Evaluation of Tropical Cyclone Forecasts with the GFDL FV3 Dynamical Core

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Experimental Design

• Version of FV3 used in this study has same horizontal resolution (~13km) and vertical resolution as current operational GFS.

• GFDL 6-Species Micro-Physics package was implemented into version of FV3 dynamical core in this study (replaces simple Zhao-Carr operational in the GFS).

• 2015 and 2016 Tropical Cyclone seasons analyzed for the Atlantic, East Pacific and West Pacific Basin (total of 1,337 forecasts).

• All forecasts initiated from May 1st through December 1st, initialized at 0 and 12 z synoptic times using the operational GFS initial conditions.

• Verifications use early guidance unless otherwise indicated, to reproduce operations as closely as possible.
FV3 & GFS track errors comparable at all forecast lead times. FV3 & GFS track errors larger than ECMWF beyond day 2.
Early Model Track Guidance

West Pacific Basin

FV3 track errors reduced 6% compared to the GFS at days 2-5.
FV3 track errors still significantly larger than ECMWF
FV3 & ECMWF track errors using the ECMWF Initial condition comparable through 96 h.
Suggest improved DA and quality control in the GFS global model is needed to become competitive with the ECMWF for TC track prediction!
Track errors of FV3 and GFS very comparable in the longer forecast lead times.

ECMWF track forecasts remain much more skillful at days 6 and 7, particularly in the Atlantic and West Pacific.
Replacement of the FV3 or addition of the FV3 in the GFS-ECMWF model consensus leads to a neutral impact on forecast track error.
Late Model Intensity Guidance

2015 & 2016 ATLANTIC SEASONS (LATE GUIDANCE)
NUMBER OF CASES: (295, 268, 242, 216, 190, 144, 114, 86)

2015 & 2016 EAST PACIFIC SEASONS (LATE GUIDANCE)
NUMBER OF CASES: (494, 459, 413, 373, 332, 259, 202, 152)

2015 & 2016 WEST PACIFIC SEASONS (LATE GUIDANCE)
NUMBER OF CASES: (548, 507, 464, 423, 383, 308, 244, 191)

2015 & 2016 ATLANTIC, EAST PACIFIC, WEST PACIFIC
NUMBER OF CASES: (1337, 1234, 1119, 1012, 905, 711, 560, 429)
Late Model Intensity Bias

2015 & 2016 ATLANTIC (LATE GUIDANCE)
NUMBER OF CASES: (295, 268, 242, 216, 190, 144, 114, 86)

2015 & 2016 EAST PACIFIC (LATE GUIDANCE)
NUMBER OF CASES: (494, 459, 413, 373, 332, 259, 202, 152)

2015 & 2016 WEST PACIFIC (LATE GUIDANCE)
NUMBER OF CASES: (548, 507, 464, 423, 383, 303, 191)

2015 & 2016 ATLANTIC, EAST PACIFIC, WEST PACIFIC
NUMBER OF CASES: (1337, 1234, 1119, 1012, 905, 711, 560, 429)
Early Model Intensity Guidance

Atlantic Basin

2015 & 2016 ATLANTIC SEASONS (EARLY GUIDANCE)
NUMBER OF CASES: (266, 242, 216, 191, 142, 108, 84)

INTENSITY ERROR (KNOTS)

FORECAST HOUR

East Pacific Basin

2015 & 2016 EAST PACIFIC SEASONS (EARLY GUIDANCE)
NUMBER OF CASES: (455, 410, 365, 326, 253, 196, 150)

INTENSITY ERROR (KNOTS)

FORECAST HOUR

Legend:
- GFS
- FV3 (GFDL MP)
- HWRF
- DECAY SHIPS
- LGEM
Early Model Intensity Guidance

West Pacific Basin

Combined Basins

2015 & 2016 WEST PACIFIC SEASONS (EARLY)
NUMBER OF CASES: (480, 437, 399, 361, 286, 222, 171)

INTENSITY ERROR (KNOTS)
FORECAST HOUR

2016 GFS
FV3 (GFDL MP)
2016 HWRF
COAMPS-TC

2015 & 2016 ATLANTIC, EAST PACIFIC, WEST PACIFIC
NUMBER OF CASES: (1203, 1089, 985, 886, 693, 538, 409)

INTENSITY ERROR (KNOTS)
FORECAST HOUR

GFS
FV3 (GFDL MP)
HWRF
ECMWF
Addition of the FV3 in the DSHP-LGEM-HWRF model consensus reduced intensity errors 11% in the Atlantic and 5% in the East Pacific at 2-5 day forecast lead times!
How About Storm Genesis?

Preliminary results for 2015 season only

*with Zhao-Carr microphysics*
In most basins, the maximum forecast lead time for genesis in FV3 is greater than the GFS.
Conclusions

• FV3 track guidance is comparable to the GFS in the Atlantic, East Pacific and West Pacific for the 2015-2016 TC seasons.

• FV3 intensity guidance is significantly better than the GFS with reduced negative bias and comparable errors to HWRF for late model guidance.

• Replacement of the GFS with FV3 in the GFS-ECMWF track model consensus has a neutral impact on track error.

• Addition of the FV3 in the DSHP-LGEM-HWRF intensity model consensus significantly improved the intensity guidance by day 2 in the Atlantic (11%) with slight reduction of error in the East Pacific (5%).

• The timing of genesis in the FV3 is more consistent with the observed timing of genesis compared to the GFS, with a comparable false alarm rate.