Clim. Past Discuss., 10, C1904–C1908, 2014
www.clim-past-discuss.net/10/C1904/2014/
© Author(s) 2014. This work is distributed under
the Creative Commons Attribute 3.0 License.

Climate of the Past
Discussions

Interactive comment on "North African vegetation-precipitation feedback in early and mid-Holocene climate simulations with CCSM3-DGVM" *by* R. Rachmayani et al.

Anonymous Referee #2

Received and published: 12 November 2014

General comments: Overall this manuscript is concise, well-structured and well written. It fits within the scope of CP; contributing to the understanding of the much-discussed vegetation feedback in orbitally-forced monsoon changes. The suggestion that not albedo but evapotranspiration is what causes the positive vegetation-precipitation feedback is rather new and interesting. The setup of the research is valid and clear and considers not only vegetation feedbacks by performing experiments with and without dynamic vegetation but also the effect of initial (vegetation) conditions. Overall I would suggest some minor revisions and clarifications before publication.

Specific comments: Page 2058, Lines 1-5: More references can be added. E.g. Renssen et al 2006a, who find a non-linear transition from humid to arid in the west Sa-

hara and a more gradual transition elsewhere in the monsoon region. Also, Claussen et al 2013, who discuss the gradual / abrupt shift from the African Humid Period into the dry-Sahara period based on plant diversity.

Page 2059, Line 2-3: why do you choose to use the low-resolution version? (Is a higher resolution computationally too expensive?)

Page 2060, Line 22-23: Using the present-day calendar results in some errors in the seasons and the exact dates of e.g. autumnal equinox (assuming you fixed vernal equinox), see references Joussaume and Braconnot 1997, Chen et al 2011.

Page 2062, Line 10: is this the location of the AEJ in your 0k(OAV) experiment or the actual observed AEJ location? Does CCSM3-DGVM correctly model the AEJ location and strength?

Page 2062, Line 25-26: the reduced surface temperatures in the monsoon region due to increased cloudiness and evaporation is also found by others (such as Braconnot et al 2007, Bosmans et al 2012)

Page 2063, Lines 1-10: in the text you mention that the increase in ground evaporation in the OAVf experiments is much smaller than the rise in canopy evaporation and transpiration in the OAV experiments. However this does not match with the numbers in table 3. E.g. the 9k-0k difference in OAV evapotranspiration is 0.23+0.29=0.52 mm/day and the 9k-0k ground evaporation difference in OAVf is 0.45. Yes that is a bit smaller but I would not say "much smaller". For 6k-0k OAV evapotranspiration is 0.18+0.23=0.41 while OAVf ground evaporation is 0.34. Hence isn't there still a big change in latent heat flux (through ground evaporation) without vegetation? Maybe the standard error of the evaporation terms can be used to see if the differences in (OAV) canopy evapotranspiration are indeed significantly larger than the (OAVf) ground evaporation differences. Or does line 6 mean to say that "increase in ground evaporation (and thus total OAVf evapotranspiration) is much smaller than the total OAV evapotranspiration"?

Page 2063, Line 13 & Figure 5: is m/s the correct unit for moisture transport? Please specify how you computed moisture transport (using specific humidity and winds perhaps?).

Page 2065 Lines 6-27: The changes you find in AEJ strength seem indeed to match nicely with surface temperature changes through the thermal wind relation. However you also mentioned earlier that the AEJ is the southern outflow of the Saharan High, so does the Saharan High weaken too? Only if the Saharan High strength doesn't change you can fully relate the AEJ changes to surface temperature changes. However the Saharan High is likely shifted / changed in your early and mid-holocene experiments as you find a northward extension of the monsoon trough.

Page 2066 Lines 5-7: at 700 hPa there is quite an increase in southwesterly moisture transport from ocean to land when dynamic vegetation is included (Figure 5e,f), especially for 6k, probably related to stronger winds (Figure 4e,f). Is 700 hPa what you mean by "low-level"?

Page 2066, Lines 27-28: For OAVf experiments you find that the ratio of total precipitation to advected precipitation increases, i.e. for 6kOAVf and 9kOAVf increased precipitation is largely due to local water recycling. This is opposite to previous studies, who find a large contribution of moisture advection in fixed-vegetation experiments (e.g. Marzin and Braconnot 2009, Bosmans et al 2012).

Page 2067, Line 11-23: How big is the albedo change due to the vegetation changes in your results? Your claim is that albedo decreases (which would allow more radiation absorption and thus warming?) do not weigh up to the increased evapotranspirative cooling? Also, your statement about the CCSM3-DGVM model having very low albedo for saturated soils and therefore diminishing the effect of vegetation on albedo, does this imply that the model underestimates albedo in certain (saturated) regions?

Page 2067-2068: The independence of (mid-) Holocene model results of initial conditions was also shown by Renssen et al, 2006. Furthermore, the idea of specific sights

having either an abrupt or gradual transition was also put forward by Claussen et al, 2013, based on plant diversity.

Discussion in general: Please specify that results might be model dependent (specifically for DGVM, is your result robust if you were to use different PFTs, more PFTs, a more frequent update of vegetation structure and PFT population densities, a different parametrization for albedo, higher resolution etc.) Figures 6b, 7: axes labels are a bit small, please enlarge.

In conclusion, I would consider the scientific significance of this paper as "good". Its conclusions contribute to the understanding of vegetation feedbacks in orbital forcing of the North African monsoon, but the feedback suggested here (through canopy evaporation and transpiration) are likely model-dependent. The scientific and presentation quality of this paper are "excellent".

Additional References:

Claussen, M., Bathiany, S., Brovkin, V., & Kleinen, T. (2013). Simulated climate-vegetation interaction in semi-arid regions affected by plant diversity. Nature Geoscience, 6(11), 954-958.

Chen, Guang-Shan, et al. (2011): Calendar effect on phase study in paleoclimate transient simulation with orbital forcing. Climate dynamics 37.9-10: 1949-1960.

Joussaume, S. and Braconnot, P. (1997): Sensitivity of paleoclimate simulation results to season definitions, J. Geophys. Res., 102, 1943–1956.

Marzin, C., & Braconnot, P. (2009). Variations of Indian and African monsoons induced by insolation changes at 6 and 9.5 kyr BP. Climate dynamics, 33(2-3), 215-231.

Renssen, H., Brovkin, V., Fichefet, T., & Goosse, H. (2006a). Simulation of the holocene climate evolution in northern africa: The termination of the african humid period. Quaternary International, 150(1), 95-102.

Renssen, H., Driesschaert, E., Loutre, M. F., & Fichefet, T. (2006b). On the importance of initial conditions for simulations of the mid-holocene climate. Climate of the Past, 2(2), 91-97.

Interactive comment on Clim. Past Discuss., 10, 2055, 2014.