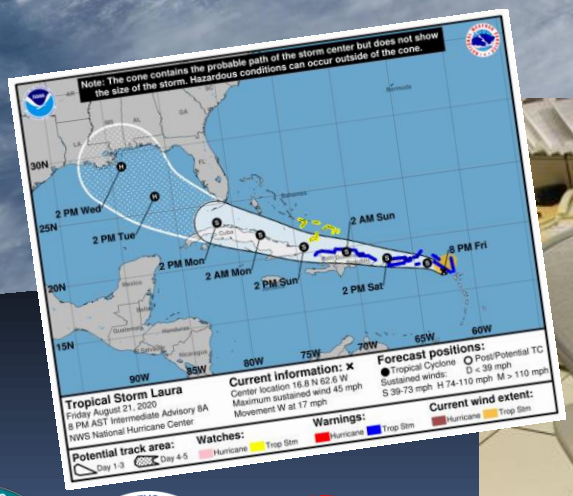
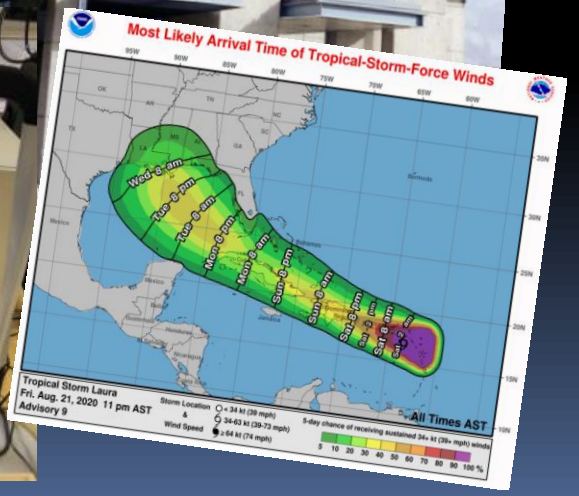
2021 WMO RA-IV Workshop
Advisory Preparation Exercise





Outline

Setting the Stage (00:00-00:45)

- Plotting Fixes
- Determining Initial Location, Intensity, and Size
- Send and receive model guidance

Creating the Forecast (00:45-02:00)

- Track
- Intensity
- Wind Radii

Outline

Forecast Coordination (02:00-02:15)

- Coordinate U.S. and International Watches/Warnings
- Coordinate rainfall and other TC hazards

Product Preparation (02:15-03:00)

- Public Advisory
- Discussion

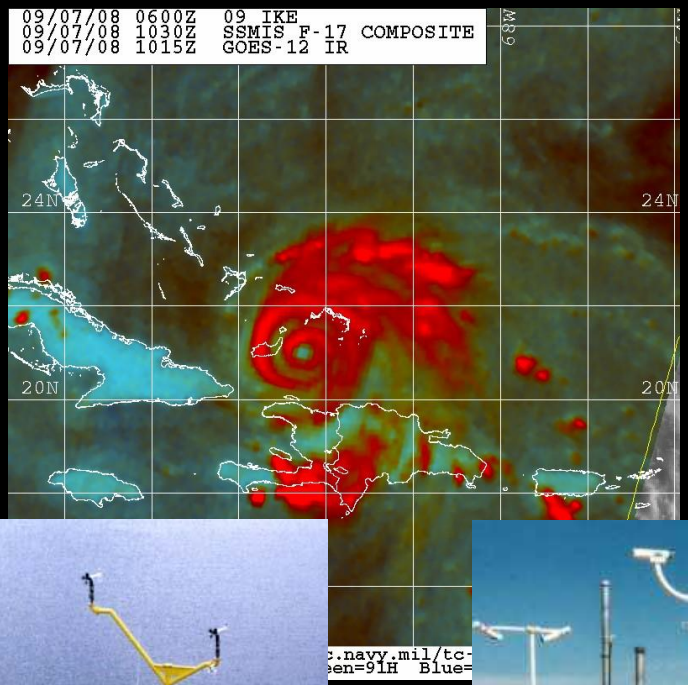
NHC Forecast Cycle

Time (HR : MIN)	Event
00:00	**Issue Tropical Weather Outlook** **Issue Intermediate Public Advisory (if necessary)** **Synoptic time / cycle begins**
00:45	**Receive satellite fix data**
01:00	**Initialize models**
01:10	**Receive model guidance and *prepare forecast***
02:00	**NWS / DOD hotline coordination**
03:00	**Advisory deadline**
03:15	**FEMA conference call**

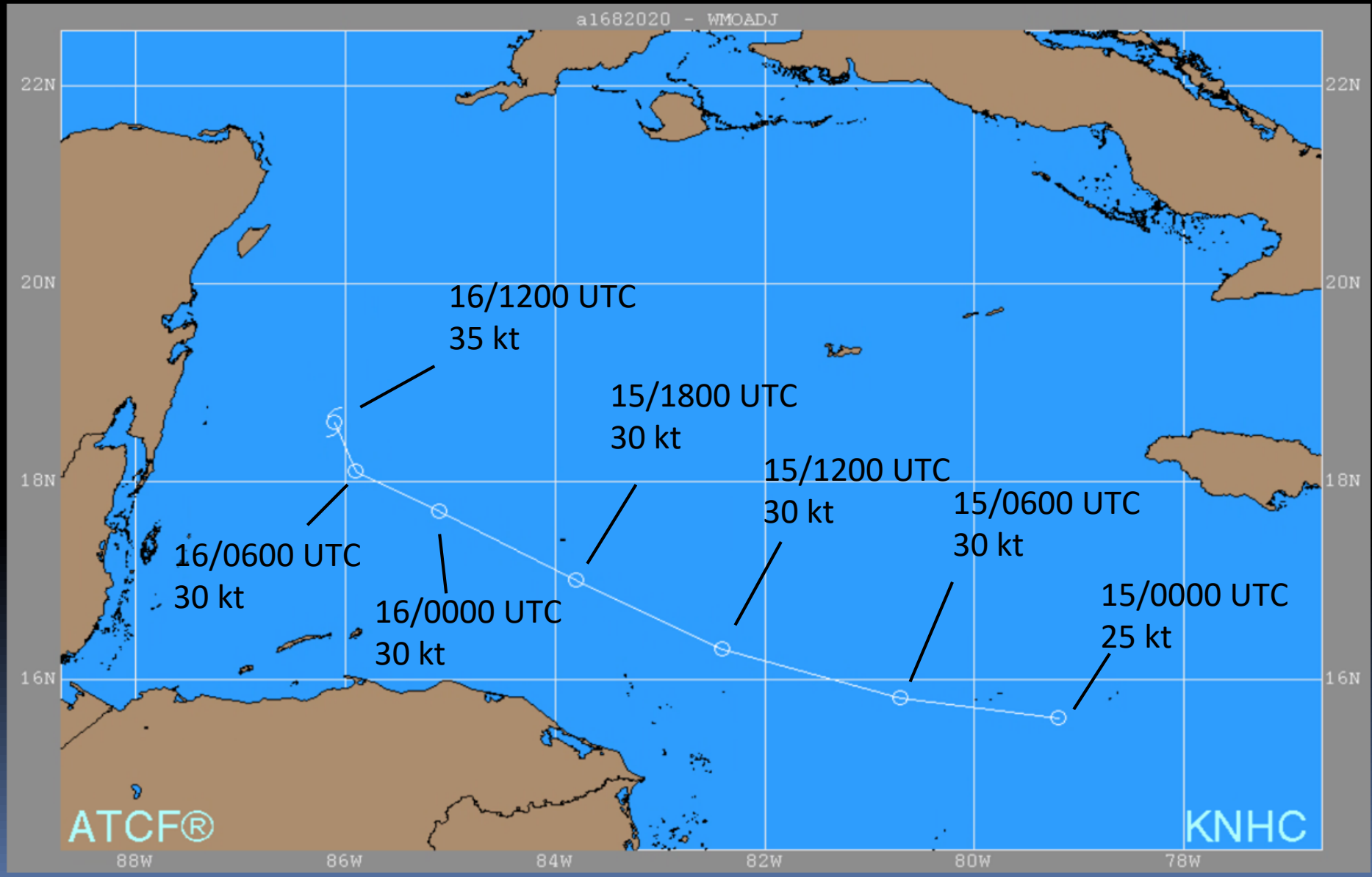
18:00 UTC

Synoptic time / cycle begins

Hurricane specialist analyzes available observations



Working Best Track in ATCF through 1200 UTC



Reconnaissance Aircraft (Air Force) Scheduled between 1800-0000 UTC

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NOUS42 KNHC 061930
REPRPD
WEATHER RECONNAISSANCE FLIGHTS
CARCAH, NATIONAL HURRICANE CENTER, MIAMI, FL.
0330 PM EDT WED 15 APRIL 2020
SUBJECT: TROPICAL CYCLONE PLAN OF THE DAY (TCPOD)
         VALID 16/1100Z TO 17/1100Z APRIL 2020
         TCPOD NUMBER.....20-001

I.  ATLANTIC REQUIREMENTS
    1. SUSPECT AREA (WESTERN CARIBBEAN SEA)
       FLIGHT ONE -- TEAL 71          FLIGHT TWO -- TEAL 72
       A. 16/1800Z                    A. 17/0530Z
       B. AFXXX 01DDA INVEST          B. AFXXX 0214A CYCLONE
       C. 16/1500Z                    C. 17/0245Z
       D. NA                          D. 20.9N 86.7W
       E. 16/1730Z TO 16/2100Z        E. 17/0500Z TO 17/0830Z
       F. SFC TO 10,000 FT            F. SFC TO 10,000 FT

       FLIGHT THREE -- TEAL 73
       A. 17/1130Z,1730Z
       B. AFXXX 0314A CYCLONE
       C. 17/0900Z
       D. 21.6N 86.7W
       E. 17/1100Z TO 17/1730Z
       F. SFC TO 10,000 FT

    2. OUTLOOK FOR SUCCEEDING DAY:
       A. CONTINUE 6-HRLY FIXES IF SYSTEM DEVELOPS.
       B. BEGIN 12-HRLY P-3 TAIL DOPPLER RADAR MISSIONS,
       WITH FIRST MISSION DEPARTING KLAL AT 17/2000Z.
       C. A G-IV SYNOPTIC SURVEILLANCE MISSION FOR 19/00Z
       DEPARTING KLAL AT 18/1730Z.

II. PACIFIC REQUIREMENTS
    1. NEGATIVE RECONNAISSANCE REQUIREMENTS.
    2. OUTLOOK FOR SUCCEEDING DAY.....NEGATIVE.

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WJM

NNNN
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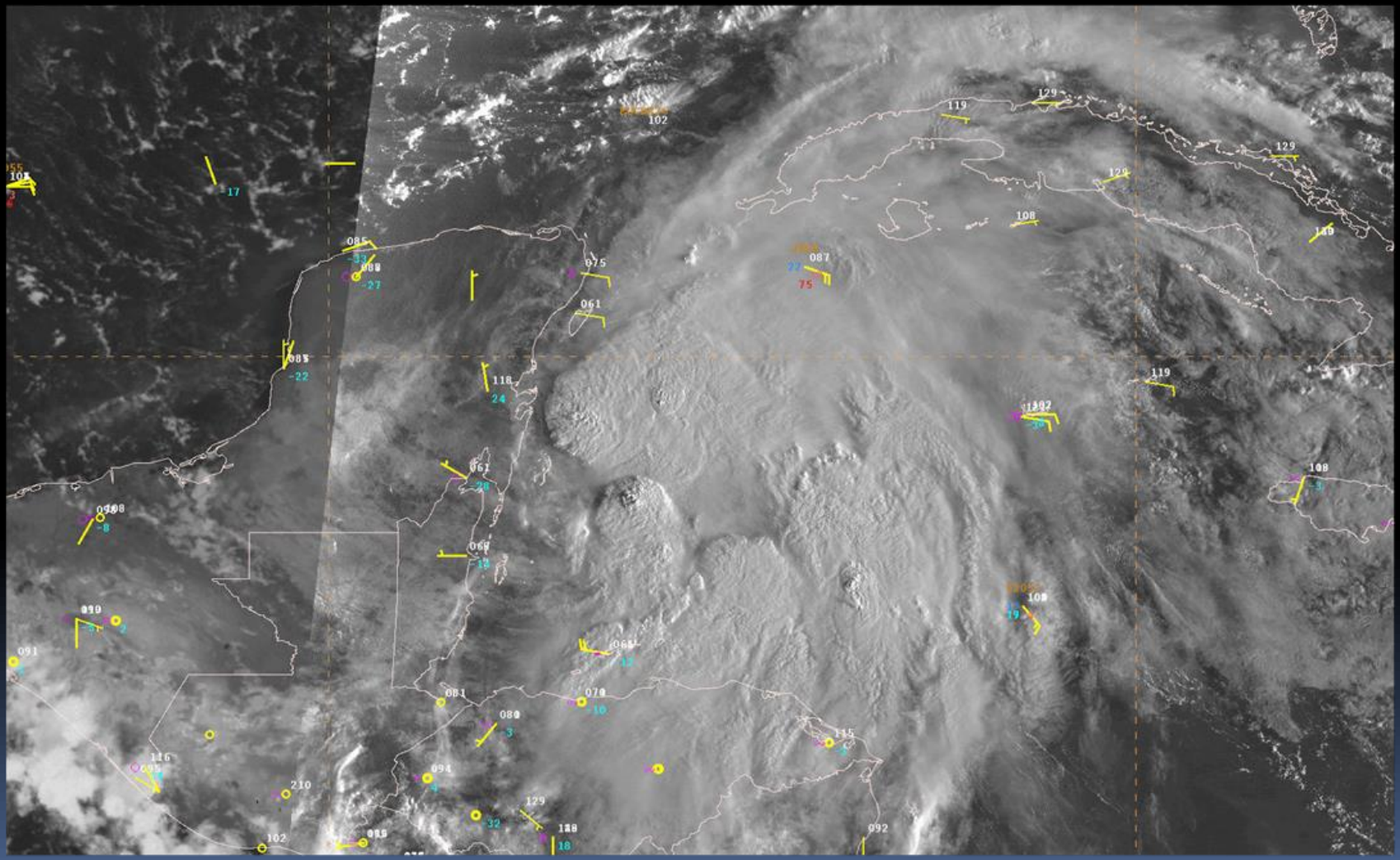
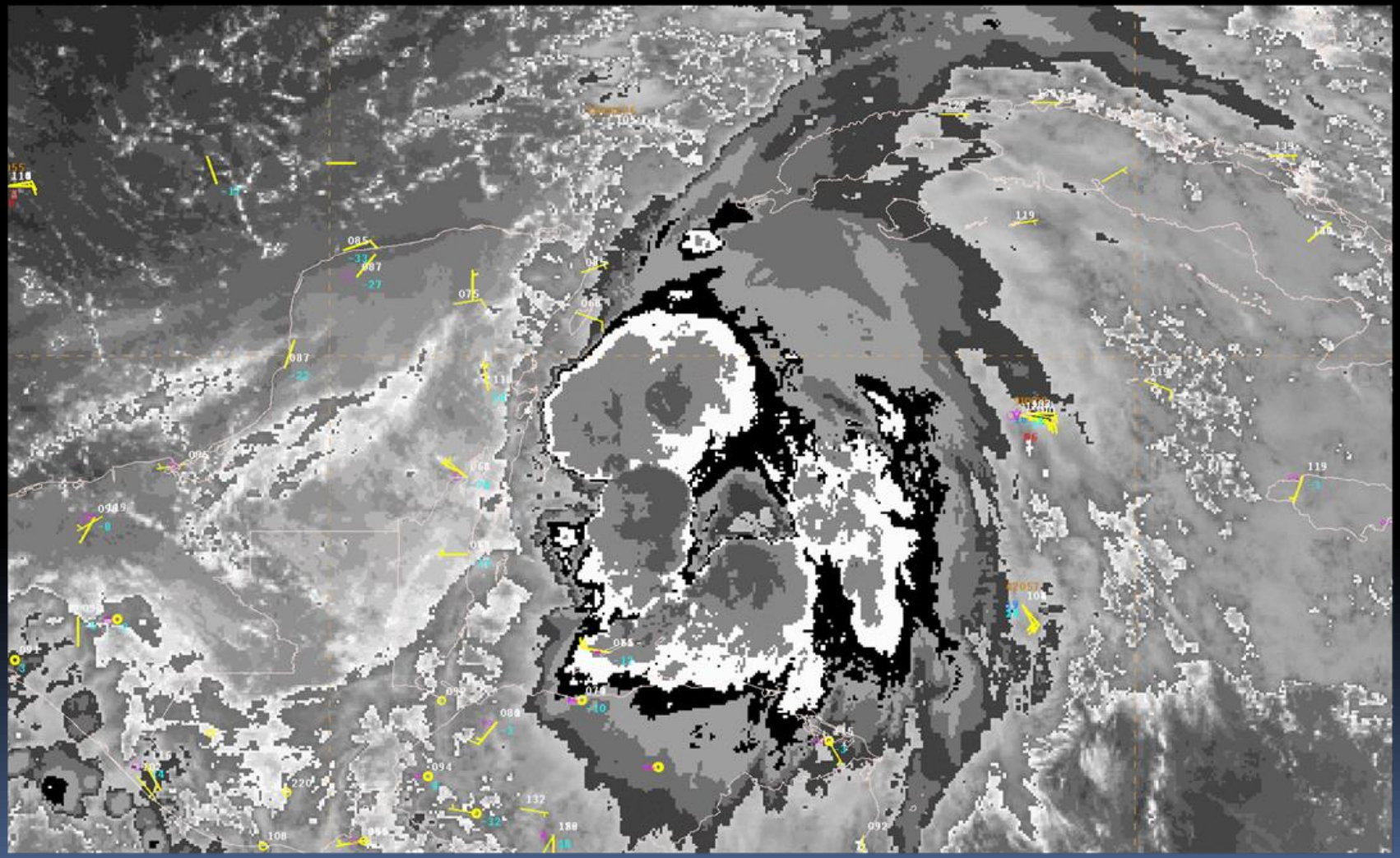
First flight into tropical storm. Mission was originally planned as an “Invest” mission, arriving at 18Z

G-IV flight planned for 0000 UTC following day

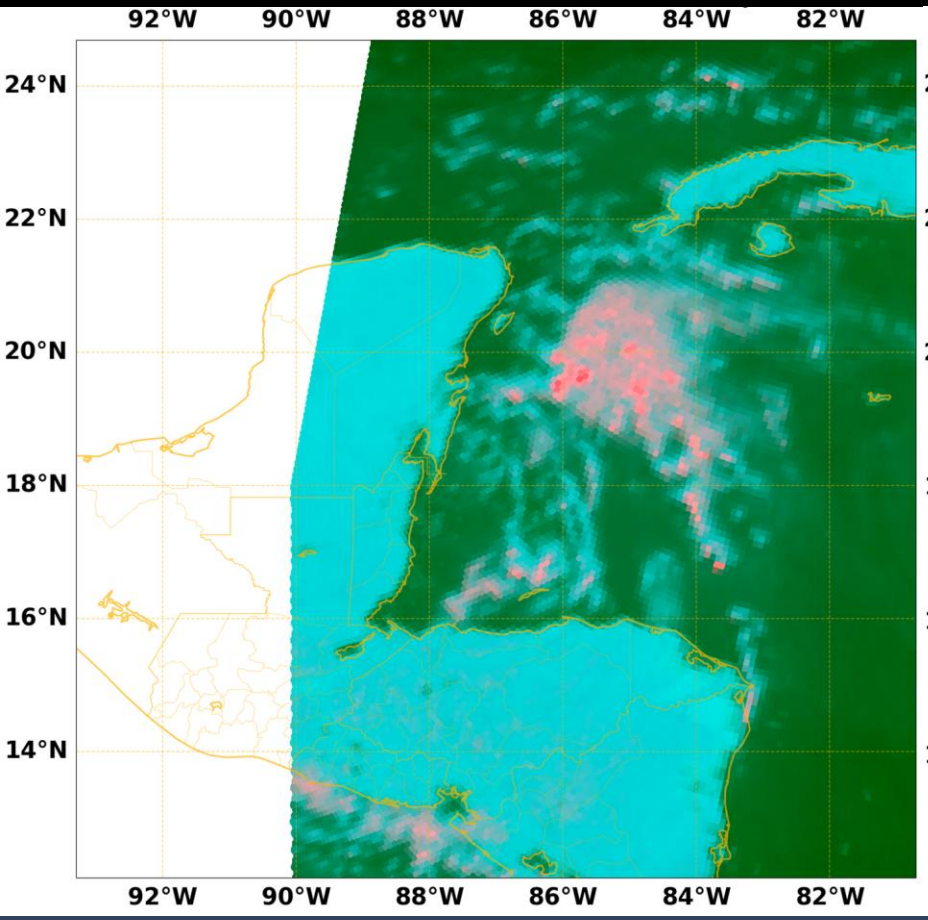
Visible Imagery



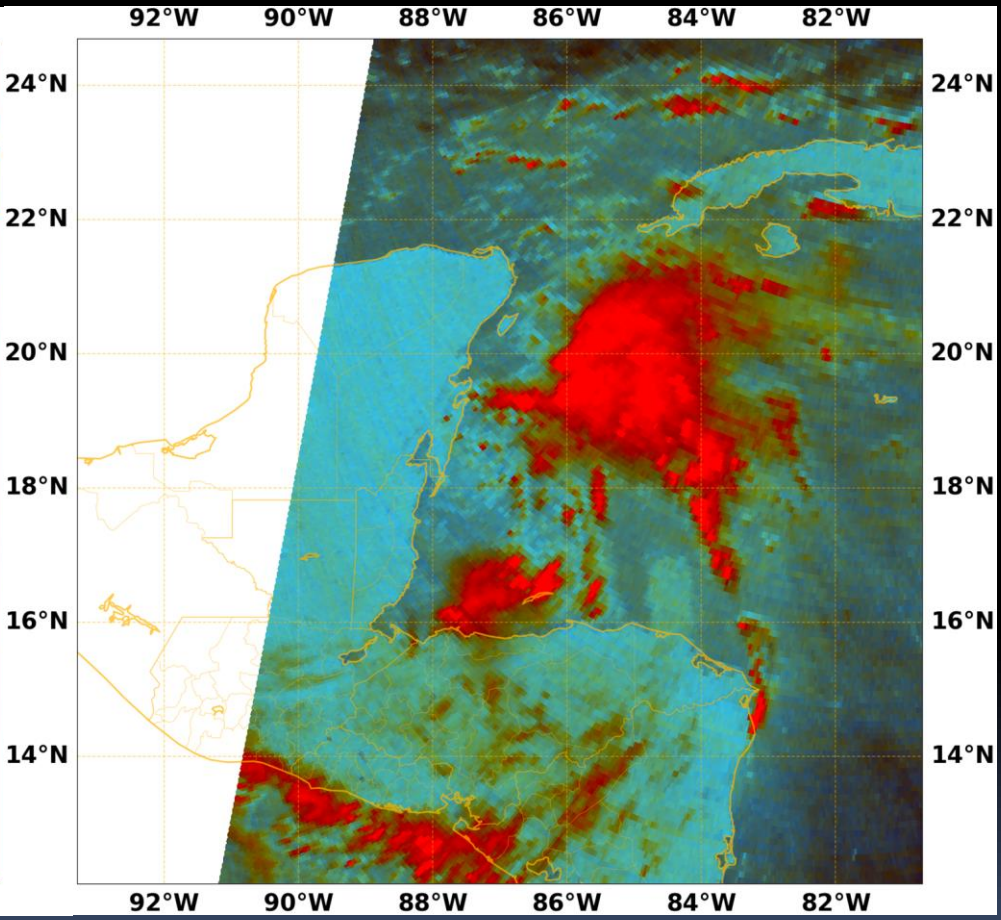
IR Imagery



Overnight Microwave Imagery
AMSR- 16/0650 UTC

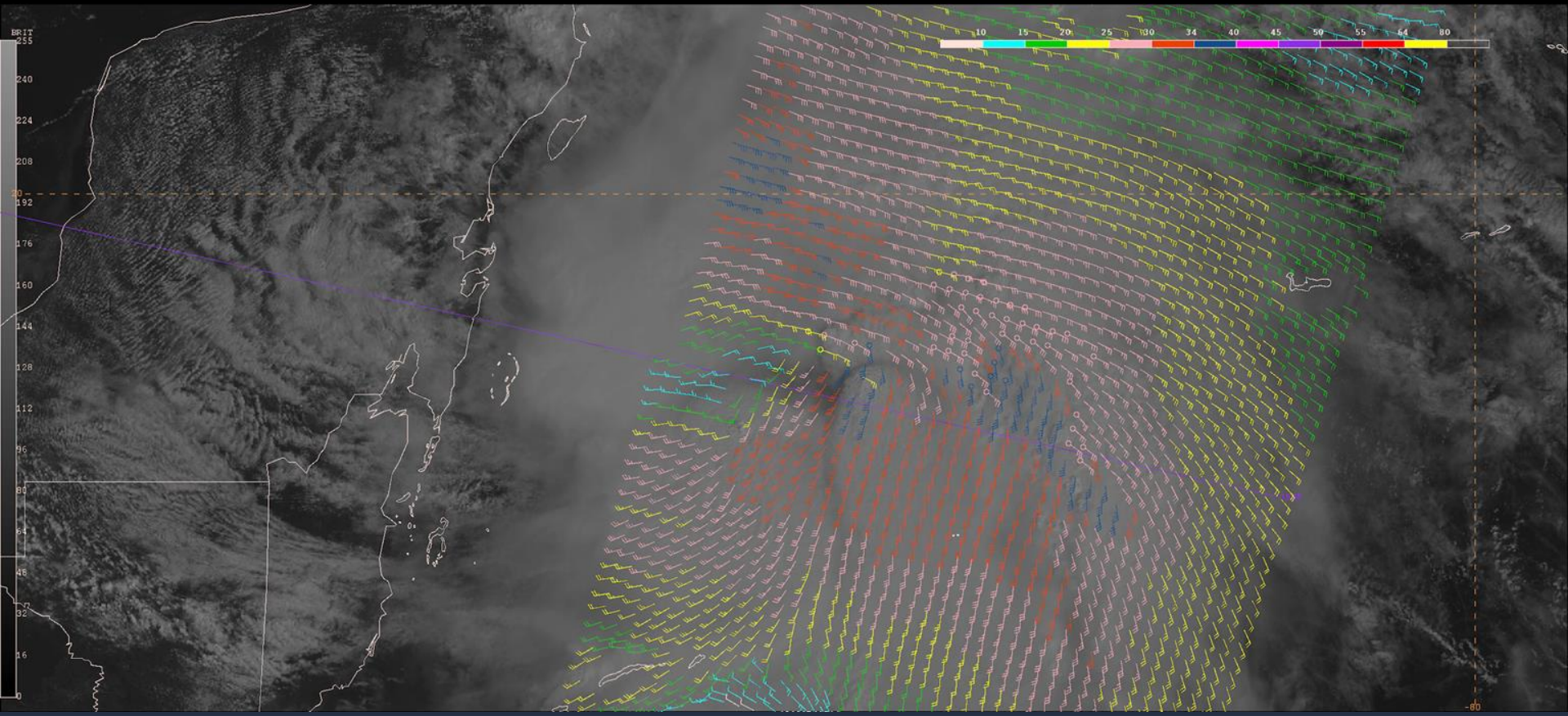


37 GHz Color Composite

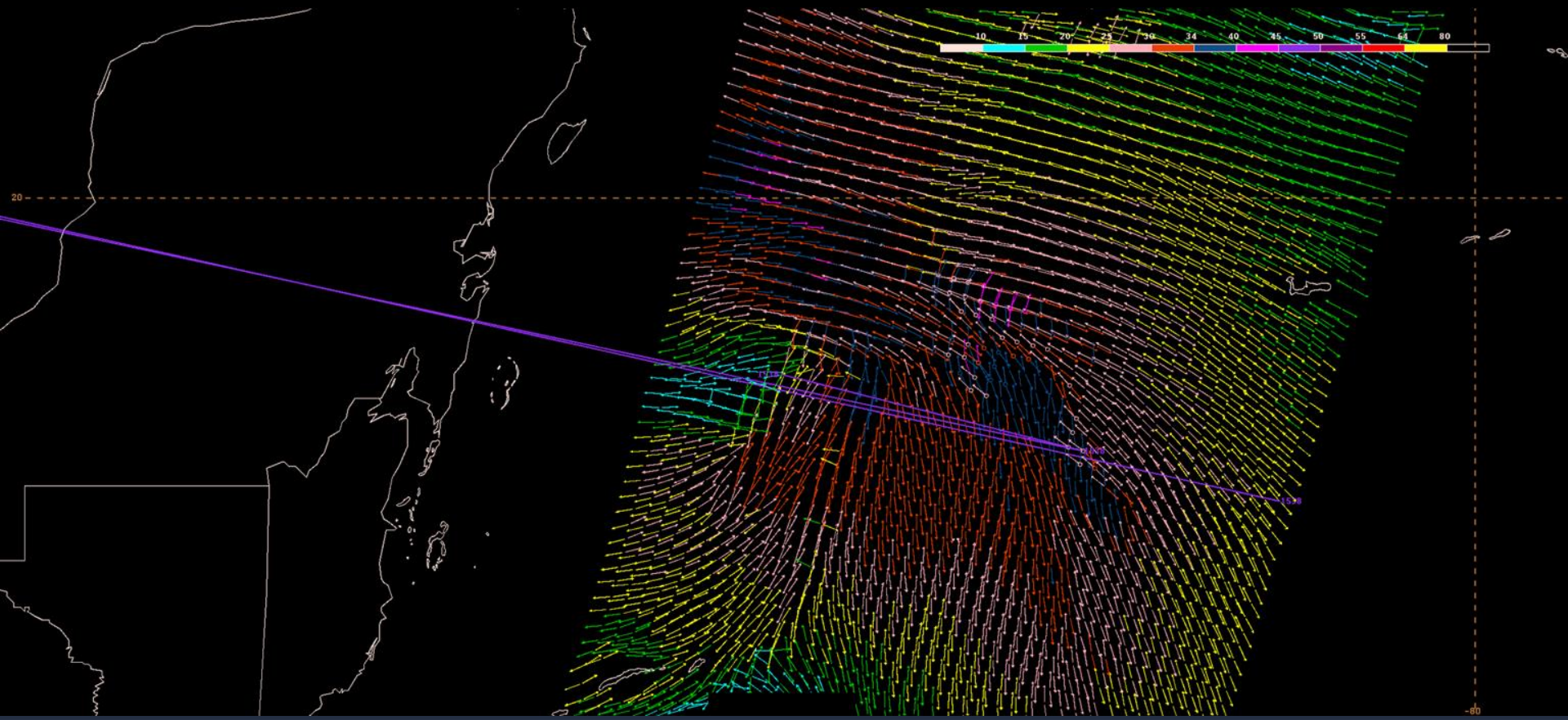


89 GHz Color Composite

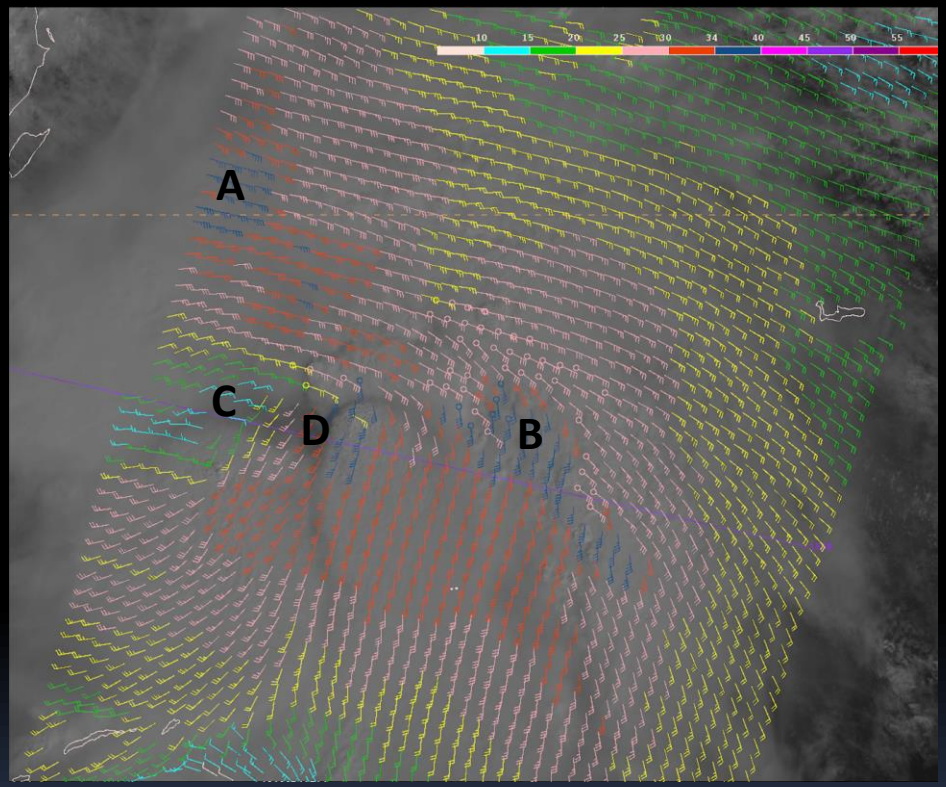
ASCAT-B 1514 UTC
Model solution

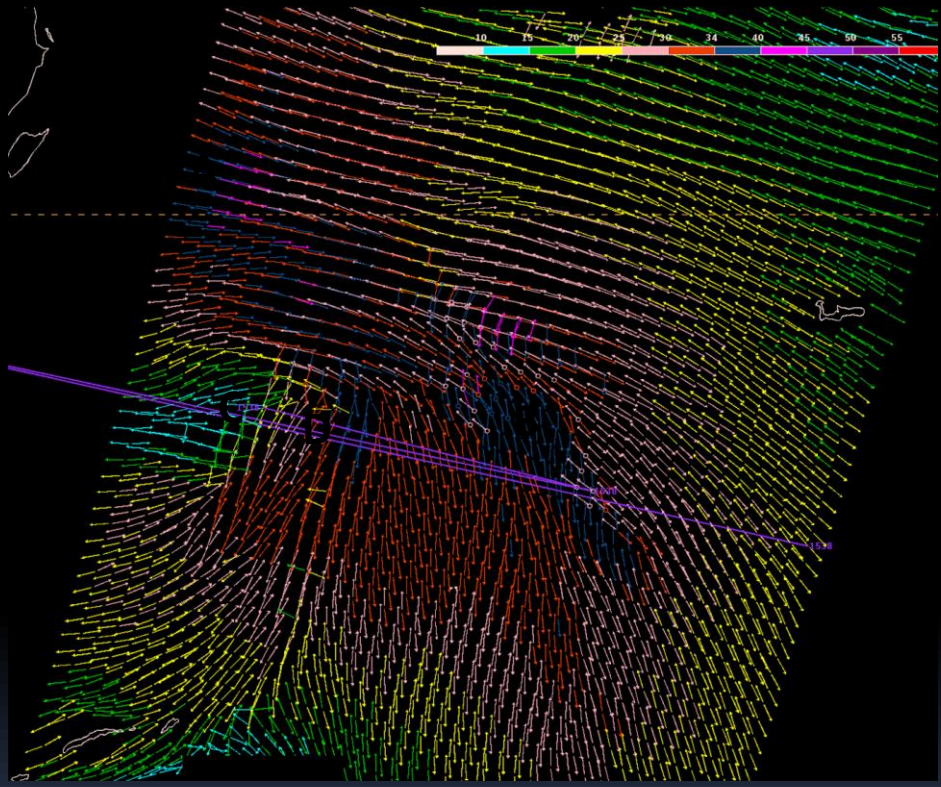


ASCAT-B 1514 UTC Ambiguities

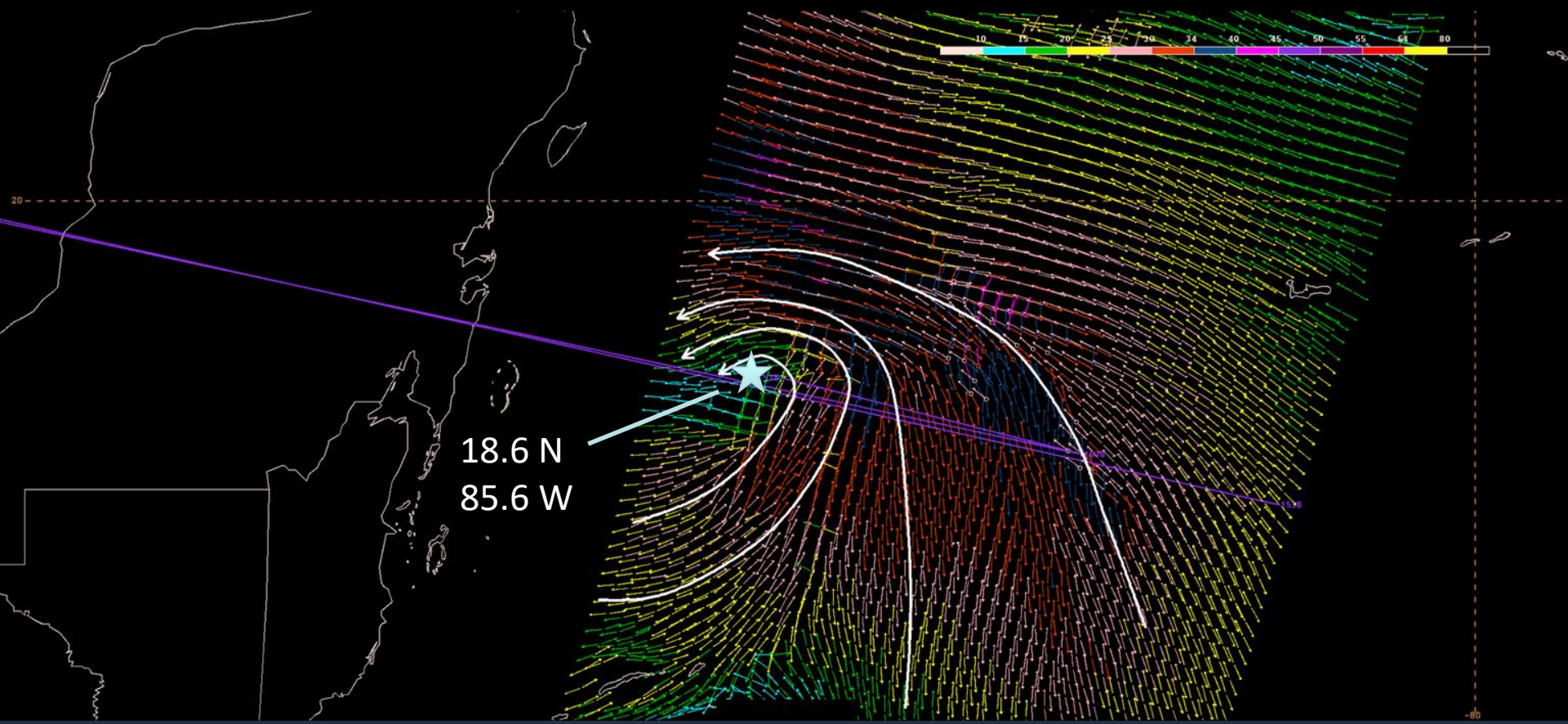


ASCAT-B 1514 UTC
Identify the center of the Tropical Storm

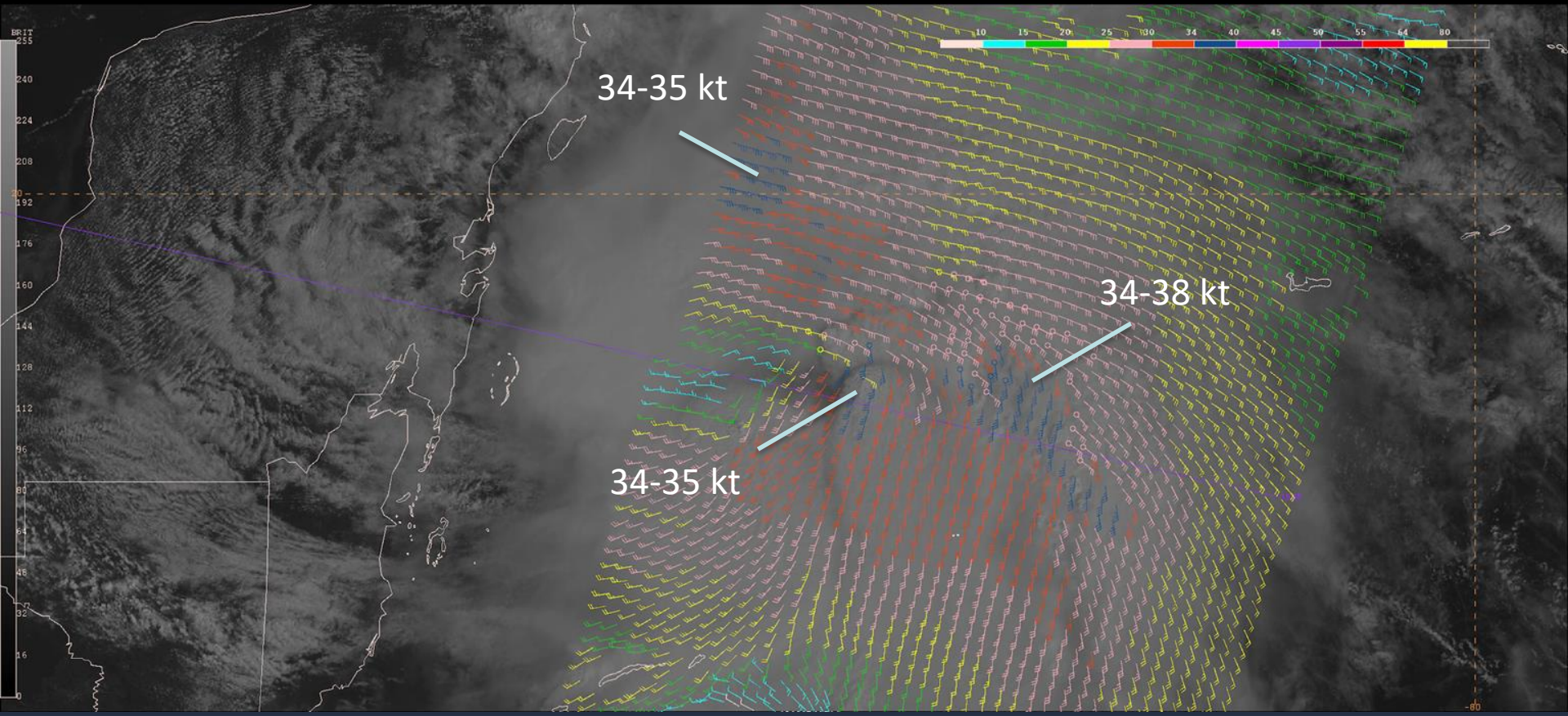




ASCAT-B 1514 UTC

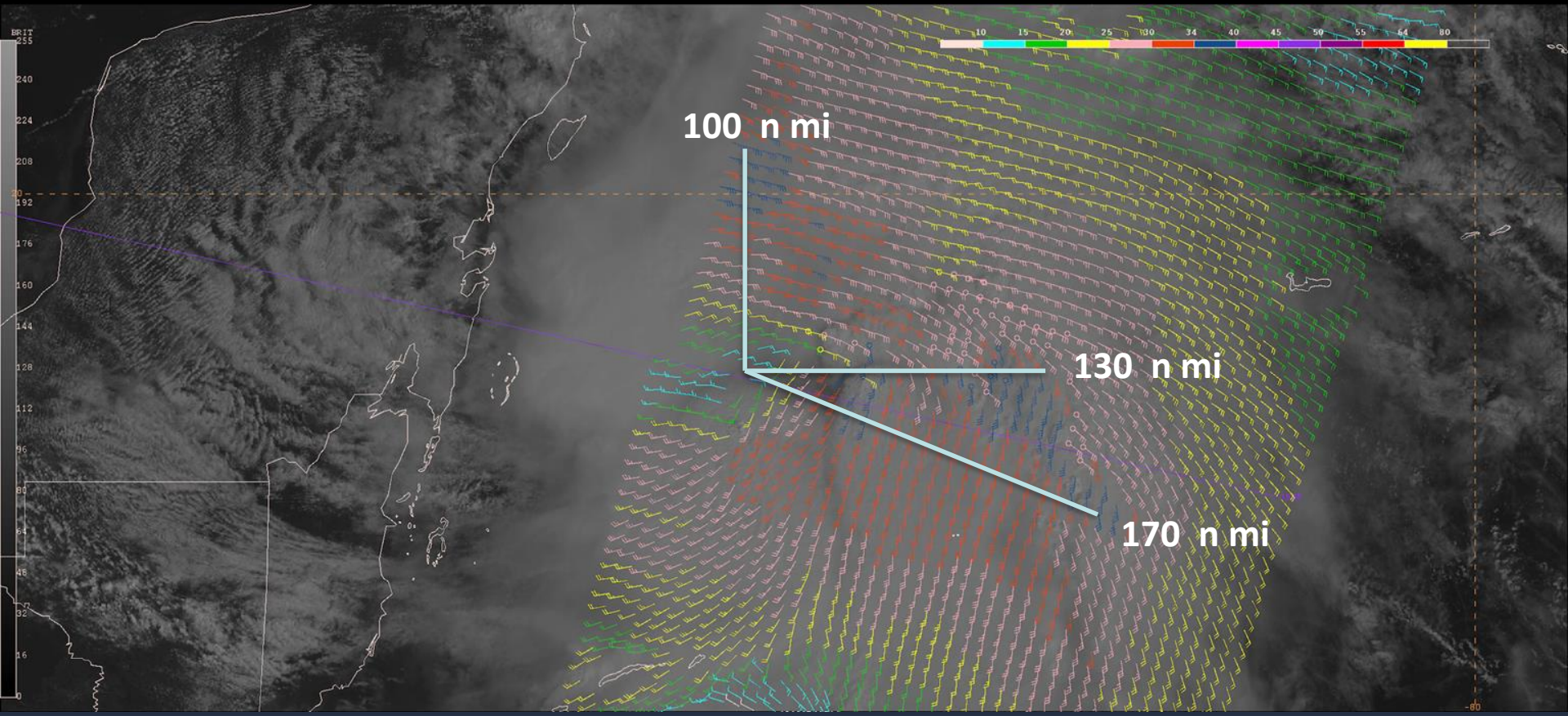


ASCAT-B 1514 UTC Intensity



Several areas of 34+ kt winds, could support an initial intensity of 40 kt after accounting for under-sampling

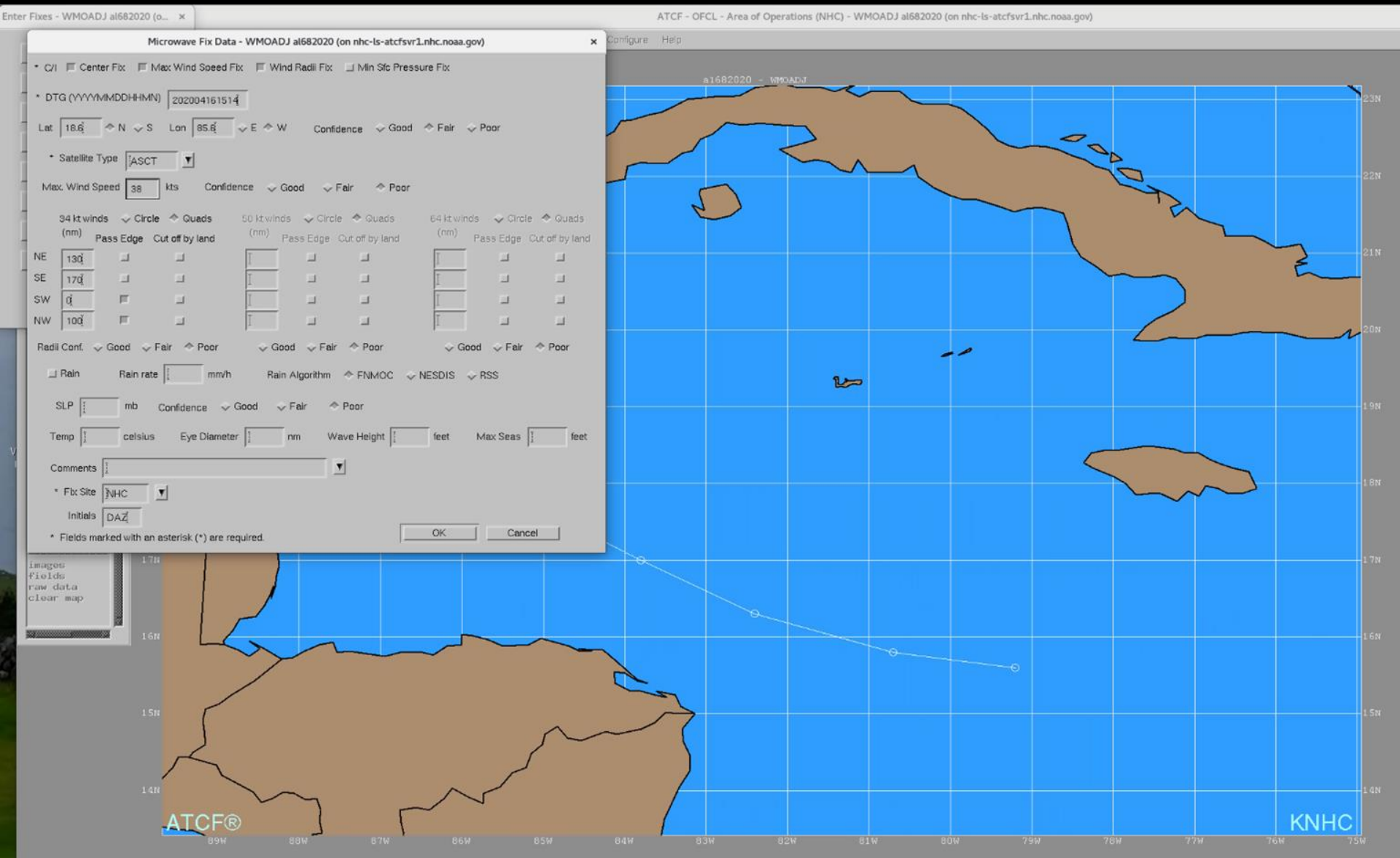
ASCAT-B 1514 UTC
Wind Radii



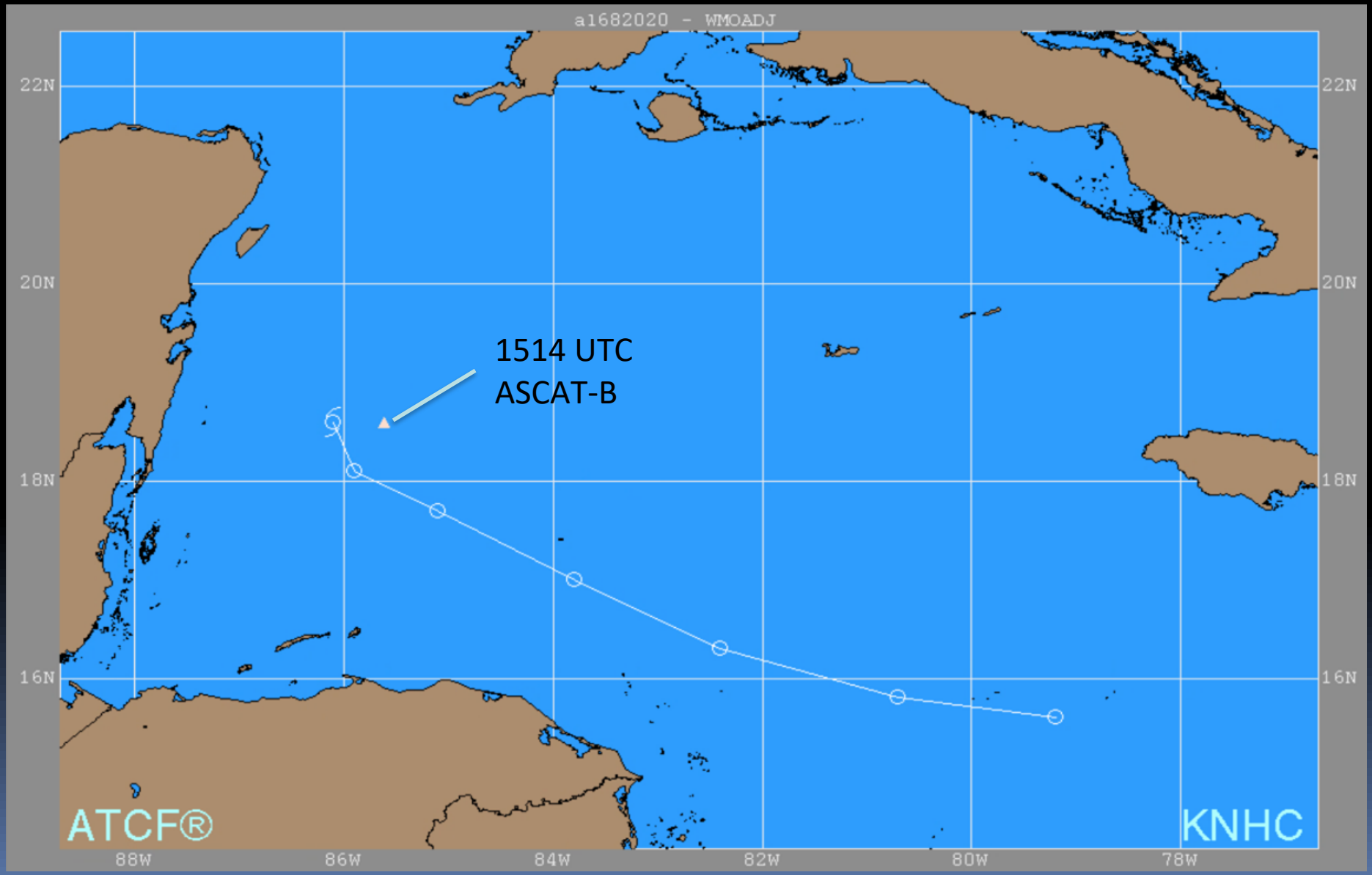
NW Quadrant: at least 100 n mi (due north)
SW Quadrant: 0 (cut off, but little reason to suspect higher winds are farther west)

NE Quadrant: 130 n mi (almost due east)
SE Quadrant: 170 n mi

Let’s enter the fix into the ATCF

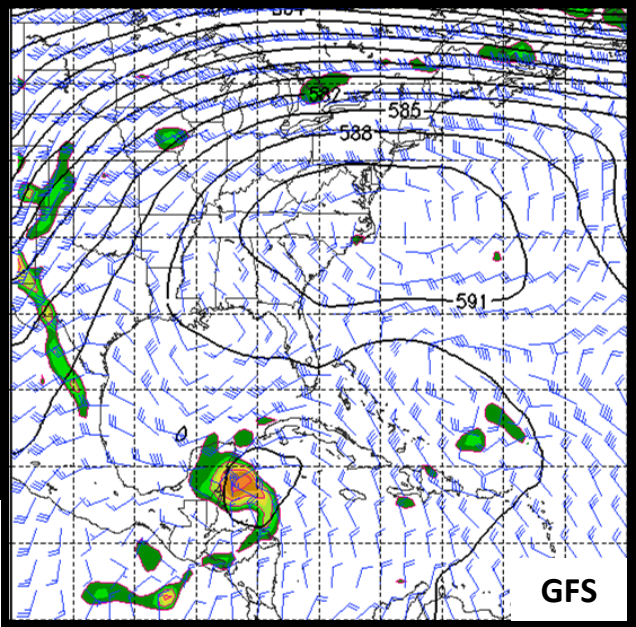


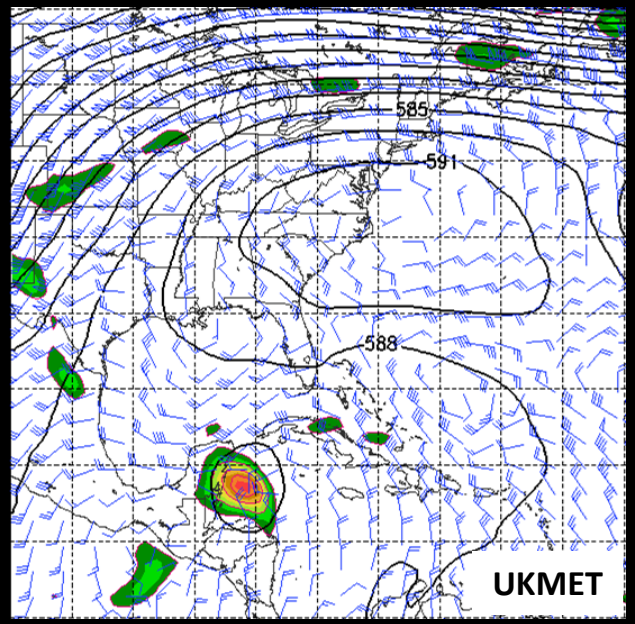
Working Best Track with 1514 UTC ASCAT-B Fix

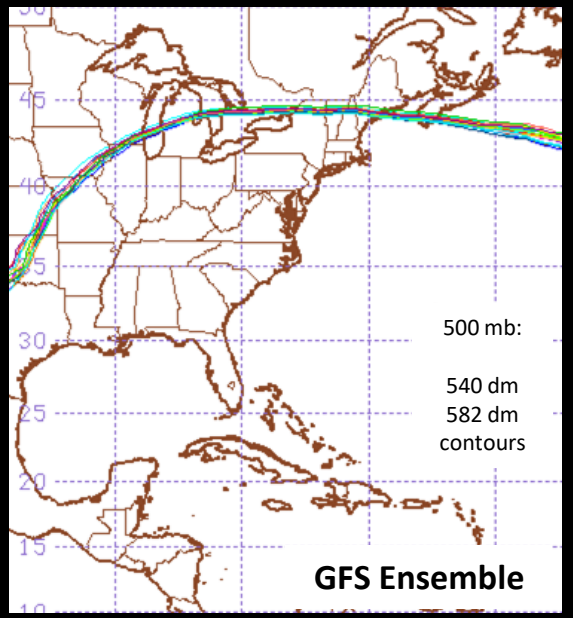


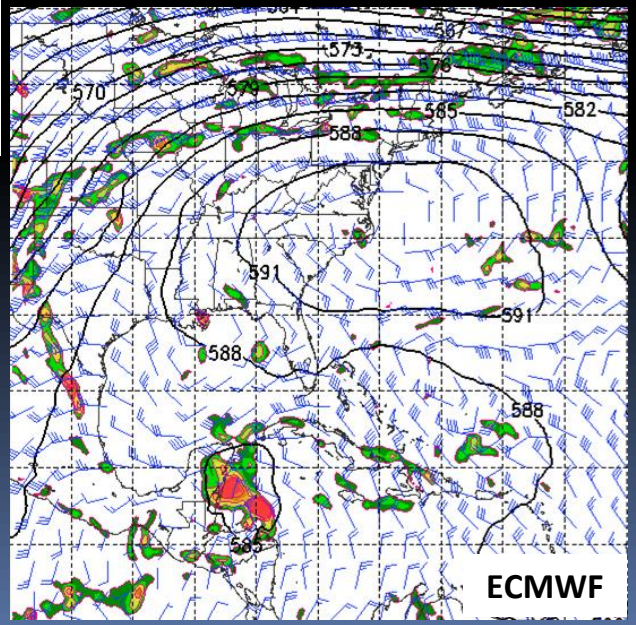
While we wait for the Aircraft and Satellite Fixes…
let's examine the 1200 UTC model guidance

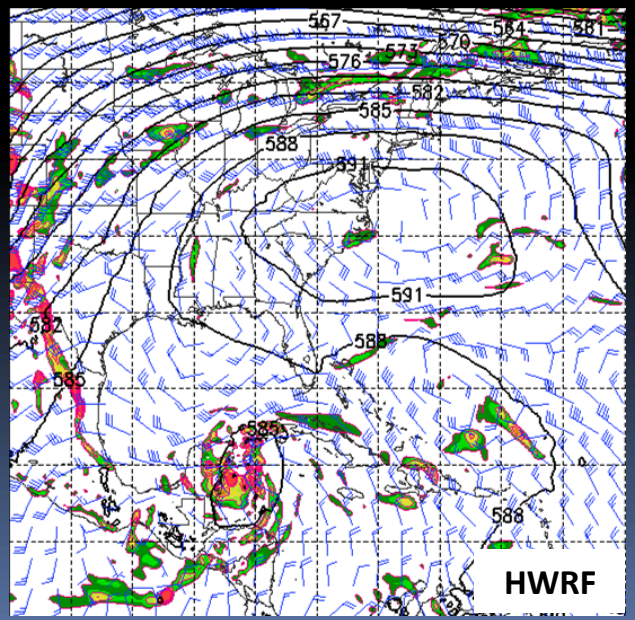
00h (initial conditions)

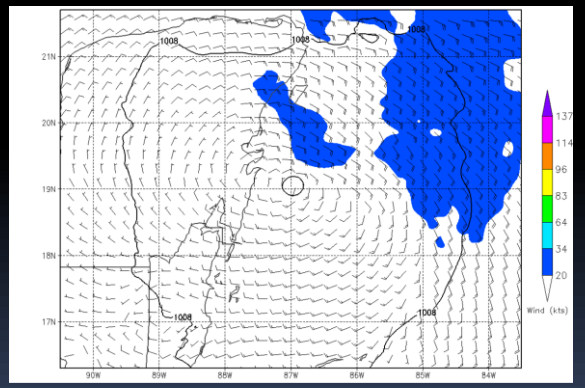






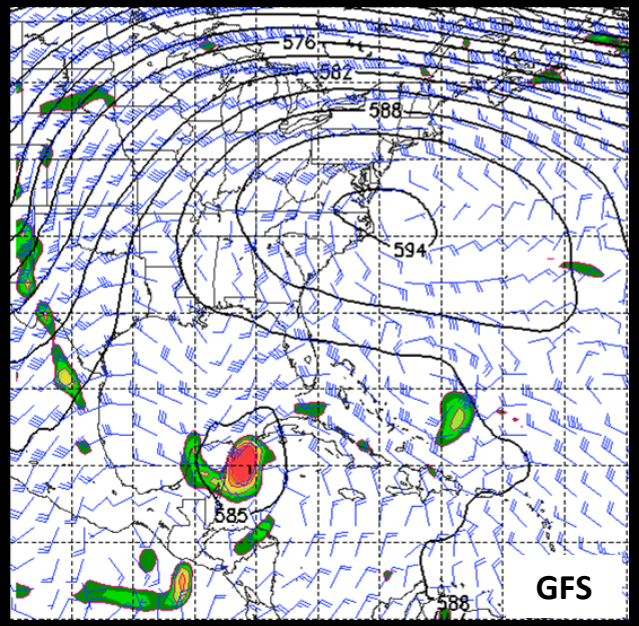


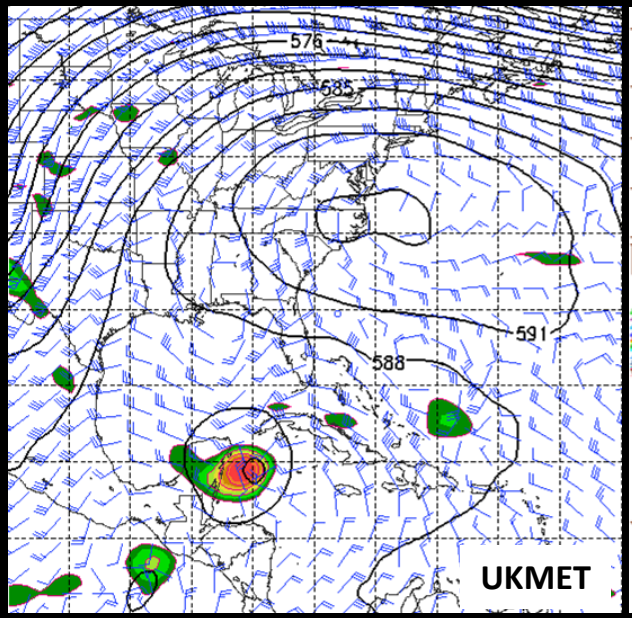


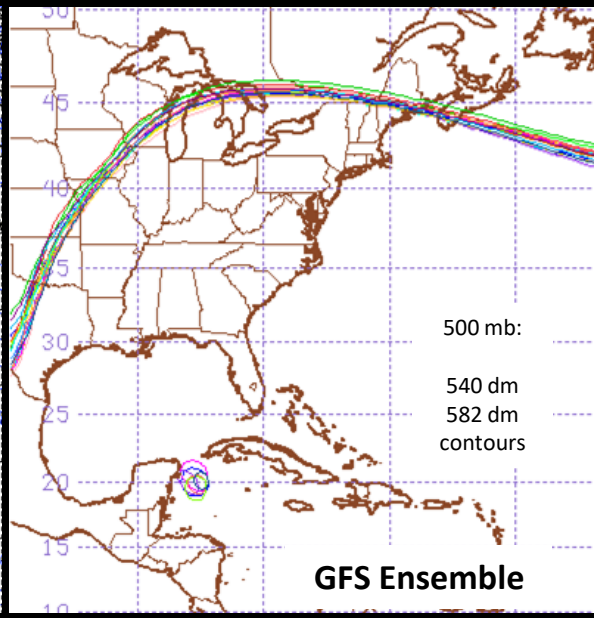


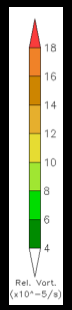
HWRF Surface

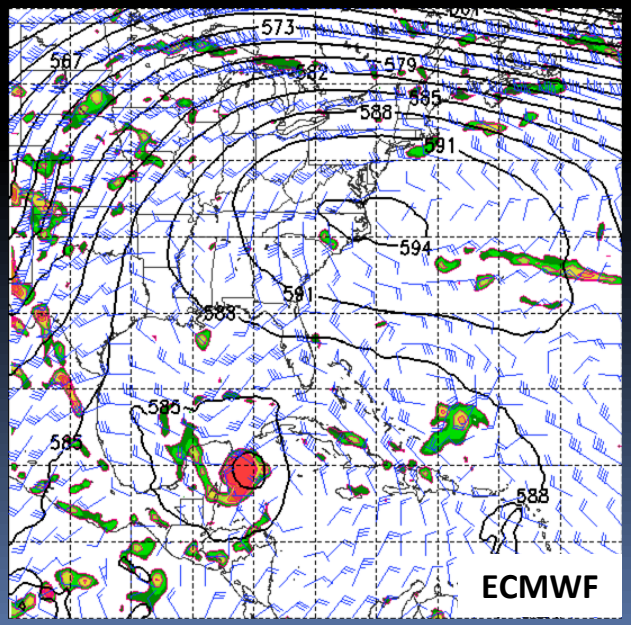
12h forecast

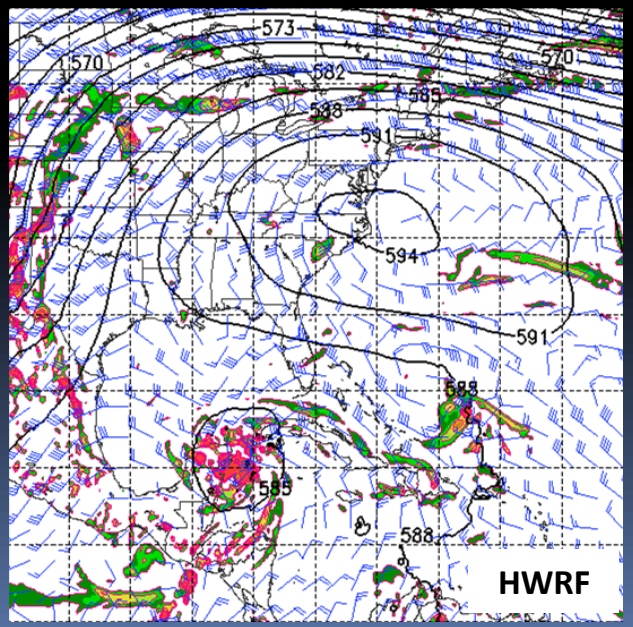


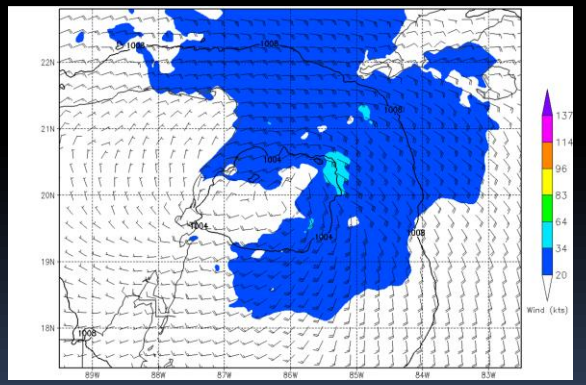






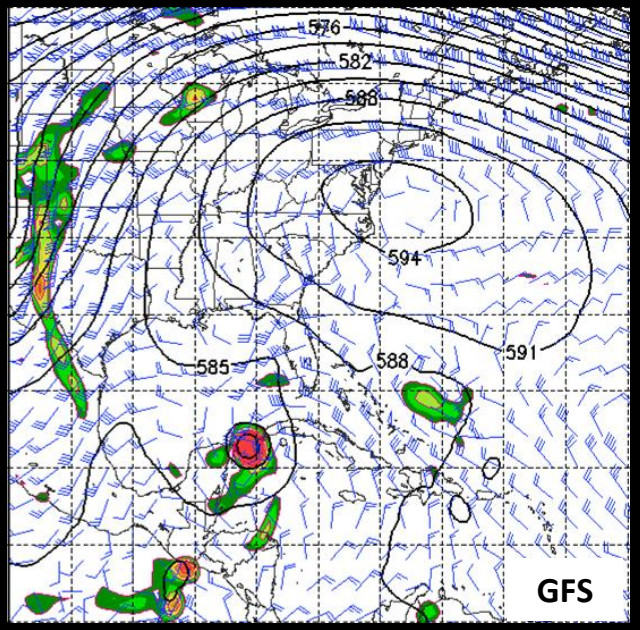


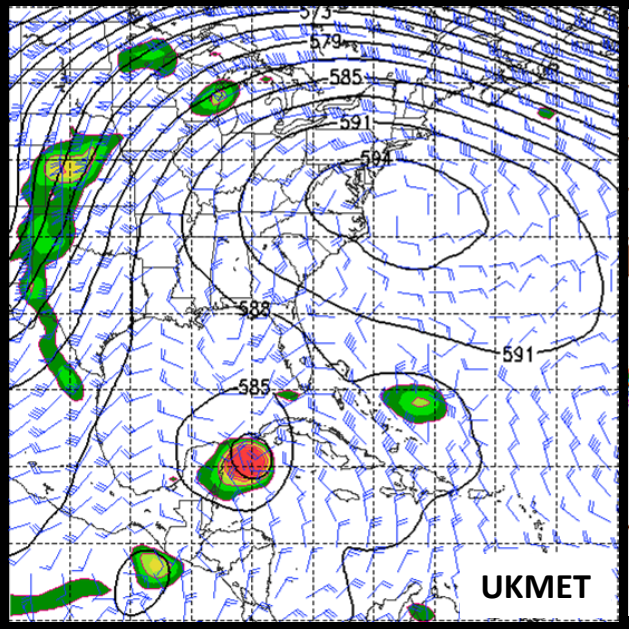


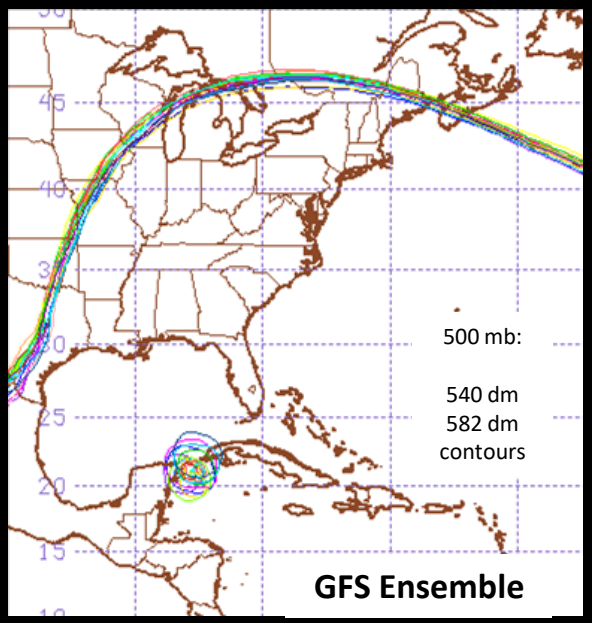


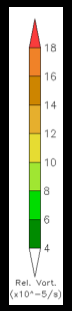
HWRF Surface

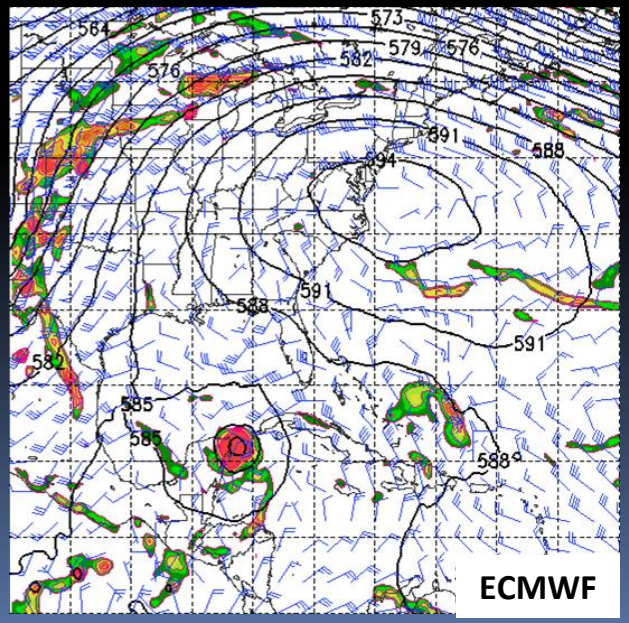
24h forecast

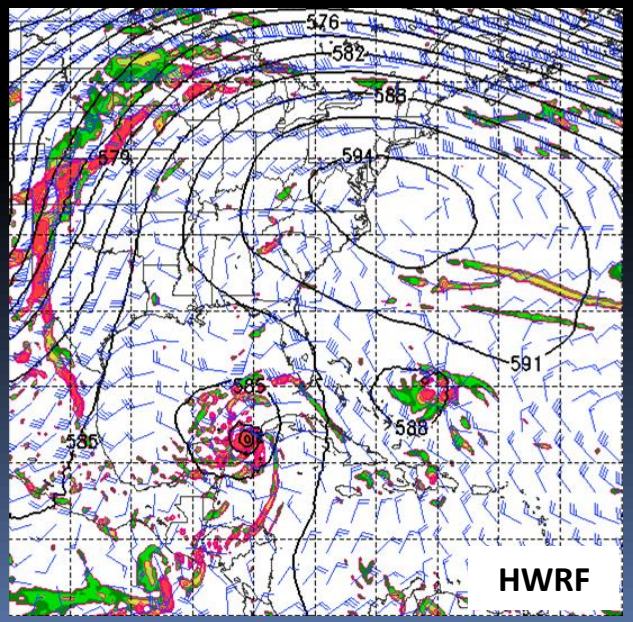


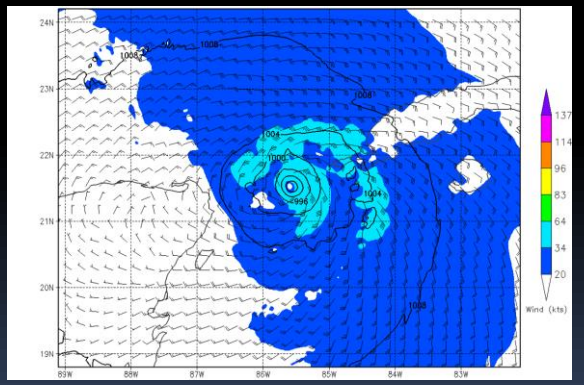






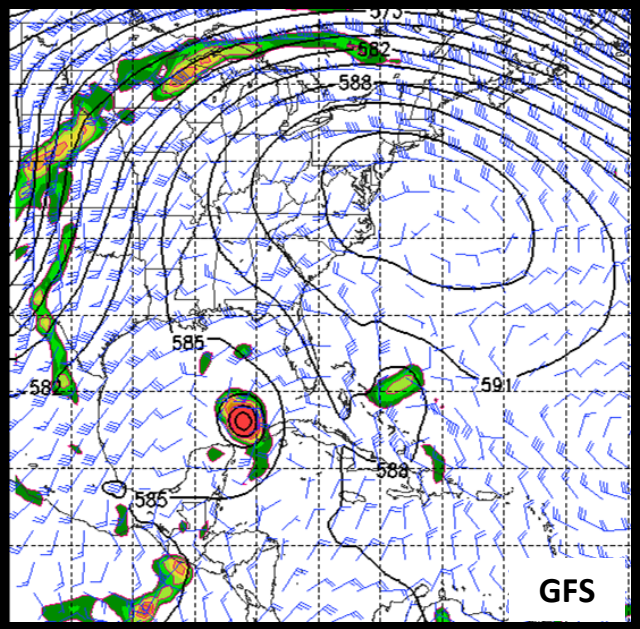


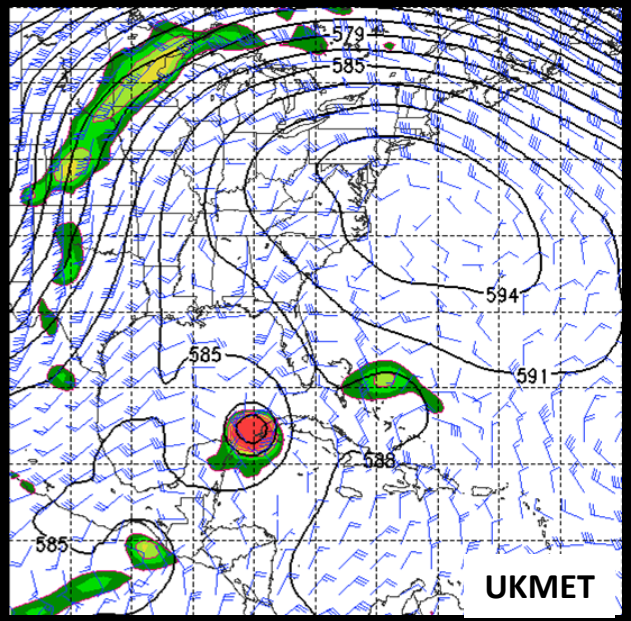


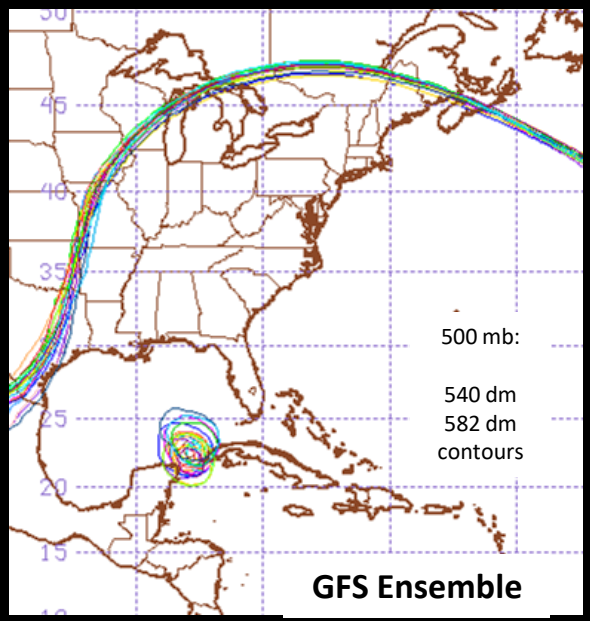


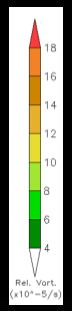
HWRF
Surface

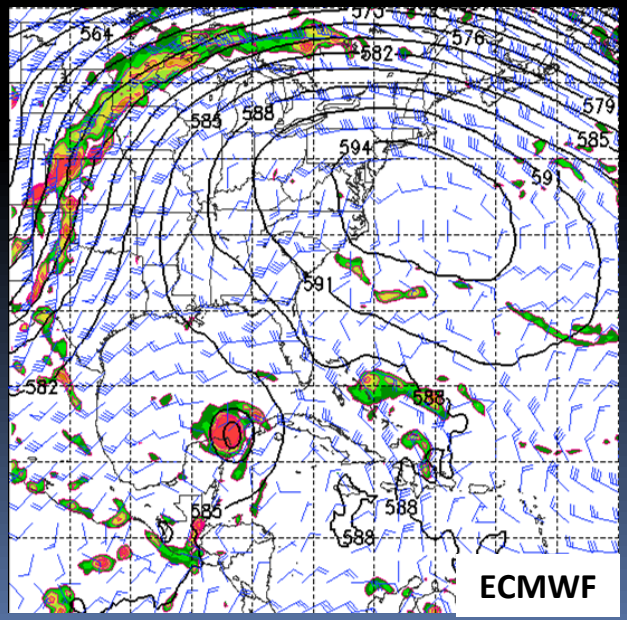
36h forecast

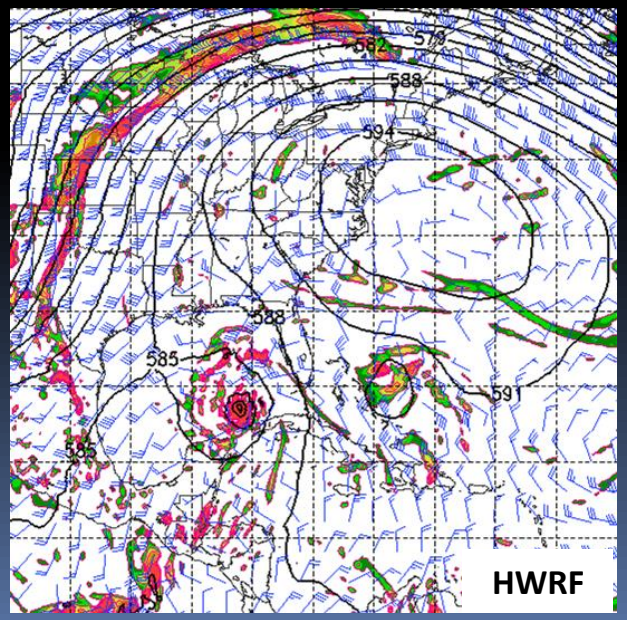


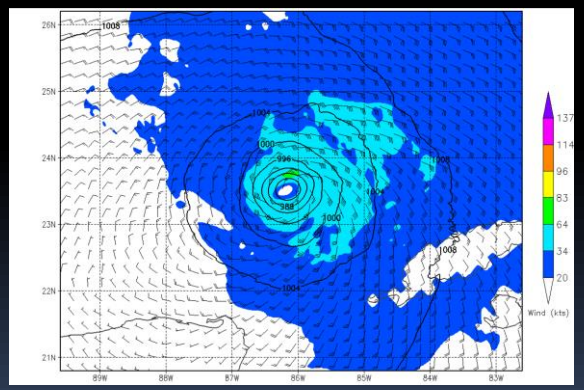






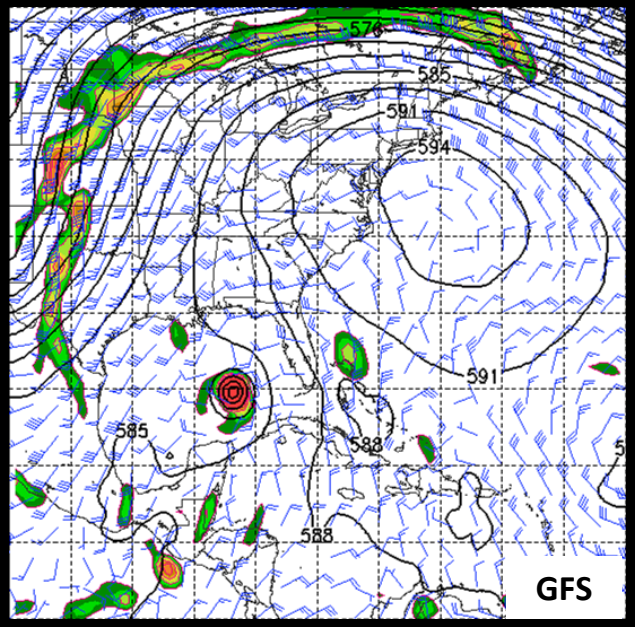


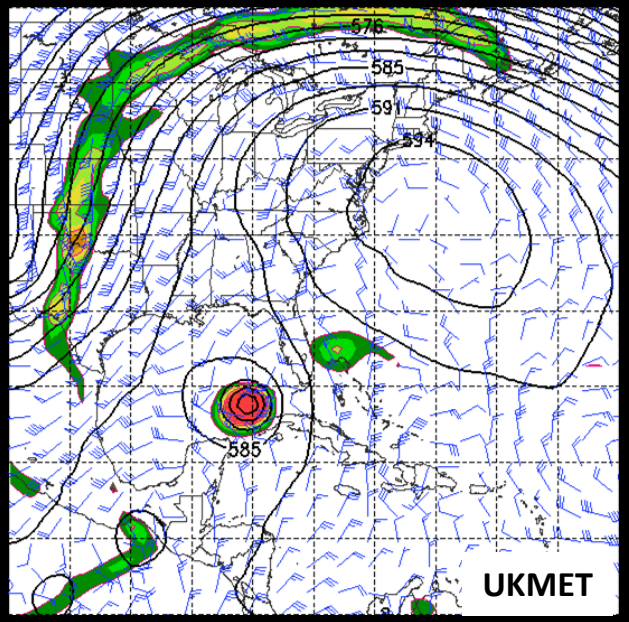


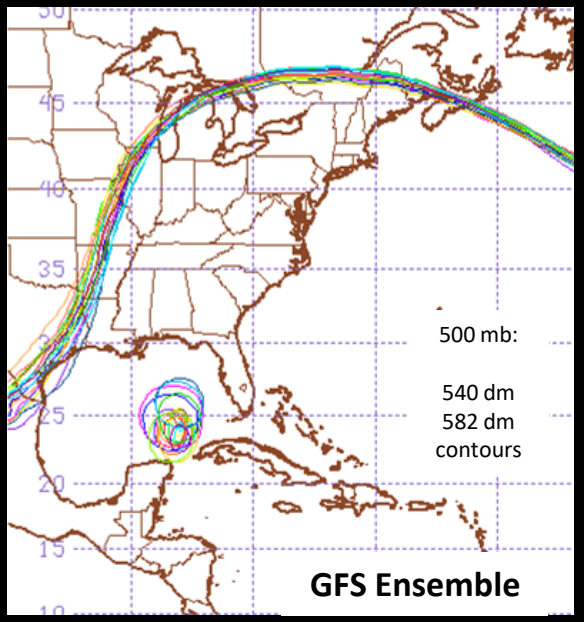


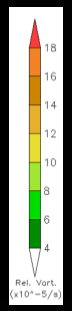
HWRF Surface

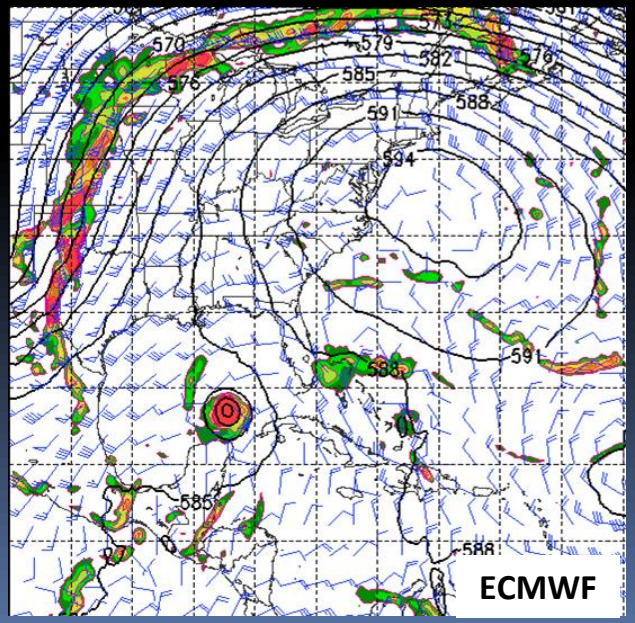
48h forecast

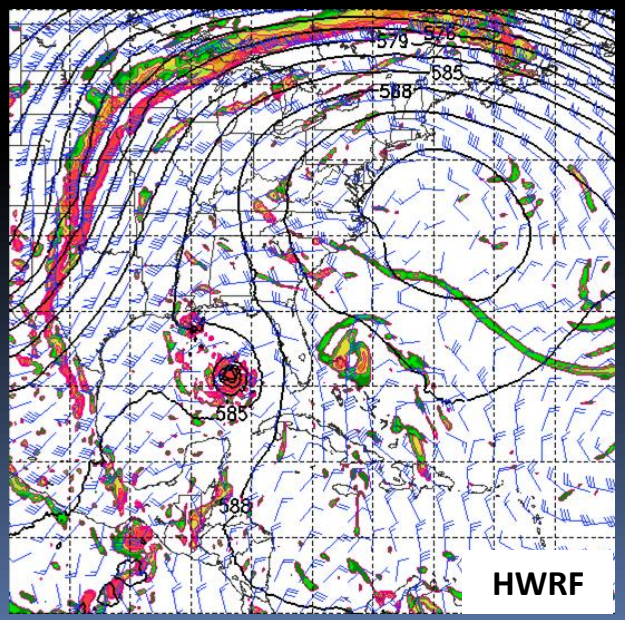


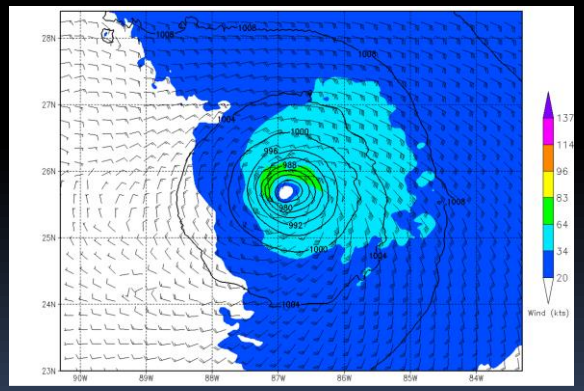






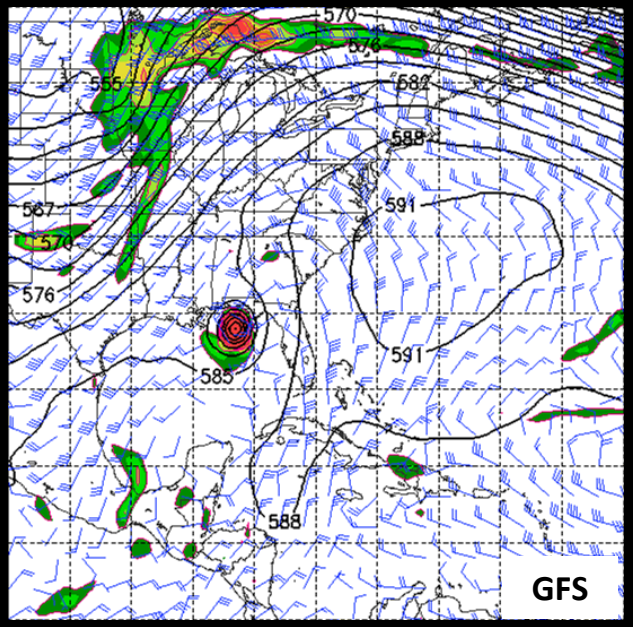


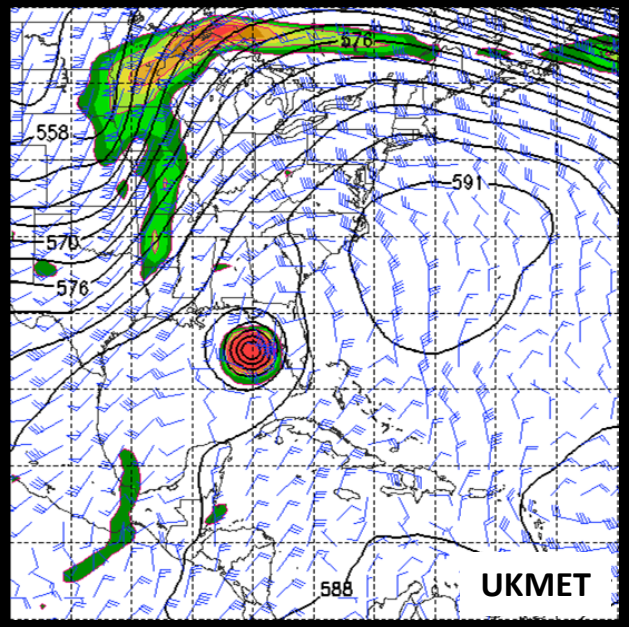


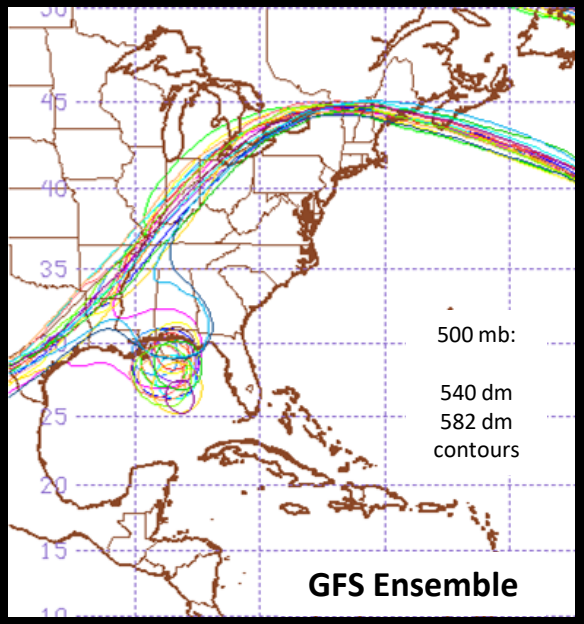


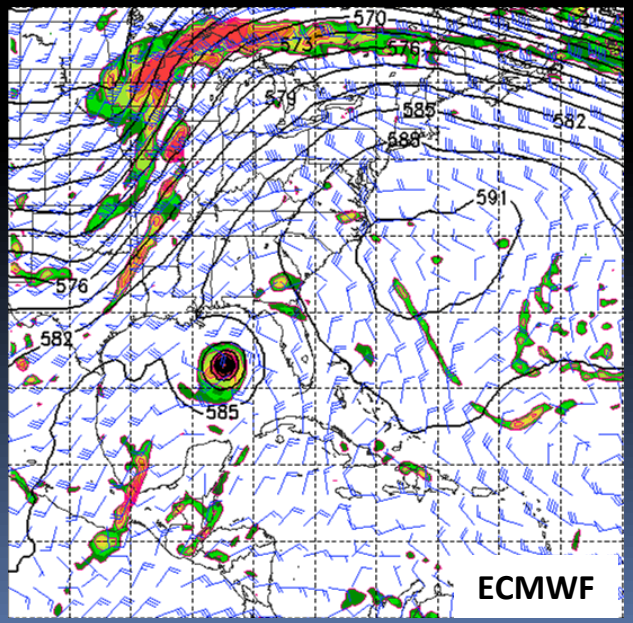
HWRF Surface

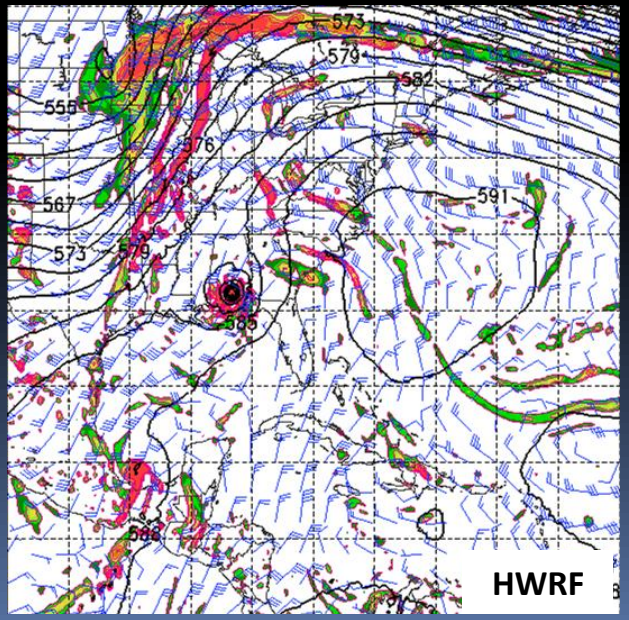
72h forecast

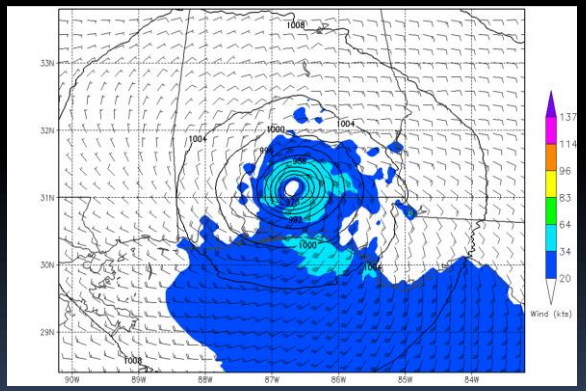












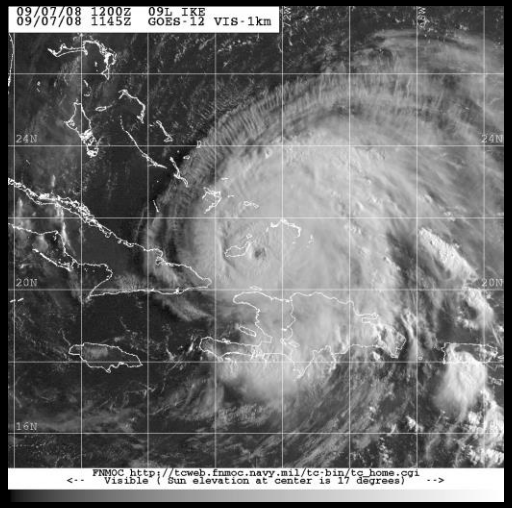
HWRF
Surface

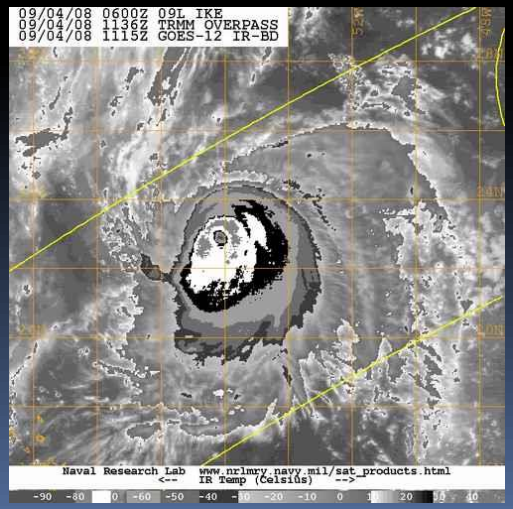
18:00-18:45 UTC

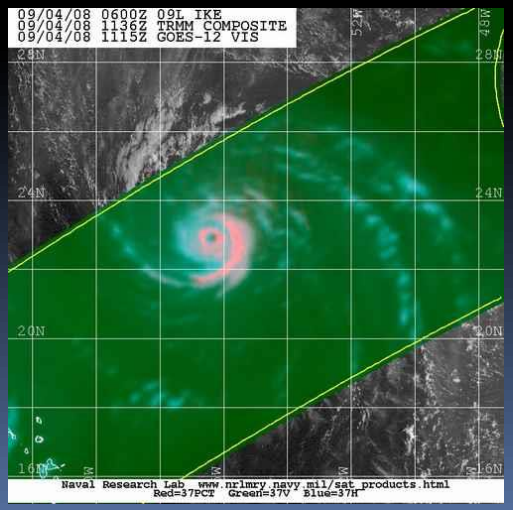
Receive fix data

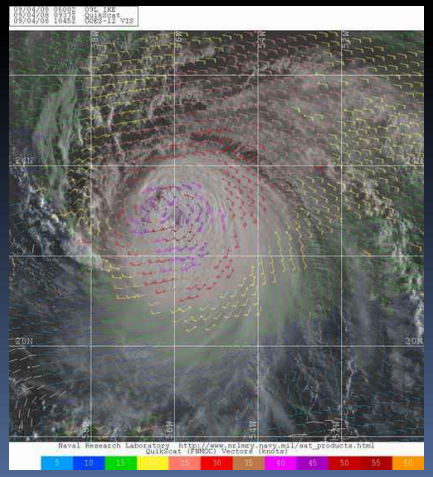
Hurricane specialist receives estimates of location and intensity via satellite imagery from 2 different agencies

- **Determine the center location**
- **Determine past motion (6-12 h)**
- **Determine the intensity/wind speed**
- **Determine various wind radii**
  - **34-, 50-, and 64-kt (when applicable)**









18:00-18:45 UTC

Receive fix data

```
000
URNT12 KNHC 161845
VORTEX DATA MESSAGE   AL502020
A. 16/18:05:20Z
B. 18.89 deg N 086.24 deg W
C. 925 mb 714 m
D. EXTRAP 1001 mb
E. NA
F. NA
G. NA
H. 40 kt
I. 003 deg 57 nm 17:45:00Z
J. 087 deg 42 kt
K. 010 deg 70 nm 17:41:00Z
L. 39 kt
M. 133 deg 81 nm 18:33:30Z
N. 225 deg 48 kt
O. 133 deg 105 nm 18:42:00Z
P. 21 C / 766 m
Q. 23 C / 757 m
R. 20 C / NA
S. 1345 / 9
T. 0.02 / 7 nm
U. AF305 0114A CYCLONE OB 07
MAX FL WIND 48 KT 133 / 105 NM 18:32:00Z
SLP EXTRAP FROM 925 MB
;
```

Position

Minimum pressure

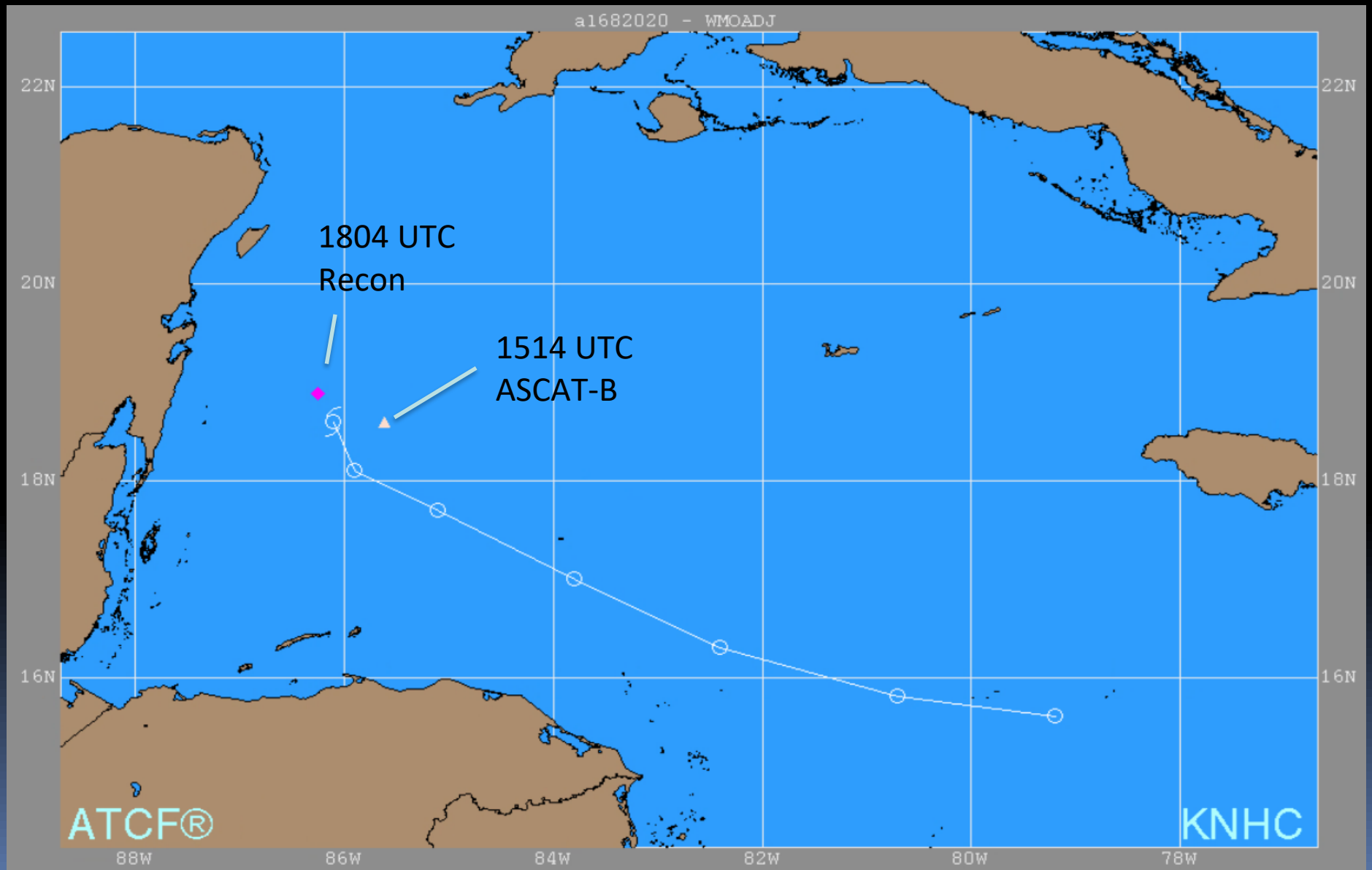
Maximum surface wind

Maximum flight level wind

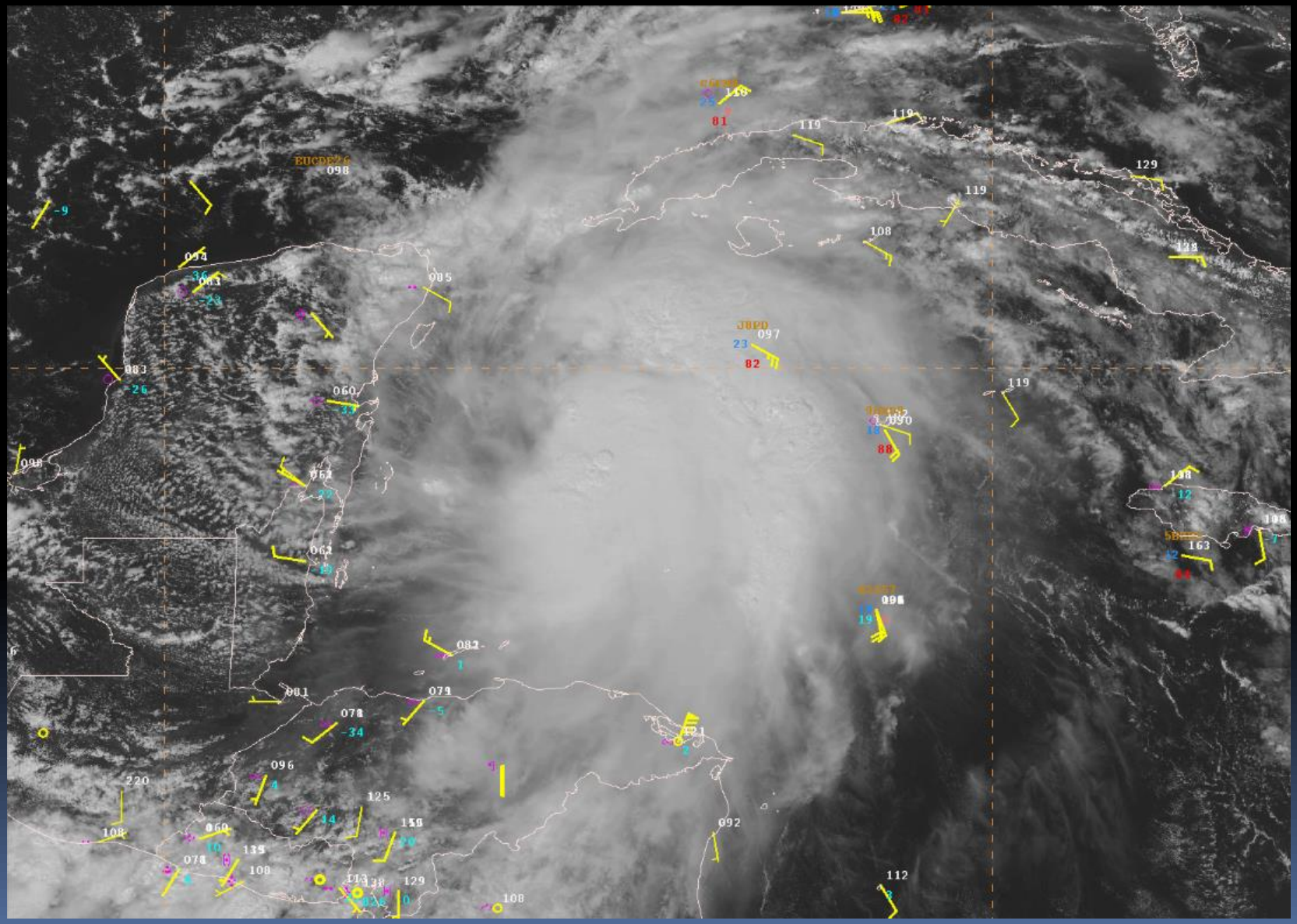
The first reconnaissance mission of this storm is underway, and the plane located the center of the tropical storm just after 18Z. Final fix with an outbound maximum flight-level wind of 48 kt, that equates to 36 kt (75%) at the surface.

Let's see how this compares to the ASCAT fix while we wait for the Dvorak fixes to arrive

Working Best Track with 1804 UTC Aircraft Fix

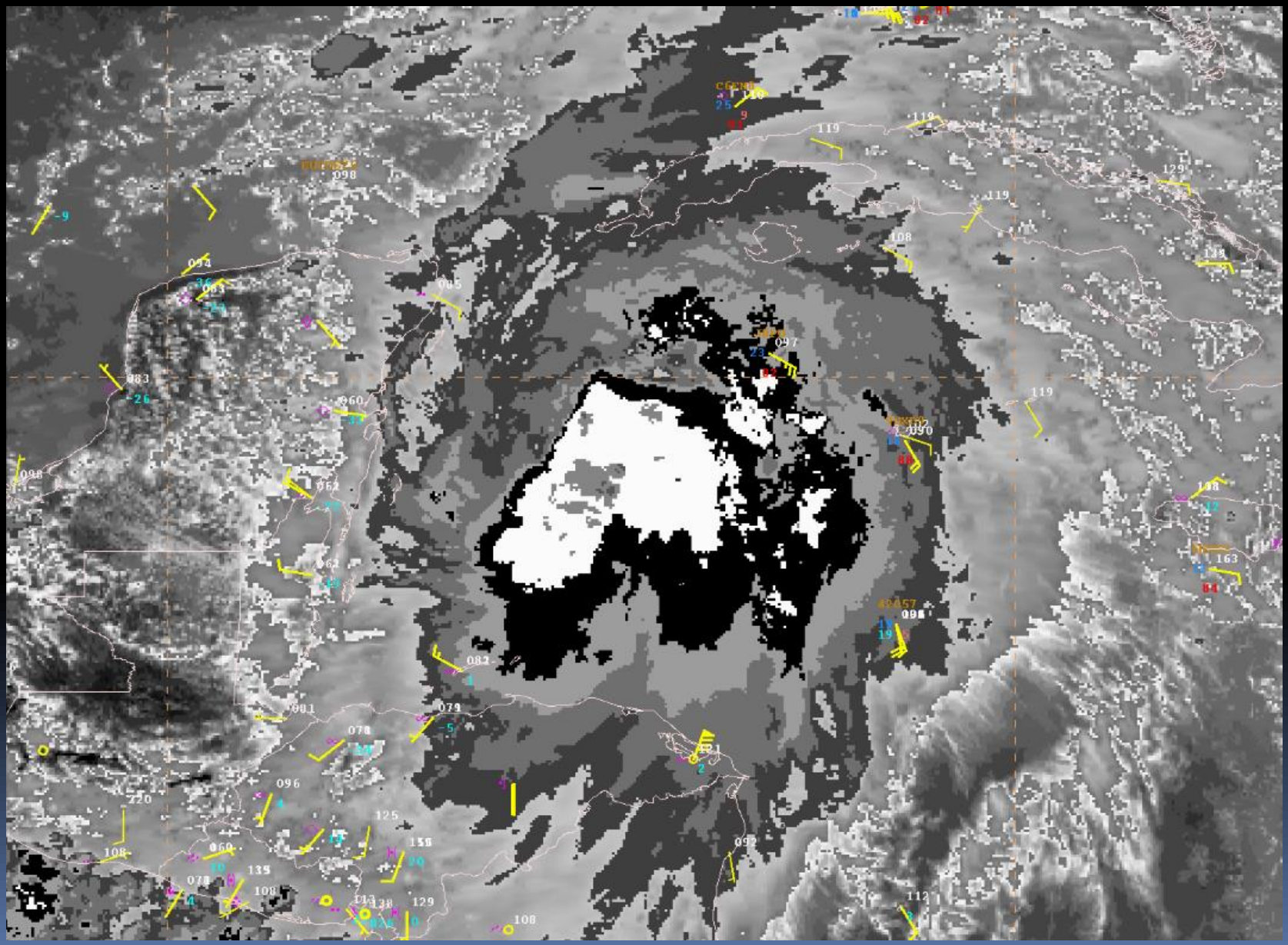


Vis Satellite Image- 1800 UTC



IR Satellite Image- 1800 UTC

BD Enhancement



18:30 UTC

TAFB and SAB Dvorak Satellite Fixes

TAFB SATELLITE CLASSIFICATION

Basin: Atlantic
Name: AL682020
Date: 16 Apr 2020
Time: 18:00 UTC
Latitude: 19.2N Longitude: 85.6W

SATELLITE:	CHANNEL:	RESOLUTION (KM):	LOCATION CONFIDENCE:
GOES16	VIS IR	1	5

CLASSIFICATION TYPE:
Tropical, DT = 2.5 BASED ON Curved Band WITH CF = 2.5 AND BF = 0.0

FINAL T:	CURRENT INTENSITY:	MAXIMUM WIND (KT):	MIN PRESSURE (MB):	INTENSITY CONFIDENCE:
2.5	2.5	35	1005	2

24 HR DEV TREND T:	MODEL EXPECTED T:	PATTERN T:
D	2.0	2.5 A

EYE DIAMETER (NM): ---
METEOROLOGIST: ASL
REMARKS:

SAB SATELLITE CLASSIFICATION

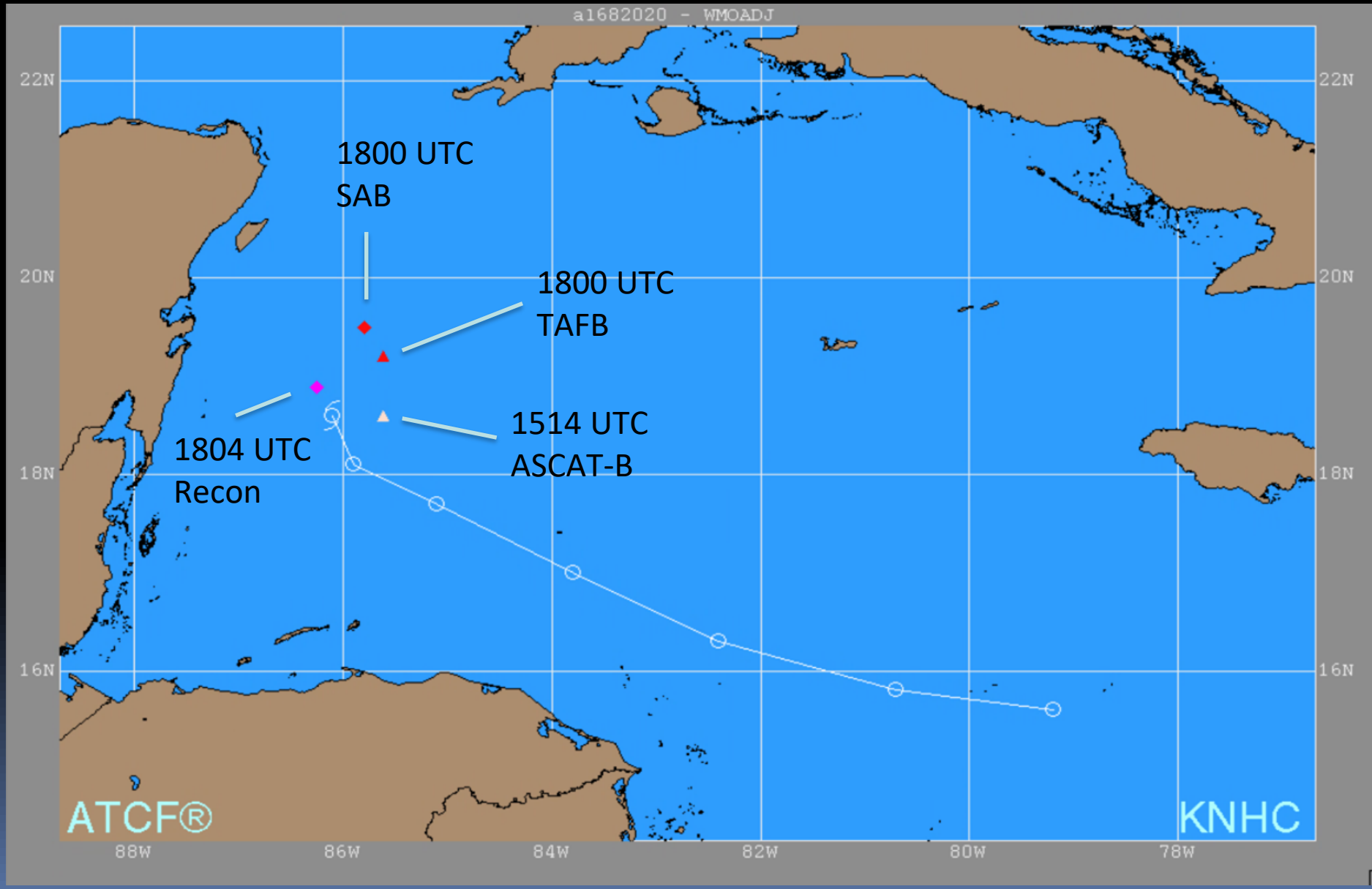
Latitude: 19.5N Longitude: 85.8W TIME (UTC): 1745 UTC
T/CI NUMBER: 2.5/2.5 (35 kt) SAT: GOES-16
LOCATION CONFIDENCE: 3 PIC: VIM ANALYST: BZ

PREVIOUS TAFB INTERMEDIATE FIX

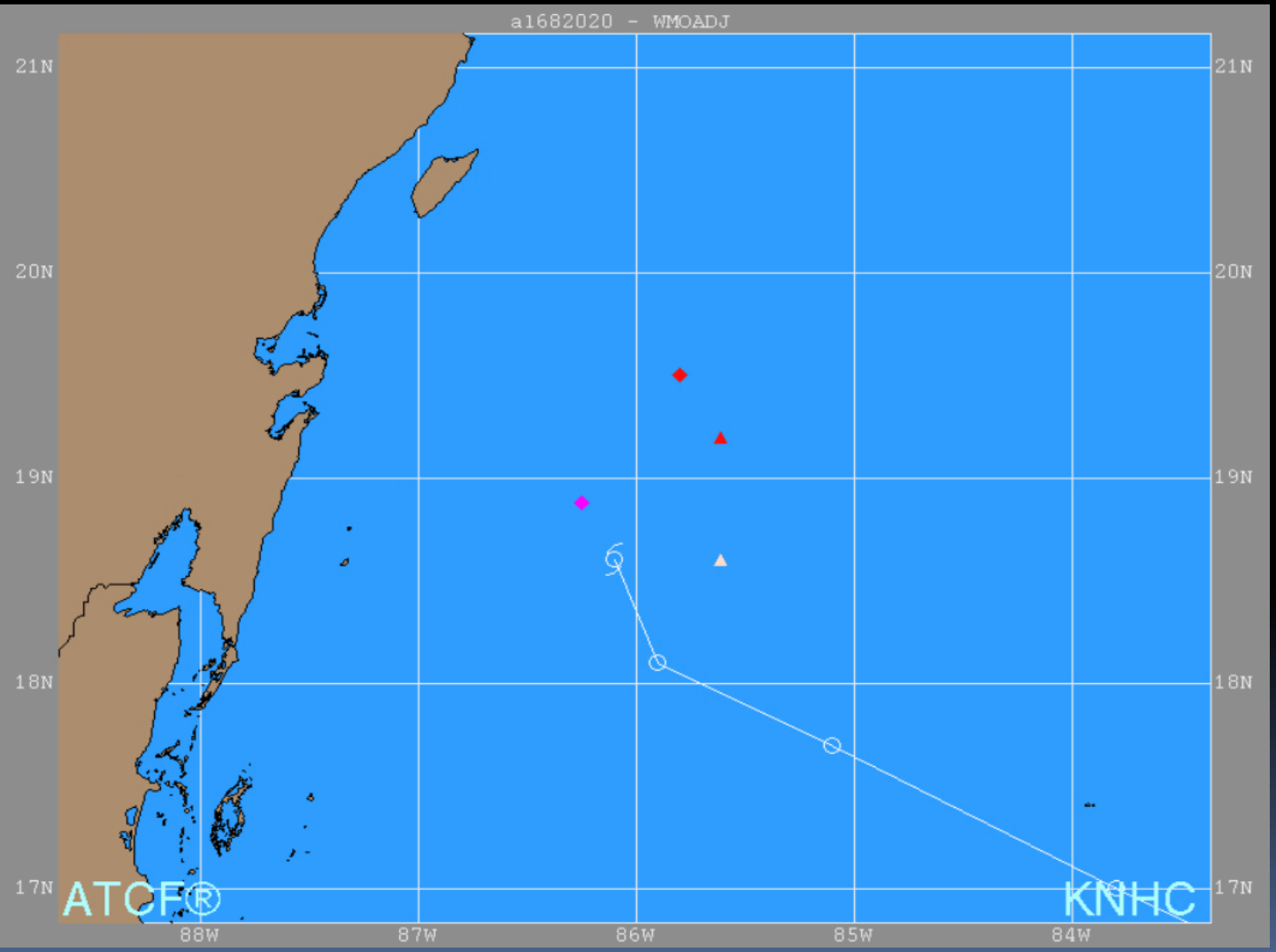
DATE: 16 Apr 2020 TIME (UTC): 15:00
Latitude: 19.6N Longitude: 85.8W SAT: GOES16
LOCATION CONFIDENCE: 5 PIC: VIS IR ANALYST: ASL

Now it's time to enter the Dvorak fixes and see how they compare to the aircraft and the ASCAT

Now that we have all the 18z fixes, let's determine the 18z best-track position and intensity



Where do you think we should center the tropical storm at 18Z?



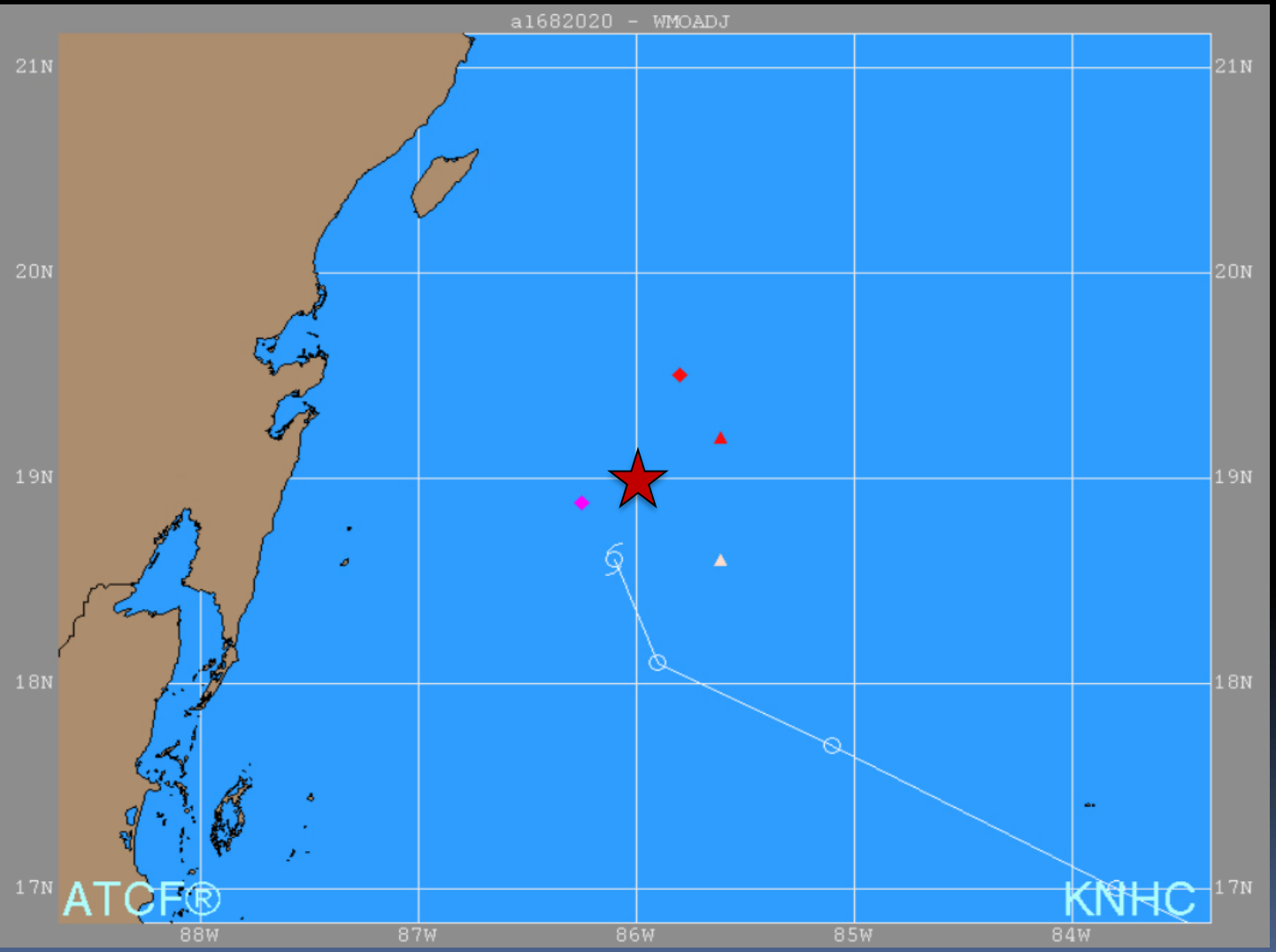
A) 18.9N 86.2W
(recon position)

B) 19.0N 86.0W
(consensus position)

C) 19.3N 85.8W
(Dvorak consensus)

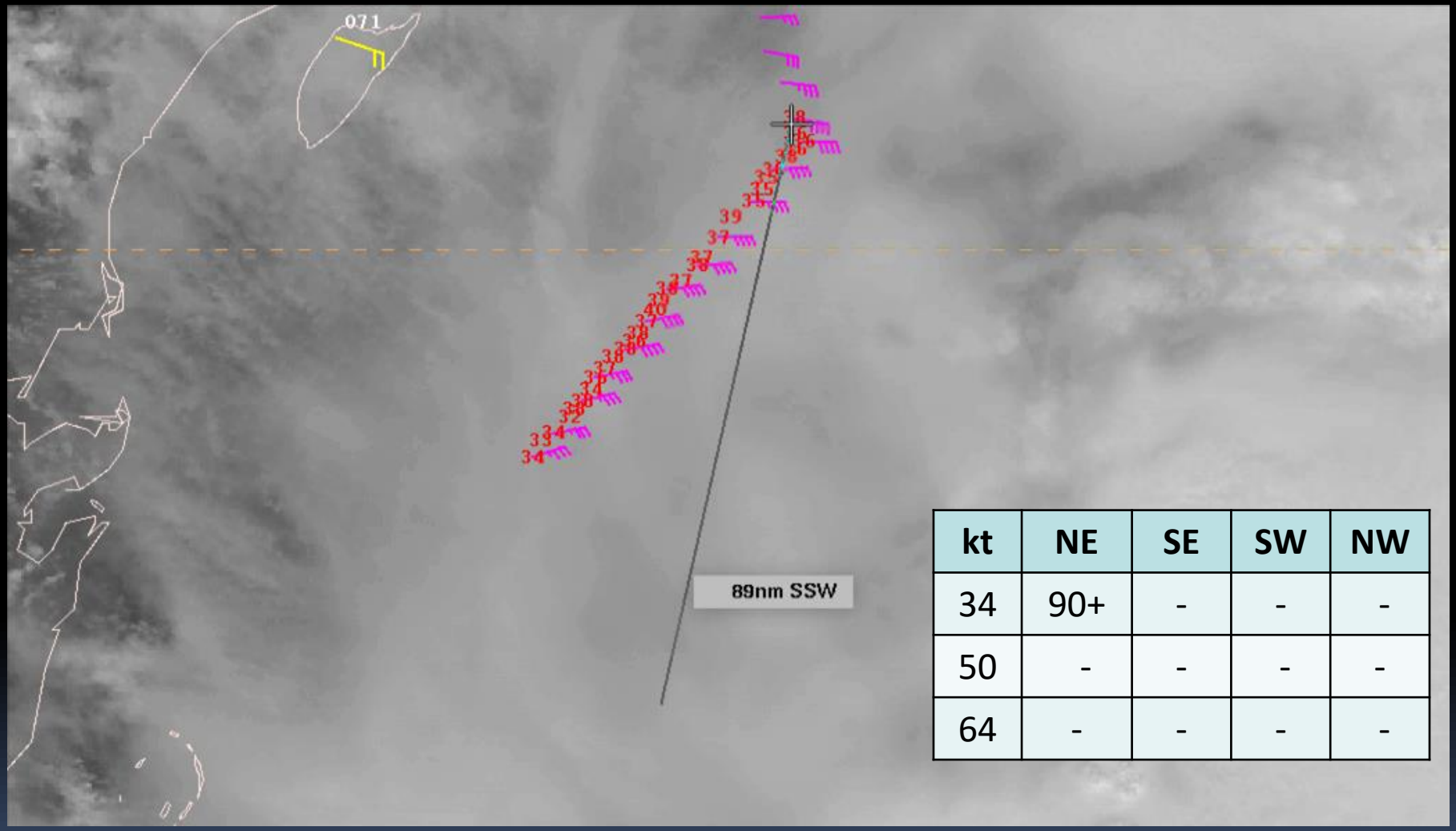
D) Somewhere else

Where do you think we should center the tropical storm at 18Z?



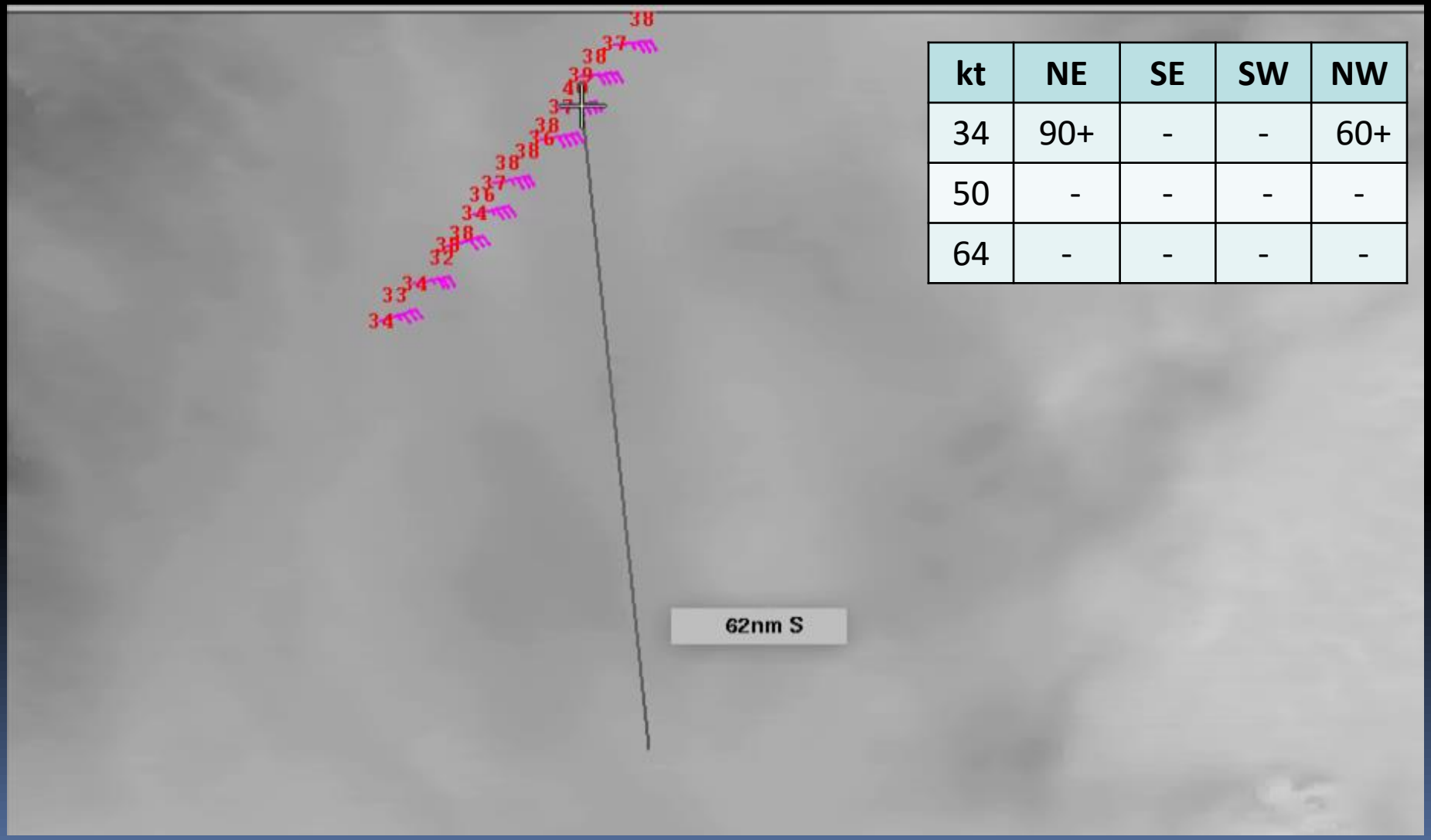
The NHC forecaster selected the consensus position, but noted the uncertainty was higher than usual

Checking Wind Radii from Aircraft Data



kt	NE	SE	SW	NW
34	90+	-	-	-
50	-	-	-	-
64	-	-	-	-

Checking Wind Radii from Aircraft Data

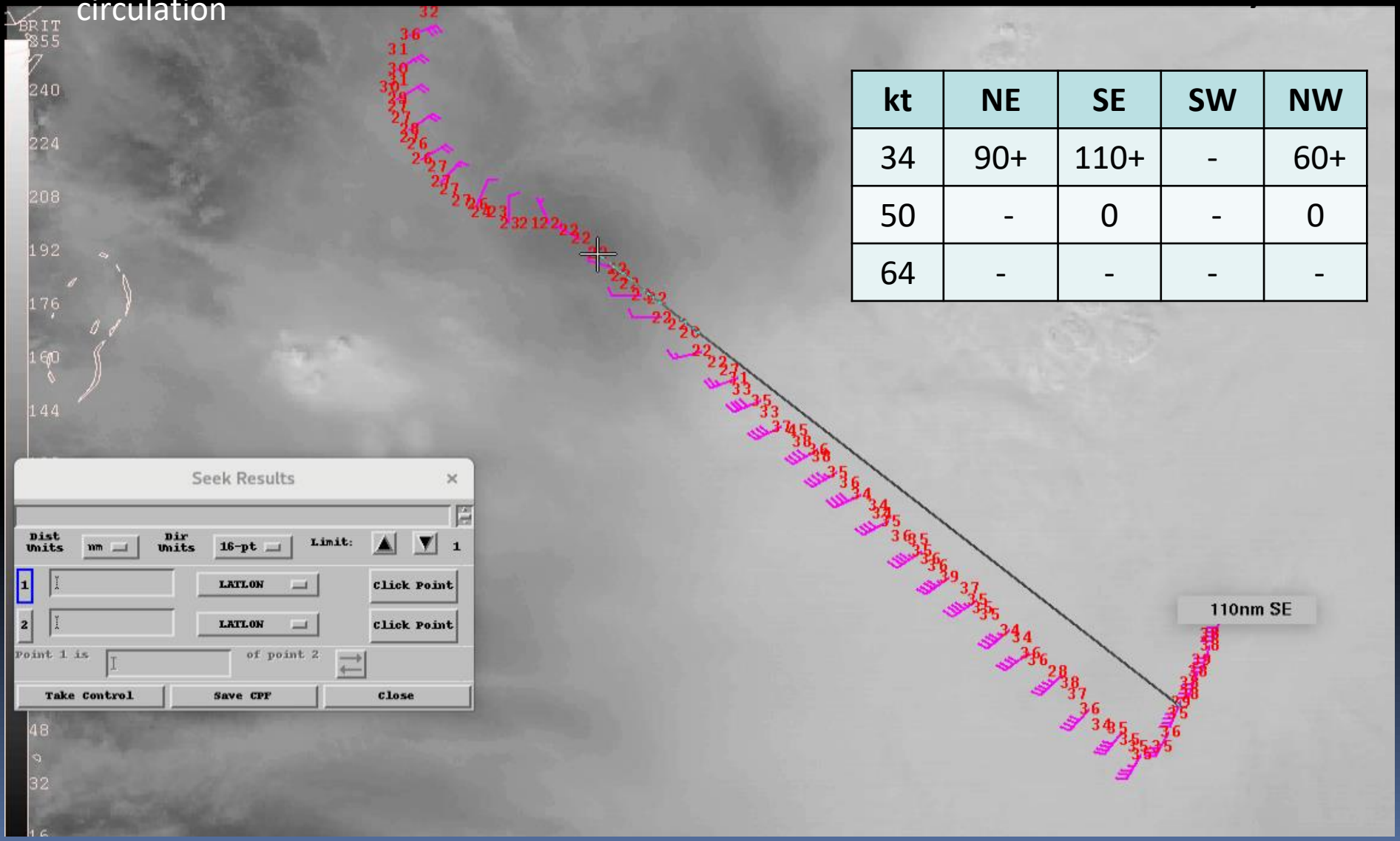


kt	NE	SE	SW	NW
34	90+	-	-	60+
50	-	-	-	-
64	-	-	-	-

Checking Wind Radii from Aircraft Data

Radii observed by ASCAT were larger than the sampling area of the reconnaissance aircraft, however the aircraft data appears to confirm the large nature of the circulation

kt	NE	SE	SW	NW
34	90+	110+	-	60+
50	-	0	-	0
64	-	-	-	-



Determine the intensity and pressure

Fix Type	Intensity (kt)
ASCAT-B	38
Recon (SFMR)	40
Recon (Flight-level adjusted)	36
Dvorak (TAFB)	35
Dvorak (SAB)	35

What should we use for the initial intensity?

A) 35 kt
B) 40 kt
C) Something else

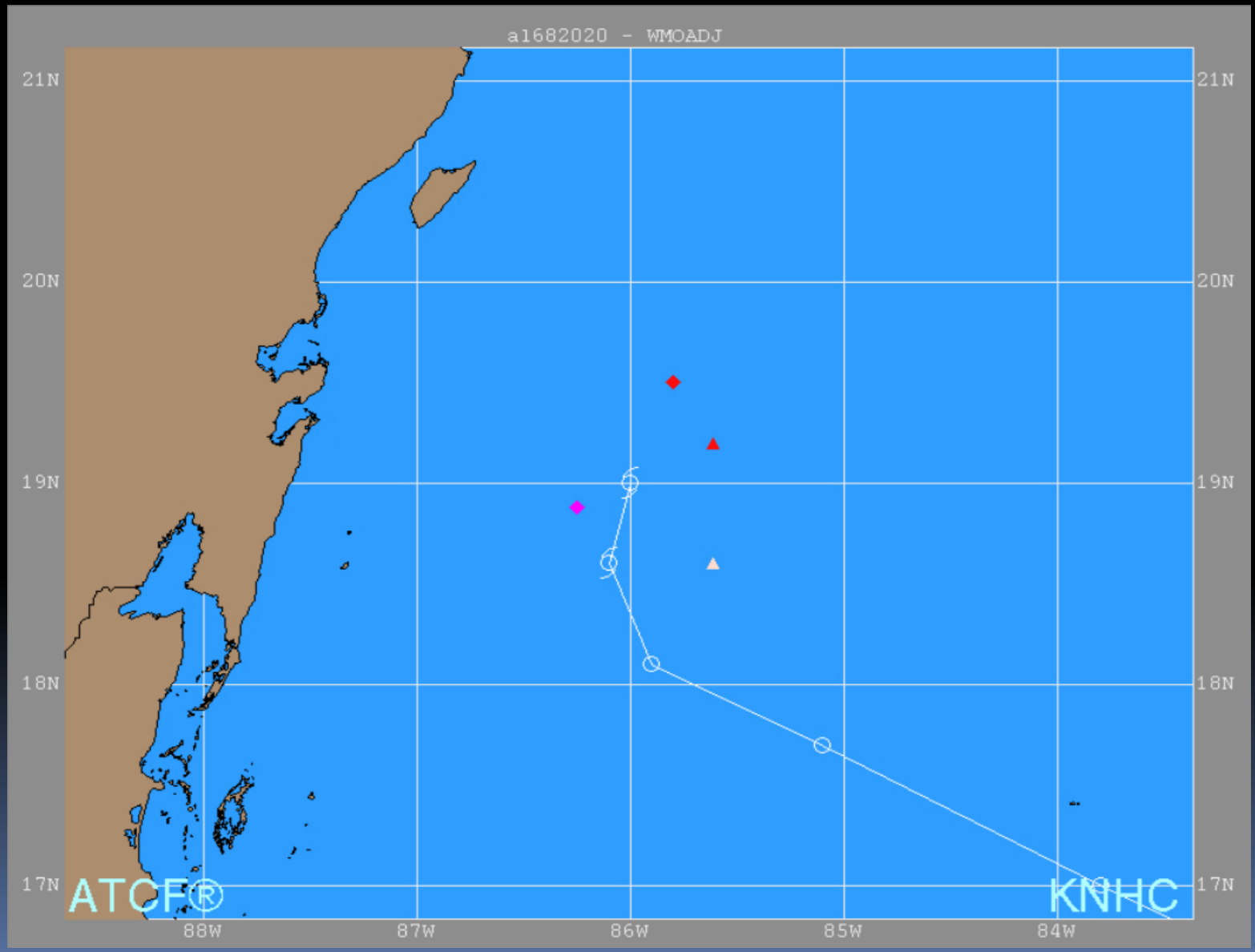
Determine the intensity and pressure

Fix Type	Pressure (mb)
Aircraft (extrapolated from 925 mb)	1001
Dvorak (TAFB)	1005
Dvorak (SAB)	1005
Knaff-Zehr-Courtney W/P relationship	999
Dvorak Wind/Pressure relationship (40kt)	1002

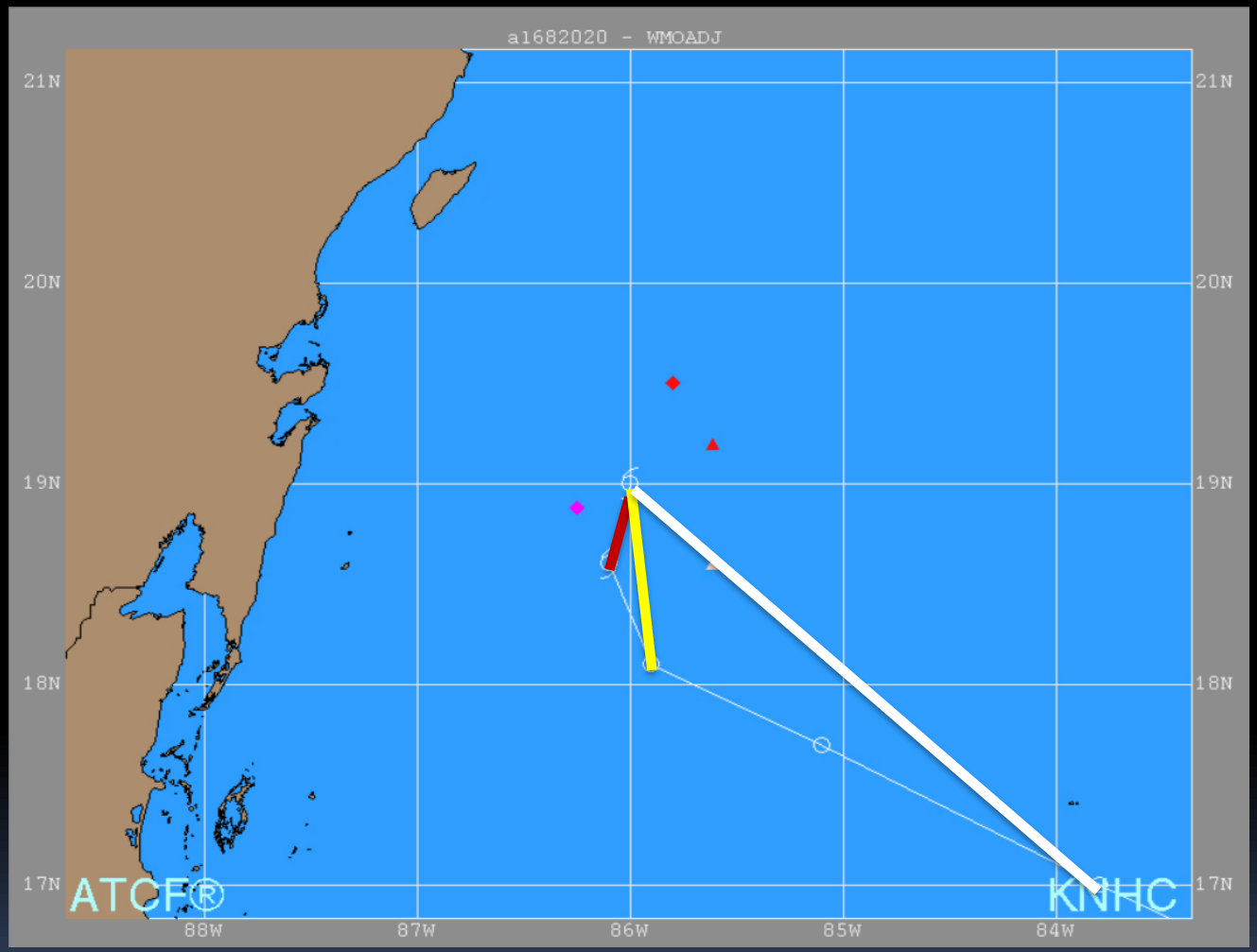
What should we use for the initial pressure?

A) 1002 mb
B) 1001 mb
C) 1000 mb
D) 999 mb

Best-Track through 1800 UTC…
Ready to initialize the guidance.



Compute/Determine TC Motion



NHC typically uses a longer-term representative motion to smooth out short term wobbles, however when a cyclone is turning a motion computed from a shorter time may be necessary

6 h: 15°/ 4 kt

12 h: 355°/ 4 kt

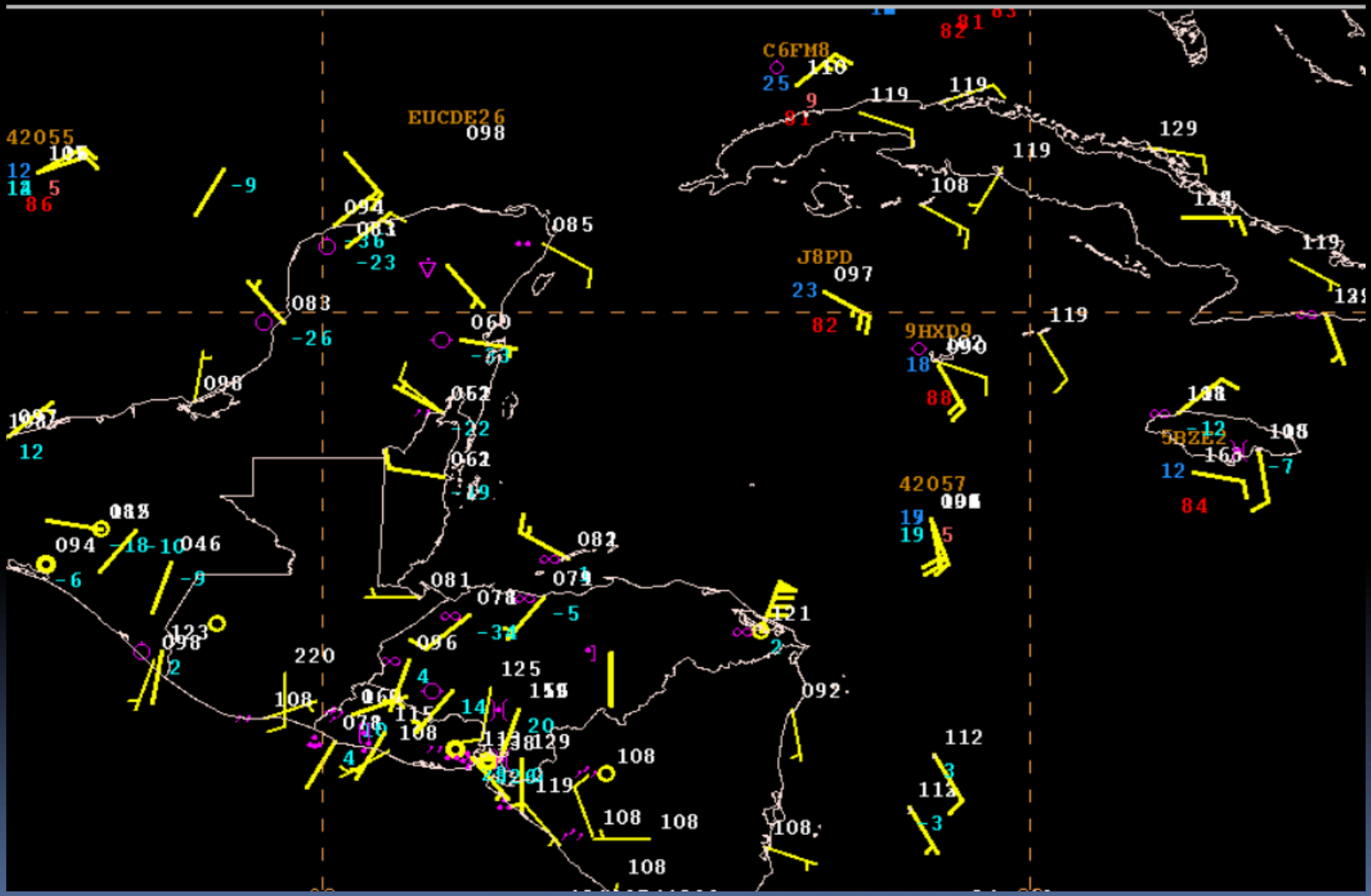
24 h: 315°/ 7 kt

Which motion do you think is most representative?

A) 6h **B) 12 h**

C) 24 h **D) Something else**

TC Size (outermost closed isobar)

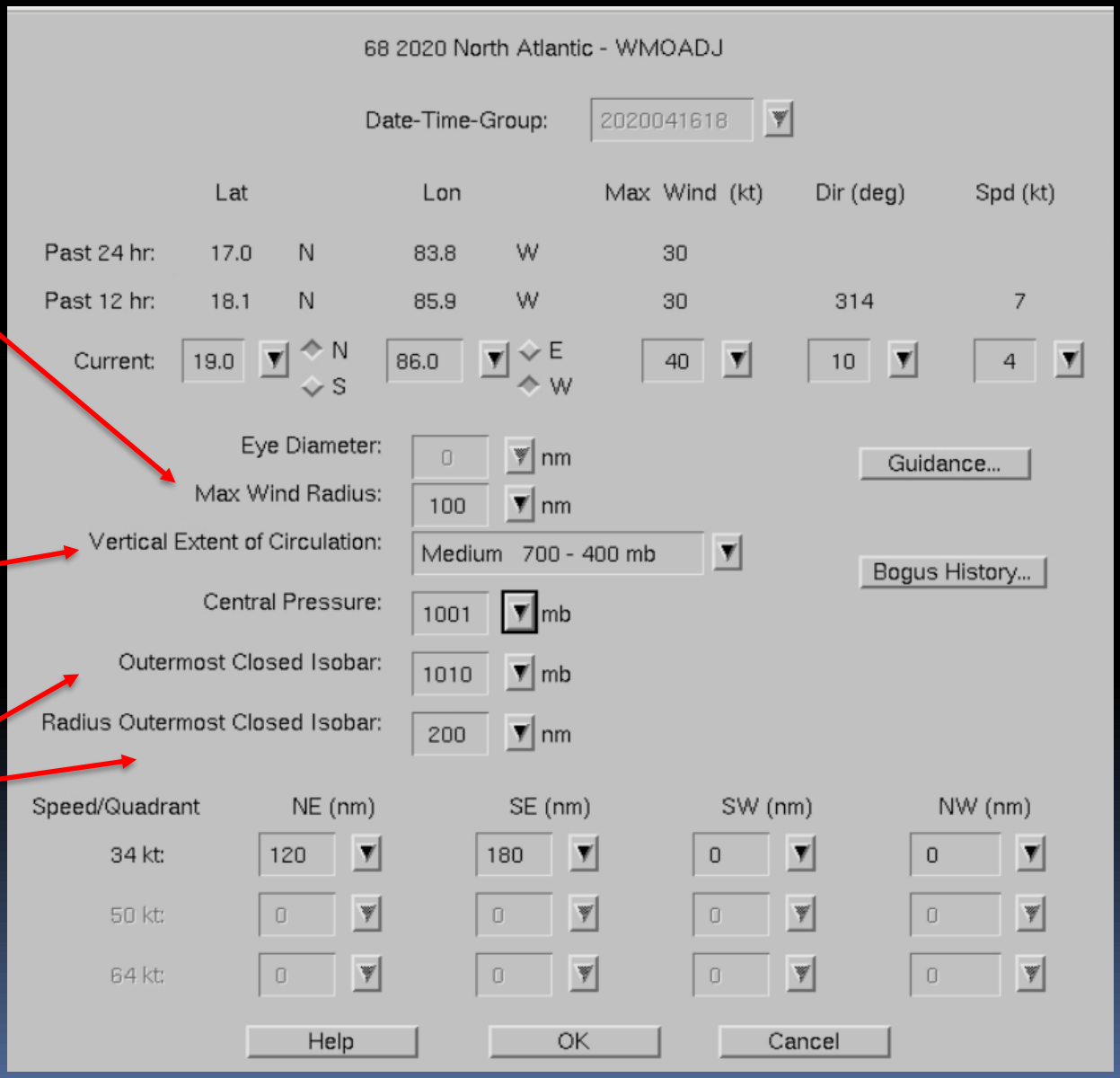


Guidance parameters for 1800 UTC

Max Wind Radius (Radius of Maximum Wind/RMW) determined from aircraft, ASCAT. important for storm surge modeling

Vertical Extent of Circulation: Subjective indication of the height/depth of a tropical cyclone, used by HWRF/HMON

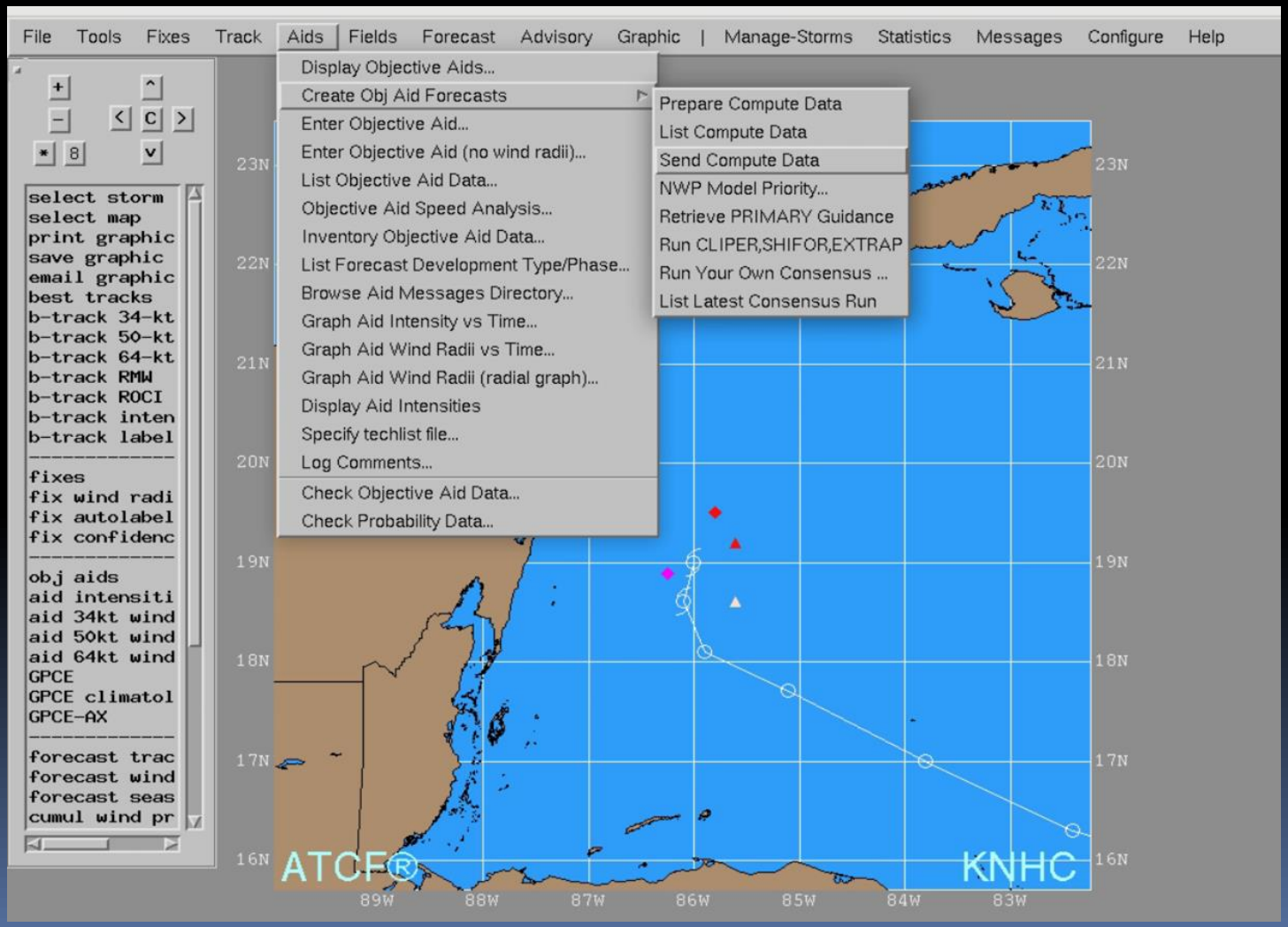
Outermost closed isobar computed from surface observations. May use global model output when no surface obs are available



18:45-19:00 UTC

Initialize models

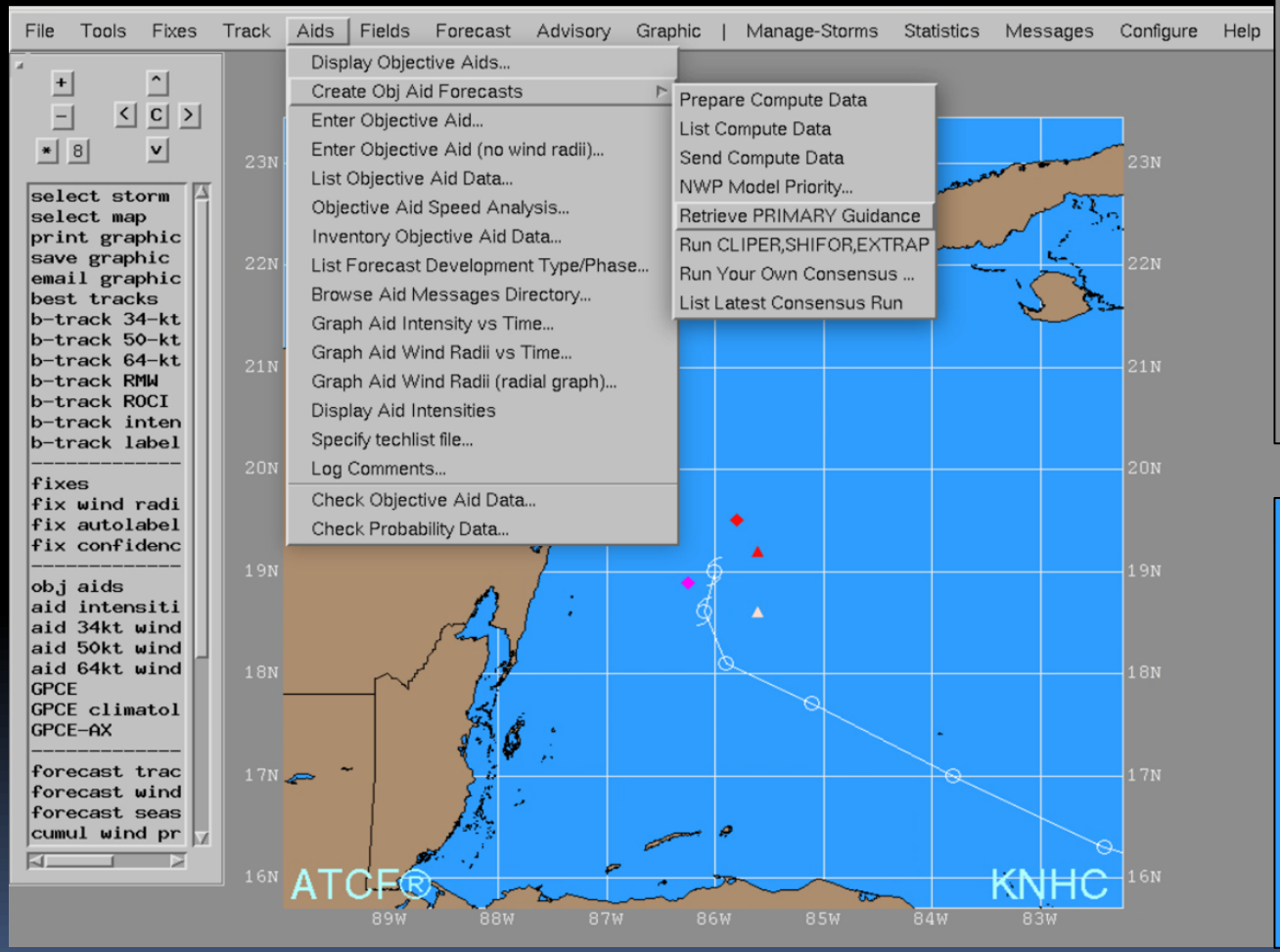
Submit the guidance to the super computer to run statistical models and the next (18Z) cycle of dynamical models. And don't forget to run the HWRF/HMON!

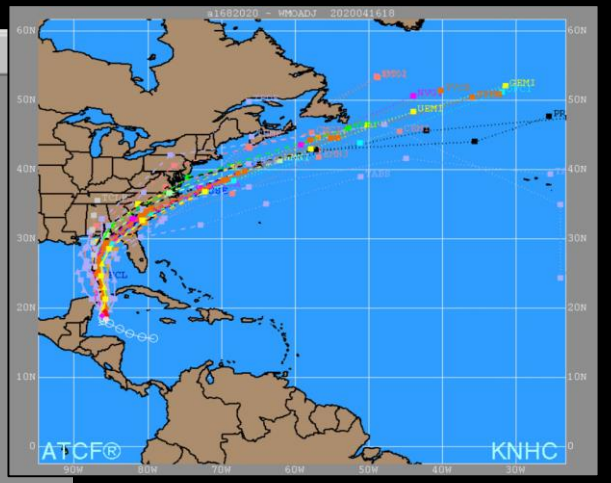


19:00-19:10 UTC

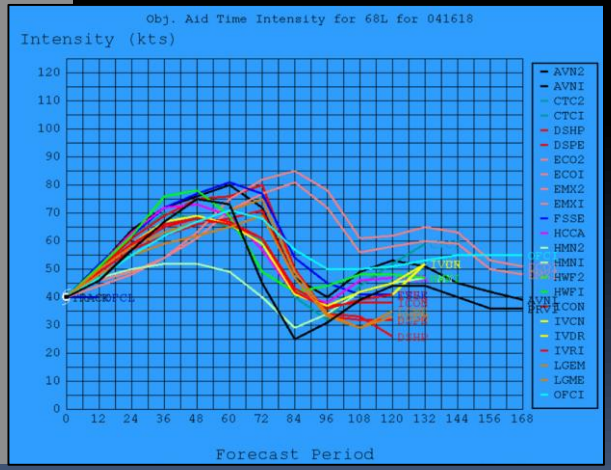
Receive model guidance

Then analyze numerical model output and prepare track, intensity, and wind radii forecasts





Track



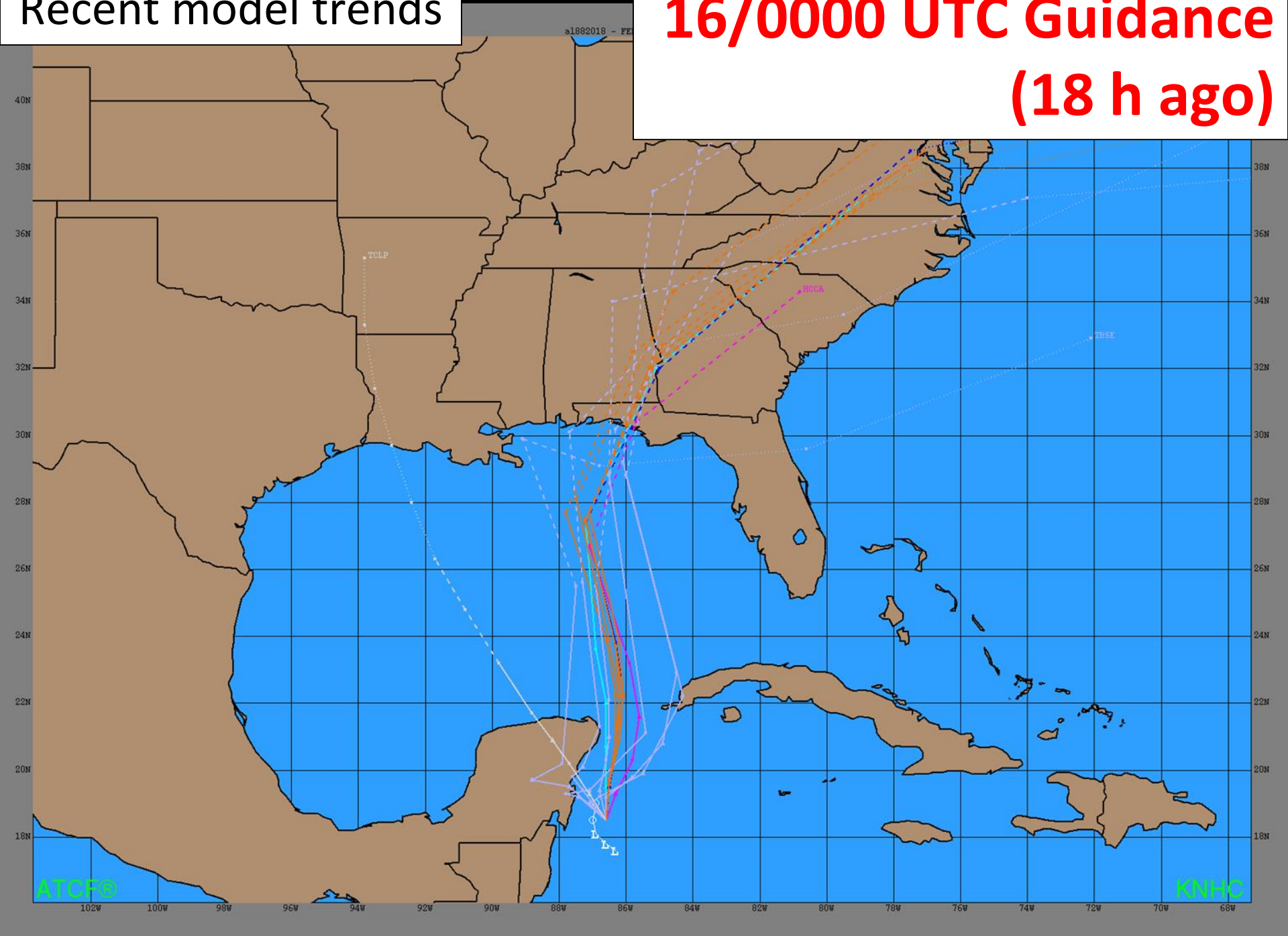
Intensity Guidance

Preparing the Track Forecast

Before we begin, let's examine recent model trends…

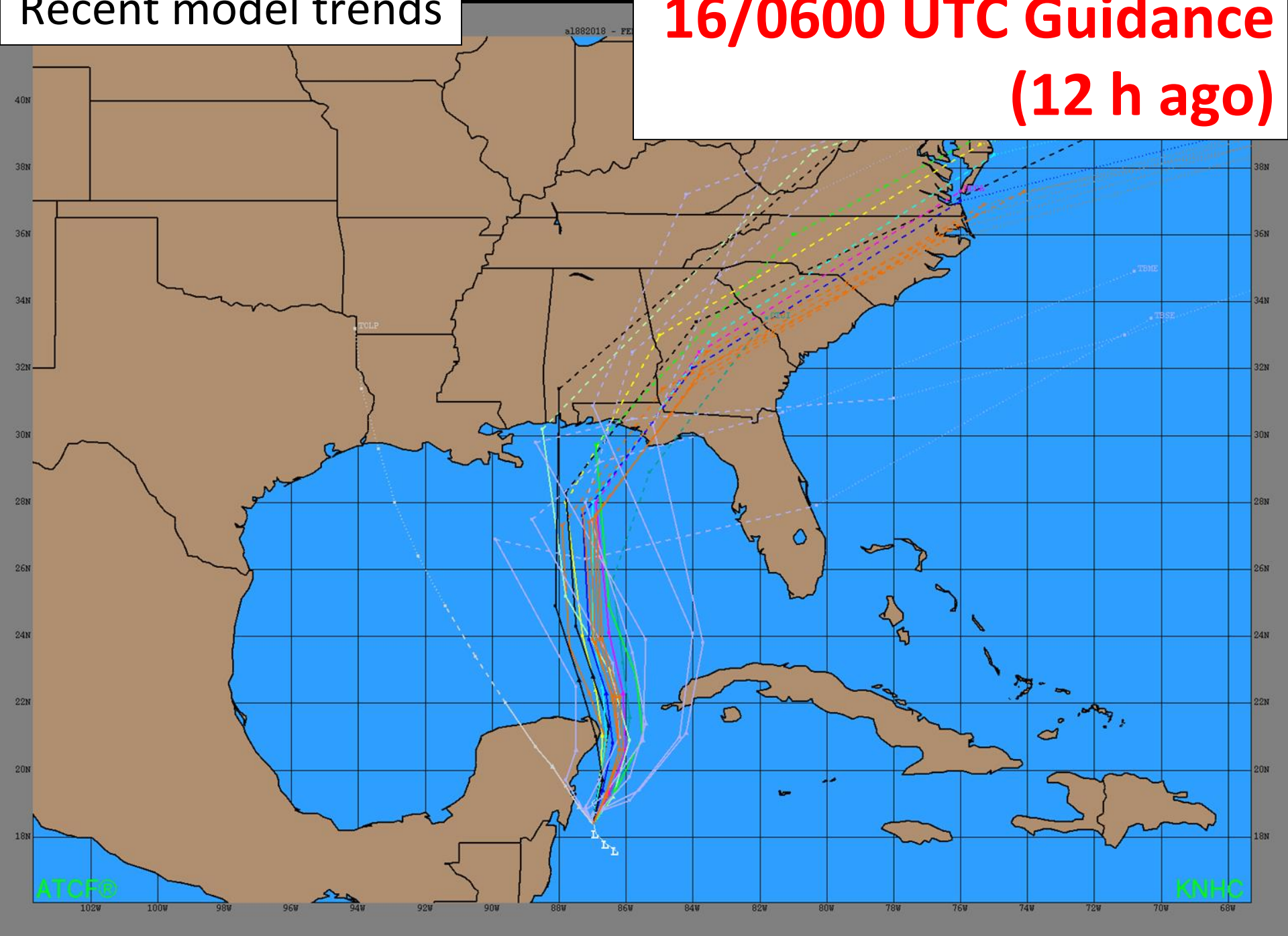
Recent model trends

16/0000 UTC Guidance (18 h ago)



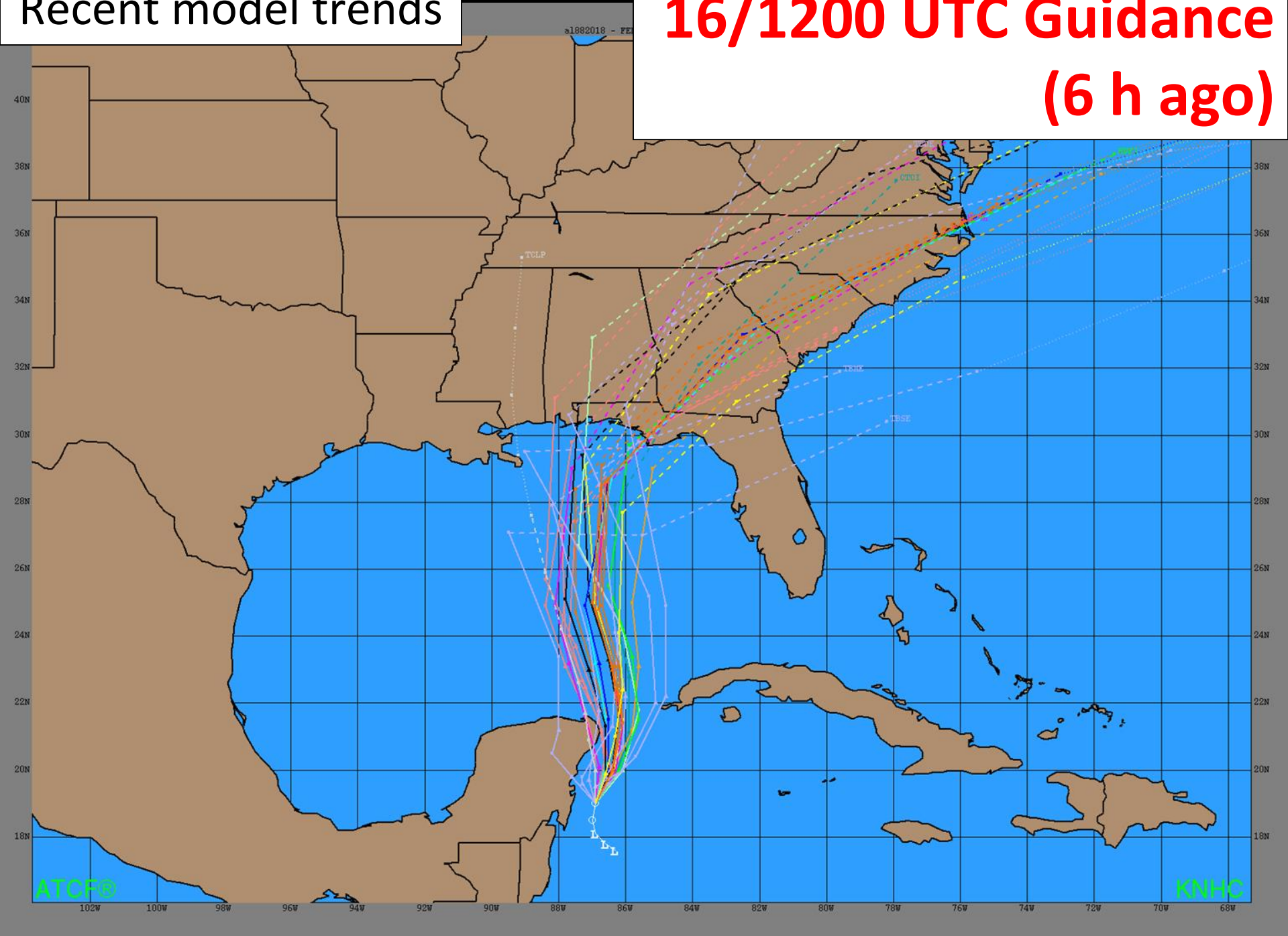
Recent model trends

16/0600 UTC Guidance (12 h ago)



Recent model trends

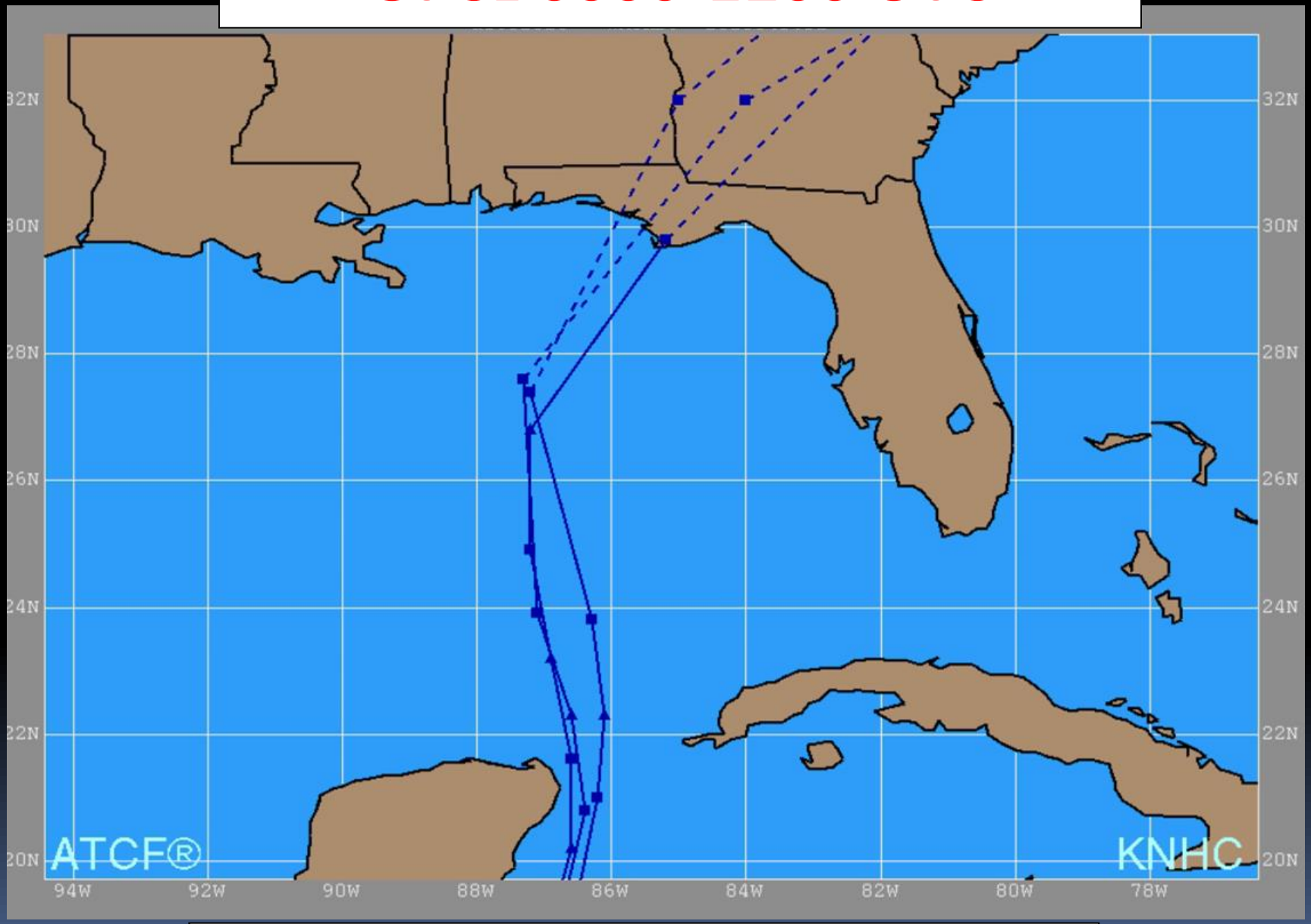
16/1200 UTC Guidance (6 h ago)



TVCN 0000-1800 UTC

TVCN Consensus trending slightly eastward

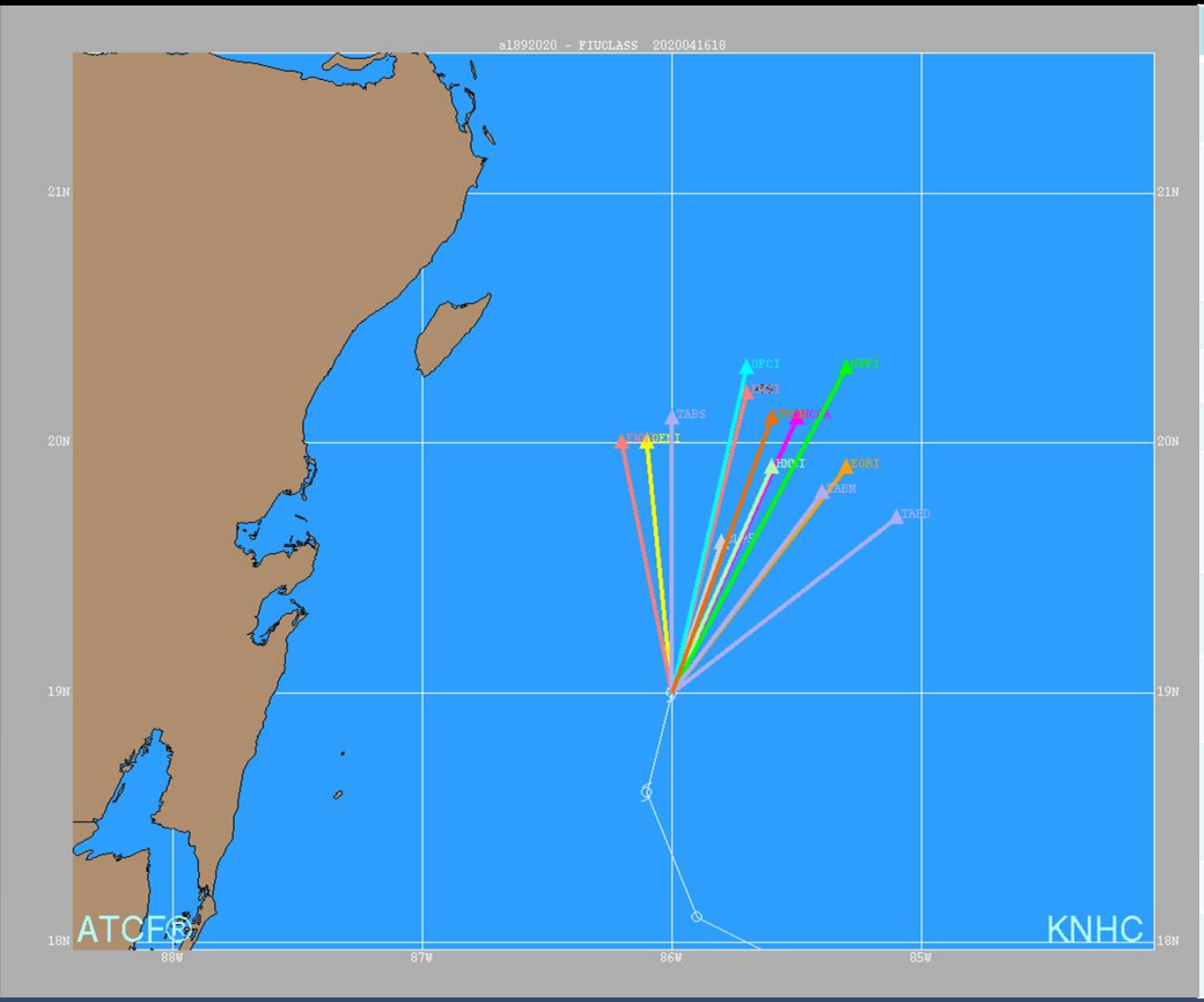
OFCL 0000-1200 UTC



OFCL also shifted slightly eastward

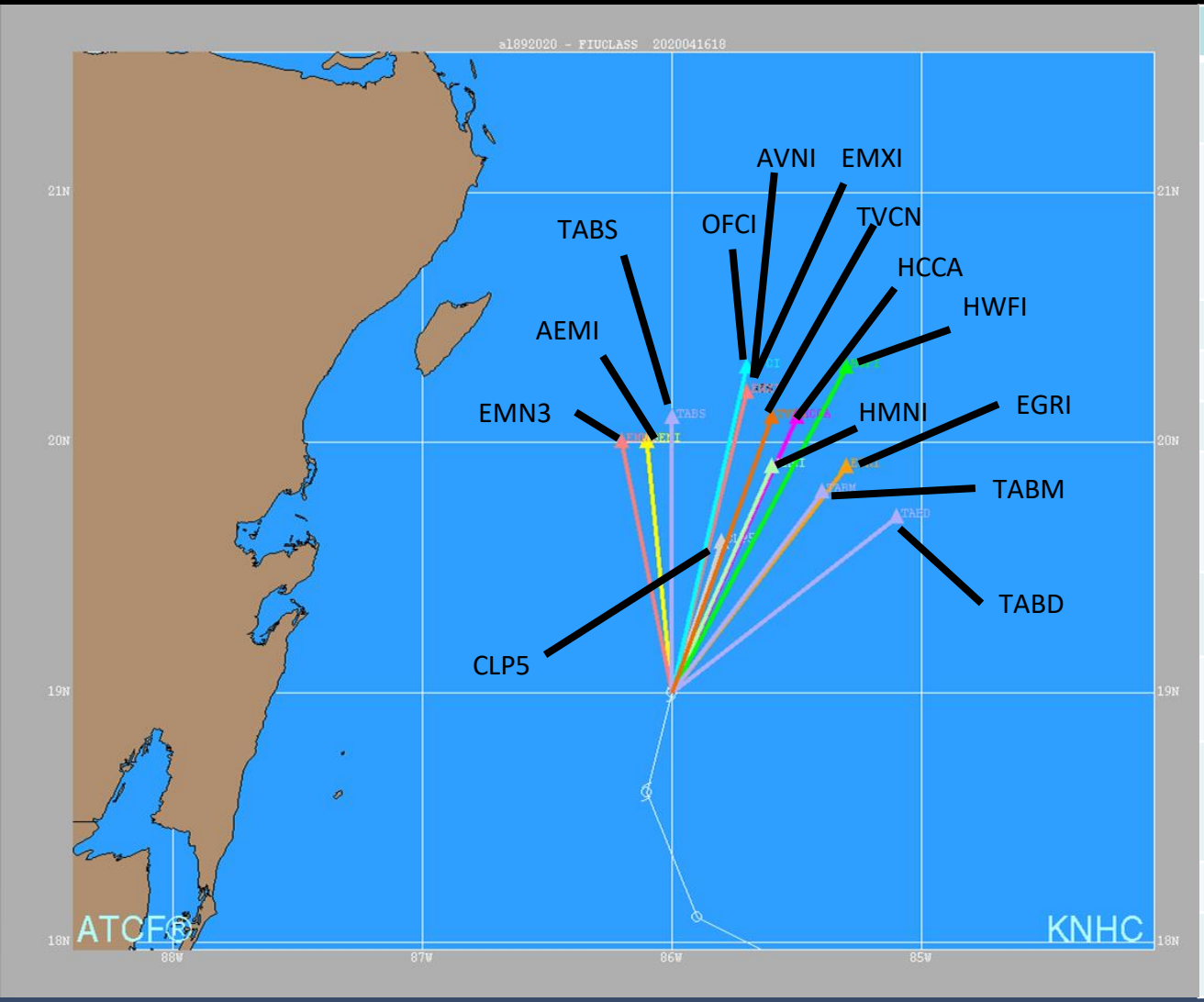
Let’s Begin

12 h forecast



Model/Color	Description
HWFI - Green	Hurricane WRF (WRF-NMM)
HMNI - Green	Hurricane Multi-Scale Ocean-coupled Non-hystdrostatic model (HMON)
AVNI - Black	GFS (Global)
EMXI - Salmon	ECMWF (Global)
EGRI - Orange	UK-MET (Global)
TABS/TABM/TABD - Pink	Trajectory Shallow/Medium/Deep
TVCN – Orange	Track Consensus (simple)
HCCA – Magenta	HFIP Corrected Consensus
OFCI – Cyan	Previous official forecast accounting for initial position
AEMI – Yellow	GFS Ensemble Mean
EMN3 – Orange	ECMWF Ensemble Mean

12 h forecast



Model/Color	Description
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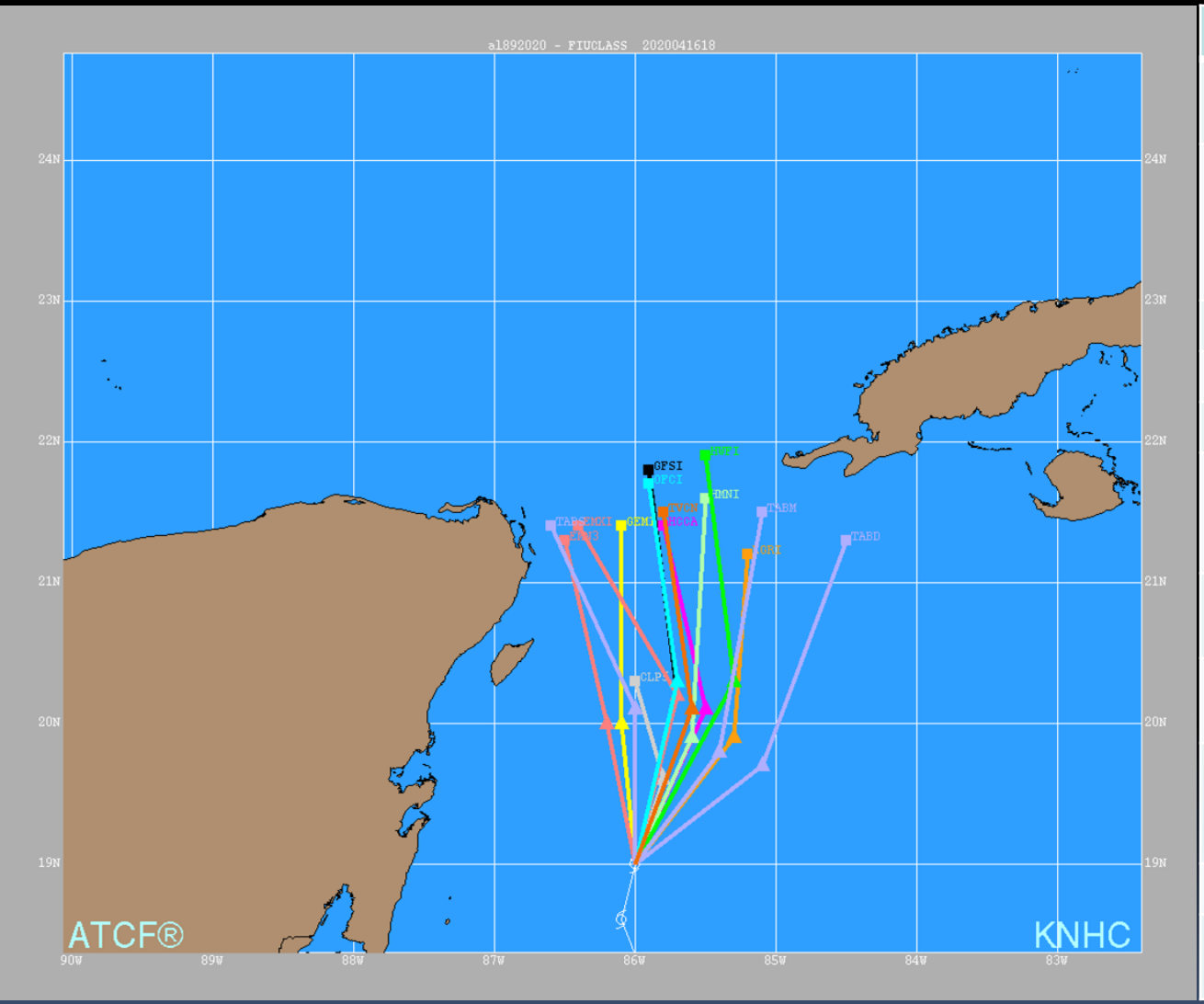
OFCI – Cyan	Previous official forecast accounting for initial position
AEMI – Yellow	GFS Ensemble Mean
EMN3 – Orange	ECMWF Ensemble Mean

24 h forecast



Model/Color	Description
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HMNI - Green	Hurricane Multi-Scale Ocean-coupled Non-hystdrostatic model (HMON)
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EMXI - Salmon	ECMWF (Global)
EGRI - Orange	UK-MET (Global)
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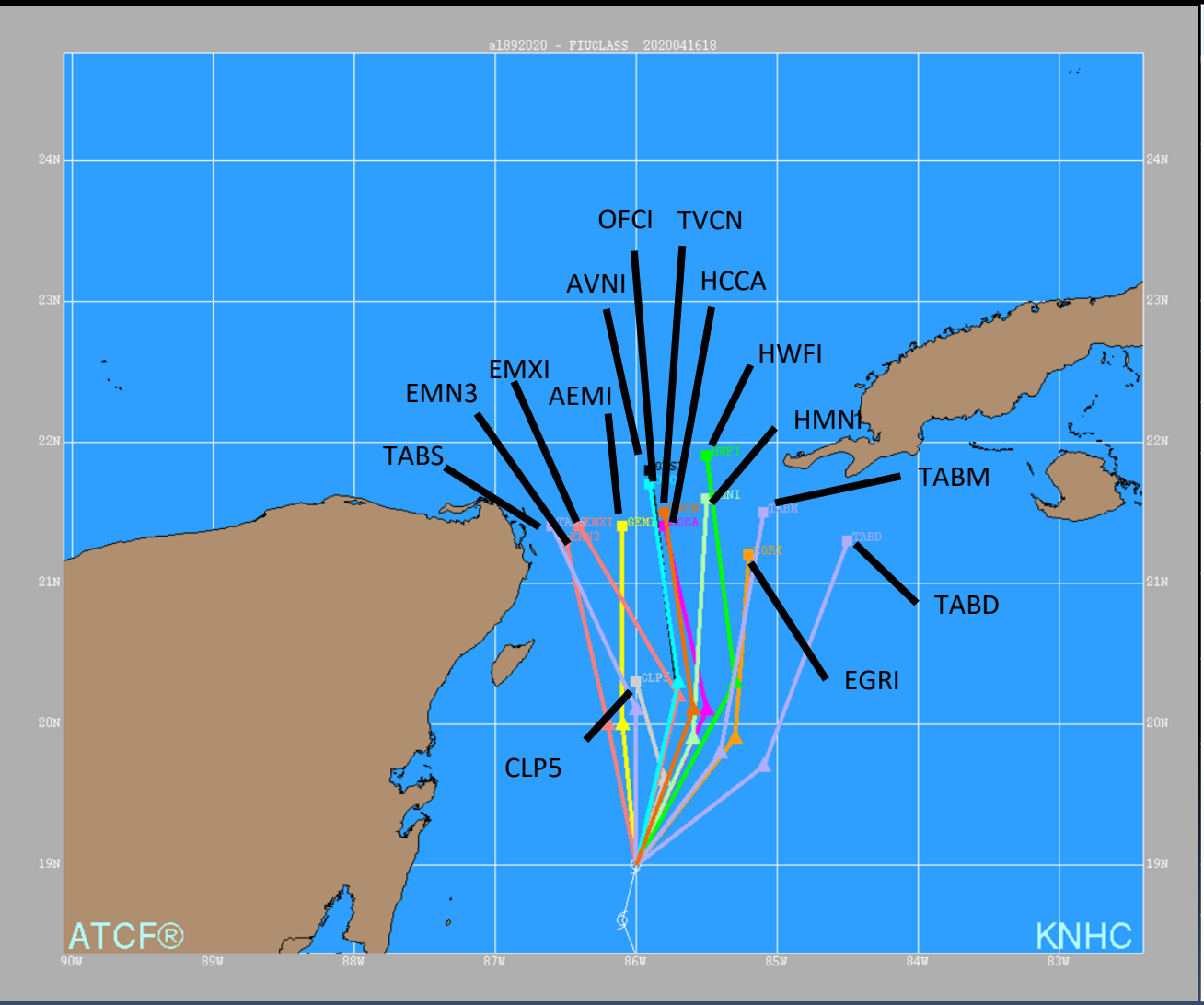
HCCA – Magenta	HFIP Corrected Consensus
OFCI – Cyan	Previous official forecast accounting for initial position
AEMI – Yellow	GFS Ensemble Mean
EMN3 – Orange	ECMWF Ensemble Mean

24 h forecast



Model/Color	Description
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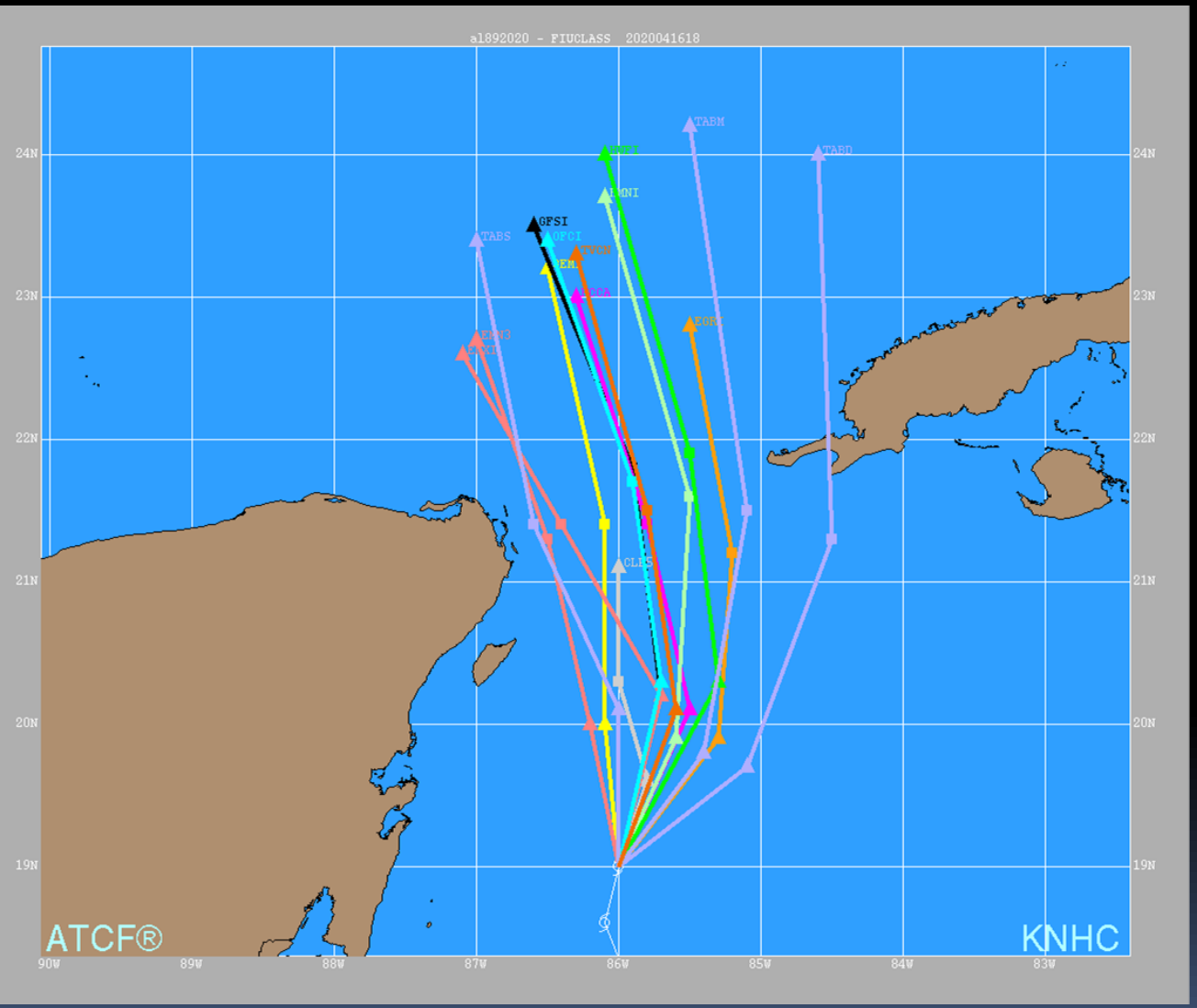
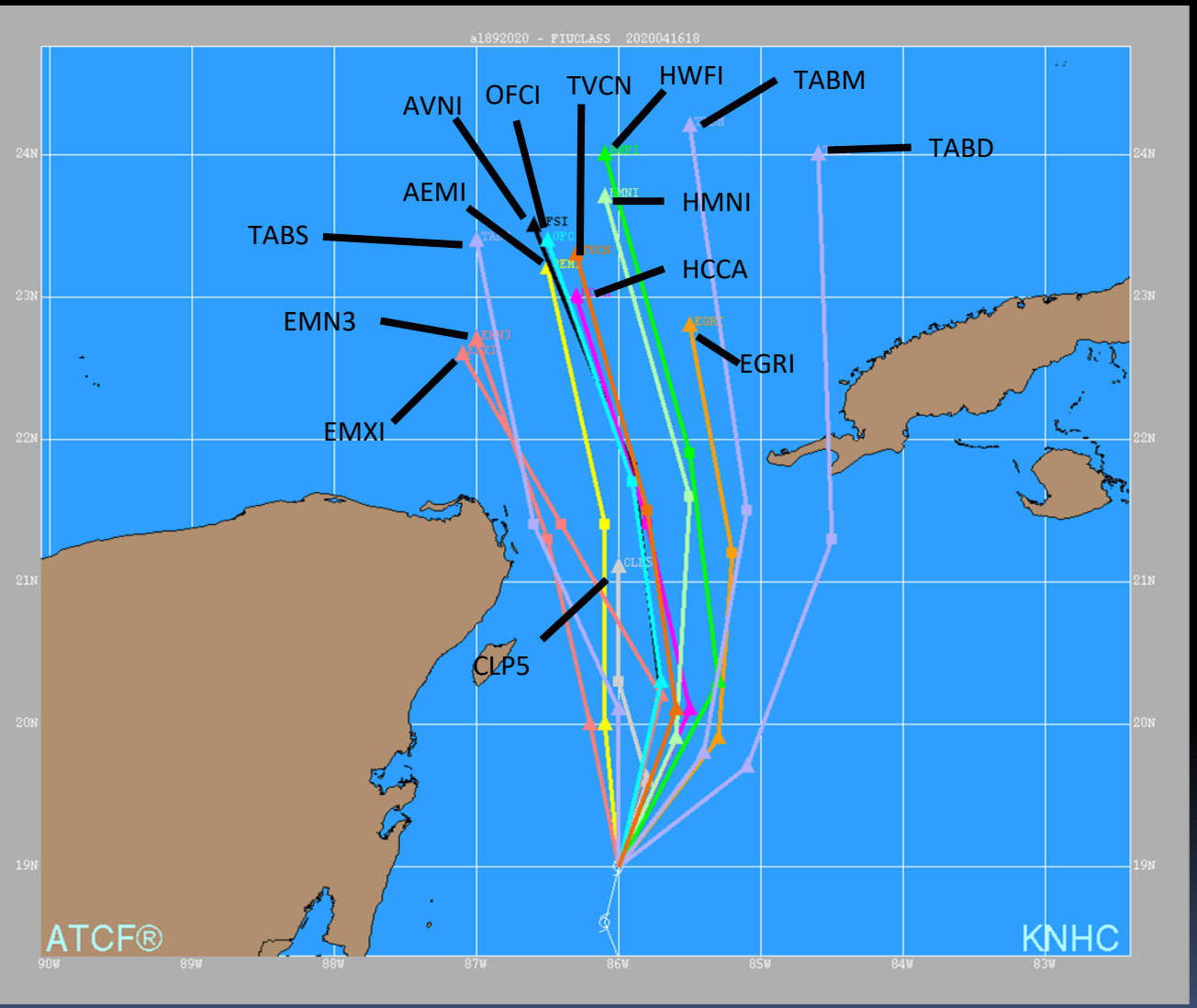
HCCA – Magenta	HFIP Corrected Consensus
OFCI – Cyan	Previous official forecast accounting for initial position
AEMI – Yellow	GFS Ensemble Mean
EMN3 – Orange	ECMWF Ensemble Mean

36 h forecast



Model/Color	Description
HWFI - Green	Hurricane WRF (WRF-NMM)
HMNI - Green	Hurricane Multi-Scale Ocean-coupled Non-hystdrostatic model (HMON)
AVNI - Black	GFS (Global)
EMXI - Salmon	ECMWF (Global)
EGRI - Orange	UK-MET (Global)
TABS/TABM/TABD - Pink	Trajectory Shallow/Medium/Deep
TVCN – Orange	Track Consensus (simple)
HCCA – Magenta	HFIP Corrected Consensus
OFCI – Cyan	Previous official forecast accounting for initial position
AEMI – Yellow	GFS Ensemble Mean
EMN3 – Orange	ECMWF Ensemble Mean

36 h forecast



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AVNI - Black	GFS (Global)
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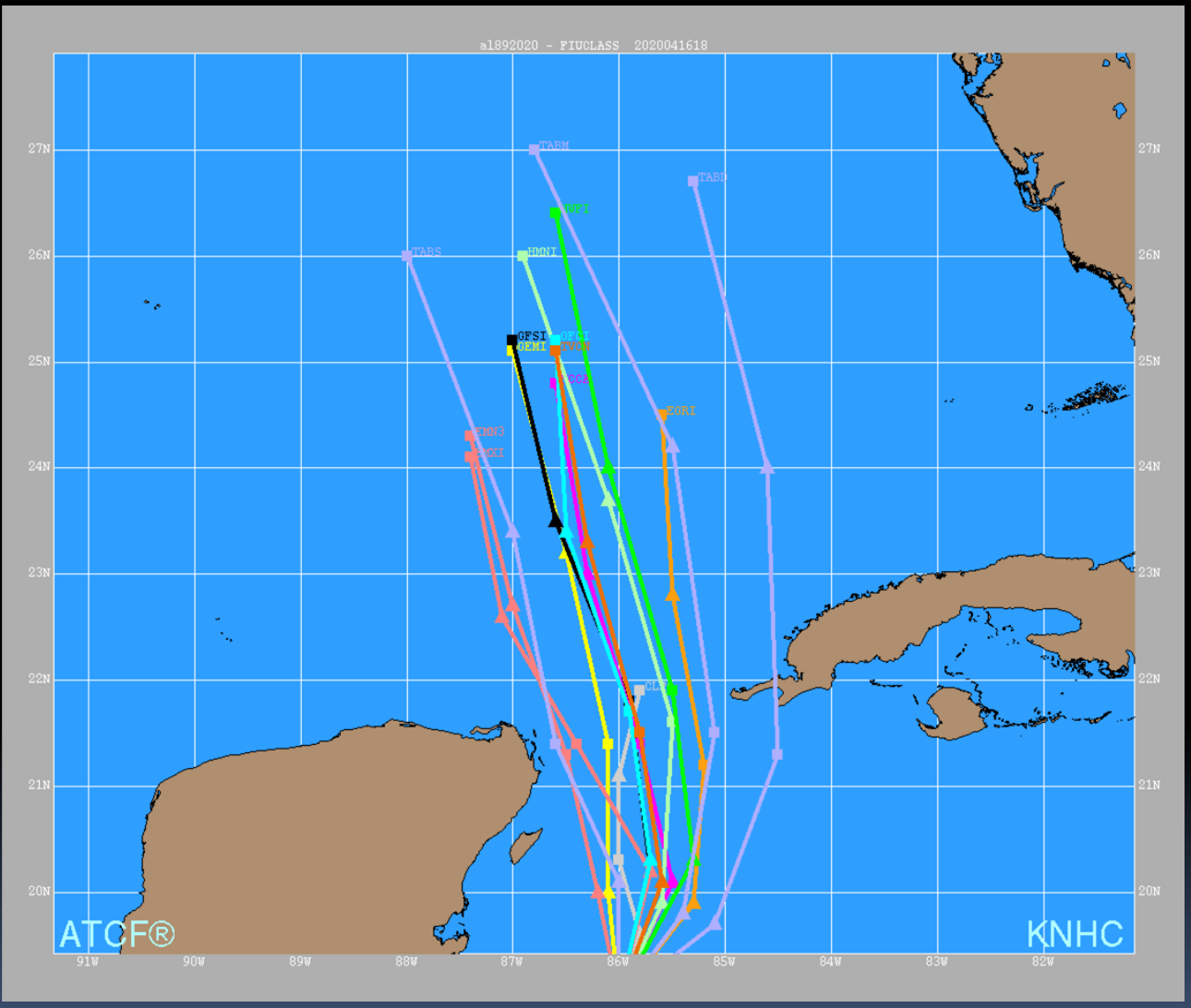
EGRI - Orange	UK-MET (Global)
TABS/TABM/TABD - Pink	Trajectory Shallow/Medium/Deep
TVCN – Orange	Track Consensus (simple)
HCCA – Magenta	HFIP Corrected Consensus
OFCI – Cyan	Previous official forecast accounting for initial position
AEMI – Yellow	GFS Ensemble Mean
EMN3 – Orange	ECMWF Ensemble Mean

Where would you place the 36 h forecast?

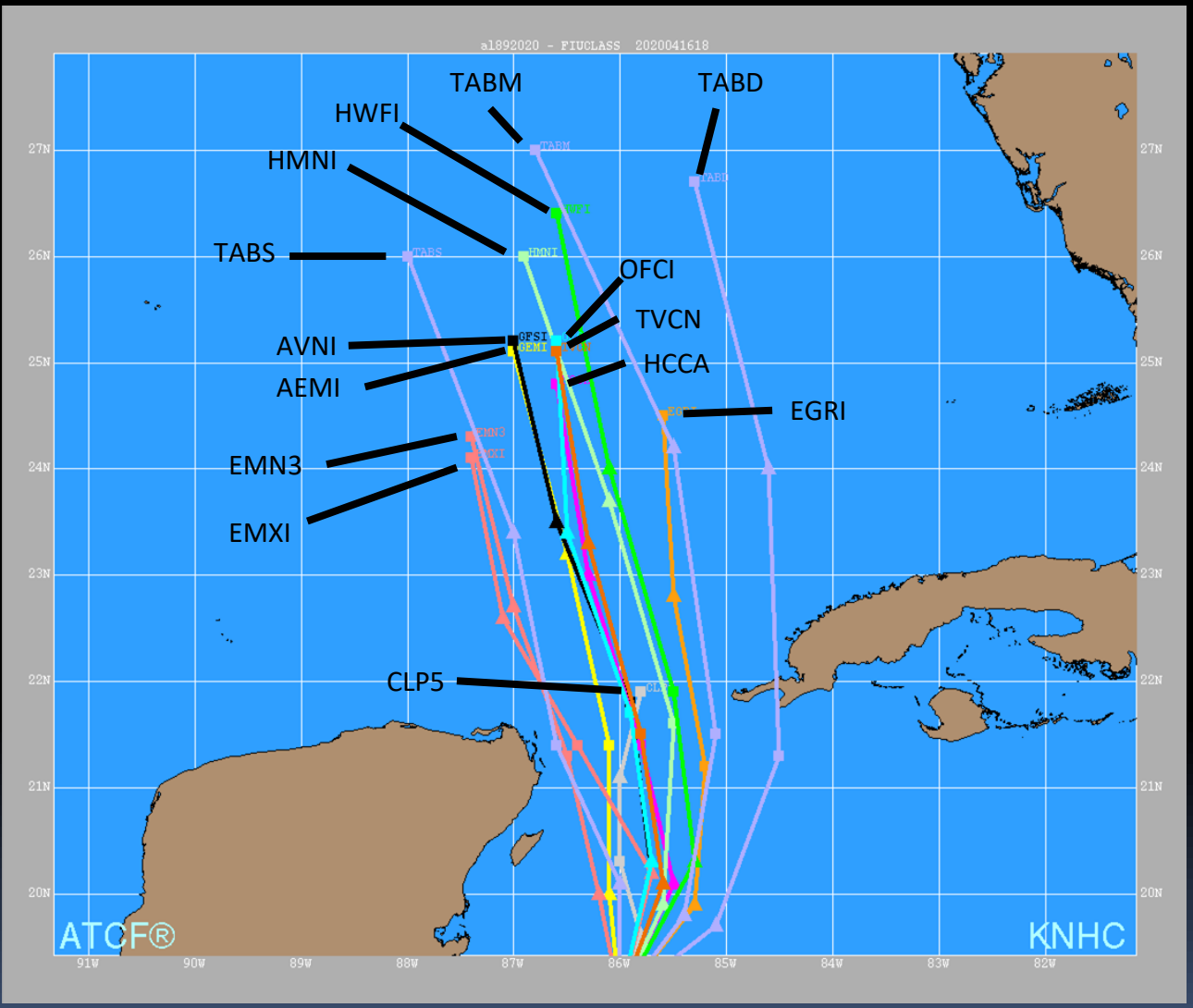
A) 23.0N 86.0W
B) 23.0N 86.5W
C) 23.5N 86.5W
D) 22.5N 86.5W

48 h forecast



Model/Color	Description
HWFI - Green	Hurricane WRF (WRF-NMM)
HMNI - Green	Hurricane Multi-Scale Ocean-coupled Non-hystdrostatic model (HMON)
AVNI - Black	GFS (Global)
EMXI - Salmon	ECMWF (Global)
EGRI - Orange	UK-MET (Global)
TABS/TABM/TABD - Pink	Trajectory Shallow/Medium/Deep
TVCN – Orange	Track Consensus (simple)
HCCA – Magenta	HFIP Corrected Consensus
OFCI – Cyan	Previous official forecast accounting for initial position
AEMI – Yellow	GFS Ensemble Mean
EMN3 – Orange	ECMWF Ensemble Mean

48 h forecast



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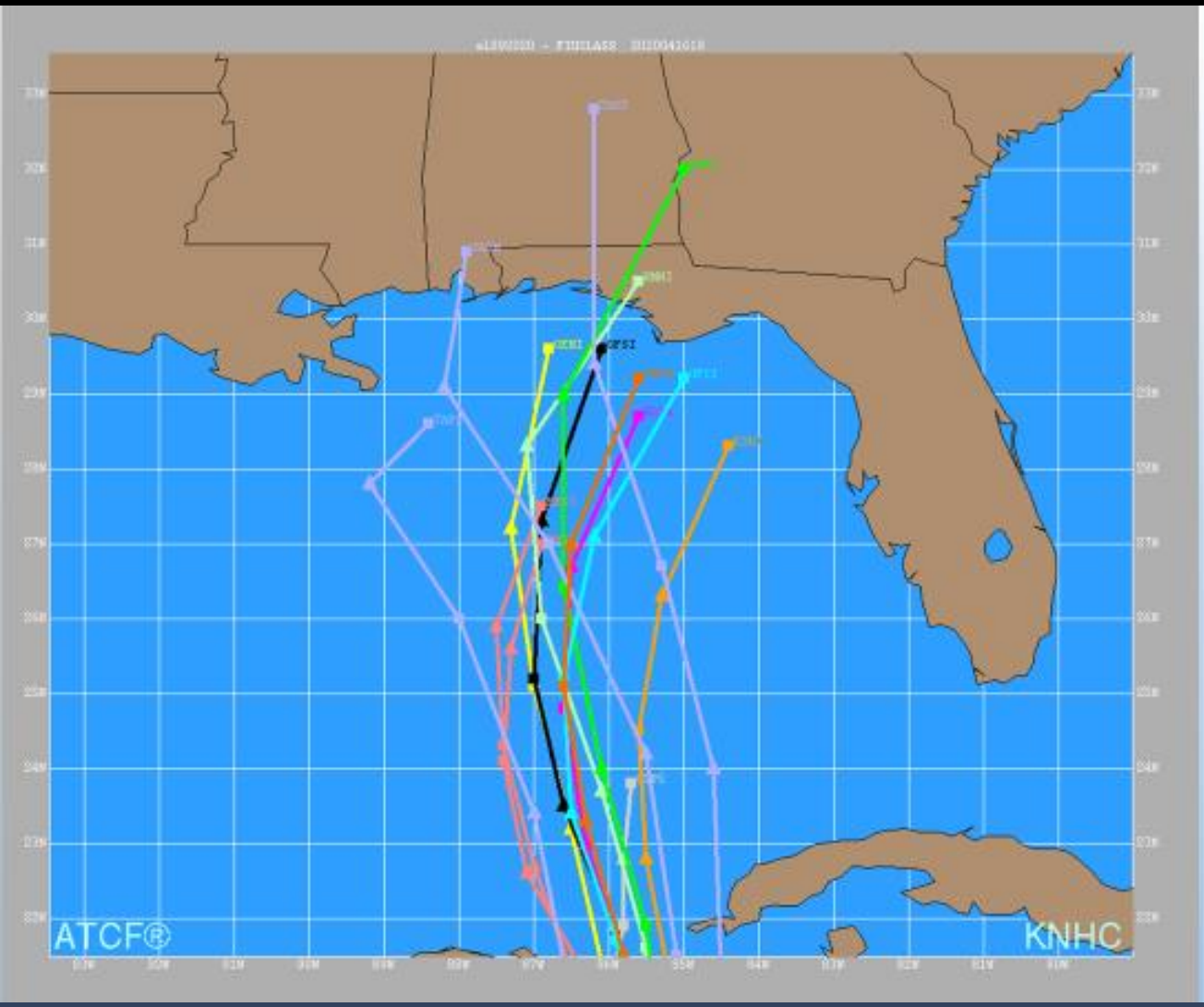
HCCA – Magenta	HFIP Corrected Consensus
OFCI – Cyan	Previous official forecast accounting for initial position
AEMI – Yellow	GFS Ensemble Mean
EMN3 – Orange	ECMWF Ensemble Mean

Where would you place the 48 h forecast?

A) 25.0N 86.5W
B) 25.5N 86.5W
C) 24.5N 86.5W
D) 25.0N 86.0W
E) 25.0N 87.0W

72 h forecast



Model/Color	Description
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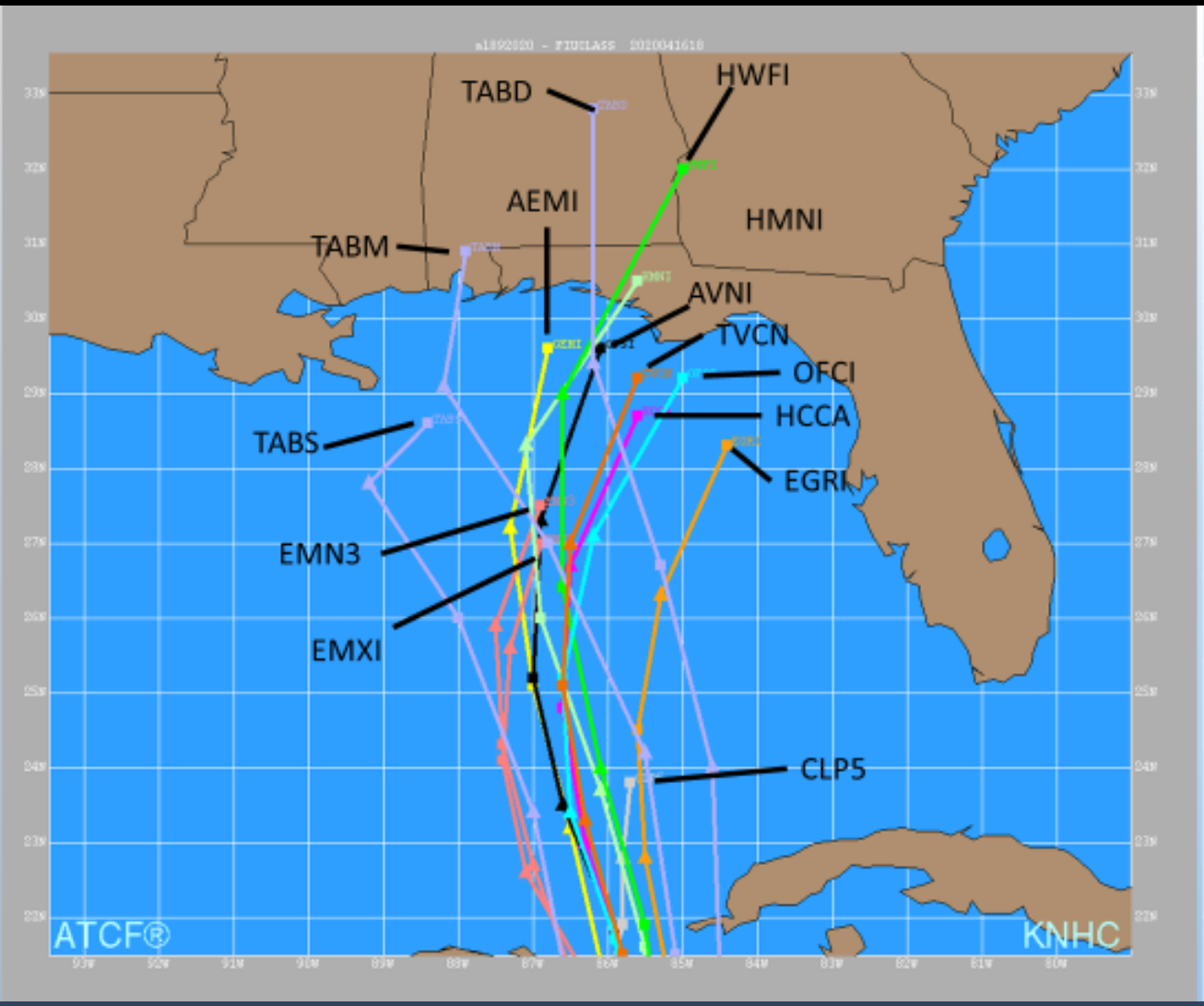
AEMI – Yellow	GFS Ensemble Mean
EMN3 – Orange	ECMWF Ensemble Mean

72 h forecast



Model/Color	Description
HWFI - Green	Hurricane WRF (WRF-NMM)
HMNI - Green	Hurricane Multi-Scale Ocean-coupled Non-hystdrostatic model (HMON)
AVNI - Black	GFS (Global)
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TABS/TABM/TABD - Pink	Trajectory Shallow/Medium/Deep
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HCCA – Magenta	HFIP Corrected Consensus
OFCI – Cyan	Previous official forecast accounting for initial position
AEMI – Yellow	GFS Ensemble Mean
EMN3 – Orange	ECMWF Ensemble Mean

Where would you place the 72 h forecast?

A) 30.0N 85.0W
B) 30.0N 86.0W
C) 29.0N 85.0W
D) 29.0N 86.0W
E) 28.0N 86.0W

Preparing the Intensity Forecast

SHIPS and LGEM Guidance

Intensity (kt)

Values of the predictors

* ATLANTIC 2020 SHIPS INTENSITY FORECAST *
* IR SAT DATA AVAILABLE, OHC AVAILABLE *
* SAMPLE STORM AL502020 4/16/20 18 UTC *

TIME (HR)	0	6	12	18	24	36	48	60	72	84	96	108	120
V (KT) NO LAND	40	45	50	56	61	69	75	76	80	76	71	65	58
V (KT) LAND	40	45	50	56	61	69	75	76	80	50	34	33	26
V (KT) LGEM	40	45	50	54	58	63	67	71	75	49	34	29	33
Storm Type	TROP	TROP	TROP	TROP	TROP	TROP	TROP	TROP	TROP	TROP	TROP	TROP	TROP
SHEAR (KT)	18	17	20	14	12	19	15	16	10	15	19	34	43
SHEAR ADJ (KT)	0	0	0	6	5	1	2	2	-1	0	4	4	8
SHEAR DIR	297	288	288	286	283	296	315	300	281	272	243	232	232
SST (C)	29.4	29.8	30.0	29.8	28.9	29.0	29.2	28.7	28.6	28.6	28.4	26.4	24.6
POT. INT. (KT)	156	164	169	165	149	151	155	147	146	147	146	123	108
ADJ. POT. INT.	141	150	155	152	136	136	138	130	129	132	132	113	100
200 MB T (C)	-52.7	-52.7	-53.0	-52.6	-52.3	-52.3	-51.6	-51.5	-50.8	-51.1	-51.1	-51.6	-52.4
200 MB VXT (C)	0.8	0.8	0.7	0.5	0.7	0.8	0.9	1.2	0.9	1.1	1.2	0.7	0.6
TH_E DEV (C)	9	9	8	8	9	9	10	9	10	8	5	1	0
700-500 MB RH	71	69	67	66	65	64	63	68	68	59	45	31	26
MODEL VTX (KT)	18	19	22	24	25	26	27	25	28	26	24	23	22
850 MB ENV VOR	72	75	80	80	72	60	50	29	46	18	25	32	38
200 MB DIV	60	45	25	43	48	23	35	49	60	41	101	66	70
700-850 TADV	2	4	9	13	12	24	23	20	12	18	13	-9	39
LAND (KM)	128	129	120	73	76	226	420	302	67	-149	-105	18	381
LAT (DEG N)	18.9	19.5	20.1	21.0	21.8	23.5	25.3	27.2	29.1	31.3	33.6	36.0	38.4
LONG(DEG W)	86.3	86.2	86.1	86.2	86.3	86.6	87.0	86.6	85.5	83.5	80.5	75.7	69.1
STM SPEED (KT)	5	6	7	9	9	9	9	10	12	16	20	26	29
HEAT CONTENT	54	59	61	50	30	30	71	34	27	3	2	0	0

Rapid Intensification Index
probability of RI during next 24 hour

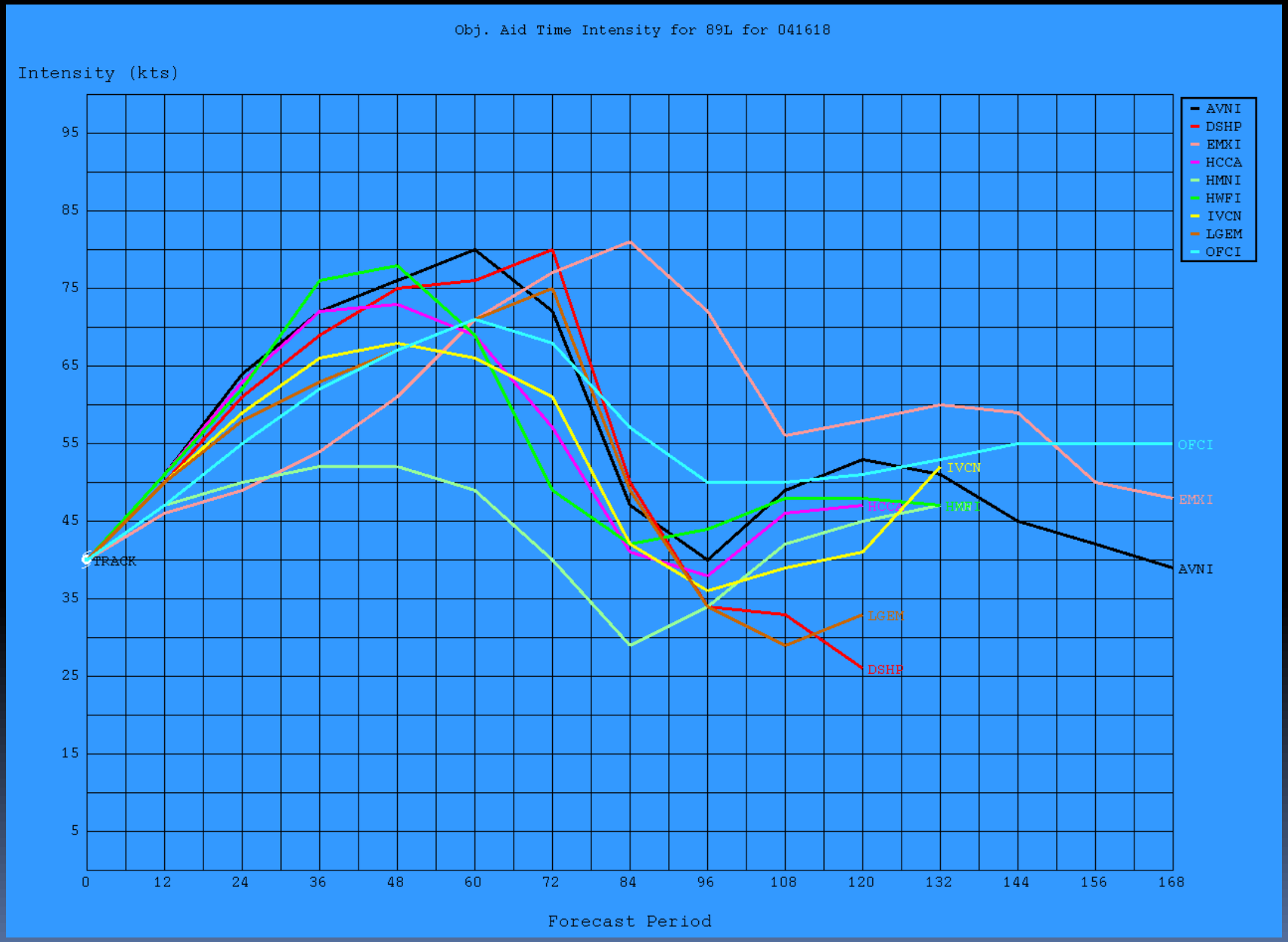
(SHIPS-RII PREDICTOR TABLE for 30 KT OR MORE MAXIMUM WIND INCREASE IN NEXT 24-h)

Predictor		Value	RI Predictor Range			Scaled Value(0-1)	% Contribution
12 HR PERSISTENCE (KT)	:	10.0	-49.5	to	38.5	0.68	6.4
850-200 MB SHEAR (KT)	:	16.5	30.1	to	2.3	0.49	2.1
HEAT CONTENT (KJ/CM2)	:	50.8	0.0	to	157.3	0.32	1.4
STD DEV OF IR BR TEMP	:	16.1	36.6	to	2.8	0.61	2.3
2nd PC OF IR BR TEMP	:	0.9	2.9	to	-2.9	0.34	1.2
MAXIMUM WIND (KT)	:	40.0	22.5	to	132.0	0.47	0.9
BL DRY-AIR FLUX (W/M2)	:	124.6	893.2	to	-67.1	0.80	2.1
POT = MPI-VMAX (KT)	:	103.9	28.4	to	141.4	0.67	0.4
D200 (10**7s-1)	:	44.2	-29.7	to	185.9	0.34	0.2
%area of TPW <45 mm upshear	:	0.0	100.0	to	0.0	1.00	0.2

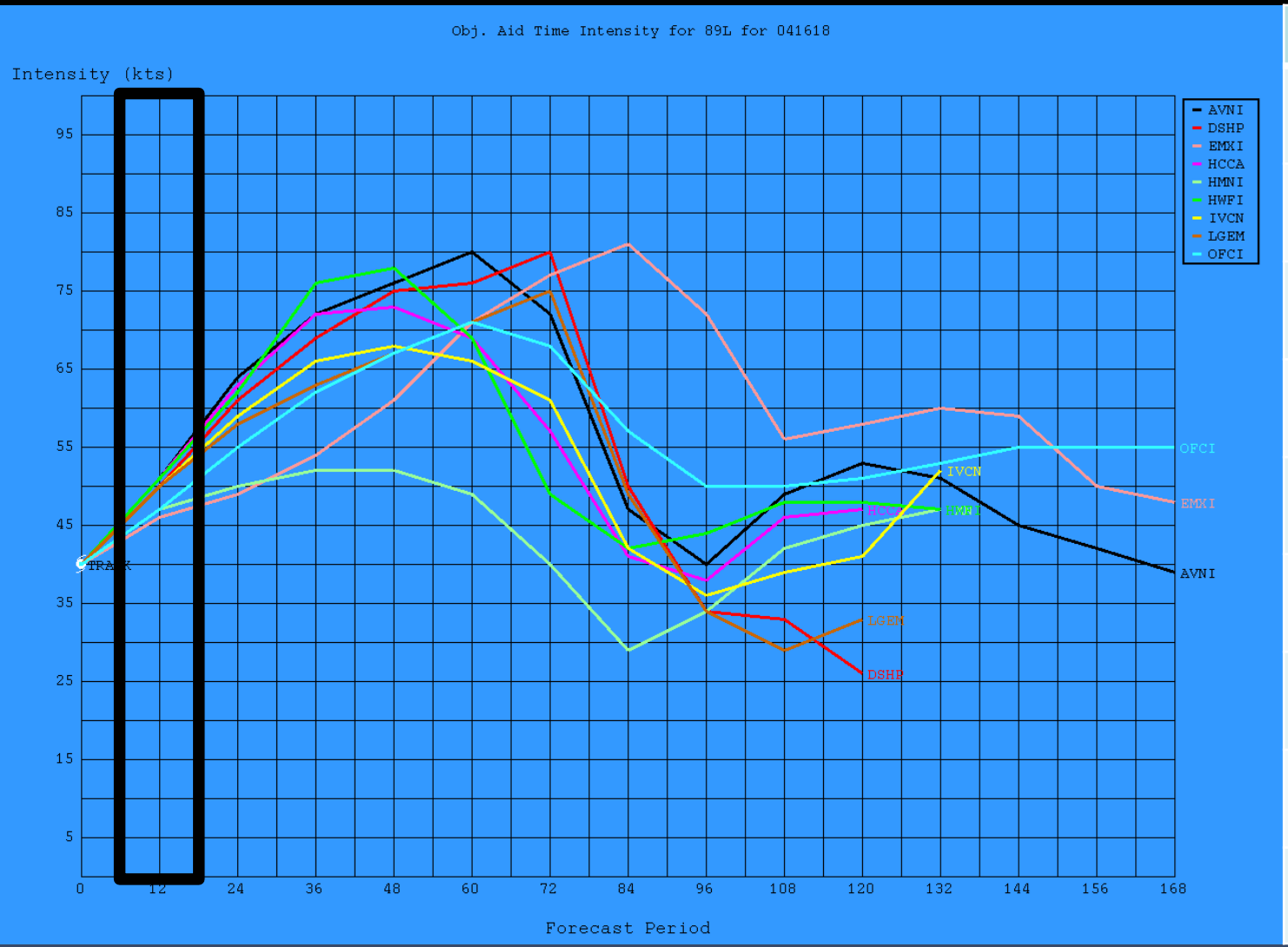
SHIPS Prob RI for 20kt/ 12hr RI threshold= 8% is 1.6 times climatological mean (5.0%)
SHIPS Prob RI for 25kt/ 24hr RI threshold= 21% is 2.0 times climatological mean (10.9%)
SHIPS Prob RI for 30kt/ 24hr RI threshold= 17% is 2.6 times climatological mean (6.7%)
SHIPS Prob RI for 35kt/ 24hr RI threshold= 12% is 3.1 times climatological mean (3.8%)
SHIPS Prob RI for 40kt/ 24hr RI threshold= 10% is 4.0 times climatological mean (2.4%)
SHIPS Prob RI for 45kt/ 36hr RI threshold= 12% is 2.8 times climatological mean (4.5%)
SHIPS Prob RI for 55kt/ 48hr RI threshold= 12% is 2.6 times climatological mean (4.6%)
SHIPS Prob RI for 65kt/ 72hr RI threshold= 21% is 3.9 times climatological mean (5.4%)

Matrix of RI probabilities

RI (kt / h)	20/12	25/24	30/24	35/24	40/24	45/36	55/48	65/72
SHIPS-RII:	7.9%	21.5%	17.2%	11.9%	9.6%	12.4%	12.0%	20.9%
Logistic:	4.9%	12.6%	6.9%	3.6%	1.2%	4.7%	5.3%	10.1%
Bayesian:	3.2%	3.5%	1.3%	1.0%	0.2%	0.3%	0.1%	0.4%
Consensus:	5.3%	12.5%	8.4%	5.5%	3.7%	5.8%	5.8%	10.5%
DTOPS:	10.0%	46.0%	34.0%	22.0%	8.0%	18.0%	26.0%	2.0%

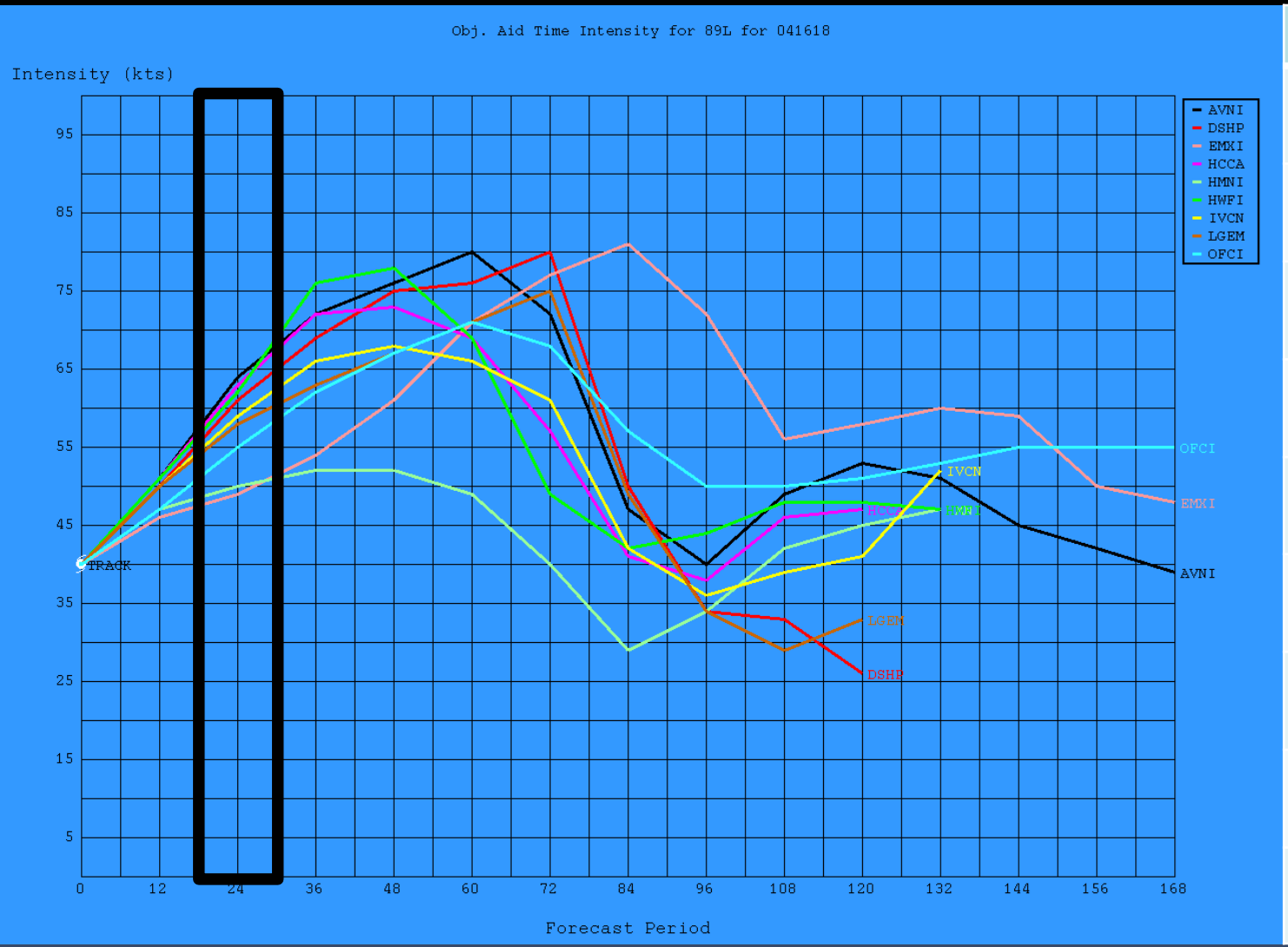

Obj. Aid Time Intensity for 89L for 041618
Intensity (kts)
95
85
75
65
55
45
35
25
15
5
0
12
24
36
48
60
72
84
96
108
120
132
144
156
168
Forecast Period
AVNI
DSHP
EMXI
HCCA
HMNI
HWFI
IVCN
LGEM
OFCI
TRACK
OFCI
EMXI
IVCN
HMNI
HCCA
AVNI
LGEM
DSHP

12 h Intensity Forecast



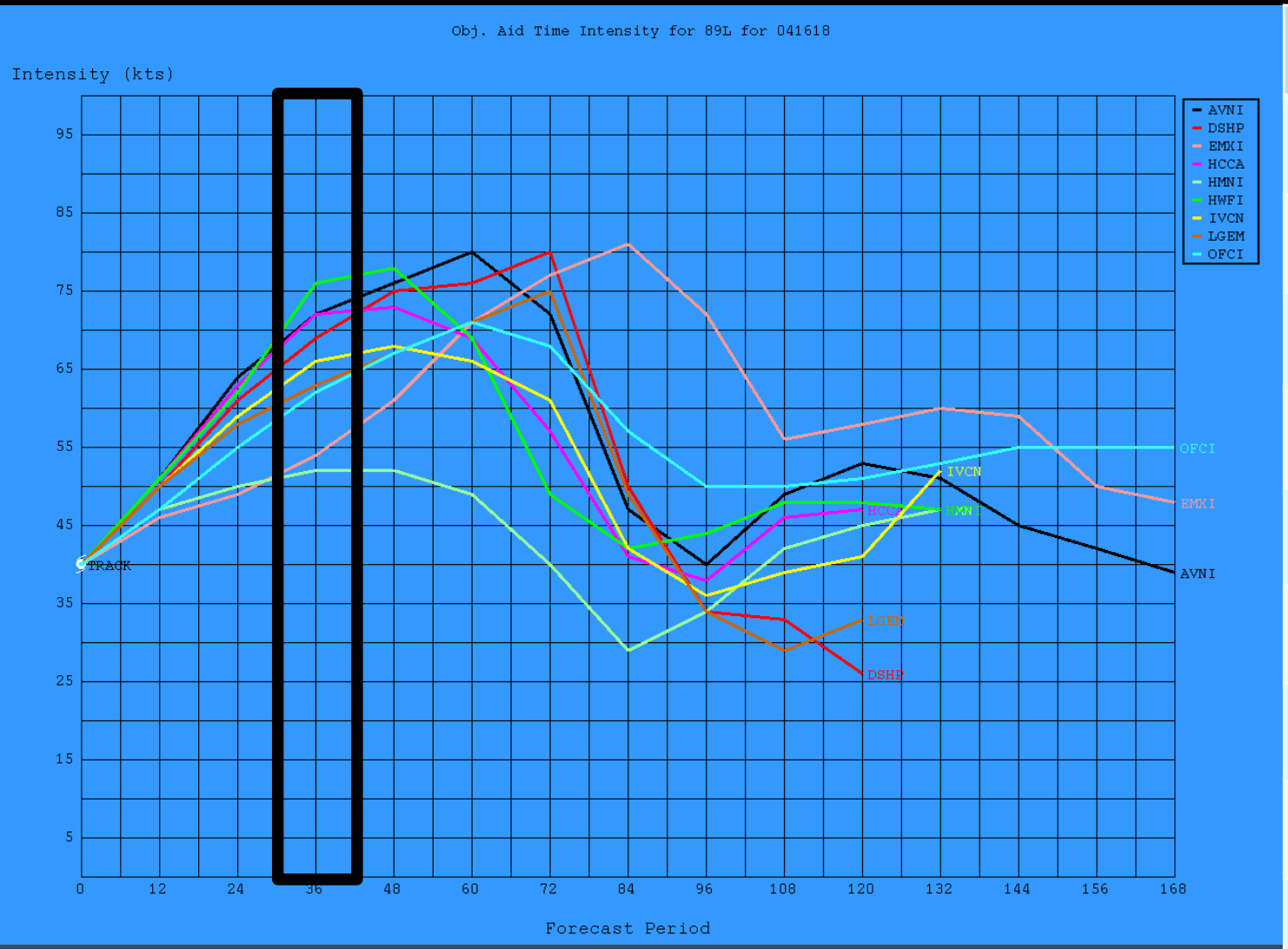
Model/Color	Intensity
HWFI - Green	51
HMNI - Green	47
AVNI - Black	51
EMXI - Salmon	46
DSHP - Red	50
LGEM - Orange	48
IVCN - Yellow	50
HCCA – Magenta	51
OFCI - Cyan	47

24 h Intensity Forecast



Model/Color	Intensity
HWFI - Green	62
HMNI - Green	50
AVNI - Black	64
EMXI - Salmon	49
DSHP - Red	61
LGEM - Orange	58
IVCN - Yellow	50
HCCA – Magenta	63
OFCI - Cyan	55

36 h Intensity Forecast

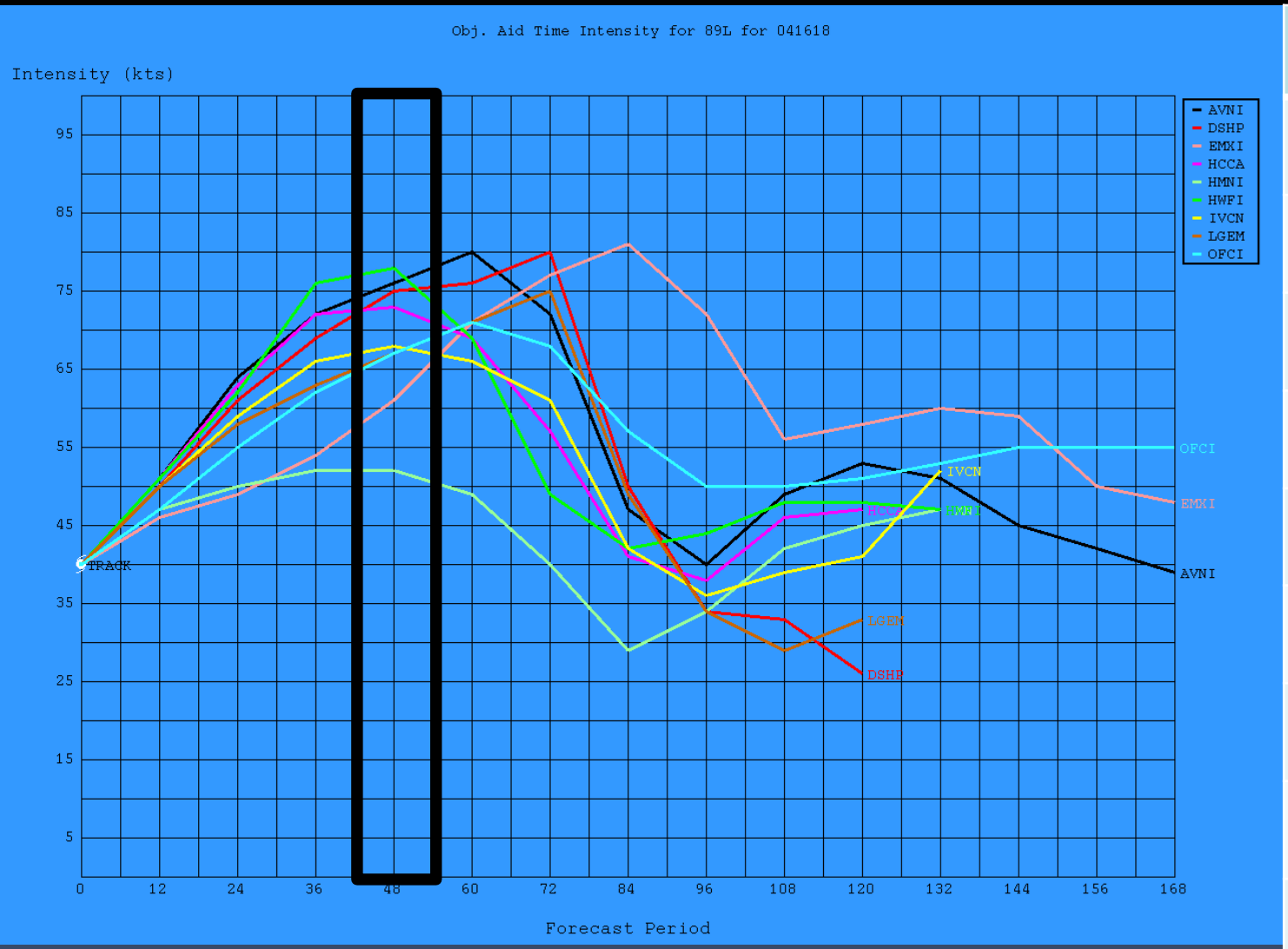


Model/Color	Intensity
HWFI - Green	76
HMNI - Green	52
AVNI - Black	72
EMXI - Salmon	54
DSHP - Red	69
LGEM - Orange	63
IVCN - Yellow	66
HCCA – Magenta	72
OFCI - Cyan	62

What would be your 36 h intensity forecast?

A) 60 kt or less
B) 65 kt
C) 70 kt
D) 75 kt
E) 80 kt or greater

48 h Intensity Forecast

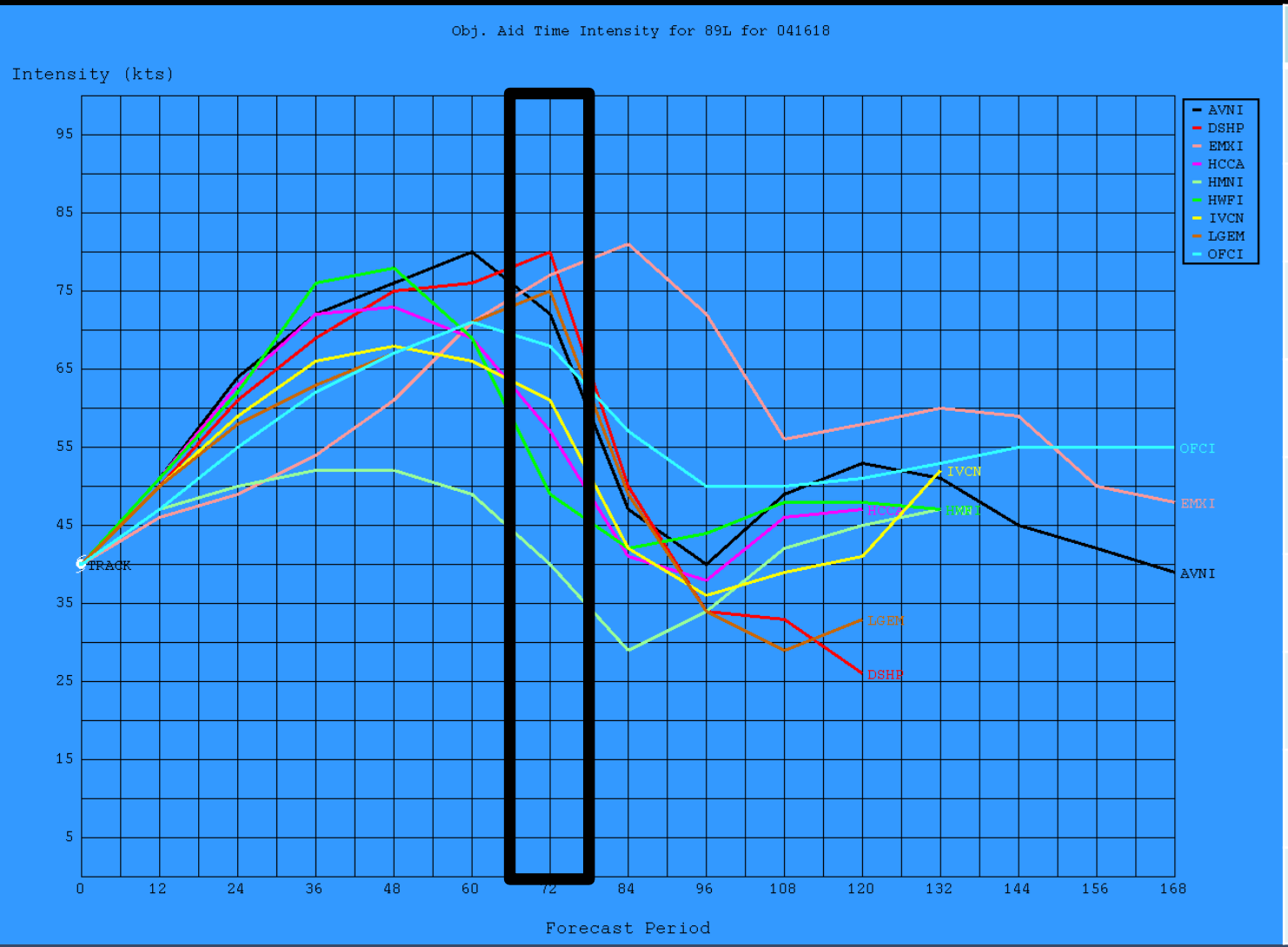


Model/Color	Intensity
HWFI - Green	78
HMNI - Green	52
AVNI - Black	76
EMXI - Salmon	61
DSHP - Red	75
LGEM - Orange	67
IVCN - Yellow	68
HCCA – Magenta	73
OFCI - Cyan	67

What would be your 48 h intensity forecast?

A) 65 kt or less
B) 70 kt
C) 75 kt
D) 80 kt
E) 85 kt or greater

72 h Intensity Forecast



Model/Color	Intensity
HWFI - Green	49
HMNI - Green	40
AVNI - Black	72
EMXI - Salmon	77
DSHP - Red	80
LGEM - Orange	75
IVCN - Yellow	61
HCCA – Magenta	57
OFCI - Cyan	68

What would be your 72 h intensity forecast?

A) 65 kt or less
B) 70 kt
C) 75 kt
D) 80 kt
E) 85 kt or greater

19:34 UTC

New Fix Data

New aircraft data has just arrived. The aircraft measured SFMR winds of 53 kt and a maximum flight-level wind of 56 kt. Do we need to update our intensity or track forecasts and re-submit the model data?

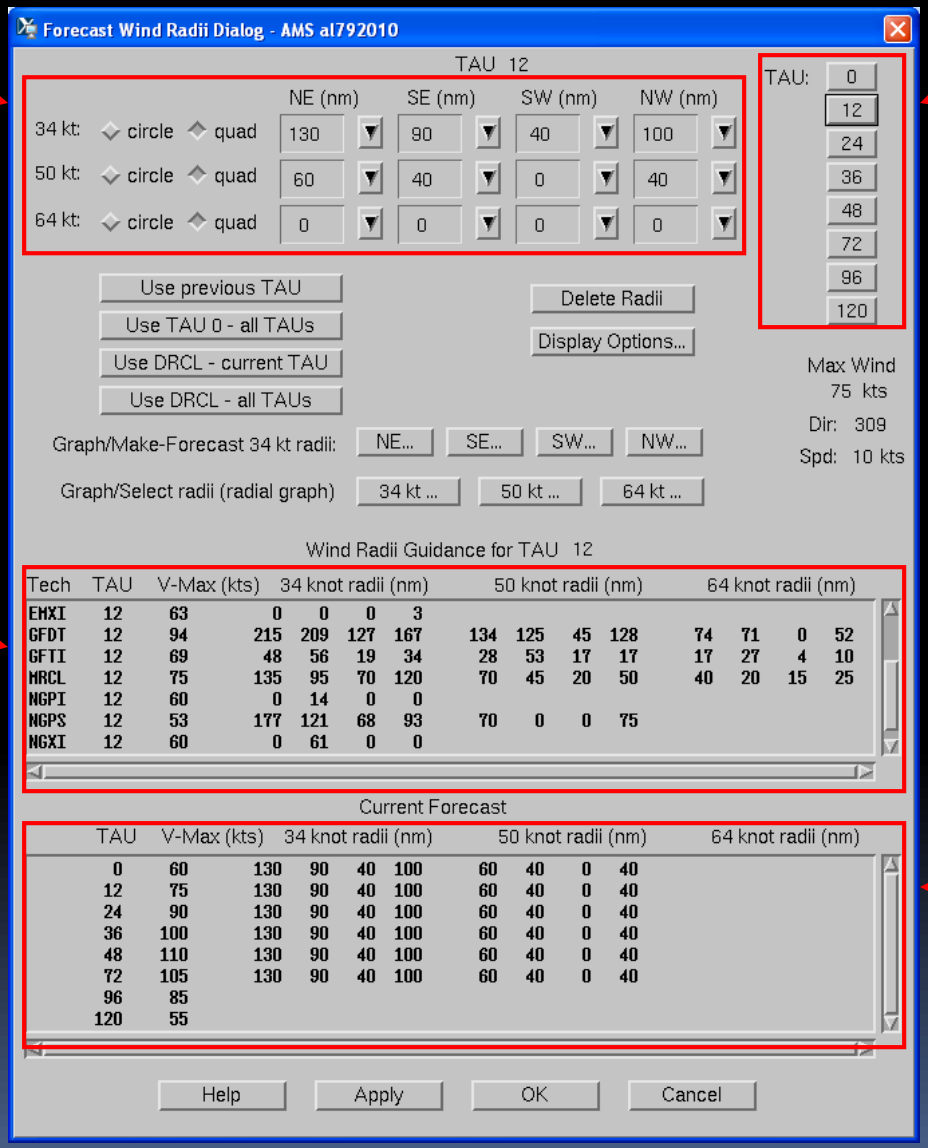
```
000
URNT12 KNHC 161945
VORTEX DATA MESSAGE   AL682020
A. 07/19:34:10Z
B. 19.19 deg N 085.78 deg W
C. 925 mb 686 m
D. EXTRAP 999 mb
E. NA
F. NA
G. NA
H. 53 kt
I. 102 deg 62 nm 19:24:00Z
J. 209 deg 56 kt
K. 105 deg 49 nm 19:28:30Z
L. 34 kt
M. 226 deg 101 nm 19:31:30Z
N. 256 deg 32 kt
O. 226 deg 106 nm 19:33:00Z
P. 21 C / 763 m
Q. 24 C / 764 m
R. 20 C / NA
S. 1345 / 09
T. 0.02 / 3 nm
U. AF305 0114A CYCLONE OB 10
MAX FL WIND 56 KT 105 / 49 NM 19:28:30Z
SLP EXTRAP FROM 925 MB
;
```

Preparing the Wind Radii Forecast

Wind Radii Forecast Dialogue Box

Enter your radii prediction (n mi) for each forecast period

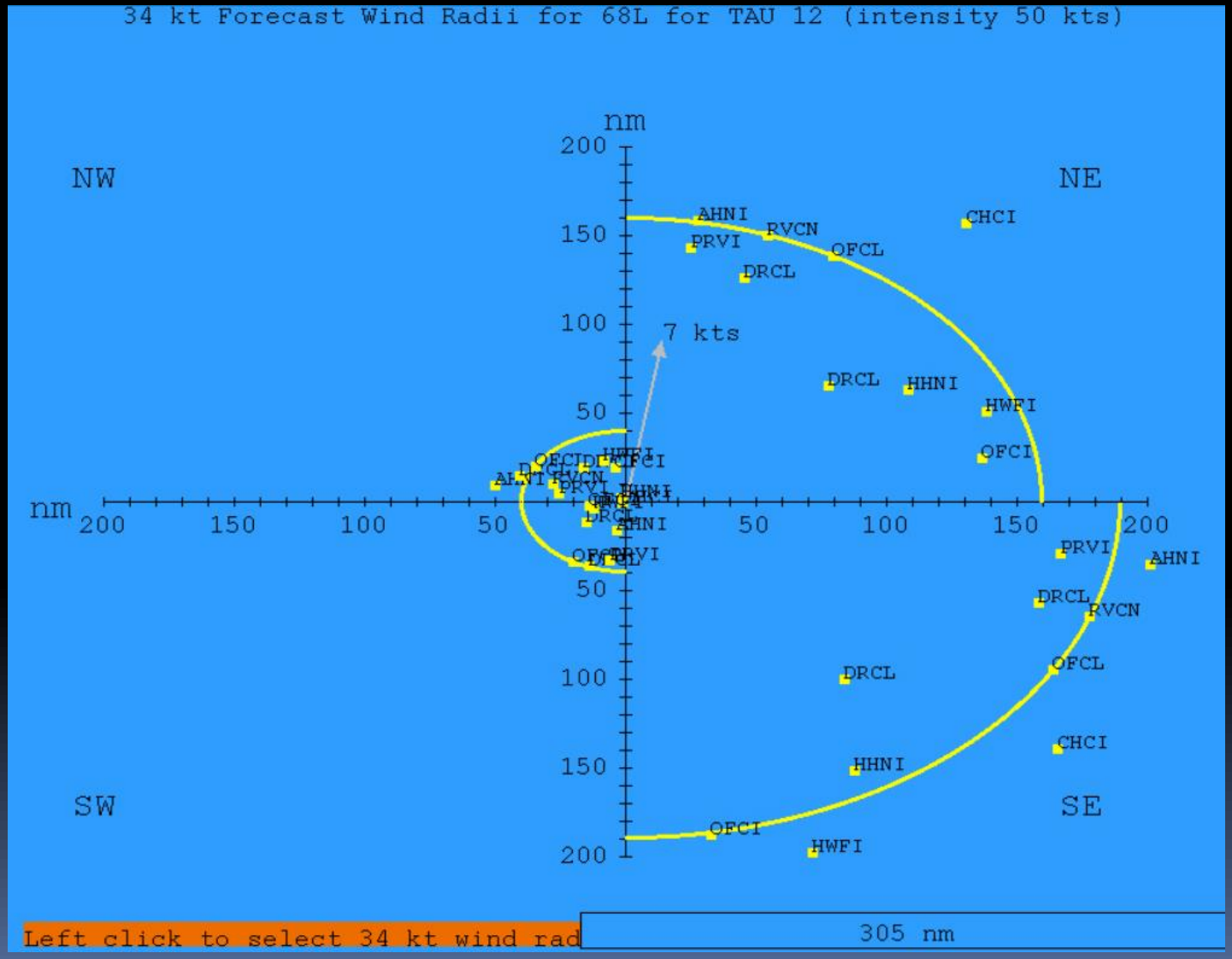
Guidance



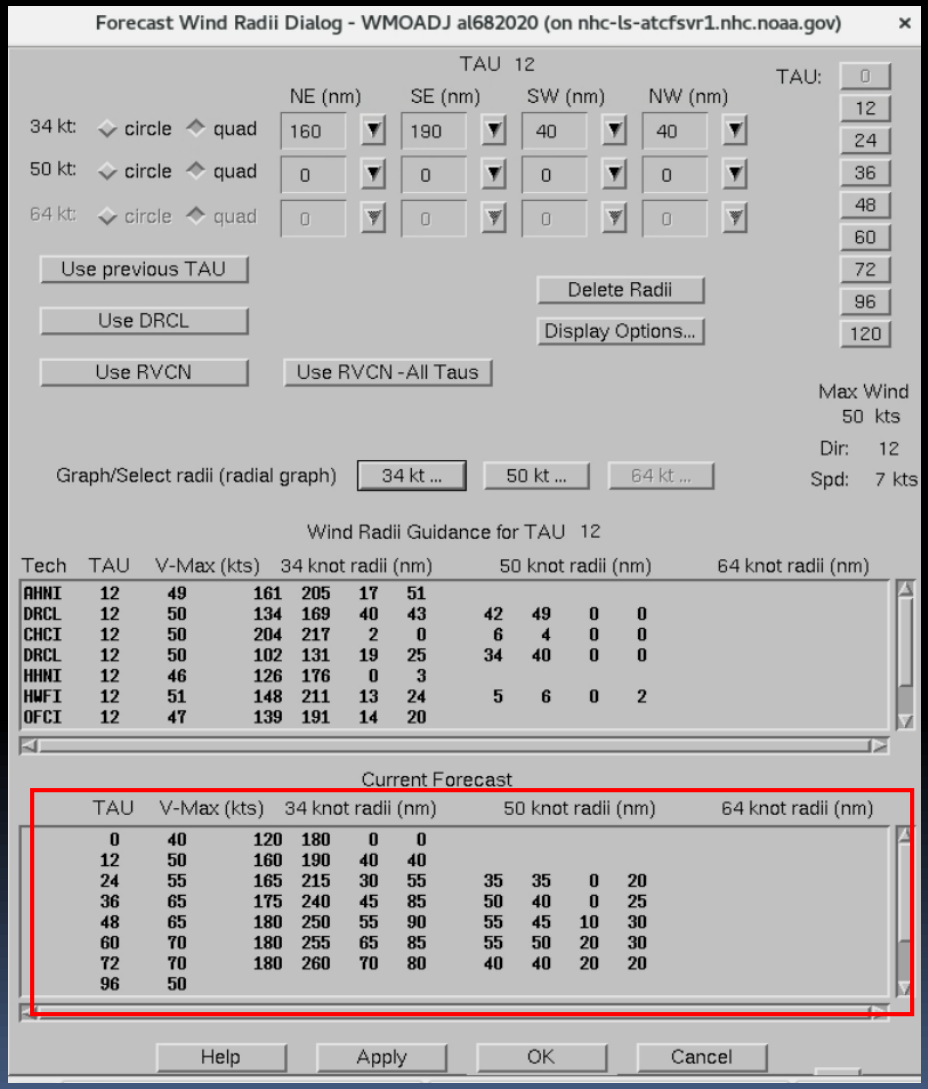
Select forecast period. Radii forecasts only out to 72 h

Summary of your radii forecasts

Forecasters can use a graphical plot to complete radii forecasts



Wind Radii Forecast Dialogue Box



← Summary of your radii forecasts

Now let’s decide if watches or warnings are required

Definitions of Hurricane Watch/Warning

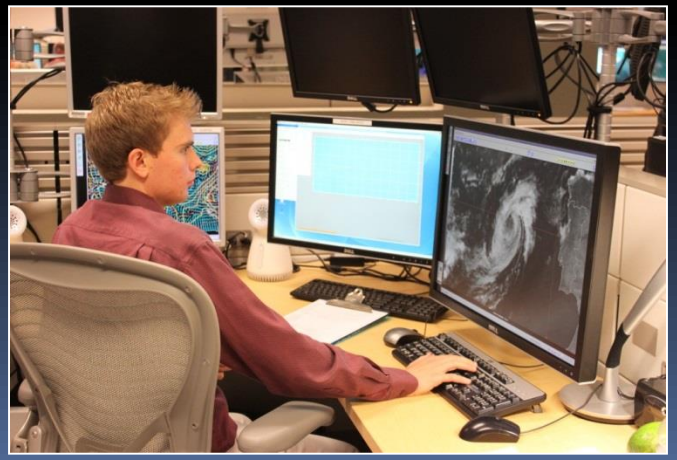
- Hurricane Watch: hurricane conditions are *possible* somewhere within the watch area. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the hurricane watch is issued 48 hours in advance of the anticipated onset of tropical-storm-force winds.

- Hurricane Warning: hurricane conditions are *expected* somewhere within the warning area. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the hurricane warning is issued 36 hours in advance of the anticipated onset of tropical-storm-force winds.

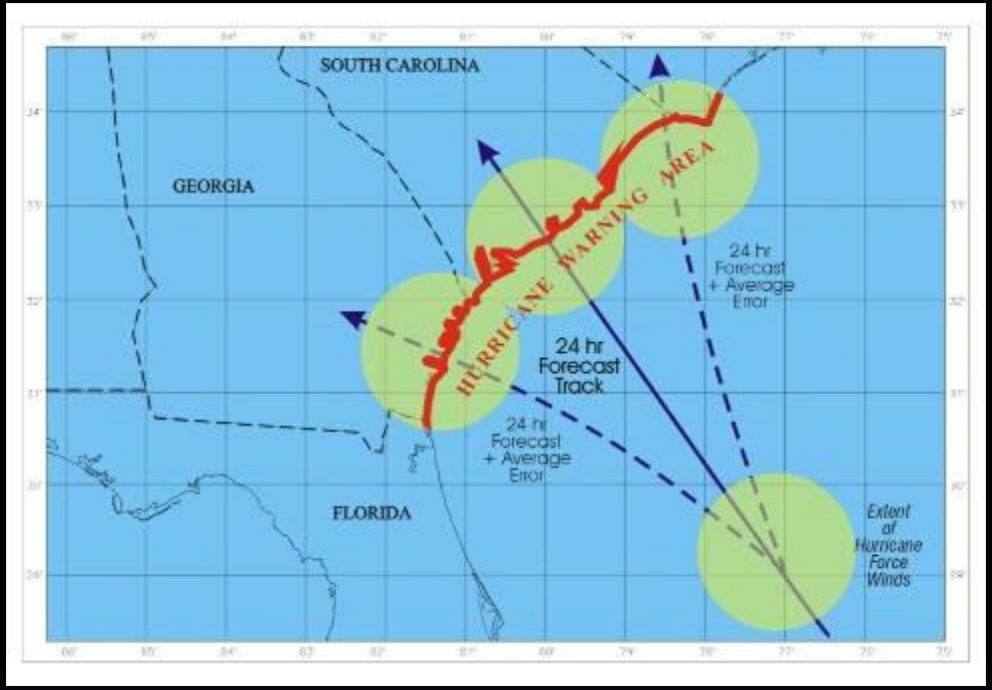
Definitions of Tropical Storm Watch/Warning

- Tropical Storm Watch: tropical storm conditions are *possible* somewhere within the watch area within the next 48 hours.

- Tropical Storm Warning: tropical storm conditions are *expected* somewhere within the warning area within the next 36 hours.



Issuing Warnings



(AVERAGE 24-HOUR FORECAST ERROR IS NOW ~50 MILES)

Warning Size is based on:

- Forecast Track
- Storm Size
- Known uncertainties in the forecasts

Orientation of the forecast track with respect to the coast plays a major role in the size of the warning area

International Coordination

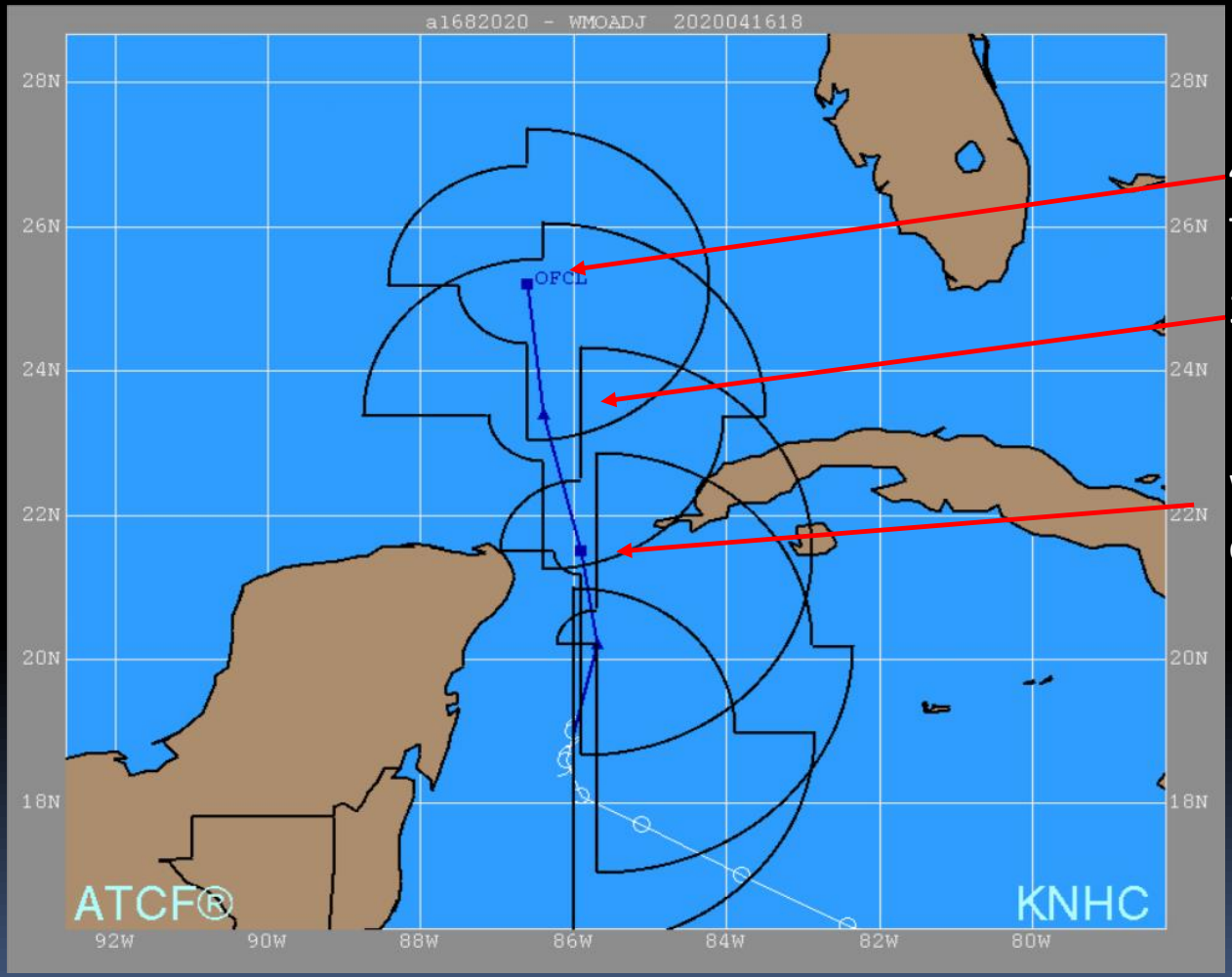
World MET. ORGANIZATION - Regional Association IV Coordination

RSMC=
Regional Specialized Meteorological Center;

RA-IV countries include Caribbean area, Central America, Mexico, Canada, and Bermuda.

Do we need watches or warnings?

Remember to consider forecast uncertainty



48 h forecast- Still time for the Gulf Coast?

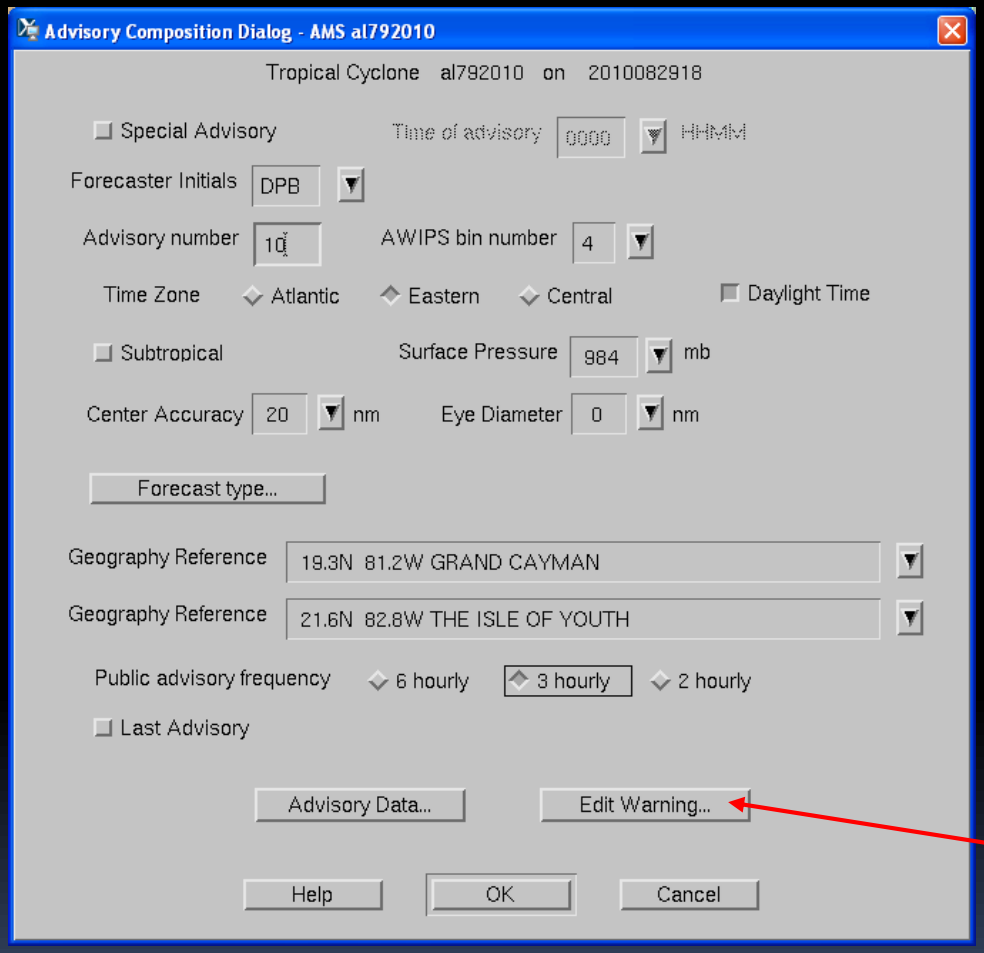
36 h forecast- Florida Keys and Dry Tortugas?

12-24 h forecast- Western Cuba, the Isle of Youth, and Mexico?

Better start calling Mexico, Cuba, and the National Weather Service Office in Key West…

If you run out of time to call NWS Key West, you can coordinate on the hotline call

Now type them up…



Now type them up…

WATCHES AND WARNINGS

CHANGES WITH THIS ADVISORY:

None

SUMMARY OF WATCHES AND WARNINGS IN EFFECT:

A Tropical Storm Warning is in effect for...
* The Cuban provinces of Pinar del Rio and the Isle of Youth
* The coast of Mexico from Tulum to Cabo Catoche, including Cozumel

A Tropical Storm Warning means that tropical storm conditions are expected somewhere within the warning area, in this case within 24 hours.

Interests along the northeastern and central U.S. Gulf coast should monitor the progress of the Tropical Storm.

For storm information specific to your area, please monitor products issued by your national meteorological service.

20:00 UTC

NWS / DOD Coordination Call

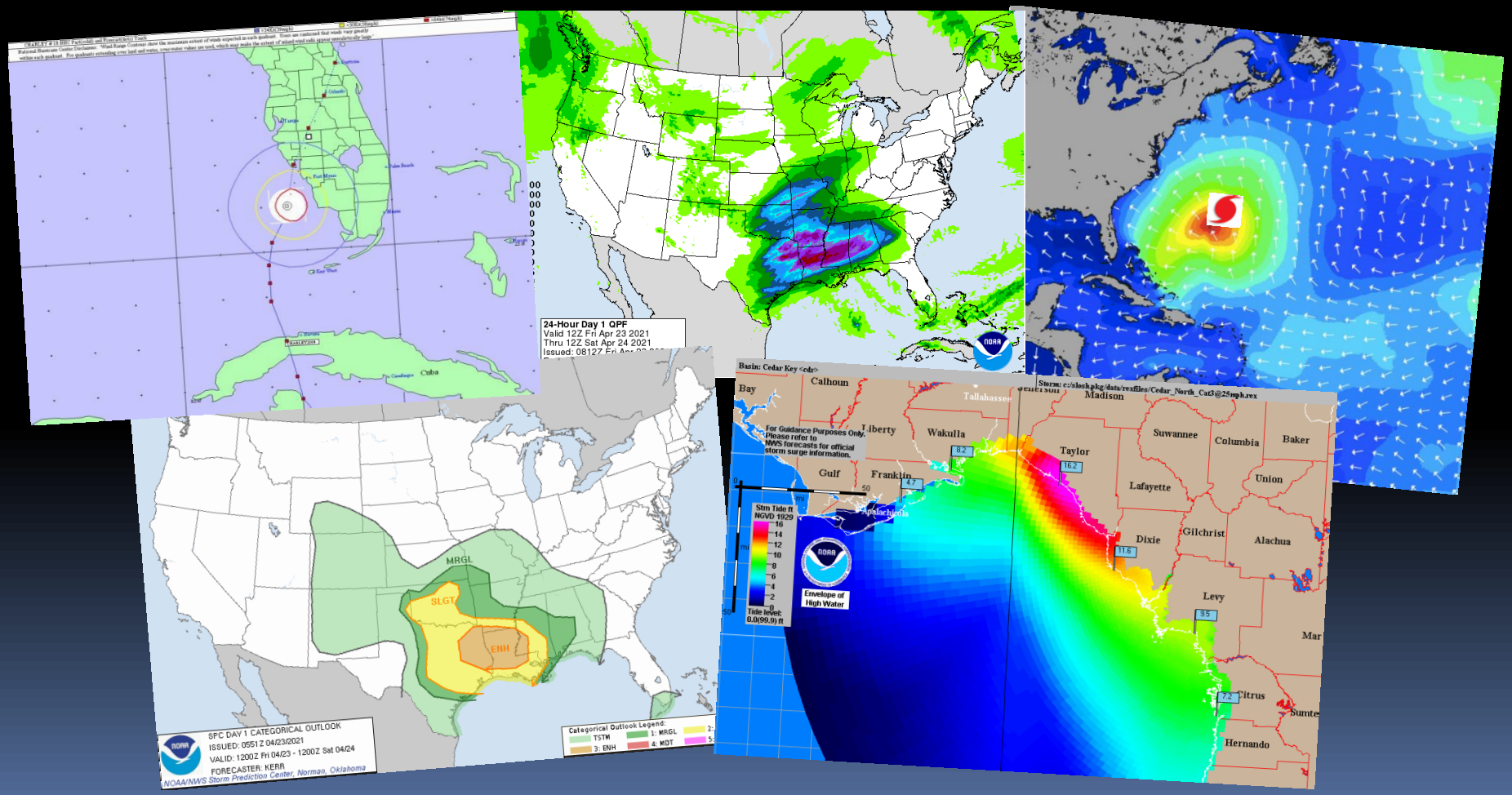
Coordinate and determine watches/ warnings

20:00 UTC

NWS / DOD Coordination Call

Coordinate and determine watches/ warnings

Coordinate storm surge, rainfall, tornado, rip current hazards



20:10 UTC

Advisory Composition

hurry up- you only have about 30-45 minutes to get it out

Forecast/Advisory and Wind Speed Probabilities

```
ZCZC MIATCMAT4 ALL
TTAA00 KNHC DDHHMM

TROPICAL STORM MICHAEL FORECAST/ADVISORY NUMBER   5
NWS NATIONAL HURRICANE CENTER MIAMI FL       AL142018
2100 UTC SUN OCT 07 2018

CHANGES IN WATCHES AND WARNINGS WITH THIS ADVISORY...

NONE.

SUMMARY OF WATCHES AND WARNINGS IN EFFECT...

A TROPICAL STORM WARNING IS IN EFFECT FOR...
* THE CUBAN PROVINCES OF PINAR DEL RIO AND THE ISLE OF YOUTH
* THE COAST OF MEXICO FROM TULUM TO CABO CATOCHE... INCLUDING
COZUMEL

A TROPICAL STORM WARNING MEANS THAT TROPICAL STORM CONDITIONS ARE
EXPECTED SOMEWHERE WITHIN THE WARNING AREA... IN THIS CASE WITHIN
24 HOURS.

INTERESTS ALONG THE NORTHEASTERN AND CENTRAL U.S. GULF COAST SHOULD
MONITOR THE PROGRESS OF MICHAEL.

TROPICAL STORM CENTER LOCATED NEAR 19.2N  85.5W AT 07/2100Z
POSITION ACCURATE WITHIN  20 NM

PRESENT MOVEMENT TOWARD THE NORTH-NORTHEAST OR  20 DEGREES AT   3 KT

ESTIMATED MINIMUM CENTRAL PRESSURE  999 MB
MAX SUSTAINED WINDS  45 KT WITH GUSTS TO  50 KT.
34 KT.......120NE 180SE   0SW   0NW.
12 FT SEAS.. 90NE  90SE   0SW   0NW.
WINDS AND SEAS VARY GREATLY IN EACH QUADRANT.  RADII IN NAUTICAL
MILES ARE THE LARGEST RADII EXPECTED ANYWHERE IN THAT QUADRANT.

REPEAT...CENTER LOCATED NEAR 19.2N  85.5W AT 07/2100Z
AT 07/1800Z CENTER WAS LOCATED NEAR 19.0N  86.0W

FORECAST VALID 08/0600Z 20.1N  85.6W
MAX WIND  50 KT...GUSTS  60 KT.
50 KT... 50NE  50SE   0SW   0NW.
34 KT...120NE 180SE   0SW  40NW.

FORECAST VALID 08/1800Z 21.5N  85.8W
MAX WIND  60 KT...GUSTS  75 KT.
50 KT... 60NE  60SE   0SW  20NW.
34 KT...120NE 150SE  30SW  50NW.

FORECAST VALID 09/0600Z 23.2N  86.2W
MAX WIND  70 KT...GUSTS  85 KT.
64 KT... 25NE  25SE   0SW  20NW.
50 KT... 60NE  60SE  20SW  40NW.
34 KT...140NE 140SE  40SW  80NW.

FORECAST VALID 09/1800Z 25.0N  86.7W
MAX WIND  80 KT...GUSTS 100 KT.
64 KT... 25NE  25SE  15SW  25NW.
50 KT... 60NE  60SE  30SW  40NW.
34 KT...130NE 130SE  60SW 100NW.

FORECAST VALID 10/1800Z 29.2N  85.7W
MAX WIND  85 KT...GUSTS 105 KT.
50 KT... 60NE  60SE  30SW  40NW.
34 KT...130NE 130SE  70SW  80NW.

EXTENDED OUTLOOK. NOTE...ERRORS FOR TRACK HAVE AVERAGED NEAR 150 NM
ON DAY 4 AND 175 NM ON DAY 5...AND FOR INTENSITY NEAR 15 KT EACH DAY

OUTLOOK VALID 11/1800Z 33.7N  80.4W...INLAND
MAX WIND  50 KT...GUSTS  60 KT.

OUTLOOK VALID 12/1800Z 39.0N  68.5W...POST-TROP/EXTRATROP
MAX WIND  55 KT...GUSTS  65 KT.

REQUEST FOR 3 HOURLY SHIP REPORTS WITHIN 300 MILES OF 19.2N  85.5W

NEXT ADVISORY AT 08/0300Z

$$
FORECASTER BROWN
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ZCZC MIAPWSAT4 ALL
TTAA00 KNHC DDHHMM

TROPICAL STORM MICHAEL WIND SPEED PROBABILITIES NUMBER   5
NWS NATIONAL HURRICANE CENTER MIAMI FL       AL142018
2100 UTC SUN OCT 07 2018

AT 2100Z THE CENTER OF TROPICAL STORM MICHAEL WAS LOCATED NEAR
LATITUDE 19.2 NORTH...LONGITUDE 85.5 WEST WITH MAXIMUM SUSTAINED
WINDS NEAR 45 KTS...50 MPH...85 KM/H.

Z INDICATES COORDINATED UNIVERSAL TIME (GREENWICH)
   ATLANTIC STANDARD TIME (AST)...SUBTRACT 4 HOURS FROM Z TIME
   EASTERN  DAYLIGHT TIME (EDT)...SUBTRACT 4 HOURS FROM Z TIME
   CENTRAL  DAYLIGHT TIME (CDT)...SUBTRACT 5 HOURS FROM Z TIME

WIND SPEED PROBABILITY TABLE FOR SPECIFIC LOCATIONS

CHANCES OF SUSTAINED (1-MINUTE AVERAGE) WIND SPEEDS OF AT LEAST
   ...34 KT (39 MPH... 63 KM/H)...
   ...50 KT (58 MPH... 93 KM/H)...
   ...64 KT (74 MPH...119 KM/H)...
FOR LOCATIONS AND TIME PERIODS DURING THE NEXT 5 DAYS

PROBABILITIES FOR LOCATIONS ARE GIVEN AS OP(CP) WHERE
    OP  IS THE PROBABILITY OF THE EVENT BEGINNING DURING
        AN INDIVIDUAL TIME PERIOD (ONSET PROBABILITY)
   (CP) IS THE PROBABILITY OF THE EVENT OCCURRING BETWEEN
        18Z SUN AND THE FORECAST HOUR (CUMULATIVE PROBABILITY)

PROBABILITIES ARE GIVEN IN PERCENT
X INDICATES PROBABILITIES LESS THAN 1 PERCENT
PROBABILITIES FOR 34 KT AND 50 KT ARE SHOWN AT A GIVEN LOCATION WHEN
THE 5-DAY CUMULATIVE PROBABILITY IS AT LEAST 3 PERCENT.
PROBABILITIES FOR 34...50...64 KT SHOWN WHEN THE 5-DAY
64-KT CUMULATIVE PROBABILITY IS AT LEAST 1 PERCENT.


  - - - - WIND SPEED PROBABILITIES FOR SELECTED LOCATIONS - - - -

                FROM    FROM    FROM    FROM    FROM    FROM    FROM
  TIME        18Z SUN 06Z MON 18Z MON 06Z TUE 18Z TUE 18Z WED 18Z THU
PERIODS         TO      TO      TO      TO      TO      TO      TO
              06Z MON 18Z MON 06Z TUE 18Z TUE 18Z WED 18Z THU 18Z FRI

FORECAST HOUR    (12)    (24)    (36)    (48)    (72)    (96)    (120)
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
LOCATION       KT

SABLE ISLAND   34  X   X( X)   X( X)   X( X)   X( X)   X( X)   4( 4)

YARMOUTH NS    34  X   X( X)   X( X)   X( X)   X( X)   X( X)   4( 4)

HYANNIS MA     34  X   X( X)   X( X)   X( X)   X( X)   X( X)   8( 8)

NANTUCKET MA   34  X   X( X)   X( X)   X( X)   X( X)   X( X)  11(11)

MONTAUK POINT  34  X   X( X)   X( X)   X( X)   X( X)   X( X)   7( 7)

ISLIP NY       34  X   X( X)   X( X)   X( X)   X( X)   X( X)   3( 3)

NWS EARLE NJ   34  X   X( X)   X( X)   X( X)   X( X)   X( X)   3( 3)

PHILADELPHIA   34  X   X( X)   X( X)   X( X)   X( X)   1( 1)   2( 3)

ATLANTIC CITY  34  X   X( X)   X( X)   X( X)   X( X)   1( 1)   4( 5)

BALTIMORE MD   34  X   X( X)   X( X)   X( X)   X( X)   1( 1)   3( 4)

DOVER DE       34  X   X( X)   X( X)   X( X)   X( X)   2( 2)   4( 6)

ANNAPOLIS MD   34  X   X( X)   X( X)   X( X)   X( X)   2( 2)   4( 6)

WASHINGTON DC  34  X   X( X)   X( X)   X( X)   X( X)   2( 2)   4( 6)

CAPE HENLOPEN  34  X   X( X)   X( X)   X( X)   X( X)   3( 3)   9(12)

OCEAN CITY MD  34  X   X( X)   X( X)   X( X)   X( X)   4( 4)  13(17)
OCEAN CITY MD  50  X   X( X)   X( X)   X( X)   X( X)   1( 1)   3( 4)
OCEAN CITY MD  64  X   X( X)   X( X)   X( X)   X( X)   1( 1)   X( 1)
```

Let’s create the public advisory

Example of Public Advisory

```
ZCZC MIATCPAT4 ALL
TTAA00 KNHC DDHHMM

BULLETIN
Tropical Storm Michael Advisory Number   5
NWS National Hurricane Center Miami FL       AL142018
400 PM CDT Sun Oct 07 2018

...AIRCRAFT FINDS MICHAEL STRONGER...
...HEAVY RAINS EXPECTED OVER WESTERN CUBA TONIGHT AND MONDAY...
...THREAT TO THE NORTHEASTERN U.S. GULF COAST INCREASING...

SUMMARY OF 400 PM CDT...2100 UTC...INFORMATION
-----------------------------------------------
LOCATION...19.2N 85.5W
ABOUT 130 MI...205 KM SE OF COZUMEL MEXICO
ABOUT 190 MI...305 KM SSW OF THE WESTERN TIP OF CUBA
MAXIMUM SUSTAINED WINDS...50 MPH...85 KM/H
PRESENT MOVEMENT...NNE OR 20 DEGREES AT 3 MPH...6 KM/H
MINIMUM CENTRAL PRESSURE...999 MB...29.50 INCHES

WATCHES AND WARNINGS
--------------------
CHANGES WITH THIS ADVISORY:

None

SUMMARY OF WATCHES AND WARNINGS IN EFFECT:

A Tropical Storm Warning is in effect for...
* The Cuban provinces of Pinar del Rio and the Isle of Youth
* The coast of Mexico from Tulum to Cabo Catoche, including Cozumel

A Tropical Storm Warning means that tropical storm conditions are
expected somewhere within the warning area, in this case within 24
hours.

Interests along the northeastern and central U.S. Gulf coast should
monitor the progress of Michael.

For storm information specific to your area, please monitor
products issued by your national meteorological service.
```

Section headers added

Storm information first

Changes to watches and warnings in the current advisory are highlighted

Bulleted summary of all watches and warnings in effect

Example of Public Advisory Format

```
DISCUSSION AND OUTLOOK
----------------------
At 400 PM CDT (2100 UTC), the center of Tropical Storm Michael was
located near latitude 19.2 North, longitude 85.5 West.  Michael is
moving toward the north-northeast near 3 mph (6 km/h).  A northward
motion with some increase in forward speed is expected over the next
few days.  On the forecast track, the center of Michael will move
over the Yucatan Channel on Monday, and then across the eastern Gulf
of Mexico late Monday through Tuesday night, and approach
the northeastern Gulf coast on Wednesday.

Data from an Air Force Reserve reconnaissance aircraft indicate that
maximum sustained winds have increased to near 50 mph (85 km/h) with
higher gusts.  Additional strengthening is expected during the next
few days, and Michael is forecast to become a hurricane Monday night
or Tuesday.

Tropical-storm-force winds extend outward up to 205 miles (335 km)
primarily to the east of the center.

The latest minimum central pressure reported by reconnaissance
aircraft is 999 mb (29.50 inches).
```

Discussion of forecast motion and intensity and other pertinent information

```
HAZARDS AFFECTING LAND
----------------------
WIND:  Tropical storm conditions are expected to first reach the
coast within the warning area by this evening or tonight, making
outside preparations difficult or dangerous.

RAINFALL:  Michael is expected to produce total rain accumulations
of 3 to 7 inches over western Cuba and 2 to 4 inches over the
Yucatan Peninsula and Belize through Tuesday.  Isolated maximum
amounts of 12 inches are possible in western Cuba.  This rainfall
could lead to life-threatening flash floods and mudslides in areas
of mountainous terrain.

Elsewhere, outer rain bands from Michael are expected to produce
total rain accumulations of 2 to 4 inches across the Florida Keys
through Tuesday.
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Storm hazards and impacts, shown by type

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NEXT ADVISORY
-------------
Next intermediate advisory at 700 PM CDT.
Next complete advisory at 1000 PM CDT.

$$
Forecaster Brown
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Timing of next advisory

Create Your Discussion

ZCZC MIATCDAT4 ALL
TTAA00 KNHC DDHHMM

Tropical Storm Michael Discussion Number 5
NWS National Hurricane Center Miami FL AL142018
400 PM CDT Sun Oct 07 2018

Deep convection has continued to develop over the eastern semicircle of the cyclone, and data from the reconnaissance aircraft indicate that the center has re-formed farther east, closer to the convection. The Air Force aircraft has measured peak 925-mb flight-level winds of 56 kt, and believable SFMR winds of 40-45 kt. Based on these data, the initial wind speed has been increased to 45 kt.

Due to the center reformation, the initial motion estimate is a highly uncertain 020/3 kt. The overall forecast reasoning has not changed much since the previous advisory. Although there could be some additional eastward re-formation of the center, the tropical storm is forecast to begin moving northward between a ridge over the western Atlantic and a deep-layer trough over the west-central United States. A general northward motion at around 10 kt is then expected to continue during the next 2 to 3 days. After that time, Michael should turn northeastward ahead of an approaching trough. The track guidance remains in overall agreement on this scenario, however, significant along-track (forward speed and timing) differences remain. The HWRF brings Michael onshore the northern Gulf coast within 72 hours, while the ECMWF is much slower and has Michael still offshore at day 4. The new NHC track has been shifted eastward primarily in the short term due to the more eastward initial position. The latter portion of the track forecast is again close to the consensus aids due to the large along- and cross-track guidance spread.

Michael has strengthened today despite moderate westerly shear. The shear is forecast to gradually decrease over the next couple of days while the system moves over warm waters. This should allow for steady strengthening and most of the intensity models bring Michael to hurricane strength within the next couple of days. It should also be noted that the global models also significantly deepen the storm over the next 72 hours to pressures below 970 mb. The new NHC intensity forecast calls for Michael to become a hurricane in about 36 hours when the storm reaches the southeastern Gulf of Mexico. Additional strengthening is indicated through 72 hours when the storm is forecast to be near the northern Gulf coast, and the NHC forecast is near the higher SHIPS and HWRF models.

Key Messages:

1. Michael is expected to produce heavy rainfall and flash flooding over portions of western Cuba and the northeastern Yucatan Peninsula of Mexico during the next couple of days.

2. Tropical storm conditions are expected tonight over portions of western Cuba and the northeastern Yucatan Peninsula, where tropical storm warnings are in effect.

3. Michael is forecast to be a hurricane when it reaches the northeastern Gulf Coast by mid-week, and the risk of dangerous storm surge, rainfall, and wind impacts continues to increase. In addition, Michael is expected to affect portions of the Florida Gulf Coast that are especially vulnerable to storm surge, regardless of the storm's exact track or intensity. Residents in these areas should monitor the progress of this system and follow any advice given by local officials.

FORECAST POSITIONS AND MAX WINDS

INIT	07/2100Z	19.2N	85.5W	45 KT	50 MPH
12H	08/0600Z	20.1N	85.6W	50 KT	60 MPH
24H	08/1800Z	21.5N	85.8W	60 KT	70 MPH
36H	09/0600Z	23.2N	86.2W	70 KT	80 MPH
48H	09/1800Z	25.0N	86.7W	80 KT	90 MPH
72H	10/1800Z	29.2N	85.7W	85 KT	100 MPH
96H	11/1800Z	33.7N	80.4W	50 KT	60 MPH...INLAND
120H	12/1800Z	39.0N	68.5W	55 KT	65 MPH...POST-TROP/EXTRATROP

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Forecaster Brown

Objective of the Discussion

Explain the reasoning and confidence behind the analysis and the forecast

- include the prognostic reasoning
- indicate objective techniques used
- describe other meteorological decisions
- plans for watches and warnings

Key Messages

- Cover the most critical information in concise bullets
- Used to message hazards on social media

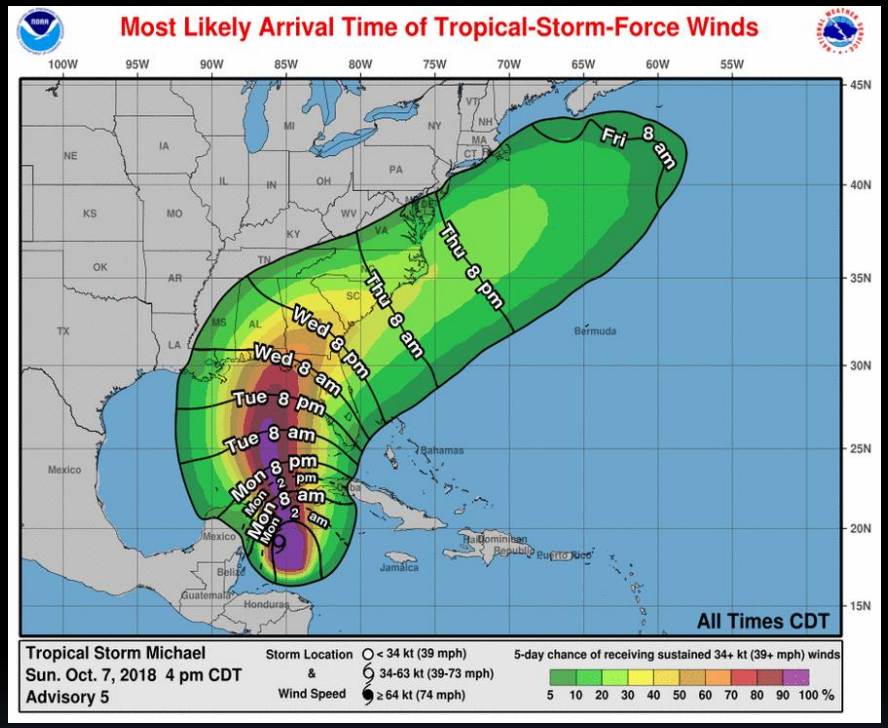
The discussion has a wide spectrum of users

- professional meteorologists
- meteorology students and professors
- the media
- emergency managers
- general public

21:00 UTC

Advisory deadline

Quick Issue the Graphics- the media is calling



21:15 UTC

FEMA and State Conference Calls and Media Interviews

Hurricane Liaison Team

FEMA

Media Interviews

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You have successfully issued your first NHC Hurricane Forecast!

How accurate was it?