Subsurface melting on iceberg C16 (Ross Sea)

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A field study of surface melting on iceberg C16 (77oS, 168oE) was undertaken during the Austral summer 2004-2005. The goals of field observations were to measure in situ firn density of the subsurface layer, and to set up an instrumentation system for continuous measurements of the subsurface-layer temperature and incoming solar flux. The purpose of this long term experiment is to observe how cold, polar firn evolves to surface melt ponds as the iceberg drifts North through the latitudinal environmental gradient.

Two sets of the density measurements were done on iceberg C16: density measurements of 2.5 m firn layer accessed via a snow pit, and density measurements of a 4.5 m firn core. Three well-distinguished ice layers were observed in the upper part of the snow pit: at 21 cm, 38 cm and 59 cm depth. In comparison with density measured at the Newall Glacier (location 77$o35'S, 162o30'E) by Mayewski and Whitlow (2000) subsurface density on iceberg C16 is relatively high. Considering the relative proximity of both sites, the denser firn on C16 might be due to increase of subsurface melting since 1987-88, when the Newall Glacier firn core was collected.
A core 4.5 m depth was obtained using a Kovacs drill. The core quality was fair, the core was broken into approximately 25 pieces, and some pieces had disintegrated into powdered snow. We can speculate, that large variations between maximum (0.63 g/cm3) and minimum (0.34 g/cm3) density are due to subsurface melting during the two previous summer seasons. The presence of melting is evident from the thin ice layers in the core.
Melting is more efficient in snow densification than compaction by the overburden. In addition, at shallow depths (depth of the core), the overburden load of snow is not big enough to compact the firn. Thus, melting is the only available explanation for the higher densities.
The instrumentation for long-term measurements consisted of a solar-flux pyranometer and twelve high-precision thermistors placed in the snow pit. Every 10 seconds, data from the thermistors and pyranometer is collected by means of a multiplexer data logger . This data, along with data obtained by AWS located in 5 m from the snow pit, is transmitted via the ARGOS satellite data system. Figure 1 shows the time series for all twelve thermistors. Analysis of the temperature data shows that during 23 days out of the 138 day observation period, the temperature in the snow pit was positive, while the daily averaged atmospheric temperature measured by the AWS exceeded the melting point only during one day. The positive subsurface temperature implies melting in the subsurface layer.

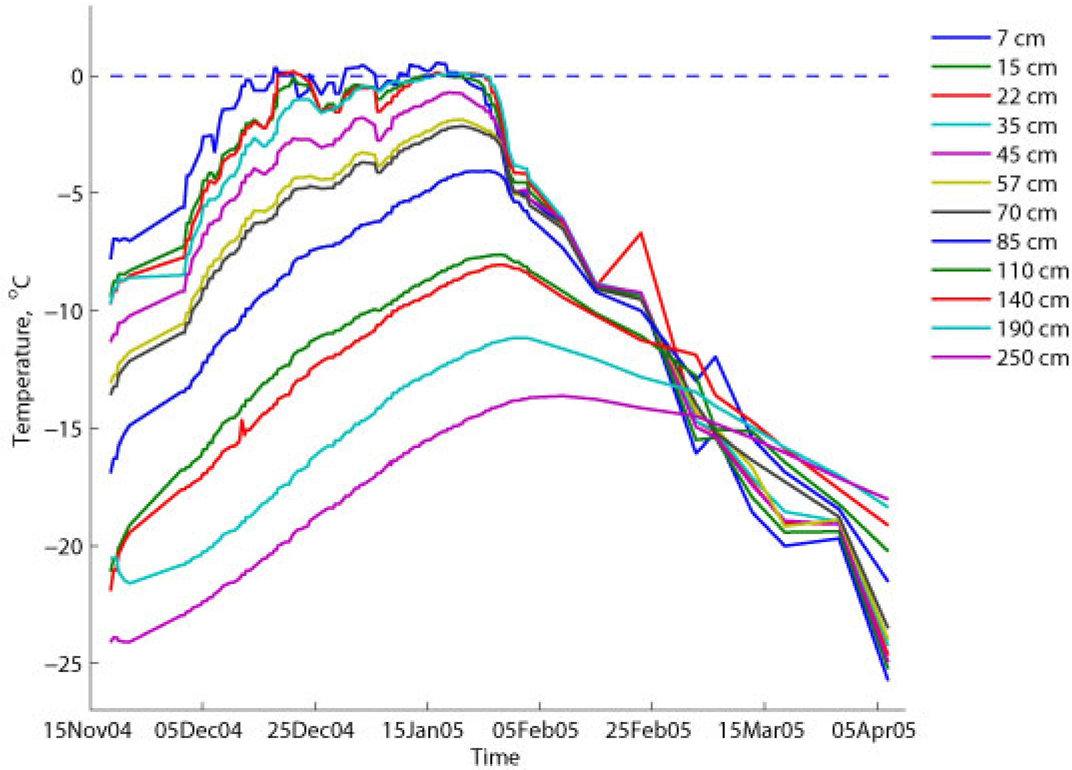

Figure. 1. Temperature of the 2.5 m subsurface layer, November 2004 - April 2005.
Each curve corresponds to one of the twelve thermistors.
Legend shows the location of the thermistors.

Fig1.jpg

Reference

Mayewski P. and S. Whitlow, 2000. Newall Glacier snow pit and ice core, 1987 to 1989, Boulder, Co: National Snow and Ice Data Center, Boulder, Co, digital media.