2025 NOAA/AOML/HRD Hurricane Field Program - APHEX

OCEAN OBSERVING EXPERIMENT
Flight Pattern Description

Experiment/Module: SASCWATCH: Study on Air-Sea Coupling with WAves, Turbulence, and Clouds at High winds

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Requirements: No requirements: flown at any stage of the TC lifecycle

Ocean Observing Science Objective(s) Addressed:

1) Collect observations targeted at better understanding air-sea interaction processes contributing to hurricane structure and intensity change. [*APHEX Goals 1, 3*]

2) Collect observations targeted at better understanding the response of hurricanes to changes in underlying ocean conditions, including changes in sea surface temperature, ocean mixed layer depth, turbulent mixing and ocean heat content [*APHEX Goals 1, 3*]

3) Test new (or improved) technologies with the potential to fill gaps, both spatially and temporally, in the existing suite of airborne measurements in TCs. These measurements include improved three-dimensional representation of the hurricane wind field, more spatially dense thermodynamic sampling of the boundary layer, and more accurate measurements of ocean surface winds and underlying ocean conditions [*APHEX Goal 2*]

P-3 Pattern #1: SASCWATCH "Light" ocean observing flyover

What to Target: Centered over "light" configuration of ocean assets (Fig. 1, left) previously deployed by U.S. Air Force Reserve (USAFR) flights.

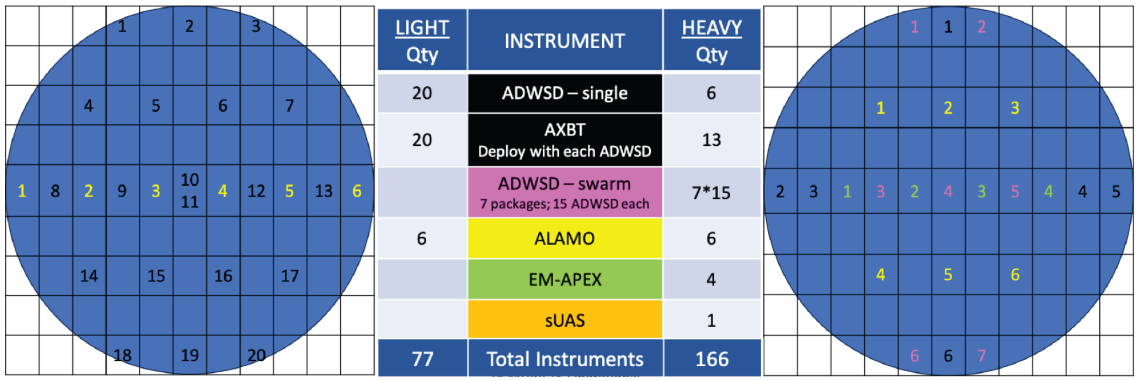
When to Target: During storm passage over ocean assets previously deployed ahead of the storm.

Pattern: Straight line or downwind leg of a Figure-4, Rotated Figure-4, or Butterfly pattern that aligns with the ocean assets present in the storm environment. Figure 2 shows example orientations of (a) Figure-4, (b) alternate Figure-4, (c) Rotated Figure-4, and (d) Butterfly patterns over the ocean assets. In (a), a TC center crossing aligns with the main centerline of ocean assets, and additional overflights occur on the downwind connecting leg. In Fig. 2b, ocean assets are targeted primarily on the downwind connecting leg due to instrument drift or operational flight constraints, with additional overpasses as targets of opportunity on center crossing legs. Similar strategies are employed for the Rotated Figure-4 or Butterfly to maximize overflight opportunities as available given safety, operational, and on-station time constraints.

Flight altitude: Typical in-storm flight altitudes (8-12 kft)

Leg length or radii: Variable from 5 – 60 n mi per leg, dependent on ocean instrument drift

Estimated in-pattern flight duration: ~5-30 minutes per leg dependent on leg length



LIGHT Qty	INSTRUMENT	HEAVY Qty
20	ADWSD – single	6
20	AXBT Deploy with each ADWSD	13
	ADWSD – swarm 7 packages; 15 ADWSD each	7*15
6	ALAMO	6
	EM-APEX	4
	sUAS	1
77	Total Instruments	166

Figure 1. Light (left) and Heavy (right) SASCWATCH ocean deployment strategy. Colored numbers denote individual ocean asset types shown in the center table, and are indexed by number up to the total of each instrument. ADWSD = A-sized Directional Wave Spectra Drifter, AXBT = Airborne Expendable Bathythermograph, ALAMO = Air-Launched Autonomous Micro Observer, EM-APEX = Electro-Magnetic APEX Float, sUAS = Small Unmanned Aerial System.

Expendable distribution: In the "light" configuration, the USAFR WC-130J will deploy 20 ADWSD wave drifters and 6 ALAMO floats ahead of the storm in 5 lines (Fig. 1, left). One AXBT will be launched in the pre-storm environment by the USAFR deployments of the ocean assets with each ADSWD. The center line with maximum instrumentation will target the future TC center position during a subsequent NOAA P-3 flight. During NOAA P-3 flights, we will supplement operational and APHEX dropsondes with targeted launches over SASCWATCH ocean assets. Combination drops with dropsondes and AXBTs over ocean assets in high-wind regions are desired, with the expendables deployed as close to the ocean assets as possible for full vertical profiles of atmosphere, ocean, and waves.

Instrumentation Notes: TDR, SFMR, KaIA, IWRAP, and/or ROARS measurements are desired, if available.

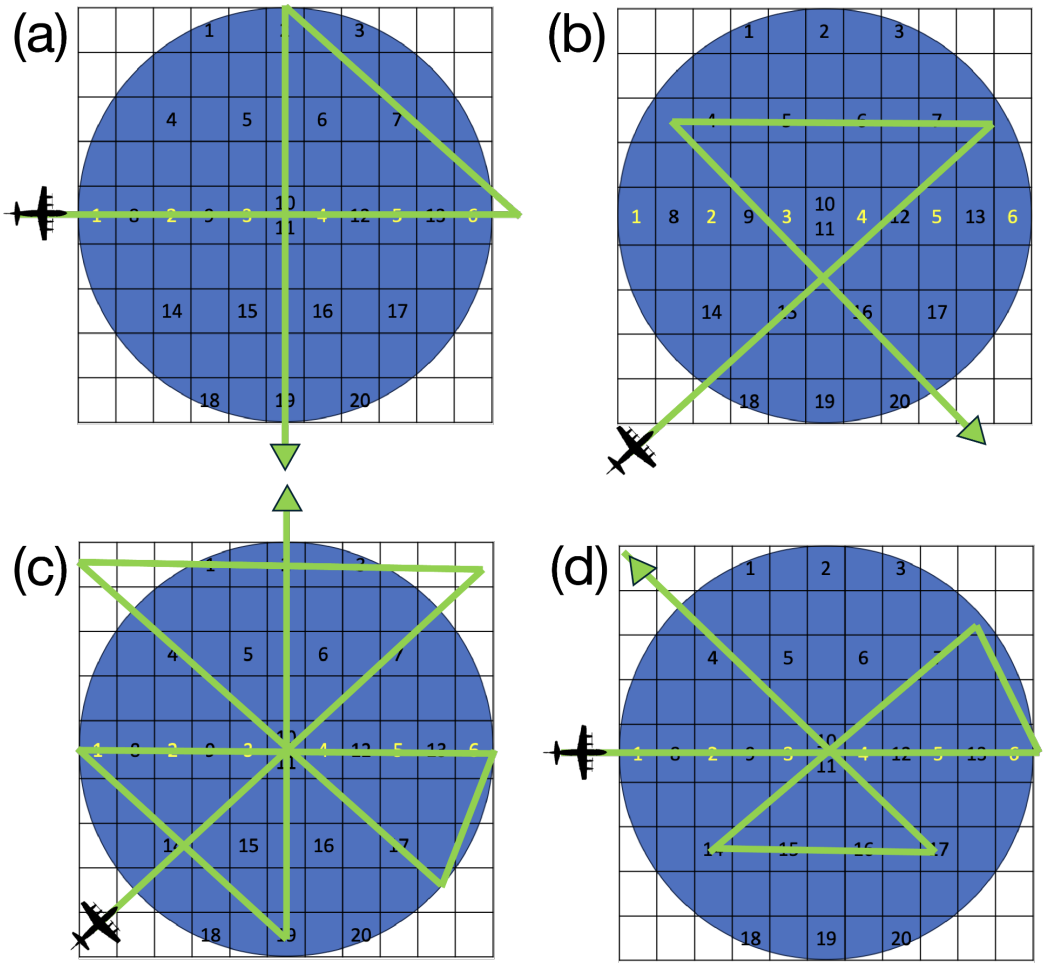


Figure 2: SASCWATCH ocean observing flyover patterns. Example orientations of (a) Figure-4, (b) alternate Figure-4, (c) Rotated Figure-4, and (d) Butterfly patterns over the ocean assets. Numbers correspond to the "light" deployment shown in Fig. 1.

P-3 Pattern #2: SASCWATCH "Heavy" ocean observing flyover

What to Target: Centered over "heavy" configuration of ocean assets (Fig. 1, right) previously deployed by USAFR flights.

When to Target: During storm passage over ocean assets previously deployed ahead of the storm.

Pattern: Straight line or downwind leg of Figure-4, Rotated Figure-4, or Butterfly pattern that aligns with the ocean assets present in the storm environment. Similar to the "Light" pattern shown in Figure 2 except with the "heavy" configuration of ocean assets and the addition of a sUAS deployment for targeted low-level measurements over the ocean assets (Fig. 3).

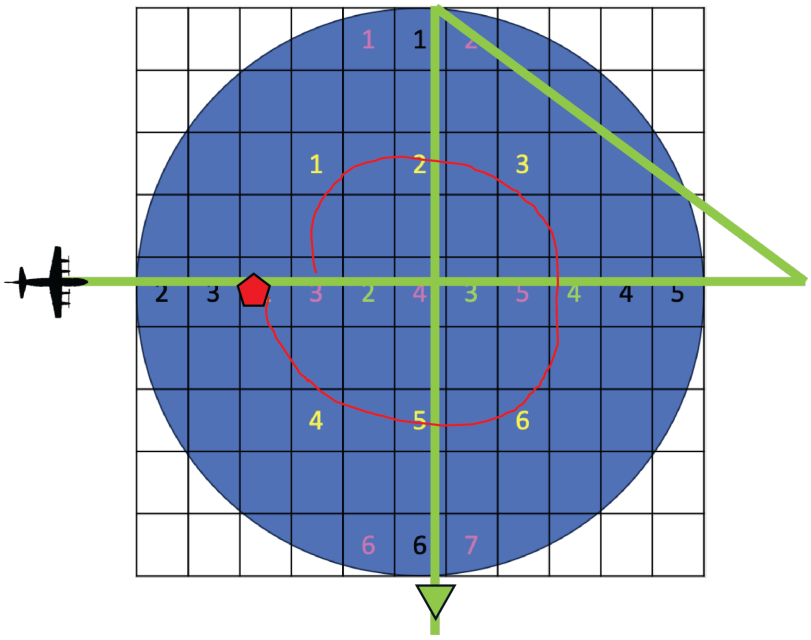


Fig. 3: SASCWATCH sUAS ocean observing flyover. The red line shows the spiral flight pattern of the sUAS unit starting at the red pentagon launch location. Numbers correspond to the "heavy" deployment shown in Fig. 1 (right).

Flight altitude: Typical in-storm flight altitudes (8-12 kft) for the P-3, constant altitude in surface layer for sUAS

Leg length or radii: Variable from 5 – 60 n mi per leg, dependent on ocean instrument drift

Estimated in-pattern flight duration: ~5-30 minutes per leg dependent on leg length

Expendable distribution: In the "heavy" configuration, the WC-130J will deploy 6 single ADWSD wave drifters and 7 swarm packages of 15 ADWSD each, along with 6 ALAMO floats and 4 EM-APEX profilers ahead of the storm in 5 lines (Fig. 1, right). One AXBT will be launched in the pre-storm environment by the USAFR deployments of the ocean assets with each ADSWD. The center line with maximum instrumentation will target the future TC center position during a subsequent NOAA P-3 flight. During NOAA P-3 flights, we will supplement operational and APHEX dropsondes with targeted launches over SASCWATCH ocean assets. Combination drops with dropsondes and AXBTs over ocean assets in high-wind regions are desired, with the expendables deployed as close to the ocean assets as possible for full vertical profiles of atmosphere, ocean, and waves. An sUAS expendable will also be deployed in the heavy flight pattern.

Instrumentation Notes: TDR, SFMR, KaIA, IWRAP, and/or ROARS measurements are desired, if available.

sUAS flight details and notes specific to this module:

Primary Objective(s): Conduct a flyover of ocean assets, particularly targeting high-density regions

with ADWSD swarms, ALAMO, and EM-APEX assets.

Methodology/sUAS flight pattern: Prior to takeoff, the P-3 will confirm the location of the target ocean asset lines. After separation from the P-3, and stabilization of the sUAS occurs, the drone will descend to a low, fixed altitude to be determined by the flight scientists. Once at this altitude, the drone will proceed to the beginning of the line of ocean assets.

After the "heavy" line flyover, the sUAS will continue to circumnavigate the TC. If it is estimated that the sUAS has enough battery to circumnavigate the TC and conduct a second flyover of the line, then it will do so. If not, then the sUAS will be directed to conduct other studies, based on the location and characteristics of the TC.

Note 1: If it is estimated that the sUAS's battery and condition will permit it to circumnavigate the TC and conduct another ocean line overflight, then the final leg of the sUAS/P-3 overflight/deployments is requested to be done again.

Note 2: The exact deployment location and leg lengths for the P-3 will be pending the location and characteristics of the TC and ocean assets, along with the safety of the P-3. These details will have to be worked out on a by-case basis. Detailed sUAS flight patterns will be provided to AOC and AOML/HRD before the P-3 flight pattern deadline and presented at the pre-flight briefing.

P-3 Pattern #3: SASCWATCH Pre- or Post-storm ocean observing survey

What to Target: Centered over either "light" or "heavy" configuration of ocean assets previously deployed by USAFR flights (Fig. 1).

When to Target: On-flight TDR working and running, with additional WSRA, KaIA, IWRAP or ROARS measurements desired

Pattern: Lawnmower pattern ahead of or behind the storm over USAFR deployed ocean assets (Fig. 3). When safety and time allow, these could be conducted on the way to the in-storm flight pattern or near the end of a mission before returning to base.

Flight altitude: Typical in-storm flight altitudes (8-12 kft)

Leg length or radii: Variable from 5 – 60 n mi per leg, dependent on instrument drift

Estimated in-pattern flight duration: ~5-30 minutes per leg dependent on leg length

Expendable distribution: During the lawnmower pattern, we will supplement operational and APHEX dropsondes with targeted launches over SASCWATCH ocean assets. Combination drops with dropsondes and AXBTs over ocean assets are desired, with the expendables deployed as close to the ocean assets as possible for full vertical profiles of atmosphere, ocean, and waves.

Instrumentation Notes: TDR, SFMR, KaIA, IWRAP, and/or ROARS measurements are desired, if available.

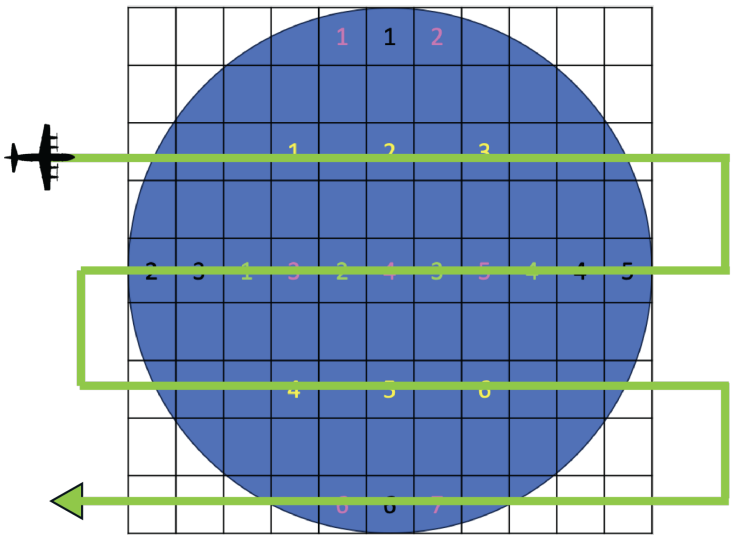


Figure 4: SASCWATCH Post-storm ocean observing survey with lawnmower pattern to target ocean assets behind the storm. Numbers correspond to the "heavy" deployment configuration shown in Fig. 1.