

2023 NOAA/AOML/HRD Hurricane Field Program - APHEX

SATELLITE VALIDATION EXPERIMENT

Flight Pattern Description

Experiment/Module: Evaluation of the tropical transition environment using satellite soundings

Investigator(s): Jason Dunion (PI), Rebekah Esmaili (Co-PI, STC/JPSS), Michael Folmer (NWS/OPC)

Requirements: No requirements: flown at any stage of the TC lifecycle

Satellite Validation Science Objective(s) Addressed:

- 1) Test new (or improved) satellite technologies with the potential to fill gaps, both spatially and temporally, in the existing suite of airborne measurements in TCs. These measurements include improved three-dimensional representation of the hurricane wind field and thermodynamic structure and more accurate measurements of ocean surface winds and underlying ocean conditions [APHEX Goal 2]

P-3 Pattern #1

What to Target: Sample a variety of environments including the Saharan Air Layer (SAL) and tropical disturbances [e.g., African easterly waves (AEWs), invests, and TCs]. Although not a requirement, SAL targets would preferably be interacting with a tropical disturbance.

When to Target: P-3 flight patterns and take-off times will be adjusted to sample targets that maximize temporal and spatial overlap with overpasses by the NOAA-20 and NOAA-21 satellites. GPS dropsonde sampling should be timed to be ≤ 1 hr and ≤ 27 n mi (50 km) of collocated NUCAPS sounding granules and will depend on the area of operation (determined on a case-by-case basis).

Pattern: For SAL-only sampling, a standard (or modified) Lawnmower pattern will be flown. For targets with a tropical disturbance interacting with the SAL, the following standard patterns can be flown: Figure-4, Rotated Figure-4, Butterfly, Lawnmower, Square Spiral, and P-3 Circumnavigation. For TC targets, circumnavigations will be flown as close to the inner core as safety permits [e.g., $R \geq 60-90$ n mi (110-165 km)] and legs should extend out to the (near) cloud free region in the periphery of the storm [e.g., $R \sim 160-215+$ n mi (300-400+ km)].

Flight altitude: 25-28 kft in storm environment and clear to partly cloudy scenes to provide better vertical sampling by dropsondes that are deployed. Over precipitating areas, altitude will be lowered to 12kft or lower, for safety purposes.

Leg length or radii: Standard leg lengths for over-storm patterns. For near-storm patterns, inner points and optional inner circumnavigation, radii should be as close to the edge of the inner core convection as possible. This distance will be dictated by safety considerations, will typically range from $\sim 60-90$ n mi (110-165 km), and will require coordination between the HRD LPS and P-3 Flight Director. Legs should extend out to the (near) cloud free region in the periphery of the storm [e.g., $R \sim 160-215$ n mi (300-400 km)] to sample regions where NUCAPS soundings will be less affected by cloud contamination.

Estimated in-pattern flight duration: $\sim 1.0-7.5$ hr

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Expendable distribution: For the near and far environments [e.g., R=80-215+ n mi (150-400+ km)], ~2–3 degree [120-180 n mi (220-335 km)] dropsonde spacing in quiescent regions and ~0.25-1 degree (15-60 n mi/30-110 km) oversampling in target areas of interest (e.g., the SAL leading edge, SAL mid-level easterly jet, or SAL dry air intrusions into the TC periphery. Standard dropsonde distributions near the outer edge of the “inner core” convection [R~80-105 n mi (150-200 km)] associated with the AEW, invest, or TC are preferred.

Instrumentation Notes: Use TDR defaults (though not a requirement for this experiment). Use straight flight legs as safety permits. All GPS dropsonde data should be transmitted to the Global Telecommunication System (GTS) in real-time to ensure availability for assimilation into forecast models.

P-3 Pattern #2

What to Target: Sample the environment of a tropical disturbance [e.g., African easterly wave (AEW), invest, or TC] or the environment of a TC undergoing extratropical transition (ET) or tropical transition.

When to Target: P-3 flight patterns and take-off times will be adjusted to sample targets that maximize temporal and spatial overlap with overpasses by the NOAA-20 and NOAA-21 satellites. GPS dropsonde sampling should be timed to be ≤ 1 hr and ≤ 27 n mi (50 km) of collocated NUCAPS sounding granules and will depend on the area of operation (determined on a case-by-case basis).

Pattern: The following standard patterns can be flown: Figure-4, Rotated Figure-4, Butterfly, Lawnmower, Square Spiral, and P-3 Circumnavigation. For TC targets, circumnavigations will be flown as close to the inner core as safety permits [e.g., R \geq 60-90 n mi (110-165 km)] and legs should extend out to the (near) cloud free region in the periphery of the storm [e.g., R~160-215+ n mi (300-400+ km)].

Flight altitude: 25-28 kft in storm environment and clear to partly cloudy scenes to provide better vertical sampling by dropsondes that are deployed. Over precipitating areas, altitude will be lowered to 12kft or lower, for safety purposes.

Leg length or radii: Standard leg lengths for over-storm patterns. For near-storm patterns, inner points and optional inner circumnavigation, radii should be as close to the edge of the inner core convection as possible. This distance will be dictated by safety considerations, will typically range from ~60–90 n mi (110-165 km), and will require coordination between the HRD LPS and P-3 Flight Director. Legs should extend out to the (near) cloud free region in the periphery of the storm (e.g., R~160-215 n mi/300-400 km) to sample regions where NUCAPS soundings will be less affected by cloud contamination. For ET cases, leg lengths should be extended as needed to sample the baroclinic environment associated with the storm and areas where the storm’s outflow is interacting with the midlatitude jet stream.

Estimated in-pattern flight duration: ~1.0–7.5 hr

Expendable distribution: For the near and far environments [e.g., R=80-215 n mi (150-400 km)], ~2–3 degree [120-180 n mi (220-335 km)] GPS dropsonde spacing in quiescent regions and ~0.25-1 degree [15-60 n mi (30-110 km)] oversampling in target areas of interest (e.g., moisture gradients in the near environment around the inner core). Standard GPS dropsonde distributions near the “inner core” [R~80-105 n mi (150-200 km)] of the AEW, invest, or TC are preferred.

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G-IV Pattern #1

What to Target: Sample a variety of environments including the Saharan Air Layer (SAL) and tropical disturbances [e.g., African easterly waves (AEWs), invests, and TCs]. Although not a requirement, SAL targets would preferably be interacting with a tropical disturbance.

When to Target: G-IV flight patterns and take-off times will be adjusted to sample targets that maximize temporal and spatial overlap with overpasses by the NOAA-20 and NOAA-21 satellites. GPS dropsonde sampling should be timed to be ≤ 1 hr and ≤ 27 n mi (50 km) of collocated NUCAPS sounding granules and will depend on the area of operation (determined on a case-by-case basis).

Pattern: For SAL-only sampling, a standard (or modified) Lawnmower pattern will be flown. For targets with a tropical disturbance interacting with the SAL, the following standard patterns can be flown: Figure-4, Rotated Figure-4, Butterfly, Lawnmower, Square Spiral, G-IV Circumnavigation, G-IV Star, or G-IV Star with Circumnavigation. For TC targets, circumnavigations will be flown as close to the inner core as safety permits [e.g., $R \geq 60-90$ n mi (110-165 km)] and legs should extend out to the (near) cloud free region in the periphery of the storm [e.g., $R \sim 160-215+$ n mi (300-400+ km)].

Flight altitude: 40–45 kft or as high as possible to provide better vertical sampling by dropsondes that are deployed.

Leg length or radii: Standard leg lengths for over-storm patterns. For near-storm patterns, inner points and optional inner circumnavigation, radii should be as close to the edge of the inner core convection as possible. This distance will be dictated by safety considerations, will typically range from $\sim 60-90$ n mi (110-165 km), and will require coordination between the HRD LPS and G-IV Flight Director. Legs should extend out to the (near) cloud free region in the periphery of the storm [e.g., $R \sim 160-215$ n mi (300-400 km)] to sample regions where NUCAPS soundings will be less affected by cloud contamination.

Estimated in-pattern flight duration: $\sim 1.0-7.5$ hr

Expendable distribution: For the near and far environments [e.g., $R = 80-215+$ n mi (150-400+ km)], $\sim 2-3$ degree [120-180 n mi (220-335 km)] dropsonde spacing in quiescent regions and $\sim 0.25-1$ degree (15-60 n mi/30-110 km) oversampling in target areas of interest (e.g., the SAL leading edge, SAL mid-level easterly jet, or SAL dry air intrusions into the TC periphery. Standard dropsonde distributions near the outer edge of the “inner core” convection [$R \sim 80-105$ n mi (150-200 km)] associated with the AEW, invest, or TC are preferred.

Instrumentation Notes: Use TDR defaults (though not a requirement for this experiment). Use straight flight legs as safety permits. All GPS dropsonde data should be transmitted to the Global

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Telecommunication System (GTS) in real-time to ensure availability for assimilation into forecast models.

G-IV Pattern #2

What to Target: Sample the environment of a tropical disturbance [e.g., African easterly wave (AEW), invest, or TC] or the environment of a TC undergoing extratropical transition (ET) or tropical transition.

When to Target: G-IV flight patterns and take-off times will be adjusted to sample targets that maximize temporal and spatial overlap with overpasses by the NOAA-20 and NOAA-21 satellites. . GPS dropsonde sampling should be timed to be ≤ 1 hr and ≤ 27 n mi (50 km) of collocated NUCAPS sounding granules and will depend on the area of operation (determined on a case-by-case basis).

Pattern: The following standard patterns can be flown: Figure-4, Rotated Figure-4, Butterfly, Lawnmower, Square Spiral, G-IV Circumnavigation, G-IV Star, or G-IV Star with Circumnavigation. For TC targets, circumnavigations will be flown as close to the inner core as safety permits [e.g., $R \geq 60$ -90 n mi (110-165 km)] and legs should extend to the (near) cloud free region in the periphery of the storm [e.g., $R = 160$ -215+ n mi (300-400+ km)]. For TCs undergoing ET at higher latitudes (e.g., 35-50oN), the lower climatological altitude of the tropopause may allow the G-IV to overfly the storm center more easily and will be assessed on a case-by-case basis.

Flight altitude: 40–45 kft or as high as possible to provide better vertical sampling by dropsondes that are deployed.

Leg length or radii: Standard leg lengths for over-storm patterns. For near-storm patterns, inner points and optional inner circumnavigation, radii should be as close to the edge of the inner core convection as possible. This distance will be dictated by safety considerations, will typically range from ~60–90 n mi (110-165 km), and will require coordination between the HRD LPS and G-IV Flight Director. Legs should extend out to the (near) cloud free region in the periphery of the storm (e.g., $R \sim 160$ -215 n mi/300-400 km) to sample regions where NUCAPS soundings will be less affected by cloud contamination. For ET cases, leg lengths should be extended as needed to sample the baroclinic environment associated with the storm and areas where the storm's outflow is interacting with the midlatitude jet stream.

Estimated in-pattern flight duration: ~1.0–7.5 hr

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