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Hurricane Field Program
Advancing the Prediction of Hurricanes Experiment (APHEX)

FLIGHT LOG - 20231022I1

MISSION PLAN			
FLIGHT ID	20231022I1	**STORM**	AL20/Tammy
MISSION ID	1220A TAMMY	**TAIL NUMBER**	NOAA-43
TASKING	HRD	**PLANNED PATTERN**	Butterfly + modules
MISSION SUMMARY			
TAKEOFF [UTC]	1303	**LANDING [UTC]**	2116
TAKEOFF LOCATION	TBPB	**LANDING LOCATION**	TBPB
FLIGHT TIME	8.2	**BLOCK TIME**	8.5
TOTAL REAL-TIME RADAR ANALYSES (Transmitted)	7 (7)	**TOTAL DROPSONDES Deployed (Transmitted)**	22 (20)
OCEAN EXPENDABLES (Type)	4 (2) AOC/HRD AXBT	**sUAS (Type)**	1 Altius-600
APHEX EXPERIMENTS / MODULES	RICO SUAVE, VAM, Microphysics Spiral, CHAOS (Saildrone 1040)		
HRD CREW MANIFEST			
LPS ONBOARD	Marks/Cione	**LPS GROUND**	Dunion
TDR ONBOARD	Marks	**TDR GROUND**	Reasor/Fischer
ASPEN ONBOARD	J. Zhang	**ASPEN GROUND**	n/a
NESDIS SCIENTISTS	n/a		
GUESTS (Affiliation)	Sosa, Person (Area I)		
AOC CREW MANIFEST			
PILOTS	Doremus/Wood/Keith		
NAVIGATOR	Miller		
FLIGHT ENGINEERS	Tyson/Wysinger		
FLIGHT DIRECTOR	Zawislak/Lundry		
DATA TECHNICIAN	Richards		
AVAPS	Waggoner/Patel		

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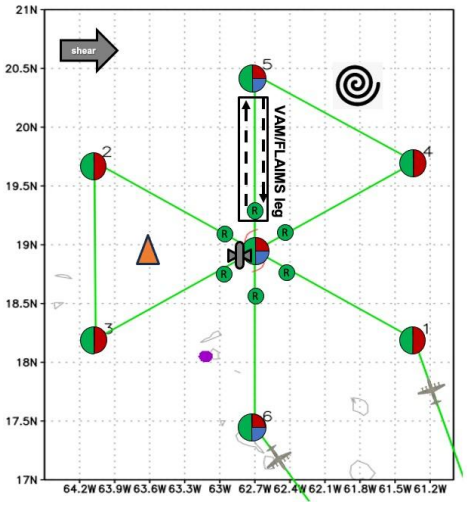
PRE-FLIGHT

Flight Plan

N43 flight into TAMMY: 22 Oct 2023 (20231022I1) *Tasking: NHC/EMC*



Flight track
Combo drop (sonde + IR sonde)
Super combo drop (sonde + AXBT + IR sonde)
RMW drop
Altius sUAS
Saildrone 1040 (18.90N 63.61W)
Microphysics Spiral

Expendable payload:
- 15 dropsondes: 6 turn, 3 center, 6 RMW (ONR)
- 4 AXBTs (1st center pass, WP 5, WP 6, 1 RMW)
  - RMW location at the discretion of the onboard LPS)
- 7 IR sondes (endpoints and 1st center pass)
- 1 Altius sUAS (2nd center pass)

AXBT/IR sonde guidance: AXBTs at 1st center, WP 5, WP 6, and at 1 RMW determined by LPS (would have to be on the 2nd or 3rd pass). IR sondes at each end point and first center.

Altius guidance: launch at center on 2nd pass (WP 3-4)

VAM/FLAIMS guidance: VAM if misaligned, FLAIMS if intensifying. Ideal leg is WP 5 to center.

MP Spiral: near WP 4 or 5, after Altius splashes (LPS discretion)

Saildrone 1040: near center-WP 2 midpoint (launch dropsonde, charge to GOMO). Position will be updated during the mission.

Pattern: Butterfly with 90 NM legs

- additional legs may be added after the initial butterfly pattern - at the discretion of the onboard HRD LPS
- legs may be shortened to maintain comms with Altius

Altitude:

- 8 or 10 kft (pressure altitude) depending on AF deconfliction requirements (FL 10 kft preferred)

Potential add-on APHEX Modules:

- Priority #1: RICO SUAVE (Altius)
  - Launch at center of 2nd pass (WP 3-4)
  - Preferred launch altitude: 12 kft (depending on AF deconfliction requirements)
- Priority #2: VAM or FLAIMS Module - see notes
  - If the storm has vertically aligned, the FLAIMS module can be substituted for VAMS - at the discretion of the onboard HRD LPS
- Priority #3: Microphysics Spiral - see notes
  - Perform only after Altius has splashed

Expendable Distribution

- Load 25 dropsondes

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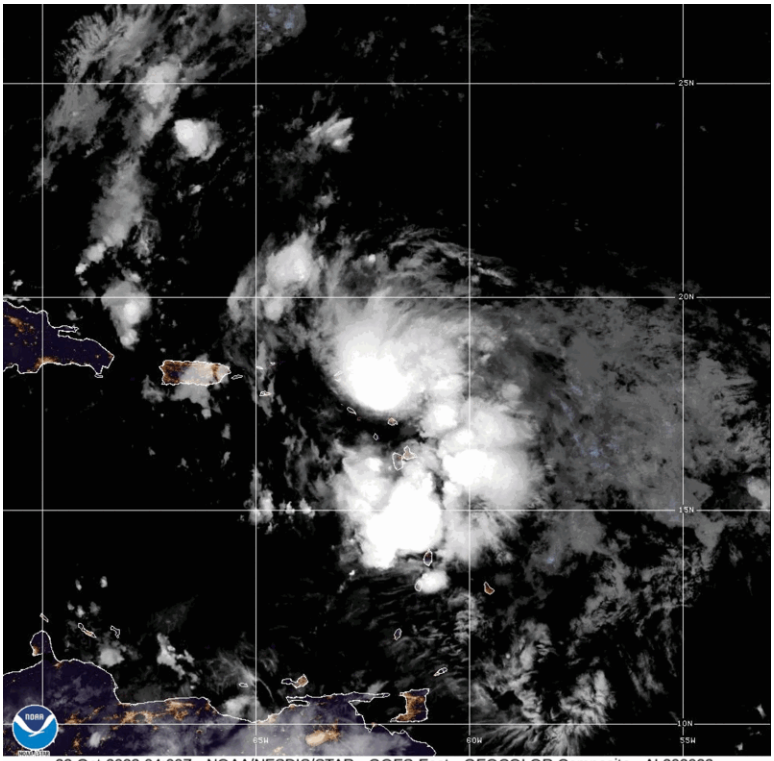
	○ Release at endpoints, centers (charged to NWS); no midpoint dropsondes ○ Possible supplemental RMW drops (charged to ONR) - if eyewall is present (at discretion of the onboard HRD LPS) ○ Additional drops may be requested at the discretion of the onboard HRD LPS ○ All dropsondes transmitted to the GTS ○ Dropsonde deployments should be adjusted as needed to avoid land ● IR dropsondes (7) - see notes below ● Altius sUAS (1) - see notes below ● 4 AXBTs (CAD launched) - see notes below ○ All AXBTs transmitted to the AOC ground server if possible
Preflight Weather Briefing	*[Notes from the Flight Crew Preflight Briefing and other relevant notes about the current and forecasted storm state from the most recent NHC advisory (location, intensity, MSLP, movement, possible intensity change during the flight)]* *[Briefly describe the relevant environmental drivers.]*  22 Oct 2023 04:00Z - NOAA/NESDIS/STAR - GOES-East - GEOCOLOR Composite - AL202023

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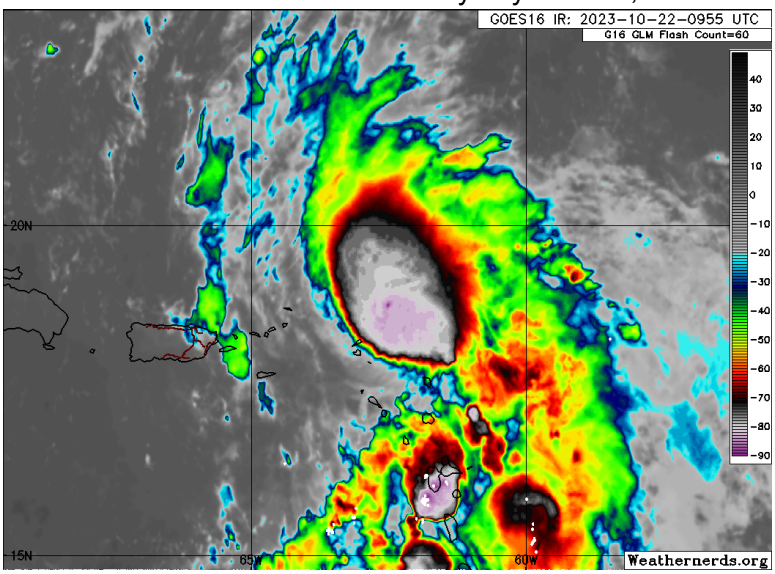
Instrument Notes	*All instruments were nominal except WSRA that was inoperative.*

IN-FLIGHT	
Time [UTC]	**Event**
1303	Take-off from TBPB
1316	TDR up and is nominal Convective structure is fairly asymmetric, consistent with SW shear 

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	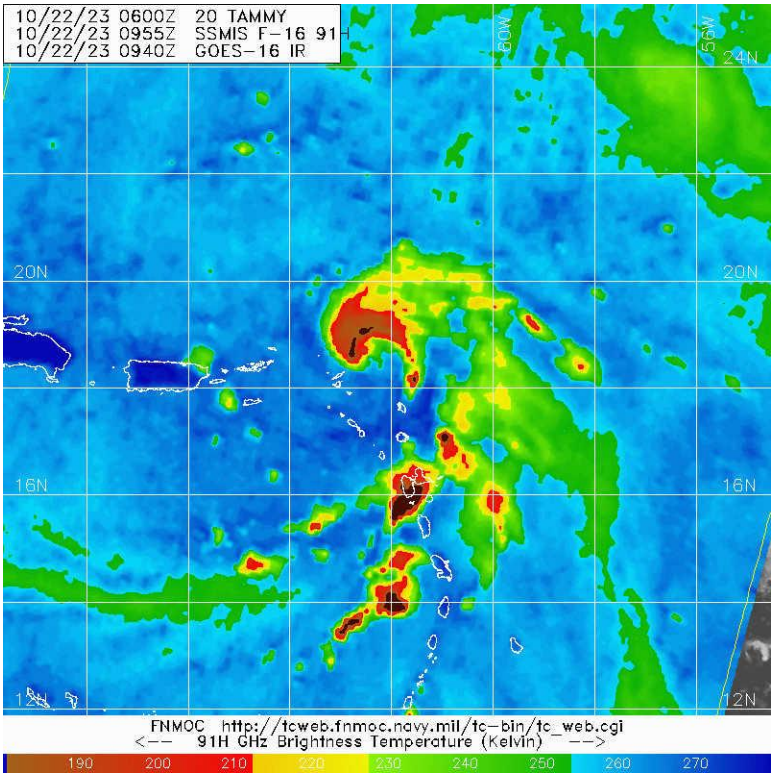
1319	we will follow plan as drawn up for 1st pass from PT#1-PT#2. On the downwind leg from PT#2-PT#3 we will do Altius prep and checklist. We will deploy Altius on the inbound leg from PT#3, orbiting to confirm launch and comms. Once confirmed we will proceed to center and outbound to PT#4 to test comm link to Altius. If we lose comms we will return to center to restore comms.
1343	entering stratiform rain area from principal rainband sitting over Guadalupe island
1359	SD 1040 18.9347008 -63.3654272 2023-10-22T11:59:00Z
1400	begin descent to 8 kft
1406	at 8 kft, test run of Altius checklist test
1409	<marks_n43> mfischer_hrd, tracking along between cells in major rainband
1414	PT #1, combo IR sonde #1, drop #2, TK 300 inbound
1419	In principal rainband we are still seeing interesting across flow convective cell alignment into almost regularly space lines like yesterday marks_n43>

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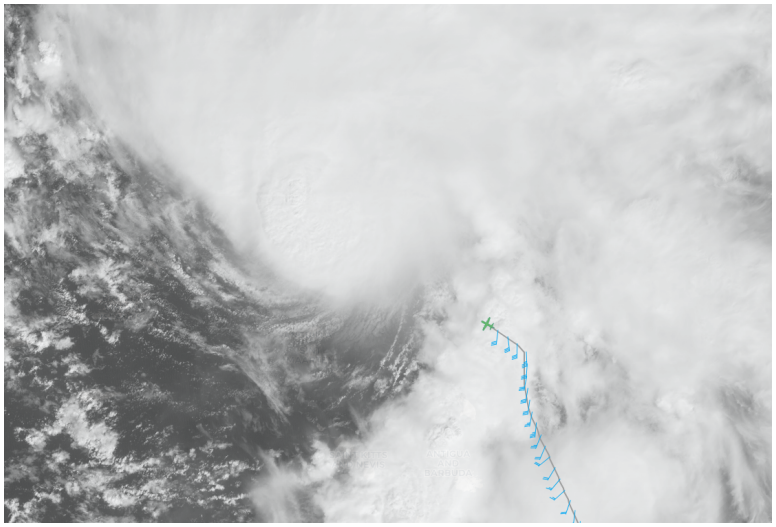
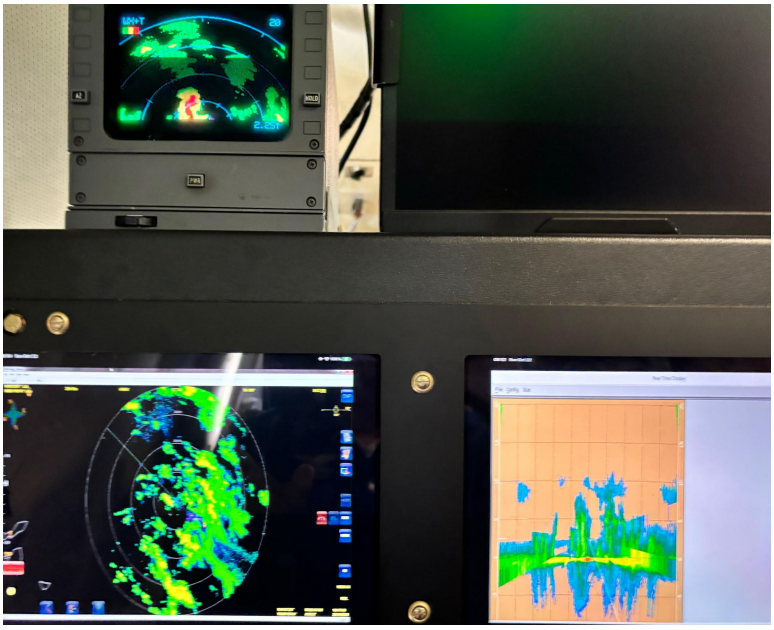
	 in the band <marks_n43> tops 12-14 km 
1427	MMR shows the radar eye is elliptical with E-W major axis of 30 nmi, minor axis 25 nmi

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	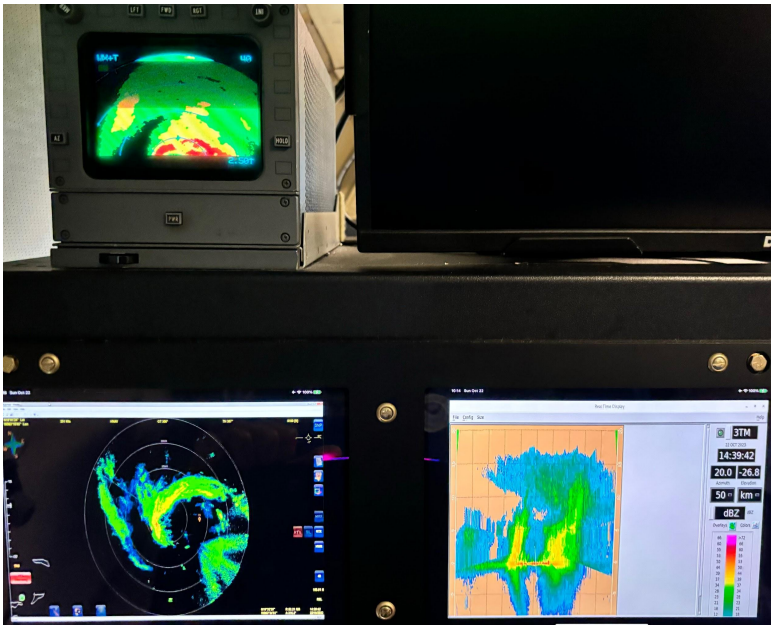
1433	RMW drop #3, well inside radar eyewall, radius ~12
1437	center super combo IR drop #4, drop #5, AXBT #1 SST 28.61, tucked up against NW eyewall
1440	RMW drop #6, good one as we hit the eyewall
1444	<marks_n43> mfischer_hrd, 1437 center supercombo IR drop #4, drop #5, AXBT #1, tucked up with NW eyewall <marks_n43> 1440 RMW drop #6, good one as we hit the eyewall <marks_n43> SST 28.6
1459	PT#2, combo drop IR drop #7, drop #8, TK 180, may have to change PT#3 to avoid islands
1502	plan is to go from PT #3 inbound to center, deploy Altius in center, verify comms, proceed to west to do super combo drop near Saildrone 1040, then return to track to NE1459
1503	1st TDR analysis submitted
1506	combo IR drop#6, drop #7 trurn downwind 180
1510	start Altius launch checklist
1517	<marks_n43> mfischer_hrd, we are shortening leg to avoid islands. turn SE to avoid islands, moving PT#3

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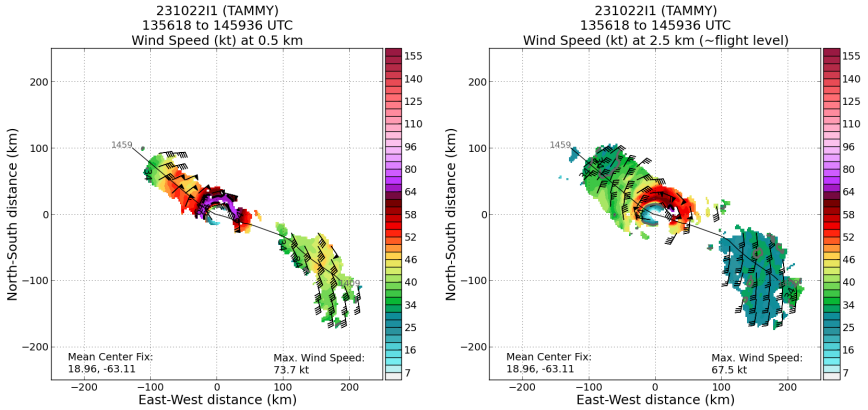
1519	1st TDR analysis complete Alt (km) Lat (deg) Lon (deg) 0.5 18.92 63.07 2.0 18.96 63.11 3.0 19.00 63.11 6.0 19.05 63.11 2-6 km vortex tilt: 10.0 km at 360 deg
1522	new PT #3, combo IR drop#9, drop #10, TK 060, start 2nd TDR leg as there were no scatterers on downwind leg
1528	<marks_n43> mfischer_hrd, heads up Saildrone is positioned in the WSW radar eyewall now.
1534	TDR analysis shows an open eyewall to the S, with deep convection in NW eyewall 
1539	1539 Altius launch inside SW eye
1542	Altius checks out, descending to 2500’
1547	marks_n43> Orbiting in SW side of eye making sure Altius is cool. looking good so far. wings deployed descending to 3000'
1549	Orbiting in eyewall after Altius launch

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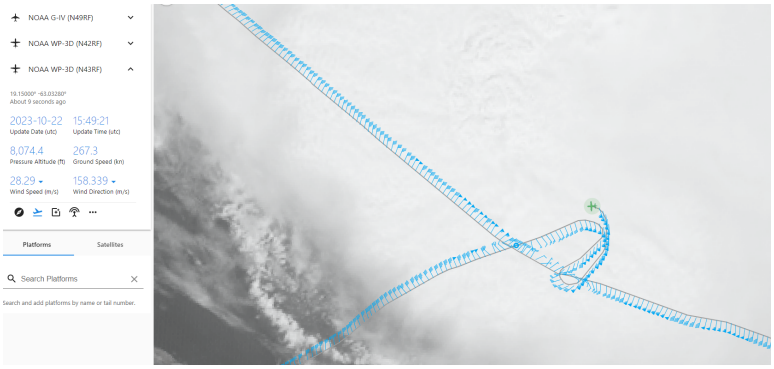
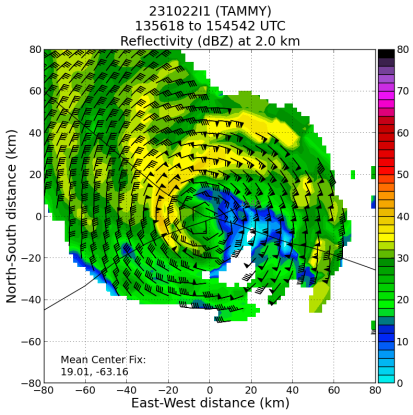
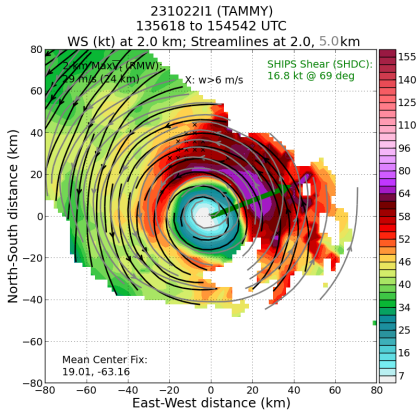
	
1555	TK 225 to Saildrone
1557	center
1558	2nd TDR analysis completed  
1559	Saildrone super combo IR drops #11, drop #12, AXBT #2 SST 28.95, just in the RMW
1601	lost Altius comms
1603	We lost Altius comms and are turning back into the eye
1604	turn back to eye
1608	<marks_n43> We will orbit for a few minutes while they troubleshoot comms
1610	center orbiting in eye to reestablish Altius comms
1614	re-establish Altius comms and continue orbiting in center to test comm range. Altius orbited ¾ of the way around the eye from drop location S of

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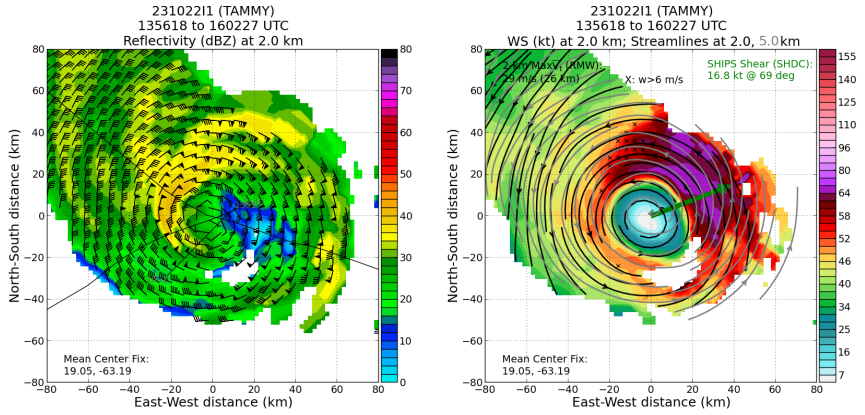
	center to the NW portion near Saildrone location.
1619	<marks_n43> mfischer_hrd, we are tracking in the clear to test comms range to Altius
1621	comm range limited to 25 nmi
1622	center, TK 060, 3rd TDR analysis completed 
1623	<marks_n43> mfischer_hrd, plan is to complete this outbound leg, turn around and come back inbound to eye to fly over Altius and uplink any data they collected while we were out NE
1626	RMW drop #13
1628	plan to TK 060 then do RMW drop #16, FL 90 kt
1635	<marks_n43> mfischer_hrd, we will track out to PT#4 or a little closer, go downwind to do FLAIMS wedge of 30 deg, turning back into eye on a 210 TK
1639	new PT#4, turn track downwind inside rainband
1650	turn, drop #14, TK 210 inbound
1703	RMW drop #15 FL 90 kt
1708	center, orbiting around Altius last position, 4th TDR analysis completed

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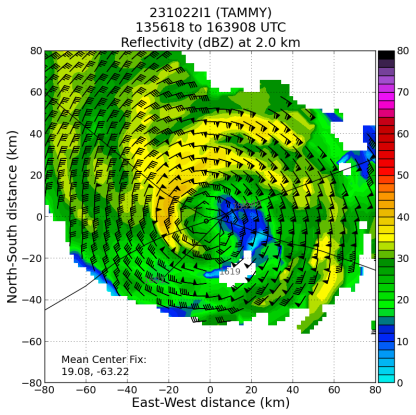
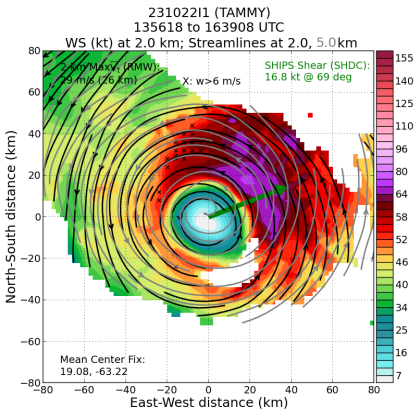
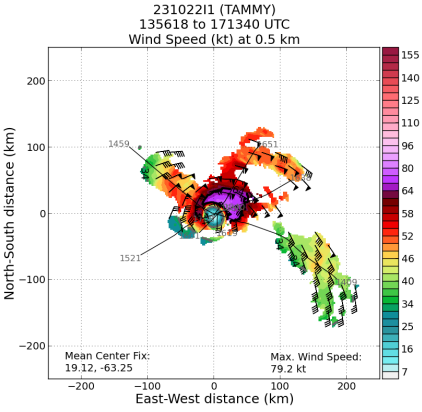
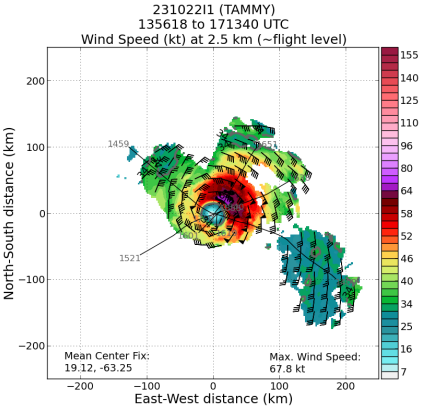
	 
1717	TK S out of eye to try to reestablish comms with Altius. The plan is to go back and forth to the S toward last known point of Altius to see if we can connect
1722	no joy! TK 180 out of RMW and then back to the eye to do leg to the N
1722	The 5th TDR analysis indicated peak low-level winds have intensified over the duration of the flight  
1724	<marks_n43> 1722 TK 180 out of the eye and then we will turn around and head N for microphysics spiral
1725	TK 360 to eye
1733	center, combo drop #16, AXBT #3, 989 mb AXBT failed
1737	RMW drop #17, FL 90 kt
1744	<marks_n43> jasond_hrd, mfischer_hrd so my thinking is to finish N leg to 90 nmi, then locate a place to do microphysics spiral near the north edge of

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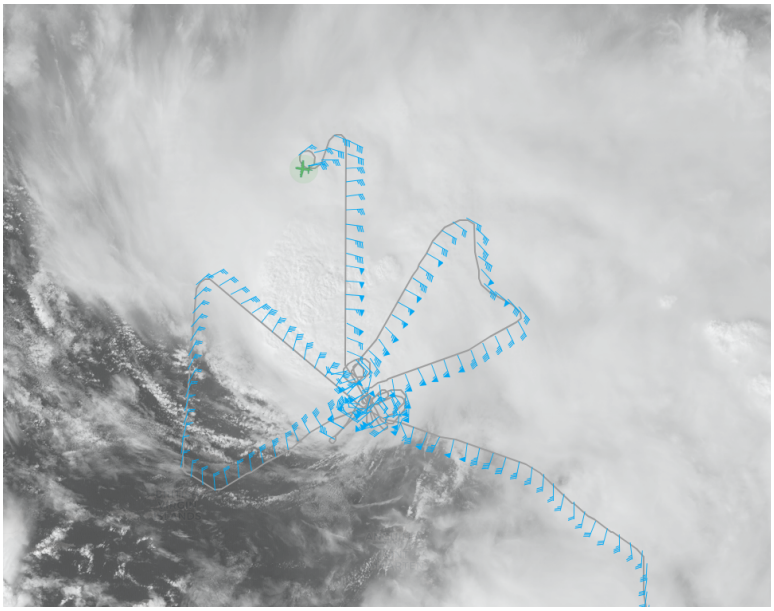
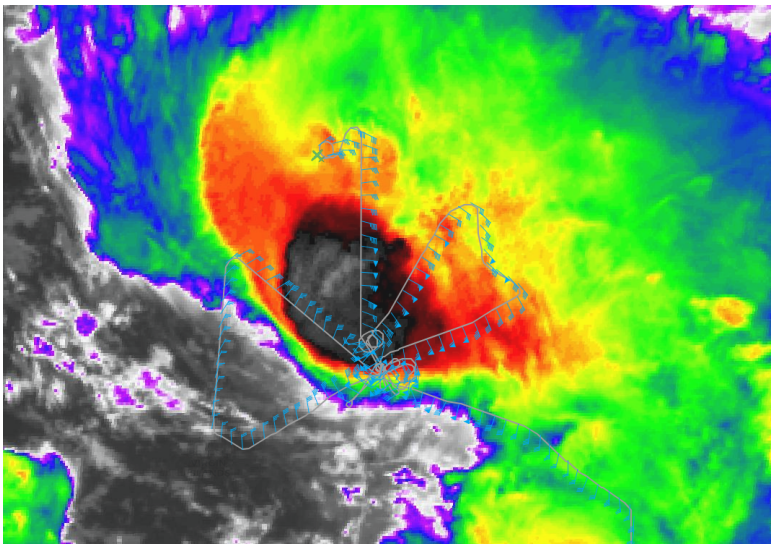
	strat area, and then move inbound to find a 2nd spiral location. There is plenty of strat out N of the center
1751	Last center drop recorded 989 mb with 11 kt, indicating some intensification
1754	end leg turn to SW to locate spiral
1759	start spiral 8,000 ft on far N edge of stratiform area N of center. 0 C 4.9 km altitude
1806	MTS screenshots of location of stratiform spiral  

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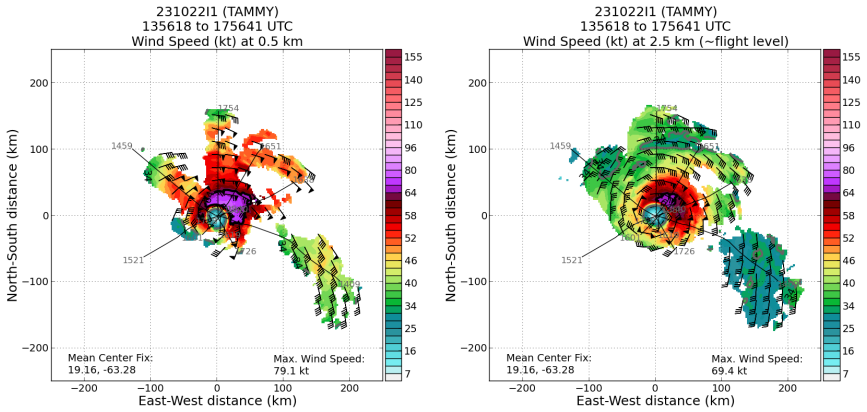
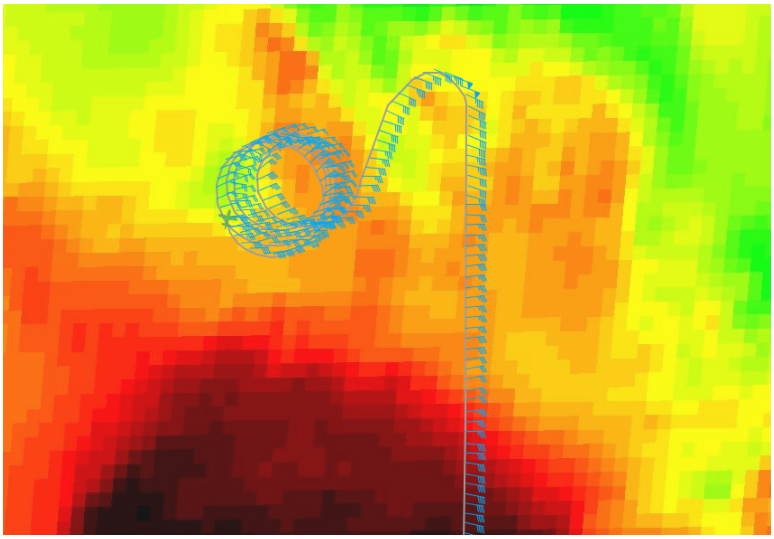
1815	spiral top -12.2 C 22,000’ drop #18 from top of spiral, 6th TDR analysis completed 
1816	start spiral down
1826	Completion of first spiral 
1827	end spiral down, 8000’, track inbound 15-20 nmi for 2nd spiral
1827	Sonde from first spiral showing an “onion sounding”

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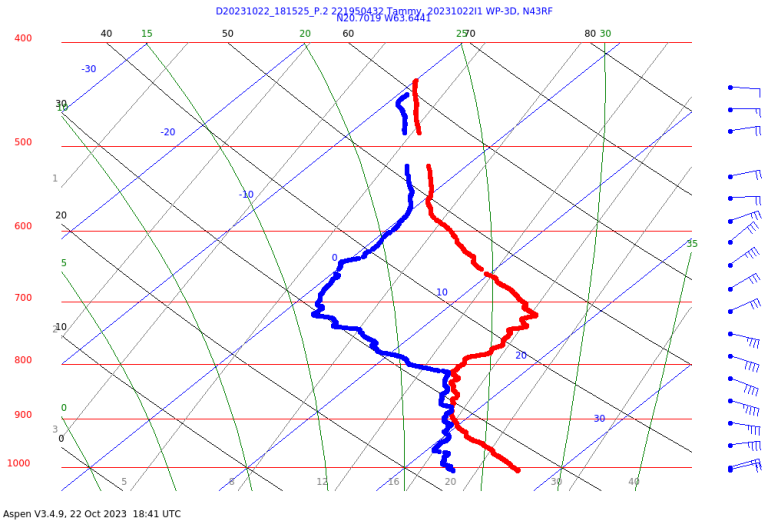
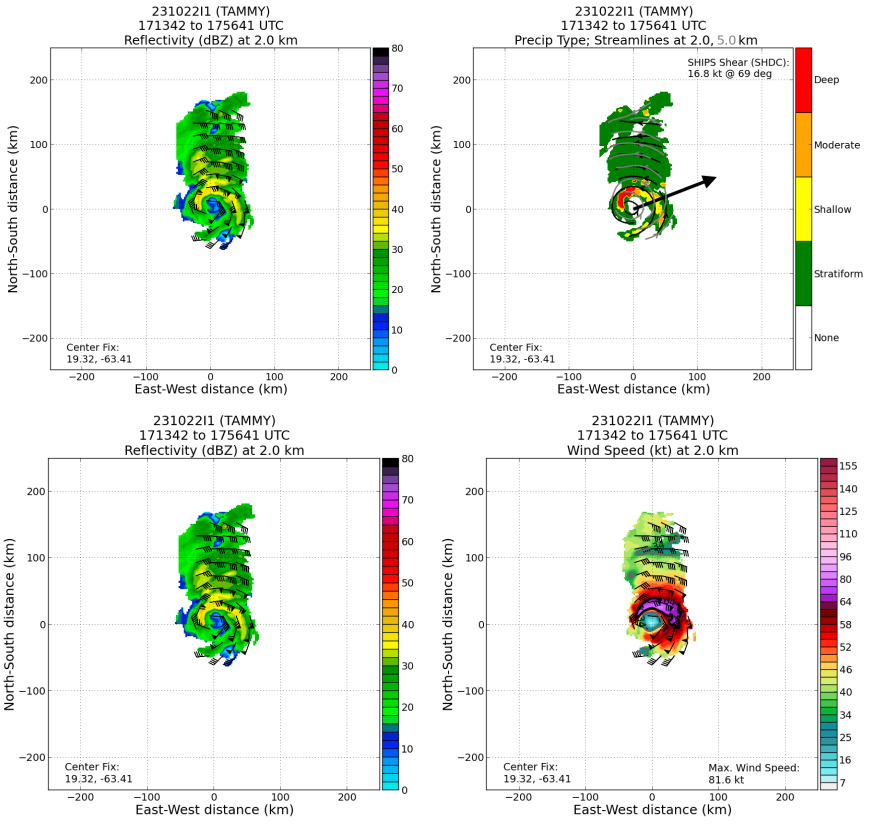
	
1832	6th TDR analysis revealed the northern eyewall is becoming better defined. GLM has indicated persistent lightning flashes over the last hour or so. 
1832	begin 2nd spiral, 35 nmi outside NW eyewall. 0 C 4.8 km altitude

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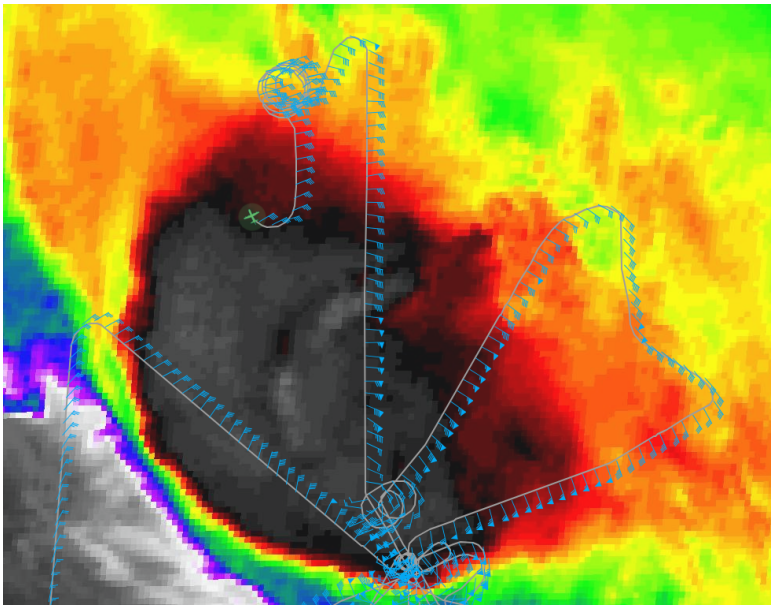
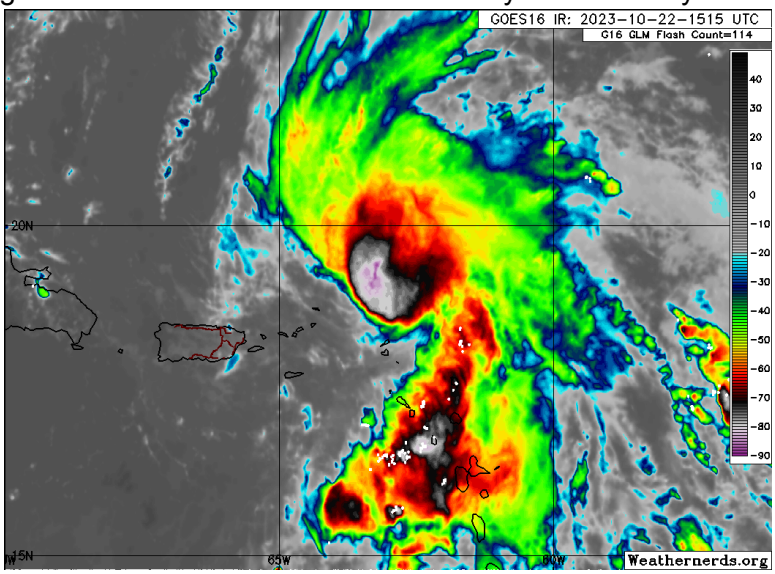
	
1846	top of spiral, drop #19, -12.2 C, 22,000’
1848	start spiral descent
1849	Lightning flashes have been observed in NW eyewall recently 
1853	MTS screenshot near the end of 2nd spiral. First time ever two spirals were flown?

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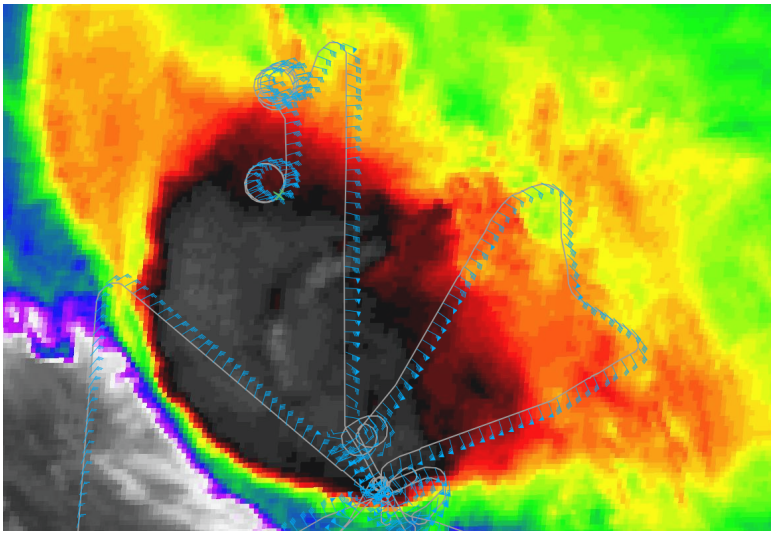
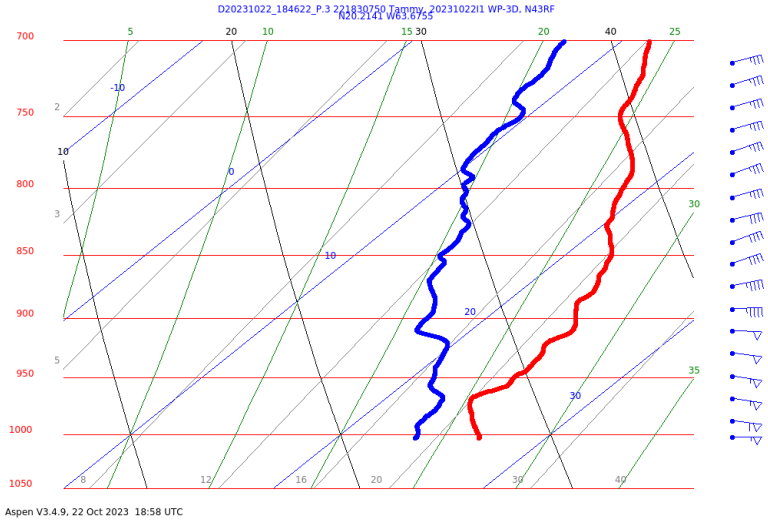
	
1857	end spiral 8,000', TK to a point N of center, climb to 10 kft and go inbound
1900	Skew-T from second spiral 
1901	start inbound, TK 170, 10,000'
1906	entering outer edge of N eyewall, Michael Fischer says there is potential meso forming in NW eyewall, definitely based on MMR presentation o

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	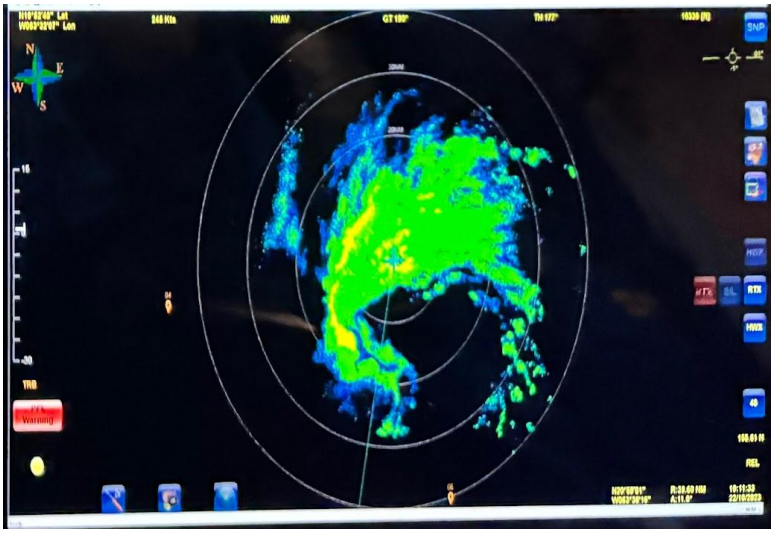
1908	<mfischer_hrd> Looks like a potential mesovortex in western eyewall FYI marks_n43 <marks_n43> JZ says definitely <marks_n43> We are in the eyewall <marks_n43> tops 16 km <marks_n43> we are trying to steer clear of it
1909	in the N eyewall, tops 16-17 km, staying east of meso hook in NW eyewall, looks nasty, lightning?
1913	in radar eye, nice view of meso (pic)

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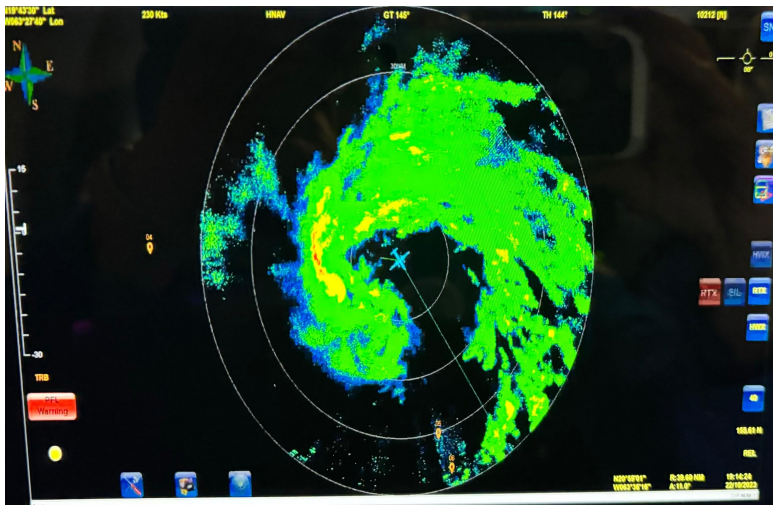
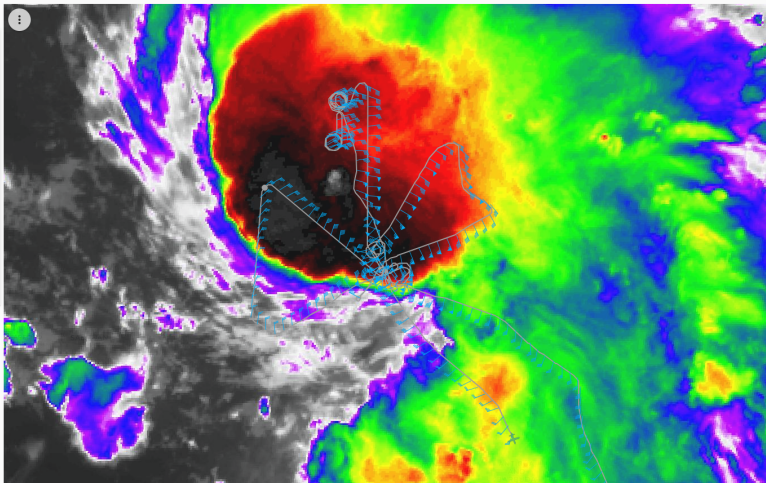
	
1914	<marks_n43> we let the TDR map it
1923	approaching outer rainband
1927	end pattern, combo drop #20, AXBT #4, AXBT failed
1952	MTS screenshot of final pattern 
2058	Setting up for the Ragged Point MAGPIE flightline offshore run (FL 5 kft). Overfly the Ragged Point Lighthouse, proceed to a point along the HSRL line out to an offshore point at 13.28 N 59.24W. Dropsonde at 3 NM offshore and a 2nd dropsonde at the midpoint (6 NM offshore).

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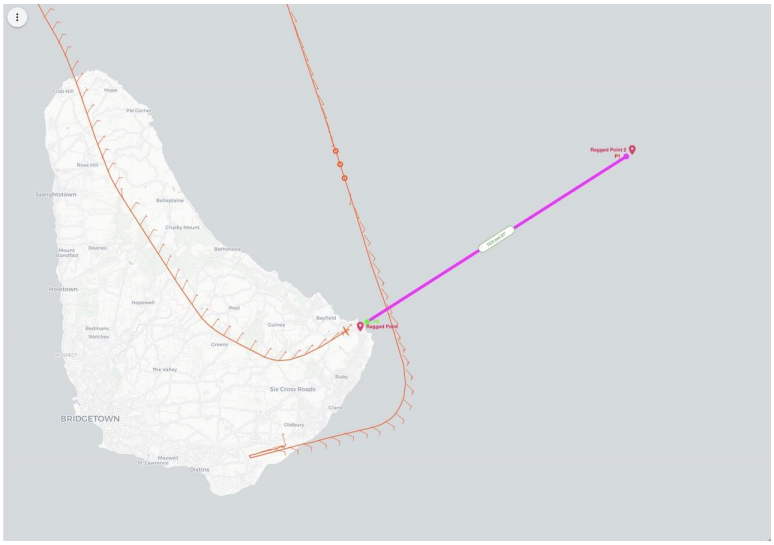
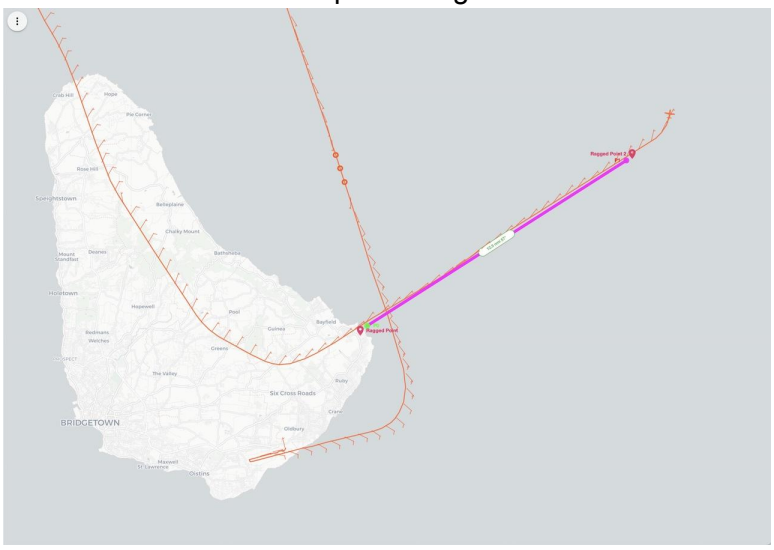
	
2103	End of MAGPIE module. Both dropsondes good. 
2115	landed TBPB
2222	Final TDR analyses

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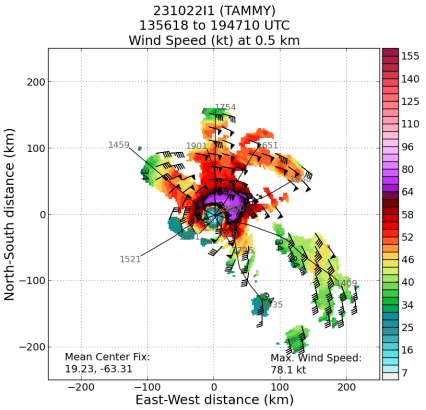

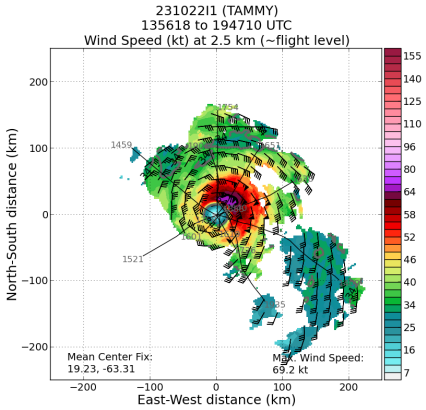

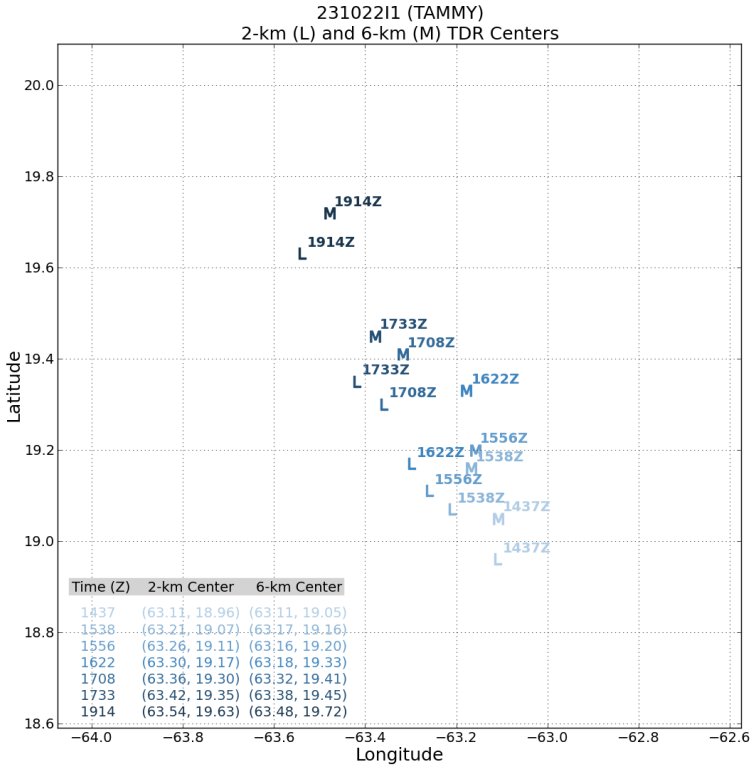

POST-FLIGHT	
Mission Summary	*Mission was successful – modified butterfly pattern was flown, a total of 19 drops were released, all of them worked and were transmitted, TDR analyses (7 of them) were transmitted – two analyses were performed as part of the FLAIMS wedge, two during the orbiting in the eye, and one on*

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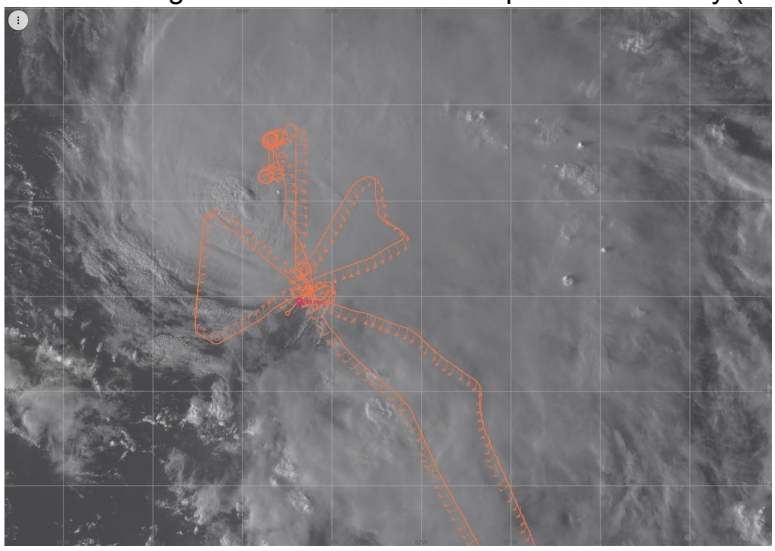
	the final inbound and outbound leg.. *<u>Emerging technology highlight:</u>* *1. BT/IR SST sonde overflight with SD1040* *2. sUAS partial eyewall circumnavigation (60kt+ winds recorded)* *3. First-ever sUAS/Saildrone operations synchronized in time and space.* *4. ~7 min eye spiral sounding (8k-2k feet)*
Actual Standard Pattern Flown	Modified butterfly pattern to get dropsonde and TDR symmetric coverage while accommodating UAS and Saildrone comparison. Butterfly (modified) 
APHEX Experiments / Modules Flown	*FLAIMS module, 2 Microphysics modules, and TDR sampling*
Plain Language Summary	● *Successfully executed module to look at the vortex tilt evolution Successful mission was flown into Hurricane Tammy, with multiple objectives accomplished.* ● *Important radar and dropsonde data was collected and transmitted to the ground for use in computer forecast models.* ● *There also was valuable data collected of precipitation particle distributions at various levels in the atmosphere below and above the freezing level. This will help evaluate and improve model representation of these structures, thought to be important for both intensity and rainfall prediction.* ● *First ever sUAS - Saildrone operations synchronized in time and space in the eye and eyewall of Hurricane Tammy*
Instrument Notes	*Instruments all worked well (TDR, sondes, AXBTs, microphysics probes, SFMR, W-band) except WSRA*

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Final Mission Track