Environmental Studies Program: Studies Development Plan | FY 2024–2025

Field	Study Information
Title	Adaptation of a Cook Inlet Circulation Model and Calculations
Administered by	Alaska Regional Office
BOEM Contact(s)	Caryn Smith (caryn.smith@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2024–2026
Final Report Due	TBD
Date Revised	February 8, 2023
Problem	The Bureau of Ocean Energy Management (BOEM) uses current and sea ice data from an ice-ocean circulation model, together with wind data in its Oil-Spill-Risk Analysis (OSRA). However, existing data for Cook Inlet are only available through 2009, and the adjacent Gulf of Alaska has experienced a series of marine heatwaves in the past decade. Additional hindcasts are needed to adequately evaluate if the marine heatwaves have changed the ice and ocean circulation compared to the known historical variability.
Intervention	This study will be conducted using an existing coupled ice-ocean model. The latest information on bathymetry, river inflows, and meteorological fields will be incorporated into the model and its forcing fields.
Comparison	An updated 10–20 year hindcast simulation for the Gulf of Alaska and Cook Inlet, with accurate bathymetry and enhanced forcing fields, will elucidate changes from previous simulation.
Outcome	The output of this study will be used in the BOEM OSRA applications. The improved currents and meteorological forcing fields will enhance the accuracy of OSRA model results and help us understand the impact of spatial resolution on the performance of the OSRA model.
Context	Cook Inlet and the Gulf of Alaska.

BOEM Information Need(s): Oil-Spill Risk Analysis (OSRA) is a cornerstone foundation for evaluating potential oil spill impacts from Outer Continental Shelf oil and gas leasing in National Environmental Policy Act analyses, and oil spill response plans. The results of this study will be used by BOEM to create the OSRA estimates of oil-spill trajectories. This study will result in a time-series of simulated current and wind fields that will be compared to field projects that have been conducted in the Cook Inlet and the Gulf of Alaska; these results will be used in the OSRA calculations.

Background: Ocean currents in Cook Inlet are forced by winds and river runoff, as well as very large tidal amplitude and extreme tides. The Alaska Coastal Current that flows into Lower Cook Inlet and continues out through Shelikof Strait is an important element of the nearshore circulation of the northern Gulf of Alaska (Johnson 2021). In the Gulf of Alaska, a large area of unusually warm ocean water (marine heatwave) formed from 2014-2019 (Litzow et al. 2020). Sea ice forms in Cook Inlet, but its effect on the overall circulation pattern has not been studied in detail.

The circulation of Cook Inlet has been studied through previous model simulations, with funding by National Oceanographic and Atmospheric Administration (NOAA), BOEM, U.S. Army Corps of Engineers, and others (Danielson et al. 2016, 2020; Shi 2020; Zhang 2022). The models were subjected to a range of sensitivity calculations and skill was assessed by teams of oceanographers. The models demonstrated significant skill in simulating the ocean surface currents. Many field programs that may provide observational data for assimilation and validation have also been conducted in this area.

Objectives: The objective of this study is to adapt and maximize the utility of an existing, coupled ice-ocean circulation model in order to obtain simulations of the circulation in Cook Inlet and portions of the Gulf of Alaska for use in OSRA. Specific objectives include:

- Ensuring the simulations have significant skill in reproducing the near-surface currents, compared to drifting buoy data, fixed current meters, acoustic Doppler current profilers (ADCPs), high-frequency radar data, and other data sets.
- Providing BOEM with 10–20 years of relevant modeled fields, such as gridded wind, surface water, ice velocity, ice cover, and other modeled fields to use as input into the OSRA trajectory calculations.

Methods: This study will adapt an existing operational or community ocean model (e.g., CIOFS, ROMS, or MOM6) to produce a hindcast of the current fields in Cook Inlet, using data assimilation methods whenever practical. The model shall have sufficiently high-resolution to resolve important features of the circulation field. The selected model will be coupled with an ice model to produce appropriate ice fields. The hindcast period will be determined by data availability but shall be at least 10 years. The tidal current must be accurately reproduced. The wind forcing will be derived from the products of an atmospheric model. Skill assessment comparisons against historical field observations, i.e., current meters and drifting buoy velocities, will be performed.

Specific Research Question(s):

1. What is the significance of different model grid resolutions to the simulation of tide rips and other dynamic processes in Cook Inlet?
2. How can the subsurface information from high resolution modeling be used in BOEM's Oil Spill Risk Analysis?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Johnson MA. 2021. Subtidal surface circulation in lower Cook Inlet and Kachemak Bay, Alaska. Regional Studies in Marine Science 41: 101609. https://doi.org/10.1016/j.rsma.2021.101609

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Shi L, Lanerolle L, Chen Y, Cao D, Patchen R, Zhang A, Myers EP. 2020. NOS Cook Inlet operational forecast system: model development and hindcast skill assessment. Silver Spring, MD: USDOC, NOAA, Coast Survey Development Laboratory. NOAA Technical Report NOS CS 40. 77 p. https://repository.library.noaa.gov/view/noaa/27560/noaa_27560_DS1.pdf

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