Validation of the Ocean Component of PIPS3.0

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LONG-TERM GOALS

Our long-term goal is to better represent the Arctic Ocean in numerical models. In order to validate these models, we need high quality gridded fields of observed quantities such as ocean temperature and salinity. Both the historical mean and the historical variance are required. We then need to discover where and when the models diverge from the observations. Armed with this knowledge, we can proceed to make improvements that will assist the Navy with their forecasting mission.

OBJECTIVES

Our specific objective is to assist in the development and validation of PIPS 3.0, the next generation Navy operational polar model. Specifically, we have developed a gridded oceanic data set that we call the Polar science center Hydrographic Climatology, or PHC. It consists of global temperature and salinity fields using new Russian and Western arctic data that can be used for model initialization, restoring, and validation. We are extending this data set by (1) filling data gaps, (2) creating variance fields, and (3) using PHC to validate a suite of numerical models.

APPROACH

Our main focus over the past year has been objective (1) above, namely filling an important data gap in PHC. The gap lies in the eastern arctic Canadian waters, i.e., Hudson Bay, Baffin Bay, and the Canadian Arctic Archipelago. This is a region where PIPS2.0 consistently underestimates sea ice cover during winter (*Van Woert et al*., 2001), the cause of which is still uncertain. It is also a region of possibly great interest to the Navy and civilian shipping interests if the Northwest passages were to open to non-ice-strengthened vessels over the next ~50 years owing to changing atmospheric conditions.

We decided to, for the first time, blend original profile data into PHC (as opposed to simply blending together previously gridded data sets). We first checked to see if unclassified data from NAVO might be available to fill this data gap. With the assistance of Bob Rushton at NAVO, we created **Figure 1**, which compares the locations in space and time of these data with that already available to us from the National Oceanographic Data Center (NODC). Unfortunately, the NAVO data do not provide much additional information in the eastern Canadian waters during winter.

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14. ABSTRACT
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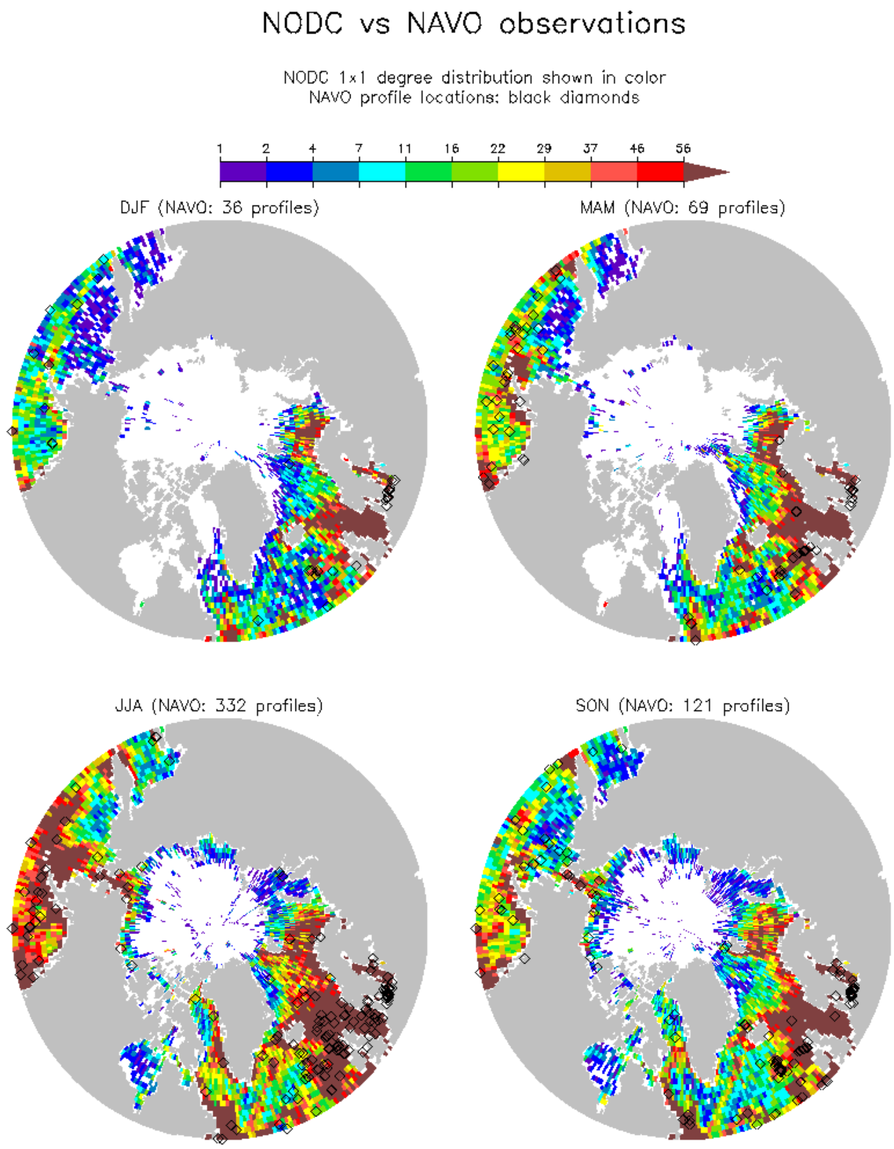

Figure 1. Hydrographic profiles in the arctic seas from 2 databases. The colored pixels show the seasonal breakdown of the number of profiles in 1x1 degree lat/lon bins from the World Ocean Database (WOD), which was published by the National Oceanographic Data Center (NODC) in 1998. Very poor data coverage is obvious in the high Arctic Ocean in all seasons, and in the eastern Canadian waters in the winter. Unclassified NAVO profiles are plotted as unfilled black diamonds, and unfortunately do not substantially enhance WOD coverage in these "data holes."

We next obtained temperature and salinity profiles from the Bedford Institute of Oceanography (BIO, Nova Scotia, Canada), which manages a database for this region. These data have not yet been included in the NODC database (S. Levitus, personal communication, 2001). We found that additional quality control was necessary to eliminate unrealistic values (e.g., surface temperatures in winter well above the freezing point), the results of which were communicated back to BIO. The remaining profiles were sparse, but still provided enough information to substantially improve the winter hydrographic fields. **Figure 2** shows the result of our efforts. We also devoted some effort to assuring that the sub-surface hydrographic fields were correct, e.g., that boundary currents along western Greenland and eastern Baffin Island are realistically confined (not shown). This will help in validation of the PIPS3.0 ocean component.

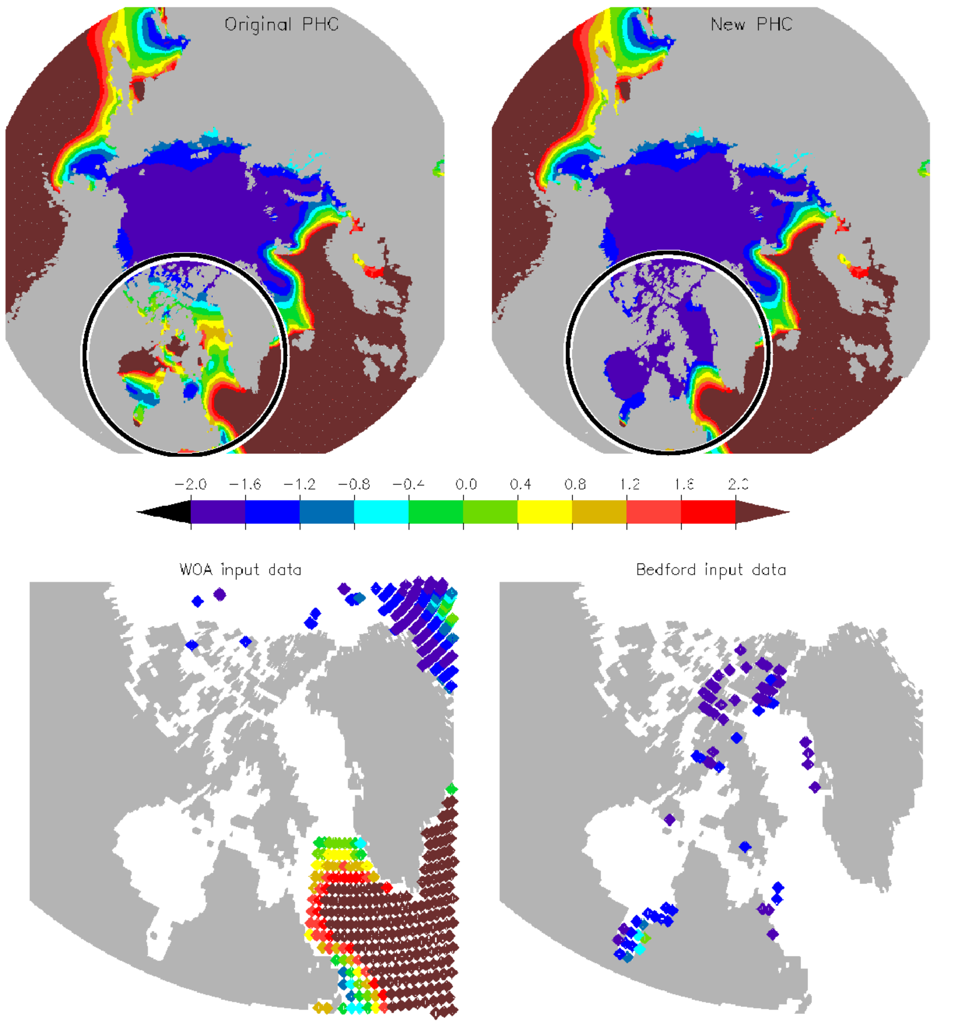

Figure 2. Improvement of winter (March-April-May) SST in the eastern Canadian sector of PHC. The top 2 panels show how blending of new data has cooled off SST in Hudson Bay, Baffin Bay, and the Canadian Arctic Archipelago (area marked by the circle). The bottom 2 panels show the paucity of winter data in the World Ocean Atlas (WOA), and the locations of profiles (after additional quality control) that we obtained from the Bedford Institute of Oceanography (BIO) in Nova Scotia, Canada.

We are also updating the analytical function that provides a synthetic monthly time series in the high Arctic Ocean and eastern Canadian waters. The new function will provide a time series that is more consistent with the seasonal fields, e.g., the average of the monthly March, April, and May fields will be the same as the seasonal MAM field. (Our previous version used MAM as the April extreme.) This improvement was suggested by a Canadian ice-ocean modeler who is actively using PHC.

M. Steele is responsible for guiding this research. W. Ermold is the main software programmer and web designer.

WORK COMPLETED

Blending of Canadian data into PHC is now complete. We are nearly finished testing the new monthly analytical function, after which we will complete web links to our new PHC2.1 web site.

We created a test "beta" version of PHC2.1 with the blended Canadian data, which is currently in use by modelers affiliated with the Arctic Ocean Model Intercomparison Project (AOMIP). This includes modelers at the Naval Postgraduate School, Monterey, CA. We presented information about PHC2.1 at the spring 2002 AGU meeting in Washington, D.C. PHC was used in a recent evaluation of the heat and freshwater content of arctic ice-ocean models (*Steiner et al*., 2002).

RESULTS

We learned that it is possible to create a gridded ocean climatology that for the first time includes a high-quality description of the eastern Arctic Canadian waters in winter.

IMPACT/APPLICATION

We anticipate that our new climatology will improve the forecasting ice/ocean conditions in the eastern Canadian waters, an area that currently produces large errors. It will also assist in model validation during hindcasting. This improvement may prove especially valuable if sea ice conditions continue to change in the near future in this possibly strategic region.

TRANSITIONS

Our PHC database has been downloaded by over 80 researchers from around the world. It is used as initialization and restoring for the Navy's PIPS3.0, for the modelers involved in the Arctic Ocean Model Intercomparison Project (AOMIP; e.g., *Steiner et al*., 2002), and others as well (e.g., *Holloway and Sou*, 2002).

RELATED PROJECTS

The Arctic Ocean Model Intercomparison Project (AOMIP) is an international effort to directly test models against observed data and against each other. Currently we are running a coordinated forcing experiment for the years 1948-1978, using PHC as model initialization and climate restoring. More information may be found at:

http://fish.cims.nyu.edu/~holland/project_aomip/overview.html.

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PUBLICATIONS

Steiner, N., G. Holloway, S. Hakkinen, D. Holland, M. Karcher, W. Maslowski, A. Proshutinsky, M. Steele, and J. Zhang, Comparing modeled streamfunction, heat, and freshwater content in the Arctic Ocean, Ocean Modelling, submitted, 2002.