

Supporting Information for

**West African Monsoon dynamics and its control on stable oxygen isotopic composition of precipitation in the Late Cenozoic**

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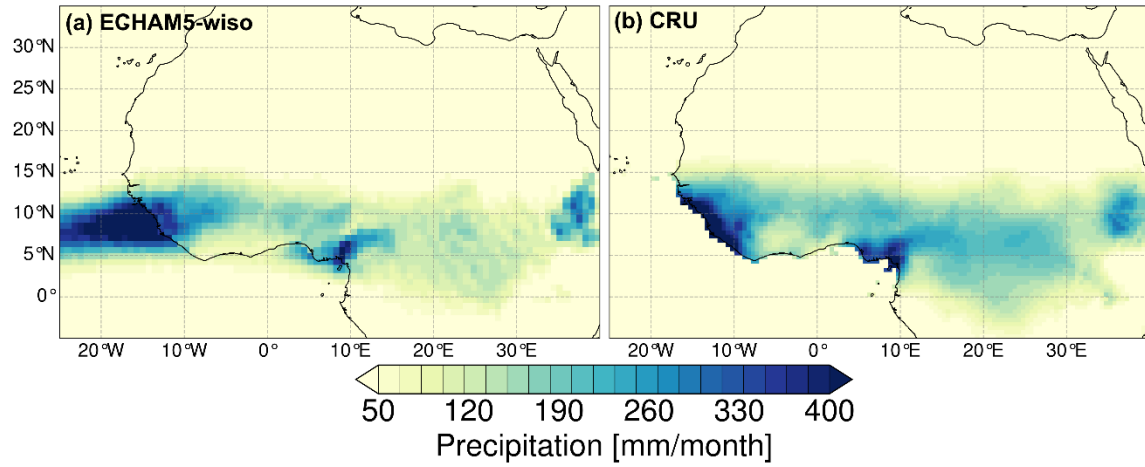
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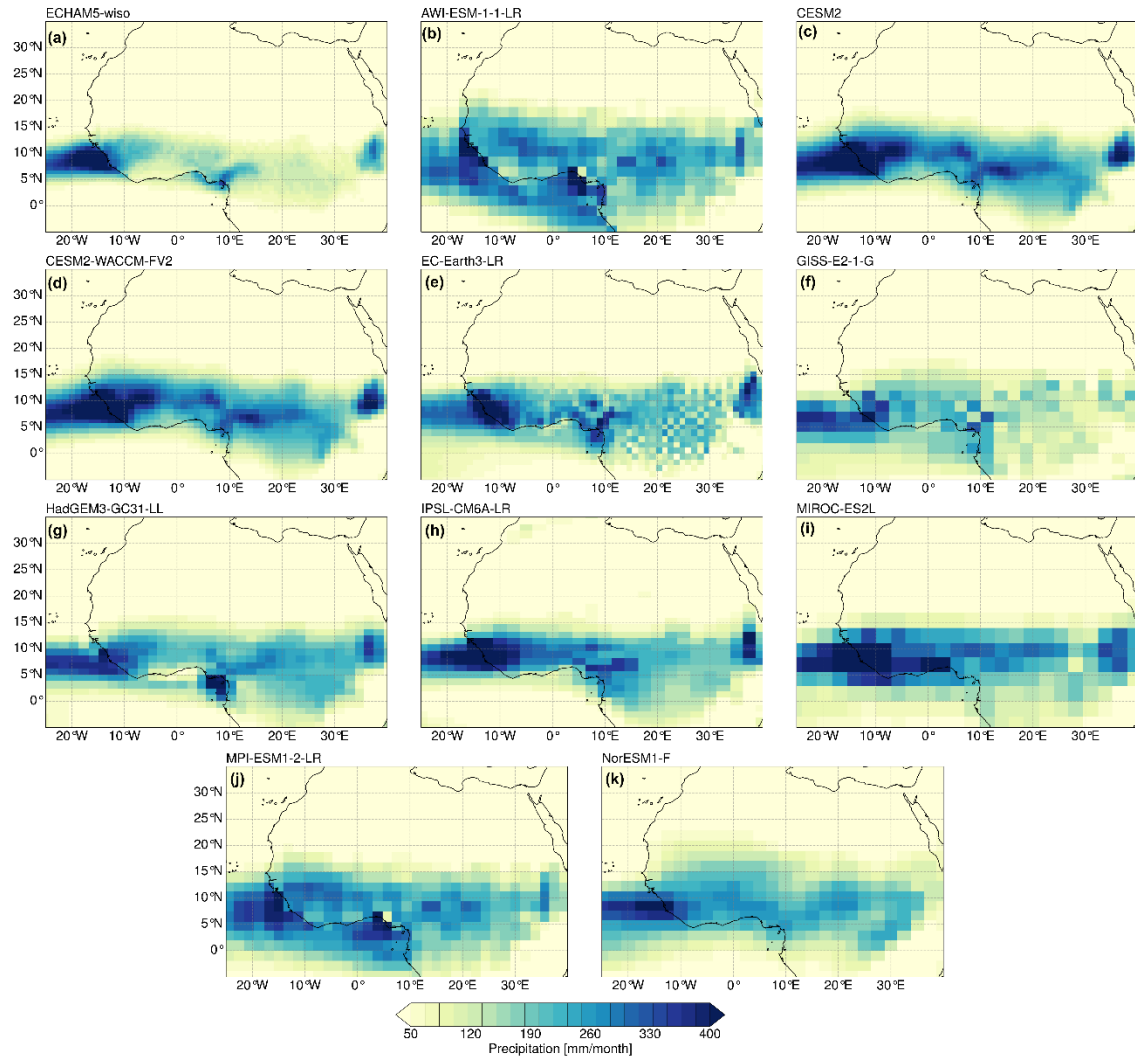
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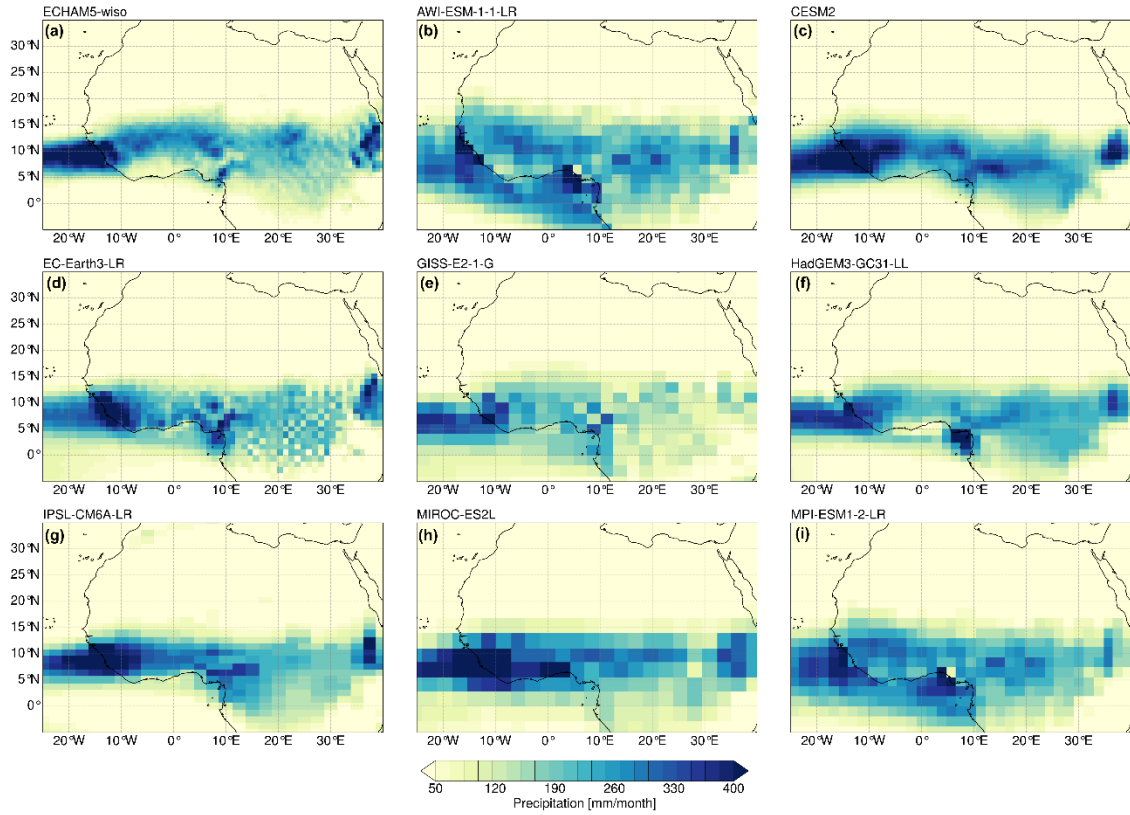
Figures S1 to S10



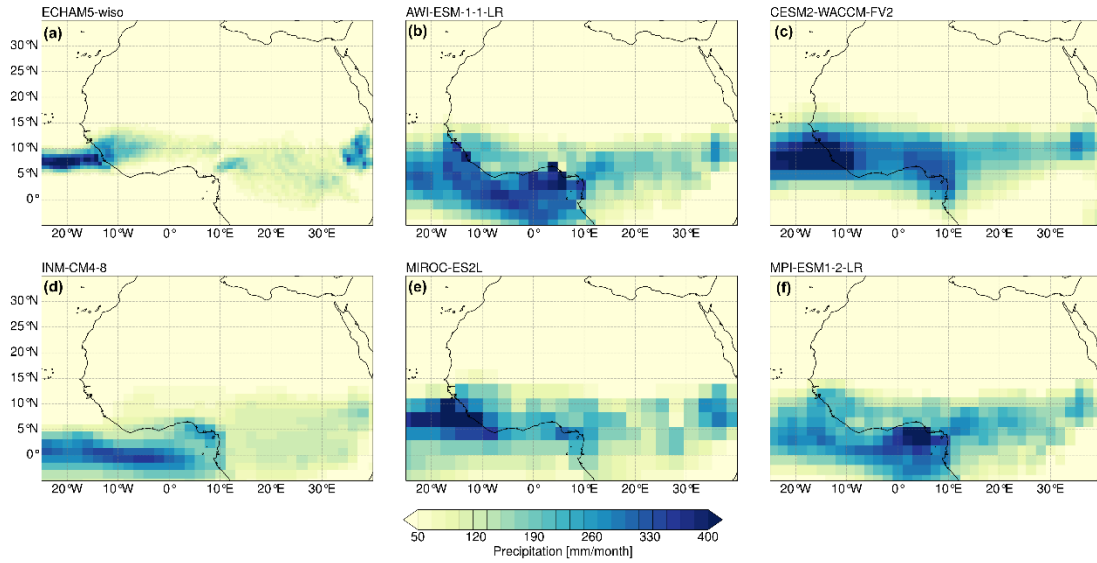
**Figure S1.** Comparison of ECHAM5-wiso simulated long-term (1979-2014) seasonal means for WAM months with the CRU interpolated gridded dataset from weather stations. The simulated patterns indicate that ECHAM5-wiso reasonably represents a latitudinal belt of maximum precipitation (i.e., a rainbelt) during the West African Monsoon (WAM) season.



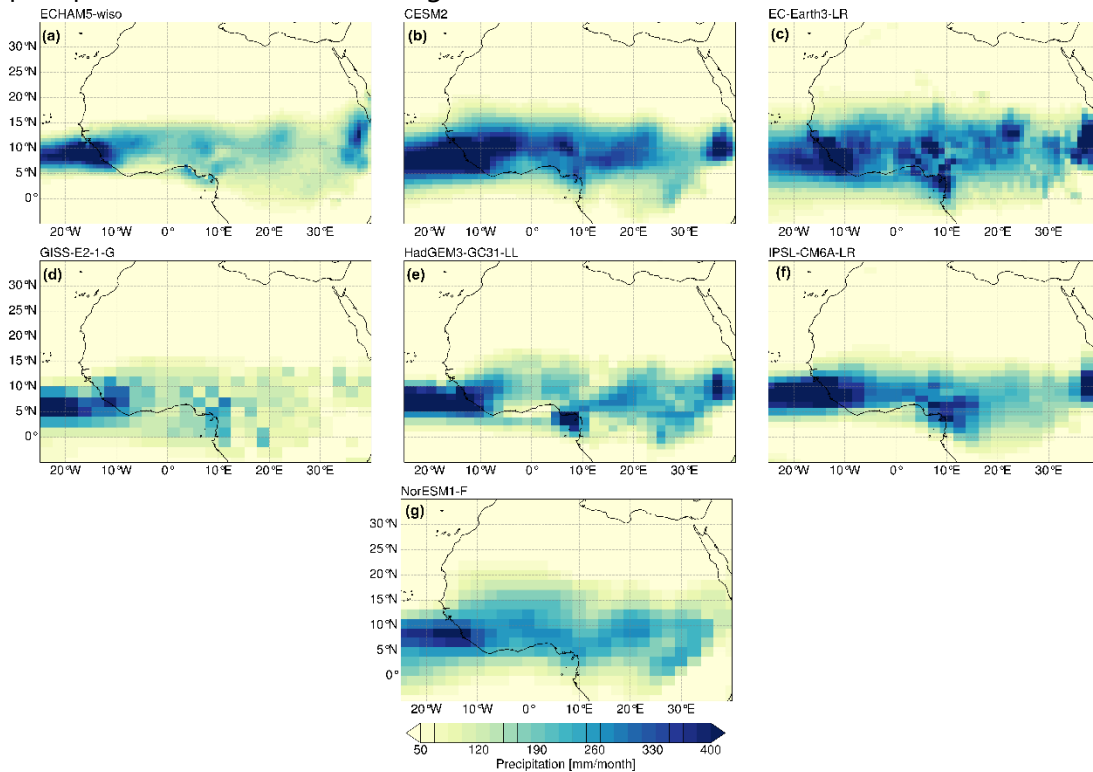
**Figure S2.** Seasonal (JJAS) long-term means of simulated precipitation by ECHAM5-wiso (a) and individual CMIP6-PMIP4 models (b-k) in response to the Pre-Industrial (PI) paleoenvironmental conditions used to estimate the respective precipitation anomalies in different past climates.



**Figure S3.** Seasonal (JJAS) long-term means of simulated precipitation by ECHAM5-wiso (a) and individual CMIP6-PMIP4 models (b-k) in response to the Mid-Holocene (MH) paleoenvironmental conditions. AWI-ESM-1-1-LR, MPI-ESM-2-LR, and ECHAM5-wiso show relatively more precipitation above 15 °N. However, the Pre-Industrial precipitation estimates reach higher latitudes in AWI-ESM-1-1-LR and MPI-ESM-2-LR compared to ECHAM5-wiso.

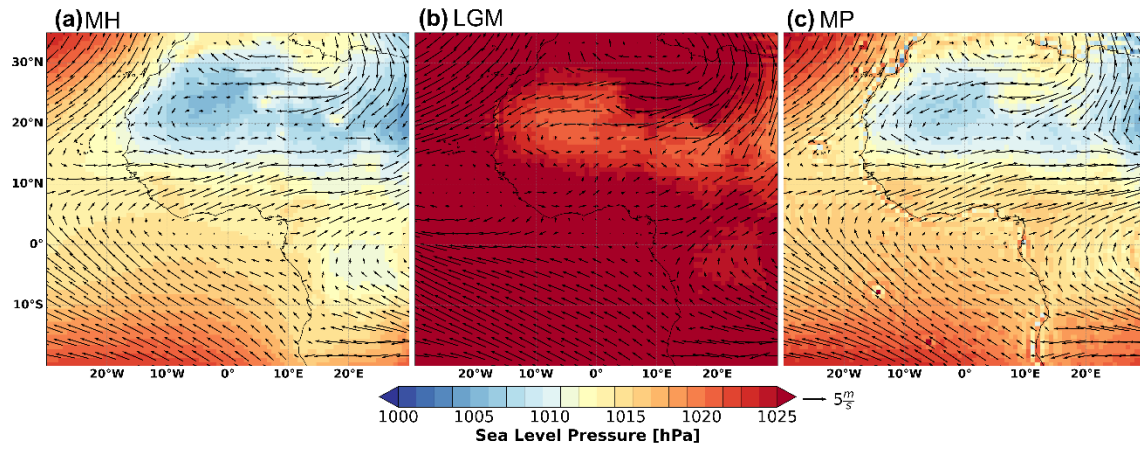


**Figure S4.** Seasonal (JJAS) long-term means of simulated precipitation by ECHAM5-wiso (a) and individual CMIP6-PMIP4 models (b-f) in response to the Last Glacial Maximum (LGM) paleoenvironmental conditions. Overall, ECHAM5-wiso indicates the lowest precipitation across the WAM region.

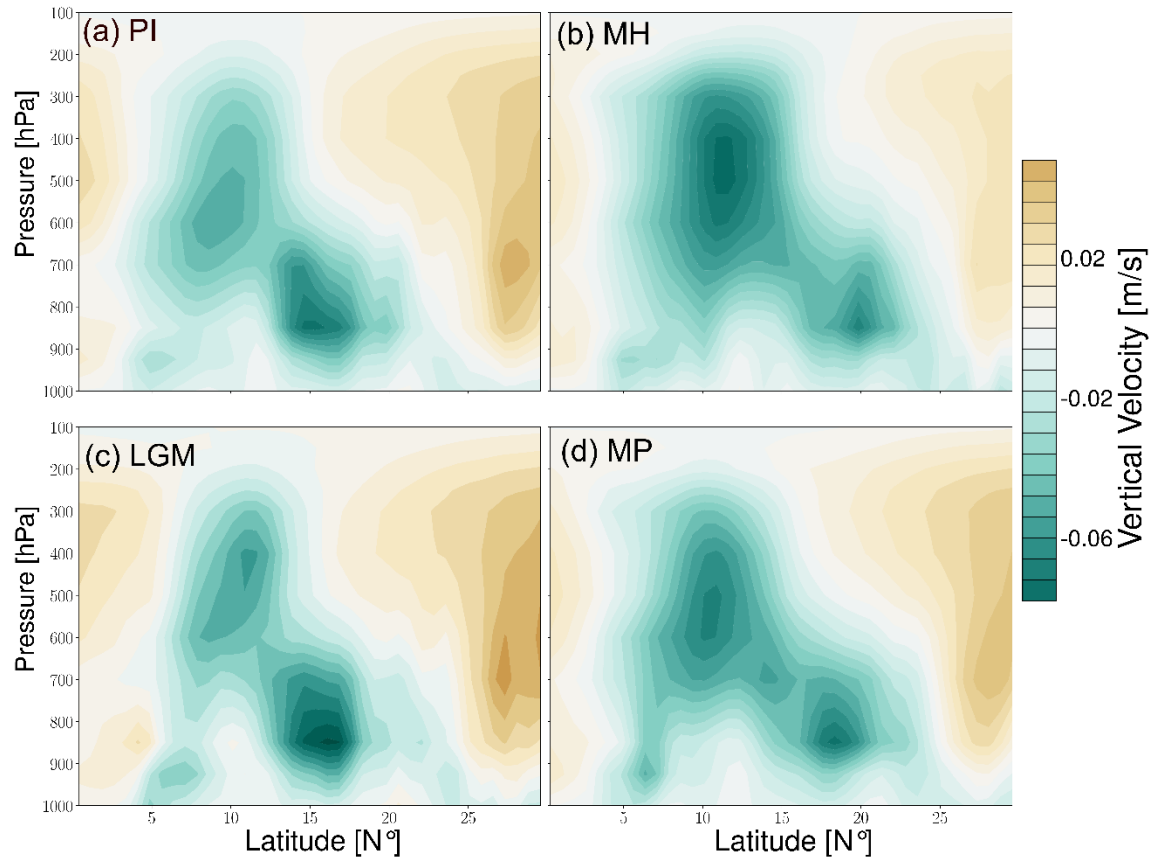


**Figure S5.** Seasonal (JJAS) long-term means of simulated precipitation by ECHAM5-wiso (a) and individual CMIP6-PMIP4 models (b-f) in response to the Mid-Pliocene (mPlio)

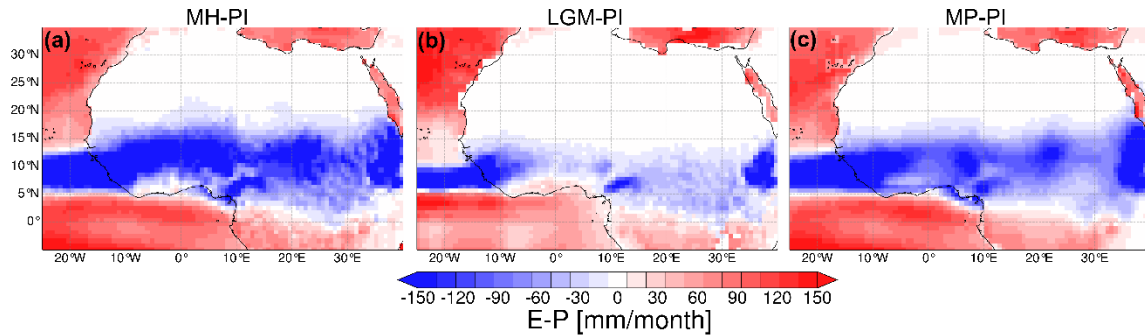
paleoenvironmental conditions. Overall, CESM2 and EC-Earth3-LR indicate >30% more precipitation over the WAM region than the other climate models.



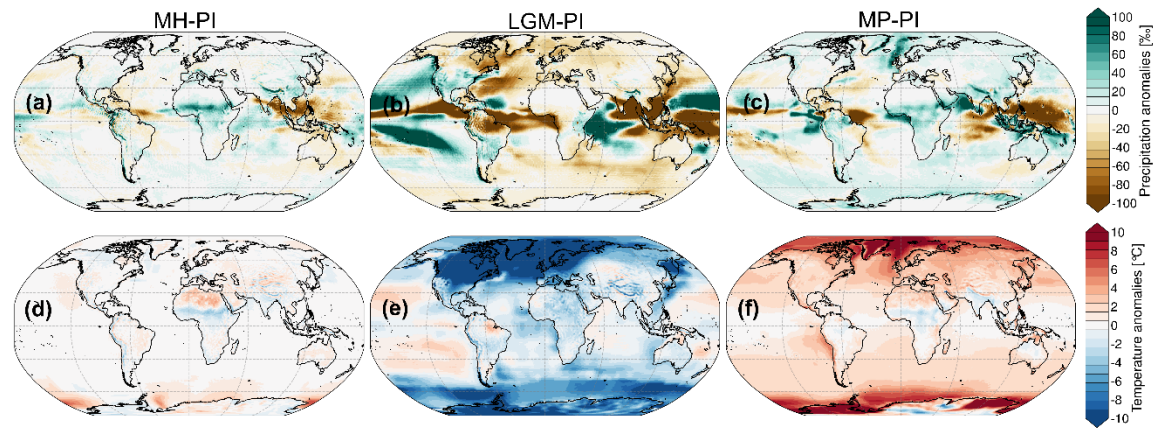
**Figure S6.** Mean sea level pressure (background colour) and wind patterns (arrows) at the 850 hPa pressure level estimated for the WAM season in response to paleoenvironmental conditions (a) MH, (b) LGM, and (c) mPlio using ECHAM5-wiso.



**Figure S7.** Latitudinal vertical (pressure levels) cross-sectional patterns of seasonal (JJAS) means of vertical wind velocity (omega) in response to (a) PI, (b) MH, (c) LGM, and (d) mPlio paleoenvironmental conditions using ECHAM5-wiso. The omega values represent the speed of air motion in the upward or downward direction. Since vertical pressure decreases with height, negative values indicate upward, or ascent velocity, and positive values indicate downward or subsidence velocity.

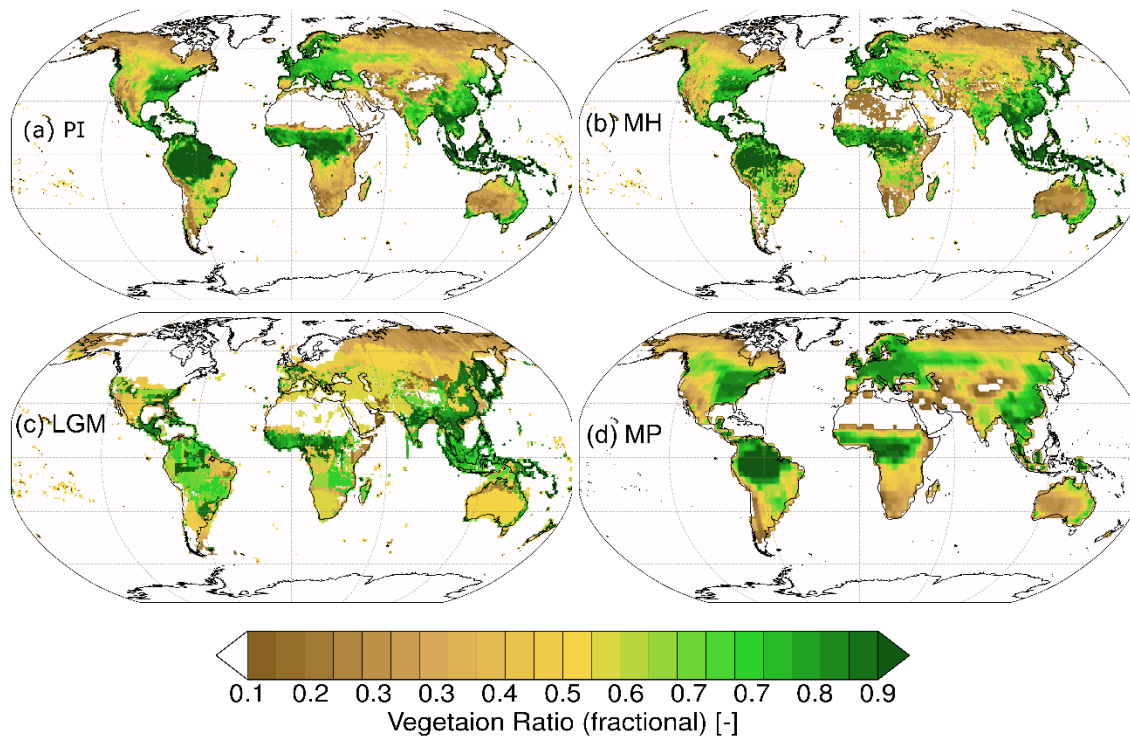


**Figure S8.** Evaporation - Precipitation anomalies during the WAM season (JJAS) estimated in response to the (a) MH, (b) LGM, and (c) mPlio paleoenvironmental conditions using ECHAM5-wiso. The positive values (red colour ranges) indicate more evaporation than precipitation, and vice versa for the negative values (blue colour ranges). The relatively higher evaporation in the MH than in mPlio suggests the role of surface fluxes in contributing to the intensification of the WAM.



**Figure S9.** Long-term annual means of precipitation (top panel) and near-surface temperature anomalies (bottom panel) estimated in response to the MH (a, d), LGM (b, e), and mPlio (c, f) paleoenvironmental conditions.





**Figure S10.** Vegetation fractional (i.e., the density of vegetation cover via the maximum vegetation fraction of a grid cell) prescribed as boundary conditions for the different past climate experiments. The values range from 0 to 1, with higher values indicating more vegetation cover.