2019 NOAA/AOML/HRD Hurricane Field Program - IFEX

MATURE STAGE EXPERIMENT
Flight Pattern Descriptions

Experiment/Module: Stepped-Frequency Microwave Radiometer Module

Investigator(s): Heather Holbach (PI)

Requirements: Categories 2–5

Mature Stage Science Objective(s) Addressed:

1) Collect Test new (or improved) technologies with the potential to fill gaps, both spatially and temporally, in the existing suite of airborne measurements in mature hurricanes. 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 [*IFEX Goal 2*]

P-3 Pattern 1 (P-3 SFMR Validation):

What to Target: Wind speeds ≥ 100 kts in the eyewall

When to Target: This module can be flown during any pass through the storm center.

Pattern: This module can be flown with any of the traditional in-storm flight patterns. The module consists of flying inbound, releasing a dropsonde targeting the surface wind speed maximum, entering the eye and then flying outbound ~30–40° azimuthally downwind of the inbound leg to overfly the splash location of the dropsonde. It may be necessary to adjust the azimuthal separation of the inbound and outbound legs to account for eye size, storm strength, and flight altitude.

Flight altitude: 7–12 kft radar

Leg length or radii: Any

Estimated in-pattern flight duration: ~10 mins. The time separation between releasing the dropsonde and the outbound pass over the estimated splash location should be as close as possible to the time it takes for the dropsonde to fall to the surface (~5-6 mins).

Expendable distribution: Release a dropsonde targeting the surface wind speed maximum on the inbound leg.

Instrumentation Notes: Use standard SFMR set-up. Important to maintain as constant of a roll angle, pitch angle, and altitude as possible.

P-3 Pattern 2 (P-3 SFMR Validation):

What to Target: Wind speeds ≥ 100 kts in the eyewall

When to Target: This module can be flown during any mission using both P-3s and during any pass through the storm center.

Pattern: This module can be flown with any of the traditional in-storm flight patterns. The module consists of one P-3 (preferably NOAA43) flying inbound and releasing a dropsonde targeting the surface wind speed maximum. The second P-3 (preferably NOAA42 with IWRAP) will fly inbound ~30–40° azimuthally downwind of the first P-3 and approximately 5-6 minutes later to overfly the splash location of the dropsonde. The two aircraft can be at different altitudes. It may be necessary to adjust the azimuthal separation of the two P-3s to account for eye size, storm strength, and flight altitude.

Flight altitude: 7–12 kft radar

Leg length or radii: Any

Estimated in-pattern flight duration: ~10 mins. The time separation between the two P-3s should be as close as possible to the time it takes for the dropsonde to fall to the surface (~5-6 mins).

Expendable distribution: The first P-3 will release a dropsonde targeting the surface wind speed maximum on the inbound leg.

Instrumentation Notes: Use standard SFMR set-up. Important to maintain as constant of a roll angle, pitch angle, and altitude as possible.

P-3 Pattern 3 (HiSFMR):

What to Target: Regions of wind speeds $\geq$ 15 m s^{-1} with homogenous rain rates (or no rain) and wind direction (e.g. not in eye). Avoid regions with large wind speed or rain rate gradients.

When to Target: This module can be flown at any point during the flight while in the storm. If the WSRA is on the plane collecting surface wave data then the preference is to fly this module at night or when the sun is low in the sky.

Pattern: This module can be flown with any of the traditional in-storm flight patterns. The module consists of flying at least 3 consecutive circles at a given roll angle (Figure 1). Roll angles to be sampled are 15°, 30°, and 45°. If time allows, it is preferable to fly 5 consecutive circles at 45°. Best to begin circles by turning upwind for station keeping.

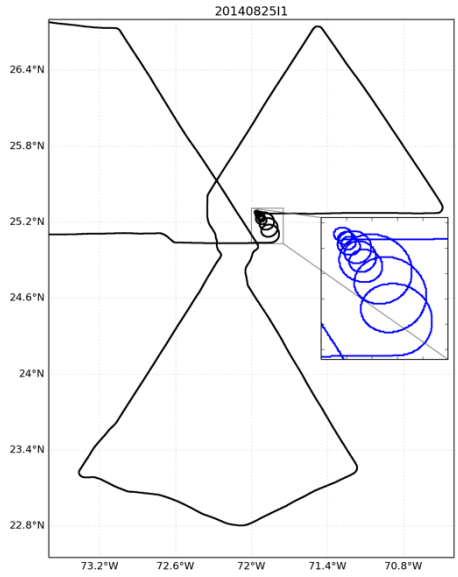

Figure 1: *Example flight path (black) with SFMR high-incidence angle module. The inset zoomed in portion with the blue track displays the SFMR module in more detail.*

Flight altitude: 7–12 kft radar

Leg length or radii: Any

Estimated in-pattern flight duration: 3 circles at 15° takes ~17 min., 3 circles at 30° takes ~7 min., and 3 (5) circles at 45° takes ~4.5 (~7) min. for a total time of ~28.5 (~31) min. If time is a concern, remove 15° circles for a total time of ~11.5 min for 3 circles each at 30° and 45° or ~14 min for 3 circles at 30° and 5 circles at 45°.

Expendable distribution: Release a dropsonde/AXBT combo at the beginning of the module. If no AXBTs are available, this module can still be flown while only releasing a dropsonde at the beginning of the module.

Instrumentation Notes: Use standard SFMR set-up. Important to maintain as constant of a roll angle, pitch angle, altitude, and rain rate as possible. Ideal to fly this module while the WSRA is also operating and gathering surface wave data. However, any data collected is useful as long as there is a dropsonde for comparison.

P-3 Pattern 4 (G-IV SFMR Validation):

What to Target: Sample various wind and rain regions within a tropical cyclone, including light (< 20 m s^{-1}), moderate (20-33 m s^{-1}), and strong wind speed regions (> 33 m s^{-1}). This strategy will depend on the strength of the TC.

When to Target: Select a point along a portion of the flight pattern (whether part of the circumnavigation ring, a downwind leg, or inbound/outbound radial pass) for the G-IV to match. The

P-3 and G-IV need to be traveling on the same heading for ~20-25 n mi (35-45 km) on either side of the module center point.

Pattern: P-3 Circumnavigation is preferred to more easily match G-IV. Other patterns are acceptable as long as a small portion of the pattern can overlap with the G-IV.

Flight altitude: 10–12 kft radar

Leg length or radii: Maximum of ~45 n mi (85 km), centered on location where the G-IV is directly above the P-3.

Estimated in-pattern flight duration: ~ 6-10 minutes for each overlap.

Expendable distribution: 1 dropsonde at module center when G-IV directly above the P-3 (required); 2 additional dropsondes at ~10 n mi (20 km) on either side of the center point (optional).

Instrumentation Notes: Use standard SFMR set-up. Also, ensure that the upward looking SFMR is working and collecting data if flown using NOAA42.

G-IV Pattern 1 (G-IV SFMR Validation):

What to Target: Same as P-3 pattern.

When to Target: Because this module depends more on aircraft coordination rather than a specific storm structure or environmental variable, any point in the TC development is acceptable. Various radial and azimuthal positions are desirable, depending on the structure of the TC and limitations of the aircraft. The P-3 and G-IV need to be traveling on the same heading for ~20-25 n mi (35-45 km) on either side of the module center point. We would also prefer the G-IV fly at the lower end of its allowable operating speed to provide more time of overflight with the P-3.

Pattern: Preferred G-IV Circumnavigation (either hexagon or octagon). Most other patterns are acceptable as well as long as they can overlap with the P-3 for a short period.

Flight altitude: 40-45 kft radar

Leg length or radii: Maximum of ~60 n mi (110 km), centered on location where the G-IV is directly above the P-3.

Estimated in-pattern flight duration: ~6-10 minutes for each overlap.

Expendable distribution: None.

Instrumentation Notes: Use the standard SFMR instrument set-up.