Precipitation Forecasts from the Weather Prediction Center

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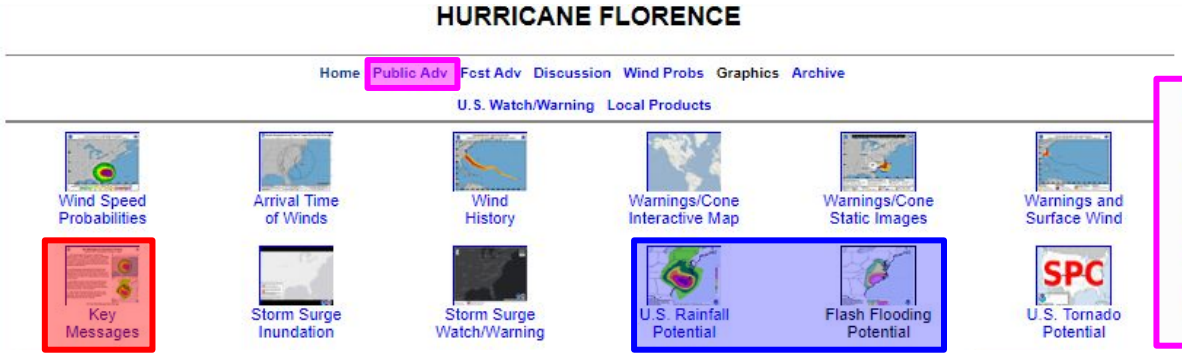
WPC Tropical Forecast and Verification

November 15, 2021 | HFIP Annual Meeting

Role in the NWS Tropical Cyclone Program

- Collaborative track forecast – medium range
- Rainfall Statements composed by WPC
- WPC assumes responsibility for inland depressions that no longer require coastal watches and warnings
- Service Backup for NHC if needed
- International Desk IDSS for USAID

Where WPC Fits in Tropical Information

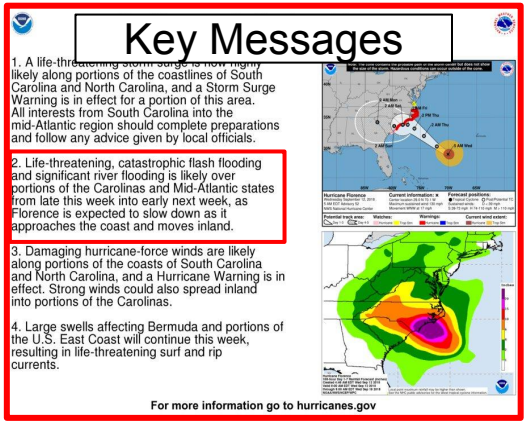


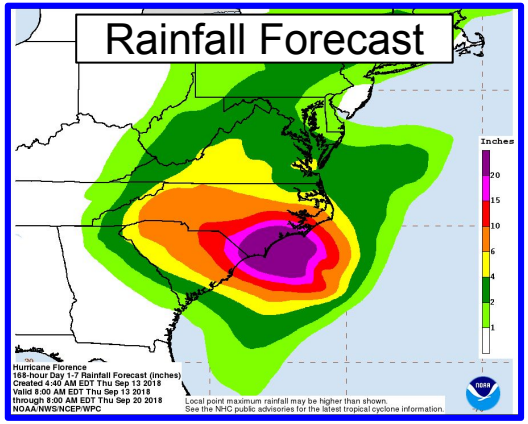
Public Advisory

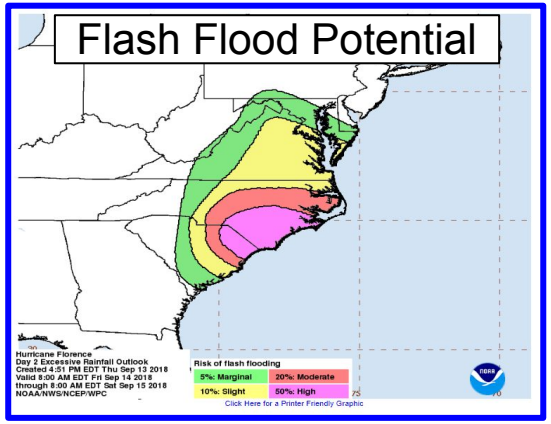
RAINFALL: Florence is expected to produce heavy and excessive rainfall in the following areas...

Coastal North Carolina...20 to 30 inches, isolated 40 inches
South Carolina, western and northern North Carolina...5 to 10 inches, isolated 20 inches
Elsewhere in the Appalachians and Mid-Atlantic states...3 to 6 inches, isolated 12 inches

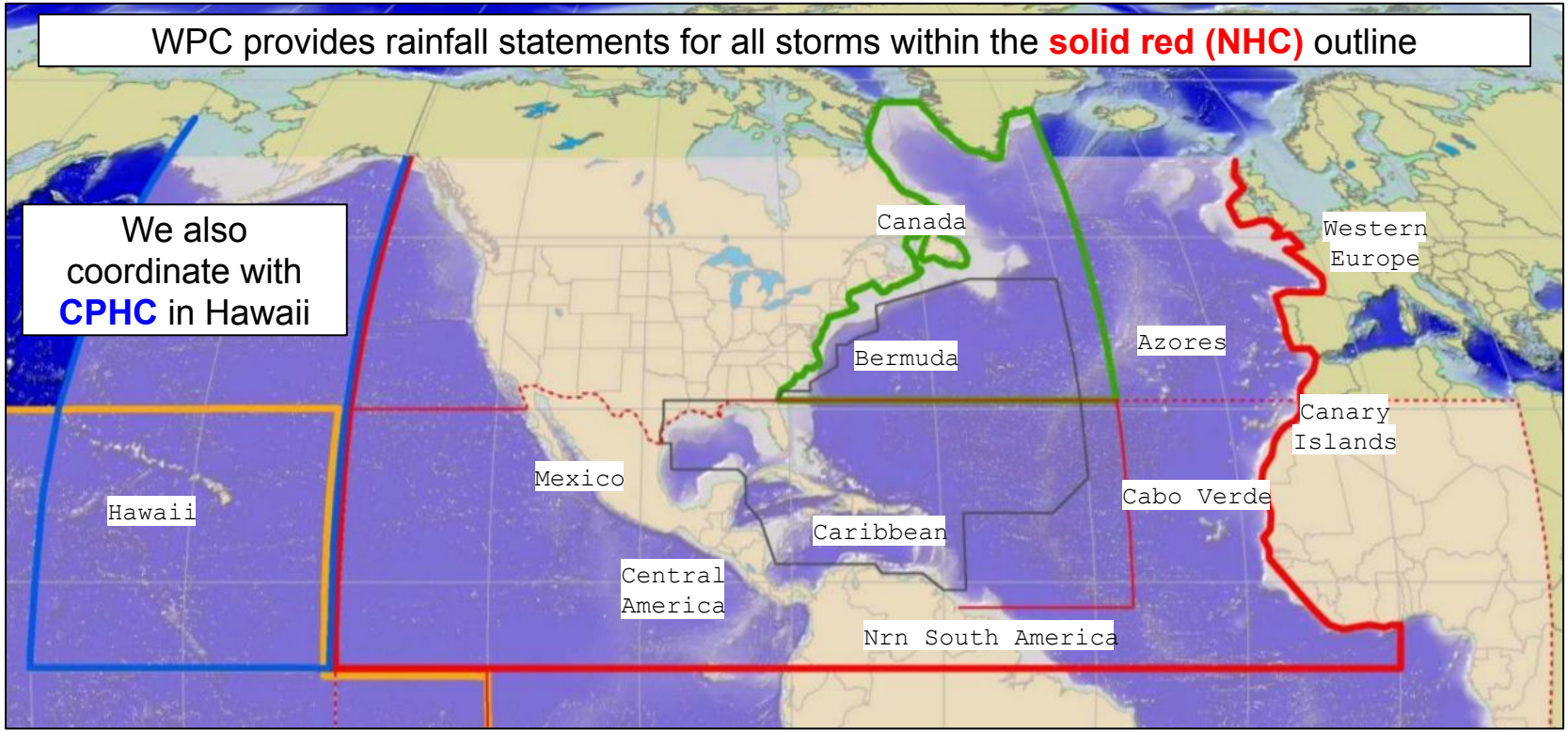
This rainfall would produce catastrophic flash flooding and significant river flooding.







International TCP Responsibilities



Coordination Timeline

Four Major Advisories; QPF Collaboration Related to 12/00Z NWP Model Cycles

Day Shift

15Z: Advisory issued by NHC. New NWP guidance begins arriving, so QPF work starts just after.

1730Z: Preliminary QPF sent by WPC

1745-1830Z: Primary collaboration window. Calls occur in this time, and also work on rainfall statement and key message.

1930Z: Statements sent to NHC via email

20Z: Hurricane hotline call, Final QPF/ERO sent by WPC by 2030Z, advisory and graphics issued 21Z

Night Shift

03Z: Advisory issued by NHC. New NWP guidance begins arriving, so QPF work starts just after.

0530Z: Preliminary QPF sent by WPC

0545-0630Z: Primary collaboration window. Calls occur in this time, and also work on rainfall statement and key message.

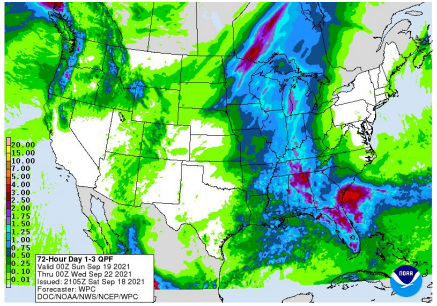
0730Z: Statements sent to NHC via email

08Z: Hurricane hotline call, Final QPF/ERO sent by WPC by 0830Z, advisory and graphics issued 21Z

QPF/ERO at WPC Overview

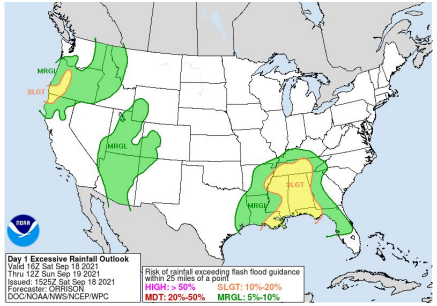
QPF Desk

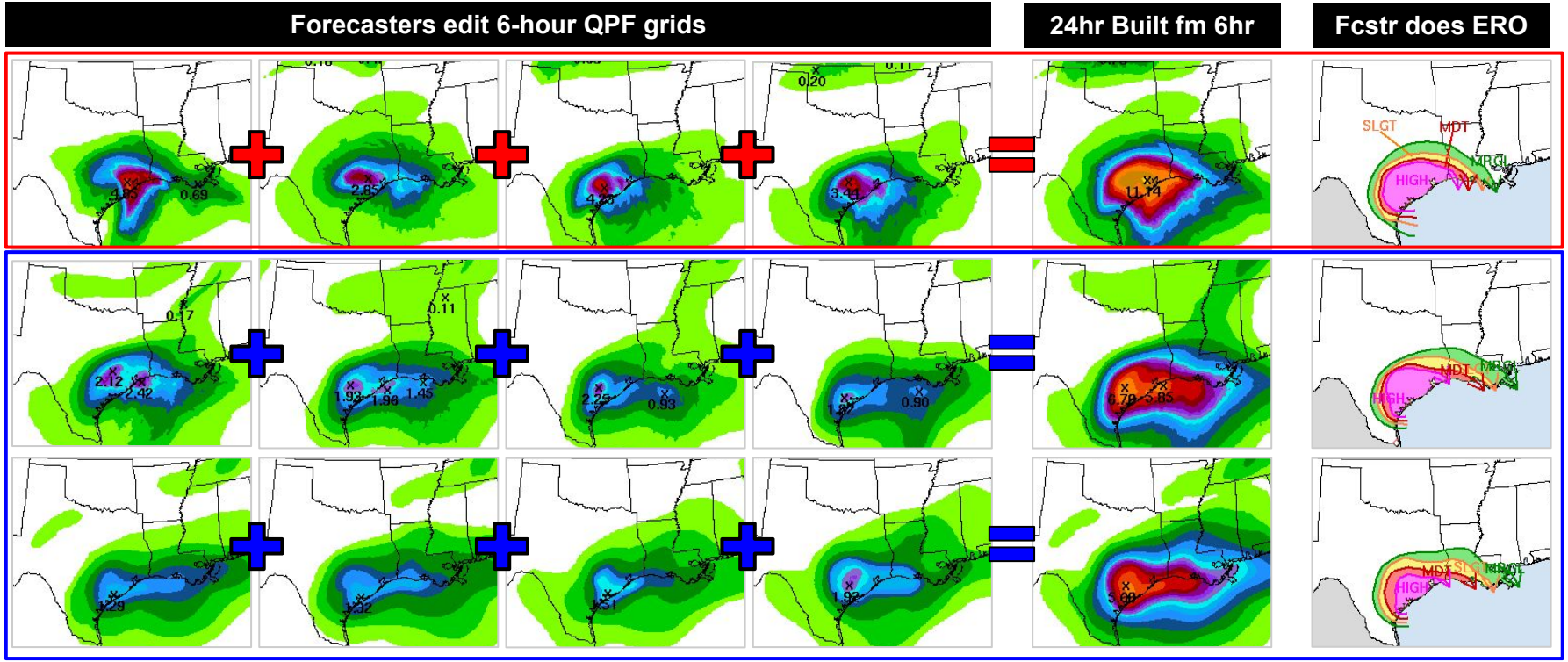
- Responsible for days 1-3 QPF across the CONUS
- Collaborates QPF with WFOs and RFCs as needed
- No longer have a day 1 and a day 2/3 QPF forecaster, which should simplify collaboration with the field
- This forecaster can focus 100% on QPF
- On day shifts this will typically be the role of the SBF
- On night shifts, the SBFs and GS13s will rotate who works which desk (QPF or ERO) to maintain proficiency on both desks



ERO Desk

- Responsible for days 1-3 EROs across the CONUS
- Collaborates EROs with the WFOs/RFCs/NWC as needed\
- One forecaster producing all 3 days of EROs should simplify collaboration with field offices
- This forecaster can focus 100% on the ERO and rainfall impacts
- On day shifts this will primarily be the role of the GS13 forecaster
- On night shifts, the SBFs and GS13s will rotate who works which desk (QPF or ERO) to maintain proficiency on both desks

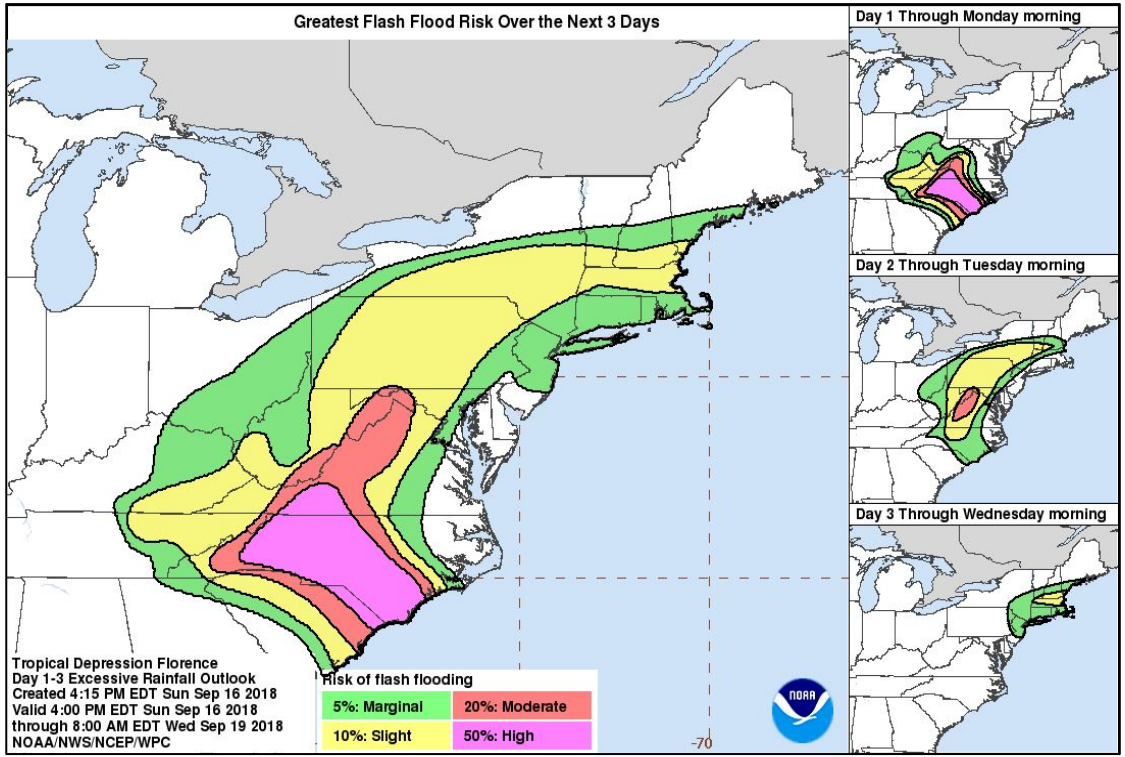




One forecaster issues the days 1-3 QPF, another the days 4-7 QPF, and a third the days 1-3 excessive rainfall outlooks

Rainfall Forecast Process

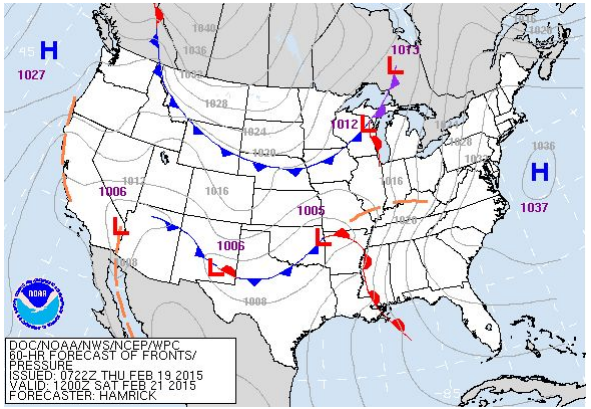
Combined ERO



- Displays greatest forecast risk at a given location over the next three days
- Specific event timing and details still found in individual day outlooks
- Used for Tropical systems

Public Advisories – Inland

- Inland advisories for cyclones that have been downgraded to tropical depression and aren't expected to move back over water during the following 60 hours.
- Forecast positions to Day 5 or loss of definable center
- Discontinued if system is no longer a flash flood threat



Content:

- Current Watches/Warnings/Advisories
- Storm description / intensity
- Observed rainfall summary
- Forecast evolution and track
- Composed in ATCF starting in 2018

IDSS Support
WPC International Desks

Tasking

- Train meteorologists from Mexico, Central and northern South America, and island nations of the Caribbean
- During the Hurricane Season, issue QPF IDSS for:
  - Mexico, Central and northern South America, island nations of the Caribbean
  - Provides the basis for the rainfall/hazards statement

Users

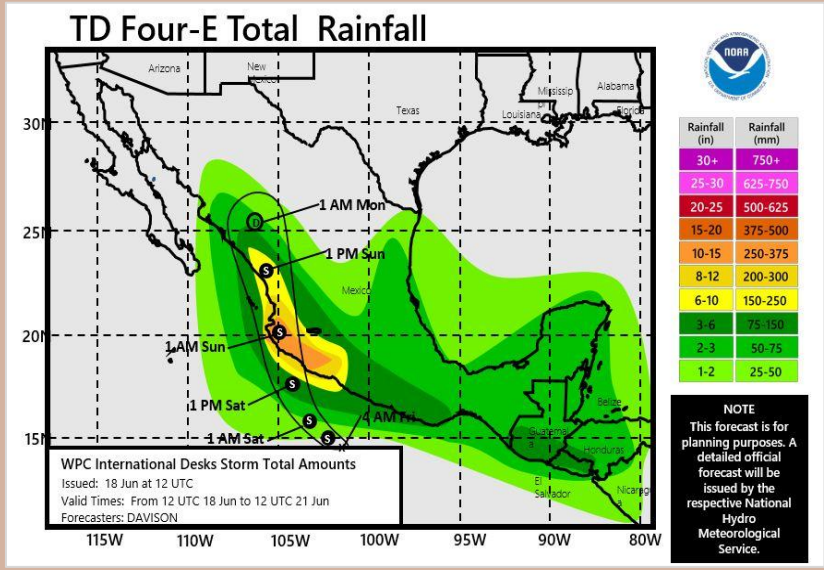
- Primary: NHC, WPC, USAID, NHMS
- Secondary: DOD: USSOUTHCOM, USARSO, USAFSO & USNAVSO

2020 Hurricane Season

- 30 Named Storms
- Two-man team issued **115 IDSS** (88 for Atlantic Basin, 27 for Pacific)

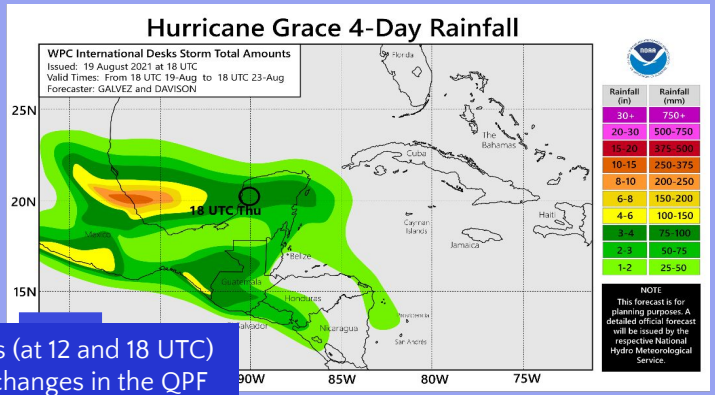
WPC International Desks

TD Four-E impacting southwest Mexico in June 2021

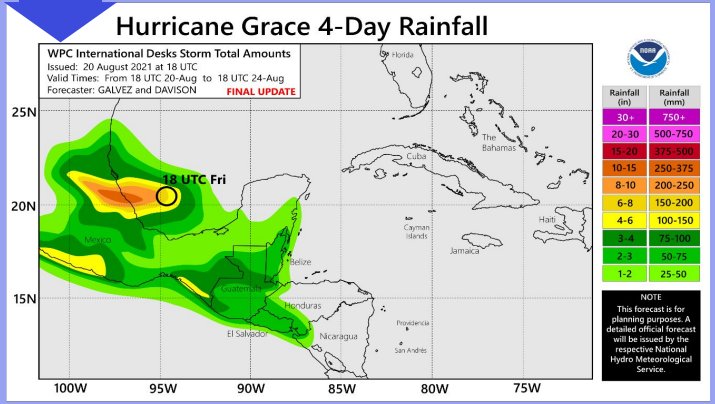


2021 Hurricane Grace's QPF Evolution

upon observations and NHC and model forecast adjustments

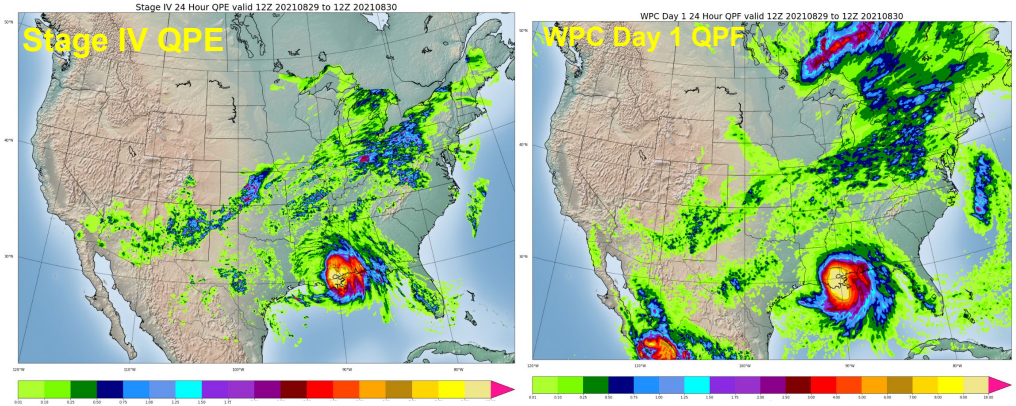


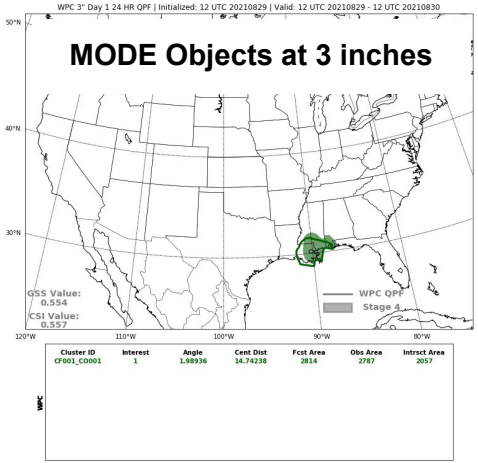
Updates (at 12 and 18 UTC) reflect changes in the QPF



WPC Tropical Cyclone QPF Displacement -- How to Calculate?

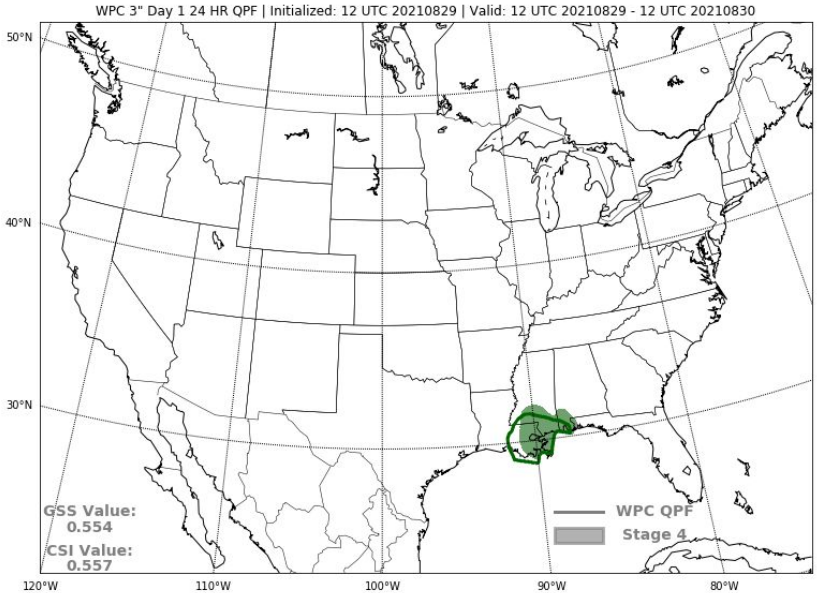
- Use WPC Day 1/2/3/4/5 24 HR QPF valid at the landfall and subsequent dates of each chosen storm.
  - Dates beyond the initial landfall were examined as long as the tropical cyclone's precipitation could be easily identified and separated from other systems.
- Stage IV QPE used as verification.
- Use the Developmental Testbed Center's (DTC) Method for Object-Based Diagnostic Evaluation (MODE) tool. It is part of their Model Evaluation Tools (MET) package.
- 23 total storms from 2016 through 2021.
- 54 total dates used.





WPC Tropical Cyclone QPF Displacement -- How to Calculate?

- WPC QPF is the contoured object in the image.
- Stage IV QPE is the shaded object in the image.
- MODE calculates statistics based off how similar they are to each other.
- Centroid distance gives the distance between each object's centroid in grid squares.
- We can then use the known size of the gr and calculate the displacement in miles between the WPC QPF and Stage IV QP



Cluster ID	Interest	Angle	Cent Dist	Fcst Area	Obs Area	Intrsct Area
CF001_CO001	1	1.98936	14.74238	2814	2787	2057

WPC

Centroid Distance = 14.74238

Grid = 5 km

Displacement = 14.74238 x 5 km = 73.71 km or 45.80 miles

WPC Tropical Cyclone QPF Displacement -- Results

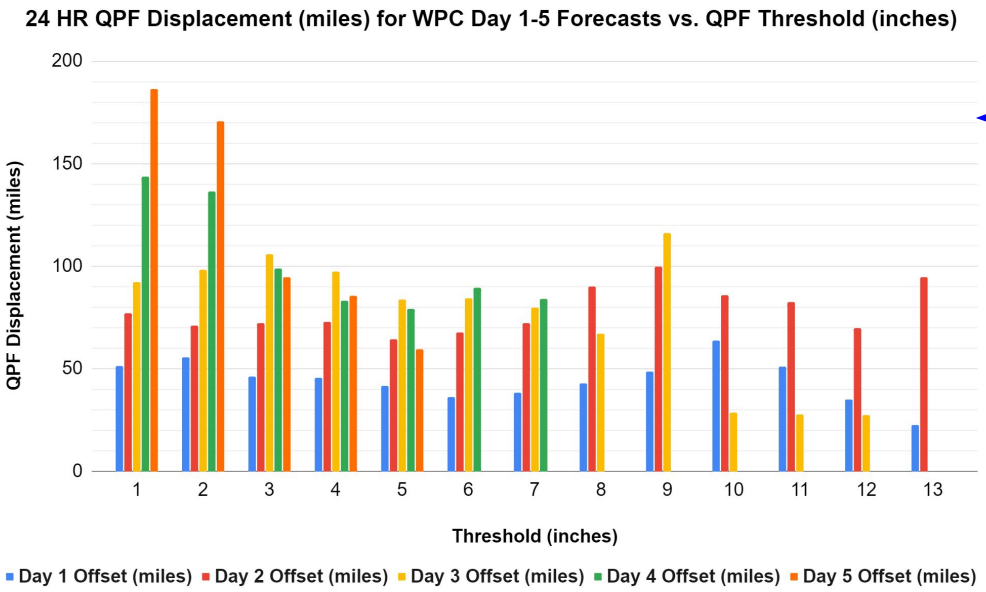


Chart showing 24 hr QPF displacement (miles) for WPC Day 1-5 forecasts for QPF thresholds of 1 through 13 inches.

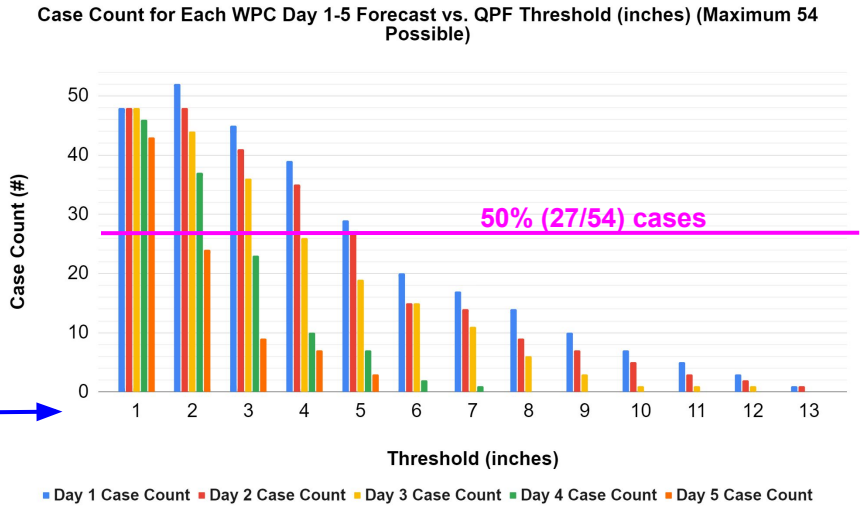


Chart showing the case count (maximum 54) for each WPC Day 1-5 forecast at each QPF threshold.

WPC Tropical Cyclone QPF Displacement -- Results

- 1 Inch WPC QPF Displacements:
  - Day 1 = 51.52 miles (48 cases)
  - Day 2 = 77.21 miles (48 cases)
  - Day 3 = 92.17 miles (48 cases)
  - Day 4 = 143.73 miles (46 cases)
  - Day 5 = 186.32 miles (43 cases)

- 4 inch WPC QPF Displacements:
  - Day 1 = 45.75 miles (28 cases)
  - Day 2 = 72.83 miles (35 cases)
  - Day 3 = 97.30 miles (26 cases)
  - Day 4 = 83.05 miles (10 cases)
  - Day 5 = 85.48 miles (7 cases)

WPC QPF GPRA Score Thresholds

Average Day 1	Threshold ---------->	1
	Centroid Dist. (grid sq.)	16.58422
	Offset (km)	82.92
	Offset (mi)	51.52

Average Day 3	Threshold ---------->	2
	Centroid Dist. (grid sq.)	31.6811
	Offset (km)	158.41
	Offset (mi)	98.43

WPC Tropical Cyclone QPF Displacement

Caveats to the Results and Process:

- QPE masking offshore:
  - The Stage IV QPE is masked offshore.
  - This could impact the true centroid location of objects making landfall as these systems' motion takes them onshore.
- QPF/QPE magnitude varies widely between systems and forecast days:
  - Example: MODE objects for Hurricane Harvey were found up to 11 inches for Day 1 but only up to 6 inches on Day 3.
  - Hurricanes Barry and Michael only had objects up to 7 inches whereas Hurricanes Harvey and Florence had objects up to 11 inches.
  - 45 Day 1 3 inch objects compared to 9 Day 5 3 inch objects.

Future Work:

- Use NHC track error for each case study date to see if the QPF displacement can be related to the track of the storms.

Feel free to email with any questions:

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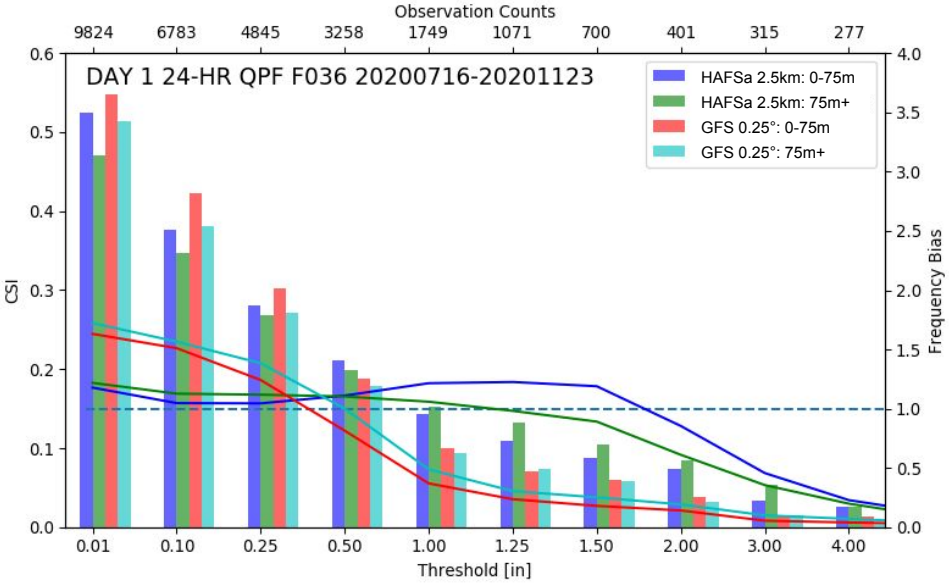
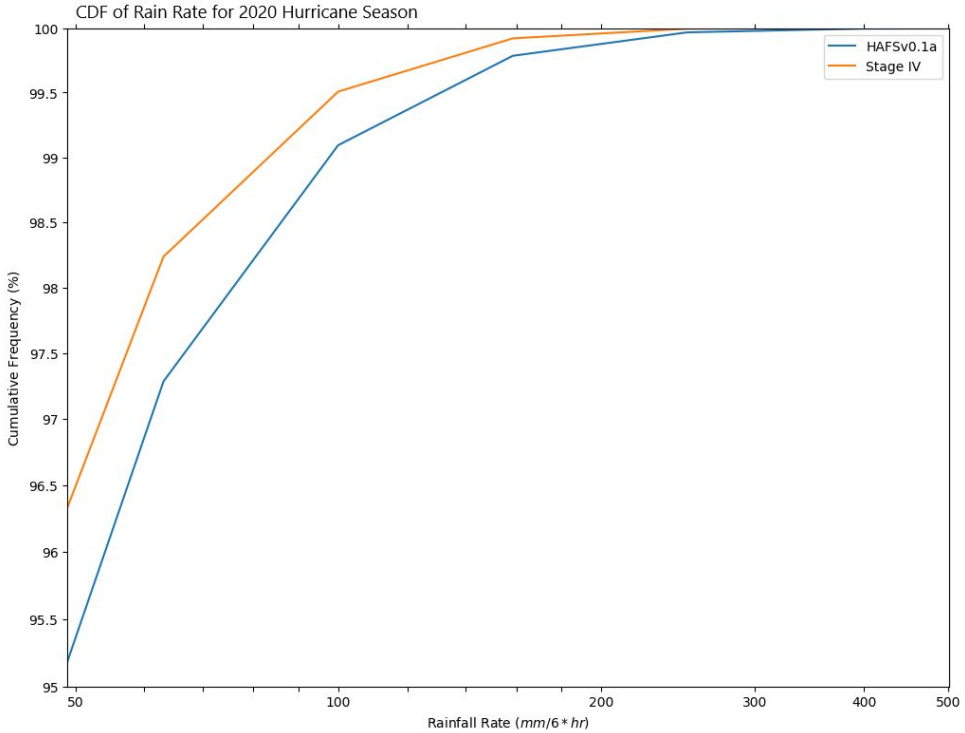
HAFS v0.1A QPF verification using rain gauges



Critical success index for HAFS and GFS for 24-hr accumulated rainfall for forecast hour 36.

- Rain gauge network assembled using a variety of sources to cover large portions of the Caribbean.
- HAFS QPF verification for 24-hr accumulated rainfall using Point Stat in MET toolkit. Verification period: 16 July 2020 - 23 Nov. 2020.
- Using 75 meters as a thresholds, rain gauges are analyzed in two different elevation categories.
- Overall, HAFS A performs better than the GFS for these locations at thresholds greater than 0.5” for 24-hrs.

TC tracking QPF metric using CONUS Stage IV QPE



Cumulative distribution functions of rain rate (mm/6hr) for 2020 Hurricane season using Stage IV within 600km radius of Best Track data over CONUS.

- CDFs constructed using forecasted QPF and Stage IV QPE data within a 600km radius of best track data for 2020 hurricane season over CONUS.
- At lower rain rates (less than 20 mm/6hr, not shown) the model underpredicts QPF compared to Stage IV.
- At rates higher than 20 mm/6hr, the model overpredicts QPF compared to the Stage IV QPE. (Shown in figure to the left)
- Although there is a difference observed on these plots, the model does considerably well with higher rain rates when compared to the Stage IV QPE.

Questions?