20.6 RECENT CLIMATE VARIABILITY IN THE ANTARCTIC PENINSULA REGION AND LARGE-SCALE ORIGINS

Ian Simmonds*
The University of Melbourne
Victoria, Australia, 3010

1. INTRODUCTION

There are many respects in which the weather and climate of the Antarctic Peninsula (AP) region differs from the rest of Antarctica. It is the most northerly part of the continent, and hence is the most subject to midlatitude influences, including longitudinally-propagating weather systems. Its location also dictates that it is influenced by large scale processes (teleconnections etc.). The Peninsula is of especial note because of the warming rate on its western side over recent decades (King 1994, Doran et al. 2002) is as great as any other region in the world. The Peninsula region has captured much attention recently because the disintegration over the last decade of a number of ice shelves, including parts of the Larsen ice shelf. Recently the northern section of the Larsen B shelf shattered and separated from the continent. In excess of 3,000 km^2 of the shelf disintegrated over a 35-day period beginning on 31 January 2002.

2. CIRCULATION FEATURES IN THE ANTARCTIC PENINSULA REGION

We explore the circulation of the region with the aid of the NCEP/DOE reanalyses (Kistler et al. 2001, Kanamitsu et al. 2002) over the period 1 January 1979 to 29 February 2000. The mean summer (December to February) (Fig. 1) regional distribution of cyclone frequency (obtained with the Melbourne University scheme (Simmonds and Keay 2000a)) shows high counts in the circumpolar trough and in the broad region to the north of the Amundsen and Bellingshausen Seas (ABS) west of the AP. The region immediately to the west of the Peninsula and into the Drake Passage exhibits amongst the highest interannual variabilities of winter cyclone counts over the entire hemisphere (see Fig. 8 of Simmonds et al. (2002)). Simmonds and Keay (2000b) have shown that the number of cyclones has shown a significant decrease since about 1970, while their mean strength has increased. The high densities here reflect the fact that this region us a termination point for many cyclones formed remotely, both further west in the subantarctic region and in the midlatitude Pacific.

Figure 1: Average summer cyclone system density (the mean number of cyclones per analysis found in a 1000 (deg. lat.)^2 area). The contour interval is 2, with an additional isoline at 1.

A wide range of air masses also impinge on the AP in association with this high level of synoptic activity. To quantify this we have calculated the origin points of all summer 850 hPa four-day trajectories which reach Esperanza on the northern tip of the Peninsula. The frequency distribution of these (Fig. 2) shows

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[*] *Corresponding author address:* Ian Simmonds, Univ. of Melbourne, School of Earth Sciences, Victoria, Australia, 3010; e-mail: simmonds@unimelb.edu.au

that greatest frequency of summer departure points is found some 40° to the west of Esperanza. However, even over this relatively short time a significant number of trajectories start from more than 90° upstream of the AP, and from the Pacific subtropics.

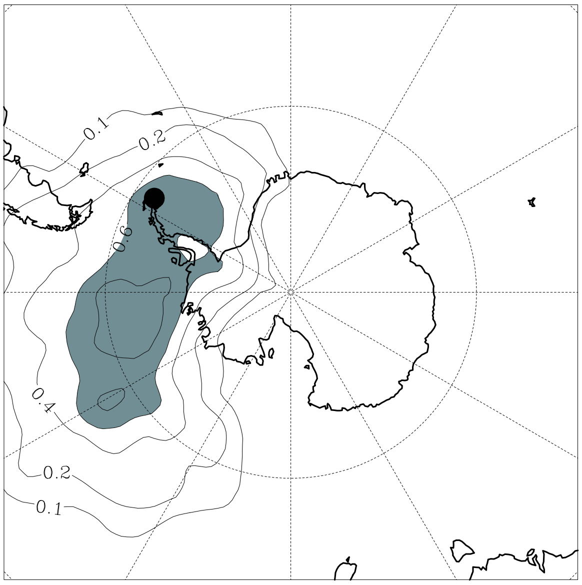

Figure 2: Frequency distribution of origin points of all summer 4-day 850 hPa trajectories which terminate at 63.1°S, 304.5°E (indicated by a solid dot). The contour interval is 0.2 origin points per 1000 (deg. lat.)^2 per trajectory, and an extra contour has been added at 0.1.

3. LARGE SCALE INFLUENCES

As well as being subject to a wide variety of regional influences, the AP is also subject to teleconnections originating in the tropics. To demonstrate this, we performed a Principal Component Analysis (PCA) on SH reanalysis 200 hPa streamfunction. The six-hourly streamfunction fields were deseasonalized by removing both the linear trend and the first four annual harmonics. The data were then low-pass filtered to retain only fluctuations having periods greater than 50 days. The second mode (7.5% of the variance) (Fig. 3) is the PSA pattern, with nodes (of alternating sign) in the central tropical Pacific, east of New Zealand, near the ABS, and to the north of the Weddell Sea. The presence of this mode is closely associated with ENSO (e.g., Harangozo, 2000). A number of works (e.g., Kwok and Comiso 2002) have shown that climate parameters in the AP region show variations coherent with those of the Southern Oscillation and that, in particular, and that periods of significant ABS sea ice retreats indicate the unique association of this region of the Antarctic with the oscillation.

There are other large-scale processes which significantly influence climate and trends in the AP region, some of which are explored by Simmonds (2003a, b). We mention briefly the 'annular mode' (Thompson et al. 2000), the Semiannual Oscillation (Simmonds and Jones 1998, van den Broeke 2000) and the 'Antarctic circumpolar wave' (White and Peterson 1996).

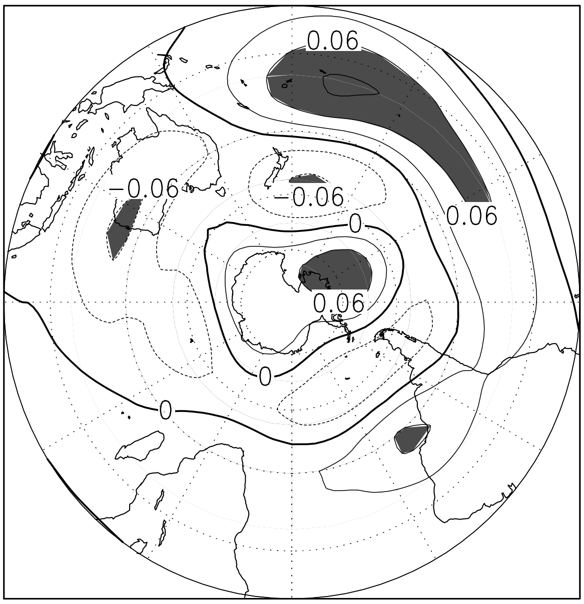

Figure 3: Second principal component of low-frequency SH 200 hPa streamfunction variability. The contour interval is 0.03, and regions over which the magnitude of the function exceeds 0.06 are shaded. The zero contour is bolded and negative contours are dashed.

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