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Subtropical precipitation and the evolution of ocean temperature gradients over the last 5 million years

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The climate of the tropics and surrounding regions is defined by pronounced zonal (east–west) and meridional (equator to mid-latitudes) gradients in sea surface temperature. These gradients control zonal and meridional atmospheric circulations, and thus the Earth's climate – take for example El Nino events wherein a strong reduction of the zonal sea surface temperature gradient across the equatorial Pacific influences global climate. Continuous sea surface temperature records from locations around the globe and spanning the last 5 million years indicate that global cooling, through the Pliocene and into the Pleistocene, was accompanied by the gradual strengthening of these temperature gradients. How might this change in large-scale ocean temperature gradients have shaped the palaeoenvironments and climate change experience by our Plio-Pleistocene ancestors in Southern Africa? Here, we investigate this question with an early Pliocene coupled climate simulation that closely reproduces the available surface temperature reconstructions. Furthermore, we contrast this experiment against a typical quadrupling-of-CO_2 experiment to provide a mechanistic understanding of why warm Pliocene conditions supported generally wetter subtropical regions, while current projections for future global warming caused by CO_2 rise suggest the strengthening of such dry conditions over subtropical regions, rather than the return to a wetter state.