Sea Ice Model for Marginal Ice Zone

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LONG-TERM GOALS

The long-term goal of the work is to understand the formation and decay of the frazil and pancake ice in the marginal ice zone.

OBJECTIVES

The objective of the work is for Northwest Research Associates, Inc. (NWRA) in collaboration with the Technical University of Denmark (DTU) to develop a frazil/pancake model suitable for use by the National Ice Center (NIC) in the marginal ice zone. The ice analyst/forecasters at NIC now use many kinds of data to produce an analysis and forecast of ice conditions near the ice edge in specific regions. The model (to be used as a tool) developed in this project will aid in this work.

APPROACH

Model operations
General model operations are outlined in Figure 1. At a certain time step (t=1), the model imports the current SSM/I derived ice conditions as well as the mean atmospheric variables (wind and temperature) for the last 24-hour period (the time since the last time step).

The ice conditions from time step t=0 are advected as prescribed by the 24 hour average wind, and a first guess of the ice conditions at t=1 are obtained by aging the ice one day. At every grid point the advected ice field parameters are compared to the observed (SSM/I) ice field at t=1. New ice is grown or some ice is melted to match the new SSM/I observations. The comparison is made at ice concentration level, making use of available knowledge of the 'visibility' of various young/thin ice types as contained in the model, to the SSM/I sensor.

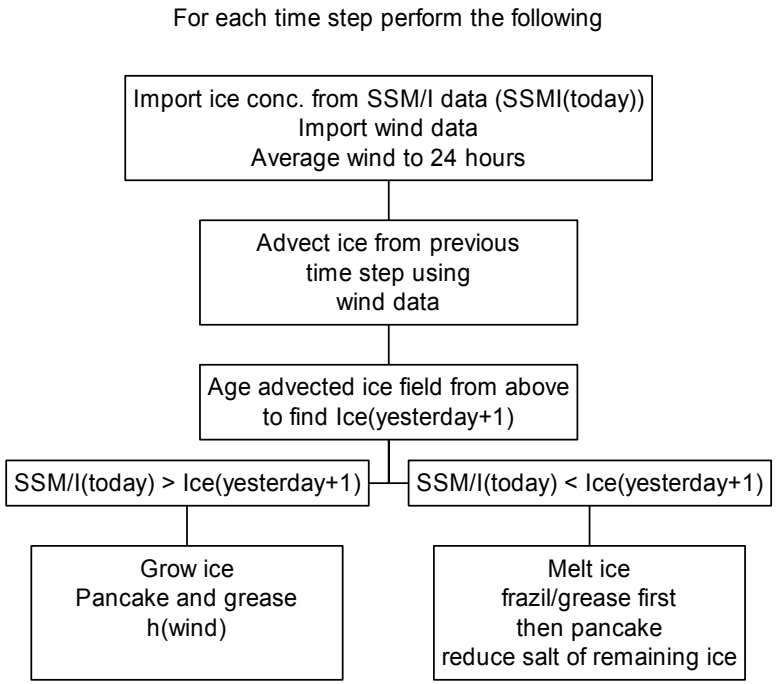
The overall plan is to deliver a model based on the present model as described above. The new model would be delivered to NIC at the end of the first contract year. During the second year, the staff at NIC will use the new model in marginal ice regions of interest to them. The model tool will be used to attempt a "best fit" to historical ice forecast. This "best fit" would be obtained by varying air stress,

A marginal ice zone model for the US National Ice Center

The ice

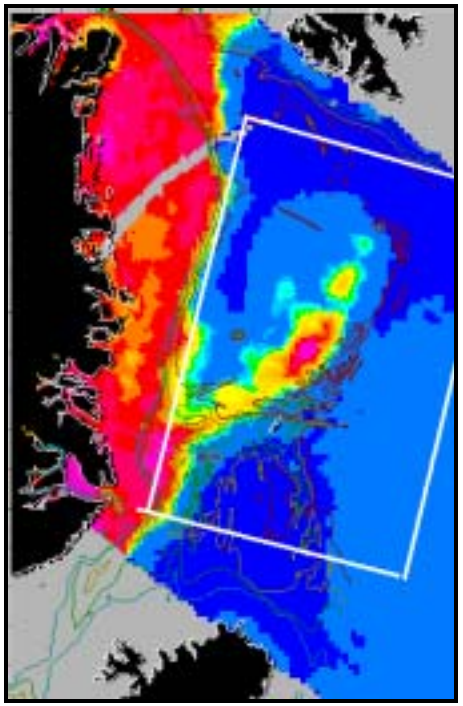
Photos of frazil and pancake ice, 1997

The model



Model forced by daily SSM/I ice observations and daily winds

The Data



Example of daily SSM/I ice concentrations

Northwest Research Associates Inc., Bellevue, Washington, USA &
Danish Center for Remote Sensing, Technical University of Denmark, Lyngby, Denmark

water stress, and some parameters in the ice growth equations. It is expected that different variants of these parameters would be required for a "best fit" in different geographic locations. In essence, the model will be tuned to best produce the historical analysis for a series of locations. Simultaneously during the second year, NWRA and DTU will make additional modifications to the model. Using the results from the second-year model testing, the model will be finalized in the third year and delivered to NIC to serve as a routine analysis and forecast tool.

The model (to be used as a tool) will be based on the present models and will be of direct use to NIC and will enhance the PIPS3.0 development. The tool being considered here would be used by an analyst/forecaster at the workstation. They would use all of the present inputs and their knowledge of the region together with this new tool. The inputs for the new tool are from PIPS:

- Ice velocities.
- Ocean currents at the mixed layer.
- Temperature at the bottom of the ice.
- Air temperature (also might use local remeasured air temperatures).
- SSM/I as enhanced by some scheme.
- Air stress.

This data is required only for the local region of interest. Therefore, the data files are not very large. Point calculations of drift can be made and ice concentration can be determined from SSM/I.

WORK COMPLETED

The first version of the model was delivered to NIC in February 2001 and it covers the Greenland, Weddell, and Bering Seas. The model is being tuned for the regions at NIC. At the February 2001 meeting the Statement of Work was revised and the schedule for the last two years of the project was set. Max Coon and Leif Toudal visited the NIC in August 2001 to work out the details of how to run the model for the Berents Sea and provide real time results to the Healy in support of the October cruise to the Barents. The plans for this operation are in place.

RESULTS

The first version of the model is being tested at NIC. The data streams needed to run the model at NIC have been established.

IMPACT/APPLICATIONS

The model (tool) being developed on this project will improve the ability of NIC to produce ice charts in the MIZ.

TRANSITIONS

This project will transition the research being done in the related projects to a tool that will be used by NIC to make ice charts.

RELATED PROJECTS

CONVECTION (2000-2003, EC)

The objective of CONVECTION is to understand the physics underlying the convection process in the Greenland Sea and how this process links with climatic factors. At the end of the project we expect that this understanding will be such that a successful technique will be in place for predicting year-to-year variability, and long-term trends, in the convection process. The investigation will be carried out by a combination of remote sensing, modeling and field measurements. The project is a continuation of the ESOP projects (European Sub-polar Ocean Programme, 1993-1999, EC), project homepage: http://www.smr.uib.no/ and project results at the Danish Center for Remote Sensing, DTU, http://www.emi.dtu.dk/research/DCRS/seaice/esop2.html. This project provides funding for carrying out laboratory remote sensing measurements of scatterometer signatures of frazil/pancake ice under varying conditions. The project also funds further development of the salt flux part of the model.

IWICOS (2000-2002, EC)

The objective of IWICOS is to develop a prototype marine information system, which will provide a single-entry access to meteorological, sea ice and oceanographic (met-ice-ocean) data and products in electronic form provided by weather forecasting, ice and research centres. Project homepage: http://www.nrsc.no/~iwicos/ and project results at the Danish Center for Remote Sensing, Technical University of Denmark: http://www.emi.dtu.dk/research/DCRS/seaice/iwicos/. This project provides access to daily processed SSM/I and QuikSCAT data for the Northern hemisphere and the Weddell Sea.

SEALION (1998-2000, EC)

The aim of this project is to assess and improve the performance of coupled global atmosphere-sea ice-ocean models in reproducing sea ice in the high southern latitudes. This will be achieved by deriving data sets of sea ice concentration and motion using remote sensing techniques, performing selected runs with a sophisticated high-resolution dynamic-thermodynamic sea ice model, which will be optimized with the data sets derived within this project, and analyzing the output of coupled global atmosphere-ocean general circulation model (AOGCM) runs.

FRAZIL and PANCAKE Sea Ice Model (1999-2000, DTU, ONR)

The objective of this project is to improve the description of sea ice in a salt-flux model developed during the above-mentioned ESOP project. The project allowed Max Coon to stay for a total of 12 months at the Technical University of Denmark, partly as a guest professor. It also co-funded Dr. Coon's participation in a cruise to the Weddell Sea, where a valuable dataset on sea ice properties in the Marginal ice Zone was collected.

PUBLICATIONS

Toudal, L. and Coon, M.D., Interannual variability of the sea ice induced salt flux in the Greenland Sea, Accepted by Annales of Glaciology, 2000.

PRESENTATIONS

Toudal, L. and Coon, M.D., Interannual variability of the sea ice induced salt flux in the Greenland Sea, IGS symposium on Sea Ice, Fairbanks, Alaska, June 2000.

Toudal, L. and Coon, M.D., Salt redistribution in the Greenland Sea driven by ice growth and Advection, European Geophysical Society 2000 General Assembly, June 2000, Nice, France.