

To Dr. Qiuzhen Yin

Climate of the Past

Subject: Revision of manuscript entitled “Effect of nitrogen limitation and soil processes on Holocene greening of the Sahara”

Dear the editor of *Climate of the Past*

We appreciate the constructive comments of the editor and revised the manuscript by incorporating all of the comments provided by the editor. Below are our responses to the editor.

We believe that our findings will be of interest to corresponding science communities and please do not hesitate to contact with us for your further inquiries.

Thank you very much for your support.

Sincerely,

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1. Page 1, line 16: change it to "...simulate the Green Sahara at 8,000 years ago by using ..."; Change "earth" to "Earth".

> Reply: We changed the word as the editor suggested.

2. Reviewer 2 suggests to add discussion on the limitations of the current study, e.g. the poor representation of precipitation-vegetation cover linkage and its implications. I don't find it in the revised manuscript. Please add such discussion.

> Reply: We added relevant sentence in Summary and Conclusion as the editor suggested.

3. Soil texture and soil processes include many properties and processes which could interact with climate and vegetation, such as those discussed in Finke et al (2017, Geology) and Ranathunga et al (2021, Quaternary International). As far as I can see, the only change in your 8KCNS experiment as compared to 8KCN is that the North African soil is prescribed as loam. This is fine, but I would suggest to mention ignoring other soil properties and processes as one of the limitations in your current study. In the same line, I would suggest to be more specific in the title and abstract of your paper, because the wording "soil processes" "soil texture" "changes in soil properties" "soil biochemical and physical properties" are very general but actually only a few limited properties and processes are considered in your study.

> Reply: Please let us explain this issue. In typical climate models, many parameters for soil thermal and biogeochemical properties (e.g., porosity, hydraulic conductivity, thermal conductivity, heat capacity, etc) are assigned with soil types (e.g., loam, sand, clay, etc.). For example, if we change the soil type from sandy to loamy soil, all soil-related parameters change and are used in the modeling. In this sense, we may be able to use general terms like soil processes and soil properties and we specify these processes and properties in the abstract and summary. We also agree that there are even many processes that are not parameterized in the climate models and we mentioned this issues with the limit of our study. Thank you for your constructive comments.

4. In the 8KCNS experiment, is there feedback between vegetation and soil texture? If not, is it appropriate to call it "fully coupled simulations"(page 1, line 19)?

> Reply: Our intention to use "fully coupled" was the coupling between the atmosphere

model and vegetation model. But we agree that this can be misleading and so we replaced “fully coupled simulations” with “coupled simulations”. Thank you.

5. A “data availability” section is required for the papers published in Climate of the Past. Please add such a section.

> Reply: We added information on data availability section as the editor suggested.

6. Table 1, row 3: change it to “...using the orbital parameters and CO₂ concentration at 8,000 years ago (Table 2)”. last row: “prescribed”

> Reply: We changed the sentence as the editor suggested.

7. Table 5: Please indicate the simulation dates of other models. 6K, 8K, 9K ?

> Reply: We indicated the simulation dates in the model as the editor suggested.

8. The quality of the figures needs to be improved. The lines and texts are not very sharp in the figures. Some gray lines occur around the panels in many figures.

> Reply: As the editor suggested, we updated all the figures.

9. Fig2 caption: change “the early to mid-Holocene” to “8K”

> Reply: We changed the word as the editor suggested.

10. Fig3: please explain in the paper why NSS and SSS share a common latitudinal band.

> Reply: We explained this common band in section 2.2 as the editor suggested.

11. indicate the unit of vegetation fraction in Fig4 caption and the unit of WUE in Fig5.

> Reply: We added the unit in both Figure 4 and Figure 5 as the editor suggested.