TC forecasting performance of the EMC & GFDL versions of global fvGFS

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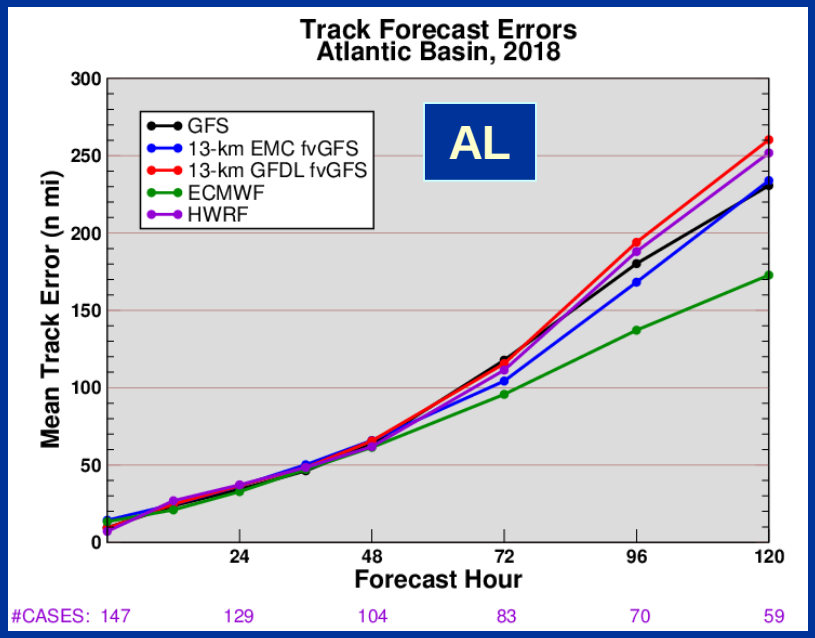
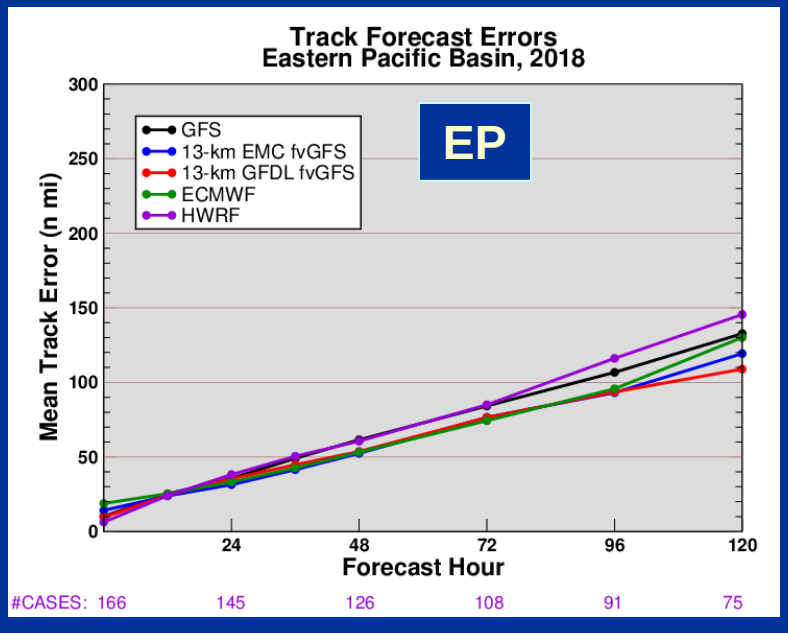
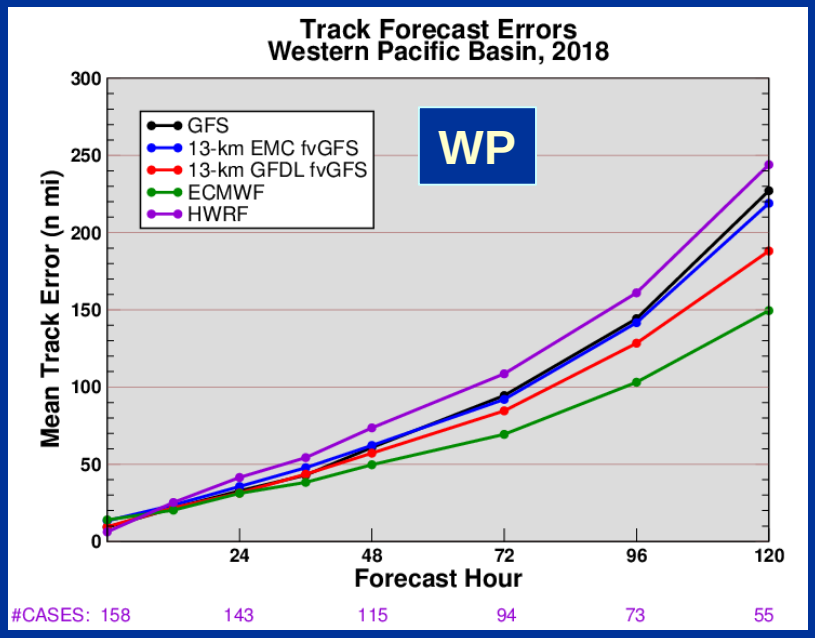
fvGFS versions run by EMC & GFDL during 2018

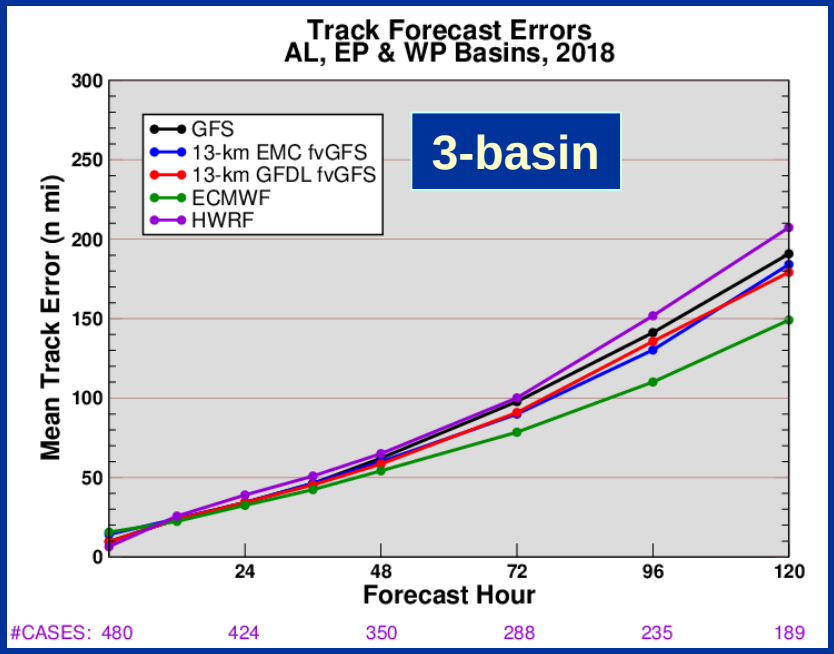
	Characteristics of fvGFS versions used for 2018 TC forecasts		
	EMC Para fvGFS	**GFDL fvGFS**	**GFDL nested 3-km hfvGFS**
Horizontal Resolution	13 km	13 km	3 km
Vertical levels	64	91	63
Data assimilation	Cycled DA using para fvGFS	Inherits from operational GDAS	Inherits from operational GDAS
Vortex Initialization	None	Inherits vortex relocation from GFS	Inherits vortex relocation from GFS
Convection	Scale-Aware SAS	Scale-Aware SAS	Scale-Aware SAS (coarse grid only)
Microphysics	GFDL	GFDL	GFDL
PBL	EDMF	YSU	YSU
Tracer Advection scheme	Strictly Monotonic	positive-definite tracer	positive-definite tracer
HORD setting	HORD = 5	HORD=5	HORD=5
Ocean Coupling	None	1-D mixed layer model	1-D mixed layer model

5-day track forecast errors in AL, EP & WP Basins

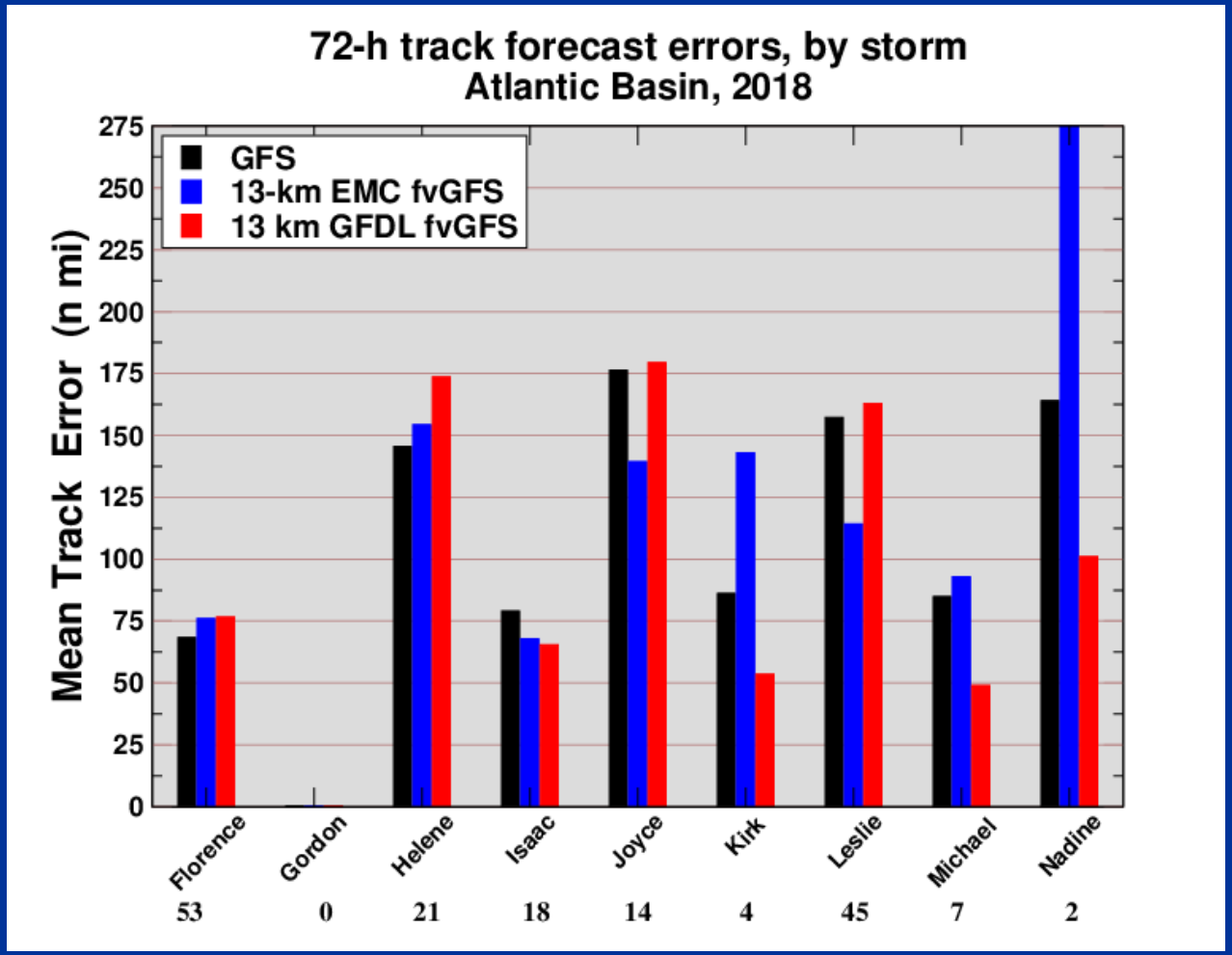






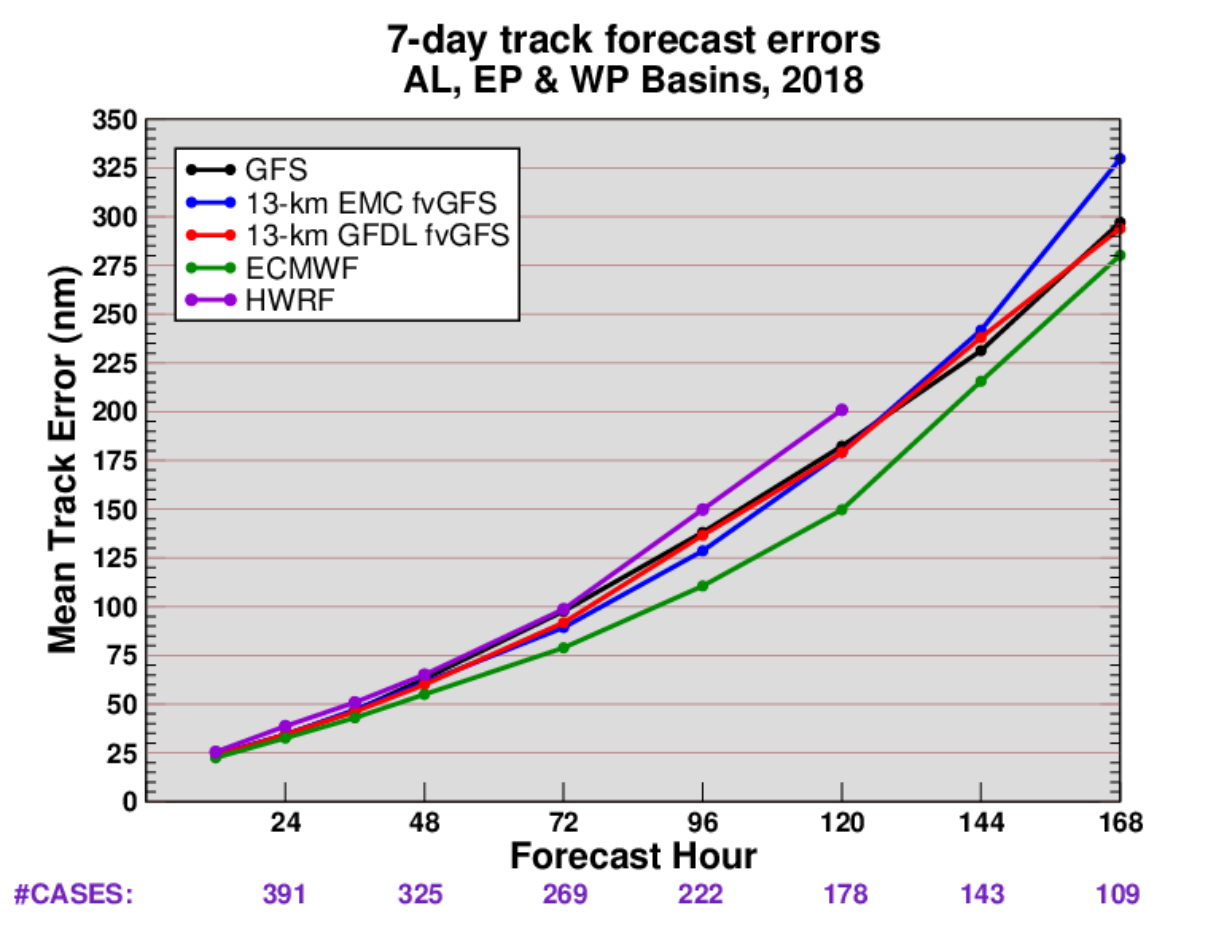


72-h track errors in the Atlantic Basin, by storm



- Mixed performance by storm among GFS and both versions of fvGFS

7-day track forecast errors

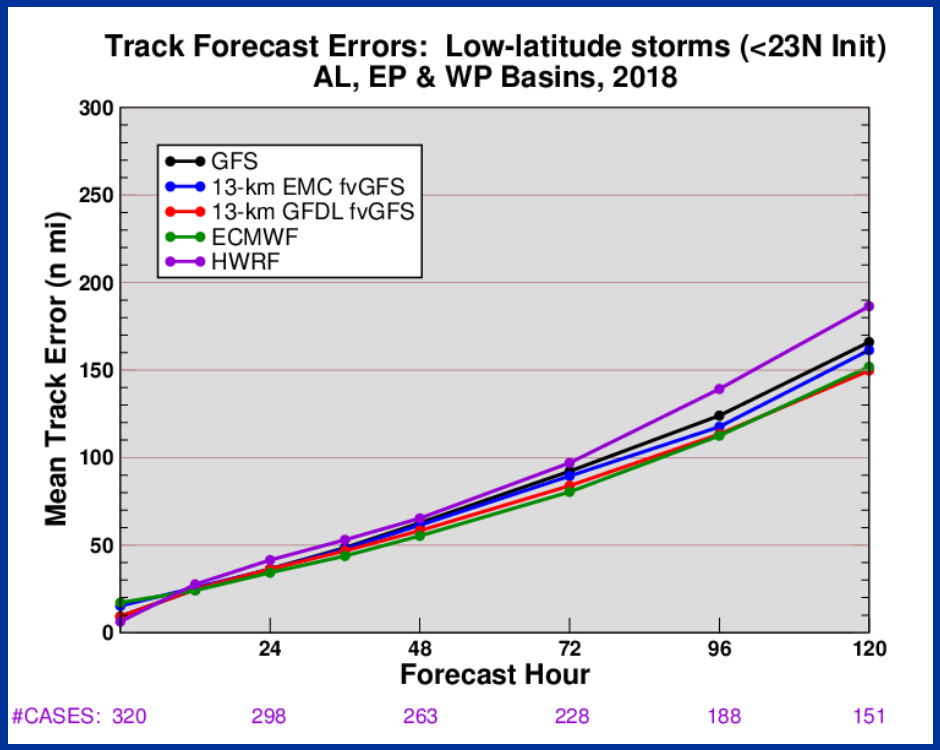


- ECMWF leads through 7 days.
- GFS and GFDL-fvGFS converge towards ECMWF by 7 days.
- EMC-fvGFS diverges from other 3 models after Day 5.

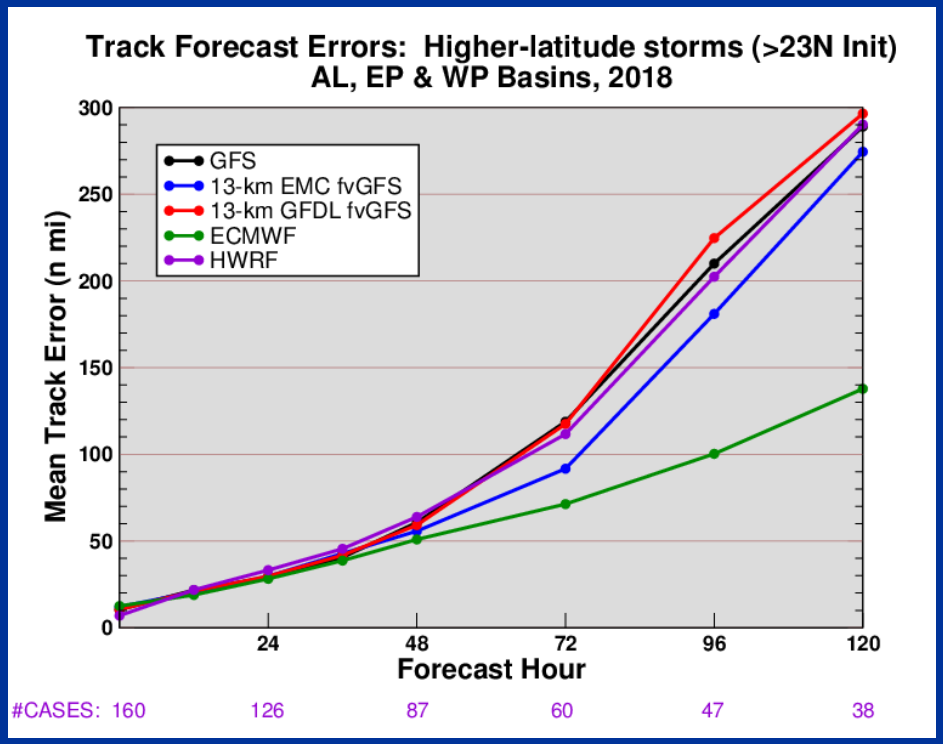
Track forecast errors, stratified by initial latitude

Combined errors for AL, EP & WP Basins

Low-latitude storms

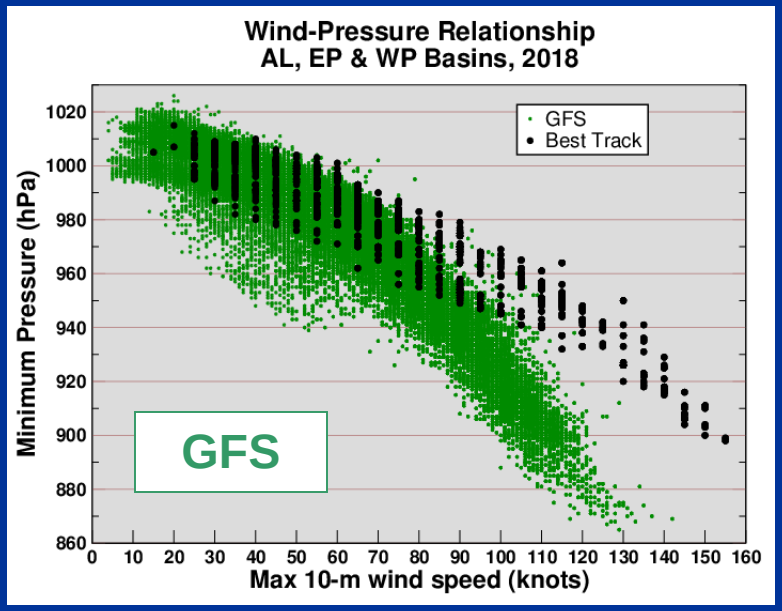


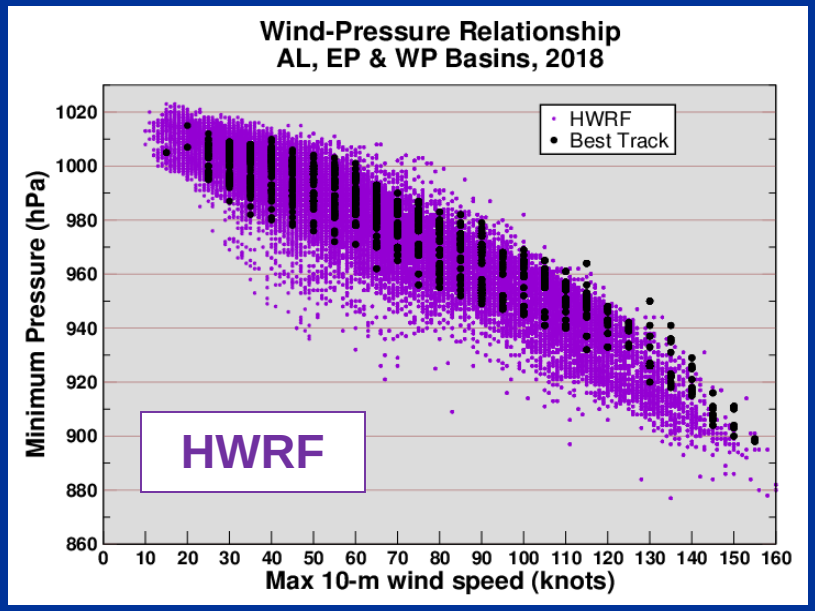
Higher-latitude storms

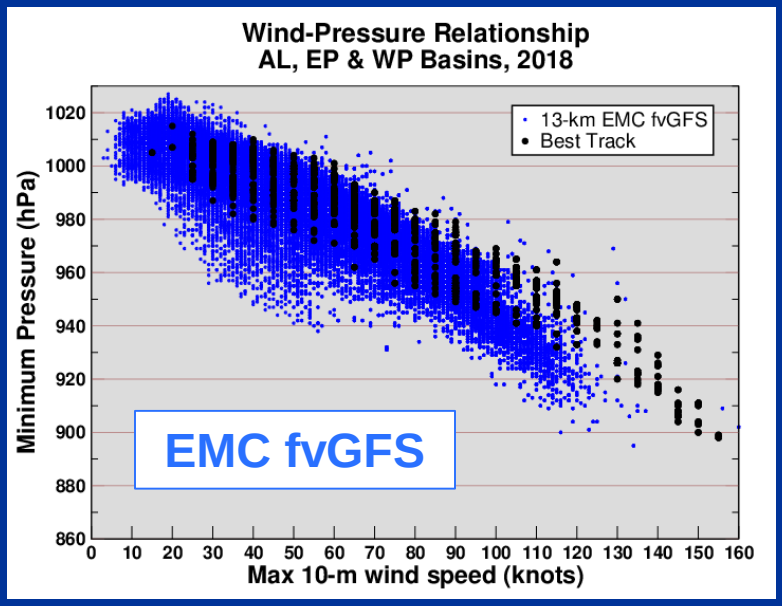


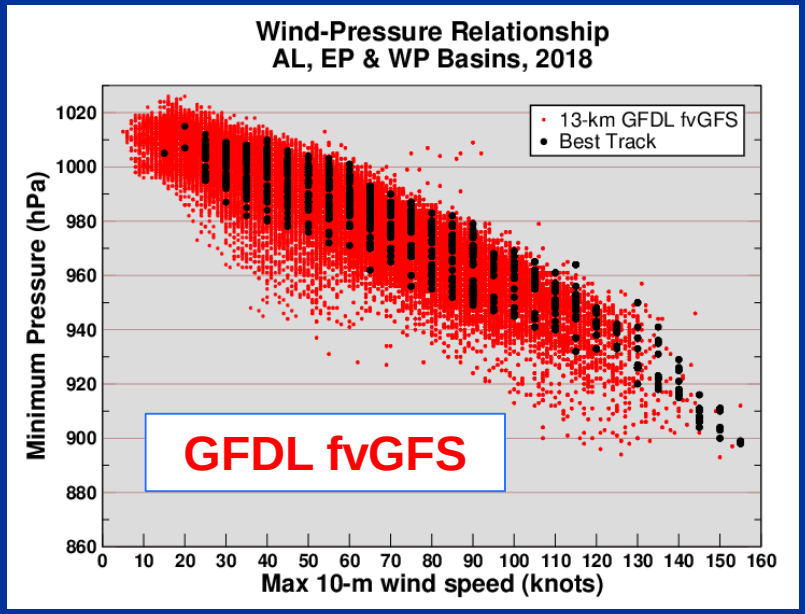
- GFS & both versions of fvGFS comparable to ECMWF at low latitudes.
- EMC-fvGFS outperforms other NCEP & GFDL models at high latitudes, but all lag behind ECMWF at 3-5 days.

Wind-Pressure relationship in AL, EP & WP Basins

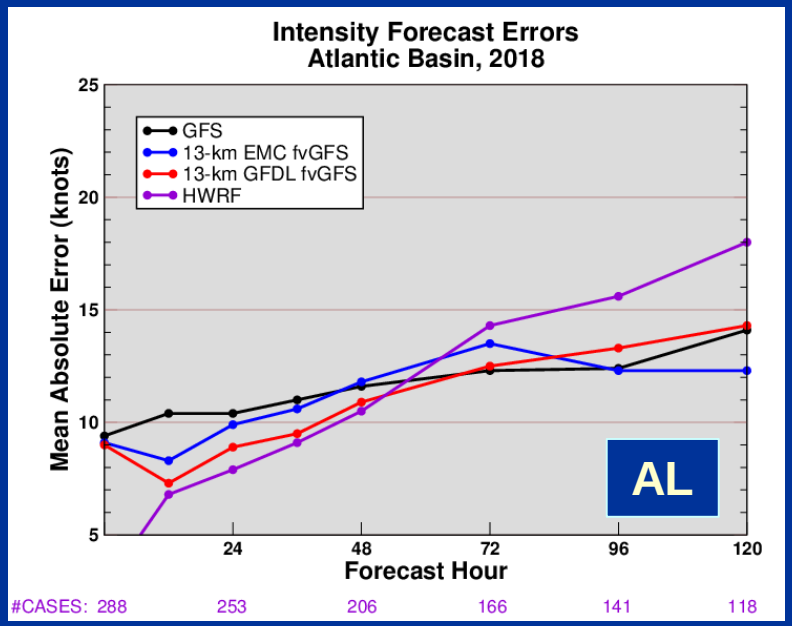


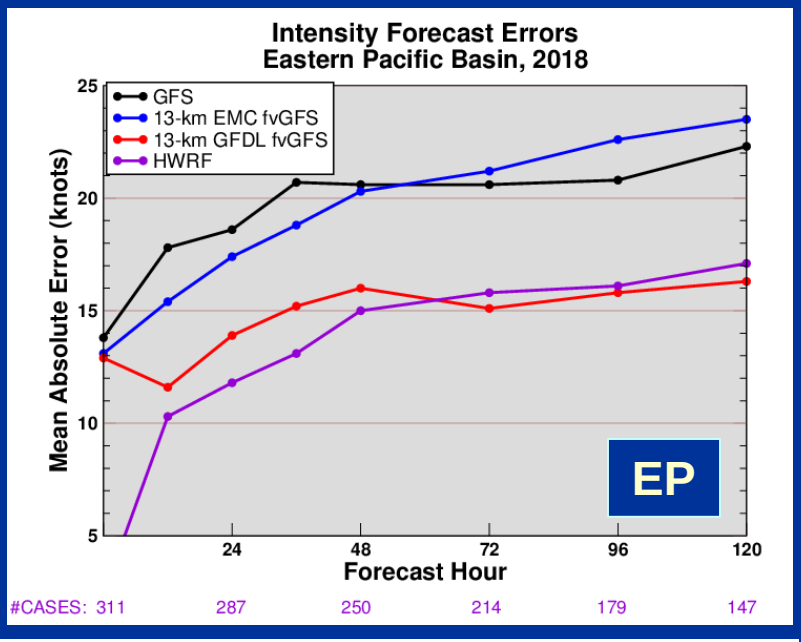


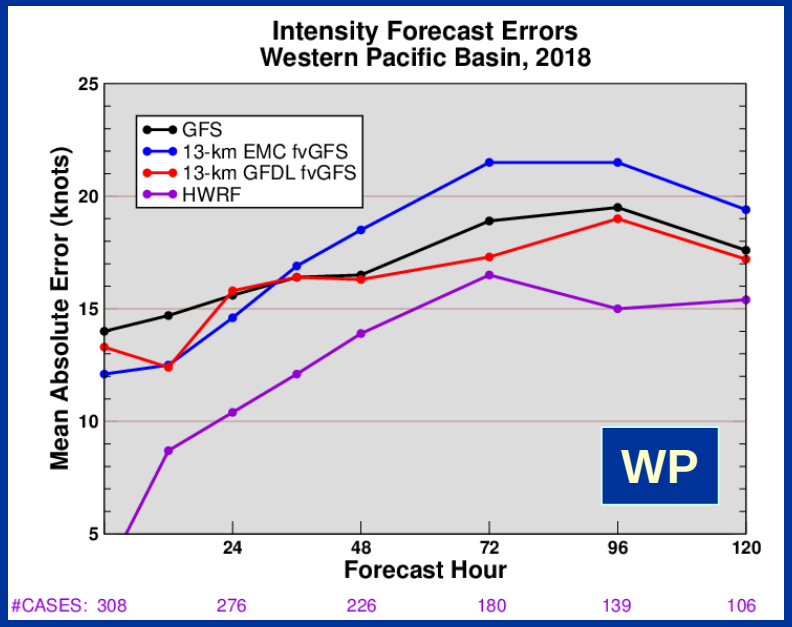


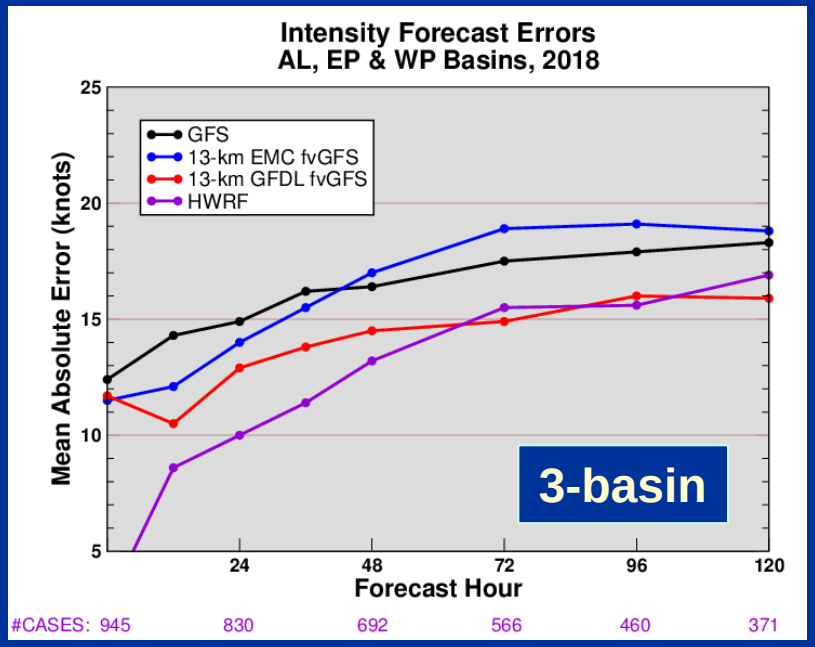


5-day intensity forecast errors in AL, EP & WP Basins





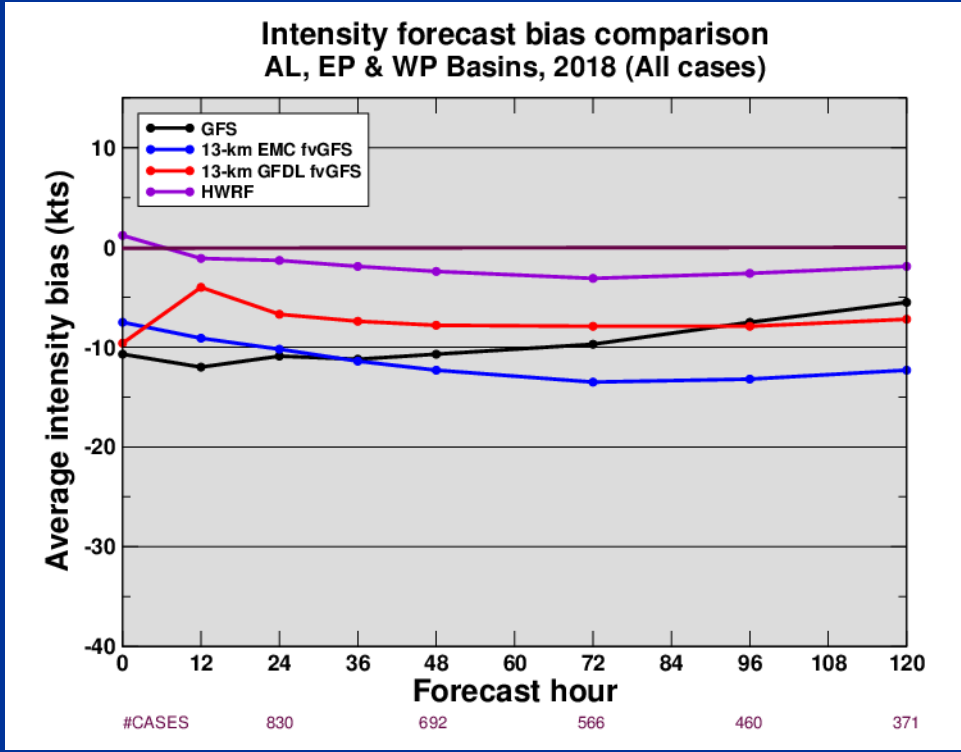




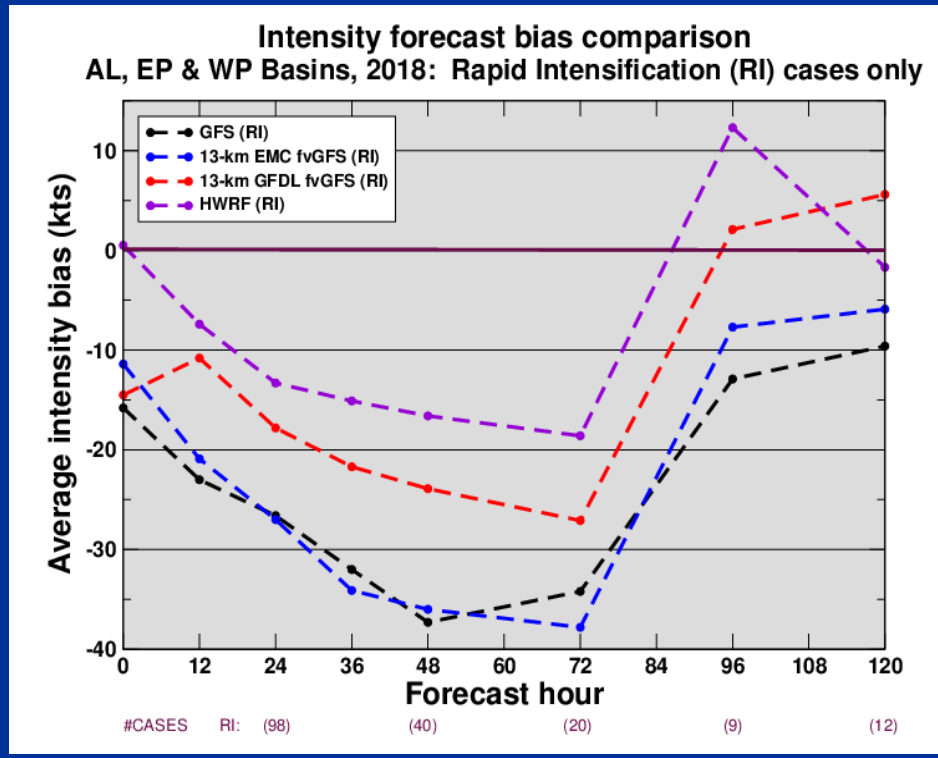
Intensity forecast bias: All cases & RI cases

Combined biases for AL, EP & WP Basins

All cases



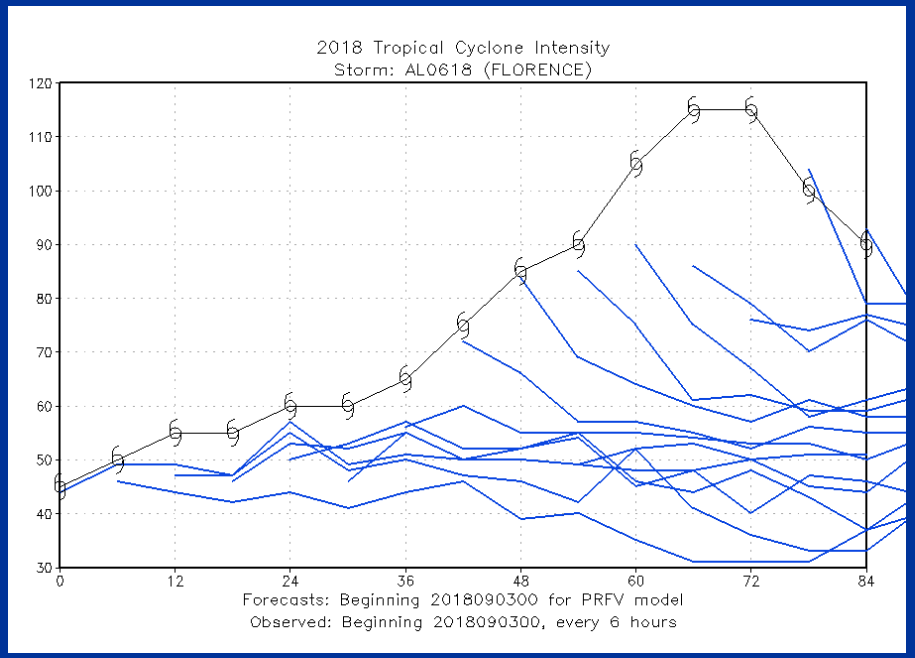
RI cases only



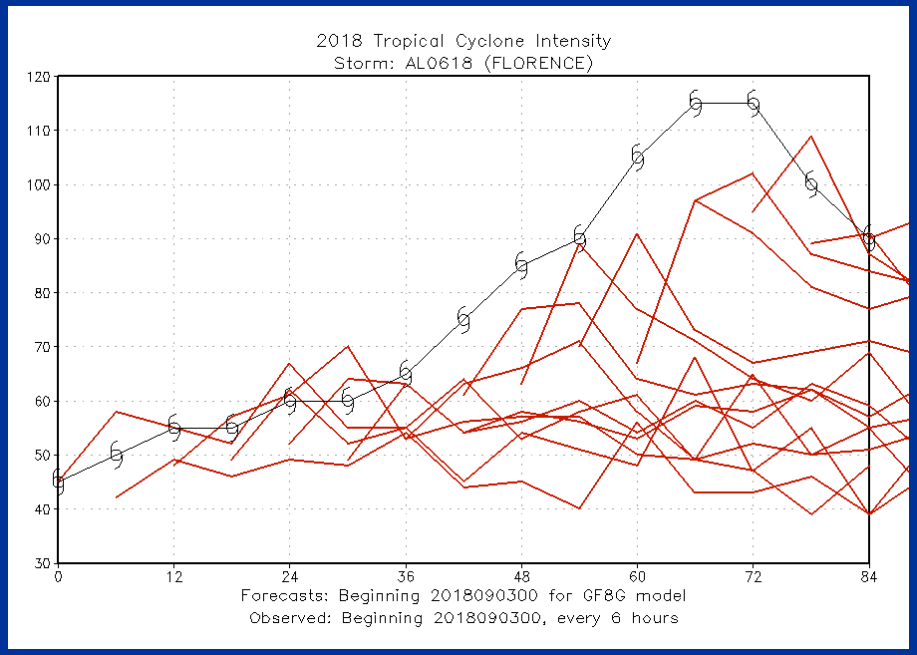
- Dramatic increase in negative intensity forecast bias for RI cases.
- GFS and EMC fvGFS experience the largest change in bias over the first 72h, relative to the “All cases” sample.

Intensity forecasts during Florence's 1st RI

13-km EMC fvGFS



13-km GFDL fvGFS



Fundamental difference (weakening vs. intensification) in first 12h of most forecasts leading up to Florence's peak intensity.

- Possible causes: Imbalance in initial condition for strong / intensifying storms; Differences in the tracer advection schemes

FV3GFS all-sky radiance assimilation with the GFDL microphysics scheme

- The advanced microphysics scheme (GFDL MP) makes it possible to assimilate all-sky radiances using full set of hydrometers.
- GSI and EnKF have been modified in order to assimilate all-sky radiances using individual hydrometeors as control variables.
- Tangent linear and adjoint operators used to convert between control and state variables is no longer needed (QLQI vs. CNTL).
- Including rain, snow and graupel allows assimilation of precipitation-affected radiance (ALLQ vs. CNTL).
- Assimilation of cloud and precipitation-affected radiance is a challenge, but has a lot of potential for hurricane initialization.

[Content provided by Mingjing Tong]

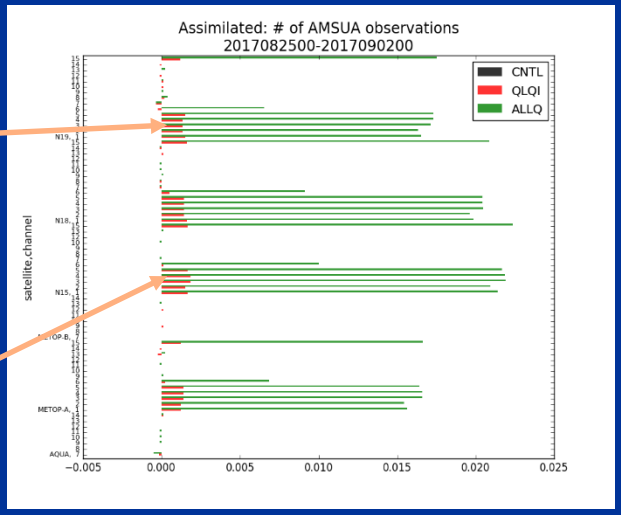
Experiment	Control Variable	CRTM	Observations
CNTL (2019 FV3GFS)	cloud water (sum of cloud liquid water and cloud ice)	2.2.3 assuming overcast	AMSUA and ATMS non-precipitating clouds over ocean
QLQI	Cloud liquid water and cloud ice	2.2.3 assuming overcast	AMSUA and ATMS non-precipitating clouds over ocean
ALLQ	Cloud liquid water, cloud ice, rain, snow and graupel	2.3.0 Two-column cloud overlap scheme (subgrid-scale variability) Improved surface reflectance for MV under scattering condition	Clouds and **precipitation** affect AMSUA and ATMS over ocean

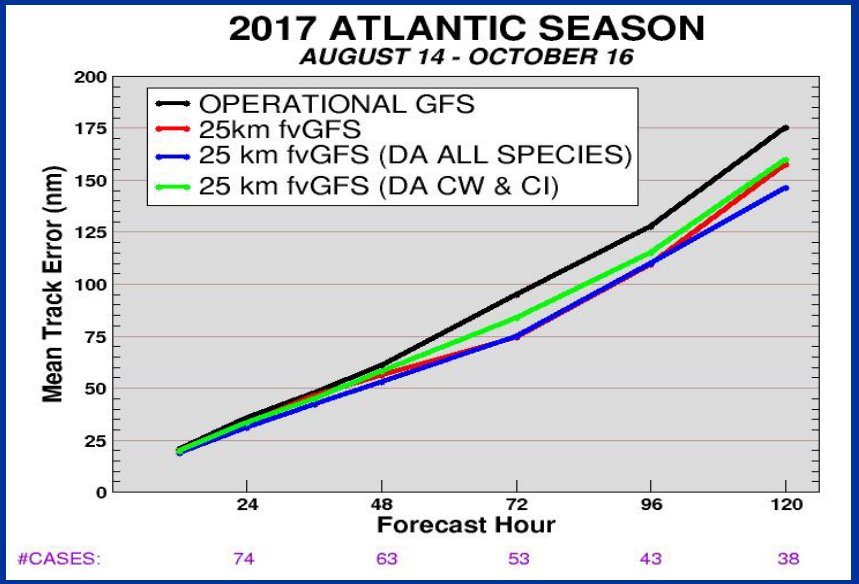
* All experiments run with 4DEnVar at C384 control and C192 ensemble. 240hr forecast from August 14 to October 16, 2017 at 00Z.

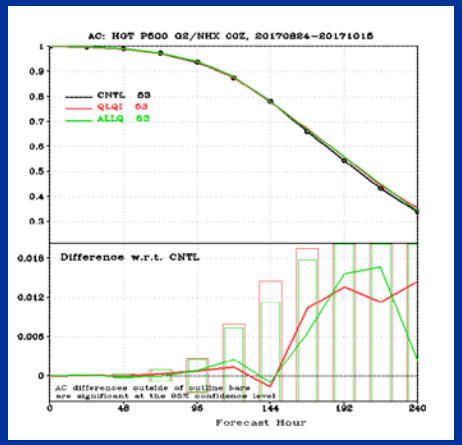
FV3GFS all-sky radiance assimilation: Results

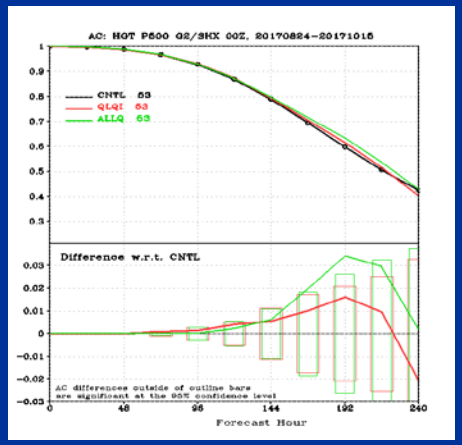
QLQI vs CNTL: more data from channels sensitive to cloud are assimilated

ALLQ vs CNTL/ QLQI: Precipitation-affected data are assimilated

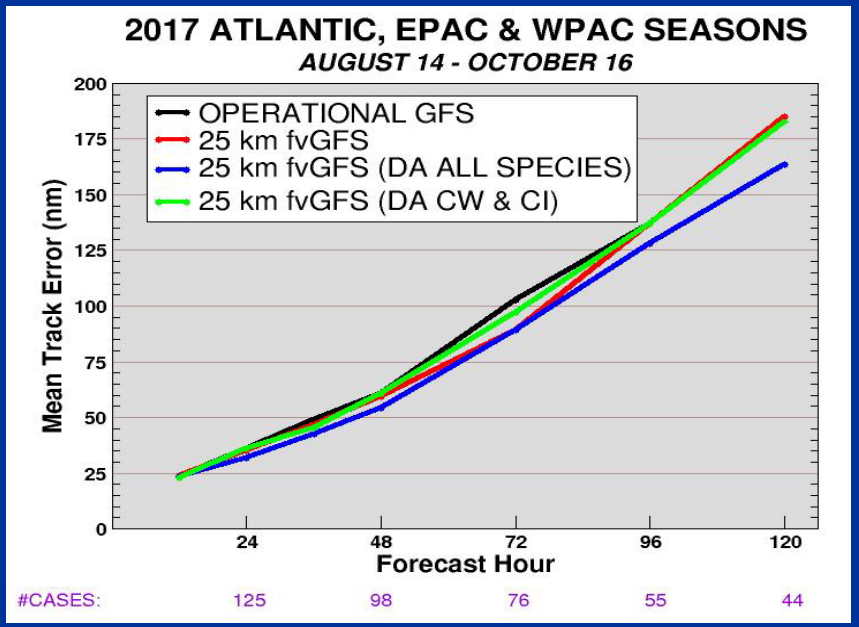








500 hPa ACC – neutral to positive impact relative to CNTL



Summary

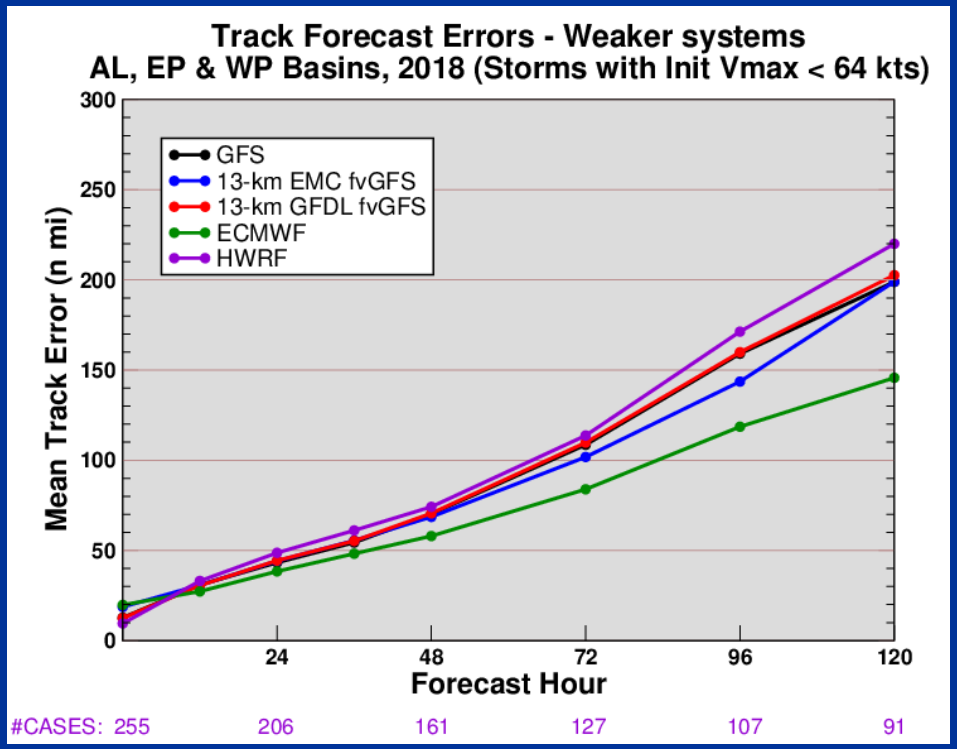
- Globally, EMC & GFDL fvGFS versions comparable for track.
- GFDL fvGFS outperforms EMC version for intensity in EP & WP.
- GFDL fvGFS outperforms GFS & EMC fvGFS for RI cases.
- Differences in intensification / weakening behavior between fvGFS versions for RI cases may be partially related to choices for advection.
- In preliminary testing, improved assimilation of all-sky radiances to initialize microphysical variables has led to a reduction in track forecast error.

Extra slides

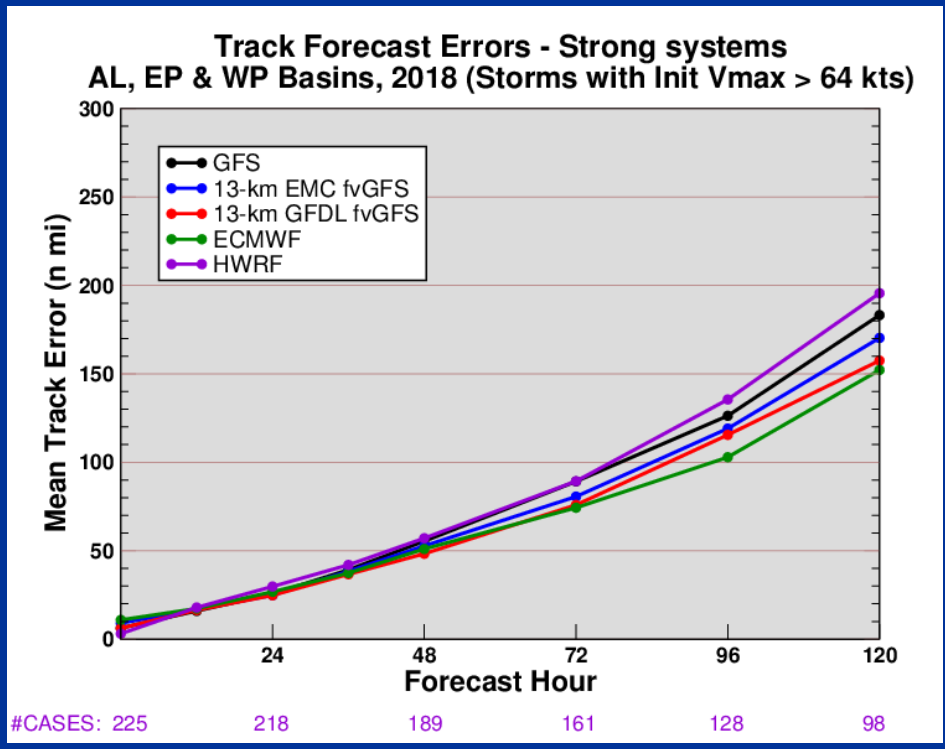
Track forecast errors, stratified by initial Vmax

Combined errors for AL, EP & WP Basins

Weaker systems (TD, TS)



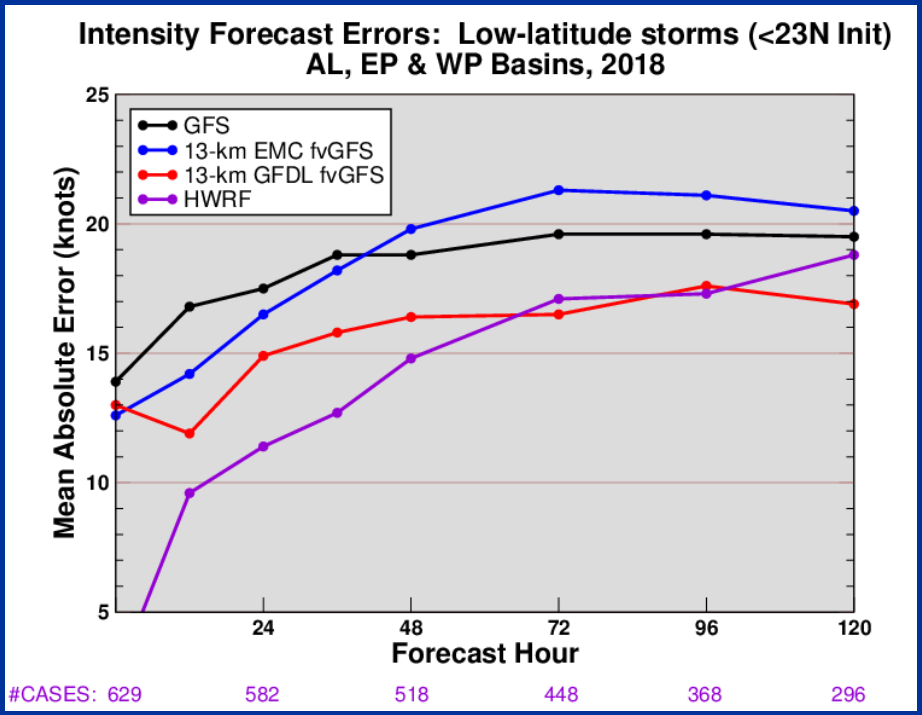
Stronger systems (Hur+)



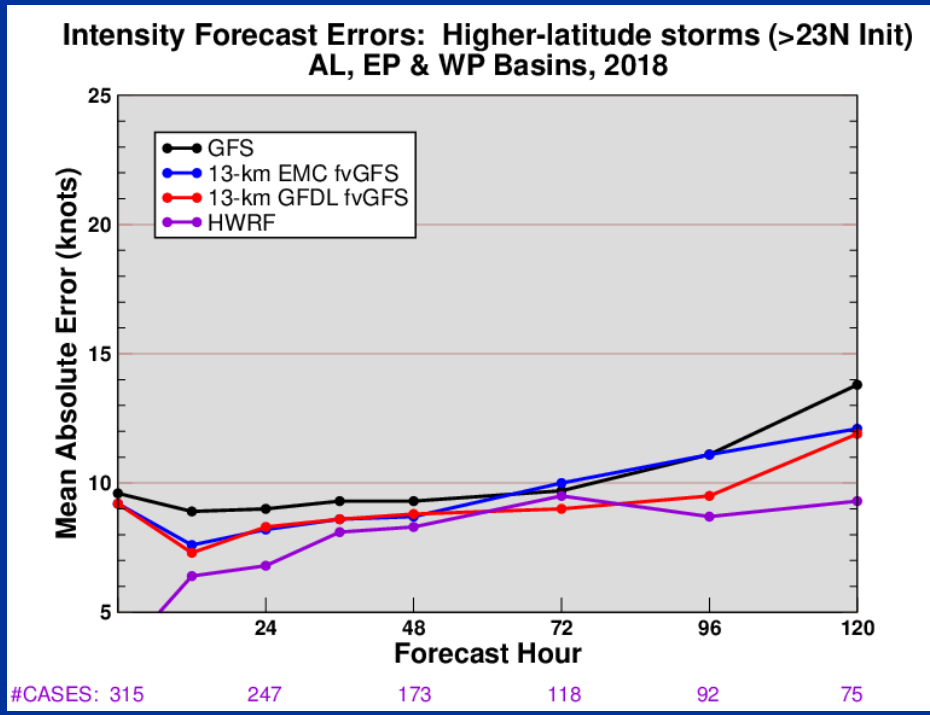
Intensity forecast errors, stratified by initial latitude

Combined errors for AL, EP & WP Basins

Low-latitude storms

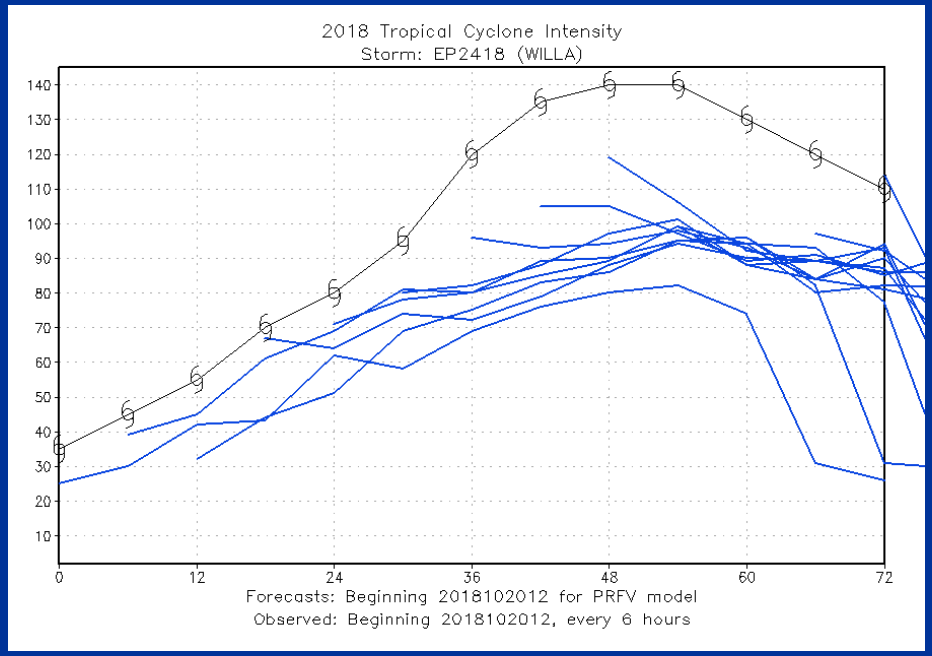


Higher-latitude storms

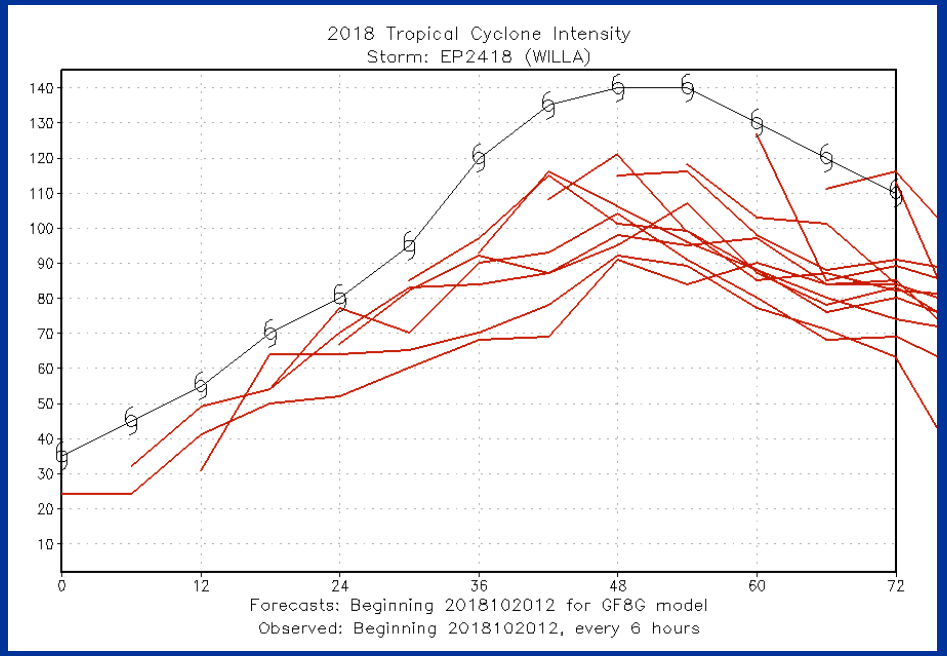


Intensity forecasts during Willa's RI

13-km EMC fvGFS



13-km GFDL fvGFS



10-m wind radii verification (bias)