2020 NOAA/AOML/HRD Hurricane Field Program - IFEX

EARLY STAGE EXPERIMENT
Flight Pattern Descriptions

Experiment/Module: Analysis of Intensity Change Processes Experiment (AIPEX)

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Requirements: TD, TS, Category 1

Early Stage Science Objective(s) Addressed:

1) Collect datasets that can be used to improve the understanding of intensity change processes, as well as the initialization and evaluation of 3-D numerical models, particularly for TCs experiencing moderate vertical wind shear [*IFEX Goals 1, 3*].

2) Obtain a quantitative description of the kinematic and thermodynamic structure and evolution of intense convective systems (convective bursts) and the nearby environment to examine their role in TC intensity change [*IFEX Goals 1, 3*].

3) Improve our understanding of the physical processes responsible for the formation and evolution of arc clouds, as well as their impacts on TC structure and intensity in the short-term [*IFEX Goals 1, 3*].

4) Test new (or improved) technologies with the potential to fill gaps, both spatially and temporally, in the existing suite of airborne measurements in early stage 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:

What to Target: Sample the inner core region of a TC

When to Target: Every 12 h [*optimal*] or every 24 h [*minimal*], possibly in coordination with a corresponding G-IV mission (G-IV Pattern #1 or G-IV Pattern #2), depending on the AIPEX *Scenario* chosen

Pattern: Standard Figure-4, potentially rotated or repeated after initial pattern; oriented such that radial passes are aligned through approximately the upshear, downshear, left-of-shear, and right-of-shear

directions –or– aligned within quadrants, i.e., downshear right, downshear left, upshear left, and upshear right

Flight altitude: 10–12 kft, either radar or pressure altitude

Leg length or radii: 105 n mi (195 km)

Estimated in-pattern flight duration: ~ 5 h

Expendable distribution: [*optimal*] (up to 32 dropsondes total) If coinciding G-IV mission, modify standard by moving the mid-point dropsonde to half the radius of innermost G-IV circumnavigation radii. AXBTs preferably paired with dropsondes at mid- and turn points and center. If the radius of maximum wind (RMW) is significantly different [>10 n mi (19 km)] from any of the standard dropsonde locations, release dropsonde there, and also release dropsonde at 1.5 x RMW, subject to same constraint regarding proximity to standard dropsonde locations. No AXBTs need to be coordinated with these RMW-based drops. Release additional dropsondes along the radial leg between principal rainband and RMW if a rainband exists and location is [>10 n mi (19 km)] from existing drop location, not to exceed >4 additional dropsondes per mission. [*minimal*] (10–12 dropsondes total) Modify standard as stated in [*optimal*], keeping only midpoint drops, as well as center drops on the first and last pass. AXBTs preferably paired with dropsondes at midpoints and center.

Instrumentation Notes: Use TDR defaults. Use straight flight legs as safety permits. Inbound-outbound passes should be uninterrupted.

P-3 Pattern #2:

What to Target: Sample the inner core region of a TC

When to Target: Every 12 h [*optimal*] or every 24 h [*minimal*], possibly in coordination with a corresponding G-IV mission (G-IV Pattern #1 or G-IV Pattern #2), depending on the AIPEX *Scenario* chosen

Pattern: Standard Butterfly; oriented such that the upshear quadrants contain the most radial legs, with an option to orient such that downshear contains most of the radial legs, if precipitation sampling is preferred when a storm exhibits an asymmetric precipitation distribution.

Flight altitude: 10–12 kft, either radar or pressure altitude

Leg length or radii: 105 n mi (195 km)

Estimated in-pattern flight duration: ~ 5 h

Expendable distribution: [*optimal*] (up to 36 dropsondes total) If coinciding G-IV mission, modify standard by moving the mid-point dropsonde to half the radius of innermost G-IV circumnavigation radii. AXBTs preferably paired with dropsondes at mid- and turn points and center. If the radius of maximum wind (RMW) is significantly different [>10 n mi (19 km)] from any of the standard dropsonde locations, release dropsonde there, and also release dropsonde at 1.5 x RMW, subject to

same constraint regarding proximity to standard dropsonde locations. No AXBTs need to be coordinated with these RMW-based drops. Release additional dropsonde along the radial leg between principal rainband and RMW if a rainband exists and location is >10 n mi (19 km) from existing drop location, not to exceed >4 additional dropsondes per mission. [*minimal*] (12–15 dropsondes total) Modify standard as stated in [*optimal*], keeping only midpoint drops, as well as center drops on the first and last pass. AXBTs preferably paired with dropsondes at midpoints and center.

Instrumentation Notes: Use TDR defaults. Use straight flight legs as safety permits. Inbound-outbound passes should be uninterrupted.

P-3 Module #1 (*"Upshear Circumnavigation Module"*):

What to Target: The relatively dry, precipitation-free upshear region of a weak TC

When to Target: Every 12 h [*optimal*] or every 24 h [*minimal*], depending on the AIPEX *Scenario* chosen

Pattern: Fly upshear semicircle, including the boundary between no convection and convection, if such a boundary exists, at up to three possible radii: 90 n mi (167 km), 60 n mi (111 km), and 40 n mi (74 km).

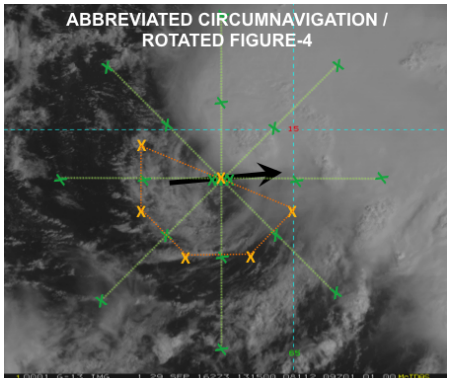

Figure AIPEX1, showing an example of one possible radius (orange) to be flown

Flight altitude: As high as possible above 20 kft radar altitude

Leg length or radii: Up to three possible radii: 90 n mi (167 km), 60 n mi (111 km), and 40 n mi (74 km)

Estimated in-pattern flight duration: 30 min to 2 hr, depending on number and radii chosen

Expendable distribution: Release up to 8 equally-spaced dropsondes along each partial circumnavigation

Instrumentation Notes: None

P-3 Module #2 (*"Rainband Module"*):

What to Target: The principal rainband

When to Target: Every 12 h [*optimal*] or every 24 h [*minimal*], depending on the AIPEX *Scenario* chosen

Pattern: Follow the principal rainband inward towards the center by paralleling the band (either radially inside or outside), keeping the band within range (~10 n mi) of TDR sampling

Flight altitude: 10–12 kft, either radar or pressure altitude

Leg length or radii: N/A

Estimated in-pattern flight duration: ~30 min

Expendable distribution: Release dropsondes approximately every 20 n mi (37 km)

Instrumentation Notes: Pattern should be flown such that TDR sampling of the rainband is optimized, but remaining safely outside of the rainband

P-3 Module #3 (*"High Density Eyewall Drops"*):

What to Target: The radius of peak wind and/or rain near the developing eyewall region

When to Target: Every 12 h [*optimal*] or every 24 h [*minimal*], depending on the AIPEX *Scenario* chosen

Pattern: On inbound/outbound pass of center, release a high-density string of dropsondes, distributed such that they cover inbound and outbound of the RMW and peak convection

Flight altitude: 10–12 kft, either radar or pressure altitude

Leg length or radii: N/A, flown part of *AIPEX P-3 Pattern #1 or #2*

Estimated in-pattern flight duration: No added time to pattern, sequence lasts up to 8 min

Expendable distribution: Release a sequence of up to 8 dropsondes, every [2.5-5 n mi (5–10 km), approximately every 30 seconds to 1 minute]

Instrumentation Notes: Use straight flight legs as safety permits. Inbound-outbound passes should be uninterrupted.

EARLY STAGE EXPERIMENT
Flight Pattern Descriptions

G-IV Pattern #1:

What to Target: Sample the near environment and environment of a TC

When to Target: Every 12 h [*optimal*] or every 24 h [*minimal*], preferably in coordination with a corresponding P-3 mission (P-3 Pattern #1 or #2), depending on the AIPEX *Scenario* chosen

Pattern: Standard G-IV Circumnavigation (octagon). Should be centered on the low-level circulation.

Flight altitude: 40–45 kft

Leg length or radii: 3 circumnavigations at constant radii: 150 n mi (277 km), 90 n mi (167 km), and 60 n mi (111 km). The innermost radii can be adjusted outward if necessitated by hazard avoidance (outer two radii rings should be similarly adjusted, if time allows).

Estimated in-pattern flight duration: ~ 5–6 h

Expendable distribution: Dropsonde at each turn point; 24 in total

Instrumentation Notes: Use TDR defaults. Use straight flight legs as safety permits.

G-IV Pattern #2:

What to Target: Sample the near environment and environment of a TC

When to Target: Every 12 h [*optimal*] or every 24 h [*minimal*], preferably in coordination with a corresponding P-3 mission (P-3 Pattern #1 or #2), depending on the AIPEX *Scenario* chosen. Supplemental observations can also be made when model sensitivity regions are indicated (e.g., derived from ECMWF and the COAMPS-TC model ensembles) that could positively impact forecasts of TC track, intensity and/or structure.

Pattern: Standard G-IV Star with Circumnavigation

Flight altitude: 40–45 kft

Leg length or radii: 2 circumnavigations at constant radii: 210 n mi (388 km) outer and 90 n mi (167 km) inner radii (*standard*). Depending on the time of day, aircraft duration limitations, and safety considerations, the lengths of the inner (outer) points could be shortened (extended) if an opportunity to sample a diurnal pulse presents itself (see TC Diurnal Cycle Experiment).

Estimated in-pattern flight duration: ~5 h

Expendable distribution: Dropsonde at each turn point; 20 in total

Instrumentation Notes: Use TDR defaults. Use straight flight legs as safety permits.

G-IV Module #1:

What to Target: Sample the inner core of a TC

When to Target: Every 12 h [*optimal*] or every 24 h [*minimal*], depending on the AIPEX *Scenario* chosen

Pattern: Standard single Figure-4

Flight altitude: 40–45 kft

Leg length or radii: Up to 105 n mi (195 km)

Estimated in-pattern flight duration: ~1 h

Expendable distribution: Dropsonde at each turn point, midpoint, and center (on first pass) and midpoint of downwind leg; 10 in total

Instrumentation Notes: Use TDR defaults. Use straight flight legs as safety permits.