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

FLIGHT LOG -- 20210703H1

MISSION PLAN			
FLIGHT ID	20210703H1	**STORM**	AL05/ELSA
MISSION ID	0605A	**TAIL NUMBER**	NOAA42
TASKING	EMC	**PLANNED PATTERN**	Rotated Figure-4
MISSION SUMMARY			
TAKEOFF [UTC]	1538	**LANDING [UTC]**	2242
TAKEOFF LOCATION	Aruba	**LANDING LOCATION**	Lakeland, FL
FLIGHT TIME	7.0	**BLOCK TIME**	7.1
TOTAL REAL-TIME RADAR ANALYSES (Transmitted)	4 (4)	**TOTAL DROPSONDES (Good/Transmitted)**	17 (17/17)
OCEAN EXPENDABLES (Type)	None	**sUAS (Type)**	None
APHEX EXPERIMENTS / MODULES	None planned		
HRD CREW MANIFEST			
LPS ONBOARD	NA	**LPS GROUND**	Zawislak
TDR ONBOARD	NA	**TDR GROUND**	Gamache/Reasor/Fischer
ASPEN ONBOARD	NA	**ASPEN GROUND**	Sellwood/Aberson
NESDIS SCIENTISTS	NA		
GUESTS (Affiliation)	NA		
AOC CREW MANIFEST			
PILOTS	Abitbol (Aircraft Commander), Shaw, Stateler		
NAVIGATOR	Urato		
FLIGHT ENGINEERS	Darby / Heysteck		
FLIGHT DIRECTOR	Parrish / Hathaway		
DATA TECHNICIAN	Mascaro		
AVAPS	Warnecke		

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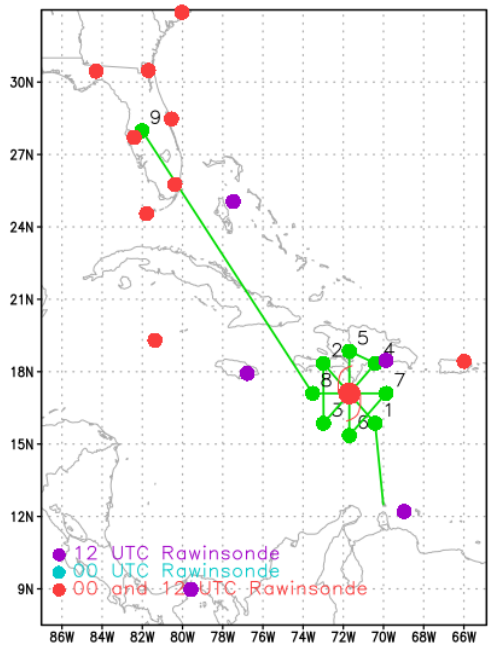
PRE-FLIGHT	
Flight Plan	
Expendable Distribution	Dropsondes released at the endpoint and midpoint of each leg, as well as at the center of each pass.
Preflight Weather Briefing	Elsa has weakened some since NOAA42 was last in the storm yesterday, down to max sustained winds of 65 kt (edit: NHC at 11am downgraded to TS at 60 kt based on the Teal aircraft fixes). The storm continues to move quickly to the WNW, which is producing some higher northwesterly shear. The storm has become even more asymmetric, particularly in the precipitation distribution. Deep convection has been pulsing just E/SE of the center overnight and this morning, but the low-level center is likely still exposed to the W/NW of the main convective burst area. Because of the proximity of Hispaniola, the planned rotated Fig. 4 will be restricted on the north side. The modified plan made in the pre-flight brief

	was to fly the planned inbound from the SE, then try and get some kind of leg to the NE if the weather and proximity to land permits it. If not, then they'll proceed as planned to the NW. If they do get NE, it would be simply a reverse track back to the center, and then proceeding outbound to the NW. The NW will also have to be truncated due to land. After that, the airplane will repo to the SW for the next inbound, then fix the center, then head outbound to the S, then reposition to the east side for the final E to W pass. Altitude is still planned for 10000 ft, and the plan is to try and fix the center each time.
Instrument Notes	The Compact Raman Lidar is not operational, and the WSRA and cloud physics probes are not yet installed. THOR is installed and operational.

IN-FLIGHT	
Time [UTC]	**Event**
Pre-Takeoff	NHC has downgraded Elsa to a tropical storm with 60 kt max winds. This will be a relatively short ferry to the IP. The satellite imagery leading up to the flight is shown below. The imagery shows the fast propagation of Elsa, pulsing of convection, and the struggle of the deep convection to keep up with the forward speed of the storm. Note that the center was being fixed by the Air Force Reserve aircraft just to the west of the new convective burst. Vertical wind shear is low to the west of the storm, but over the center is higher due to the fast forward speed.

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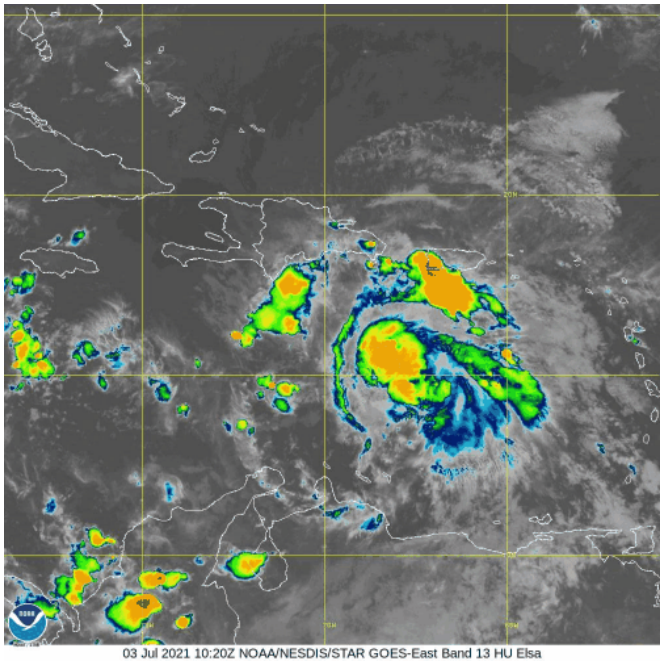
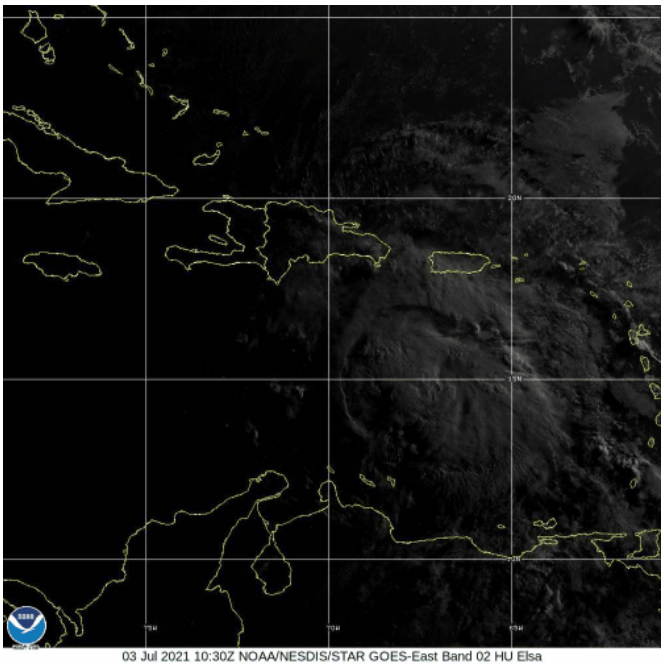
FLIGHT LOG -- 20210703H1



03 Jul 2021 10:20Z NOAA/NESDIS/STAR GOES-East Band 13 HU Elsa



03 Jul 2021 10:30Z NOAA/NESDIS/STAR GOES-East Band 02 HU Elsa

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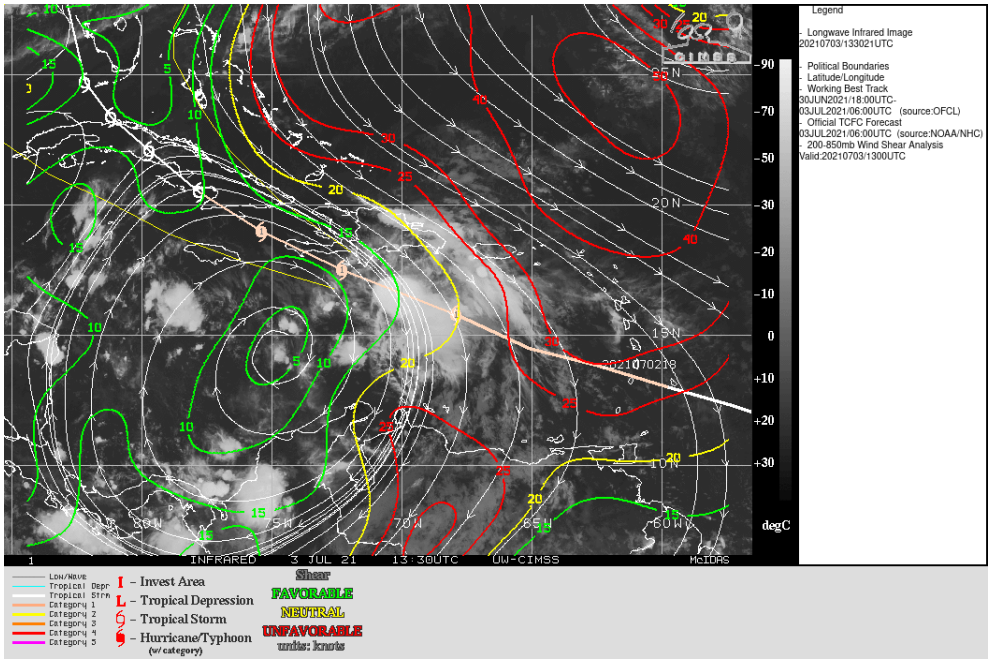
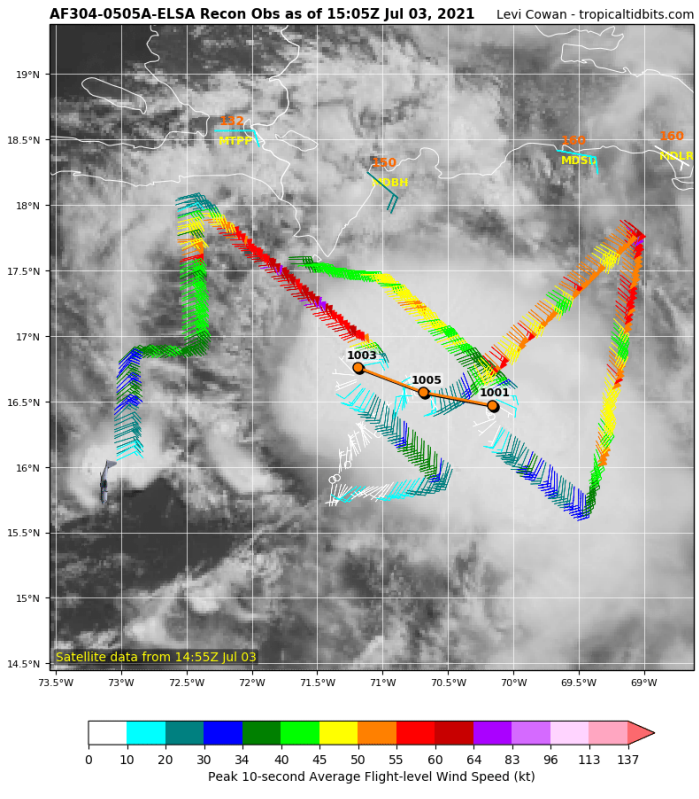
FLIGHT LOG -- 20210703H1





1538	Takeoff from Bermuda; delayed takeoff due to working clearances

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1603	Teal73 fixed the center around 17N/72W and will be doing one more pass of the center from east to west. At that position, it may still be possible to go outbound some to the NE on the first pass.
1624	Reached IP, released Sonde #1 at SE (135 deg azimuth) inbound
1636	Released Sonde #2 at the midpoint of inbound from the SE; Inbound to the center, likely seeing quite a bit of precipitation; other than the last east to west inbound, this may be the most precipitation observed today and among the best passes for winds.
1643	Released Sonde #3 at the CPA of the center; they were not able to release a center sonde since they were well east of the actual center. So while they did not get a center sonde, they can get about 80 miles out to the endpoint to the NE (and 40 mile at the midpoint). The plan is to proceed out 80 miles, reverse track on the same azimuth, and then hunt the center again, which will be further west of their original turn to the NE.
1651	Released Sonde #4 at the midpoint of the outbound to the NE
1700	Released Sonde #5 at the endpoint of the outbound to the NE; will turn around and retrace back inbound. The images below show the pass east of the center and the outbound to the NE. The timeseries of SFMR indicates that 60 kt winds were observed at the surface on the NE outbound. The strongest flight level winds were on the inbound and up at 55 kt.

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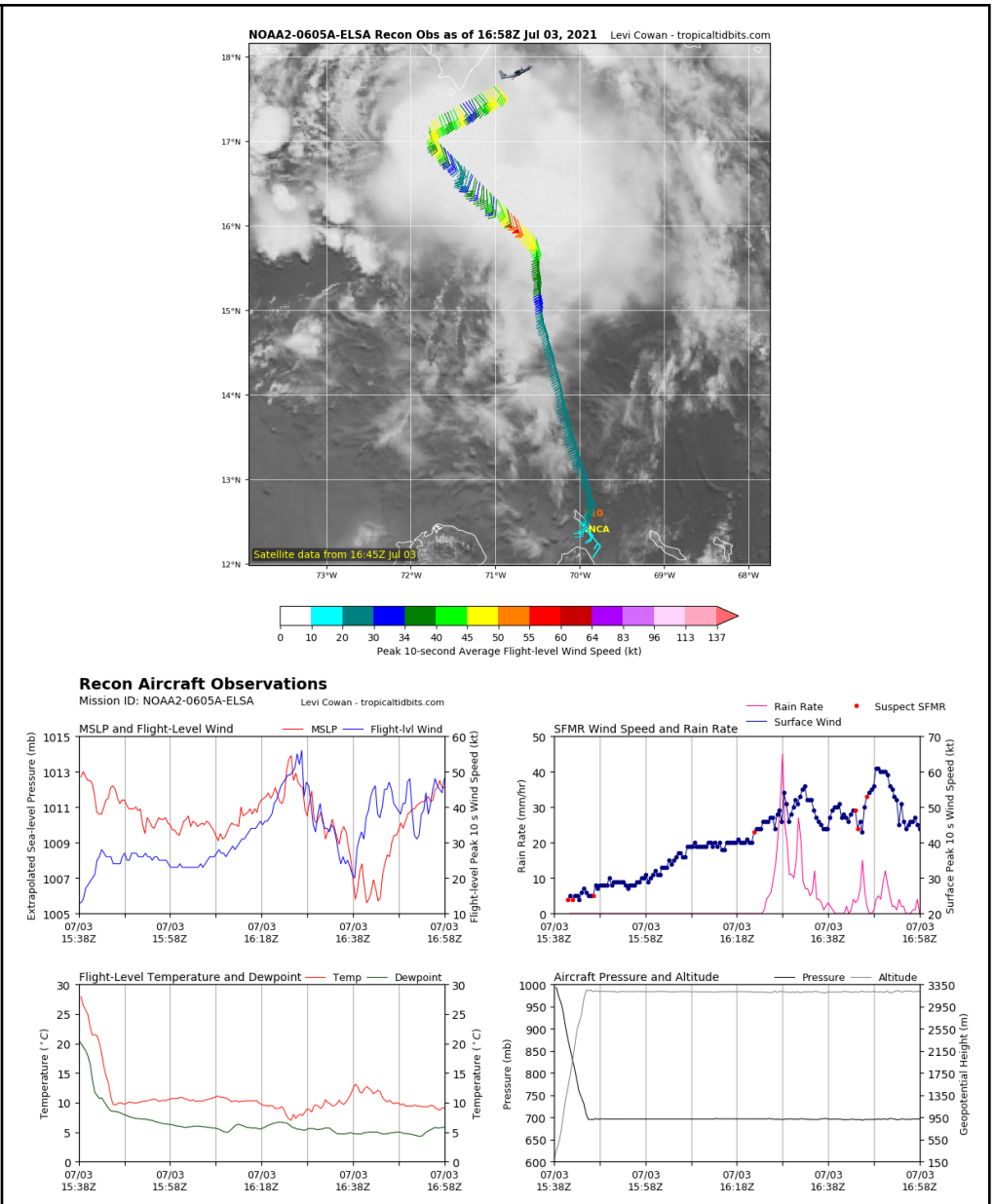
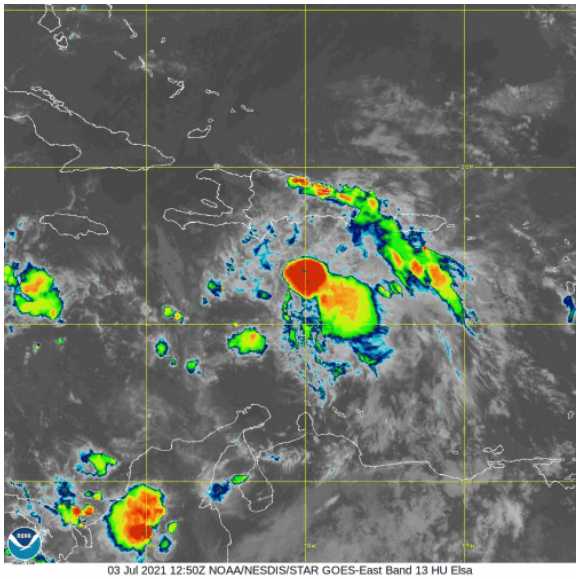
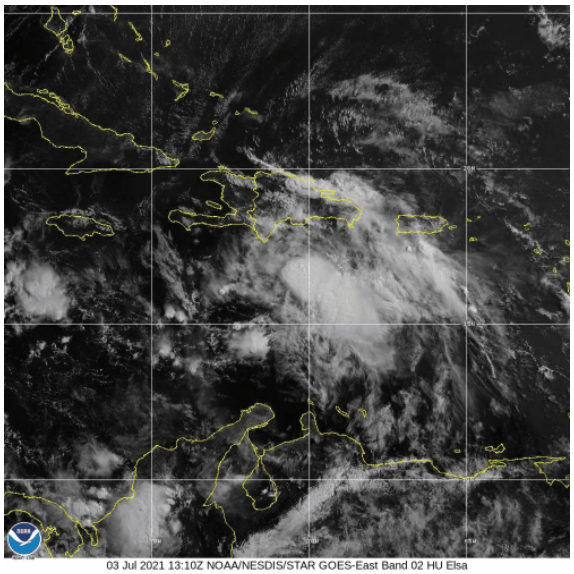
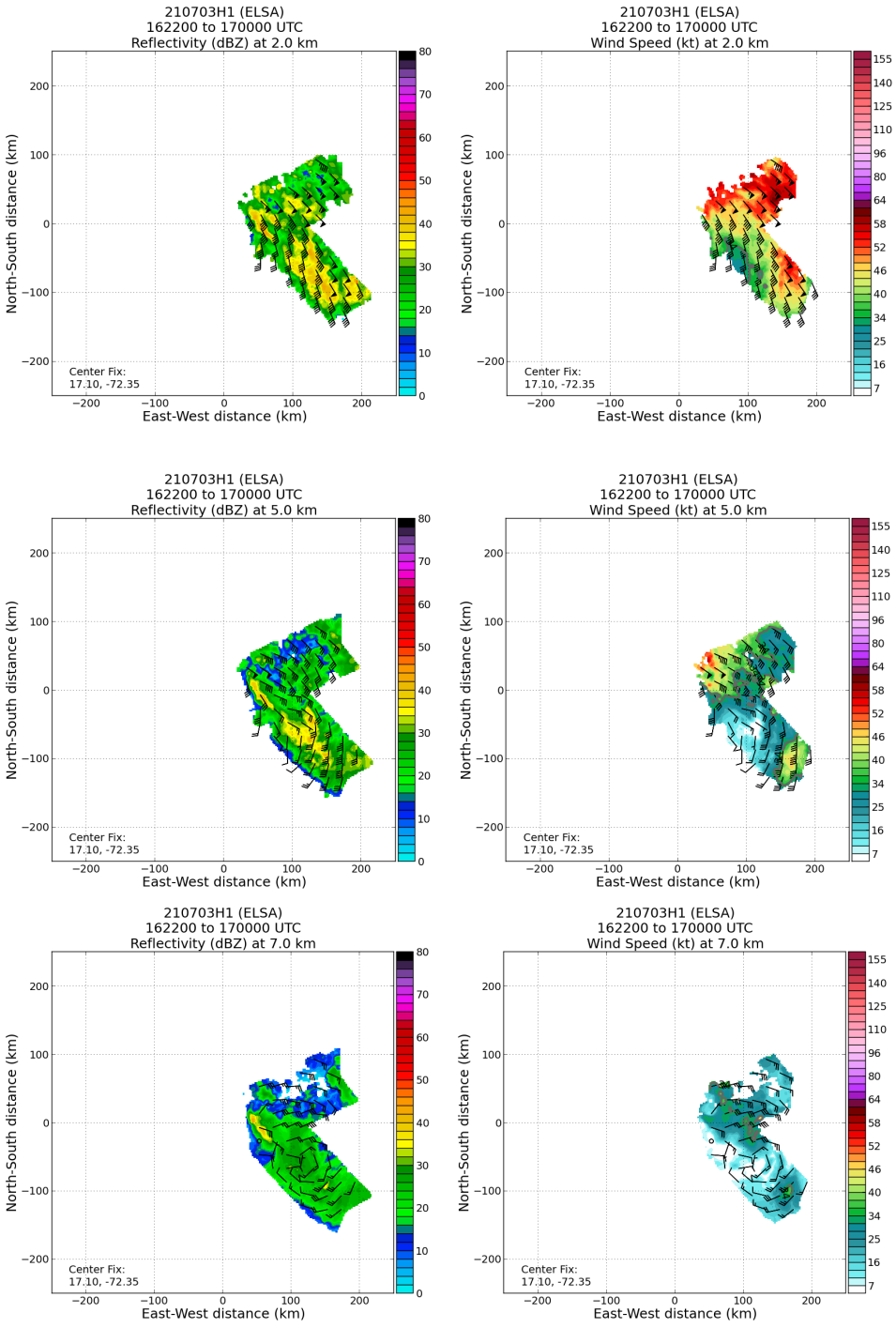
	
1717	The outbound leg to the NW will only be about 60 miles. We decided to not drop the midpoint sonde on that outbound, only the endpoint. Instead we'll drop a sonde at approximately the midpoint of the downwind reposition leg from the NW to the SW, which will help get us a better look at the surface circulation (we'll have dropped a sonde on each side of the circulation). Below is the satellite imagery from the first "pass". The convective burst

	downshear (east of the center) appears to be very “squall-line like” in that it may have a leading edge of convection and trailing stratiform.  03 Jul 2021 12:50Z NOAA/NESDIS/STAR GOES-East Band 13 HU Elsa  03 Jul 2021 13:10Z NOAA/NESDIS/STAR GOES-East Band 02 HU Elsa
1729	Released Sonde #6 near them marked flight level center; sonde had 1002.6 mb, 17 kt at the surface
1733	Below is a look at the first radar analysis from the TDR. It shows that we did indeed miss the flight-level center, and indicates substantial tilt in the storm between the low-levels and mid- to upper levels. At 2 km, the circulation is not in the swath, but at 7 km there is a clear circulation that was sampled

on the inbound, downshear and SE of the low-level center. The center tilts even more SE above 7 km:



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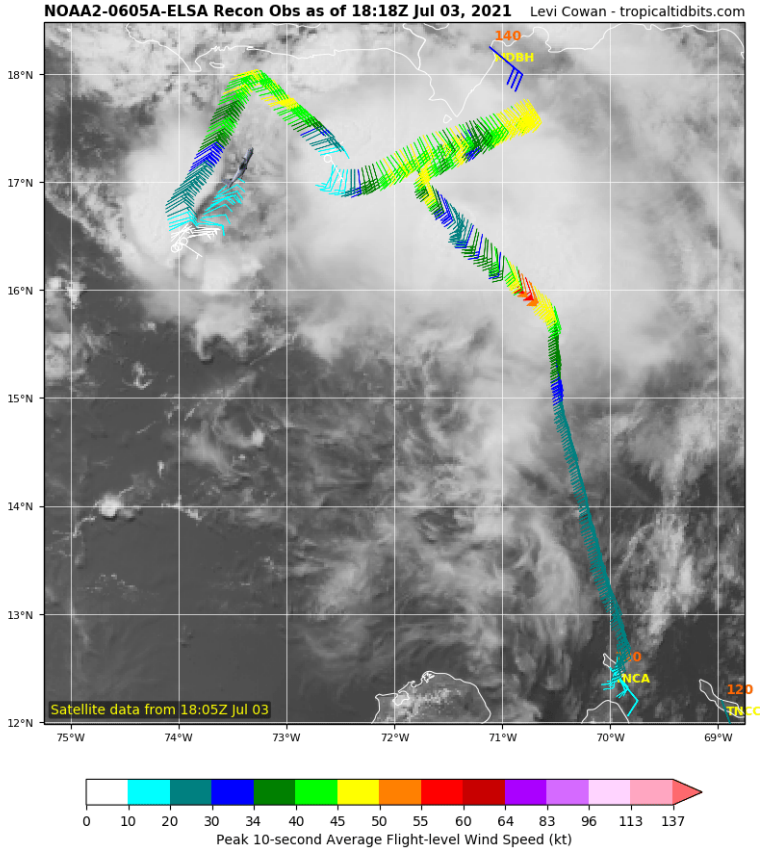
1744	Released Sonde #7 at the endpoint of the outbound to the NW, now turned downwind to reposition to the SW IP.
1757	Released Sonde #8 at the midpoint of the downwind reposition leg from NW to SW
1807	Released Sonde #9 at the IP for the inbound from the SW. TDR analysis #2 submitted. A look at the 2nd pass of the center below. Flight level winds are generally still near 50 kt, maybe peak 55 kt. Surface winds from SFMR indicated peaking around 60 kt. The satellite imagery indicates that some new convection has developed to the west of the center -- convection they had to actually divert around as they got close to the end of the downwind leg at the SW point. 

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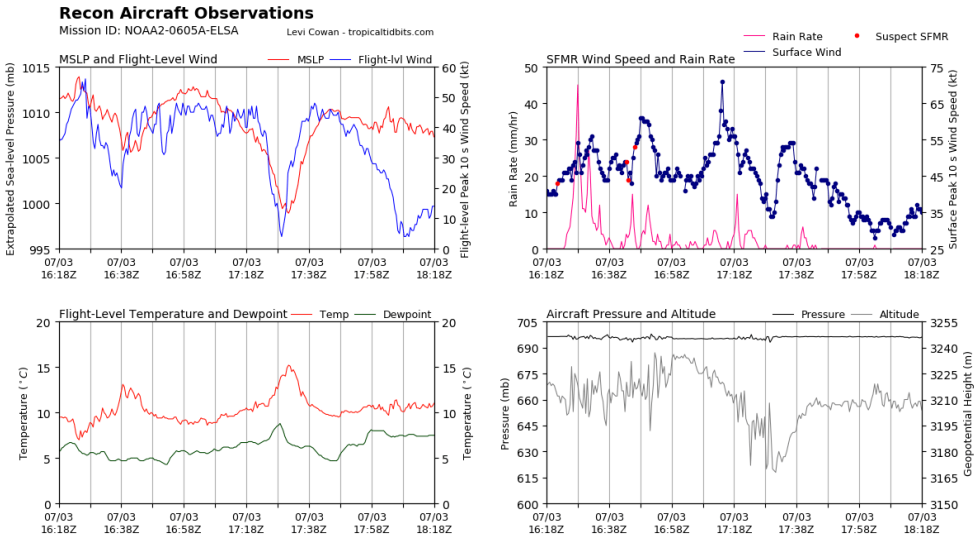

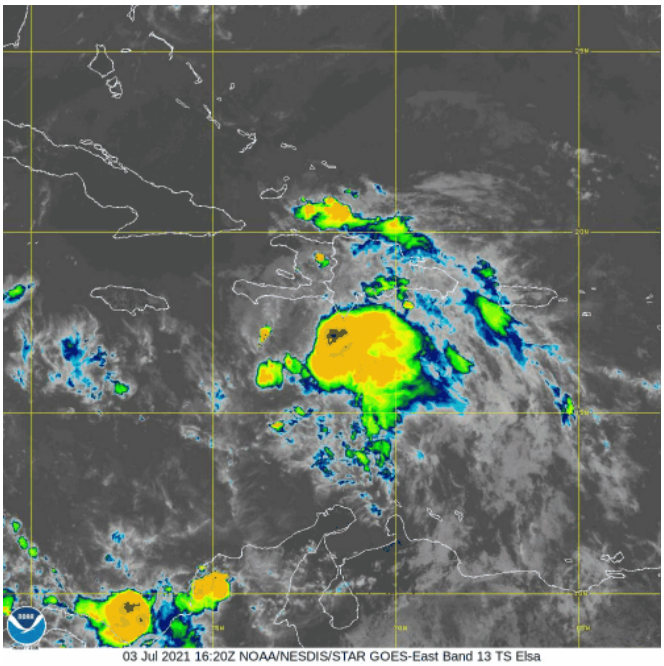

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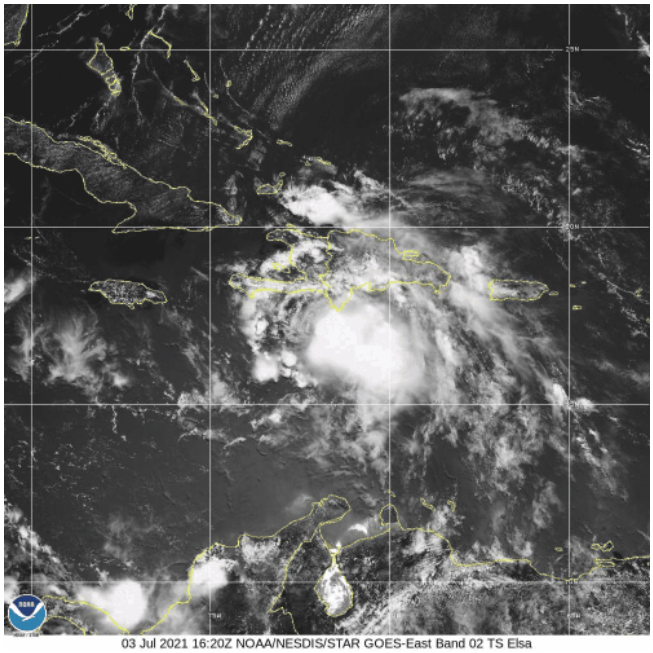
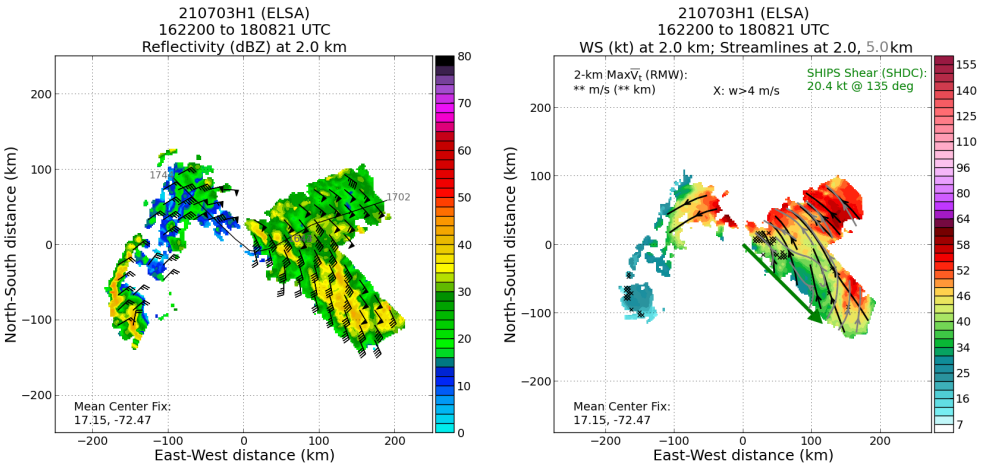
FLIGHT LOG -- 20210703H1

	 03 Jul 2021 16:20Z NOAA/NESDIS/STAR GOES-East Band 02 TS Elsa
1819	Released Sonde #10 at the midpoint of the inbound from the SW
1843	Released Sonde #11 at the midpoint of the outbound leg to the south. Here is the composite from the TDR so far: Actually got pretty good coverage on the leg to the NW and the downwind in that convective band that developed. 
1857	Released Sonde #12 at the endpoint of the outbound to the south.

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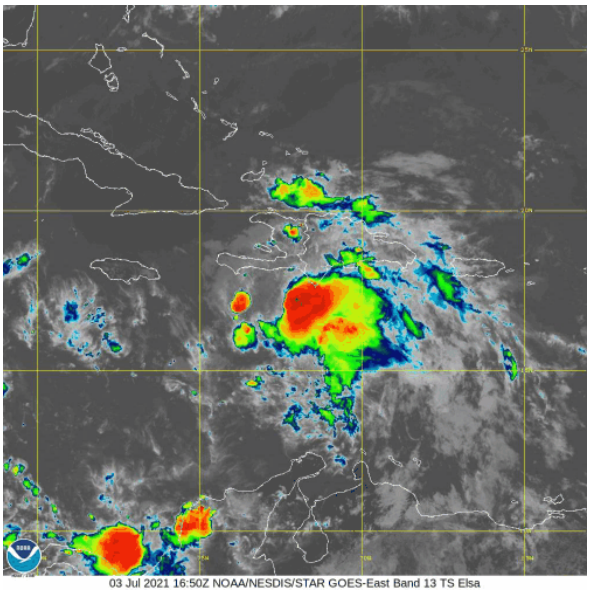
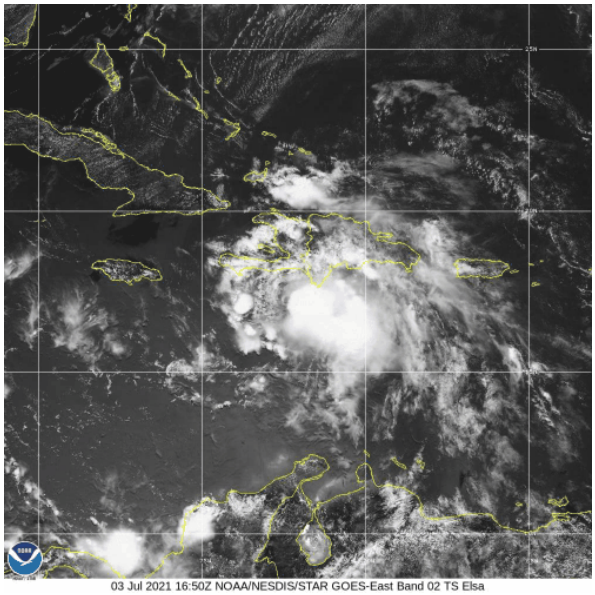
Satellite imagery indicates that not only is there convection to the west of the center, but also deep convection developing north of the center near the coast of Hispaniola. Plenty of lightning developing in the burst to the north of the center. There should be plenty of precipitation on the final downwind and west to east pass to provide additional wind analyses.



03 Jul 2021 16:50Z NOAA/NESDIS/STAR GOES-East Band 13 TS Elsa



03 Jul 2021 16:50Z NOAA/NESDIS/STAR GOES-East Band 02 TS Elsa

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	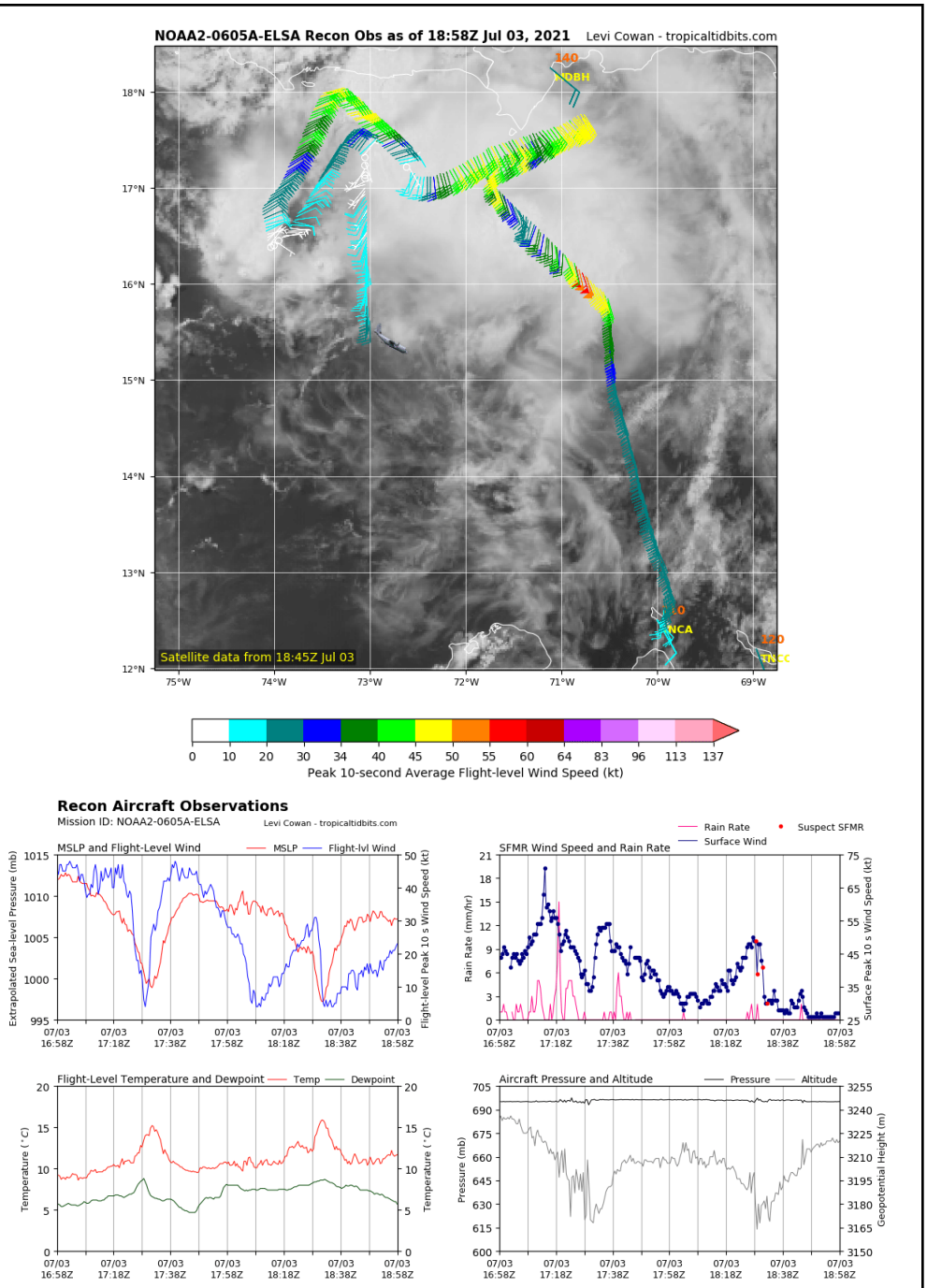
1930	Released Sonde #13 at IP of the inbound from the east, now heading into the center towards the west.
1942	Released Sonde #14 at the midpoint of the inbound from the east.

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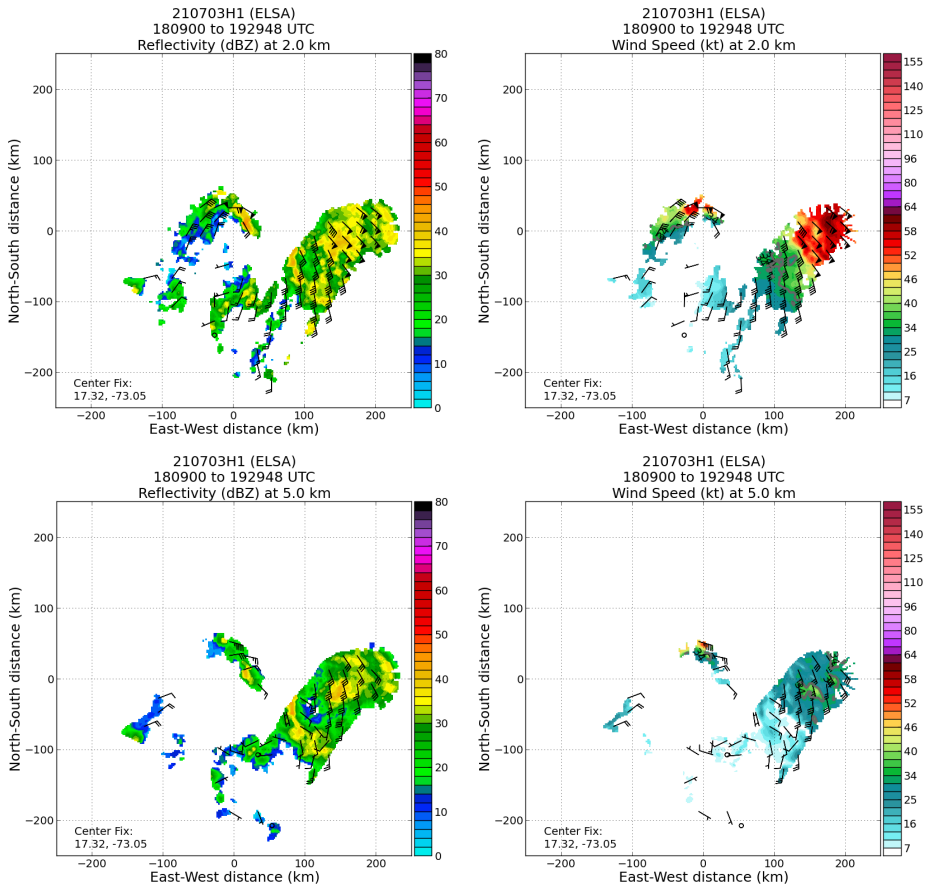
1954	Released Sonde #15 at the approximate center of the east to west pass; center sonde splashed at 1000 mb with a 22 kt at 110 deg wind, so just missed the actual surface center.
2005	Released Sonde #16 at midpoint of outbound leg to the west The third TDR analysis is complete. Just as before, the low-level center (below 5 km) seems to be fairly disorganized and displaced well to the west of the mid- to upper-level center (shown below is 7 km). Although it's possible that a circulation is trying to develop upward over the low-level circulation with the deep convection that has been developing in the vicinity of the surface and low-level circulation. 

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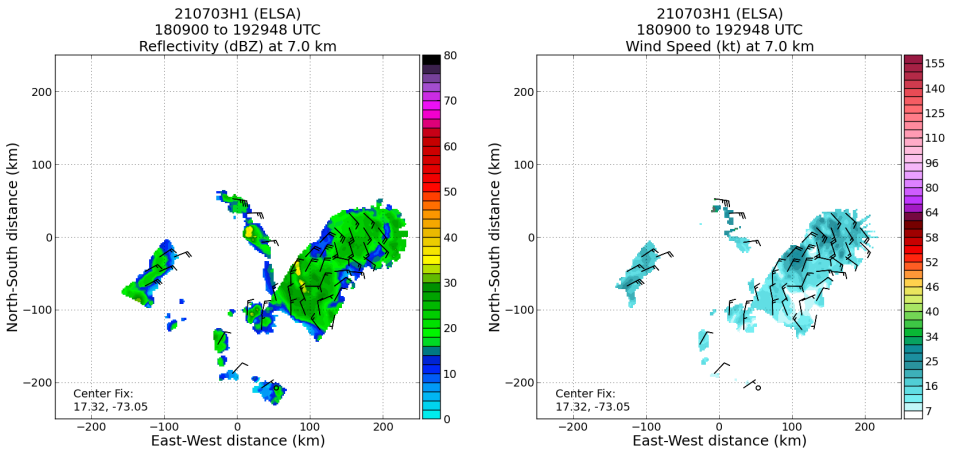
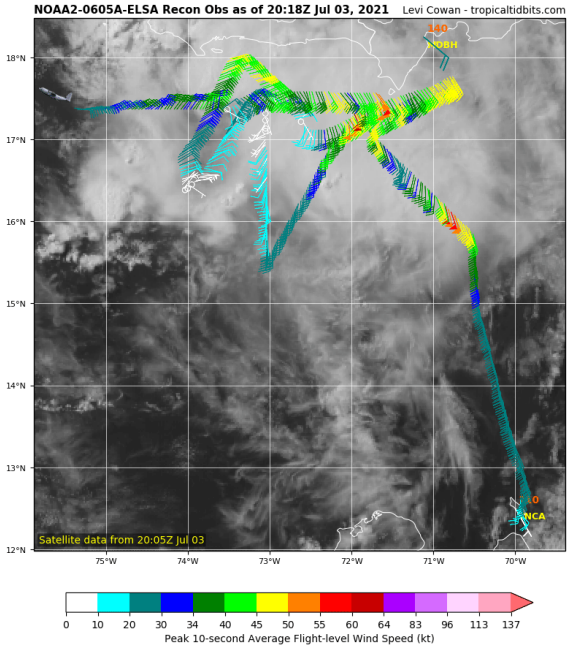
	
2017	Released Sonde #17 at the endpoint of the outbound to the west. This is the last sonde and the pattern is complete. Here is the timeline for the last pass. It appears that the extrapolated MSLP may be a bit lower, but the peak flight level (55-60 kt) and surface winds (55-60 kt) appear to be consistent with the earlier in the flight. 

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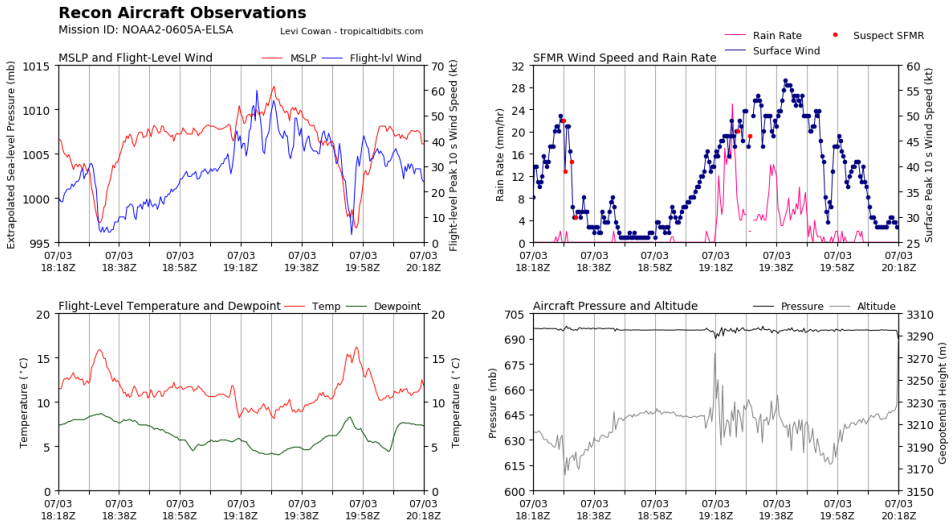
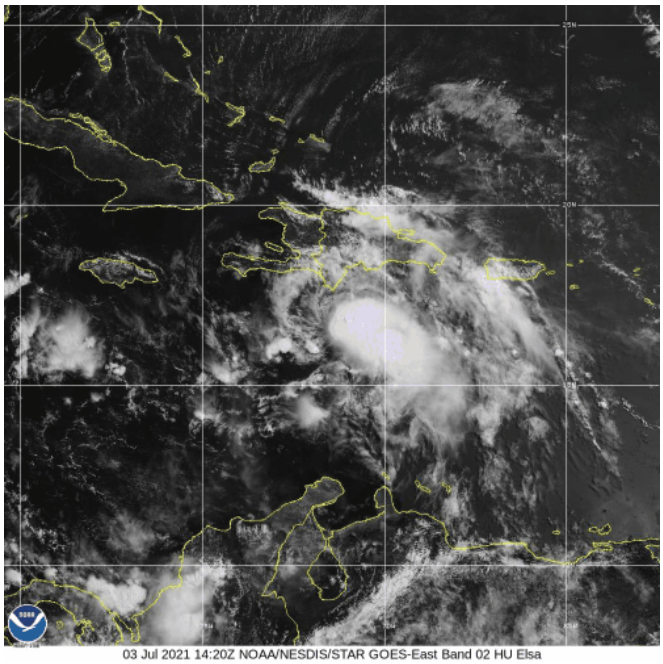
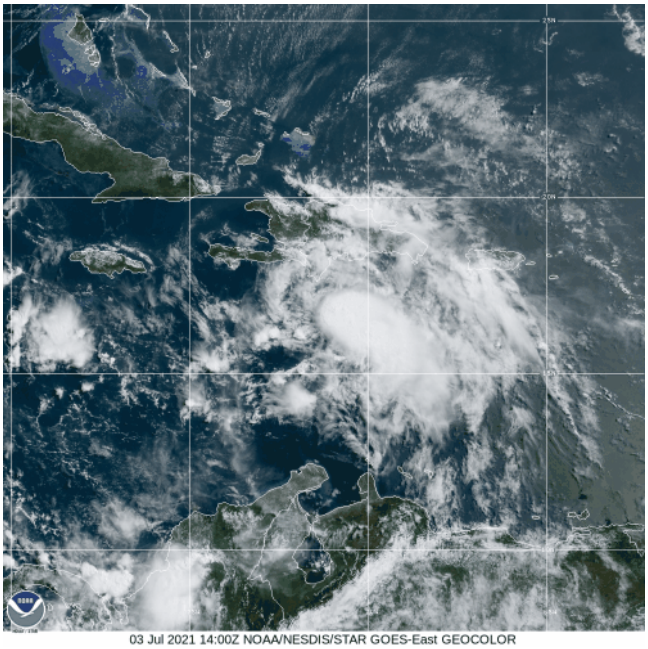


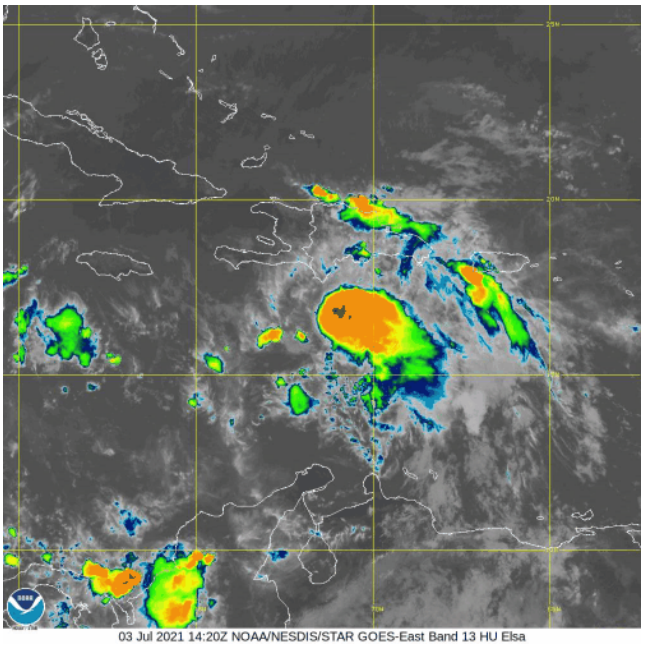
Here is the satellite imagery from the full on-station time showing the increased convective coverage to the W of the center:



FLIGHT LOG -- 20210703H1



03 Jul 2021 14:00Z NOAA/NESDIS/STAR GOES-East GEOCOLOR



03 Jul 2021 14:20Z NOAA/NESDIS/STAR GOES-East Band 13 HU Elsa

Here is a look at the radar analyses from the final pass:

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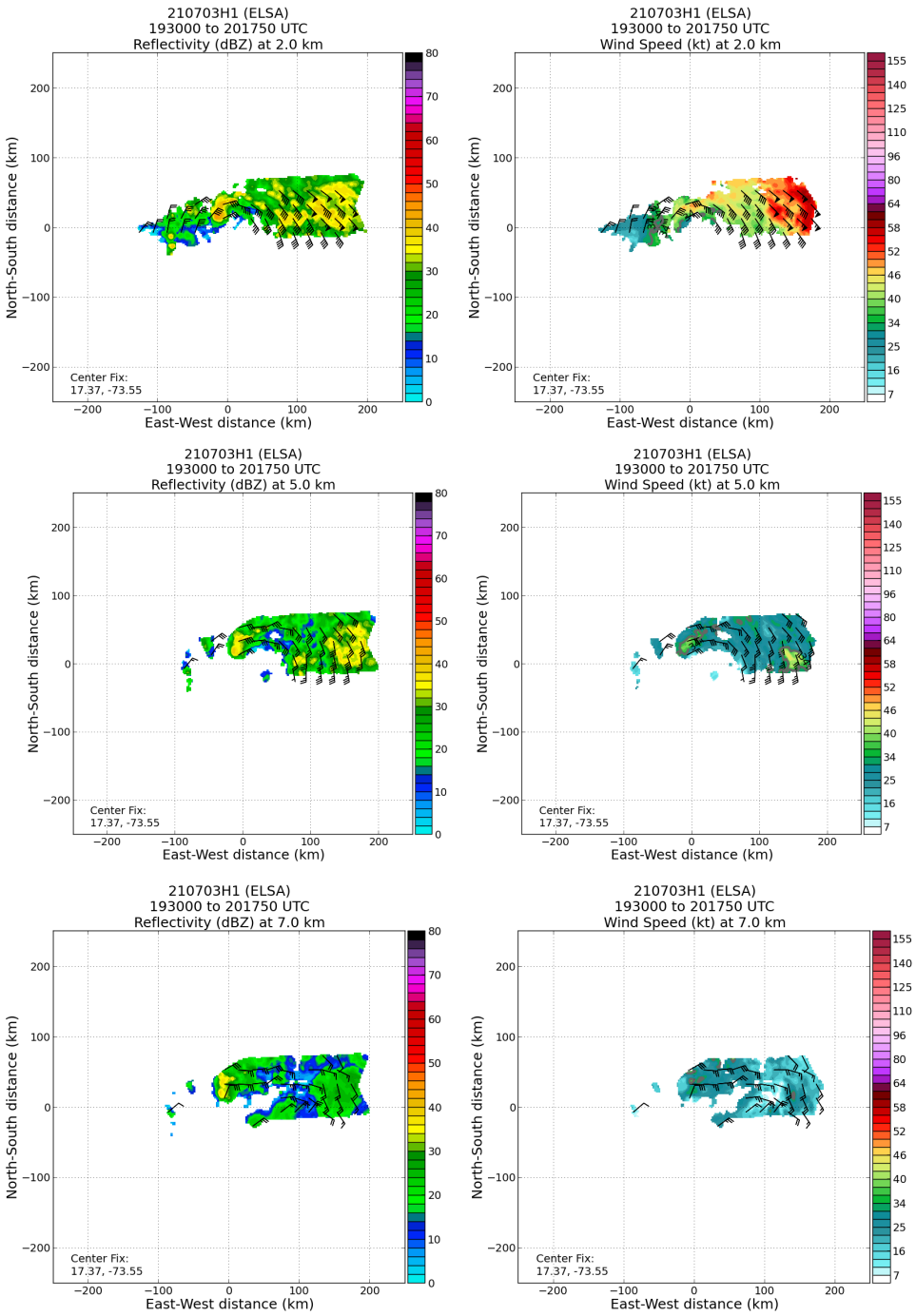

2242	Landed in Lakeland

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POST-FLIGHT	
Mission Summary	Overall, this flight was successfully flown for EMC as all planned sonde releases and tail Doppler radar analyses were transmitted off the airplane. The pattern was challenging to fly due to the fast forward speed of Elsa and its close proximity to Hispaniola. Despite these challenges, all quadrants were sampled to some extent, with precipitation in each to provide some winds from the TDR on each radial. Overall, the storm did not appear to strengthen or weaken during the flight, maintaining generally 50-60 kt winds at the surface and flight level. The radar analyses showed a highly tilted vortex structure, with the low-level center well to the west (by ~100 km) of the mid- to upper-level center -- a clear signal of the northwesterly shear impacting the storm (also likely due to the fast forward speed). While precipitation began asymmetric in distribution, there was interestingly an increase in deep convection on the west side of the low-level circulation -- a couple of deep convective bursts developed to the west and north. How this convection will impact the vortex is unclear as the mission ended before observing this response. 17 total sondes released; all good and all transmitted. The HRD crew was able to overcome challenges of not having NASA's Mission Tools Suite for situational awareness; they used a number of other tools, as well as direct communication with the aircraft crew to get the pertinent information.
Actual Standard Pattern Flown	Rotated Figure 4; got heavily distorted due to proximity to land and the fast forward speed of the storm
APHEX Experiments / Modules Flown	None
Plain Language Summary	● The NOAA P-3 flew this mission in support of data ingestion into NOAA/National Centers for Environmental Prediction/ Environmental Modeling Center's Hurricane Weather Research and Forecasting (HWRF) forecast model. ● Elsa's circulation was observed to be fairly disorganized such that the circulation center tilted substantially with height, indicative of unfavorable northwesterly shear that was displacing the higher altitude circulation to the southeast of the surface center location.

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	• This wind shear prevented Elsa from strengthening further, and likely led to the weakening trend observed prior to the mission.
Instrument Notes	The THOR instrument did not appear to be functional during the flight; otherwise, no noted issues with installed instrumentation.
Final Mission Track