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Influences of the Agulhas Current on South African terrestrial climate as inferred from speleothem stable isotope records

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South African (SA) climate is strongly influenced by the circulation systems surrounding the subcontinent. The warm tropical Agulhas Current provides large amounts of moisture, transported onshore by south-easterly trade winds during summer. As the trade wind shifts north during winter, the south-western tip of SA is especially affected by temperate westerlies. High amounts of rainfall from the Benguela region off the west coast then only affect the very south-west of the country. This seasonal pattern creates a highly variable terrestrial climate, characterized by strong E-W gradients in the seasonal distribution and amount of rainfall. As summer and winter rain is derived from sources with different properties (density, salinity, temperature), the rainfall also displays seasonal isotopic compositional variations, as for example the present mean δ18O of rainfall in Mossel Bay located in the transition region varies from $\sim$0.13‰ in January to -6.05‰ in July. Vegetation type (C3 vs C4) also follows the rainfall regime with C4 vegetation dominating in the summer rainfall region. As part of the GATEWAYS project, speleothems are used as an excellent, high resolution, precisely dated archive of terrestrial paleoenvironmental conditions[1].

This study focuses on a speleothem record from Crevice Cave on the South African south coast (near Mossel Bay), covering the interval between $\sim$111 and $\sim$53 ka[1,2]. At present, the area is influenced by both summer and winter rainfall, and has mostly C3 type vegetation. Variations in the past show more positive δ18O and δ13C values in the interval corresponding to the glacial MIS 4 and indicate increased summer rainfall and C4 vegetation. This contradicts the common assumption that MIS 4 was characterized by a northward shift of the climatic belts over SA and an increase of winter rainfall and C3 vegetation in the cave area[3]. Comparison of the record to marine sediment cores from the Agulhas Retroflection area[4] and the Cape Basin[5,6] as well as an ice-core record from Antarctica[7] reveal that the speleothem δ18O and δ13C are more closely related to the sea surface temperature shifts in the Agulhas region and Antarctica (with lower δ18O and δ13C values corresponding to higher temperatures) than to the influence of global ice-volume related changes in the isotopic composition of the ocean. A contemporary record from a cave site situated $\sim$92 km inland from Mossel Bay (E-Flux Cave, Klein Karoo) shows a very different signal, corresponding to overall changes in Obliquity[8]. The influence of the Agulhas Current is thus apparent on the coast, but reduced inland.

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