ADAC Summary Overview
7 May 2020

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 Alaska Native communities.
ADAC Overview and Summary

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
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 a educational Programs
(Some) of the Challenges faced by the maritime operator

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

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

Goal = Strengthening Research Partnerships in support of Operations
ADAC Overview and Summary

ADAC Organization and “web of control and coordination”

Board of Directors
DHS S&T OUP PM
Chancellor & Provost

ADAC Leadership Team

Principal Customer: U.S. Coast Guard

ADAC Research Network

ADAC Center Management Team

ADAC Research Projects

ADAC Executive Counselors (External Advisors Board)

President
Douglas Causey
Larry Hintzman
Randy "Church" Kee
Jason Roe

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

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

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

Ukallaysaq Okleasik, Vice President of External Affairs, Sitnasuak Native Corporation, Nome, Alaska.

Tom Case, Lt Gen, USAF (Ret), Chancellor Emeritus, UAA, Anchorage, Alaska.

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

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.


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.
ADAC’s Research Network...of both current and completed investigations...contribute to building bridges and partnerships!

• ADAC’s Research Network has been crucial in helping the Center advance in Building Agency Partnerships
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.
ADAC’s “Arctic Environmental Security” Course (BIOL 490/690)

Experimental course co-instructed by ADAC Principal Investigator and Executive Director at UAA Spring Semester 2018 and 2019

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.
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.
Addressing problems...via interconnected research
Such as increasing forecasts of sea ice and queuing bathymetry surveys...to improve safety of Arctic shipping
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.
ADAC’s Current S&T Research Projects

- ICECON
- LRAUV
- ASIP
- Arctic GIS
- Geofencing
- Arctic Copepods
- Arctic Mussels
- AMSM
- MIPM
- ARCTICE

Note: Anticipating approximately 4 new projects from Arctic IoNS 2019 Workshop
ADAC’s Recently Completed S&T

HIOMAS
SIWF
AOSM
AIS-PAC

ADAC’s Prior Completed or Concluded S&T

CBONS
AIFC
Arctic Sensors
IHIF
MMA
CubeSat
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 Medium and Long Term Environment (MaLTE) Workshops

Tailored workshops that “Look long term to identify emerging trends, challenges and opportunities”

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.

In support of HQ U.S. Coast Guard “Evergreen” (for future concepts) and HQ U.S. Coast Guard Arctic Advisors to the Commandant.

Goal: Produce Knowledge Products ...focused on USCG needs
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
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. This includes:

- Approved project research support.
- Center activity research (such as workshop reports and literature reviews).
- Individual research activity (with assigned ADAC mentor)
- Minority Serving Institute participation.
- Summer Internships.
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.
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 Project Champions,
- U.S. Coast Guard Stakeholders and advocates,
- Other DHS maritime mission communities,
- 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.

Arctic Domain Awareness Center’s Next “Customers and Partners” Roundtable
20 June 2019 via Teleconference

The Center will host its Final Program Year 5, Customer and Partner’s Roundtable via webinar on Thursday, 20 June 2019, with Center update, Project Reviews and associated Customer and Partner Feedback Discussions from 1:00-5:00 PM Eastern Daylight Time (9:00 AM-1:00 PM Alaska Daylight Time). Please join us at ADAC Teleconference information. In order to connect with each of the above teleconferences, ADAC provides the following new contact (Zoom) information: https://zoom.us/j/7691540232. If the link does not work, you can dial 1 408 638 0968 or 1 646 558 0232. Meeting ID is 769 154 0232, Participant ID is 14.
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.
Ready for Questions & Discussion

...Thank you for your attention!
So many thanks you for your attention!

Back-ups follow
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 report 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.
Photo-enhanced toxicity of dispersed and burned Crude Oil to Arctic Mussels

Project goal:
To determine whether dispersants or in-situ burning has a greater effect on Arctic mussel toxicity, and whether extreme seasonal differences in sunlight affect acute sublethal response.

Project deliverables:
- Knowledge product publishing the research conducted, analysis, conclusions and recommendations.
- The published works will also include peer-reviewed scientific article(s)
- Researchers will create a weighted Pugh concept selection matrix. Project personnel will perform concept selection and identify relative criteria weights.

Transition: As outlined in the “Key Stakeholder Engagement Plan,” research team will work with USCG HQ Project Champion to ensure knowledge products are of interest, useful and disseminated widely to USCG, and HQ USCG Project Champion designated points of contact that support USCG led unified command for oil spill response.
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 a series of knowledge products (technical reports and supporting data) that may demonstrate Marine IP technology can be effectively utilized in the Arctic environment.

**Phase 1:**
Design plan for ice tests.

**Phase 2:**
Construct two marine IP cables for open water tests and integrate into existing control system. Conduct lab testing.

**Phase 3:**
Conduct open water testing.

**Phase 4:**
Construct two marine IP cables for CRREL tests and integrate into existing control system. Conduct lab testing.

**Phase 5:**
Conduct ice tank testing.
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.

Year 6 milestones:

- This project will conduct a 3-day workshop bringing together oil spill modeling (OSM) experts to discuss the current state of the art and identify specific key improvements to Arctic OSM.
- As a result of the 3-day workshop, 3-4 Working Groups will be established focusing on these key improvements.
- Working groups will be tasked with researching their respective topics, and ultimately resulting in white papers for each.

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.
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 2016-2019 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 2013-2019 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.

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

**Project Challenges and Opportunities:**
- Keep the mariner safe – primary purpose!
- Physical differences between fresh and salt water ice
- Interoperability of index with Canadian and international ice regimes
- Choosing the dependent variable: ice versus vessel class
- Environmental input source (resolution, accuracy, hindcast capabilities)
- Ease of access in remote locations
- Visualizations
- Lack of direct observations for validation
- Inability to utilize AIS data as originally thought
- New validation ideas with CNRC model, CGC Healy, and accident data
- Utilize expert advice by assembling a Council of Experts

**Transition:**
- USCG led Council of Experts will drive the transition/hosting destination
- USNIC to project ICECON Via AOOS & Axiom Data Science Computation.
**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.

**Completed project phases:**
- Phase 1: Interviewing, survey and research brief [Complete].

**Project milestones on deck:**
- Phase 2: Data acquisition and development of web application [Completion on schedule – 15 May]
- Phase 3: Alpha Release [Expected to begin on schedule – 1 June]
- Phase 4: Beta Release and user guide development [Expected to begin on schedule – 1 Aug]

**Future project phases:**
- Phase 5: Go Live and Final Delivery [Expected on schedule – Early 2020]
- Phase 6: Final Usability Report [Expected Feb. 2020]
- Phase 7: Submit peer-reviewed publication [February 2020]

**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

Project goal:
To 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.

- 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 will be 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 can receive tailored notification and alerts.

Transition: Software will transitioned to the U.S. Coast Guard, State of Alaska, and the maritime industry within the U.S. Arctic Exclusive Economic Zone.
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.

Plume mapping auto detection and mapping Buzzard Bay MA, (Prototype) November 2016 and Actual vehicle, Monterey Bay 2018
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.
- 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.
- Just created a 1 KM resolution version for the US. EEZ for Bering, Chukchi and Beaufort Seas.

Transition: Completed to AOOS and Axiom Data Sciences as destination to publish to NOAA, NWS, & US National Ice Center
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 3D 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.
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 developing 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://aoos.org/ais-4-bathy/
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 underway in developing decision support tools, grounded in stakeholder interactions, to support weather and sea ice-sensitive decision making. Developing a prototype with software and hardware in the Barrow region. In discussions to create pathway for transition completed research to AOOS, and prototype observations provided via AOOS to NOAA/NWS Observations and as determined by USCG Project Champion.
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.

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.
ADAC Overview and Summary

ADAC’s Prior Concluded/Completed Research

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

- Smart-Camera research.

- CBON-SA/CBONS-FIST.


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

- Integrated Ice Hazards.

- Develop low-cost wireless sensors.

- Arctic Information Fusion Capability (AIFC)