2019 NOAA/AOML/HRD Hurricane Field Program - IFEX

END STAGE EXPERIMENT
Flight Pattern Descriptions

Experiment/Module: Tropical Cyclones at Landfall

Investigator(s): Ghassan Alaka (Co-PI), Heather Holbach (Co-PI), John Kaplan, Peter Dodge, Jun Zhang, Frank Marks

Requirements: Tropical cyclone either making landfall or nearing the coastline

End Stage Science Objective(s) Addressed

1) Collect observations targeted at better understanding changes TCs undergo at landfall. Objectives include validation of surface wind speed estimates and model forecasts, understanding factors that modulate intensity changes near and after landfall, and to understand processes that lead to tornadoes in outer rainbands [*IFEX Goals 1, 3]*

2) Test new (or improved) technologies with the potential to fill gaps, both spatially and temporally, in the existing suite of airborne measurements in landfalling TCs. These measurements include improved three-dimensional representation of the TC 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 (Offshore Intense Convection):

What to Target: An intense rain band > 150 n mi (280 km) from the center of either a tropical storm or hurricane that is forecast to make landfall along the U.S coastline

When to Target: This module should be performed within ~12–24 h of the time of landfall

Pattern: Break-away/non-standard (see Fig. EN-1 and description below):

Fig. EN-1 shows a sample Offshore Intense Convection flight pattern near the Carolina coast. The P-3 should cross the target band 10-15 n mi (20–25 km) downwind of the intense convective cells and then proceed to 15 n mi (25 km) outside the rain band axis. The aircraft then turns upwind and proceeds along a straight track parallel to the band axis. When the P-3 is 10-15 n mi (20–25 km) upwind of the target cells, the aircraft turns and proceeds along a track orthogonal to the band axis until the P-3 is 15 n mi (25 km) inside the rain band then turns downwind and flies parallel to the rain band axis.

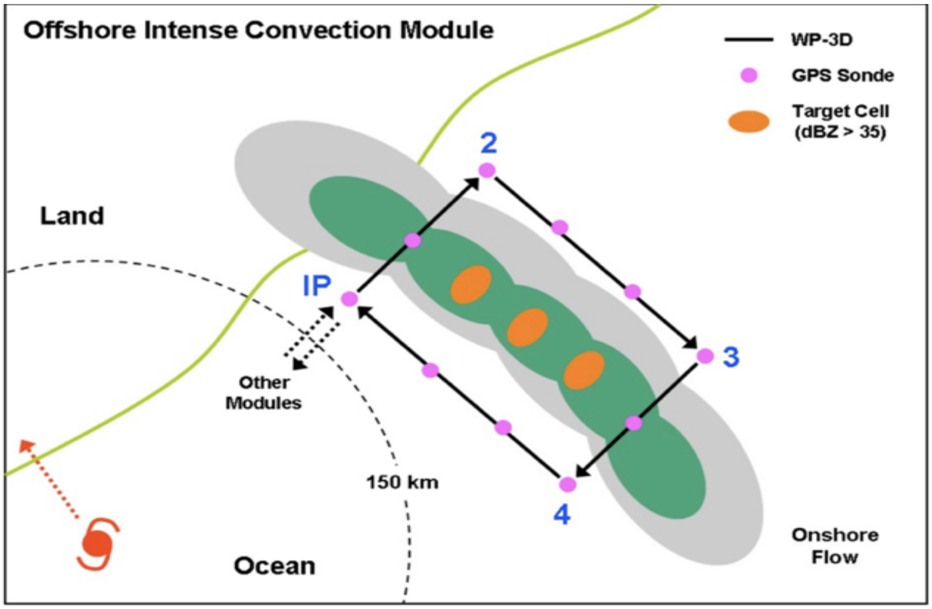

Figure EN-1. Offshore Intense convection module

Flight altitude: 10 kft or higher

Leg lengths: ≥40 n mi (75 km) for each parallel leg

Estimated in-pattern flight duration: 1–2 h

Expendable distribution: Deploy dropwindsondes at the start or end points of each leg, at the band axis crossing points, and at 10-15 n mi (20–25 km) intervals along each leg parallel to the band. At least 2 dropwindsondes should be deployed on either side of the convection and at least 1 dropwindsonde should be deployed each time the band-axis is crossed (for a minimum of 6 dropwindsondes).

Instrumentation Notes: The Doppler radars should be turned on and scanning normally. Aircraft should avoid penetration of intense reflectivity regions (particularly over land).

P-3 Pattern 2 (Coastal Survey):

What to Target: A tropical storm or hurricane that is forecast to make landfall along the U.S coastline

When to Target: This module should be performed within ~6–12 h of the time of landfall

Pattern: Break-away/non-standard (see Fig. EN-2 below and description below):

Fig. EN-2 shows a sample Coastal Survey pattern for a hurricane landfall near Melbourne, Florida. The P-3 would fly parallel but ~5-8 n mi (10–15 km) offshore so that the SFMR footprint is out of the surf zone. The second pass should be parallel and as close to the coast as safety permits. Finally, a short leg would be flown from the coast spiraling towards the storm center.

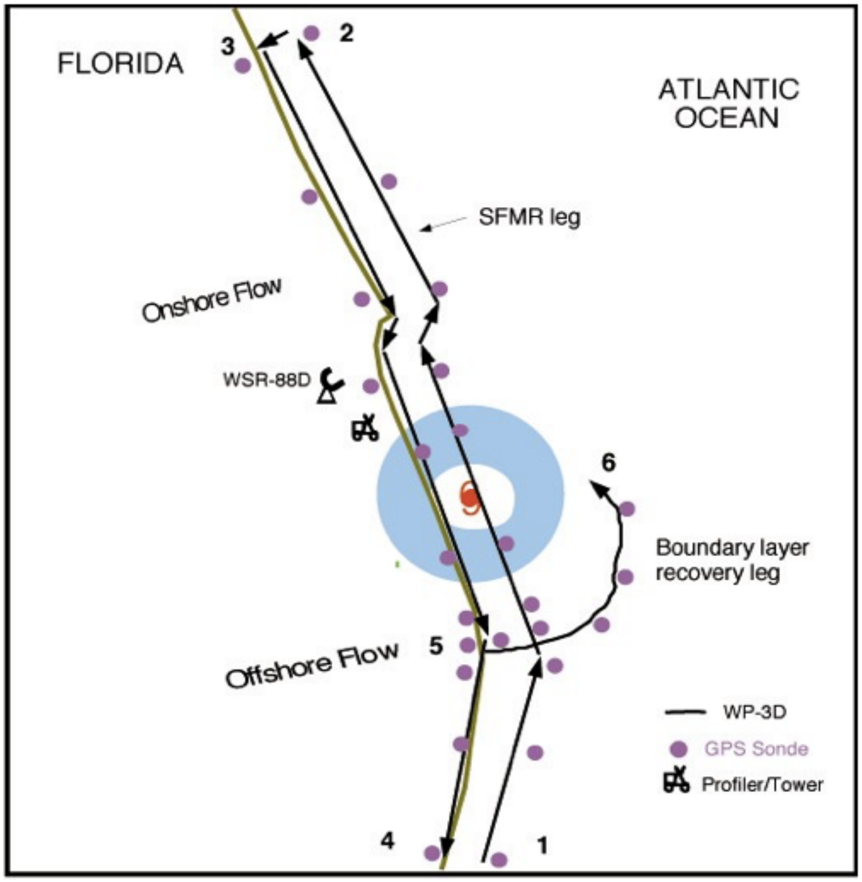

Figure EN-2. Coastal Survey module

Flight altitude: ~5 kft for first pass and then climb to slightly higher altitude (~7.5 kft) if needed for second pass.

Leg lengths: ~80 n mi (150 km)

Estimated in-pattern flight duration: ~2 h

Expendable distribution: Dropwindsondes at RMW and at 7, 14, 27, 41 and 54 n mi (12.5, 25, 50, 75, 100 km) from the RMW on either side of storm in both the near shore and offshore legs that are to be flown parallel to the shoreline. Dropwindsondes should be deployed quickly at the start of the outbound leg between near shore and offshore parallel legs and then every 5-8 n mi (10–15 km) thereafter.

Instrumentation Notes: The Doppler radars should be turned on and scanning normally. Aircraft should avoid penetration of intense reflectivity regions (particularly those overland).

END STAGE EXPERIMENT
Flight Pattern Descriptions

P-3 Pattern 3 (Real-time):

What to Target: A hurricane that is forecast to make landfall along the U.S coastline

When to Target: This module should be performed within ~6–12 h of the time of landfall

Pattern: Break-away/non-standard (see Fig. EN-3 and description below):

Fig. EN-3 shows a sample Real-time module flight pattern. The P-3 descends at the initial point and begins a low-level Figure-4 pattern, possibly modifying the legs to fly over buoy or C-MAN sites if possible. If time permits, the P-3 would make one more pass through the eye and then fly the Dual-Doppler option.

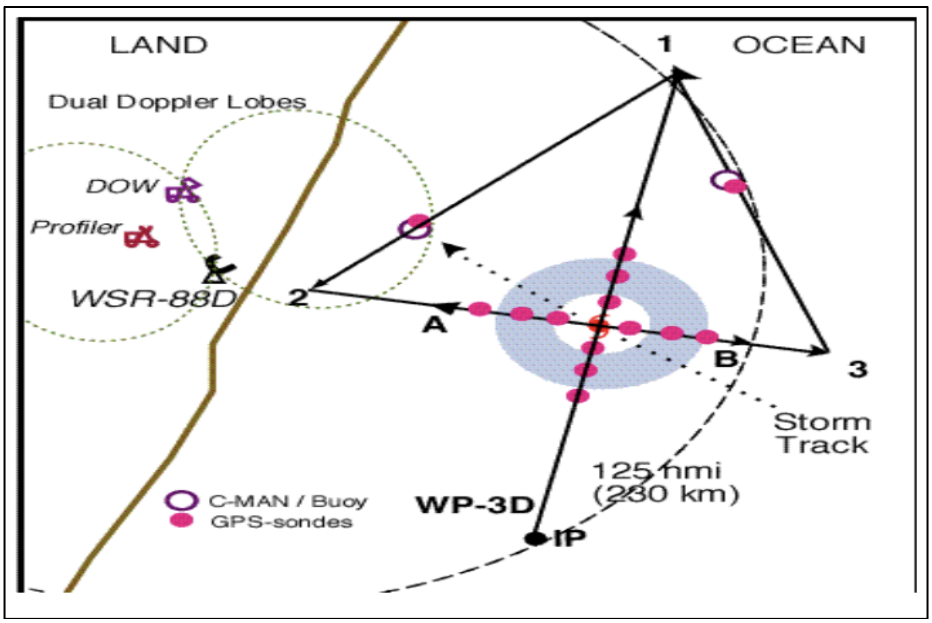

Figure EN-3. Real-time module

Flight altitude: Below 5,000 ft (1.5 km) (or the lowest level deemed to be safe by flight personnel)

Leg lengths: ~100 n mi (185 km)

Estimated in-pattern flight duration: ~2–3 h

Expendable distribution: Dropwindsondes should be released near buoys or C-MAN sites (if possible) and at or just inside the flight-level RMW

Instrumentation Notes: The Doppler radars should be turned on and scanning normally. Also, it is essential that these passes be flown as straight as possible, because turns to fix the eye will degrade the Doppler radar coverage.

END STAGE EXPERIMENT
Flight Pattern Descriptions

P-3 Pattern 4 (SFMR Coastal):

What to Target: A tropical storm or hurricane that is forecast to make landfall in a region with varying bathymetry near the coastline

When to Target: This module should be performed when sustained winds are greater than 30 kt in the region of interest

Pattern: Break-away/non-standard (see Fig. EN-4 and description below):

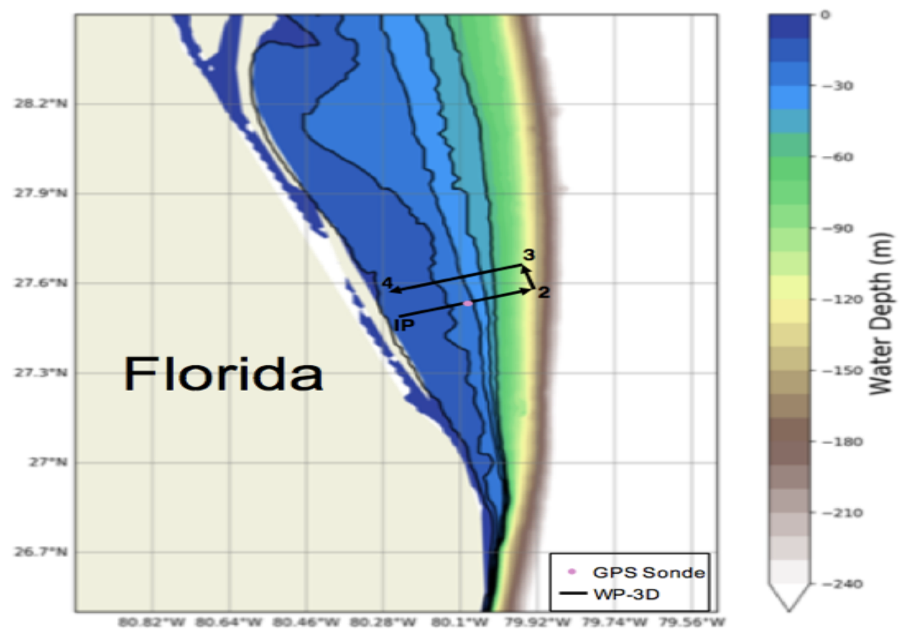

Figure EN-4. SFMR coastal module

The P-3 would fly perpendicular to the coastline, across the bathymetry gradient, in a region with near constant surface winds. After flying away from the coast for about 27 n mi (50 km), the P-3 would turn downwind and then back towards the coast repeating a similar line as the first leg.

Flight altitude: Can be performed at any altitude between 5 kft to 12 kft. Aircraft should maintain a constant altitude throughout the module.

Leg lengths: ~13-27 n mi (25–50 km)

Estimated in-pattern flight duration: ~30–45 min

Expendable distribution: Dropwindsonde at middle of first leg. If winds appear to vary over the leg then an additional dropwindsonde may be necessary.

Instrumentation Notes: SFMR should be operating normally