

Introduction

The Polar Ice Prediction System 2.0 (PIPS 2.0), run by the Fleet Numerical Meteorology and Oceanography Center (FNMOC), is a coupled ice-ocean model that forecasts ice conditions for most of the sea ice-covered areas in the northern hemisphere. The PIPS 2.0 system was developed in the early 1990's and has been operational since 1995. The Naval Research Laboratory has been developing a replacement for the PIPS 2.0 system that would include both upgrades to the ice and ocean models as well as the data assimilation techniques used in the system. Once completed the new system will be called PIPS 3.0.

Improving the Navy's Sea Ice Forecasting System – PIPS 2.0 to PIPS 3.0

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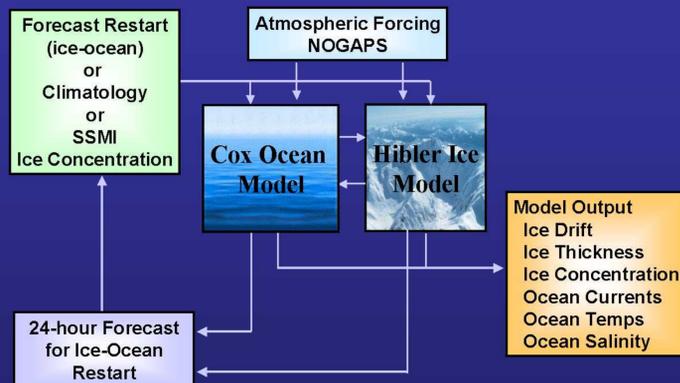
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The Present System - PIPS 2.0

The PIPS 2.0 model consists of the Hibler ice model coupled to the Cox and Bryan ocean model. The horizontal grid resolution of the PIPS 2.0 ice and ocean models varies from 17-33 km while 15 vertical levels are used to resolve the ocean structure with depth. PIPS 2.0 is driven by atmospheric forcing from the Navy Operational Global Atmospheric Prediction System (NOGAPS). The ice model is initialized from the ice concentration fields derived from SSMI passive microwave data. A 120-hr forecast is generated each day for ice drift, ice thickness and ice concentration.

Polar Ice Prediction System 2.0

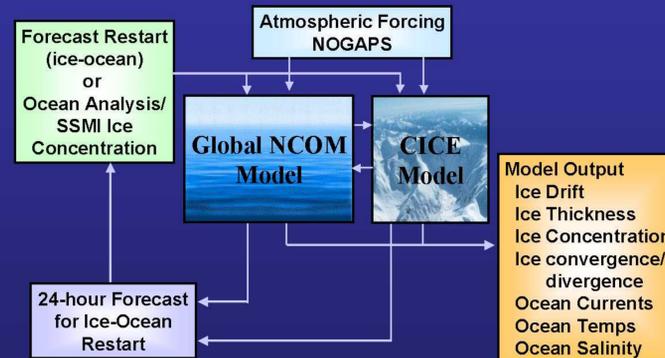


The Future System - PIPS 3.0

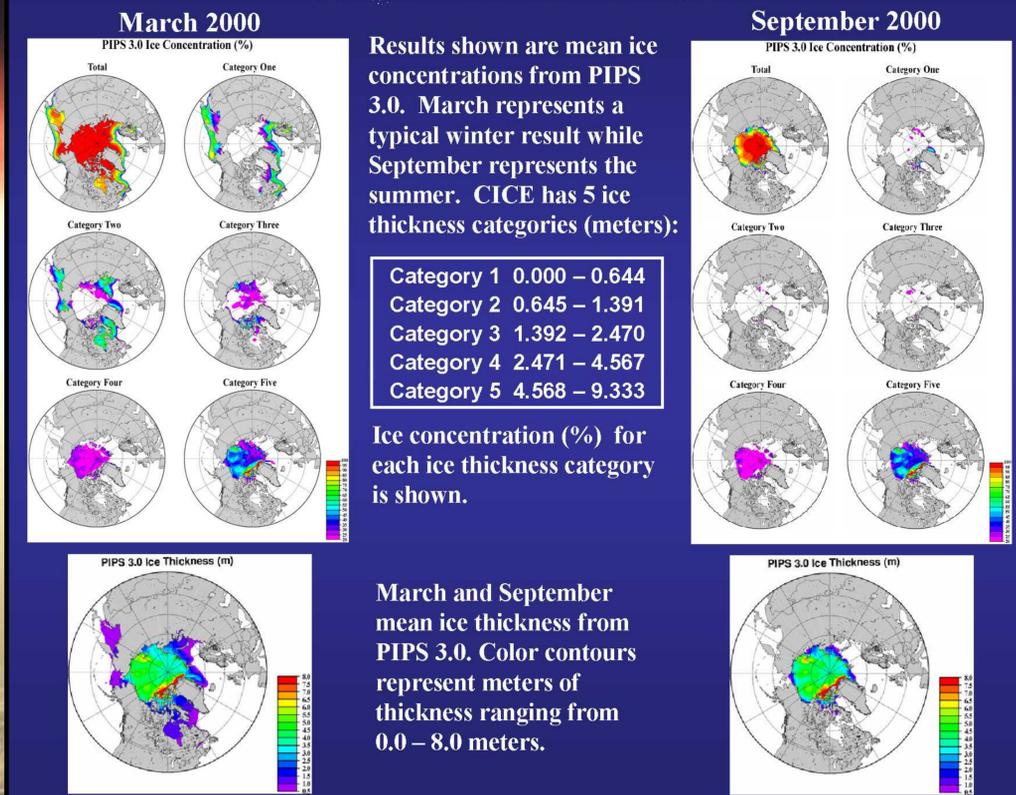
A new sea-ice forecast system, PIPS 3.0, is presently being tested. This system is based on technology developed during the last 10 years. The system will have, at its core, the Los Alamos ice model, CICE, coupled to the Navy's Global NCOM Ocean Model. CICE, an improvement over other models, uses:

- Energy conserving Bitz and Lipscomb (1999) thermodynamics
- Multi-category, linearly remapped ice thickness
- EVP (efficient, improved response to forcing)
- Energy-based ice ridging
- Other improvements to physics parameterizations

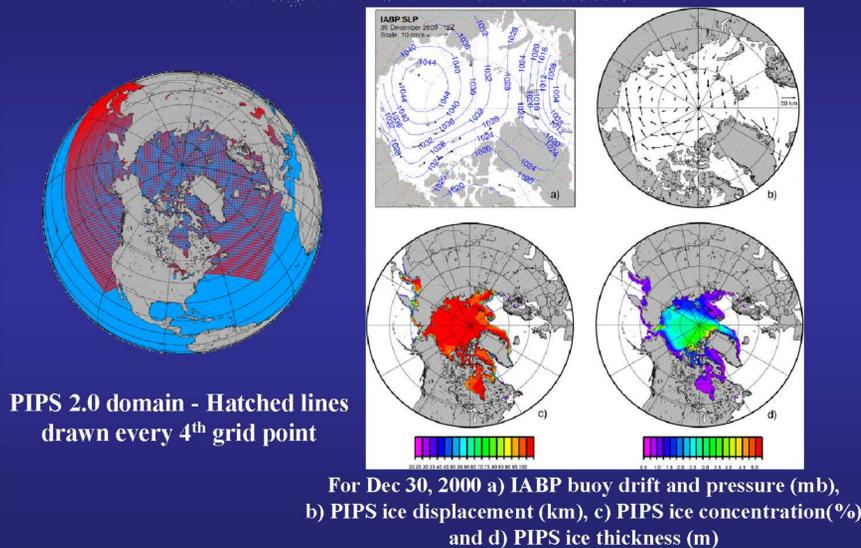
Polar Ice Prediction System 3.0



Sample PIPS 3.0 Forecasts

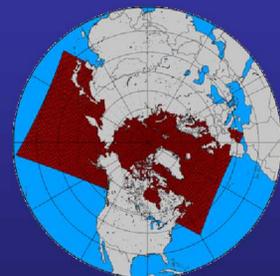


Sample PIPS 2.0 Forecasts



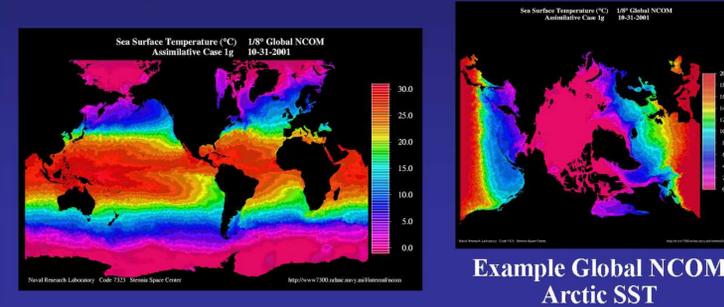
CICE Model

CICE is first being tested decoupled from an ocean model to evaluate its sensitivity to NOGAPS atmospheric forcing. The grid below, used for these tests, has a 9 km resolution (see below – every 10th point plotted). This resolution was chosen to provide a better estimate of locations where ice may open or close, thus providing guidance in the forecasting of leads.



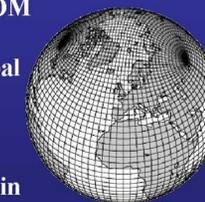
One advantage of the CICE code is the use of multi-category ice thickness. For our testing, five categories of ice thickness were used ranging from 0.0 – 9.33 meters.

Global NCOM Model



- 40 vertical sigma-z levels
- 19 sigma-levels to ~137 m
- 21 z-levels below
- 72-hr forecast each day
- Driven by NOGAPS forcing
- Assimilates MODAS 3-D synthetic T/S fields

The global NCOM horizontal grid produces a global overlap by introducing an Arctic cap with poles over land in Canada and Russia.



Conclusions

The US Navy has been running the PIPS 2.0 system operationally since 1995. The next generation ice forecast system PIPS 3.0 will be able to provide a sea ice forecast with higher resolution by using a more sophisticated ocean model, an improved data assimilation scheme, and an improved sea ice model. These improvements are geared towards providing, not only a better forecast of ice edge, ice motion, and ice thickness, but also the possibility to forecast regions of lead formation. The CICE model has been successfully run using NOGAPS forcing from 1999-2002. CICE will be coupled to the Global NCOM this summer and transitioned to the Navy in 2004.