THE ENTRY OF THE BERING SEA WATER INTO THE CANADIAN BASIN GYRE

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LONG TERM GOALS

This project's primary scientific goal concerns the contribution of the Bering Sea Water to the maintenance of the Arctic Halocline in the Canadian Basin (CB). This study relates to changes/variability in the acoustic propagation characteristics and in the maintenance of the polar ice cap of the CB. Subsidiary goals concern: 1) the circulation of the Bering Sea Water (BSW) from its entry near Herald Canyon to the CB Gyre; 2) its mixing evolution en route and the its contribution to the heating and freshening of the surface waters of the CB Gyre; 3) the relative contribution of the Eurasian Shelf Waters and their extent of influence in the Canadian Basin; and 4) the pathway, transport and role of the underlying Polar Atlantic Intermediate Water (PAtIW) to the heat and salt balance of the CB Halocline layer.

OBJECTIVES

The main observational task was to locate the route of the BSW from its point of entry near Herald Canyon to its destination in the center of the CB. This involved a mapping of the BSW in the area of the Chukchi Borderland (Phase I & V) and observing its structure within the Canadian-Basin Transect (Phase II). Primary data acquisition was by means of expendable Conductivity, Temperature and Pressure (XCTD) casts, surface CTD casts, hull-mounted, online CTDs, and online water sampling. The physical parameters of interest were temperature, salinity, density and oxygen, nutrients and other chemical tracers.

This project undertook the responsibility of acquisition, pre-processing, processing, archiving and distributing the hydrographic data, except for the post-cruise processing of the XCTDs, which was done by Co-PIs from Science Applications International Corporation (SAIC).

The types of interpretive objectives expected to be addressed with the data set are: 1) the water-mass distribution of the BSW; 2) the adjusted geostrophic circulation and transports; 3) the fresh-water content; 4) the contribution of the Lower Halocline Water (LHW) to the CB Halocline; and 5) the water mass distribution of the PAtIW.

APPROACH

The above scientific objectives will be realized through the following briefly described analytical approaches.

1) The water-mass distribution of the BSW will involve characterizing the input water type, mapping the vertical and horizontal distributions of the BSW, determining its mixing history as a function of space, and estimating the transport contributions to the CB Gyre.

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2) Determining the adjusted geostrophic circulation will involve constructing the adjusted steric-height field to the deepest common point using historical density data, calculating the circulation over the Chukchi Borderland, estimating the recirculating volume of the CB Gyre, and calculating the associated water property transports;
3) Calculating and mapping the fresh-water content will involve determining the Chukchi Sea reference salinity and vertically integrating for the fresh-water content of all stations and mapping its distribution over the Chukchi Borderland and in the center CB;
4) Distinguishing the extent of the contribution of the LHW to the CB Halocline will involve using both physical and chemical parameters (with Co-PIs from Lamont-Doherty Earth Observatory, LDEO) to separate the water properties of the BSW from the LHW by comparing water-types, nutrient ratios and other information.
5) Describing the PAtIW in the Western Arctic will involve identifying and tracing its water type within the observed data set, conducting water-mass mixing ratios between it and the BSW and LHW, and estimating heat and salt requirements to sustain the CB halocline.

ACCOMPLISHMENTS

List of major activities conducted during FY97 and relation to objectives:

1. Participation in the SCICEX-96 Cruise. Mark Cook, NCSU marine technician, participated in the pre-cruise sea trials, was responsible for the physical oceanographic data acquisition, the archiving of raw-data files, the maintenance of the CTDs and general watch duties of the scientific party. He also was responsible for determining the 427 bottle salinity samples for calibration of the various conductivity sensors and for scientific analysis.
2. Processing of the Hydrographic Data. Carol Kinder, NCSU Data Technician, completed the post-cruise data reduction for the surface CTD casts and the two hull mounted SeaCat CTDs. MarySue Moustafa, SAIC, completed the processing and drop-speed adjustment for the XCTDs. The final Hydrographic Data Report accompanies this report under separate cover. Special requests from other SCICEX PIs for intermediate-processed data products were satisfied during this time.
3. Acquisition of the Historical Data File. The historical data files for determining the reference density for the Canadian Basin have been acquired.

SCIENTIFIC/TECHNICAL RESULTS

Scientific. Effort in FY97 was spent on data acquisition and processing. As of the submission of the SCICEX-96 Data Report, the calibrated files are completed and work will proceed with the scientific analyses. Preliminary analysis suggests the data set is sufficient to significantly address the interpretive analyses outlined above.

Technical. The following items relate to the hydrographic capability of the Submarine Cruises.

1. Surface casts are essential for insuring high quality hydrographic data.
2. The SeaCat CTDs mounted in the sail hull need more protection against freezing (particularly oxygen sensor) and/or should be relocated to a deeper part of the hull.
3. Pre-cruise trials should be done with in mock-up mode with the same equipment, already calibrated, as is to be used on the cruise.
4. Scientific riders should have more access to necessarily equipment mounted in restricted spaces (online acquisition system).

5. To avoid post-cruise delays in data processing and report writing, Scientific Riders should have greater access to relevant navigational and station keeping information (preferably a selective online data logger).

IMPACT FOR SCIENCE

Acoustic. The data from the SCICEX cruises will improve significantly the spatial coverage needed for acoustic propagation models and validation of acoustic monitoring programs.

Climate Change. The data and its interpretations will provide a clearer understanding of the dynamics of the Polar Ocean circulation and thereby its response to climatic changes. They also will provide the critically needed monitoring of oceanic parameters for the long-term Arctic Data Base.

TRANSITIONS

No comment yet available.

RELATED PROJECTS

This project will relates to several of the other SCICEX Projects concerned with hydrography and water-property distributions. Most particular are the projects of Dr. Ray Sambrotto LDEO and of Dr. Peter Mikhalevsky SAIC.

With Sambrotto, we expect to shed light on the formation of the Halocline Layer in the Canadian Basin, particularly to differentiate the influences of the Upper and Lower Halocline waters deriving from the Bering Sea Inflow and the Eurasian Shelf Waters, respectively. With respect to the Bering Sea Inflow, we expect to comment on the relative contributions of the Eastern Branch entering via the Barrow Canyon, and of the Western Branch entering via the Herald Canyon.

With Mikhalevsky, we expect to share some of the interpretive analysis concerning the distribution of water masses observed and concerning the sustenance of the halocline layer.

The results of this project are expected to strongly couple with the Augmentation Awards for Science and Engineering Training (ASSERT) project entitled "Upper Ocean Responses to Climatological Changes in the Canadian Basin in Conjunction with The SCICEX Program". This effort proposes to construct simple simulation models to address the question of how robust is the Canadian Basin ice cover to any climatic trends that could change the local heat and fresh water balance in the Canadian Basin.

PUBLICATIONS

Hopkins, T.S., M. Moustafa, C.A. Kinder and M. O. Cook. 1997. SCICEX-96 Hydrographic Data Report, USS POGY SSN 647 Polar Cruise, 27 August - 12 November 1996. MEAS/NCSU Data Report, dtd 31 October 1997.