Harvey - $125 Billion

KCRP - CORPUS CHRISTI
08/25/2017 02:00:24 GMT
LAT: 27/47/02 N
LON: 97/30/38 W
ELEV: 45 FT
VCP: 21

REFLECTIVITY
ELEV ANGLE: 0.51
SWEEP TIME: 02:00:30 GMT

Legend: dBZ
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
-10
-15
-20
-25

RF

Irma - $50 Billion

NEXRAD LEVEL II
KBYX - KEY WEST, FL
09/09/2017 09:05:28 G
LAT: 24/35/48 N
LON: 81/42/11 W
ELEV: 08 FT
VCP: 212

REFLECTIVITY
ELEV ANGLE: 0.47
SWEEP TIME: 09:05:31

Legend: dBZ
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
-10
-15
-20
-25

RF

Maria - $90 Billion

NEXRAD LEVEL II
TJUA - SAN JUAN, PR
09/19/2017 11:02:21 GMT
LAT: 18/07/02 N
LON: 66/04/42 W
ELEV: 2794 FT
VCP: 21

REFLECTIVITY
ELEV ANGLE: 0.52
SWEEP TIME: 11:02:27 GMT

Legend: dBZ
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
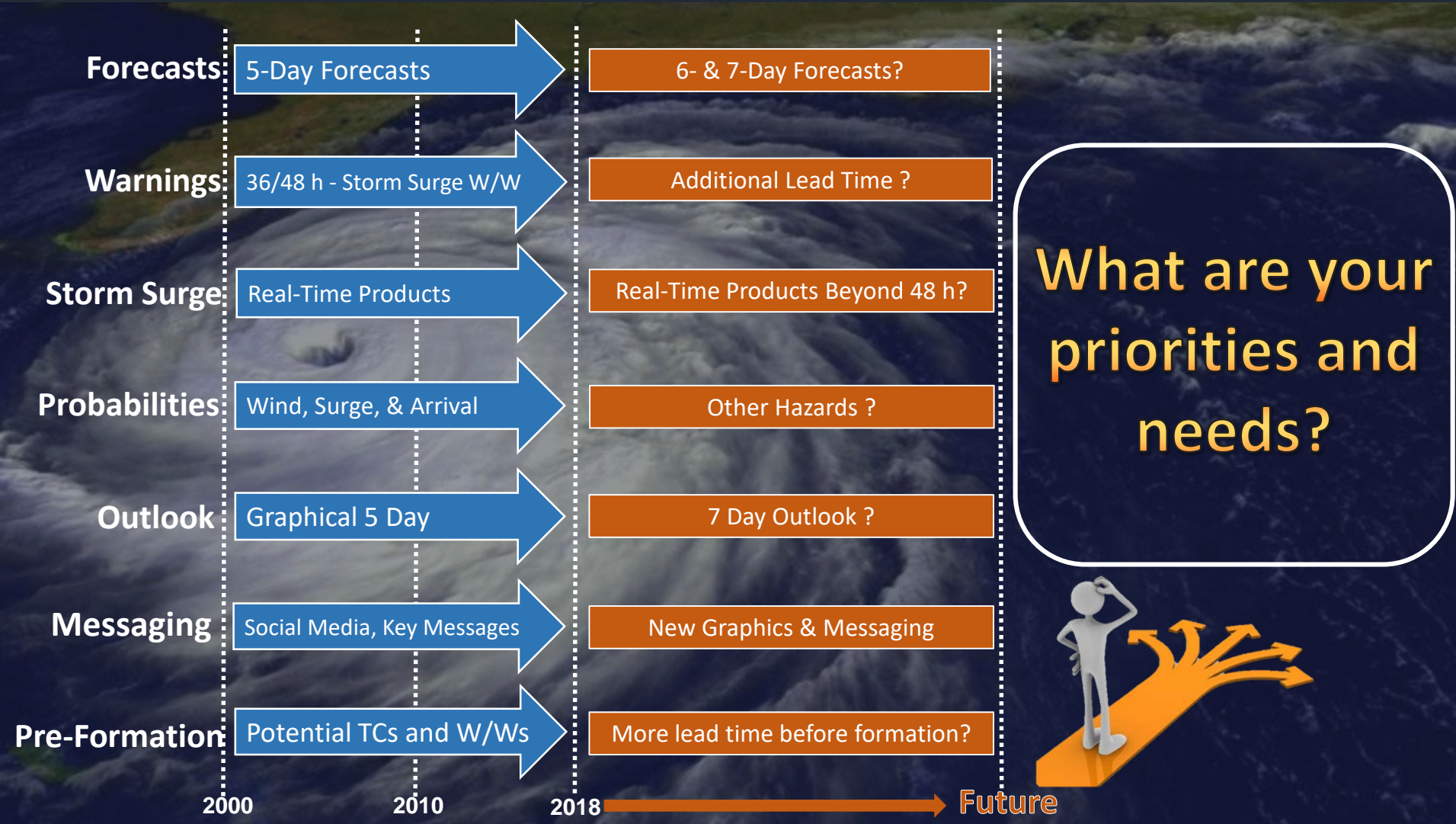
RF

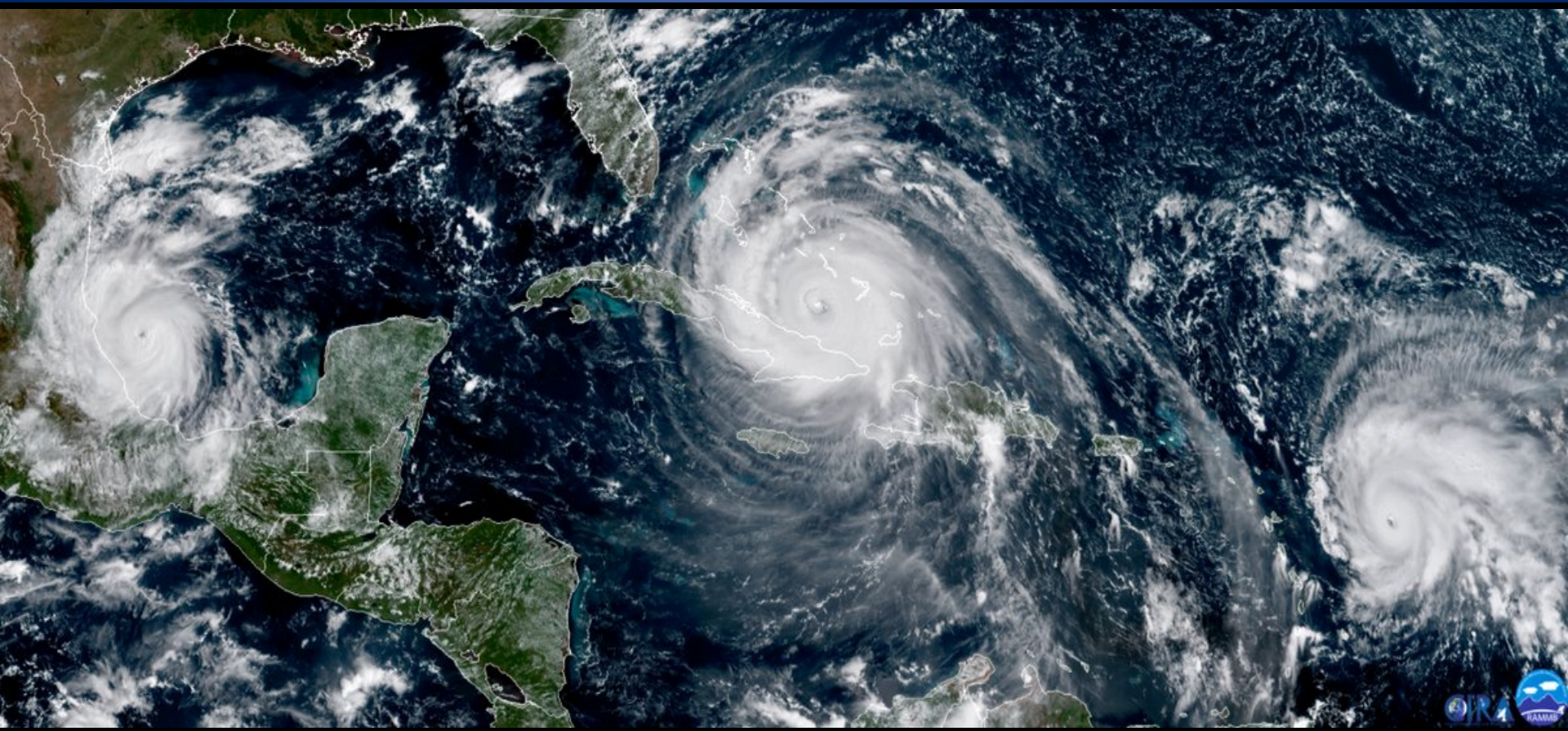## United States Facts & Figures

- Three Category 4 hurricane landfalls- unprecedented.

- Costliest year on record for the U.S., more than $250 billion in damage

- Maria was the strongest hurricane to make landfall in Puerto Rico since 1928

- Harvey: heaviest storm-total rainfall (60.58") on record, deadliest Texas hurricane since 1919

Recent NHC product evolution

	2000–2018	Future
Forecasts	5-Day Forecasts	6- & 7-Day Forecasts?
Warnings	36/48 h - Storm Surge W/W	Additional Lead Time ?
Storm Surge	Real-Time Products	Real-Time Products Beyond 48 h?
Probabilities	Wind, Surge, & Arrival	Other Hazards ?
Outlook	Graphical 5 Day	7 Day Outlook ?
Messaging	Social Media, Key Messages	New Graphics & Messaging
Pre-Formation	Potential TCs and W/Ws	More lead time before formation?

2000   2010   2018 → Future

What are your priorities and needs?

Successes and challenges during the 2017 hurricane season & new products for 2018/19

Eric Blake, Hurricane Specialist
Interdepartmental Hurricane Conference 2018
**Thanks to Lixion Avila, Robbie Berg & Dan Brown**

2017 Hurricane Season
Facts and Figures

- **17 named storms, including 10 hurricanes, and 6 major hurricanes**
  - **Most number of MHs since 2005**

- **Five category 5 hurricane landfalls across the Caribbean basin from Irma and Maria**

- **Several hundred fatalities across the basin from direct or indirect causes**
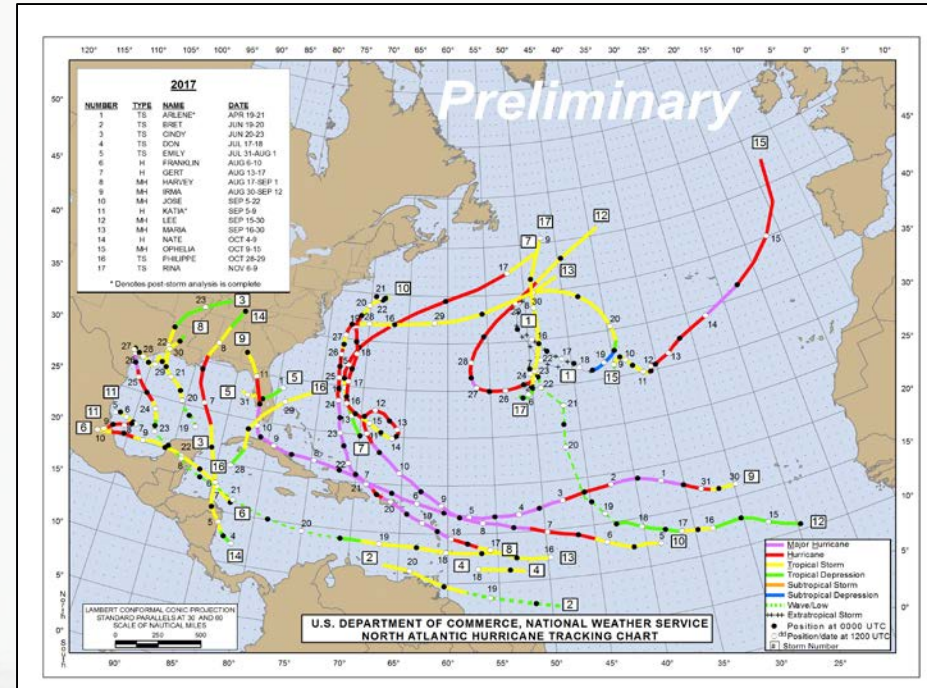
Much of the U.S. Gulf and Atlantic Coastline Under Watches or Warnings in 2017
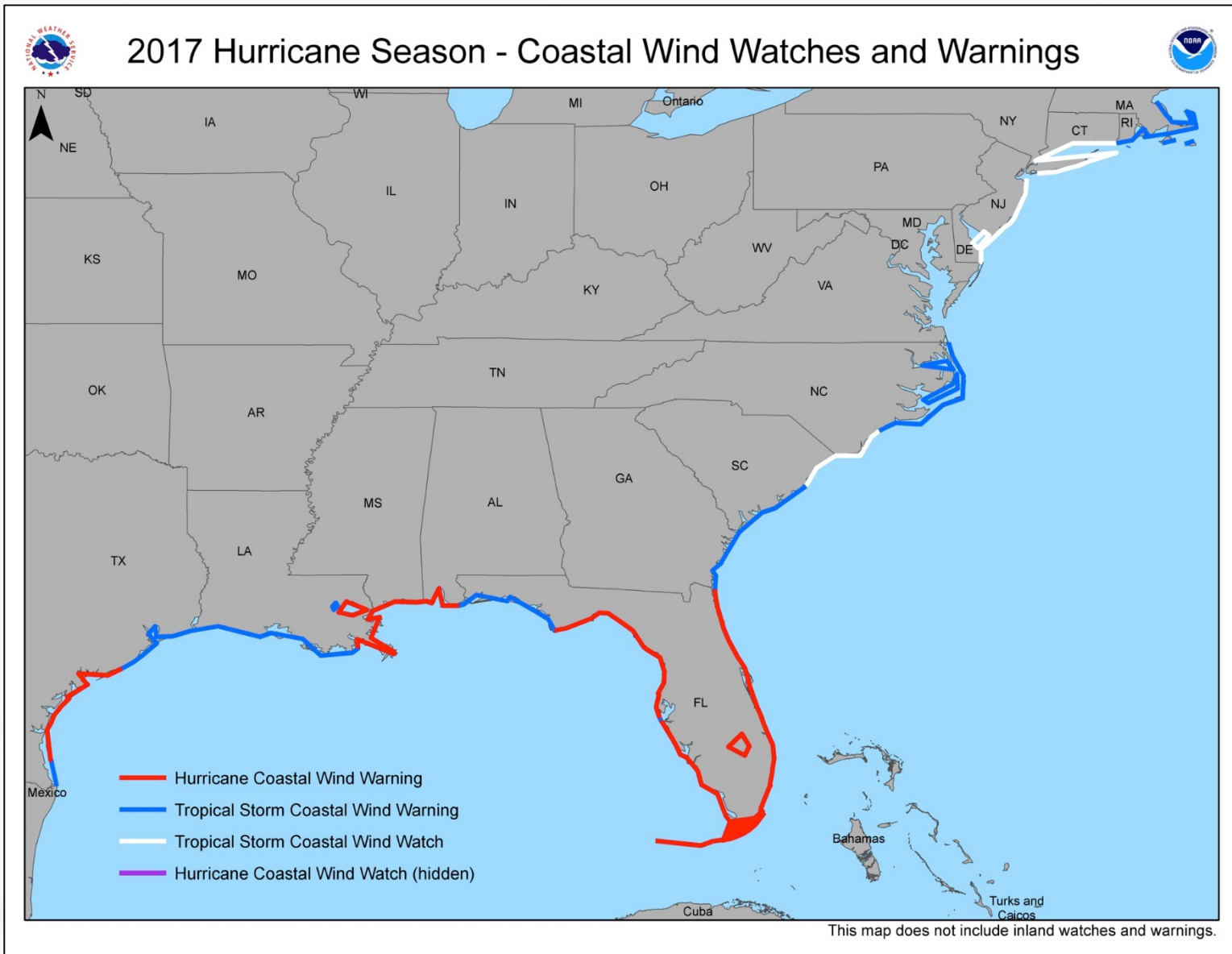
2017 Season in Review: Hurricane Program Successes

- Launch of the capability to issue watches & warnings before tropical cyclone formation
  - Potential Tropical Cyclone Advisories

- First use for the United States was before the formation of TS Cindy in the Gulf of Mexico in June
  - Resulted in nearly a day of additional lead time that was deemed a "huge success" by EMs & staff of WFO New Orleans

- Time of Arrival Graphics deployed experimentally
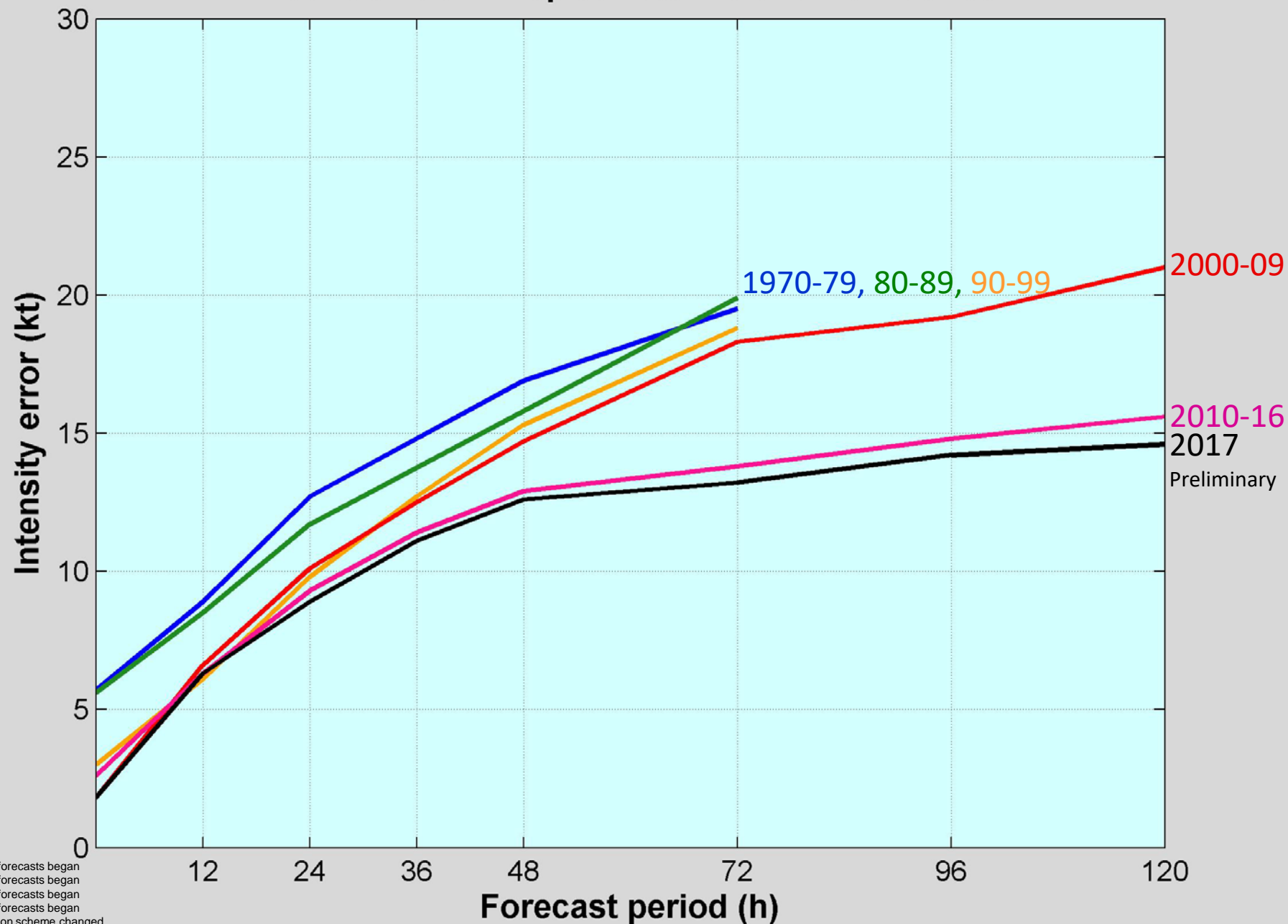 - Earliest reasonable arrival
  - Most likely arrival time
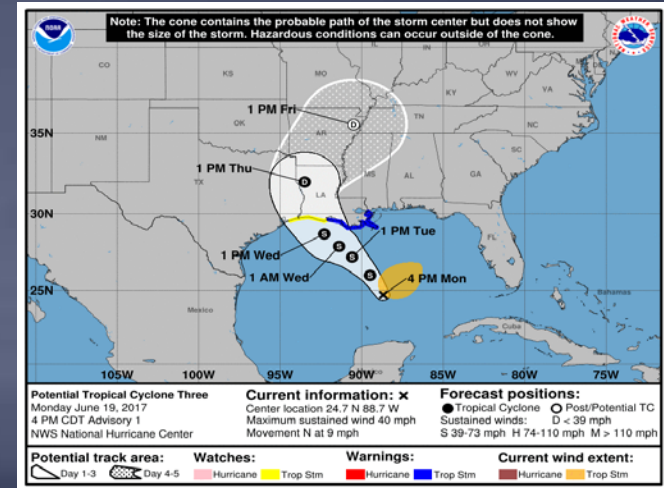
NHC Official Average Track Errors
Atlantic Basin Tropical Storms and Hurricanes
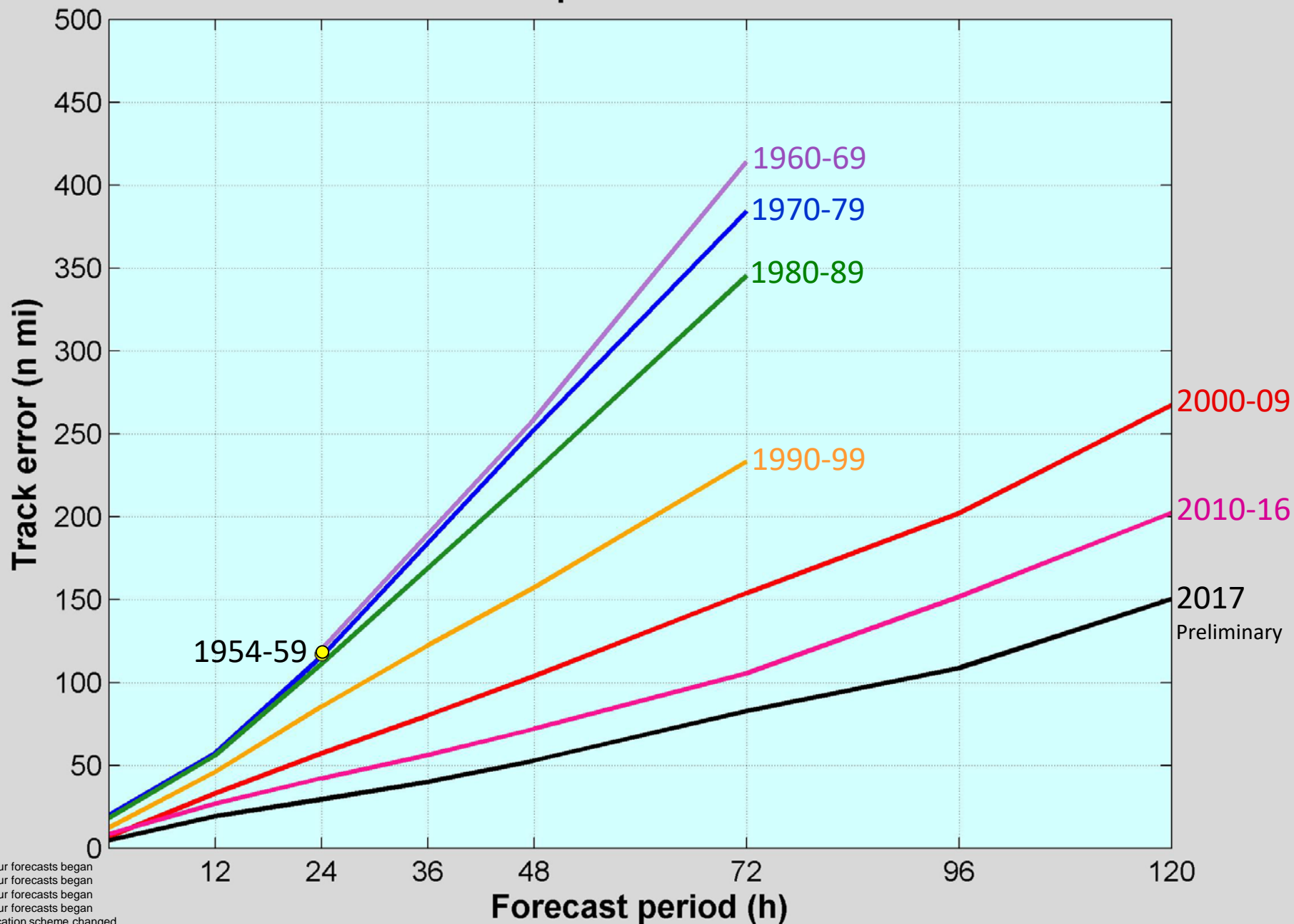
1954: 24 hour forecasts began
1961: 48 hour forecasts began
1964: 72 hour forecasts began
1967: 12 hour forecasts began
1970: Verification scheme changed
1988: 36 hour forecasts began
2001: 96 and 120 hour forecasts began (became public in 2003)

Source: NHC ENR/JPC 1/2018

NHC Official Average Intensity Errors
Atlantic Basin Tropical Storms and Hurricanes

1970-79, 80-89, 90-99

2000-09

2010-16

2017

Preliminary

Intensity error (kt)

Forecast period (h)

1954: 24 hour forecasts began
1961: 48 hour forecasts began
1964: 72 hour forecasts began
1967: 12 hour forecasts began
1970: Verification scheme changed
1988: 36 hour forecasts began
2001: 96 and 120 hour forecasts began (became public in 2003)

Source: NHC ENR/JPC 1/2018
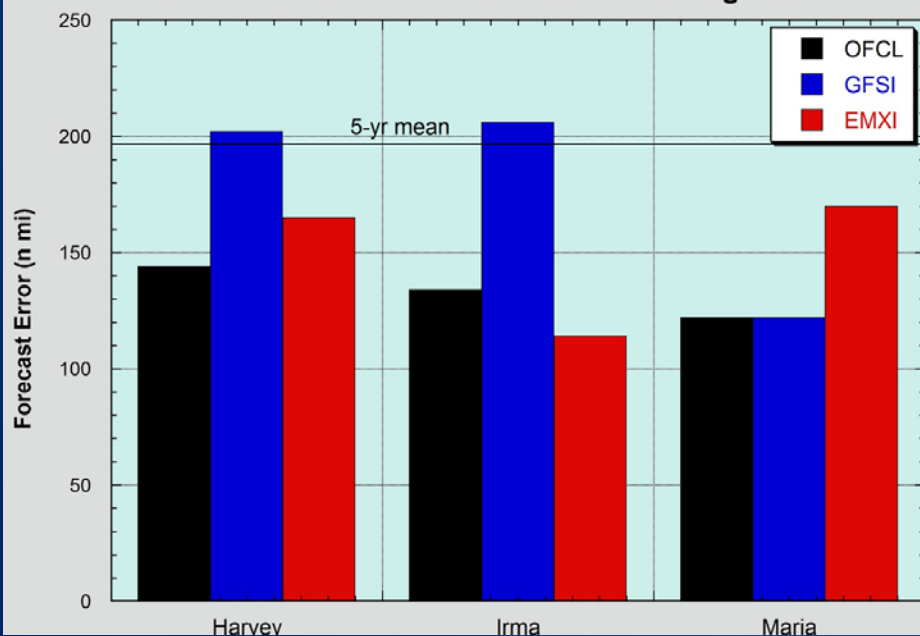
Harvey, Irma, Maria verification

24-h Track Errors for 2017 U.S. Landfalling Major Hurricanes
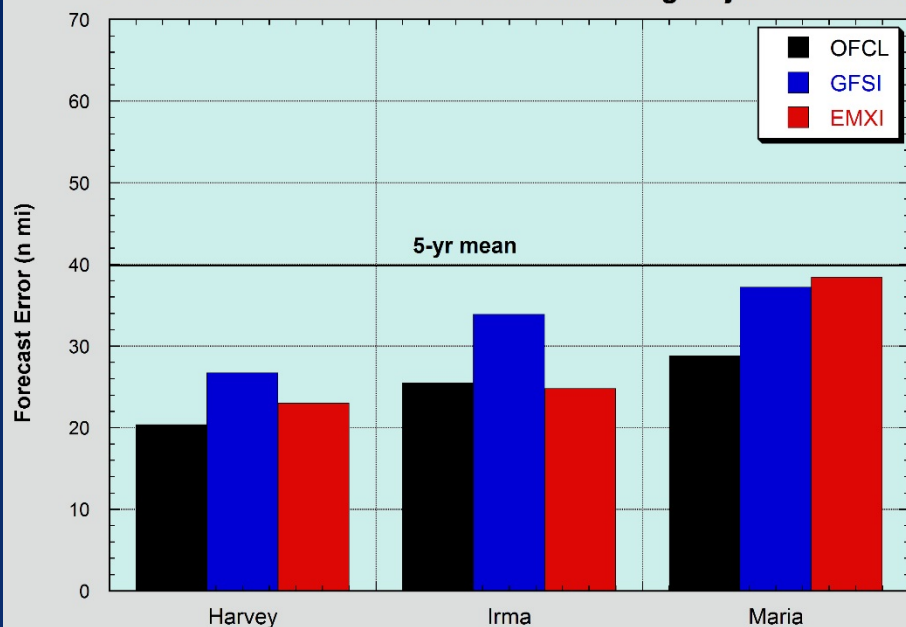
72-h Track Errors for 2017 U.S. Landfalling Major Hurricanes
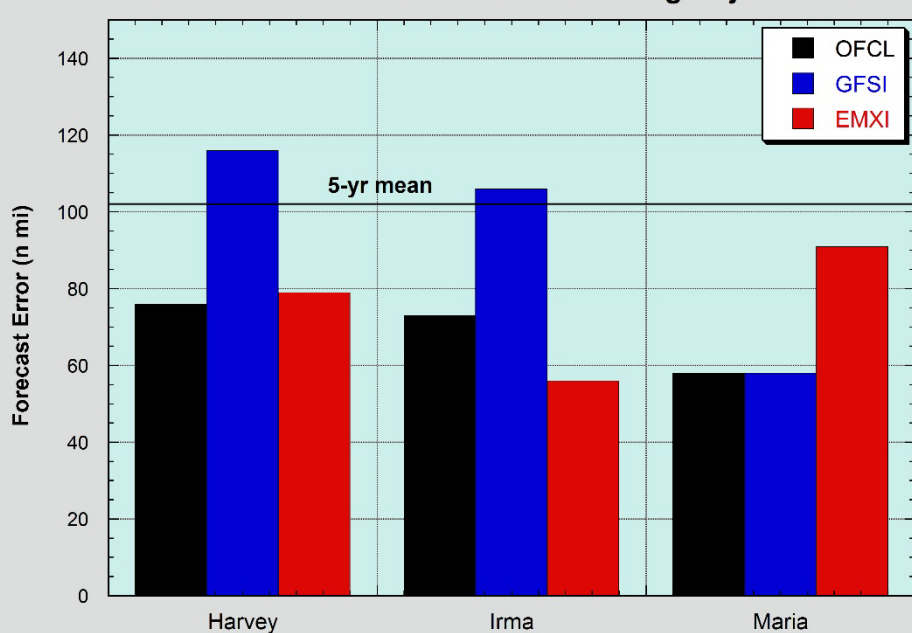
120-h Track Errors for 2017 U.S. Landfalling Hurricanes

- NHC track forecasts (in black) performed quite well.

- About 33% better than the past 5-year average error at all ranges

Rapid Intensification

CHALLENGE

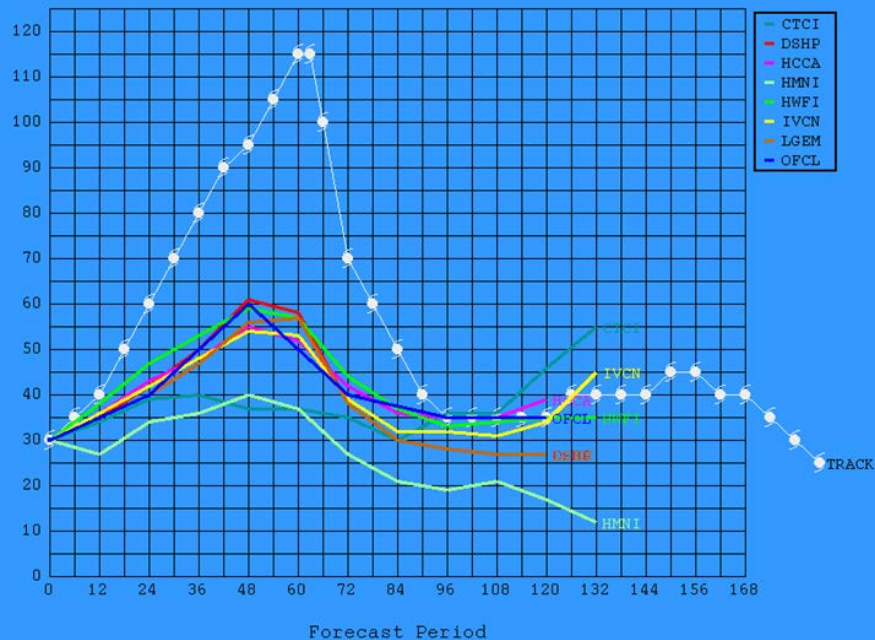**39 cases of RI observed (more frequent than normal)**

NHC correctly forecast 6 of them

SUCCESS

For the first time ever, NHC forecast a storm to go from tropical storm to major hurricane in the last 36 hours before landfall (Harvey)

Obj. Aid Time Intensity for 09L for 082312

Unexpected Regeneration

ZCZC MIATCDAT4 ALL
TTAA00 KNHC DDHHMM

Remnants Of Lee Discussion Number 17
NWS National Hurricane Center Miami FL   AL142017
1100 PM AST Mon Sep 18 2017

Lee has degenerated into a tight swirl of low clouds with intermittent burst of convection, and no longer classifies as a tropical cyclone. As forecast by global models, strong upper-level westerly winds have become established over the disturbance, and this pattern should not allow regeneration. Some additional bursts of convection could still develop while the disturbance moves northwestward until dissipation in a day or so.

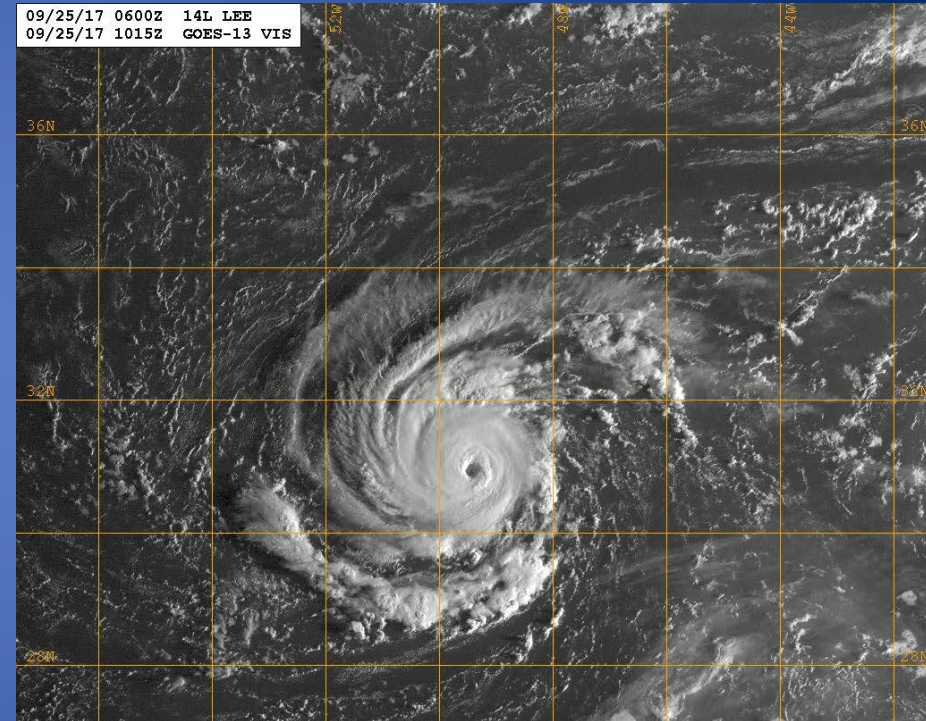This is the last advisory on Lee issued by the National Hurricane Center.

FORECAST POSITIONS AND MAX WINDS

INIT 19/0300Z 15.1N 43.0W   25 KT 30 MPH...POST-TROP/REMNT LOW
 12H 19/1200Z 16.0N 44.0W   25 KT 30 MPH...POST-TROP/REMNT LOW
 24H 20/0000Z...DISSIPATED

$$
Forecaster Avila

5 days later…

Lee track models

5-day actual

a. At regeneration

5-day actual

b. 12 hours later

Huge bust, good case of track strongly dependent on intensity

2017 Season in Review:
Storm Surge Unit Successes

- Operationally launched the first-ever storm surge watch/warning in the U.S.

- No known deaths arising from storm surge despite four (4) U.S. landfalling cyclones including 3 major hurricanes;
  - Harvey: Estimated peak inundation 10 ft
  - Irma: Estimated peak inundation 10 ft
  - Maria: Estimated peak inundation 9 ft
  - Nate: Estimated peak inundation 9 ft
  - Sandy: Peak inundation was 9 ft and resulted in 41 deaths from storm surge

- Significant improvement in hurricane evacuation execution arises from new surge products

- "Storm surge" terminology and products involved in national conversation

Fear of deadly storm surge grows along Florida's coast

2018 Product Changes

- ## Overall Messaging

  - **NHC Public Advisories will now discuss forecast information beyond 48 hours**

  - **Format of WPC Public Advisories will mirror NHC Public Advisories**

  - **WPC will issue Storm Summary products as needed providing observed rainfall and wind information during U.S. landfalling tropical cyclones**

- ## Wind Products

  - **NHC will begin issuing 48-h hurricane-force wind radii forecasts (previously out to 36 h)**

  - **Time of Arrival graphics become operational**


```
STORM SUMMARY NUMBER 1 FOR HURRICANE HARVEY RAINFALL AND WIND
NWS WEATHER PREDICTION CENTER COLLEGE PARK MD
500 AM EDT SAT AUG 26 2017

...HURRICANE HARVEY OBSERVED RAIN TOTALS AND WIND REPORTS...

FOR A DETAILED GRAPHICAL DEPICTION OF THE LATEST
WATCHES...WARNINGS AND ADVISORIES...PLEASE SEE WWW.WEATHER.GOV

AT 400 AM EDT...THESE ARE THE MOST RECENT RAINFALL AND WIND
REPORTS FROM HURRICANE HARVEY.  PLEASE REFER TO THE NATIONAL
HURRICANE CENTER FOR THE LATEST PUBLIC ADVISORIES ON HURRICANE
HARVEY.

...SELECTED STORM TOTAL RAINFALL IN INCHES FROM 800 PM EDT THU AUG
24 THROUGH 400 AM EDT SAT AUG 26...

...TEXAS...
ARANSAS                          10.54
AUSTWELL 6 SSE                     9.61
VICTORIA 2 SW                      9.37
EDNA                              8.24
BRAZORIA NWR                       7.86
SAN ANTONIO RIVER NEAR MCFAD       7.37
BRAZORIA COUNTY AIRPORT            7.12
PALACIOS MUNICIPAL AIRPORT         6.38
HOUSTON SOUTHWEST AIRPORT          5.39
GARCITAS CREEK NEAR INEZ           5.27
TIVOLI 3 NNE                       4.86
GALVESTON                         3.02
CORPUS CHRISTI 5W                  2.89

...SELECTED PEAK WIND GUSTS IN MILES PER HOUR EARLIER IN THE
EVENT...

...TEXAS...
PORT ARANSAS 2 ENE                132
COPANO VILLAGE 1 ENE              125
LAMAR 2 SSW                       110
```
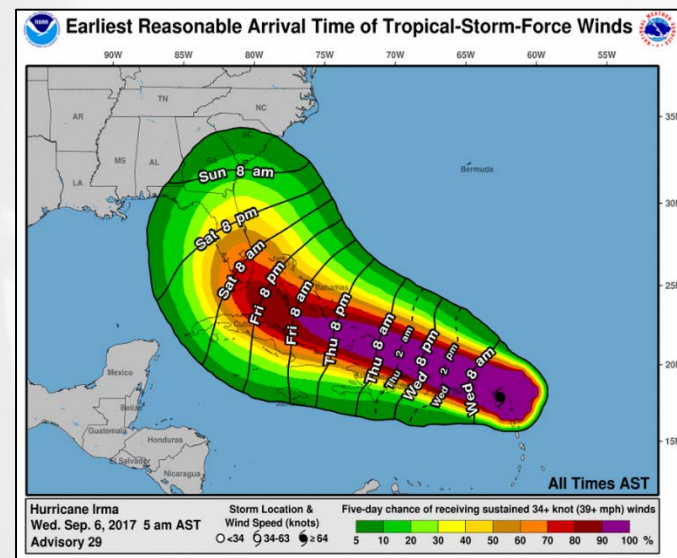

Earliest Reasonable Arrival Time of Tropical-Storm-Force Winds

Hurricane Irma
Wed. Sep. 6, 2017 5 am AST
Advisory 29

Recon Vortex Message 2018 Change

OLD

```
URNT12 KNHC 241133
VORTEX DATA MESSAGE     AL162016
A. 24/11:12:50Z
B. 10 deg 58 min N
   082 deg 46 min W
C. 700 mb 2927 m
D. 90 kt
E. 144 deg 5 nm
F. 253 deg 78 kt
G. 158 deg 8 nm
H. 977 mb
I. 10 C / 3042 m
J. 18 C / 3045 m
K. NA / NA
L. CLOSED
M. C20
N. 12345 / 7
O. 0.02 / 1 nm
P. AF301 0616A OTTO               OB 13
MAX OUTBOUND AND MAX FL WIND 108 KT 349 / 14
NM 11:17:00Z
CNTR DROPSONDE SFC WIND 210 / 11 KT
```

NEW

```
URNT12 KNHC 241133
VORTEX DATA MESSAGE     AL162016
A. 24/11:12:50Z
B. 10.97 deg N 082.77 deg W
C. 700 mb 2927 m
D. 977 mb
E. 210 deg 11 kt
F. CLOSED
G. C20
H. 90 kt
I. 144 deg 5 nm 11:07:00Z
J. 253 deg 78 kt
K. 158 deg 8 nm 11:07:30Z
L. 95 kt
M. 314 deg 5 nm 11:17:00Z
N. 033 deg 108 kt
O. 349 deg 14 nm 11:17:30Z
P. 10 C / 3042 m
Q. 18 C / 3045 m
R. NA / NA
S. 12345 / 7
T. 0.02 / 1 nm
U. AF301 0616A OTTO OB 13
MAX FL WIND 108 KT 349 / 14 NM 11:17:00Z
```

- New formal entry for outbound wind maxima (Items L-O)
- Latitude and longitude now given in decimal degrees (Item B)
- New data block for TC center attributes.
- Includes observation times for max wind data.

Questions/Comments?

WPC deployment during Irma 9/10