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

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

Coastal North Carolina...28 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.

Key Messages

1. A life-threatening storm surge is likely along portions of the coastlines of South Carolina and North Carolina, and a Storm Surge Warning is in effect for a portion of the area.

2. Life-threatening, catastrophic flash flooding and significant river flooding is likely over portions of the Carolinas and Mid-Atlantic states from late this week into early next week, as Florence is expected to slow down as it approaches the coast and moves inland.

3. Damaging hurricane-force winds are likely along portions of the coasts of South Carolina and North Carolina, and a Hurricane Warning is in effect. Strong winds could also spread inland into portions of the Carolinas.

4. Large swells affecting Bermuda and portions of the U.S. East Coast will continue this week, resulting in life-threatening surf and rip currents.

For more information go to hurricanes.gov
International TCP Responsibilities

WPC provides rainfall statements for all storms within the solid red (NHC) outline.

We also coordinate with CPHC in Hawaii.
## Coordination Timeline

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

<table>
<thead>
<tr>
<th>Day Shift</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>15Z</strong>: Advisory issued by NHC. New NWP guidance begins arriving, so QPF work starts just after.</td>
</tr>
<tr>
<td><strong>1730Z</strong>: Preliminary QPF sent by WPC</td>
</tr>
<tr>
<td><strong>1745-1830Z</strong>: Primary collaboration window. Calls occur in this time, and also work on rainfall statement and key message.</td>
</tr>
<tr>
<td><strong>1930Z</strong>: Statements sent to NHC via email</td>
</tr>
<tr>
<td><strong>20Z</strong>: Hurricane hotline call, Final QPF/ERO sent by WPC by 2030Z, advisory and graphics issued 21Z</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Night Shift</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>03Z</strong>: Advisory issued by NHC. New NWP guidance begins arriving, so QPF work starts just after.</td>
</tr>
<tr>
<td><strong>0530Z</strong>: Preliminary QPF sent by WPC</td>
</tr>
<tr>
<td><strong>0545-0630Z</strong>: Primary collaboration window. Calls occur in this time, and also work on rainfall statement and key message.</td>
</tr>
<tr>
<td><strong>0730Z</strong>: Statements sent to NHC via email</td>
</tr>
<tr>
<td><strong>08Z</strong>: Hurricane hotline call, Final QPF/ERO sent by WPC by 0830Z, advisory and graphics issued 21Z</td>
</tr>
</tbody>
</table>
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
- 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)
TD Four-E impacting southwest Mexico in June 2021

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

2021 Hurricane Grace’s QPF Evolution
upon observations and NHC and model forecast adjustments
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 grid and calculate the displacement in miles between the WPC QPF and Stage IV QPE.

\[
\text{Centroid Distance} = 14.74238 \\
\text{Grid} = 5 \text{ km} \\
\text{Displacement} = 14.74238 \times 5 \text{ km} = 73.71 \text{ km or 45.80 miles}
\]
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

<table>
<thead>
<tr>
<th>Threshold ---------------</th>
<th>1</th>
</tr>
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<tbody>
<tr>
<td>Centroid Dist. (grid sq.)</td>
<td>16.58422</td>
</tr>
<tr>
<td>Offset (km)</td>
<td>82.92</td>
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<tr>
<td>Offset (mi)</td>
<td>51.52</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Threshold ---------------</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centroid Dist. (grid sq.)</td>
<td>31.6811</td>
</tr>
<tr>
<td>Offset (km)</td>
<td>158.41</td>
</tr>
<tr>
<td>Offset (mi)</td>
<td>98.43</td>
</tr>
</tbody>
</table>
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:

benjamin.albright@noaa.gov
HAFS v0.1A QPF verification using rain gauges

- Rain gauge network assembled using a variety of sources to cover large portions of the Caribbean.
- 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.

Critical success index for HAFS and GFS for 24-hr accumulated rainfall for forecast hour 36.
TC tracking QPF metric using CONUS Stage IV QPE

- 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?