Environmental Studies Program: Studies Development Plan | FY 2022–2023

Title	Cook Inlet Physical Oceanography: Synthesis and Modeling (AK-22-04)
Administered by	Alaska Regional Office
BOEM Contact(s)	Dr. Heather Crowley, heather.crowley@boem.gov
Procurement Type(s)	Cooperative Agreement
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2022–2025
Final Report Due	TBD
Date Revised	August 3, 2021
PICOC Summary	
Problem	Physical oceanographic information for Cook Inlet is not synthesized into a regional framework and is difficult to access. This dispersion of data, particularly for the most recent period, adds complexity for evaluating a changing baseline or for use in general circulation model (GCM) verification and validation.
Intervention	This partnership will collate physical oceanographic data since 2000 in Cook Inlet and Shelikof Strait. Synthesize it into a regional framework, identify information needs for sampling, and generate a three-dimensional oceanographic hindcast product using the NOAA Cook Inlet Operational Forecast System (CIOFS).
Comparison	This study will compare areas to determine where low resolution, little, or dated sampling exists to inform the future collection of physical oceanographic measurements. The study will also conduct detailed model hindcast-to-data and model-to-model hindcast comparisons to improve GCMs and observe trends in a changing climate.
Outcome	A comprehensive and understandable reference of Cook Inlet oceanography datasets and data visualization tools, that are readily available for environmental analyses. The study will also provide a 20-year GCM hindcast simulation for Cook Inlet.
Context	Cook Inlet Planning Area

BOEM Information Need(s): BOEM uses baseline physical oceanographic information, including their seasonal variation and how the baseline is changing, to inform National Environmental Policy Act analyses in Cook Inlet. Teasing apart impacts to the environment from multiple stressors, including a warming Gulf of Alaska, requires historical and up-to-date physical oceanographic measurements. These measurements are also necessary to verify and validate GCM output to assure quality products for use in oil spill trajectory analyses.

Background: Because Cook Inlet physical oceanographic data depict relatively short-term deployments focused on specific features of Cook Inlet's complex oceanography, there is a need to: assemble the data and make it accessible; synthesize it into a comprehensive understanding of the spatial and temporal circulation of the region; and plan for coordinated focused sampling where information needs are identified to improve GCMs (Johnson and Okkonen, 2000; Two Crow, 2006). Recently Johnson (2021) compiled surface and upper layer Lagrangian drifter data, collected mostly from spring through fall.

Accurate information on surface wind fields, ocean currents, and sea ice is important for oil spill trajectory simulations and the potential impacts on Cook Inlet physical, biological, or social resources from a large spill. It is particularly important to know locations and seasonal changes in oceanographic features that have substantial impact on oil transport. Prior GCM validation by Danielson et al. (2016) identified areas for improvement in Cook Inlet, including a bias towards summer conditions, inability to model high resolution features that are known to impact oil fate in the Inlet (e.g. convergence zones on the scale of ~100 m), and over-stratification of the water column by the model (sometimes by 10 psu). In addition, the Gulf of Alaska is warming substantially (Litzow et al. 2020) and the downstream influences on the oceanography of Cook Inlet and Shelikof Strait are not well documented.

Objectives:

- Improve access to and utility of existing oceanographic data in Cook Inlet.
- Enhance the understanding of the large-scale surface and subsurface circulation and density fields and their interannual variation with focus on these four primary areas:
    a. Fronts: Investigate the dominant physical forces governing circulation and the development of fronts in Cook Inlet and their spatial and temporal timescales.
    b. Buoyancy-forced Coastal/Estuarine Circulation: Gain better understanding of the processes which enhance or inhibit transport and their seasonality in lower Cook Inlet including snowmelt and freshwater discharge.
    c. Lateral Ocean Boundaries: Develop a better understanding of Gulf of Alaska boundary influences including the seasonality of Cook inlet outflow and the degree of infiltration and seasonality of Alaska coastal water into eastern Cook Inlet.
    d. Offshore Boundary: Investigate processes that control exchange between the Gulf of Alaska and Cook Inlet.
- Identify improved algorithms and data tools to support future development of oceanographic process models, particularly for tide rips.

Methods: This partnership will identify and gather existing, relevant, and readily available physical oceanographic datasets for the Cook Inlet and Shelikof Strait. The datasets will be organized into a common framework for review and identification of specific information needs to guide development of field plans. Researchers will develop recommendations for additional oceanographic measurements needed to provide stratification, freshwater forcing, and higher resolution surface and subsurface current data to enhance the ability to model 3-D currents. When possible, researchers will leverage existing data research efforts to opportunistically collect these data. Researchers will generate a three-dimensional oceanographic hindcast product using the NOAA Cook Inlet Operational Forecast System (CIOFS) to elucidate relevant oceanographic processes and help identify additional model improvements through model intercomparisons. Information from all project components will be synthesized to

describe and discuss the physical oceanography of Cook Inlet and Shelikof Strait within a regional framework. Data products and associated metadata will be disseminated through the AOOS web portal.

Specific Research Question(s):

1. What is the current physical oceanographic baseline in Cook Inlet and Shelikof Strait?
2. Where and what types of additional data collections and algorithms will improve GCM model output?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Danielson SL, Hedström KS, Curchitser E. 2016. Cook Inlet Circulation Model Calculations. OCS Study BOEM 2015-050. Anchorage, AK: USDOI BOEM, Alaska OCS Region. 71 pp.

Johnson MA 2021. Subtidal Surface Circulation in Lower Cook Inlet and Kachemak Bay, Alaska. Regional Studies in Marine Science: 101609. First published online 11 January 2021

Johnson MA, Okkonen SR. 2000. Proceedings Cook Inlet Oceanography Workshop. OCS Study MMS 2000-043. Fairbanks, AK: University of Alaska, Coastal Marine Institute and Oil Spill Recovery Institute. 103 pp.

Two Crow, ed. 2006. Cook Inlet Physical Oceanography Workshop Proceedings. Kenai, AK: AOOS, CIRCAC and Kachemak Bay Research Reserve. 172 pp.