

# UAS Capabilities for Future Shipboard Operations:

Launch and Recovery of a Vertical Take Off and Landing  
(VTOL), Fixed Wing (FW) UAS with 10 kg Payload  
Capabilities from a NOAA Ship

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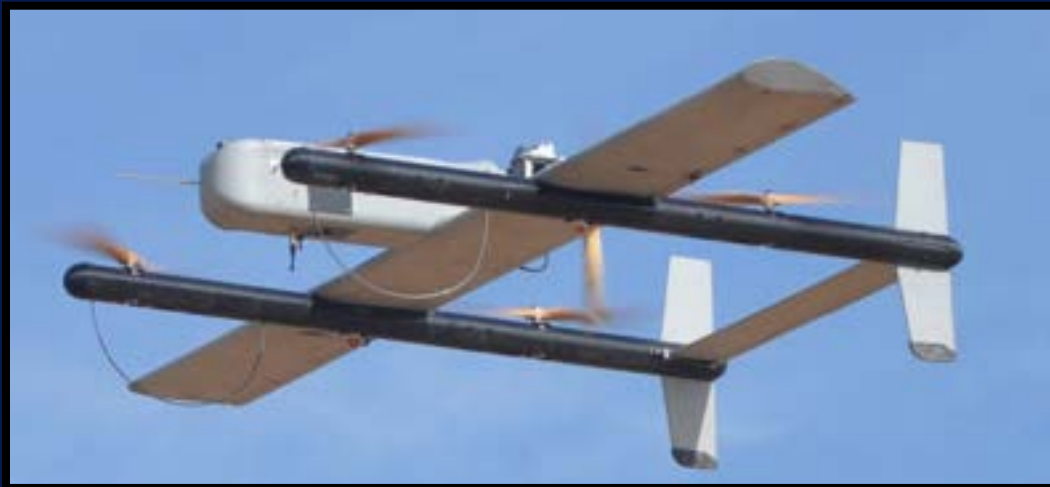


# Potential Applications:

- Horizontal and vertical distributions of atmospheric gas and particulate phase species relevant to air quality and climate (e.g., pollution plumes, ship emissions, forest fire smoke, sea spray aerosol).
- Fishery surveys
- Oil spill detection
- Weather observations
- Post severe weather damage assessments

# Hybrid Quadrotor (HQ) Technology

Combines vertical takeoff and landing (VTOL) capabilities of a quadrotor and the speed and range of a fixed-wing (FW) aircraft



- No runway needed
- Portable
- Shipboard operation possible
- Pusher engine – required for gas and aerosol measurement
- Nose cone payload

# Demonstration of the Shipboard Launch and Recovery of a VTOL-FW UAS



*NOAA R/V Oscar Elton Sette*  
Off the coast of Oahu  
June 17 – 21, 2016

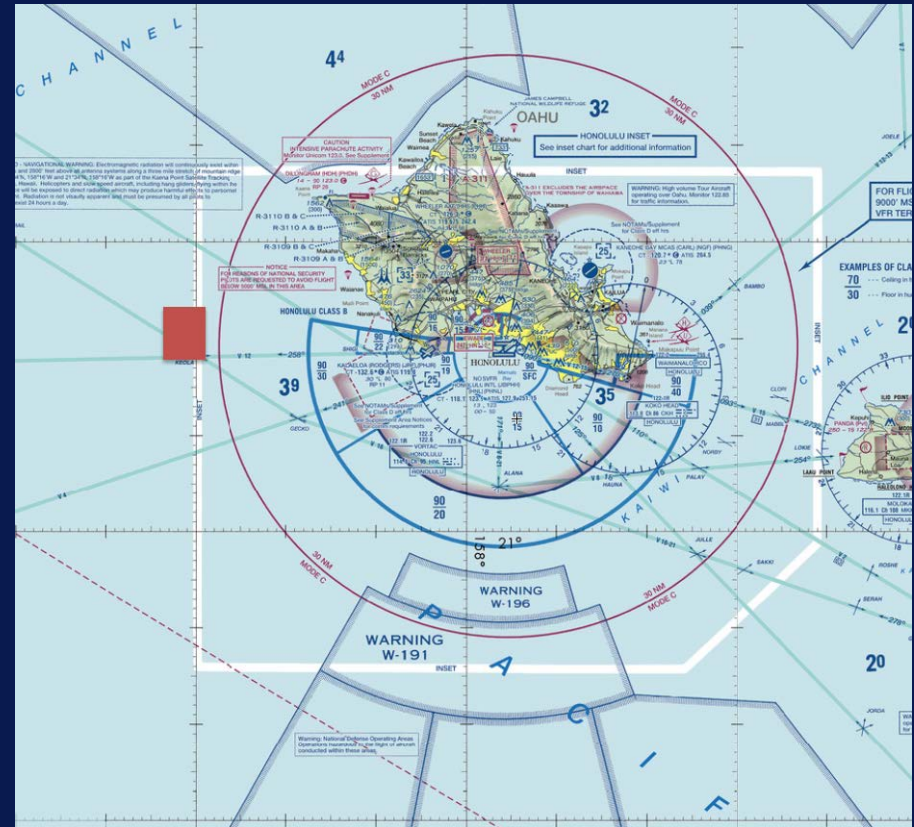
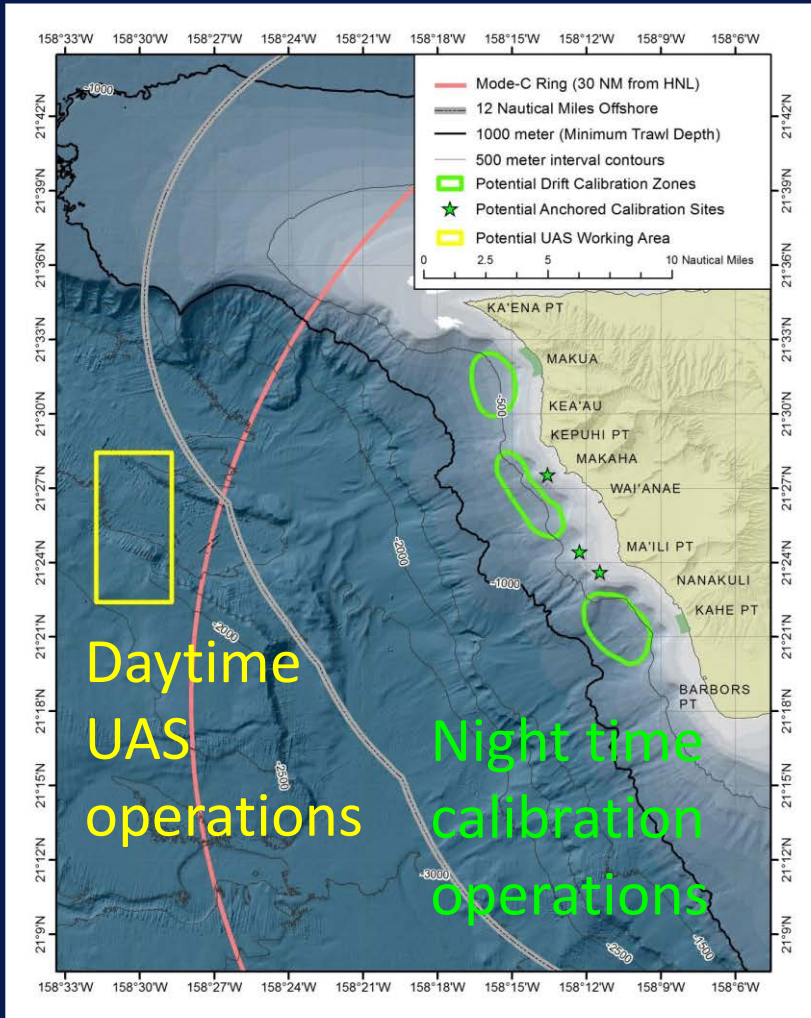


Latitude Engineering  
Hybrid Quadrotor (HQ)  
technology



# Operating Area

Operating area (yellow rectangle) west of Oahu outside the Mode C ring (orange line) and 35 nm from shore.



# Operational Limits

**Range:** Operations were limited to daytime and line of sight.

**Altitude:** Operations were limited to below 1000 ft.

**Wind and Sea State:** Operations were limited to wind speeds less than 30 knots (Beaufort 6 or above).

**Clouds and Visibility:** Operations were limited to visual line of sight and class E airspace weather minimums (3 statute miles flight visibility and 500 ft below any clouds).



# HQ-20 on the Fantail of the Sette



The HQ-20 is a 25 lb, all electric VTOL fixed wing UAS. It is designed to be an inexpensive, highly ruggedized test vehicle for flight control software testing. It is capable of 10 minutes of vertical mode flight and 10 minutes of fixed wing flight.



# HQ-20 Ground Station

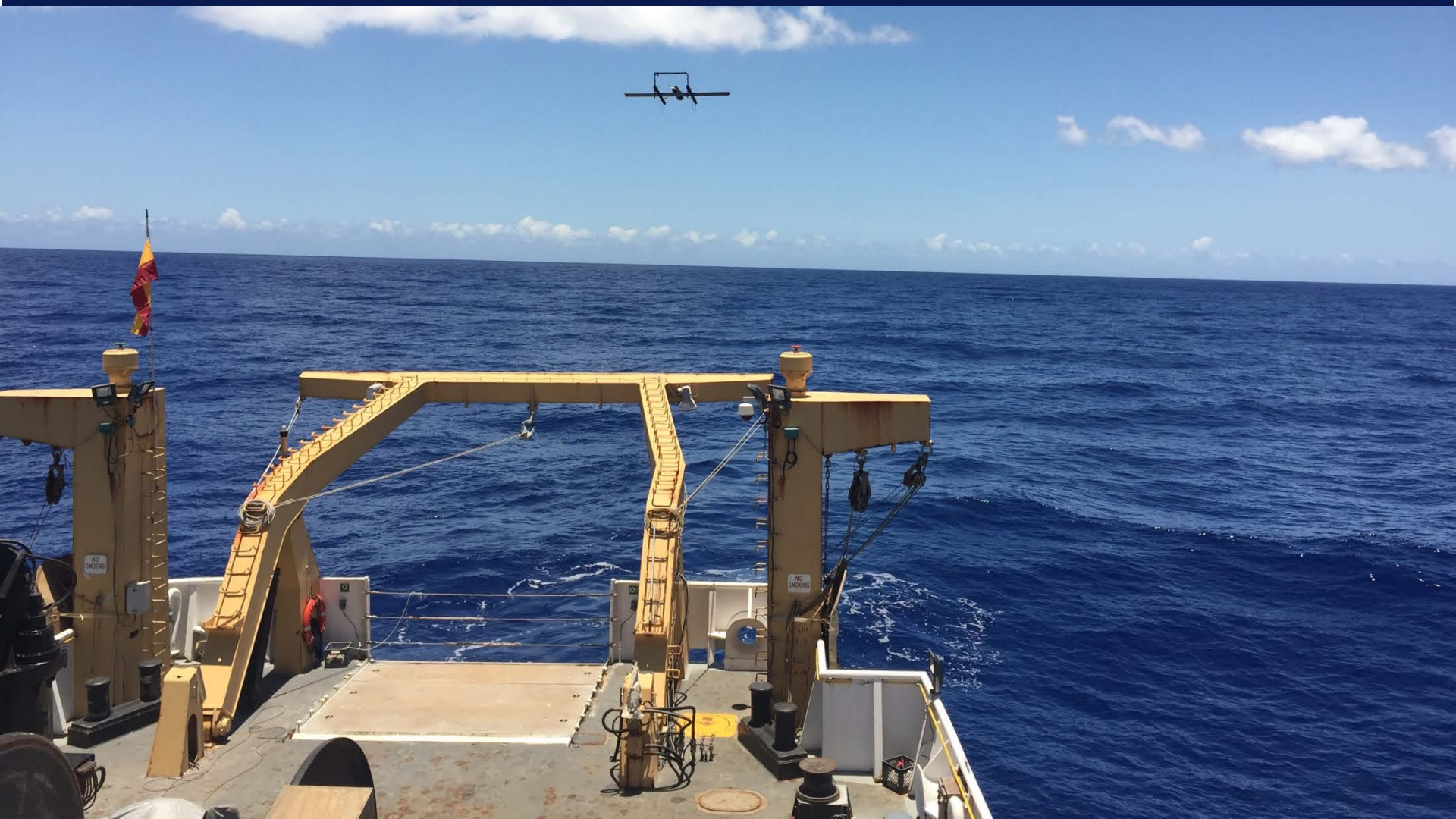


# HQ-20 Hover Test





# HQ-20 transitioning from VT to FW flight



HQ20 Launch : June 19, 2016  
Wind speed 10 – 15 knots, Seas 2 – 4 feet



HQ20 Recover : June 19, 2016  
Wind speed 10 – 15 knots, Seas 2 – 4 feet





# Accomplishments

- 5 successful hover flights
- 4 successful flights with vertical take off, switch to fixed wing flight, and vertical landing.
- Successful flights were conducted with takeoff toward the stern and wind on the stern.
- Demonstrated the ability to operate the HQ technology from a ship with limited deck space.
- Demonstrated the ability to operate the HQ technology from a ship under 10 – 18 kt wind speed conditions.

# Lessons learned

- Pitch and roll of the deck posed a less significant challenge than anticipated.
- The large steel structure of the ship was significant enough to cause a large interference with the magnetometer. Autonomous landing will require another approach. Latitude Engineering is exploring the use of a downward looking camera and a calibrated target fixed to the deck to guide the UAS while in VTOL mode near the flight deck. This method does not require expensive and heavy differential GPS and aids the magnetometer while in close proximity to the ship.
- Take off with the bow of the ship into the wind, with wind speeds of 20 kts, resulted in significant superstructure related turbulence that overpowered the HQ motors. Latitude Engineering plans to increase the VTOL system control authority (power, responsiveness) for future shipboard operations.

# Next steps

- These tests should be repeated when Latitude Engineering is ready to demonstrate autonomous take offs and landings with the HQ-20 without use of the magnetometer.
- After successful autonomous operations with the HQ-20 have been demonstrated, test flights should be performed with a larger HQ aircraft capable of carrying a 10 kg payload.

# Project Summary

**Milestone:** “to demonstrate shipboard fixed wing hybrid quadrotor (HQ) technology with repeated take-offs, transition to fixed wing flight, return to ship and landings”.

**Tasks Accomplished:** The HQ UAS technology was tested between June 18 and 20, 2016 aboard the NOAA Ship *Oscar Elton Sette* using Latitude Engineering’s HQ-20 UAS. Three different air frames were used to conduct eleven test flights, including 5 Hover flights, and 4 successful VTOL-FW flights. The successful flights demonstrated the ability of the UAS to take off from the ship, switch to fixed wing flight, and return and land on the ship.

**Technical Readiness Level (TRL):** The successful flights of the HQ-20 demonstrated that the HQ technology has reached a TRL of 5 - Concept validated in relevant environment. The VTOL fixed wing UAS shows great promise for NOAA.

# Project Summary

The VTOL fixed wing UAS shows great promise for NOAA. The technology allows the UAS to take off and land on a ship while having the long duration of a fixed wing UAS. This technology is also applicable to land-based operations where a runway is not available.

The HQ-40 and HQ-60 have the payload capacity to accommodate NOAA's camera monitoring programs and atmospheric chemistry studies.

## Current Latitude Engineering Products:

	HQ-40	HQ-60
Payload:	5 lb	8 – 12 lb
Endurance:	5 hrs	12 – 24 hrs

Acknowledgements: NOAA UAS Program for funding and officers and crew of the *RV Oscar Elton Sette* for assistance and hospitality.

Thank you for your attention.