Difficult TC Cases Working Group

Performance of GFS and GEFS for 2021 TCs

Vijay Tallapragada
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Global Model Track Errors for 2021 NATL Season

From GFSv16 Retrospective evaluation: Reduced errors overall for strong TCs but slow & right-of-track biases at long lead times.
GFS TC Forecast Performance in 2021: Strong vs. Weak Storms

Improved forecast skill for strong storms
Highlights of GFS/GEFS 2021 TC Performance from MEG Reviews

Hurricane Elsa, July 2021
• GEFS mean, GFS, and UKM mean all **correctly** showed Elsa turning north, making landfall in Cuba, and making landfall again along the FL Gulf Coast.

• EC mean and determ. EC showed Elsa turn north much too early. EC mean recurved over the western North Atlantic, whereas deterministic EC dissipated.
- GEFS and the UKM ensemble became increasingly confident about Elsa making landfall along FL coast.
- EC became increasingly bimodal. EC mean still supported recurvature over western North Atlantic.
Successful Medium-Range GFS Forecasts

SLP/10m Wind Fcsts Valid 00Z 7/7
Elsa-GFS

All 7/1-7/6
00/12z
SLP/10m Wind Fcsts
Valid
00z 7/7

10m Wind Speed
Elsa-ECMWF

DAY 6

DAY 5

DAY 4

DAY 3

DAY 2

DAY 1

All 7/1-7/6
00/12Z
SLP/10m
Wind Fcsts
Valid
00Z 7/7
• GFS track guidance was overall stellar with consistent prediction of a landfall along Florida’s Gulf Coast

• Intensity guidance was also fairly good with early forecasts showing rather quick intensification. Later GFS cycles initialized after Elsa’s initial weakening tended to slightly underestimate Elsa’s subsequent intensity
With the exception of two early cycles, the GEFS Mean track solution consistently forecasted landfall over Northwest Florida. It was clearly biased to the left (i.e., to the west) of Best Track, though.

While a global ensemble mean would not be expected to capture TC intensity, the mean did appear to signal the strengthening-weakening-strengthening pattern that was observed.
24-h Elsa QPF Comparisons

- GFS struggled to properly forecast the QPF footprint, particularly with amounts as the remnants of Elsa moved up the East Coast.

Initialized: 12Z 7/6/21
Valid: 12Z 7/8/21 (F48)

Initialized: 12Z 7/7/21
Valid: 12Z 7/9/21 (F48)
Explanation of Poor GFS 24-h QPF

Comparison of MSLP and 10-m wind

- Elsa was consistently notably weaker than analyzed in short-range GFS forecasts
- GFS tended to move Elsa too quickly to the north
- A weaker and faster storm led to disorganized / underdone GFS QPF amounts
Highlights of GFS/GEFS 2021 TC Performance from MEG Reviews

Hurricane Ida, August 2021
• Track guidance was quite good with the majority of tracks showing landfall along the southeastern LA coast

• Overall, all deterministic models, including the EC and UK (not shown), tended to have a slight left-of-track bias when predicting Ida’s track through the Caribbean and Gulf of Mexico

• **GFS best captured Best Track in its forecast envelope**, while Best Track was on the eastern edge of the envelope for other models
GFS/GEFS had the best tracks for Ida, with other models further west.

GFS and GEFS were the closest to Best Track through Day 5, but GFS performed a loop over the Southeast.

No indication in GFS/GEFS that Ida would be a threat to the Mid-Atlantic in the medium range.
Deterministic models and ensemble means continued to forecast landfall in Louisiana, but were too far west.

Ida tracked on the very eastern edge of the ensemble envelopes for all models.

GFS was the closest to Best Track through Day 5 but continued to perform a loop over the Southeast.
GFS and GEFS mean incorrectly brought Ida too far north over TN but then correctly tracked across NJ.

ECMWF deterministic and ensemble mean were notably further south (with several members showing the “southeast loop” scenario that the GFS had abandoned by this cycle.)
Deterministic UKM and ensemble mean brought Ida west of Best Track nearly immediately.

EC ensemble exhibited the most spread, with two ens. members moving Ida southwest into Texas.

GEFS mean was the closest to Best Track through NJ.
NHC’s Official Forecast had smaller track error than the determ. EC/UKM and EC ensemble at all lead times.

GFS had the smallest track error of the three global models at all lead times (smaller than NHC at F60+).

UKM had the largest track error of the three global models partially due to its persistent left-of-track bias.

GEFS mean had smaller track error than the EC mean at all lead times (EC mean was shifted too far west).

Images from Marcel Caron
Highlights of GFS/GEFS 2021 TC Performance from MEG Reviews

Hurricane Henri, August 2021
GEFS and UKM ensemble mean correctly brought Henri nearly due west for ~48 h before turning northeast and approaching New England.

Deterministic EC and ensemble mean were still too far to the east, keeping Henri (mostly) either out to sea or making landfall in the Canadian Maritimes.
• GEFS mean and GFS struggled to capture the left-hand turn towards southeast NY and the loop that occurred there.
GEFS and GFS struggled more than the EC or UKM to capture the sharp jog to the west seen in Henri’s Best Track, bringing Henri closer to the Canada/New Hampshire border instead.
TC Forecast Performance from EP1

Track error, AL/EP/WP, 2017-2019

Before 120hrs, Couple-C384 is better than Reforecast.

Track error/spread, AL/EP/WP, 2018

After 120hrs, the spread is smaller than the track error (under-dispersive).
Concluding Remarks

- Not comfortable making any blanket statements about performance of GFS and GEFS for the entirety of the season, as we only reviewed a few storms.
- Shifting focus to evaluation of coupled global models for future implementations
- Leveraging UFS-R2O Project for coordinated model development, testing and evaluation
- MEG and MDAB will continue documenting model issues for potential future improvements in collaboration with the community