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STUDY TITLE: Adaptation of an Arctic Circulation Model

REPORT TITLE: Adaptation of an Arctic Circulation Model

CONTRACT NUMBER: M10PC00116

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KEY WORDS: Arctic, Chukchi, Beaufort, ocean model, circulation, sea ice

BACKGROUND:

This study was funded by the U.S. Department of the Interior, Bureau of Ocean Energy Management (BOEM), Headquarters, Herndon, VA, under Contract No. M10PC00116, as part of the BOEM Environmental Studies Program.

OBJECTIVES:

The primary aim of the work done under this award was to use a high-resolution state-of-the-art coupled circulation-sea ice numerical ocean model to simulate several decades of the currents in the Chukchi and Beaufort seas, which can be used as inputs to oil-spill models.

DESCRIPTION:

The main research tool used for this work is a state-of-the-art coupled ocean/sea ice model based on the Regional Ocean Modeling System (ROMS). The model was setup regionally for the Arctic with enhanced resolution (5 km) in the region of interest, the Chukchi and Beaufort seas. The sea ice model was adapted to represent land-fast ice, mostly on the Chukchi coast. Extensive model skill assessment was carried out as part of the effort.

SIGNIFICANT CONCLUSIONS:

Despite known deficiencies in the surface heat flux of available atmospheric forcing fields, the model was able to reproduce many aspects of the seasonal fluctuations that exist in the observations. We note particular success in the implementation of landfast ice in the Beaufort Sea, which led directly to a close reproduction of the observed annual cycle of currents on the inner Beaufort Sea shelf. Particular strengths of the model include its ability to reproduce (to within the 95% confidence level) the observed U and V

mean velocity components at nearly all mooring sites. In addition, the model was able to reproduce approximately 50% of the monthly mean sea ice concentration anomaly. Temperature/salinity fluctuations in Barrow Canyon were signatures of up-canyon and down-canyon flows and often matched the timing and magnitude of the observed variations.

Computations of transport across selected transects (Figure 23) provide insight to the circulation pathways over the Chukchi shelf, how the Bering Strait inflow is partitioned amongst the various branches of the northward flowing Bering Sea waters, and how these may change on a seasonally varying basis. We note that some aspects of these figures suggest seasonal variations that have not been previously appreciated for the Chukchi Sea circulation. These variations are not currently verifiable by observations due to lack of data (although current meter moorings scheduled for recovery in 2013 may provide some of the answers). Examples of new insights suggested by these model integrations include 1) the direction and magnitude of the seasonally varying flow through Long Strait; 2) the magnitude of flow across Herald Shoal in winter; 3) the direction of the flow (and its possible seasonal reversal) to the north and northeast of Hanna Shoal.

STUDY RESULTS:

Model simulations using the coupled circulation-sea ice model were carried out for the twenty-year period of 1985-2005 and archived. Extensive model evaluation was carried out with an analysis of 1. Ocean currents and Ice motion Vectors, 2. Sub-tidal currents, 3. Temperature and salinity variability, 4.Density gradients and 5. Sea ice cover. The extensive model-data comparison shows significant skill in the model capability to reproduce observed circulation and sea ice patterns in the Beaufort and Chukchi Seas.

STUDY PRODUCTS:

The following were delivered as part of this project:

1. Coupled ocean-sea ice regional model for the Chukchi and Beaufort seas.
2. Model manual
3. 20-year hindcast simulation at 3-hourly intervals
4. Forcing datasets
5. Final report including extensive model skill assessment.

*P.I.'s affiliation may be different than that listed for Project Manager(s).