UCAR Visiting Scientist Program at the National Ice Center

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LONG TERM GOALS

The long-term goal of the University Corporation for Atmospheric Research (UCAR) Visiting Scientist Program at the National Ice Center (NIC) is to recruit the highest quality visiting scientists in the ice research community for the broad purpose of strengthening the relationship between the operational and research communities in the atmospheric and oceanic sciences.

The University Corporation for Atmospheric Research supports the scientific community by creating, conducting, and coordinating projects that strengthen education and research in the atmospheric, oceanic and earth sciences. UCAR accomplishes this mission by building partnerships that are national or global in scope. UCAR's goal is to enable researchers and educators to take on issues and activities that require the combined and collaborative capabilities of a broadly engaged scientific community.

OBJECTIVES

The objectives of the UCAR Visiting Scientist Program at the NIC are:

- Manage a visiting scientist program for the NIC Science Center in support of the mission of UCAR.
- Provide a pool of researchers who will share expertise with the NIC and the science community.
- Facilitate communications between the research and operational communities for the purpose of identifying work ready for validation and transition to an operational environment.
- Act as a focus for interagency cooperation.

The NIC mission is to provide worldwide operational sea ice analyses and forecasts for the armed forces of the U.S. and allied nations, the Departments of Commerce and Transportation, and other U. S. Government and international agencies, and the civil sector. The NIC produces these analyses and forecasts of Arctic, Antarctic, Great Lakes and Chesapeake Bay ice conditions to support customers with global, regional and tactical scale interests. The NIC regularly deploys Naval Ice Center NAVICECEN Ice Reconnaissance personnel to the Arctic and Antarctica in order to perform aerial ice observation and analysis in support of NIC customers. NIC ice data are a key part of the U.S. contribution to international global climate and ocean observing systems.

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APPROACH

The UCAR Visiting Scientist Program works with participating Federal agencies to recruit scientific visitors and recent PhDs who are interested in conducting applications-oriented research and product evaluation of relevance to the NIC ice-monitoring mission. The UCAR visiting scientists are a source of expertise for the NIC as well as mentors to the recent PhDs.

Current participating agency representatives are:

- Tony Beesley: UCAR Visiting Scientist
- Cheryl Bertoia: National Ice Center liaison to UCAR
- Phil Hovey: NOAA physical science technician
- Eric Lindstrom: NASA program sponsor
- John Marra: NASA program sponsor
- Walt Meier: UCAR Visiting Scientist
- Kim Partington: NASA Polar Programs (NASA advisor to program)
- John Powell: Executive Officer, Naval Ice Center (visitor program sponsor & advisor)
- Juanita Sandge: NRL Stennis Space Center program sponsor
- CDR Zdenka Willis: Director, National Ice Center & Commanding Officer, Naval Ice Center (visitor program advisor)
- Michael VanWoert: NOAA Senior Scientist serving as Chief Scientist
- Cheng-Zhi Zou: UCAR Visitor Agreement

WORK COMPLETED

This ONR sponsored activity is developing an improved Polar Ice Prediction System (PIPS) and to verify its use for short-term operational sea ice forecasting. The NIC science team is responsible for four PIPS related activities: 1) to evaluate the quality of the SSM/I sea ice product used to initialize the PIPS system; 2) to evaluate the suitability of the Naval Operational Global Atmosphere Prediction System (NOGAPS) for forcing the PIPS system; 3) to evaluate the skill of the PIPS forecasts; and, 4) to assemble a PIPS case study database of satellite data for validating the model dynamics.

Figure 1 provides a schematic diagram depicting the various elements of the NIC PIPS verification and validation activities.

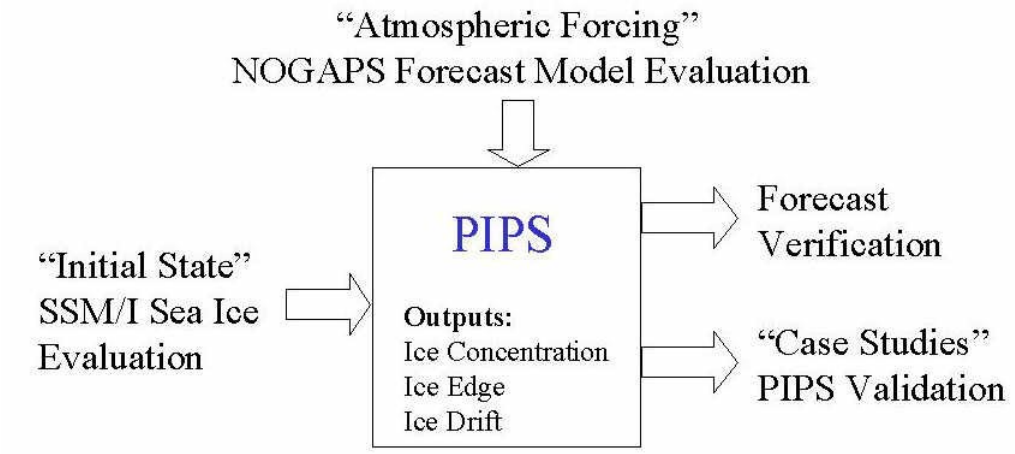

Figure 1. This schematic depicts the NIC PIPS validation and verification activities.

The different approaches used for each activity are:

1) To evaluate the SSM/I sea ice algorithms, algorithm outputs are intercompared and then compared against National Ice Center charts and RADARSAT satellite imagery. As appropriate, other ancillary data are used to verify the environmental conditions at the time of the satellite product. (W. Meier)

2) The NOGAPS atmospheric model is evaluated against in situ data collected during the Surface HEat Budget of the Arctic (SHEBA) experiment. Direct comparisons between model and in situ atmospheric pressure, air temperature, and wind provide quantitative assessments of the quality of the NOGAPS fields. (T. Beesley)

3) The PIPS sea ice concentration and edge forecasts are being evaluated using statistical methods designed for model validation. Currently the focus is on establishing the root mean square error (RMSE) between the model forecast and observed conditions (Willmott et al., 1985). However, other forms of skill assessment are also being considered (e.g. Stephenson, 2000) (M. Van Woert/P. Hovey)

4) The test case database is a collection of five sets of satellite imagery depicting various sea ice conditions. The satellite imagery are being converted to GIF format and provided to the PIPS development team. (M. Van Woert/P. Hovey)

The work completed on this activity is:

1. To date activities have focused on comparing the Navy operational Cal/Val SSM/I sea ice concentration algorithm to the NASA Team algorithm and the NASA Team algorithm modified to handle thin ice regions (ThinTEAM). Focus has been on evaluating specific case studies, but attention is now turning to more comprehensive comparisons.

2. We have made an initial assessment of the NOGAPS pressure, temperature, and wind fields by comparing the model fields to data collected during the SHEBA program.

3. In preparation of model verification, we have begun assembling a database of PIPS nowcast, forecast, and SSM/I satellite-derived sea ice fields. The database begins January 1, 2000 and is ongoing. A milestone in the database development is the collection of data during the ice melt season (completed) and the freeze-up (currently being collected) period. Evaluation of the data is now underway. An example of a forecast field, the observed conditions at the valid time for the forecast, and their difference is shown in Figure 2.

4. Initial entries into the sea ice case study database have been made. The first and second case studies are from 13-17 July and July 17-26 1998 in the Beaufort Sea. They focus on large multi-year and first-year ice floes at a time when the ice edge is well north of its climatological limit. Case study three (31 January – February 4 2000) captures the rapid growth of ice near the Pribilof Islands in the Bering Sea. Case study four (7-10 January 2000) captures an extreme regression of the ice edge in the Barents sea, which is the result of strong and sustained winds from the south. Case study five from 17-19 June 2000 shows a recurring polynya in the Barent Sea. Other case studies are being evaluated for inclusion in this database.

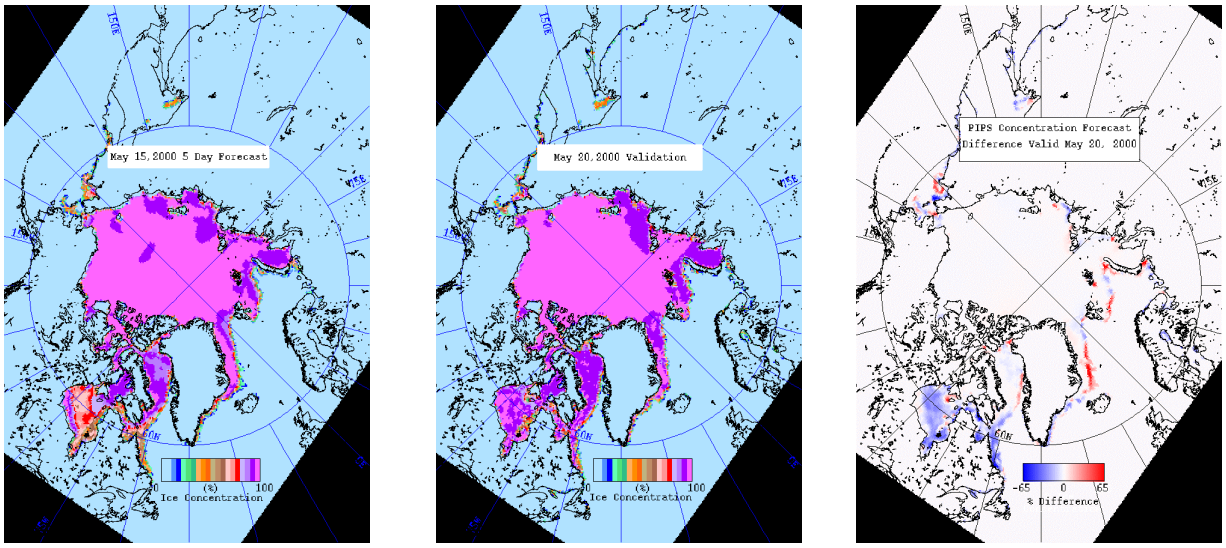

Figure 2. Five day forecast made on May 15, 2000 which is valid for May 20, 2000 (a), valid conditions on May 20, 2000 (b) and the difference (observed minus the forecast) (c). Red denotes areas where ice was observed and no ice was forecast; blue denotes areas where ice was not observed yet was forecast.

RESULTS

1. SSM/I-derived ice concentration imagery using the Navy Cal/Val, the NASATEAM and the ThinTEAM algorithms were compared for the period November 1999 – January 2000. The results of our study indicate that the ThinTEAM performs comparable to the Cal/Val in regions of operational interest, particularly near the ice edge and in thin ice regimes. Additionally, ice concentrations from the ThinTEAM algorithm retain spatial variability in central pack where the Cal./Val traditionally tends to saturate. Thus, the ThinTEAM seems to be a viable alternative to the Cal/Val algorithm in the regions of highest operational interest while retaining structure in high Arctic areas as well. Figure 3 illustrates the difference between the Cal/Val and NASA ThinTEAM algorithms.

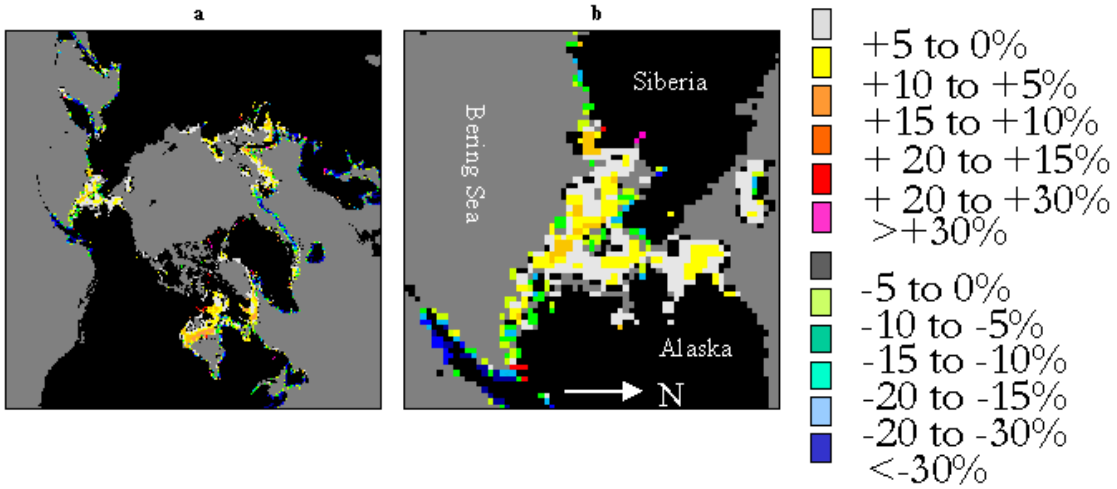

Figure 3. Difference between the Cal/Val and NASA ThinTEAM concentrations for December 12, 1999 (a) northern hemisphere and (b) Bering/Chuckchi Sea region.

2. Results of the NOGAPS/SHEBA comparisons indicate that NOGAPS has a large positive bias (warm) relative to the SHEBA data during the winter months (Figure 4). In addition, the model tends to over estimate the wind speed and produce excessive cloud cover during the winter. In contrast, the forecasts of temperature and wind were much more successful at the 850 mb level, suggesting that the source of the problem may be the sea-ice or atmospheric boundary layer scheme in NOGAPS. The impact of these errors on PIPS forecasts is currently being assessed.

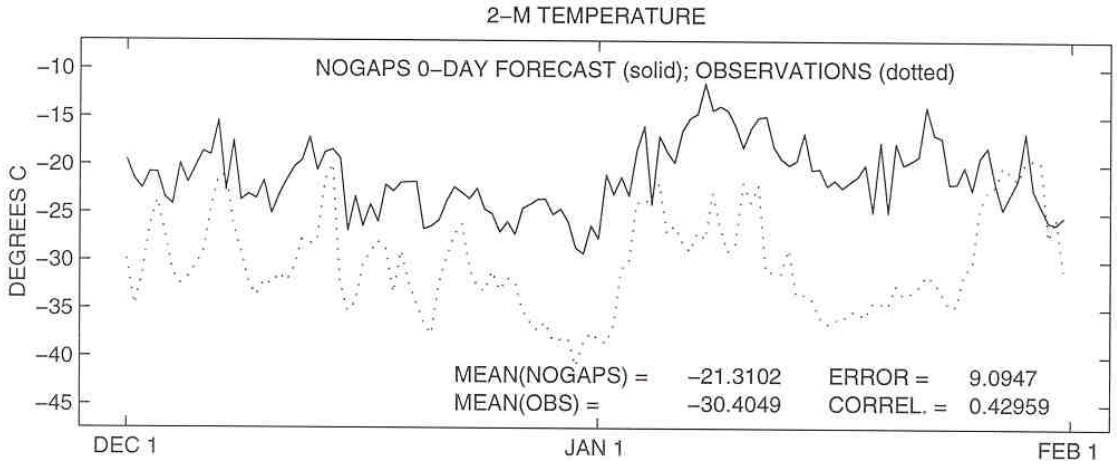

Figure 4. Temperature versus time for the period December 1, 1997 to February 1, 1998. The NOGAPS nowcast is depicted with a solid line and the SHEBA observations are shown as dotted.

IMPACT/APPLICATIONS

At the completion of this activity it is hoped to have an improved, high resolution, sea ice forecasting model that has been verified for use at high northern latitudes. Major emphasis is placed on verifying the system, so that forecasters have clear guidance on when and where they can rely strongly upon the forecast fields.

UCAR's Visiting Scientist Programs have served many federal agencies in developing valuable partnerships between the research and operational communities. The benefits have included an influx of new ideas and collaborations, and the improvement of products for the agency, the scientific community and for society at large.

TRANSITIONS

SSM/I ice motion vectors are an important source of data for constraining sea ice models (Meier et al., 2000). Code was recently transitioned to FNOC to operationally produce sea ice motion vectors.

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