2024 NOAA/AOML/HRD Hurricane Field Program - APHEX

MATURE STAGE EXPERIMENT
Flight Pattern Description

Experiment/Module: NESDIS Ocean Winds

Investigator(s): Paul Chang (PI), Zorana Jelenak, Joe Sapp (NOAA/NESDIS/STAR): Ricky Roy (Tomorrow.io), Sim Aberson (NOAA/AOML/HRD)

Requirements: Invest – category 5

Mature Stage Science Objective(s) Addressed:

1) Collect observations targeted at better understanding internal processes contributing to tropical cyclone structure and intensity change [*APHEX Goals, 1 3*].
2) Collect observations targeted at better understanding the response of tropical cyclones to their changing environment, including changes in vertical wind shear, moisture and underlying oceanic conditions [*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 tropical cyclones. These measurements include improved three-dimensional representation of the tropical cyclone wind field, more spatially dense thermodynamic sampling of the boundary layer, and more accurate measurements of ocean surface winds [*APHEX Goal 2*]

P-3 Pattern #1

What to Target: The entire storm.

When to Target: Tropical cyclones with hurricane strength winds with rain are preferred, but weaker tropical cyclones are still useful.

Pattern: Figure-4, Rotated Figure-4, or Butterfly

Flight altitude: 7 - 10 kft radar altitude. Constant radar altitude is strongly preferred.

Leg length or radii: 50 n mi (93 km) from the storm center

Estimated in-pattern flight duration: 1 – 1.5 hours

Expendable distribution: Dropsondes preferred at the RMW and center, but only at the PI's discretion if not already prescribed.

Instrumentation Notes: Straight and level flight with a 2° nominal pitch offset 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.

P-3 Pattern #2

What to Target: The highest wind **or** rainy areas of the storm, typically the eyewall.

When to Target: Hurricane wind conditions with rain are preferred, but rain-free conditions are still useful.

Pattern: Flight legs performed to and from the storm center radially. The PI will typically call the turns. Loitering may occur at the furthest point from the center or in the eye.

Flight altitude: 7 - 10 kft radar altitude. Constant radar altitude is strongly preferred.

Leg length or radii: Any length of legs from the storm center, but typically 50 n mi (93 km) 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: 10 – 30 minutes per radial.

Expendable distribution: Dropsondes at the PI's discretion; often in the highest wind conditions **or** where there is both significant rain and strong winds.

Instrumentation Notes: Straight and level flight with a 2° nominal pitch 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.

P-3 Pattern #3

What to Target: Regions of precipitation that the P-3 can fly above so the Ka-band radar on the P-3 is sampling the full precipitation column that the satellite instrument will be sampling. Additionally, cloud-free observations coordinated with Tomorrow.io Pathfinder overpass for targeted altimetry comparison.

When to Target: This will most likely be in weaker systems or areas of precipitation during a transit to or from the storm environment that aren't necessarily directly associated with a TC. And, any Pathfinder overpass coordination opportunities in cloud-free areas over the ocean during transits to and from the storm environment.

Pattern: If coordination with Pathfinder is during a transit leg to the TC the request might be a deviation in flight track to intercept the satellite track. If an opportunity for coordination with a satellite overpass arises during a mission, there could be adjustments and additions to the planned flight pattern to underfly the satellite.

Flight altitude: as high as able to get above the precipitation

Leg length or radii: This pattern will typically not be associated with a TC center

Estimated in-pattern flight duration: 10-30 minutes (time to transit precipitation area of interest

Expendable distribution: Dropsondes at the PI's discretion; will target areas of precipitation

Instrumentation Notes: Straight and level flight with a 2° nominal pitch 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.

P-3 Pattern #4

What to Target: The entire invest region

When to Target: Invest system when trying to identify a closed circulation at the surface

Pattern: Figure-4, Rotated Figure-4, or Butterfly. Once demonstrated that IWRAP can retrieve the ocean surface wind vector in an invest following standard invest flight pattern the desire will be to fly a higher altitude survey pattern over the most likely "center" before initiating the standard invest flight profile.

Flight altitude: normal invest altitude to demonstrate, but then if successful fly at **7 -** 10 kft radar altitude. Constant radar altitude is strongly preferred.

Leg length or radii: 50 -100 n mi (93-185 km) from the "center"

Estimated in-pattern flight duration: 1 – 1.5 hours

Expendable distribution: N/A

Instrumentation Notes: Straight and level flight with a 2° nominal pitch offset 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.