

Arctic Information Fusion Capability (AIFC)

Project Investigators:
- Dr. Kenrick Mock
- John DeLaurentis

Lead Institutions:
- University of Alaska Anchorage
- ASRC Federal Solutions

Supporting Team:
- Eric Velte
- Mark Rowan
- Rob Bochenek
- Ed Page
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- Robb Wright
- Dr. Amy Merten
- Leo Naboyshchikov
- Dr. Rebecca Koskela
- Dr. Craig Tweedie
- Todd Boone
- Dr. Ben Nguyen
- Jared Spigner

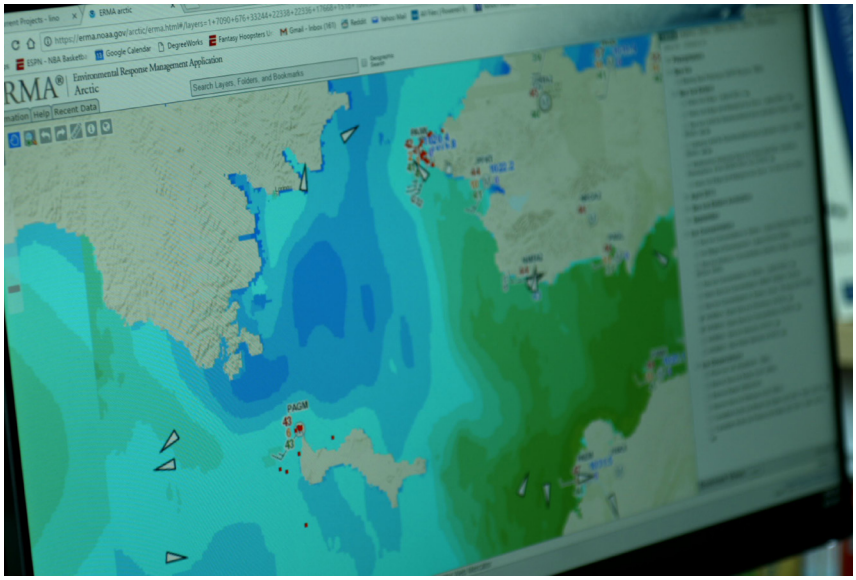
Project Period:
- July 2015 -June 2018

Project Description

The Arctic Information Fusion Capability (AIFC) project developed a 'proof-of-concept system' capable of fusing multiple data sources (outputs from environmental models, etc.) and providing visualizations to end users in the field or in a center. The resulting prototype product fused together a collection of near real-time, high resolution data sources into a cohesive domain picture. With an easy to understand interface to support operational decision makers in the maritime domain to inform operational commanders, to tactical operators, to community-based observers. AIFC featured two dimensional geographic orientation of precision mapping data, near-real-time and high resolution satellite imagery incorporated with available modeling, sensors, web based communications and appropriate social networking feeds to gain domain awareness in support of operational decision making and interface with humans and responders in the field. Further, AIFC provided elements of domain awareness from a 3 dimensional "column" view to gain insights vertically from seabed to surface and surface skyward. AIFC sought to achieve near- real-time and forecast decision support that can transition to intelligent decision support tools. AIFC near-real-time products will be delivered as rapidly as possible following capture and processing of the observation. The strategic research question addressed by AIFC is to determine if fusing multiple sensors, models, observations, and data streams can improve decision support in the maritime domain.

Relevance to USCG and Transition Status

To address the AIFC core research questions, the team implemented the plan to develop and demonstrate multiple aspects of Arctic Information Fusion for operators in the field (fusion forward) or in the command center (fusion central). This included developing an operator-determined "use case"/scenario data and geo-referenced decision visualizations and Fusion Engine prototypes. These prototypes were demonstrated to HQ USCG AIFC Project Champion, and USCG D17 subject matter experts in June 2017. ADAC received feedback from the DHS S&T OUP Biennial Letter Review that the AIFC project would be discontinued and would not receive further funding. AIFC team achieved their planned target TRL of 3 at the end of Y3, which is to have a prototype constructed and proof of concept delivered over a limited range of operating conditions. This target was met by the successful prototype demonstrations. As due diligence, the AIFC research team did an initial inquiry into U.S. Federal security standards associated with prototype systems, necessary for USCG acquisition.



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Project Investigator:
- Dr. Martin Cenek

Lead Institutions:
- University of Alaska Anchorage
- ASRC Federal Solutions

Supporting Team:
- Dr. Aaron Dotson
- Christopher Bartley
- Kevin Wainwright
- Eric Velte
- Mark Rowan

Project Period:
- January 2015 - June 2017

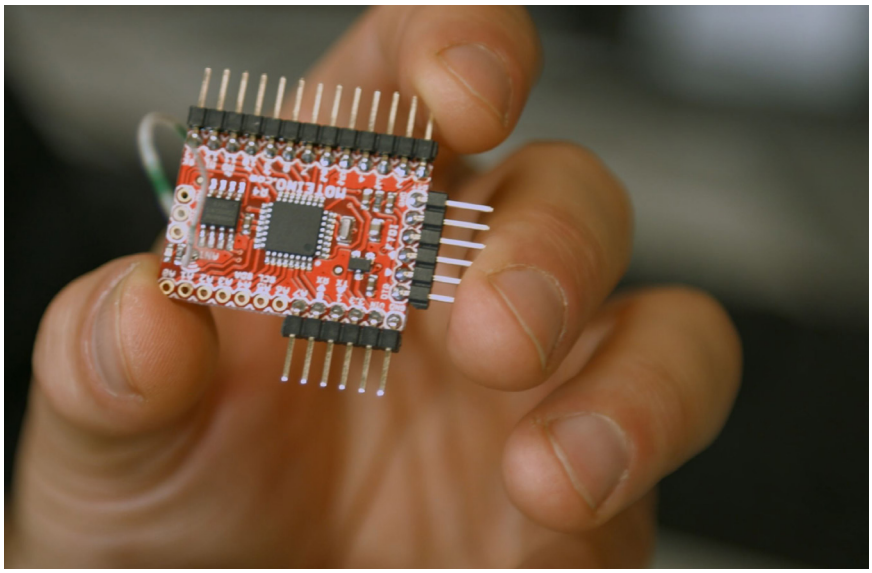
Low Cost Wireless Remote Sensors for Arctic Monitoring and Lifecycle Assessment

Project Description

The project goal was to develop low-cost wireless sensors for use in remote monitoring, asset management, surveillance, and security, particularly in Arctic and marine environments. The team categorizes a sensor's functionality into three areas: detection of an input event, computation of the detected event, and communication of the data. The team will develop an inexpensive, self-organizing network of devices that can reliably compute and communicate detected events. The team constructed a software simulator and hardware proof-of-concept consisting of a 7x7 array of nodes. The initial target application was to utilize acoustic and electromagnetic signal detectors to classify human vs. animal traffic in a remote area. A concurrent phase of the project included the evaluation of the lifecycle cost (LOC) for the deployed sensor array. The team applied the LOC framework to the monitoring of the US-Canada border for intrusions deployment scenarios. The team assessed common techniques in life cycle assessment with focus on geospatial array structure associated with terrain and climate as well as overall power requirements, proximity to urban areas and the end-of-life considerations. The primary research objective was to develop a non-aggregative sensor network architecture for robust detection of environmental or security breach events in the Arctic or subarctic regions without reliable source of communication and power infrastructure.

Relevance to USCG and Transition Status

The Project achieved TRL-3 status in ADAC Program Year 3. The sensor network project delivered proof-of-concept of novel network architecture with emergent signal-to-event spatial computation. The deliverables include several software products and a hardware integration logic. The software products include the sensor node communication and spatial computation operating code, the event and signal collecting database, test harness automation operating code, and the acoustic signature opcode. The architecture also demonstrates the use of machine learning's approach to high precision event triangulation in asynchronous, clock-less, spatially non-explicit sensor networks. The software deliverables demonstrate the architectural POC and the feasibility of the technology's integration with the downstream fusion technologies and integration into the operator's decision support tool. As a TRL 3 project there were no technology transition plans in place. While ADAC concluded research for this project at the end of Program Year 3, the Center determined the technology could find applications through the U.S. Navy ICEX to monitor ice conditions and ice breakup.





Community Based Observer Networks for Situational Awareness (CBON-SA)

Project Investigator:
- Dr. Lilian Na'ia Alessa

Lead Institution:
- University of Idaho

Project Period:
- January 2015 - June 2018

Project Description

This project established a community-based observing network and system (CBONS) to acquire fine scale, local data on a range of variables critical to USCG operations. It was developed to enhance the Coast Guard's ability to successfully respond to Arctic-related Incidents of National Significance (Arctic IoNS). Variables were associated with environmental change, subsistence activities/habitats and vessel transits. CBONS data was then used to enhance the preparedness of communities on the ground, leading to increased effectiveness of USCG in the Arctic and reduced long-term costs. The project also generated community maps consisting of areas critical to culture and subsistence, allowing the Coast Guard to operate in ways that protect livelihoods and traditional lifeways. Finally, CBONS data is potentially useful to enhance the precision of data from other Arctic Observing Networks (AON) by placing them in situational context.



Relevance to USCG and Transition Status

After three years of project investigation, the CBONS-SA network comprised four active observing communities - Gambell, Kotzebue, Unalaska, and Utqiaġvik. This included five High Fidelity Observers, supported by a research team at University of Idaho, coordinators at Aleut International Association and research partners at NOVA-DINE and Kestrel Corporations. These communities applied standardized protocols for trained observers and demonstrated near real-time transmission of observations. CBONS research concluded that community based HFOs equipped with an effective communications device capable to relay timely observations from austere and remote locations in the Aleutians, Bering, Chukchi and Beaufort regions. Observers were capable of providing data relevant to USCG Arctic operators. However, input from USCG operational community concluded that the providing stipends to community based HFOs could potentially create a programmatic burden in excess of available funding. The project consulted with the State of Alaska to determine if a future Alaska Scouts Program could serve as a potentially feasible/suitable transition destination. The outcome of these discussions was that such a program clearly not feasible in the near term due to insufficient funding for the ASP initiative This project achieved TRL-7 Status in ADAC's third program year and was closed in Program Year 4. The results from project research were communicated to the scientific and USCG community through peer-reviewed manuscripts: DOI:10.1007/s10113-017-1220-7 and Workshop Report.





Identifying, Tracking and Communicated Sea-Ice Hazards in an Integrated Framework

Project Investigator:
- Dr. Andrew Mahoney

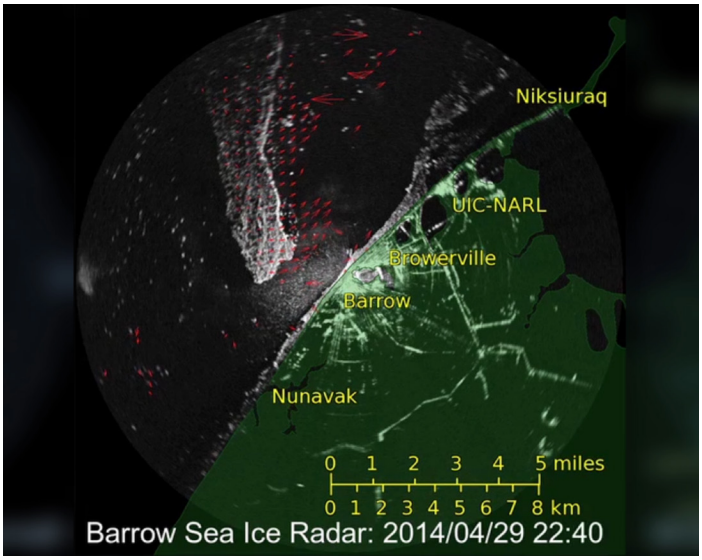
Lead Institution:
- University of Alaska Fairbanks

Supporting Team:
- Dr. Hajo Eicken
- Josh Jones

Project Period:
- January 2015 - June 2017

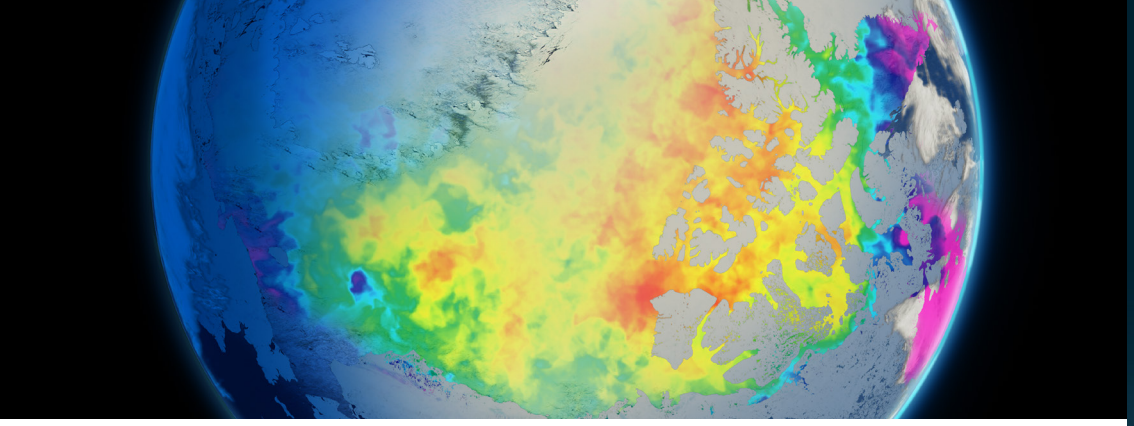
Project Description

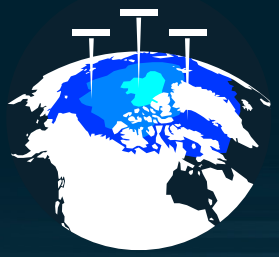
Increasing shipping and offshore activity together with emerging climate change-related threats to coastal and marine infrastructure related to traffic have greatly increased threats to environmental security in the maritime Arctic. In order to minimize and manage risks, hazards need identification and tracking. The overarching purpose of this project was to develop new science and technology to identify, track, and distribute sea ice-related hazards efficiently to emergency responders and planners. The project methodology focused on three activities: Ice hazard tracking with marine radar, detection of small-scale movement of landfast ice, and synthesizing and communicating sea ice and other Arctic MDA hazards information. This project focused on detecting sea ice hazards associated with entrapment of vessels, structural damage to vessels, and infrastructure and risks to personnel and assets due to detachment of landfast ice. During an Arctic emergency response, assets need safe and effective deployment in regions that are often remote and challenging. Involvement of local first responders will be a critical part of any Arctic response. Therefore, responders need a framework at the local scale to enhance and inform Arctic MDA and emergency response by identifying, tracking and communicating key environmental hazards in ice-covered extreme maritime environment. Predicting the real-time ice velocity from Utqiaġvik (formally Barrow), Alaska will improve capabilities for ice hazard monitoring. As the northernmost point in the North American mainland, Point Barrow is often the last location along the Alaska coastline to open up to navigation and therefore represents a potential chokepoint for maritime operations in the U.S. Arctic. Making real-time data available to analysts will improve the ability of decision makers to assess hazards posed by sea ice in this location. Additionally, the project team demonstrated that the technology developed to track ice motion is transferable to ship-based platforms, where it is potentially useful to provide tactical information about ice conditions to crew.



Relevance to USCG and Transition Status

The project achieved TRL: 6 status in ADAC Program Year 5. The research team demonstrated that the ice tracking technique developed for a coastal marine radar system is useful for a variety of different radar modalities including atmospheric weather radar, ship-based marine radar and satellite-based synthetic aperture radar. Two peer-reviewed articles were published to describe project results (DOI:10.1109/TGRS.2012.2217972 and doi:10.3189/2015AoG69A565). For radar ice-tracking technology, the team transitioned long term archiving and processing of current and any future data streams from University of Alaska Fairbanks to ADAC industry partner, Axiom Data Sciences. Intellectual property remains held at the University of Alaska.





Project Investigator:
- Dr. Jinlun Zhang

Lead Institution:
- University of Washington

Supporting Team:
- Rob Bochenek

Project Period:
- January 2015 - June 2022

High-resolution Ice-Ocean Modeling and Assimilation System (HIOMAS)

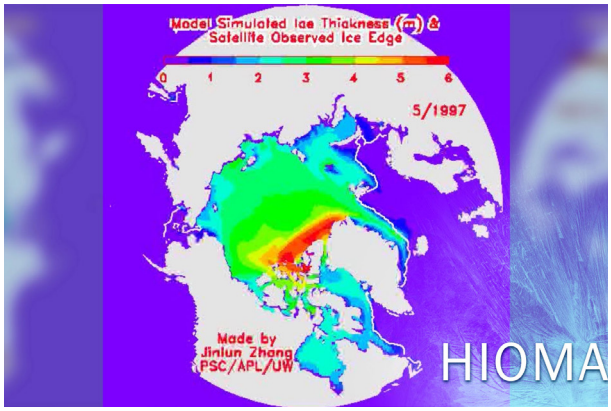
Project Description

This ADAC project completed an accurate High-resolution Ice-Ocean Modeling and Assimilation System (HIOMAS) to simulate and predict sea ice and currents in the Arctic Ocean. The system is used for near real-time hindcasting and daily to seasonal forecasting of the Arctic Ocean currents, sea ice, and other environmental changes calibrated and validated using a range of available sea ice and ocean observations. The research addressed several concerns including the prediction of spatial distribution of ice motion and thickness, the fraction of thick-ridged or multiyear ice, and the retreat and advance of ice edges. Prediction data is useful to improve Coast Guard safety and consistency when conducting any operation in the Arctic domain and is capable of supporting other stakeholders with decision-making in planning and management of economic activities. In addition, the data is useful for other modeling efforts, such as oil spill and wave modeling. An inherent strength of HIOMAS is the ability to generate high precision models of sea ice thickness, the movement of ice, and ocean currents across the Arctic Ocean.

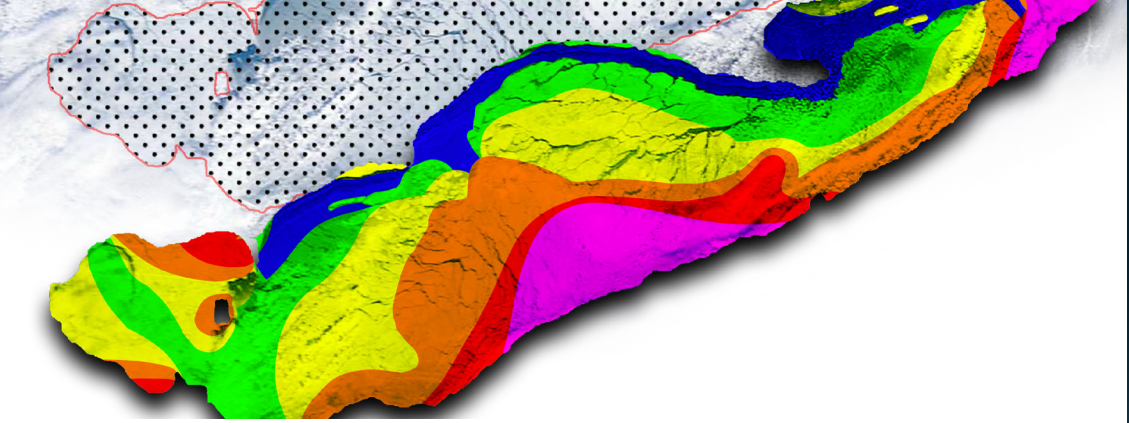


Relevance to USCG and Transition Status

This ADAC project developed a robust numerical tool useful to conduct high-resolution hindcast and forecast of Arctic sea ice and ocean currents. Research provided accurate, high-resolution hindcast and forecast data to help enhance USCG's ability to conduct search and rescue missions more safely and reliably. This is done by modeling and publishing HIOMAS on a customer driven schedule at 2 KM resolution pan-Arctic and 1 KM resolution for the U.S. Arctic Extended Economic Zone (EEZ) in the Chukchi and Beaufort Seas. In ADAC Program Year 5, HIOMAS achieved a Technology Readiness Level of 8. HIOMAS models in 6, 4, 2 KM resolution via hindcast and forecast of sea ice thickness, concentration, and velocity; a fraction of thick ridged or multi-year ice; ice edge locations; snow depth; and ocean velocity for pan-Arctic display. The 2 KM resolution HIOMAS was fully transitioned to Alaska Ocean Observing System (AOOS) and Axiom Data Sciences (Rob Bochenek) for bi-weekly hindcast and forecast model execution. A manuscript was submitted to the Journal of Geophysical Research and published 11 December 2020 (DOI/10.1029/2020JC016686).



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Project Investigators:
- Dr. Jifeng Peng
- Dr. Andrew Mahoney

Lead Institutions:
- University of Alaska Anchorage
- University of Alaska Fairbanks

Supporting Team:
- Dr. Shawn Butler
- Kelsey Frazier

Project Period:
- July 2016 - June 2020

Ice Condition Index (ICECON) for the Great Lakes

Project Description

In collaboration with USCG and others, the project team developed an ice condition index (ICECON) for the Canada-U.S. Great Lakes. ICECON is a USCG decision support tool combining vessel class with nowcast and forecast lake ice conditions. ICECON is able to forecast up to 120 hours and make use of the circulation and ice models developed by NOAA's Great Lakes Environmental Research Laboratory (GLERL). Researchers accounted for icebreaker activity and its impact on ICECON. In parallel with the development of ICECON, ADAC also identified a vessel classification system with correlations between key ship characteristics and ICECON. The ICECON system helps the USCG provide guidance and appropriate decision support to Great Lakes marine vessels (for a given class) planning a given transit

Relevance to USCG and Transition Status

This project was achieved TRL 8 and a final operationally relevant tool for U.S. National Ice Center was transitioned in ADAC's sixth program year. The Great Lakes ICECON now continuously generates automated plots which are distributed seasonally to USNIC and USCG customers via email distribution. A collection of charts generated by ICECON are now hosted on the ADAC website via a Tool Portal. Great Lakes ICECON served as the basis for the ADAC's subsequent investigation Arctic Ice Conditions Index or "ARCTICE," which produces an Arctic ice conditions index for the Bering, Chukchi, and Beaufort Seas. As ARCTICE is a continuation of Great Lakes ICECON project, simply focusing the research team on a different geographic region, the ARCTICE project team has continued implementing refinements of the Great Lakes product as requested by the Great Lakes ICECON, Project Champion and USCG-led Council of Experts.





Development of Propeller Driven Long Range Autonomous Underwater Vehicle (LRAUV)

Project Investigators:
- Amy Kukulya
- Brett Hobson
- Dr. Jim Bellingham (Former PI)

Lead Institutions:
- Woods Hole Oceanographic Institution
- Monterey Bay Aquarium Research Institution

Supporting Team:
- Brian Kieft
- Ben Raanan
- Daniel Gomez-Ibanez
- Noa Yoder
- Amanda Besaw
- Ryan Govostes
- Steven Seeberger

Project Period:
- January 2015 - June 2022

Project Description

The Propeller Driven LRAUV System is a proven helicopter-portable platform, with corresponding communications buoys which functions as a multi-mission capable system in Open Ocean or under-ice. Through designing, fabricating and testing two platforms, two sets of sensing capabilities and three communication and navigation buoys, the LRAUV project team is providing a suitable deployment package to support USCG-led Arctic oil spill response and associated incidents of national significance (IONS). In sum, the ADAC LRAUV project, led by WHOI and MBARI, creates a rapid response solution to incidents occurring in the maritime environment, and increases situational awareness by characterizing the undersea and under-ice conditions of ocean surroundings, autonomously, and capable at great distances from first responders in an Arctic maritime crisis.

Relevance to USCG and Transition Status

The goal of this project is to create an operational system that the USCG can use for characterizing spills in ice-covered ocean environments. Accordingly, while ADAC, MBARI and WHOI are designing, fabricating, testing and documenting the LRAUV System, consisting of two platforms, three Arctic communications buoys, associated sensors, firmware and software. Outcomes of effort will provide a commercially available off-the-shelf sensor package that is AUV ready, and turnkey for Arctic seafloor and capable of characterizing oil under ice. This turnkey system will be designed for ease of integration onto the LRAUV vehicle. According to the DHS S&T Terms and Conditions, DHS and USCG may leverage this IP royalty free to acquire and construct additional LRAUVs to USCG and other DHS maritime mission needs in coordination with WHOI and MBARI's IP and licensing agreements.

The LRAUV will serve as a portable, versatile, multi-mission AUV capable of performing a variety of tasks to meet the mission needs of the USCG in the Arctic. The LRAUV is proven to be helicopter transportable and is light enough to be carried by 2-3 personnel over short distances. The LRAUV is suitable for small boat or shore-launch (whether on land or on ice pack) and recovery. LRAUV can operate in shallow (2 meters) to continental shelf range depths (300 Meters). While existing ocean gliders (propeller-less) have a sufficient operational range to achieve the desired range goals needed by USCG, they do not have the payload capacity or power to carry the chemical and biological and mapping sensors that are required and cannot operate at higher speeds without redesign. In contrast, existing propeller-driven AUVs consume more power, resulting in a shorter endurance. In contrast to existing AUVs, LRAUV is uniquely capable in its combination of payload capacity, range, and endurance for remote under-ice oil detection. Following the completion of LRAUV's testing plan, and completion of data relay devices, the overall system will be TRL 7 and ready for production in the open ocean. Further testing and validating of the LRAUV system by the research team is recommended prior to commercial use in under-ice or high latitude locations.





Arctic Oil Spill Modeling

Project Investigators:
- Dr. Scott Socolofsky
- Dr. Jifeng Peng

Supporting Team:
- Dana Brunswick
- Inok Jun

Lead Institution:
- Texas A&M University (TAMU)
- University of Alaska Anchorage

Project Period:
- January 2015 - December 2019

Project Description

In support of the USCG marine oil spill response mission the research team developed an analytical model to estimate the spread of oil released in an ocean environment under ice due to a well blowout, ruptured pipeline, or ship grounding. The overall research goal of the project was to develop a tool to forecast the spread of oil in an Arctic marine environment in the immediate aftermath of an oil spill event (i.e., within 24 or 48 hours of the spill). The approach for under ice oil release from an offshore well blowout or pipeline rupture involved coupling output from the ocean oil plume model developed by TAMU with the UAA derived analytical density current models to forecast oil spreading. These tools have in turn been included in the NOAA's oil spill forecasting model, the General NOAA Operational Modeling Environment (GNOME). For oil released near the ocean surface, the project team adopted approaches derived from the research literature compatible with NOAA's GNOME model, and worked to have these algorithms included in GNOME. Modeling accounts for the character of the oil spill (e.g., well blowout or pipe rupture), the release rate or amount, the environmental conditions (ice concentration, water depth, water velocity (drift), and salinity). Research prioritized near-surface releases of oil (e.g., vessel source) as there is a greater risk of oil spills from a vessel source.

Relevance to USCG and Transition Status

This project has achieved a TRL of 7 in ADAC Program Year 5. All model algorithms developed through AOSM to the GNOME model, maintained by NOAA, were transitioned and validated for NOAA operational use. Ice simulation data in HIOMAS were made available to GNOME through GNOME Online Oceanographic Data Server (GOODS) when Axiom Data Science completed a translation script. AOSM team conducted orientation on model operations associated with PyGNOME and NOAA ORR. In order to make the AOSC algorithms more broadly available to all GNOME stakeholders, the Web front-end to GNOME was modified to include access to the oil-in-ice algorithms. This was completed via a no-cost extension in late 2019. Research outcomes were disseminated via a peer-reviewed article submitted to Marine Pollution Bulletin (DOI: 10.1016/j.marpolbul.2018.10.047).





Developing Sea-Ice and Weather Forecasting Tools to Improve Situational Awareness and Crisis Response in the Arctic

Project Investigator:
- Dr. Nathan Kettle

Lead Institution:
- University of Alaska Fairbanks

Project Period:
- July 2017 - June 2019

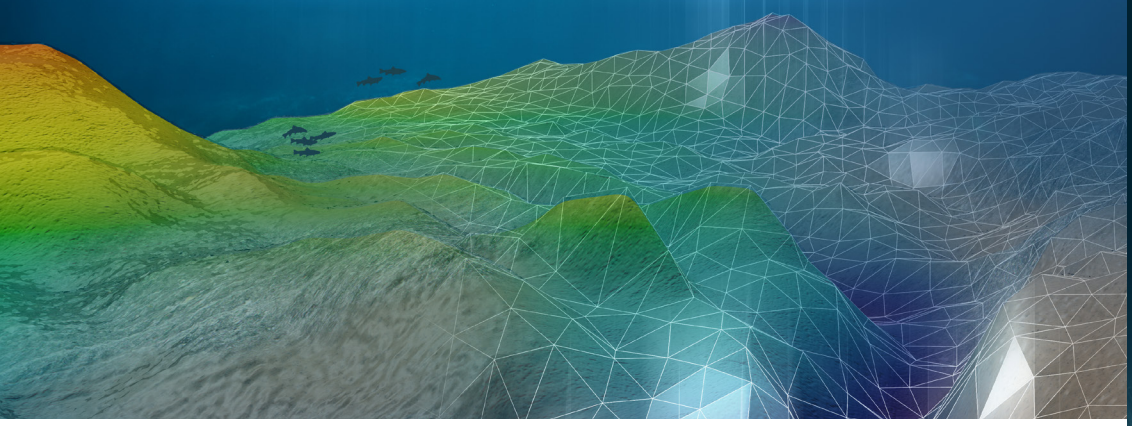
Project Description

Improving situational awareness and crisis response are key priorities in reducing potential risks and vulnerabilities associated with sea ice and environmental-related hazards in the Arctic. To address this need, the research team on this project developed a prototype decision support tool, grounded in stakeholder interactions, to support weather and sea ice-sensitive decision-making related to marine environmental hazards in the Arctic. The project was focused on the waters surrounding Utqiagvik, Alaska. First objective of this project was to assess the decision contexts for marine operators in the Arctic, including weather and sea ice-sensitive decisions, use of weather/climate information, factors influencing information use, thresholds, and uncertainties. The second objective was to assess the usability of weather and sea ice forecasting tools to predict and respond to environmental hazards threatening vessels and marine activities via the development of a prototype forecasting module. The third and final objective was to identify lessons learned and best practices for supporting knowledge co-production of decision support tools in the Arctic. The project involved three phases: preliminary tool development; stakeholder feedback and tool optimization; and outreach, dissemination, and evaluation.



Relevance to USCG and Transition Status

This project was a two-year research endeavor which achieved a TRL 4 in ADAC Program Year 5. Destination of applications of the research was principally focused on the National Weather Service Alaska Sea Ice Program. The project resulted in the integration of information tools and products directly into the operations of the NWS ASIP information and advisory dissemination process and Arctic ERMA's response management portal and advisory framework. The Project team developed sea ice tools for three types of sea ice hazards: convergence, break-out, and high speed and provided enhanced usability of weather and sea ice forecasting tools to predict and respond to environmental hazards. Additionally the project team identified both challenges within local monitoring systems and best practices to support co-production of decision support tools in order to address identified challenges. Overall outcomes of the project include the following: (1) improved understanding of decision contexts for marine operators in the Arctic, (2) enhanced usability of weather and sea ice forecasting tools to predict and respond to environmental hazards, threatening vessels, and marine activities, and (3) identified best practices for supporting knowledge co-production of decision support tools in the Arctic. Research results and project outcomes were communicated to stakeholders through project-specific presentations and a peer-reviewed manuscript submitted to Polar Geography (DOI: 10.1080/1088937X.2019.1707318).





Project Investigator:
- Dr. Carol D. Janzen

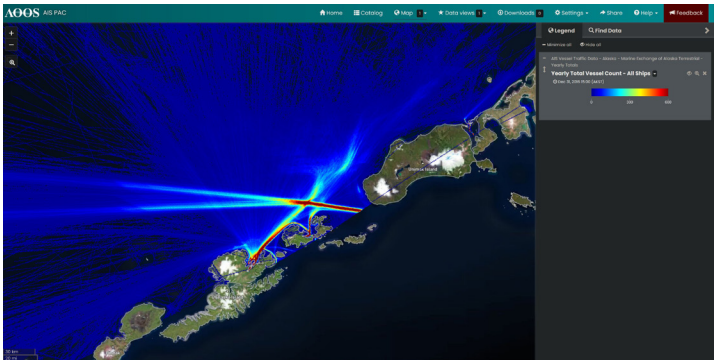
Lead Institution:
- Alaska Ocean Observing System

Project Period:
- July 2017 - June 2019

Using Vessel Tracking Data to Prioritize Bathymetric Surveying in a Rapidly Changing Arctic (AIS-PAC)

Project Description

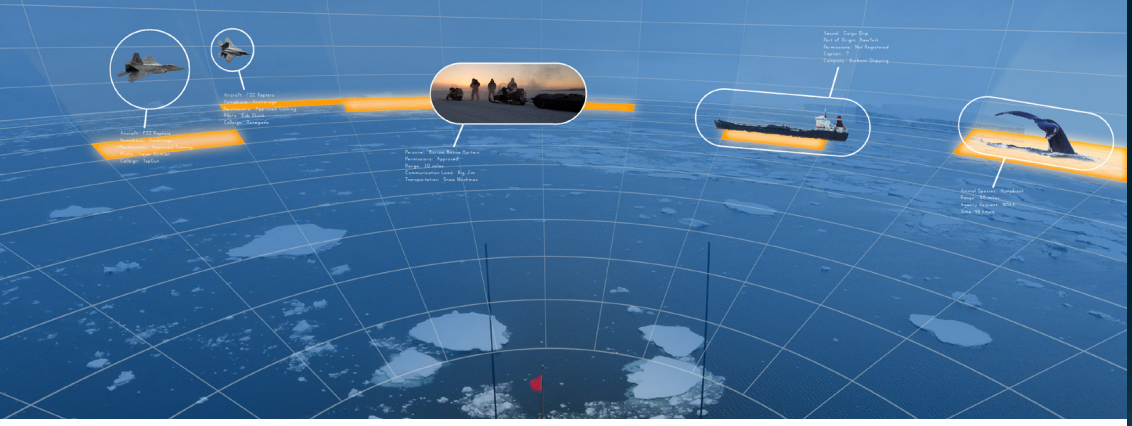
This research project supplied critical data related to vessel tracking and bathymetric information. The project team created products to improve maritime domain awareness and support decision-making concerning vessel traffic and vessel safety in a rapidly changing Arctic environment. The capability to reduce execution time required for handling and analyzing exceptionally large collections of Automated Information System (AIS) vessel tracking data was developed, which enabled the investigating team to develop AIS-derived data products that identify marine vessel risk areas, such as those with outdated bathymetry or insufficient coastal detail for safe passage of vessel traffic. Using and optimizing a high-capacity, parallel compute workflow resolved data volume processing challenges and the streamlined workflow delivered valuable summaries of vessel density patterns across multiple vessel types, environments, and locations.



Relevance to USCG and Transition Status

In Program Year 5, this project achieved a TRL of 7/8. The project team completed and publicly launched an Alaska Oceanic Observation System (AOOS)-hosted AIS PAC Project webpage and data portal. Research results were disseminated through a peer-reviewed article submitted to Frontiers in Marine Science (doi.org/10.3389/fmars.2019.00537)

Other deliverables included the development of a capability to reduce execution time for handling and analyzing exceptionally large collections of AIS data - a large data analytics effort, which benefits future regional AIS data projects. This project produced vessel density grids of 5-years of documented U.S. Arctic traffic activity across several types of vessels and metrics. This information was and will continue to be used by NOAA to prioritize the allocation of limited surveying capabilities to improve navigational charting in the U.S. Arctic. Highest priority for surveying and charting will likely be for the routes historically sailed by deeper draft vessels that present the greatest consequences if they ground in Arctic waters. These vessels are large passenger vessels and tankers. NOAA conducts the soundings of these waters as per current day standards, after which the USCG, who is responsible for issuing Marine Safety Information Bulletins will recommend vessels transit advice in these surveyed waters. This was done by the USCG for the Bering Strait region after NOAA surveyed a portion of these waters where AIS data indicated a majority of vessels were transiting and later went to IMO to establish Routing Measures in the region. The AIS PAC project investigators role was to provide a 5-year record of AIS data formatted as heat maps for model input to help NOAA prioritize where to conduct modern bathymetric surveys in the U.S. Arctic. AIS datasets were instrumental in the current PARS for the Bering Strait and will be equally important in the Arctic PARS. USCG's routing measures principally focus on areas where there is high confidence that the soundings of the waters reflect the adequate depth of water, as well as accommodate traditional vessel routes when the traditional routes are verified to be in well-charted waters and do not present environmental threats.





Project Investigator:
- Dr. Shawn Butler
- Dr. Marcus Boyd (former PI)

Lead Institution:
- University of Alaska Anchorage
- University of Maryland (former lead)

Supporting Team:
- Rob Bochenek
- Buddy Custard
- Aaron Poe
- Ed Page

Project Period:
- June 2017 - July 2022

Arctic Vessel Monitoring Geofencing/Alert Awareness

Project Description

This project seeks to extend the Arctic Vessel Monitoring Geofencing/Alert Awareness project, initially funded in ADAC Program Year 5, by providing enhanced command and control features that improve on the original goals of monitoring and alert awareness developed for the unclassified Marine Exchange PACTRACS system. The project will result in a geofence prototype that can be integrated into the current CG One View version/edition, which will allow users the ability to create, display, share, and manage static and dynamic geofences. In addition, planners and operators will receive alerts via the CG One View display. Operators will have the ability to define and display geofences and receive notifications via the CG One View console, either visually or textually. Geofences, in conjunction with Automatic Identification Systems (AIS) which report a vessel's speed and position, will allow USCG Watchstanders to establish sensitive areas for vessel monitoring, providing constant feedback of vessel activity in these areas.

Relevance to USCG and Transition Status

As USCG's determined common operating picture, CG OneView 3.0, displays both terrestrial and satellite AIS data, there is a need for a geofencing/alert awareness application that supports Coast Guard planning and command and control decision making tasks within the CG OneView platform. Geofences could be used in a variety of USCG applications and operations including law enforcement, environmental monitoring, and maritime traffic control. Ultimately Geofences could serve as a flexible and valuable tool to enhance USCG situational awareness in the maritime environment. This tool could be highly valuable with vessel tracking in all regions of USCG operations, especially in remote regions with limited communications or domain awareness capabilities like the Arctic.

ADAC Program Year 8 will result in a geofence prototype that includes USCG Anchorage Sector's specific geofence operation center's requirements and a fully developed CG One View integration process. The final deliverable will be able to integrate into the current CG One View version/edition, which will allow users the ability to create, display, share, and manage static and dynamic geofences. In addition, planners and operators will receive alerts via the CG One View display. Operators will have the ability to define and display geofences and receive notifications via the CG One View console, either visually or textually. As the Arctic Vessel Monitoring Geofencing/Alert Awareness application will be a third-party application developed and integrated with CG OneView, project investigators and project partners are documenting the integration process, providing a roadmap for future third-party application development.





Real-Time Storm Surge and Coastal Flood Forecasting for Western Alaska

Project Investigator:
- Dr. Thomas Ravens

Lead Institution:
- University of Alaska Anchorage

Supporting Team:
- Dr. Jifeng Peng
- Dr. Craig Tweedie
- Jon Allen
- Seth Campbell

Project Period:
- January 2015 - June 2017

Project Description

From 2010-2014, the University of Alaska Anchorage (UAA) developed a high resolution storm surge model for the Yukon-Kuskoswim Delta area to provide high-resolution forecasts of storm surge and coastal flooding for vulnerable coastal communities in Western Alaska. In addition to flooding, the model also predicts thirty-one associated ecological impacts, assuming different sea level rise scenarios. The storm surge modeling was conducted with Delft3D software. In ADAC's first program year, the project team worked in collaboration with NOAA's National Weather Service (NWS) to develop a high resolution storm surge forecasting model for a portion of the Yukon Kuskokwim Delta. The objective of this project in Program Year 2 was to develop a similar model for the Norton Sound area.

Relevance to USCG and Transition Status

In Program Year 2, the ADAC project team developed high resolution, nearshore forecasts of storm surge, coastal flooding, and wave conditions at two sites on the West Coast of Alaska: the Yukon Kuskokwim river delta and Norton Sound. The Delft3D and SWAN models were used for the storm surge and wave modeling, respectively. The ocean boundary of the SWAN wave model came from nowcasts and forecasts from NOAA's Wavewatch III wave model. The project team conducted a comparison of measured and calculated water levels in an assessment of the model performance Following the Biennial Review, DHS S&T OUP Program Manager notified ADAC that the project would be discontinued at the end of Program year 3. UAA College of Engineering continued to advance model refinement of ADAC sponsored research for the Norton Sound and Yukon-Kuskokwim River Delta. Project transitioned to an Alaska Coastal Forecasting research project funded by the Alaska District of the U.S. Army Corps of Engineers.





Monitoring Intentional and Unintentional Catastrophic Events:

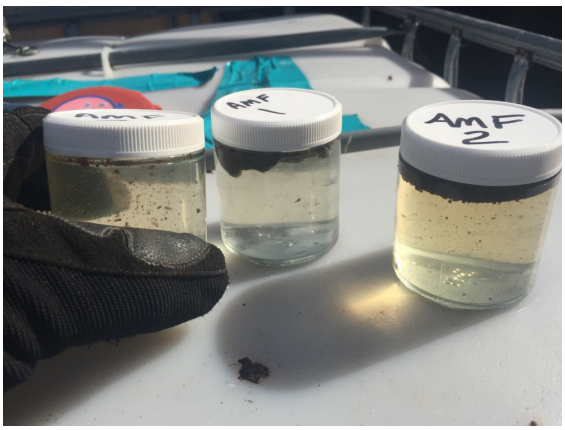
Detecting Sea Ice and Oil Spills through Measurement of the H2O and C Isotope Geochemistry in Wind

Project Investigator:
- Dr. Jeff Welker

Lead Institution:
- University of Alaska Anchorage

Supporting Team:
- Dr. Eric Klein
- John Ferguson

Project Period:
- January 2015 - June 2016



Project Description

Winds of the maritime environment have been continuously monitored as a means of detecting sea ice conditions; vessel emissions and oil spills against a natural background of marine boundary-layer atmospheric chemistry. This research project was accomplished by measuring water vapor isotopic attributes each second (averaging over 5 min) while transiting from the Gulf of Alaska to the Beaufort Sea on the USCG Healy as well as placed-based station measurements at the Port of Anchorage. The primary aim was to provide ship or vessel captains real-time data of sea ice conditions (open water, light sea ice, heavy sea ice and total sea ice coverage) that will be displayed at the helm of vessels that are fitted with the detection systems as well as making sea ice conditions estimates available from shore/platform-based systems via a link at the ADAC web site. Simultaneously, the project attempted to detect unusual petroleum events in the marine environment, developing a visualization model that will display petroleum (carbon) in the environment across a range of categories. The final facet of the project proposed testing a ship-based in situ seawater isotope device as a tool to map the spatial patterns of the marine food web as a commercial fish security technique and ocean current awareness.



Relevance to USCG and Transition Status

The project achieved baseline TRL–7/8 for sea ice detection system, TRL-5/6 for oil/emission detection and TRL- 5/6 for the new seawater food web isotope system in ADAC's Second Program Year. Project team demonstrated success of the fundamental research theories but plans for equipment purchases to conduct real-time monitoring on Bering Sea coast and Cook Inlet through research stations were not supported due to insufficient interest by HQ USCG on application of project protocols. Fundamental research results were disseminated through peer-review articles (doi.org/10.1038/srep10295 and doi.org/10.1002/2016GL071748).

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SmartCam (Computational Photometer)

Project Investigator:
- Dr. Samuel Siewert

Supporting Team:
- Embedded Systems Engineering Program
- ERAU Aviation Science Weather RADAR Station

Lead Institution:
- Embry–Riddle Aeronautical University (ERAU)

Project Period:
- January 2015 - June 2017

Project Description

The goal of the SmartCam project was the construction of a power efficient (less than 10 Watt peak) three channel (visible + long wave infrared) camera system. The SmartCam integrated all off-the-shelf optics, computing and detectors, so it is defined by software and the system design. Unlike traditional cameras that either stream live video for remote analysis or simply store data for post analysis, the SmartCam system can perform image processing on the camera itself in real time to save the most salient images, pre-processed for efficient opportunistic download or uplink to the "cloud." The processing can provide passive 3D mapping, fusion of thermal images with visible light and provide low-light and night vision. The software-defined multi-spectral imaging is hypothesized to enable collection of salient security and safety images with greater efficiency and will be compared directly to continuous image archives also taken by SmartCam (continuous 1-to-30 Hz). Overall, key performance metrics for the SmartCam were total power used (total energy consumed in Watt/hours) as well as the number of false and correct positive and negative images collected.

Relevance to USCG and Transition Status

The project team completed an "off-the-shelf" SmartCam reference that could be replicated at the same cost by any partner in the program using developed documentation, reference software, and tests. A baseline power analysis was completed in various operational conditions including continuous monitoring, uplink, sleep states, and stand-by. Project team additionally validated power-aware implementations of object recognition algorithms to validate the Smart-Cam object recognition performance in terms of true and false positive rates. The project was descoped and eventually cancelled due to insufficient funding. SmartCam research continued as part of Embry Riddle Aeronautical University "DroneNet" investigations.

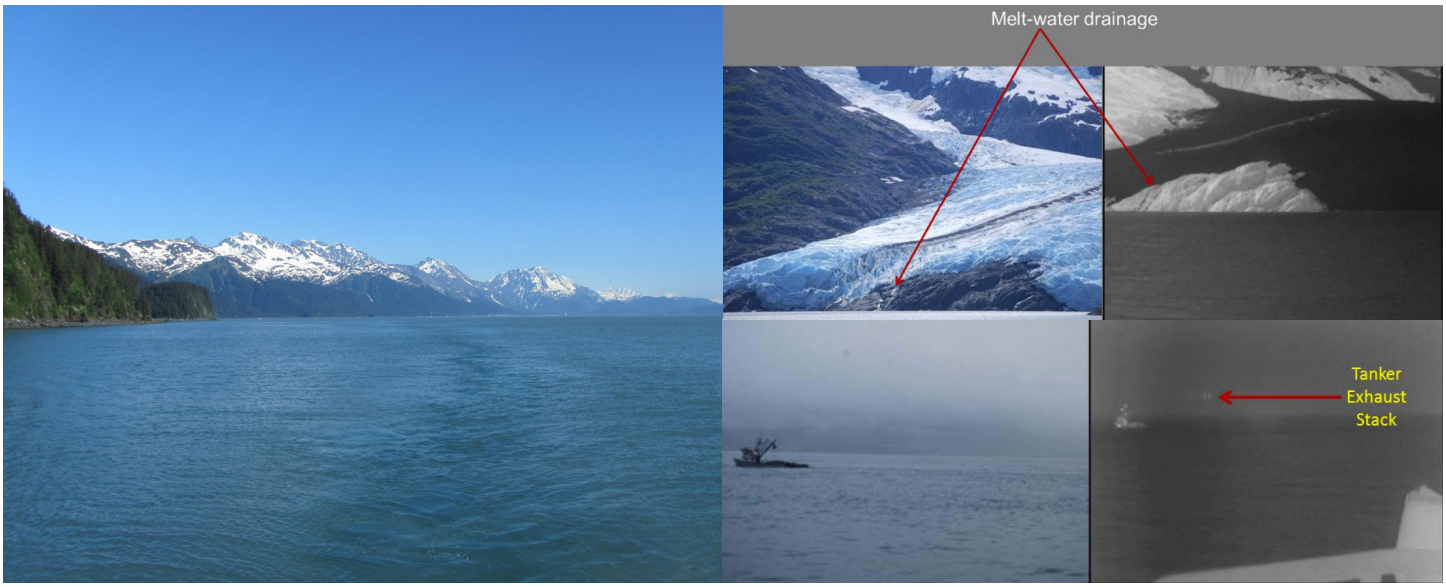




Photo-enhanced Toxicity of Dispersed and Burned Crude Oil to Arctic Mussels

Project Investigator:
- Dr. Patrick L. Tomco

Lead Institution:
- University of Alaska Anchorage

Supporting Team:
- Colin McGill
- Katrina Counihan
- Phoebe Zito

Project Period:
- June 2019 - July 2022

Project Description

This research project studied the direct effects of oil, dispersants, and in-situ burning on a cold-water species of mussel. Previous research has demonstrated that increased exposure to sunlight enhanced physical damage of oil to marine organisms. This study will determine if dispersed oil or burned oil is more toxic to mussels and if sunlight increases the toxicological effects of these pollutants.



Relevance to USCG and Transition Status

As filter feeders, mussels provide an excellent vantage point to view the environmental effects of oil spill response techniques. Sunlight-exposed oil is potentially more toxic to aquatic organisms than non-weathered oil, yet there remains little information on what effects (if any) dispersants and in-situ burning have on bay mussels in the arctic environment when exposed to sunlight, which in the Arctic summer months is continuous. This study sought to determine if dispersed oil or herded/burned oil are more toxic to bay mussels than oil alone and if these effects are more pronounced during periods of long sun exposure. Researchers also sought to determine the changes in chemical composition of Alaska North Slope (ANS) crude oil as it is exposed in each of these scenarios. Since these concentrations that marine life would be exposed to during an oil spill are realistic, these results are applicable to management decisions on the use of recovery methods.



The major scope of this project is to develop knowledge products to advance our broad understanding of the environmental toxicology of petroleum, chemically treated petroleum, and weathered chemically treated petroleum exposure. This is classified TRL 1 (fundamental research). By understanding the specific biological harms or benefits of different oil spill response techniques, Federal On-Scene Response coordinators will be able to make informed decisions on when, where, and how to utilize response techniques like chemical dispersants or in-situ burning. By including the additional factor of light exposure, researchers will shed light on the effects of these techniques during the long-summer days and long-winter nights of the Arctic.

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Mitigating the Damage to Arctic Copepods from Surface Oil Spills: When to Apply Dispersants

Project Investigators:
- Dr. Christoph Aeppli
- Dr. David Fields

Lead Institution:
- Bigelow Laboratory for Ocean Sciences

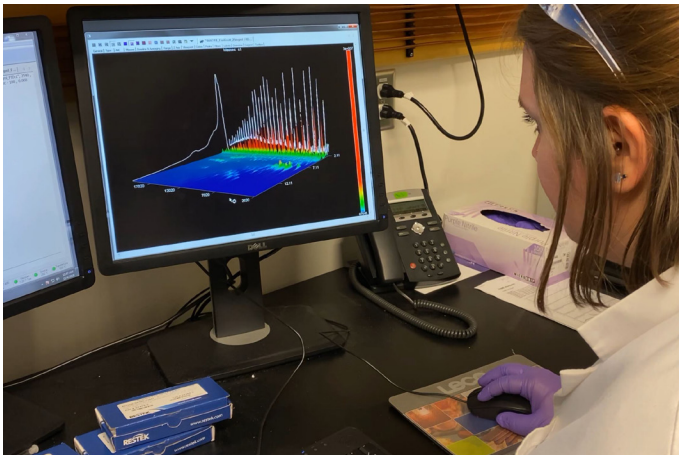
Project Period:
- June 2019 - December 2021

Project Description

This research project is dedicated to understanding the effects of chemical dispersants used in oil spill response on a critical arctic zooplanktonic organism, copepods. While previous laboratory experiments have recorded the effects of oil and dispersant exposure on copepods, the project employs new methodology that allows for Copepods to move through a simulated water column. The main hypothesis of this project is that in the ocean, copepods can separate themselves from surface oil spills during portions of their developmental cycle. Therefore, they might be exposed to much lower concentrations and for much less time than has been assumed based on previous laboratory studies. Therefore this methodology is intended to more simulate the response of these animals to chemical dispersants and oil in the Arctic environment. By allowing the animals to move vertically in the water column, researchers will achieve a more accurate understanding of the toxicity effects of oil and chemical dispersants on this keystone Arctic species and the potential environmental impact of oil spill response strategies in the Arctic.

Relevance to USCG and Transition Status

With the decreased ice coverage in the Arctic and sub-Arctic, there has been a substantial increase in trans-Arctic shipping and renewed interest in Arctic oil and gas exploration. This poses a growing risk for oil pollution in the Bering and Beaufort Sea and raises concern about its impact on Arctic food webs. While dispersants are a highly efficient and proven tool for oil spill response in sub-Arctic and Arctic environments, there is concern about negative impacts on copepods, which are a critical organism in the Arctic food chain. Copepods are the most numerically abundant multicellular zooplankton in the water column and are a major food source for young fish and krill, which serve as prey for higher trophic levels. Therefore, any attempt to assess the ecological impact of oil spills in marine environments requires a good understanding of the effects of crude oil pollution on planktonic communities. There is an imperative to understand the potential toxicological effects of dispersants and dispersed oil on planktonic species to inform the development of oil spill response strategies in the Arctic region.



ADAC and the project team is committed to ensuring the results of this fundamental research will be useful for the USCG and DHS mission and is oriented to support USCG-led spill response for decisions making in dispersant application. Project research has been collected into a peer review manuscript, the results of which will advance Coast Guard and the Federal On Scene Coordinator (FOSC) understanding of the environmental effects of oil spill response mitigation measures in the Arctic. This research provides Coast Guard an opportunity to operationalize research findings through the development of operational manuals, training curricula, etc.



Oil Spill Modeling for Improved Response to Arctic Maritime Spills: The Path Forward

Project Investigator:
- Dr. Nancy E. Kinner

Lead Institution:
- University of New Hampshire Coastal Response Research Center (CRRC), Center for Spills in the Environment (CSE)

Supporting Team
- Megan Verfaillie
- Jessica Manning

Project Period:
- July 2019 - June 2022

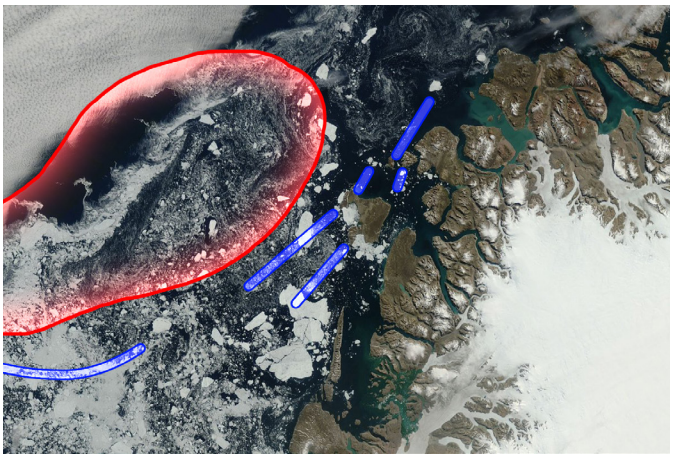
Project Description

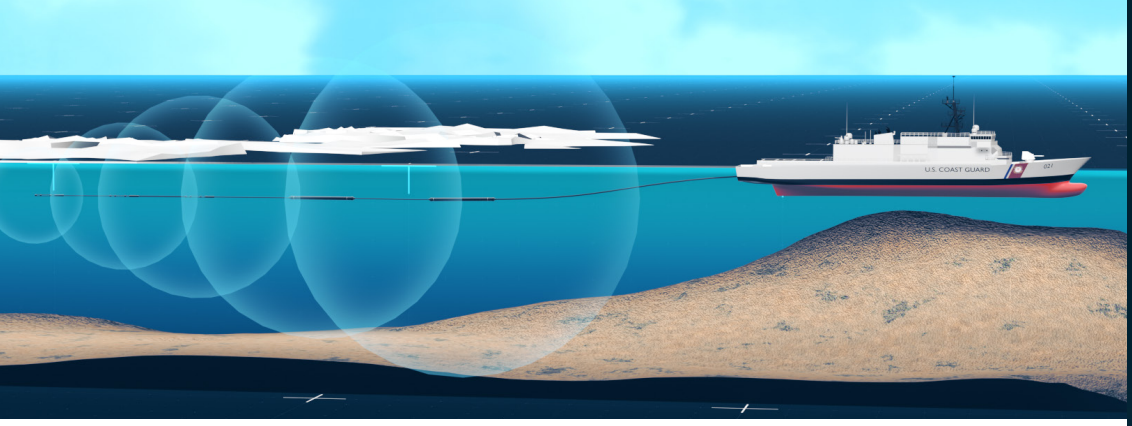
The Oil Spill Modeling for Improved Response to Arctic Maritime Spills, the Path Forward project provides a structured approach to assess the state of oil spill modelling in an Arctic context and the current and future needs of the Federal On-Scene Coordinators moving forward. The project is designed to solicit expert advice from the academic community, government agencies, and international partners in order to develop strategy for addressing the USCG FOSC core needs in an Arctic oil spill response. The project will result in a comprehensive knowledge product that will recommend new components to include in arctic oil spill modelling and how to best coordinate further modelling efforts to aid in Arctic maritime oil spill response.

Relevance to USCG and Transition Status

The Arctic region is projected to realize more maritime shipping and natural resource development. Accordingly, the probability of more and larger spills, particularly of petroleum, is increasing the need for response- relevant computer modeling calibrated for Arctic conditions. The rising risk of an Arctic oil spill increases the urgency to identify the current state-of-the-art models and the potential for integration across current and emerging environmental models. This research investigation will generate a knowledge product guided by a Project Core Team, Workshops and expert Working Groups. The intention of the knowledge product is to assist future USCG-led spill response communities in strategizing new investment in model development and associated integration.

The investigators formed a core group of multi-disciplined experts who examined the limitations of current spill modeling for the Arctic and structured a workshop to establish a comprehensive campaign formation of Working Groups related to establish improved understandings in specific response model components/criteria determined for future modeling. The investigators have successfully collaborated with Arctic-oriented maritime spill response modeling communities as well as responder perspectives from both USCG and Alaska Department of Environmental Conservation. In addition, researchers have examined potential Arctic spill scenarios (well blowout under ice, pipeline spill under shore fast ice, and a large vessel spill of combinations of oil in the shoulder season) and answered questions related to: responder needs that can be addressed by modeling, limitations of ice in response modeling, observational gaps, and potential updates needed for existing algorithms and process understanding. Working groups are now underway in advancing understanding of oil-in-ice interactions, new and existing technologies for filling data gaps for modeling, and how to improve visualization and uncertainty when communicating model results. The findings from these groups will be used to draft sections of the Knowledge Product that will be developed and integrated into the final Knowledge Product.







Project Investigator:
- Dr. Scott Socolofsky

Lead Institutions:
- Texas A&M University
- Induced Polarization Associates

Supporting Team:
- Kari Walker
- Art Wright
- Nathan Lamie

Project Period:
- July 2019 - June 2022

Marine Induced Polarization Methods for the Detection and Mapping of Oil in an Arctic Marine Oil Spill

Ruggedized Field Kit Production and Testing

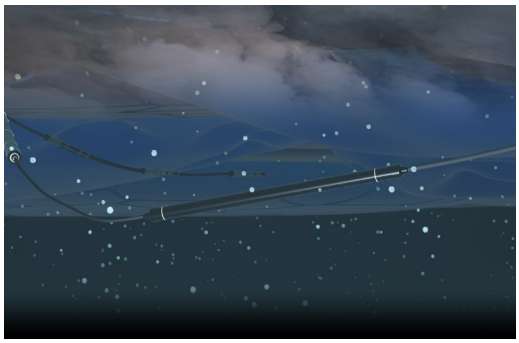
Project Description

ADAC is supporting the application of a Marine Induced Polarization (Marine IP) ready kit adapted for Arctic operations as a tool to detect and track oil under sea-ice. Marine IP is a proven and effective tool to detect oil in fresh, brackish, and seawater at all ocean depths, including the seafloor. Development is now underway to utilize this same technology to detect oil in the open-Arctic Ocean, broken ice fields, and oil under and in ice. The team is working to make a more compact and durable system capable of operating in cold temperatures to assist federal on-scene coordinators in oil spill response.

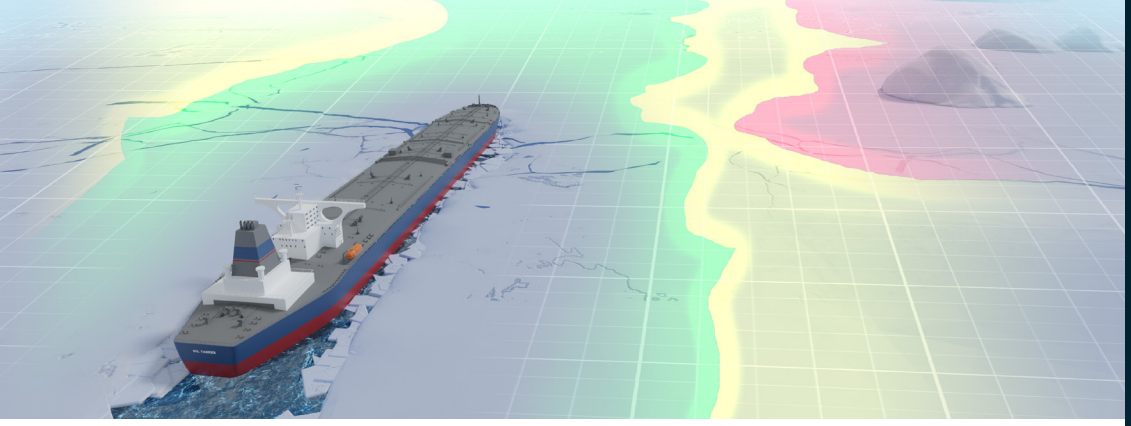
Relevance to USCG and Transition Status

When an oil spill occurs under ice, the oil collects on the bottom side of the ice and then becomes encapsulated as the ice grows and can infiltrate into brine channels, thereby complicating the ability to detect oil in these environments. During the melt season, the oil will migrate through the expanding brine channels, drawing the oil to the surface of the ice. Wind-driven sea ice formation and mixing in affected coastal polynyas will further complicate the cleanup effort. These freeze-melt mechanisms and natural processes driving sea ice evolution can significantly increase the cleanup difficulty and the duration of the environmental impact of the spill. Therefore, the ability to detect and map the extent of oil below the ice and in mixed or broken ice is critical to the spill response effort. Modern induced polarized systems are capable of identifying materials like oil in a marine environment. These systems may prove useful to help minimize the effects of spilled oil in the Arctic marine environment, and assist U.S. Coast Guard led, Federal on-scene spill response needs. In particular, Marine IP may significantly contribute to remote sensing tools to detect and map oil slicks in the open-ocean, broken ice fields, and oil under ice.

This research effort will leverage previous Marine IP oil under ice detection research to inform the design, build, and delivery of an Arctic-ready, rugged Marine IP field kit for transition of the Marine IP technology into a turn-key system that is easy to transport, set up, and deploy by trained personnel. One important outcome of this project has been creation of the Engineering Design Report detailing the procedures to manufacture a ruggedized field-ready Marine IP kit. This Engineering Design could be used by other researchers or commercial entities to manufacture Marine IP equipment meeting the specifications of the products created here. Once the firmware and software implementations are complete, these could also be made available, allowing the Marine IP system designed here to be built and used by others. Following the field trials planned as part of the no-cost extension, this will represent a Technical Readiness Level of 7 – system prototype demonstration in a realistic environment.



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Arctic Ice Conditions Index (ARCTICE)

Project Investigator:
- Dr. Jifeng Peng

Lead Institution:
- University of Alaska Anchorage

Supporting Team:
- Dr. Shawn Butler
- Dr. Jinlun Zhang
- Kelsey Frazier
- Sam Cheung

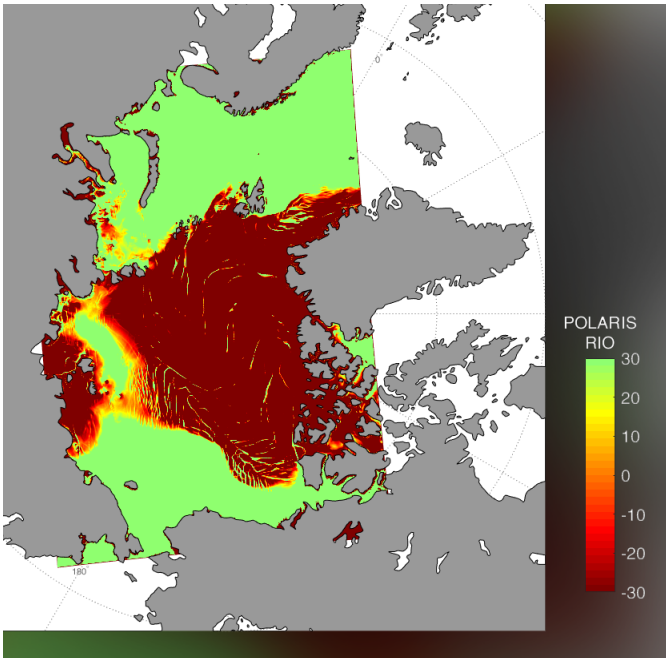
Project Period:
- July 2019 - June 2022

Project Description

ADAC has developed the ARCTICE project to create an ice conditions index to inform mariners on sea ice in the Bering, Chukchi, and Beaufort Seas. Leveraging a previous model generated for the Great Lakes region, ARCTICE produces an easy-to-understand index to communicate ice conditions in the Arctic. The index is capable of providing forecasts on ice conditions from 72 Hours to 1 month in advance.

Relevance to USCG and Transition Status

For this project, the team is focused on the ice-laden waters of the Bering, Chukchi, and Beaufort Seas (corresponding to the U.S. Arctic Extended Economic Zone (EEZ). Similar to the completed project creating ICECON for the Great Lakes region, ARCTICE will create a visualized decision support product, a numeric index that combines marine vessel size, gross tonnage, and hull strength polar classification to contrast against current and forecast ice of the planned route of sail. Through ARCTICE, USCG and shipmasters will have improved insight in determining routes of safe passage through the ice-laden waters of the U.S. Arctic.



Based on the completed and transitioned Great Lakes ICECON and developed in coordination with USCG District 7, the ARCTICE team seeks to replicate the transition planning used for Great Lakes ICECON from research to an operationally relevant tool. The ADAC team has delivered the ARCTICE mariner support tool to a web-based operational destination currently hosted by Axiom Data Science. The website is located here (temporarily): https://adac.portal.axds.co/#. The ADAC Team will pursue an agreement with USNIC to host the generated ARCTICE data. In addition to USNIC, the Alaska Ocean Observing System based in Anchorage potentially serves as an alternate or replication of a USNIC destination.

As global climate change has caused the Arctic to warm at unprecedented speed, the volume and extent of sea ice in the polar regions has reduced. This has enabled new opportunities for economic activity in the Arctic, increasing maritime activity in the area when sea ice behavior has become more unpredictable. To navigate the ice-laden waters of the Arctic, mariners need accurate, high-resolution information on ice conditions to make safe and informed decisions. ARCTICE will fill this niche, serving as a decision-support tool for route planning and in determining associated risk with traveling through a particular region in the Arctic Waters. Tools like ARCTICE will allow for safe navigation in the Arctic, reducing the risk of oil spills or vessel stranding in high-risk areas of the Arctic.



Remote Unmanned Aircraft System (UAS) Inspection and Response Team Development in the Bering Strait Region

Project Investigator:
- Dr. Jessica Garron

Lead Institution:
- University of Alaska Fairbanks

Supporting Team:
- John P. Henry
- Margaret Hall

Project Period:
- July 2020 - June 2022

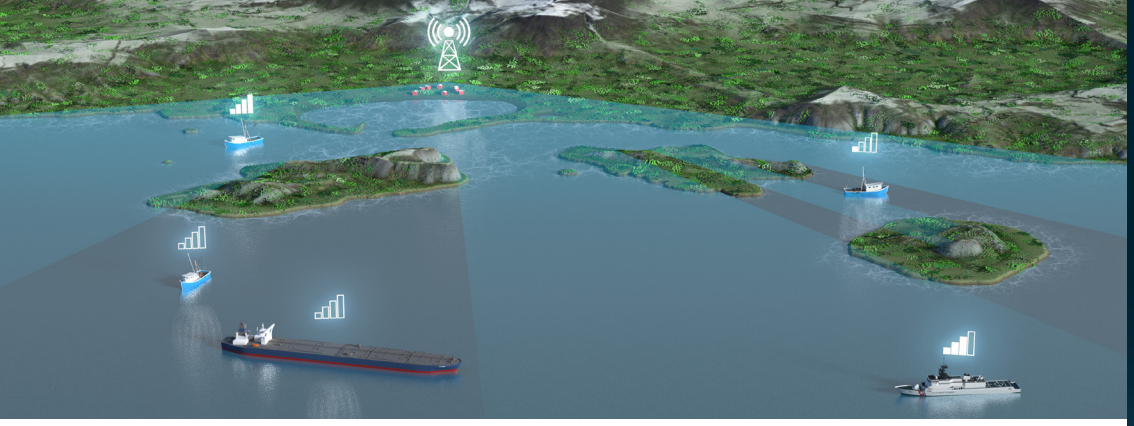
Project Description

The Remote Unmanned Aircraft System (UAS) Inspection and Response Team Development in the Bering Strait Region project is utilizing UAS systems to pioneer a new method for infrastructure inspections in rural Alaska. The project will train community members in the rural hub community of Unalakleet in Western Alaska to perform inspection operations utilizing Unmanned Aerial Systems (UAS) platforms. UAS Pilots will be equipped to provide information on the status of key infrastructure like bulk fuel facilities and assist with emergency response efforts in their local community. The project will also co-produce infrastructure inspection protocols and emergency response flight protocols with members of the Native Village of Unalakleet which could be transferred to other remote communities across Alaska. The critical outcome of this program will be a research knowledge product of the investigations for USCG consideration as well as a set of trained pilots and flyable UAS staged in the Bering Strait region, prepared to support the community and USCG operations.

Relevance to USCG and Transition Status

This project was designed to answer the question, what opportunities exist to train local observers to provide quality information to support local infrastructure inspections and emergency response actions? Therefore, the project research methodology was designed to incorporate USCG inspection requirements, provide rural regional UAS pilot training, coproduce routine inspection and emergency response protocols for UAS operations, and conduct UAS data collections by vetted and approved local citizens in rural Western Alaska. Key information about the project has been disseminated to a wide group of potential stakeholders throughout Alaska and USCG in order to determine the feasibility of expanding the program to other rural communities or USCG Sectors across the nation. The aim of this methodology is to meet both the community objectives of Unalakleet and mission objectives of USCG by using remotely sensed data sets for local and regional decision-making.

The transition plan is focused on a comprehensive dissemination of knowledge products and research findings for journals, and other practical measures to help communities and other agencies assess the utility to consider such an approach for remote area use of UAS for inspection purposes. The formal adoption of the operational protocols by the community of Unalakleet will be encouraged through the co-production process and by providing the community pilots the hardware and software to continue the operational collection, processing and archiving of UAS-based data sets on Unalakleet infrastructure to inform USCG in their inspection regime and decision-making. A regional feasibility study will determine the viability of applying this project's methodology to other communities in the Bering Strait region. If formal adoption is determined to be warranted, ADAC leadership and the project team will work with USCG Project Champion and USCG Project Advisors to codify protocol components into USCG operational policies. If USCG determines that either or both protocols should be adopted into USCG operations, the project team will coordinate with USCG partners to identify funding and mechanisms to deliver instruction about protocol use, including data processing, delivery and archiving if desired, to identified members of the USCG community.



Alaska and Arctic Maritime Communications and Connectivity Analysis (AAMC&CA)

Project Investigators:
- Dr. Doug Causey
- Dr. Mark Ivey
- Jason Roe

Lead Institution:
- University of Alaska Anchorage

Supporting Team:
- Bruce Heinrich
- Greg Stihel
- Matthew Ahlrichs
- Buddy Custard
- Ed Page
- Wade Albright
- Nagruk Harcharek

Project Period:
- June 2020 - July 2022

Project Description

This project will provide a comprehensive review of communications capabilities and needs for mariners in Alaska and the U.S. Arctic Extended Economic Zone (EEZ). The project will identify the short-term needs of the U.S. Coast Guard, fishing vessels, and other mariners and will investigate medium and long-term technology solutions. Researchers are in the process of engaging the maritime industry, coastal communities, and USCG to identify the current gaps and shortfalls in communications capabilities needed for their respective region, industry, or community. Later phases of the project will culminate in a draft knowledge product featuring an expert assessment of the Alaskan and Arctic maritime communications system. The knowledge product will be assessed and finalized through a final capstone workshop. The principal focus of this planned series of investigations is to review current-to-long term mission connectivity needs, and to assess current and emerging technologies in order to develop an expert-driven comprehensive knowledge product.

Relevance to USCG and Transition Status

As identified in the USCG 2019 Arctic Strategic Outlook, USCG views communication shortfalls as the critical gap in achieving high latitude domain awareness. In particular, satellite, cellular, Very High Frequency (VHF) coastal land-mobile radio communications along with associated digital domain awareness capabilities (such as GIS products to visualize the domain of interest) were identified as critical to effect rapid coordination and cited in both the preparatory literature reviews and workshop findings as a routinely identified, yet unaddressed shortfall. The goal of this project is to create and publish a comprehensive knowledge product that will contain:

- A review of mariner communications and connectivity mission needs for the Alaska and the U.S. Arctic Extended Economic Zone (EEZ).
- An updated and expanded market survey and literature review of current and baseline communications technology solutions
- A geographic review of the Alaskan and U.S. Arctic regions in terms of communications/ connectivity shortfalls
- A technology-focused review of known/understood existing communications and connectivity capabilities, assessed against researched gaps for the high latitudes
- An expert-derived set of options and recommendations via a framework oriented to a Doctrine, Organization, Training, Material, Leadership and Education, Personnel and Facilities (DOTMLPF) framework

Additionally, recommendations will consider and address solutions in the context of buying services vs. organically deriving and developing technologies. The final knowledge product will include prioritized options (while considering options such as commonality of usability/application of high latitude solutions to lower latitudes). The Comprehensive Research Report will be promulgated to the Arctic maritime community and across USCG in accordance with HQ USCG Project Champion desires. The knowledge gained from this project will be directly transferable to HQ USCG CG 5PW, CG7 and CG926.



Arctic Facilities and Infrastructure Environmental Change Risk Index

Project Investigators:
- Dr. Craig Tweedie
- Dr. Matthew Calhoun

Lead Institutions:
- University of Alaska Anchorage
- University of Texas El Paso

Supporting Team:
- Kelsey Frazier
- Dr. Ben Jones
- Jeff Libby
- Dr. Molly Grear
- Nagruk Harcharek

Project Period:
- July 2020-June 2022

Project Description

In order to better inform the USCG on the impact of climate change to infrastructure in the Arctic, ADAC is supporting the Arctic Facilities and Infrastructure Environmental Change Risk Index (ERI) project. The project will primarily focus on bulk oil/fuel containers and pipelines, and piers, docks, and platforms in permafrost coastal and riverine landscapes of the Bering, Chukchi and Beaufort Seas. The research effort will produce three products: a comprehensive Arctic facilities and infrastructure environmental change knowledge product, an operationally relevant Arctic facilities and infrastructure environmental change risk index, and an Arctic inspector and responder structural environmental impacts training guide. Products developed through the ERI project will inform responders and inspectors of the current and predicted future structural integrity of those facilities, and the bearing capacity, stability, and susceptibility to environmental changes in the Arctic.

Relevance to USCG and Transition Status

This project will address direct concerns regarding structural risks of facilities and infrastructure in Arctic Alaska due to cumulative effects of environmental change. Based on these concerns, this research will address two principal questions: What are the risks and severity to USCG monitored facilities along the Arctic coastal regions of the Bering, Chukchi and Beaufort Seas? What are the risk weightings related to the USCG monitored facilities along the Arctic coastal regions?

The principal outcome of the project will be a comprehensive assessment and public document on the approaches to improving risk mitigation and operational decision-making for USCG facilities inspections and response operations. The Comprehensive Research Report and corresponding peer-review journal article will be promulgated across USCG and ADAC networks. The knowledge gained from this project will be directly transferable to USCG Facilities Inspections and Maritime Environmental Response, which maintain representation on the Core Team. The Project development team anticipates that much of the knowledge gained and consensus reached will be used to manage facilities inspections schedules, inform inspectors as to the severity of observed environmental changes, and determine expected future conditions of USCG facilities and USCG regulated infrastructure. The long-term goal is to establish a credible and useable framework for categorizing Arctic infrastructure and facility status and calculating risk of future failure based on the various erosion, permafrost, and facilities engineering conditions that routinely occur in the Arctic. If such a risk framework can be available for use by government entities such as USCG, it will be useful scheduling the frequency of facilities inspections, and identifying the most at-risk locations. In the case that USCG was interested in advancing the Environmental Risk Index to higher level of technology readiness, ADAC and the research team are at the ready to support additional investigations via ADAC's Basic Ordering Agreement (BOA).

