

## SHOUT Research Flight 9 – 20161009 - Hurricane Matthew

Shift-1 Mission Scientists: Jason Dunion, Trey Alvey, Chris Velden

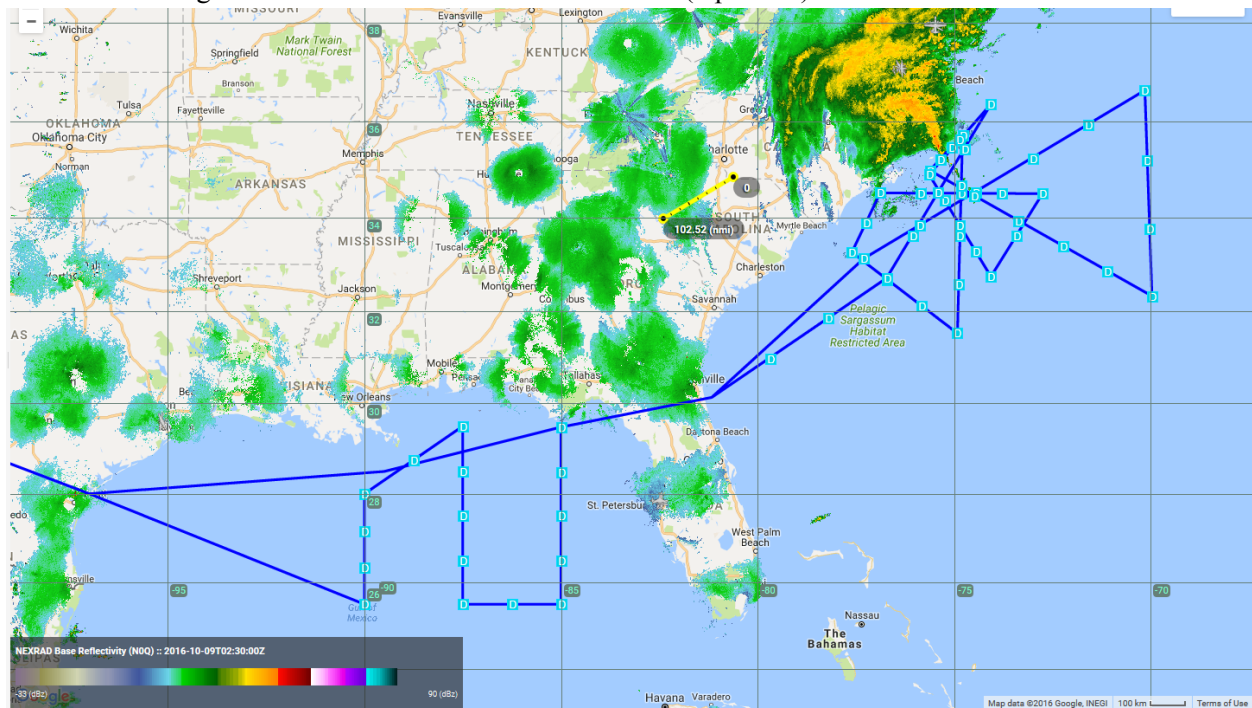
Shift-2 Mission Scientists: Jon Zawislak, Derrick Herndon, Sarah Griffin

Shift-3 Mission Scientists: Rosimar Rios-Berrios, Peter Black, Tim Olander

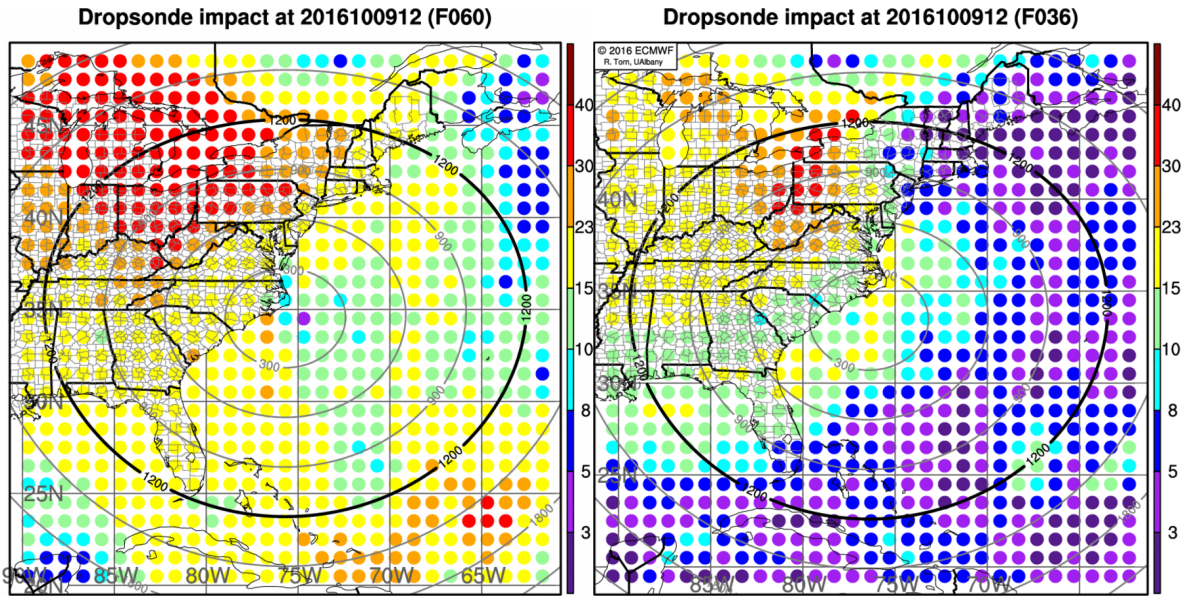
Log initiated by J. Dunion

Mission Objective: Sample category 1 Hurricane Matthew and model sensitivity areas (HWRP and ECMWF) east of the storm, near the storm environment, and in the Gulf of Mexico.

Global Hawk flight track for Hurricane Matthew mission (Update 1):



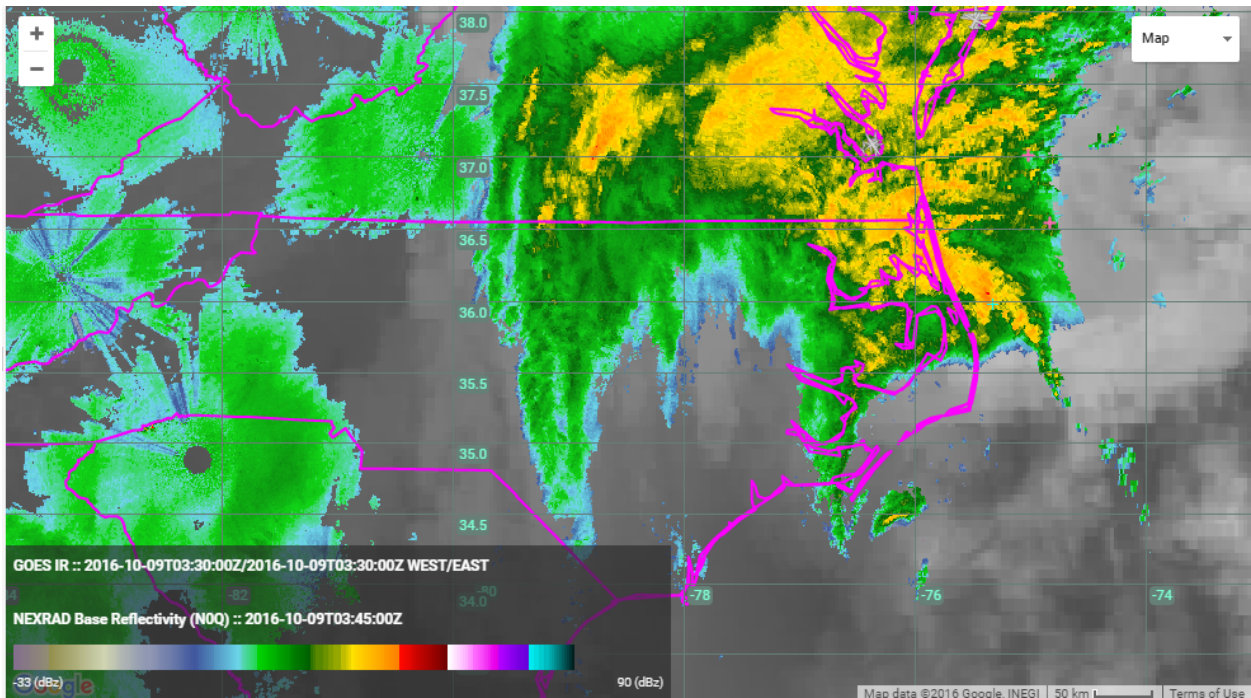
Potential improvement of HWRP (left) and ECMWF (right) track forecasts:



Potential improvement of HWRF track forecasts:

Take-off delay (flight plan filing delays). Take-off at 0300 UTC

0350Z: Rain shield over land moving off shore; area decreasing

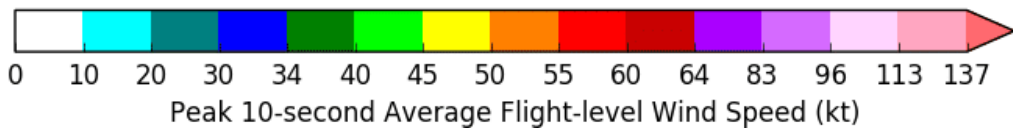
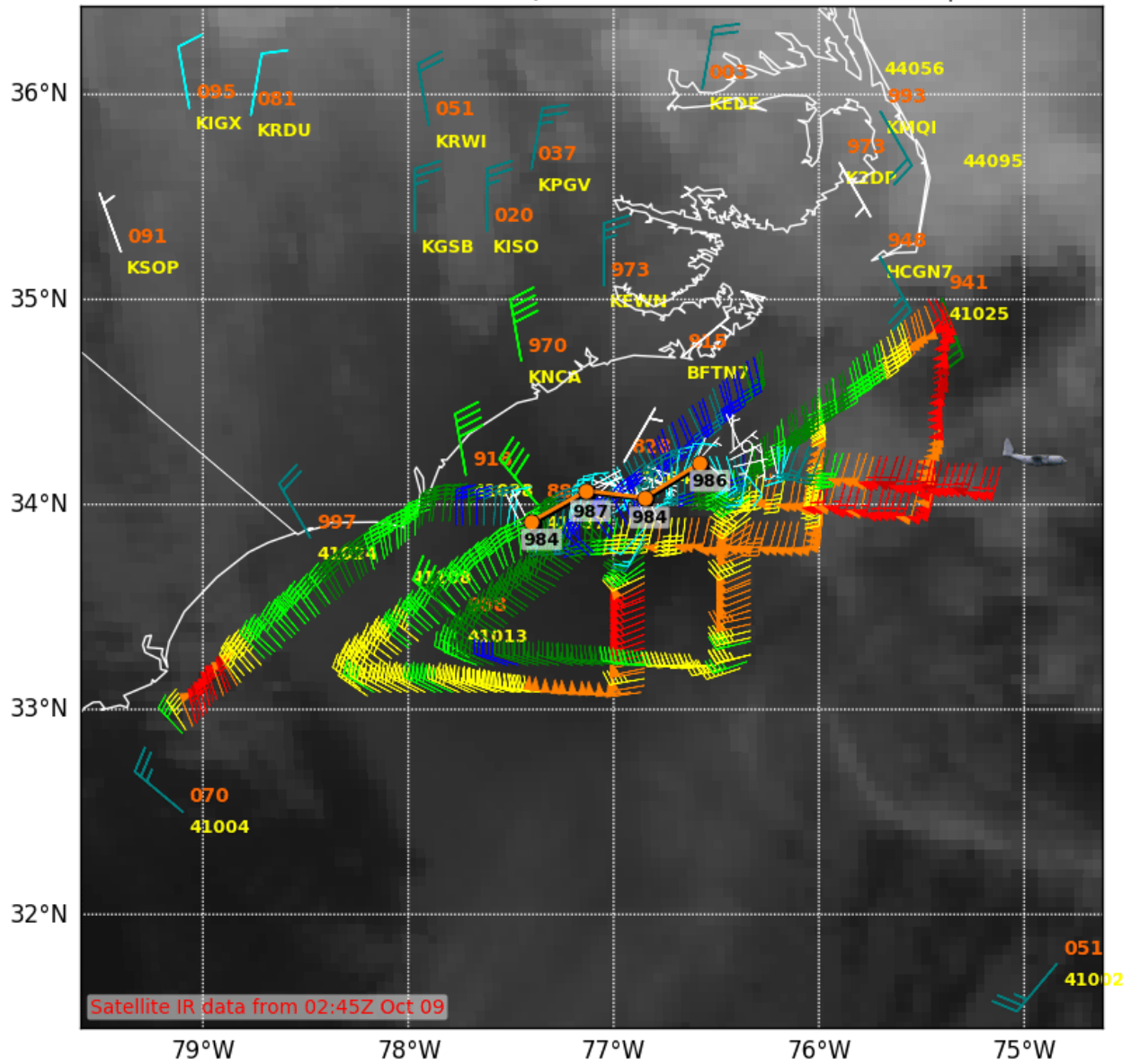


Air Force flight 9Oct 0323Z: 4 fixes

X

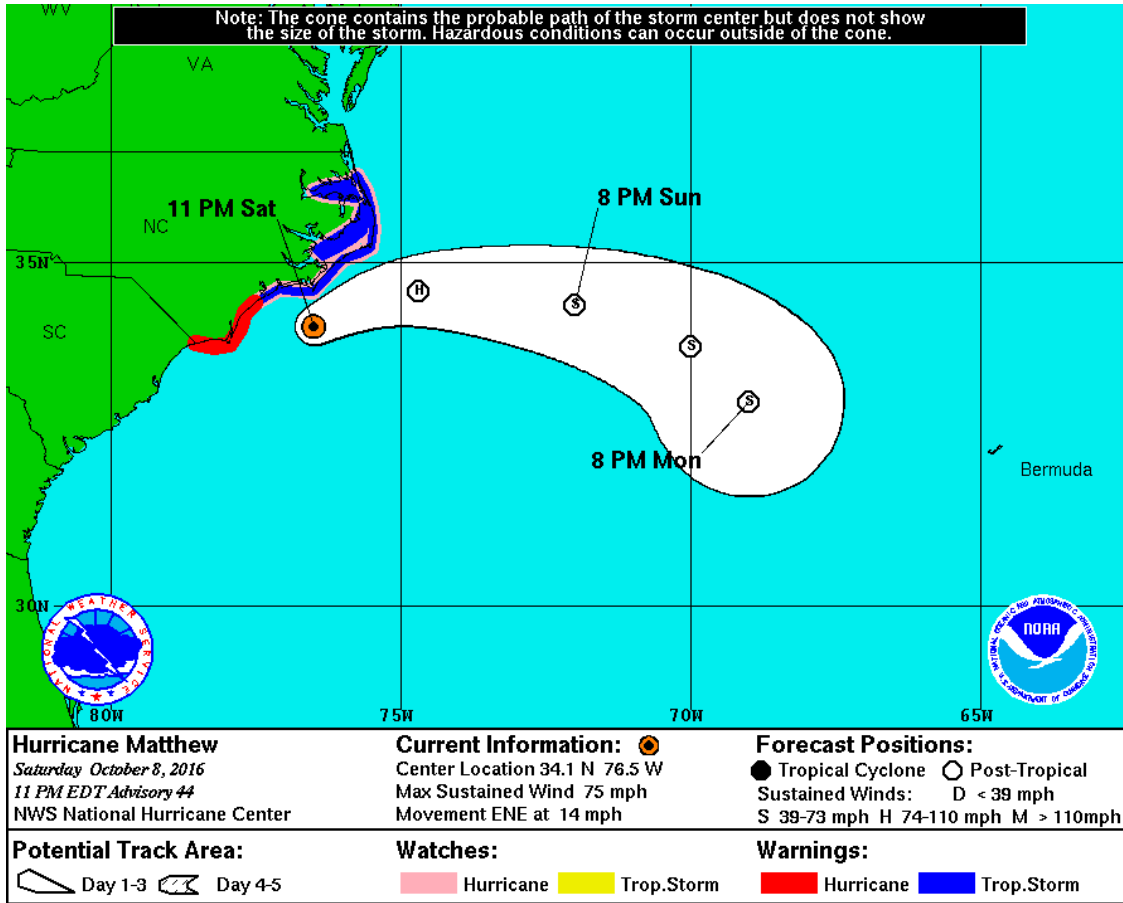
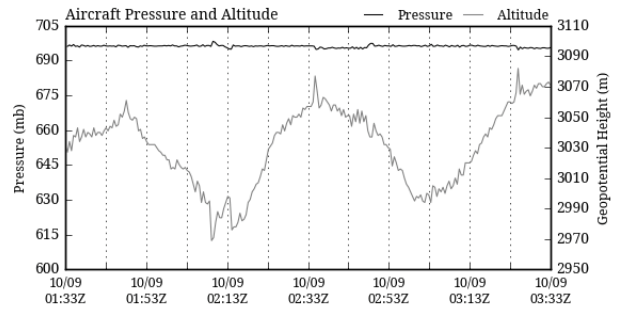
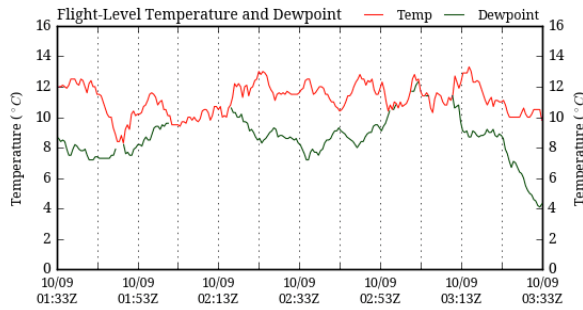
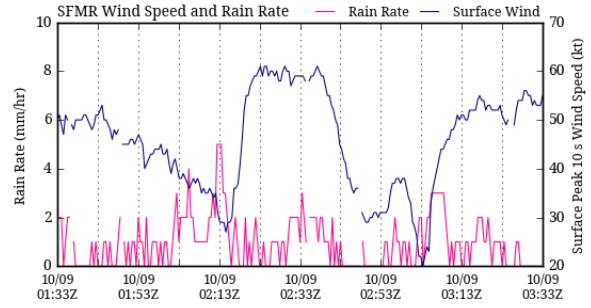
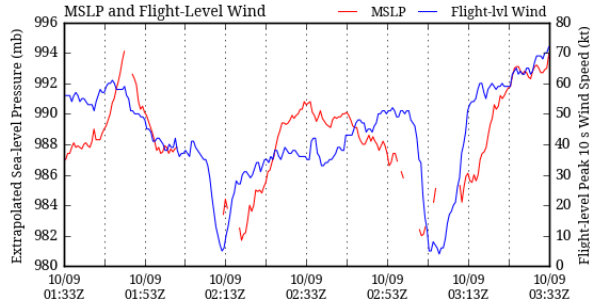
### AF301 Recon Obs as of 03:23Z Oct 09, 2016

Levi Cowan - tropicaltidbits.com



### Recon Aircraft Observations

Mission ID: AF301 4014A MATTHEW Levi Cowan - tropicaltidbits.com



HURRICANE MATTHEW DISCUSSION NUMBER 44  
NWS NATIONAL HURRICANE CENTER MIAMI FL AL142016  
1100 PM EDT SAT OCT 08 2016

A combination of satellite imagery, aircraft data, and coastal surface and radar observations indicate that Matthew is undergoing extratropical transition, and there is barely enough convection near the center to keep the system classified as a hurricane. However, SFMR data from an Air Force show hurricane-force winds to the southwest of the center, and based on this and the marginal convection Matthew remains a hurricane for this advisory. The cyclone is likely to become post-tropical in 12 hours or less and become an extratropical frontal low by 24 hours. As this happens though, a band of strong winds forming in the western semicircle near eastern North Carolina and the adjacent waters should keep the intensity near 65 kt for the next 12 hours or so. After that, Matthew should weaken and become absorbed within the frontal system between 48-72 hours. The new intensity forecast is mostly an update of the previous forecast.

The initial motion is now 070/12. Matthew is embedded in the mid-latitude westerly flow and this steering pattern is forecast to move the system east-northeastward and then eastward until dissipation. The new forecast track is a little south of the previous track for the first 12 hours and a little north of it after that time.

The forecast strength of the band of winds over the eastern North Carolina coastal area requires a northward extension of the hurricane watch. Strong winds in the Tidewater Region of Virginia are being handled by non-tropical wind warnings.

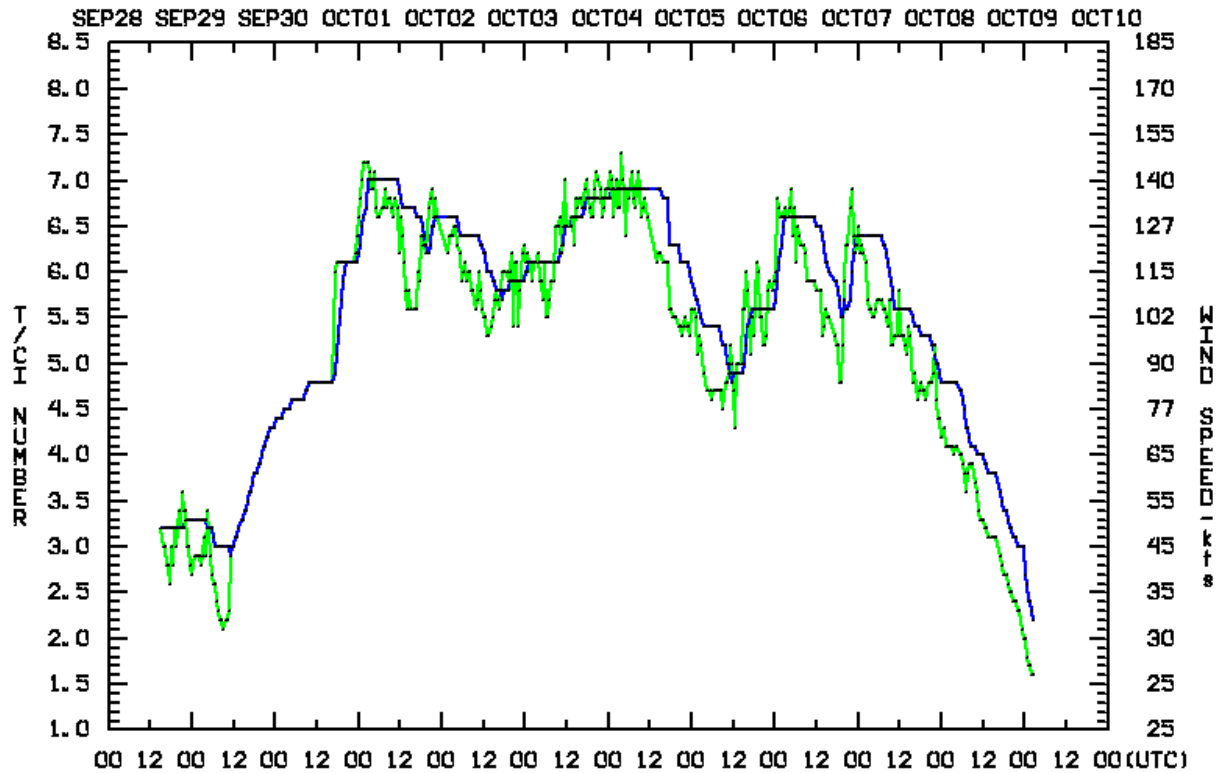
Watch/Warning Graphic for a depiction of the areas at risk.

#### FORECAST POSITIONS AND MAX WINDS

INIT 09/0300Z 34.1N 76.5W 65 KT 75 MPH  
12H 09/1200Z 34.6N 74.7W 65 KT 75 MPH...POST-TROPICAL  
24H 10/0000Z 34.4N 72.0W 55 KT 65 MPH...POST-TROP/EXTRATROP  
36H 10/1200Z 33.8N 70.0W 45 KT 50 MPH...POST-TROP/EXTRATROP  
48H 11/0000Z 33.0N 69.0W 35 KT 40 MPH...POST-TROP/EXTRATROP  
72H 12/0000Z...DISSIPATED

UW-CIMSS ADT Tropical Cyclone Intensity Estimate

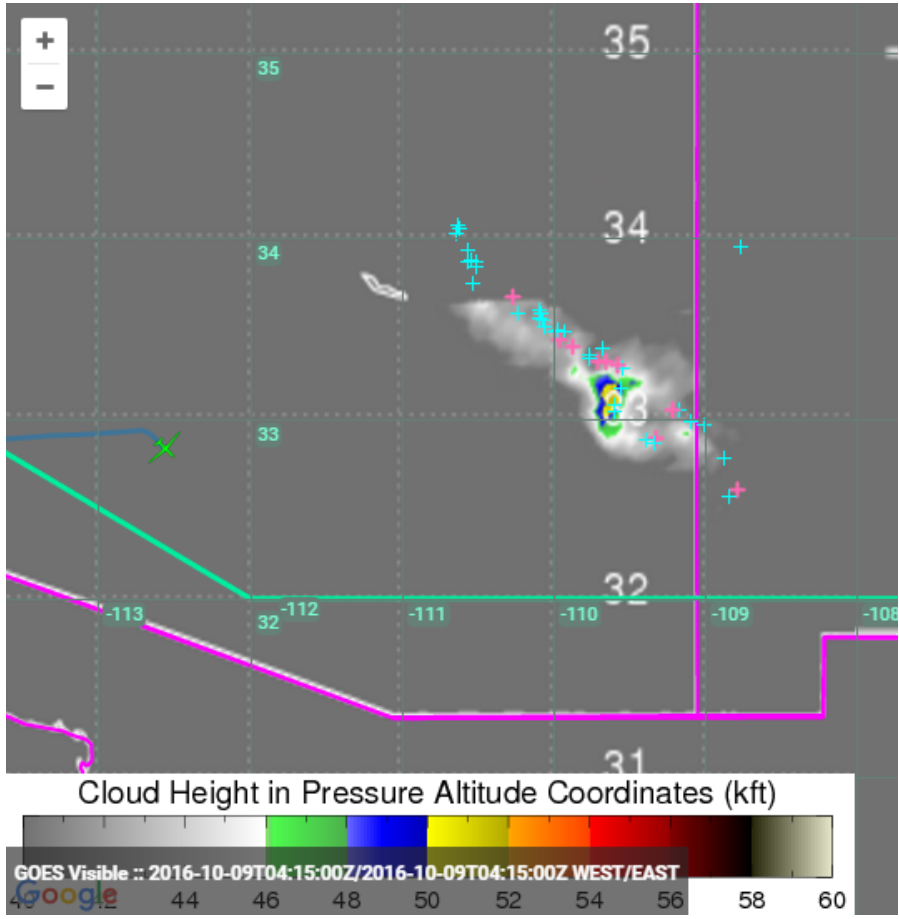
Legend : — AdjT# — CI#



STORM NAME : 14L

Matthew has decreased intensity quite rapidly over they last 24-48 hours. Convection over they system has diminished markedly, with very little remaining over the storm as it undergoes extratropical transition. The storm is forecast to move eastward in general over the Global Hawk sampling time.

0433 UTC: Active region of convection over the NM/AZ/TX border:



We alerted the pilots and suggested a path south of the convection.

0511 UTC: Global Hawk sees line of convection over AZ/NM/TX



0511Z: Lost link with GH- plane turning to come back home.

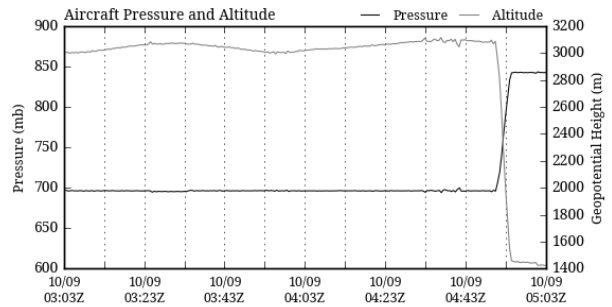
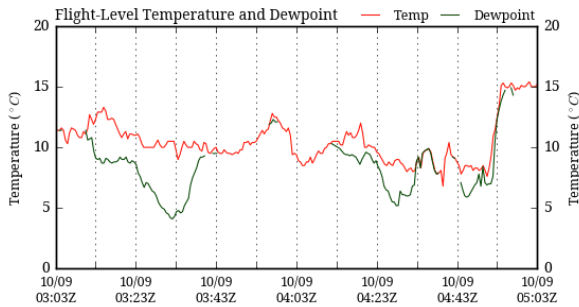
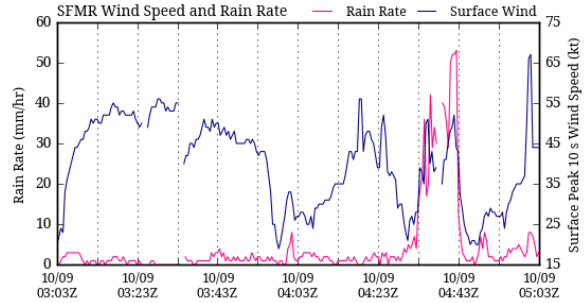
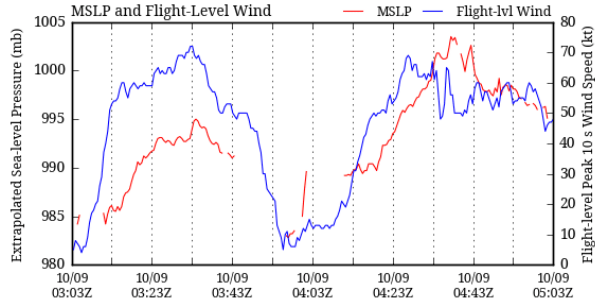




## Recon Aircraft Observations

Mission ID: AF301 4014A MATTHEW

Levi Cowan - tropicaltidbits.com



0522Z vortex message:

000

URNT12 KNHC 090538

VORTEX DATA MESSAGE AL142016

A. 09/05:22:50Z

B. 34 deg 43 min N

075 deg 57 min W

C. 850 mb 1282 m

D. 44 kt

E. 054 deg 12 nm

F. 154 deg 54 kt

G. 048 deg 39 nm

H. 984 mb

I. 15 C / 1533 m

J. 21 C / 1528 m

K. 18 C / NA

L. NA

M. NA

N. 1345 / 8

O. 0.02 / 1.5 nm

P. AF301 4014A MATTHEW

OB 36

MAX FL WIND 54 KT 048 / 39 NM 05:10:00Z  
CNTR DROPSONDE SFC WIND 120 / 15 KT

;

Based on latest fixes, the storm is moving at about 20 kts (twice as fast as anticipated).

**0600 UTC: Intermediate advisory from NHC:**

SUMMARY OF 200 AM EDT...0600 UTC...INFORMATION

-----  
LOCATION...34.8N 75.8W

ABOUT 30 MI...50 KM SSW OF CAPE HATTERAS NORTH CAROLINA

ABOUT 50 MI...80 KM E OF MOREHEAD CITY NORTH CAROLINA

MAXIMUM SUSTAINED WINDS...75 MPH...120 KM/H

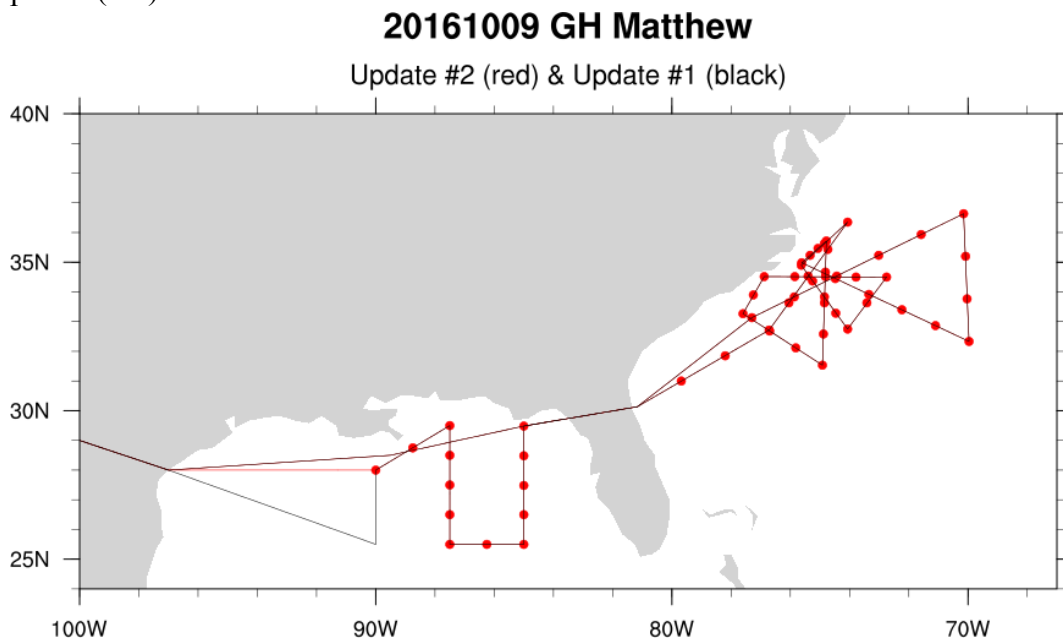
PRESENT MOVEMENT...NE OR 40 DEGREES AT 16 MPH...27 KM/H

MINIMUM CENTRAL PRESSURE...983 MB...29.03 INCHES

0632 UTC: Update #2 submitted and uploaded to MTS.

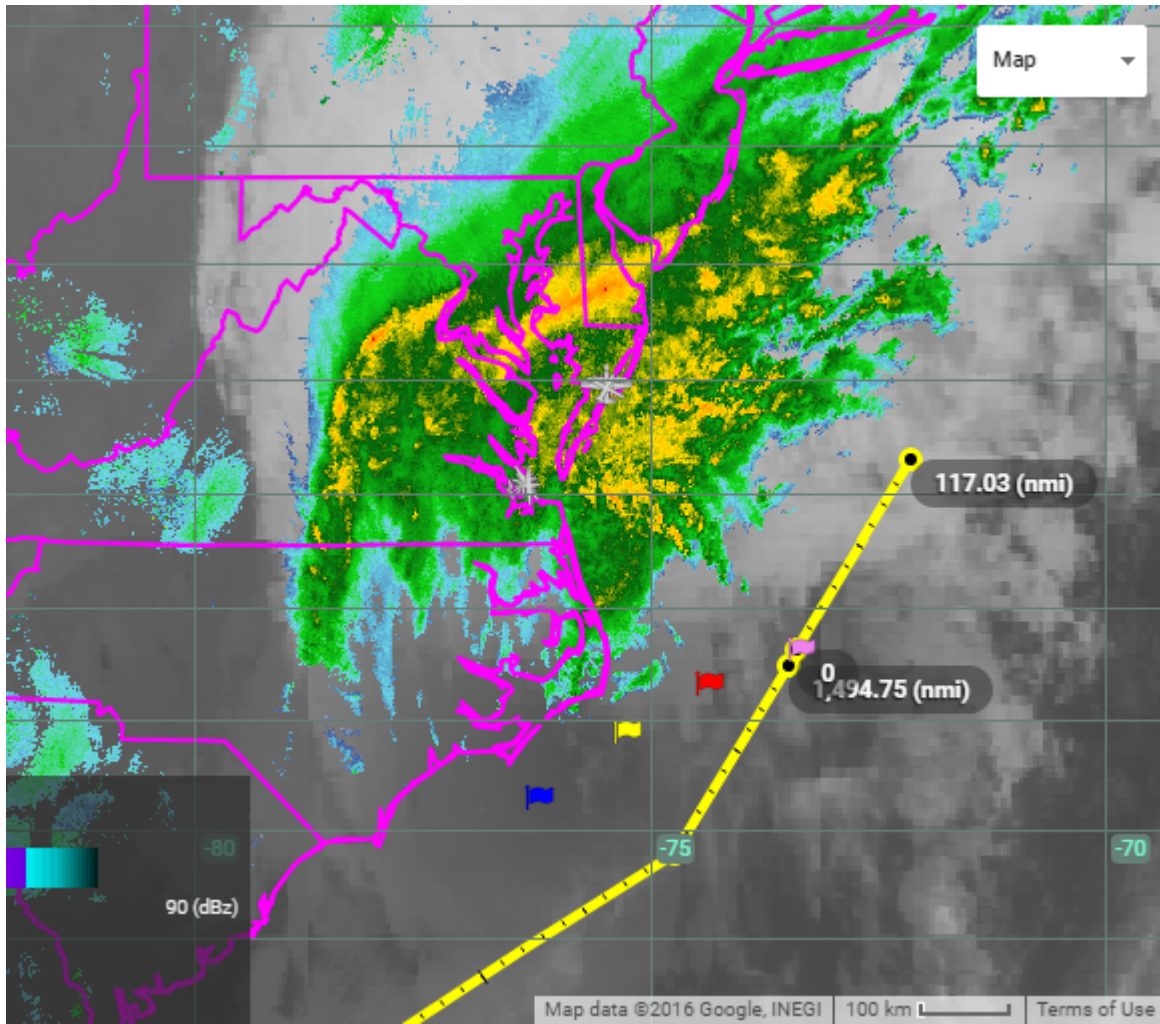
Changes: removed the first S-N leg over the Gulf of Mexico to reduce the transit time to Matthew.

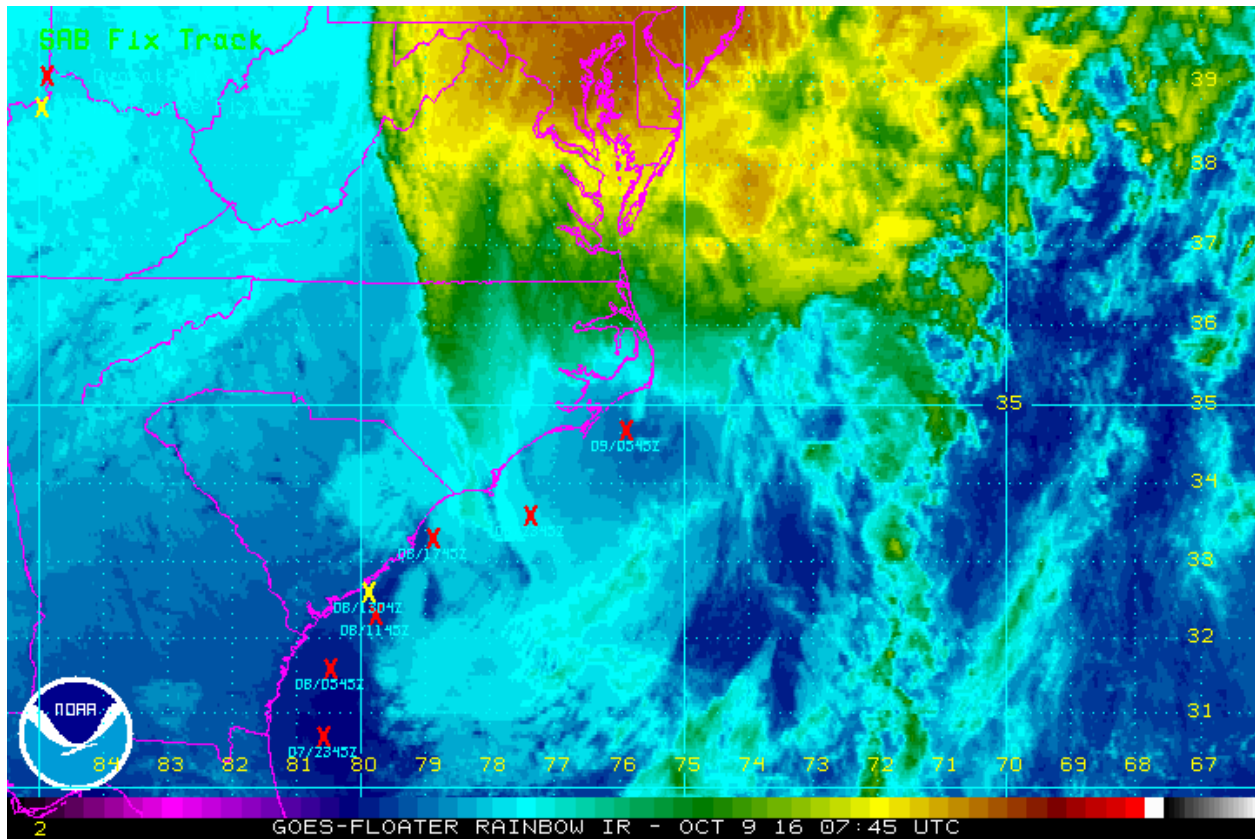
Comparison of original (black) and current (red) flight plan along with current drop points (red).



0645 UTC: Steve from NHC indicates that Matthew will likely be declared a post-tropical cyclone at 09Z or at 12Z.

0800Z Radar IR centers very difficult to locate:

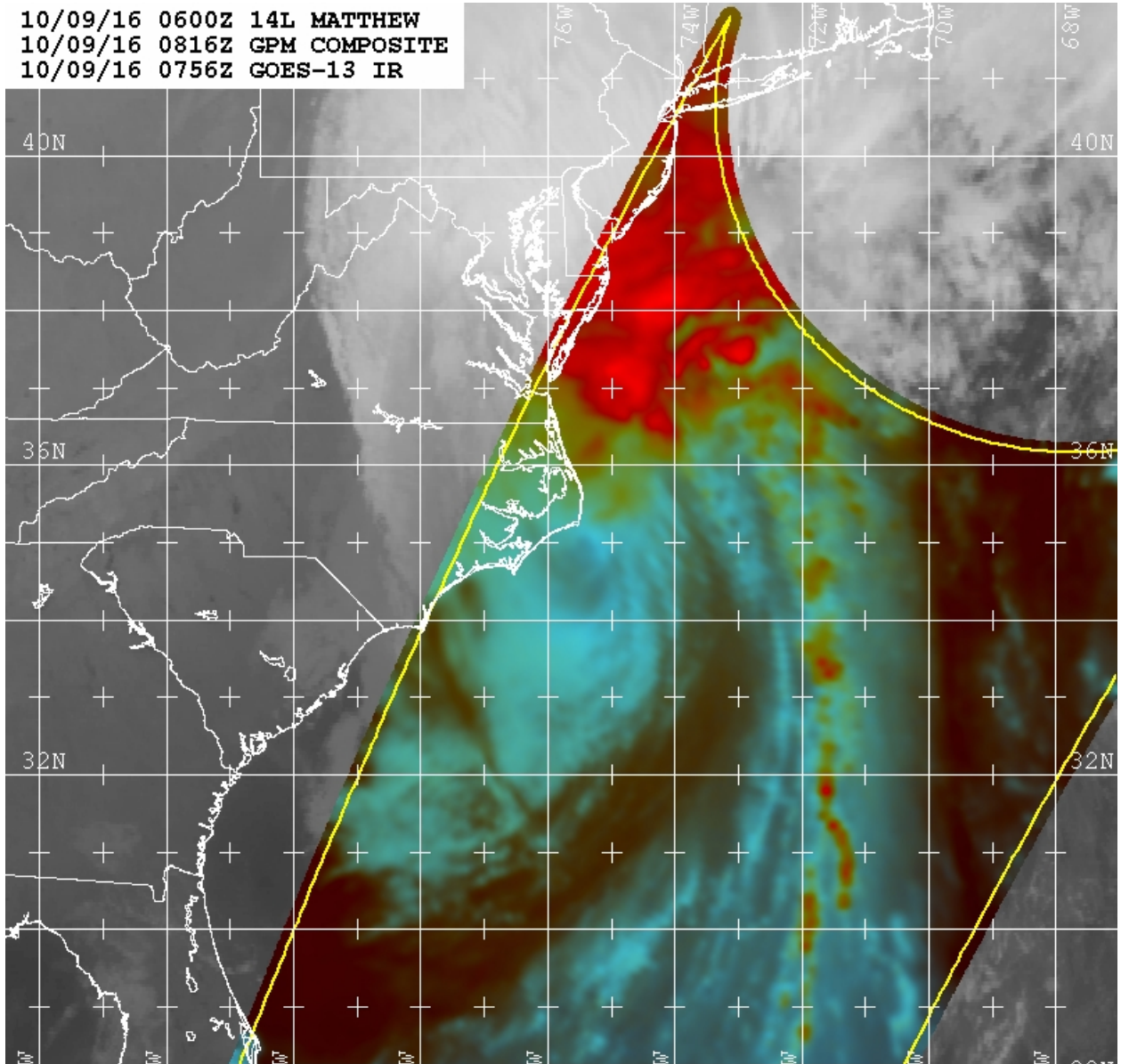




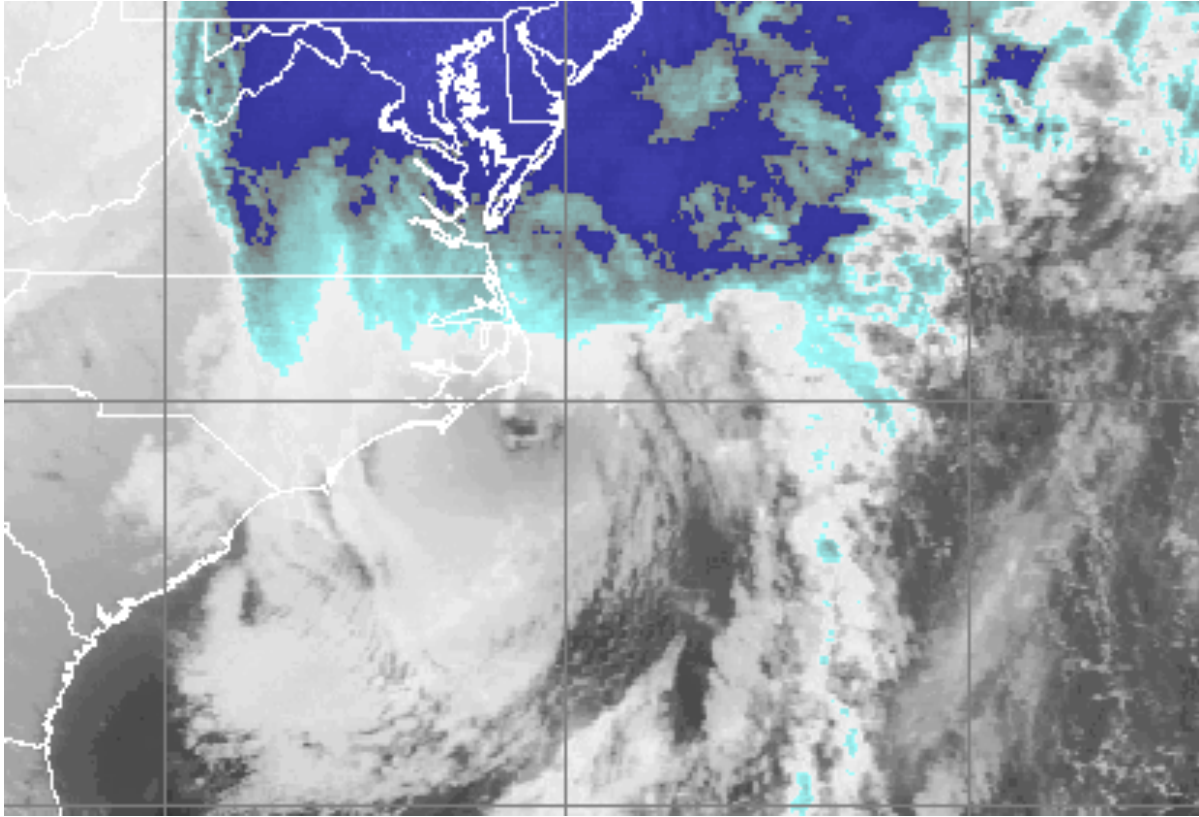
0847 UTC: Passed first drop point because Ku was down.

0849 UTC: Sonde #1 released a little past location 1. Good drop.

10/09/16 0600Z 14L MATTHEW  
10/09/16 0816Z GPM COMPOSITE  
10/09/16 0756Z GOES-13 IR



Naval Research Lab [www.nrlmry.navy.mil/sat\\_products.html](http://www.nrlmry.navy.mil/sat_products.html)  
Red=89PCT Green=89H Blue=89V



SW-IR 9Oct 0745Z

0900 UTC: Sonde #2 released at location 2. Good drop.

0900 UTC: NHC downgraded Matthew to a post-tropical cyclone.

-----  
POST-TROPICAL CYCLONE MATTHEW DISCUSSION NUMBER 45

NWS NATIONAL HURRICANE CENTER MIAMI FL AL142016

500 AM EDT SUN OCT 09 2016

Satellite and radar imagery indicate that Matthew has become a post-tropical cyclone, with the closest deep convection now located more than 150 nmi north and northeast of the exposed low-level center. Despite this change in structure, surface observations across eastern North Carolina and an earlier ASCAT pass indicate that strong winds persist northwest through southwest of the

center. An Air Force Reserve reconnaissance mission completed earlier this morning also indicated that hurricane-force winds were occurring southwest of the center, so the initial intensity is being maintained at 65 kt for this advisory. Surface observations indicate that a cold front should overtake Matthew's center shortly, resulting in extratropical transition. The global and regional models forecast Matthew to slowly weaken over the next 48 hours, and that trend has been followed in the official intensity forecast. In the 48-72 hour time period, Matthew's circulation is expected to dissipate within the frontal system.

A combination of satellite and radar imagery, aircraft data, and coastal surface observations indicate that Matthew is moving 065/12 kt. Matthew is now fully embedded within the mid-latitude westerly flow, and this deep-layer steering pattern is expected to move the cyclone east-northeastward and away from the coast of North Carolina today. An eastward motion is expected by tonight and should continue until Matthew dissipates in 48 hours or so. The new NHC track forecast is a little north of the previous track and lies close to a blend of the ECMWF, UKMET, and GFS solutions.

Recent observations and the forecast strength of the band of winds over the eastern North Carolina coastal area requires maintaining the Hurricane Watch. Strong winds in the Tidewater Region of Virginia are being handled by non-tropical wind warnings.

#### KEY MESSAGES:

1. As Matthew's structure changes, the system's strongest winds continue to shift to the west side of the circulation. The winds are expected to increase significantly over the coastal areas of eastern North Carolina during the next several hours, and during the next 6 to 12 hours there is the possibility of near-hurricane

force winds over the North Carolina Outer Banks, as well as the Pamlico and Albemarle Sounds. There is also an increased threat of storm surge in these areas. Please see the Prototype Storm Surge Watch/Warning Graphic for a depiction of the areas at risk.

2. Although Matthew has become a post-tropical cyclone, NHC will continue to issue its full suite of advisory and warning products as long as the system remains a significant threat to land areas.

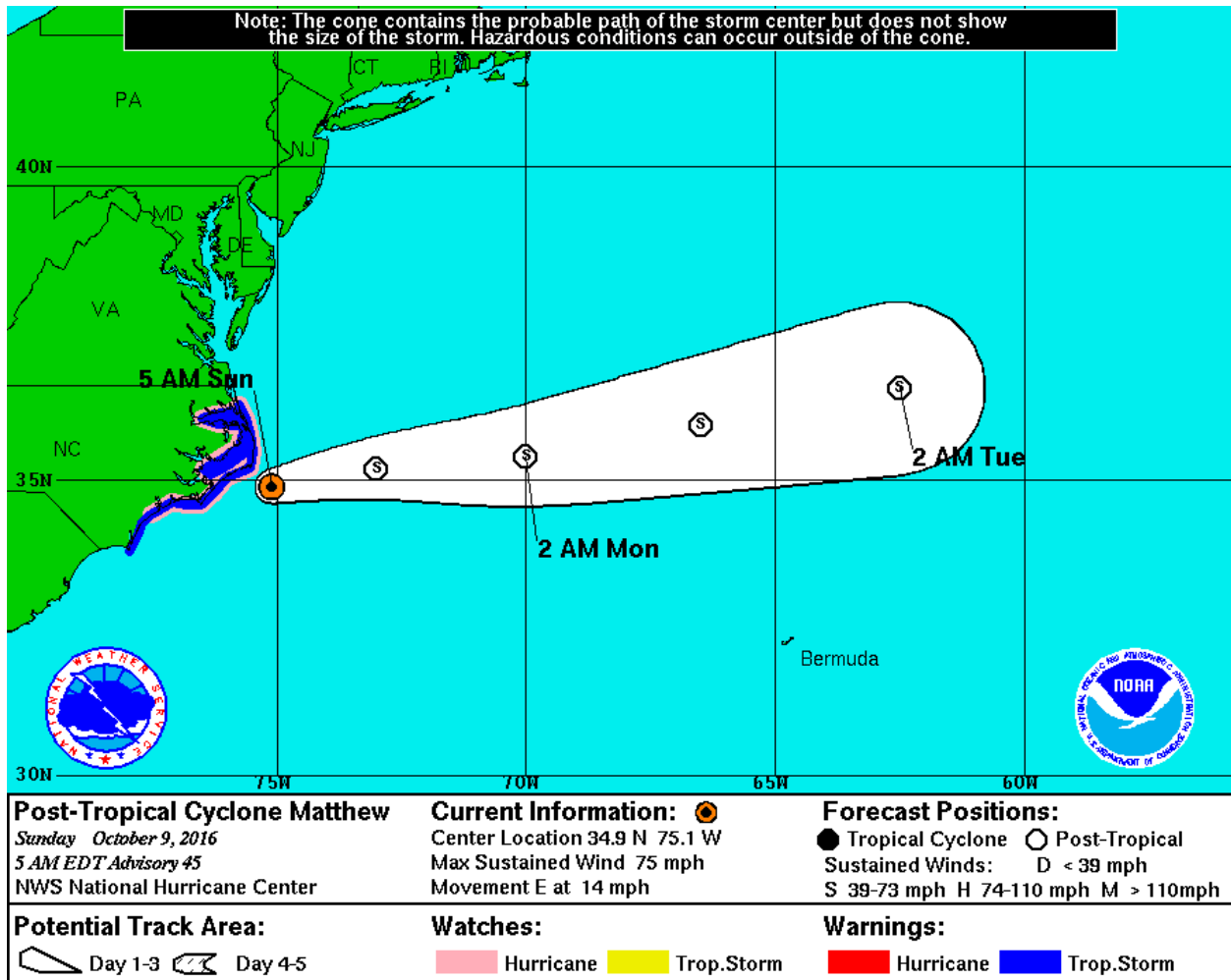
#### FORECAST POSITIONS AND MAX WINDS

INIT 09/0900Z 34.9N 75.1W 65 KT 75 MPH...POST-TROPICAL  
12H 09/1800Z 35.2N 73.0W 60 KT 70 MPH...POST-TROP/EXTRATROP  
24H 10/0600Z 35.4N 70.0W 50 KT 60 MPH...POST-TROP/EXTRATROP  
36H 10/1800Z 35.9N 66.5W 40 KT 45 MPH...POST-TROP/EXTRATROP  
48H 11/0600Z 36.5N 62.5W 35 KT 40 MPH...POST-TROP/EXTRATROP  
72H 12/0600Z...DISSIPATED

\$\$

Forecaster Stewart





0915 UTC: Sonde #3 released at location 3. Good drop.

0925 UTC: We had to skip location 4 due to air traffic.

0934 UTC: Sonde #4 released at location 5. Good drop.

0945 UTC: Sonde #5 released at location 6. Good drop.

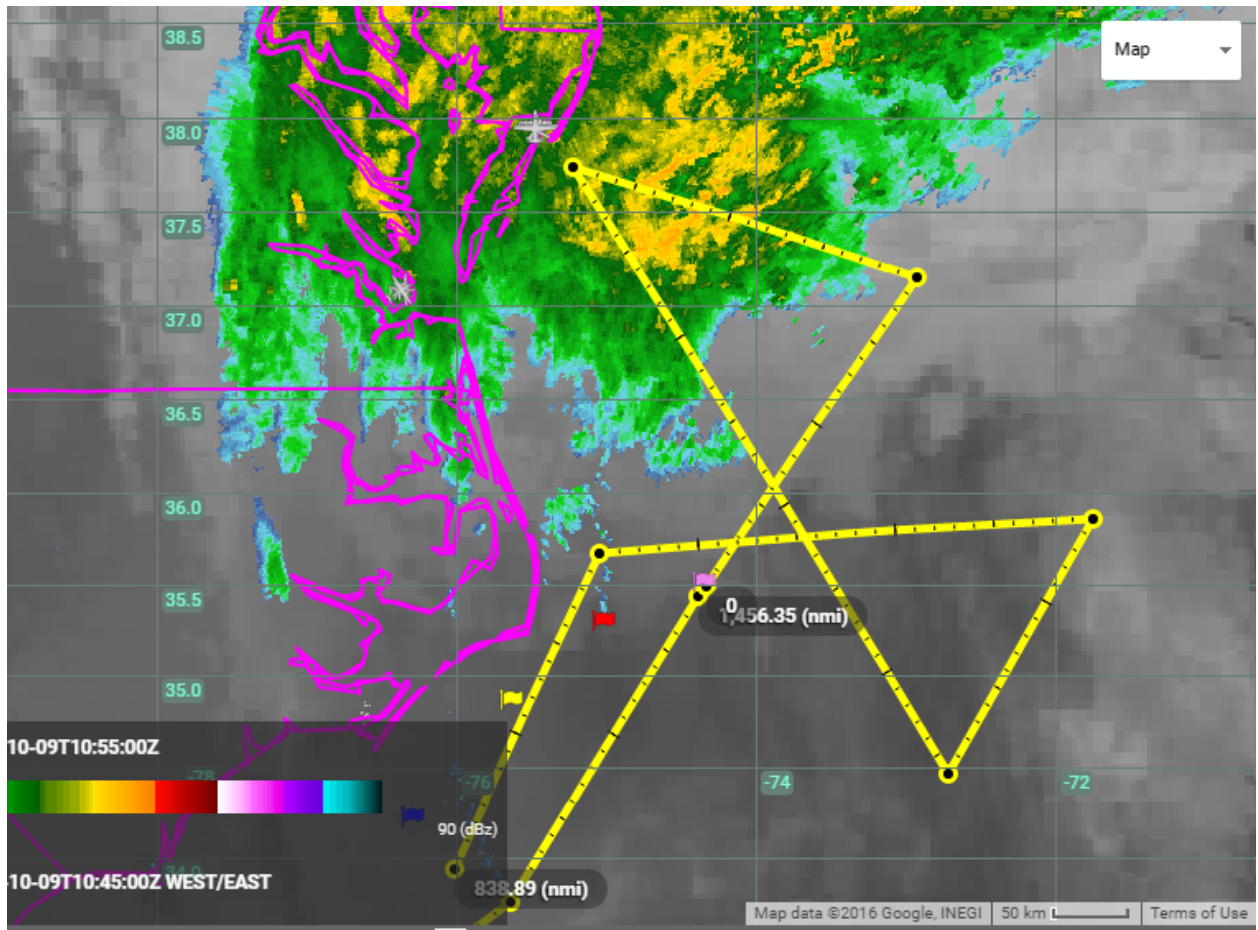
0958 UTC: Sonde #6 released at location 7. Good drop.

1009 UTC: Sonde #7 released at location 8. Good drop.

1023 UTC: Sonde #8 released at location 9. Good drop.

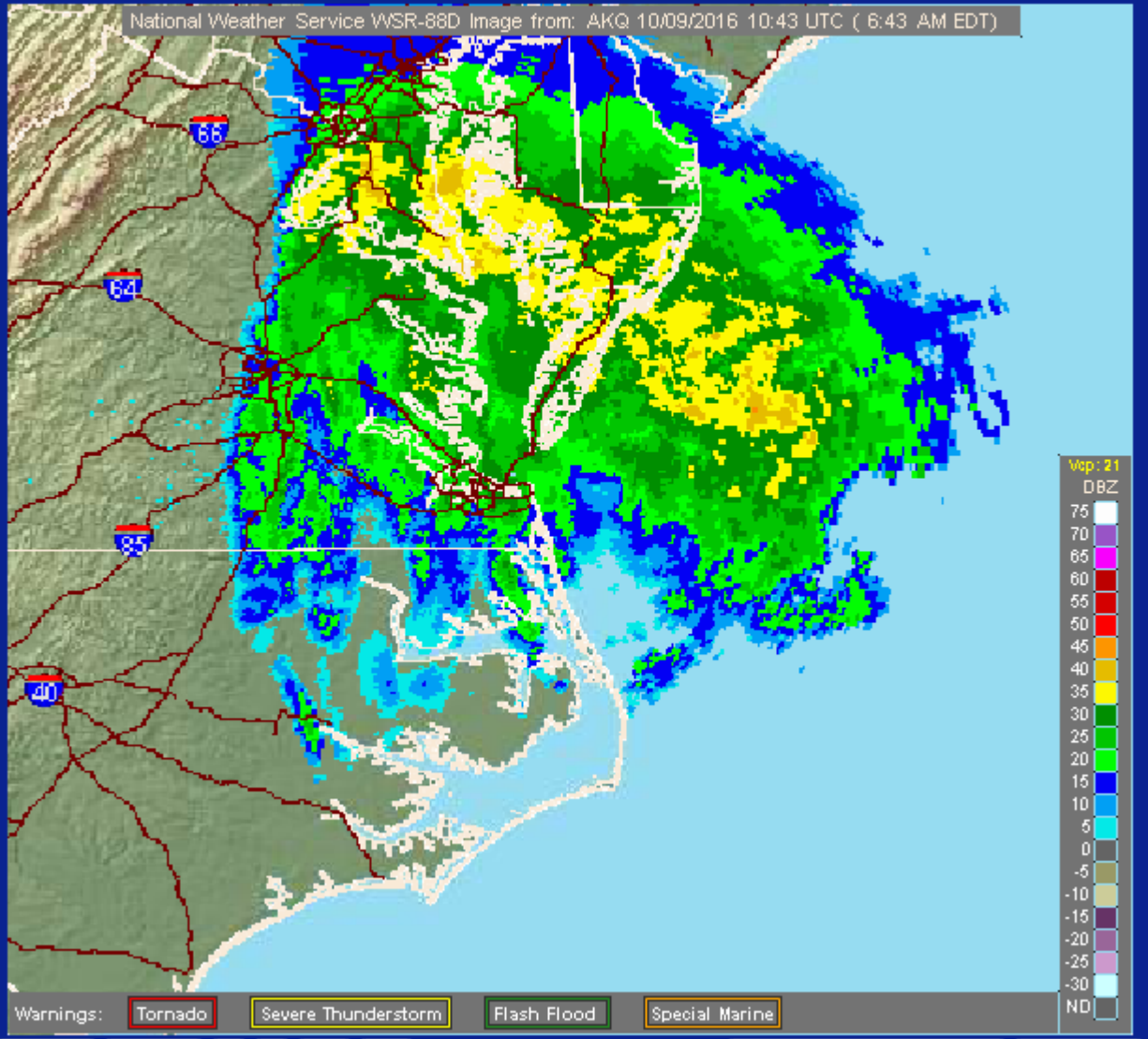
1032 UTC: Sonde #9 released at location 10. Good drop.

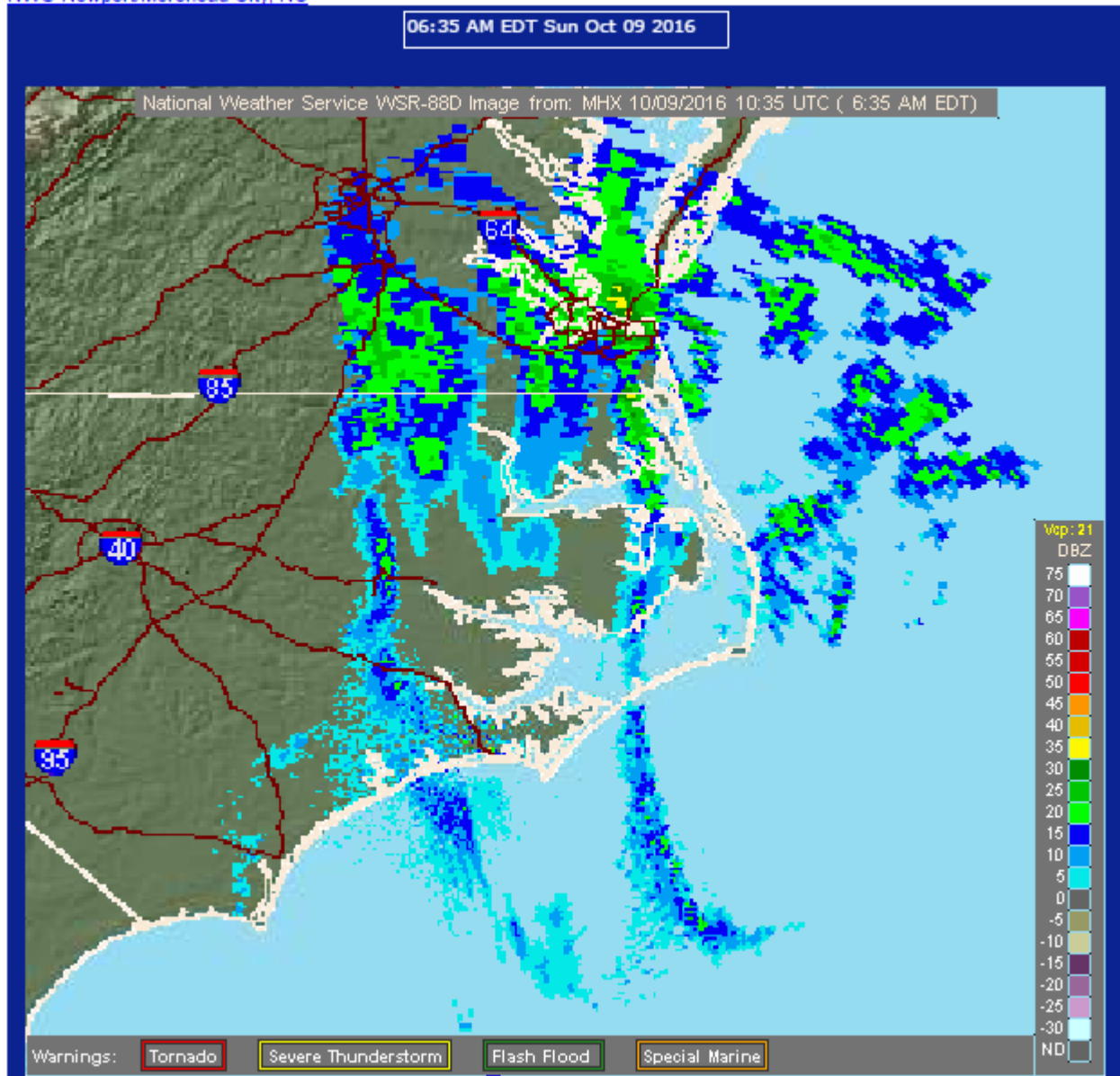
1044 UTC: Sonde #10 released at location 11. Good drop.



06:43 AM EDT Sun Oct 09 2016

National Weather Service WSR-88D Image from: AKG 10/09/2016 10:43 UTC ( 6:43 AM EDT)





1050 UTC: Update #3 uploaded to MTS. Main goal: shift flight pattern northeastward to account for storm motion.

Changes:

Shifted sondes 16-32 northeastward to adjust for storm motion.

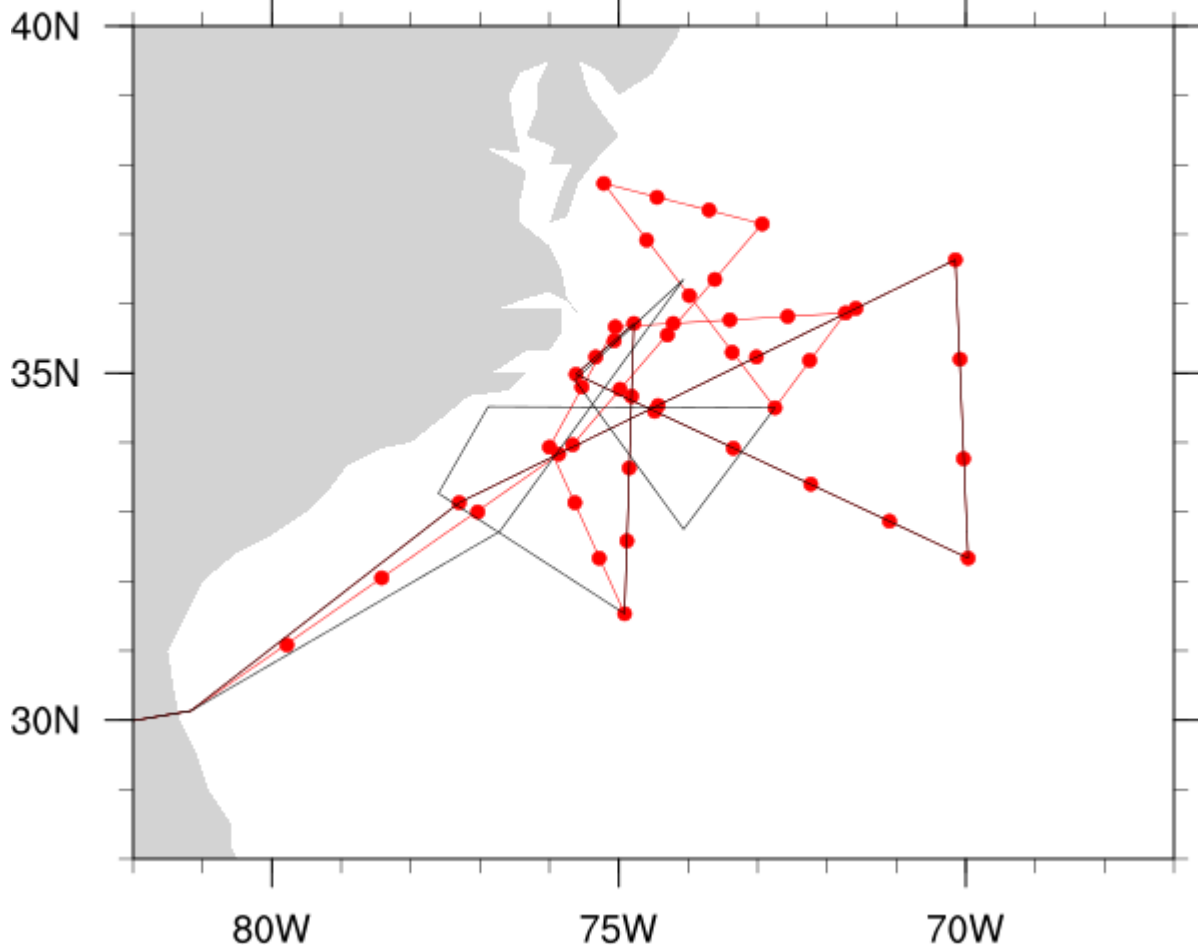
Added a sonde between sondes 14 and 16 (between east of Florida and beginning of SW-NE leg)

Added a sonde between sondes 20 and 22 (northernmost segment of first butterfly)

Update #3 (red) and update #1 (black, track submitted just before take off)

# 20161009 GH Matthew

Update #3 (red) & Update #1 (black)



1103 UTC: Sonde #11 released at location 13. Good drop.

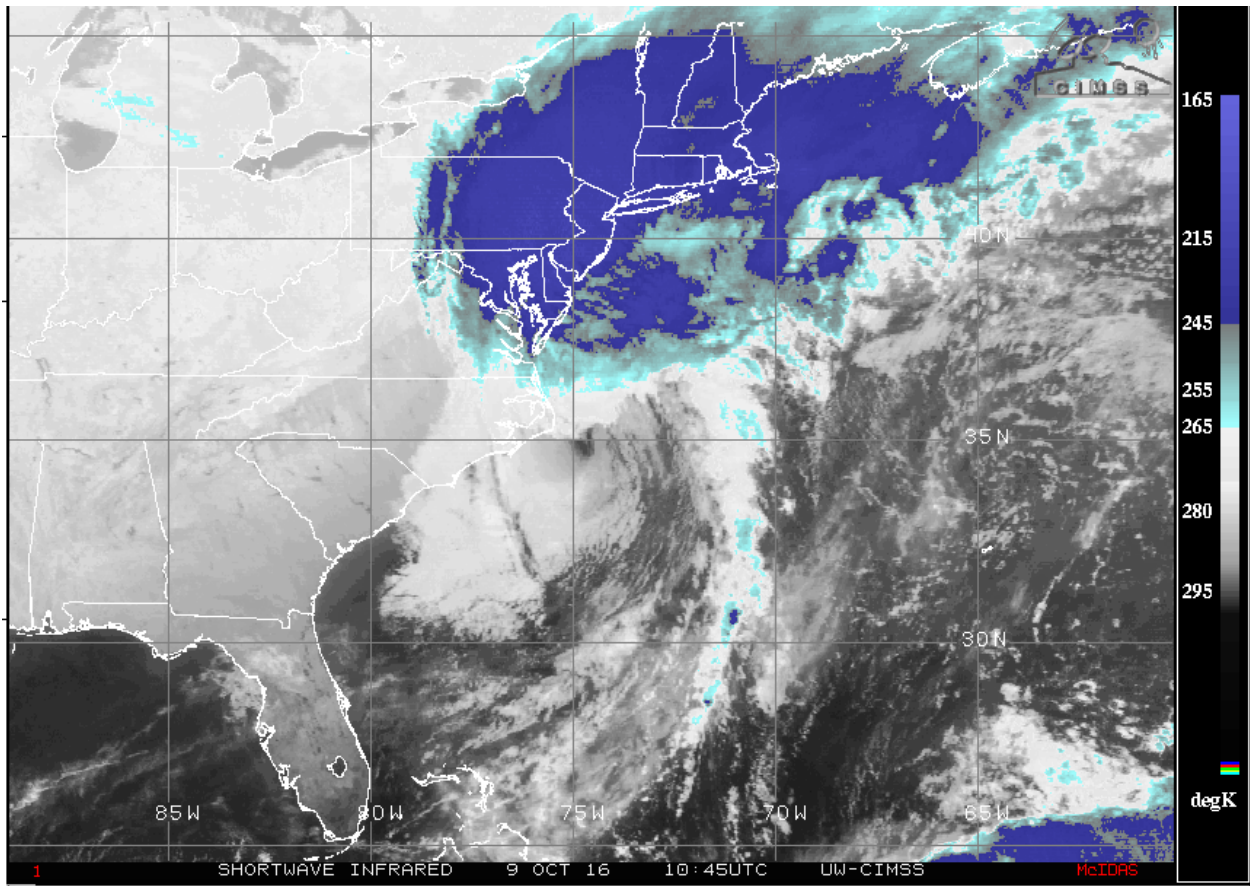
Centers used in GH track revision:

03Z 34.16 -76.38 983 mb

06Z 34.75 -75.8

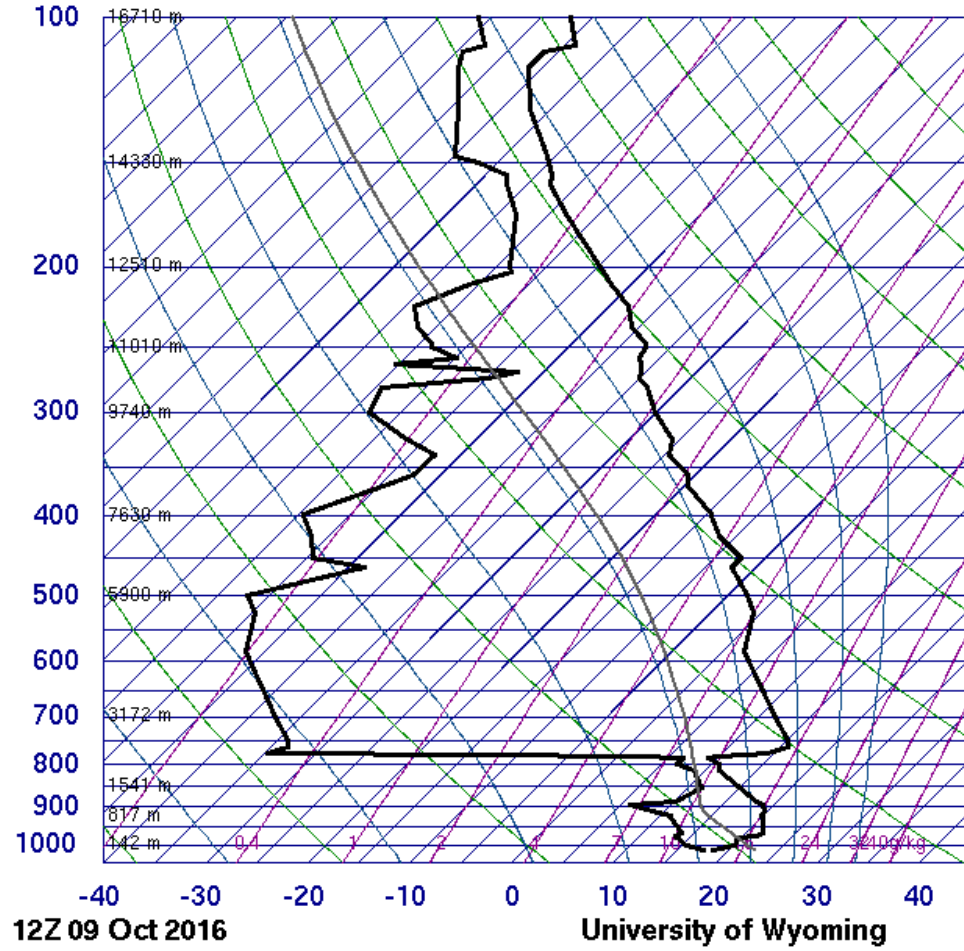
09Z 35.24 -75.10

12Z 35.46 -74.4

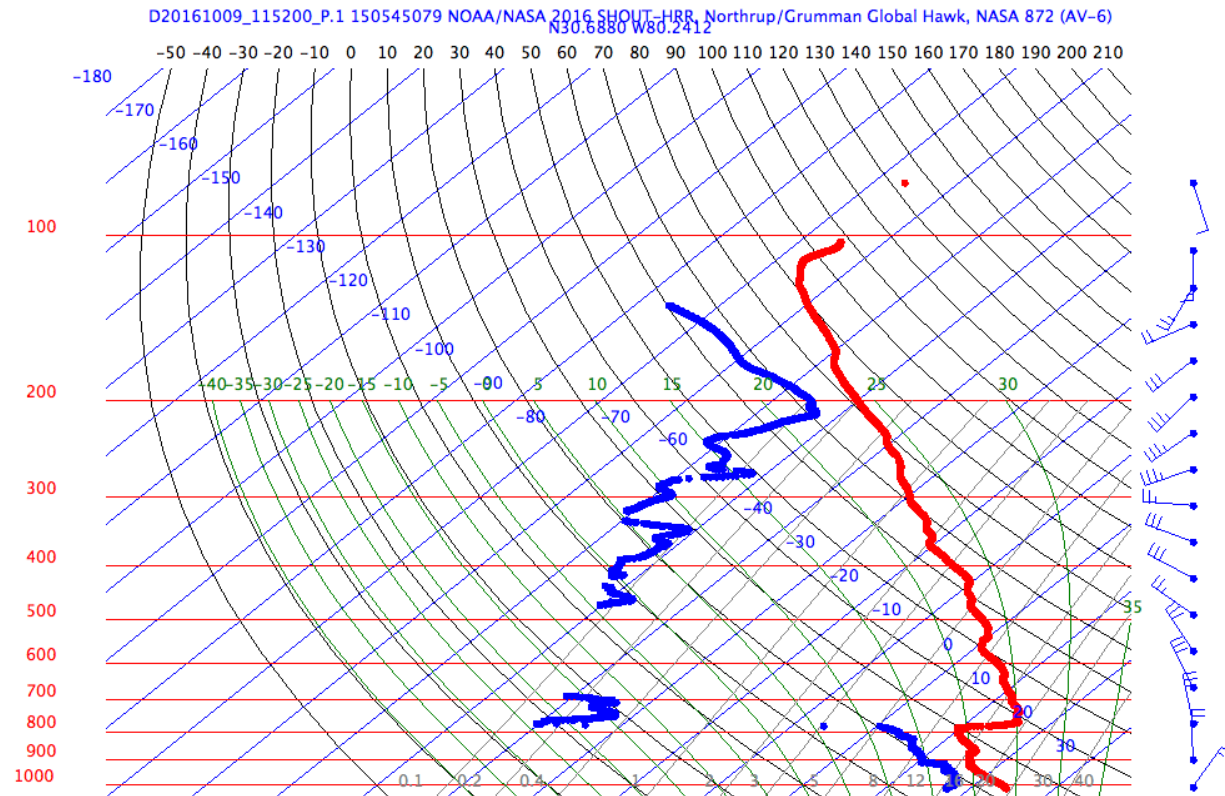


Extra drop launched for comparison with 12z JAX RAOB (sonde launched at 1152z ~70 nm E of JAX). Attempted to do 2 drops closer to the coast, but air traffic delayed dropping). JAX and GH drop soundings below.

72206 JAX Jacksonville Intl



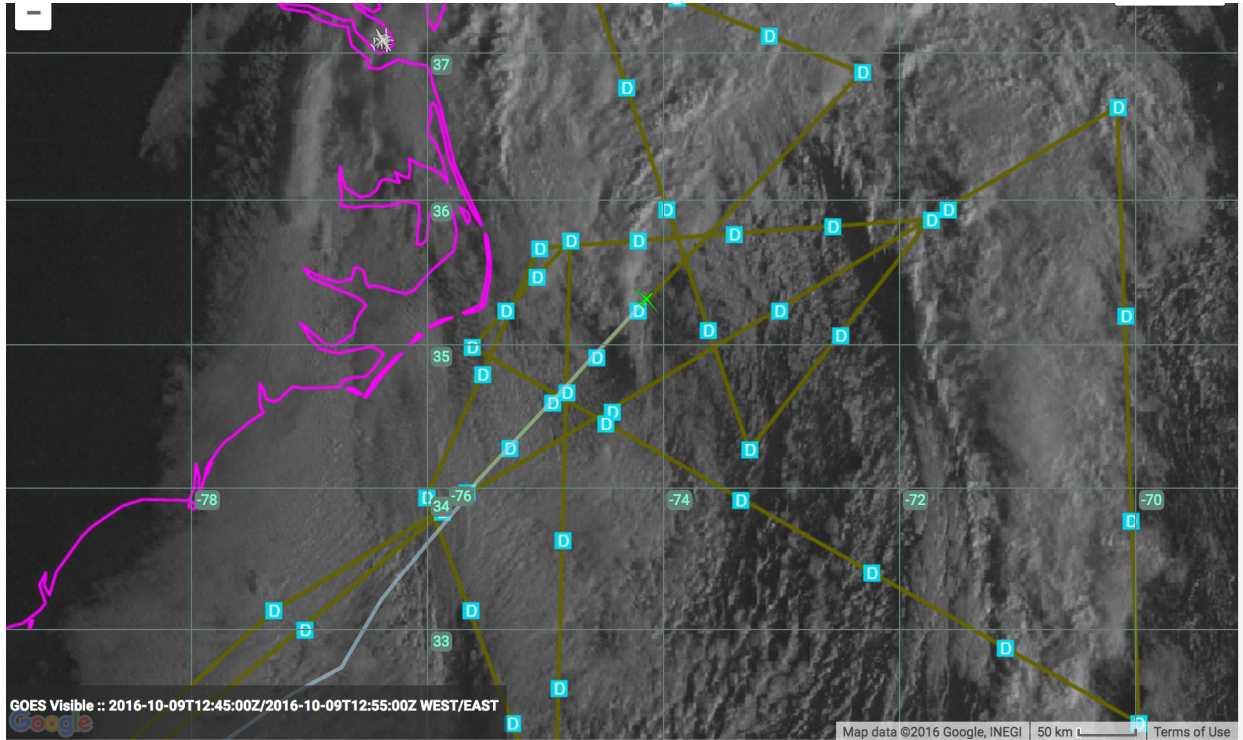
SLAT	30.50
SLON	-81.70
SELV	9.00
SHOW	7.75
LIFT	10.30
LFTV	9.88
SWET	202.2
KINX	-20.0
CTOT	14.20
VTOT	17.90
TOTL	32.10
CAPE	0.00
CAPV	0.00
CINS	0.00
CINV	0.00
EQLV	-9999
EQTV	-9999
LFCT	-9999
LFCV	-9999
BRCH	0.00
BRCV	0.00
LCLT	286.6
LCLP	907.9
MLTH	294.6
MLMR	10.82
THCK	575.8
PWAT	23.06



Aspen V3.3, 09 Oct 2016 12:23 UTC

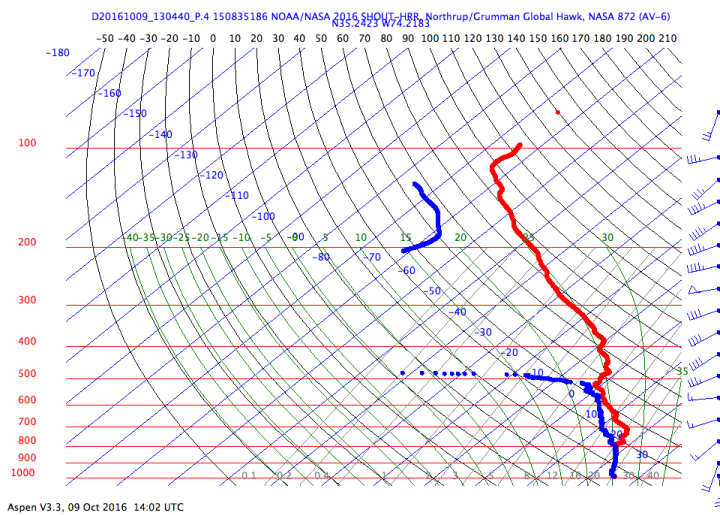
Modified the first butterfly to cross the center. Center is difficult to located in IR imagery. Shortwave IR helps a lot and should be **added to MTS display!** First few visible images just coming in also helping.





First center drop near 35.2N 74.3W 1309Z

Drop missed the center to the east. Good drop position but splash position pushed east by strong mid level winds. Splash pressure of 988 mb with 25 knots of wind supports MSLP of 986 mb (NHC at 984 mb).



POST-TROPICAL CYCLONE MATTHEW DISCUSSION NUMBER 46

NWS NATIONAL HURRICANE CENTER MIAMI FL

AL142016

1100 AM EDT SUN OCT 09 2016

Satellite data and surface observations indicate that a cold front has wrapped around the southwestern portion of Matthew's circulation and the post-tropical cyclone is now analyzed as an extratropical low. Despite the change in the cyclone's structure over the past 24 hours, Matthew continues to produce an area of very strong winds to the southwest and west of the center. Sustained winds of 55 to 60 kt with gusts above hurricane force were reported at several coastal marine observing stations near the Outer Banks of North Carolina this morning, and a **recent dropsonde from the Global Hawk unmanned aircraft reported surface winds of 58 kt**. Based on these data, the initial intensity remains 65 kt. The global models indicate that the post-tropical cyclone will gradually weaken during the next 24 to 36 hours, and be absorbed by a frontal boundary in about 48 hours.

Matthew is moving eastward at about 13 kt. The low should continue moving eastward within the mid-latitude westerly flow during the next day or so. The NHC forecast track is close to a blend of the ECMWF, GFS, and UKMET models, and is similar to the previous advisory.

Strong winds in the Tidewater Region of Virginia are being handled by non-tropical wind warnings.

KEY MESSAGES:

1. Tropical-storm-force winds will continue over the North Carolina Outer Banks this afternoon, with gusts to near hurricane force possible during the next hour or two. Storm surge flooding continues over portions of the Outer Banks. Please see the Prototype Storm Surge Watch/Warning Graphic for a depiction of the areas at risk.
2. Although Matthew has become a post-tropical cyclone, NHC will continue to issue its full suite of advisory and warning products as long as the system remains a significant threat to land areas.

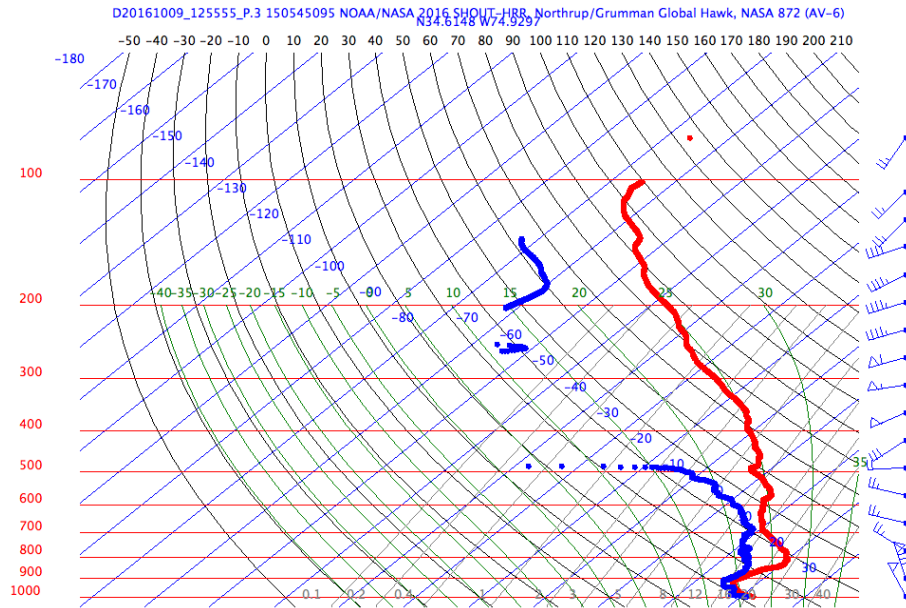
FORECAST POSITIONS AND MAX WINDS

INIT	09/1500Z	35.2N	73.7W	65 KT	75 MPH...	POST-TROP/EXTRATROP
12H	10/0000Z	35.3N	71.2W	60 KT	70 MPH...	POST-TROP/EXTRATROP
24H	10/1200Z	35.7N	68.0W	50 KT	60 MPH...	POST-TROP/EXTRATROP
36H	11/0000Z	37.0N	64.0W	35 KT	40 MPH...	POST-TROP/EXTRATROP
48H	11/1200Z...					ABSORBED

\$\$

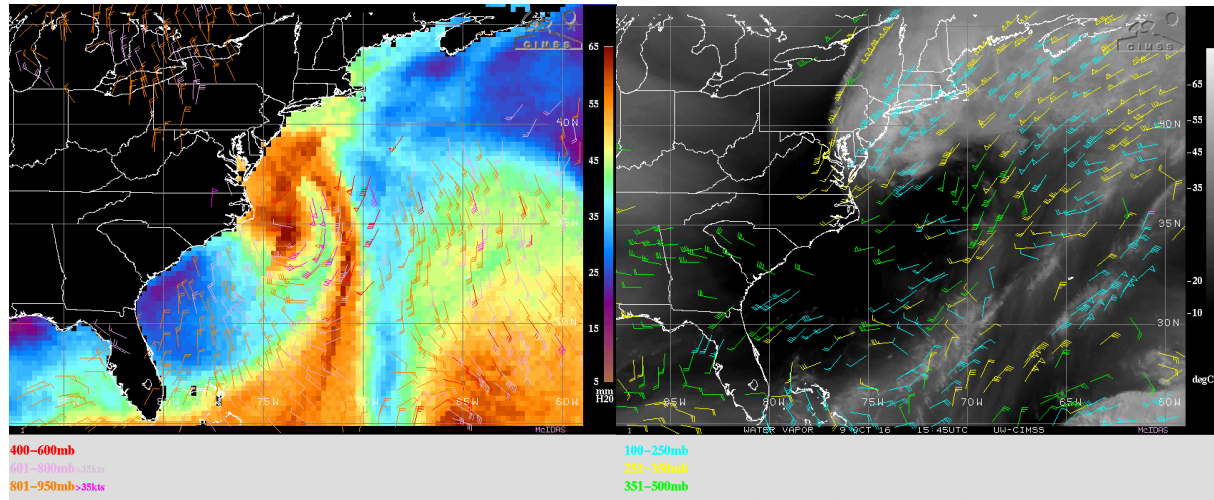
Forecaster Brown

80 knot winds at 900 mb on the 1255Z drop.

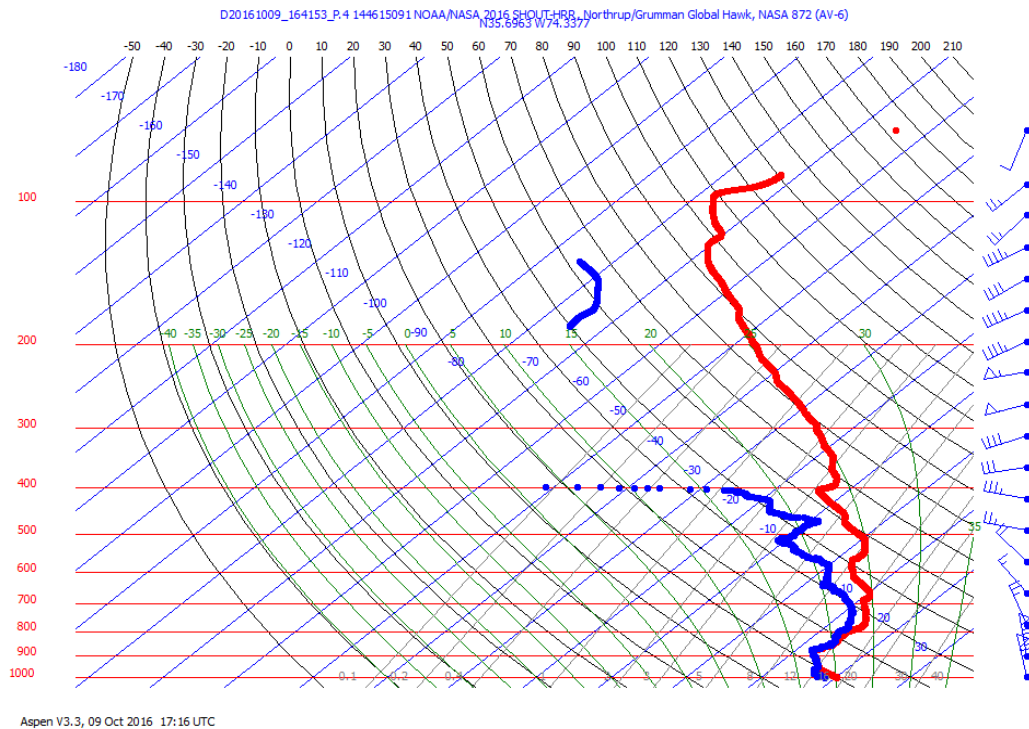


Aspen V3.3, 09 Oct 2016 13:43 UTC

TPW plot along with low-mid level winds at 1300Z shows the dry air wrapping into Ex-Matthew. Water vapor shows the extent of dry air above the llcc.

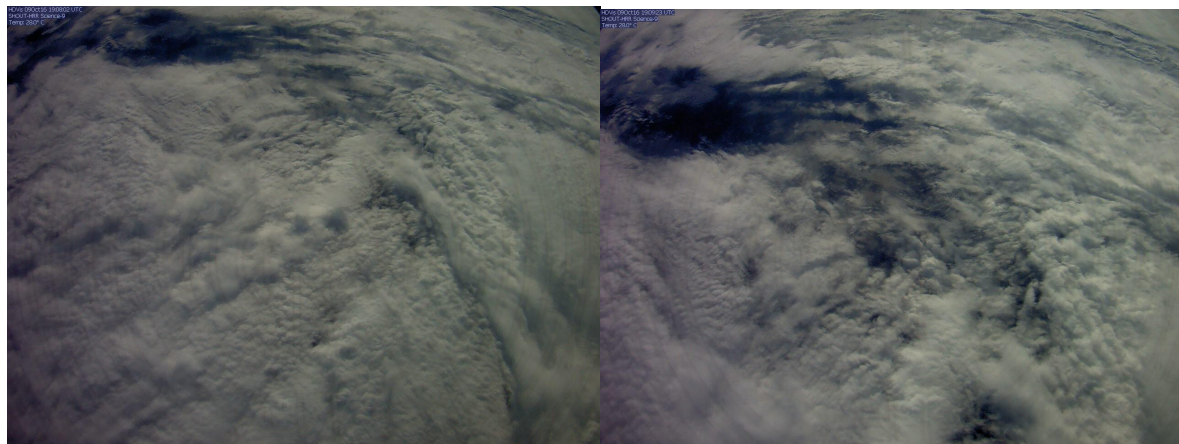


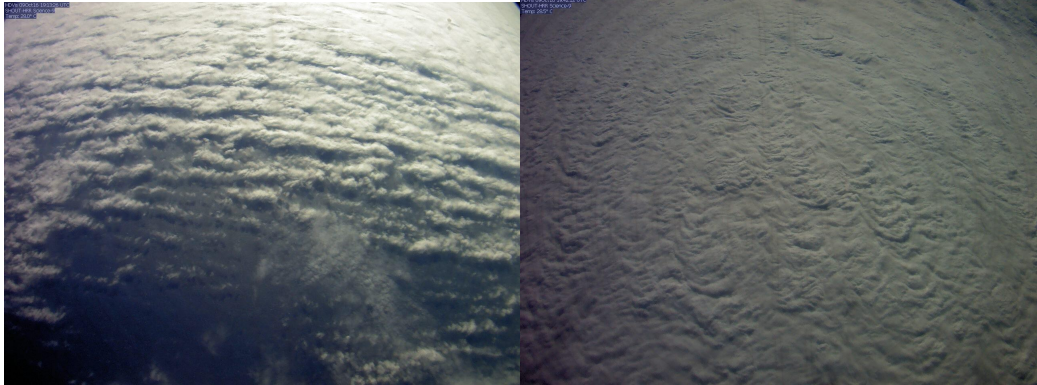
Continue to find strong winds on the backside of Matthew in a shallow layer. 67 knots at the surface and 87 knots at 900 mb.



Starting at 1844Z: increased dropsonde resolution on final NE - SW leg to ~10 minutes (no update filed in MTS)

Near "center" GH overpass of post-tropical Matthew (~1910Z)



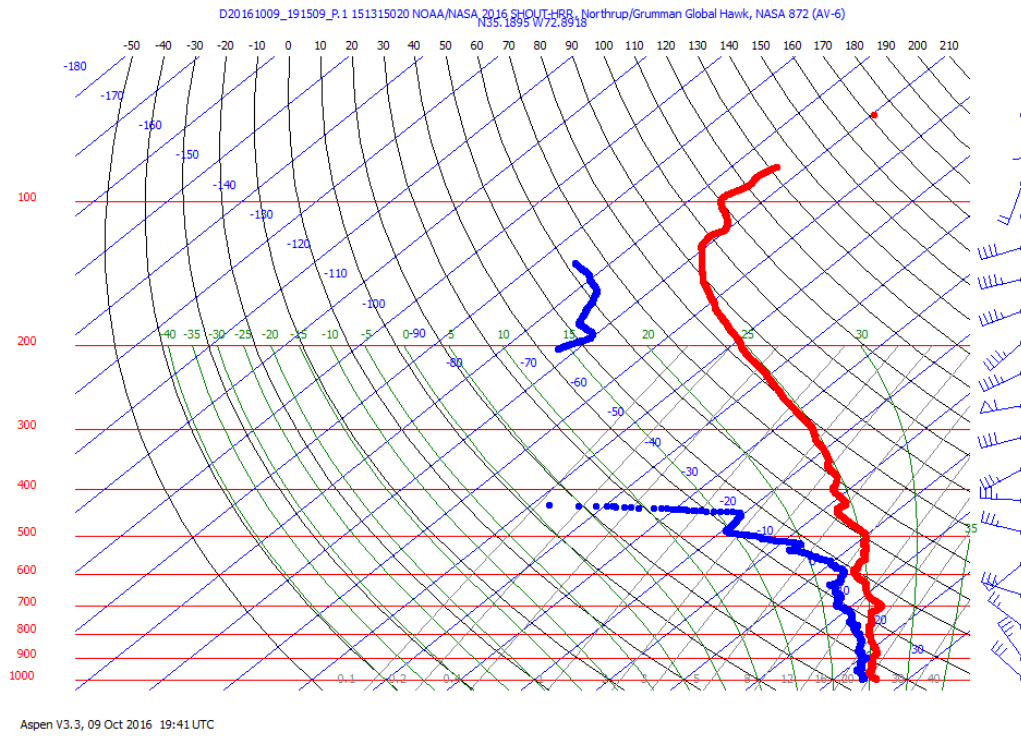
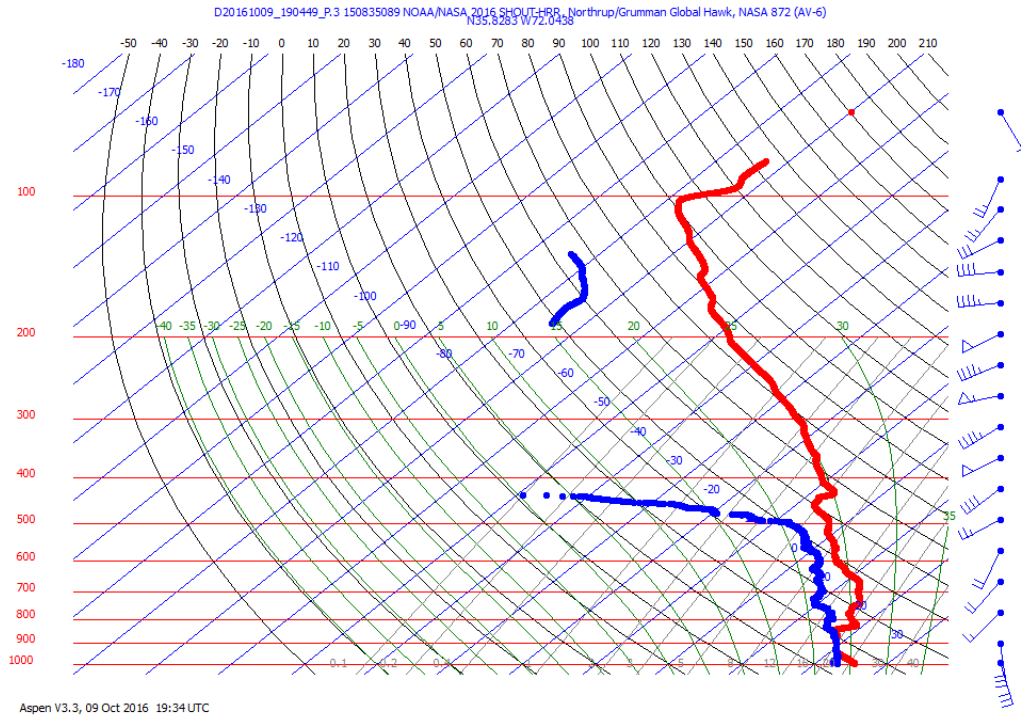


Final NE-SW transect across post-tropical Matthew:

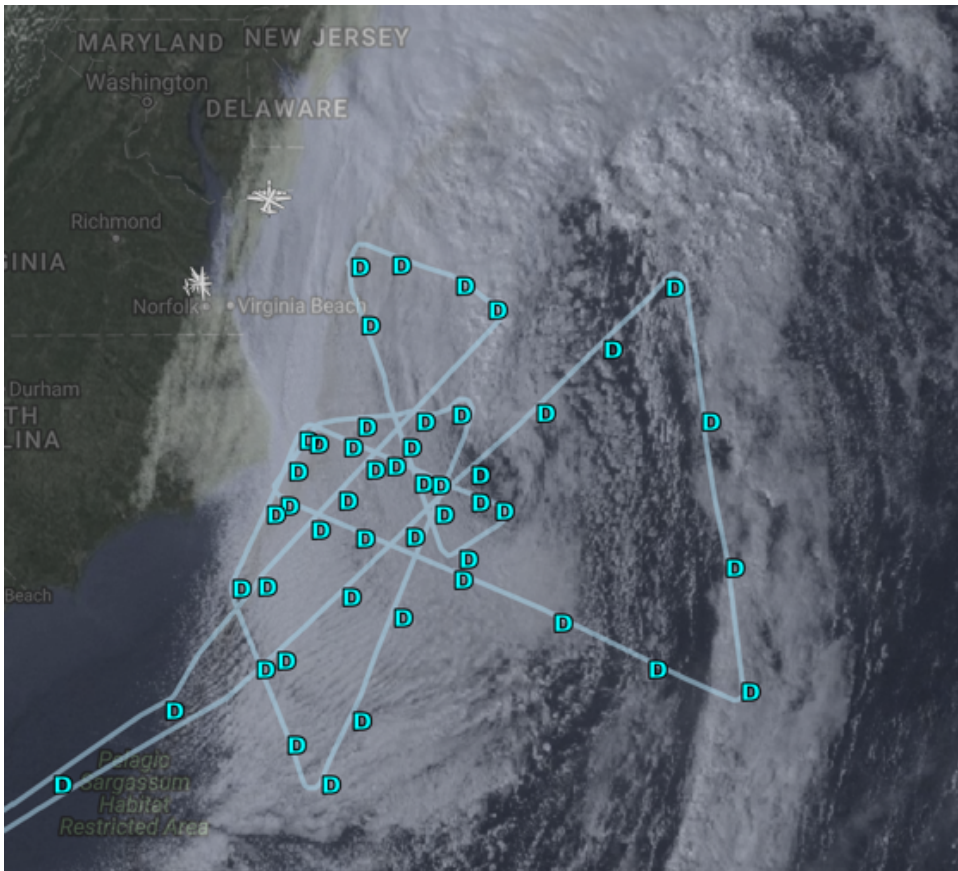
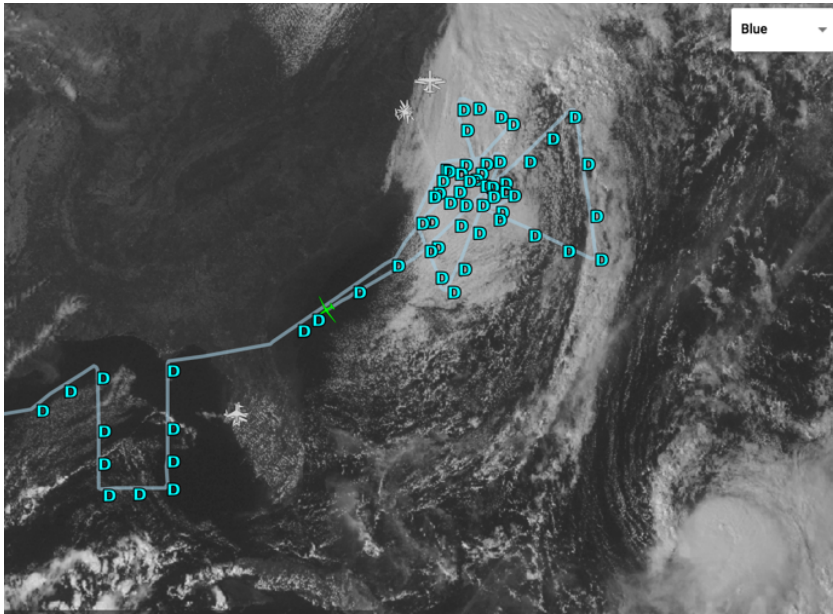
top left - just after "center" pass, top right - short time later, below - exiting the cloud shield



2 “near center” dropsondes from final NE-SW leg: Warm air advection (top) and cold air advection (bottom) evident in the 2 soundings



2030z: Final overstorm AV-6 track



POST-TROPICAL CYCLONE MATTHEW DISCUSSION NUMBER 47

NWS NATIONAL HURRICANE CENTER MIAMI FL AL142016

500 PM EDT SUN OCT 09 2016

**Dropsonde data from a NASA Global Hawk mission into Matthew today indicate that the post-tropical cyclone has not weakened. The observations continue to show a band of 60-65 kt winds to the southwest and west of the center.** Matthew is moving east-northeastward at about 13 kt, and an east-northeastward motion within the mid-latitude westerlies should continue through tonight. Matthew is forecast by the global models to weaken and be absorbed within a frontal boundary on Monday, and the NHC forecast follows suit. It should be noted that a strong baroclinic low is expected to develop along the same frontal boundary near Nova Scotia on Monday.

Winds over the Outer Banks of North Carolina have gradually diminished this afternoon, and the tropical storm warning has been discontinued. Dangerously high water levels over portions of the Outer Banks will gradually subside overnight and early Monday. Based on these trends, this will be the last NHC advisory on Matthew. For additional information on the elevated water levels in the Outer Banks and the ongoing freshwater flooding in eastern North Carolina, see products and warnings issued by your local National Weather Service forecast office. Additional information on Matthew can also be found in High Seas Forecasts issued by the National Weather Service, under AWIPS header NFDHSFAT1 and WMO header FZNT01 KWBC.

#### FORECAST POSITIONS AND MAX WINDS

INIT 09/2100Z 35.4N 72.0W 65 KT 75 MPH...POST-TROP/EXTRATROP

12H 10/0600Z 36.4N 69.2W 55 KT 65 MPH...POST-TROP/EXTRATROP

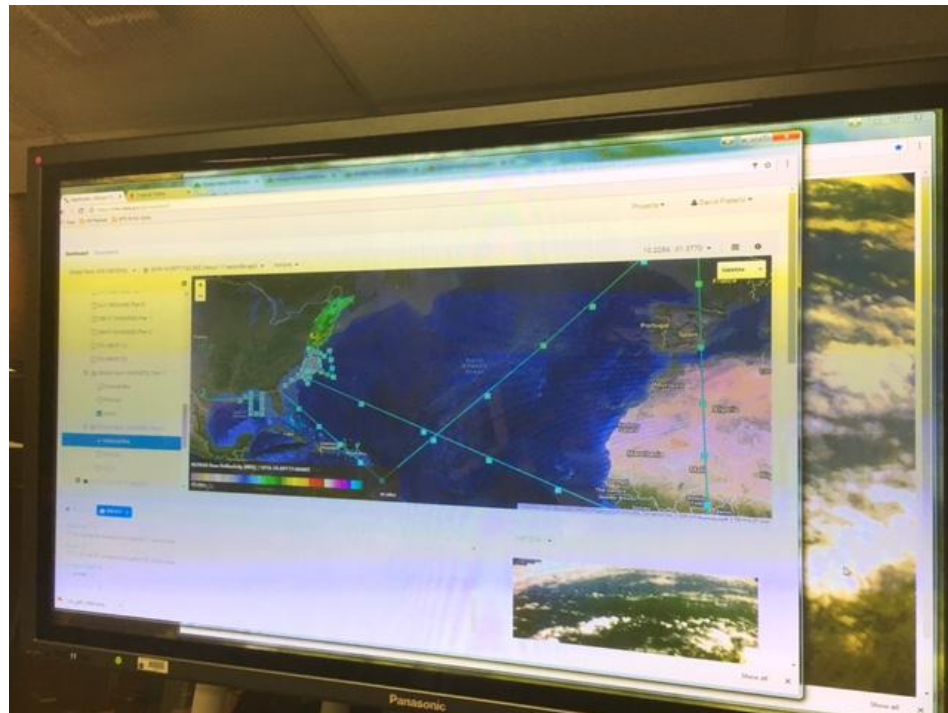
24H 10/1800Z...ABSORBED BY FRONT

\$\$

Forecaster Brown

J. Dunion adds in one last bowtie pattern just E of Matthew (environmental sampling). Total track time 62 hr 56 min.





Great job to all on this historic flight and mission. As Pete Black said, "We will be talking about SHOUT data for the next 50 years!"