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Late Miocene biomarker and pollen records in Southeast Atlantic Ocean sediments indicate environmental changes

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The Late Miocene epoch is characterized by fundamental changes in Earth‘s climate system: sea-level variability, changes in surface- and deep-water circulation, increase in upwelling intensity along the coasts and turnover in marine and terrestrial biota [1,2]. It is thought that plants using the CO2 concentrating C4 mechanism for photosynthesis potentially evolved during times of a global drop in atmospheric CO2 content and at relatively hot and dry habitats. During the Late Miocene C4 plants expanded nearly simultaneously at different places in the world, while temperatures declined and global CO2 levels exhibited no corresponding change [1,3]. Our objectives concern the climatic and environmental change of Miocene Southwest Africa between ∼14 to ∼5 Myrs BP and how these conditions may be linked to the C4 plant expansion.
We use a variety of organic geochemical techniques combined with palynology on sediments of ODP Site 1085. The site is situated in the Cape Basin at the south-west African continental margin, within the today's upwelling zone of the Benguela Coastal Current. Miocene sea surface temperature (SST) estimates applying two indices (TEX86 and UK'37) suggest a transition to cooler temperatures from above 27 to 18°C over a time period from ∼14 to ∼5 Myrs BP, but are different in rate and timing. Increased upwelling leads to cooler SSTs and enhanced marine primary production as implied by a small but clear overall shift in total organic carbon content after 11 Myrs BP. Concurrently, the abundance of both marine cysts and terrestrial pollen and spores increase and the relative contribution river run-off from the nearby Orange River declines, as indicated by the BIT-index (from ∼0.8 to <0.1). We connect these findings to a change in strength and the predominant direction of the wind combined with an intensification of the Benguela upwelling current bringing cold, nutrient-rich waters from the South Atlantic and the Antarctic circumpolar current, probably driven by the formation of the West Antarctic ice sheet [1,2]. The transport way for terrestrial organic matter, pollen and spores changed from riverine to predominantly airborne contribution potentially accompanied by a change of the source area. However, pollen records and molecular stable carbon and hydrogen isotopic measurements of plant leaf wax n-alkanes exhibit spreading grassy vegetation due to a stepwise growing aridity in South Africa. After 8 Myrs BP terrestrial floral assemblages got more affinity to those of the Pleistocene and mark the beginning of the floral change towards C4-dominance. We infer that by the end of the Miocene C4 grasslands became important in Southwest Africa.

References

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