Annals of Glaciology 11 1988

BASAL MASS BALANCE ALONG A FLOW LINE ON RONNE ICE SHELF, ANTARCTICA

(Abstract)

by

A. Jenkins and C.S.M. Doake

(British Antarctic Survey, Natural Environment Research Council, High Cross, Madingley Road, Cambridge CB3 0ET, England)

ABSTRACT

Recent glaciological work on Ronne Ice Shelf has focused on an assumed flow line which extends from Rutford Ice Stream grounding line to the ice front. Results from doppler satellite surveying and radio echo-sounding are used in kinematic calculations to determine the basal mass balance, assuming the flow line to be in a steady state. Models suggest that basal melting dominates over most of the flow line and is most pronounced at the extremities. In the region within 300 km of the grounding line and over the final 45 km before the ice front, at least 1 m/a on average must melt away to maintain the observed velocity and thickness profile. More gentle melting occurs over about half the remaining distance, but in a region between 130 and 300 km in from the ice front, basal freezing must occur at an average rate of about 0.1 m/a to maintain a steady state. The existence of a thin layer of saline ice underlying the ice shelf, which persists for a further 80 km down-stream before being melted away entirely, is consistent with the weak returns observed during both airborne and ground-based radio echo-sounding in this region.

GEDANKENEXPERIMENTE: ASSESSING FIELD-PROGRAM EFFECTIVENESS BY NUMERICAL SIMULATIONS

(Abstract)

by

M.A. Lange

(Alfred Wegener Institute for Polar and Marine Research, Postfach 12 01 61, Columbusstraße, D−2850 Bremerhaven, Federal Republic of Germany)

and

D.R. MacAyeal

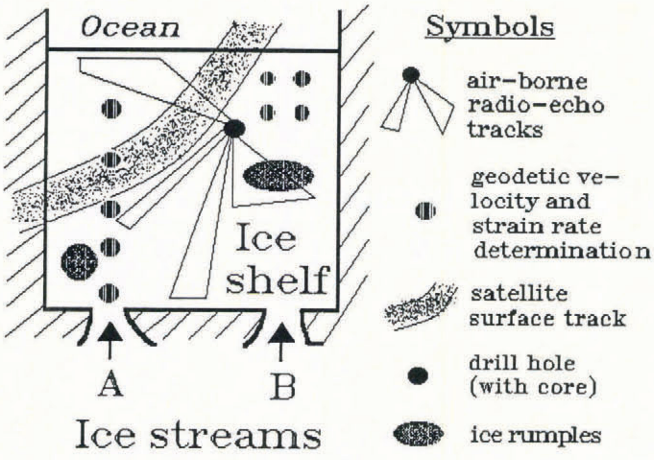
(University of Chicago, Department of the Geophysical Sciences, 5734 S. Ellis Avenue, Chicago, IL 60637, U.S.A.)

Glaciological field programs may be regarded as imperfect sampling schemes designed to provide fundamental physical information on the dynamics and climatic sensitivity of the Antarctic ice sheet. Uncertainty arises as a result of technical and human factors such as: (i) logistic and financial constraints, (ii) measurement errors, (iii) low spatial resolution (see (i)), and (iv) (possibly!) misconceptions on the part of glaciologists who plan and execute field work. Regardless of such uncertainty, we depend on field data as the fundamental intellectual driving force of glaciology. Introspective evaluation of our field methods and program designs is thus reasonable, and perhaps necessary, to insure that our field programs are indeed satisfying their intended purpose.

In our study, we conduct a variety of *Gedankenexperimente* (imaginary field programs), which sample an arbitrary, idealized ice shelf, subject to fluctuations and climatic changes on a variety of time and space scales. The "actual" behavior of this ice shelf is produced by a time-dependent numerical simulation of ice-shelf evolution under specified forcings, using a model based on that of Lange and MacAyeal (1986). Each *Gedankenexperiment* consists of a spatially incomplete sampling of the model grid data at a particular moment in the evolution of the ice shelf (just as a real field program presently would sample the current state of an Antarctic ice shelf). The spatial sampling patterns are based on particular techniques commonly used in field programs (Kohnen 1985, Bindschadler and others 1987, Doake and others 1987, Shabtaie and Bentley 1987). Such sampling is designed to simulate field techniques such as airborne radio echo-sounding, surface geodetic measurements, aerial photography, and satellite altimetry (Fig. 1). We also add "random noise" to the sampled data, to simulate instrumental and navigational uncertainties.

Having sampled the idealized ice shelf by using an imaginary field program, we "process" the supposed field data in order to test how well it reveals certain aspects of ice-shelf flow and evolution. This test is conducted by comparing the field-program results with the "known" behavior (by definition) of the numerical simulation. A variety of field-program design schemes are compared on

https://doi.org/10.3189/S0260305500006595 Published online by Cambridge University Press



the basis of their ability to predict: (i) the long-term growth or decay of the ice shelf, (ii) the "current" state of mass balance, (iii) the "current" partitioning of ice-stream input, and (iv) the balance of forces acting on the grounding line, and the tendency of the balance to change with time.

A major aim of our study will be to point out how seriously the understanding of current ice-shelf dynamics and the ability to measure initial effects of global climatic changes (due to CO^2 warming) are hampered by: (i) inability to map accurately all the regions of ice-shelf grounding, and (ii) inability to distinguish the effects of short-term variability from long-term, large-scale trends. To simulate the effects of ice-shelf grounding and ice-stream – temporal fluctuations, we specify in our idealized simulations that: (i) several ice rumples occasionally appear or disappear, and (ii) ice-stream fluxes, which feed the imaginary ice shelf, fluctuate (arbitrarily) with periods of 300 years.

Since we assess the *Gedankenexperimente* in terms of their ability to detect long-term climatic trends, we run the ideal ice-shelf simulation forward in time until a statistically steady state is achieved (that is, all thickness and velocity patterns are stationary when averaged over the time-scale of fluctuation). At this point, we conduct the imaginary field programs in our study. Our main intention is to determine which *Gedankenexperiment* can best "see through" the short-term transient "noise" of the ideal ice-shelf evolution to detect the long-term condition of steady state.

REFERENCES

Bindschadler, R.A., S.N. Stephenson, D.R. MacAyeal, and S. Shabtaie. 1987. Ice dynamics at the mouth of Ice Stream B, Antarctica. *J. Geophys. Res.*, **92**(B9), 8885-8894.

Doake, C.S.M., R.M. Frolich, D.R. Mantripp, A.M. Smith, and D.G. Vaughan. 1987. Glaciological studies on Rutford Ice Stream, Antarctica. *J. Geophys. Res.*, **92**(B9), 8951-8960.

Kohnen, H., *comp.* 1985. *Filchner-Ronne-Ice-Shelf-Programme. Report No.* 2. Bremerhaven, Alfred-Wegener-Institute for Polar and Marine Research.

Lange, M.A., and D.R. MacAyeal. 1986. Numerical models of the Filchner-Ronne Ice Shelf: an assessment of reinterpreted ice thickness distributions. *J. Geophys. Res.*, **91**(B10), 10457-10462.

Shabtaie, S., and C.R. Bentley. 1987. West Antarctic ice streams draining into the Ross Ice Shelf: configuration and mass balance. *J. Geophys. Res.*, **92**(B2), 1311-1336.

CRARY ICE RISE, ANTARCTICA: FORMED IN RESPONSE TO A SURGING ICE STREAM?

(Abstract)

by

D.R. MacAyeal

(University of Chicago, Department of the Geophysical Sciences, 5734 S. Ellis Avenue, Chicago, IL 60637, U.S.A.)

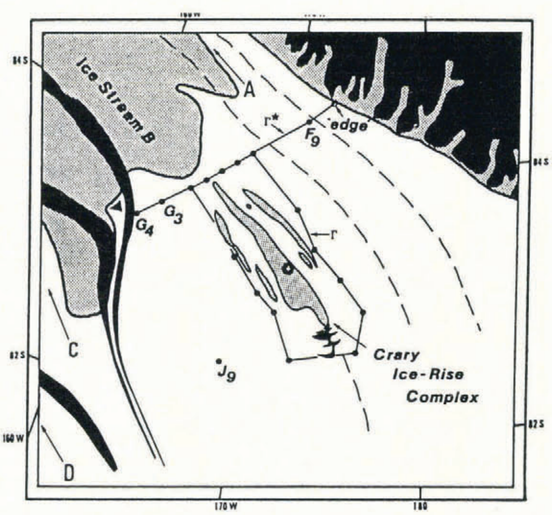
and

R.A. Bindschadler

(Oceans and Ice Branch, Code 671, NASA / Goddard Space Flight Center, Greenbelt, MD 20771, U.S.A.)

ABSTRACT

Field data is presented to support the hypothesis that Crary Ice Rise (on Ross Ice Shelf, Fig. 1) has substantially increased in area over the last 500 years, in response to ice advection through the mouth of Ice Stream B. The up-stream end of the ice rise is now surrounded by ice shelf that is currently thickening at 0.44 ± 0.06 m/year (under an assumed zero basal melting rate). This rate of thickening suggests that the ice rise's contribution to back-stress resistance of Ice Stream B's flow, presently calculated to be 50% of the total back stress, is growing in the course of time. We speculate that this current development of the ice rise is the precursor to the possible future stagnation of Ice Stream B. It is convenient to conceptualize a possible see-saw oscillation between ice-stream surging and ice-rise build-up.



https://doi.org/10.3189/S0260305500006595 Published online by Cambridge University Press