Environmental Studies Program: Ongoing Study

Field	Study Information
Title	Satellite Ocean Color Remote Sensing of Water Mass Dynamics in Cook Inlet (AK-19-02-17)
Administered by	Alaska Regional Office
BOEM Contact(s)	Caryn Smith, caryn.smith@boem.gov
Procurement Type(s)	Cooperative Agreement
Conducting Organization(s)	University of Alaska Coastal Marine Institute
Total BOEM Cost	$214,230 plus Joint Funding ($212,750)
Performance Period	FY 2022–2025
Final Report Due	September 2025
Date Revised	February 16, 2023
Problem	Characterization of the spatial and temporal water mass dynamics in Cook Inlet, Alaska and where potential oil spills could be advected is needed for ecosystem understanding and oil spill impact assessment.
Intervention	Develop a satellite ocean color-based method for mapping water mass distribution in Cook Inlet, Alaska.
Comparison	The results of this study would be compared with historical oceanographic field data and modeled circulation fields.
Outcome	Identify intra-annual (i.e., seasonal and subseasonal) and interannual (i.e., several years to decades) variations in water mass dynamics based on satellite ocean color time series, thereby improving baseline understanding and predictive capability related to Cook Inlet Outer Continental Shelf activities.
Context	Cook Inlet Planning Area

BOEM Information Need(s): Improved understanding of water mass dynamics, currents, and circulation, in Cook Inlet, Alaska is needed to inform environmental reviews and decision-making regarding energy exploration and development plans and provide context for interpretation of changing ecosystem patterns. In addition, BOEM needs updated information about water masses, currents, and circulation, to validate coupled ice-ocean circulation models used to support oil-spill risk analysis and to better understand pathways of potential oil spills.

Background: Cook Inlet is a subarctic estuary stretching from the Gulf of Alaska to Anchorage in south–central Alaska. It is a productive marine ecosystem supporting social, economic, and biological resources. Cook Inlet waters are a mixture of freshwater, from river discharge, and marine water, from Shelikof Strait and the Gulf of Alaska (Johnson 2021). Satellite remote sensing of ocean color is a cost-effective, near real-time data acquisition technique that can provide long-term time series of consistent and continuous data (McClain 2009, Hirawake et al. 2021). In particular, Moderate Resolution Imaging Spectroradiometer (MODIS) provides high spatial (~4 kilometers) and temporal (multiple passes per day over Cook Inlet) sampling, over two decades, that is unmatched by any other sensor. Machine learning

algorithms can be applied to discriminate and monitor water mass dynamics from satellite optical signatures.

Objectives: The overarching goal is to achieve a better understanding of both the spatial and temporal contexts of water mass dynamics in Cook Inlet using satellite imagery. The specific objectives focus on:

- leveraging the advanced capability of satellite ocean color data for water mass determination, using the satellite-derived optical properties of surface waters as the primary proxy for water mass classification;
- characterizing intra-annual and interannual water mass dynamics of Cook Inlet; and
- exploring whether the extent of oil spill coverage can be determined using optical characteristics and provide insight to where oil may accumulate in Cook Inlet.

Methods: Researchers will download Level 1A MODIS/Aqua ocean color images from the National Aeronautics and Space Administration Ocean Color website (https://oceandata.sci.gsfc.nasa.gov) from 2002–2022. A training dataset will be prepared following the method described by Mélin and Vantrepotte (2015). The researchers will apply techniques (Jensen 1996, Mélin and Vantrepotte 2015) to discriminate water masses in Cook Inlet based on satellite-retrieved optical signatures using the training dataset which covers a wide range of temporal and spatial variations. Several supervised machine learning algorithms (partial least squares, artificial neural network, and support vector machine) will be developed and trained to identify water masses within Cook Inlet and their performance will be assessed. The researchers will apply the machine learning algorithms to previous oil spill incidents (e.g., Deepwater Horizon, Leifer et al. 2012) to demonstrate their utility for Cook Inlet or other locations.

Specific Research Question(s):

1. How diverse and complex is the water mass distribution in Cook Inlet, given that it comprises a mixture of terrestrial sources from numerous river inputs and marine waters of the Gulf of Alaska?
2. How can satellite remote sensing enhance the monitoring of water mass dynamics of Cook Inlet by providing better coverage of the spatial and temporal dynamics?
3. Can satellite-based water mass determination provide an aerial footprint or outline of potential surface oil extent to support oil spill assessment and response?

Current Status: Ongoing, data analysis underway

Publications Completed: None

Affiliated WWW Sites:

http://www.boem.gov/akstudies/

https://www.uaf.edu/cfos/research/cmi/

References:

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