2023 NOAA/AOML/HRD Hurricane Field Program - APHEX

OCEAN OBSERVING EXPERIMENT
Flight Pattern Description

Experiment/Module: *CHAOS*: Coordinated Hurricane Atmosphere-Ocean Sampling

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Collaborators: Dave Jones, StormCenter Communications | GeoCollaborate

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: P-3 coordination with combined ocean expendable and platform deployments

What to Target: Sample the TCs core region using a standard flight pattern (rotated figure-4, figure-4, or butterfly). This can be done as part of other science modules such as the hurricane boundary layer module. Additionally, the pattern will target the cold wake region for airborne ocean expendables. Pre-storm flight pattern will be designed for maximum likelihood of ocean instrument (saildrone, floats) flyover. If possible, targeting the highest wind and/or rainy areas of the storm, typically the eyewall of strong storms is desired, especially if the P-3 with IWRAP is executing the pattern.

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When to Target:
Hurricane wind conditions with and without rain are preferred coincident with saildrone, A-DWSB drifters and EM-APEX floats. Weak storms that have potential for rapid intensification based on SHIPS forecast or dynamical model guidance.

Pattern:
In coordination with the standard P-3 patterns (Figure-4, Rotated Figure-4, Butterfly, etc.), the CHAOS flight pattern will involve repeated flight legs performed to and from the storm center radially over the in-situ sensor (saildrone, A-DWSB drifter, or EM-APEX float. The repeated flight legs can occur at any stage of the flight pattern. The PI will typically call the turns. Loitering may occur at the furthest point from the center or in the eye as conditions allow. If a small uncrewed aerial system (sUAS) will be used in the mission, it should be launched at least 10 miles upwind of the ocean instrument platforms.

Flight altitude: 7 **-** 10 kft radar altitude. Constant radar altitude is strongly preferred. 6-8 kft is preferable for AXBT deployment. This range is also acceptable for deployment of A-DWS drifters (5-10 kft).

Leg length or radii: Any length of legs from the storm center, but typically 50 n mi from the center **or** until the surface winds are at least 50% of the peak winds observed during the leg (at PI's discretion)**.**

Estimated in-pattern flight duration: Including standard flight pattern, total mission is likely 5-9 hours depending on ferry length. Each radial overflight will be 10 – 30 minutes .

Expendable distribution:
Dropsondes at the PI's discretion; often in the highest wind conditions **or** where there is both significant rain and strong winds for IWRAP collocated observations. In weak storms, dropsonde and AXBT combos are preferred in rear and upshear quadrants. These combo drops can be at endpoint, midpoints and center points along the standard flight pattern. Deploy collocated dropsondes with ocean platforms such as Saildrones and gliders. sUAS are also preferred (1 per mission) and should be launched upwind of the ocean platforms. A-DWS drifters will be deployed at the PI's discretion, ideally ~100-150 nm ahead of the storm center in a transect perpendicular to the storm's forward motion. This transect would have a range of ~150 nm to account for storm width and track uncertainty. Additional A-DWS drifters be deployed ~20-30 nm ahead of the eyewall, either as an additional perpendicular transect to storm motion or as part of the regula sampling pattern.

Instrumentation Notes:
Required instruments on the P-3 are the airborne radar, dropsondes, and either AXBTs or sUAS (both highly preferred, if possible). Also, it is required to have IWRAP and KaIA installed on one aircraft as well as a SFMR. However, this can be flown with either P-3 if the WSRA is available on the non-IWRAP aircraft. Flight should be Straight and level with a 2° nominal pitch (i.e., 210 kts IAS) required to maintain radar altitude and consistent speed.

Maintain consistent ground speed as safety permits. Data link to ground systems for near-real-time data transmission throughout the pattern is important, but not critical. Regular, real-time center fixes transmitted to ground systems available to the PI are required as safety permits.

G-IV Pattern #1 G-IV coordination with combined ocean expendable and platform deployments

What to Target: No preference

When to Target: Hurricane wind conditions with and without rain are preferred coincident with saildrone, A-DWSB drifters and EM-APEX floats. Weak storms that have potential for rapid intensification based on SHIPS forecast.

Pattern: Any standard G-IV flight patterns. Coordination with CHAOS team to fly over the ocean platforms (e.g., saildrones, gliders, etc.)

Flight altitude: standard G-IV flight pattern required altitude

Leg length or radii: follow standard G-IV flight pattern

Estimated in-pattern flight duration: standard G-IV flight pattern

Expendable distribution: Coordination with ocean platforms and release dropsondes close to the ocean platforms (saildrones, gliders, etc.) to collect collocated data.

Instrumentation Notes: no preference