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Southern Ocean winds at the LGM: The influence of state dependency and sea ice

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Latitudinal shifts in the Southern Ocean westerly wind jet could drive changes in the glacial-interglacial ocean CO_2 inventory. However, whilst CMIP5 model results feature consistent future-warming jet shifts, there is considerable disagreement in deglacial-warming jet shifts. One reason for the disagreement is that glacial jet positions are strongly related to the sea ice edge, which varies between the models. We find an equatorwards extension of the sea ice edge correlates with a poleward shift in the jet latitude (r = -0.9). The relationship is strongest for the 850 hPa jet diagnostic, but similar results are obtained for the 1000 hPa and tauU jet positions. A 1 deg difference in the sea ice edge suggests a -0.8 deg shift in the 850 hPa jet. However this applies only to models which have interglacial jets which are at a realistic latitude. If we look at the relationship between Southern Ocean sea surface temperature changes and jet shifts, a cooling of -1 K over the Gersonde et al. (2005) Southern Ocean data locations results in a 3.0 deg poleward shift in the 850 hPa jet (r = 0.83; n=5). Initial jet position, or state dependency is also shown to be a major cause of CMIP5-PMIP3 inter-model disagreement. State dependency explains up to 56% of the glacial-interglacial jet shifts in the Atlantic sector (r = -0.75, N=9, for tauU). For the whole of the Southern Ocean region, the variance explained by state dependency is 38% (r = -0.62, N = 9, for tauU). Finally, we also find that the glacial-interglacial moisture model-data agreement is strongly dependent on the interglacial jet position. State dependence is thus also important when determining past glacial-interglacial moisture changes over the Southern Ocean.