Climate of the Past Discussions

Clim. Past Discuss., referee comment RC2
https://doi.org/10.5194/cp-2022-27-RC2, 2022

Comment on cp-2022-27

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Referee comment on "Comparison of the green-to-desert Sahara transitions between the Holocene and the last interglacial" by Huan Li et al., Clim. Past Discuss., https://doi.org/10.5194/cp-2022-27-RC2, 2022

This manuscript presents the results from transient simulations for Holocene and LIG. They use an intermediate complexity climate model iLOVECLIM, coupled with two dynamical vegetation model synchronously and asynchronously, to estimate the contribution of the vegetation feedback in a transition of Green to Desert Sahara. The results confirmed such changes suggested in the paleo proxy data and previous model studies, demonstrated the capability of the model to simulate the climate response to changes in insolation and corresponding precipitation-vegetation feedbacks. The authors compared the abrupt transition under different orbital forcing and provided some quantitive features such as a faster vegetation decline during LIG than that of Holocene, and further highlight the vegetation feedback in prompting the abrupt change in vegetation in north Africa. These are the new contribution on this topic, regarding the more complicated model usually can not afford several thousands years simulations.

The model experiments are carefully designed to examine the climate response and climate-vegetation interaction to different strength of insolation forcing. the results are logically presented and the manuscript is well written. The authors know the previous studies on the topic very well and have had thorough comparison with their results. The conclusions are sound and relevant uncertainties are discussed. I hope my following comments can help to improve the manuscript for final publication.

- There are more proxy evidence on the green Sahara during Holocene, while less reporting on a green Sahara and the abrupt transition from green to desert during LIG from the proxy aspect. Line 85 cited three papers on such evidence, it would be good to provide more detailed information on their findings , such as what kind of proxy, the location and what do the data imply.

- In model description, more information on the physics of the atmospheric model ECBilt should be provided, since the manuscript mainly discuss the changes in precipitation. When coupled to the LPJ-GUESS module, it also uses could cover as one climate input, the description on relevant physics such as the cloud and convection of the model would be helpful to understand the simulated precipitation and climate and how they further influence the vegetation simulation. For the model resolution T21, would be good to provide the grid distance in kilo-meters as a reference to paleoclimatologist who are not familiar with the spectral grid.

- For the coupling to vegetation model, climate input for LPJ-GUESS is the monthly mean, while VECODE uses annual mean temperature, precipitation and GDD0 (Line 132). We know that the changes in seasonality due to orbital forcing are the major cause for changes in African monsoon, the authors need to comment the potential effect by using annual coupling with dynamic vegetation model VECODE.

- In line 150, it is mentioned that pre-industrial vegetation from the CMIP LUH2 dataset is upscaled and used as the prescribed vegetation in PI_FIX, it would be helpful to show this pre-industrial vegetation map, and mention what information from the vegetation map is read by the ECBilt (albedo, evaporation?). Also good to compare this vegetation pattern with the simulated ones in PI-VEC and PI_LPJ, this would help to image and understand the changes in vegetation cover in Fig3.

- When present the area averaged vegetation cover and climate parameters for north Africa in Fig1 and Fig2, should mention the domain for the average. If they are averaged over the entire region north of equtor showed in fig3, it includes the equatorial African region and African monsoon region, which are known as wet and vegetated even today when Sahara is desert. One might wonder what happens in these regions from 121K when vegetation cover is close to zero in Fig2, even equatorial and monsoon region became desert?

- I understand the variables showed in Fig1 are annual mean. Following the given insolation in summer, one might wonder why the annual mean temperature has warming trend when the summer insolation has the decreasing trend in the case of no vegetation feedback. Even though the authors mentioned in Line 225 that this warming trend is also seen in other simulations, would be good to explain what cause the warming trend, it can not be due to the GHG forcing since GHG is fixed.

- Fig3 showed an interesting anomaly pattern in vegetation cover, I am curious if such a pattern in supported by the proxy data or other model simulations. the authors mentioned in line 297-298 about the spatial complexity in two references, would be nice to provide more information from these findings.

- The manuscript focuses on the interaction between the climate and vegetation, it would be helpful to show the spatial anomaly pattern of precipitation, temperature and soil moisture, in order to understand how the climate anomaly pattern affect the vegetation anomaly pattern in Fig3.

- In Fig.4 the simulation for HOL_VEC did not show the full simulation period and stopped at 2000, and HOL_LPJ stopped at 3000 yr BP, what is the reason? Something strange happened in the late periods?

- Fig 6, can you explain why the model simulate more precipitation during Holocene than during LIG, e.g., when insolation is the same, despite with fixed or coupled vegetation. According to Fig1, insolation declined below 460 W/m2 after 121 K during LIG and after 3 K during Holocene, in Fig2 almost no vegetation after 119 K but some 5-10% remain after 3K in coupled VECODE, please comment on what cause these differences. Please also comment on the possible reason for an accelerated increase in precipitation during LIG when insolation greater than 480 W/m2.