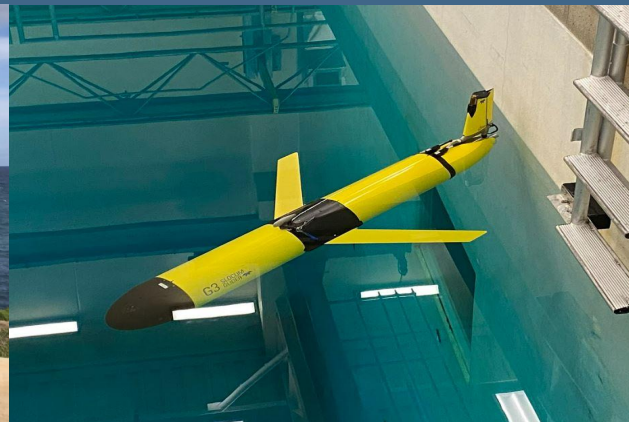




Uncrewed Systems Industry Engagement Kickoff

Sponsored By: NOAA Uncrewed Systems
Operations Center
July 22, 2024



Overview

1:00pm RADM (sel) Chad Cary, OMAO | Welcome and Opening Remarks

1:10pm CAPT Bill Mowitt, Uncrewed Systems Operations Center | Introductions and Intentions

1:20pm NOAA Mission Holders | Review of NOAA Requirements

John Cortinas, Deputy Asst. Administrator for Science | OAR

Lisa Nakamura, Uncrewed Systems Operations Center | OMAO

Michael Gallagher, Office of Science and Technology | NMFS

Martin Getrich, Office of the Asst. Administrator | NOS

Mark Miller, Office of Observations | NWS

Katharine Weathers, National Center for Environmental Information | NESDIS

BREAK

2:40pm Uncrewed Systems End Users | Experiences and Use Cases

Jamison Gove, Pacific Islands Fisheries Science Center

Timothy Oram, NWS Southern Region HQ Meteorological Services Branch

Liza Wright-Fairbanks and Kaity Goldsmith, Ocean Acidification Program

Patricia Quinn, Pacific Marine Environmental Laboratory

Michael Stephens, Office of Coast Survey Hydrographic Surveys Division

Shawn Dahle, Alaska Fisheries Science Center

Lisa Bucci and Jason Sippel, National Hurricane Center and Atlantic Oceanographic and Meteorological Laboratory

Noah Lawrence-Slavas, Pacific Marine Environmental Laboratory

Josh Wadler, Embry-Riddle Aeronautical University

BREAK

3:55pm CAPT Bill Mowitt, Uncrewed Systems Operations Center | Forum Announcement

4:10pm Amy McLiverty, Acquisition and Grants Office | Engagement Guidelines

4:15pm CAPT Bill Mowitt, Uncrewed Systems Operations Center | Closing Remarks and Open Question Period



Event Guidelines

- Stay muted unless asking a question, raise virtual hand to ask a question
- Hold questions until the end of each topic
- NOAA Uncrewed Systems Center personnel will be monitoring the chat



Event Guidelines

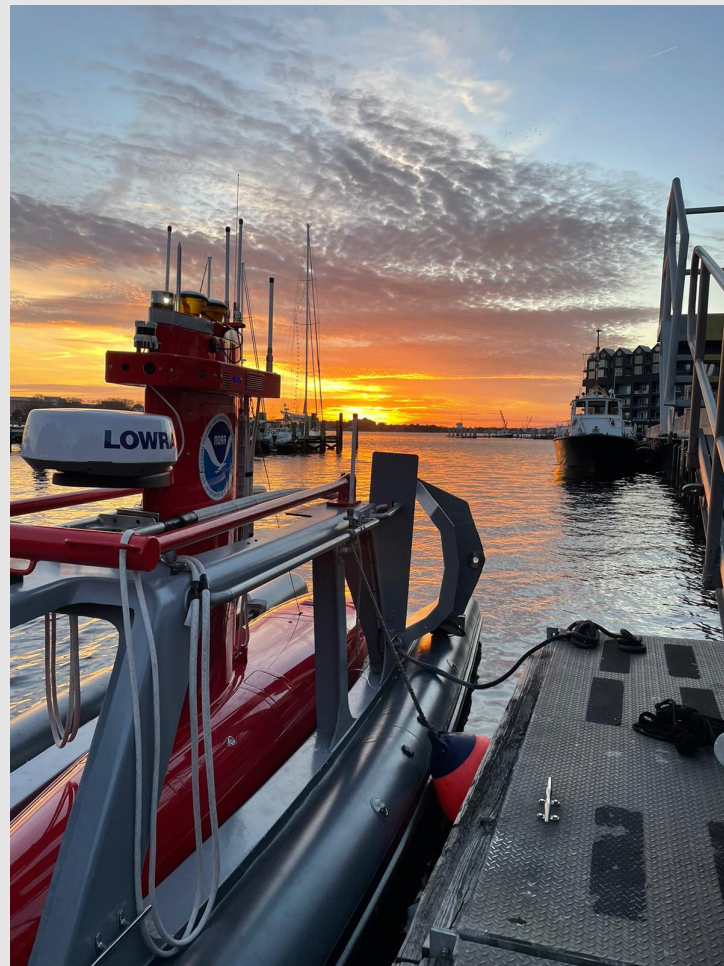
- This event and future forums are for market research purposes only. Participants may not discuss pricing or contract details without a NOAA AGO contract specialist present and may not use this event and future forums to establish requirements for contracts
- Any use of trade, firm, or product names throughout this event and future forums is for informational purposes only and does not imply endorsement by the U.S. Government
- All details and answers provided during this event and future forums are subject to change and do not represent any binding agreement with the U.S. Government





Opening Remarks

RADM (sel) Chad Cary,
OMAO





Introductions and Intentions

CAPT Bill Mowitt, Uncrewed
Systems Operations Center



Overview

Purpose:

- The Uncrewed Systems Operations Center is standing up a new Forum for engagement between uncrewed systems vendors of platforms, sensors, and services and the NOAA uncrewed systems community.
- This Kickoff Event will formally announce the Forum while highlighting NOAA requirements, current NOAA end users of UxS from industry, and potential applications of Uncrewed Systems Operations Center funding to UxS work.





Questions



Review of NOAA Requirements

NOAA Mission Holders:

- John Cortinas
- Lisa Nakamura
- Michael Gallagher
- Martin Getrich
- Mark Miller
- Katharine Weathers





OAR



UxS Applications in Oceanic and Atmospheric Research

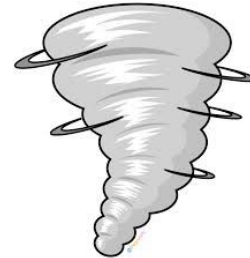
John V. Cortinas, Jr., Ph.D.

Deputy Assistant Administrator for Science

NOAA Research



NOAA
RESEARCH





Broad Application of UxS in NOAA Research



- Extremely broad and extensive use of both aerial maritime systems across OAR
 - Global reach
 - Long-term monitoring and short-term experiments
 - Extreme environments
- Many data acquisition scenarios
 - Government owned and operated platforms
 - Contracted platform activities
 - Data as a service

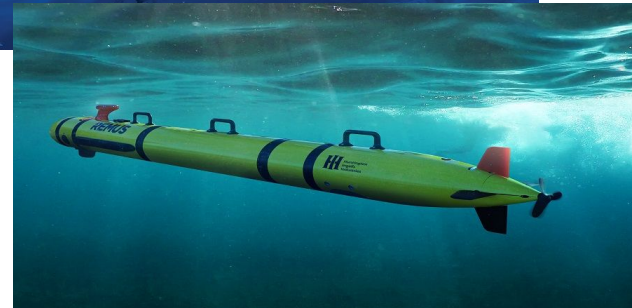




Partnership is essential to NOAA UxS



- OAR cannot achieve our mission alone
 - Highly productive partnerships academia, private sector, other agencies
- Cooperative Research and Development Agreements (CRADA)
- Tech transfer - R2O2R
- SBIR
- Investigating lower cost ways to access observations





Aerial Systems Applications



- Imagery
 - Tornado, hurricane, fire or severe event damage
 - Infrastructure assessments
 - Multi and hyperspectral imagery
- Boundary Layer
 - Met data for numerical weather prediction
 - Met observations for targeted events (e.g. severe storm research)
 - Atmospheric chemistry
 - Earth's radiation budget
- Stratospheric
 - Long-term greenhouse gas monitoring
 - Observations and deployment of sensors in severe weather

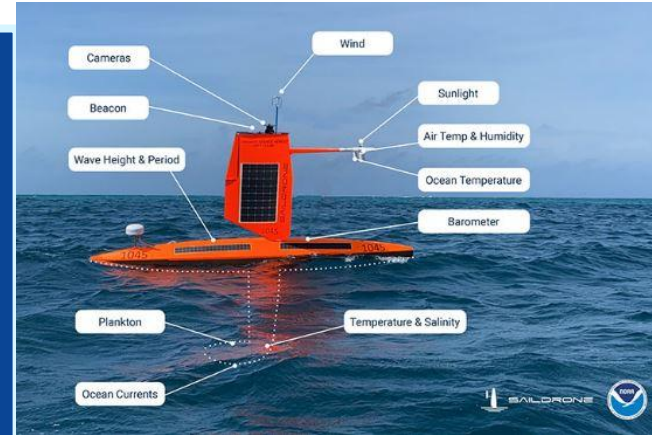




Maritime Systems Applications



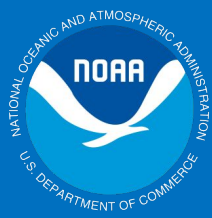
- Surface Vehicles
 - Long-term climate and oceanographic monitoring
 - Bathymetry
 - Ocean biology and chemistry
 - Harmful algal blooms
- Subsurface Vehicles
 - Buoyancy gliders
 - Under ice exploration in Arctic and Great Lakes
- Hurricane and Severe Storm
- Ocean exploration and bathymetry





OMAO





NOAA

Office of Marine and Aviation Operations (OMAO) and Uncrewed Systems

Lisa Nakamura, Deputy Director
Uncrewed Systems Operations Center





Mission and Vision



Mission

Optimize NOAA's observational platforms and unique workforce capabilities to meet NOAA's science, service, and stewardship missions.



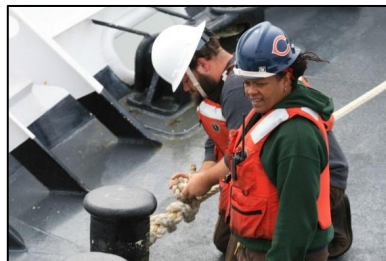
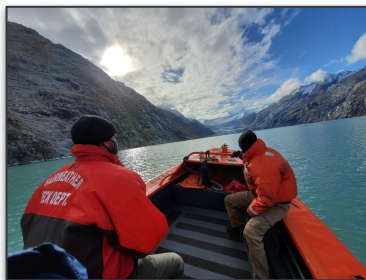
Vision

Protect environmental security through intelligence and stewardship.





OMAO Personnel





Fleet

Ships



Aircraft



Uncrewed Marine Systems



Uncrewed Aircraft Systems



NOAA Fleet Operations Centers



- Homeport
- Marine Operation Center (MOC)
- Aircraft Operations Center (AOC)
- Uncrewed Systems Operations Center (UxS)
- * Under construction

- Nautical Charting
- Fisheries Research
- Oceanographic Research



U.S. Department of Commerce | National Oceanic and Atmospheric Association | Office of Marine and Aviation Operations





OMAO Uncrewed System Operations Center

- **Development, Transition, and Innovation**
 - Fund R,D,T&E UxS projects to explore new capabilities and mission applications, and transition technologies to regular operations
 - Assess UxS capabilities in relation to NOAA requirements
 - Measurably increase reliability, capacity, efficiency, and safety of NOAA UxS missions
- **Operations and Support**
 - Operationalize UxS corporate assets for use across NOAA missions, or establish other operating models (i.e., industry operated) where fiscally appropriate
 - Provide UxS expertise and associated services
- **UxS Leadership and Collaboration**
 - Inform, coordinate, and implement UxS policies, authorities, and positions
 - Coordinate and collaborate within NOAA and with industry, academia, government, and NGOs
- **Model Workplace**
 - Recruit and develop an expert workforce empowered by a strong culture and infrastructure





Current Corporate UxS Assets



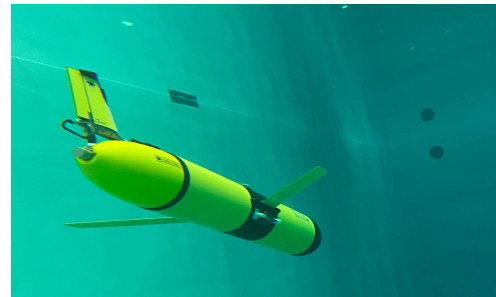
Resources for all of NOAA to use across areas



- Two DriX uncrewed surface vehicles
- Two Slocum underwater buoyancy gliders
- UAS Kickstarter Program
 - Provide Blue Drones and training across NOAA



These assets were realized through partnerships!





Facilitating Data as a Service

Exploring when industry owned and operated UxS is the best operating model

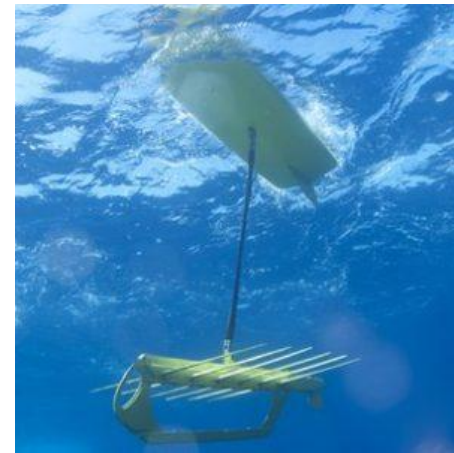
- UMS Services IDIQ Contracts
- Industry owned and operated medium-UAS for complex missions





Supporting R&D and Operations with UxS

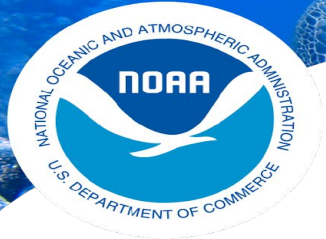
- **Allocated over \$32.9M to over 60 projects that utilize UxS to meet a NOAA missions since FY20**
 - Typically funded through internal-to-NOAA Requests for Proposals
 - Projects often have partnerships with academia or industry per Congressional direction
- **Enabling other efforts to make substantive advances for NOAA with UxS such as**
 - Beyond visual line of sight UAS operations
 - Underwater buoyancy glider recovery
 - Severe weather UAS
 - NOAA-wide UxS emergency response
 - Trained UxS operators



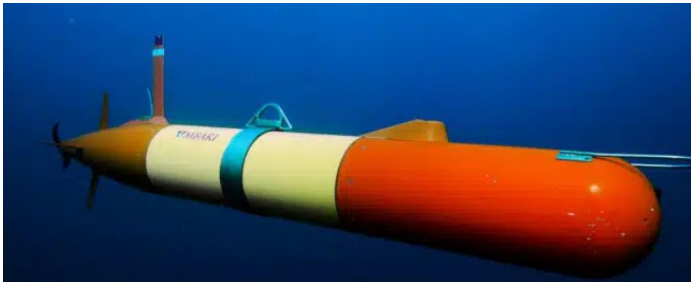


NMFS





NOAA
FISHERIES



National Marine Fisheries Service

UxS Industry Engagement

Michael Gallagher
Research Platform Coordinator



NMFS Mandates

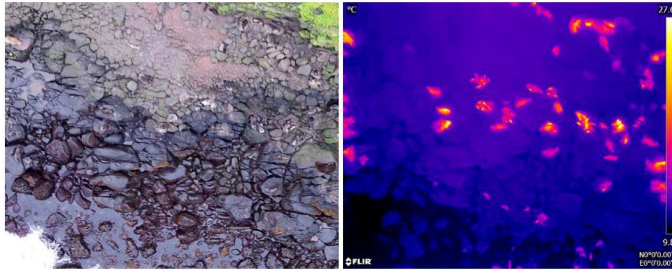
- Magnuson Stevens Fishery Management and Conservation Act – stewardship of marine fisheries and habitats
- Marine Mammal Protection Act and Endangered Species Act – recovery and conservation of protected species (whales, sea turtles, corals, salmon, etc.)

Mandates encompass the U. S. EEZ, with international and high-seas commitments
NMFS Science is performed by six regional science centers; Northeast, Southeast, Southwest, Northwest, Alaska, Pacific Islands

NMFS Missions; Pinnipeds, UAS, line of sight



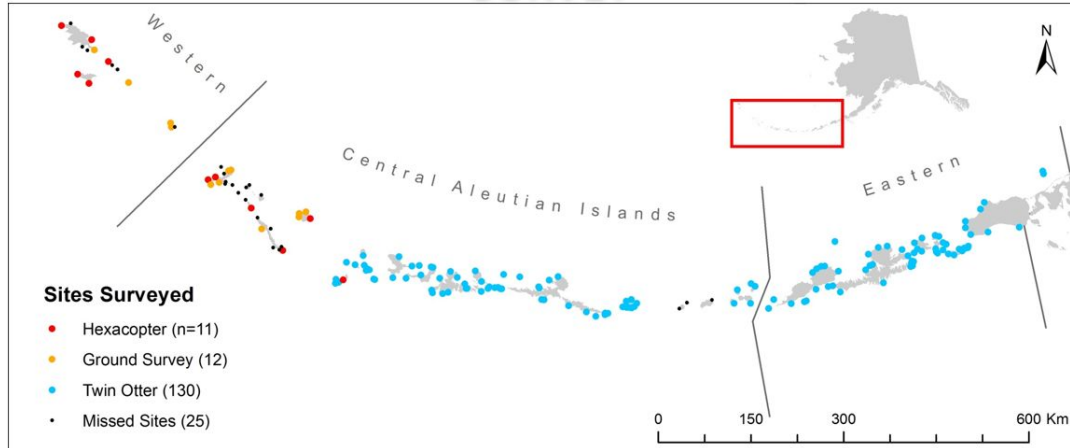
- Seals and sea lions, hauled out on beaches, rocky shores, ice floes
- Platforms – low altitude, low endurance VTOL copters and hybrids, beach, hand and boat launch, low disturbance, quiet operation
- Sensors – visual and IR cameras for counts, brand resights, behavior, orthophotos for morphometrics
- Data – AI assisted processing of images (100,000's)



Fur seal pups are difficult to count from a visual image (left), but show clearly in a thermal image captured from a hexacopter.

NMFS Missions; Pinnipeds, UAS, BVLOS

- Seals and sea lions, hauled out on beaches, rocky shores, ice floes, remote Aleutians, Bering Sea, areas hazardous to crewed aircraft
- Platforms – low altitude, medium endurance, fixed wing
- Sensors – visual and IR cameras for counts
- Data – AI assisted processing of images (100,000's)



NMFS Missions; turtles, UAS, line of sight

- Sea turtles in known congregations counted and assessed
- Leatherback tagging efforts use boat launched UAS to find turtles and guide tagging boat to animals
- Platforms – low altitude, low endurance VTOL copters and hybrids, beach, hand and boat launch, low disturbance, quiet operation
- Sensors – visual cameras for counts, brand resights, behavior, orthophotos for morphometrics



NMFS Missions; cetaceans, UAS, line of sight

- Whales, open ocean conditions
- Platforms – low altitude, low endurance VTOL copters and hybrids, hand and boat launch, low disturbance, quiet operation
- Sensors – visual cameras for ID, entanglement status, orthophotos for morphometrics, blow sampling for health assessment, biome analysis
- Data – imagery used on-the-spot for entanglement, blow samples preserved for laboratory analysis

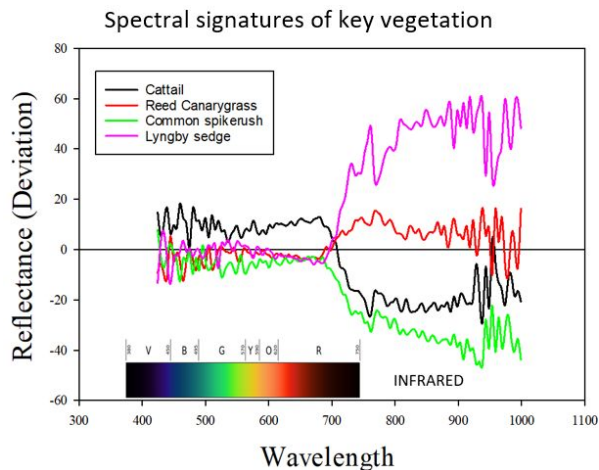


NMFS Missions; cetaceans, UAS, BVLOS

- Whales, dolphins, other creatures, basin scale line transect survey design, open ocean conditions
- Platforms – low altitude, medium/high endurance, ship launched,
- Sensors – visual and IR cameras, counts and species ID
- Data – AI assisted processing of images (100,000's)
- Force multiplier - small VTOL UAS for item investigations

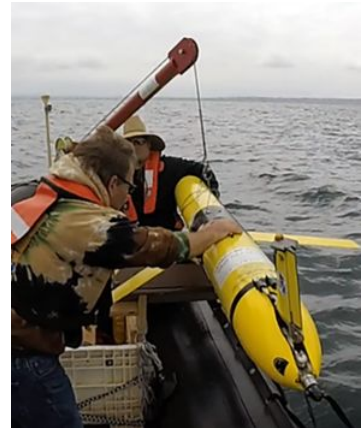
NMFS Missions; habitat, UAS, line of sight

- Natural and restored wetlands, salmon redds, riverine habitat, coral reefs
- Platforms – low altitude, low endurance, VTOL and Hybrid
- Sensors – visual and hyperspectral cameras, LIDAR
- Data – hyperspectral for vegetation analysis, LIDAR for digital elevation models



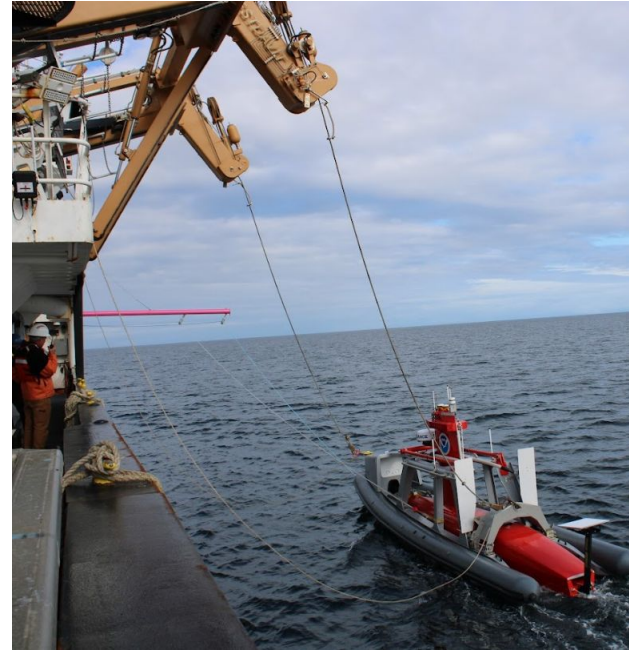
NMFS Missions; buoyancy gliders

- Cost effective presence in targeted areas (Antarctic, California Current, wind energy areas, right whale habitat)
- Sensors – temperature, salinity, fluorescence, eDNA, broadband water column sonars, optical plankton sensor with taxonomic ID under development, passive acoustic monitors
- Data – PAM and eDNA equipped gliders characterize marine mammal occurrence, gliders with enviro, plankton and sonar sensors for systematic ecosystem observations



NMFS Missions; powered USVs

- Platforms – wind, wave, solar powered USVs for low power/long endurance missions. Diesel powered USV for high speed/high power missions
- Sensors – environmental sensors, water column sonar
- Larger, diesel powered USVs require significant ship capabilities for launch/recovery at sea.





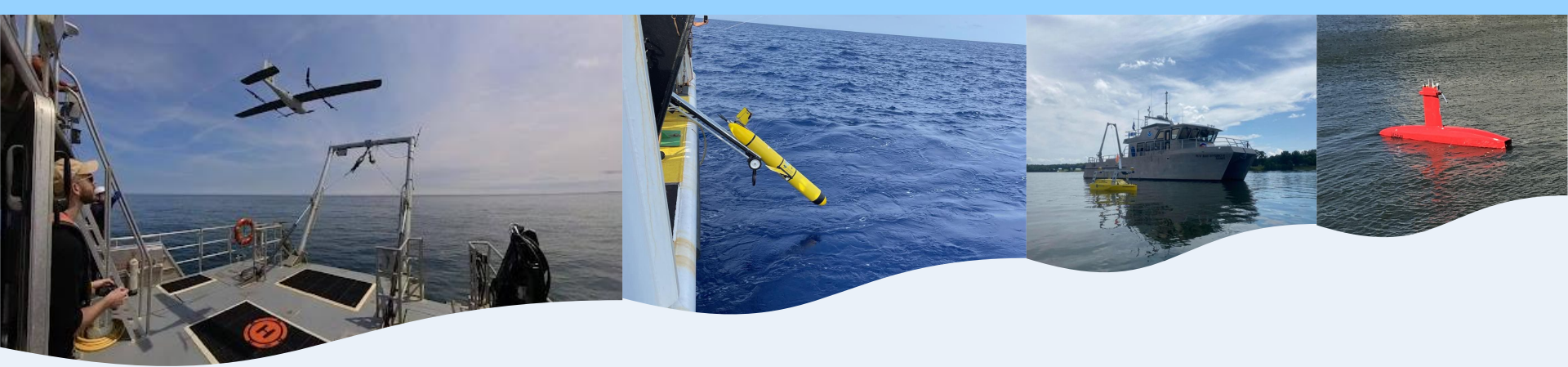
Thank You!

Michael Gallagher
Research Platform Coordinator
NOAA National Marine Fisheries Service
206 383 5731 mobile
Michael.s.gallagher@noaa.gov



NOS





National Ocean Service UxS Operations

NOAA UxS Industry Engagement Kickoff Event
July 22, 2024

Marty Getrich
Operations Administrator
National Ocean Service



NOS Program Offices



National Ocean Service

**Center for Operational
Oceanographic Products and
Services (CO-OPS)**

**U.S. Integrated Ocean Observing
System (IOOS)**

**National Centers for Coastal
Ocean Science (NCCOS)**

National Geodetic Survey (NGS)

Office for Coastal Management (OCM)

Office of Coast Survey (OCS)

**Office of National Marine
Sanctuaries (ONMS)**

**Office of Response and
Restoration (OR&R)**

NCCOS

Harmful Algal Bloom (HAB) monitoring in coastal marine waters and the Great Lakes

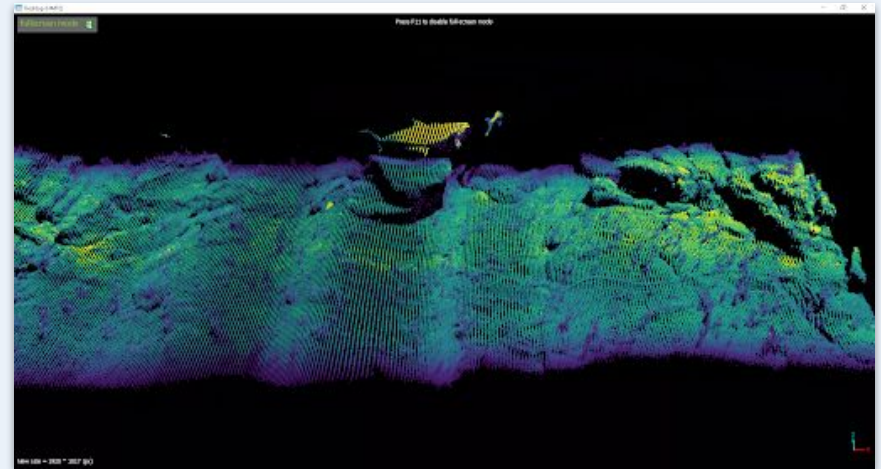
- Long-range AUV gliders & USV
 - Depth range of 10 - 1,500 meters (AUV)
 - CTD
 - Chlorophyll fluorescence/backscatter
 - Dissolved Oxygen (DO)
 - Photosynthetically active radiation (PAR)
 - 3rd Generation Environmental Sample Processor (3G ESP)
 - Algal toxin concentrations, and eDNA sample collection

Shoreline Habitat Monitoring & Characterization

- VTOL - Quadcopter
 - Structure from Motion (SfM)
 - Quantifying biomass of emergent vegetation
 - Digital elevation models
 - Analysis of nearshore vegetative communities

Shallow, Mesophotic and Deep Coral Ecosystem Mapping and Characterization

- UUV's - Micro/Small Class (300m)
 - Georeferenced images, SfM image mosaics
- UUV's - Medium Class (600 - 6000m)
 - Large area imaging, mapping and characterization
 - High resolution seabed characterization



NGS

Remote Sensing Division

- Coastal/Offshore Mapping, Living Marine Resource Survey, and Emergency Response
- Small UAS Platforms
 - VTOL - Fixed Wing
 - VTOL - Quadcopter
- Sensors/Features
 - RTK/PPK
 - RGB Camera 40 MP
 - RGB Camera 20.1 MP
 - Multispectral dual five-band cameras
 - LiDAR
 - Thermomap
 - 3D mapping photogrammetry
- Structure from Motion (SfM) outputs
 - Enables generation of 3D point clouds, Digital Elevation Models, and Orthoimages



OCS

Navigation Service Division

- Currently employs portable, short endurance USV's in nearshore, shallow water environments for seafloor mapping in support of emergency response navigation safety, routine charting, and hydrodynamic modeling
 - 400 - 550 kHz Multibeam sonar
 - 450 kHz Side scan sonar



Hydrographic Surveys Division

- Currently employs ship-based, medium endurance USV's in support of coastal, port and harbor, and offshore hydrographic surveys in support of nautical charting
 - 200 - 700 kHz broadband multibeam echo sounder



ONMS

Managing the Living Marine Resources of National Marine Sanctuaries

- VTOL - Quadcopter (land/vessel launched/recovered)
 - Kelp forest restoration monitoring
 - Rapid emergency response
 - Whale entanglement documentation and response
 - Post-accident habitat damage assessments
 - Coral reef ecosystem monitoring (bleaching, etc)
 - Post-storm assessment of impacts to critical terrestrial and marine habitats.
- AUV
 - Deepwater mapping of habitats
 - Invasive species distribution and abundance (e.g. invasive algae in the Papahānaumokuākea Marine National Monument)
- ASV
 - Deepwater mapping of habitats
 - Wave glider based hydrophone deployments for assessments of right whale abundance and tracking
 - Marine domain awareness (MDA) for monitoring and quantifying human use patterns in vast and remote MPA's



OR&R

NOAA's Marine Debris Program

Focusing on detecting, quantifying, and classifying shoreline marine debris. Collaborate with regional, national, and global partners to prevent debris from entering coastal areas, and responds to debris created by disasters.

- Small RTK UAS platforms
 - Image shoreline and nearshore environments at low altitudes (<1,000 AGL)
 - RGB Camera
 - Polarimetric Camera



IOOS

Coordinates with Regional Associations who deploy AUV's (gliders) in U.S waters for subsurface monitoring.

- Applications
 - Hurricane intensity forecasting
 - Ecosystem dynamics monitoring
 - Fisheries management
 - Impacts of offshore wind development
 - HAB and Hypoxia events
 - Marine heat waves
 - Ocean Acidification
 - Climate monitoring
- Upper ocean environments from surface to ~1000m
- Sensors
 - CTD
 - Physical variables such as pressure, noise (background, ambient, ships, marine mammal, etc), and currents
 - Biological variables related to phytoplankton and zooplankton
 - Ecologically important chemical variables such as DO and Nitrates
 - pH sensors for ocean acidification





NWS





NATIONAL
WEATHER
SERVICE

UxS Industry Engagement

NWS Perspective

#ItStartsWithObs

Mark B. Miller, Chief Technology Officer
Office of Observations
July 22, 2024



Our Vision Drives Our Mission Every Day

The Vision

A Weather-Ready Nation: Society is prepared for and responds to extreme weather, water, and climate events.

***“Ready, Responsive, Resilient”
through the provision of IDSS***



The Mission

Providing weather, water, and climate data, forecasts, warnings **and Impact-based Decision Support Services** for the protection of life and property and enhancement of the national economy.



Realization: Can't Accomplish Mission without WRN and IDSS



NWS Interest in UxS



- NWS evaluating ways to use UxS for:
 - Storm damage assessments
 - Atmospheric data measurements
 - Oceanic data measurements
 - Maintenance and repair operations
- NWS currently engaged in experiments and proofs of concept to establish feasibility and technical readiness





Storm Damage Assessments



- Current process takes personnel resources
 - Local Weather Forecast Office (WFO) personnel travel to impacted area to assess damage
 - Evaluating extent of damage for tornado intensity assessment, hail damage, extent and depth of flooding, etc.
- Location and extent of impacted area/damage, photos, documented for analysis and shared with core partners
- Time-sensitive process for highly-perishable information (e.g., need to assess before damage cleared/cleaned-up)





Examples of Storm Damage Uses



UAS imagery used to survey tornado damage from the remnants of Hurricane Elsa



UAS imagery of EF-3 damage, complete destruction of a mobile home with debris blown downstream



UAS imagery used to survey flooding along the Ashley River in South Carolina

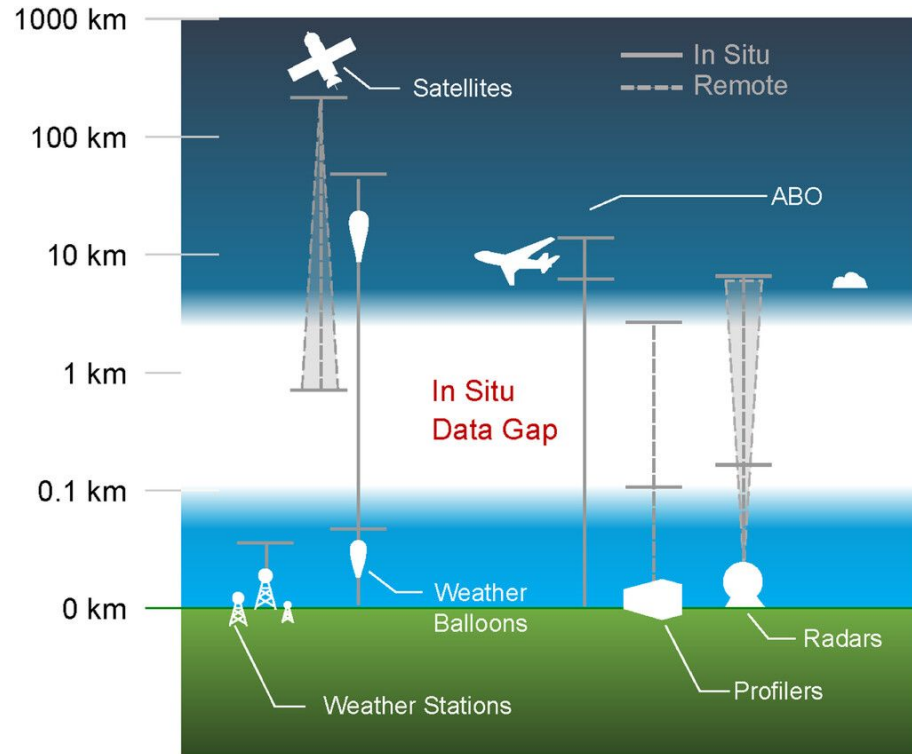


UAS imagery used to observe rip currents on Isle of Palms



Atmospheric Measurements

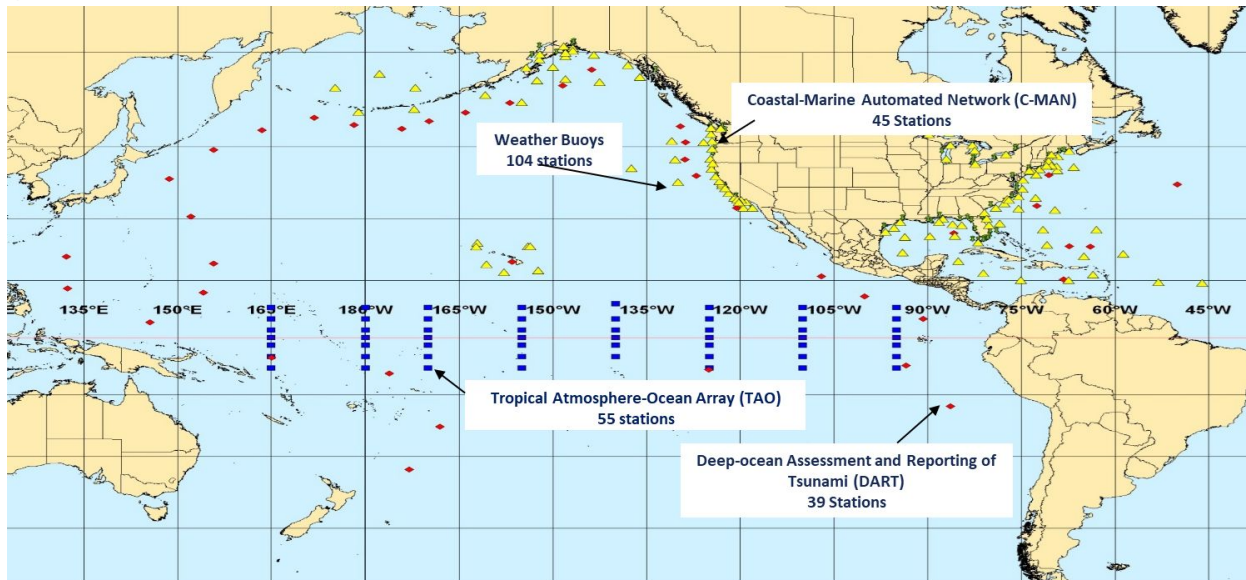
- The radiosonde network (aka weather balloons) has been in existence since the early 1930s.
 - Launch sites are sparse (92)
 - Launches occur twice per day (up to 4 times per day for extreme weather)
 - Can be costly to operate (time and money)
- Data from this network is coupled with aircraft, radar and satellite data, but still limited.
- Seek new ways to obtain vertical profiles of temperature, moisture and pressure to supplement the current network, or to provide gap mitigation (e.g., combo of low-level and hi-level UAS)



Source: Bulletin of the American Meteorological Society 102, 11; [10.1175/BAMS-D-20-0138.1](https://doi.org/10.1175/BAMS-D-20-0138.1)

Oceanic Measurements

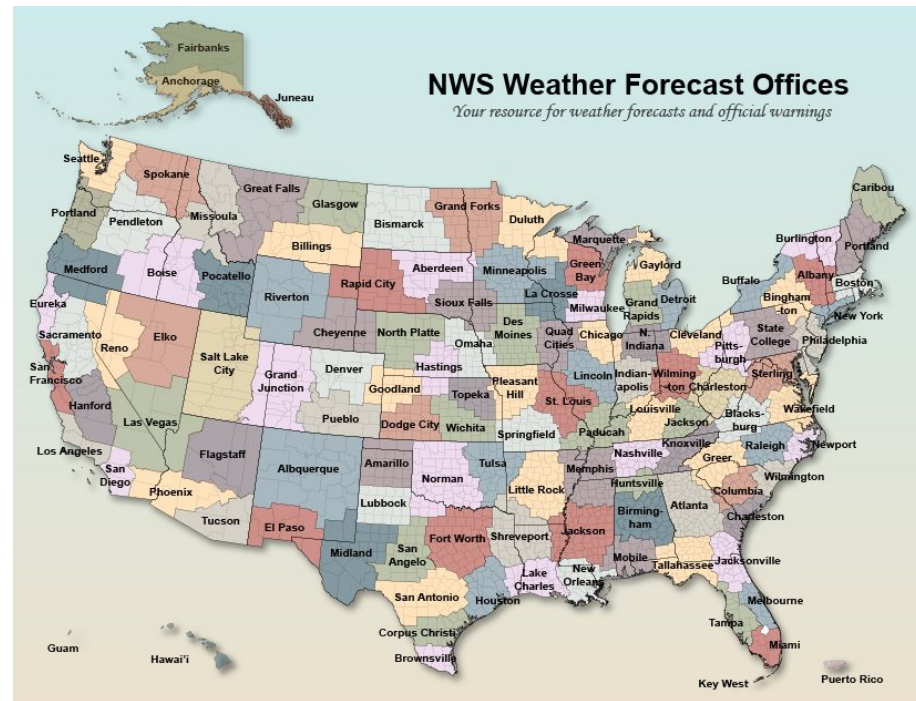
- Ocean data is largest gap in observing capabilities for:
 - Atmospheric information over water
 - Ocean information (temp, salinity, wave info, etc.)
- Important for global and for atmosphere/ocean-coupled forecast models



NWS Marine Network

Maintenance and Repair

- NWS has 122 Weather Forecast Offices
- Each office oversees a forecast area in the country
- Each office has equipment maintenance personnel to support repairs and maintenance of observing equipment and facilities



Maintenance and Repair

- Drones are being evaluated for use in inspections, damage and equipment outage assessments
- Efficiently offers imagery from a unique perspective otherwise attainable only through time consuming, high risk climbing.



WSR-88D damaged radome panels observed from UAS



UAS imagery of upper air inflation building during facility inspection



UAS visual of needed repairs for NOAA Weather Radio tower



Final Thoughts

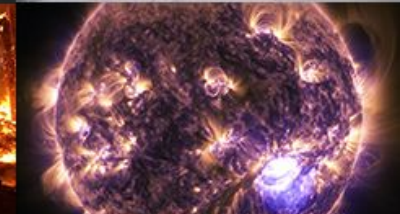
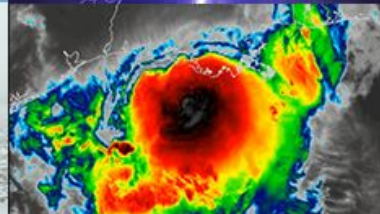
- NWS evaluating ways to use UxS for NWS operations in multiple ways to enable itself to be more flexible and responsive in its operations in the future
- Use of UxS solutions can be:
 - Gov't owned/operated capabilities
 - “UxS as a service”
 - UxS data purchase/buy
- Solutions or combination of solutions will depend upon:
 - Technical readiness
 - Affordability of capabilities, service or data
 - Feasibility of implementation
 - Company business model for capabilities, services, data





NATIONAL
WEATHER
SERVICE

#ItStartsWithObs





NESDIS





**National Oceanic and
Atmospheric Administration**

July 22, 2024

NOAA Uncrewed Systems Data Management

UXS Industry Engagement Event

Katharine Weathers, *UXS Data Coordinator, on behalf of Jennifer Bowers*
katharine.weathers@noaa.gov, jennifer.bowers@noaa.gov OR uxs.data.ncei@noaa.gov

NOAA NESDIS National Centers for Environmental Information

Uncrewed systems (UxS) are vehicles – aerial, terrestrial or marine and associated elements, such as sensors and communications software, that can execute data-collection missions *without a human presence aboard*.

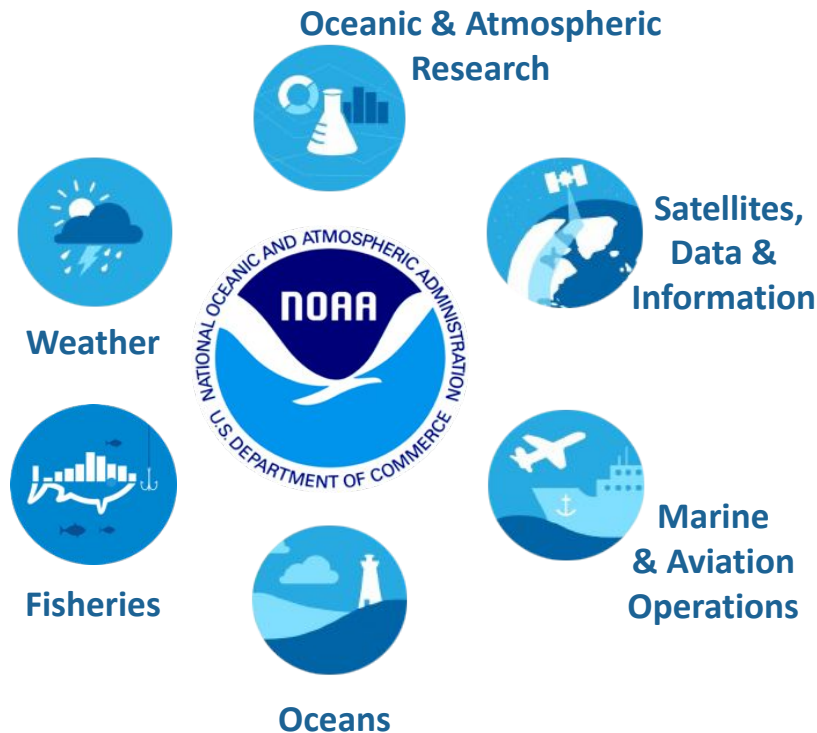


Effective data management is an important aspect of Mission Success and User Experience.

NOAA Uncrewed Systems (UxS) is a distributed capability

NOAA coordinates internally and with interagency partners along with private and academic sectors to evaluate and integrate **Uncrewed Systems (UxS)** technology in support of our diverse research and operational missions.

“Programmatic success” relies on cross-organizational collaboration and external partnerships.



NOAA Line Offices and Missions

National Ocean Service

Hydrography & Nautical Charting
Marine Pollution
Harmful Algal Blooms
Coastal Zone Management

National Marine Fisheries Service

Fish Population Surveys
Habitat Mapping
Marine Mammal/Turtle Surveys
Aquaculture Management

National Weather Service

Provide weather, water and climate data, forecasts and warnings for the protection of life, property and enhancement of the national economy

Office of Marine and Aviation Operations

Operates NOAA's Ships & Aircraft
Operationalize Uncrewed Systems

Office of Oceanic and Atmospheric Research

"NOAA Research"
provides research foundation
Ocean Exploration

National Environmental Satellite Data and Information Service

Environmental Satellites
Data and Information Services
Retrospective Products

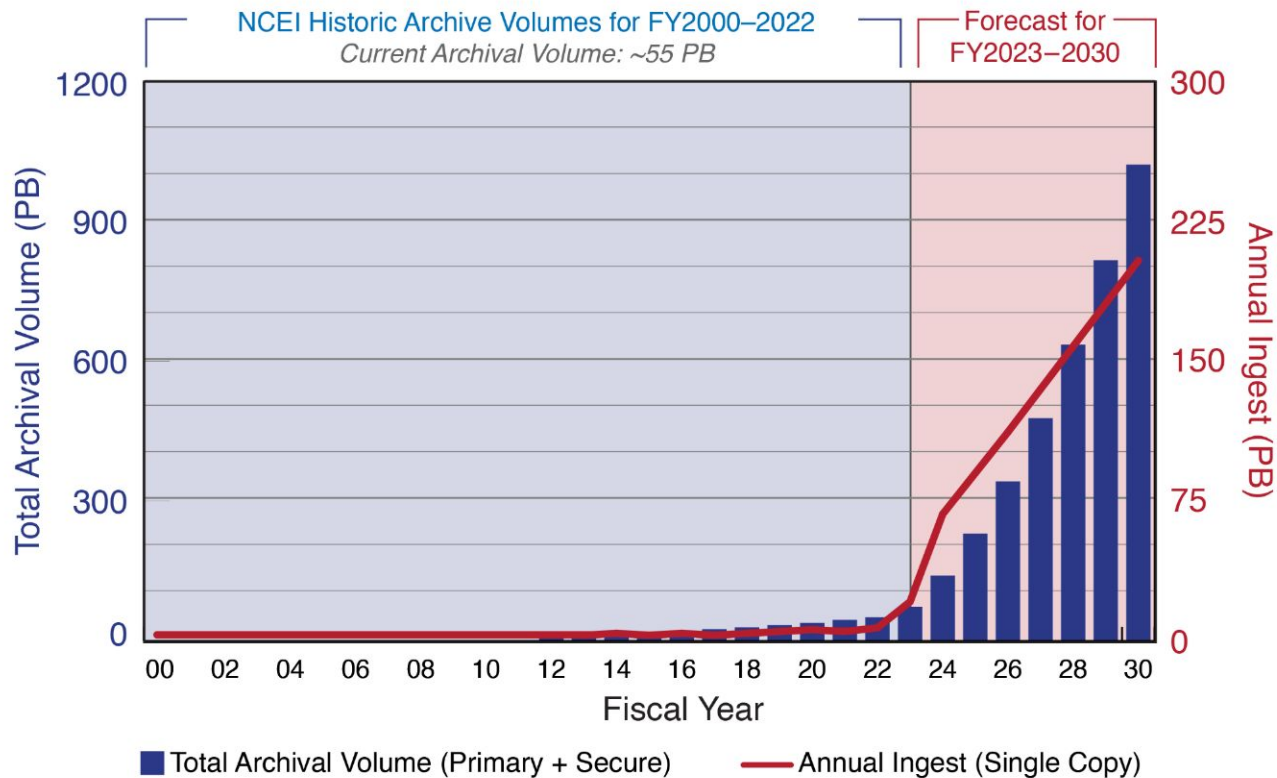


What does the National Centers of Environmental Information (NCEI) do?

- Hosts one of the largest environmental data archives on Earth.
- Maximizes the utility of the Federal government's billion-dollar investment in environmental data.
- Acts as the "Nation's Scorekeeper" regarding trends and anomalies of weather and climate, ocean climate, Earth's magnetic field, and more.

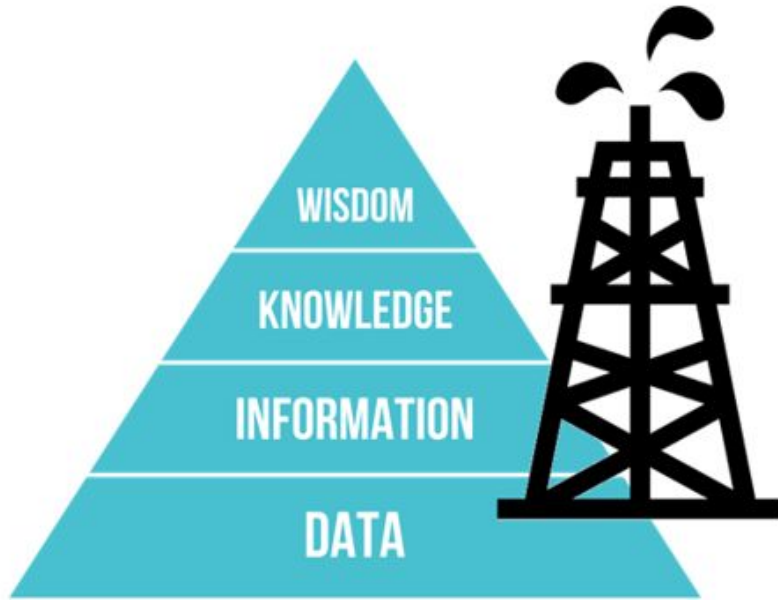


NCEI Archival Volume History and Forecast



Increasing data volumes from station, model, radar, **UxS**, acoustics, omics, and satellite sources

Creating value in data



“Data is the new oil.”

2006, British mathematician Clive Humby

- In a knowledge based society, data is what leads to success. Data creates trust in decision making.
- Properly curated - “**refined**”, it can lead to large societal and economic returns.
- When data is used as a resource for follow on products it becomes an indispensable asset.

***Usability* gives data POWER!**

Contextualizing data: from the surface of the Sun to Earth's seafloor

Weather



Short & mid- range forecasts,
Watches, warnings

29 Sep 2012 10:30 NOAA/STAR GOES-EMU GEOCOLOR


Climate monitoring



BUILDING A **CLIMATE READY NATION**

NOAA FY22-26 STRATEGIC PLAN

Fisheries



Biochemical monitoring,
species identification


Ocean Discovery



Sea floor mapping & full depth exploration

Fish Acoustics, ROV, Deep Camera

Power Grid



Space weather events can
cripple power grids

Global Positioning




Provides framework for all
positioning activities

Airplanes



Increases in solar radiation
affect airline routing

Farming



Initial inputs for drought
monitoring

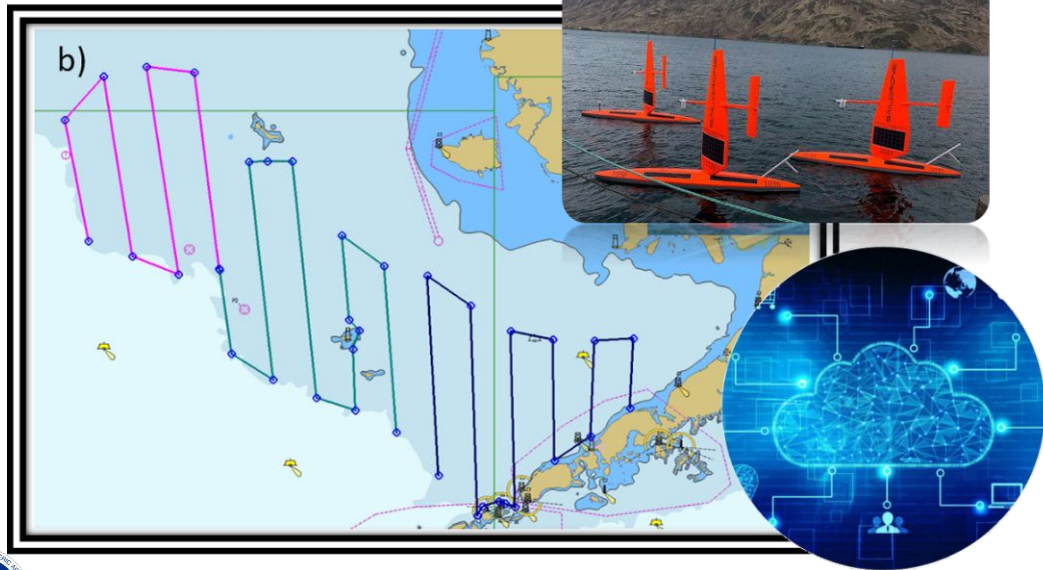


UxS Data Enterprise: Cloud Re-engineering

Leveraging the Saildrone COVID-19 missions



Pollock comprise the Nation's largest fishery. COVID-19 impacted traditional survey capability. Uncrewed systems were deployed in the east Bering Sea to collect this time critical data.



- Leveraging this opportunity to re-engineer end to end data processes with Cloud optimization using Saildrone data from Pacific Marine Environmental Laboratory.
- Enables cost optimization
- Extensible to other sensors





Data Assembly Hub for UxS : (Research)

Scalable Architecture to support Data Federation

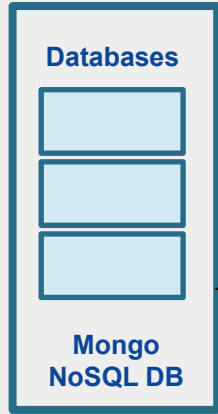
POCs: (NECI) J Bowers, S Mesick; (NOS ACDO) M Cromwell

Input Data Partners, ex. IOOS, PMEL, academia, NOAA NODD



Tiered Storage

“Books”



Database Storage

“Library Catalogue”

Compute Nodes



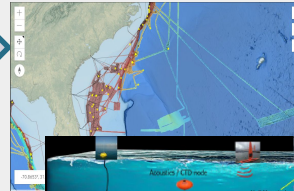
Compute Cluster

“Librarian”

Application Programming Interface



GUI



User tools for data search, access & visualization

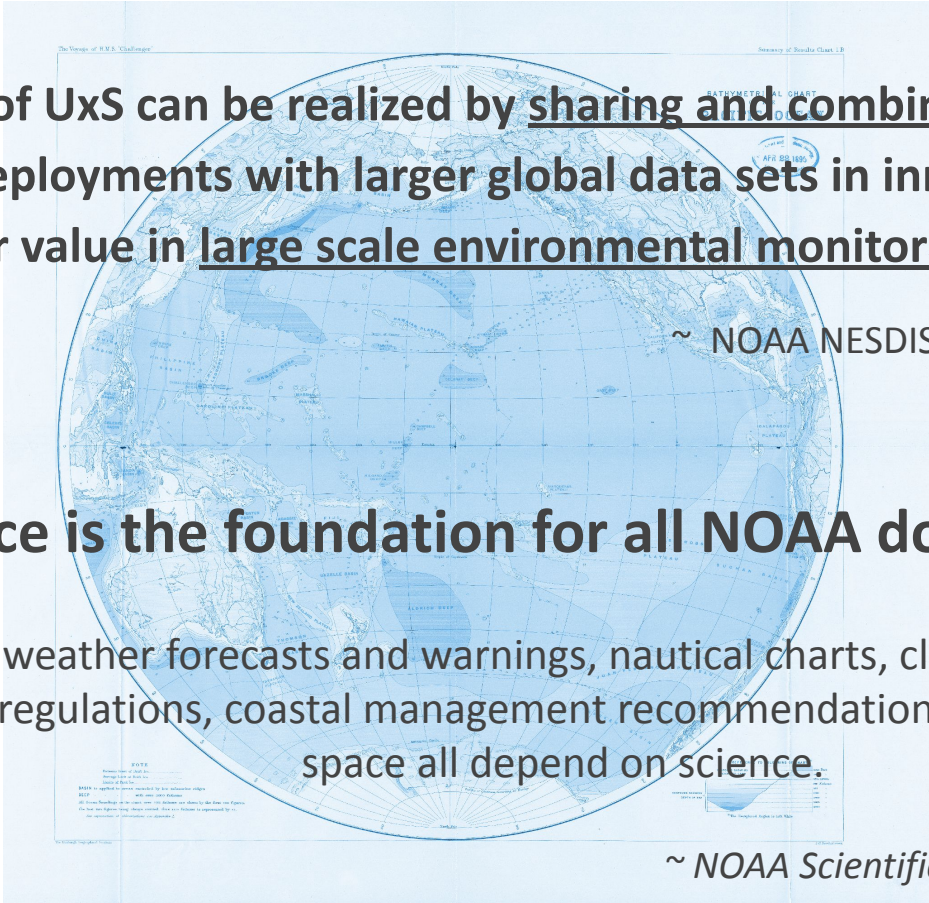

Federated approaches enable leveraging partner expertise

- Platform
- Sensor
- Data types
- Tracking and accountability
- Robust QA/QC
- Platform to user workflow
- Socioeconomic valuation



USM Data Assembly Hub for Uncrewed Systems

POC: Dr. Henry Jones



The true power of UxS can be realized by sharing and combining data from individual UxS deployments with larger global data sets in innovative ways, amplifying their value in large scale environmental monitoring activities.

~ NOAA NESDIS NCEI UxS Data Team

“Science is the foundation for all NOAA does.”

NOAA's weather forecasts and warnings, nautical charts, climate information, fishing regulations, coastal management recommendations, and satellites in space all depend on science.

~ NOAA Scientific Integrity Policy 2020





Questions





Experiences and Use Cases

Uncrewed Systems End Users:

- Jamison Gove
- Timothy Oram
- Liza Wright-Fairbanks, Kaity Goldsmith
- Patricia Quinn
- Michael Stephens
- Shawn Dahle
- Lisa Bucci, Jason Sippel
- Noah Lawrence-Slavas
- Josh Wadler





Assessing Ecosystem Productivity in Support of Ecosystem-Based Management in Hawaii

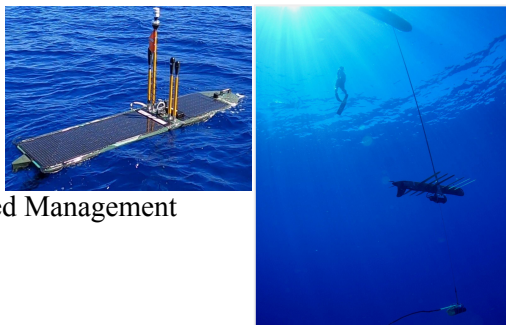


Overview

TEAM: Jamison Gove¹, Jon Whitney¹, Jim Ruzicka¹, Joey Lecky¹, Erin Oleson¹, Margaret McManus²

¹NOAA's National Marine Fisheries Service

²University of Hawaii



UxS: Liquid Robotics Wave Glider

NOAA MISSION: Ecosystem-Based Management

LOCATION: Hawaiian Islands

Why Use UxS?

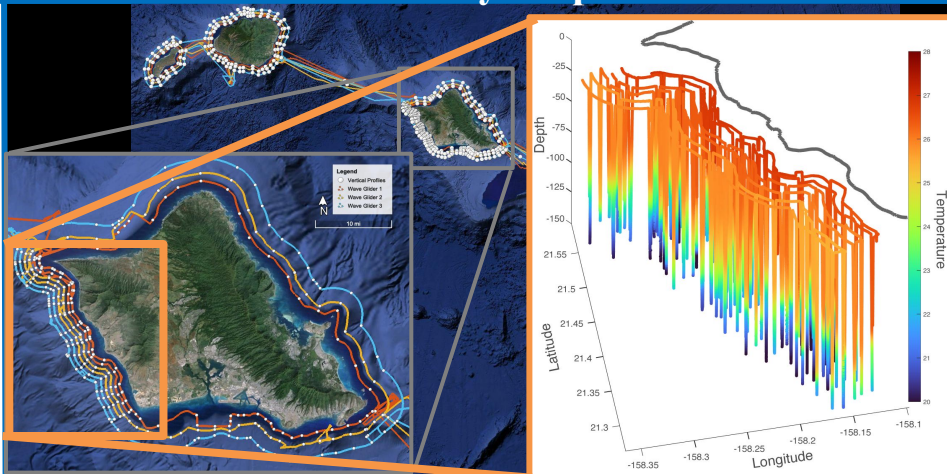
- **NEED:** Near coastal (0 - 6 km) surface and subsurface ocean measurements around all of the Hawaiian Islands (no other means beyond UxS to do so)
- **WHY WAVE GLIDERS:** UxS platform is ideal for operating nearshore in Hawaii: low profile and relatively small footprint (community concerns), wave-propelled (as opposed to wind), long-duration (months), surface and subsurface measurements, profiling winch (150 m), local testing and operations facility (quick response)

Partner Engagement

Engagement and collaboration prior to and during UxS mission.

- Hawaiian Islands Cetacean Ecosystem and Assessment Surveys (HICEAS)
- Academia: University of Hawaii (Margaret McManus) is a collaborator, providing important expertise and knowledge to this project.
- Community: UxS project summary was sent to local community groups for awareness.
- Industry: The Wave Gliders are being run as a Company Owned, Company Operated mission, providing data as a service.
- NGOs, Academia, and Government (Lahaina Water Quality Mapping): We surveyed ocean water quality following the first major rain event after the Lahaina fires in Maui, in which ~35% of annual rainfall occurred in < 2 days.

Survey Map





Exploration of External UxS Imagery for Damage Assessments



Overview

TEAM:	NWS Southern Region NOAA National Severe Storms Laboratory
UxS:	Verizon, Florida State University, University of Alabama Huntsville
NOAA MISSION:	NWS - Post-Storm Data Acquisition and StormData NSSL - NSSL Damage Assessments and Science
LOCATION:	Targeting “Dixie Alley” for demonstration

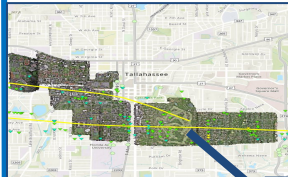
Why Use UxS?

- The use of airborne imagery for research into severe weather, and operational damage assessments, has a long history.
- Damage assessments require the rapid deployment of trained teams to gather damage evidence for assessment and research.
- CRADA partners: Locally sourced UxS, a variety of platforms and sensors.
- Biggest gap: Refinement and documentation of requirements and procedures that could be implemented as a “data buy.”

Partner Engagement

- RFI - July 2022 to assess partner interest.
- Follow-on discussions with respondents.
- Established CRADAs with Verizon and Florida State University, and working on CRADA with University of Alabama Huntsville
- Our CRADA partners have performed initial imagery gathering for tornadoes in Alabama and Florida Panhandle, as well as Texas Gulf Coast for Hurricane Beryl.
- Continuing planning meetings and operational tests to iterate on requirements and operations concepts.

Tallahassee Tornado May 10, 2024



“We’ve made some minor changes to our path from the imagery, but it definitely helped confirm the intensity of damage in areas we were not able to get to on the ground.”



Science and Ops Officer



NOAA Ocean Acidification Program - pH Gliders



Overview

TEAM: NOAA Ocean Acidification Program & funded partners

UxS: Slocum gliders, Spray gliders, carbon sensors integrated into various platforms.

NOAA MISSION: Understand & predict changes in climate, oceans, and coasts.

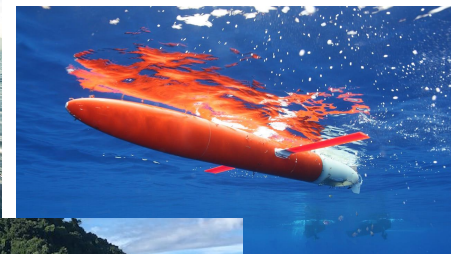
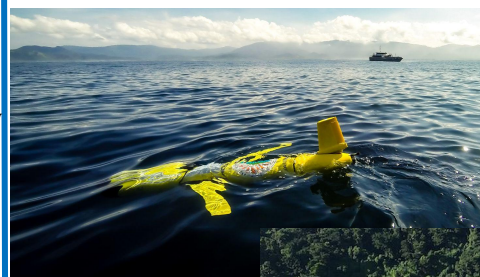
LOCATION: Mid-Atlantic Bight, Northeast coast, Gulf Stream, California current.

Why Use UxS?

- OAP is tasked with characterizing the coastal carbonate system and ocean acidification in U.S. coastal waters. Uncrewed systems provide higher spatial and temporal resolution measurements that better inform ocean models and stakeholder needs. Major historical gaps in the observing system include the subsurface and year-round measurements.
- Gliders are an ideal tool to use for year-round operations in coastal waters. OAP has funded multiple projects to support the design of glider-capable OA sensors and subsequent deployments.

Partner Engagement

- OAP funds external partners (academic and industry) via grants to develop and deploy new sensors on UxS
- OAP also funds NOAA scientists for sensor development
- There is still a large gap in sensor commercialization. The community relies on commercial production of sensors, yet industry partners have historically withdrawn support when the market becomes saturated beyond the level that federal funding can sustain.
- But, this historically niche field is growing
 - Closing the carbon budget is key to understanding human impacts
 - Marine carbon dioxide removal Measurement, Monitoring, Reporting, and Verification
 - Biden/Harris funds - \$2.1 million for surface carbon observing





Use of a hybrid VTOL - fixed wing UAS (FVR-90) for Investigations of Aerosol, Cloud, and Radiation Interactions in Marine Atmospheres



Overview

TEAM:

Science planning: NOAA PMEL and UW CICOES

Mission planning and command: NOAA OMAO UxS Operations Center

Pilots and Engineers: L3Harris and Overwatch Aero

UxS: FVR-55 and FVR-90, Hybrid Fixed Wing-VTOL UAS

NOAA MISSIONS:

- Provide science-based use-inspired decision support tools
- Improve weather, water, and climate predictions and projections
- Advance cutting-edge integrated research to observations

Partner Engagement

- The NOAA SBIR program was crucial in developing a partnership between a UAS manufacturer (Latitude Engineering/L3Harris) and PMEL to provide the UAS needed for our measurements.
- The SBIR program also aided in the development of miniature instruments by Brechtel Manufacturing Inc. that are used in our payloads.
- Gaps in our UAS use that could be filled by further partner engagement include a detect-and-avoid system that allows flights in unrestricted airspace, less expensive versions of the FVR-90, and additional miniaturized instruments.

Why Use UxS?

- Measurements of vertical profiles of particles and clouds in marine atmospheres are required to assess aerosol radiative forcing and improve climate models.
- UAS measurements from ships and coastal regions allows for more frequent and less expensive flights than crewed aircraft.
- The FVR-90 allows for take-off and landing in a confined space, provides long endurance (6 hrs) and high altitudes (10,000'), and the capability of carrying a 23-lb payload.

FVR-55 with Clear Sky Payload



FVR-90 with Cloudy Sky Payload



Swapping payload nose cones between flights



UxS for Hydrographic Surveying



Overview

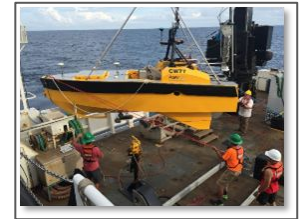
TEAM: Office of Coast Survey, Hydrographic Surveys Division
PRIME CONTRACTORS: David Evans and Associates (DEA), eTrac (Woolpert), Fugro, GeoDynamics (NV5), Leidos, Ocean Surveys, Inc. (OSI), TerraSond
UxS: C-Worker, WAM-V, X-Ocean, Sea Machines Automation, DriX, EchoBoat, Fugro Blue Shadow, Leidos *Pathfinder* vessel
NOAA MISSION: Hydrographic Surveying
LOCATION: Entire U.S. EEZ

Why Use UxS and UxS Requirements

- In some cases, UxS can be cheaper than manned platforms, especially in a force multiplication capacity
- UxS in uncharted/shallow areas keep personnel out of danger
- UxS platforms generally need to be able to keep up with manned vessels (6-8 knots)
- UxS need to be maneuverable/pilotable (drive straight lines)
- Endurance needs can vary

Partner Engagement

- HSD has a 5 Year A&E IDIQ contract with a ceiling of \$250M
- Contractors propose Technical Approach to Government
- UxS utilized when appropriate in conjunction with traditional manned survey vessels
- UxS are subcontractors to Primes
- HSD contracts with Primes are FFP
- HSD also partners with OMAO for use of the DriX on NOAA Hydrographic Survey ships
- Generally deployed from Mothership for “Force Multiplication” type surveying, although shore launched operations are also utilized





UAS Surveys of Pinnipeds in the Aleutian Islands with “SIERRA”



Overview

TEAM: NOAA Alaska Fisheries Science Center, Marine Mammal Lab and NASA Ames Research Center, Aviation Operations Division

UxS: NASA’s “SIERRA” UAS carrying NOAA’s imaging system

NOAA MISSION: Monitor population trends of Steller sea lions and harbor seals in Alaska

LOCATION: Western Aleutian Islands

Why Use UxS?

- Aerial surveys of Steller sea lions and harbor seals in the western Aleutian Islands are a high priority for NOAA, but the area’s remoteness and frequent poor weather make crewed surveys challenging and higher risk
- Small UASs have been used successfully, but they have limited range and payload capacities, and require ship support
- SIERRA can fly up to 9 hrs carrying a 40-lb payload and has UHF radio and Iridium satellite comm-links for BVLOS operations
- UHF worked well out to 30 nmi but issues with Iridium comms prevented surveying more distant sites (up to 65 nmi away)

Partner Engagement

- NOAA lacked the UAS platform and expertise for this complex mission so we entered into an Interagency Agreement with a team of UAS experts at NASA Ames
- NOAA provided the survey objectives, technical requirements, and payload operators while NASA led the payload integration, safety reviews, logistical coordination, and flight operations
- We also engaged with the U.S. Air Force for logistical support at Eareckson Air Station, our base of operations in the Aleutian Islands, and with the FAA for the required airspace approvals
- NASA recently withdrew from the project (due to platform and staffing issues) so we will need to find a new platform or different path to address our Aleutian survey challenges



Steller sea lions



Harbor seals



NASA's "SIERRA" UAS



UxS Used for NOAA Hurricane Hunting



Overview

TEAM: National Hurricane Center (NWS), Atlantic Oceanographic and Meteorological Laboratory (OAR), Aircraft Operations Center (OMAO)

UxS: Altius, Saildrone, Gliders, Global Hawk (retired), Coyote (retired)

NOAA MISSION: Operational forecasting and research

LOCATION: Northern Atlantic and eastern Pacific Oceans

Why Use UxS?

- NHC needs surface location, intensity, minimum central pressure, and wind field structure every 3-6 hours.
- NOAA weather models need 3D fields of winds, temperature, moisture. Beginning to use ocean observations in coupled models.
- Variety of UxS used for ocean, inner core, and high-altitude/long-endurance missions targeting different needs.
- Greatest regions in need of observations are in the E. Atlantic and the Pacific (coast of Mexico to 180°W).
- Overnight observations are needed to make up for fewer manned missions.
- UxS could be used as backup for critical, landfalling systems

Partner Engagement

- New technologies (ex. UASs) are tested by and for the research community (OAR) during NOAA's annual Hurricane Field Program.
- If desired, technologies are transitioned to operational use as their readiness matures.
- Formal engagements through SBIR awards, DoD agreements, NASA agreements.
- Data buys have been arranged through UxS Operations Center.
- Partnership engagement has been ad hoc, often driven by research community with less input from operational community.

Possible Future CONOPS

	7-day Outlook	Disturbance	Tropical Storm	Hurricane	Landfall Extratropical
Air Force					
NOAA		Invest missions	Fix missions	Fix missions	Landfall
UAS	Adaptive UAS deployments	Genesis	Early stage TDR/Synoptic	Mature stage TDR/Synoptic	Landfall
		Pre-deploy UAS swarms	Distant storms and boundary layer Night time operations		CONOPS Backup Extratropical taskings?



Developing UxS into Tools for Ocean Research: ASVCO₂ Sensor



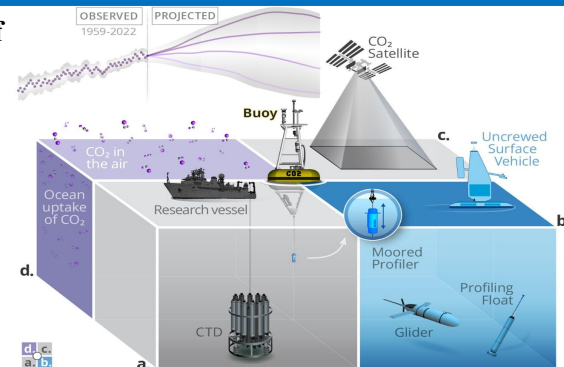
Overview

Pacific Marine Environmental Laboratory:

- **What:** Conduct scientific research and engineering development in support of NOAA's mission.
- **Why:** To make environmental predictions from hours to decades.
- **How:** Design, develop and operate large, global, observational arrays.
 - ASVCO₂: Autonomous Surface Vehicle CO₂ sensor:
 - Generates critical air-sea CO₂ climate records
 - Developed for technical transfer to partners

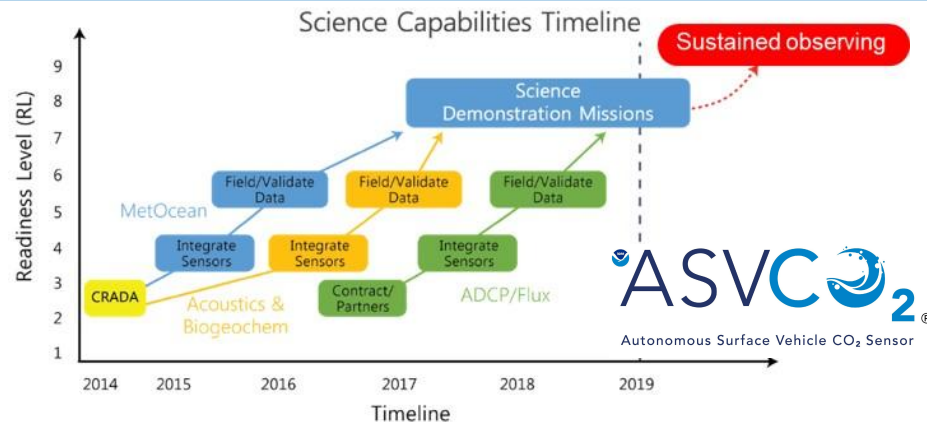
Why Use UxS?

- Cost and availability of ship time is a primary limitation to our observing activities.
- A USV network FILL GAPS in space, time, disciplines and complement existing infrastructure.



Partner Engagement

- CRADA (Saildrone)
- MOU (Jupiter Research)
- MOU & IA (CSIRO)



Air-Deployed small UAS in Tropical Cyclones

Overview

TEAM: Joseph J. Cione (NOAA AOML Hurricane Research Division)
Jun A. Zhang (NOAA HRD and UM/CIMAS)
Joshua B. Wadler (Embry-Riddle Aeronautical University)
Mikal Montgomery (NOAA NWS San Joaquin Valley, CA)

UxS: Anduril's Altius 600, Black Swift Technologies S0

NOAA MISSION: To understand and predict changes in climate, weather, the ocean and coasts (through Hurricane Field Program)

LOCATION: NOAA P-3 Hurricane Hunter

Why Use UxS?

- The exchange of heat, moisture, and momentum near the ocean surface plays a key role in tropical cyclone intensity change.
- Obtaining measurements near the air-sea interface is challenging due to the dangers of flying crewed aircraft close to the ocean
- Air-deployed sUAS uniquely allows low-level measurements of winds, temperature, humidity, pressure, and sea surface temperature.

Partner Engagement

- Original development of air-deployed sUAS with both companies were with a NOAA SBIR.
- After successful development/deployment, further funding is provided by NOAA UxS and WPO to obtain low-level in-storm measurements.
- Project team partnered with UMiami CIMAS (NOAA CI) and Embry-Riddle to obtain and analyze in-storm measurements
- Each sUAS deployed provides data in real-time. For operational transition, we will send data to forecasters at the National Hurricane Center and into the global telecommunications system (GTS) for operational model data assimilation



Questions

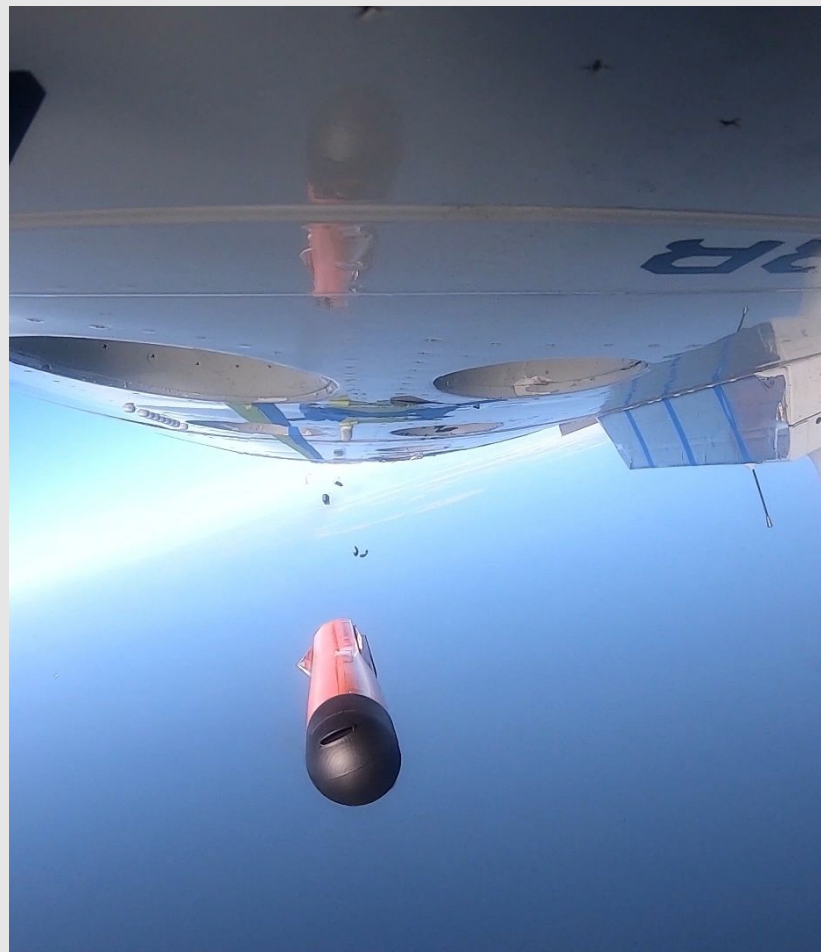
Presenter Contact Information:

- Jamison Gove (jamison.gove@noaa.gov)
- Timothy Oram (timothy.oram@noaa.gov)
- Liza Wright-Fairbanks, Kaity Goldsmith (liza.wright-fairbanks@noaa.gov, kaity.goldsmith@noaa.gov)
- Michael Stephens (michael.stephens@noaa.gov)
- Shawn Dahle (shawn.dahle@noaa.gov)
- Lisa Bucci, Jason Sippel (lisa.bucci@noaa.gov, jason.sippel@noaa.gov)
- Noah Lawrence-Slavas (noah.lawrence-slavas@noaa.gov)
- Josh Wadler (wadlerj.erau.edu)



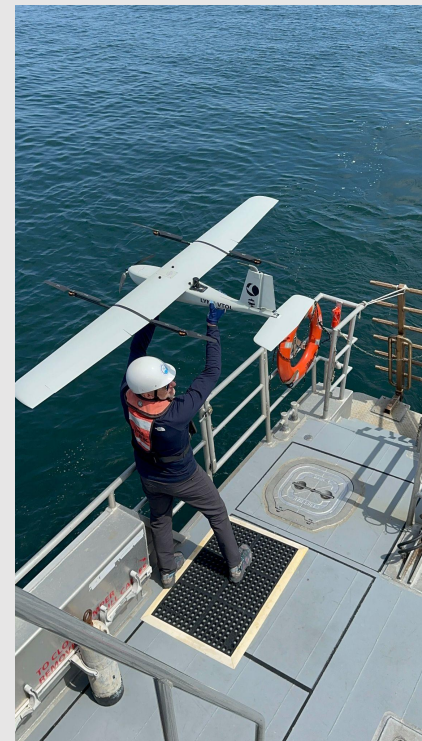
Forum Announcement

CAPT Bill Mowitt, Uncrewed
Systems Operations Center



Uncrewed Systems Industry Engagement Forum

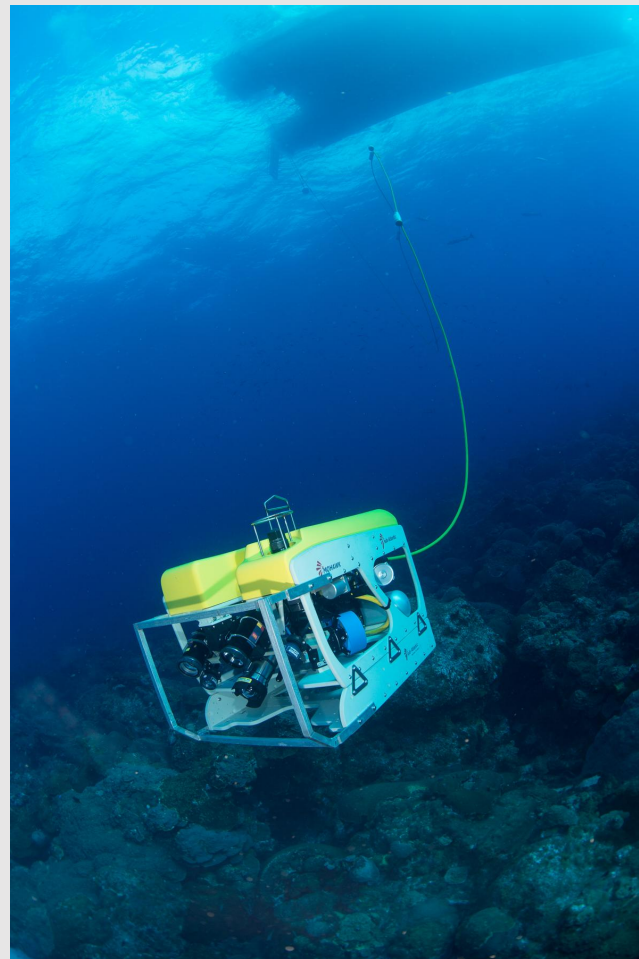
- A space for direct market research to occur between vendors and NOAA end users surrounding uncrewed systems platforms, sensors, and services
 - Allow NOAA scientists to understand new industry capabilities
 - Allow industrial partners to hear more about NOAA requirements
 - Allow NOAA and industry to directly engage
- Forums will occur monthly and will be themed around specific NOAA interest areas
- Following each Forum, vendors and NOAA end users are free to engage in continued market research
 - Participants may not discuss pricing or contract details without a NOAA AGO contract specialist present and may not use this event and future forums to establish requirements for contracts
 - All details discussed are subject to change and do not represent any binding agreement with the U.S. Government

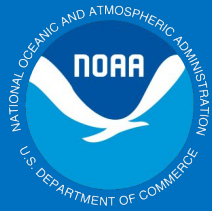




Engagement Guidelines

Amy McLiverty, Acquisition and
Grants Office





NOAA

NOAA Acquisition & Grants Office (AGO)

Eastern Acquisition Division (EAD)
Amy McLiverty, Contracting Officer
Supporting OMAO





Rules of Engagement



- **AGO Core Value**



Innovation-Constantly engage with our clients and industry to bring cutting-edge technology and solutions to address NOAA's complex requirements



- **Innovative Technique: Meeting with Vendors**

Misconception - "Attending industry dates and outreach events is not valuable because the agency doesn't provide new information."






Fact - Industry days and outreach events can be a valuable sources of information for potential vendors and are increasingly being used to leverage scarce staff resources.*



***OFPP Myth-Busting #4-Strengthening Engagement with Industry Partners through Innovative Business Practices**



Rules of Engagement



“Market research must be conducted thoroughly to ensure the right strategies, industry participants, and process are established to conduct an efficient, robust competition. Prior to issuance of the solicitation, government officials - including the program manager, users, or contracting officer - should meet with potential offerors to exchange general information and conduct market research related to an acquisition. While meeting with potential offerors, there is no requirement that the meetings include all possible offerors, nor is there a prohibition on one-on-one meetings.”

- 
- 
- **Stay up to date on opportunities posted in SAM.gov.**
 - **All future Virtual or In person Industry Days will be posted on SAM.gov.**



Closing Remarks and Open Question Period

CAPT Bill Mowitt, Uncrewed
Systems Operations Center



Additional Resources

- Visit www.oma.noaa.gov/uncrewed-systems/external-partners to sign up to be a presenter at an upcoming UxS Industry Engagement Forum Session
- Reach out to ashley.hann@noaa.gov with any questions

Thank you for tuning in!