EARLY STAGE EXPERIMENT
Flight Pattern Descriptions

Experiment/Module: Convective Burst Structure and Evolution Module (CBM)

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Requirements: TD, TS, Category 1

Early Stage Science Objective(s) Addressed:

1) 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*].

P-3 Pattern 1

What to Target: An area of vigorous, deep convection occurring within the circulation of a tropical cyclone (TC)

When to Target: When deep convection is identified either by radar or satellite during the execution of a survey pattern at or near the radius of maximum wind (RMW) of a tropical depression, tropical storm, or Category 1 hurricane. Particular attention should be paid when a developing area of deep convection can be detected on the downshear (shear direction inferred by real-time SHIPS analyses) side of the storm. When possible, coordination with a ground scientist should be used to improve situational awareness, as they may have better access to satellite loops, lightning data, etc. that aid identification of convective evolution. Additionally, it is recommended that the onboard scientists use radar (lower fuselage, i.e. MMR) looping features and/or storm ID tracks if available.

(A) **Pattern:** <u>Series of inbound/outbound radial penetrations / bowtie pattern</u>: Repeated sampling can allow for a following of the burst around the storm, or if the burst remains confined downshear.

- Repeat penetrations as long as time permits within the 1-2 h window
- When a high-altitude aircraft is present, efforts should be made to coordinate the pattern with the high-altitude aircraft, so that the two aircraft are as close to vertically stacked as possible.

(B) If the CB has transitioned to stratiform convection and is located at a larger radius, perform a spiral ascent from low-levels up above the freezing level to make direct hydrometeor measurements with the P-3 cloud and precipitation probes. After a short transect and a dropsonde launch at higher altitude, the P-3 should return to standard flight level via a spiral descent.

The following procedure should be used to select a location to safely complete the spiral ascent/descent:

1. At typical P-3 flight altitudes (below the freezing level), assess whether a region **consists entirely of stratiform radar echo**, which can be determined using a combination of the lower fuselage Multi-mode Radar (MMR) and the tail Doppler radar (TDR):

   a. The MMR should present a **uniform region of reflectivity**, indicative of stratiform rain, with **no cellular (convective) echoes within 20 n mi of the aircraft position**
   b. The TDR sweeps should indicate **no high reflectivity (>40 dBZ) cores above the freezing level (bright band signature)**, which would suggest convective cores embedded within the stratiform region
2. A ground scientist should report to the scientist onboard the P-3 that **no lightning activity has been detected within the region in the previous 15 minutes**, using the detection networks available on the NASA Mission Tools Suite (MTS).
3. If these conditions are met, that location should be marked, the airplane repositioned to that location, and the module completed as outlined above.

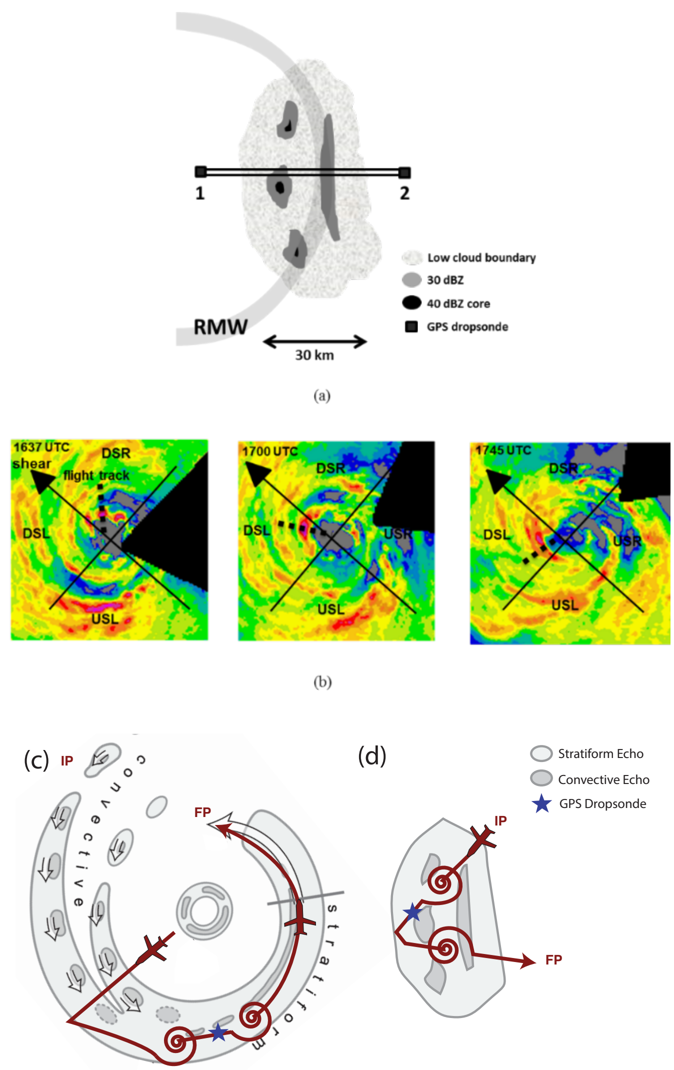

Figure CBM1: P-3 Convective burst module: (a) Radial penetrations / bowtie pattern. Black squares denote locations of GPS dropsondes from P-3. This pattern should be repeated multiple *times as time allows, following the CB around the storm or remains confined downshear. (b) Example of sampling strategy following CBs around the storm, beginning downshear right (DSR) and into the upshear quadrants. Each radial pass is separated by ~30 minutes. (c) Example spiral ascent and descent in stratiform portion of primary rainband. (d) Example spiral ascent and descent in isolated CB during stratiform transition.*

Flight altitude: A constant altitude of 10–12 kft (radar or pressure altitude) is preferable for pattern (A). For the microphysical spiral pattern (B), the altitude should range from 5 kft to ~20 kft.

Leg length or radii: Variable depending on size of CB, but should extend at least 10 n mi (19 km) inside and 10 n mi (19 km) outside radar-defined edges of CB. Spiral ascents and descents should maintain roll angle of 15–20° to confine spiral to limited geographical area, with an ascent or descent rate of ~5 m s^{-1}.

Estimated in-pattern flight duration: 1-2 h added to the mission

Expendable distribution: Dropsondes at turn points. No more than 15 dropsondes needed for this module. If AXBTs available, drop one AXBT paired with a dropsonde in each shear-relative quadrant sampled during the module.

Instrumentation Notes: Every effort made to fly the aircraft level for optimal Doppler radar sampling during the radial penetrations and bowtie patterns. Cloud and precipitation imaging probes should be on and collecting data during the spiral ascents and descents.

Dual P-3: This is not a requirement for the module but can be treated as an add-on. If multiple P-3 aircraft are available and sampling simultaneously, one aircraft should perform the radial penetrations as described above. The other aircraft should attempt to complete a box pattern or circumnavigation, preferably at the maximum allowable altitude (≥ 18,000 feet) and centered on the CB but outside the precipitation shield. Dropsondes should be released at upwind and downwind portions of the CB.

G-IV Pattern 1: G-IV is not an explicit platform used with the module, science objectives of module will be enhanced if G-IV is flying coincident with P-3 and releasing dropsondes in close spatial and temporal proximity to P-3 during CB module.