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SIR,

*Extraordinary melt-water run-off near Søndre Strømfjord,  
West Greenland*

During late January 1990, two melt-water rivers started to flow from the western margin of the Greenland ice sheet into Søndre Strømfjord despite air temperatures of below  $-30^{\circ}\text{C}$ . Description of this unusual event is based upon local observations made by S. Malmquist (personal communication, May 1990).

The Ørkendalen river started flowing in the last week of January at one-third of its normal summer level (Fig. 1). One week later, melt water started to flow from Sandflugtsdalen river at approximately one-quarter of its normal summer level (Fig. 1). Both rivers continued to flow for a further 3 weeks during which air temperatures were consistently below  $-30^{\circ}\text{C}$ . Discharge from these rivers over-ran the ice-covered fjord for a distance of 10 km (Fig. 1). A heavy freezing fog resulted from the exposure of relatively warm river water to sub-zero air temperatures. The fog was observed leading from the ice margin along the river channels towards the fjord by overflying trans-Atlantic aircraft.

From the above information, it was possible to quantify the volume of water involved in this event. Based on estimated "normal" summer discharges totalling  $140\text{ m}^3\text{ s}^{-1}$  for Ørkendalen and Sandflugtsdalen rivers, an estimated  $90 \times 10^6\text{ m}^3$  of water were involved in this event. This figure probably underestimates the total volume of water drained but provides an approximation on which discussion can be based.

Until now, river flows have only been documented within the normal summer melt season (c. mid-May–c. mid-October). Not only are the flows described above outwith the usual period but they are in excess of those witnessed by the author in late October 1986 and early June 1987. As such, this event probably represents the release of stored melt water, as it cannot represent ice-surface ablation given the sub-zero temperatures.

Possible sources of stored melt water along this section of the ice-sheet margin include ice-dammed lakes and englacial or subglacial reservoirs. Ice-dammed lake drainage, although common within this region (Sugden and others, 1985; Russell, 1989; Russell and others, 1990), is unlikely to have resulted in this unseasonal outburst as there does not appear to be a suitably large lake located between Ørkendalen and Sandflugtsdalen melt-water streams (Fig. 1). The total volume of water drained during this

event is 2.5 times that drained from an ice-dammed lake (Russell, 1989) and 300 times that noted by Russell and others (1990) for a small ice-dammed lake. Although this ice margin is likely to have been frozen to the bed during the winter months, sub- and/or englacial melt water originating at great distances from the ice margin may have still been travelling towards the ice margin down an equipotential gradient (Shreve, 1972). On meeting the cold, impermeable ice margin, melt water may have been stored as a sub- or englacial reservoir under considerable pressure. The release of water within such a reservoir is likely to have been maintained by high water pressures. The drainage of such a sub- or englacial reservoir located at a considerable distance from the ice margin may provide an explanation for the unusual events noted in Søndre Strømfjord in January and February 1990.

Although similar events may occur, unnoticed, during the summer melt flows, these winter discharge events may have important geomorphological effects upon the glacier margin and the pro-glacial river channels. The volume of water released in this event was far greater than that so far noted for any of the ice-dammed lakes within this area, constituting a significant part of run-off from this section of the ice margin.

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12 June 1990

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SIR,

*Comments on: "6000-year climate records in an ice core from the Høghetta ice dome in northern Spitsbergen"*

Fujii and others (1990) have recently presented an estimate of climatic conditions in northern Svalbard during the last 6000 years, based on their interpretation of an 85.6 m long ice

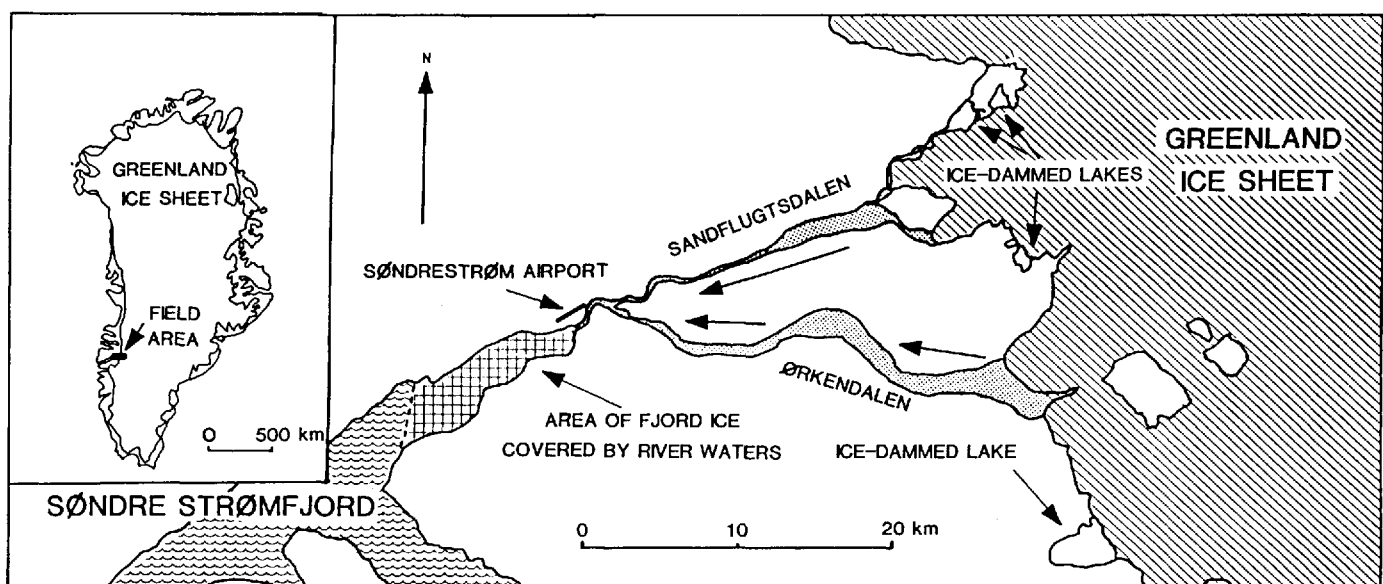


Fig. 1. Location map showing the melt-water routeways into Søndre Strømfjord, West Greenland.