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Cold climate westerly winds over the Southern Ocean

L. Sime (1), C. Le Quere (2), E. Wolff (1), W. Connolley (1), A. De Boer (2), and L. Bopp (3)

(1) British Antarctic Survey, Cambridge, United Kingdom (lsim@bas.ac.uk), (2) School of Environmental Sciences, University of East Anglia, Norwich, NR4 7TJ, U.K, (3) Centre National de la Recherche Scientifique, CEA, Saclay, 91191 France

Many elements of the ocean circulation depend on the Southern Ocean wind field, however Quaternary cool climate westerlies are poorly understood. We use an atmospheric general circulation model HadAM3 to simulate wind changes over a large variety of cool climates.

We show that extra-tropical latitudes which experience the most intense sea surface temperature (SST) cooling anomalies show the largest changes in the westerlies, mainly in the winter season. New sea ice, formed under the cooler conditions, slows the surface westerlies winds by up to 2.8 ms^{-1} in winter. Together SST and sea ice affects produce complex bimodal change patterns. The seasonally dependent response to changes in sea ice and SST, plus the inability of simple wind statistic to convey the changes, explain the disagreements found between previous observations and modelling studies.

In general the wind maximum tends to increase and move north with the hemispheric meridional temperature gradient. Tropical temperature reductions strongly affect the wavenumber-3 southern hemisphere pattern producing differing responses across different sectors of the southern ocean, again dominated by wintertime changes. However, the total mean Southern Ocean shear stress (which may drive the ACC) depends strongly on the hemispheric temperate gradient and is almost independent of experiment details.