NOAA Unmanned Aircraft Systems (UAS) Program Update

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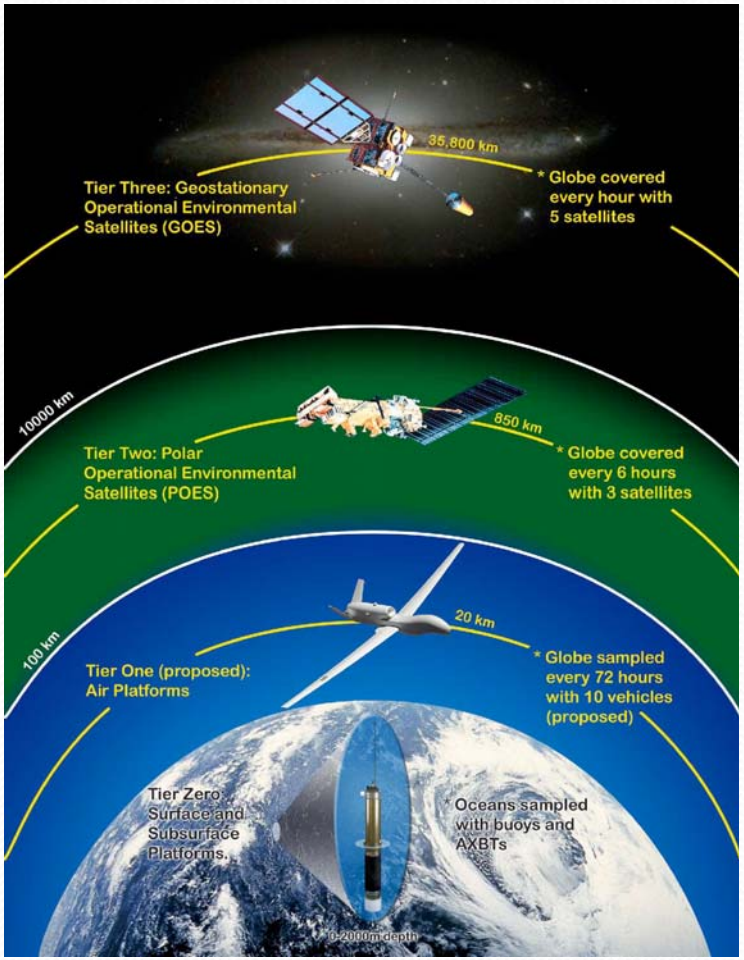
National Oceanic and Atmospheric Administration

Overview of UAS Program

The NOAA Unmanned Aircraft Systems (UAS) Program is evaluating the feasibility of UAS platforms to meet the NOAA Mission's goals in

- **Climate**
- **Weather and Water**
- **Ecosystems**
- **Commerce and Transportation**



The evaluation will be based on NOAA observational requirements, technology readiness assessments, UAS science demonstrations and acquisition strategy

Unmanned Aircraft Systems NOAA Position Statement

Unmanned Aircraft Systems (UAS) have the potential to efficiently and safely bridge critical information gaps in data-sparse and remote locations of the global environment and advance the understanding of key processes in Earth systems. Optimizing the capabilities that UAS offer will advance NOAA's mission goals through improved understanding of oceanic and atmospheric exchanges, hurricanes, wildfires, polar regions, and other environmental processes and hazards ultimately leading to improved climate and weather predictions. NOAA is partnering with other civilian agencies, including NASA and FAA, and with industry and academia to develop UAS operations, systems and platforms that can be safely deployed, both nationally and globally, to fill observational data gaps with increased efficiency and decreased risk to personnel.

Statement will be useful during development of international partnerships

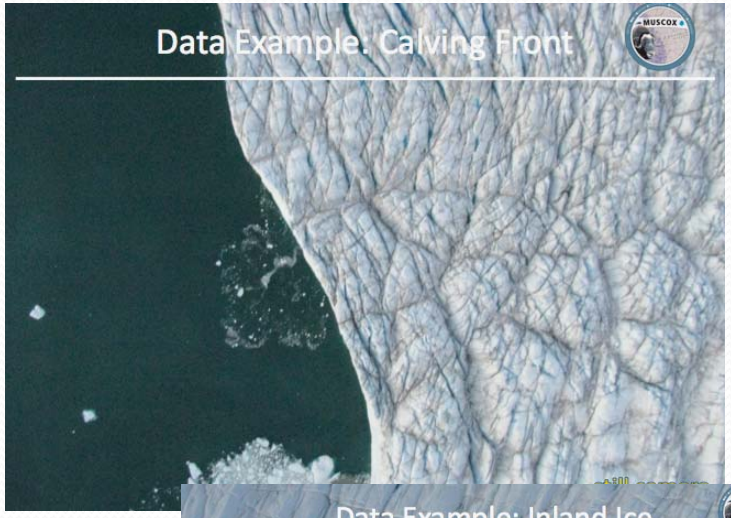
9 November 2009

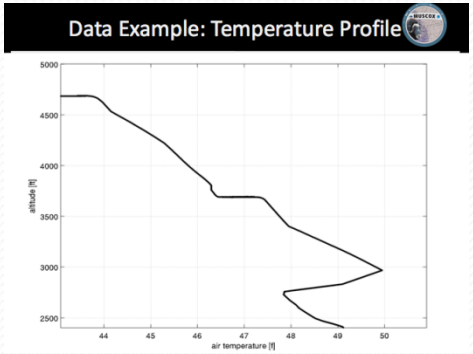
Testbed Approach to UAS Science and Technology Assessment

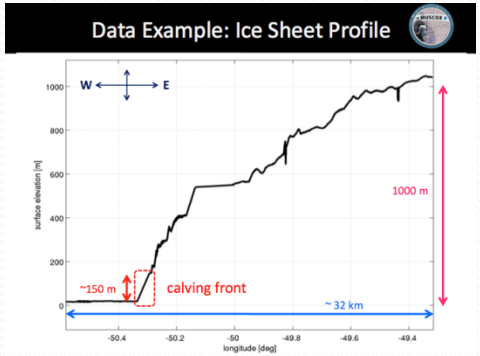
- ***ARCTIC MISSIONS***
  - Operational low altitude effort to monitor Arctic ice seal populations
  - Research low and high altitude effort to monitor Arctic sea ice conditions
- ***GULF/ATLANTIC MISSIONS***
  - Research low altitude effort to study air-sea interactions during hurricanes
  - Research/ Operational high altitude effort to study/monitor hurricane intensity
- ***PACIFIC MISSIONS***
  - Research low and high altitude effort to study air-sea interactions during atmospheric water vapor river event
  - Operational low altitude effort to monitor USA national marine monument
- ***CROSS-CUTTING APPLICATIONS***
  - Research low altitude effort to study fire weather

Greenland Glacier Melt Pond Demonstration

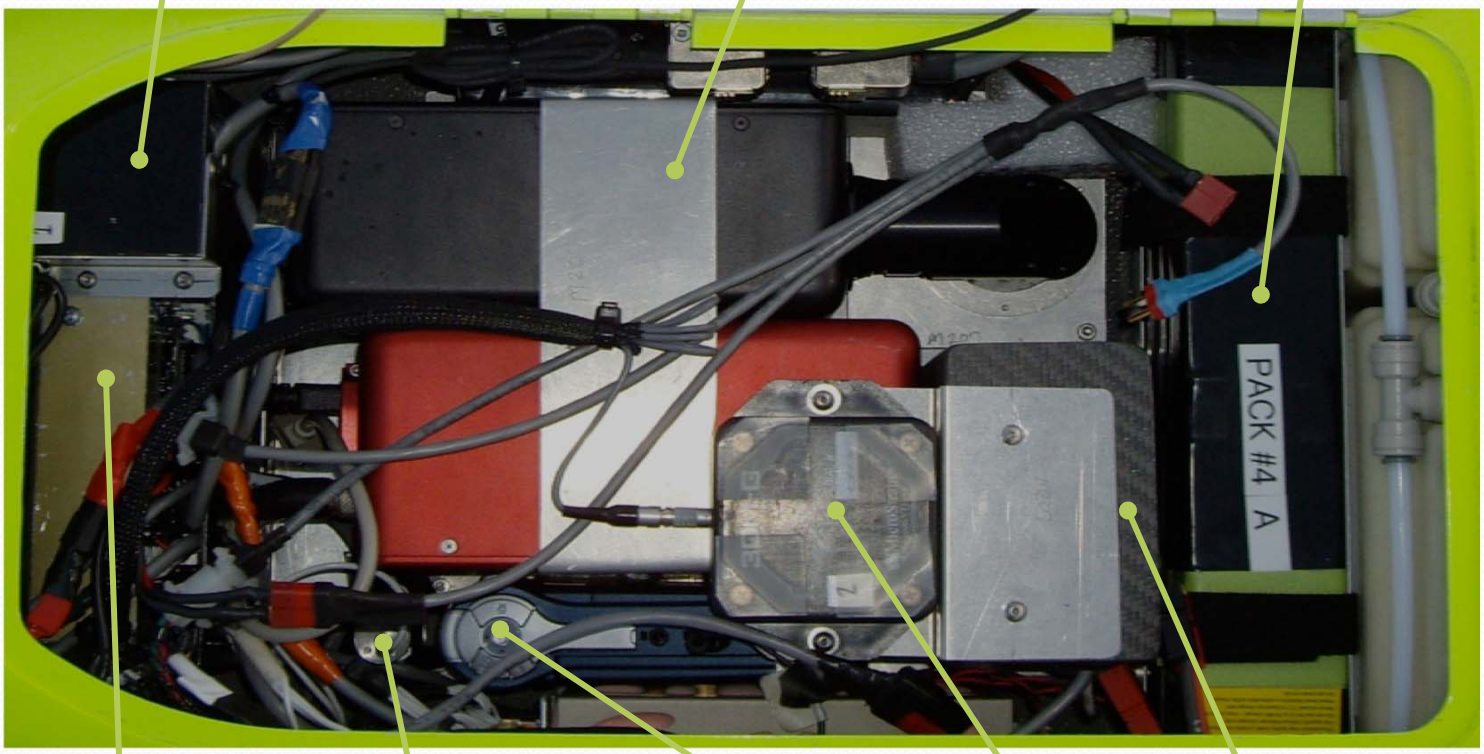
Partners: NOAA Earth Science Research Laboratory
University of Colorado
BAE / Advanced Ceramics Research



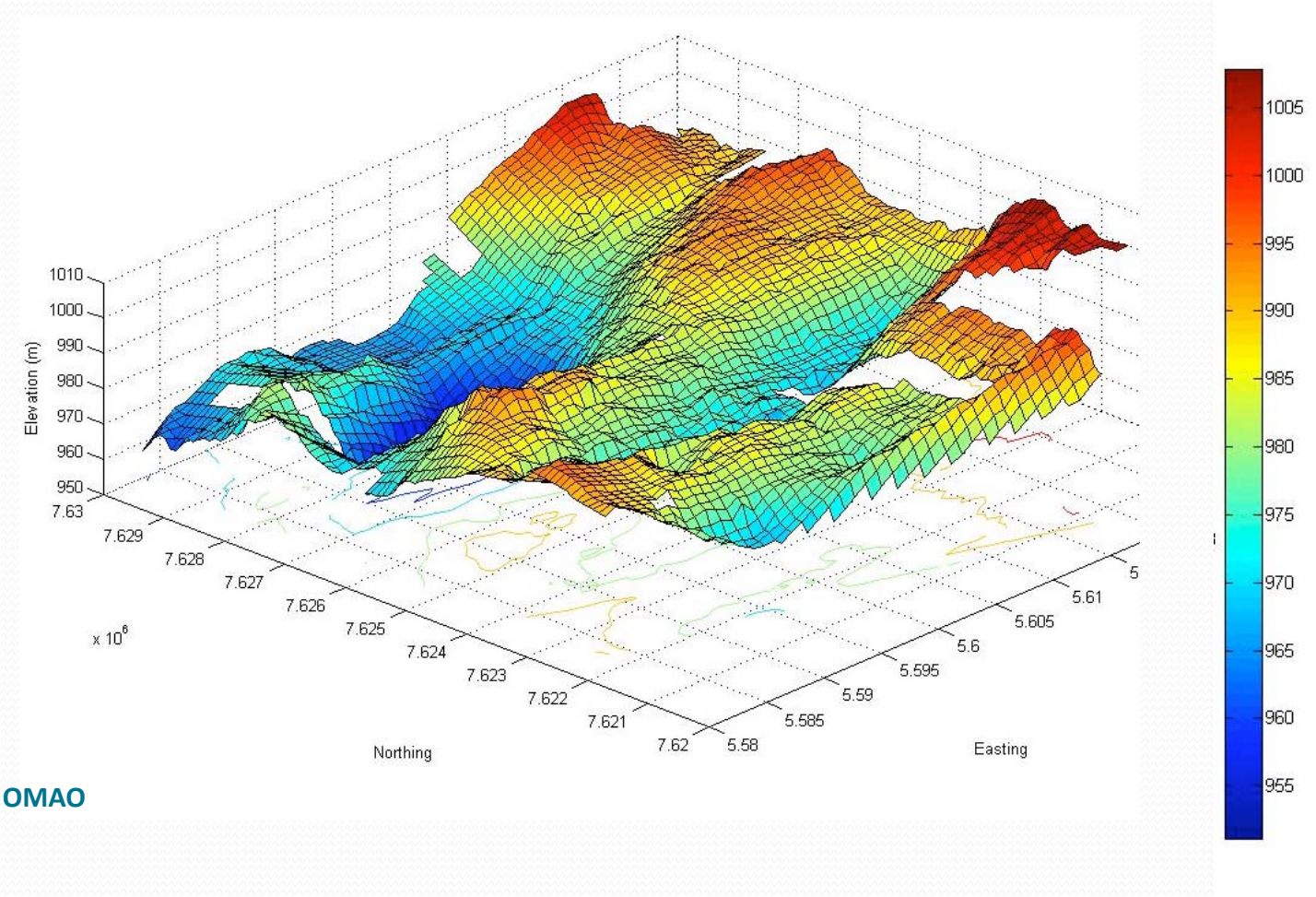




Greenland Payload



Preliminary Greenland Digital Elevation Map

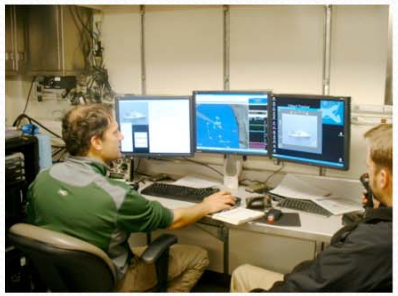


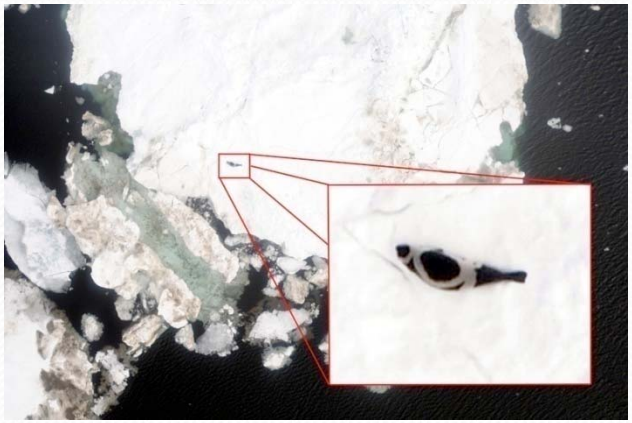
John Adler /NOAA OMAO

Arctic Ice Seal Demonstration

Partners: NOAA National Marine Fisheries Service /National Marine Mammal Laboratory
University of Alaska – Fairbanks
Boeing / InSitu Corporation

Sample Target

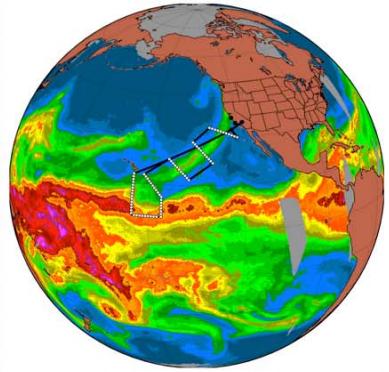


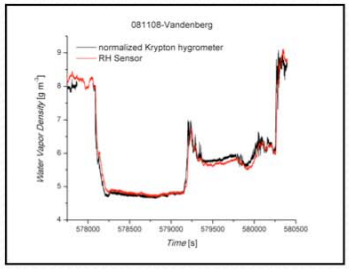


UAS Observation from 400 ft Altitude
6 June 2009

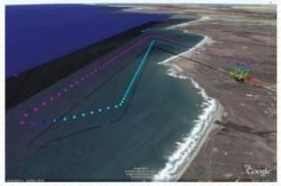
Pacific Testbed

Integrated Water Vapor From SSM/I

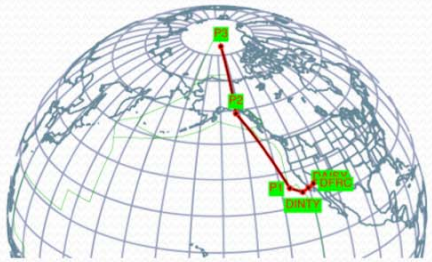




Preliminary water vapor data



System testing of Low Altitude Long Endurance (LALE) UAS from Vandenberg, AFB for water vapor flux monitoring of atmospheric rivers



Collaboration with NASA on Global Hawk Pacific (GloPac) Experiment

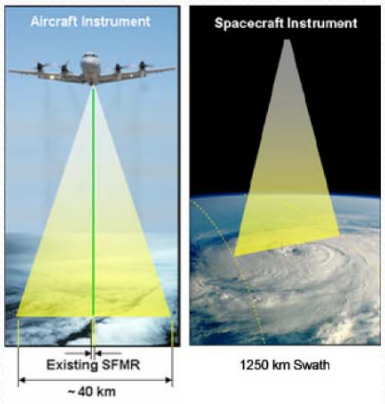
Gulf / Atlantic Testbed

Potential Areosonde flights in collaboration with NASA

Global Hawk Hurricane Missions in collaboration with NASA

Potential Coyote / P-3 flights in collaboration with Navy

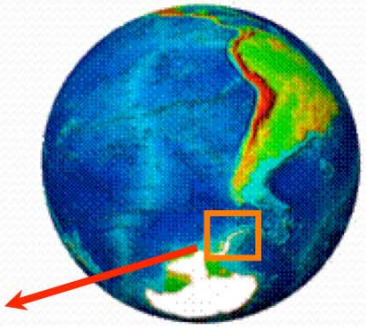
HIRAD



Hurricane Imaging Radiometer development for ocean wind sensing in collaboration with NASA

Global Hawk dropsonde development in collaboration with NSF and NCAR

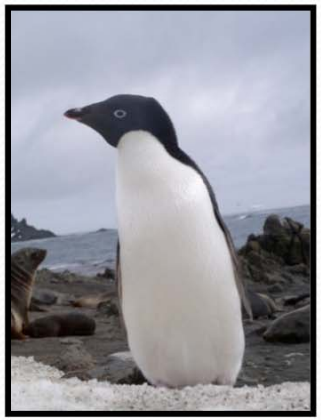
Antarctic Mission



Partners: NOAA National Marine Fisheries Service / Southwest Fisheries Science Center

Enerdyne

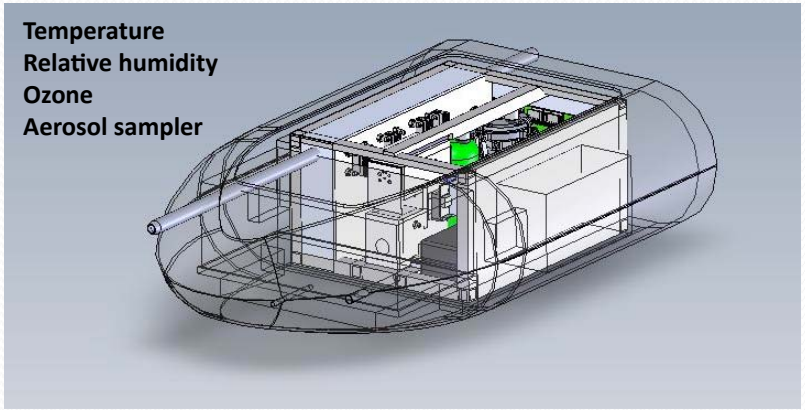
Aerial Imaging Solutions



- **UAS will collect vertical images of penguin colonies (Adelie, Chinstrap, Gentoo) and fur seal rookeries at Cape Shirreff for calibration of counts from images against those collected by scientists on the ground**
- **Aircraft will be taken aboard ship and will stage from vessel to sample otherwise inaccessible sites.**

Arctic Atmospheric Chemistry System Test

Partners: NOAA Pacific Marine Environmental Laboratory
Advanced Ceramics



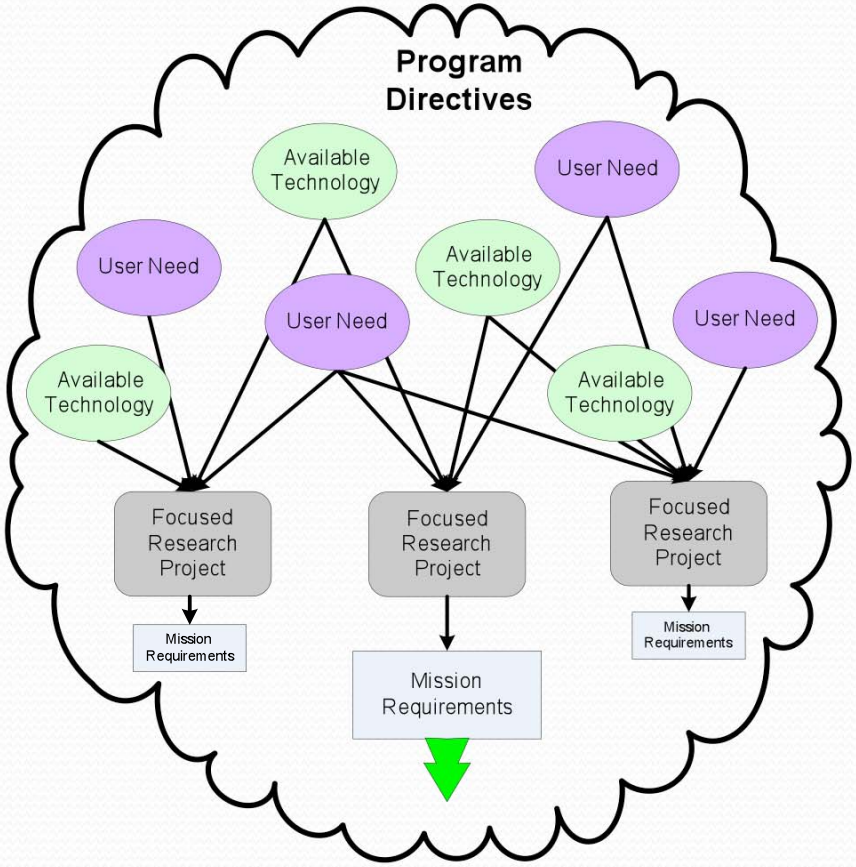
•Identifying aerosol layers in the atmosphere and the optical properties of the aerosols in these layers (example: black carbon in the Arctic).

• Aerosol-cloud interactions – simultaneously flying below, above and within clouds to quantify the radiative effect of changing cloud droplet number.

• Climate-Air Quality studies – mapping the vertical and spatial extent of pollution plumes advecting off the continents.

Mission Definition Development

- Program Directives guide overall mission
- Formulate User Needs based on Program Directives and Available Technology
- Perform Trade Studies to define top level requirements for focused research projects
- Develop requirements for individual projects



Courtesy of Southwest Research Institute

NOAA Program Directives

NOAA Responsibilities and Mandates

NOAA Strategic Plans

NOAA Core Competencies identified in NOAA Annual Guidance Memo

- *Improve high-impact weather and water forecasts,*
- *Manage ocean and coastal resources,*
- *Support coastal communities*
- *Deliver information for safe transportation*

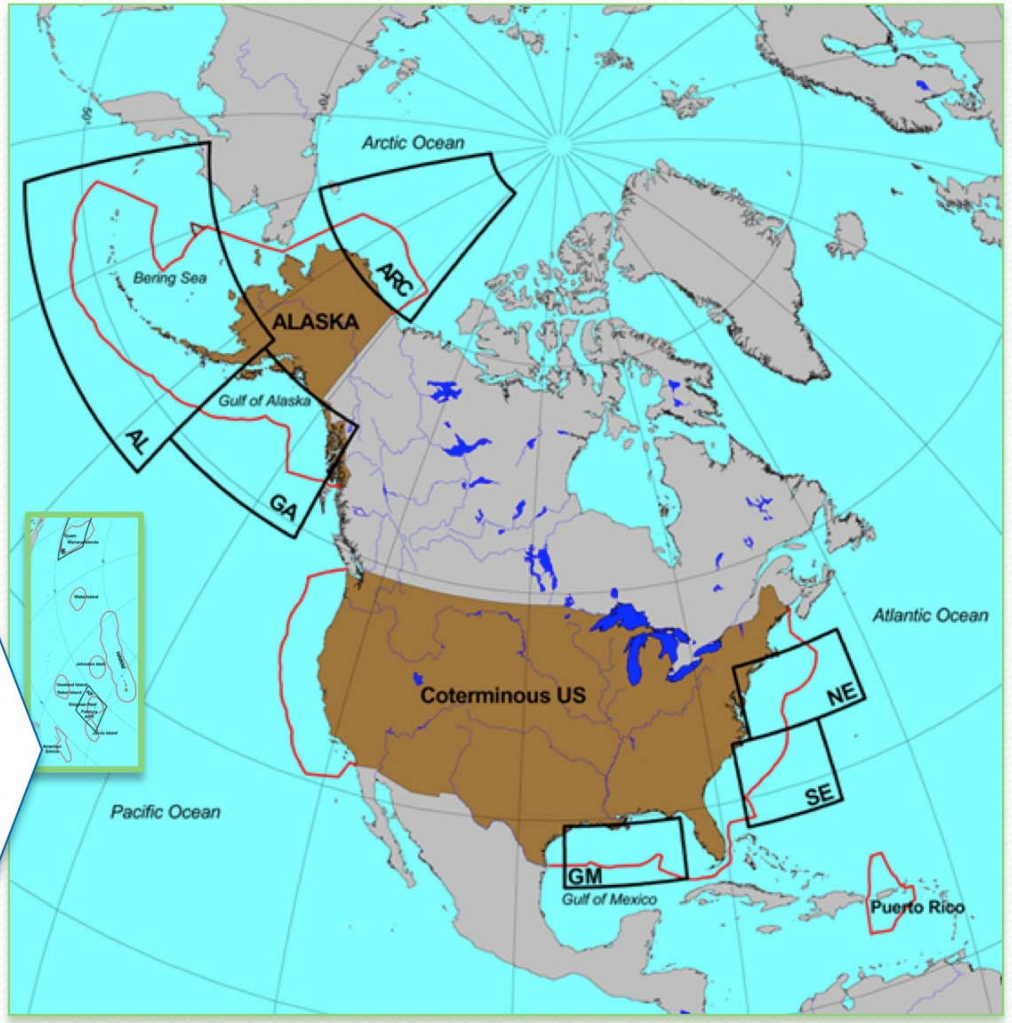
NOAA Arctic Action Plan Theme Areas

- *Climate Science and Services*
- *Coastal Community Resilience*
- *Weather and Water Services*
- *Marine Transportation*
- *Marine Ecosystems and Resource Management*
- *Homeland Security and Arctic Governance*

A Healthy American Economy Depends on Healthy Oceans

The U.S. exclusive economic zone (EEZ) is the largest in the world

Within this area, NOAA sustainably manages fisheries and implements marine sanctuaries
In the global ocean, NOAA deploys observing systems, conducts scientific research, and monitors the oceanic ecosystem



Red regional outline indicates current U.S. Continental Shelf
Black regional outline indicates likely extension of U.S. Continental Shelf

Interim Report of the Interagency Ocean Policy Task Force

National Policy and Implementation Strategy for 9 Priority Objectives:

- ***Ecosystem-Based Management***
- ***Coastal and Marine Spatial Planning***
- ***Inform Decisions and Improve Understanding***
- ***Coordinate and Support***
- ***Resiliency and Adaptation to Climate Change and Ocean Acidification***
- ***Regional Ecosystem Protection and Restoration***
- ***Water Quality and Sustainable Practices on Land***
- ***Changing Conditions in the Arctic***
- ***Ocean, Coastal, and Great Lakes Observations and Infrastructure***

Implementation Strategy should:

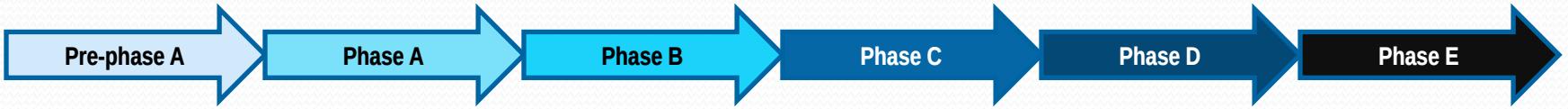
- ***"Identify specific and measureable near-term, mid-term, and long-term actions, with appropriate milestones, performance measures, and outcomes to fulfill each objective"***
  (Pages 7 & 28)

Ocean, Coastal, and Great Lakes Observations and Infrastructures should include:

- ***"The use of unmanned vehicles and remote sensing platforms and satellites*** *to gather data on the health and productivity of the ocean, our coasts, and the Great Lakes" (Page 38)*

PHASES OF MISSION DEVELOMENT

Pre-phase A	*Pre-Formulation and Concept Studies*
Phase A	*Definition of Mission Science Requirements and Technology Solutions*
Phase B	*Initial Design, Development, and Test of Mission Solutions*
Phase C	*Final Design and Development of Mission Solutions*
Phase D	*Final Test of Mission Solutions under Operational Conditions*
Phase E	*Operations and Sustainment*

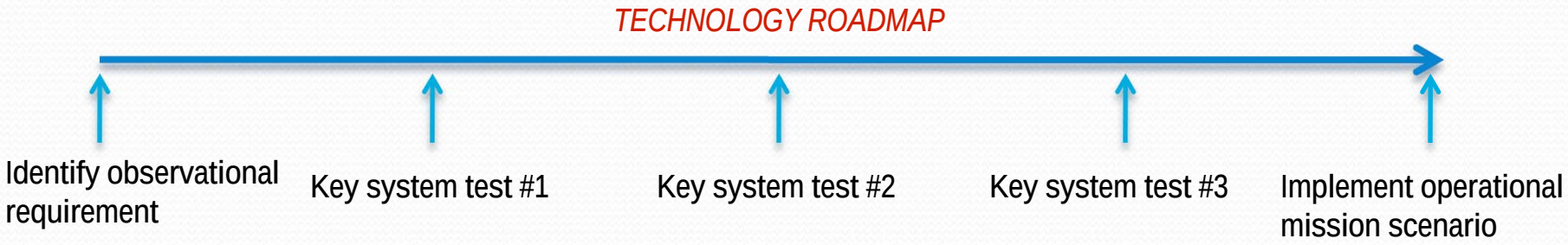


Science and Technology Roadmap

Apply systems engineering approach of matching appropriate UAS solutions to unique or unmet NOAA observing requirements ***(The right platform and right sensor for the right observational requirement)***

Identify critical NOAA observational requirement for research or operational mission need

Define key system tests that will advance science and technology readiness of UAS solution to operational mission scenario capable of meeting the observational requirement



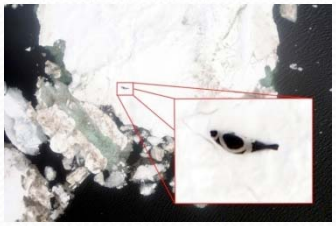
Potential Ice Seal Roadmap

TECHNOLOGY ROADMAP

Observing Need

Key system test #1

Key system test #2



Key system test #3

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Operational Application

Future Platforms Needs

- Long endurance
- Low, medium, and high altitude
- Beyond line of sight operation
- Flexible payload integration
- Deployable from other platforms
- Dependable communication and data transfer
- Quiet noise levels for wildlife surveys and law enforcement

Future Payload Needs

- Synthetic aperture radars
- Temperature and humidity profiling radiometers
- All weather ocean wind speed, sea surface temperature, precipitation, ice edge imaging radiometers
- Precipitation and wind profiling radars
- Wind and aerosol lidars
- Dropsonde systems
- Hyperspectral imagers
- Lightning and electric field sensors
- Radar and laser altimeters
- UAS deployed from other platforms
- *In situ* samplers of aerosols, gases, and hydrometeors

Challenges

Technologically mature payloads and information products ready for operational applications

Compact and lightweight sensors

On-board processing and real-time information products

Efficient information management and visualization

Contact Information

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