Numerical modeling of ocean circulation over the continental shelf and beneath the ice shelves in the Amundsen Sea, Antarctica

David M. Holland
Courant Institute of Mathematical Sciences
New York, NY, 10012, USA
Email: holland@cims.nyu.edu

Stanley S. Jacobs
Lamont-Doherty Earth Observatory of Columbia University
Palisades, New York, NY, 10964, USA

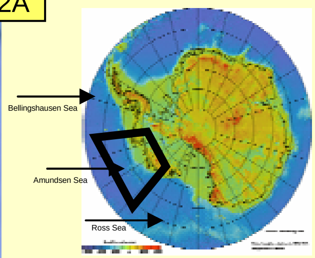
Adrian Jenkins
British Antarctic Survey
Cambridge, CB3 0ET, UK

1. OVERVIEW

Using a 3-D numerical model, we investigate the hydrography and circulation of ocean waters overlying the continental shelf in the Amundsen Sea. The goal of this study is to better understand processes which govern the temporal and spatial distribution of 'warm' circumpolar deep water (CDW) on the continental shelf, and its derivatives. That deep water, abundant off-shelf, migrates onto the continental shelf and subsequently beneath the floating ice shelves that drape most of the coastline in this sector. This leads to extensive basal melting, which may be negatively impacting the mass balance of the West Antarctic Ice Sheet. We employ a coupled isopycnic ocean, dynamic-thermodynamic sea ice, and thermodynamic ice-shelf model, along with daily varying atmospheric forcing and available bathymetry, to simulate the pathways and properties of waters on the continental shelf.

2. ORIENTATION

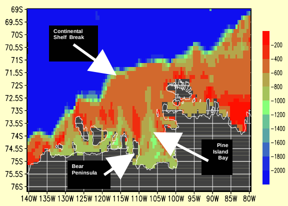
2A



Orientation map for modeling-study area. Shown is the bedrock elevation for the Antarctic continent (yellow and red shading) and surrounding ocean sea floor (blue shading) (image from BEDMAP webpages (*Lythe and Vaughan*, 2000)). The black trapezoid outlines the geographic focus area for this modeling study. The major seas are marked as the Bellingshausen, Amundsen, and Ross Seas.

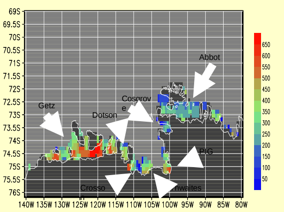
2B

Plan view of the southern part of the model domain and its bathymetry (depth in negative *m*). The model full-domain extends to northward to 60°S. The focal point of the study is on the waters of the Pine Island Bay, here loosely defined as the waters south of 72°S, and bounded east at 99°W and west at 111°W. The western boundary is also indicated by the Bear Peninsula, marked at 111°W. Red shading indicates relatively shallow continental shelf area; blue represents deep open-ocean area (maximum model depth is clipped at 2000 *m*).



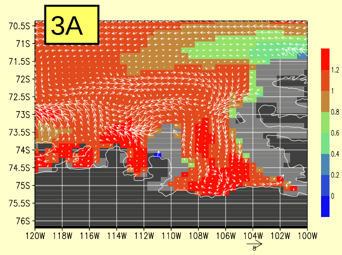
2C

Plan view of the southern part of model domain and the ice-shelf thickness (in *m*). Dark gray shading indicates Antarctic continent and grounded ice. Light gray shading represents ocean model domain where there is no ice shelf cover. Marked for reference are the Abbot, Cosgrove, Pine Island Glacier (PIG), Thwaites, Crosson, Dotson, and Getz ice-shelf complexes. The individual grid boxes composing the model ice shelf are visible as the distinct, color squares.

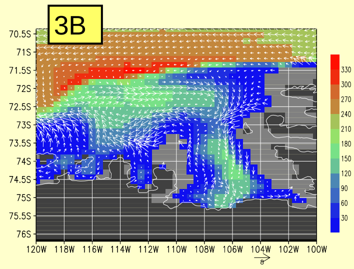


3. SOME RESULTS

3A

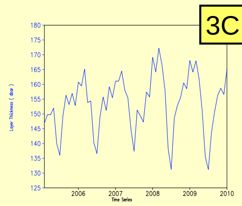


3B



Properties of isopycnic layer 7 in a subdomain of the model. a) Potential temperature (°C) of layer 7 with overlay of velocity vectors. b) Thickness (m) of layer 7 with overlay of velocity vectors. In a) and b) the velocity scale (*cm/s*) for both panels is given to the lower right of each panel. c) Time series over the last five years of the simulation of the thickness of layer 7, focused in the Pine Island Bay area (between 100°W and 110°W).

3C



4. OUTLOOK

Upcoming observational campaigns are expected bring us better quality ice-shelf thickness and other forcing data. Additionally, development of our code in terms of parallelization, and development in compilers and processors, will mean that future simulations will hopefully provide simulations with smaller uncertainties than is presently the case in polar ice-ocean modeling studies. Such modeling tools will provide us the capability for predicting how these complex environments may change under climate forcing. Studies such as the present represent a necessary step in the overall development of numerics and physics of computer modeling of the polar environments that will ultimately allow that predictive capability to be reached.

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