large source of uncertainty in the computed timing of grounding-line retreat. Alternative retreat histories for the ice-shelf calving front were investigated, subject to control provided by a date from the basal portion of the Holocene sediment layer on the bottom of the Ross Sea (Kellogg and others 1979). Within the context of a given ice-shelf retreat history, the feedback effects of isostatic uplift caused a reduction of the grounding-line retreat rate, a reduction of the total computed retreat distance, and a re-advance of the grounding line after the eustatic sea-level stopped rising.

ACKNOWLEDGEMENTS

This study was supported by National Science Foundation grants DPP-7920736 and DPP-8119989 to Charles R. Bentley. Thanks are extended to Dr Bentley for valuable discussions and constructive criticism.

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TIDES, TIDALLY DRIVEN BAROTROPIC CIRCULATION AND THE FORMATION OF TIDAL FRONTS BELOW THE ROSS ICE SHELF, ANTARCTICA

(Abstract)

by

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ABSTRACT

Ocean circulation and heat transport below the Ross Ice Shelf are difficult to observe because of the thick ice cover. Numerical modeling thus provides a practical method for testing ideas about sub-ice-shelf circulation and basal melting. In this study, tidal rectification (Zimmerman 1981), tidal front formation (Fearnhead 1975), and their impact on the sub-ice-shelf environment are determined from a numerical tidal model.

The model indicates that periodic tidal currents drive steady circulations having magnitude less than 0.02 m s^{-1} along the sides of several topographic bumps and ridges below the ice shelf. Ventilation of the sub-ice-shelf cavity is indicated by the Lagrangian trajectories shown in Figure 1. The cross-ice-front heat transport resulting from this flow is estimated to induce approximately 0.5 ± 0.25 m a^{-1} basal melting over 10% of the ice-shelf area closest to the eastern and western ends of the ice front.

The observed rate of water mass renewal within the entire sub-ice-shelf region cannot be attributed to tidally driven barotropic circulation alone. Another circulation mechanism related to tidally induced vertical mixing may, however, operate in the deeper reaches of the sub-ice-shelf cavity. Away from the ice front, the warmest water resides at the sea bed because of its high salinity. Basal melting is thus suppressed unless turbulence generated by tidal currents is sufficiently strong to completely mix the water column against buoyancy input. From analysis of the tidal-energy budget produced by the numerical simulation, complete vertical mixing is anticipated in the shaded regions of Figure 2. These mixed zones are primarily along the Siple Coast where the water-column thickness is less than 100 m.

Basal melting in the well-mixed region is estimated to be between 0.05 and 0.5 m a^{-1}, and will drive a thermohaline circulation having the following characteristics: warm high-salinity water formed in the open Ross Sea during winter flows along the sea bed towards the tidal-mixing fronts, vertical mixing behind the fronts promotes heat transfer between the water and ice, catalyzing basal melting, and meltwater produced behind the fronts flows out of the sub-ice-shelf cavity between the inflowing warm water and the ice-shelf base.

Given present conditions, basal melting along the

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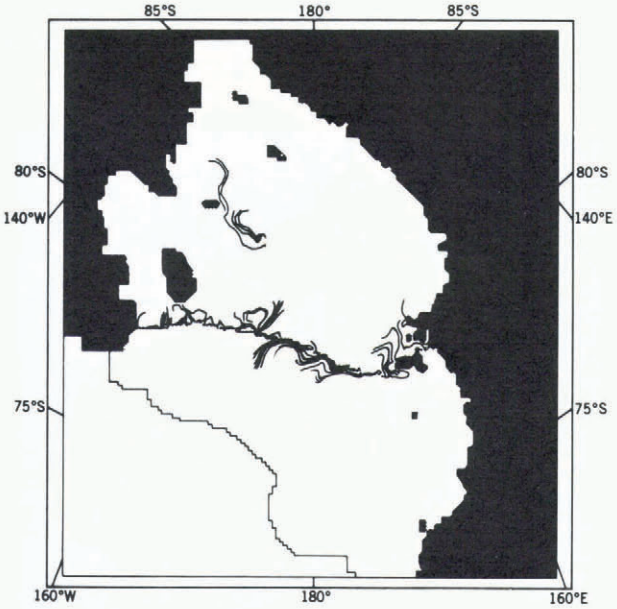
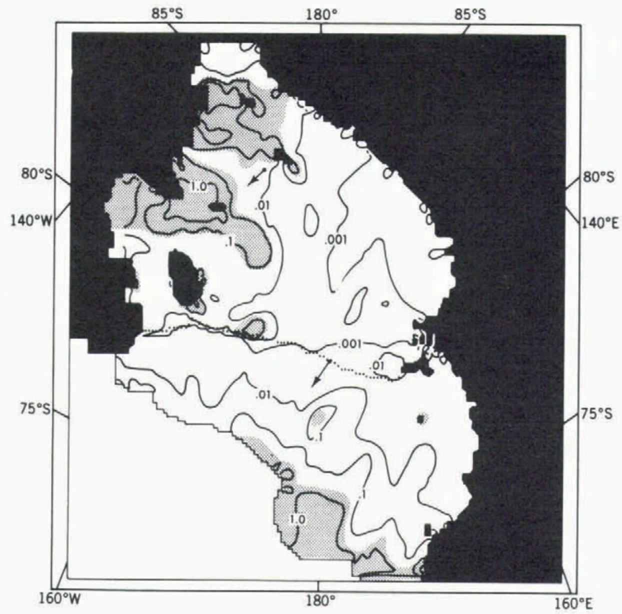
https://doi.org/10.3189/S0260305500003876 Published online by Cambridge University Press



MIXING INTO THE SUB-ICE SHELF REGION: 3 YEARS

Fig.1. Tracer streak-lines emitted from the ice front and select sub-ice-shelf locations display how tidal rectification ventilates the sub-ice-shelf cavity.



THE MELT RATE NEEDED TO MAINTAIN STRATIFICATION (m/yr)

Fig.2. Shaded regions indicate where tidal-energy dissipation is predicted to cause vertically well-mixed waters and thereby to induce strong basal meltin(

well-mixed Siple Coast is not expected to be sensitive to climatic change because the inflowing water mass is constrained to have the sea-surface freezing temperature. For this buffering to be upset by climatic change, the production of high-salinity water on the continental shelves of Antarctica must be eliminated.

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A TIME-DEPENDENT SIMULATION OF THE ROSS ICE SHELF FLOW

(Abstract)

by

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ABSTRACT

The finite-element model discussed by MacAyeal and Thomas (1982) has been improved to include solution of the heat equation within each element, and to accelerate convergence to solution of the momentum-balance equations in terms of ice-shelf spreading rates. The model is now sufficiently rapid to permit both snapshot and time-marching simulations of a large ice shelf at high spatial and temporal resolution (grid size 10 km; time step 0.1 a). Here, we describe three model simulations of Ross Ice Shelf behavior.

First, a snapshot solution was obtained for ice velocities, strain-rates, stresses and temperatures, using measured values of ice thickness and inflow velocities of tributary glaciers and ice streams. Ice rheology and its temperature dependence were prescribed to be compatible with laboratory and ice-shelf measurements, and ice temperatures were calculated using observed surface temperatures and

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https://doi.org/10.3189/S0260305500003876 Published online by Cambridge University Press