16. Convective Burst Module

Principal Investigator(s): Robert Rogers (HRD), Altug Aksoy (HRD), Jon Zawislak (Florida International University)

Objective: To sample the wind, temperature, and moisture fields within and around an area of deep convection at high time frequency and to use them in high-resolution data assimilation experiments.

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

When to Target: When deep convection is identified either by radar or satellite during the execution of a survey pattern. Particular attention should be paid when a developing area of deep convection can be detected on the downshear (as inferred by real-time SHIPS analyses) side of the storm.

This is a stand-alone module that takes 1-2 h to complete. Execution is dependent on system attributes, aircraft fuel and weight restrictions, and proximity to operations base. The objectives are to 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 tropical cyclone genesis and intensity change. It can be flown separately within a mission designed to study local areas of convection or at the end of one of the survey patterns. Once a local area of intense convection is identified, the P-3 will transit at altitude (10-12,000 ft.) to the nearest point just outside of the convective cores and sample the convective area (Fig. 16-1). The sampling pattern will be either a circumnavigation (when sampling a burst within a TC of tropical depression strength or less or well-removed from the radius of maximum wind (RMW) of a tropical storm or stronger) or a series of inbound/outbound radial penetrations or bowtie patterns (when sampling a burst within the radius of maximum wind of a tropical storm or hurricane). If the convective burst is at or near the RMW, repeated sampling can allow for a following of the burst around the storm. This is especially useful to sample the structural evolution of the burst as it moves around the storm.

The high-resolution data collected in this module is planned to be embedded within the typical Hurricane Ensemble Data Assimilation System (HEDAS) framework to carry out storm-scale data assimilation that focuses specifically on the high-resolution analysis of the identified intense convective region. With current technology, a smaller domain with 1-km grid spacing will be nested within the HEDAS 3-km analysis domain, where the data will be assimilated for the duration of its collection (1-2 hours, at 5-10 min intervals). This is a typical setup that has been traditionally used in continental storm-scale radar data assimilation applications and has been shown to be effective to obtain realistic storm structures in analyses and short-range forecasts. With such high-resolution analyses, we hope to be able to obtain fully three-dimensional model representations of the observed convective regions for more detailed investigation, as well as investigate their short-range predictability. In an observing system experiment (OSE) mode, various assimilation experiments can also be devised to investigate hypothetical scenarios for how an observed convective region could interact with the surrounding vortex and impact its evolution.

For circumnavigation patterns, the aircraft should fly a series of straight legs just outside of the main convection, with every effort made to fly the aircraft level for optimal Doppler radar sampling. The tail radar should optimally be operated in F/AST sector scan and regularly spaced dropwindsondes (10-20 km apart) will be released during this time. While flying parallel to the leading convective line, dropwinsonde deployment should occur as close to the leading line as is safely possible. Once the circumnavigation is completed, and the P-3 is near the original IP, two straight-line crossings of the convective area should be performed with the P-3 avoiding the strongest cores, as necessary for safety considerations. The P-3 should fly at a constant altitude of 10-12,000 ft – radar or pressure altitude is fine. When a high-altitude (i.e., above the flight-level of the P-3) aircraft is present, efforts should be made to coordinate this portion of the pattern with the high-altitude aircraft, so that the two aircraft are as close to vertically-stacked as possible. The P-3 should perform as many circumnavigations (or partial ones) of the convective burst as time permits within the 1-2 h window.

For bowtie (radial penetration) patterns, the tail radar should be operated in F/AST full-scan mode. Dropsondes should be released ~10-20 km apart on all passes. 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.

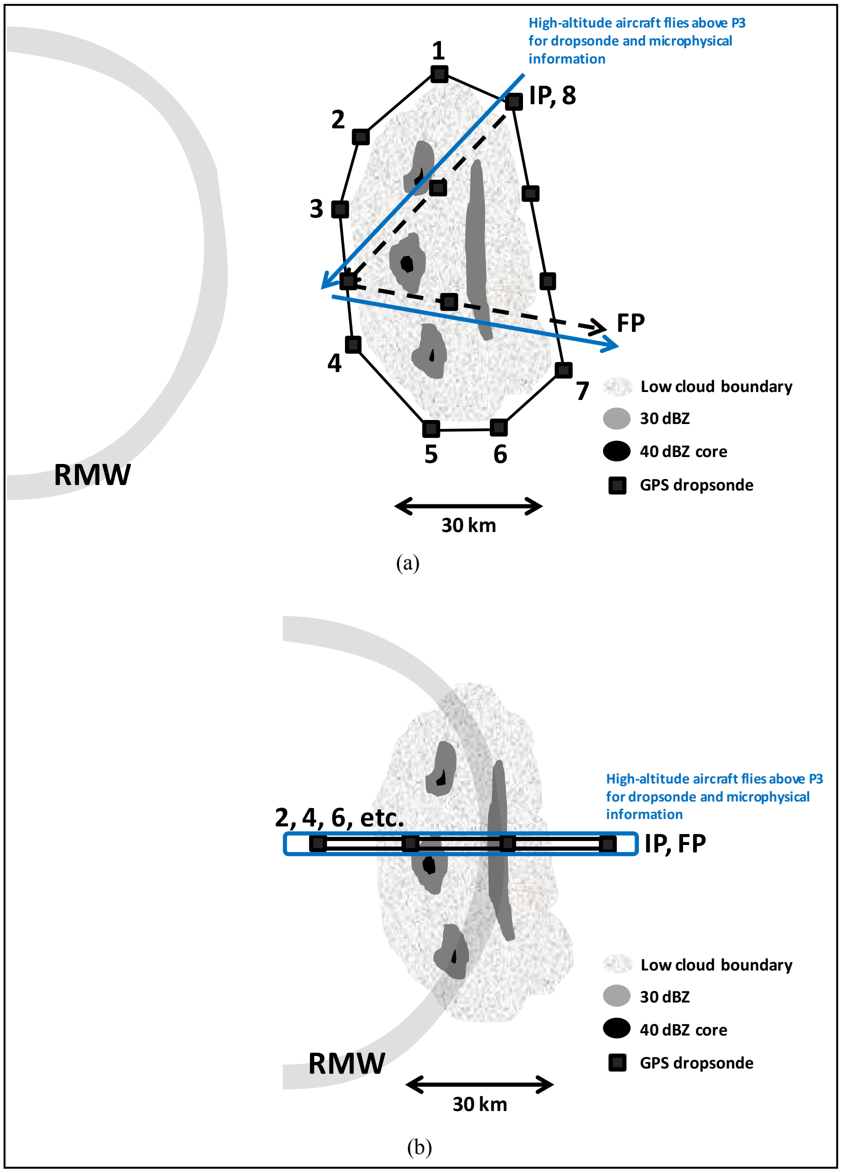

Figure 16-1: *P-3 Convective burst module. (a) circumnavigation for when burst is well outside RMW or within a TC of tropical depression strength or less; (b) bowtie pattern for when burst is within or near RMW of tropical storm or hurricane.*

- Altitude: 12,000 ft (4 km) altitude preferable.
- Expendables: Release dropsondes at turn points and at intermediate points as indicated in Figure. Additionally, release 1-2 drops during penetration of convective system. No more than 15 dropsondes needed for this module.
- Pattern: Circumnavigation (IP to point 6) by single P-3 when burst is outside RMW or in weak system. Then fly convective crossing (6-7-FP). Repeat circumnavigation (time permitting). If available, high-altitude aircraft (e.g., ER-2 or Global Hawk) flies either racetrack or bowtie pattern during P-3 circumnavigation, flies vertically aligned with P-3 during convective crossing. Repeated radial penetration (i.e. bowtie) when burst is inside or near RMW of tropical storm or hurricane.
- Instrumentation: Set airborne Doppler radar to scan F/AST on all legs.