2018 NOAA/AOML/HRD Hurricane Field Program - IFEX

END STAGE EXPERIMENT
Pattern and Module Descriptions

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Requirements: TC making landfall, undergoing rapid weakening, or extratropical transition

SCIENCE OBJECTIVE #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.*
[Landfall]

P-3 Module #1: Landfall (Offshore Intense Convection)

What to Target: An intense rain band > 150 n mi 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 ~20–25 km downwind of the intense convective cells and then proceed to ~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 ~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 25 km inside the rain band then turns downwind and flies parallel to the rain band axis.

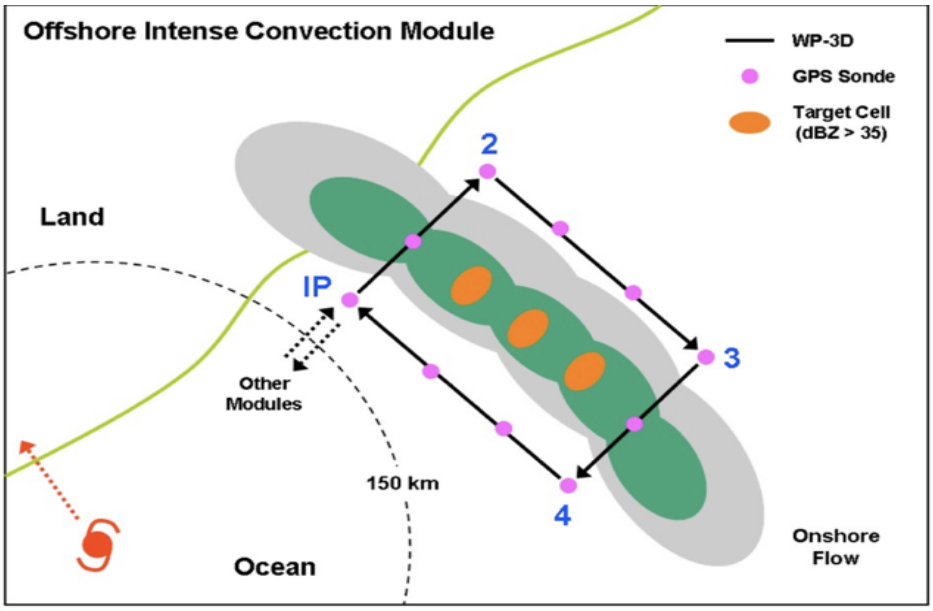

Figure EN-1. *Offshore Intense convection module*

Flight altitude: 10,000 ft (3000 m) or higher

Leg lengths: $\geq$ 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 ~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 radar should be turned on and scanning normally. Aircraft should avoid penetration of intense reflectivity regions (particularly over land).

P-3 Module #2: Landfall (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 ~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.

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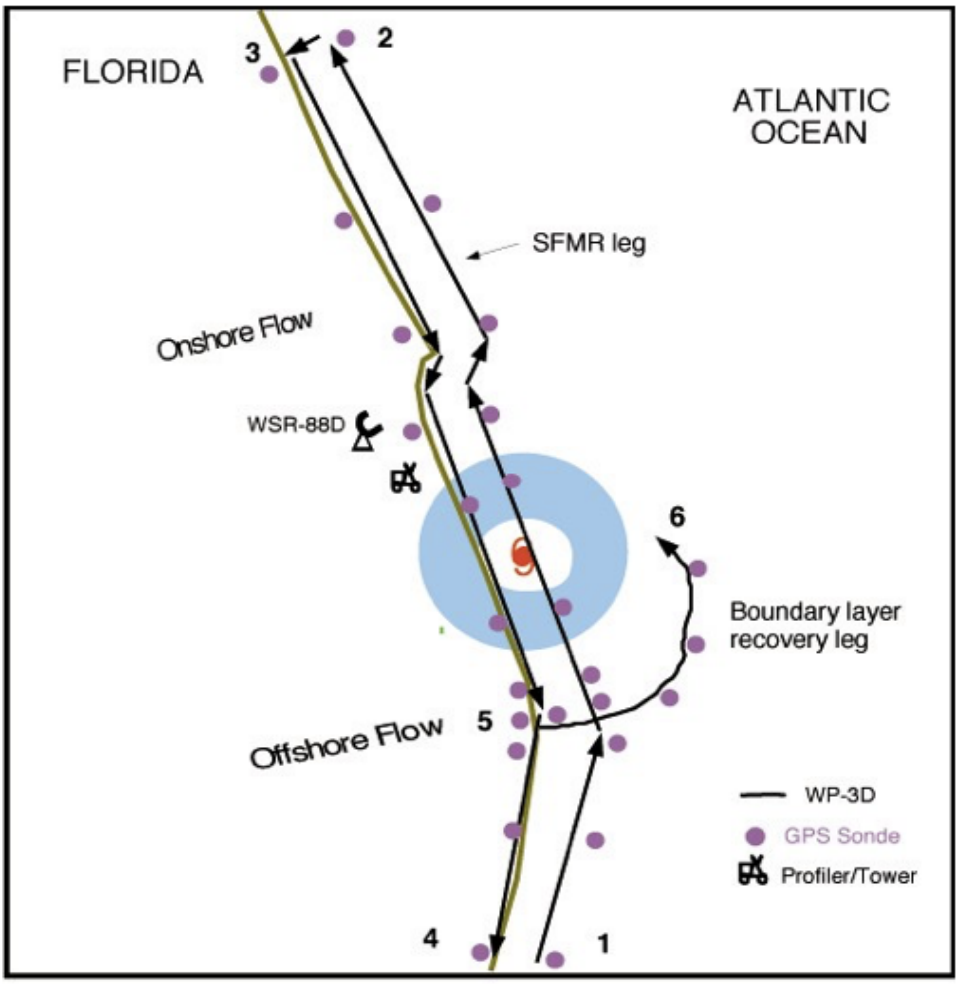

Figure EN-2. *Coastal Survey module*

Flight altitude: 5000 ft (1.5 km) for first pass and then climb to slightly higher altitude (~7,500 ft) if needed for second pass

Leg lengths: ~150 km

Estimated in-pattern flight duration: ~2 h

Expendable distribution: Dropwindsondes at RMW, and 12.5, 25, 50, 75, 100 km from 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 start of outbound leg between near shore and offshore parallel legs and then every 10–15 km thereafter.

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

P-3 Module #3: Landfall (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.

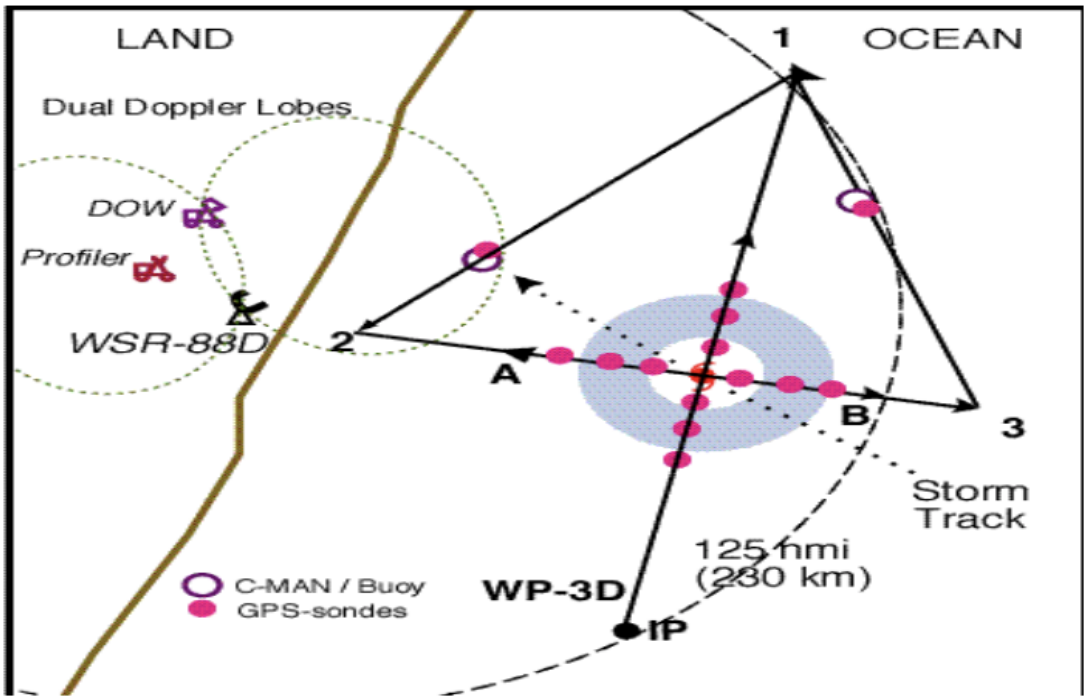

Figure EN-3. *Real-time module*

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

Leg lengths: ~ 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 radar 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.

P-3 Module #4: Landfall (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 15 m s^{-1} in the region of interest

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

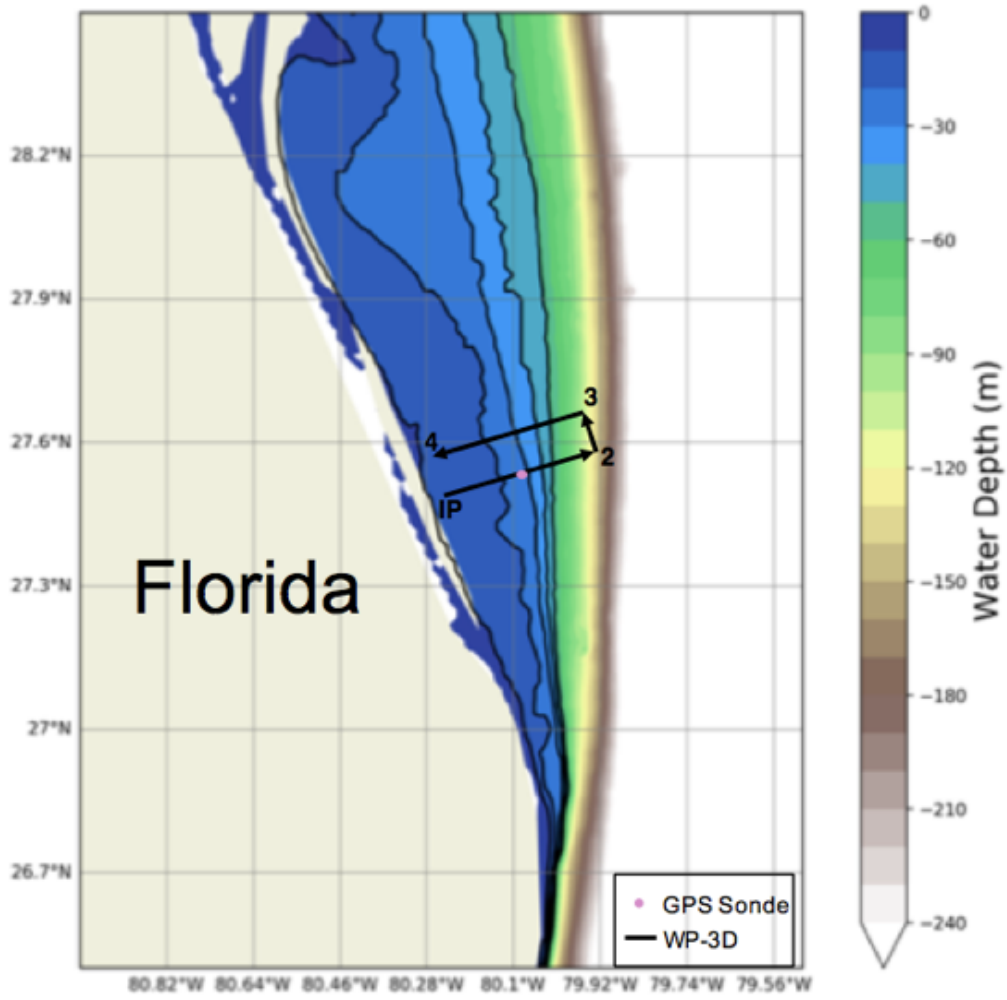

Figure EN-4. *SFMR coastal module*

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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 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 5,000 to 12,000 ft. Should maintain a constant altitude throughout the module.

Leg lengths: ~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

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SCIENCE OBJECTIVE #2: *Collect observations targeted at better understanding changes TCs undergo while rapidly weakening over the open ocean or undergo extratropical transition.*
[Weakening/Extratropical Transition (ET)]

P-3 Pattern #1: Weakening/ET

What to Target: Two specific targets are to be sampled during each mission, the TC itself, and the interface between the TC and the environmental flow

When to Target: The systems will be sampled every 12 h from the time it begins the transition to an extratropical cyclone to the time it is out of range of the aircraft, or the system dissipates

Pattern: The patterns would likely be non-standard patterns. At least two passes through the center of the TC will be completed during the mission, though they need not be consecutive (Fig. EN-5). The P-3 will fly as high as possible to avoid hazards such as convective icing. Legs should be of equal length, except that they can be shortened to the south of the storm center if necessary to save time, or shortened due to land. If extra time is available, important interactions between the midlatitude jet stream and the outflow from the TC occur. This region will be investigated by releasing dropwindsondes every ~120 n mi during this part of the pattern.

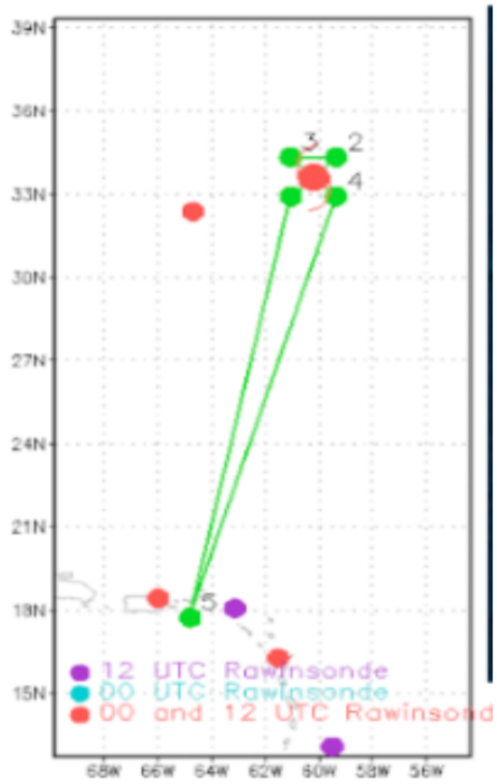

Figure EN-5. *Sample P-3 track investigating storm experiencing ET*

Flight altitude: As high as safely possible

Leg length or radii: Leg lengths depend on the size of the transitioning system. They should be of equal length, but can be shortened to the south, or due to land.

Estimated in-pattern flight duration: 8 h

Expendable distribution: 10 dropwindsondes, 10 AXBTs. During passes through the center, dropwindsondes will be deployed at each turn point and at evenly spaced intervals along each leg with optimal spacing near 90 n mi. AXBTs will be deployed at each turn point and at the midpoint of each leg only in the northern semicircle from the cyclone center.

Instrumentation Notes: Due to a trapped-fetch phenomenon, the ocean surface wave heights can reach extreme levels ahead of a TC undergoing ET. Therefore, primary importance for the P-3 in the northeast quadrant of the TC will be the scanning radar altimeter (WSRA) to observe the ocean surface wave spectra, if available. Flight level will be chosen to accommodate this instrument.

G-IV Pattern #1: Weakening/ET

What to Target: Two specific targets are to be sampled during each mission, the TC itself, and the interface between the TC and the environmental flow

When to Target: The systems will be sampled every 12 h from the time it begins the transition to an extratropical cyclone to the time it is out of range of the aircraft, or the system dissipates

Pattern: The patterns would likely be non-standard patterns. At least two passes through the center of the TC will be completed during the mission (Fig. EN-6), though they need not be consecutive. Legs should be of equal length, except that they can be shortened to the south of the storm center if necessary to save time, or shortened due to land. Ahead of the TC, important interactions between the midlatitude jet stream and the outflow from the TC occur.

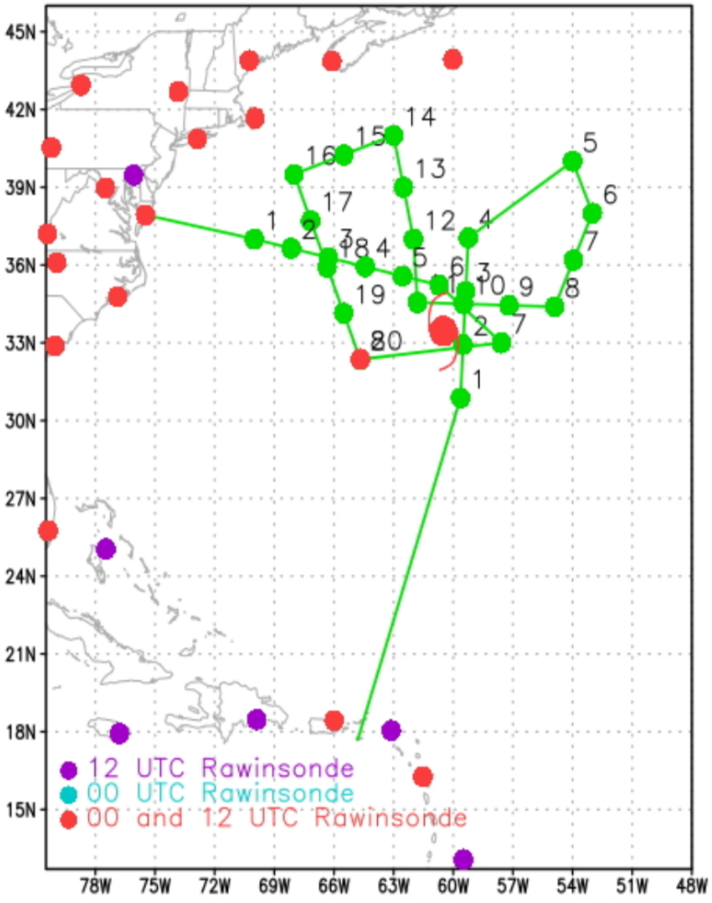

Figure EN-6. *Sample G-IV track investigating storm experiencing ET*

Flight altitude: At altitude

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Leg length or radii: Leg lengths depend on the size of the transitioning system. They should be of equal length, but can be shortened to the south, or due to land.

Estimated in-pattern flight duration: 8 h

Expendable distribution: ~20 dropwindsondes. During passes through the center, dropwindsondes will be deployed at each turn point and at evenly spaced intervals along each leg with optimal spacing near 90 n mi. At the TC-environment interface, dropwindsondes should be released every ~120 n mi.

Instrumentation Notes: None