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Influence of changes in boundary conditions on Southern ocean winds at the last glacial inception

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The location and the strength of Southern Ocean westerly winds plays a role for the global climate system and the global carbon cycle. An understanding of Southern Ocean deep water ventilation changes through change in Antarctic Circumpolar Current (ACC) may be critical to understanding atmospheric CO2 changes at a range of timescales. We know that changes in the westerlies can drive changes in the ACC on time-scales from 2 days to thousands of years.

We present a large (+30) set of atmospheric model experiments designed to examine the response of the westerlies to a range of changes in boundary condition. Experiments are selected to reproduce changes that may have occurred between the last inter-glacial and 110 K before present. This time period covers the initial 50 ppm of atmospheric CO2 drawdown that occurred during the last glacial cycle. Initially we examine 7 experiments designed to isolate different elements of the atmospheric boundary conditions. Experiments include: changes in sea surface temperature (SSTs), sea ice cover, sea ice cover and SST combined, continental ice, orbital forcing, atmospheric CO2, and a control experiment. We then present a further set of experiments that examine the sensitivities to experiment setup.

All experiments induced changes in wind strength and position of variable amplitude in different basins and different seasons, within a maximum monthly change in amplitude of 5 m/s and displacement of 15 degrees of latitude. Winds were most sensitive to changes in the SSTs and sea-ice extent. We show a strong correlation between

hemispheric temperature gradients and the latitude of the westerly belt, supporting an equatorward displacement of the maximum winds between the last inter-glacial and 110K. Our results suggest that wind changes may indeed be part of a positive feedback between climate, CO2, and deep ocean ventilation in the Southern Ocean.