Introduction

Heavy precipitation is a critical consequence of a landfalling tropical cyclone (TC). Historically, heavy rainfall induces fresh water floods and mudslides, which accounts for 27% of deaths (Rappaport, 2014). In 2017, three hurricanes made landfall in the U.S. – Harvey, Irma, and Maria. Hurricane Harvey made the landfall as a cat-4 hurricane and delivered over 60 inches rainfall over Texas. Harvey devastated Texas and Louisiana for 4 days, causing historical flooding and at least 68 deaths. This hurricane also caused the second highest economic loss in U.S. history (Blake and Zolesky 2018). With support from the Hurricane Forecast Improvement Project (HFIP), the NOAA/AOML/HRD developed and maintained an experimental “basin-scale HWRF” model (2017 version; HB17), which produced one of the most outstanding track forecasts in 2017. Due to the high dependence of precipitation on TC track, HB17 is leveraged as a rainfall research tool to evaluate precipitation performance on Harvey. At the end of this project, a probability rainfall product will be presented for fulfilling HFIP’s objectives.

Methodology

<table>
<thead>
<tr>
<th>Model</th>
<th>Temporal Step</th>
<th>Spatial Step</th>
<th>Format</th>
<th>Note</th>
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<tr>
<td>HB17</td>
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<tr>
<td>ST4</td>
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<td>IREPS</td>
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<tr>
<td>Best</td>
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</tbody>
</table>

- HB17: Baseline HWRF (2017)
- ST4: National Stage IV (2017)
- IREPS: Integrated Multi-Satellite Retrievals for GPM
- Best: Rainfall climatology and persistence model

Fig. 1. Left panel: HB17 Harvey track forecasts in Gulf of Mexico. Colored tracks are selected cycles of this study. Right Panel: HB17 Ensemble tracks of Harvey cycle 00 UTC 25 Aug 2017.

Pattern Analysis

- Produce realistic patterns along the track. 8 inch contour is impressive.
- Successfully simulated heavy rainfall over Houston.
- Overestimated rainfall in earlier forecasts on San Antonio and Austin.

Azimuthal Analyses I

- Rain Rate Distribution
- Rain Flux Distribution

Azimuthal Analyses II

- CFRD

Precipitation Probabilities

- Better simulation of peak rainfall center.
- Wider light rainfall range, but more realistic over ocean.

Conclusions

- HB17 has the capability of generating realistic precipitation pattern and also reasonable rainfall amount.
- In Harvey case study, HB17 successfully captured the peak rainfall over outer rainband region.
- HB17 slightly overestimated core heavy rain rate.
- Probabilistic rainfall prediction generated from ensemble helps improve rain pattern forecasting capability.

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