Evaluation and Guidance Development of HAFS Version A QPF over the Caribbean and Surrounding Regions

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Background

- 27% of tropical cyclone (TC) deaths are caused by freshwater floods from extreme rainfall (Rappaport, 2014).
- Flood deaths occur more often than deaths resulting from any other hazard associated with TCs (Rappaport, 2014).
- Skilled TC track forecasts are associated with skilled quantitative precipitation forecasts (QPF; Lord et al. 2007, Marchek et al. 2007).
- Hurricane models (HWRF) have shown to provide skillful QPF forecasts in comparison to global models (GFS; Ko et al. 2020).
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- 2020 Hurricane season evaluation period: (July 2020 – November 2020)
- GOALS:
  1. Analyze 2020 hurricane season for extreme precipitation over Caribbean and surrounding regions using HAFS v0.1A.
  2. Post-process high-percentile precipitation for 2021 hurricane season for the same region with special focus on elevated terrain using HAFS v0.1A.

Datasets

- 2020 Hurricane season evaluation period:
  - July 2020 - November 2020
- HAFS v0.1A QPF is model used for evaluation
- Stage IV gridded rainfall observations are used over CONUS
- Collection of rain gauges are used over Caribbean, Central and South America, and Southeast US. Obtained from:
  - Caribbean Institute for Meteorology and Hydrology (CIMH)
  - National Meteorological Institute in Costa Rica (CIMH)
  - Climate Prediction Center (CPC), NWS, NOAA
  - Community Collaborative Rain, Hail, and Snow Network (CoCoRaHS)
- 2004 stations reporting at 12 UTC daily
- There are some daily inconsistencies in stations reporting.

2020 Hurricane Season QPF Verification using Gauges

Rain Gauge Evaluation Analysis

- Why partition data by elevation?
- Investigate the difference between the forecasted rainfall near sea level and in higher terrain (likely further from coast).
- Is the influence of orographic features observed within the model forecast?
- If pattern exists, can this influence be included within bias-correction?
- 75 meters ASL splits dataset well with geographically diverse distribution.
- Rain characteristics for gauges above and below 75m also have different daily average rainfall.

Bulk Critical Success Index (CSI) Statistics

- GFS outperforms HAFS in rainfall thresholds up to 0.25 inches.
- HAFS improves skill over GFS at higher thresholds (greater than 0.25 inches) for shorter lead times (days 1 & 2).
- HAFS 6-hrs is much closer to 1 in all scenarios in comparison to GFS.
- Evaluating skill by elevations:
  - Higher terrain forecasts perform better for HAFS on days 3 & 4.
  - Days 1 & 2 don’t show conclusive evidence of difference in skill between station elevations.

QPF Bias analysis using Stage IV QPE

Cumulative Distribution Function (CDF) Statistics

- Completed for landfalling TCs over CONUS during 2020.
- Overall, HAFS produces rain rates close to Stage IV observations.
- HAFS initially produces higher frequency of lowest rain rates which prolongs underforecast.
- High percentiles events (greater than 95% cumulative frequency) have potential for large overforecasting deviations.

References