2023 NOAA/AOML/HRD Hurricane Field Program - APHEX

EARLY STAGE EXPERIMENT
Flight Pattern Description

Experiment/Module: Stratiform Spiral Module (SSM)

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Requirements: TD, TS, Category 1

Early Stage Science Objective(s) Addressed:

1) Obtain a quantitative description of the distribution of liquid and frozen hydrometeors in stratiform precipitation to better understand the processes that govern these distributions and how they are represented in numerical models [*APHEX Goals 1, 3*].

P-3 Pattern #1

What to Target: An area of stratiform precipitation outside the RMW.

When to Target: When stratiform precipitation 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. 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 precipitation structure. Additionally, it is recommended that the onboard scientists use radar (lower fuselage, i.e., MMR) looping features and/or storm ID tracks if available.

Pattern: 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. This module may only be conducted in sufficient daylight to allow for visual inspection of aircraft surfaces to be conducted during the spiral.
4. If these conditions are met, that location should be marked, the airplane repositioned to that location, and the module completed as outlined above.

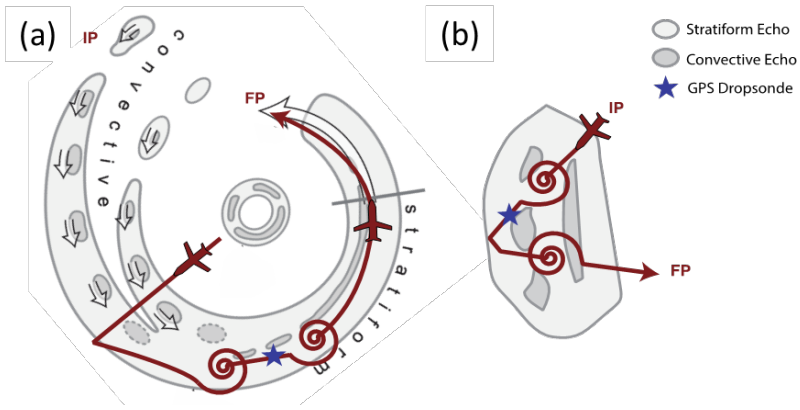

Figure SSM1: P-3 Stratiform Spiral module: (a) Example spiral ascent and descent in stratiform portion of primary rainband. (b) Example spiral ascent and descent in isolated CB during stratiform transition.

Flight altitude: The altitude should range from 5 kft to ~25 kft or the maximum safe altitude.

Leg length or radii: Spiral ascents and descents should maintain a roll angle of ~10–20° to maximize utility of the lower fuselage radar for situational awareness during ascents/descents (adjusted for safety considerations at the pilot's discretion). Ascent and descent rates should be ~5 m s^{-1} (~1,000 ft fpm) during this module.

Spiral ascents and descents should maintain roll angle of ~10–20° (adjusted for safety considerations at the pilot's discretion) to confine spiral to a limited geographical area, with an ascent or descent rate of ~5 m/s (~1,000 ft/min).

Estimated in-pattern flight duration: ~30 min added to the mission. To ensure adequate sampling by the microphysics probes, at least one minute (but preferably longer) should be spent in frozen precipitation. The spiral would preferably occur later in the mission, when more fuel has been expended, provided there is adequate daylight at the time of the spiral.

Expendable distribution: A dropsonde should be released at the apex of any spiral ascents to provide a profile of thermodynamic structure over the depth of the spiral.

Instrumentation Notes: Cloud and precipitation imaging probes should be on and collecting data during the spiral ascents and descents.

G-IV Pattern #1: G-IV is not an explicit platform used with the module. However, science objectives of the 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 Stratiform Spiral Module.