

Environmental Studies Program: Ongoing Studies

Study Area(s): Beaufort Sea, Chukchi Sea

Administered By: Alaska OCS Region

Title: Characterization of the Circulation on the Continental Shelf Areas of the Northeast Chukchi and Western Beaufort Seas (AK-12-03a)

BOEM Information Need(s) to be Addressed: BOEM needs information on several aspects of the temporal and spatial structure of ocean currents in the northeastern Chukchi and western Beaufort Seas. This characterization encompasses a description of the mean circulation under different wind and sea ice coverage conditions. This knowledge will be valuable for (a) improving the quality of information used in the Oil-Spill Risk Analysis conducted by BOEM, (b) inferring the transport of zooplankton, contaminants and other quantities in key areas, (c) providing insight into the flow-related feeding aggregations of bowhead whales near Barrow, (d) providing important information for the preparation of NEPA documents, (e) providing information for ocean modeling efforts (including validation and skill assessment), and (f) complementing ongoing social research on offshore subsistence hunting.

Total BOEM Cost: \$5,056,252
plus Joint Funding (~\$1,000,000)

Period of Performance: FY 2012-2018

Conducting Organization: CESU-UAF

Principal Investigator(s): Dr. Tom Weingartner

BOEM Contact: [Warren Horowitz](#)

Description:

Background: The circulation in the region of the junction between the Chukchi and Beaufort continental shelves is likely complex given the abrupt change in the orientation of the isobaths, change in shelf width, and the convergence of the mean westward wind-driven flow over the U.S. Beaufort Sea with the mean northeastward flow along the eastern flank of Barrow Canyon. The nature of this junction varies with the winds and ice environment. The regional circulation is such that contaminants introduced on either the Chukchi or Beaufort shelf will likely have a variety of fates. These include being advected from one shelf to the other, being flushed offshore into the Arctic basin, or perhaps accumulating within the vicinity of the western Beaufort Sea due to flow convergence from currents on both shelves. The conditions under which these various scenarios occur are not well known.

This proposed study is a continuation and expansion of the existing surface circulation study within the northeast Chukchi Sea. Prior to 2009, surface current observations on the Chukchi shelf were extremely limited. Through a joint Industry/BOEM supported study, the University of Alaska Fairbanks (UAF), Coastal Marine Institute began

measuring surface currents during the open water period on the Chukchi shelf beginning in September 2009 with the deployment of long range (180 km), High Frequency (HF) radar systems located at the villages of Barrow and Wainwright. In 2010, coverage was expanded to the southwest to include additional OCS lease areas. The surface current data was supplemented by water column profile data collected by Slocum Gliders. Acoustic Doppler current profilers (ADCPs) were also deployed across the Alaska Coastal Current at the head of Barrow Canyon to assess the annual flow regime, the connectivity between surface and subsurface currents during the open water season, and the changes in subsurface currents beneath the mobile pack ice and lead system during the winter months. This new study will expand our present efforts to improve understanding of the flow regime and shelf dynamics between the inner and outer Chukchi shelf, the exchange of waters between the Chukchi Sea and western Beaufort shelf through Barrow Canyon, and the upwelling of Atlantic Waters.

Objectives:

- Extend the present Chukchi Sea HF radar, mooring and glider study to include the western Beaufort shelf slope and Barrow Canyon to investigate the spatial and temporal structure of ocean currents within the western Beaufort and northeast Chukchi shelves and the exchange of waters between these areas.
- Characterize the flow regimes and surface water exchange among areas of the inner and outer Chukchi shelf and the western Beaufort shelf under varying conditions of wind forcing and sea ice coverage.
- Describe the oceanic response, at different levels in the vertical, using all available wind observations, as well as those generated by atmospheric and/or coupled models.

Methods: The above objectives will be pursued using a suite of instrumentation including: ADCPs, CTDs, Ice Profiling Sonar (IPS5), gliders, surface drifters and HF radars. Long Range HF radar systems presently deployed along the Chukchi coast at Point Lay, Wainwright and Pt. Barrow will be modified to increase the maximum observable range to approximately 250 km to capture the summer surface current flow over a larger area of the Chukchi shelf and around Hanna Shoal. A planned HF radar deployment at Cape Simpson (CIAP funds) will capture surface current flow along the western Beaufort shelf and slope and within Barrow Canyon. Gliders, surface drifters, moored ADCPs and towed CTDs will collect data on depth and time dependent current, temperature and salinity structure. Ice Profiling Sonar and moored ADCPs will be used to calculate ice drift and velocity. Sea ice extent will be obtained from satellite information, while drifting buoys will be crucial for computing flow trajectories and diffusivities. Data from the ADCPs, CTDs, glider deployments, HF radars, planned drifter measurements and available industry data will be synthesized to acquire a comprehensive characterization of the circulation in the study area. This project will coordinate and collaborate with other research projects in the area (BOEM, WHOI, AOOS/IOOS, industry, etc.) to synthesize and integrate all available data.

Current Status: Completed

Final Report Due: January 2018

Publications Completed:

- Carmack, E., P. Winsor and W. Williams. 2015. The contiguous riverine coastal domain: A unifying concept, *Prog. Oceanogr.*, 139, 13-23, doi:10.1016/j.pocean.2015.07.014.
- Danielson, S. L., T. J. Weingartner, K. S. Hedstrom, K. Aagaard, R. Woodgate, E. Curchitser, and P. J. Stabeno. 2014. Coupled wind-forced controls of the Bering-Chukchi shelf circulation and the Bering Strait throughflow: Ekman transport, continental shelf waves, and variations of the Pacific-Arctic sea surface height gradient, *Prog. Oceanogr.*, 125, 40-61, doi:10.1016/j.pocean.2014.04.006.
- Danielson, S. L., L. Eisner, C. Ladd, C. Mordy, L. Sousa, and T. Weingartner. In press. A comparison between late summer 2012 and 2013 water masses, macronutrients, and phytoplankton standing crops in the northern Bering and Chukchi Seas, *Deep Sea Research Part II: Topical Studies in Oceanography*, Available online 8 June 2016, ISSN 0967-0645, <http://dx.doi.org/10.1016/j.dsr2.2016.05.024>.
- Fang, Y-C., R.A. Potter, H. Statscewich, T.J. Weingartner, P. Winsor and B.K. Irving. 2017. Surface current patterns in the northeastern Chukchi Sea and their response to wind forcing. *Journal of Geophysical Research—Oceans*.
<http://dx.doi.org/10.1002/2017JC013121>
- Fang, Y.-C., T. J. Weingartner, R. A. Potter, P. R. Winsor, and H. Statscewich. 2015. Quality Assessment of HF Radar-Derived Surface Currents Using Optimal Interpolation, *J. Atmos. Ocean Technol.*, 32(2), 282-296, doi:10.1174/ JTECH-D-14-00109.1.
- Lu, K., T. Weingartner, S. Danielson, P. Winsor, E. Dobbins, K. Martini, and H. Statscewich. 2015. Lateral mixing across ice meltwater fronts of the Chukchi Sea shelf, *Geophys. Res. Lett.*, 42, 6754–6761, doi:10.1002/2015GL064967.
- Martini, K. I., P. J. Stabeno, C. Ladd, P. Winsor, T. J. Weingartner, C. W. Mordy, and L. B. Eisner. 2016. Dependence of subsurface chlorophyll on seasonal water masses in the Chukchi Sea. *J. Geophys. Res.*, 121, doi:10.1002/2015JC011359.
- Pickart, R. S., G.W.K. Moore, C. Mao, F. Bahr, C. Nobre, and T. J. Weingartner. 2016. Circulation of Winter Water on the Chukchi Shelf in Early Summer. *Deep-Sea Res. II.*, 130:56-75.
- Corlett, W.B., Pickart, R.S., 2017. The Chukchi Slope Current. *Progress in Oceanography*, V153., P50-65.
- Weingartner, T. J., R. A. Potter, C. A. Stoudt, E. L. Dobbins, H. Statscewich, P. R. Winsor, T. D. Mudge, and K. Borg (2017), Transport and thermohaline variability in Barrow Canyon on the Northeastern Chukchi Sea Shelf, *J. Geophys. Res. Oceans*, 122, doi:10.1002/2016JC012636.

Affiliated WWW Sites: <http://www.boem.gov/akstudies/>
<http://dm.sfos.uaf.edu/chukchi-beaufort/>
<https://marinecadastre.gov/espis/#/search/study/26869>

Revised Date: January 30, 2018