

Environmental Studies Program: Studies Development Plan | FY 2026–2027

Field	Study Information
Title	Development of Open-Source Oil Spill Trajectory Model and Products for Cook Inlet (AK-26-01)
Administered by	Alaska Regional Office
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Procurement Type(s)	TBD
Conducting Organization(s)	TBD
Total BOEM Cost	TDB
Performance Period	FY 2026–2029
Final Report Due	TBD
Date Revised	April 10, 2025
Problem	The Bureau of Ocean Energy Management (BOEM) historically used Oil Spill Risk Analysis (OSRA) to estimate oil spill contact or occurrence and contact for use in National Environmental Policy Act (NEPA) analyses. New open-source oil spill trajectory models and oil spill trajectory statistics are needed for impact assessment. Additional analyses are needed to evaluate if the marine heatwaves in the Gulf of Alaska have changed the ocean circulation and resulting oil spill trajectories compared to the known historical variability.
Intervention	This study will use or adapt an existing coupled ocean model hindcast and open-source particle tracking model. The latest information on bathymetry, river inflows, and meteorological fields will be incorporated into the hindcast and trajectory model and its forcing fields.
Comparison	An updated 10–20 year hindcast and oil spill trajectory simulation for the Gulf of Alaska and Cook Inlet, with accurate bathymetry and enhanced forcing fields, will elucidate changes from previous hindcasts and oil spill trajectory simulations.
Outcome	The output of this study will be used in BOEM oil spill analysis applications. The updated currents as well as meteorological and forcing fields will enhance the accuracy of oil spill trajectory and impact analyses and help BOEM understand the impact of spatial and temporal resolution on the performance of the trajectory 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 (NEPA) analyses. Oil spill trajectory models are critical to support the NEPA processes for energy projects that could result in oil spills. This study would provide the ability to utilize an existing open-source trajectory model and long-term hindcast data set to create better quality estimates of oil-spill trajectories used for NEPA analyses to inform environmental reviews and decision-making regarding energy leasing and development.

Background: The National Oceanic and Atmospheric Administration (NOAA) recently completed a Cook Inlet operational forecast system (CIOFs) hindcast and model verification and validation (Thyng et al. 2023). NOAA determined that the freshwater forcing algorithms could be substantially improved and are currently incorporating freshwater, based on Hill et al. (2015), into the CIOFs model. Depending on timing, funding, and science needs a CIOFs hindcast with the improved freshwater forcing may or may not be readily available. Concurrently a pilot project for an open-source particle tracking model using Open Drift is ongoing in Cook Inlet (Pegau et al. 2025). NOAA's Trajectory Analysis Planner is another open-source particle tracking model (Righi et al. 2024).

Ocean currents in Cook Inlet are forced by winds and river runoff, as well as very large tidal amplitude and extreme tides (Danielson et al. 2016, 2020; Shi 2020; Zhang 2022). 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) which may have modified circulation (Rallu De Malibrán et al. 2024). Existing BOEM hindcast data for Cook Inlet and the Gulf of Alaska are only available through 2009 (Danielson et al. 2016). Updated hindcasts, such as CIOFs, could be used to evaluate if marine heatwaves in the last decade have influenced ocean circulation and resulting oil spill trajectories compared to the known historical variability.

Objectives: The objective of this study is to adapt an open-source oil spill trajectory model and use an updated CIOFs hindcast to obtain simulations and statistics of oil spill trajectories in Cook Inlet and portions of the northwestern Gulf of Alaska for use in oil spill impact assessment. Specific objectives include:

- Implement or enhance existing open-source oil spill particle tracking model for Cook Inlet and northwestern Gulf of Alaska.
- Provide statistical trajectory calculations using 10–20 years of relevant modeled fields for hypothetical oil spills originating in the Cook Inlet Planning Area.
- Develop high-performance data formats and data management capabilities that can be used to derive other products (e.g. calculate contact probabilities for specific resources).
- Evaluate CIOFs model output and resulting stochastic trajectories including changes due to marine heatwaves.

Methods: This study will adapt an existing open-source particle tracking model and hindcast output to produce a statistical oil spill trajectory analysis in Cook Inlet and the northwestern Gulf of Alaska. The oil spill trajectory hindcast period will be determined by data availability but shall be at least 10 years. Additional hindcast model verification and validation will be conducted where needed. This study will create statistical oil spill metrics and visualizations for hypothetical spills in the Cook Inlet Planning Area as well as develop data formats, data management, and documentation. The investigation will evaluate potential changes in circulation or oil spill trajectories over the most recent decade.

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. Are there any locations in Cook Inlet and the northwestern Gulf of Alaska where the model shows higher skill than others?

3. Has ocean circulation changed in Cook Inlet or the northwestern Gulf of Alaska due to recent marine heatwaves?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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