Using Anticyclonicity to Determine the Position of the Southern Hemisphere Westerlies: Implications for the LGM

Richard Wardle

School of Earth Sciences
The University of Melbourne
Victoria, Australia, 3010
Email: *rwardle@unimelb.edu.au*

In this work, a new perspective on the position of the Southern Hemisphere westerlies is presented. We utilize the ensemble statistics of surface high-pressure systems (anticyclones) as a dynamical determination of the westerlies. The westerlies are defined to be the westerly surface winds poleward of latitudes that correspond to the maximum anticyclone system density. A sophisticated vortex-tracking scheme (Simmonds *et al.*, 1999), applied to the results of the Melbourne University atmospheric general circulation model (MUGCM), is used to investigate the statistics of southern hemisphere anticyclones.

GCM simulation data sets for the present day (PD) and the Last Glacial Maximum (LGM) have been used in this study. Figures 1 and 2 display the characteristics of the mean system density of anticyclones for the PD and LGM simulations for DJF and JJA, respectively. The PD distributions (Figures 1a and 2a) agree well with climatology of Jones and Simmonds, (1994). Figures 1b and 2b display the same fields for the LGM, with the (LGM-PD) anomaly presented in Figures 1c and 2c (shading indicates regions of statistical significance at the 95% level). For both seasons, the anomaly patterns for each ocean sector, Australia and Southern Africa are all similar with a negative system density anomaly at approximately 30^oS and a positive anomaly near 40^oS. This anomaly pattern shows greater numbers of anticyclones at high latitudes during the LGM in each season. The ridges of anticyclonicity (the maximum system density) are plotted in Figures 1d and 2d with shading indicating longitudes of statistically significant displacement. The southern hemisphere anticyclonicity at the LGM was different to that of today in the Indian, eastern South Atlantic, much of the Pacific, and south of Australia. The position of the ridge at the LGM (solid line) is for the most part, poleward of its PD position (dashed line) during both the summer and winter seasons, which indicates a poleward displacement of the westerly surface winds. Modeled changes to the location of the ridge in South America are small.

The comparisons of the statistics of two characteristic features of the anticyclones reveal difference in the nature of atmospheric baroclinicity and the surface westerly winds. The modeled changes are also being compared to those inferred from the paleo-reconstructions.

Jones D.A., and I. Simmonds, A Climatology of Southern Hemisphere anticyclones, *Climate Dynamics*, 10, 333-348, 1994.

Simmonds, I., R.J., Murray, and R.M. Leighton, 1999: A refinement of cyclone tracking methods with data from FROST. *Aust. Meteor. Mag.*, Special Issue, 35-49.

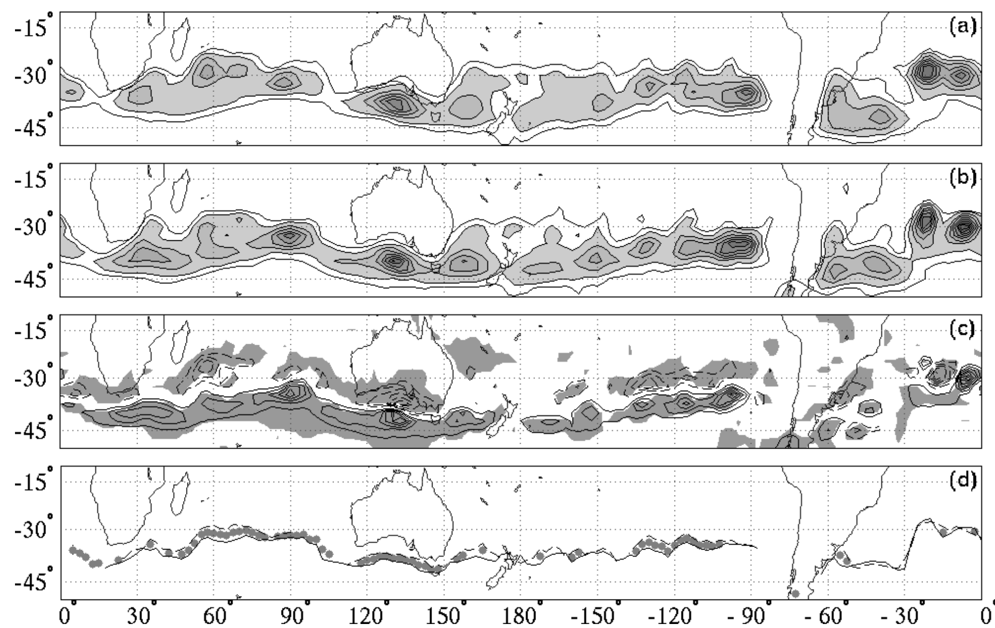

Figure 1: Anticyclone system density [the mean number per 10^3 (deg lat)^2 area] during DJF for the (a) PD, (b) LGM, and (c) the difference (LGM-PD). The contour intervals are (a)-(b) 1×10^{-3} (deg lat) $^{-2}$ and (c) 0.5×10^{-3} (deg lat)$^{-2}$. In (d), the positions of the maxima in system density for the PD (dashed) and LGM (solid) are presented with longitudes of statistical significance at the 95 % level indicated by a shaded dot.

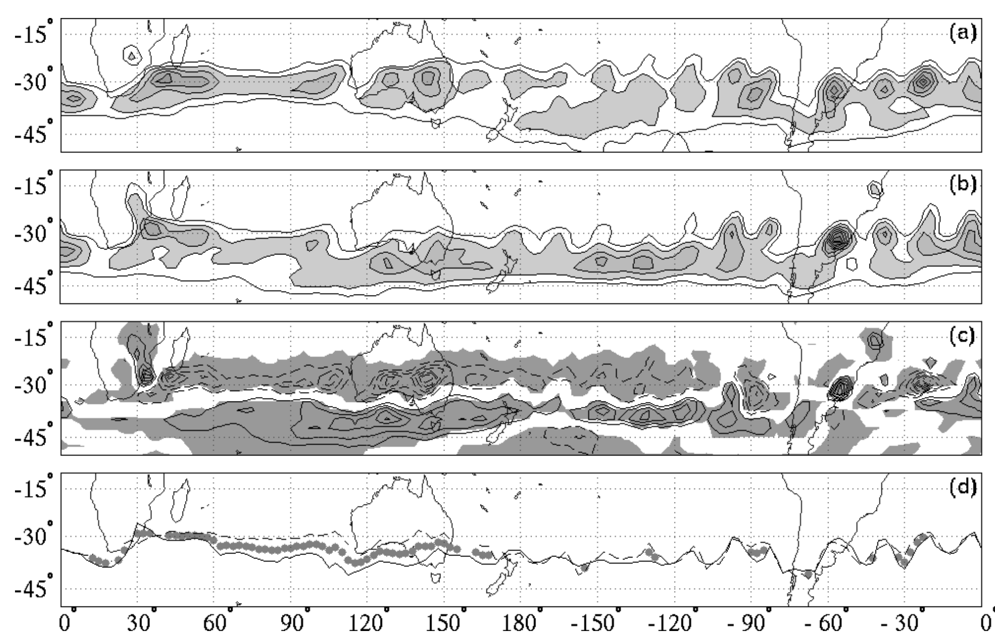

Figure 2: The same as for Figure 1, except for JJA.