Southern Sea Ice, cyclone behaviour and rainfall in Melbourne and Perth

Alexandre Bernardes Pezza, Tom Durrant, Ian Simmonds and Ian Smith
School of Earth Sciences, The University of Melbourne, Victoria 3010, Australia
e-mail: apezza@unimelb.edu.au

We explore the relationship between Southern Hemisphere (SH) sea ice extent (SIE) given in pre-defined sectors around Antarctica and rainfall in Perth and Melbourne, respectively located in the south-western and south-eastern corners of Australia. Significant decreasing trends in rainfall in the seventies particularly over Perth followed by a more recent strong negative tendency in both regions have motivated this study after it has been identified that SIE significantly interacts with the general circulation (Kwok and Comiso, 2002). The principal aim is to determine if the rainfall time series relate to any of the five main ice sectors around Antarctica (figure 1) via changes in cyclone and anticyclone behaviour. The study covers the 'satellite era' from 1979 to 2003, and results are presented for the wintertime (JJA) when midlatitude baroclinicity is enhanced.

Results suggest that high (low) sea ice extent is associated with low (high) rainfall in both localities, more significantly in Perth (figure 2). Local and upstream sectors of the ice appear most associated, i.e., the Indian Ocean sector with Perth rainfall, and the West Pacific sector south of Australia with Melbourne rainfall. An automatic tracking scheme applied to the National Centers for Environmental Prediction (NCEP) reanalysis-2 data suggests a possible link between SIE and the winter storms affecting Perth and Melbourne via a well defined anomalous pattern impinging from midlatitudes which resembles some of the recent links found between the circulation and the Pacific Decadal Oscillation (PDO, Pezza et al 2007).

The possible impacts of a third party mechanism influencing both the ice and the circulation leading to rainfall anomalies are discussed in terms of the El Niño/Southern Oscillation (ENSO) and the Southern Annular Mode (SAM), which are known to modulate rainfall anomalies in Australia. The results suggest that when the ENSO influences are isolated the same relationship between SIE and rainfall is still observed, however this is not true for the SAM. Here we propose SAM and SIE as being part of a complex coupled mechanism which is relatively independent from ENSO. These associations add insight to the recent literature and may help to understand the large scale mechanisms potentially associated to declining trends in

Australian rainfall. Further results are under investigation and will be published in the peer-reviewed literature in the near future.

Kwok, R., and Comiso, J.C., 2002: Southern Ocean climate and sea ice anomalies associated with the Southern Oscillation. *Journal of Climate*, **15**, 487-501.

Pezza, A.B., Simmonds, I. and Renwick, J, 2006: Southern Hemisphere cyclones and anticyclones: Recent trends and links with decadal variability in the Pacific Ocean. *International Journal of Climatology*, in press.

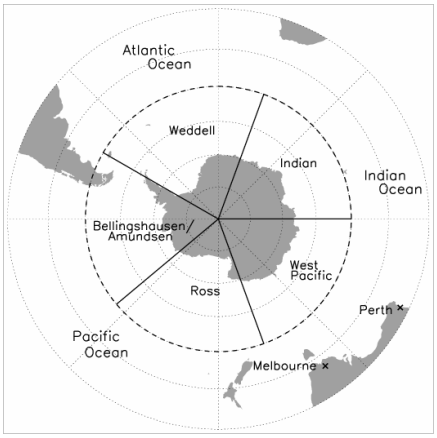

Figure 1: Polar Stereographic plot showing the five sectors used to calculate the sea ice extent. The locations of Perth and Melbourne are also indicated.

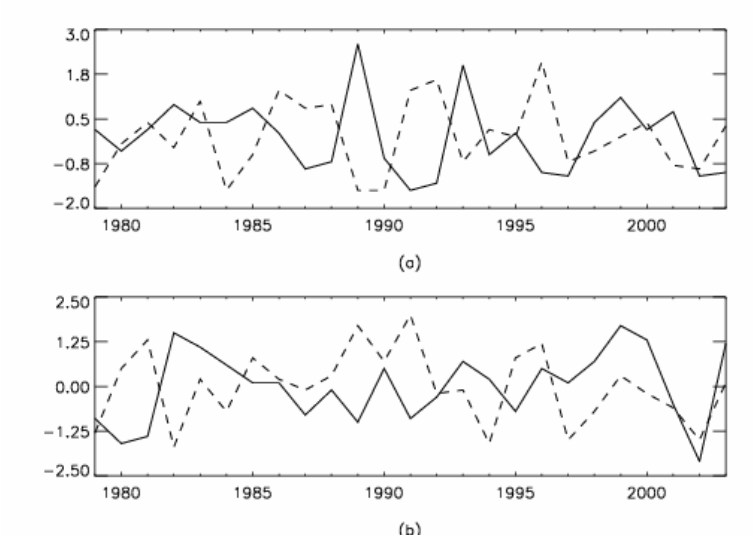

Figure 2: (a) Perth rainfall and Indian Ocean SIE and (b) Melbourne rainfall and West Pacific SIE anomalies for JJA 1973 – 2003. Rainfall is given by dashed lines and SIE is given by solid lines.