# NOAA / AOML / Hurricane Research Division
# 2021 Hurricane Field Program
# Advancing the Prediction of Hurricanes Experiment (APHEX)

## FLIGHT LOG -- 20210812H2

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| MISSION PLAN | | | |
|---|---|---|---|
| **FLIGHT ID** | 20210812H2 | **STORM** | AL06 / FRED |
| **MISSION ID** | 0706A | **TAIL NUMBER** | NOAA42 |
| **TASKING** | EMC | **PLANNED PATTERN** | Butterfly |
| **MISSION SUMMARY** | | | |
| **TAKEOFF [UTC]** | 2003 | **LANDING [UTC]** | 0119 |
| **TAKEOFF LOCATION** | Lakeland | **LANDING LOCATION** | Lakeland |
| **FLIGHT TIME** | 5.3 | **BLOCK TIME** | 5.6 |
| **TOTAL REAL-TIME RADAR ANALYSES (Transmitted)** | 2 (2) | **TOTAL DROPSONDES (Good/Transmitted)** | 11 (10/10) |
| **OCEAN EXPENDABLES (Type)** | None | **sUAS (Type)** | None |
| **APHEX EXPERIMENTS / MODULES** | Early Stage Experiment: AIPEX | | |
| **HRD CREW MANIFEST** | | | |
| **LPS ONBOARD** | Zawislak | **LPS GROUND** | Rogers |
| **TDR ONBOARD** | Zawislak | **TDR GROUND** | Alvey, Gamache |
| **ASPEN ONBOARD** | Sellwood | **ASPEN GROUND** | None |
| **NESDIS SCIENTISTS** | None | | |
| **GUESTS (Affiliation)** | None | | |
| **AOC CREW MANIFEST** | | | |
| **PILOTS** | Mitchell, Rannenberg, Copare | | |
| **NAVIGATOR** | Urato | | |
| **FLIGHT ENGINEERS** | Darby, Wysinger | | |
| **FLIGHT DIRECTOR** | Carpenter | | |
| **DATA TECHNICIAN** | Mascaro | | |
| **AVAPS** | Underwood | | |

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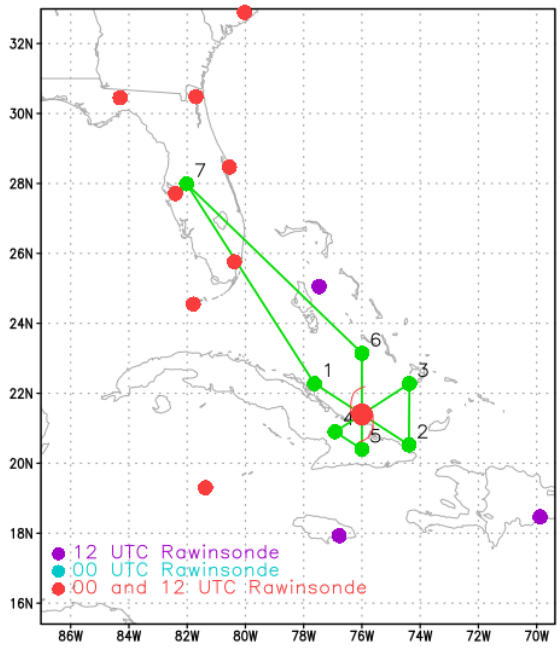
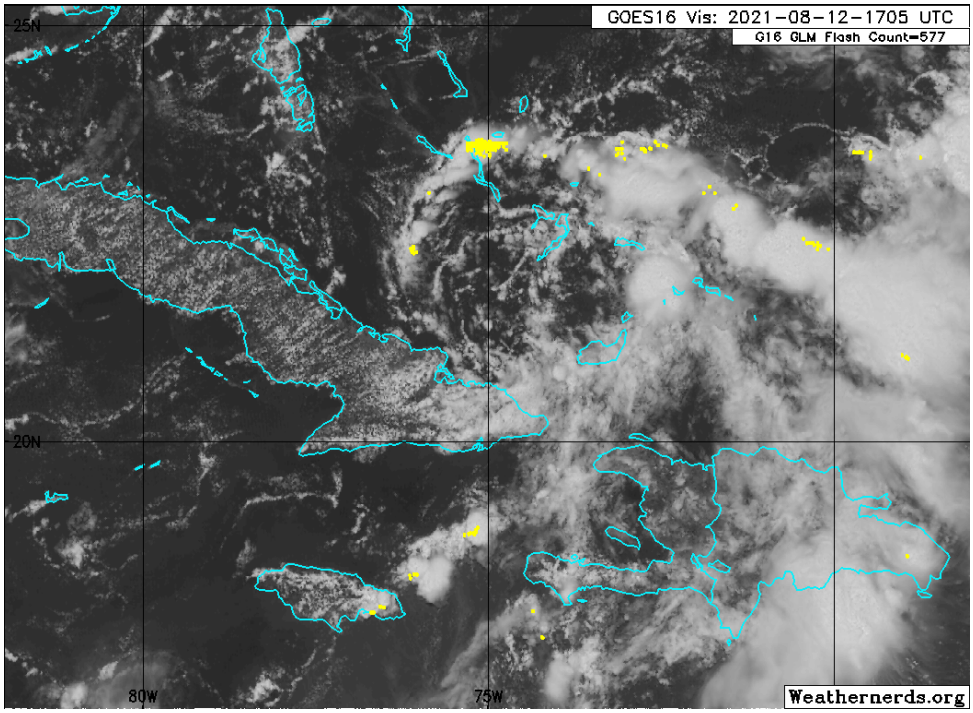
| PRE-FLIGHT | |
|---|---|
| **Flight Plan** |  <br>Original plan (above) called for a modified butterfly pattern with truncated legs on the southwest due to land. Due to a lack of scatterers, however, the plan has been modified, with points 4 and 5 removed. It will be point 1 - point 2, point 2 - point 3, point 3 - center, center to point 6, then return to Lakeland. Plan is to fly at 15 kft for the duration of the mission, unless conditions warrant descending to avoid icing. |
| **Expendable Distribution** | Dropsondes (not over land) at all endpoints (EP), midpoints (MP), and the closest point of approach (CPA) to the center. No AXBTs. |
| **Preflight Weather Briefing** | Fred has spent the past ~18 h traversing the steep topography of Hispaniola and emerged back over the water about 12 h ago. The journey over the island significantly degraded the structure of the storm, leaving an exposed swirl virtually devoid of convection. Fred was downgraded to a |

tropical depression by NHC last night while over Hispaniola.




The current visible animation shows the exposed circulation just north of the southeast Cuban coast. Some convection appears to be developing in the southeast portion of the circulation, though the circulation center remains free of any convection, at least at the moment. Most of the precipitation is on the east and northeast side of the circulation, which likely reflects the moderate (~20 kt) westerly shear impacting the system.

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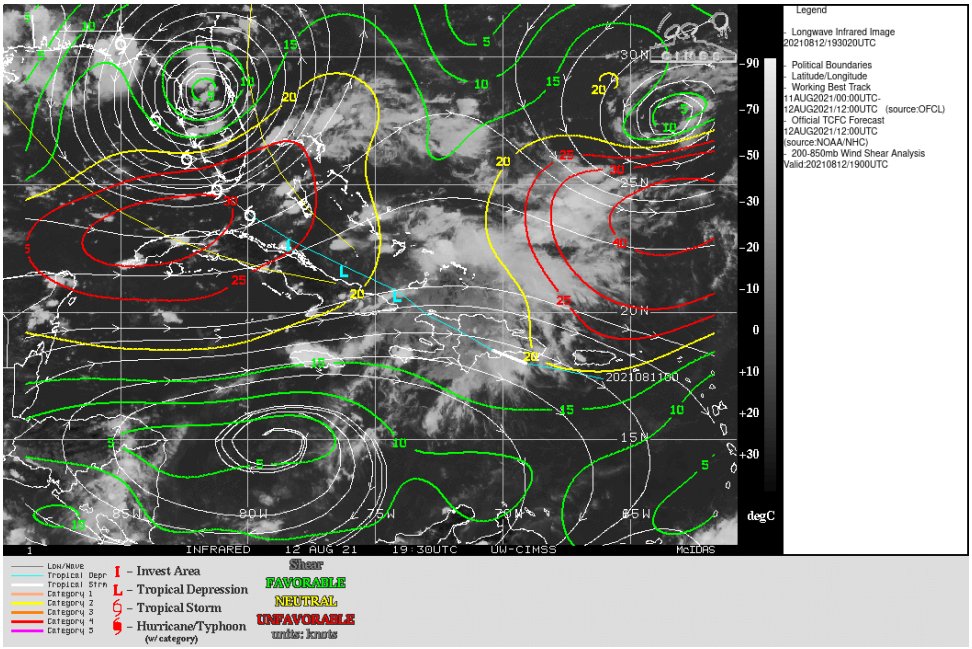
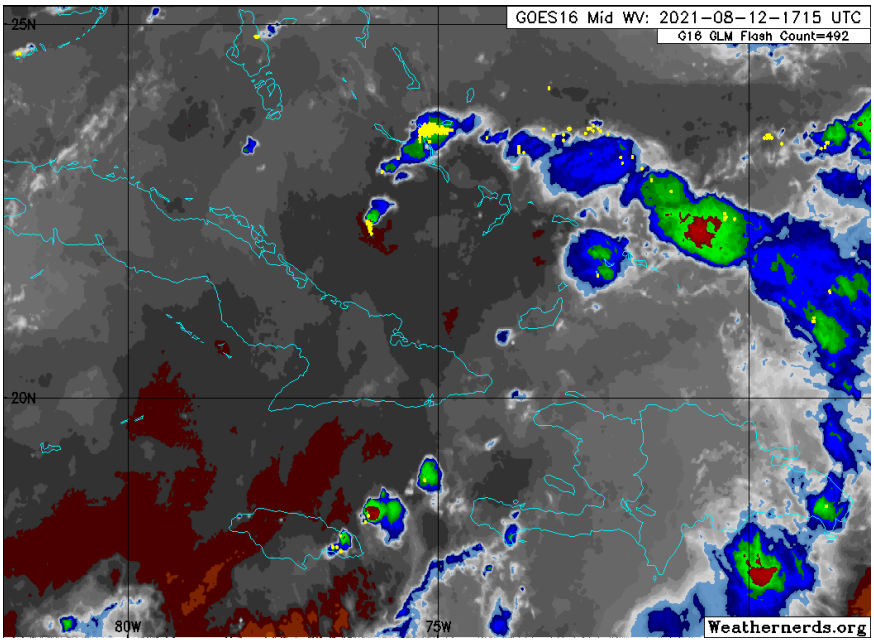



The moisture environment is more humid today than it was yesterday, suggesting that is likely not a limiting factor to any potential redevelopment.




The question is what the prospects are for the redevelopment of Fred. The

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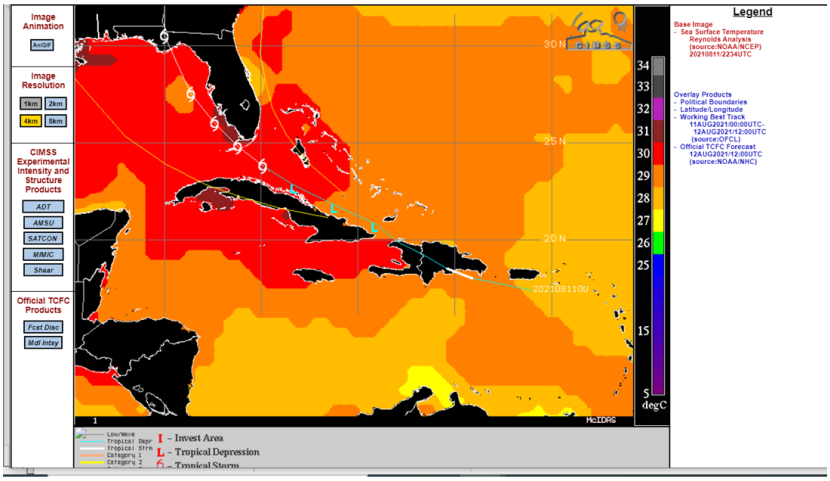
| | shear gets stronger along the projected west-northwestward track of Fred, which should limit any significant strengthening. Once the circulation gets through the Florida straits, though, some models suggest the shear could abate, and, coupled with warm waters there, Fred could intensify.<br><br>  <br><br>Past experience with exposed swirls emerging from time over land, however, suggests redevelopment is unlikely. This is perhaps because of a stable profile within the remnant vortex warm core that suppresses convection. Dropsondes from the P-3 may shed some light on this hypothesis. |
| **Instrument Notes** | All instruments are functional. An altitude threshold was applied to flag SFMR observations when the aircraft is above 12.5kft. Since much of this flight will be above that altitude, SFMR transmission via HDOBS will likely be limited unless flight gets below that altitude. |

| IN-FLIGHT | |
|---|---|
| **Time [UTC]** | **Event** |
| 2003 | Takeoff from Lakeland |
| 2110 | Flight will now be at 12 kft radar altitude, so the SFMR will actually be transmitted over HDOBS. |
| 2125 | Convection continues to flare in the SE part of the circulation. Given the |

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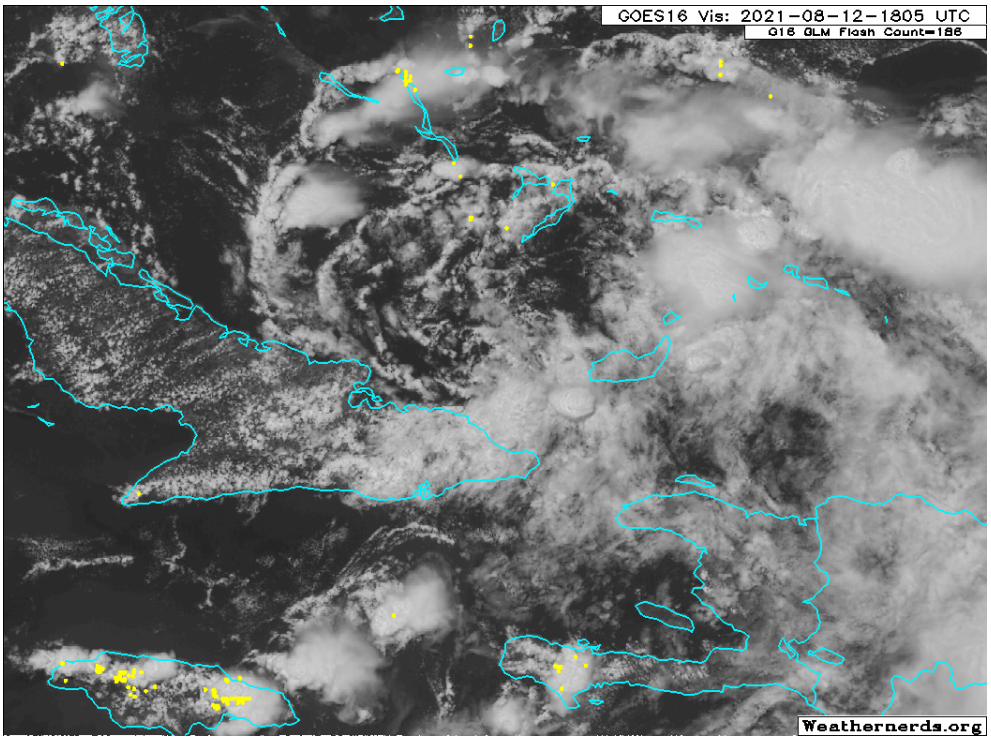
| | weak state of the LLC, it's possible that a center could reform here.<br>  <br>Radar is not too impressive yet. The main echoes could be out of range, though. |

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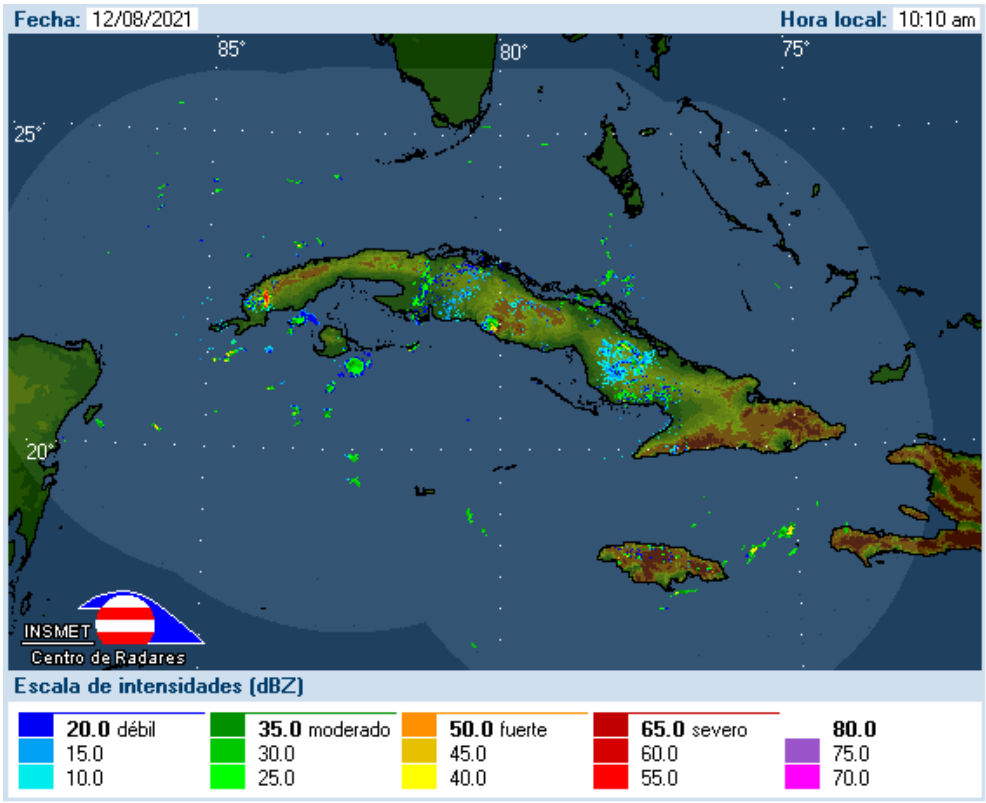
| |  |
| 2128 | At IP, Sonde 1 |
| 2138 | Cold cloud tops at the SE portion of the planned flight track. No lightning in the last 30 minutes though. All lightning currently inland over Cuba. |

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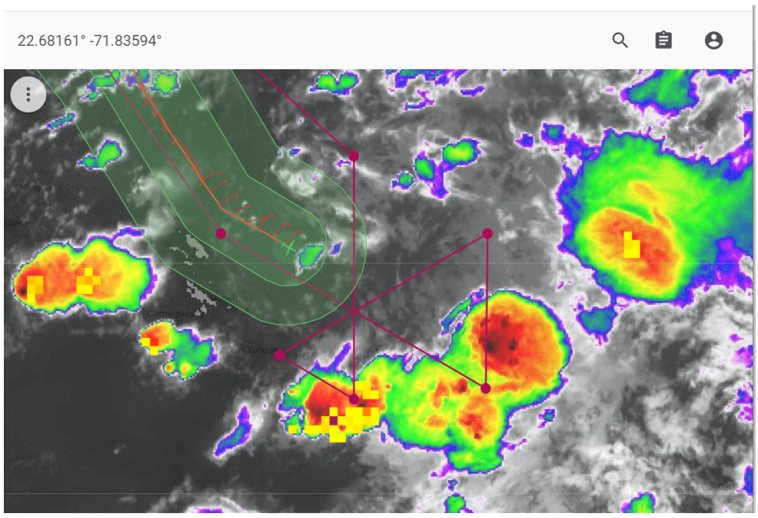
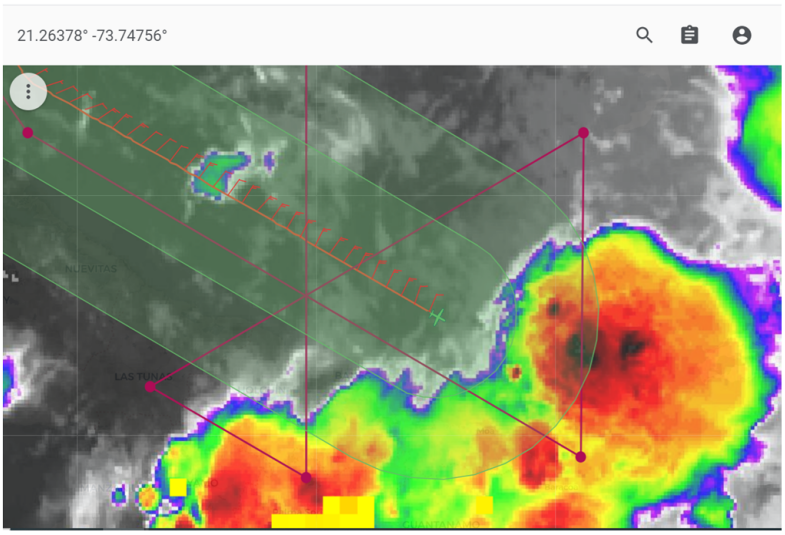
| |  |
| 2140 | Sonde 2, midpoint |
| 2152 | Sonde 3, nominal center |
| 2205 | Flight-level winds showing continued NNE winds, which indicates that flight level center is to the southeast of where the predicted center would be (based on the center of the planned pattern)<br>  |
| 2205 | Descending to 12 kft, since SFMR still not getting transmitted over HDOBS. Needing to deviate a bit soon to avoid convection. |

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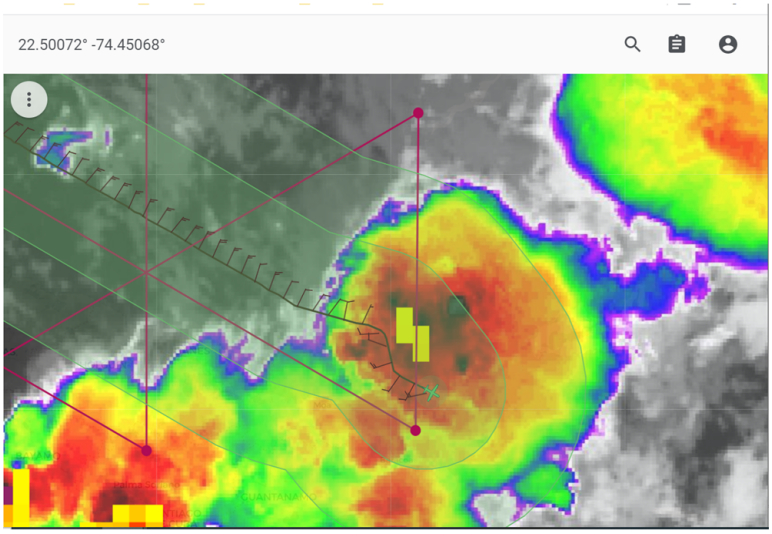
| 2205 | Drop 4, outbound midpoint |
| 2205 | Extending leg to the SE by 40 n mi |
| 2219 | Sonde 5, outbound endpoint |
| 2221 | Convection continues to flare up. Aircraft had to deviate around convection, lightning has also developed. Winds at flight level showed a shift there. Looks like a center is reforming in this convection. There is mixed convective and stratiform precipitation here.   |
| 2225 | End of new outbound leg, turning to north |
| 2236 | Dropsondes 3 (original center) and 4 (outbound midpoint) show that LLC seems to be between the two. NW winds in lower troposphere in drop 3, weak SE winds in drop 4 with a splash pressure of 1012 hPa. Indicates the surface center is between the original center and outbound midpoint (i.e., to the southeast). Downshear reformation? |

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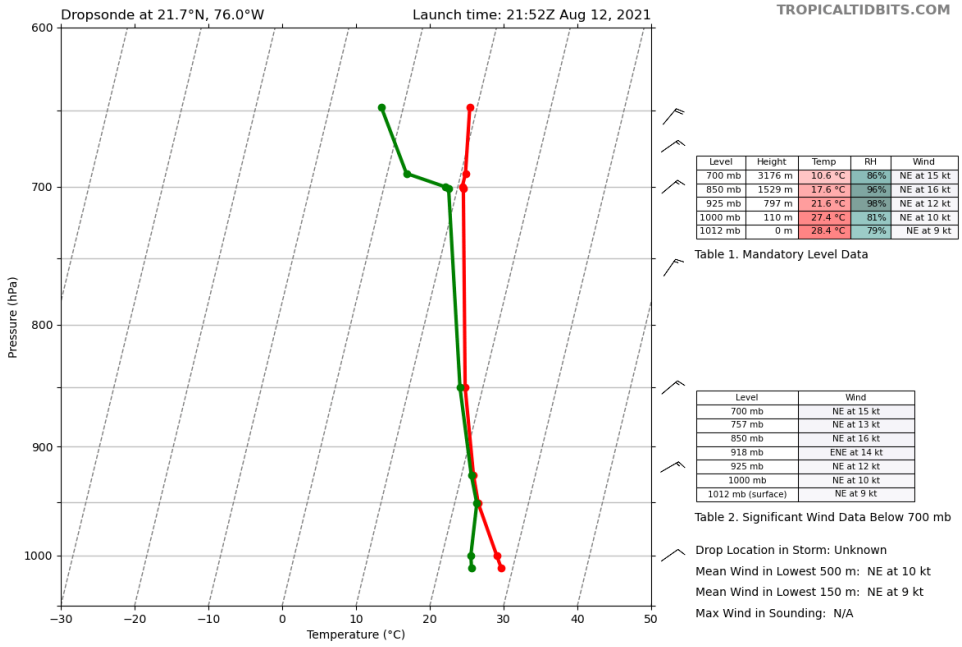


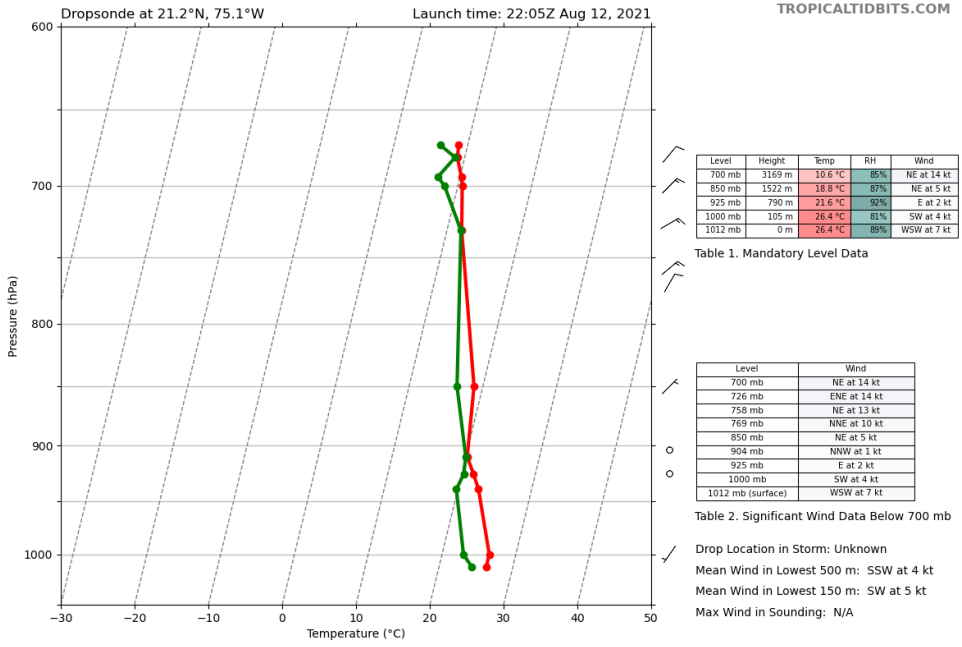

| Level | Height | Temp | RH | Wind |
|---|---|---|---|---|
| 700 mb | 3176 m | 10.6 °C | 86% | NE at 15 kt |
| 850 mb | 1529 m | 17.6 °C | 96% | NE at 16 kt |
| 925 mb | 797 m | 21.6 °C | 98% | NE at 12 kt |
| 1000 mb | 110 m | 27.4 °C | 81% | NE at 10 kt |
| 1012 mb | 0 m | 28.4 °C | 79% | NE at 9 kt |

Table 1. Mandatory Level Data

| Level | Wind |
|---|---|
| 700 mb | NE at 15 kt |
| 757 mb | NE at 13 kt |
| 850 mb | NE at 16 kt |
| 918 mb | ENE at 14 kt |
| 925 mb | NE at 12 kt |
| 1000 mb | NE at 10 kt |
| 1012 mb (surface) | NE at 9 kt |

Table 2. Significant Wind Data Below 700 mb

Drop Location in Storm: Unknown
Mean Wind in Lowest 500 m: NE at 10 kt
Mean Wind in Lowest 150 m: NE at 9 kt
Max Wind in Sounding: N/A




| Level | Height | Temp | RH | Wind |
|---|---|---|---|---|
| 700 mb | 3169 m | 10.6 °C | 85% | NE at 14 kt |
| 850 mb | 1522 m | 18.8 °C | 87% | NE at 5 kt |
| 925 mb | 790 m | 21.6 °C | 92% | E at 2 kt |
| 1000 mb | 105 m | 26.4 °C | 81% | SW at 4 kt |
| 1012 mb | 0 m | 26.4 °C | 89% | WSW at 7 kt |

Table 1. Mandatory Level Data

| Level | Wind |
|---|---|
| 700 mb | NE at 14 kt |
| 726 mb | ENE at 14 kt |
| 758 mb | NE at 13 kt |
| 769 mb | NNE at 10 kt |
| 850 mb | NE at 5 kt |
| 904 mb | NNW at 1 kt |
| 925 mb | E at 2 kt |
| 1000 mb | SW at 4 kt |
| 1012 mb (surface) | WSW at 7 kt |

Table 2. Significant Wind Data Below 700 mb

Drop Location in Storm: Unknown
Mean Wind in Lowest 500 m: SSW at 4 kt
Mean Wind in Lowest 150 m: SW at 5 kt
Max Wind in Sounding: N/A

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| 2247 | Pattern adjustment: after completing this downwind leg, which has been extended 40 n mi, will turn inbound to the lat/lon of the original outbound midpoint (near where the flight-level wind shift occurred), then go outbound to NW (at 320 degrees) so we head a bit more in the direction of home, but |

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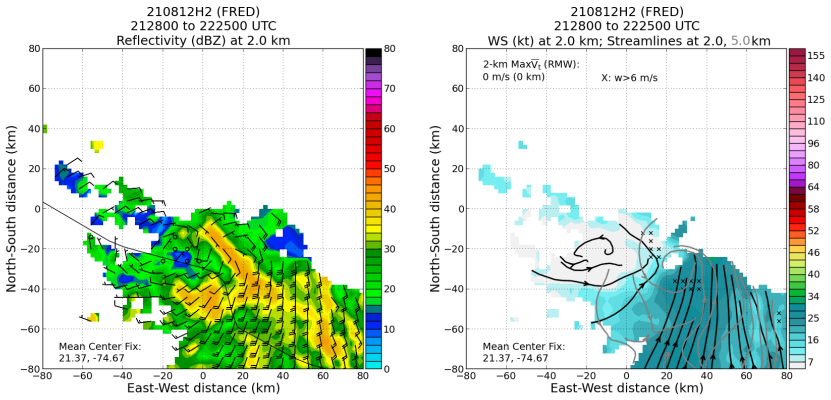
| | also angle a bit spaced from our NE inbound. There will be two TDR analyses, both sampling the same convective feature. This will provide potentially a nice time evolution, over ~45 min to 1 h. |
| 2259 | Sonde 6 (NE end point) |
| 2300 | Sonde 7 (NE end point, no launch detect for sonde 6) |
| 2313 | TDR analyses from the first pass show a clear displacement between the lower troposphere and the middle troposphere. A displacement of about 60 km to the ESE with height between 2 and 5 km.<br>  <br>There’s a broad cyclonic envelope at 2 km. Deep convection is indicated nearly coincident with the 5-km center, both by the “x” ‘s in the streamline plot and also by the partitioning. |

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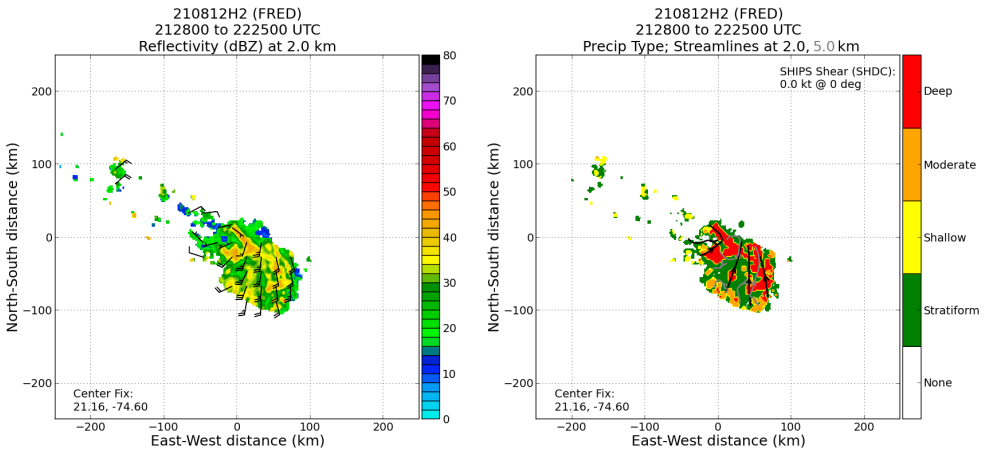
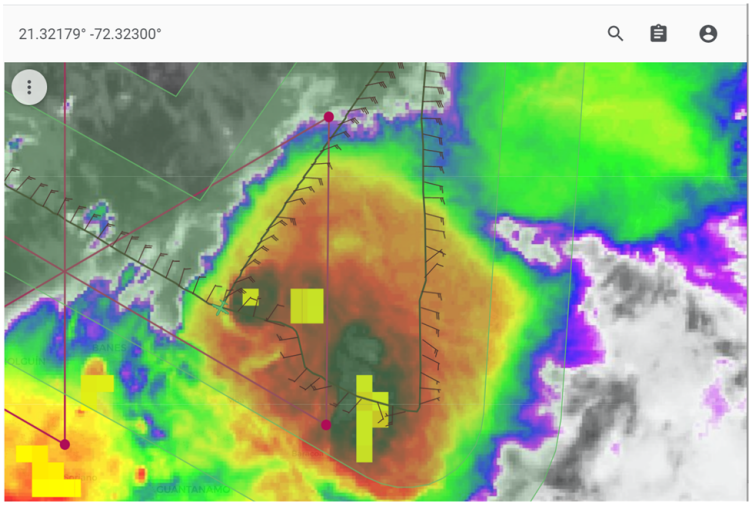
| |  |
| 2313 | Sonde 8 at 2313, midpoint from the NE |
| 2326 | Aircraft passing just to the right of deep convection, echo tops of 17 km, widespread lightning  |
| 2327 | Sonde 9, new center, heading outbound to track 320 |
| 2335 | Analysis of vorticity and tilt hodograph from first pass showed centers displaced toward the ESE with height. Convective bursts all along and to the right of the downtilt vector. |

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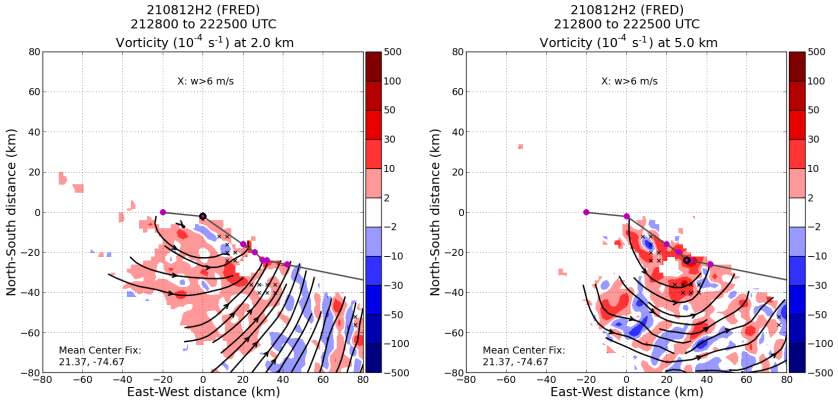
| |  |
| 2340 | Sonde 10, midpoint outbound to NW |
| 2345 | On the outbound leg toward NW, after just leaving center, LPS noted moderate convection, topping out well above flight level. Was widely scattered, but presence of moderate convection suggests thermodynamic conditions favorable for some convection. Could perhaps become deep convection in subsequent cycles. |
| 2353 | Sonde 11, endpoint outbound to NW, end of pattern, climbing out |
| 0043 | TDR analyses from the second pass shows a similar structure to the first pass, about a 50-60 km tilt/displacement toward the ESE between about 2 and 5 km. |

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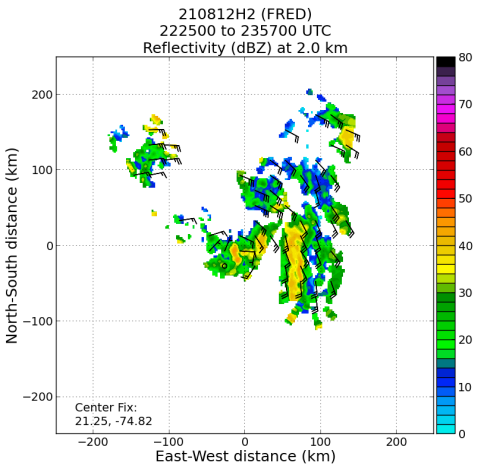


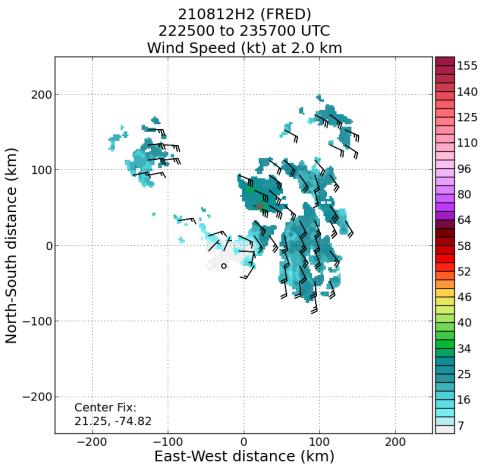


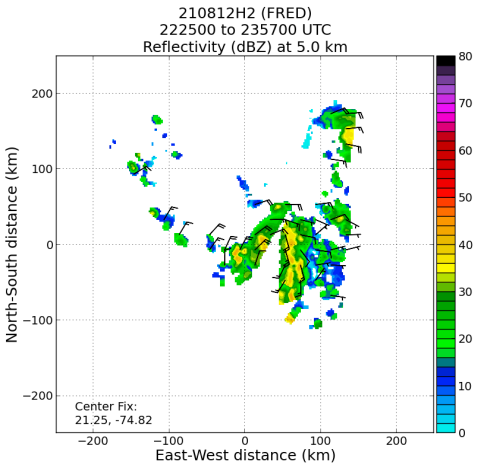


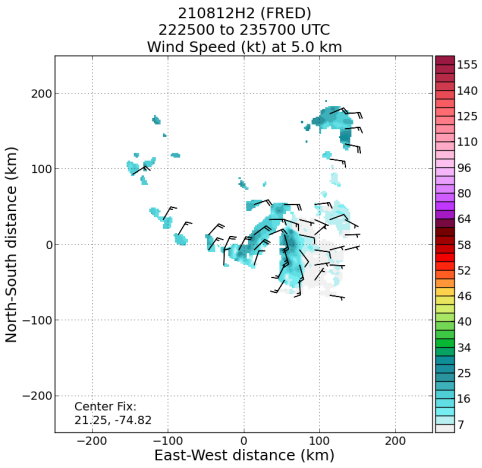


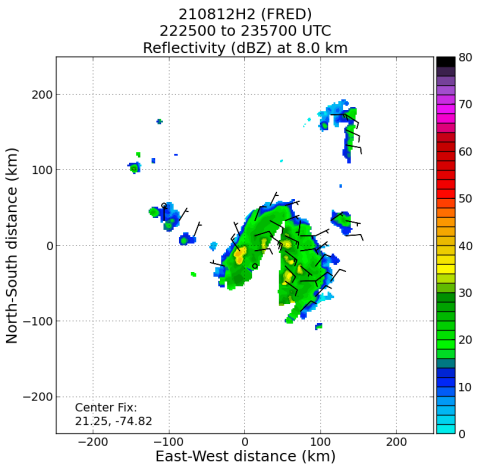


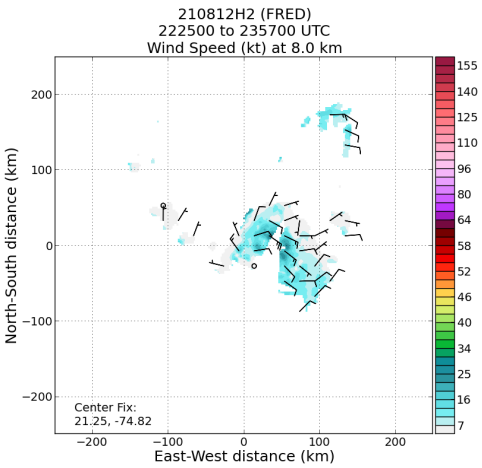

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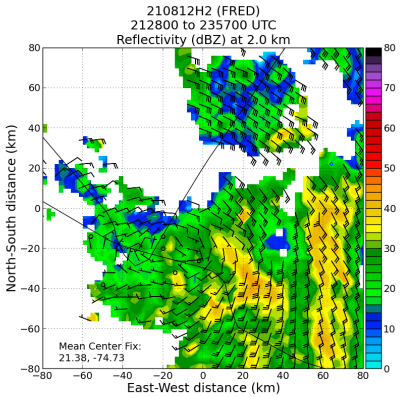
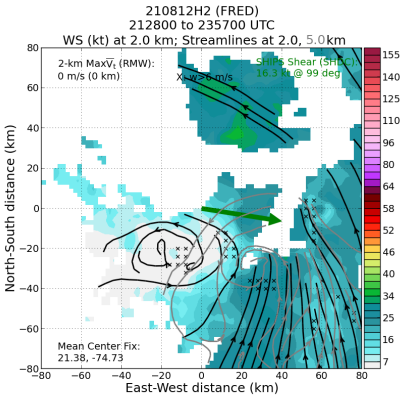
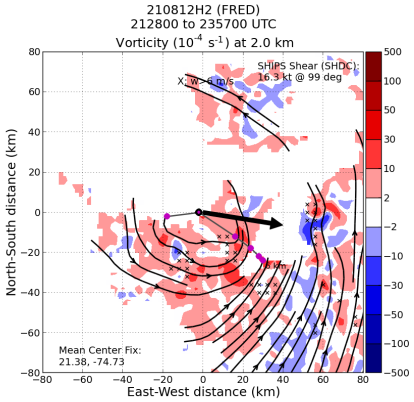
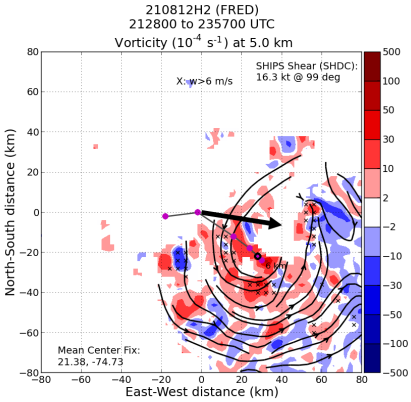
| | A zoomed in analysis from the composite analysis shows this displacement as well, as does the tilt hodograph. So not too much evolution between passes. This perhaps is not surprising, since there was only about a ~1 h difference in the analysis times, and the system is still weak and disorganized, so adjustment time scales are likely rather large.<br>  <br>  <br>  <br>  |
| 0119 | Land at Lakeland |

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| POST-FLIGHT | |
|---|---|
| **Mission Summary** | This mission ended up being quite a bit more interesting than expected at the beginning. The convective flare-up mentioned at the start of the mission on the southeast side of the previous LLC ended up becoming a dominant feature. There was a wind shift at flight level on the first inbound pass that was further to the southeast than the anticipated location. This shift was also confirmed by dropsondes released along the first NW-SE pass. As a result of this, and also to get through the deep convection that was along this leg, the pattern was extended to the southeast. The downwind leg continued to the north as planned (though shifted to the east now), and it was extended to allow for endpoint dropsondes (to avoid islands). Then the inbound leg from the NE was directed toward the location of the flight-level wind shift, passing along and just to the west of the previously-sampled deep convection. There was widespread lightning and echo tops of 16-18 km there. Upon reaching the center again, the aircraft turned outbound toward the NW, where some developing moderate convection was observed, though it was widely scattered at the time.<br><br>The rapidly-evolving convective structure made this an interesting mission. Radar analyses showed that the center was tilted (or displaced) toward the ESE with height between 2 and 5 km. Interestingly, though, there was little difference in the tilt between these two altitudes from pass to pass. In fact, there are qualitative indications that the displacement between these two altitudes increased during this time, despite the presence of deep convection, lightning, and echo tops up to 16-18 km. This is rather surprising. It could reflect shear values strong enough to prevent alignment, the apparent lack of evolution over a 1-h time scale, and/or the disorganized nature of the system with its associated large adjustment time scale. It's basically a question of why the system did not become better aligned, despite the presence of deep convection. Perhaps an examination of mass flux profiles could shed some insight into this -- with a top-heavy mass flux profile perhaps the stretching was dominated in the midlevels rather than the low levels. A quick observation that the midlevel circulation seemed to strengthen from pass to pass lends some credence to this speculation. But further research is needed.<br><br>The pattern did involve deviations as noted above. The aircraft flew at altitudes ranging from 12-12.5 kft. It descended to 12 kft to ensure transmission of SFMR data via HDOBS.<br><br>A total of 11 sondes were dropped, all of which were transmitted. Two radar analyses were completed and transmitted. No ocean drops. All sondes were charged to NWS. |

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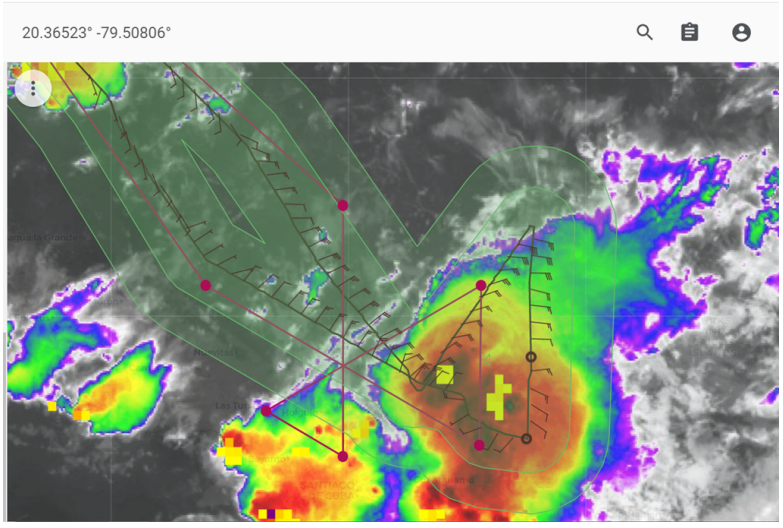
| **Actual Standard Pattern Flown** | A modified butterfly pattern was flown, with deviations as noted above to account for the reposition vortex and avoidance of convection. |
| **APHEX Experiments / Modules Flown** | Data collection could support research for the *Early Stage Experiment: AIPEX* and the flight was flown in collaboration ONR TCRI. |
| **Plain Language Summary** | • P-3 mission sampled the structure of tropical depression Fred, which had become quite disorganized after passage over Hispaniola<br>• Strong thunderstorms developed to the southeast of the existing center during the mission, causing many rapid adjustments to the flight pattern during the mission<br>• These thunderstorms contributed to a change in the structure of the storm, causing the center to reposition to the southeast. Despite this repositioning and the presence of strong thunderstorms, there was no clear indication of a significant improvement in the storm organization. The question is why not? |
| **Instrument Notes** | Instruments worked well. One dropsonde had no launch detect. |
| **Final Mission Track** |  |