Effects of Sea Ice On Barrow Canyon Flow

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LONG-TERM GOAL

My long-term goal is to evaluate the effects of sea ice on the stratification and circulation in and around Barrow Canyon. In addition, I want to quantify the salt balance and salt transport in connection with surface salt injection from winter polynyas in the Chukchi Sea and Barrow Canyon region. The short-term goal is to use a stand-alone ocean model; the long term goal is to repeat the numerical experiments using a fully coupled ice-ocean model.

OBJECTIVES

Under my previous grant, I used a high resolution model of the Chukchi and Beaufort Seas to provide a better dynamical understanding of the flow in and around Barrow Canyon (*Signorini et al.*, 1997). An analysis of the along-canyon dynamic balance using simulated fields suggests that the non-linear interaction of the variable barotropic flow with the steep topography is the primary mechanism for bringing Atlantic water to shallower depths within the canyon. In my previous study I also analyzed the relative importance of the barotropic and baroclinic components on the momentum balance and stratification in Barrow Canyon. My primary objective in this new study is to evaluate the effects of air-ice-ocean interactions on the dynamics of Barrow Canyon flow. Of primary concern is the interaction of high salinity water originating from brine rejection in winter polynyas with the regional dynamics.

APPROACH

The high resolution (1-5 *km*) model consists of a three-dimensional, rigid-lid, primitive equation ocean model developed at Rutgers University (SPEM version 5.1). The geographic domain of my study is shown in Figure 1. The solid line is the grid boundary for the ocean model. The ocean model is forced by surface salt flux daily fields obtained from the algorithm described in *Cavalieri and Martin* [1994] using ECMWF meteorological data and SSM/I images. Dr. Don Cavalieri of NASA/GSFC is providing help to this project with no cost to ONR. We have identified 2 very large events in January-February, 1997. I am modeling the effects of these two events on the circulation and salt transport within the Barrow Canyon area. Figure 1 shows the surface salt flux distribution during the February 18, 1997, polynya event (in units of 10^7 *kg/d*). The crosses in Figure 1 show the locations of the SSM/I 25-*km* resolution pixels, while the solid circles are the grid points of the ECMWF model output. The model is forced on its western boundary with a coastal jet. The transport of this coastal jet off Cape Lisbourne is about 1/3 of the northward transport through Bering Strait (Dr. Tom Weingartner's personal communication). The Bering Strait transport is obtained from a linear regression between wind speed (190^o T) and northward transport in the Bering Strait (*Coachman and Aagaard*, 1988).

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WORK COMPLETED

The accomplished tasks so far are:

1. The model grid and bathymetry have been implemented and tested
2. ECMWF wind and temperature data were obtained and unpacked for use in the salt flux calculation and model forcing
3. The daily salt flux fields have been calculated and gridded onto the model domain
4. *Coachman and Aagaard* [1988] wind vs. transport regression for the Bering Strait was used to prepare a time series of transport to force the model on its western boundary
5. A test run of about 10 days was completed to evaluate the initial model response to the forcing fields

RESULTS

There are no final results yet. After the results from the initial run are analyzed, I will prepare a longer run (20-30 days) to evaluate the impact that the salt sources from the polynyas have on the stratification and circulation, and their interaction with the coastal flow.

IMPACT/APPLICATIONS

The study of the effects of dense water formation in polynyas, and its impact on the coastal dynamics, has been done in the past with the use of process-oriented numerical experiments (for example, *Chapman and Gawarkiewicz* [1995]) in a idealized bathymetry and forcing. These studies were very insightful in the understanding of the dynamics of dense water plumes and contributed significantly to our understanding of polynya effects in the coastal stratification and circulation. I want to carry this understanding a step further in terms of realistic geometry and external forcing. The model experiment will be conducted using daily surface salt flux forcing from SSM/I analyses and daily wind-driven transport to hindcast the effects of polynyas on realistic temporal and spatial scales.

TRANSITIONS

No transitions are applicable since the work is in progress.

RELATED PROJECTS

The more recent process-oriented studies of Chapman and Gawarkiewicz (WHOI), and the work of Münchow (Rutgers) in Mackenzie Canyon, are the most closely related projects. I am in periodic contact with these investigators to ensure that there is a mutual benefit in our efforts.

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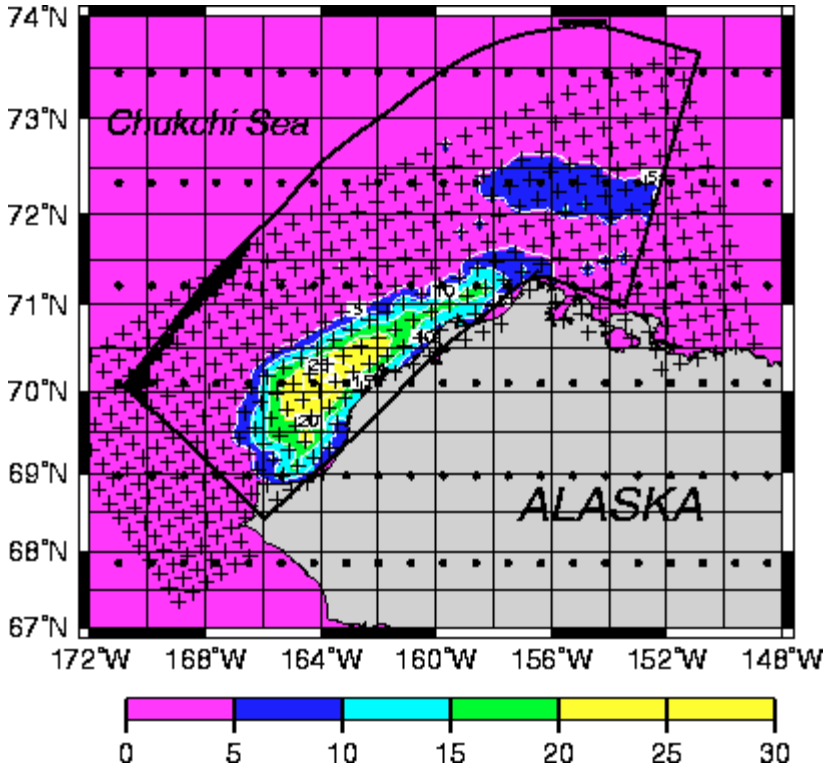

Figure 1. Map showing the geographic domain of the model. The color scale shows the polynya surface salt flux (107 kg/d), the crosses represent the center of the SSM/I pixels, the solid line shows the model's grid domain, and the solid circles show the location of the ECMWF grid points.

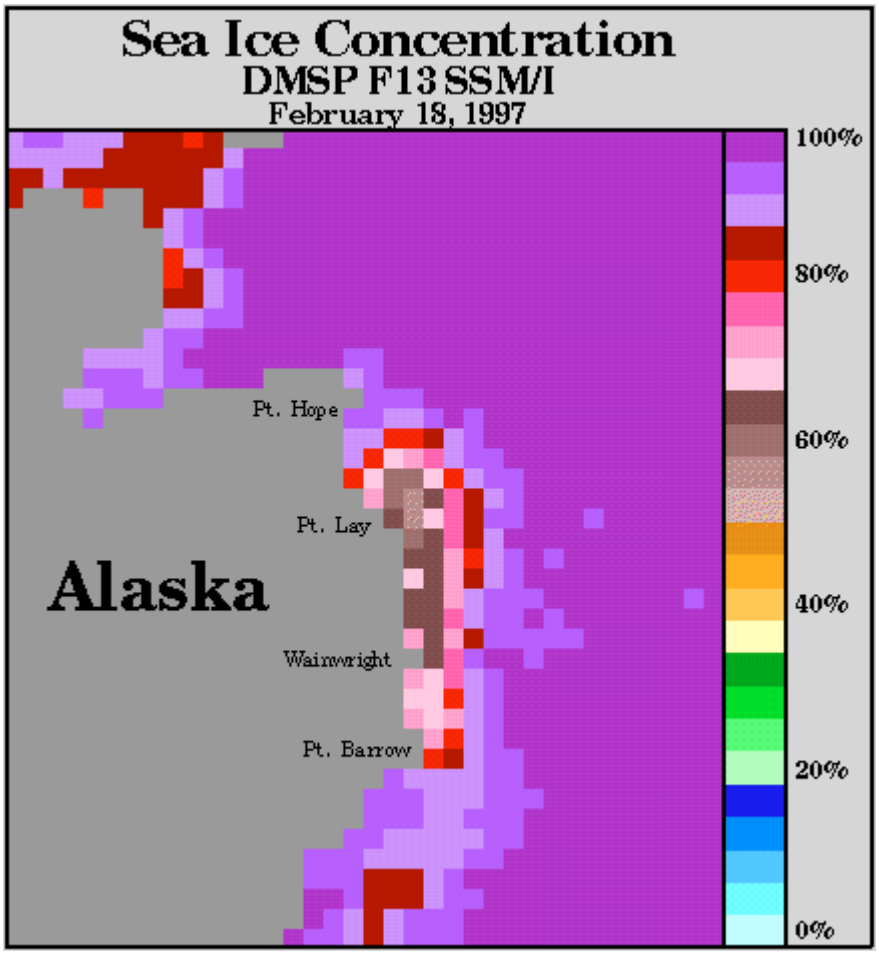

Figure 2. Sea ice concentration for February 18, 1997 from SSM/I data.