

THERMAL REGIME OF GEORGE VI ICE SHELF, ANTARCTIC PENINSULA

(Abstract)

by

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ABSTRACT

New data on the thermal regime of George VI Ice Shelf have been obtained by thermistor chains installed through the use of a hot-water drill. Twenty thermistors are used at each site, spaced close together at sea-level and at the base of the ice shelf, and farther apart elsewhere in the ice shelf and in the sea beneath. Based on earlier observations (Bishop and Walton 1981, fig. 7) that the 10 m temperature warms from around -10°C in the central melt-lake area of the ice shelf (from $70^{\circ}45'$ to $71^{\circ}45'$ S) to around -2°C near the northern ice front ($70^{\circ}00'$ S), the thermistor chains were deployed at three sites ($70^{\circ}00'$, $70^{\circ}15'$ and $70^{\circ}30'$ S) along a presumed flow line.

The observations show that as ice flows towards the northern ice front of George VI Ice Shelf, it becomes more temperate in character. Heat from the sea and from the percolation of melt water at the upper surface progressively warms the ice shelf. At mid-depth (the coldest level in the ice shelf) the recorded temperatures were -6°C off Moore Point ($70^{\circ}30'$ S), -4°C off Carse Point ($70^{\circ}15'$ S) and, near the northern ice front ($70^{\circ}00'$ S), between -1.6° and -1.8°C depending on the time of year.

The ice-shelf temperatures near the ice front, warmer in mid-summer than the freezing point of fully saline

sea-water, are most unusual. The only explanation of the high, fluctuating temperatures found 1 year after drilling is that the hole through the ice shelf was open, allowing unimpeded water movement. This implies that the ice shelf is also warmed by the percolation of sea-water, whose presence was confirmed by ice-core drilling to below sea-level. Confirmation of the presence of brine below sea-level in the ice shelf comes from geo-electrical investigations. A Schlumberger georesistivity array modelled the ice shelf as a simple two-layer structure, with ordinary glacier overlying highly conductive ice. This is consistent with the fact that no radio echoes have been received from the bottom of George VI Ice Shelf to the north of $70^{\circ}09'$ S.

A detailed analysis of the ice-shelf / ocean-temperature profiles was undertaken. This included an analysis of the fluctuation observed in mid-summer at the warmest site and the subsequent transition to a stable isothermal profile through the submerged part of the ice shelf.

REFERENCE

- Bishop, J.F., and J.L.W. Walton. 1981. Bottom melting under George VI Ice Shelf, Antarctica. *J. Glaciol.*, 27(97), 429-447.

GLACIER FLUCTUATIONS IN THE ANTARCTIC PENINSULA:

THE LAST DECADE

(Abstract)

by

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ABSTRACT

Following international recommendations (UNESCO / IASH 1969), the decision was made to determine the surface profile of a number of glaciers in Palmer Land and Alexander Island. By comparison with the ice sheet elsewhere on the continent, the chosen glaciers were small and hence more sensitive to the effect of climate over the last few decades. Six profiles were established between 1972 and 1976 and they were re-levelled in the 1985-86 summer. The profiles are between 0.5 and 4.5 km long and are terminated, at one end at least, by a bench mark established on rock. The profiles were re-measured close to the calendar date of the original survey so that recent trends would not be masked by the annual cycle of accumulation,

densification and ablation. Five of the six profiles show that the ice sheet has thickened in the last 10-15 years, albeit at a slow rate. Changes in four profiles on Alexander Island within 300 m of sea-level range from a thickening of 66 mm a^{-1} to a thinning of 83 mm a^{-1} ; on average the sites show a thickening of just 6 mm a year. This is similar to the thickening rate of 5 mm a^{-1} which was found for a cold site on the spine of the Antarctic Peninsula at 1600 m above sea-level. The greatest change was found at an intermediate elevation (500 m). In a snow-field between two parallel mountain groups in the Batterbee Mountains of Palmer Land, thickening averaged 165 mm a^{-1} . To put these values into perspective, in the absence of glacier flow and summer melting, the glaciers would thicken by up to about 500 mm each year as a result of the accumulation of snow.

Except in the Batterbee Mountains, we find that glacier flow is in close balance with present climate, despite the general warming trend that has occurred in the Antarctic Peninsula region over the past 30 years.

REFERENCE

UNESCO/IASH. 1969. *Variations of existing glaciers. A guide to international practices and their measurement.* Paris, United Nations Educational, Scientific and Cultural Organisation / International Association of Scientific Hydrology. (Tech. Pap. Hydrol., 3.)

AIR TEMPERATURE AND SNOW ACCUMULATION IN THE ANTARCTIC PENINSULA DURING THE PAST 50 YEARS

(Abstract)

by

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ABSTRACT

Trends in climate affecting the West Antarctic ice sheet may be detected first in the Antarctic Peninsula region. Although the area contains the most comprehensive weather records for any part of Antarctica, reliable snow-accumulation data are lacking.

Mainly as a result of the large snow-accumulation rate in the region (typically in the range $4.0\text{--}10.0\text{ kg m}^{-2}\text{ a}^{-1}$), stratigraphic evidence of climate derived from ice cores can be resolved in much greater detail than is possible over most of the continent. Ice cores have been drilled at two sites, representing the extremes of climate type encountered in the region. A 133 m core has been obtained from Dolleman Island ($70^{\circ}35.2'\text{ S}$, $60^{\circ}55.5'\text{ W}$) to represent the continental-type climate of the Weddell coast region, and an 87 m core has been obtained from the Palmer Land plateau ($74^{\circ}01'\text{ S}$, $70^{\circ}38'\text{ W}$) to represent the more maritime regime of the west coast and central areas. Replicated cores were obtained at both sites in order to assess the contribution of local noise factors to the climatic signal preserved in the cores. Climatic trends during the period 1938–86 have been assessed on the basis of stable-isotope analysis of the top

47 m of the Palmer Land core and of the top 32 m of the Dolleman Island core.

A statistical analysis of derived profiles of mean annual $\delta^{18}\text{O}$ and accumulation rate indicates that the local noise factors at these sites are sufficiently small that data averaged over periods as short as 5 years should reveal climatic shifts at the level of 0.2‰ and 5% respectively. These changes are much smaller than trends that have actually occurred during the past 50 years.

The most notable trend over the past 30 years is an increase of more than 30% in the snow-accumulation rate that has occurred in parallel with an overall temperature increase of 0.06°C/a during the same period. Increases of similar magnitude can be inferred from studies in East Antarctica, and may be related to a significant increase in precipitation rate that has been documented recently at mid- to high-latitude stations in the Northern Hemisphere. The finding may have relevance to studies of the possible consequences of a CO_2 -induced climate change. More extensive accumulation time series are now required from Antarctica, if satisfactory models of the long-term balance of the ice sheet are to be derived.