Community Based Observing Networks and Systems for Situational Awareness Enabled by the Field Information Support Tool (CBONS-SA e FIST)

Dr. Lilian “Lil” Alessa, President’s Professor and Director, CRC, U Idaho; International Liaison and CBONS Lead, Arctic Domain Awareness DHS Center of Excellence, Alaska; The CBONS Team, Aleut International Association and the Center for Resilient Communities, U Idaho; Mr. Leo Naboyschikov, Senior Analyst, Kestrel Technology Group.
Project Title: Community-Based Observer Networks for Situational Awareness (CBON-SA)

FOA/NOFO Research Question(s): Topic 1a, Maritime Risk & Threat Analysis; Topic 2c, Information & Intelligence Integration within Maritime Operations. Specific research question: 2c. 1. question iii.

Project Objectives:
- Utilize distributed human observers as sensors to systematically observe and document Arctic environmental changes relevant to resource security.
- Utilize human observers to detect and place in context a range of critical variables pertinent to maritime security.
- Develop reliable data streams, in real time, that are compatible with other monitoring data streams.

Potential Impact:
- Provision of local fine-scale data and situational awareness for maritime security.
- Observations support and observers are supported by AIFC.

Key Milestones/Deliverable Schedule:
- Project Start………………………………….……………..Jan 15 √
- Developed and documented data intakes ....................May 15 √
- Tested cell-to-satellite phone data relay .....................Jun 15 √
- Completed observer training and protocols...............Jun 15 √
- Replicated protocols in new communities...............May16 √
- Expanded network to three communities...............Jun16 √
- Operational CBON-SA in place..............................Jun 16 √
- Test CBON-SA with field operator tool (FIST)..........Mar 17
- Project end date......................................................Jun 19

Performance Metrics:
- Successful image and data relays, integration of observing data with FIST tool, detection of anomalous events.

Key Accomplishments:
- Established operational CBON for Bering Sea comprising 3 communities.
- Developed and tested protocols in villages of Gambell, Unalaska, and Wales.
- Successful preliminary test of Field Information Support Tool (FIST) by local observer with USCG Exercise.
- Program was highlighted at White House Arctic Science Ministerial in DC Sep 2016.

Funding:
- Expended to Date by End of Year 2 ............$153,774.80

Program Champions:
- Mr. H. Blaney, HQ USCG CG-255.
- CDR S. Hale, HQ USCG CG-5PW.
- CAPT D. Evans, USCG RDC.

Stakeholders:
- HQ USCG, UCSG RDC, USCG Pac Area & USCG D-17
- NOAA and NWS.

Points of Contact:
- Lil Alessa, Univ. of Idaho, Project Principal Investigator.
- Andy Kliskey, Univ. of Idaho, Project Co-investigator.
Community Based Observing Networks and Systems (CBONS) are high fidelity observers (HFOs) who submit quality assured and coordinated observations on biophysical variables that are critical to USCG operations. These observations are integrated with data from other observing systems.
The long-term answer to true domain security lies in an integration of the perceived but often false dualities of formal and informal work, of online technical activity and offline human activity, of daily operations and emergency response, of central and local. We can address these challenges more holistically, recognizing their existence within a wider, interdependent and dynamic sociotechnical system. This is not easy, but there are emerging fields of trust based innovation and engineering dedicated to achieving this goal.

Maritime Operational Information Sharing Analysis (MOISA 1) Project and National Maritime Intelligence Integration Office (NMIO).

**FOA Question addressed**

- Topic 2c, Information & Intelligence Integration within Maritime Operations.

**Specific research question: 2c. 1. question iii.**

- What new approaches, technologies, and command & control system innovations can increase timely access to relevant information at multiple sector levels, including first responders, authorized elements in the private sector and international partners, while maintaining appropriate information security?
Where we were: Bering Sea SubNetwork and CONAS

Project Summary: Bering Sea Sub-Network II
Sharing Knowledge – Improving Understanding – Enabling Response
International Community-Based Environmental Observation Alliance for a Changing Arctic
A Predecessor to CONAS, the Community-Based Observing Network for Adaptation and Security
Where we are … From Theory to Practice

Diagram:
- Timescales
- Scientific
- Operational

Venn diagram with overlapping circles.
• Proof of Concept: Operational CBONS for maritime situational awareness;

• Forward Fusion: First Eyes and Ears on the ground
• It is a **tech-enabled systematic information acquisition system** that allows precise, fine-scale data to be systematically acquired by boots-on-the-ground before a coordinated response is mounted;

• combines a the **science of Community Based Observing (CBO)** with the Field Information Support Tool (FIST) to establish a network of human-sensors capable of placing environmental change in a **situational awareness context for Forward Fusion** component of the AIFC;

• simple to use and can be **deployed in remote communities** with limited comms;

• provides **authoritative data** through systematic CBONS protocols;

• can **enhance community preparedness** and reinforce trust networks;

• Builds a **science of resilience** to incidents of national significance while developing a ready capability for implementation by the US Coast Guard;

• **Contributes to DHS’ Homeland Security Enterprise** through CoE collaborations and applications to challenges such as border security.
Best Practices for Community-based Observing: A National Workshop Report
(Oct 5-6, 2015, Seattle, WA)

Quality
Assured/Controlled Variables co-identified (extensive);
Structured Data Intakes; Data interoperable; Mixed Methods;
On-going Verification and Validation; Local Science Team Leaders

QA/QC variable; Variables co-identified (fewer)
Semi to Structured Data Intakes; V&V for protocols variable;
Individuals

QA/QC occurs less often; Variables driven by Scientists (usually single to few); V&V for protocols absent;
Individuals, usually a restricted "backyard" demographic.

Little to No QA/QC; Variables at random; V&V for protocols absent; open to anyone with access.

Data Interoperability/Authoritativeness

CBONS CBM Citizen Science Observer Blogs

Data Accessibility

NCB Center for Resilient Communities
University of Idaho

Arctic Domain Awareness Center
A U.S. Department of Homeland Security Center of Excellence
Hosted by the University of Alaska

School of Law
University of Washington

Arctic Regional Collaboration
University of Alaska

IARC

Arctic Domain Awareness Center
A DEPARTMENT OF HOMELAND SECURITY CENTER OF EXCELLENCE

Abstract
The purpose of this report is to give the reader insight into a range of community-based observing (CBO) types as well as understand their appropriate applications and trade-offs. In this report, we estimate CBO broadly, in part as a result of a workshop held on October 5-6, 2015 at the University of Washington, and in part as a reflection of broader conversations with communities, organizations, agencies, and academics.
WORKSHOP REPORT

“Using Science & Technology to Understand How Environmental Changes Impact National Security”

May 2016
• Hand-held interface (FIST) allows CBO data to be used during a response operation.

• Small details matter: incorrect approaches to beach head can mean the difference between a capsize or a landing.

• FIST bridges the language barriers by providing translation

• Provides First Responders with Ship, Facility and Physical Environment Topography

• Can ingest and fuse Communication, RFID, Card and GPS Technology for location and condition of passenger/crew (eg “People Tracking System”)

• Securely provide medical information if available and required by First Responders
Technology Enabled CBO Maximizes Data Fusion and Creation of Information for Both Decision Makers and Field Operators

- Multi-mission common operating picture
- Situational awareness
- Data segregation based on permissions and roles
- Seamlessly imports and exports diversified data
- Enhances in-place systems capabilities
- Easy to operate
- Quickly deployable
- Secure
Smart phone, sensor & web based Knowledge Management System:

- Easy to deploy
- Scalable and secure
- Multi-media/multi-lingual field reports
- Simple and open standards data & system exchange
- Works anywhere (Cellular/WiFi/SATCOM)
- Tasking from HQ to the field
CBONS Scenario: Forward Fusion in an Austere Environment

WiFi Range Sphere (approx. 300ft)

Full Function FusionPortal

Compact Field CPU

Basic Requirement

Linux VM **
Gather Protocols

- Send and Forget (SnF)
  - Broadband, VPN, Full Media
  - Hardened send process
  - Store and forward
- Satcom Burst (inReach)
  - *Standard* Gather Reports in Text
  - Media Auto-synch w/ Broadband
  - C2 => Position, Messaging, Status
- Low Bandwidth Satellite (LoSat)
  - Tuned for text + media reporting
  - Relay Server instead of VPN
  - C2 + Reports pulldown, PLAN

Forward Fusion

- System of Systems – Forward
  - Fixed IP not required - connect and synch
  - User defined sync content
    - Assignable content fields
    - Report text, report media, messaging, C2, etc.
    - Menu driven choices
  - Flexible sync addressing
- System of Systems – HQ
  - Manages content download
  - Forward node is rebuilt from the HQ master
Multilingual & media rich field collection reports

- Audio, video, photographs and text
- Date time group
- GPS, signal strength (cell and Wi-Fi)

Works in multiple connectivity scenarios

- Data stored locally when no connectivity
- Special protocol for intermittent connection
- Satellite burst protocol for remote areas

Rapid field operational awareness

- Text messaging, blogging and real-time alerts
- “Blue Force Tracking”
- Team / Group real-time map location
- Mission status notification
- Alarming
CBONS-SA e FIST Current Quick Buttons
The CBONS FIST team was tasked with testing the Field Information Support Tool within the operational guidance of the Community Based Observation Network Systems project. The CBONS FIST team tested multiple types of reports in various connectivity and operational scenarios, including:

- Quick Reports – text only – via inReach SE
- Quick Reports – multi-media – via inReach SE
- Quick Reports – text only – via Save/Forget
- Quick Reports – multi-media – via Save/Forget
- Full Survey Form – text only – via inReach SE
- Full Survey Form – multi-media – via inReach SE
- Full Survey Form – text only – via Save/Forget
- Full Survey Form – multi-media – via Save/Forget
- Quick Reports – text only – via Forward Operating Command/Control Center
- Quick Reports – multi-media – via Forward Operating Command/Control Center
- Full Survey Form – text only – via Forward Operating Command/Control Center
- Full Survey Form – multi-media – via Forward Operating Command/Control Center
- Quick Reports – multi-media – using Sony RX10 High Resolution Camera
- Full Survey Form – multi-media – using Sony RX10 High Resolution Camera

The CBONS FIST team successfully submitted 76 field reports to the live FusionPortal, of which 16 were classified as "High" or "Critical" Alarm. A further 8 field reports were submitted to the Forward Operating Command/Control Center.

The CBONS FIST team successfully submitted or received 39 messages to/from the HQ support that was in Anchorage, Alaska and Orlando, Florida.
# Field Test Overview

<table>
<thead>
<tr>
<th>Field Test Name</th>
<th>Community Based Observation Networks – Field Information Support Tool Field Test 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exercise Dates</strong></td>
<td>Monday August 22nd 2016 – Friday August 26th 2016</td>
</tr>
<tr>
<td><strong>Scope</strong></td>
<td>This field test is a joint technology and environment test planned for the week of August 22nd 2016 at Wales Alaska, Tin City Alaska, and surrounding areas. Field test environment is limited to all surrounding land areas and cities/villages in driving proximity of Wales Alaska.</td>
</tr>
<tr>
<td><strong>Mission Area(s)</strong></td>
<td>Austere Field Reporting, Humanitarian Assistance / Disaster Relief, Search and Rescue, Community Engagement, Command / Control / Communication Operations, Maritime Domain Awareness</td>
</tr>
<tr>
<td><strong>Core Capabilities</strong></td>
<td>Field Reporting (Text) – Communications Austere / Unavailable; Field Reporting (Multi-Media) – Communications Austere / Unavailable; Personnel Messaging (Group and HQ) – Communications Austere / Unavailable; Personnel Safety Tracking – Communications Austere / Unavailable; Reporting and Analytically Capable Forward Operating Base (FOB) system</td>
</tr>
<tr>
<td><strong>Threat or Hazard</strong></td>
<td>Unreliable communications within Wales Alaska proper, no communications available outside of Wales Alaska proper, weather related hazards (cold, wind), wildlife hazards</td>
</tr>
<tr>
<td><strong>Scenario</strong></td>
<td>The testing team self-imposed a scenario surrounding a Search and Rescue Mission as a result of a disabled Cruise Ship off-shore</td>
</tr>
<tr>
<td><strong>Sponsor</strong></td>
<td>Arctic Domain Awareness Center</td>
</tr>
</tbody>
</table>
| **Participating Organizations** | Arctic Domain Awareness Center  
Department of Homeland Security – Science & Technology Office  
University of Alaska Anchorage  
University of Idaho, Center for Resilient Communities  
Kestrel Technology Group  
NOVA Corporation  
Wales Native Corporation |
| **Point of Contact**            | Leonid Naboychikov, Sr. Analyst – Kestrel Technology Group;  
naboychikov@kestrel-tech.com  
818-584-6016  
Dr. Lilian “Lil” Alessa; alessa@uidaho.edu |
Recently Submitted User Tracks
INCORPORATING COMMUNITY-BASED OBSERVING NETWORKS AND SYSTEMS: ENHANCING COMMUNITY PREPAREDNESS AND RESPONSE TO ARCTIC CRITICAL EVENTS

Lilian Alessa,* Paula Williams,‡ Andrew Kliskey,* Grace Beaujean†

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V. INCORPORATING CBONS IN THE NATIONAL
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• **Leverage Assets in Communities:** Local and Place Based Knowledge (LPBK) can provide unparalleled SA with high resolution and geographic specificity.

• **Provide Detailed Situational Context:** LPBK is a facet of domain awareness that no other sensor can acquire.

• **Command & Control:** encrypted messaging and asset tracking of field assets in real time.

• **Data Visualization and Management:** Integrated field reports with various data sources for a geospatial Common Operating Picture; Quick and secure multi-source data access across internal and external databases and data feeds

• **Sensor Integration and Analysis:** Integrate cameras and other sensors feeds for increased situational awareness; Leverage field information and other data sources for rapid analysis and effective decision-making
• Applications to Border Security and Coastal Resilience: Building capacity across Centers of Excellence;
• Connecting data streams across the “inverted triangle” for ADAC projects: sea ice, infrastructure, community preparedness capacities;
• “Small Data”: deriving pattern from individual data across CBONS settings, enabled by a standardized and systematic data intake system (FIST);
• Working with Canada on ADSA: All Domain Situational Awareness;
• E.g., DHS Secretary and Canadian Ministers of Public Safety, Justice, and Transport met recently to enhance perimeter security and economic competitiveness;
• Arctic is a region of concern.
THE WHITE HOUSE
Office of the Press Secretary
September 28, 2016

FACT SHEET: United States Hosts First-Ever Science Ministerial to Advance International Research Efforts

Science Ministers from 25 governments and the European Union gathered at the White House to discuss Arctic research priorities and sign a Joint Statement on increased international collaboration on Arctic science and inclusion of Indigenous peoples in understanding and responding to changes in the Arctic.

Science Ministers, or their representatives, from 25 governments—Canada, China, the Kingdom of Denmark, the Faroe Islands, Finland, France, Germany, Iceland, India, Italy, Japan, the Republic of Korea, the Netherlands, New Zealand, the Russian Federation, Singapore, Spain, Sweden, Switzerland and the United States of America—and the European Union and representatives from peoples’ organizations gathered to discuss collective efforts to increase the pace of scientific collaboration in the Arctic.

The United States is among the countries that will work with the INTAROS scientists. In 2017, the U.S. Office of Naval Research will initiate a 5-year project—Arctic Mobile Observing System (AMOS)—that will develop new sensors, platforms, and techniques for mobile-observing systems that drift with the moving sea-ice cover, or operate autonomously in the ocean below the ice.

The United States Government will support “EyesNorth,” a U.S. National Science Foundation supported research-coordination network of community-based observing initiatives in the Arctic and Western United States. Involving scientists and northern residents in Finland, Greenland, Iceland, Norway, the Russian Federation, Sweden, the United States, and elsewhere, EyesNorth will expand the science of community-based observing, including the use of Indigenous knowledge and local place-based knowledge, and provide a critical connection between observing environmental change and community preparedness and response. “EyesNorth” will contribute to the work of SAON—Sustaining Arctic Observing Networks—a joint effort of the Arctic Council (through its Environmental Monitoring and Assessment Programme) and the International Science Committee.

In a further contribution to SAON, the U.S. National Oceanic and Atmospheric Administration (NOAA) will open a U.S. SAON Office which will coordinate with the “EyesNorth” program. It will foster interagency and international collaboration in the development of Arctic observing and data systems, as well as the delivery of higher-level data and information to the scientific community and policymakers.
Harmonize with Oceans Networks Canada and MEOPAR

University of Victoria
Ocean Networks Canada
Dalhousie University
MEOPAR
• DHS is currently engaged in developing a whole-of-enterprise **Arctic Security Strategy**, with coordination and collaboration between the U.S. and Canada envisioned as a foundational element;

• **Community development and observing** capabilities are a potential means for collaborative operations and mutual support;

• **Leveraging each others capabilities** in the remote, logistically challenging, and under-resourced Arctic region to meet emerging challenges resulting from climate change;

• **“If You See Something Say Something”**: potential **early warning capability using CBONS**, enabled by FIST for e.g., infrastructure resilience and security.
Questions / Comments?

Contacts:

Dr. Lil Alessa alessa@uidaho.edu; CBONS Lead--US Cel +1.208.310.5400
The CBONS-FIST Team

Master Observers: Mr. Eddie Ungtok, Ms. Joni Ungott, Mr. Amos Oxereok, Ms. Laresa Syverson; Dr. Andrew Klskey and Dr. David Griffith, Center for Resilient Communities, U Idaho; Ms. Jessica Veldstra and Ms. Leah Morrow, Aleut International Association; Mr. Leo Naboyshchikov and Mr. Ivan Cardenas, Kestrel Technology Group; Mr. Brian Conroy, Nova Dine Corporation and our Community Observers at Large.
Arctic Information Fusion Capability (AIFC)

Dr. Kenrick Mock, University of Alaska Anchorage
Mr. John DeLaurentis, Mr. Thomas Mogck, Mr. Mark Rowan, and
Mr. Eric Velte, ASRC Federal Mission Solutions, LLC.
Mr. Brian Conroy, Nova-Dine
Mr. Leo Naboshchikov, Kestrel
Maritime Environmental Response Scenario

Vision of an operational AIFC
Mission Specific Operating Picture
Alert – Vessel in Distress

Name: XYZ
MMSI: 2129550
Nav Status: Not under command
Fusion of Drift, Sensitive Areas

Important bird areas

Horned Puffin Colony

Walrus foraging
Additional MDA from CBONS

- 11/2/16: 75 Puffins
- 11/1/16: 4 foraging walrus
- 11/6/16: Ice thickness
Spill Response

Run on-demand model to compute high-resolution currents and tidal surge for impacted area. Provide information for informed OSRO response. In longer-term recovery, oil readings (potentially under ice) mapped via AUV.
Response Coordination

The Field Information Support Tool (FIST) provides rapid decision support for responders.
Project Title: Arctic Information Fusion Capability (AIFC)

FOA/NOFO Research Question(s): Topic 1a, Maritime Risk & Threat Analysis; Topic 2b, Coastal and Marine Modeling and Analysis; Topic 2c, Information and Intelligence Integration within Maritime Operations; Topic 2d, Arctic Analysis; Topic 3f, Maritime IoNS; Topic 5c, Arctic E2E.

Specific research questions: 2d. i & iii.

**Project Objectives:**
- Integrate and fuse information from an array of authoritative data sources in support of USCG operators in the Arctic.
- Enhance domain awareness by communicating both from and to community-based observers in the field achieving “Fusion Central and Fusion Forward.”
- Provide decision support through data visualization, connecting to and from the field despite austere comms; and in later stage, apply artificial/machine intelligence.
- Through NOAA partnering, utilize and advance Arctic ERMA, as the base platform, a tool already used by USCG.

**Potential Impact:** Next generation agile decision support.

**Key Milestones/Deliverable Schedule:**
- Project restart…………………………………………… Mar 16 √
- Identify elements of domain awareness……………… Oct 16 √
- Integrate community based observer through Field Information Support Tool (FIST) demonstration..........Aug 16 √
- 2D map of geospatial data, feeds………….………..…Mar 17
- Completion of demonstration scenario……………..…May 17
- Near-real-time and intelligent support…………………May 17
- Project End…………………………….……...….………Jun 19

**Performance Metrics:**
- AIFC products in Arctic ERMA. Some products ingested
- Model data available via Arctic ERMA. Status: completed √ for some products, others in testbed stage.
- AIFC fusion demo. Status: in development.

**Key Accomplishments:**
- Use case scenarios developed with USCG D17 with agreement on initial focus on marine environmental response.
- Catalog of over 1800 data feeds in support of use cases established.
- Coordination with NOAA on delivery of fusion products through ERMA.
- Field Information Support Tool portal established as conduit between CBONS and AIFC.
- Data fusion testbed / prototype established with oil spill simulation and high-resolution storm surge model.

**Funding:**
- Expended to Date by End of Year 2 ……. $229,312.72

**Program Champions:**
- Mr. H. Blaney, HQ USCG CG-255.
- CAPT D. Evans, USCG RDC.

**Stakeholders:**
- DHS S&T.
- HQ USCG, USCG RDC, USCG Pac Area & USCG D-17.
- NOAA / NWS.
- NASA-ACE.

**Points of Contact:**
- Federal Agency POC: Amy Merten, NOAA/ORR.
- Kenrick Mock, UAA, Principal Investigator.
- John DeLaurentis, ASRC Federal Mission Solutions, Project Manager.
Integrate and fuse information from authoritative data sources in support of USCG operators in the Arctic

AIFC Year 3 Progress
✓ Define and Document Y3 Focus Catalog of Data Sources
✓ Define and Document Mission Scenario Use Cases for Y3
✓ Coordinate with D-17 to Identify Data Gaps
• Refine Use Case, Existing Data Visualizations and Create Fusion Products to meet Y3 End User Goals/Needs
Define and Document Y3 Focus Catalog of Data Sources

- Narrowed down the 250,000 data feeds available through Data One and Axiom Data Science to the feeds important to the arctic and D-17
- Created a list of over 1,800 feeds available and shared data sources with NOAA that were not currently accessed by ERMA

Integrate and fuse information from authoritative data sources in support of USCG operators in the Arctic
### Define and Document Y3 Mission Scenario Use Cases

#### Use Case 4: Marine Environmental Protection Response

<table>
<thead>
<tr>
<th>Domain awareness info environment</th>
<th>Response information environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Traffic monitoring data shows a near-real-time plot of positions for vessels transiting Alaskan Arctic waters(^1)</td>
<td>• A transiting vessel reports loss of power; direction of drift in 5/10s ice coverage indicates imminent grounding</td>
</tr>
<tr>
<td>• Command center data shows real-time &amp; forecast air temperature, visibility, precipitation, wave height/direction, water temperature, sea ice coverage, currents</td>
<td>• Command center obtains detailed info (# persons, nature of propulsion casualty, amount of fuel or other hazardous material onboard, last known position, etc.)</td>
</tr>
<tr>
<td>• Command center data base permits rapid access to information about any registered vessel</td>
<td>• Comms schedule with distressed vessel instituted</td>
</tr>
<tr>
<td>• Command center data shows detailed coastal bathymetry</td>
<td>• Safety broadcasts made for any other vessel able to assist</td>
</tr>
<tr>
<td><strong>Response case opened</strong></td>
<td>• Diversion of vessel traffic (if any) considered, based on proximity &amp; capability</td>
</tr>
<tr>
<td><strong>Oil spill confirmed</strong></td>
<td>• Area oil spill response organization mobilized</td>
</tr>
<tr>
<td>• Incident command system activated, begins spill response mobilization</td>
<td>• Fixed-wing (C-130) launched with droppable repair parts, pumps or other emergency equipment</td>
</tr>
<tr>
<td>• Command center monitors all response assets, coordinates with incident commander, provides direction and appropriate data (including spill trajectory) to all involved parties</td>
<td>• USCG cutter diverted to area to act as forward command post (C2), staging platform, assist with vessel refloating &amp; repair, etc.</td>
</tr>
<tr>
<td>• Command center documents case, provides input for lessons learned &amp; final report</td>
<td>• Helos dispatched to FOL or cutter for spill monitoring, movement of personnel &amp; equipment, etc.</td>
</tr>
</tbody>
</table>

#### Variables

- **Domain awareness info environment**
  - Locations of vessels (i.e. NAIS) supplemented by Canadian Arctic Reporting System. Validated by cutter and aircraft sensor reports (i.e. COP)
  - Locations of commercial activity (i.e. oil and gas, construction)
  - Environmental conditions (sea ice, tide, current, temp & wx changes)
  - Ice and WX forecast data

- **Response information environment**
  - Environmental conditions (sea ice, tide, current, temp & wx changes)
  - Targeted forecast information for the area of response

#### Desired process and outcome

- Command center has adequate information to evaluate urgency of situation and alert/allocate response resources as quickly as possible
- If possible, vessel can be assisted early enough to prevent grounding (repair parts provided, towing, ice management to allow anchoring, etc.)
- Once a spill is imminent, rapid movement of response personnel and equipment is crucial to minimize the spill and prevent environmental impact

#### Use Cases not selected:

1. **Mass Marine Rescue Operation (MMRO)**
2. **Ship in Distress; Ship Lost at Sea (SLAS)**
3. **Search and Rescue (SAR)**
4. **Ice Operations – Multi-ship research expedition in the high Arctic**
Arctic ERMA: Advancements to date

Over 20 data layers applicable to the identified use case scenario added over the past two months.

- Weather, Oceanography, & Natural Hazards -> Wind -> Global Winds (NOSAPS) (IIOOS)
- Weather, Oceanography, & Natural Hazards -> Wind -> Global GFS Winds (IIOOS)
Provide decision support through data visualization

Bathymetry &
Electronic
Navigation
Charts
Provide decision support through data visualization
• Wind speed, direction and wave height
Provide decision support through data visualization
• Sea Ice Extent
Provide decision support through data visualization

- Marine Mammal Zones
Provide decision support through data visualization
• Marine Mammal Zones (.pdf)
Provide decision support through data visualization

- Communication Coverage
Provide decision support through data visualization

- Geographic Response Strategies
Provide decision support through data visualization

• Response Equipment
Integrate and fuse information from authoritative data sources in support of USCG operators in the Arctic

- **Coordinate with D-17 to Identify Data Gaps**
  - Fuel Station Availability (Data Layer needs to be created or source found)
  - Oil and Gas Drill Sites (Data Layer needs to be created or source found)
  - Community Based Observers nearby (Need interface from FIST Fusion Portal)
  - Communities willing to render on-shore aid/support (Need interface from FIST Portal)
  - Vessel Tracking (Satellite AIS feeds not currently in ERMA)
  - Satellite Imagery (Leverage commercially available or other sources available to DHS)
  - Vessel Data (Need interface from FIST portal)
    - Crew status
    - Ship status
    - Release of hazardous materials (including cargo)
    - Communications with vessel
    - Life Saving Appliances Onboard
    - Medical Needs Information (Care Phases)
    - Vessel Crew/Passenger Accountability
  - Air and Surface Asset Support Availability (location and time to on-station)
    - Need to identify data source for this dynamic input. USCG data feed available? NSB Data, Canadian CG data
Integrate and fuse information from authoritative data sources in support of USCG operators in the Arctic

• Refine Use Cases, Existing Data Visualizations and Create Fusion Product to meet Y3 End User Goals/Needs
  • Beginning to participate in weekly calls with D-17 and RDC
  • During the call enhancements are demonstrated and feedback is solicited
  • Future enhancements, fusion products and use cases will be worked in priority order

• Leveraging agile software development values:
  • Our highest priority is to involve the user through early and continuous delivery of the product
  • Breaking work into small features and once accomplished start on the next task in a prioritized backlog
Near Term Milestones and Coordination
Fusion Central and Fusion Forward

**Fusion Central**
- Alert: AIS data overlapped with mammal exclusion zone
- Alert: AIS signal not transmitting for long enough to land vessel
- Utilized existing drift projections (SAR OPS) to forecast time to impact nearby hazards (grounding, marine mammals, etc.)
- Hypothermia calculator based on ship location and Wx data and highlight vessels and assets within responding range

**Fusion Forward**
- Incident alerts trigger message to CBONS targeted observers and/or USCG responders in the area
- High fidelity observers can validate on scene conditions and model data based on thresholds applied to existing data sets
- Drawings and map attributes created in ERMA can be shared with CBONS responders working out of an off the grid operating base
Enhance domain awareness by communicating both from and to community-based observers in the field

**FIST / CBONS**

The Field Information Support Tool (FIST) provides rapid decision support for responders.

Hand-held interface supports austere environment communication and CBO data to be used during a response, domain awareness with fusion portal.

Can provide first responders with ship, facility, physical environment topography, medical information, critical information on local details such as beach landings.
Benefits of Arctic ERMA

**Benefits to AIFC**

- Existing presence in D-17 command center which allows rapid visualization of new feeds, fusion and models
- Data imported using industry standards (e.g. WMS) to maximize leveragability to future systems
- Leverage existing data layers
- Role based security & minimal training
- Past history in environmental disasters

**Benefits to ERMA**

- Involvement and feedback allows improvements and additional data to be prioritized to facilitate biggest impact to users
- Arctic improvement / National impact
Arctic ERMA Inherited Features: Standard Layout
Arctic ERMA Inherited Features: Security

• Public accounts
  • Publicly available data (no login required)

• Restricted accounts for planning & response
  • Username/password required
    • Verified by NOAA
    • Various levels of access
      • Active incidents
      • Sensitive datasets
      • NRDA/Trustees
      • Drills
  • Password reset 90 days; Inactive accounts 6 months
  • Only NOS application that uses these password requirements

• Data available only to appropriate users and use
Arctic ERMA Inherited Features: Tool Support

• Create Incident (2014)
  • Used to create initial incident location

• Draw Tool (2016)
  • Creates permanent features
  • On the fly feature creation and attribution
  • Allows the creation of preliminary GRP sensitive sites and strategies
  • Supports the consensus based review and modification of GRPs from Area Committee, RRTs and other partners
Arctic ERMA Inherited Features: Developer Views
Arctic ERMA: Advancements to date

HIOMAS current model view available in ERMA
Arctic ERMA: Advancements to date

Barrow Sea Ice Radar view available in ERMA
Arctic ERMA: Commitments during ADAC Year 3

Polar Projection
- Planned to be implemented to ERMA by May 2017

OpenLayers 3
- Enhanced mobile visualization
- Hexagonal binning
Future enhancements (not currently scheduled):

- Allow operator to select an Arctic mission & region and automatically turn on required data layers that align to that mission and regional need.
- Allow operator to select region shape (i.e. square, rectangle, polygon), allow external application to receive that data and compare region to the displayed data layers. If data layer does not fall within selected region, de-clutter screen by turning off data layer (layer clipping).
- Allow additive bookmarks (layer grouping).
- Reviving development of standalone ERMA.
- Enhancing the ability to quickly download relevant feeds for a selected area for deployment in a no comms environment.
Storm Surge, Coastal Inundation and Erosion

Dr. Thomas Ravens, University of Alaska Anchorage
Dr. Craig Tweedie, University of Texas--El Paso
Project Title: Real-Time Storm Surge, Coastal Flooding, & Coastal Erosion Forecasting for Arctic Alaska

FOA/NOFO Research Question(s): Topic 1a, Maritime Risk & Threat Analysis; Topic 2b, Coastal and Marine Modeling and Analysis. Specific research question: Topic 2b. questions 1 & 3.

Project Objectives:
- Work in collaboration with the US Coast Guard and NOAA to provide high resolution surge, wave, and erosion forecasts for vulnerable coastal communities.
- Calibrate and validate the models with available data, including observations of ice and geomorphic change.

Potential Impact:
- The research has the potential to transform the Arctic coastal zone from an area with little or no real-time or forecasted coastal data to one with data that is comparable in quality to Continental U.S.
- An added benefit of the high resolution coastal data is that it will potentially improve oil spill modeling and search and rescue operations by providing high resolution velocity data.

Key Milestones/Deliverable Schedule:
- Project Start…………………………………………….…...Jan 15
- Code for real-time surge forecasting..……………….…...Jun 15
- Forecasting of surge in YK Delta…………….……….…..Jun 15
- Forecasting of surge in Norton Sound….……….…….…Jun 16
- Validation of YK Delta surge model…………………..….Jun 16
- Coding for real-time surge and wave forecasts………...Jun 16
- Develop forecasts of storm surge, coastal flooding, nearshore waves, and coastal erosion.……………………Jun 17
- Project end date…………………………………...…….…Jun 19

Performance Metrics:
- Accuracy of surge/flooding forecasts (target error 0.25 to 0.5 m), target achieved.
- Number of months the surge model was “operational” (target: 0 to 12 months). Model operational: 12 months.

Key Accomplishments:
- Successful development of a high resolution coastal surge/flooding and wave forecasting model for the Yukon Kuskokwim (YK) Delta and for Norton Sound.
- Successful validation of the surge forecasting model based on near-shore water level data in the YK Delta.
- Validation of surge/flooding calculations with satellite observations of inundation extent.
- Expansion of original scope to include links with UAF’s Ice Radar observations and Univ. of Texas El Paso (UTEP) observations of geomorphic change in Barrow Alaska.

Funding:
- Expended to Date by End of Year 2 ……. $202,814.06

Program Champions:
- Awaiting Project Champion designation.

Stakeholders:
- HQ USCG, USCG RDC, USCG Pac Area & USCG D-17.
- NOAA and NWS.

Points of Contact:
- Tom Ravens, UAA, Project Principal Investigator.
- Craig Tweedie, UTEP, Project Principal Investigator. (Starting in Year 3)
Where We Were – High Resolution Modeling of Storm Surges and Coastal Flooding.

RadarSat1 - Cloud penetrating satellite imagery

Hooper Bay
Chevak
Bering Sea

July 2005 - normal high tide

September 2006 - extreme flood event

Golovin (Norton Sound) during Nov. 2011 storm
Where We Were – High Resolution Modeling of Storm Surges and Coastal Flooding.
Where We Were – High Resolution Modeling of Storm Surges and Coastal Flooding.

Fine-grid model domain and bathymetry and topographic data:
Where We Were – High Resolution Modeling of Storm Surges and Coastal Flooding.

Assessment of course-grid/fine grid model system for coastal water level:

- **2009 storm**
  - Good performance

- **2011 storm**
  - Marginal performance
Where We Were – High Resolution Modeling of Storm Surges and Coastal Flooding.

Assessment of course-grid/fine grid model system for coastal flooding extent:

2006 storm
Reasonable performance (over-calculation)

2005 storm
Marginal performance (under-calculation)
Where We Were – High Resolution Modeling of Storm Surges and Coastal Flooding.
Where We Were – High Resolution Modeling of Storm Surges and Coastal Flooding.
Where We Were – High Resolution Modeling of Storm Surges and Coastal Flooding.

high (170 m) resolution velocity and wave data:
[Note, a typical coarse grid model has 1 computational cell in the domain shown.]
Where We Were – High Resolution Modeling of Storm Surges and Coastal Flooding.

Validation/assessment of high resolution forecasting system, with ET-Surge forcing.
Where We Were – High Resolution Modeling of Storm Surges and Coastal Flooding.

Norton Sound storm surge modeling:
Where We Were – Arctic Coastal Erosion Modeling

Image courtesy of BEM Systems

Barrow coastal zone during 2015 storm/erosion event

Beach profile change due to erosion event
Where We Were – Arctic Coastal Erosion Modeling

Environmental change in the Arctic Alaska coastal zone: increasing fetch, open water period, and temperature

*Figure 7.* Distance to the sea-ice edge from Drew Point for the period 1979–2012. Both the length of the open-water season and the distance to the sea-ice edge have increased in this time period. The distance to the sea-ice edge has increased the most in the northwest direction, which is the direction from which wind blowing sets up nearshore water levels.
Where We Were – Arctic Coastal Erosion Modeling

Arctic Coastal Erosion Mechanisms:

Niche erosion / block collapse

Bluff face thaw / slumping

Cape Halkett
Ben Jones, USGS

Erosion rates on north coast of Alaska (1980’s era rates)

Erosion Rate (m a⁻¹)
- 5 to 8
- 0 to 2
- 2 to 5
- Deposition

Ben Jones, USGS
Where We Were – Arctic Coastal Erosion Modeling

Forecasting erosion vulnerability based on geological character:

- Glaciomarine, Niche erosion /block collapse
- Old alluvium, Bluff face thaw /slump
Where We Were – Arctic Coastal Erosion Modeling

Arctic Coastal Erosion – Drew Point

<table>
<thead>
<tr>
<th>Time period</th>
<th>Measured erosion rate (m/yr)</th>
<th>Calculated erosion rate (m/yr)</th>
<th>Calculated fraction of time shoreline is block-free (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug. 1979 – July 2002</td>
<td>8.0 ± 0.9</td>
<td>8.0 ± 0.8</td>
<td>68 ± 3</td>
</tr>
<tr>
<td>Aug. 2002 - July 2007</td>
<td>14.1 ± 1.7</td>
<td>14.9 ± 1.4</td>
<td>78 ± 2</td>
</tr>
</tbody>
</table>
Where We Were – Arctic Coastal Erosion Modeling

Bluff face thaw / slump - Barter Island
Where We Were – Arctic Coastal Erosion Modeling
Xbeach modeling of storm-induced coastal erosion at Ninilchik in Cook Inlet:

$H_s = 3\text{m},\ 12\text{ hr duration}$

erosion from beach face (red)
deposition offshore (green)
Where we are – “operational” YK Delta inundation forecast
Where We Are Going – Collaboration with NOAA NWS to develop a nested grid (high resolution storm surge model) for north coast (“brw”) using SLOSH model.

Alaska Nested Grid Plan
Where we are going – high resolution wave forecasting and coastal erosion forecasting

Forecast nearshore wave conditions at high resolution (based on Wave Watch III or NOAA’s Nearshore Wave Prediction System).

Forecast beach profile change based on water level and wave forecasts.
Where We Are Going – Arctic Coastal Environmental Monitoring for Model Calibration/Validation

**Model Calibration:**
We will develop hindcasting models of surge and waves and geomorphic change and calibrate them using available observations/data on the historic hydrodynamic environment and data on beach morphology change due to those storms.

**Model Validation:**
There will be a complementary effort to monitor water surface elevation, wave heights, and beach profile change due to storms.
Wave Cut bluff
Erosion tool
Chukchi Sea
Beaufort Sea
Elson Lagoon
Utqiaġvik (Barrow)
http://barrowmapped.org/

Beaufort Sea Coast/ Elson Lagoon

Ground ice
Eroding bluff
Coastal engineering
Chukchi Sea Coast

Undercutting
Slumping
Research legacy

Chukchi Sea
Utqiaġvik (Barrow)
Elson Lagoon
Beaufort Sea
Coastal Change Research 2002-2016

http://barrowmapped.org/
Coastal erosion is impacting communities

- Old Boat Ramp
- New Boat Ramp
- Shallow/Narrow Passage
- Shoals
- Historic Shoreline

Historic Erosion Rates

A map showing changes in coastal erosion over time, with markers for old and new boat ramps, a shallow/narrow passage, and shoals. The map also highlights historic shoreline and erosion rates.
Spatiotemporal Trends – Areal Loss 2003-15

- Mean annual erosion/section ~ 0.7 – 2.8m
- High spatial and temporal variability
- Areas with high erosion rates are most variable between years
- Little evidence for change in rate since 2003
Spatiotemporal Trends - Change

- Erosion increased 25-30% in 2000’s
- Areas with high erosion rates in past still have high erosion rates
- Greatest change for historical hotspots
Motivations for Proposed Year 3 Project:

- Recognized urgency for improving arctic coastal erosion and storm surge models
- Models need calibration for the Arctic (permafrost, sea ice... ~ thermal needs)
- Models need to perform at multiple spatiotemporal scales ~ decision making...
- Models also need calibration for the future state of the Arctic (picture from July 2015)
New Software for Digital Image Analysis

- Patent pending
- Developed for landscape ecosystem ecology
- Works with all digital imagery ~ low cost, easy, accessible...
- Multiple color spaces, ROI’s, spectral indices
- Desktop (at the moment) ~ PC or Mac friendly
Algorithm Development

- Preliminary analysis of Barrow sea ice camera
- 2013 spring-fall only
- Solar noon, RGB color space
- ~65,000 images annually
- Opportunity to build off legacy effort
Sky Conditions

- Proxy for irradiance captures sky conditions
- Need to normalize for seasonality
Snow Melt

- Proxy captures daily events
- Some problems with lens shadowing
- QAQC needed for identifying compromised instrumentation
Visibility

- Preliminary analysis of Barrow sea ice camera
- 2013 spring-fall only
- ~65,000 images annually
- Opportunity to build off legacy effort
New Cameras

- Progress for Research-Operation will benefit from new hardware capacities – network of camera feeds on ERMA
- New camera system - patent pending
- RGB, NIR, thermal imagery
- Multiple options for telemetry
- Accepting of smart sensors
- Highly configurable
- Low-cost
- Yr 3 Goal: Replace ageing cameras, co-locate with sea ice radar in Barrow
- Yr 3 Aims: sea ice cover & movement (?), sea state, shore conditions
Compatible efforts – all student focused

**ADAC Year 3 activities are timely and synergistic with:**

- NOAA-CREST (with CCNY) 2016-2021
  - Automated feature extraction ~ coastlines
  - Nearshore water chemistry and bathymetry from satellite
  - Drones for repeat mapping of coastlines?
  - Internships with NOAA
- NSF BAID 2012-2017
  - Web mapping and decision tools
  - Rediscovery of historic research sites
  - Climate station network
- NASA-ABOVE 2017-2020
  - Coastal flights with LiDAR and hyperspectral imaging?
- NSF Arctic Coastal LTER (pending) 2017-2022
- Pending USCG project champion and students
Sea-Ice Hazards

Dr. Andrew Mahoney, University of Alaska Fairbanks
Dr. Hajo Eicken, University of Alaska Fairbanks
Mr. Joshua Jones, University of Alaska Fairbanks
Project Title: Identifying, Tracking and Communicated Sea-Ice Hazards in an Integrated Framework  

FOA/NOFO Research Question(s): Topic 1a, Maritime Risk & Threat Analysis; Topic 2d, Arctic Analysis; Topic 5c, Arctic E2E. Specific research question: Topic 2d. question 1.

<table>
<thead>
<tr>
<th>Project Objectives:</th>
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</thead>
<tbody>
<tr>
<td>▪ Develop framework for identifying, tracking and communicating sea ice-related hazards utilizing existing Arctic observing assets</td>
</tr>
<tr>
<td>▪ Enhance the capability of surface-based radar for monitoring sea ice hazards, particularly in coastal settings.</td>
</tr>
<tr>
<td>▪ Communicate imagery, velocity data and sea-ice related hazards to USCG and other operator centers and provide acquired information to ADAC's AIFC.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Potential Impact:</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Improved ability to leverage Arctic observing assets for sea ice hazard mitigation</td>
</tr>
<tr>
<td>▪ Development of transferable technology to enhance Arctic MDA capabilities of surface-based radar assets.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project Milestones/Deliverable Schedule:</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Project Start......................................................Jan 15 ✓</td>
</tr>
<tr>
<td>▪ Development of near-real time ice velocity data product from Barrow coastal radar.............................May 15 ✓</td>
</tr>
<tr>
<td>▪ Conceptual framework for Arctic MDA testbed..............Dec 15 ✓</td>
</tr>
<tr>
<td>▪ Application of ice tracking technique to other radar platforms and assessment of MDA value.......................Mar 17</td>
</tr>
<tr>
<td>▪ Planning document for TTX within Arctic MDA testbed...Jun 17</td>
</tr>
<tr>
<td>▪ Project end..........................................................Jun 19</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Performance Metrics:</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Radar ice velocity product: TRL 6: achieved ✓</td>
</tr>
<tr>
<td>▪ Radar ice divergence product: TRL 5 achieved (Target 6)</td>
</tr>
<tr>
<td>▪ Framework document for Arctic MDA testbed: TRL 2: achieved ✓</td>
</tr>
<tr>
<td>▪ Overlap with AIFC model grid: in progress.</td>
</tr>
</tbody>
</table>

**Key Accomplishments:**
- Implementation of software to provide near-real time data on sea ice velocity and convergence from Barrow coastal ice radar (June 2016).  
- Dissemination of radar imagery and velocity data to Barrow search and rescue team during landfast ice detachment event (29 April 2014).  
- Demonstration of ship-based application of radar ice tracking methods on board USGC Healy (July 2015)  
- Publication of whitepaper outlining Barrow Arctic MDA testbed concept and relevant observing system resources (March 2016).

**Funding:**
- Expended to Date by End of Year 2.......$127,922.78

**Program Champions:**
- LCDR M. Kennedy, HQ USCG CG-751.  
- CAPT D. Evans, USCG RDC.

**Stakeholders:**
- HQ USCG, USCG RDC, USCG Pac Area & USCG D-17.  
- NOAA and NWS.  
- Alaska North Slope Borough.

**Points of Contact:**
- Andrew Mahoney, UAF, Principal Investigator.  
- Hajo Eiken, UAF, Co-Investigator.
Overview

- Increasing Arctic maritime activity
- Driven in part by decreasing sea ice extent

Trend: -80,000 km$^2$/yr
Area of S. Carolina

Sep 16, 2012
3.67 mil. sq km

1980 1990 2000 2010

Data from National Snow and Ice Data Center
Overview

Risk posed by sea-ice hazards growing despite declining sea ice

• Urgent need for enhanced sea-ice hazard awareness

• Sparseness of real-time data and forecasts represents significant challenge
Case in point:

- No real time ice drift data or forecasts available when barge became entrapped in ice pack
- Average drift over previous 10 years underestimated speed by factor of 2.5

Projected drift trajectory on November 21 based on “climatological” drift

October 22, 2014: Barge NATL II breaks loose of tug in Canadian Arctic
Objectives

1. Develop framework for identifying, tracking and communicating sea ice-related hazards utilizing existing Arctic observing assets

2. Enhance the capability of surface-based radar for monitoring sea ice hazards, particularly in coastal settings

3. Evaluate technology for monitoring small-scale motion of landfast ice as possible precursors to detachment events
Project Champions

Primary: **LCDR Margaret Kennedy (CG-571)**

Additional: Hank Blaney - MDA Policy (CG-255)
CAPT D. Evans (RDC)

Interactions to date
- USCG Project Champion teleconference Oct 13, 2016 and follow-up email

Recommendations received
- Perform analysis of ice detection radar used by VTS Valdez in Prince William Sound

Action taken
- Initiated preliminary inquiries VTS Valdez (Ben Bauman) PWS Citizens Advisory Council (Joe Banta).

- Researching technical data available in online publications (C-CORE, 2003; 2007)
Approach: 1

Arctic MDA Testbed in Barrow, AK

**Goal:** Assess MDA value of existing Arctic observing potential infrastructure and its application in documented incidents

- High level of marine subsistence hunting activity (highest contribution to marine traffic, by number)
- Increasing marine traffic during open water season (northernmost point for most through-traffic)
- Highest density of observing assets in U.S. Arctic (possibly Arctic-wide)
- Large number of long-term research activities (including by non-U.S. researchers)
- Remote location and challenging environment (farthest point in U.S. from USCG base)
MDA observing assets in Barrow

Federal / state / borough
- NOAA NWS weather station
- NOAA RDL climate monitoring
- DOE Atmos Radiation Monitoring
- NOAA Marine Mammal Lab
- NSB Dept. Wildlife Management
- NSB search and rescue
- USCG seasonal FOB

Community
- Local hunters
- Community observers
- Volunteer search and rescue

University / academia
- U. Alaska sea ice observatory
- U. Alaska HF radar
- U. Texas coastal cameras
- Hokkaido U. sub-ice moorings

- Weather and atmosphere
- Wildlife and ice
- Marine activity
- Ice, wildlife and activity
- Sea ice and surface currents
- Erosion and storms
- Hydrography and currents

University of Alaska
ARCTIC DOMAIN
AWARENESS CENTER
A DEPARTMENT OF HOMELAND SECURITY CENTER OF EXCELLENCE
MDA incidents in Barrow

Entrapment

Convergence

Detachment
Approach: 2

Enhanced ice hazard detection with surface radar

- Sea ice can be difficult to distinguish from open water in single image
- Analysis of image sequences allow assessment of ice motion and hazards
Near real time sea ice velocity

http://seaice.alaska.edu/gi/observatories/barrow_radar/
sea-ice-velocity

• Velocity calculated on 20 x 20 pixel grid (438 m)

• Combination of sparse and dense optical flow techniques

• Local “similarity filtering” used to exclude spurious results

Year 2 highlights

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Completion of vector product for ice velocity field in format and delivery mode that conforms with USCG and NOAA ERMA needs (March 2015).</td>
<td>✓ Near-real time (&lt; 1hr lag) data available in KMZ format for GoogleEarth and raster for web visualization (TRL 6)</td>
</tr>
<tr>
<td>• Multi-parameter suite of products as vector and raster data available in May 2016.</td>
<td>Convergence / divergence still in development (TRL 5)</td>
</tr>
<tr>
<td>• Baseline TRL-4, target TRL-6.</td>
<td>✓</td>
</tr>
<tr>
<td>• Capabilities to produce mean velocity and divergence / convergence fields compatible with ADAC model architecture and coastal HF radar data. (February 2015).</td>
<td>✓ Compatibility of ice velocity project with HIOMAS ice-model grid demonstrated through a preliminary comparison of velocity grid values focusing on a recent 2-week period from April 29 to May 12, 2016.</td>
</tr>
<tr>
<td>• Full time series from Barrow site processed by January 2016. Baseline TRL-4, target TRL-6.</td>
<td>✓ We have processed the complete time series of ice velocity using archived radar data from the UAF Barrow sea ice observatory from 2007-20-16.</td>
</tr>
<tr>
<td>• Identify and review suitable DGPS hardware for use in harsh Arctic sea-ice environment to detect small-scale deformation as threat precursor (April 2016). Baseline TRL-2, target TRL-5.</td>
<td>✓ Despite not being allocated resources for this research component we were able to leverage support from an NSF-funded project to demonstrate the use of UAF-owned DGPS hardware to detect microtidal and thermal expansion and contraction of sea ice. Current TRL 4.</td>
</tr>
</tbody>
</table>
The Potential Contribution of Sustained, Integrated Observations to Arctic Maritime Domain Awareness and Common Operational Picture Development in a Hybrid Research-Operational Setting

H. Eicken, A. Mahoney, J. Jones, T. Heinrichs, H. Bader, D. Broderson, H. Statscewich, T. Weingartner
University of Alaska Fairbanks

T. Ravens
University of Alaska Anchorage

M. Ivey
Sandia National Laboratories

A. Merten
NOAA Office of Response and Restoration

Highlights:
• 11 authors from 4 institutions
• Assessment of MDA capabilities of current sensors
• 9 recommendations and action items testbed development

MDA capability assessment of sensing assets operated by UAF
Real world application

UAF ice radar data used by Barrow Search & Rescue

April 29, 2014:
• Mid-season breakout of landfast ice casts several hunters adrift
• Weather conditions prevent launch of SAR helicopter
• Radar data used to help coordinate rescue effort using small boats
• All people and gear safely recovered!
Ice divergence / convergence

- Red indicates closing/ridging ice
- Blue indicates opening ice
- Once operational, data can be formatted to meet stakeholder needs

Additional layer of operational information (in development)
## Year 3 milestones

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Description</th>
<th>Projected achievement date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>Development of ice velocity and hazards data products from additional radar-based modalities using algorithms and processing streams developed in years 1 and 2</td>
<td>12/31/2016</td>
</tr>
<tr>
<td>1b</td>
<td>Assessment of MDA relevance for each data product with recommendations for further development</td>
<td>3/31/2017</td>
</tr>
<tr>
<td>2</td>
<td>Integration of ice radar-derived data feeds (ice velocity, divergence and ice edge position) into ADAC data fusion architecture for model validation</td>
<td>6/30/2017</td>
</tr>
<tr>
<td>3</td>
<td>Development of plan for tabletop exercise in Barrow Testbed region to assess and inform design of ADAC data fusion infrastructure</td>
<td>6/30/2017</td>
</tr>
<tr>
<td>4</td>
<td>Development of demonstration ice stability data products from satellite-based measurements of small-scale sea ice motion</td>
<td>6/30/2017</td>
</tr>
</tbody>
</table>
Milestone 1a: Development of ice velocity and hazards data products from additional radar-based modalities using algorithms and processing streams developed in years 1 and 2
Projected achievement date: 12/31/2016

• We have identified and begun acquiring data from three additional sources:

1. Under-way data from USCGC Healy (collected in year 2)
2. DoE ARM radar in Barrow, AK
3. ESA Sentinel-1A/B satellite SAR data

✓ On track for achievement date
Milestone 1b: Assessment of MDA relevance for each data product with recommendations for further development

Projected achievement date: 03/31/2017

• No progress yet to report on this milestone

✓ On track for achievement date
Milestone 2: Integration of ice radar-derived data feeds (ice velocity, divergence and ice edge position) into ADAC data fusion architecture for model validation
Projected achievement date: 06/30/2017

- We have made a preliminary comparison between radar-derived ice velocity at Barrow and output from HIOMAS model
  1. HIOMAS output (May 12, 2016)
  2. Radar-derived ice velocity

✓ On track for achievement date
Milestone 3: Development of demonstration ice stability data products from satellite-based measurements of small-scale sea ice motion

Projected achievement date: 06/30/2017

- One manuscript is currently in press with the journal Remote Sensing of the Environment and another is being prepared describing methods for measuring small-scale motion of landfast ice and its impact on stability.

- **Since Yr3 education funds have not yet been released and the student completing the research may not be eligible to receive DHS funding, we have found alternative source of support to complete his thesis. However, this research will directly tie into the goals of this project.**

- **We are looking into alternative students to receive ADAC support through this project.**

✓ On track for achievement date
Milestone 4: Development of plan for tabletop exercise in Barrow Testbed region to assess and inform design of ADAC data fusion infrastructure
Projected achievement date: 06/30/2017

• We are currently preparing a manuscript expanding on the whitepaper that was presented during year 2 at the Arctic Observing Summit in Fairbanks (March 15-18, 2016).

• This involves analysis of historical data from Barrow and the compilation of contributions from partners and stakeholders.