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A self-sustaining katabatic wind-driven ice shelf in southern McMurdo Sound, Antarctica

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The McMurdo Ice Shelf (MIS) is considered to be an extension of the Ross Ice Shelf (RIS) into the McMurdo Sound region of Antarctica, although the two are divided by a transitional strike-slip shear zone. The northern part of the MIS shows a significant flow component from across this transition zone, while the southern MIS (SMIS) is effectively bypassed by the RIS ice in the region of maximum sinistral shear. Geophysical data collected between Black Island, Mount Discovery and Minna Bluff over two consecutive Antarctic field seasons (2002/2003 and 2003/2004), suggest that the SMIS may be a self-sustaining, katabatic wind-driven ice shelf. The occurrence of significant surface ablation on the SMIS further distinguishes it from the RIS, where accumulation is dominant.

There are few published glaciological studies relating to the SMIS and fieldwork reported here has supplied much of the primary data for the fundamental parameters of this ice shelf, including ice thickness, pinning points and flow characteristics. Ice thicknesses were obtained from seismic and GPR surveys along transects across the ice shelf. Thickening, reflecting net accumulation, is observed near the southern shores of Black and White Island, where the ice depth is up to 180 m. Thinning to $<$ 50 m, from mid-shelf values of $\sim$160 m, occurs on the SMIS toward the northern shore of Minna Bluff.

In the 2002/2003 field season, 36 marker poles were established in a 2.5 km-spaced grid over the SMIS, and these were positioned using differential GPS. These poles

were subsequently resurveyed in the 2003/2004 field season, when a further 9 poles were added to the survey grid. The resultant motion vectors support sparse measurements made in the 1960s (Swithinbank, 1970), and indicate that the SMIS is moving ∼2–7 m/yr; to the W/NW between Black Island and Mount Discovery, and to the W/SW south of Black and White Islands. Oblique ice flow from the accumulation area south of Black and White Islands, toward the confining southern coastline is supported by thrust sheets identified in the coastal moraines on the northern shore of Minna Bluff.

Satellite imagery, topographic surveying with GPS, and GPR and bathymetry profiles have been used to determine the presence of a crater-shaped bathymetric high, upon which the SMIS is grounded. Located between the SW tip of Black Island and the northern coastline of Minna Bluff, and with a diameter of ∼2.5 km, this feature appears to be a significant pinning point for the SMIS. Pinning at this mid-shelf position and from the surrounding coastline exerts a major control on the dynamics of the SMIS, constraining its flow and ensuring its stability. The field data support a hypothesis that ice travels by gravitational flow from the accumulation areas of the RIS transition zone and snow aprons of southern Black and White islands, in the direction of Mount Discovery and Minna Bluff, where the cycle is maintained by katabatic winds ablating the surface.