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Southern Hemisphere Westerly Wind Changes during the Last Glacial Maximum: Model-Data Comparison

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The Southern Hemisphere (SH) westerly winds are thought to be critical to both past and future global ocean circulation, productivity, and carbon storage. For example, an equatorward shift in the winds has been suggested as the leading cause for the reduction in atmospheric CO_2 during the Last Glacial Maximum (LGM), through its affect on the Southern Ocean circulation. Despite the importance of the SH westerlies, paleo-records and modelling studies still disagree on how they behaved during the LGM. Here, a joint model-data evaluation study is performed to determine likely changes in the SH westerly winds during the LGM. HadAM3 atmospheric simulations, along with published PMIP2 coupled climate model simulations, are assessed against our newly synthesised database of moisture records for the LGM (Kohfeld et al., accepted, QSR). While moisture data are the most commonly cited evidence in support of a large equatorward shift in the SH winds during the LGM, none of the models that produce realistic LGM precipitation patterns show a large equatorward shift. In fact, the model which best simulates the moisture proxy data, our HadAM3 LGM simulation, shows a small poleward wind shift. Thus, moisture proxies do not provide a robust observational evidence base for equatorward shifted winds during the LGM (Sime et al, in press, QSR). Sensitivity simulations, featuring individual boundary condition changes, suggest that changes in sea surface temperatures are the strongest factor behind LGM wind changes, compared with sea ice and land ice effects. If the SH westerly winds were not shifted equatorward at the LGM, this raises intriguing questions regarding past and future carbon storage in the Southern Ocean.