2. ICE-ATMOSPHERE INTERACTIONS IN THE POLAR OCEANS

Lead Investigator: Dr. Robert Crane

2.1 Overview

Sea ice forms a major reservoir in the global water cycle and both polar regions undergo a large seasonal variation in their sea ice cover. The extent of this sea ice cover is a function of both dynamic and thermodynamic interactions with the atmosphere and ocean. Changes in the ice cover can be regarded as an indicator of climate change and variability, while interactions between the sea ice and climate make it likely that changes in the ice cover will also feed back to effect a further change in climate over a variety of temporal scales.

This research examines these sea ice - atmospheric interactions in terms of the atmospheric controls on ice cover, and the resulting feedbacks to the climate system. The primary objective is to determine the role of sea ice in global climate change.

As a subset of the overall project, we are interested in examining the relationship between sea ice and the synoptic-scale atmospheric circulation in the North Atlantic. This region is chosen for more detailed study because, first, the project involves land ice and we have a focus on Greenland. Second, there have been several previous international field programs in the region, and a couple more are planned for the early 1990's.

2.2 Research Plan

A significant feature of all General Circulation Model experiments is an enhanced high latitude response to a doubling of atmospheric CO_2. Unfortunately, both sea ice and cloud processes are poorly dealt with in current GCM's. Given this situation, it is important to examine polar energy budgets through observational and empirical analyses in order to improve on GCM performance in the polar regions, and to use the models to estimate the consequences of global climate warming. A major constraint to both the empirical analyses and GCM validation has been the lack of adequate data -- a situation that should improve with the new observational possibilities offered by the Eos Program.

The synoptic circulation modes of the observed and GCM climates will be extracted using rotated principal components analysis, and the GCM modes will be assessed in terms of the observational fields. The circulation modes will be further categorized using ancillary data such as temperature, humidity, winds, cloud cover, etc. The analysis will be used to assess the results obtained from GCM experiments of past or future climate states.

2.3 Data Needs

This study focuses on ice-atmosphere interactions and requires data on ice extent type and concentration, and on the composition and state of the atmosphere.

2.3.1 Ice data

Ice extent, concentration, and ice type will be derived from passive microwave radiometry. The primary source of these will be the Nimbus-7 Scanning Multichannel Microwave Radiometer (SMMR). This source provides a continuous and consistent 10 year record of brightness temperatures that can be used to calculate ice concentration and the multiyear ice fraction at a 50km resolution. These data are currently available from the National Snow and Ice Data Center, which will be a node on EosDis.

2.3.2 Atmospheric data

Three types of atmospheric data will be used:

1) *long-term 'observational' data from the National Meteorological Center* - These are gridded products based on station observations, which will be used for GCM validation and as a consistency check for the Diagnostic Model fields. These data are available from the National Center for Atmospheric Research.

2) *Atmospheric fields from the European Center for Medium Range Forecasting diagnostic model* - These will be used for the actual ice-atmosphere interaction studies as the fields are more complete than the observational data, and are internally consistent. I would not expect to see either of these two data streams in EosDis, although I would expect to be able to find information on these data sets in the Master Directory database.

3) *Cloud cover data derived from NOAA AVHRR* - In this case I would expect to find both the brightness counts and temperatures, and the derived cloud products in EosDis.

2.3.3 GCM data

GCM sea ice and atmospheric data is to be compared with present day data sets to determine how well GCM's simulate the interactions observed in the empirical data, and the doubled CO_2 runs will be used to examine how these processes may change in the future. This type of analysis requires daily data for as long a time period as is available. It is assumed that baseline data sets of the major GCM's will be available in EosDis.

A breakdown of needed data variables, their characteristics and expected sources are given in the table on the following page.

2.4 Results of Master Directory Search

This particular project was chosen as one of the scenarios from among Penn State's interdisciplinary Eos program components because this effort is characterized as having data needs that were expected to be included in the Master Directory database.

The Master Directory search was performed from Penn State utilizing a SUN SparcStation running SUN OS and a Micro VAX II running VMS. NSSDC's on-line data and information services were accessed via Internet.

2.4.1 Usefulness of the database contents

In searching the Master Directory database for the desired specific data sets, there was a good although not complete inclusion of needed data sets. There were some derived data sets (e.g., generated via a General Circulation Model) that potentially could have been included. These were not found. SMMR data was found in the Master Directory database, however. This entry also seemed to be up-to-date in its description of the data set. Some AVHRR data was found, but not for the required geographical area.

Variable	Temporal Resolution	Temporal Extent	Spatial Resolution	Spatial Extent	Source Instrument	Source Organization
Ice Extent Concentration Type	3 days	1979-1989	50km	80°N-50°N 70°W-90°E	 SMMR SMMR SMMR	National Snow & Ice Data Center
Atmospheric (diagnostic model) Sea level pressure Surface air temperature Cloud extent Surface wind 3-d moisture fields 500 mb heights	Daily	1979-1989	4° x 5°	80°N-50°N 70°W-90°E		European Center for Medium Range Forecasting
Atmospheric (observational) Sea level pressure Surface air temperature Surface wind 500 mb heights Cloud extent	Daily	1965-1990	4° x 5°	80°N-50°N 70°W-90°E	 AVHRR	National Meteo. Center (via NCAR) NOAA
General Circulation Model Sea Ice Sea level pressure Surface air temperature 500 mb heights Clouds 3-d moisture	Daily	3 - 10 years	4° x 5°	80°N-50°N 70°W-90°E		Goddard Inst. for Space Studies NCAR Geophysical Fluid Dynamics Lab U.K. Meteo. Office

Information in the 'brief' description for specific data sets found in the Master Directory database was seen as overly brief and often inconsistent. Information on how to actually obtaining some data sets was incomplete (e.g., AVHRR data for Spitsbergen).

2.4.2 Functionality of the user interface

For individuals with a priori knowledge of the specific data sets desired, the strictly hierarchical, menu-driven interface was found to be more of a hindrance than a help. This was true even for such a person who was using the Master Directory for the first time. For example, once a specific data set was located on the database, it did not seem possible to go directly to the 'contact' level without first going through generalized descriptions.

After some initial searches utilizing a SUN workstation, it was decided to try the same exercise on a Micro VAX running the VMS operating system. The reason for this was that one of the initial dialogue screens for NSSDC's on-line data and information services asks for terminal type. Since the choices included 'VT compatible', 'Tektronix 4025' and 'other', there was hope that using a 'VT compatible' terminal on a system compatible with NSSDC's computer might provide some additional screen/menu capabilities. Although there was some improvement in the apparent speed of generating displays on our remote terminal, the user interface mechanism was identical.