedo and lower layer soil moisture data. However, we have provided with additional plots (new Figs. 3 and 4), which include top layer soil moisture and annual precipitation patterns in North Africa for both climate models.

5. The authors use annual precipitation (figure 1) and, I guess, annual transpiration/ evapotranspiration/ground evaporation (figure 2) to compute the feedbacks. Annual

precipitation is largely (even completely) determined by summer precipitation, however I guess that the annual transpiration/evapotranspiration/ground evaporation is determined by both summer and winter. It could be informative to show and/or mention the possible differences between the feedbacks of figure 2 for all seasons.

Response: Our figure 3 has indicated that the feedback parameter at monthly and seasonal scales is positive for both climate models. In an incoming paper, we found that the evapotranspiration is closely associated with the precipitation patterns so that the summer months have the maximum values of evapotranspiration, while winter season, the value of evapotranspiration is close to zero.

Specific comments.

1. P 964 lines 4/5. The model resolutions should (also) be given in degrees.

Response: Yes, we have modified our revised paper to take into account this comment.

2. Why is FPAR used in figure 3 instead of total vegetation fraction as in figures 1 c/d/g/h and figures 2a-f?.

Response: When calculating monthly/seasonal vegetation-precipitation feedbacks, we cannot use the vegetation-fraction as it is updated at the end of the model year. On the other hand, the FPAR datasets are updated (derived) at monthly/seasonal timescales. The vegetation variable that reflects the monthly/seasonal variation is the FPAR data, which includes the leaf phenology terms for individual PFTs and the corresponding annual vegetation fractions.

3. I do not understand what the authors mean by "we bin individual monthly data into one-month, three-months, six-months, and twelve-month timeseries" (caption figure 3). Do they pick one month (in that case, which month?) to compute the feedback parameter? Or do they use all individual months to obtain an annual range? Some more information is needed.

Response: For example, when we calculate vegetation-precipitation feedback at three-

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month timescale, we average every three-month data into a single data slice to create a new time series for our statistical model. This is also true for the calculation at six-month timescale. We have revised our paper so that the detailed description is available for readers.

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