

Supplementary materials for
theoretical reconstructing the Green Sahara periods
over the Quaternary

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Supplementary Figures 1 to 5.

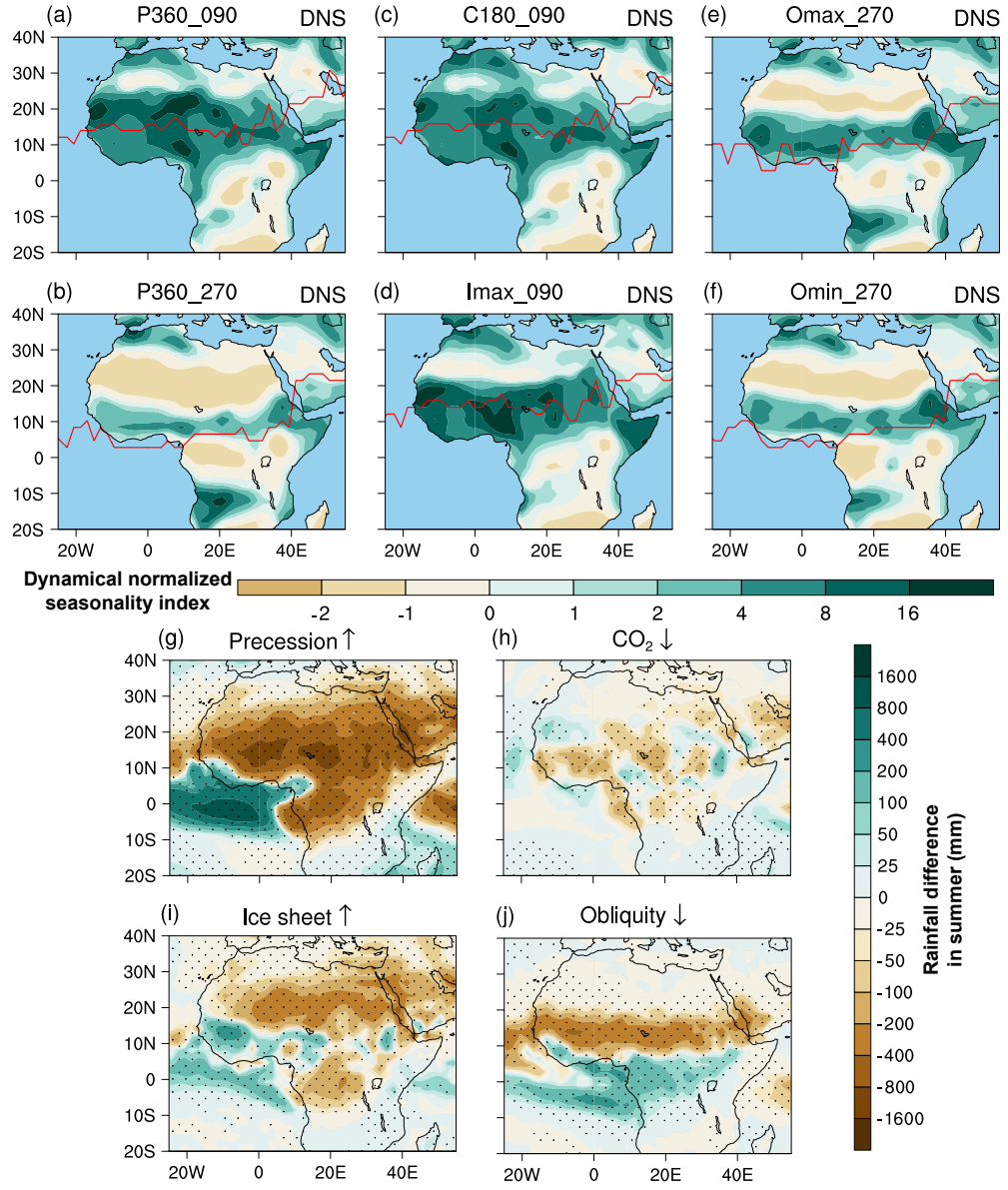


Fig. S1 The southward movement of ITCZ has weakened the summer monsoon and precipitation in Sahara. (a~f) Shading shows the monsoon index defined by Li and Zeng [1]. Area with values greater than 0 indicates monsoon regions. The meridional location of boreal summer ITCZ is marked by red line for each experiment; (g~j) The summer precipitation difference (shading) among different sensitivity experiments.

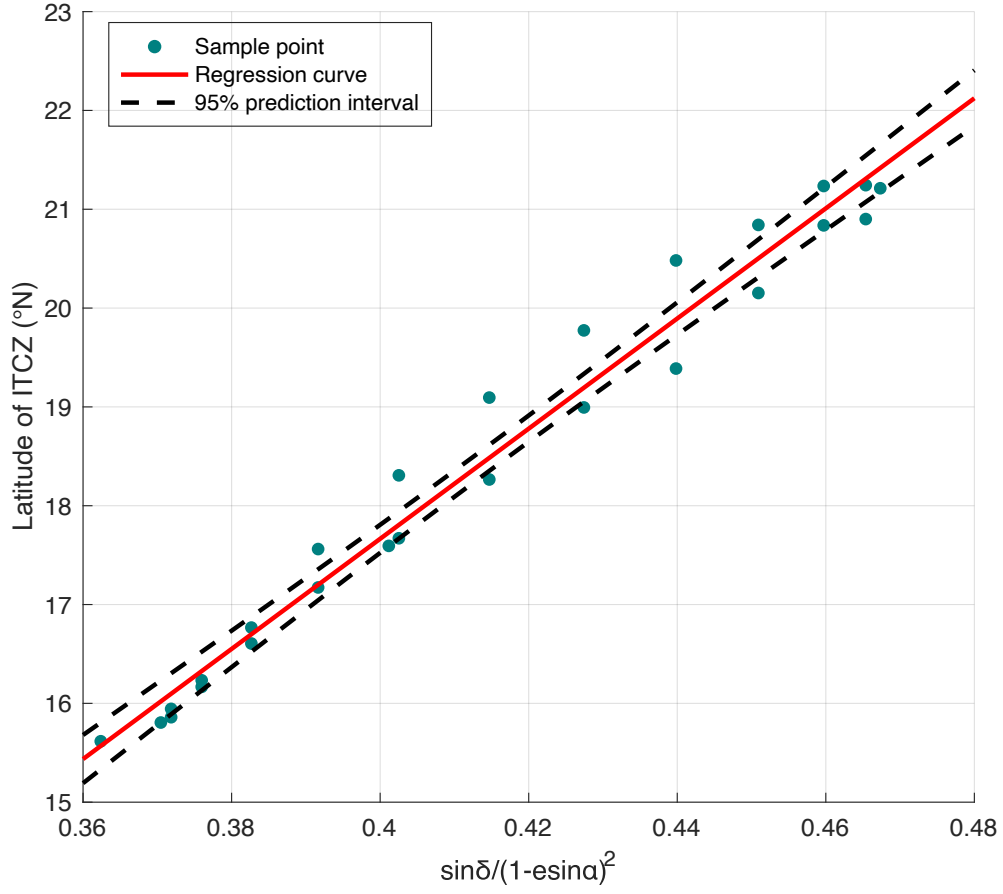


Fig. S2 The energy difference between hemispheres calculated from Earth's orbit parameters (Equation 1) shows a linear relationship to the latitude of ITCZ.

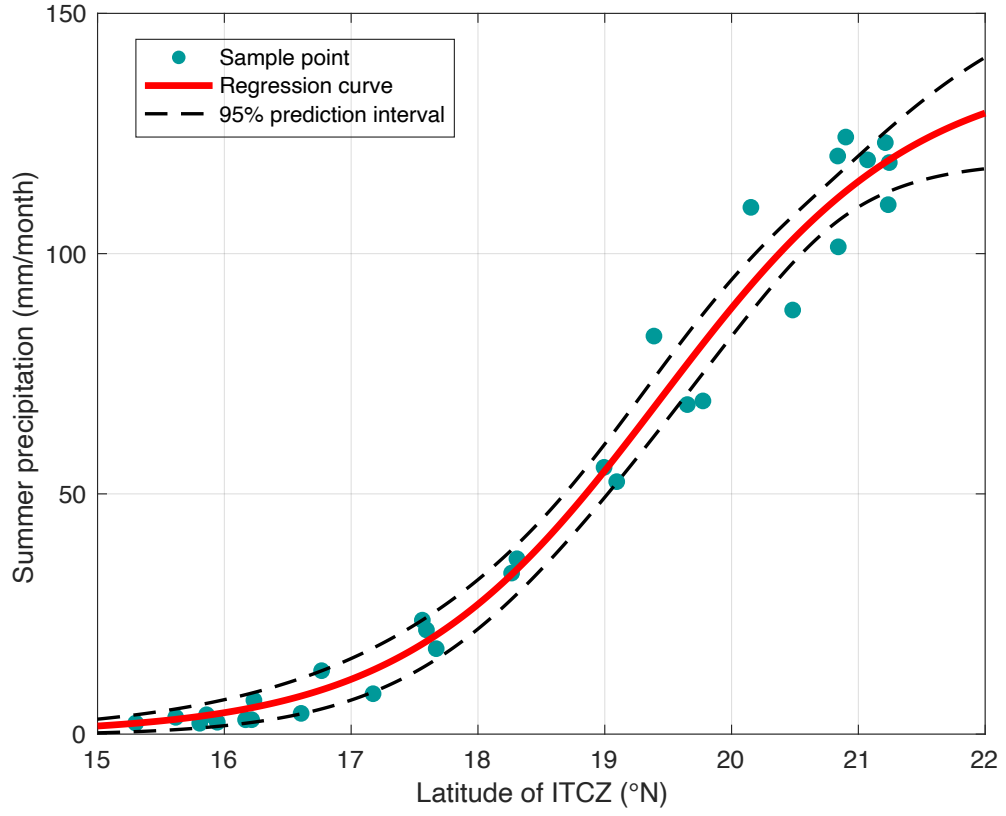


Fig. S3 A Logistic-Sigmoid fitting for Saharan summer precipitation and the latitude of ITCZ based on several experiments.

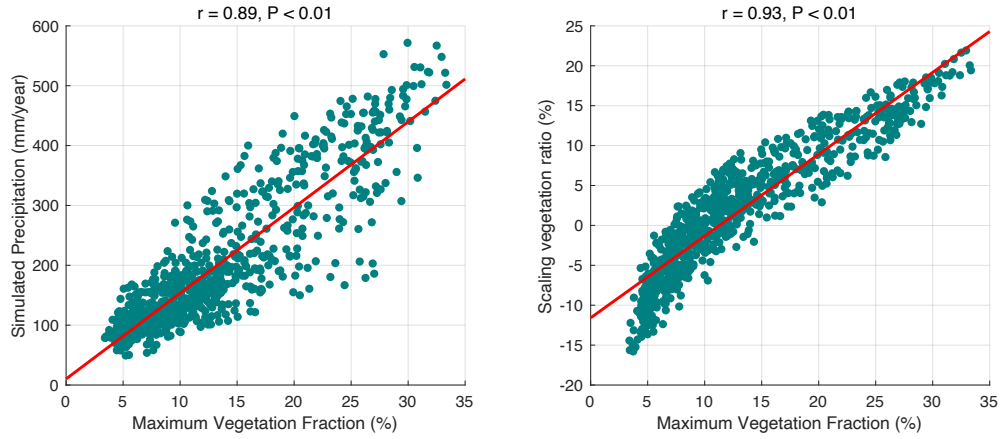


Fig. S4 Comparison between the vegetation fraction of our theoretical model and the simulated Saharan precipitation (left) [2] and scaling vegetation ratio [3].

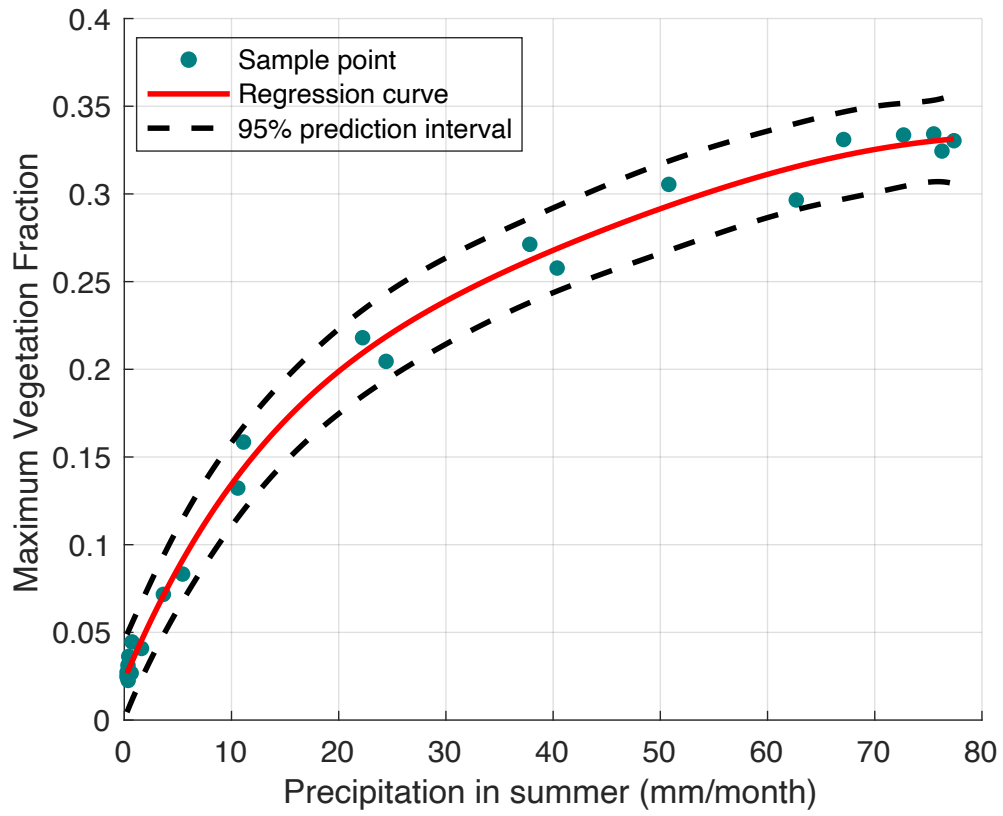


Fig. S5 Nonlinear fitting between regional average maximum vegetation fraction (veg_ratio_max, var20) and summer Saharan precipitation based on the component JSBACH in AWI-ESM.

References

- [1] Li, J., Zeng, Q.: A unified monsoon index. *Geophysical Research Letters* **29**(8), 115–11154 (2002)
- [2] Armstrong, E., Tallavaara, M., Hopcroft, P.O., Valdes, P.J.: North african humid periods over the past 800,000 years. *Nature Communications* **14**(1), 5549 (2023)
- [3] Duque-Villegas, M., Claussen, M., Kleinen, T., Bader, J., Reick, C.H.: Pattern scaling of simulated vegetation change in north africa during glacial cycles. *Climate of the Past Discussions* **21**, 1–30 (2025)