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A DEPARTMENT OF HOMELAND SECURITY CENTER OF EXCELLENCE

ADAC Summary Overview 9 April 2021

A presentation by

Arctic Domain Awareness Center
University of Alaska Executive Director



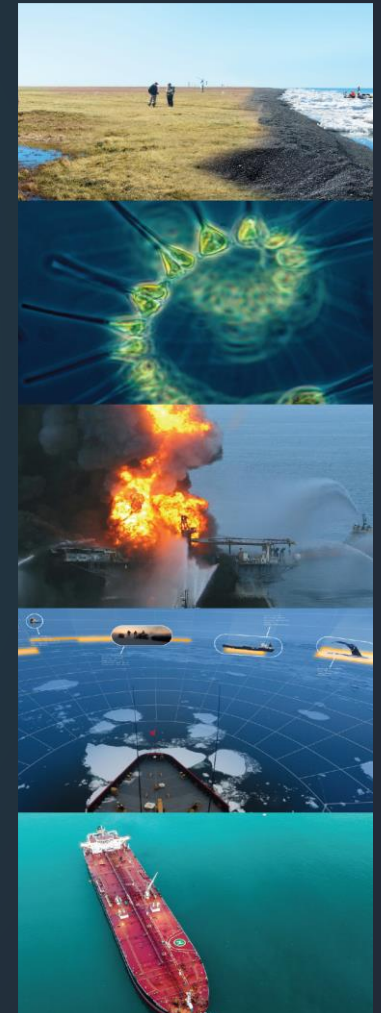
Upfront: Addressing ADAC's contributions to Homeland Security

ADAC is a DHS S&T UP Center of Excellence in Maritime Research, hosted by the University of Alaska.

ADAC is a research network with its hub located at the University of Alaska Anchorage.

ADAC advances Arctic Science in the following categories of research:

- Geophysical environmental modeling;
- Marine robotics;
- Decision support science;
- Biological & marine environmental science;
- Satellite support;
- Civil engineering;
- Big data analytics;
- Social science...to include gaining insights from rural Alaska and Arctic communities.



ADAC: Research for the Arctic Operator... For Today and For the Future

University of Alaska's Arctic Domain Awareness Center...

- “Operator driven research” to support the Arctic maritime mission of the U.S. Coast Guard...
- ...and other U.S. federal maritime security and safety activities
- ...and to support the public good.

Meet our customers



Courtesy NASA.gov



Courtesy The Arctic Institute



Courtesy Defense news.com



Courtesy The Alaska Eskimo Whaling Commission

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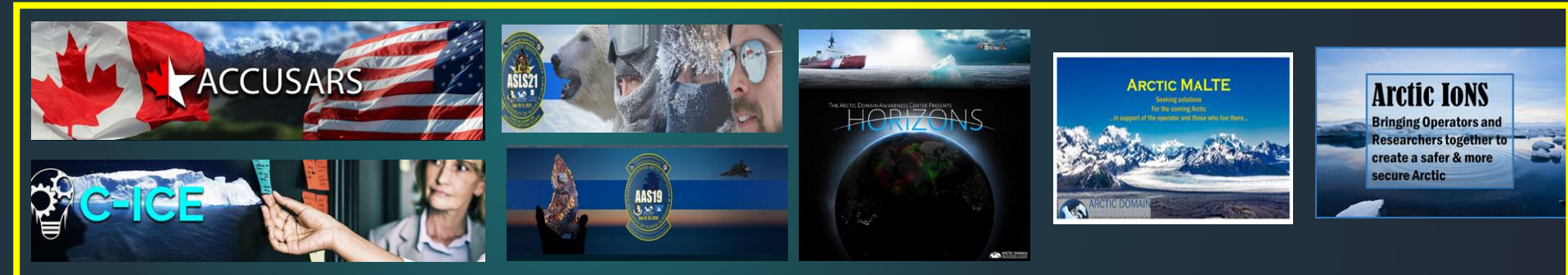
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ADAC's strategic approach Advance S&T, Convene and Educate

1. Lead Arctic focused Science and technology research



2. Convening experts via Arctic focused workshops to create new understandings and solve problems



3. Conduct educational Programs



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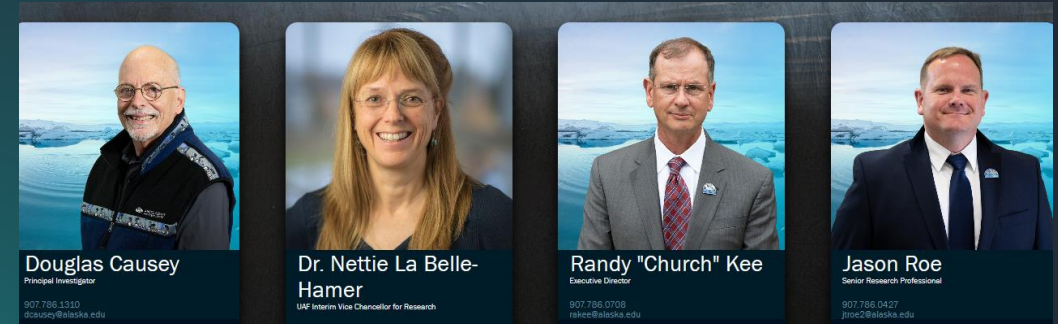
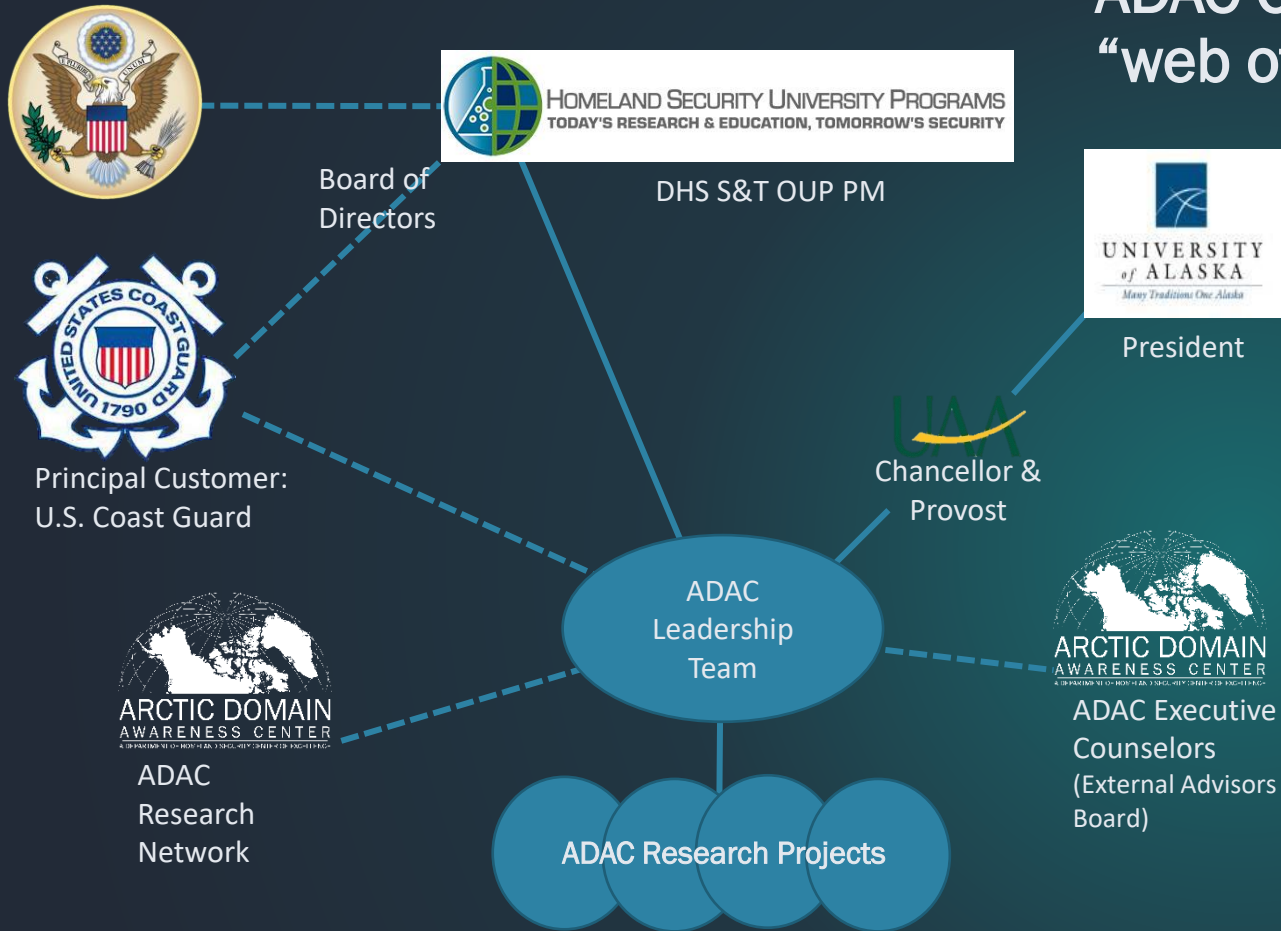


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ADAC Organization and “web of control and coordination”



ADAC Center Management Team

ADAC: Research for the Arctic Operator... For Today and For the Future



Tom Barrett, VADM (Ret), USCG, Former President, Alyeska Corporation, Anchorage Alaska.



John Farrell, PhD, Executive Director, U.S. Arctic Research Commission, Washington D.C.



Rudy Peschel, RADM USCG (Ret), Washington D.C.



Tom Case, Lt Gen, (Ret) USAF, Chancellor Emeritus, University of Alaska Anchorage, Anchorage, Alaska



Gail Schubert, JD, President & CEO, Bering Straits Native Corporation, Nome, Alaska



Paul Hubbard, PhD, Director General, Director General at Defence Research and Development Canada's Centre for Security Science (DRDC CSS) in Ottawa Canada Department of National Defense, Ottawa Canada.



Heather Quilenderino, PhD, CDR, USN, Director, U.S. National Ice Center, Suitland Maryland.



Michael Duxbury, Former Deputy Commissioner, State of Alaska Department of Public Safety. Anchorage, Alaska (on assignment to U.S. Federal Government, Washington D.C.)

ADAC's Executive Counselors—The Center's Board of Advisors

- The ADAC Executive Counselors advise ADAC leadership on overall strategy for the Center efforts, connected ADAC to greater research collaboration and provide advice for individual Center projects.

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ADAC: Research for the Arctic Operator.

- ADAC: Research for the Arctic Operator... For Today and For the Future



Presenting to the community of Arctic and Maritime Research

- ADAC Leadership and research investigators presented and or participated in a large number of notable Arctic and/or Maritime Research or operator forums to advance Safety and Security.



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ADAC's "Arctic Environmental Security" Course at UAA (also accredited to University of the Arctic)



Course co-instructed by ADAC Principal Investigator and Executive Director at UAA Spring Semester 2018, 2019, 2020 and 2021

Topics include:

- Ecological Dynamics.
 - Social Resilience.
 - Subsistence and Food Security.
 - Environmental Conservation.
 - Regional and National Security.
-
- 25 Students.
 - Seminar style.
 - On-line participation, including guest lectures.

BIOL A469 Arctic Environmental Security 3 Credits

Offers an introduction to a broad array of biological, ecological, political, economic, social and defense security issues that make the present-day Arctic a focus of global interest, in the context of global climate change and the end of the Cold War.

Special Note: Not available for credit to students who have completed [BIOL A669](#).

May Be Stacked With: [BIOL A669](#)

BIOL A669 Advanced Arctic Environmental Security 3 Credits

Offers an introduction to a broad array of biological, ecological, political, economic, social and defense security issues that make the present-day Arctic a focus of global interest, in the context of global climate change and the end of the Cold War. Graduate students will complete a publishable manuscript based on the course-based synthesis.

Special Note: Not available for credit to students who have completed [BIOL A469](#).

May Be Stacked With: [BIOL A469](#)

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The Mission...Prosecuting Research

- ADAC has a comprehensive approach to conducting research,
 - Led by project teams executing DHS S&T OUP Approved Workplans.
 - Guided by Center leadership.
 - Communicated with the community of key stakeholders across the U.S. and Canada...Federal, State, Local, Tribal, Academic and Industry.
 - Advised by the Center's Executive Counselors.
 - Driven by Project Champions at HQ USCG.
 - Administered by DHS S&T OUP.

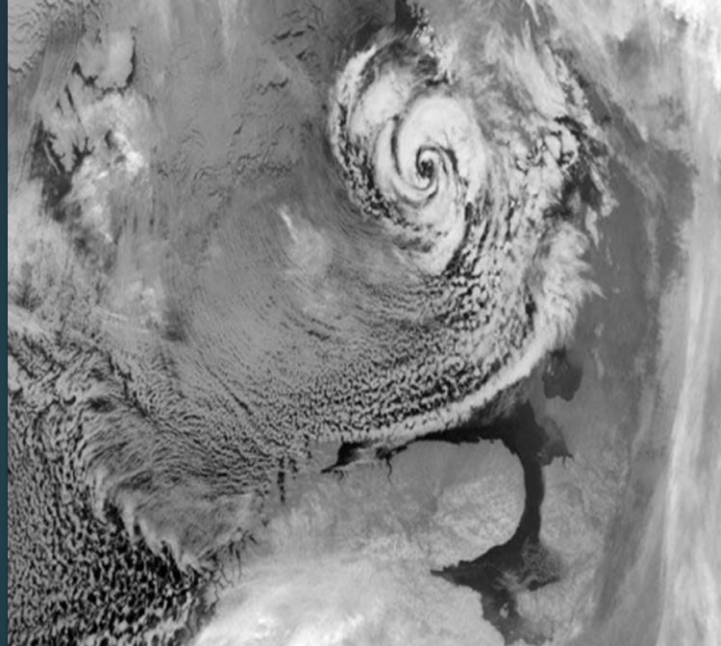


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(Some) of the Challenges faced by the maritime operator

- Weather
- Illumination
- Distances
- Sea ice (its more complicated than one may think)
- Logistics
- Infrastructure
- Communications
- Bathymetry (what's below the waves?)

Goal = Strengthening
Research Partnerships
in support of Operations



A polar low northeast of Scandinavia in the Barents Sea.
Credit: Erik Kolstad/Tlickr.

Helping the operator...means improving the...

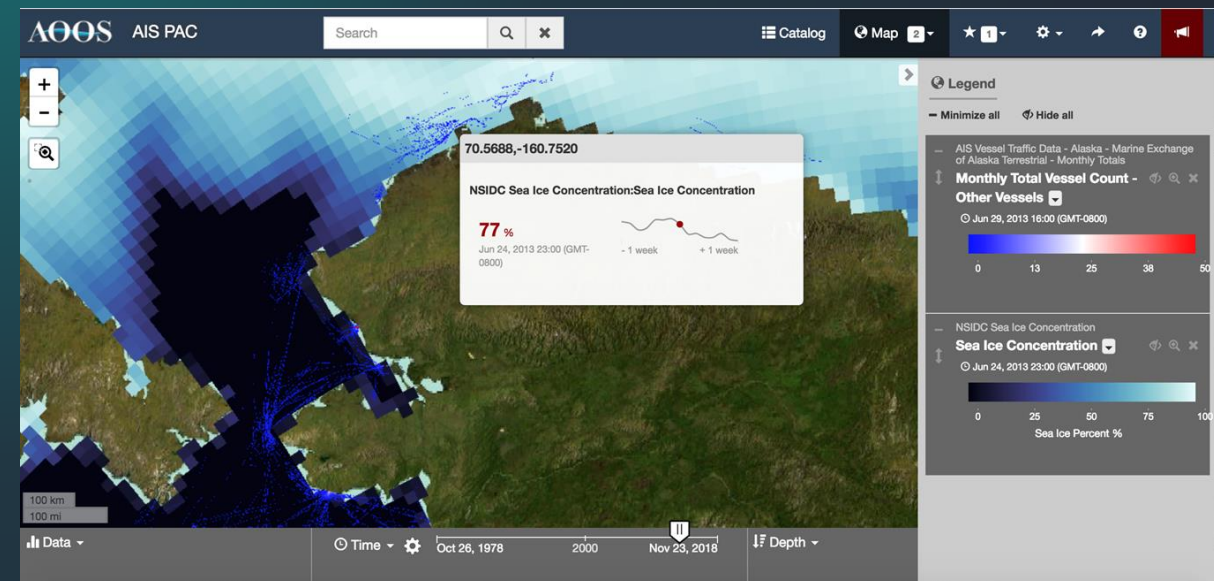
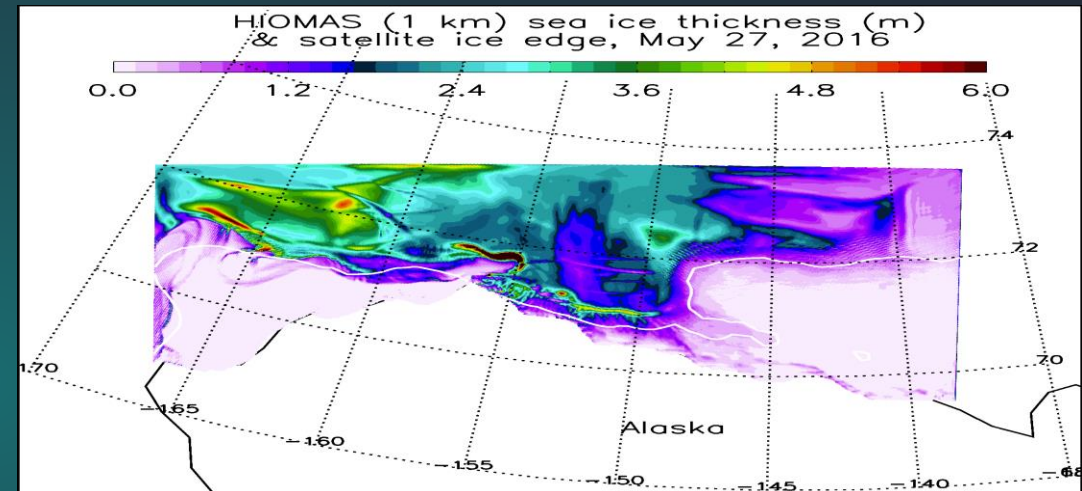
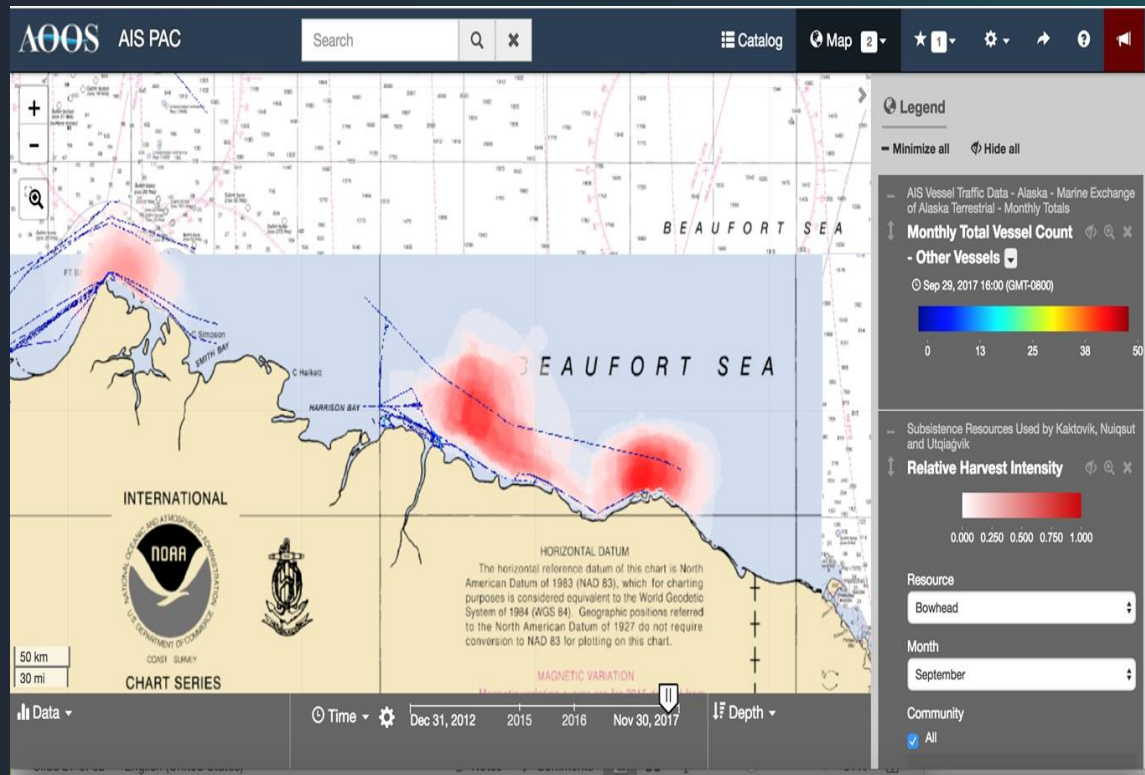
- Ability to locate people who need help
- Ability to locating people who are doing illegal activities
- Ability to suitably respond to disasters
- Ability to identify threats and risks to our interests
- In sum...an ability to respond

Accordingly...ADAC's Mission = an opportunity to help via:

- S&T Solutions
- Knowledge Products
- Convening experts to study, discern and propose
- Educate next generation of HSE professionals...steeped in science

Addressing problems...via interconnected research

Such as increasing forecasts of sea ice and queuing bathymetry surveys...to improve safety of Arctic shipping



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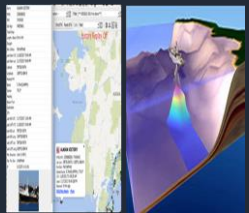
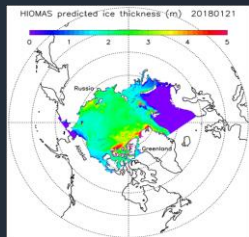
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ADAC...*operator driven science & technology*...for the Arctic

- **Models on the Physical Characteristics of the Arctic**, such as fine scale sea-ice characterization at various scales.
- **Decision support tools** for Marine operations in the Bering, Chukchi & Beaufort Seas and Great Lakes ice conditions characterized and tailored for vessel types.
- **Tactical tools** for mariner use based on localized sea-ice hazards.
- **Oil spill studies** to understand impact to Arctic mussels and copepods, & future Arctic spill modeling.
- **Induced polarization** to characterize oil spills within sea ice conditions
- **Big Data analytics** to support NOAA bathymetric survey prioritized on vessel traffic.
- **Models to support disaster response**: Oil Spills in Arctic Ocean environments and Storm Surge in Western Alaska.
- **Long-range Autonomous Platforms** to support oil spill response characterization and other physical aspects
- **Geo-spatially oriented data aggregation** for all hazards & geofencing for USCG command centers
- **Support to small satellites** to improve Arctic communications.
- **Sensors, chemical isotope detection, smart camera development & community based observations**
- **Mariner training** in support of IMO polar code.



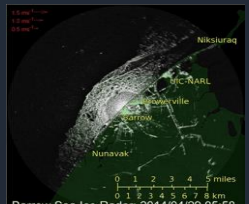
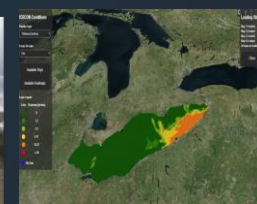
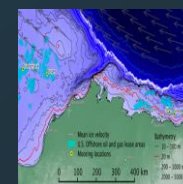
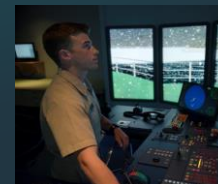
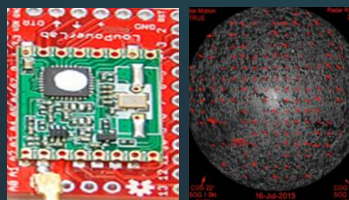
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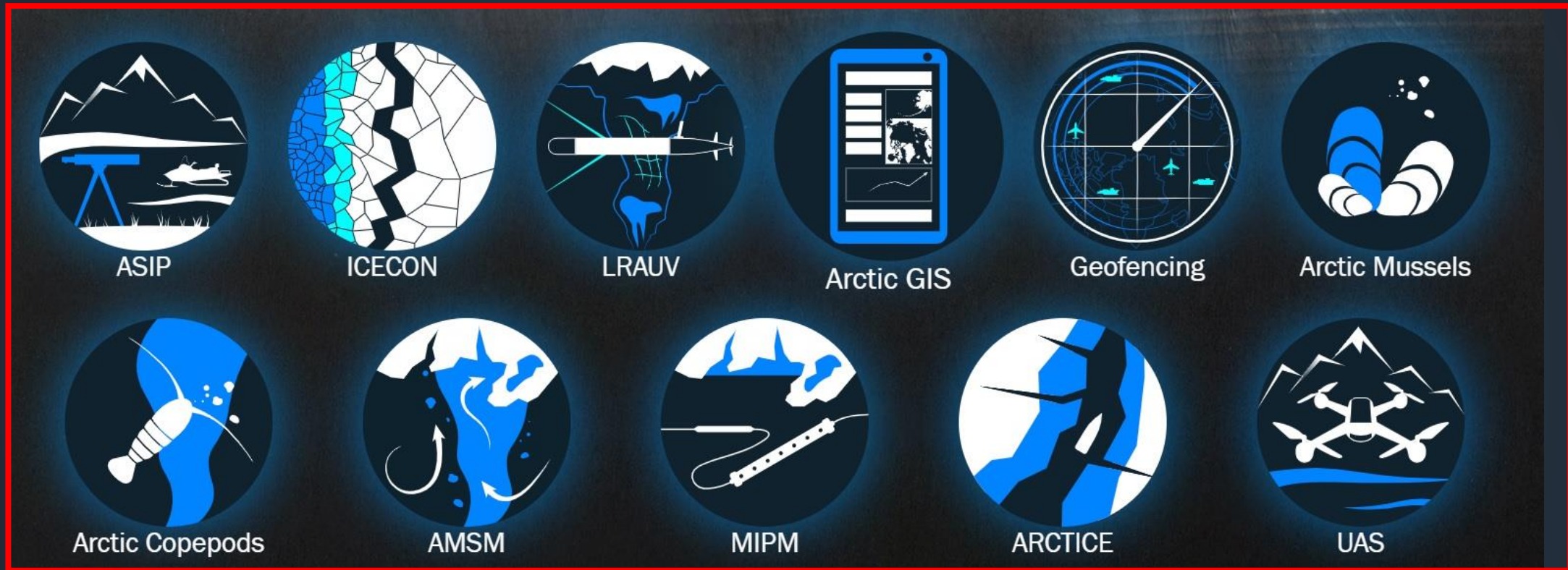
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ADAC's Current S&T Research Projects



Note: 2 new projects just underway:

1. Alaskan and Arctic Communications and connectivity Assessment
2. Arctic Facilities and Infrastructure Environmental Change Risk Index.

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ADAC's Completed S&T Research Projects



AIFC



Arctic
Sensors



CBONS



IHIF



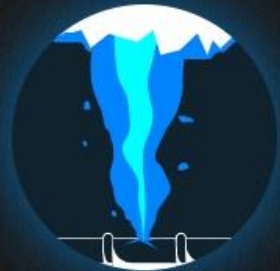
MMA



CubeSat



HIOMAS



AOSM



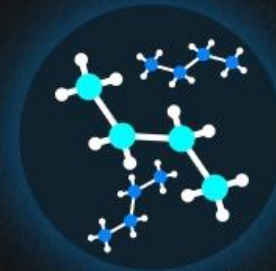
SIWF



AIS-PAC



Arctic Storm
Surge



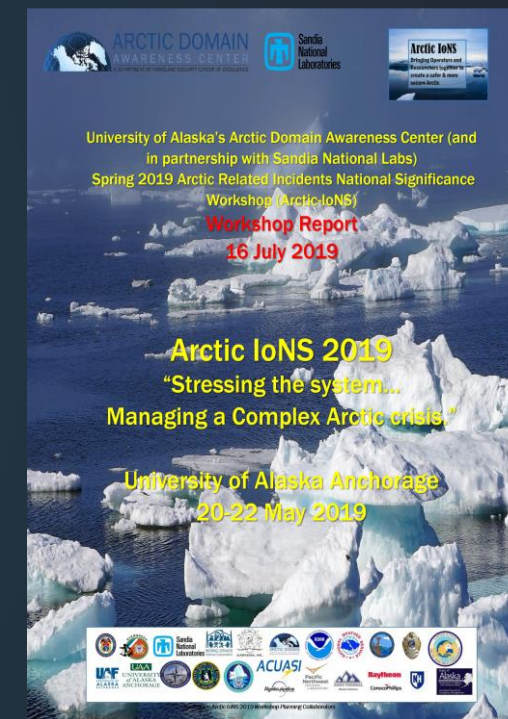
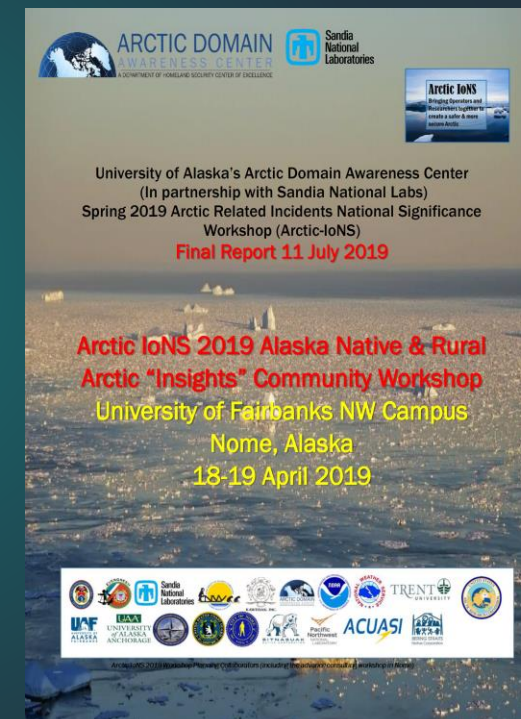
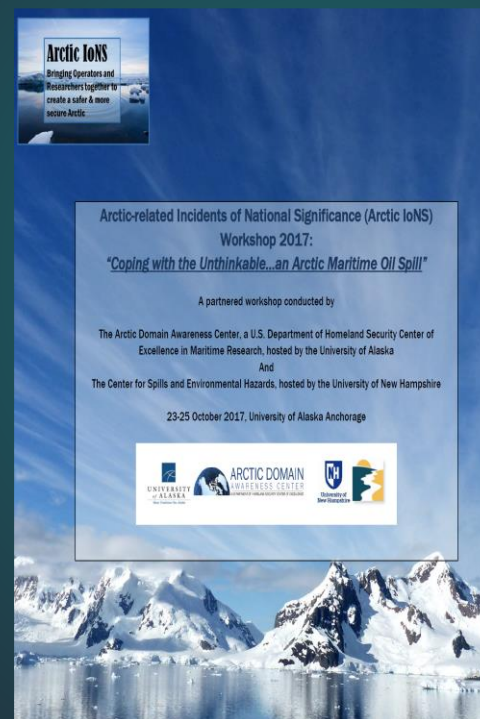
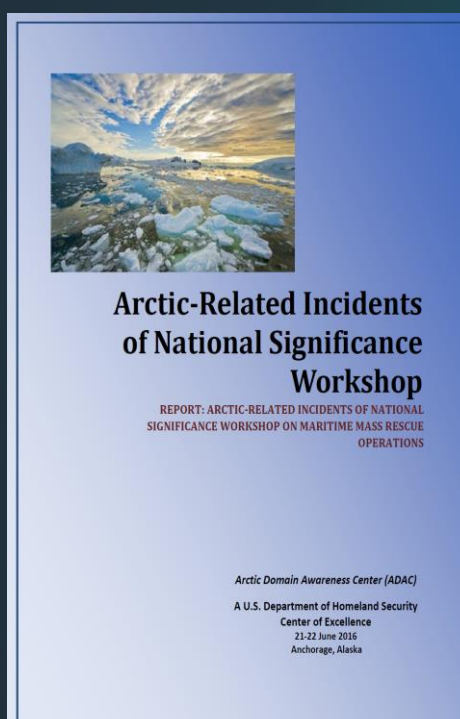
Chemical
Isotope
Analysis



Smart-Cam

Operator driven research workshops...a tool to advance capabilities useful for U.S. Coast Guard and other Arctic mariners

ADAC's Arctic-related Incidents of National Significance (Arctic IoNS).



Arctic IoNS 2016: Coping with a disabled large cruise vessel in Arctic waters.

Arctic IoNS 2017: Responding to a large oil spill just as winter sea ice was advancing.

Arctic IoNS 2019: Complex "two part" workshop, Responding to Massive Arctic Wx Event.

Arctic IoNS 2021: Two stage event with an Aleutians and High Arctic Scenario (Fall 2021)

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Arctic Medium- and Long-Term Environment (MaLTE) Workshops

MaLTE 2017: “Arctic 2030+” University of Alaska Fairbanks

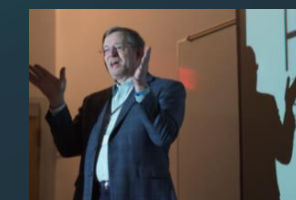
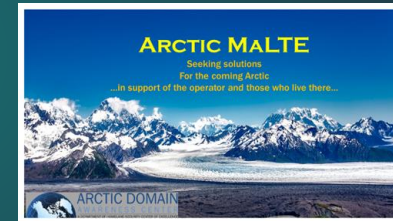
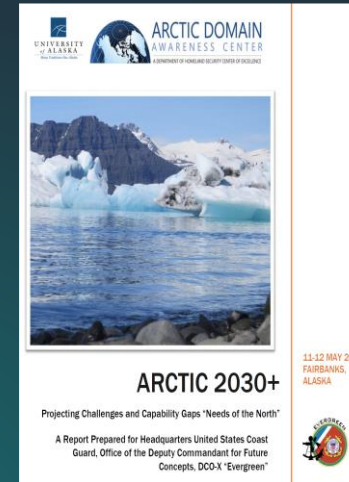
MaLTE 2018: “Arctic in the distant future...gaining Alaska Native Insights to Challenges anticipated across Maritime and Coastal Regions”

CANUS MaLTE 2018: North American Arctic Maritime and Environmental Security

MaLTE 2019: The Blue Economy...Identifying Northern Industry Opportunities.

CANUS MaLTE 2020: Advancing Collaboration in Canada-U.S. Arctic Regional Security
Invitational Virtual Workshop

MaLTE 2021: Arctic Maritime Horizons 21: 4-6 May 2021 ISO USCG Arctic MTS Analysis

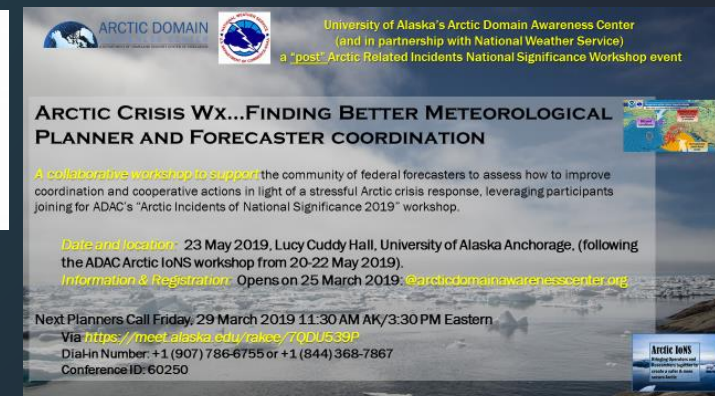
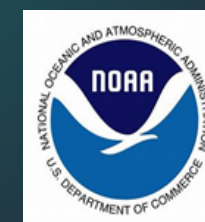
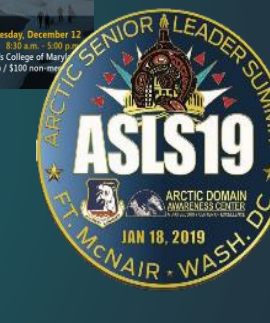


Hosting and Supporting other Arctic Workshops

In addition to presenting at a variety of Arctic related research forums and hosting specific workshops, ADAC has hosted and supported workshops and symposiums that benefit the communities of Arctic operators and researchers...

..within the U.S. and internationally

Goal: advance knowledge in the forums and provide focused knowledge products following



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Preparing the next generation for HSE..ADAC Fellows

ADAC Student Fellows Program. ADAC's Fellows are undergraduate and graduate students across the ADAC Research Network that supports Operator Driven research for the Center.



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ADAC's Arctic Summer Intern Project (ASIP)

ASIP (a 10 week program) conducted in summer 2018 and 2019 which involved:

- Student orientation to U.S. Federal, and State of Alaska “Arctic oriented” mission agencies in Anchorage
- Two week “Arctic Field Research Mission” hosted at the Barrow Arctic Research Center, North Slope Borough Alaska
- Follow-on, tailored programs for each student that involved individual research efforts, aligned to Student goals and education program.



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A tool for engagement...ADAC's Customers and Partner's Roundtable

On a quarterly basis, ADAC conducts a "Customers and Partner's" Roundtable.

These events are conducted in order to facilitate interaction with the following entities:

- U.S. Coast Guard Stakeholders and advocates,
- U.S. Federal and Canadian government officials,
- State of Alaska and local officials,
- Academic/research and industry professionals from across the U.S. and Canada.



ADAC...steadily advancing to provide operator driven S&T research

- ADAC's efforts...can help to reduce risk, improve safety, increase awareness, increase decision precision.
- ADAC will continue to seek research that addresses shortfalls and gaps as the priority.
- ADAC will seek to leverage prior investments to find suitable futures as practically as possible
- ADAC will prosecute approved investigation to develop, and transition ...in order to field capability.
- We believe in our mission...and sincerely strive to deliver.



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ADAC Project Summary Details



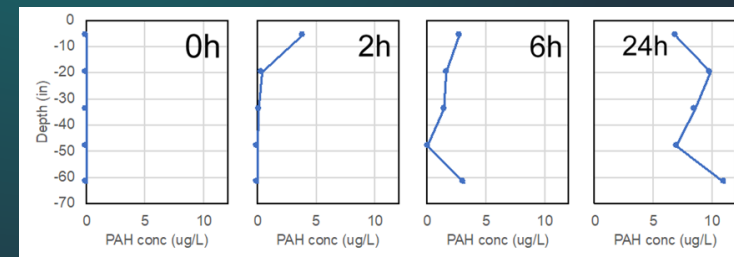
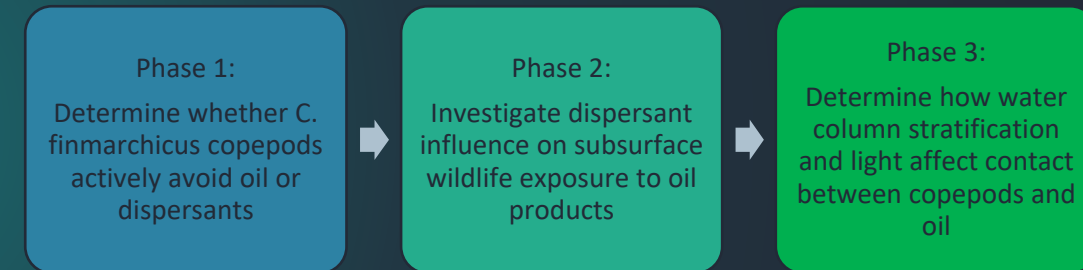
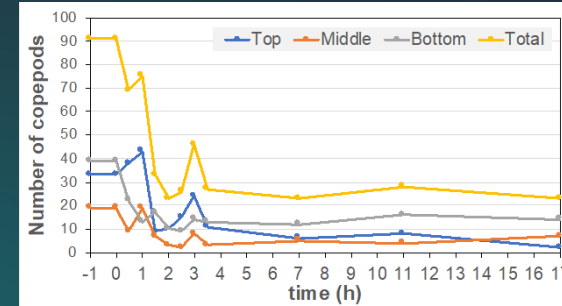
Mitigating the Damage to Arctic Copepods from Surface Oil Spills: When to Apply Dispersants

Project Description:

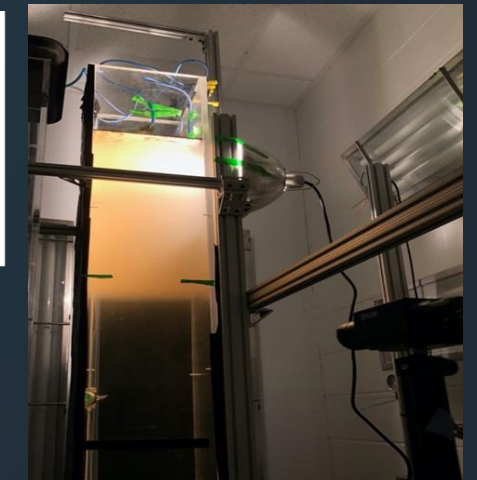
Copepods are tiny oceanic crustaceans that not only occupy an extremely vital niche in ecological food chains, but can serve a role as biodiversity indicators as well. This project's goal is to determine if Arctic *Calanus* copepods can spatially separate themselves from surface oil spills during portions of their developmental cycle. The primary benefit to stakeholders is a greater understanding of how oil spills and dispersants impact copepods.

Project deliverables/Transition:

1. Technical reports with all results of the research, delivered to USCG and DHS.
2. Three peer-reviewed publications, addressing each of the phases and objectives individually.
3. Make all data produced during this project publicly available at the Knowledge Network for Bio-Complexity data repository.
4. FOSC Crisis Response Guide



An example of PAH concentrations (ug/L) over depth (in), 0 hr., 2 hr., 6 hr., and 24 hr. after introduction of fresh crude oil (ANS).



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

ADAC's research seeks to provide practical solutions for operators. Scientific research sometimes provides divergent solutions – i.e., using one specific approach to examine the effects on an overall system.

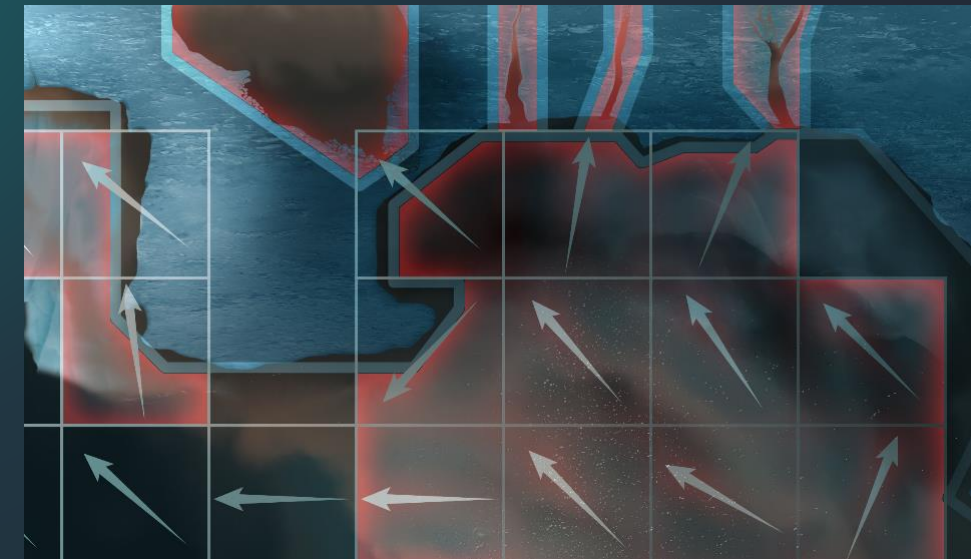
The goal of this project is to provide a path forward to improving Arctic oil spill response models by using convergent solutions – how to improve an overall system by potentially incorporating multiple approaches.

Project uses workshops and working groups of cross functional experts in oil spill modeling.

Project deliverables/Transition:

This project will result in a knowledge product describing:

1. Specific needs and questions that must be addressed by Arctic oil spill response models;
2. Current state-of-the-art Arctic oil spill models available;
3. State-of-the-art Arctic oil spill response model utility in response modeling;
4. Components from recent research efforts (e.g., Gulf of Mexico Research Initiative (GOMRI) useful for incorporation in order to improve current Arctic spill response models.



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Marine Induced Polarization Methods for the Detection and Mapping of Oil in an Arctic Marine Oil Spill; Including Investigation of Oil Within and Under Broken Ice Fields

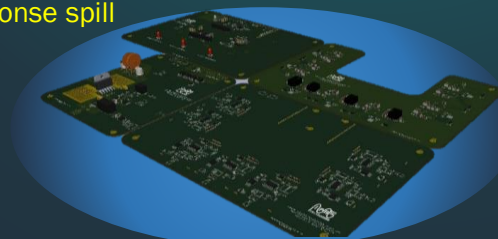
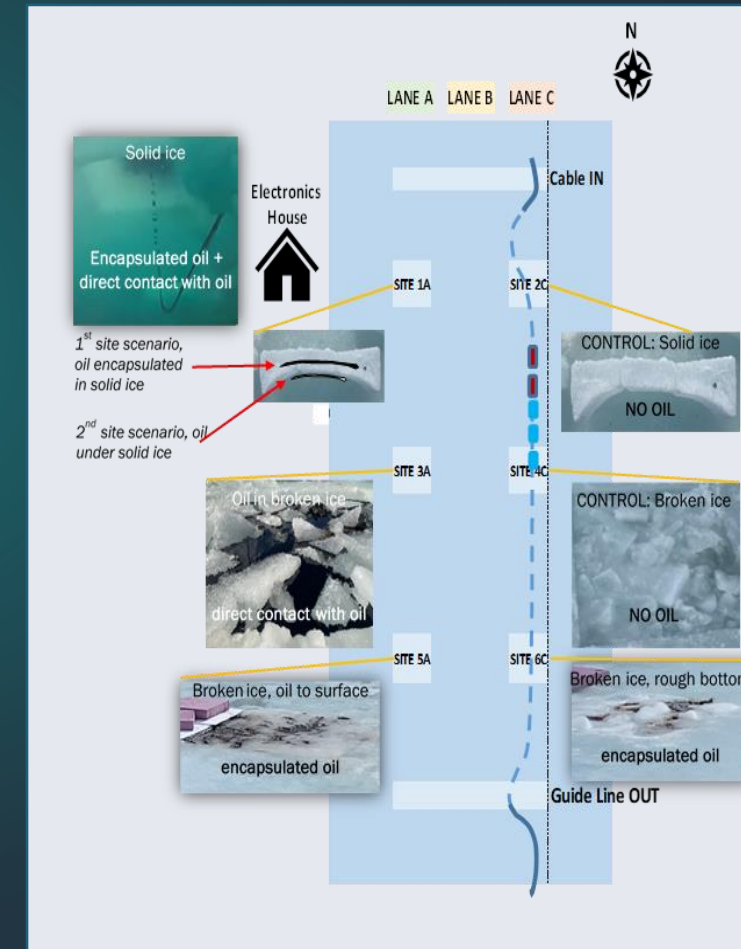
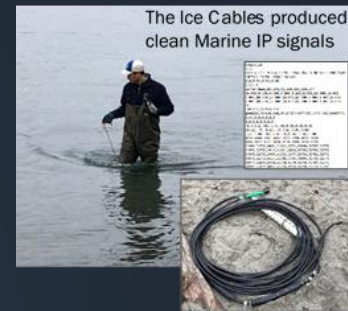
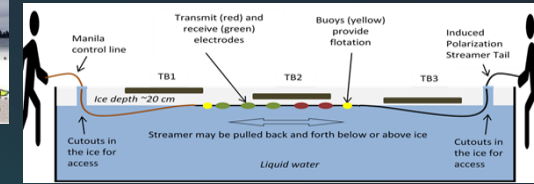
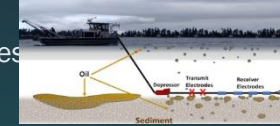
Marine Induced Polarization (IP) is a USGS-patented technology that takes advantage of material properties to sense subsurface materials, such as oil trapped in ice.

- In IP, a voltage is adsorbed (adhered to the surface of a material) through electrodes placed in the ground.
- A different set of electrodes measures subsurface electric resistance and capacitance. All materials have unique resistive and capacitive properties.
- Measuring subsurface capacitance and resistance enables identification of possible subsurface materials.
- Detecting location of trapped oil within or under broken ice fields greatly improves Federal On-Scene Coordinator decision-making capability.
- Planned research seeks to understand the ability of Marine IP to characterize the nature and mapping of Arctic oil spills, thereby honing ability to conduct effective oil spill responses.

Project deliverables/Transition:

The outcome of this research will be

1. **A series of knowledge products** (technical reports and supporting data) that may demonstrate Marine IP technology can be effectively utilized in the Arctic environment
2. **Marine Ready IP Kit as a prototype for rapid use in a crisis response spill**



3D rendering of new Marine IP hardware components: printed circuit board (PCB) layout

Ice Conditions Decision Index for the Great Lakes region

Project Goal:

ADAC researchers are finalizing an ice condition index (ICECON) for the Great Lakes for USCG operators and lake mariners, which uses available data to forecast ICECON up to 3 days into the future. This enhances ship safety, potentially reducing number of icebreaker deployments for rescuing vessels entrapped in ice.

With ice parameters collected by USCG and Canadian Coast Guard crews operating in the Great Lakes in the 2016-2020 time frame, the team has advanced Monte Carlo simulations to determine the most predictive relationship between the ice parameters and ICECON.

- The team is also using ice data from the 2013-2020 period in conjunction with AIS data to determine which parameters affect vessel speed and are important to ICECON.
- Researchers continue to pull nowcast and forecast data in real-time (every 6 hours), compute the ICECON nowcast and forecast, and display it on a project website...currently using Canadian Ice Services Environmental data.

Transition: USNIC projects ICECON Via AOS & Axiom Data Science Computation.

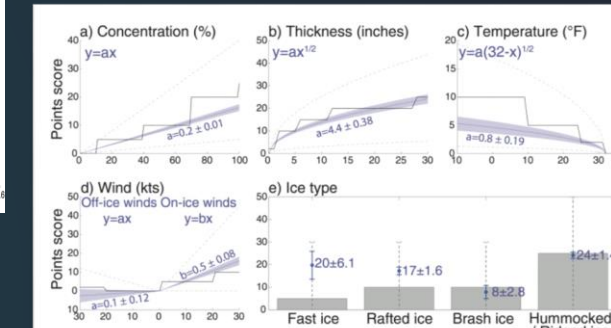
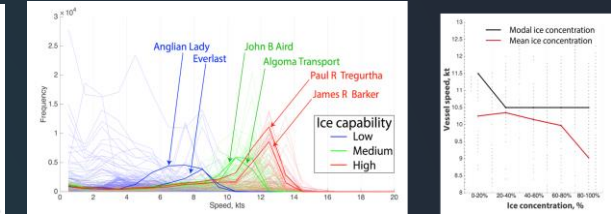
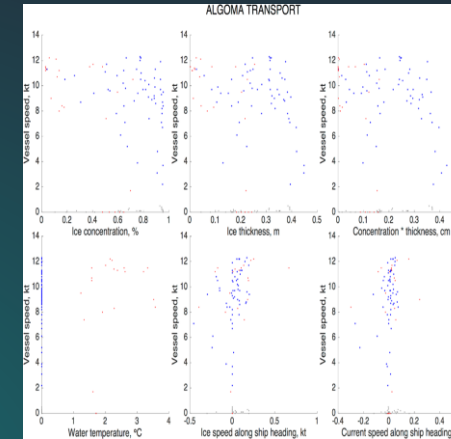
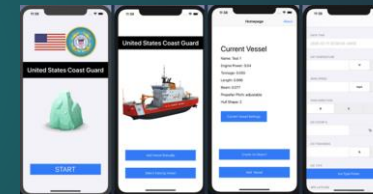
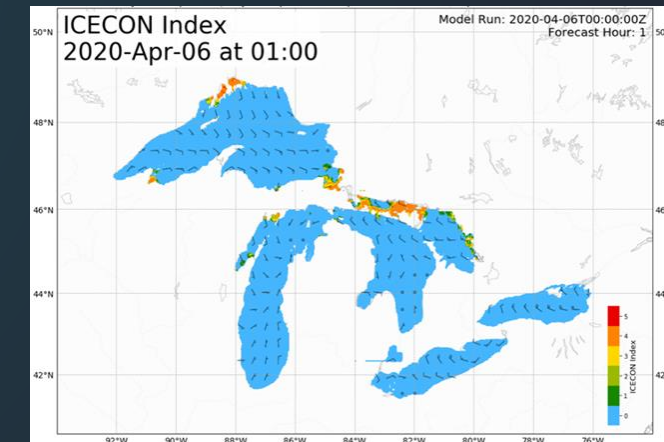


Figure 1: Graphical representation of scoring schemes used in the NIC algorithm (black lines and grey columns) and an optimized ICECON algorithm developed here (blue curves and error bars). The blue shaded region indicates the range of scores associated with the stated range of parameter values. The dashed gray lines indicate the initial range of parameter values used prior to optimization.



Phone application



ICECON Great Lakes Summary



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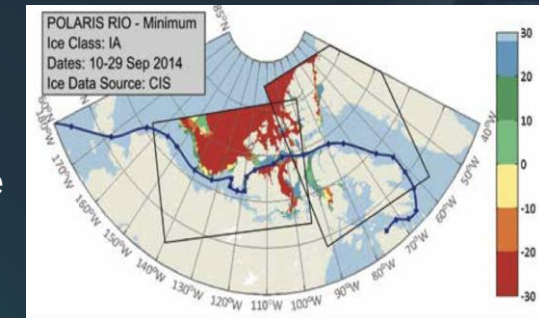
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Arctic Ice Condition Index (ARCTICE)

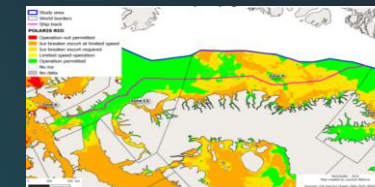
Project Description: ARCTICE produces an easy-to-understand numeral to communicate ice conditions that are relevant to the capabilities of an individual vessel. This index will be available for current and future ice conditions, providing forecasts up to 72 hours in advance. Based on prior Great Lakes ICECON investigations, research will provide marine operators a transition destination ready access to this information (such as the U.S. National Ice Center...USNIC) supporting vessel captains in route planning and determining associated risk with traveling through a particular region in Arctic Waters.

RIO	Ice Classes PC1-PC7	Ice Class below PC7 or not assigned
$RIO \geq 0$	Normal sailing	Normal sailing
$-10 \leq RIO < 0$	Elevated sailing risk, proceed sailing with caution	Sailing subject to special consideration (i.e., sailing not recommended)
$RIO < -10$	Sailing subject to special consideration (i.e., sailing not recommended)	Sailing subject to special consideration (i.e., sailing not recommended)

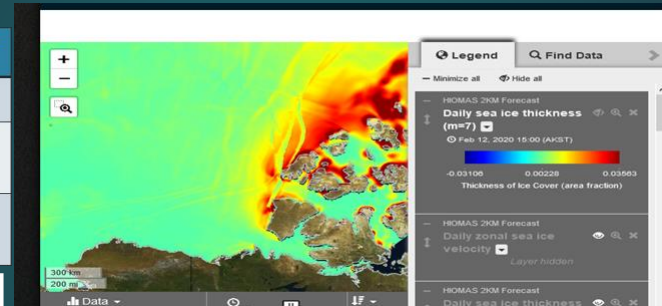
Increasing Ice Thickness (Severity)													
Winter Risk Values (RVs)													
Polar Ship Category	Ice Class	Ice Free -	New Ice 0-10 cm	Grey Ice 10-15 cm	Grey White Ice 15-30 cm	Thin First-year Ice 1st Stage 30-50 cm	Thin First-year Ice 2nd Stage 50-70 cm	Medium First-year Ice 1st Stage 70-95 cm	Medium First-year Ice 2nd Stage 95-120 cm	Thick First-year Ice 120-200 cm	Second-year Ice 120-200 cm	Light Multi-year Ice 250-300 cm	Heavy Multi-year Ice 300+ cm
A	PC 1	3	3	3	3	2	2	2	2	2	2	1	1
	PC 2	3	3	3	3	2	2	2	2	2	1	1	0
	PC 3	3	3	3	3	2	2	2	2	2	1	0	-1
	PC 4	3	3	3	3	2	2	2	2	1	0	-1	-2
	PC 5	3	3	3	3	2	2	1	1	0	-1	-2	-2
B	PC 6	3	2	2	2	2	1	1	0	-1	-2	-3	-3
	PC 7	3	2	2	2	1	1	1	-1	-2	-3	-3	-3
C	1A Super	3	2	2	2	2	1	0	-1	-2	-3	-4	-4
	1A	3	2	2	2	1	0	-1	-2	-3	-4	-4	-4
	1B	3	2	2	1	0	-1	-2	-3	-4	-4	-5	-5
	1C	3	2	1	0	-1	-2	-2	-3	-4	-4	-5	-6
No Ice Class		3	1	0	-1	-2	-3	-3	-3	-4	-5	-6	-6



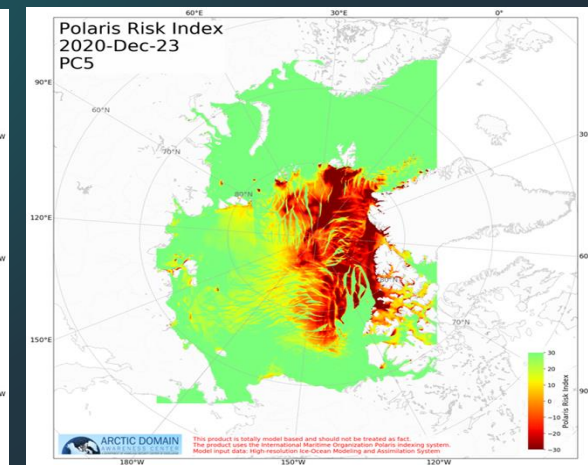
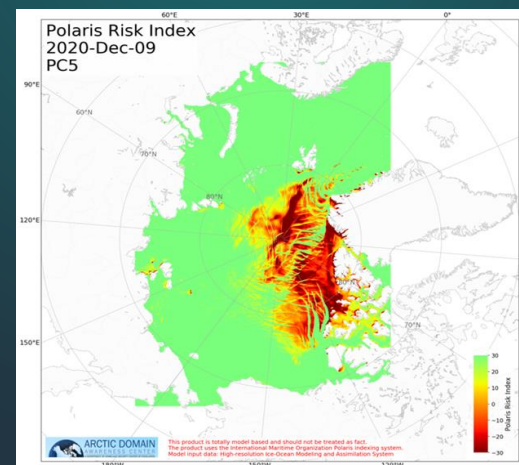
Broad area, low resolution idealized chart for ARCTICE output



High resolution/low area idealized chart for ARCTICE output



Currently leveraging HIOMAS for environmental factors



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Transition:

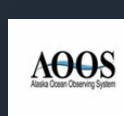
- USNIC to project ICECON Via AOOs & Axiom Data Science Computation.



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Arctic Domain All-Hazards WebGIS

Project goal:

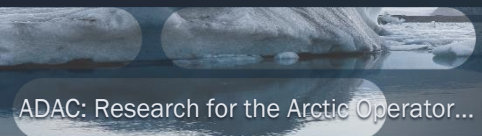
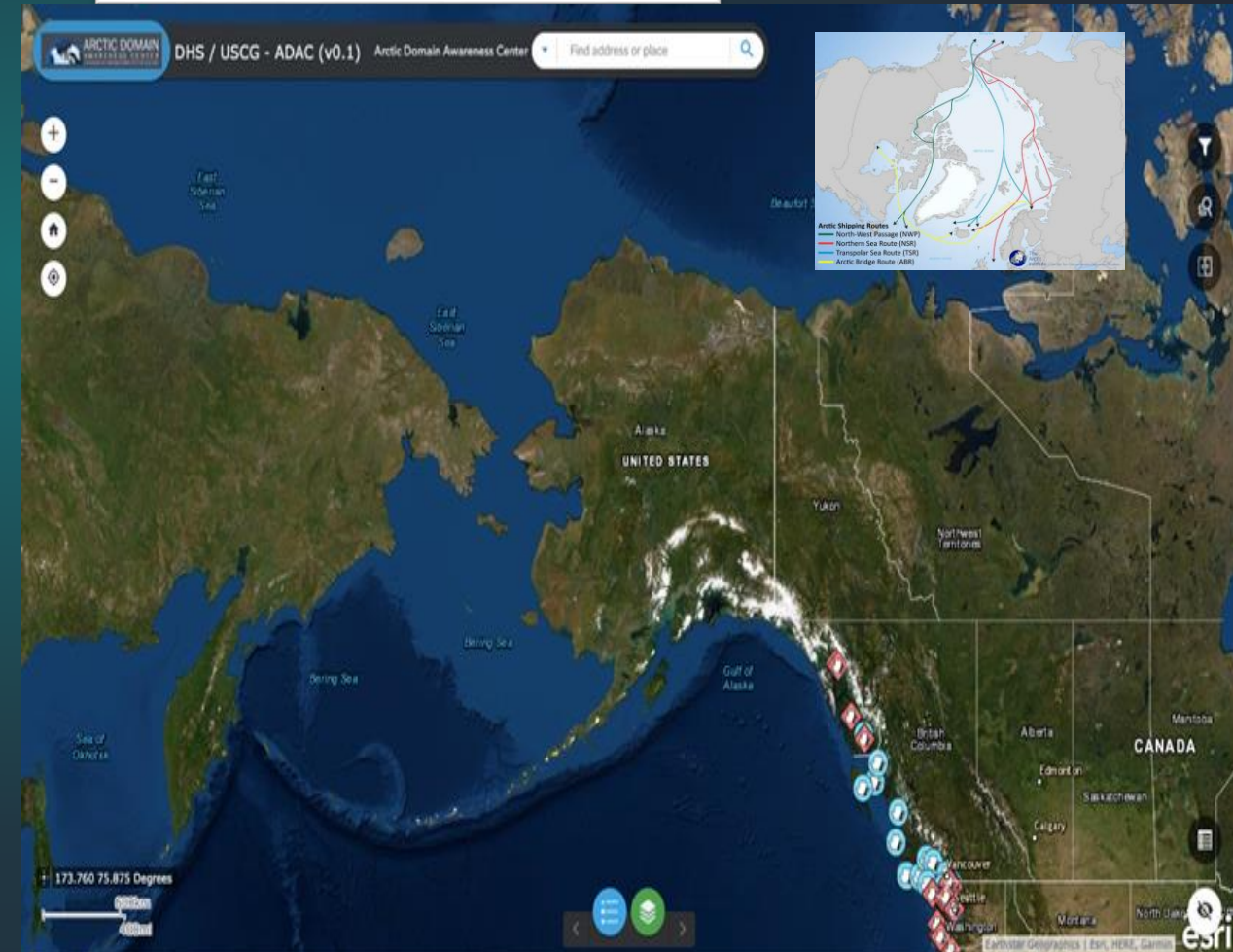
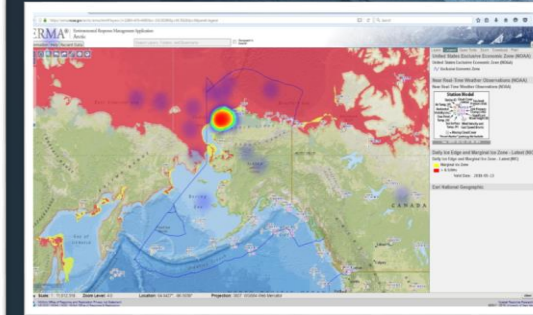
To assist and enhance U.S. Coast Guard domain awareness by developing an Arctic All-Hazards webGIS product built within the DHS Geospatial Information Infrastructure and the Homeland Security Information Network.

The All-Hazards project seeks to improve usability, interoperability, and function by developing the webGIS geo-visualization product.

Project phases:

- Phase 1: Interviewing, survey and research brief
- Phase 2: Data acquisition and development of web application
- Phase 3: Alpha Release
- Phase 4: Beta Release and user guide
- Phase 5: Go Live and Final Delivery
- Phase 6: Final Usability Report
- Phase 7: Submit peer-reviewed publication

Transition: Test application with USCG uniformed and civilian staff during alpha and beta testing, then house Arctic All-Hazards WebGIS within the GII/HSIN.



Arctic Vessel Monitoring Geofencing/ Alert Awareness

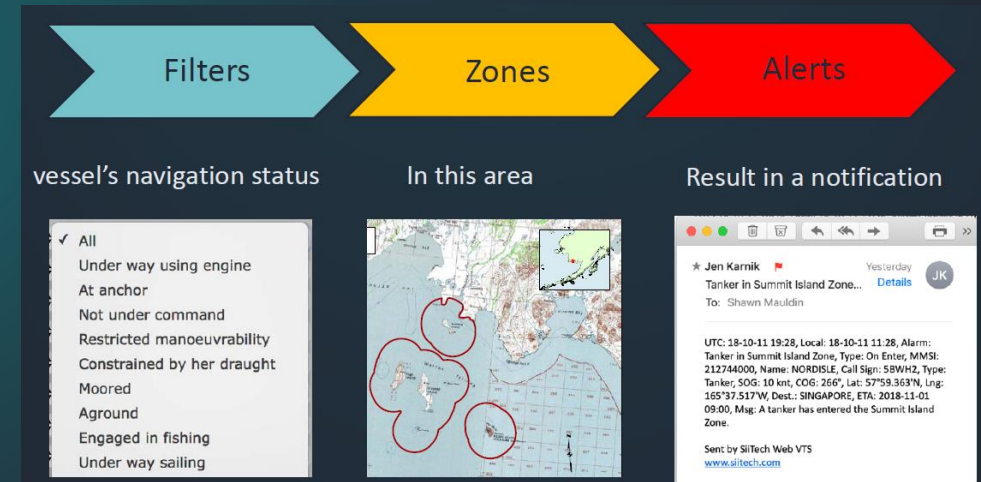
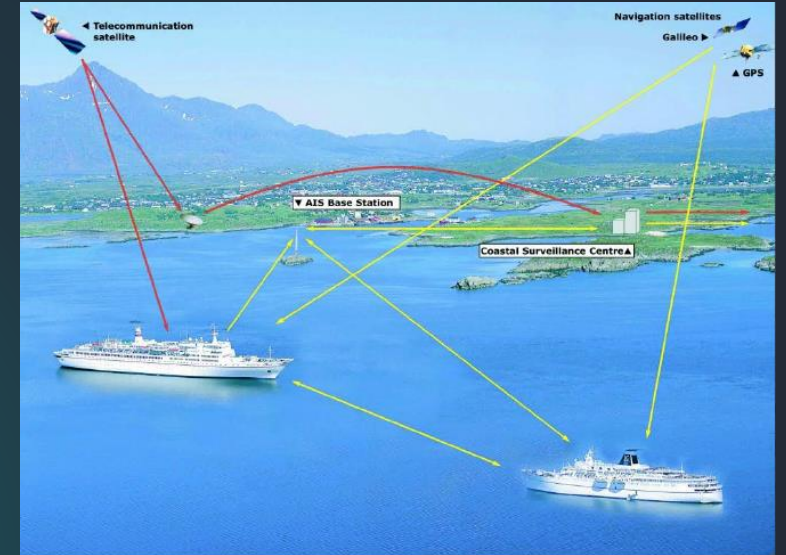
Advance Arctic Maritime Domain Awareness and Management by boosting the development and implementation of automated geofencing alerts to the U.S. Coast Guard to enhance maritime safety, security, environmental protection, and vessel regulatory compliance in U.S. Arctic Waters.

Two prong effort: 1. PACTRACS (for commercial mariner community) via Alaska Marine Exchange 2. USCG "CGOneView" for USCG operational watch standers

- Geofences can be customized by the end-user to meet agencies requirements.
- Have multiple filters and GIS overlays to better discriminate vessel type and activities.
- GIS files importable and exportable by end-users.
- Alerts and notifications can be received on multiple unclassified platform devices by government agencies.
- Geofence/alert notifications sent to Social Media/email platforms for other Federal/State agencies and Arctic stakeholders.
- Coastal Communities receive tailored notification and alerts.

Supports: U.S. Coast Guard, State of Alaska, and the maritime industry within the U.S. Arctic Exclusive Economic Zone

Transition: PACTRACS version completed and mid-way for developing CGOneView edition in coordination with HQ USCG.



Propeller Driven Long Range Autonomous Underwater Vehicle

Project Description:

LRAUV is helicopter portable, carrying an environmental mapping payload which allows rapid response to provide situational awareness and damage mitigation for first responders/USCG.

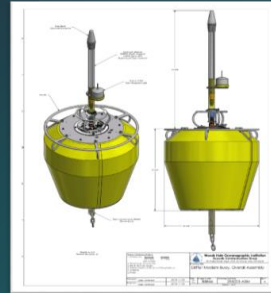
Initial Capabilities (expandable):

- Ability to map in 3D.
- Extended unattended deployment (days to weeks).
- 600 KM range...under ice.
- Detection and quantification of dissolved particles and fluorescent material (with current sensor package).
- Environmental characterization.

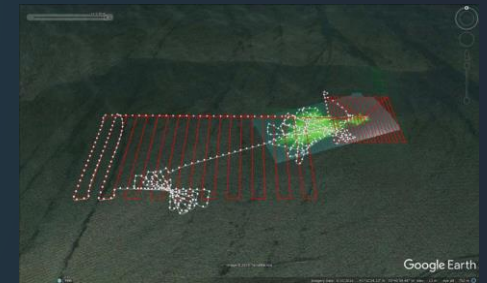
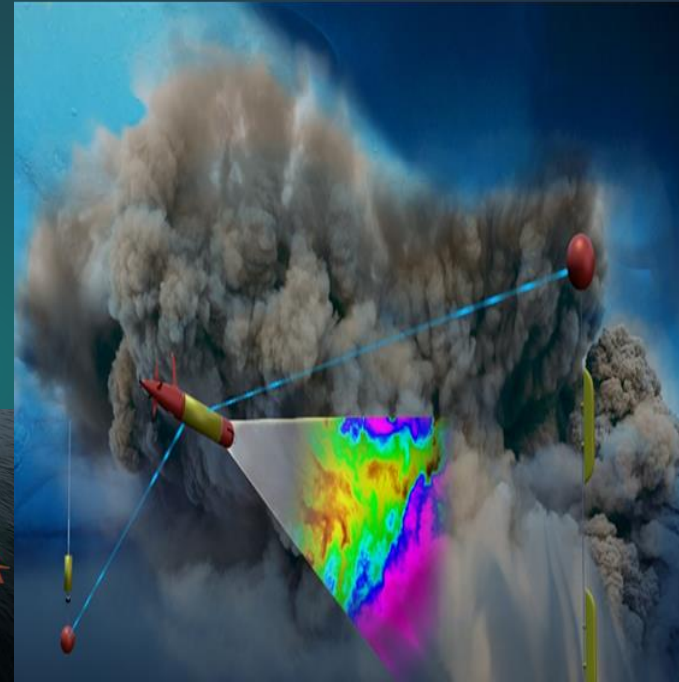
Transition: CG-926, USCG RDC & or Commercialization.



Monterey Bay Aquarium
Research Institute



Tethys testing deployment
January 2018 being operated
from a cell phone in
Monterey Bay California



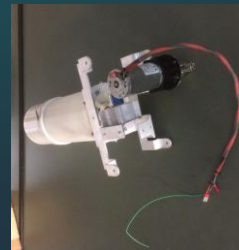
Photos of LRAUV, fabrication at MBARI



Vehicle cart and
Nbell/chassis



Thruster assembly



Variable Ballast Assembly



Plume mapping auto detection
and mapping Buzzard Bay MA,
(Prototype) November 2016 and
Actual vehicle, Monterey Bay 2018



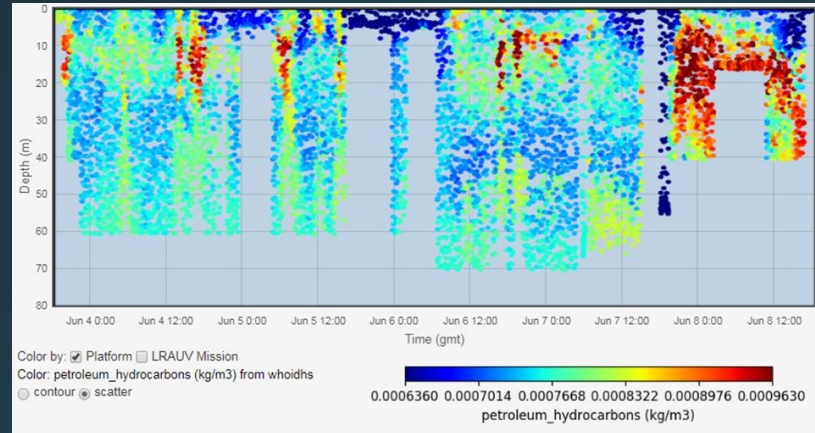
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Propeller Driven Long Range Autonomous Underwater Vehicle Page 2

"It's the data" that drives decision making for FOSC

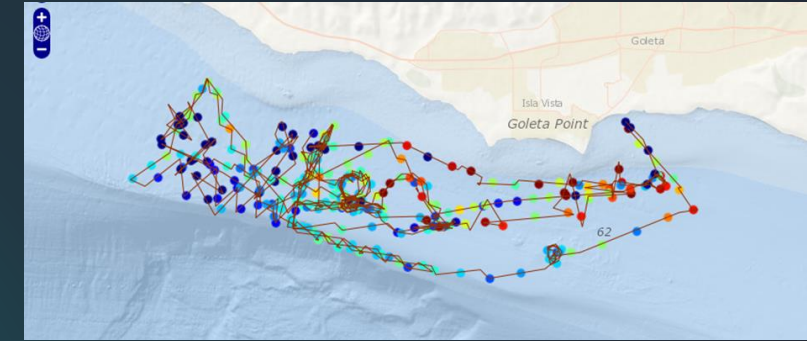


Detections of petroleum hydrocarbons from the SeaOwl onboard the LRAUV are displayed on the dashboard

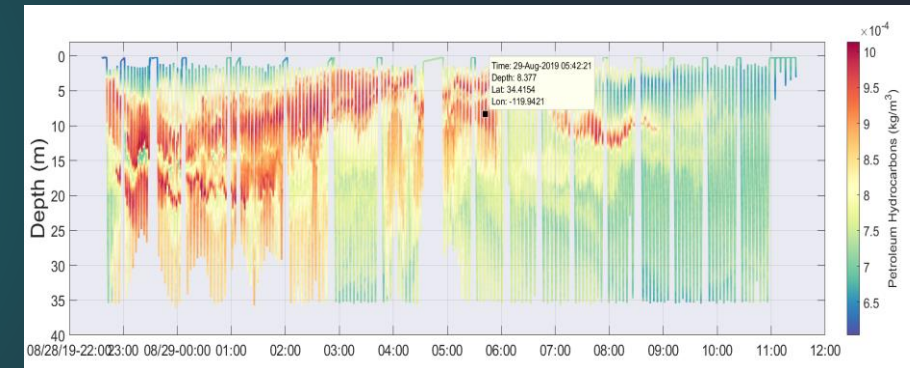
LRAUV ice camp as seen from a UAV. Shown is a 3x9 foot hole with a simple gantry used to hoist the LRAUV in and out of the water.



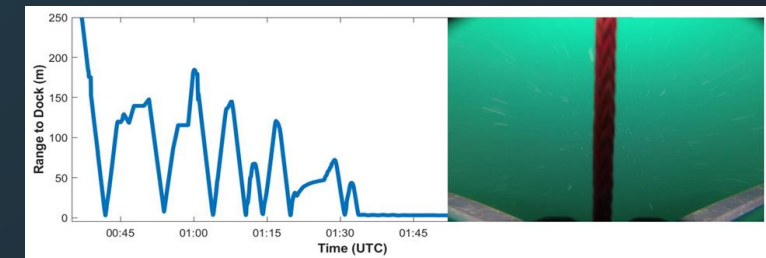
LRAUV is docked under ice to the Arctic buoy cable and awaits its next mission command.



LRAUV route during Santa Barbara seeps testing



Near real-time data as seen from the web portal that the LRAUV sends data to which is accessible from the Dash website



LRAUV Docked to a 3/8 line! The plot of the vehicle's acoustic ranges to the dock show it making a few passes before finally docking.

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

This program will develop a trained pilot team (planned at five individuals) within the community of Unalakleet, versed in the operation of off-the-shelf U.S. made UAS technologies



Project goals:

1. Create a knowledge product providing analysis of experiments using multispectral sensor capacity to support infrastructure monitoring
2. Co-produce a UAS-based monitoring program focused on USCG regulated bulk fuel facility inspections and emergency response, with the Alaska Native Village of Unalakleet
3. Understand the feasibility of expanding the developed monitoring program to communities throughout the Norton Sound region to effectively support CG facility inspections and the response efforts in remote western Alaska
4. Determine if this project can be used as a roadmap for that expansion

Drone footage taken of a Modern Blanket Toss mission in Shishmaref, Alaska, in April 2014. (Photo courtesy Charlie Parr/Alaska Upward Bound).

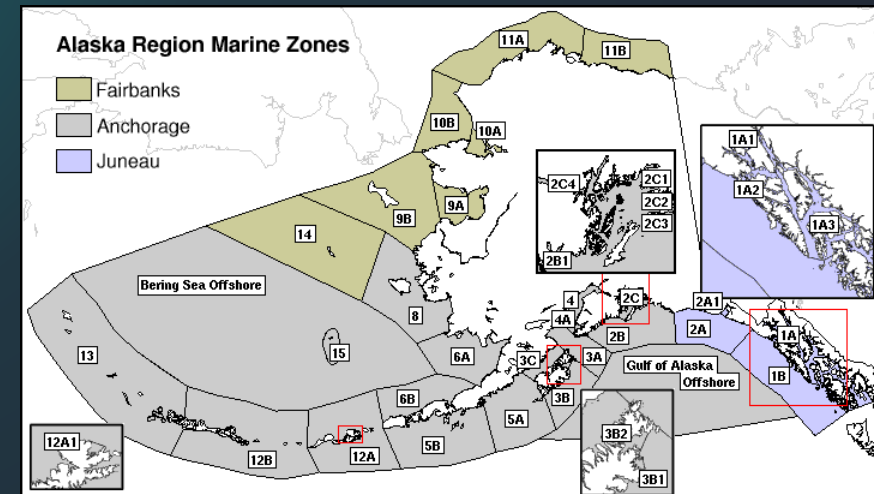


Alaska and Arctic Maritime Communications and Connectivity Analysis (AAMC&CA)

Project Description: This project provides a comprehensive review of mariner communications and connectivity mission needs for the Alaska and the U.S. Arctic Extended Economic Zone (EEZ), with a particular focus on the Arctic (based on near, mid-term, and long-term time horizons)

The knowledge product will contain:

- Comprehensive review of mariner communications and connectivity needs for the Alaska and the U.S. Arctic Extended Economic Zone (EEZ)
- An updated and expanded market survey current communications technology
- A geographic review of communications/ connectivity shortfalls
- A technology-focused review of known/understood existing capabilities, assessed against researched gaps for the high latitudes
- An expert-derived set of options and recommendations



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Arctic Facilitates and Infrastructure Environmental Change Index

This project provides the U.S. Coast Guard an “Arctic facilities and infrastructure environmental change” risk index, training guide, and comprehensive knowledge product to inform U.S. Coast Guard operations and inspections in order to manage inspection and response decision risk in a rapidly changing Arctic environment.



Drew Point, Alaska Photo from USCG.gov



Bonanza Fuels, Nome, Alaska Photo from AIDEA.org

Objective/Purpose.

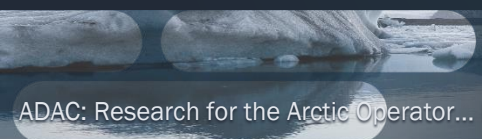
This project will address direct concerns regarding structural risks of facilities and infrastructure in Arctic Alaska due to cumulative effects of environmental change.

Based upon analyzing these concerns, this research will address two principal questions:

1. What are the risks and severity to USCG monitored facilities along the Arctic coastal regions of the Bering, Chukchi and Beaufort Seas?
2. What are the risk weightings related to the USCG monitored facilities along the Arctic coastal regions?

Project outcomes for the research:

Synthesize published literature, existing data from available sources, USCG infrastructure and incident reporting, and consolidate expert opinion to establish a baseline knowledge project in support of USCG Project Champion and USCG Project stakeholders. This information will guide and inform the project’s interdisciplinary workshops and focused working groups. Examples provided: Alaska District U.S. Army Corps of Engineers, State of Alaska Department of Environmental Conservation, Denali Commission, University of Alaska Fairbanks Institute of Northern Engineering, Associated State of Alaska Boroughs, Ports and Villages associated with USCG designated infrastructure and facilities of concern and others as determined by the research team and established project research groups.



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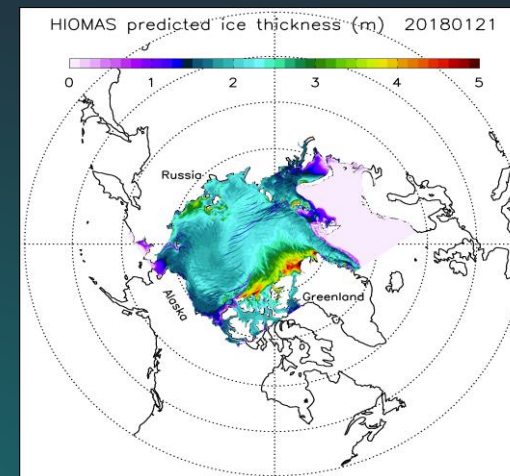
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High resolution Modeling of Arctic Sea Ice and Currents

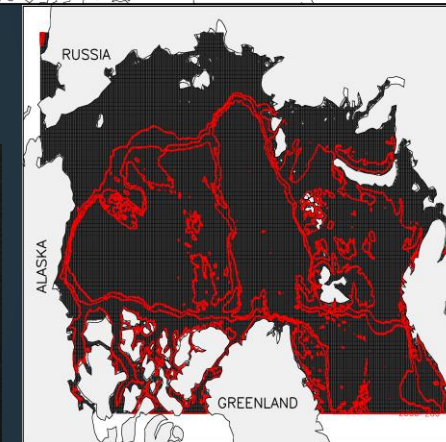
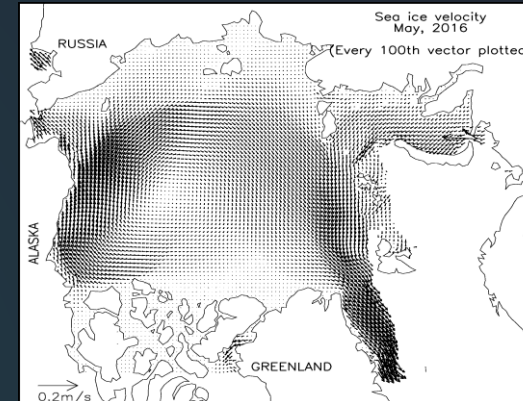
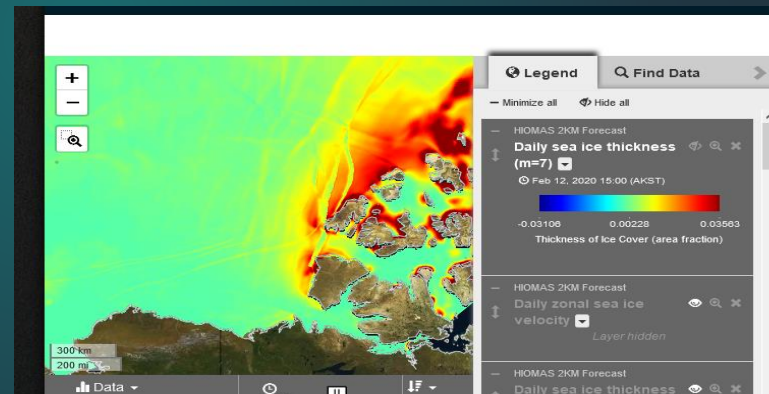
HIOMAS (High-resolution Ice-Ocean Modeling and Assimilation System)

- A forecast system that can distribute the forecast data to the Coast Guard and other Arctic stakeholders.
- Developed 3 versions of HIOMAS with 6, 4 and 2 km horizontal resolutions. **Now 24 Factors of detail!**
- Assimilate satellite sea ice concentration in HIOMAS hindcast to improve initial conditions for forecast.
- Calibrated and validated HIOMAS hindcast using sea ice observations; no excessive ice thickness buildup in areas such as the Beaufort Sea.
- Conducted (near) real-time hindcast and daily to seasonal forecast of Arctic sea ice and currents.
- Prototype 1 KM resolution version for the US. EEZ for Bering, Chukchi and Beaufort Seas
- **Publishing...Bi-weekly, 7 Day Hindcast, 30 Day Forecast**

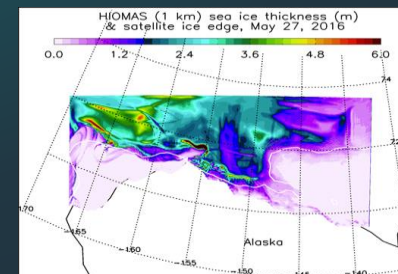
Transition: Completed to AOS and Axiom Data Sciences as destination to publish to NOAA, NWS, & US National Ice Center



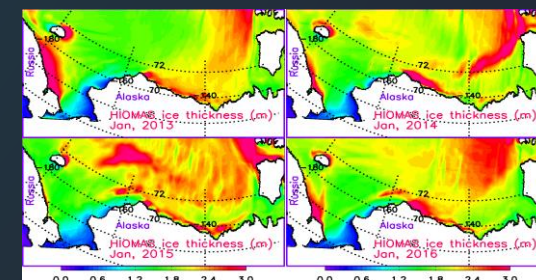
2 km resolution Pan Arctic HIOMAS



Ice ridges above and month to month planning below...



1 km resolution HIOMAS...US Arctic EEZ

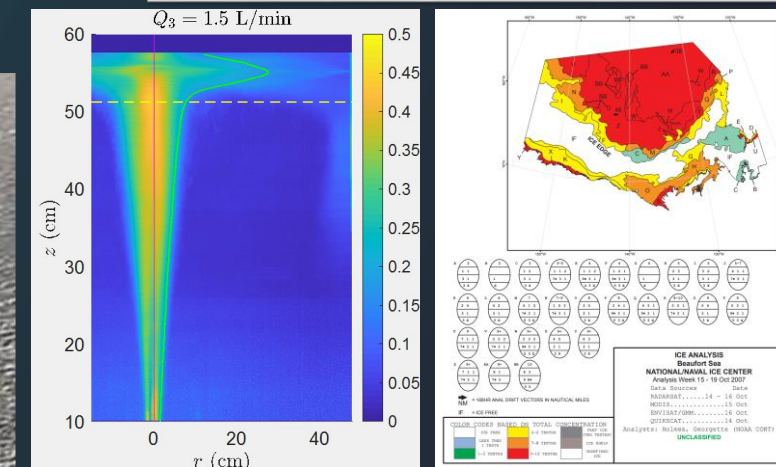
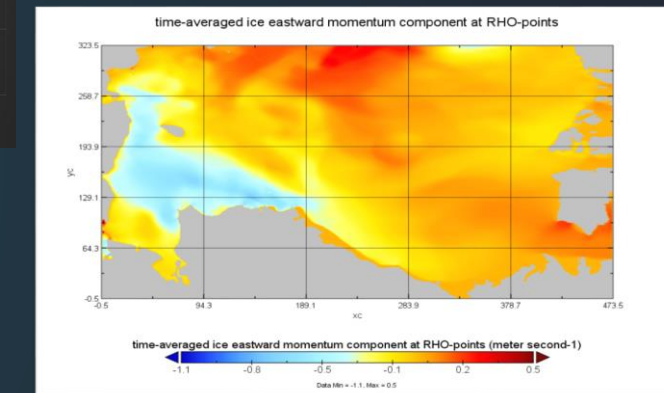
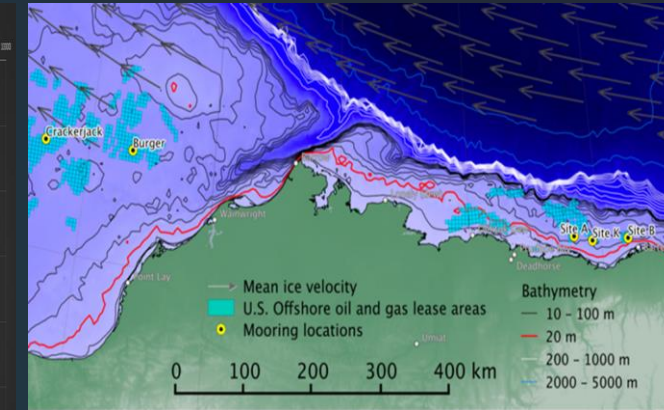
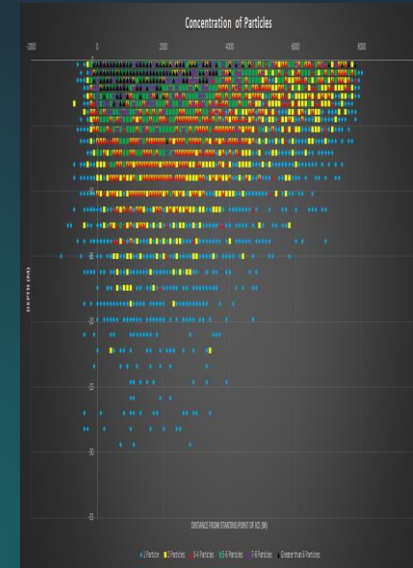


Arctic Oil Spill Modeling (AOSM)

Project assists U.S. Coast Guard and the NOAA Office of Response and Restoration with the development of an Arctic-capable oil spill model that can be leveraged via NOAA's General NOAA Operational Model Environment (GNOME).

- Worked with NOAA to develop a new variable within GNOME: under-ice storage capacity.
- Ice storage capacity has been estimated at several locations in the Chukchi and Beaufort Seas, based on ice draft data.
- Provided 3 D model support for LRAUV.
- Improving integration of TAMOC with GNOME to include all oil fate processes.
- Training with NOAA staff to use TAMOC and AOSC algorithms within GNOME.
- Capable of “On-demand” support (such as Cook Inlet Methane Leak).

Transition: Completed to NOAA's GNOME.



Credit: Cook Inletkeeper

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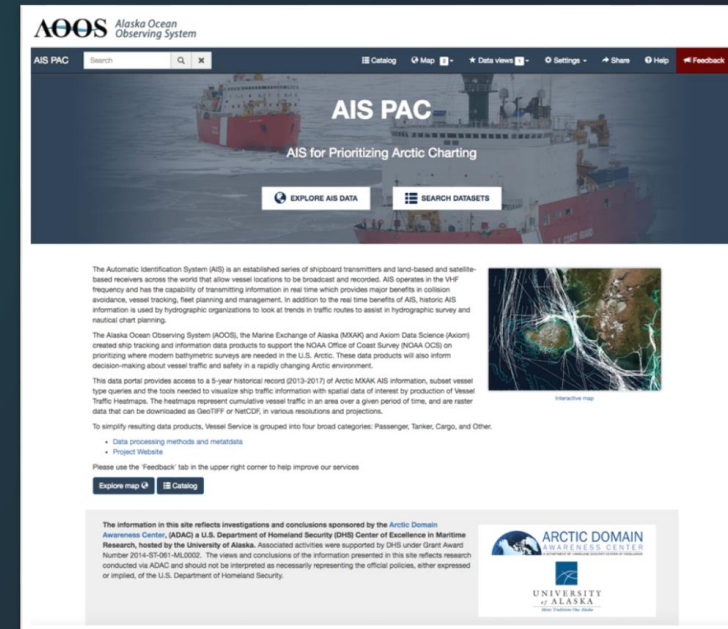
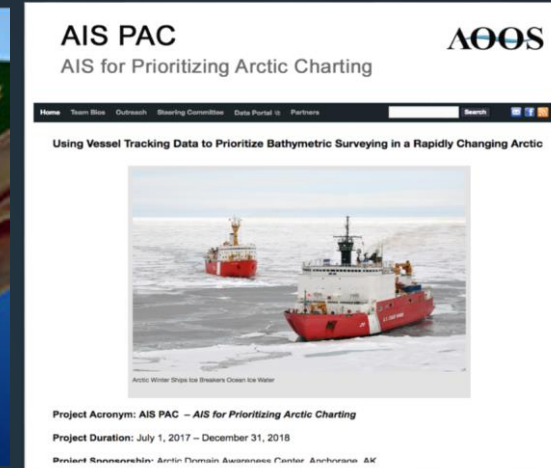
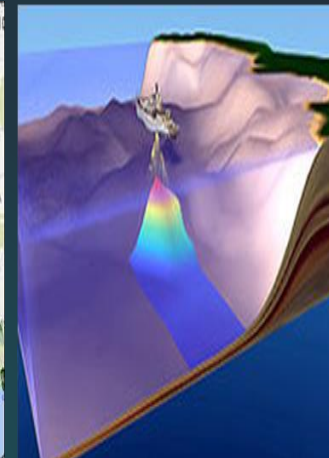
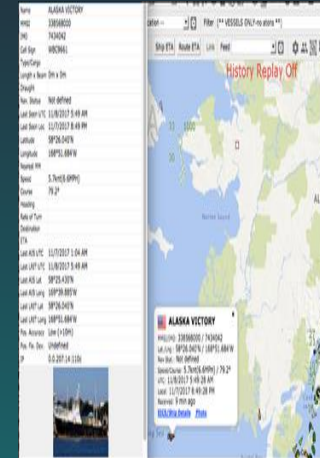
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Using Vessel Tracking Data to Prioritize Bathymetric Surveying

Project creates products that inform decision-making about vessel traffic and vessel safety in a rapidly changing Arctic environment.

- The research effort is develop the capability to reduce execution time for handling and analyzing exceptionally large collections of Automated Information System (AIS) vessel tracking data.
- A large data analytics effort.
- Gridded files provide the extracted AIS information needed for decision makers and stakeholders in the U.S. Arctic area.

Transition: Completed: A set of knowledge products useful for USCG and NOAA to apply to survey/mapping efforts for Alaska (including Arctic Alaska). **Now being leveraged for NOAA Summer Bathymetric Surveys**



AOOS AIS-PAC Completed Project Webpage: <http://aoot.org/ais-4-bathy/>

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Crisis Response Sea-Ice and Weather Forecasting tools

Research project strives to improve USCG and other DHS Arctic maritime operator situational awareness and crisis response by enhancing support for planning and emergency response to meteorological and environmental marine hazards in the Arctic.

- Literature Reviews and interviews with a host of marine operators.
- Identification of hazardous ice events using coastal radars:
 - Ice Convergence, Landfast ice breakout and Anomalous ice motion.

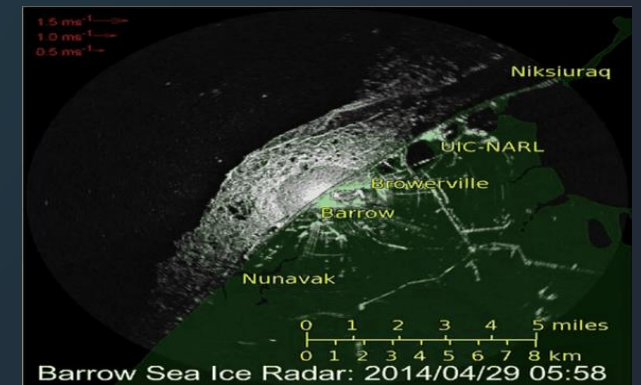
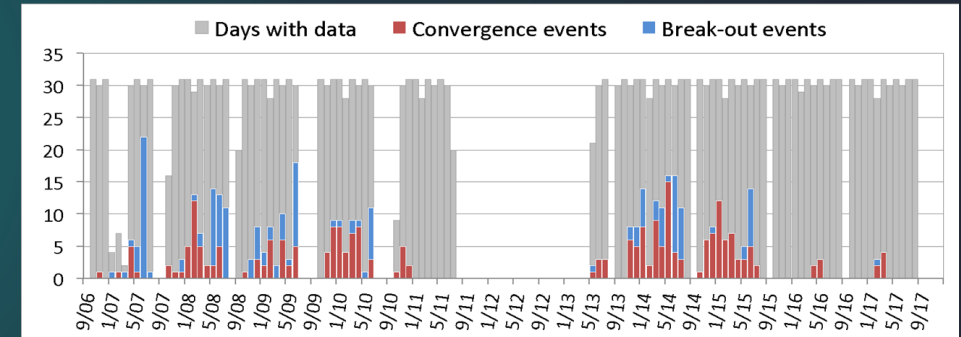
Transition: Researchers developed decision support tools, grounded in stakeholder interactions, to support weather and sea ice-sensitive decision making. Developed a prototype with software and hardware in the Barrow region. Provided prototype observations provided via AOOs to NOAA/NWS Observations. Established working prototype at Barrow Arctic Research Facility in conjunction with UAF and Sandia National Labs

Phase 1: Preliminary tool development

- 1a: Assess decision context
- 1b: Develop early warning systems for coastal ice hazards
- 1c: Define hazard notification formats and procedures

Phase 2: Stakeholder feedback and Tool optimization

Phase 3: Outreach Data dissemination and Evaluation



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Exploring Enhancements to Arctic Communications and Domain Awareness using the ASF CubeSat Antenna Farm Experiment (CAFE)

Project is direct USCG award, that partners ADAC and University of Alaska Fairbanks' Alaska Satellite Facility to conduct cube satellite research in support of USCG Arctic Communications shortfall research via a Mobile CubeSat Command and Control (MC3) antenna system and radome at the Alaska Satellite Facility. Research will increase USCG knowledge on Arctic communications and viability of Cube satellites to improve maritime communication in Bering, Chukchi and Beaufort Seas.

Transition: Depends on directions from HQ DHS S&T.



<https://www.nasa.gov/feature/goddard/2016/mini-nasa-satellite-begins-environmental-testing>

4 Dec 2019: Satellites Kodiak and Yukon deployed on Polar Low Earth Orbit...Kodiak functioning in accordance with plan, but while Yukon initially functioned, communications was lost shortly following first contact.

However, **experiment is considered a success.**

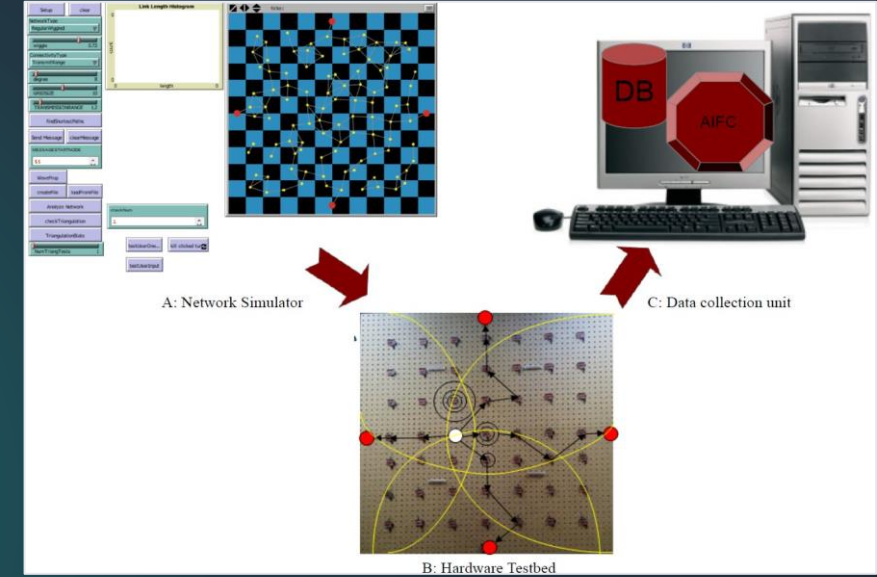
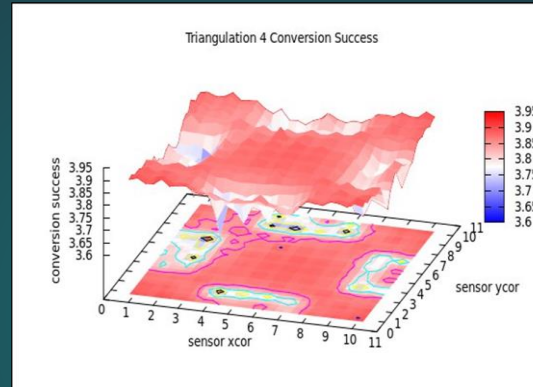
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Low-Cost Wireless Remote Sensors for Arctic Monitoring and Lifecycle Assessment

The Arctic is hard to constantly monitor. In order to resolve this problem, low-cost wireless sensors were developed to detect an input event, analyze detected events, and communicate that event data to other sensors in the network.

These inexpensive, self-organizing network devices reliably computed and communicated detected human, animal, and environmental events. By utilizing a variety of sensors, it was possible to detect sounds, vibrations, radio and cellphone signals, location, and more based upon the needs of each sensor.

When implemented, the project would have provided a quick method to deploy and monitor an Arctic region. Potential uses were events such as ice breakup, environmental events, model validation, vehicle detection in regions of concern, or even assisting with the safety monitoring of personnel and equipment during training exercises.



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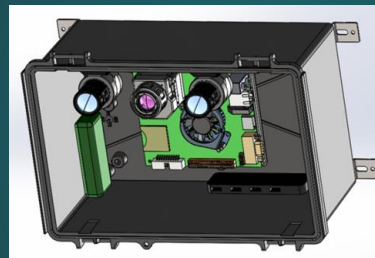
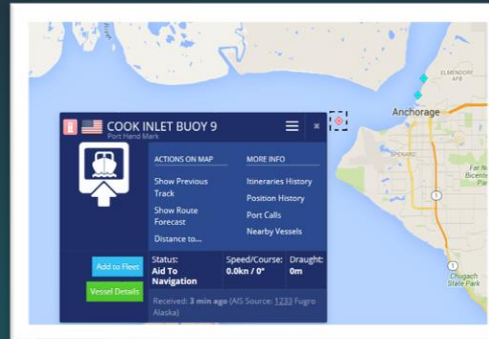
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Smart-Cam Computational Photometer

The goal of this project was to construct a proof-of-concept visible two channel (optional visible + long wave infrared multispectral) camera proof of concept to be tested at the Port of Anchorage. The proof-of-concept was to be constructed using all off-the-shelf hardware components and used to form a baseline of comparison for the longer-term Computational Photometer (“Smart-Cam”), for a longer-term goal of the research, for Arctic operations with drop-in-place multi-spectral and stereo vision cameras.

From the proof-of-concept it was expected that challenges of long-term battery operations, drop-in-place packaging for Arctic environments, and power efficiency and methods to recharge can be better understood for follow-on phases.

Potential uses were for oil detection under ice in an AUV and tracking and detecting vessels, animals, and people in fog and ice environments typical of the Arctic.



<http://www.uscg.mil/d17/cqcspar/>



<http://www.oceanpowertechnologies.com/>



<http://www.esrl.noaa.gov/gmd/obop/brw/>



Community Based Observer Networks for Situational Awareness

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 are potentially useful to enhance the precision of data from other Arctic Observing Networks (AON) by placing them in situational contexts.



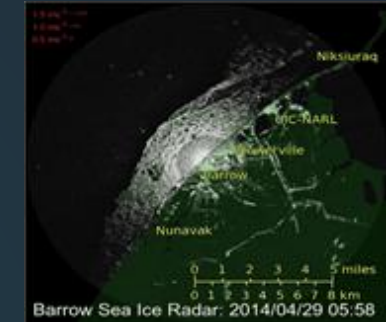
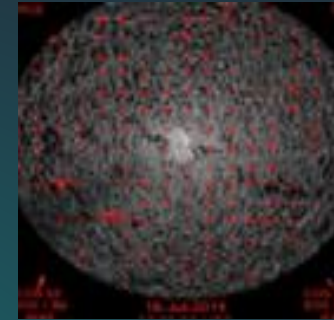
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Identifying, Tracking and Communicated Sea-Ice Hazards in an Integrated Framework

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. This project focuses on those hazards associated with ice in the ocean such as 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 Utqiagvik (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 transferrable to ship-based platform, where it is potentially useful to provide tactical information about ice conditions to crew.



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Community Based Observer Networks for Situational Awareness

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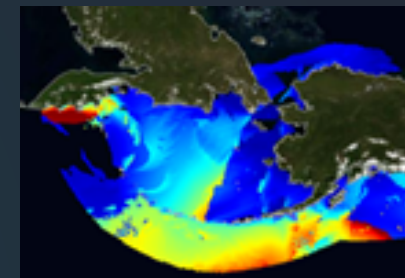


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Real-Time Storm Surge and Coastal Flooding Forecasting for Western Alaska

University of Alaska Anchorage (UAA) developed a high-resolution storm surge model for the Yukon-Kuskokwim 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. The ocean boundary of the storm surge model was “forced” by real-time and forecasted water level data generated by National Weather Service’s Extra Tropical (ET)-Storm Surge model. In addition, we developed a hindcasting storm surge model for the Norton Sound.

The model was forced on its ocean boundary by output from a coarse grid ADCIRC storm surge model developed by the U.S. Army Corps of Engineers. 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 model wave calibrated and validated using nearshore water level data and using satellite observations of inundation extent.



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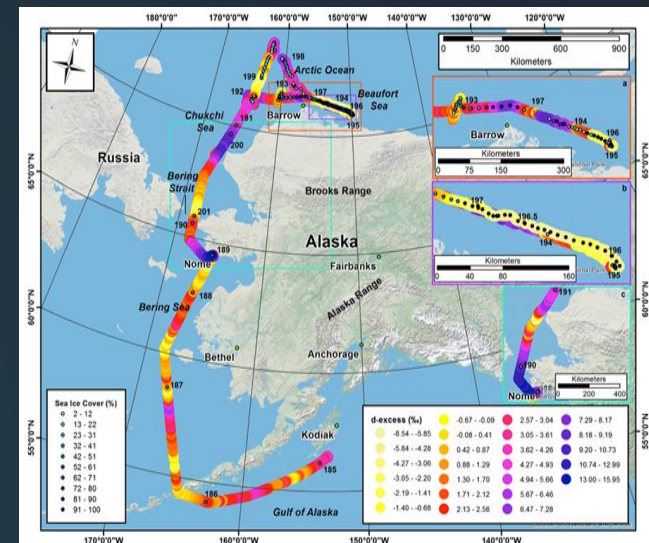
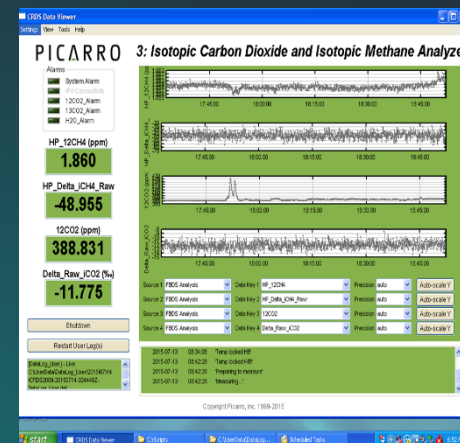
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Monitoring Intentional and Unintentional Catastrophic Events: Detecting sea ice and oil spills through measurement of the H₂O and C isotope geochemistry in winds.

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. Research measured 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. Our primary aim is 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, team detected unusual petroleum events in the marine environment, developed a visualization model that will display petroleum (carbon) in the environment across a range of categories (green=ambient/background conditions; yellow=changing conditions; red=extreme changes-i.e. vessel or aircraft emission plume or oil spill plum in the direct vicinity). Our primary findings are that sea ice conditions are reliably reflected in situ on ships as is the presence of aircraft emissions. Shore based systems (Port of ANC) are more complicated and sea ice coverage detection is less reliable, in our case do to the distance (~100 yards) of the measurement system from the ocean.

Winds and seawater of the maritime environment are to be 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 was accomplished by measuring these attributes while transiting from the Gulf of Alaska to the N end of the Chukchi Sea (78°N) on the USCG Healy as well as placed-based stations in Cook Inlet/Port of Anchorage.



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Mariner Ice Navigation Courseware for IMO Polar Code

This project saw the development of an advanced ice navigation course required by the Polar Code for all masters and chief mates operating in polar waters.

Through this project, a class and simulator was created to teach the basic and advanced ice navigation courses satisfy these requirements for U.S. mariners. Upon completion of these courses, American ship's officers will have met or exceeded all Standards for Training, Certification, and Watchkeeping (STCW) required by international maritime law.



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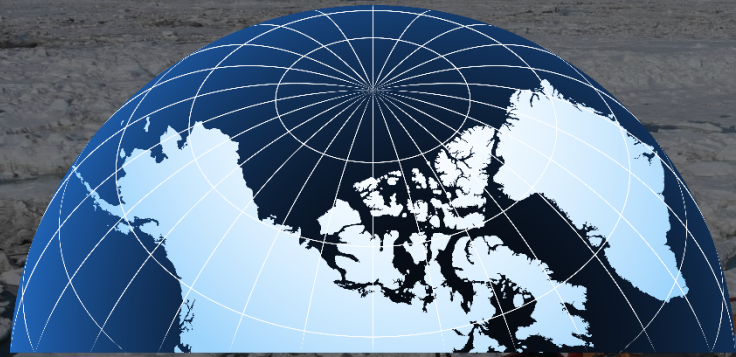
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Ready for Questions & Discussion

...Thank you for your attention!



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