NOAA Unmanned Aircraft Systems (UAS) Program Activities

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Where? – Dangerous, Dull, Dirty and Denied (Arctic) Missions

Why? – Efficient, Effective, Economical, Environmentally Friendly

Cherokee Nation Technology Portfolio

NOAA UAS Program Strategic Vision and Goals

- ***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:

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

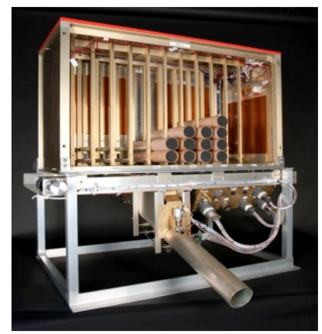
Developed technology review process for funded projects

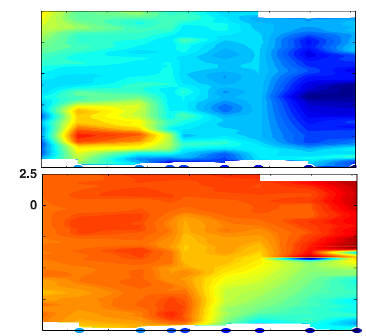
Supported operator training and initial concept of operations

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
- 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





Sensing Hazards Using Operational Unmanned Technology (SHOUT)

Overall Goal

- Demonstrate and test prototype UAS concept of operations that could be used to mitigate the risk of diminished high impact weather forecasts and warnings in the case of polar-orbiting satellite observing gaps

Objective 1

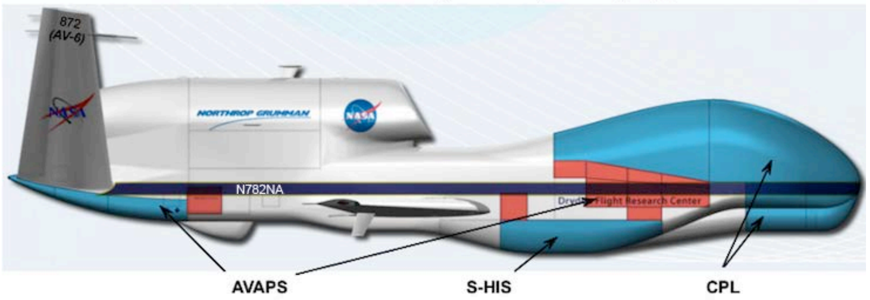
- Conduct data impact studies
  - Observing System Experiments (OSE) using data from UAS field missions
  - Observing System Simulation Experiments (OSSE) using simulated UAS data

Objective 2

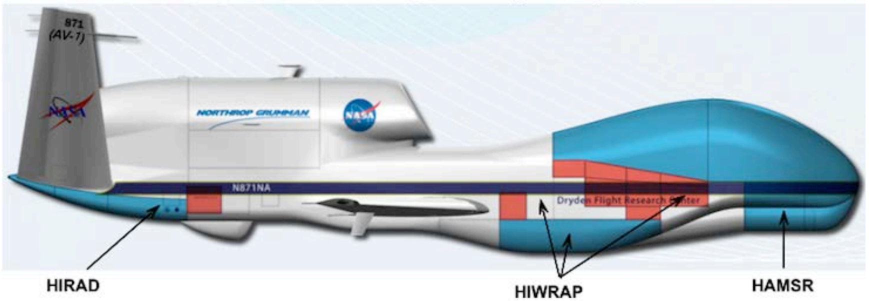
- Evaluate cost and operational benefit through detailed analysis of life-cycle operational costs and constraints

Example of Weather Observations Being Collected During NASA Hurricane Severe Storm Sentinel (HS3) Experiment

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



HS3 *Over-Storm Payload (AV-1) @ WFF '12*



Environment Observations

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

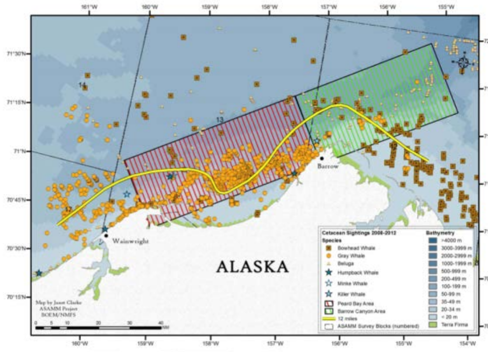
Over-storm Observations

- **Doppler velocity, horizontal winds, and ocean surface winds**
- **Profiles of temperature and humidity and total precipitable water**
- **Ocean surface winds and rain**

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 awareness and oil spill detection
- Development of partnership with Conoco Philips for ScanEagle flights in the Arctic

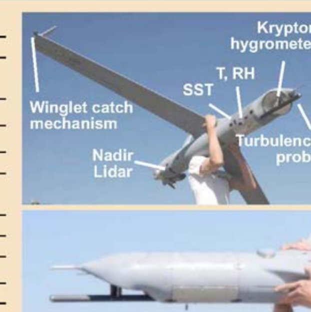


ScanEagle Operational Assessments (2009-2014)

- (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 Conoco Philips (2013-2014)**
  - **Government 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

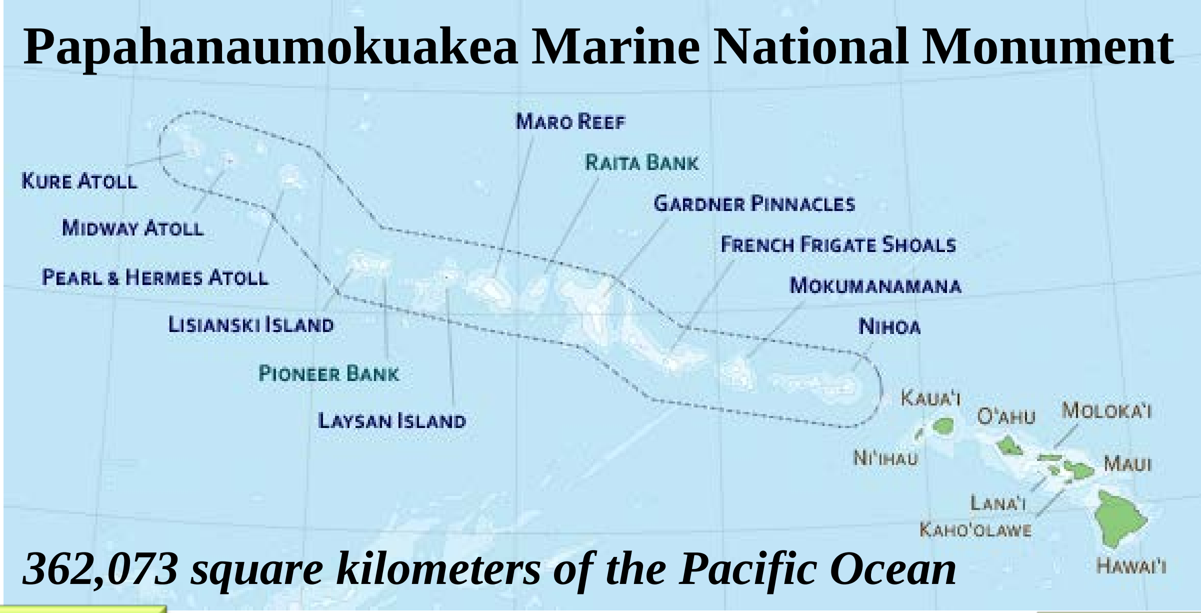


Marine Monitoring

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

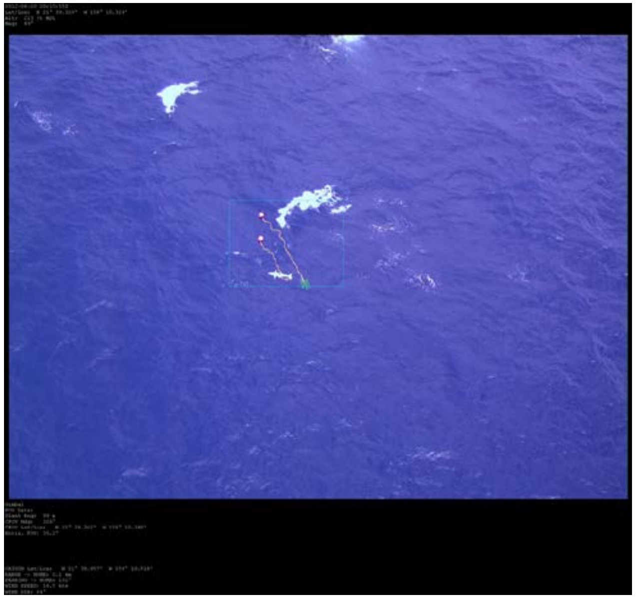
Hawaii Actitivies



NOAA PUMA

NASA IKHANA

Marine Resource Monitoring



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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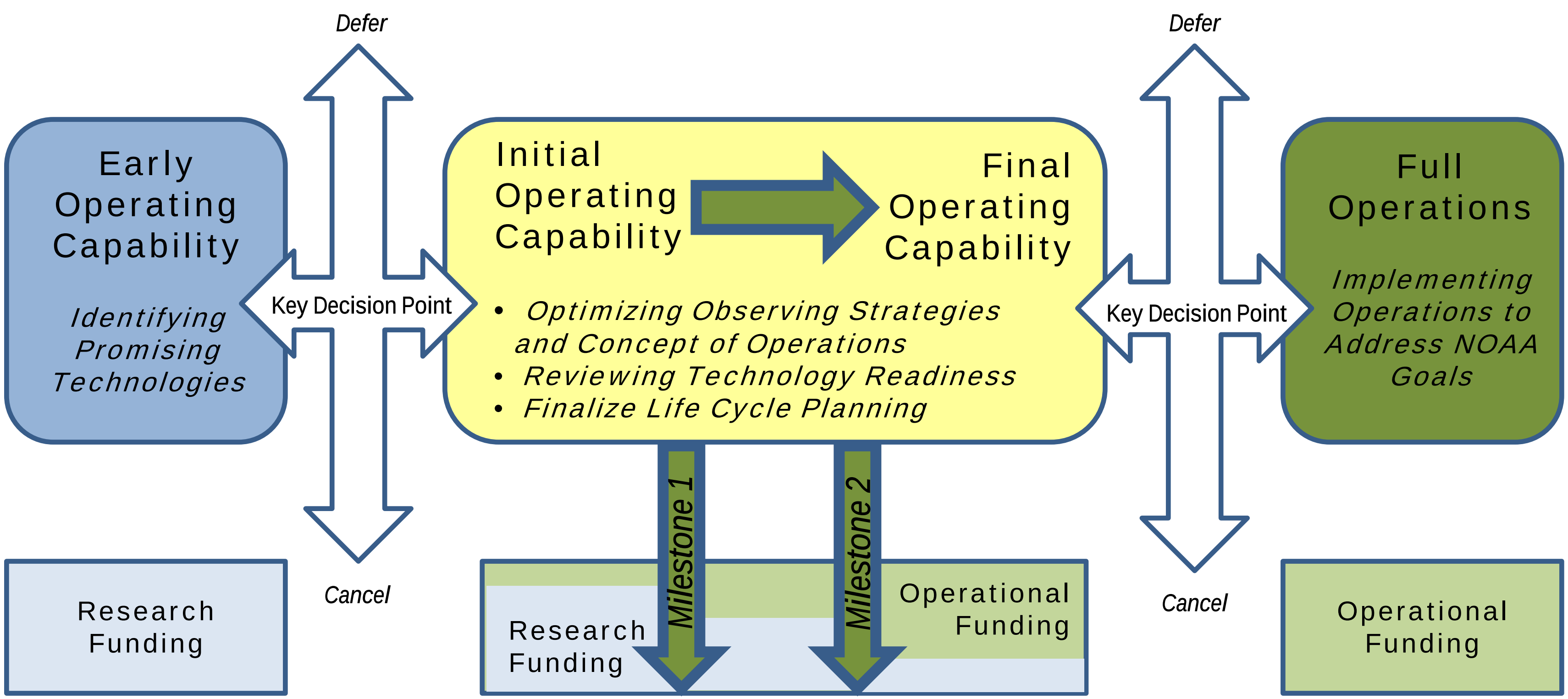
Backup Slides

UAS Transition Process



SHOUT General Plan

FY14

- OSE with previous HS3 data underway
- OSSE with simulated data starting soon for Atlantic / Gulf of Mexico tropical cyclones and Pacific / Arctic weather systems
- 5 extra missions added to HS3
- NOAA aviation personnel supporting NASA and NOAA Global Hawk missions

FY15

- Continued OSE and OSSE studies
- 10 – 16 NOAA-dedicated Global Hawk missions
- NOAA aviation personnel supporting NASA and NOAA Global Hawk missions

FY16

- NOAA-dedicated Global Hawk missions and possible partnership with NASA Earth Venture experiment
- NOAA aviation personnel supporting NASA and NOAA Global Hawk missions
- Finalize data impact studies and analysis of cost and operational benefits

GRAV-D Benefits From SBIR Program

- **Vast areas remain to be surveyed in remote regions that are difficult to access**
  - Aleutians, Pacific Islands
- **Survey blocks are outside the range of our usual aircraft (King Air) and would require very expensive P-3 survey**
  - Likely at least 50% cheaper with UAS
  - UAS much safer operation
- **SBIR program hastens our move to the superior TAGS System 6 sensor**
  - Relatively impervious to turbulence
  - Aurora will engineer this instrument onto their aircraft: we can use this effort to assist us in getting FAA/NAVAIR certification for this sensor