INLAND ICE SHEET THINNING DUE TO HOLOCENE WARMTH

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Abstract. The Holocene warmth is now affecting the flow of the central West Antarctic ice sheet. It is supposed that the ice sheet reached approximate steady-state during the Wisconsinan. A perturbation analysis of ice-sheet temperatures indicates that deep ice has warmed by one or two degrees since the Wisconsinan. Warmer ice deforms more rapidly and the ice sheet should now be flowing 10 to 30% faster than during the Wisconsinan.

Earlier studies comparing ice outflow with the replenishment by new snow accumulation show that the velocities are about 20% faster than those needed to balance the accumulation. The warming effect is therefore a sufficient explanation for the imbalance and it is not necessary to suggest that there were also changes in accumulation-rate or in sea-level that affected this part of the ice sheet.

The increased ice outflow resulting from the warming, propagates down-glacier and causes marginal thickening and advance. In the case of the Laurentide and Scandinavian ice sheets, a major increase in net ablation and a decrease in total ice volume is expected, by this mechanism, to lag behind a climatic warming by many thousands of years.

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DISCUSSION

D. A. Yuen [written question]: Your analysis of the effect on the velocity of ice sheets due to sudden perturbation of surficial temperature does not include the feed-back of the $\mathbf{u}\cdot\nabla T$ term on the resultant energy equation. In a stability analysis, where dynamical effects are included, the effects of the temperature and velocity on one another are fully coupled, and must be solved in a fully self-consistent manner. How do you make *a posteriori* estimates of the perturbed velocity field from your approach?

I. M. Whillans: I am concerned here only with the first effects of the warming on ice flow. Calculations of later effects should include this feed-back.

FLOW OF ANTARCTIC ICE SHELVES BETWEEN LONG. 29° E. AND 44° W.

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Abstract. This paper discusses the mass outflow and dynamics of a 3 000 km long front of the Antarctic ice sheet—the coastline from Prinsesse Ragnhild Kyst to the Filchner Ice Shelf. Ice shelves, mostly 50–100 km wide, account for more than 95% of this coastline. Large mass losses by calving generally occur at intervals of several decades at any particular location, and usually involve shelf areas of 10–1 000 km². The mass loss by calving during the

periods between the large calvings is insignificant, except where ice streams run directly into the sea without forming ice shelves. The latter sections account for 2% of the coastline in question and a similar part is made up of ice rises. Thus, with the exception of these short segments, the ice front advances systematically over time intervals of a few decades. Large calvings interrupting the advance can be recognized by significant change in shape and position of the ice front.

A nearly continuous survey of the coastline from long. 9–44° W. was carried out during January–February 1977 from the ship of the Norwegian Antarctic Research Expedition, 1976–77. The position of the ice front could be determined within ±200 m by use of an integrated navigation system including a two-channel satellite receiver, in combination with a calibrated radar. Selected points along the coast were determined with a precision of ±10 m, using both the shipborne navigation system and a separate, mobile, two-channel system.

A comparison of the repeated surveys of the position of the ice front reveal a pattern of high-velocity ice streams bounded by slow-moving ice, giving rise to complex strain fields. For example, the Filchner Ice Shelf shows northward movements increasing from nearly zero at long. 44° W. (Gould Bay) to 2 km year^{-1} at long. 40° W., over a distance of only 90 km. At long. 40° W. the ice front advanced 43 km between 1956 and 1977, and during this period a 20 km × 25 km piece of the ice shelf calved off between long. 42° W. and 43° W. East of 40° W., toward Vahsel Bay, the velocities decrease to around 1 km year^{-1}. Other complicated patterns, with velocities exceeding 1 km year^{-1} in the fastest sections, are found in several other places along the coast. The larger outflow rates are generally observed west of Kap Norvegia (long. 12° W.) with a major exception at Jutultunga (long. 1° W.), where the velocity exceeds 1 km year^{-1} over a 60 km wide ice front. The velocity patterns reflect complicated ice dynamics related to the up-stream subglacial topography, and permit identification of zones of varying dynamic activity in the corresponding parts of the inland ice sheet.

Control on the early surveys is provided by those short coastal segments where ice shelf is absent, and generally the positions agree to within 1 km.

The calving is related to the strain patterns, and incipient break-off can be identified 20 years prior to final severing. This final calving is probably a rapid event, triggered by a storm, collision by a large iceberg, or large ocean swells.

The elevation of the ice front was measured at numerous locations by the 1976–77 expedition with a precision better than ±1 m. In general the elevations increase westwards from long. 9° W. to 44° W. Firn density at fixed depth also increases westwards, and consequently the mass of a unit width of the ice front is nearly doubled along this section. The mass outflow across separate coastline segments is calculated and related to the up-stream mass balance.

EVIDENCE AGAINST AND FACTORS PREVENTING MAJOR SURGES OF THE ANTARCTIC ICE SHEET

By G. de Q. Robin

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Abstract. Although computer modelling using realistic flow parameters can simulate surging of the Antarctic ice sheet, the present model does not take into account certain factors that make surging less probable. Before discussing these factors, knowledge of the Antarctic ice sheet that might indicate the occurrence of former surging is reviewed. The following studies appear relevant:

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