THE DISTRIBUTION OF MEAN ANNUAL TEMPERATURES IN THE ANTARCTIC PENINSULA

By JOHN M. REYNOLDS

ABSTRACT. Altitudinal lapse rates derived from multiple regression analyses of temperatures from two different climatic regimes, *viz* maritime on the west of the Antarctic Peninsula and pseudo-continental on the east, are identical (−0.57 °C/100 m) over the altitude range from sea-level to 1 050 m. Latitudinal lapse rates for the western (−0.77 °C/degree latitude) and east coast (−0.85 °C/degree latitude) regions are very similar, especially when compared with latitudinal lapse rates from other parts of the Antarctic. A latitudinal lapse rate deduced for Drake Passage to the north of the Antarctic Peninsula is very similar to that obtained for the western region. Despite the apparent uniformity of lapse rates over the peninsula the mean annual air temperatures at sea-level differ by 6 °C, the east being colder than the west. This climatic contrast is related to a topographic effect caused by the Antarctic Peninsula. The divide between the two climatic regimes lies parallel to the topographic axis of the peninsula but offset to the east and at an altitude around 1 000 m above sea-level.

Mean annual air temperatures adjusted to sea-level have been used to derive a map of isotherms for the Antarctic Peninsula. With this information, suitable sites for the recovery of ice cores can be chosen in order to further climatic research as part of the Glaciology of the Antarctic Peninsula (GAP) programme.

Larsen, George VI and Prince Gustav Channel ice shelves have mean annual air temperatures in the range of −6 °C to −10 °C. These three ice shelves undergo considerable surface melting which results in the formation of extensive melt-lakes during the summer.

All ice shelves in the Antarctic Peninsula lie to the south and east of the −4 °C mean annual isotherm.

THE principal objective of the Glaciology of the Antarctic Peninsula (GAP) programme is to establish a climatic record for the area from ice-core research (Swithinbank, 1974). In order to choose the most appropriate sites for deep ice drilling, a study of the present climatic regimes of the peninsula was required. It is well known that in glaciers where there is no warming caused by the refreezing of melt-water, a temperature measured at a depth of 10 m is within 1 °C of the mean annual surface air temperature (Loewe, 1956, 1970). Thus, by studying measurements of 10-m ice temperatures over the peninsula our knowledge of the climate of the region could be extended from the limited area covered by meteorological stations. Martin and Peel (1978) have reported ice temperatures for the Antarctic Peninsula but here 10-m ice temperatures are analysed together with surface air temperatures measured at manned bases.

BACKGROUND

The Antarctic Peninsula is a physical barrier to tropospheric circulation (Schwerdtfeger, 1970; Schwerdtfeger and Amaturo, 1979). Depressions from the Bellingshausen Sea affect the western and central areas of the peninsula (Kyle and Schwerdtfeger, 1974). Cold air masses moving westwards across the Weddell Sea influence the eastern low-lying regions (Schwerdtfeger, 1974, 1975, 1979). The net effect of these two weather regimes is to produce a maritime climate in the western and central region (hereafter referred to as the western region) and a colder pseudo-continental climate in the east coast region (Schwerdtfeger, 1975; Martin and Peel, 1978). Martin and Peel (1978) showed that it was both climatically and statistically justifiable to divide the peninsula temperature data into western and east coast regions. This subdivision has also been demonstrated from oxygen isotope studies of 10-m ice cores by Peel and Clausen (in press) and from ecological studies by Holdgate [1964]. Data from the east coast region are therefore treated separately from those of the western region.

Paterson (1969, p. 173) states that the temperature at a depth of 10 m in a glacier approximates to the mean annual air temperature at the surface only in regions where "the *maximum* air temperature is less than 0 °C". In areas where melting does occur, the refreezing of melt-water generates sufficient heat to warm the firn to a temperature greater than the mean annual air temperature (Loewe, 1956; Müller, 1976; Paterson, 1969; Paterson and Clarke, 1978). Martin and Peel (1978), in their study of 10-m ice temperatures from the Antarctic Peninsula, tried to avoid situations affected by such warming by restricting their analysis to ice