NOAA Unmanned Aircraft Systems (UAS) Program Activities

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CHEROKEE NATION™ Technology Portfolio

NOAA UAS Program Vision & Strategy

- ***Vision***
  - **UAS will revolutionize NOAA observing strategies comparable to the introduction of satellite and radar assets decades earlier**
- ***Goals***
  - **Goal 1: Increase UAS observing capacity**
  - **Goal 2: Develop high science-return UAS missions**
    - ***High impact weather monitoring,***
    - ***Polar monitoring***
    - ***Marine monitoring***
  - **Goal 3: Transition cost-effective, operationally feasible UAS solutions into routine operations**

Program Progress

Conducted UAS market survey and developed data base of UAS performance capabilities and costs

Developed UAS Analysis of Alternatives & Strategy:

- ***High altitude long endurance – Global Hawk***
- ***Medium altitude long endurance – Predator or Ikhana***
- ***Low altitude long endurance – ScanEagle***
- ***Low altitude short endurance – Puma and Vertical Take Off and Landing (VTOL)***
- ***Air-Launched – Coyote, Cutlass, GALE, SBIR***
- ***USV – EMILY***

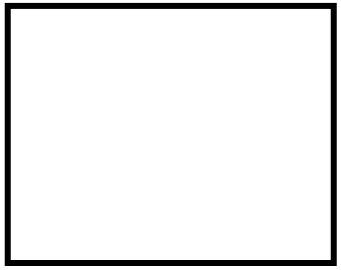
Developed technology review process for funded projects

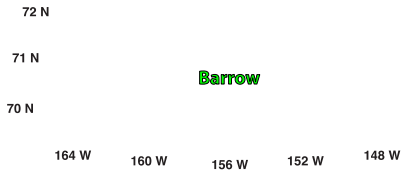
Supported operator training / initial concept of operations

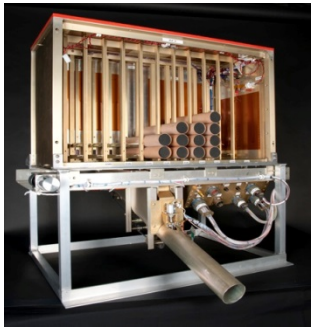
High Impact Weather Monitoring

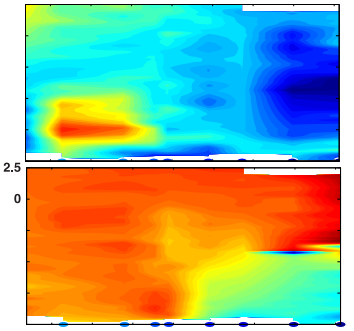
Key Accomplishments

- Observations of oceanic weather systems in Atlantic, Arctic, and Pacific using NASA Global Hawk
- Development of Global Hawk dropsonde system with NSF
- Lower Mississippi River Forecast Center demonstration with Puma and Altavian
- Aircraft-launched UAS development through SBIR Phase I
- Development of Fire Weather UAS through NSF collaboration
- Development of EMILY unmanned surface marine vehicle
- Two peer-reviewed journal articles published in 2014



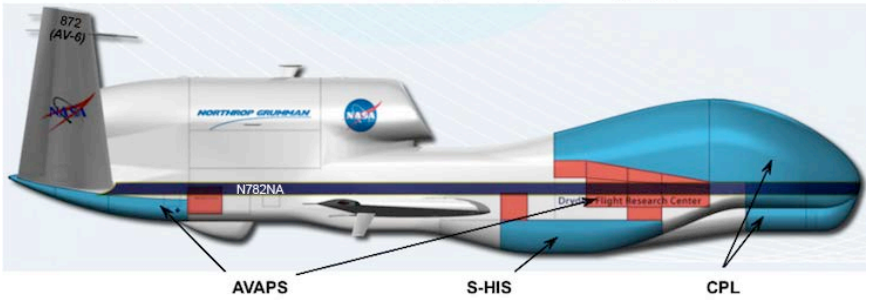


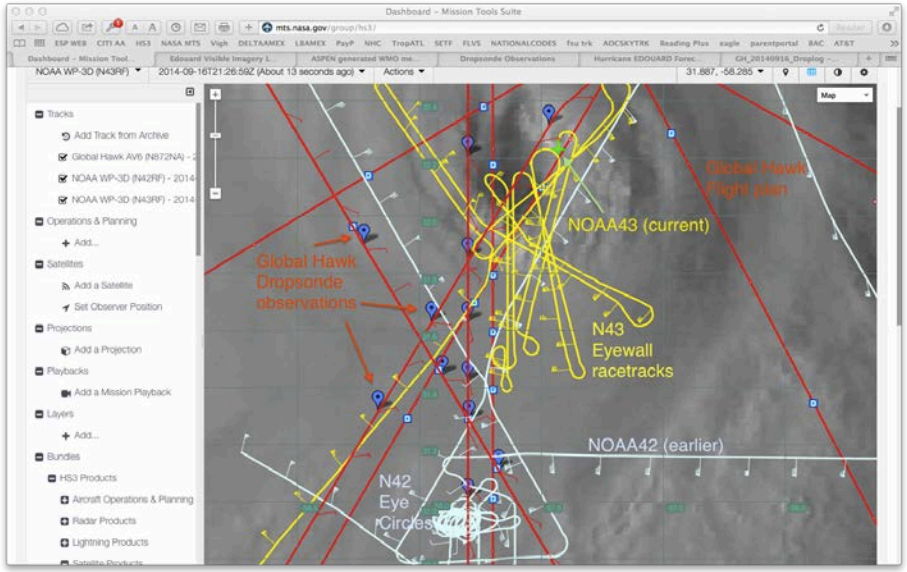




NASA Hurricane Severe Storm (HS3) & NOAA Sensing Hazards Using Operational Unmanned Technology (SHOUT) Missions

HS3 *Environmental Payload (AV-6) @ WFF '12*





Environment Observations

- **Profiles of temperature, humidity, wind, and pressure**
- **Cloud top height**
- **Cloud top temperature and profiles of temperature and humidity**

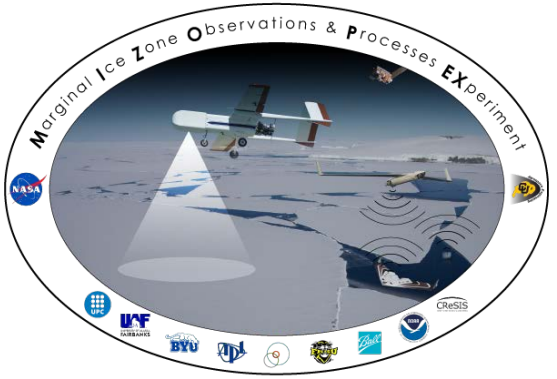
Hurricane Edouard 9/16/14

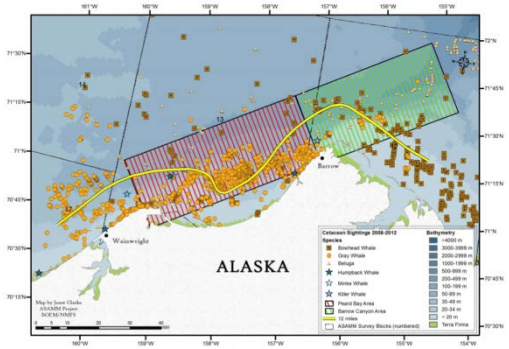
- **NE of St Croix**
- **Buoy Drops Highlighted**
- **NOAA's P-3s, GIV and GH Flying this week**
- **Watch our flights: http://airbornescience.nasa.gov/tracker/**

Polar Monitoring

Key Accomplishments

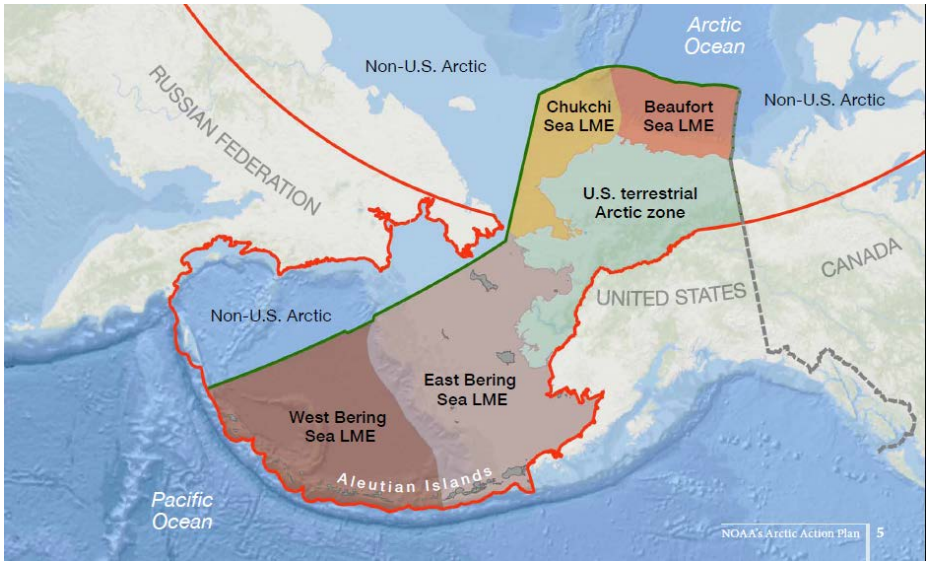
- Peer-reviewed journal article based on black carbon mission using Manta in Norway
- Deployment of three different UAS during Marginal Ice Zone Experiment in partnership with NASA
- Puma UAS deployed from US Coast Guard Healy Ice Cutter ship for marine monitoring and oil spill detection with ONR, AeroVironment
- Development of partnership with UAF, US Navy, USCG, Conoco Philips for ScanEagle flights in the Arctic
- Other platform coordination Aerosonde, Flexrotor…





National / NOAA Arctic Vision & Strategy

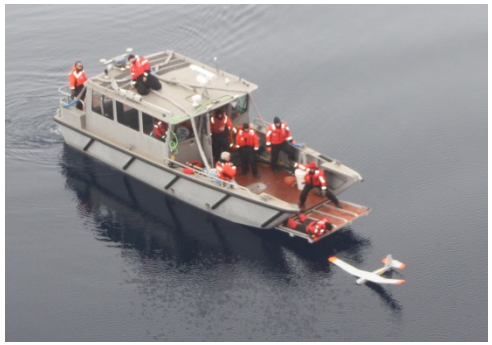
National Strategy for the Arctic Region — lines of effort —	NOAA's Arctic Vision and Strategy — strategic goals —
• Advance U.S. security interests	• Forecast sea ice
	• Improve weather and water forecasts and warnings
• Pursue responsible Arctic region stewardship	• Strengthen foundational science to understand and detect Arctic climate and ecosystem changes
	• Improve stewardship and management of ocean and coastal resources in the Arctic
	• Advance resilient and healthy Arctic communities and economies
• Strengthen international cooperation	• Enhance international and national partnerships



NOAA USCG Healy Deployment, Operational and Scientific Goals

- ✓ **Conduct Puma AE "due regard" operations from USCG (Icebreaker) Healy**
  - ✓ **Water and Ice Landings**
  - ✓ **Deck Landing**
  - ✓ **Net Capture System**

- ✓ **Conduct Intelligence, Surveillance, and Reconnaissance (ISR) Operations Stream Full Motion Video (FMV), EO and IR from Puma AE for**
  - ✓ **Sea ice ridge detection/monitoring**
  - o **Producing a Digital Elevation Map (DEM) of ice ridge and surrounding area**
  - ✓ **Marine and marine mammal monitoring**
  - ✓ **Usefulness in search and rescue (emergency response) scenarios**
  - ✓ **Detection and monitoring of oil spilled from ship or oil exploration**
  - ✓ **Detection and monitoring of marine debris from ship**
  - o **Preparation for future boundary layer research from sUAS**



- ✓ **Utilize the Environmental Response Management Application (ERMA)**

- ✓ **Coordinate with ONR Marginal Ice Zone Experiment (MIZOPEX) FY14**

- ✓ **Coordinate with the UAF for ScanEagle flight operations coordination and data exchange**

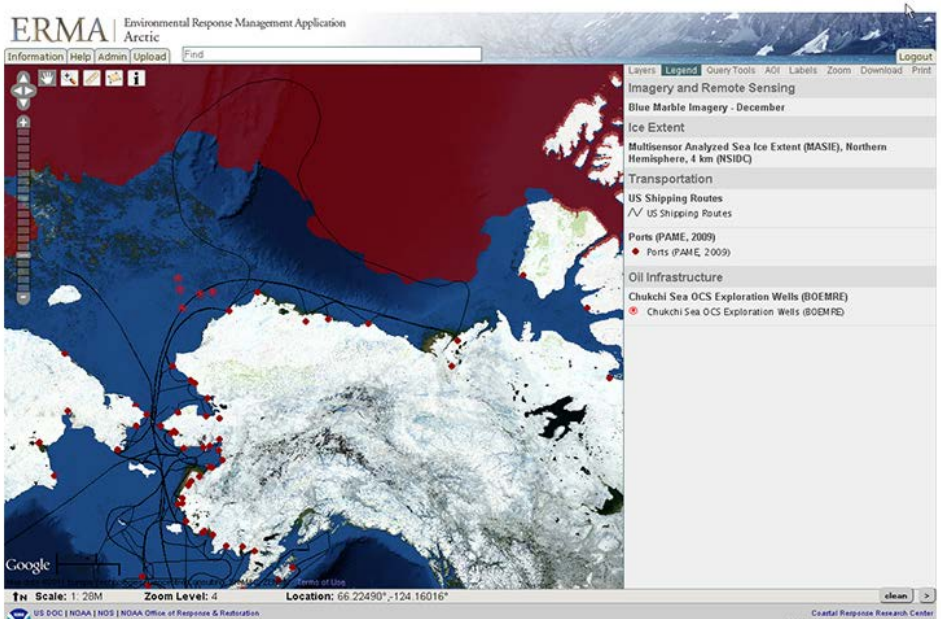
ISR Missions including Oil Spill & SAR

- ✓Sea ice ridge detection/monitoring
- ✓Marine and marine mammal monitoring
- ✓Usefulness in search and rescue scenarios
- ✓Detection and monitoring of oil spilled from ship
- ✓Detection and monitoring of marine debris from ship

ERMA Coordination

- ✓ ERMA® is an online mapping tool that integrates both static and real-time data, such as Environmental Sensitivity Index (ESI) maps, ship locations, weather, and ocean currents, in a centralized, easy-to-use format for environmental responders and decision makers. ERMA enables a user to quickly and securely upload, manipulate, export, and display spatial data in a Geographic Information System (GIS) map.
- ✓ Second year participations through the UAS Program.

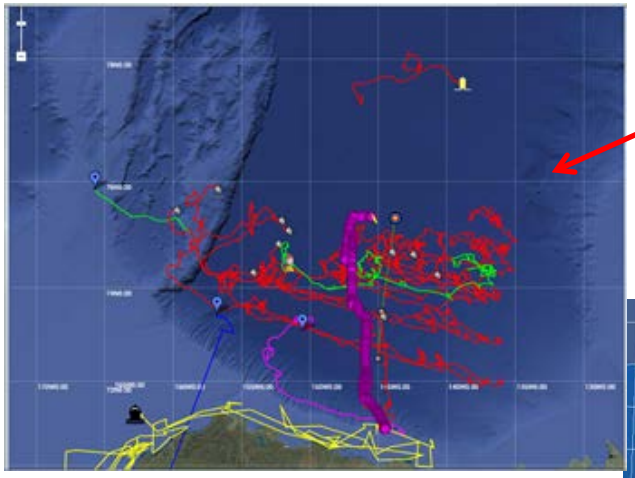
Visit Arctic ERMA.



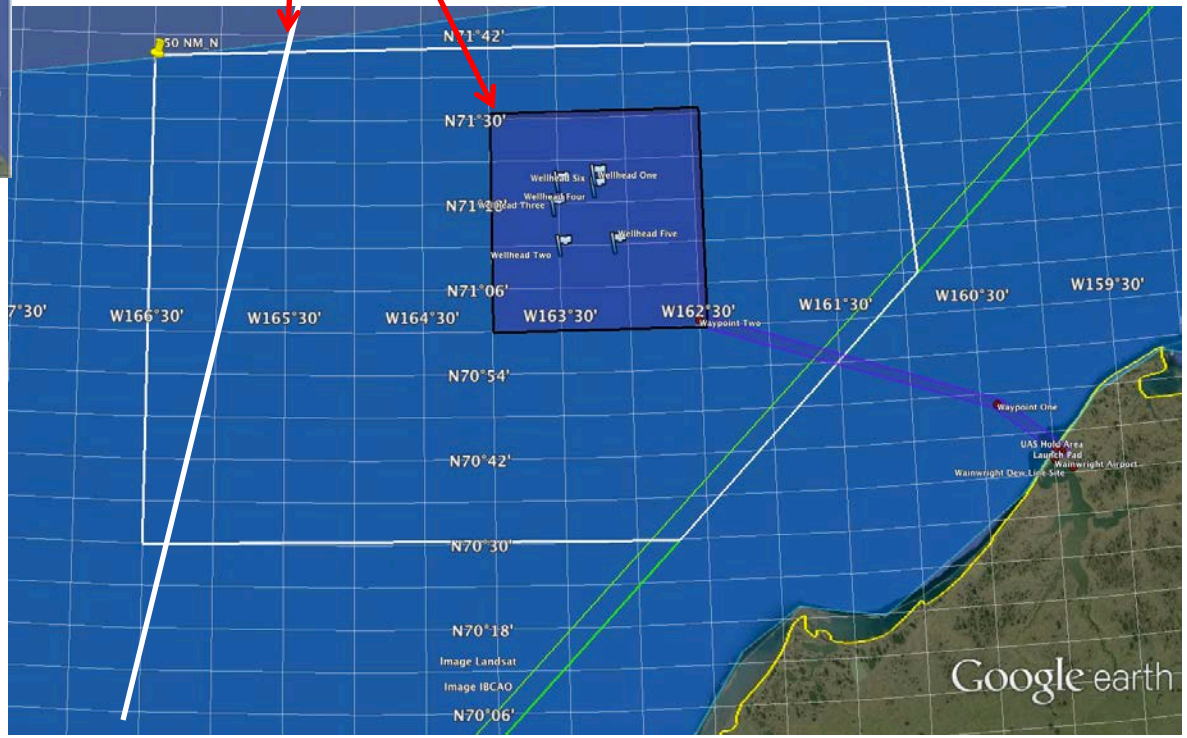
Software and Datasets

- ADIOS, oil weathering model.
- ERMA®, online mapping tool for environmental response data, adapted to a variety of regions.
- GNOME, oil spill trajectory model.
- GOODS, a tool that helps GNOME users access base maps, ocean currents, and winds.
- NUCOS, a unit converter that includes units unique to oil spill response.
- Spill Tools, a set of three programs: the Mechanical Equipment Calculator, the In Situ Burn Calculator, and the Dispersant Mission Planner.
- Trajectory Analysis Planner, oil spill contingency planning software.
- Environmental Sensitivity Index (ESI) maps and data, concise summaries of coastal resources that may be at risk in a spill incident.

Healy Planned Track, MIZOPEX, ScanEagle Op Areas



- ONR MIZOPEX BUOYS & Gliders (8/24
- USCG (Icebreaker) Healy Track
- ScanEagle Operations Area



Rover - used to intercept UAS Platform Signals

ScanEagle Operational Assessments (2008-2014)

- (Goal) Fly a combination of different types of remote sensing instruments for atmospheric research, marginal ice zone, polar & marine monitoring
- (Outcomes) Operational Coordination and Operations
  - **Maritime and Ice Seal Survey from MacArthur (2009)**
  - **Atmospheric Testing from NSWC Dahlgren (2012)**
  - **Atmospheric Research Deployment from R/V Revelle (2012)**
  - **Atmospheric Testing from NSWC Dahlgren (2013)**
  - **Atmospheric Research Deployment from R/V Knorr (2013)**
  - **Marginal Ice Zone Experiment (MIZOPEX) for Oliktock Pt (2013)**
  - **Data Management and Coordination with ERMA (2014)**
  - **Maritime survey Data Exchange with UAF & Conoco Philips (2013-2014)**
  - **Alaskan Wildfire Night / Beyond-Line-of-Sight Flights 2014**
  - **Government, Academia and Industry Platform Updates and Coordination (2014)**

"Flux" payload

Instrumentation	Measurement
9-port turbulence/gust probe	Winds, momentum fluxes, other fluxes (vertical wind est. accuracy 2.6 cm/s)
Laser altimeter	Surface waves, a/c control
Humidity/temperature	H/T profiles and bulk fluxes
SST sensor	SST, frontal processes
Fast response optical temp. sensor	T, sensible heat flux
Krypton hygrometer	H_2O covariance fluxes
DAQ system	Data acquisition
DGPS	georeferencing, winds, a/c control
IMU – LN200	georeferencing, winds

Marine Monitoring

Key Accomplishments

- **Acquisition and deployment of two Puma UAS**
- **Two years of Puma missions in partnership with National Marine Sanctuaries Program**
- **Development of Puma Transition Plan in collaboration with OMAO and NOS**
- **Demonstration of NASA Ikhana and observing capabilities for long distance monitoring of Hawaiian marine monument**
- **Development of medium altitude UAS observing capabilities for gravity measurements and coastal mapping through SBIR Phase II study**

Hawaii Activities

Papahanaumokuakea Marine National Monument

362,073 square kilometers of the Pacific Ocean

NOAA PUMA

NASA IKHANA

Take Aways & Operational Assessment

- Arctic is a Challenging Environment
  - Platform flight envelope must be expanded
  - Platform recovery process and sensors must continue to be improved
  - “Due Regard” operations must be expanded
- Partnerships are crucial (Maritime Strategy)
  - People, property and platforms (data captured) are valuable
  - Must maximize operations and date sharing opportunities for safety’s sake
- S&T to R&D to T&E to Operations
  - Simple but not easy!
  - SBIRs, CRADAs, MOUs, OAs

Issues & Barriers to Success

- Unmanned Systems have been “Wildly successful!”
- Plenty of issues but, “We have chosen to admire the problem.”
- Issues & Barriers to Success
  - Privacy
  - FAA Regulations & Access – Airspace, Airworthiness, Quals
  - Program Management
    - Engineering, Logistics, T&E, Operations, Contracting…
    - Cost, Schedule, Performance, Risk, **Requirement Traceability, Commonality**
  - Administrative hurdles to cooperation & asset pooling
    - MOUs & IAAs
    - Buying data or capability (assets, personnel, infrastructure)?
    - Understanding utilization rates and metrics
      - S&T… R&D… “Three months of install and ground test for 1 Flt-Hr
      - Flt Hours vs On-station Hours vs Sensor Hours vs Data Hours vs Used DH

Success!!!

- R&D to Operations
  - Optimized existing infrastructure
  - Airspace Access
    - Dangerous, Dirty, Dull, Denied
    - Efficient, Effective, Economical and Environmentally Friendly
  - Common and Pooled Assets & Operators
    - Logistic, Configuration Management, Training
    - Data Standardization, Quality, Storage and Cataloging
- Affordable & Environmentally Friendly
  - Autonomous
    - Multiple platforms controlled by single operator
  - Uses 10% of the fuel or “new fuels” or “no fuel”

Contact Information

UAS Web Site: http://uas.noaa.gov/

Questions should be directed to:

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