

Modeling the Annual Variation of Sea-Ice Cover in Baffin Bay

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ABSTRACT

Baffin Bay is partially covered by sea ice all year except September. The distribution of sea ice and its annual variation are controlled mainly by the meteorological conditions and ocean currents. To model the annual variation of sea ice, a coupled ice-ocean model has been developed. The ocean model is the Princeton Ocean Model which is formulated in sigma coordinates with 16 levels and uses second order turbulence closure to parameterize vertical mixing. The ice model is based on the viscous-plastic rheology of Hibler and contains multiple ice categories defined by thickness range. The heat and salt fluxes between ice and ocean are based on the formulation of Mellor and Kantha. The model domain encompasses Baffin Bay and the Labrador Sea with a grid resolution of 1/3 degree longitude and variable in latitude to maintain approximately square grid cells. Forcing fields are computed from 3-hourly meteorological variables provided by Canadian Meteorological Centre. The model is integrated from September 2004 to January 2006. The main features of the model simulations include an increasing ice cover from October to February, an approximately constant ice cover from February to May and a decreasing ice cover from June to August. In mid-May, a polynya starts to develop in northern Baffin Bay (North Water Polynya), which is maintained through July. Thick ice up to 2.5 m appears off the coast of Baffin Island and Melville Bay in April and May. The concentration and thickness in western Baffin Bay are higher than those in eastern Baffin Bay due to the influence of the warm East Greenland Current flowing into Baffin Bay. The ice velocities are relatively high in the northern straits, off the Baffin Island coast and in western Davis Strait, reflecting the seasonal wind conditions and surface circulation. The modeled ice distribution is compared with satellite data and good agreement is obtained.

KEY WORDS: Baffin Bay; sea-ice model; annual variation.

INTRODUCTION

Baffin Bay is a mediterranean sea located between the Canadian Archipelago and the Labrador (Fig.1). There are three connections

to the Arctic Ocean – the smallest through Jones Sound with a 120 m deep sill at Hell’s Gate (western end of Jones Sound) and a channel width of less than 30 km at the mouth. The other shallow connection is to the west of Lancaster Sound at Barrow Strait where the sill depth is about 125 m and the width is about 55 km. The deepest connection is through Nares Strait with the sill in Kane Basin at a depth about 250 m. The circulation, water masses and meteorologi-

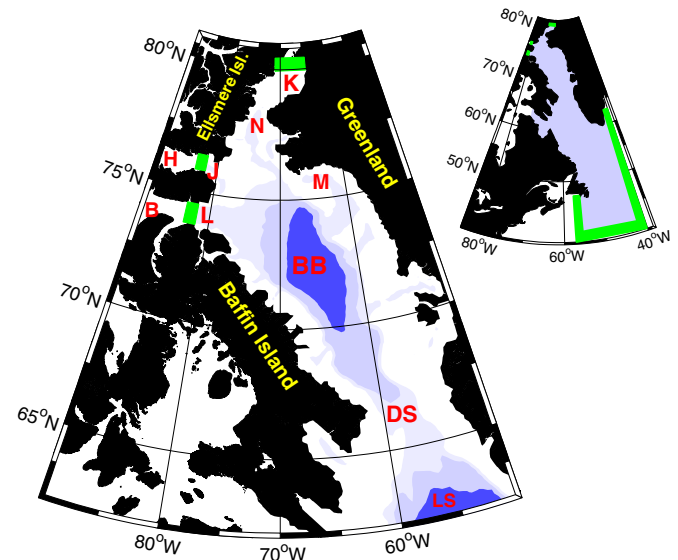


Figure 1. Map and bathymetry for Baffin Bay. Model domain is shown on the map to the right. Open boundaries are marked in green. Depth contours are 500, 1000, and 2000 m. Symbols in the map are: B -Barrow Strait; BB – Baffin Bay; DS – Davis Strait; H – Hell’s Gate; J – Jones Sound; K – Kane Basin; L – Lancaster Sound; LS – Labrador Sea; M – Melville Bay; N – Nares Strait.

cal conditions of Baffin Bay have been reviewed by Tang et al. (2004). Sea ice is present all year in Baffin Bay except September. The onset of local freezing occurs in early fall and near complete