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Changes in Southern Hemisphere westerlies from Last Glacial Maximum to mid-Holocene in southern Africa: a CMIP/PMIP ensemble-data comparison

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Southern Hemisphere (SH) westerlies are an important factor in understanding Quaternary climates. Mid-latitude SH westerly winds drive dust transport to the southern Oceans, modulate ocean-atmosphere exchange of CO_2 and the marine biological pump, as well as influence regional rainfall patterns in mid-latitude terrestrial settings via their association with temperate frontal systems. An accurate understanding of the dynamics of the SH westerly wind jet under glacial-interglacial cycles is important to refine the next generation of models in the Palaeoclimate/Coupled Modelling Intercomparison Project (PMIP4/CMIP6), and is also essential to understand the mechanisms of glacial terminations. Roughly half of PMIP3/CMIP5 model experiments identify a poleward shift in the SH mid-latitude westerly jet at the Last Glacial Maximum (LGM), a phenomenon which has been linked to increased sea ice extent. Significantly, these models contradict the long-held view of equatorial shift of SH westerlies at the LGM, and long-standing hypotheses about expansion of the winter rainfall zone in southern Africa, and the issue is thus important to resolve. Proxies of past hydroclimate play an important role in ground truthing these hypotheses. These proxies have been used to test modelled shifts in hydroclimate, and therefore the position and strength of the SH westerlies, but are subject to considerable uncertainties, and often provide frustratingly poor temporal resolution. Global SH paleoclimate evidence is often just as ambiguous, showing a variety of scenarios for change in the westerlies which include no change at the LGM, a poleward shift, and an equatorial shift. Here, we present an analysis of regional change in hydroclimate across southernmost Africa according to the LGM (21 ka) and mid-Holocene (6 ka) scenarios of PMIP3/CMIP5 ensemble models. Model predictions are compared to a novel compilation of several high-resolution palaeoclimate records from southern Africa, dated precisely to 21 ka and 6 ka. The compilation includes pollen, stable carbon and oxygen isotopes from speleothems and biominerals, and SST measurements. Criteria for strict data selection and model agreement are presented, and results are discussed in relation to changes in the latitude and strength of the mid-latitude SH westerly wind jet.