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Green Sahara Megaperiods during the Pliocene: What was the role of North Atlantic Ocean temperature?

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The Sahel region is one of the most vulnerable regions on Earth to anthropogenically-driven climate change, but also one of the least equipped to deal with the consequences. Predictions of precipitation levels over the forthcoming centuries diverge, not only in magnitude, but also in the sign of change. One key aspect of this uncertainty comes from the role of Atlantic Ocean sea surface temperatures (SST), which are known to exert a strong control over precipitation in the Sahel and are implicated in both the major drought of the late 20th century and extreme droughts associated with the Heinrich events of the last glacial. To better understand how Sahelian hydroclimate may respond to SST variability in a warmer world, we turn to the Pliocene epoch, when atmospheric CO₂ levels were comparable to present.

We studied sediments from Ocean Drilling Project Site 659, which is situated in the subtropical North Atlantic beneath the major modern summer Saharan dust plume. Our new dust accumulation rates and X-ray fluorescence core scan data indicate that there were major shifts between highly arid conditions and humid intervals with vegetated or “Green Sahara” conditions over much of northern Africa, driven by both solar insolation and glacial-interglacial variability. We also report three unusually long Plio-Pliocene humid intervals (each lasting ca. 100 kyr) characterised by very low dust emissions, that we term “Green Sahara Megaperiods (GSMPs)”. All three of these GSMPs occur at times when insolation variability was weak, resulting in values close to the long-term mean. This observation strongly suggests that factors other than insolation drove the sustained humidity of GSMPs. We present paired alkenone SST estimates and multi-species planktonic foraminiferal isotope records from 3.5–2.3 Myr ago to explore the extent to which the GSMPs were accompanied by intervals of extended warmth in the surface waters of the North Atlantic Ocean.