Links between the Southern Annular Mode and Australian rainfall

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The Southern Annular Mode (SAM) is an out-of-phase fluctuation in pressure at the mid- and high-latitudes of the Southern Hemisphere (SH). The dynamics (and the involvement of transient eddies) is still far from understood (Rashid and Simmonds, 2004, 2005). An index of the SAM (the AOI) can be taken as the normalized zonal average pressure difference between 40^{o} and 65^{o}S (Gong and Wang, 1999). The index shows strong positive trend since the mid-1970s. Over that time there have been significant decreases in winter rainfall in southwest Western Australia, Victoria and Tasmania (Smith, 2004). Given the role of the transient eddies in maintaining the SAM (and the trends that SH cyclones have displayed over that period (Simmonds and Keay, 2000)), we are exploring the extent to which these Australian rainfall changes can be seen as associated with the SAM.

Over the period 1958 – 2002 we extract the Australian monthly rainfall (Bureau of Meteorology) and also calculate the AOI from the NCEP reanalysis. Fig. 1 shows the correlation of the July time series. Significant (95% confidence level) negative correlations are found in the southeast and southwest corners of the continent. A belt of significant *positive* correlations over a large portion of NSW, extending to the west. This overall structure is strongly suggestive of the meridional translation of rain-bearing systems according to the phase of the SAM.

Many authors (e.g., Simmonds and King (2004)) have emphasised that the SAM is far from zonally symmetric, and clearly *local* reflections of the SAM are associated with regional climate variations. To explore this we have derived an *Australian region* AOI which follows the above definition, but makes use of the data only in the 90-180^{o}E sector. The pattern of correlations with this index resemble those above, though the negative correlations referred to above are considerably stronger.

Gong, D. Y., and S. W. Wang, 1999: Definition of Antarctic Oscillation Index. *Geophysical Research Letters,* **26,** 459-462.

Rashid, H. A., and I. Simmonds, 2004: Eddy-zonal flow interactions associated with the Southern Hemisphere annular mode: Results from NCEP-DOE reanalysis and a quasi-linear model. *Journal of the Atmospheric Sciences,* **61,** 873-888.

Rashid, H. A., and I. Simmonds, 2005: Southern Hemisphere annular mode variability and the role of optimal nonmodal growth. *Journal of the Atmospheric Sciences,* (in press).

Simmonds, I., and K. Keay, 2000: Variability of Southern Hemisphere extratropical cyclone behavior 1958-97. *Journal of Climate,* **13,** 550-561.

Simmonds, I., and J. C. King, 2004: Global and hemispheric climate variations affecting the Southern Ocean. *Antarctic Science,* **16,** 401-413.

Smith, I., 2004: An assessment of recent trends in Australian rainfall. *Australian Meteorological Magazine*, **53,** 163-173.

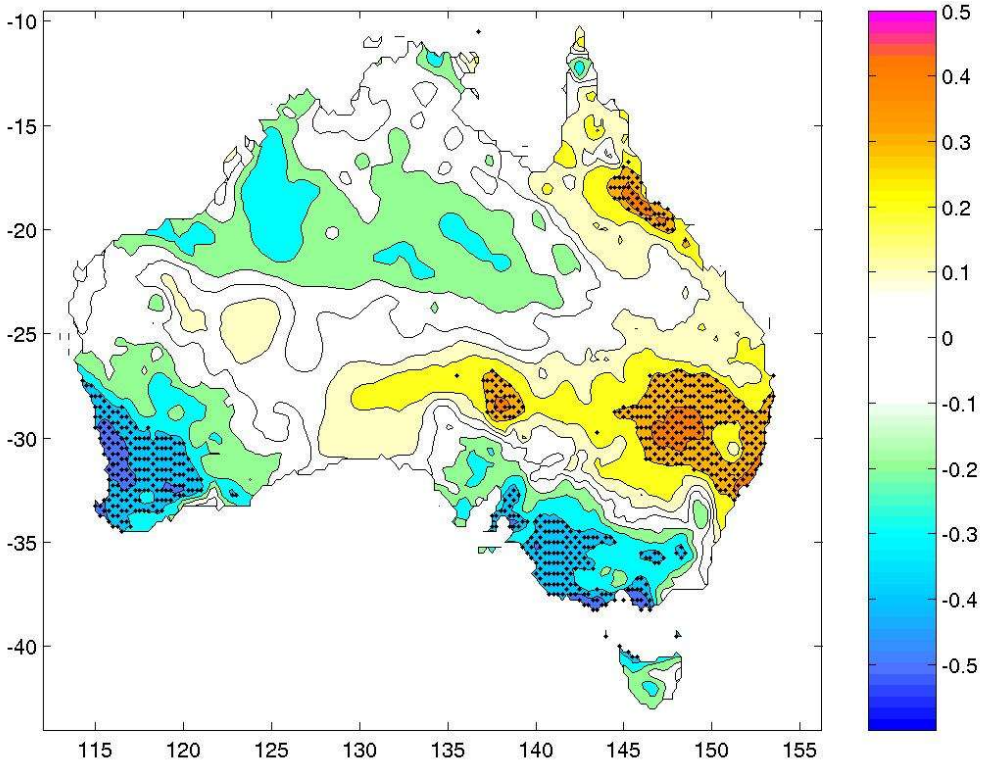

Figure 1: Correlation of July AOI and precipitation (1958 – 2002) (contour interval is 0.1). Stippling denotes regions over which the correlations differ significantly from zero (95% confidence level).

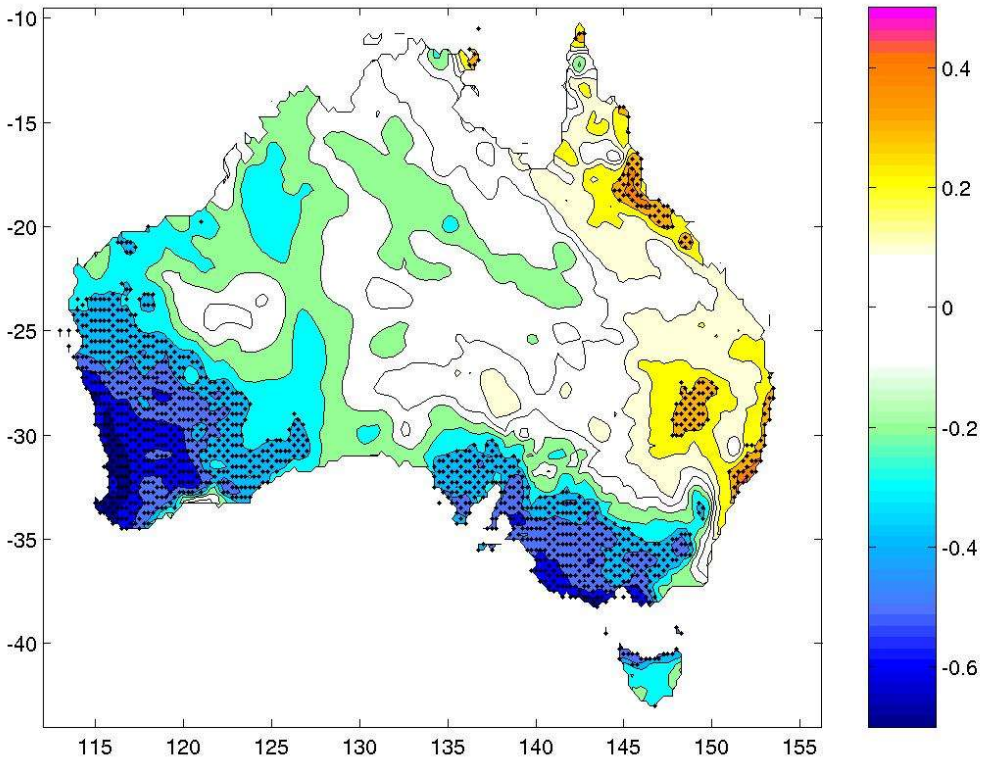

Figure 2: As for Fig. 1, but AOI calculated from data in the 90-180^{o}E sector only.