Presentation to the 6th Symposium on the Impacts of an Ice-Diminishing Arctic (IDA)

Arctic Domain Awareness Center (ADAC)
A DHS Center of Excellence at UAA

ARCTIC DOMAIN AWARENESS CENTER
A DEPARTMENT OF HOMELAND SECURITY CENTER OF EXCELLENCE
at UAA UNIVERSITY of ALASKA ANCHORAGE

By
Dr. Helena S. Wisniewski
Vice Provost for Research & Graduate Studies
University of Alaska Anchorage
Executive Director, ADAC

ARCTIC DOMAIN AWARENESS CENTER
A DEPARTMENT OF HOMELAND SECURITY CENTER OF EXCELLENCE
at UAA UNIVERSITY of ALASKA ANCHORAGE

Arctic Domain Awareness Center (ADAC)

- **To address Arctic challenges DHS established ADAC as a COE with UAA as the Center Lead in August 2014.**
- **ADAC was formed at a critical time.**
  - **The U.S. took on the Chairmanship of the Arctic Council in April 2015.**
  - **The Arctic is being recognized as a key region of the U.S. not only for critical natural resources but also for its strategic location globally.**
  - **The Arctic has abrupt impacts of climate change** – for example, sea ice diminishing in thickness and extent **– that are leading to increased use of maritime spaces including:** increased navigation, tourism, development of resources.
    - **DHS recognized that these changes are generating new challenges and risks for the US Coast Guard and other DHS missions and established ADAC to address these challenges.**

ARCTIC DOMAIN AWARENESS CENTER
A DEPARTMENT OF HOMELAND SECURITY CENTER OF EXCELLENCE
at UAA UNIVERSITY of ALASKA ANCHORAGE

ADAC Key Facts

Mission: Develop and transition technology solutions, innovative products, and educational programs to improve situational awareness and crisis response capabilities related to emerging maritime challenges in the dynamic Arctic environment.

Through its mission ADAC is addressing:

- DHS S&T goal – **"Enable the Decision Maker."**
- Needs stated in the National Strategy of the Arctic, May 2013.

ADAC develops systems to observe, assess, predict, and alert incident commanders with actionable information and decision support to respond and prepare for Arctic challenges.

Consortium of 16 Partners:
UAA Center Lead

University Partners

- University of Idaho
- University of Washington
- University of Alaska Fairbanks
- Maine Maritime Academy

Institutional Partner

- Woods Hole Oceanographic Institute

Industry Partners

- MDA Systems
- GeoNorth (Native Alaskan Company)
- Lockheed Martin
- AeroVironment
- Spectron
- Liquid Robotics
- Robotic Technology
- Port of Anchorage

Alaskan Community Observers

Native Village Gambell

ARCTIC DOMAIN AWARENESS CENTER
A DEPARTMENT OF HOMELAND SECURITY CENTER OF EXCELLENCE
at UAA UNIVERSITY of ALASKA ANCHORAGE

Engaging Indigenous Observers & Communities through CBONS

ADAC already has communities in the Bering Strait – town of Gambell - participating in CBONS and has provided them with the means to interface with ADAC's intelligent integrated system of systems (IISoS). **Will migrate CBONS to other communities.**

Purpose:

To have local community members observe, document changes, and communicate changes to ADAC in and around the Bering Sea. These changes include unusual sea ice, oil spills, sick animals, storm surges, tracking ship/vessels, and natural and/or man-made disasters such as ship grounding.

ARCTIC DOMAIN AWARENESS CENTER
A DEPARTMENT OF HOMELAND SECURITY CENTER OF EXCELLENCE
at UAA UNIVERSITY of ALASKA ANCHORAGE

CBONS Method & Outcomes

- **Observers transmit real-time observations**, including spatial data **to IISoS in Anchorage** via Iridium satellite phone **– goal to help in U.S. Coast Guard (USCG) Search and Rescue efforts.**
- **Maintain a log** of observations made and photograph unusual observations that are shared with ADAC.
- **Provide now-cast conditions in an emergency that satellites or models may not detect** – important for SAR, improving spill response, **spotting and reporting non-AIS** (Automatic Identification System) vessels.
- Increases observational capacity of residents of Gambell for swifter responses.
- **Townspeople equipped and trained to become first responders.**

(Work by: Dr. Alessa University of Idaho; Grace Beaujean Aleut International Assoc; Village of Gambell)

ARCTIC DOMAIN AWARENESS CENTER
A DEPARTMENT OF HOMELAND SECURITY CENTER OF EXCELLENCE
at UAA UNIVERSITY of ALASKA ANCHORAGE

Integrated Intelligent System of Systems (IISoS)

Purpose: improve situational awareness for maritime responders by:

Collecting, integrating and analyzing data from multiple heterogeneous sources:

- ADAC developed remote sensors
- Event modeling
- Community based observer networks
- Databases
- Unmanned autonomous vehicles
- Alaska Marine Exchange data.

Providing:

- **Incident commanders with actionable information** to respond to intentional and unintentional catastrophic events.
- **Predictive models for preparing and planning** for these events.
  - Example: Enhance the Coast Guard's ability to prepare for and respond to oil spills in the Arctic Ocean, to conduct search and rescue missions, and support efforts to prepare for disasters caused by large coastal storms.
    - **Big data – predictive analytics - of Arctic activities**.

ARCTIC DOMAIN AWARENESS CENTER
A DEPARTMENT OF HOMELAND SECURITY CENTER OF EXCELLENCE
at UAA UNIVERSITY of ALASKA ANCHORAGE

Integrated Intelligent System of Systems (IISoS)

Methodology:

- **Modify architecture developed by NIST - 4D/RCS (Real time Control System)** - includes modules for autonomous intelligent control to process inputs from multiple heterogeneous sources**, understand the data, and provide a format for rapid decision making** (Robotic Technologies – Dr. Finkelstein, Dr. Mock, Dr. Kamberov (UAA); GeoNorth.
- Use improved assessment and prediction models and data fusion methods.
- **Incorporate software from HSARPA** – Stephen Dennis, **- "Narrative Science"** software that fuses data and automatically generates reports for decision making.
- **Employ automatic methods to integrate Arctic environmental models** with observational validation and verification and to plan sensor deployments and observations.

Accomplishments:

- **Began initial development** of IISoS – Integrating data from external sensors (isotope data), CBON observations, modeling, AIS.

ARCTIC DOMAIN AWARENESS CENTER
A DEPARTMENT OF HOMELAND SECURITY CENTER OF EXCELLENCE
at UAA UNIVERSITY of ALASKA ANCHORAGE

High-Resolution (2X) Modeling of Arctic Sea Ice and Currents

Purpose: Develop new High-resolution Ice-Ocean Modeling and Assimilation System (HIOMAS) for now-casting and forecasting of Arctic sea ice and **currents to assist USCG in navigation for search and rescue.**

Goal to Provide:

- **Increased resolution - 2km** (up from 4km) ocean/sea ice models.
- Sea ice thickness, concentration, extent, floe size, growth/melt, motion, and deformation, snow depth, surface heat fluxes, salt and freshwater fluxes, stress on the surface of sea ice and ocean, 3-D ocean temperature, salinity, and velocity.

Methods:

- **Based on ROMS** (Regional Ocean Modeling System)**, builds on** the Hybrid Coordinate Ocean Model **(HYCOM)** developed by the NRL, and the **University of Washington (Dr. Jinlun Zhang) Marginal Ice Zone Modeling and Assimilation System**; model development by **Dr. Ravens (UAA)**.
- Select appropriate data from HYCOM Consortium and the NAVY Global Environmental Model (NAVGEM) to drive the model.

ARCTIC DOMAIN AWARENESS CENTER
A DEPARTMENT OF HOMELAND SECURITY CENTER OF EXCELLENCE
at UAA UNIVERSITY of ALASKA ANCHORAGE

New High-Resolution Oil spill Modeling for the Bering, Chukchi, and Beaufort Seas

Purpose: Enhance USCG's ability to prepare for and respond to oil spills in the Arctic. Support oil spill response planning and risk assessment of the ecosystem impacts of potential oil spills in the Arctic.

Goal: to double the resolution in current models (achieve 2km) and develop an Arctic capable GNOME (General NOAA Operational Modeling Environment).

Methodology:

- **Dr. Ravens (UAA) working with NOAA (Glen Watabayashi, Catherine Berg), UW (Dr. Jinlun Zhang) to integrate high resolution sea ice and currents data from the ADAC ocean/sea ice model into the GNOME modeling framework** to:
  - Improve oil spill modeling and planning in the arctic by providing higher resolution ocean current and sea ice data than is currently available.
  - Eliminate over-estimation of oil spreading by current models in Arctic cold waters, in pack ice, under and on ice, and account for sea ice conditions in drift computations.

ARCTIC DOMAIN AWARENESS CENTER
A DEPARTMENT OF HOMELAND SECURITY CENTER OF EXCELLENCE
at UAA UNIVERSITY of ALASKA ANCHORAGE

High-Resolution Storm Surge and Coastal Flooding Modeling for Alaska

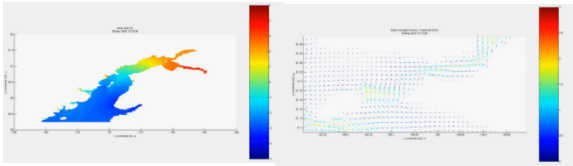
Purpose: Provide quantitative measure of the vulnerability of communities and support the development of tactics and strategies for best response by the communities. This will **support DHS efforts to prepare and plan for disasters caused by large coastal storms and more reliably conduct search and rescue.**

Methodology: Dr. Ravens (UAA) working with Aimee Fish, NOAA; NWS; CBONS.

- Obtain surge level on the ocean boundary from a course-grid NWS model.
- Integrate high resolution sea ice and currents model data.

Accomplishments:

- **Developed operational code for a real-time storm surge forecasting model for Cook Inlet**. Achieved high resolution.
- **Developed robust, automated, storm surge now cast/forecast model for Yukon-Kuskokwim (YK) delta.** Presented to Aimee Fish, NOAA and James Nelson, NWS.
- **Developed preliminary Norton Sound Storm Surge model.**
- **Engaged with coastal community** providing recommendations for water level monitoring stations. Data will be used for model validations.
- **Integrated models into IISoS.**



ARCTIC DOMAIN AWARENESS CENTER
A DEPARTMENT OF HOMELAND SECURITY CENTER OF EXCELLENCE
at UAA UNIVERSITY of ALASKA ANCHORAGE

Integrated Framework to Identify, Track and Communicate Sea-Ice Hazards

Purpose:
Provide a framework at the local scale to identify, track and communicate key environmental hazards in ice-covered extreme maritime environments **to enhance and inform MDA emergency response.**

Methodology:

- Develop and implement a geolocation and conversion algorithm for generation of ice velocity vector data in near-real time, in USCG/ERMA compatible format.
- Generate ice radar data for model ingestion/inter-comparison through averaging and potentially resampling to match the model grid.
- Deployment and calibration of dedicated ADAC and COTS sensors to derive sea-level benchmarks to support ingestion of data from in/sub-ice sensors.

- Dr. Hajo Eicken, Dr. Andy Mahoney, UAF)

ARCTIC DOMAIN AWARENESS CENTER
A DEPARTMENT OF HOMELAND SECURITY CENTER OF EXCELLENCE

Long Range AUV For Undersea Ice Exploration

Woods Hole – Dr. Bellingham

- **Purpose:** Develop new class of propeller-driven long-range AUV for under ice mapping of oil spills and environmental hazard.

- **Methodology:**
  - Long Range AUV is based on the **Tethys system (IMBARI).**
  - **The new AUV will have range up to 600 km with area coverage of up to 1000km^2**.
  - Variable buoyancy enable efficient operations at low speed, and also permits the surfacing and submerging at zero speed, as in open water between ice floes, for satellite communications and navigation fixes.
  - Incorporates ultrashort baseline (USBL) acoustic systems for recovery via homing.
  - Uses augmented AUV simulator and test scenarios addressing high-risk elements, including navigation and sensing systems.
- **Deliverable:**

A long range AUV with high-latitude navigation and oil sensors.

ARCTIC DOMAIN AWARENESS CENTER
A DEPARTMENT OF HOMELAND SECURITY CENTER OF EXCELLENCE

New Low Cost Wireless Sensors for Arctic Monitoring (UAA)

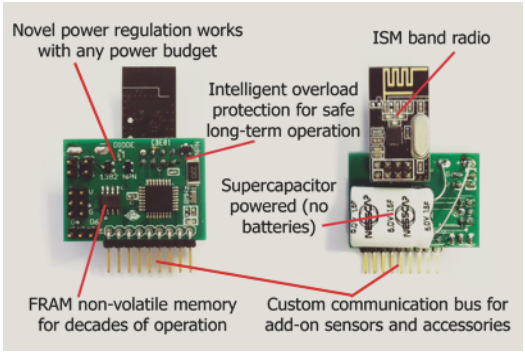
ZENSOR Sensors – wireless sensors ad hoc networks yielding an order of magnitude improvement for remote monitoring, asset management, surveillance and security. The sensors collect, transmit and store data for long periods of time without external power. Successfully tested in Alaska – patent pending.

ADAC Implementation

- *Deploy from UAVs, or other vehicles to pepper a remote landscape* - include water and sea ice to monitor ice floe, changes in ice level, movement of oil spills, surges in water surface levels.
- Integrate with Arctic Sea Ice and Storm Surge Prediction model validation, IIOS.

Capabilities:

- No batteries.
- Long lasting.
- Distributed wireless networked.
- Each sensor can store information from every device in the network.
- Maintenance free.
- Current data suite: humidity, light intensity, temperature, color, sound, thermal images, vibrations.



ARCTIC DOMAIN AWARENESS CENTER
A DEPARTMENT OF HOMELAND SECURITY CENTER OF EXCELLENCE

Transitioning ADAC Technology/Products to Stakeholders

ADAC's primary stakeholder is USCG. Working with USCG: Headquarters, R&D Center, District 17, Anchorage Command to ensure customer satisfaction.

Examples of products targeted for initial transition at end of second year:

- **Sea Ice and Ocean Currents models for** now casting and forecasting data to the Environmental Data Server for the USCG SAROPS, Mr. Allen, Oceanographer for USCG Search and Rescue mission.
- **Modular Arctic-specific Ice Navigation course plus simulator**-based practical assessments. Ms. Medina, Chief of USCG Marine Personnel and Qualifications Division **to assess and certify the course** using the TRANSAS simulator.
- **Test a prototype of the IISoS** with USCG District 17, RADM Abel.
- **SmartCam installation** at the Port of Anchorage to enhance the existing port surveillance system, as requested by the Port Director.
    - **Long Range Autonomous Underwater Vehicle** with high-latitude navigation and oil sensors for testing.

ARCTIC DOMAIN AWARENESS CENTER
A DEPARTMENT OF HOMELAND SECURITY CENTER OF EXCELLENCE

Integrated Education

- **To develop a future work force that will address DHS needs through:**
  - Curriculum Development
  - Experiential Learning
  - Training
  - Internships
  - Scholarships for students in STEM, and interest in DHS related careers.

- **Arctic Education: Implementing the Arctic Strategy in Training (Maine Maritime Academy – Victoria Blackwood, Capt. Pundt)**
  - Develop an ice navigation course with ice navigation software and simulator for training.
    - Incorporate research results from Maritime Domain Awareness research, in particular "Arctic Sea Ice and Storm Surge Predictions" into the training software.

ARCTIC DOMAIN AWARENESS CENTER
A DEPARTMENT OF HOMELAND SECURITY CENTER OF EXCELLENCE
at UAA UNIVERSITY of ALASKA ANCHORAGE

2015 Healy Expedition

7 ADAC team members including students will be participating on two different excursions.

- **To gain an understanding** of U.S. Coast Guard operations.
- **To Perform Experiments, collect data** not accessible on land and in different geographic areas, **and work side by side with USCG** :
  - **Using isotope sensing systems** for determining changes in ocean productivity and contaminants, including fuel/oil leaks and discharges; and a better understanding of how water vapor isotopes vary (sea ice extent) (Dr. Welker UAA).
  - **Ice Floe research** - To collect imagery from the ship's radar system to test and develop algorithms for deriving motion and deformation fields of ice around the vessel (Dr. Mahoney UAF).

ARCTIC DOMAIN AWARENESS CENTER
A DEPARTMENT OF HOMELAND SECURITY CENTER OF EXCELLENCE
at UAA UNIVERSITY of ALASKA ANCHORAGE

Final Thought

- **Through its mission ADAC will help to improve maritime situational awareness and crisis response** to emerging maritime challenges in the dynamic Arctic environment.

- Additionally – climate change in Alaska is one of the most dramatic and earliest effects making Alaska an ideal predictor for a global view – methods developed and lessons learned at ADAC all have ***global transferability.***

ARCTIC DOMAIN AWARENESS CENTER
A DEPARTMENT OF HOMELAND SECURITY CENTER OF EXCELLENCE
at UAA UNIVERSITY of ALASKA ANCHORAGE

For Additional Information Contact

Dr. Helena S. Wisniewski
Vice Provost for Research & Graduate Studies, UAA
Director, ADAC
E-mail: hswisniewski@uaa.alaska.edu

Theophilos C. Gemelas
Program Manager - Office of University Programs
Science and Technology Directorate
U.S. Department of Homeland Security
202.254.6108 voice
202.689.5787 mobile
E-mail: Theophilos.Gemelas@dhs.gov