WAVE-NUMBER ANALYSIS OF ICE-FLOW MODELLING

(Abstract)

by

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The response of glaciers and ice sheets to climate or sea-level forcing over a range of time scales must be calculated for several different climate variation studies. Most time-dependent ice-flow modelling uses finite differences to solve the continuity equation. Any numerical scheme can be treated as a filter f(x) whose input is the ice profile at time step n and whose output is the ice profile at time step (n+1). The physics of ice deformation is contained in f(x). Employing the usual linearizations (e.g. Paterson 1981: 254), the filter f(x) has a complex transfer function F(k) in the wave-number domain. The standard linear stability analysis is obtained by choosing time and space mesh intervals so that the modulus of F(k) is never greater than unity. In addition, the modulus of F(k) describes the rate of diffusion of wave disturbances, and the phase of F(k) describes the propagation speed. The transfer functions for several finite-difference schemes are compared to an analytical solution. For given time and space mesh intervals, implicit schemes are more accurate than explicit schemes. Schemes with a staggered grid for the flux calculations can model diffusion out to the highest wave number seen by the mesh. Non-staggered schemes do not attenuate these wave numbers; they require additional numerical smoothing to suppress nonlinear aliasing effects which arise at the high wave numbers regardless of the time step sizes. This smoothing must be restricted to wave numbers higher than those contributing to the ice-profile spectrum.

Large errors in amplitude and propagation speed can result even at low wave numbers from using time steps larger than the limit set by standard stability analysis, then smoothing out the resulting instability. In this case, the filter f(x) based on the physics of deforming ice has been effectively replaced by an arbitrary low-pass smoothing filter with no physical significance.

REFERENCE

Paterson W S B 1981 *The physics of glaciers.* Oxford etc, Pergamon Press

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THE EFFECT OF LAND-SEA DISTRIBUTION ON ICE-SHEET FORMATION

(Abstract)

by

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INTRODUCTION

The response of a simple ice-sheet model forced by a periodic change in the climate point (the distance from the poleward limit of land to the point where snow persists at sea-level year-round) exhibits a bifurcation when certain dimensionless parameters undergo realistic changes. These dimensionless parameters are related to the poleward limit of continents as well as to the frequency of the climate point variation and other parameters. It is postulated that this bifurcation may be responsible for the initiation of large glacial cycles about 900 ka BP, following smaller, higher frequency ice-sheet advances and retreats before that time (Watts and Hayder 1983). It seems clear that the latitudinal locations of continents can affect the formation of ice sheets through interaction with the seasonal cycle.

We present here some results that we recently obtained with a two-dimensional, seasonal, diffusive, energy-balance climate model with a mixed-layer ocean and simple continents. The model itself has been discussed by Hayder (unpublished) and Watts and Hayder (in press), and the interested reader is referred to those papers for details.

The results that we present here are mostly concerned with the effect on the model seasonal cycle of shifting land-sea distribution. The model was first run with the distribution shown in Figure 1. There is

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