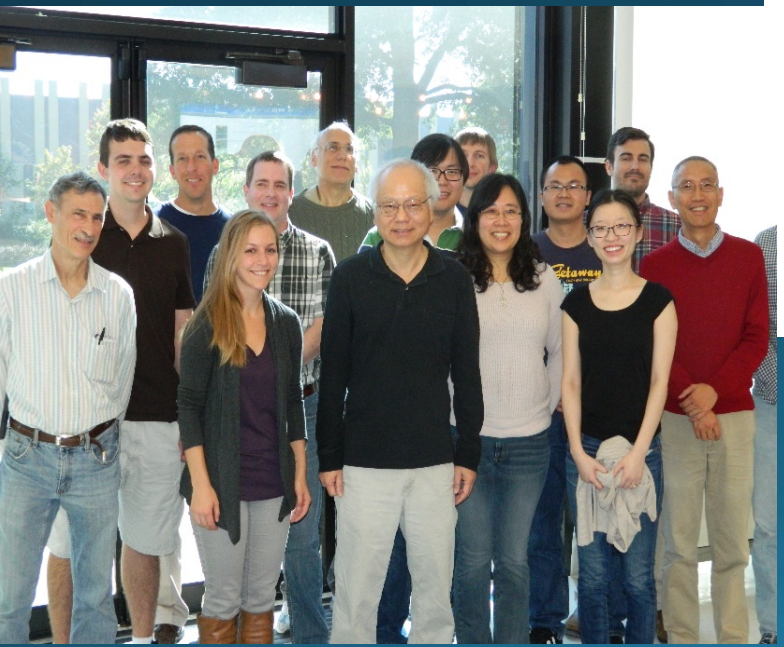
Evaluation of Tropical Cyclone Forecasts with the GFDL FV3 Dynamical Core

Morris Bender, Jan-Huey Chen, Matthew Morin and Shian-Jiann Lin

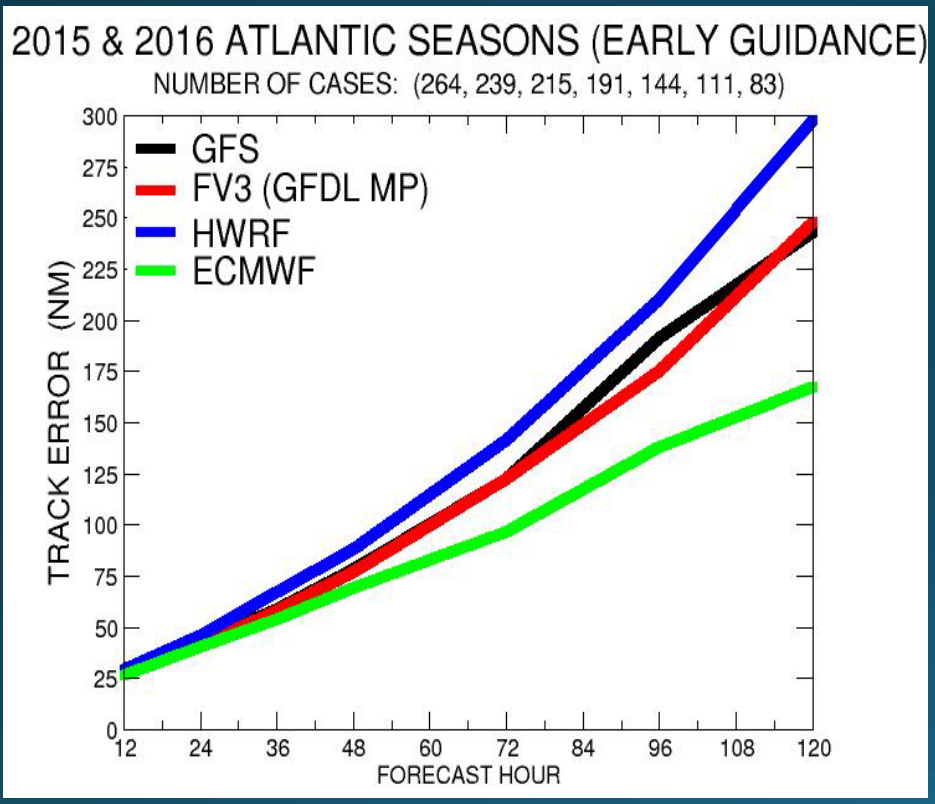


Experimental Design

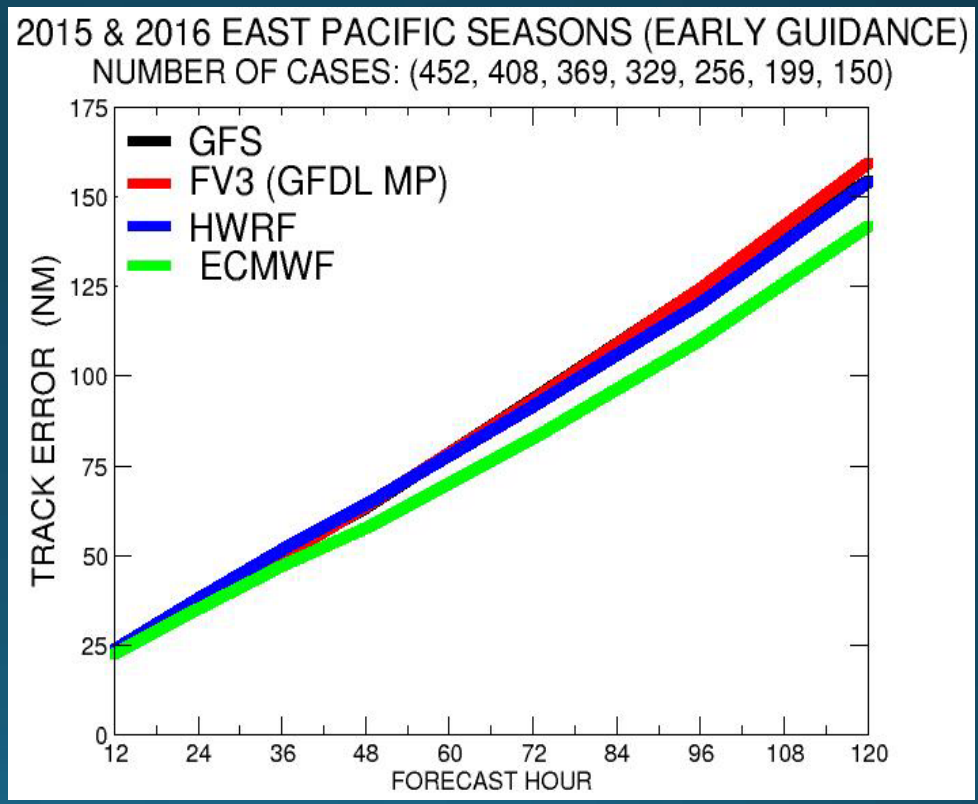
- Version of FV3 used in this study has same horizontal resolution (~13km) and vertical resolution as current operational GFS.
- GFDL 6-Species Micro-Physics package was implemented into version of FV3 dynamical core in this study *(replaces simple Zhao-Carr operational in the GFS).*
- 2015 and 2016 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.

Early Model Track Guidance

Atlantic Basin



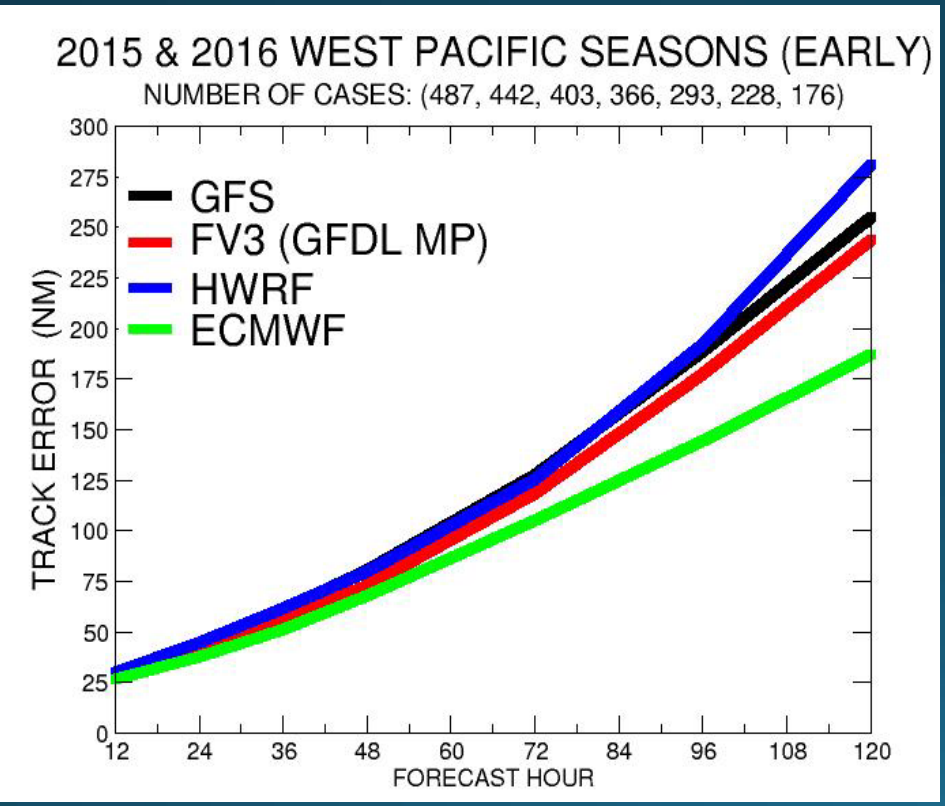
East Pacific Basin



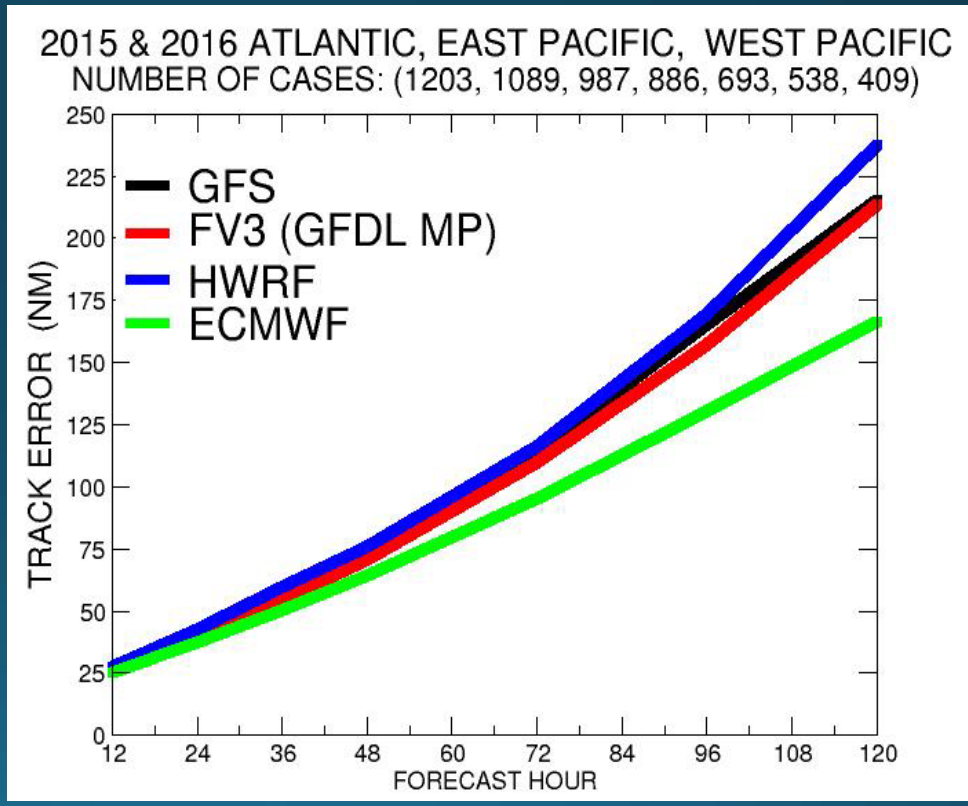
FV3 & GFS track errors comparable at all forecast lead times.
FV3 & GFS track errors larger than ECMWF beyond day 2.

Early Model Track Guidance

West Pacific Basin

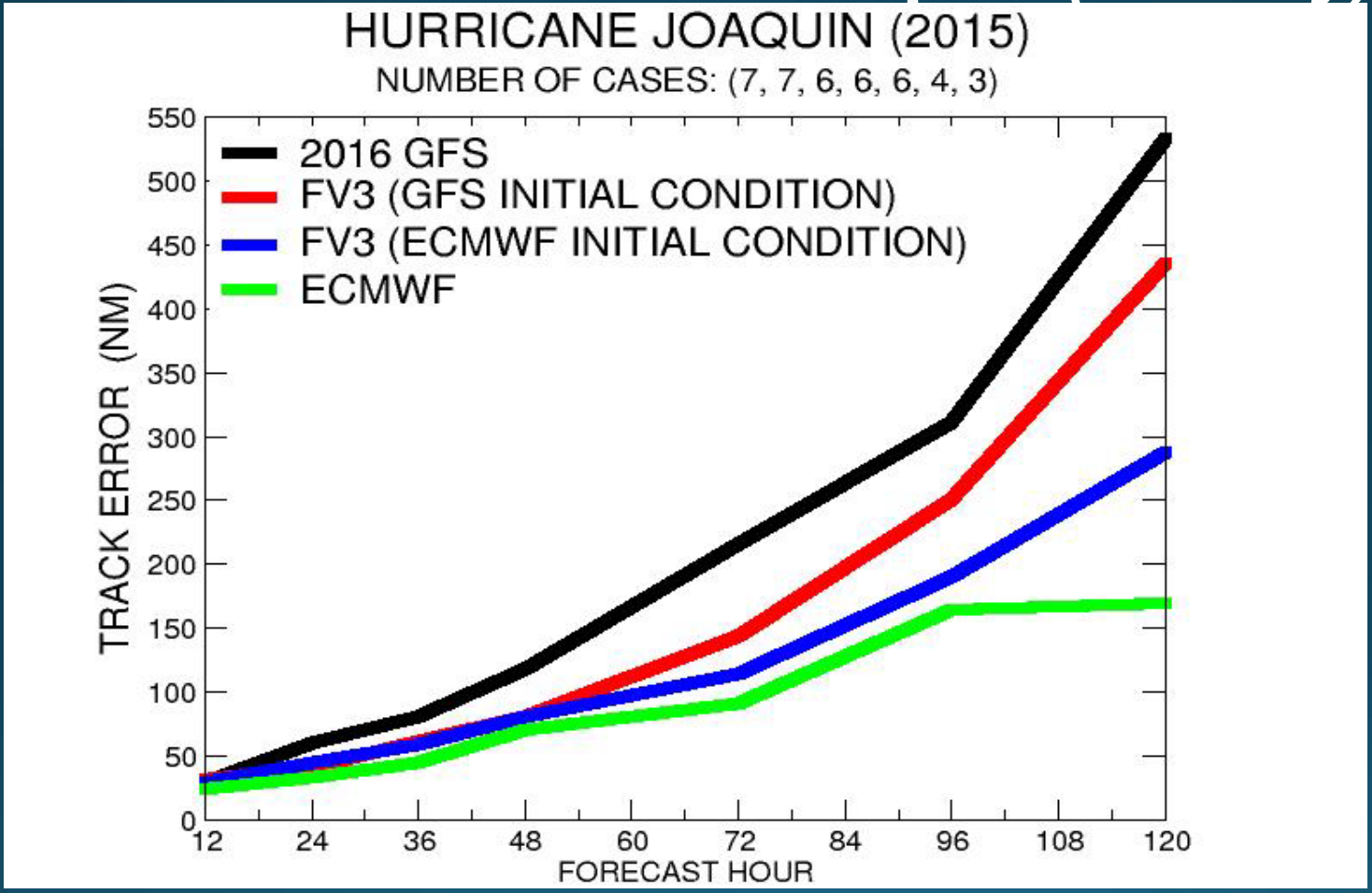


Combined Basins



FV3 track errors reduced 6% compared to the GFS at days 2-5.
FV3 track errors still significantly larger then ECMWF

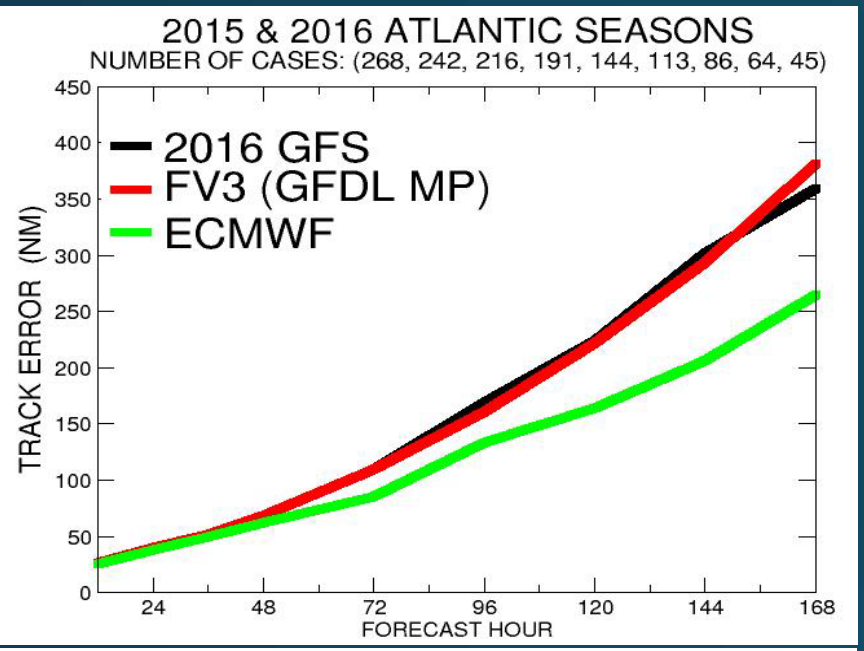
Impact using ECMWF Initial Condition for Joaquin *(0z only)*

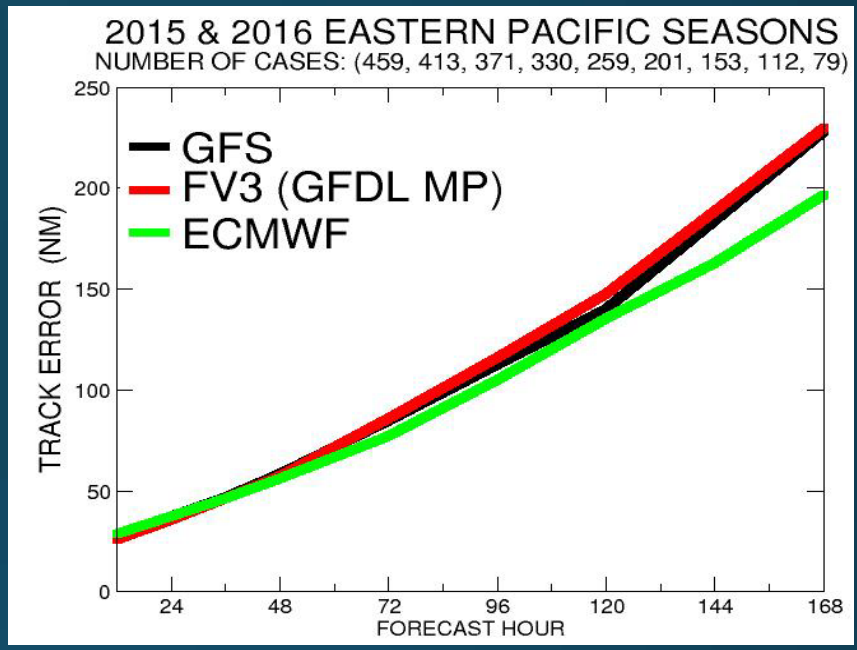


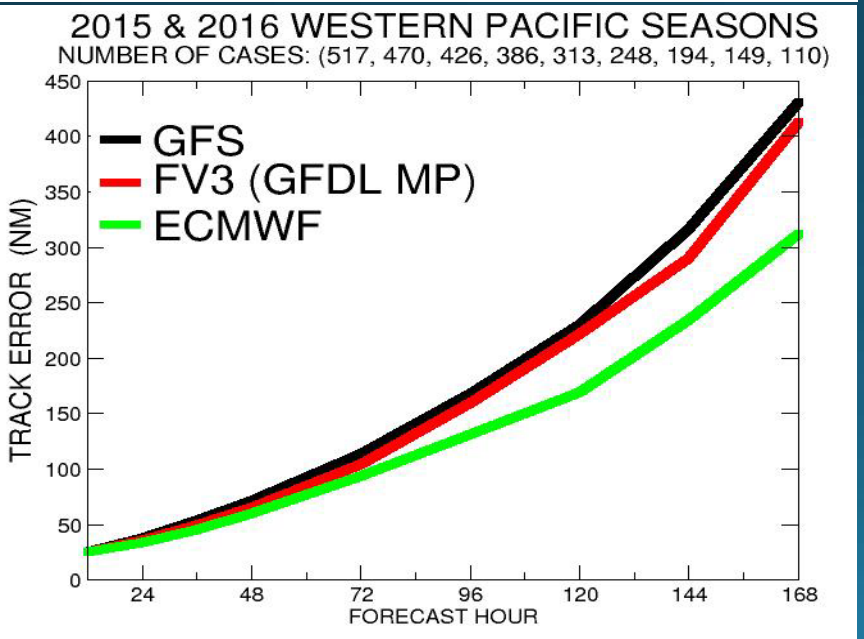
FV3 & ECMWF track errors using the ECMWF Initial condition comparable through 96 h.

Suggest improved DA and quality control in the GFS global model is needed to become competitive with the ECMWF for TC track prediction !

7 Day Track Guidance (Late)



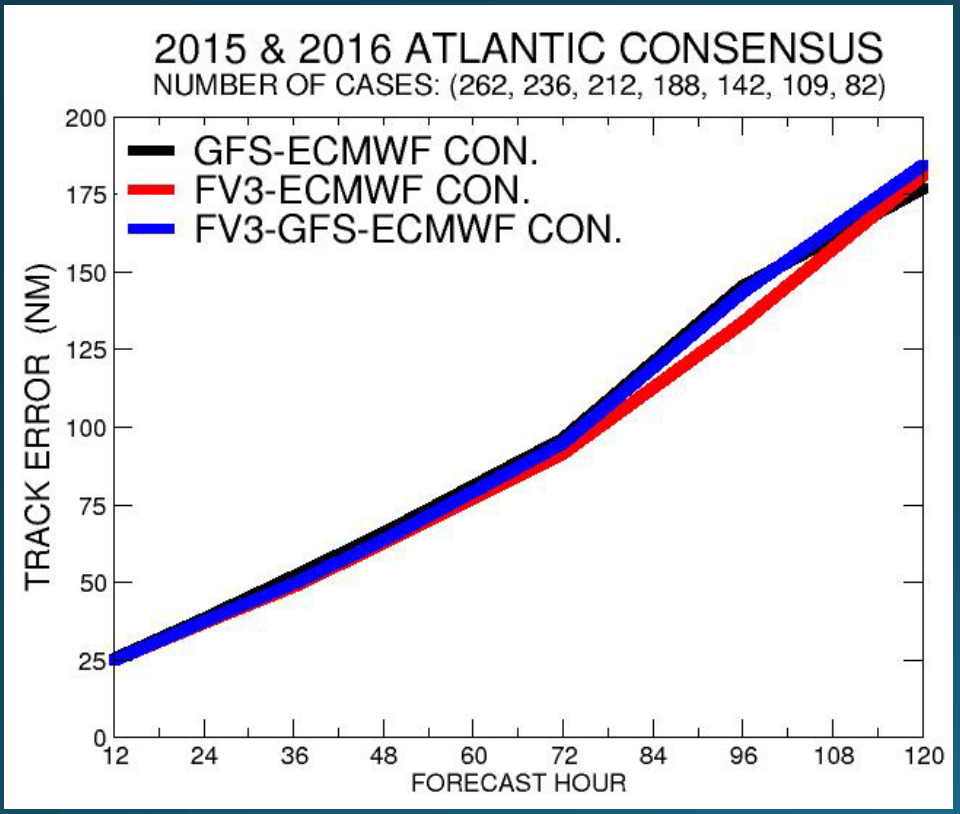


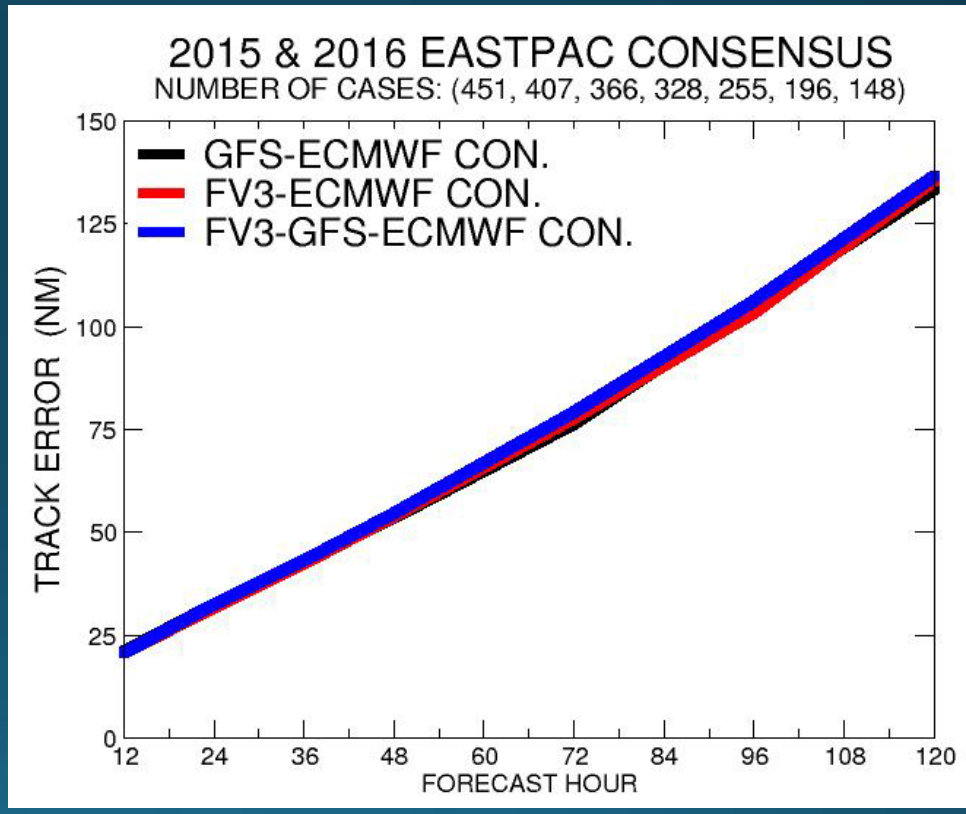


Track errors of FV3 and GFS very comparable in the longer forecast lead times.

ECMWF track forecasts remain much more skillful at days 6 and 7, particularly in the Atlantic and West Pacific.

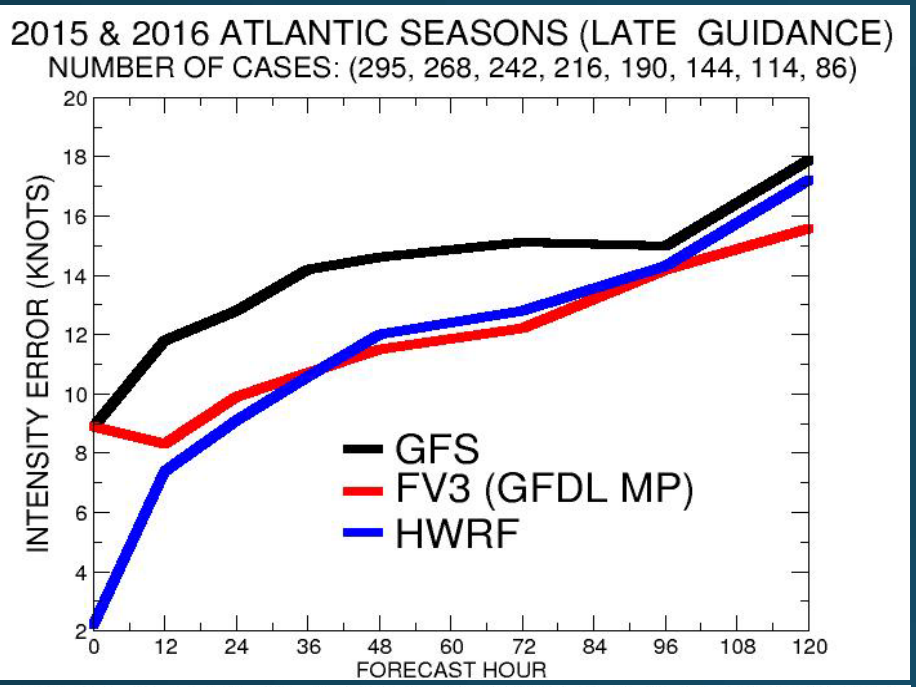
Impact of FV3 Track Guidance on Model Consensus

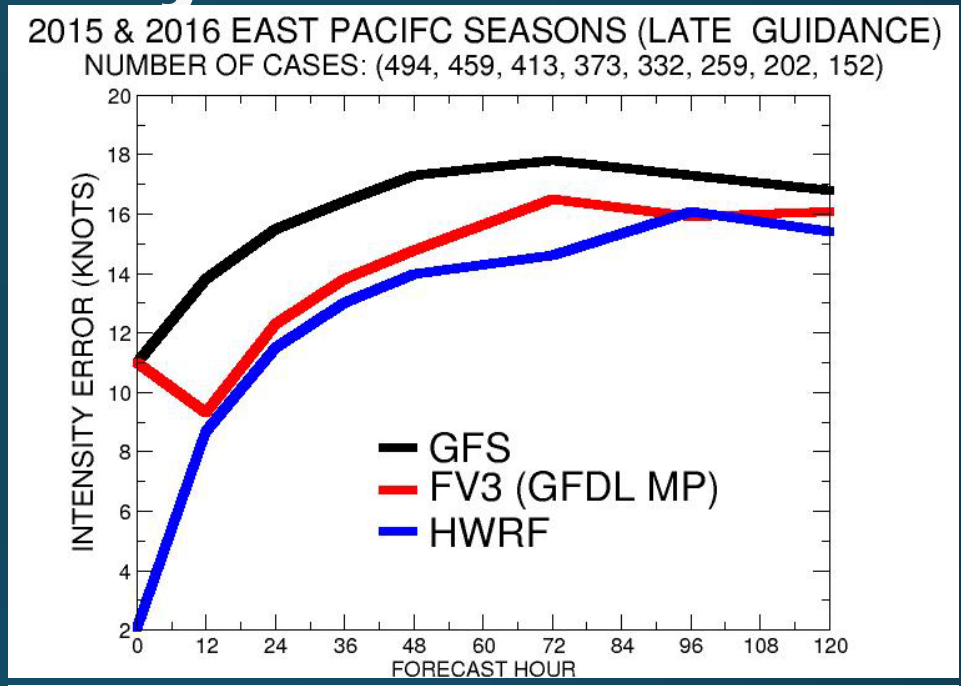


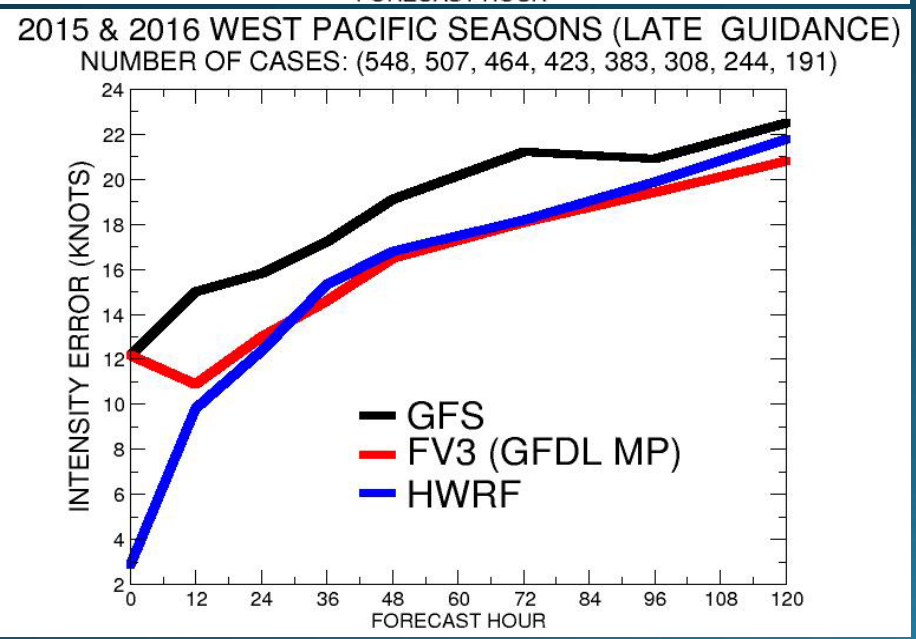


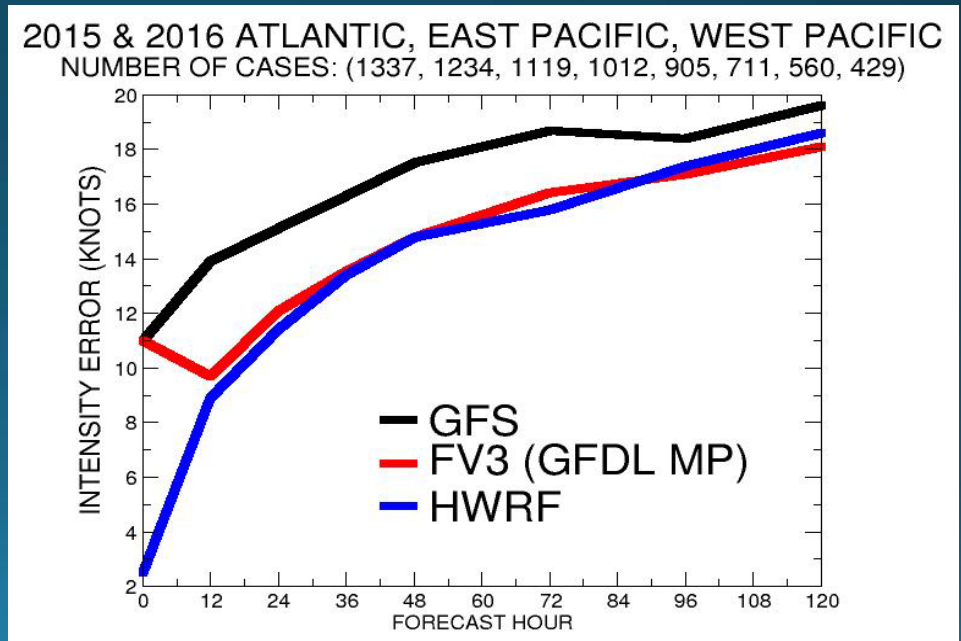
Replacement of the FV3 or addition of the FV3 in the GFS-ECMWF model consensus leads to a neutral impact on forecast track error.

Late Model Intensity Guidance

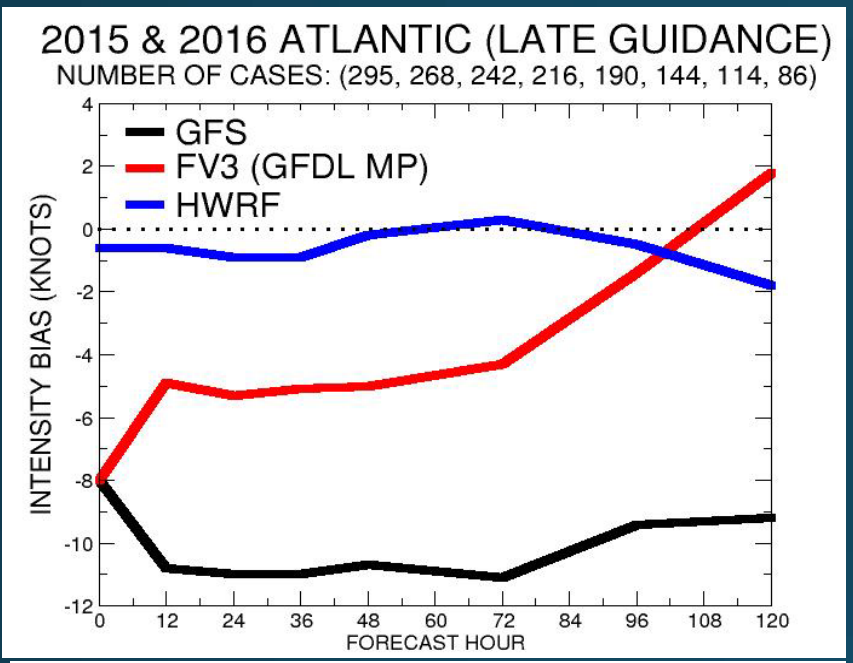


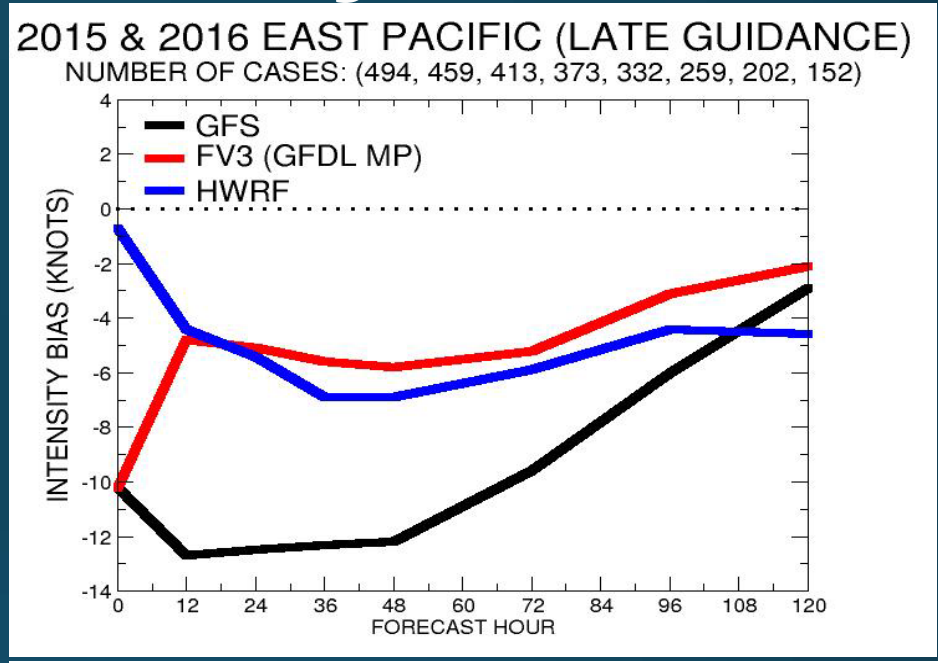


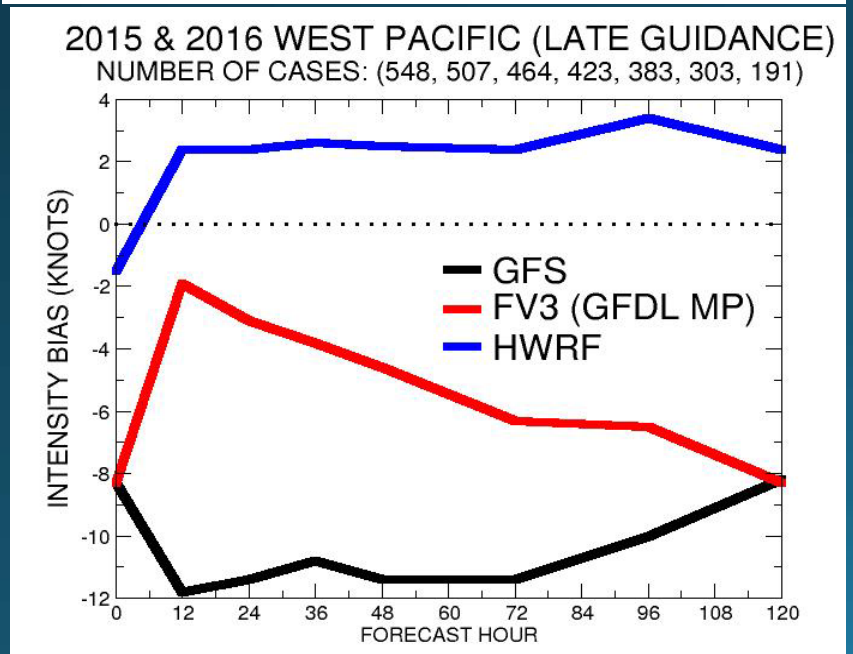


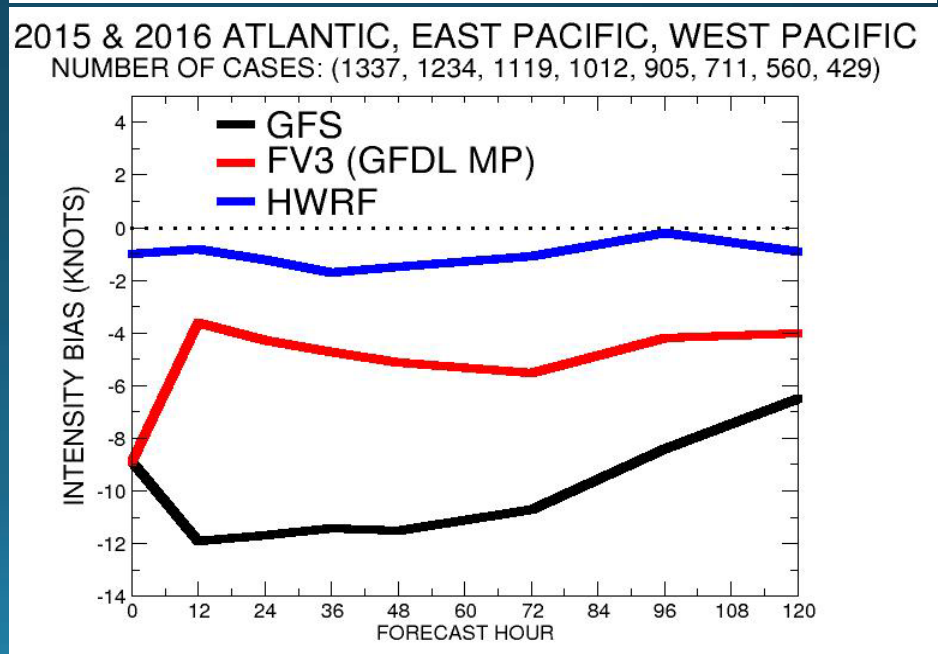


Late Model Intensity Bias



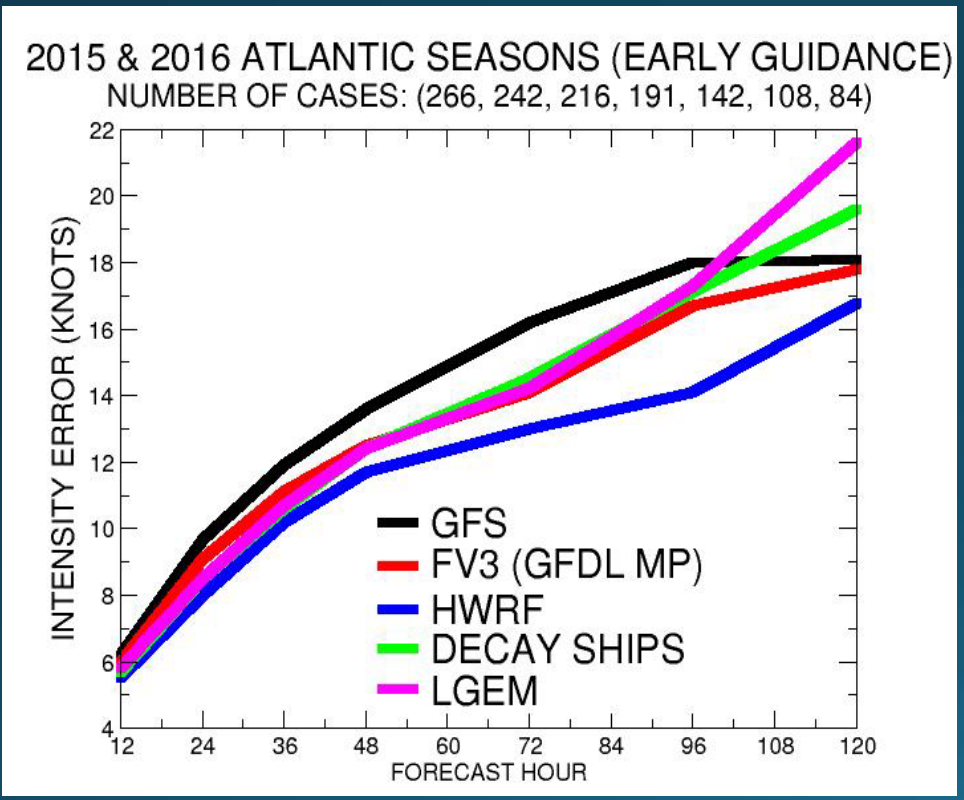




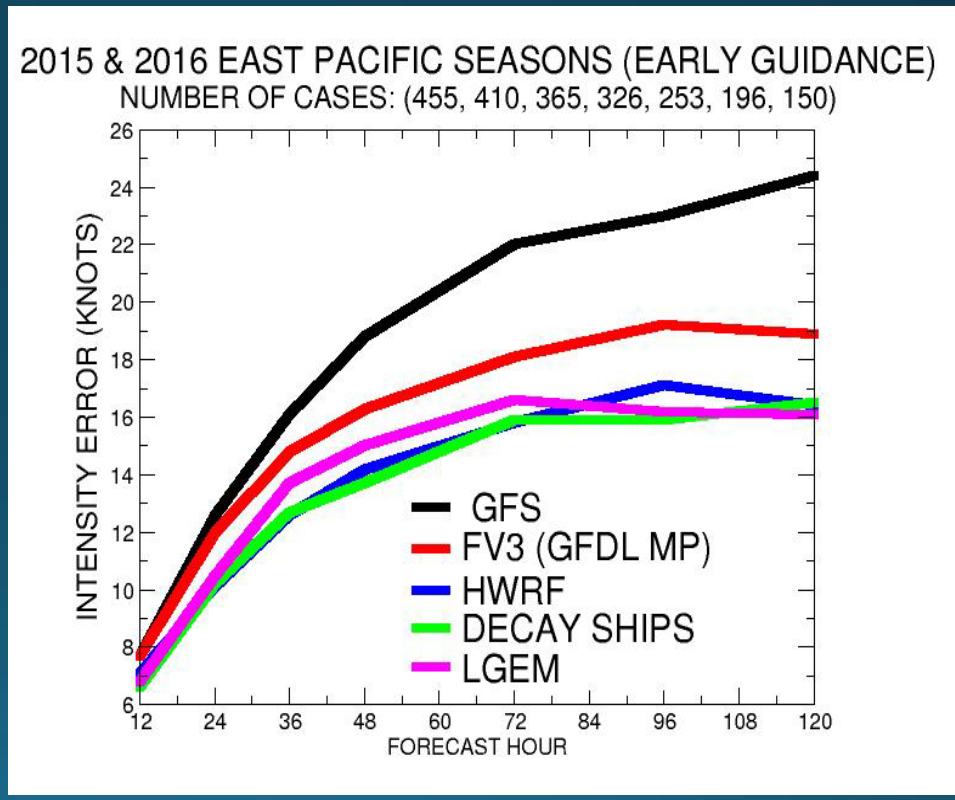


Early Model Intensity Guidance

Atlantic Basin

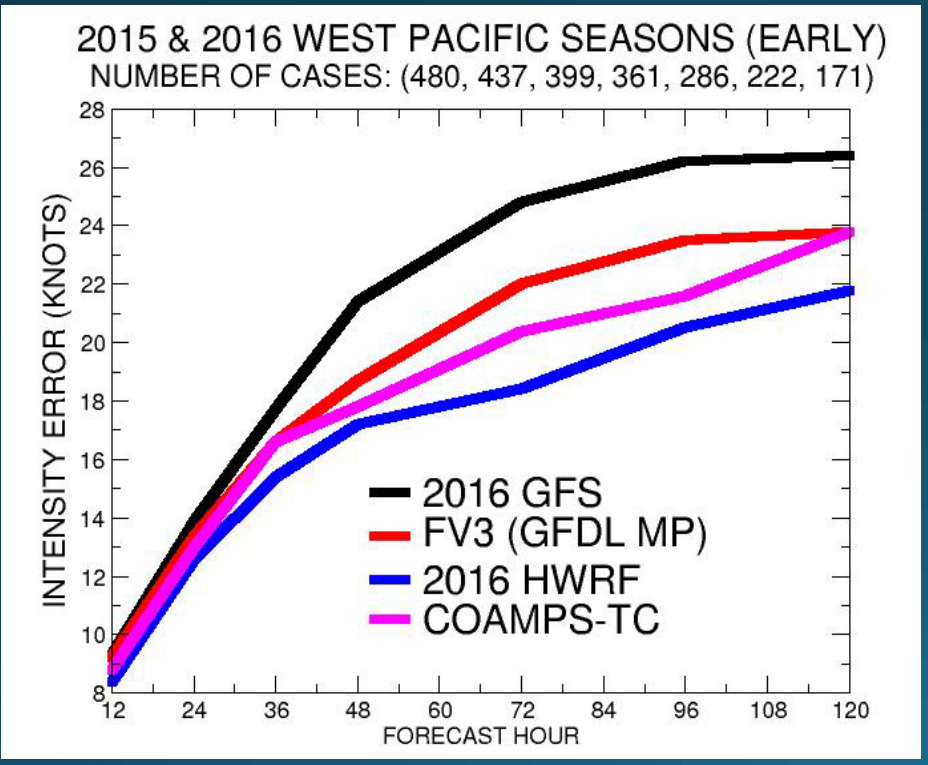


East Pacific Basin



Early Model Intensity Guidance

West Pacific Basin



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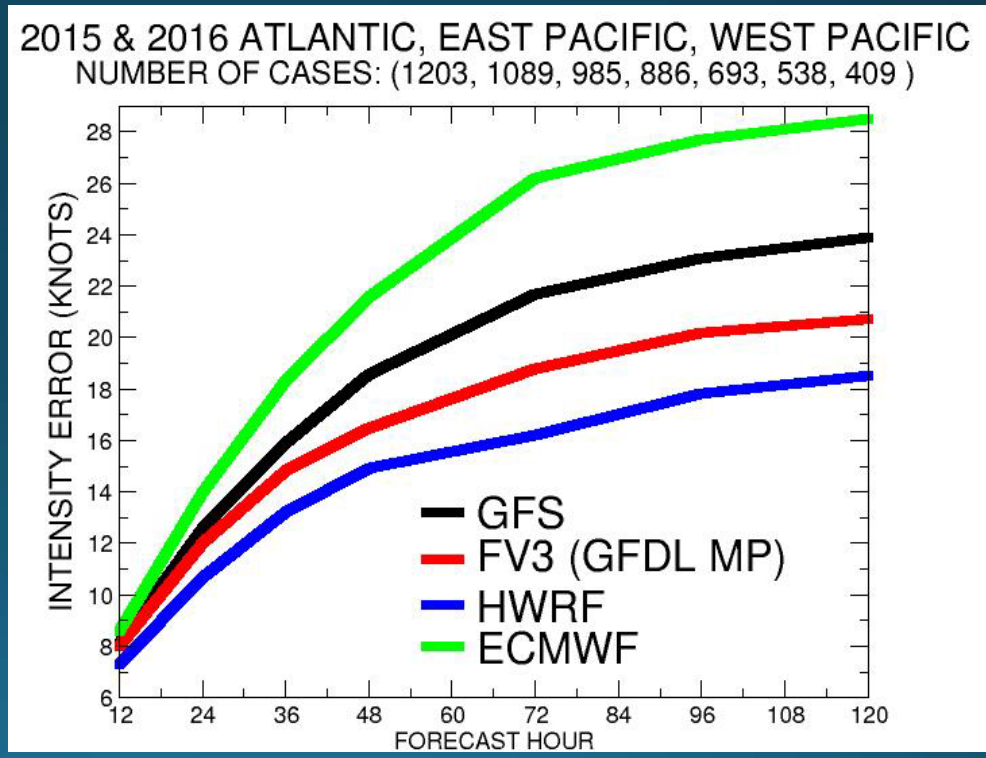
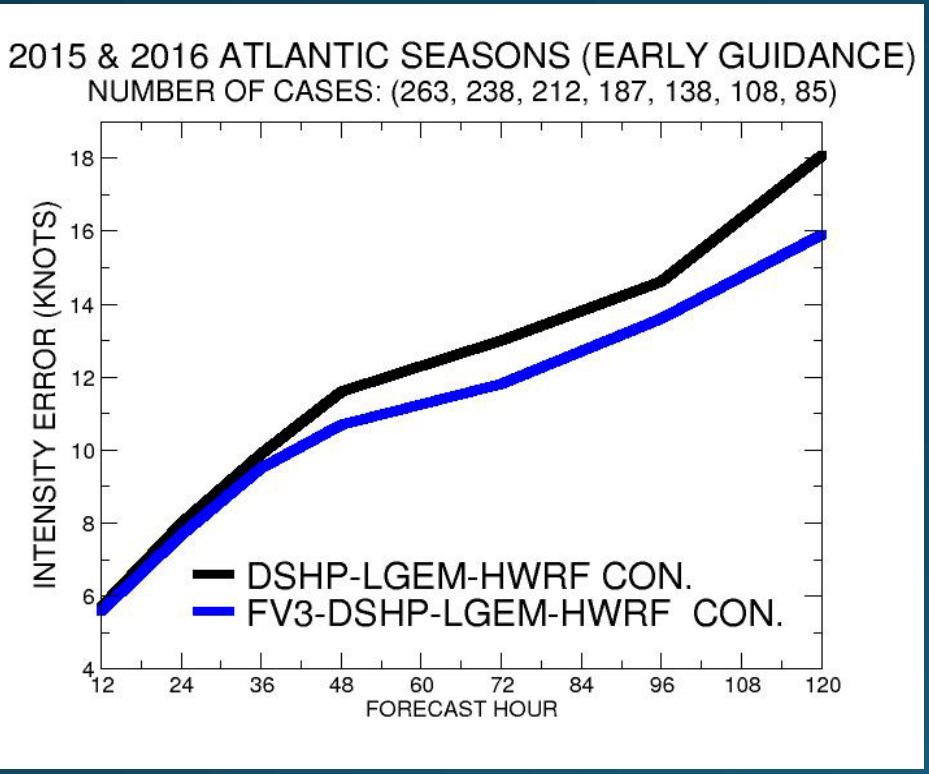
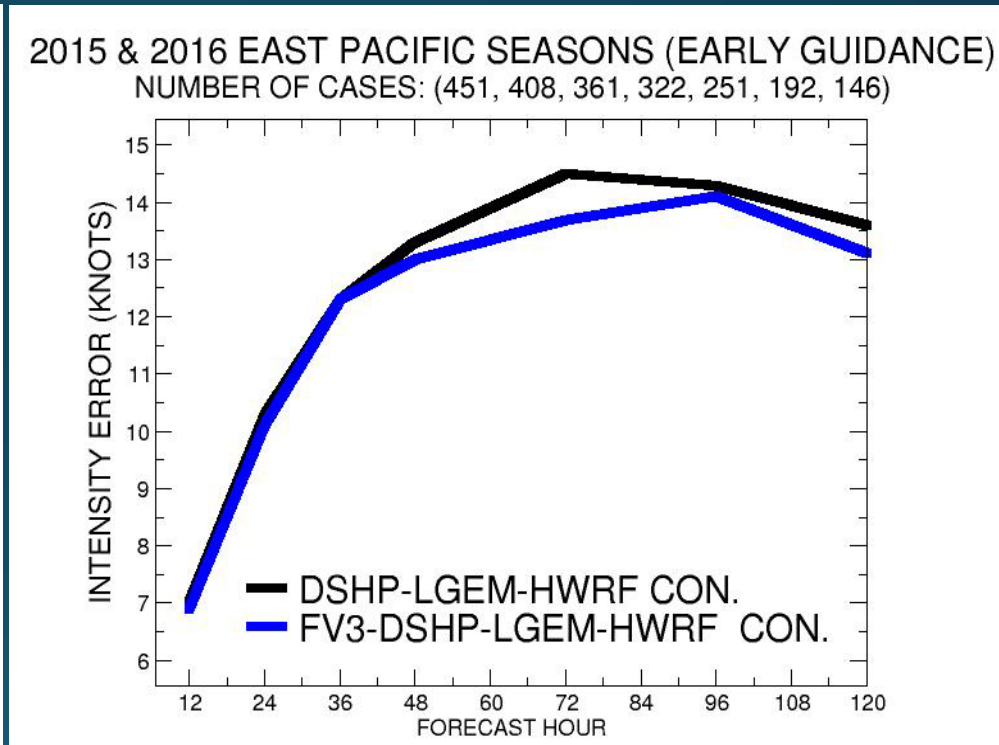


Impact of FV3 Intensity Guidance on Model Consensus



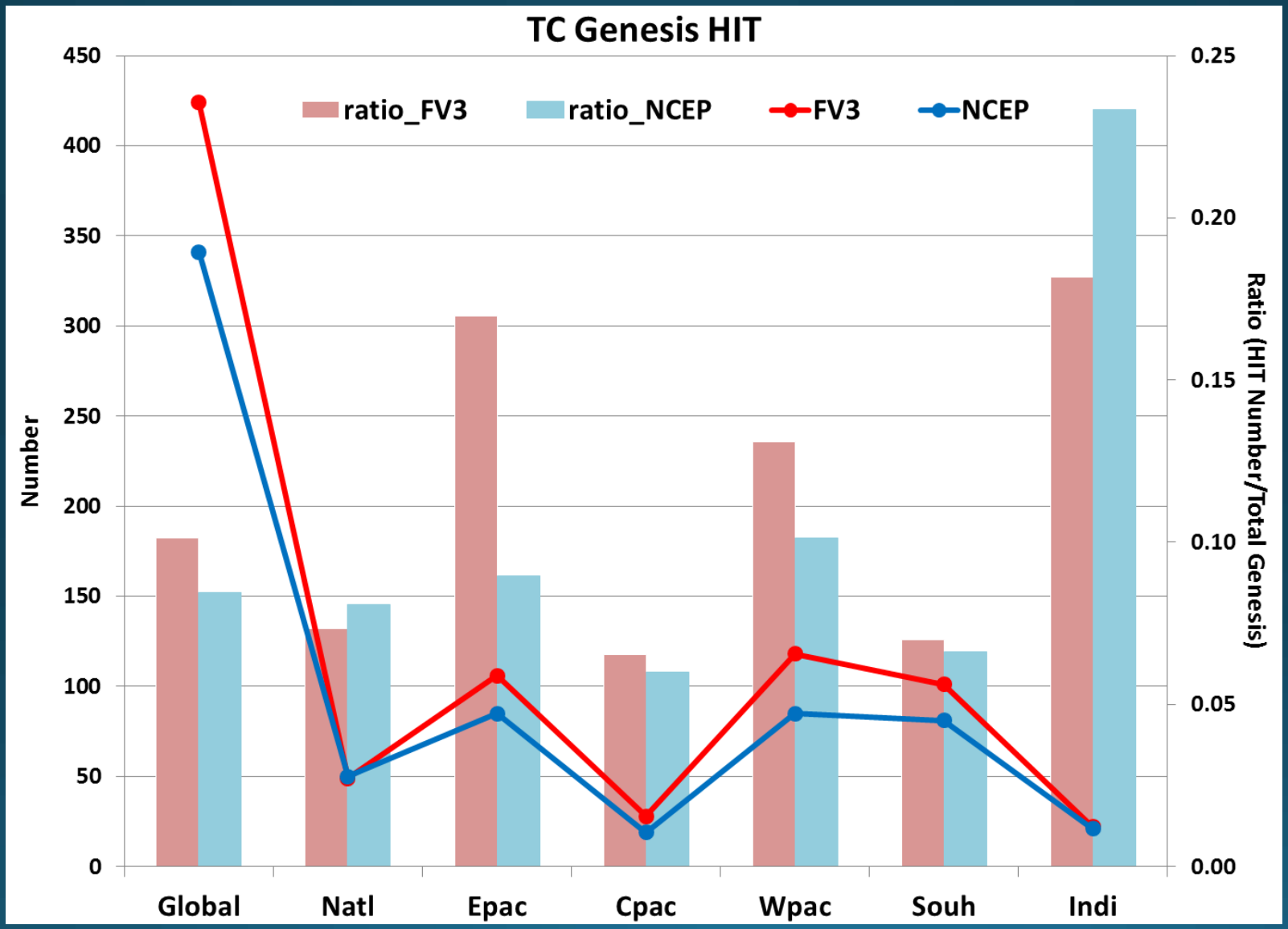


Addition of the FV3 in the DSHP-LGEM-HWRF model consensus reduced intensity errors 11 % in the Atlantic and 5% in the East Pacific at 2-5 day forecast lead times!

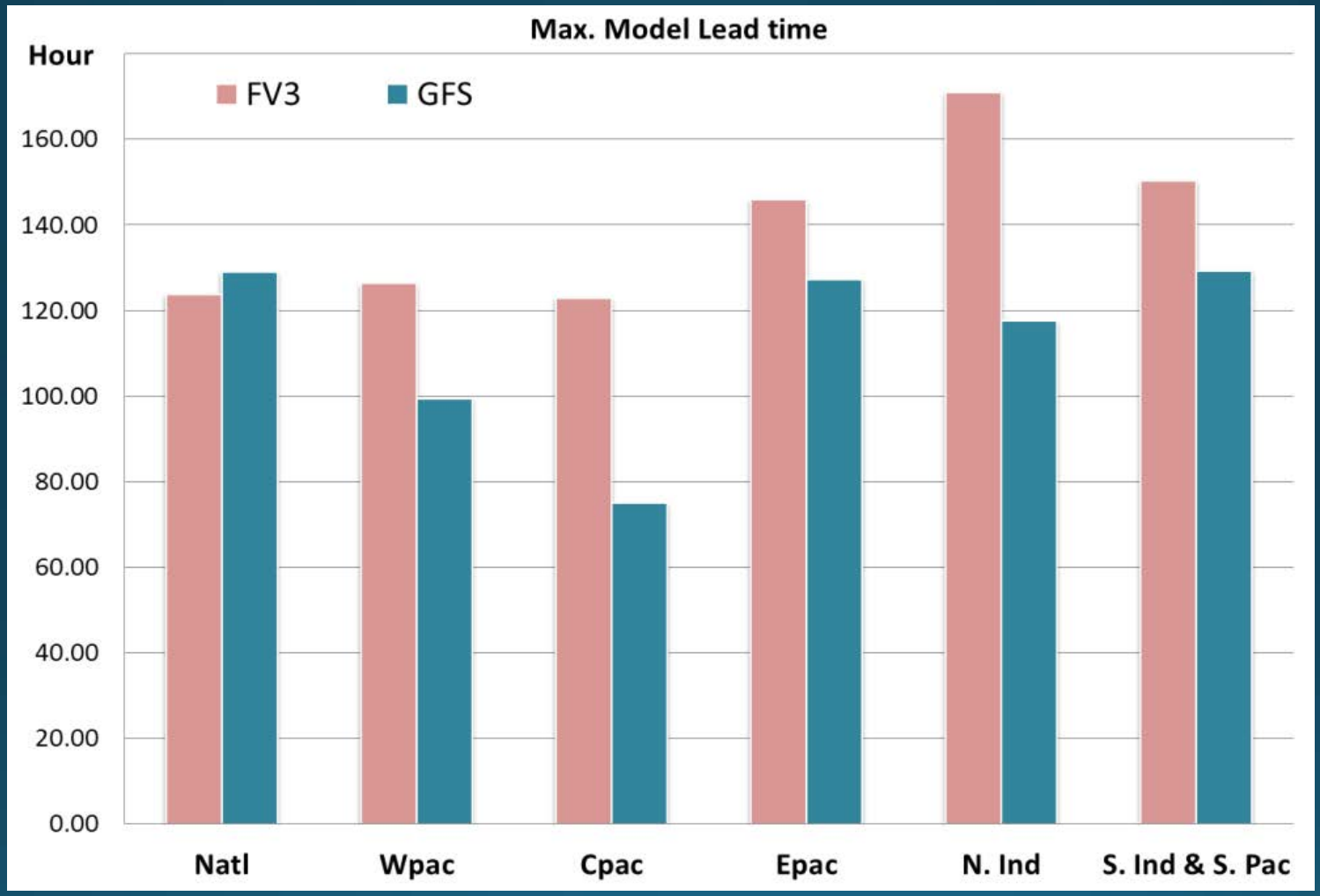
How About Storm Genesis?

Preliminary results for 2015 season only

with Zhao-Carr microphysics


TC Genesis HIT
ratio_FV3
ratio_NCEP
FV3
NCEP
Number
Ratio (HIT Number/Total Genesis)
450
400
350
300
250
200
150
100
50
0
0.25
0.20
0.15
0.10
0.05
0.00
Global
Natl
Epac
Cpac
Wpac
Souh
Indi

Lead Time for Storm Genesis



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.