



Building on Existing Strengths to meet DHS Needs

CIMES

The Center for Island, Maritime and Extreme Environment Security (CIMES)

Roy Wilkens – Center Director

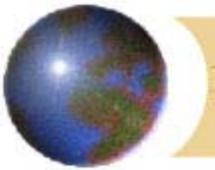
Overview

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University of Hawaii

03/20/08



CIMES Collaborating Institutions

Core Partners

- University of Hawaii
- Applied Physics Laboratory and College of Engineering, University of Washington
- University of Alaska Fairbanks
- University Puerto Rico at Mayagüez

Including

- University of Alaska Anchorage
- Pacific Disaster Center (Hawaii)
- Maui High Performance Computer Center
- Intelesence Technologies

Plus Affiliates



Initial CIMES Affiliates

- National Center for Maritime and Port Security, SRI International Marine Technology Program. (Globally recognized capability in underwater chemical and biological sensing, underwater imaging, unmanned underwater vehicles, and specialized marine research).
- Navatek Ships. (Research and development of manned/unmanned surface vehicles, deploy and maintain prototypes of sea based sensing systems).
- Trex Enterprises Corporation. (Provides expertise in microwave sensing, high resolution imaging, digital signal processing, applied optics and materials).
- Southwest Public Safety Technology Center, University of Houston. (Serves the first responder and public safety community in major interdisciplinary research areas of surveillance and security systems, enabling technologies and human behavior, integrating engineering, social sciences, computer science, and life science).
- Center of Homeland Security, University of Colorado at Colorado Springs. (Recognized national leader in homeland defense education, provides relationship with the United States Northern Command grounded in both joint education and research initiatives, provides active research in physical security technologies and security policy related to MDA).



Initial CIMES Affiliates

- Referentia Systems Incorporated. (Provides technologies and capabilities that support DoD C41 programs, in Net-Centric Command and Control, Mission Planning and Situational Awareness, Data fusion and Signal Processing).
- Consortium led by School of Engineering, University of Santa Cruz. (Provides access to many California Institutions and the Monterey Bay arena, and research programs emphasizing critical technologies for MDA including detection, monitoring, tracking, surveillance).
- Center for Remote Imaging, Sensing and Processing, National University of Singapore. (Provides access to a major Asian port and associated security challenges, and research on remote sensing that meets the needs of the scientific, operational and business requirements of Singapore and the region).
- Pacific Telehealth and Technology Hui, Telemedicine and Advanced Technology Research Center, US Army Medical Research and Materiel Command. (Provides metrics for evaluating success of proposed objectives and provides access to Army research in areas of interest to DHS).



Primary Driver:

98% of US foreign trade moves by sea – 2 billion tons of cargo moves through US ports and will double in volume by 2020.

Other Specific Drivers:

- Near shore protection from terrorism
- Smuggling (human and contraband)
- Environmental protection
- Natural disaster mitigation, relief and recovery
- Piracy protection

Primary Customer: US Coastguard

Other Customers: all agencies related to specific drivers



Primary Foci:

- Maritime Domain Awareness (MDA)
 - Persistent Monitoring of the Maritime Environment
 - NOT persistent presence
- Creating and educating a professional community that is the future workforce of the customers

Other of areas of attention:

- Marine transportation security, infrastructure protection, resiliency, recovery
- Maritime enforcement and C³
- Risk management, legal, policy, and governance



Probable Primary Research Objectives:

- Improve and rationalize data gathering
 - (FAA for Maritime traffic?)
 - Design new observing platforms (especially in remote and harsh environments)
 - Re-purpose/re-design existing data gathering mechanisms
- Refine, fuse and analyze raw data to create low level information
 - Space, radar, acoustic, discrete data streams
- Make low level decisions to create higher level actionable information
 - Distinguish between ships, mammals, swimmers, bad weather, fish, small craft, etc
 - This is ship “x” registered in country “y” destined for port “z”
 - This is a small craft headed in direction “z” and speed “y” – this is “unusual” behavior.
- “Pass on” actionable information to decision makers – e.g. Coast Guard – NOAA - Pacific Disaster Center – State Department of Defense – may be first responders in general?
 - Intelligible information passing mechanisms – visualization platforms



Example sources of data (data sources originally created for non DHS purposes)

- US Navy (need to “clean” the data)
- NOAA (environmental monitoring)
- NASA (environmental, resource management, etc)
- NOPP (National Oceanographic Partnership Program) – IOOS (Integrated Ocean Observing System)
- AON (Arctic Observing Network)
- Discrete data sources -Identities, manifests – AIS (Automatic Identification System – for ships)
- GPS Satellites
- Etc.



Distinct sectors of interest often require different monitoring techniques

- Harbors and maritime waterways – (More focus by Sister CoE at Stevens Institute)
- Near shore
- Ocean
- Origins of maritime traffic (overseas)
- Tropical
- Arctic
- Remote Island



Probable Initial Research Areas

- Satellite Detection and Tracking of Ships in the Tropical and Polar Oceans - Rob Wright (UH), Tom Heinrichs (UAF), Miguel Velez-Reyes (UPRM), Kevin Engle (UAF), Buck Sharpton (UAF)
- Coastal Radars, Tropical and Arctic - Pierre Flament (UH), Hajo Eicken (UAF), Magdy Iskander (UH), Sungkyun Lim (UH), Mark Johnson (UAF)
- Harbor Acoustic Monitoring Systems - John Allen III (UH), Eva Nosal (UH)
- Decision Support Systems - David Jones (UW/APL), Kevin Montgomery (Intelesence/UH)



Creating and Educating a Technologically based Professional Community for the DHS/Coastguard

- Hard to develop technologically focused DHS/Coastguard specific curricula given the new and evolving nature of the culture and technology – took decades to create computer science! – how does one define the community?
- Take a project based approach to undergraduate curriculum development – involving student teams (inter campus even), across disciplines and student seniority
- Develop a library of projects suitable for undergraduate and maybe graduate students
- Maturing projects & groups of projects later turned into curricula components and introduced into the formal curriculum



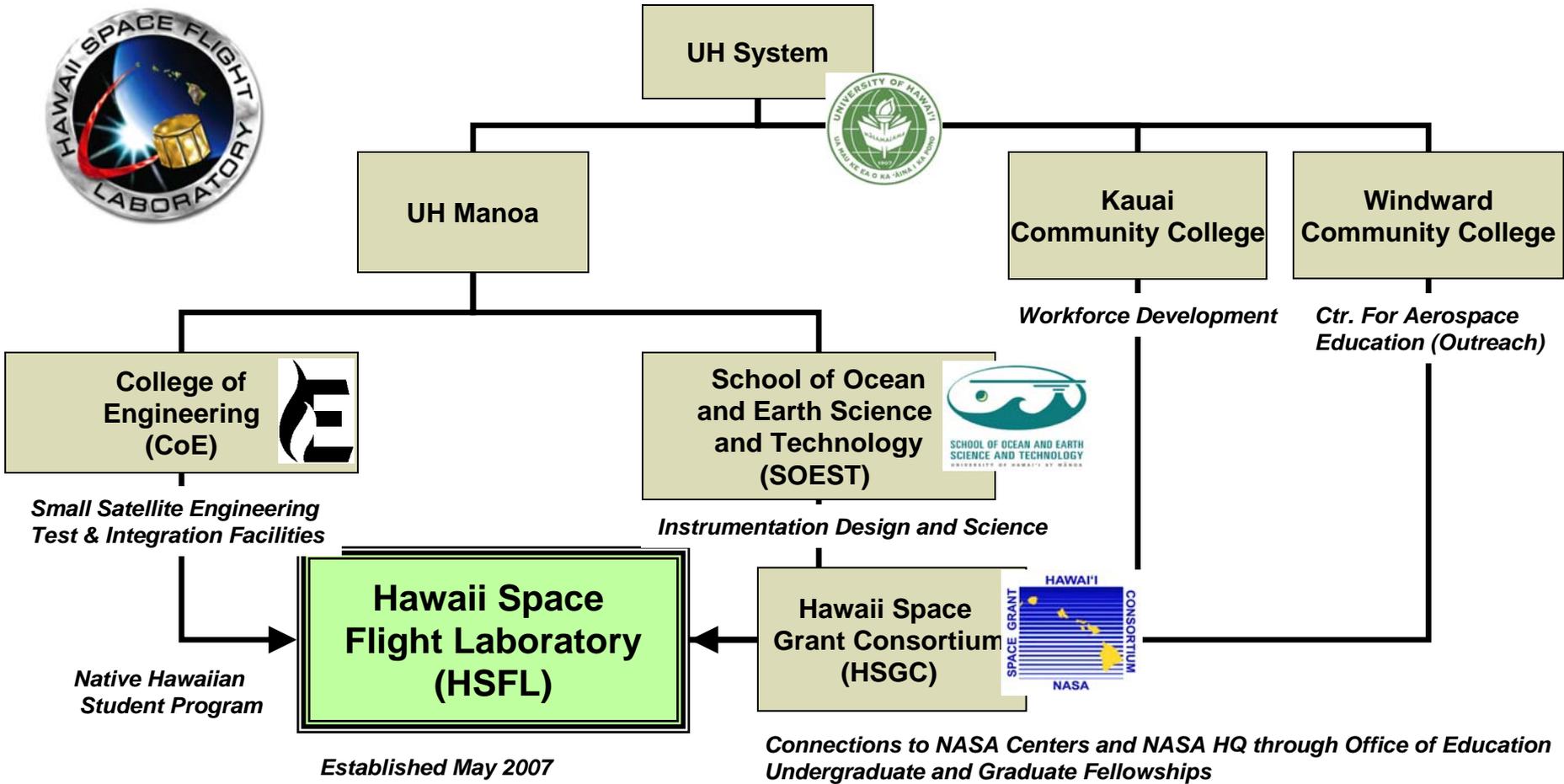
Example – UH Cube Sat Program

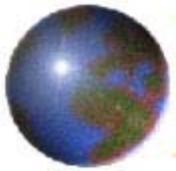
- > 150 EE and ME students have participated
- 7 in PhD programs, > 20 in MS programs
- 1 patent awarded
- \$500,000 in funding, including student-solicited proposals
- > 20 undergraduate publications
- Involves Northrop Grumman, Boeing, Raytheon, Lockheed Martin
- Program run by Professor Wayne Shiroma boasts three recent winners of the Eta Kappa Nu National Student award “best EE student of the year” – 2001, 2003 and 2005





UH CubeSat Program led to HSFL





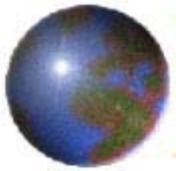
Building on Existing Strengths to meet DHS Needs

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Pacific Alliance



University of Alaska Anchorage
University of Alaska Fairbanks
University of Hawai'i Manoa
University of Washington
Kapiolani Community College
Kuskokwim Community College



Continued support of the Pacific Alliance to Hawaii through:

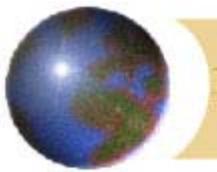
Islands of Opportunity Alliance



Partners:

University of Guam
Northern Marianas College
Guam Community College
Palau Community College
College of the Marshall Islands
American Samoa Community College

University of Hawaii, Hilo
University of Hawaii, Manoa
The Community Colleges of the University of Hawaii System
Chaminade University
Hawaii Pacific University



Brief Research Objectives and Descriptions

Satellite Detection and Tracking of Ships in the Tropical and Polar Oceans

- Identify ships in open ocean and waters around, Hawaii, Alaska and Puerto Rico
- Research optical properties of ship wakes – first from aircraft images and then satellite images
- Recommendations for deployment of small satellites and instrumentation

Coastal Radars, Tropical and Arctic

- Identify sea craft and parameters (speed, heading etc) “close” to the coast and ambient sea state (currents, waves, etc)
- Research on (low power, low cost, readily deployable) HF Radars capable of operating in harsh environments (tropics and the Arctic – and periodic ice presence)
- Leveraging existing ocean observing systems, including space based data, and remote sensor platforms



Brief Research Descriptions

Harbor Acoustic Monitoring Systems

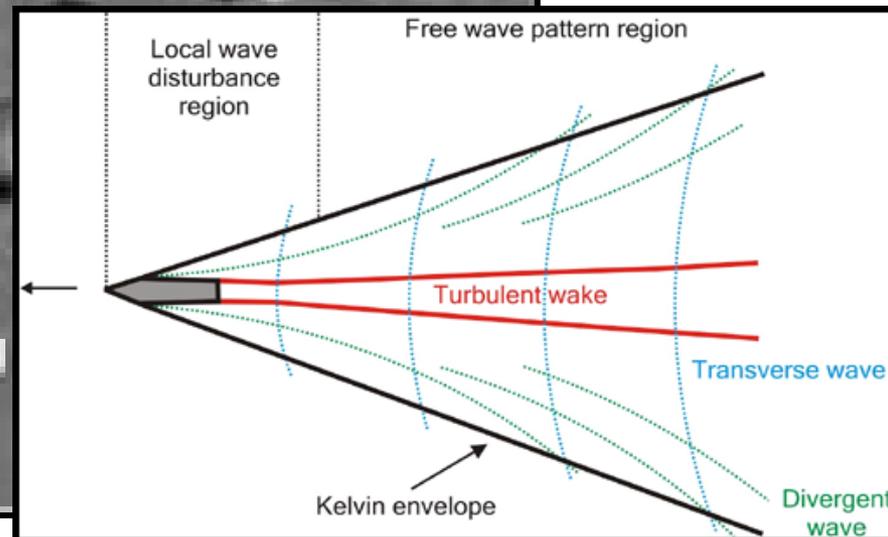
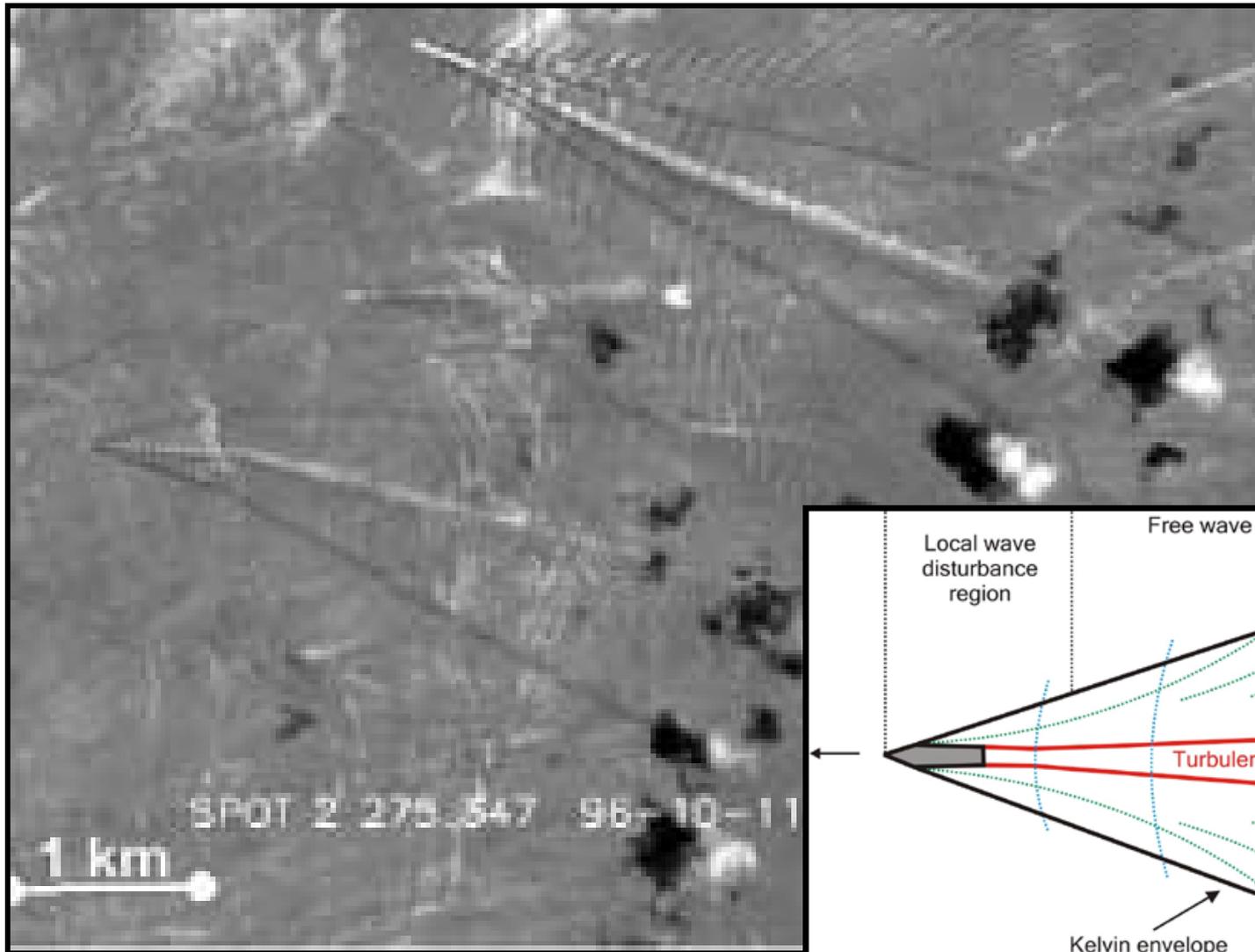
- Locate, identify, distinguish - waves, ships, people and mammals in and around harbors and near shore
- Research real time acoustic monitoring systems – developing acoustic signatures of ships, divers, swimmers
- Build upon knowledge of acoustic monitoring systems and develop purpose built system for Honolulu Harbor and extend to other harbors

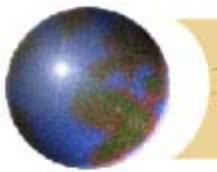
Decision Support Systems

- Develop data gathering, analysis and display tools for heterogeneous data sources
- Research statistical learning architectures capable of utilizing small numbers of samples and fusing disparate data sources
- Development of 3D computer visualization tools based on Intelisense's internet-based data integration engine



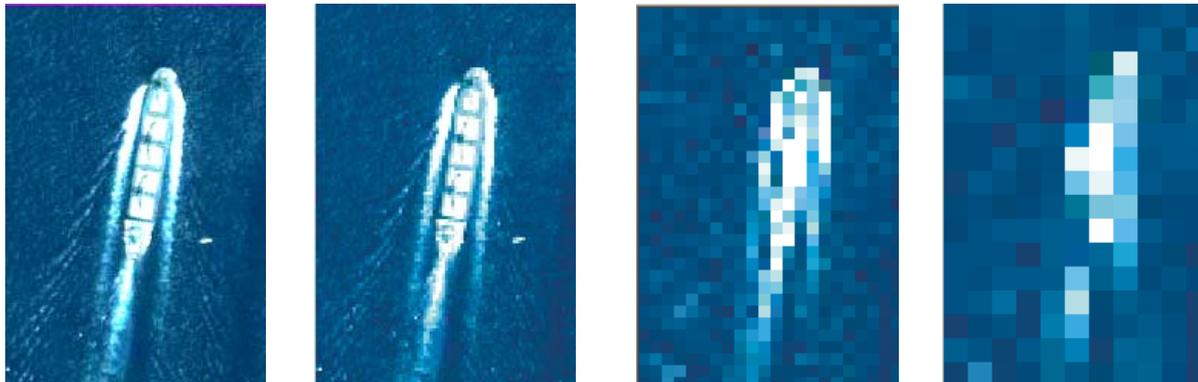
Detection of ships via their wakes seen in satellite data





Requirements for remote detection of ships using an optical remote sensing system

Step #1: Acquire high spectral/spatial/radiometric resolution data from an airborne sensor



Using these high resolution reference data, we can determine the spatial, spectral, radiometric and temporal resolution necessary to detect ship wakes using an optical remote sensing instrument

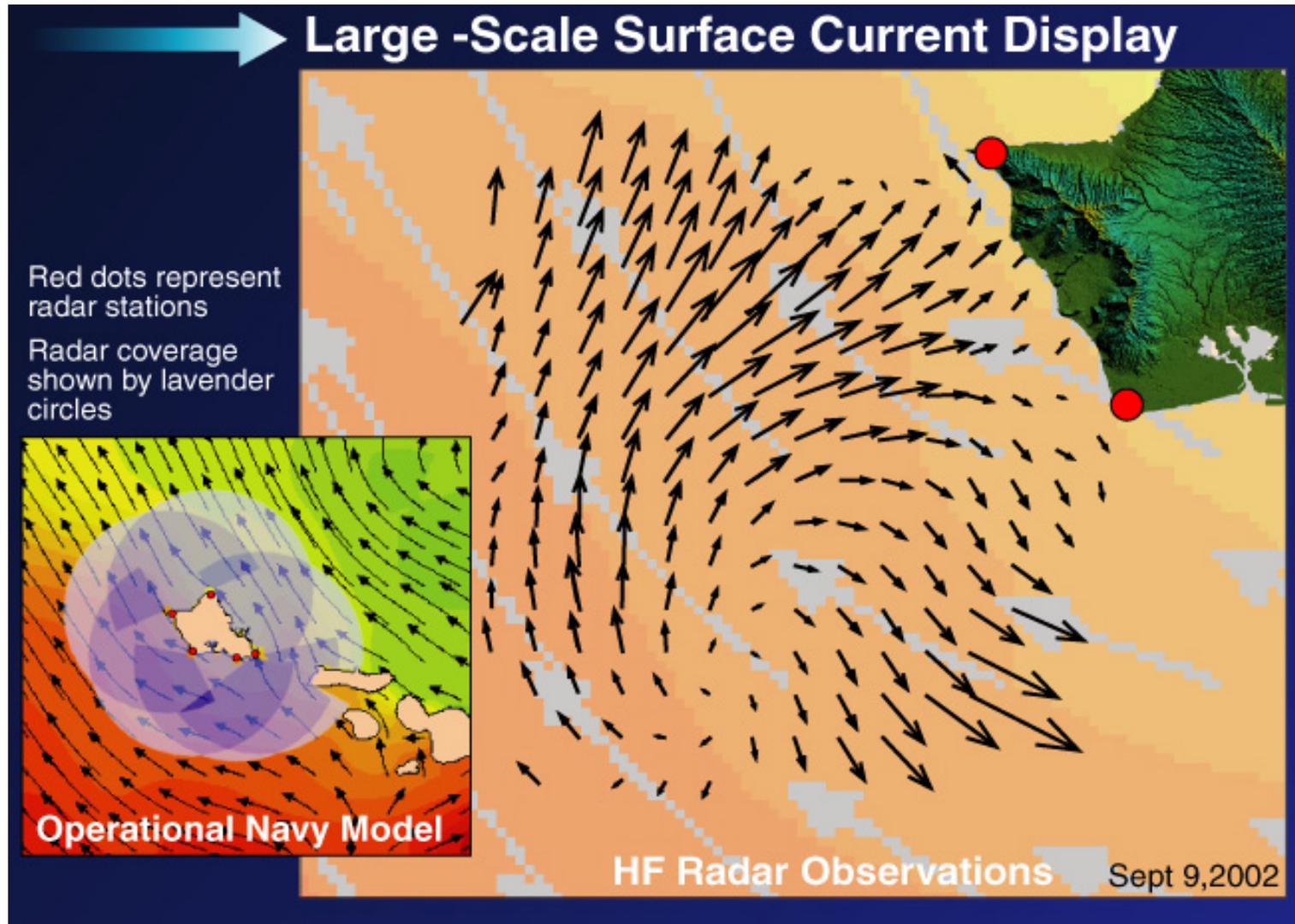
Step #2: Design UH space missions



- UH to become the gateway for university-class and small satellite space access.
- Partner with Pacific Missile Range, Kauai
- Will send 300 kg to low-Earth orbit (400 km) or 225 kg to mid-orbit (700 km)



HF Radars - Comparison with Navy Operational Model





Development of antennas for HF radar applications

Conventional monopole: $h \sim \lambda/4$ (5 m at 15 MHz, 15 m at 5 MHz) electrically small monopoles: $h \ll \lambda/4$

Advantages: low cost, low environmental impact, reduced risk of vandalism, easier permitting, fast deployment

Past attempts: resonant f depends on detailed geometry, ground and environment

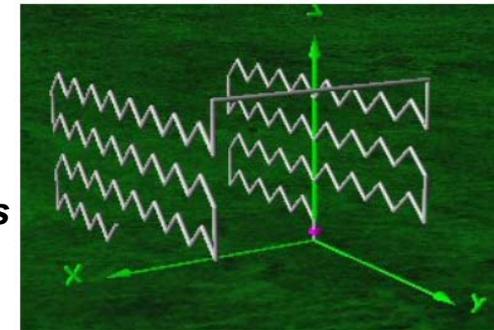


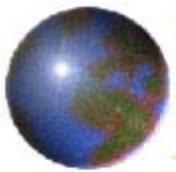
Existing antennas deployed on W. Oahu



Meander line 12 MHz antenna, Bonner, SONDR, 2006 (too unstable)

Spiral 27 MHz antenna, Rogers and Buhl, ARL/UTA, 2001 (too narrow band)

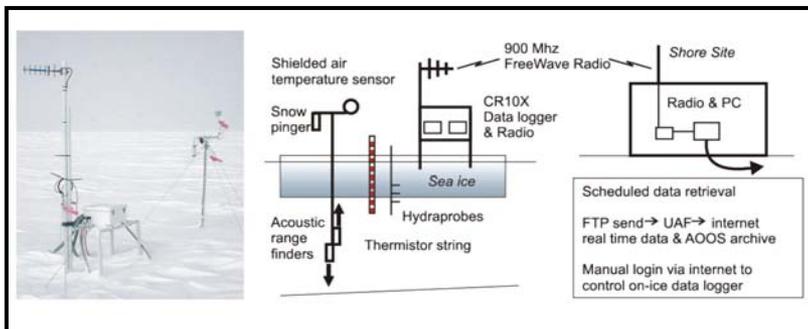
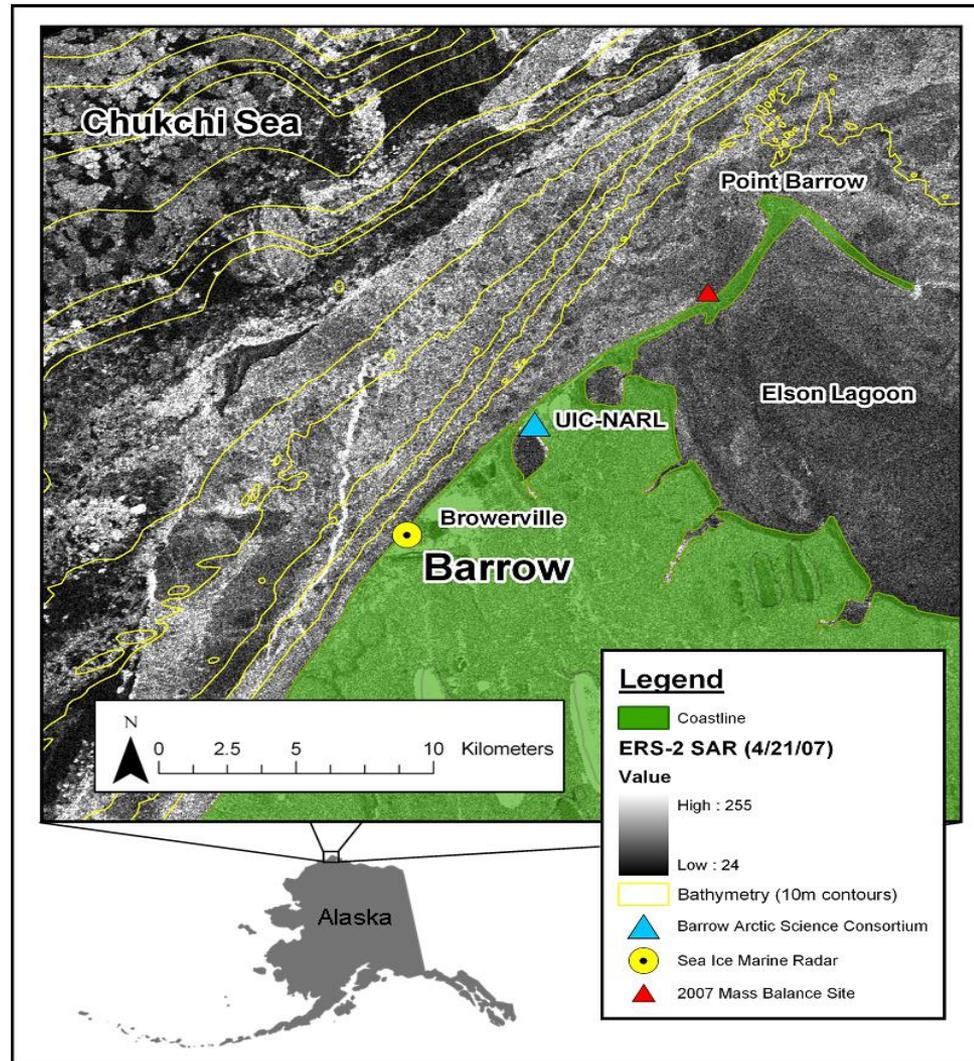


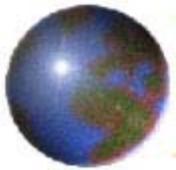


Improving cold-regions maritime domain awareness

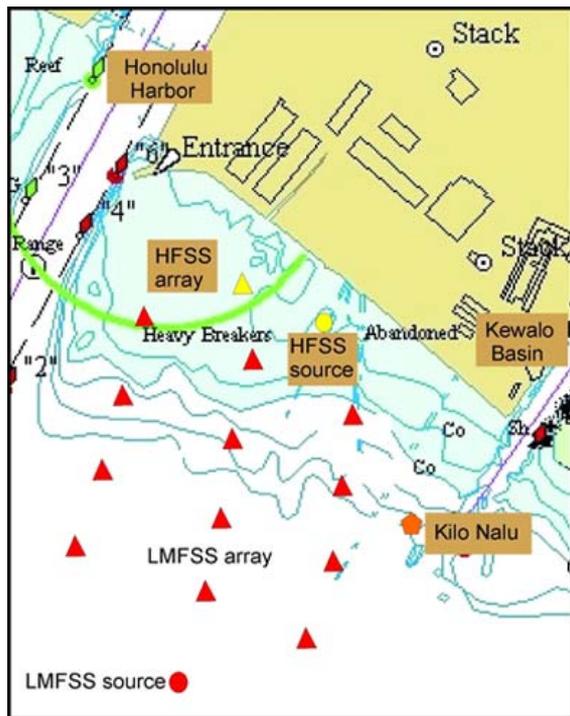
- *Coastal radar* (sub-km scale): Vessel & ice tracking, ice dynamics & potential disaster response
- *Aerial surveys, ice & sub-ice sensor systems**
- *Local knowledge**: Potentially important role for disaster response
- Integration of data streams, GIS-based decision support systems

* Leveraged through integration & assimilation of existing ocean observing system resources (AOOS.org)





Proposed Hydrophone and Transducer Arrays Off Honolulu Harbor



Initial Deployment



Second Deployment

All Data - both acoustic and environmental - will be delivered to shore in real-time through the Kilo Nalu Offshore Observatory



Boater Information System

Fusion of forecasted wind
Information

User specified thresholding
(red/yellow shading)

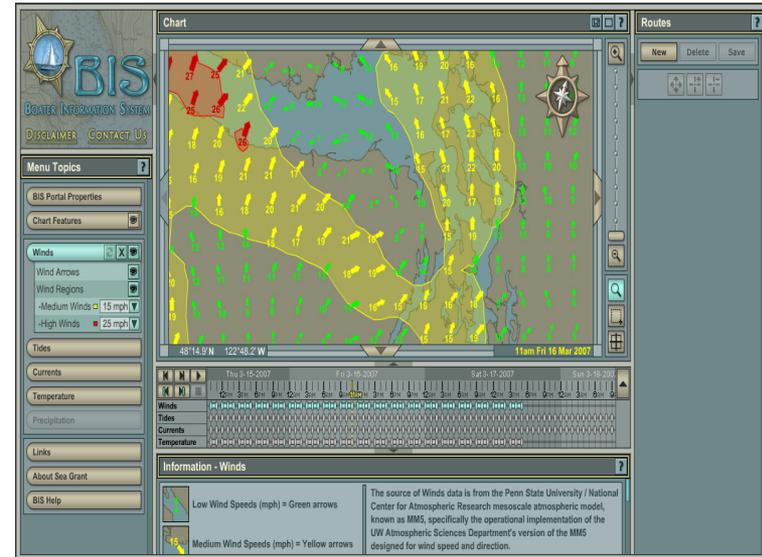
Looping through time windows

Fusion of tidal & current
forecasts and marina
locations

Interactive by location and time

Route Planning

Allows better decision making





Data Fusion

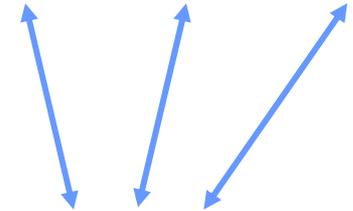
InteleCell / InteleNet

In-Situ Sensors

- Multiparameter sensors
- Remote sensor network
- Local intelligence



External Data Sources



Intelesense Server

Server: Integration & Analysis

- Integration of disparate data sources
- Algorithms to analyze data
- Input for future modeling and sim

InteleView

Display & Dissemination

- GIS-based display over web
- Custom, secure online views
- Collaboration tools

