Further Updates to the Tropical Cyclone Logistic Guidance for Genesis (TCLOGG)

Bob Hart[1] and Dan Halperin[2]

Ryan Remondelli[1] (Ph.D. student) and Ian Mutschler[1] (UROP student)

[1]Florida State University, [2]Embry-Riddle Aeronautical University

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Project Background

- TC genesis forecasting has been added as a key operational priority.

- Global NWP guidance has advanced in terms of resolution and physics. The biases in the raw NWP output can be exploited by developing calibrated TC genesis guidance products.

- This guidance applies logistic regression to key variables from global NWP output to produce well-calibrated probabilities for TC formation.

Project Background (Continued)

- The logistic regression approach is applied to GFS, UKMET, CMC, NAVGEM, and ECMWF real-time output, and has provided well-calibrated guidance for TC genesis at 48 h and 120 h for the central & eastern Pacific and north Atlantic basins to aid the NHC/CPHC Tropical Weather Outlook (TWO) products:

  http://moe.met.fsu.edu/modelgen and http://moe.met.fsu.edu/modelgenec

- However, there has been considerable evolution in the raw global NWP guidance available over the past five years that, along with additional NHC goals and improved local techniques, have warranted further modifications to the TCLOGG guidance.

Major current project (JHT cycle 2019-2022) goals

- Extend genesis guidance from 2/5-days to 7-days. (COMPLETED)

- Develop a most likely time of genesis forecast through comparison of the timing of TC genesis within the individual models. (PROCEEDING)

- Expand the TCLOGG approach to use the GEFS Reforecast output to make use of ensemble data and the longer developmental dataset. (YEAR 3)

TCLOGG was run by the JHT facilitator on an NHC workstation in 2019 and 2020.
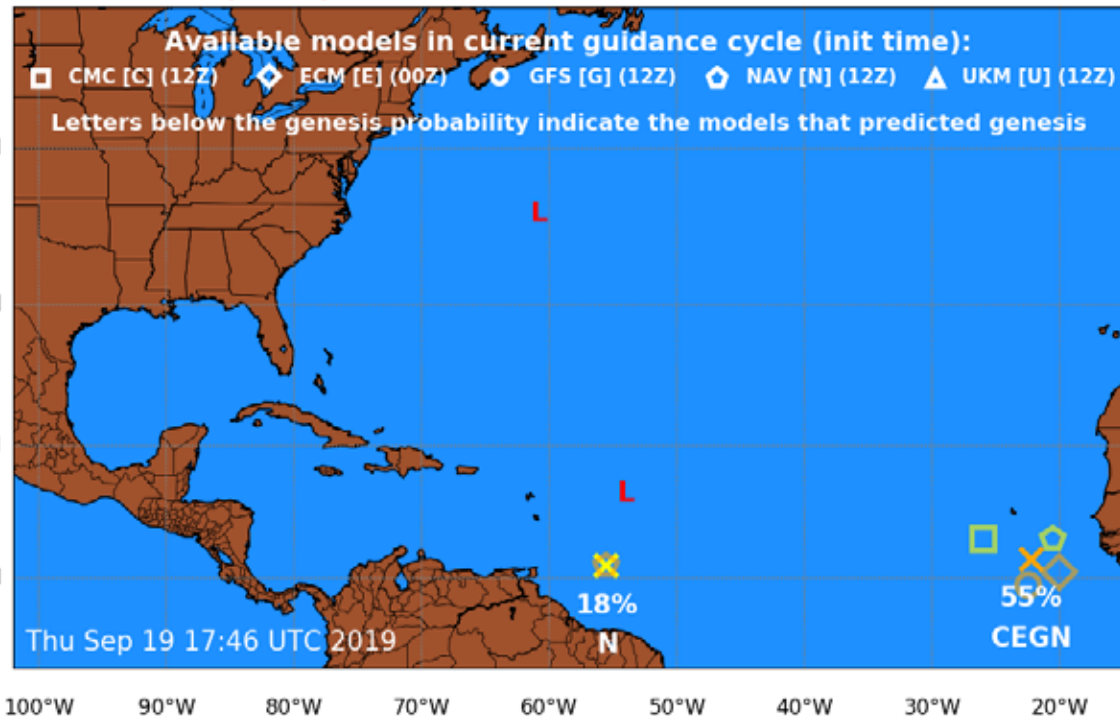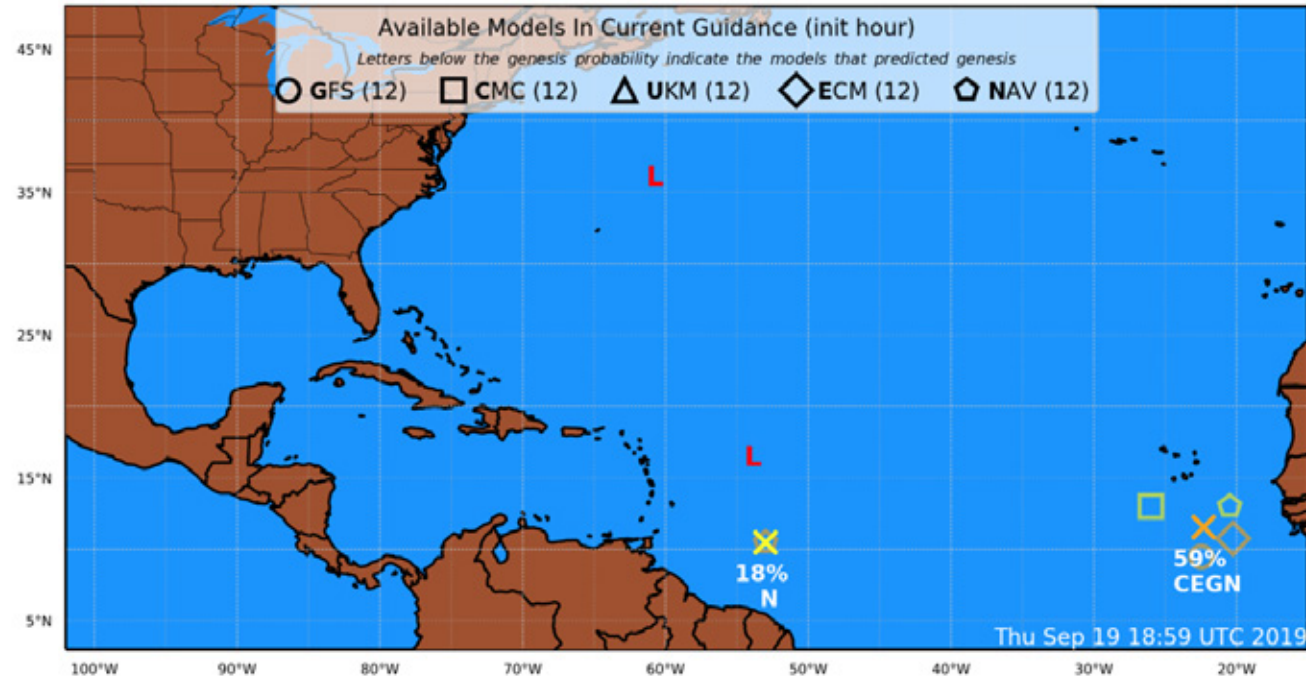
Guidance products with ECMWF output included are not available to the public and can only be shared with JHT project personnel (including NHC) per the licensing agreement.
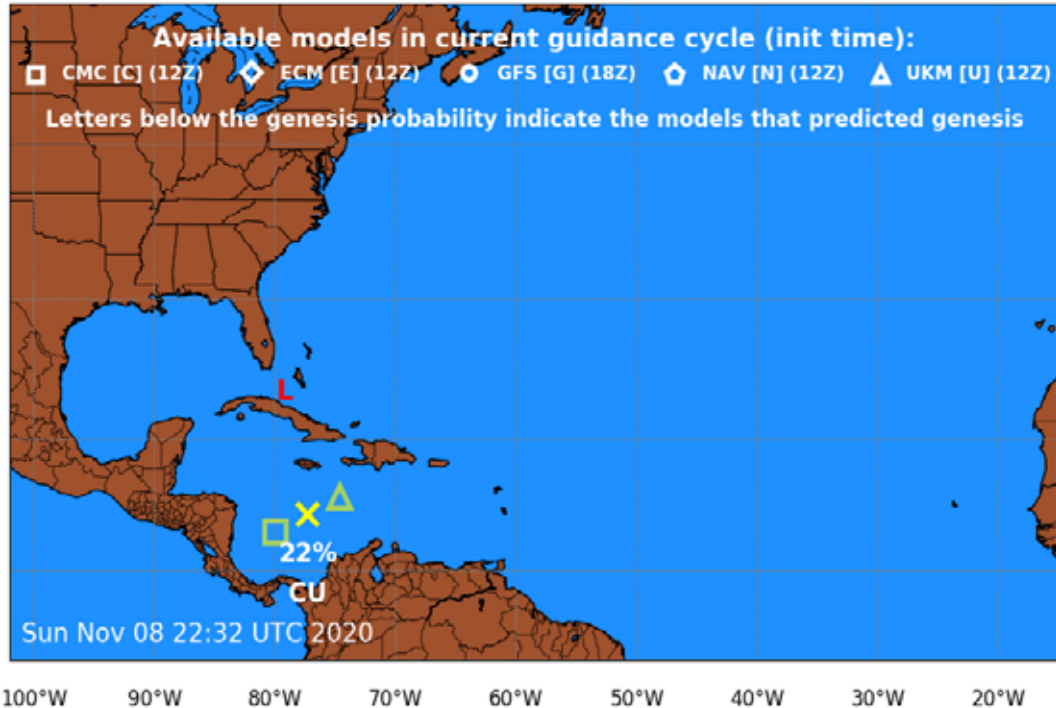Guidance products without ECMWF output are available to the general public at **http://moe.met.fsu.edu/modelgen**

Latitude-dependent thickness threshold improved detection of higher latitude events.

Current version

Experimental Version
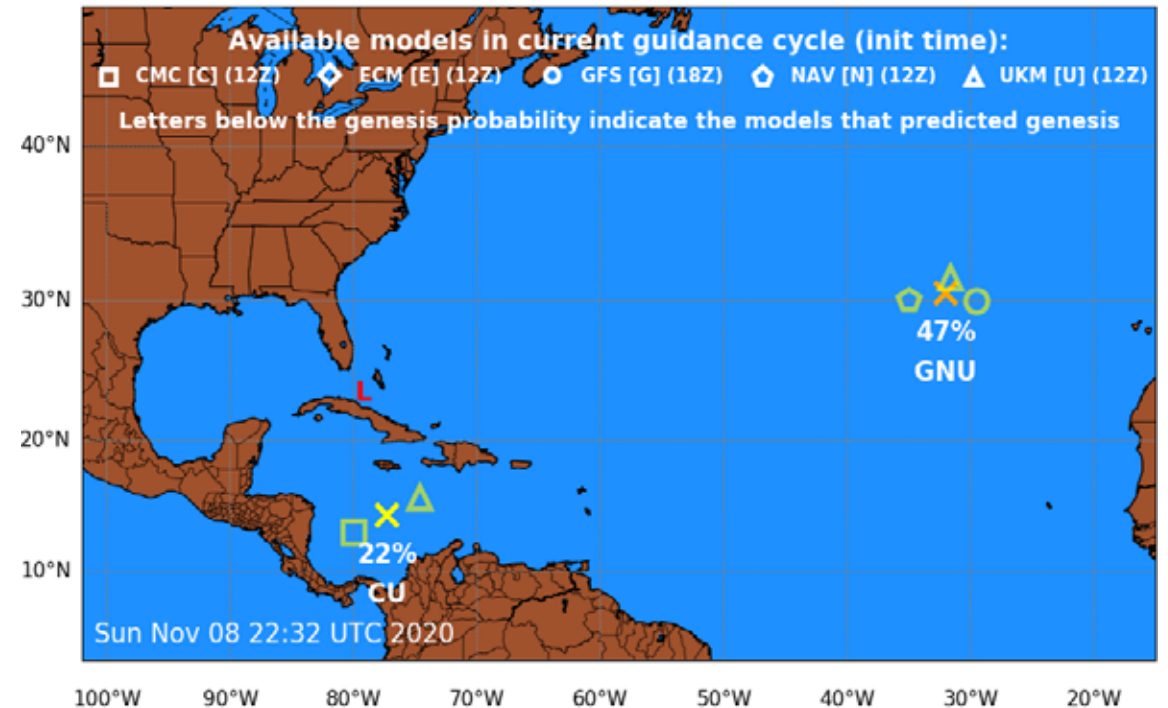
TCLOGG probabilities using the operational TC tracker (left) and experimental TC tracker with the latitude-dependent thickness threshold (right). The operational TC tracker failed to detect the system in the east-central Atlantic, but the experimental TC tracker detected the system and provided TC genesis guidance. This system became TS Theta.

0-48 h guidance generally had a low bias for the NATL and a high bias for the EPAC. CMC maintains a low bias due to model upgrade in 2019.

Preliminary 2020 TC genesis forecast verification within 48 h for the NATL

Preliminary 2020 TC genesis forecast verification within 48 h for the EPAC
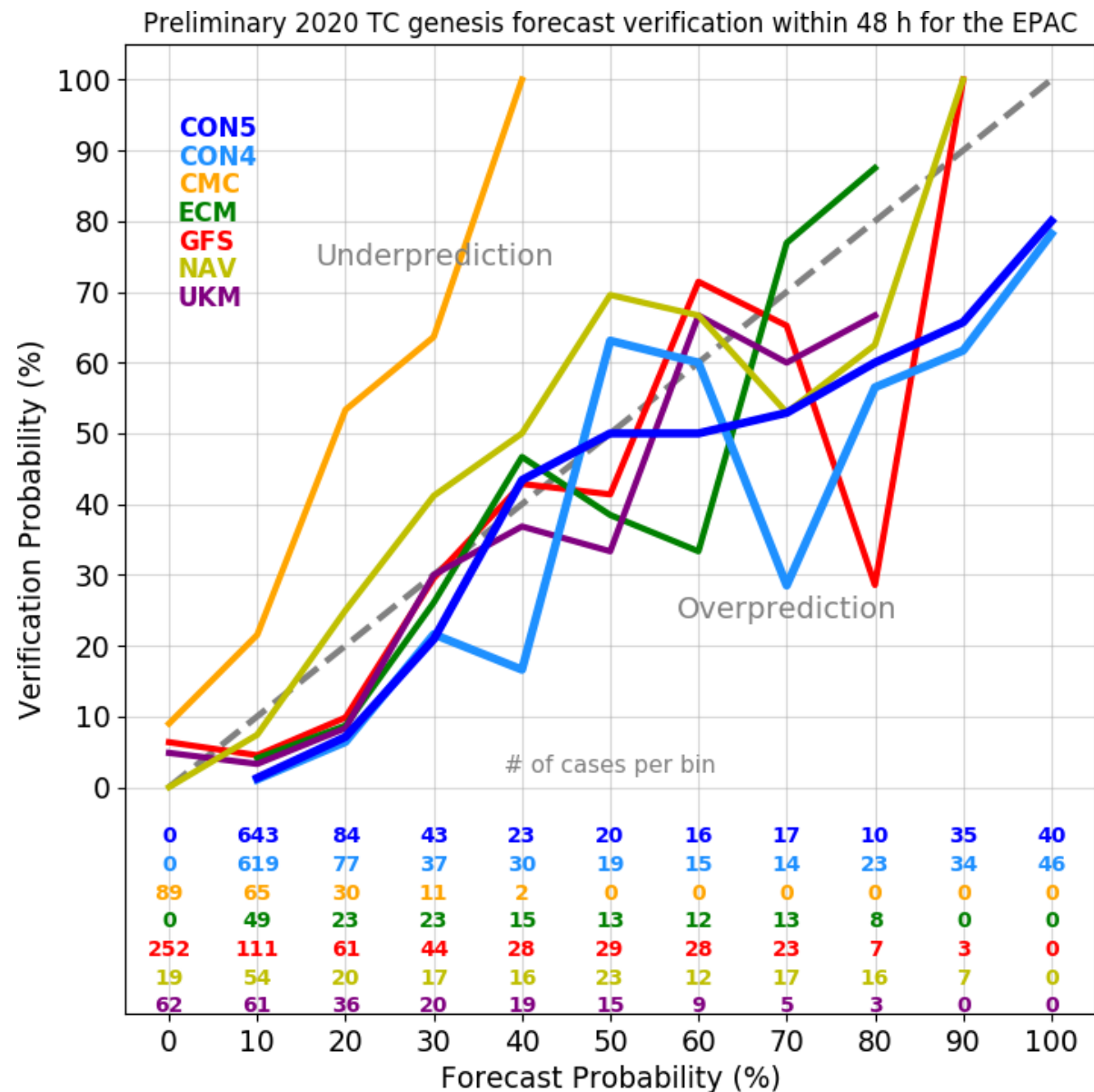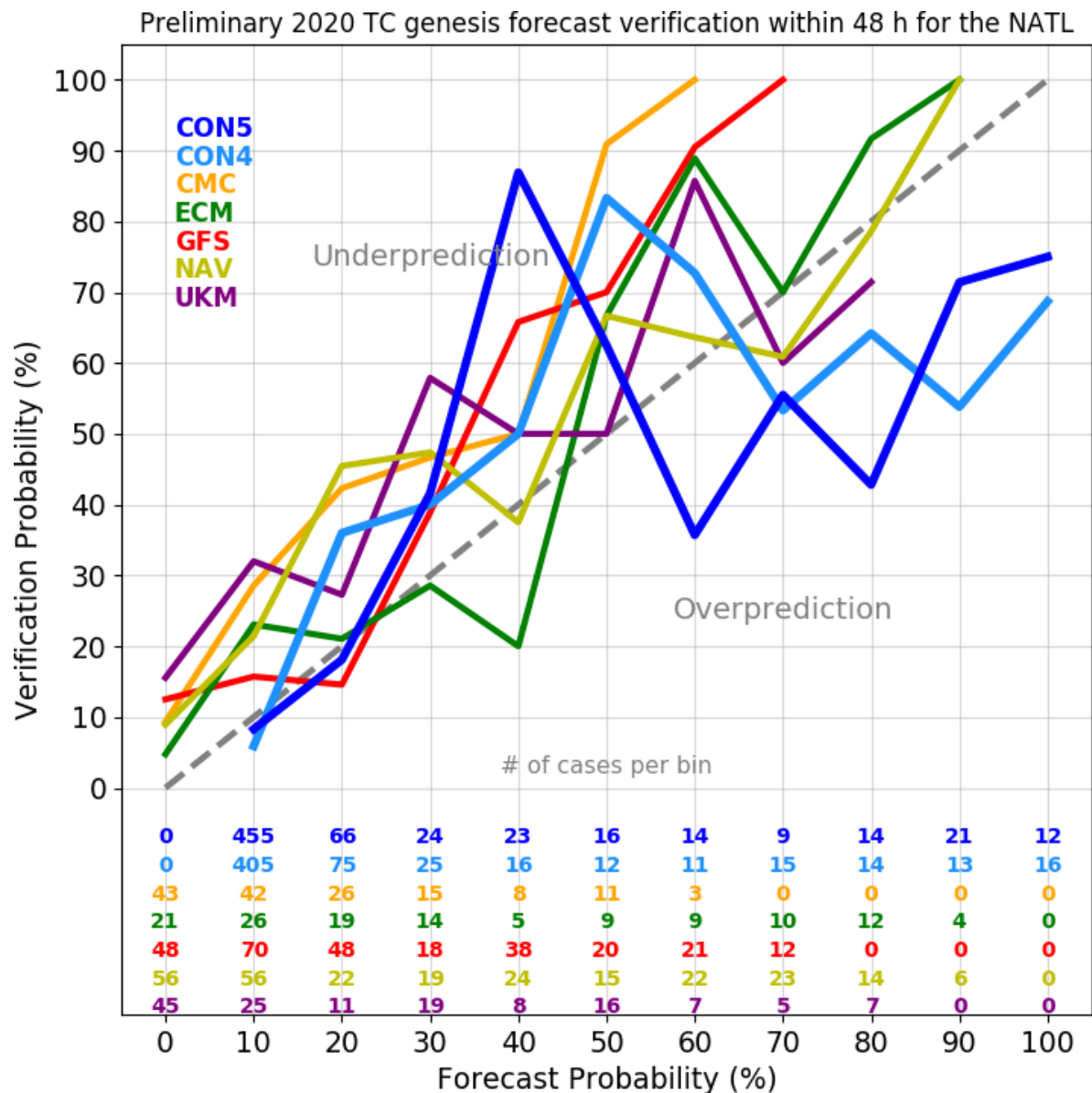
# 0-120h verification demonstrated very well calibrated consensus guidance, in particular the five-model version. NATL low bias (increased over 0-48h verification) perhaps related to record breaking activity in that basin?

Preliminary 2020 TC genesis forecast verification within 120 h for the NATL
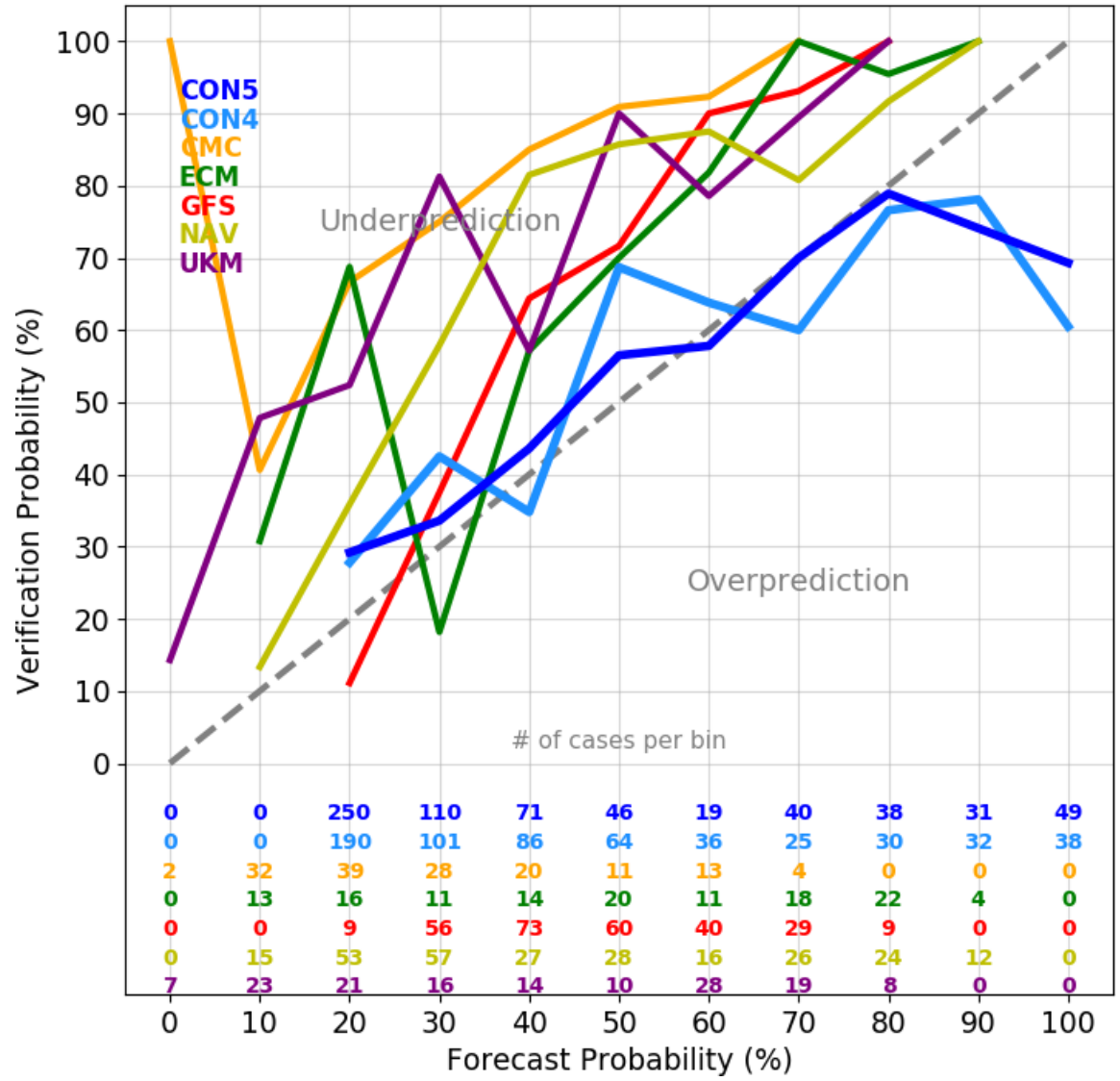
Preliminary 2020 TC genesis forecast verification within 120 h for the EPAC
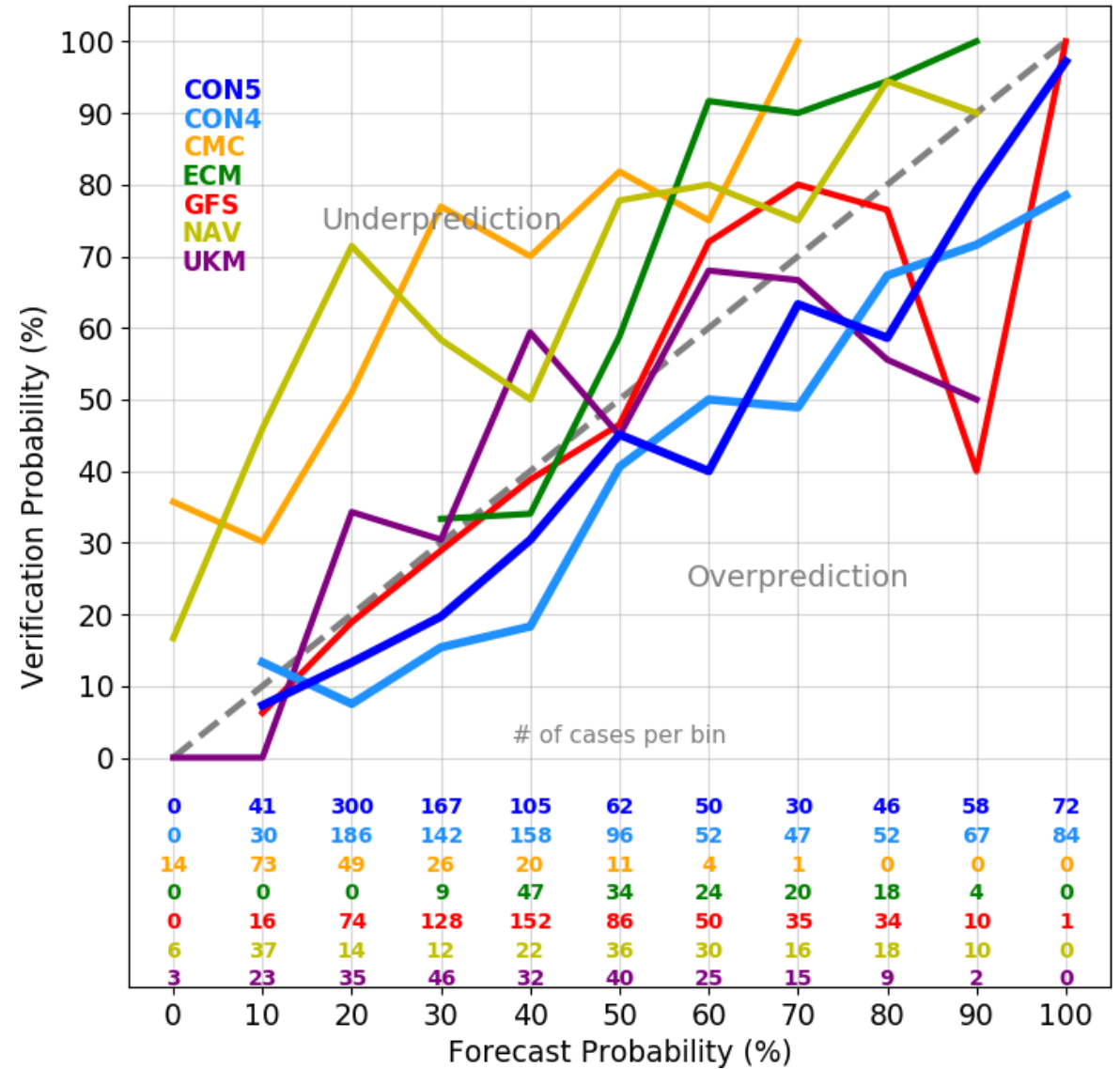
0-168 verification similar to 120h, with the most noteworthy signal being the consensus guidance in both basins (in particular NATL) very successfully removed the significant individual model biases.
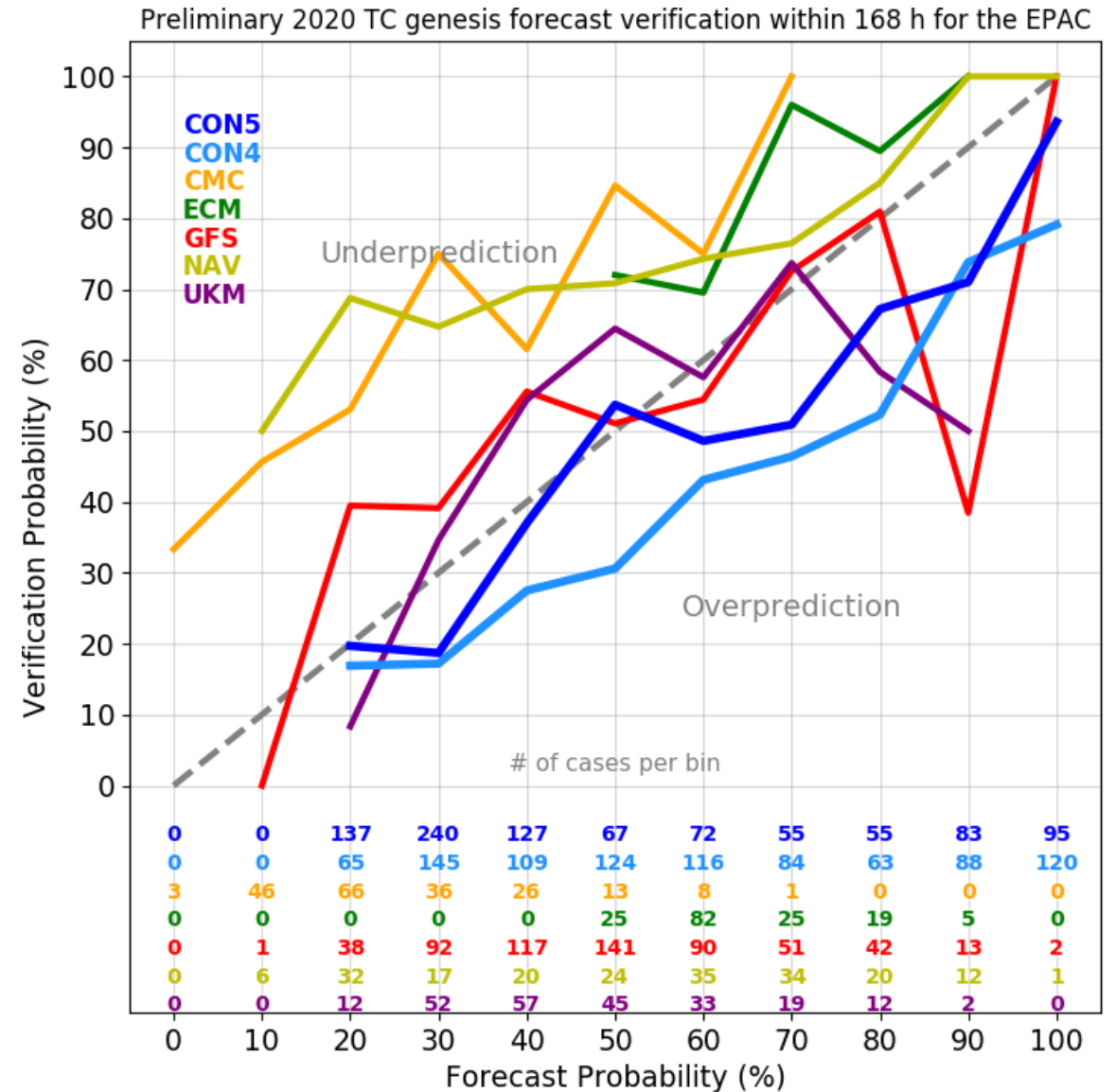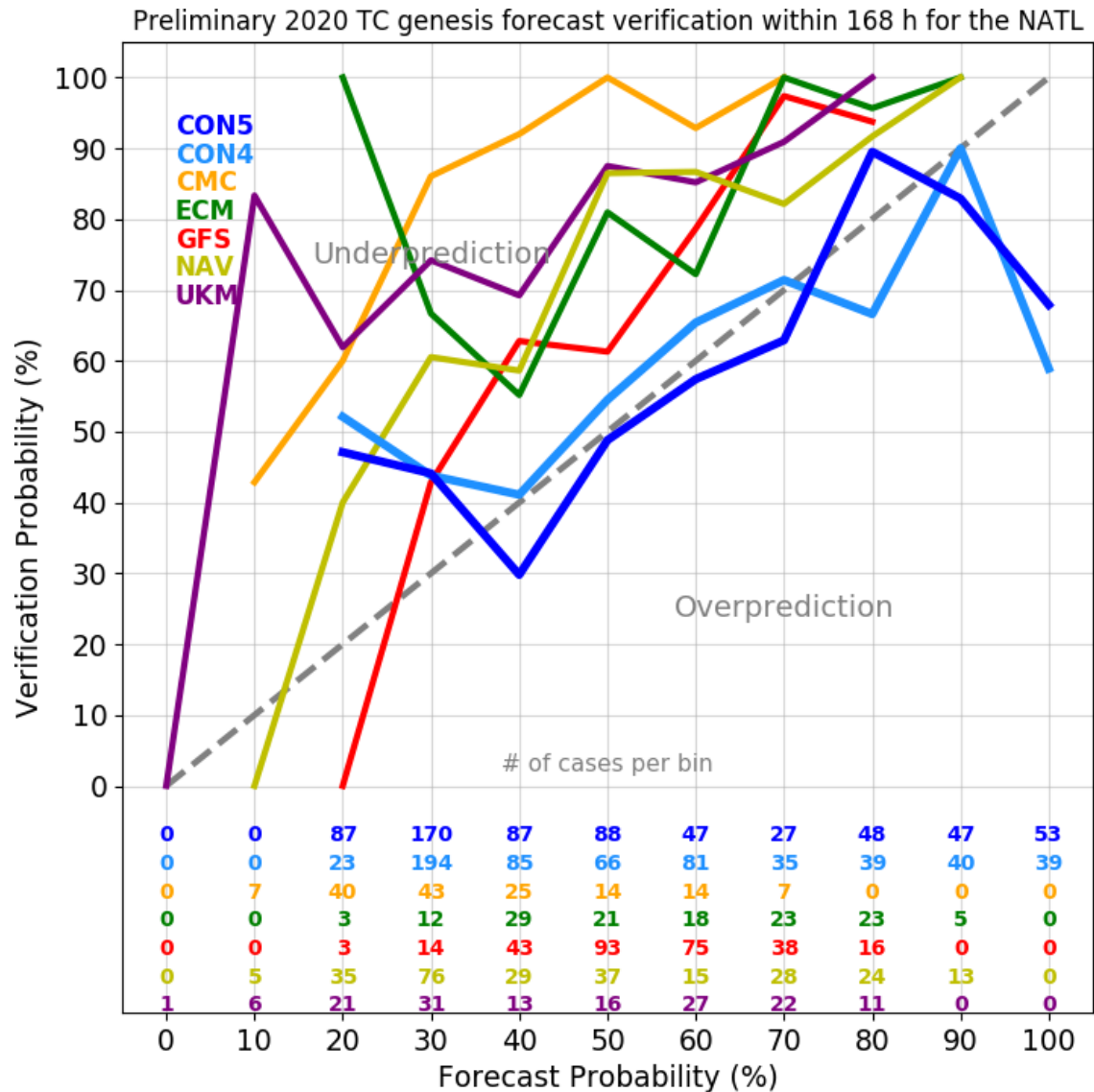

Preliminary 2020 TC genesis forecast verification within 168 h for the NATL

Preliminary 2020 TC genesis forecast verification within 168 h for the EPAC

High probability forecasts (>90%) of genesis for non-developing disturbances were primarily a result of the models struggling to forecast the time and location of genesis for Paulette and Rene.

Season-to-date TC genesis forecast verification
2020 CON based 120 hour genesis forecasts through 12/31 12Z
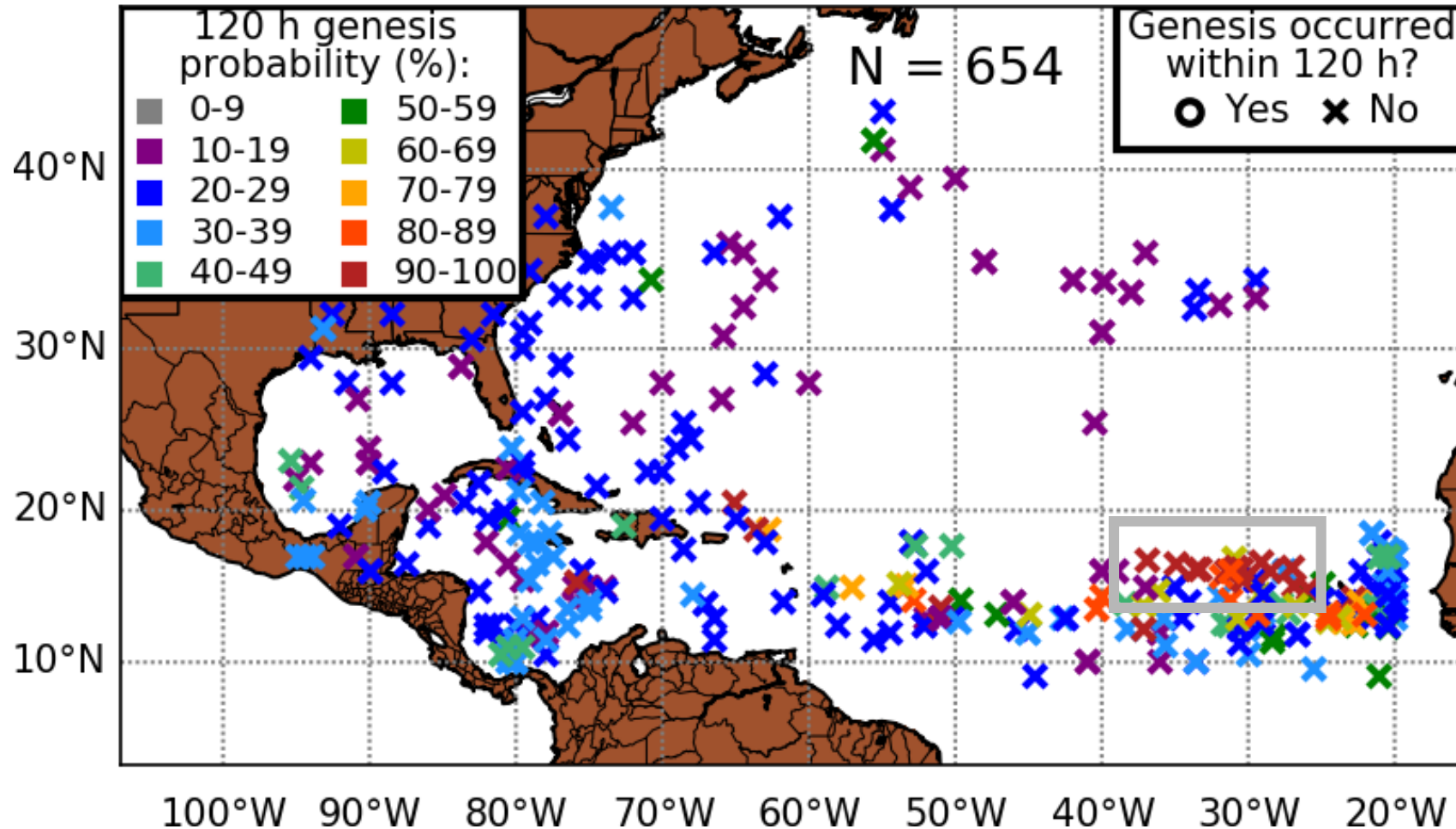
A climatology of genesis spatiotemporal errors shows that the GFS typically forecasts genesis to occur too late and (consequently) too far NW.
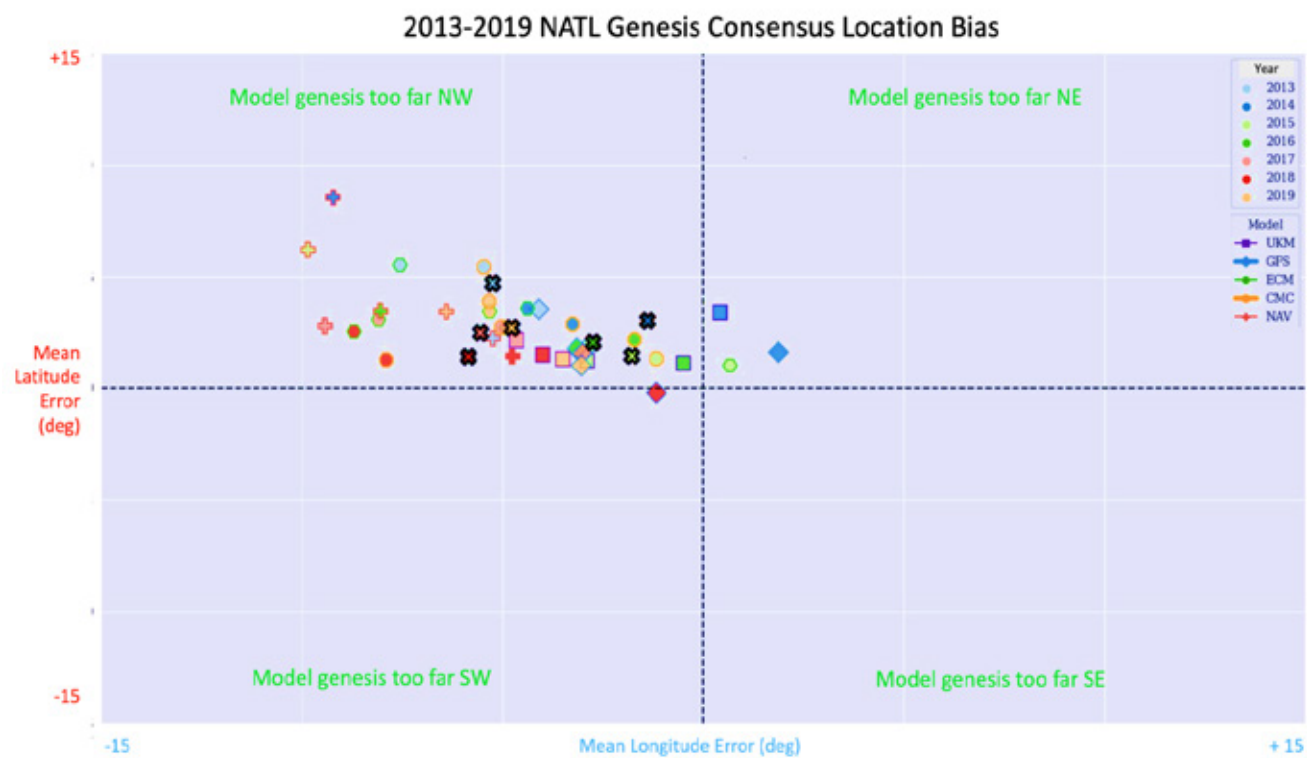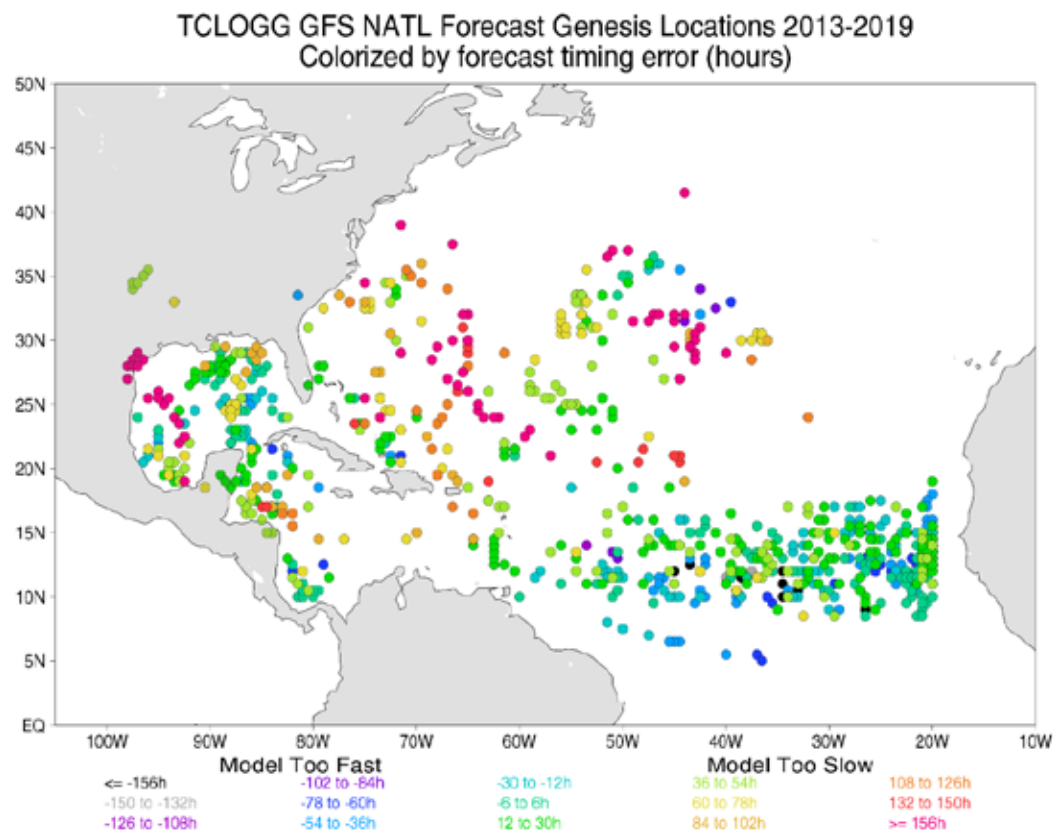
Regression was performed using spatiotemporal variables (e.g., latitude, longitude, forecast hour) as well as forecast meteorological variables to provide improved genesis timing.

Improved TCLOGG guidance for timing of genesis to improve confidence

Regression performance (in-sample) by event

2013-2019 NATL GFS Regression Prediction (Orange) and Verification (Blue)

R (regression,verification)=0.80
Adjusted R (regression,verification)=0.65
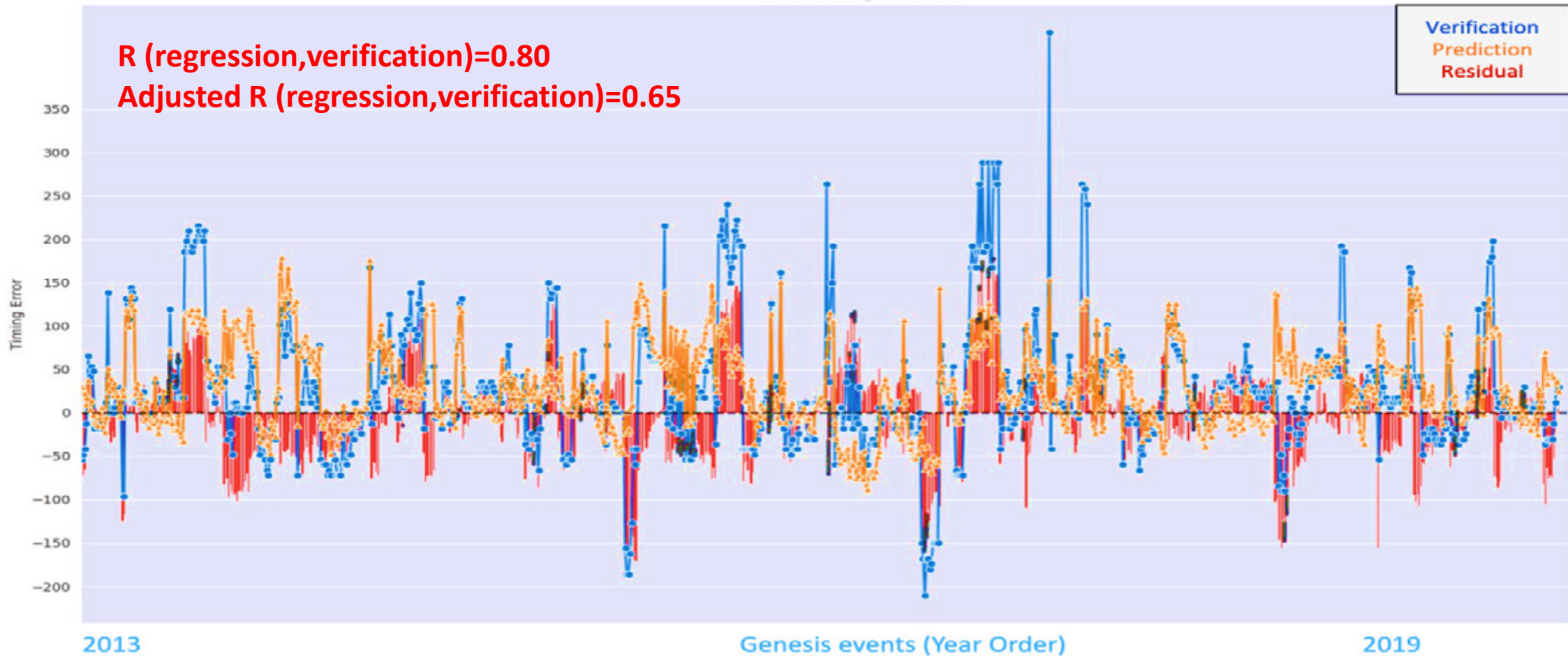
Initial regression equations were able to reduce forecast genesis timing errors for Hurricane Michael (2018) and increase model timing agreement.

Example application of regression guidance for adjusted genesis timing for **Hurricane Michael (2018)** formation using 12 UTC 5 October 2018 model runs.

		Current version	**Experimental Version**	
Model	TCLOGG Genesis Datetime	TCLOGG Genesis Model Forecast Hour	Experimental forecast adjustment	Experimental TCLOGG Genesis Timing
GFS	00 UTC 8th	60hr	ΔT = -13hr	47hr
CMC	18 UTC 6th	30hr	ΔT = +3hr	33hr
ECM	00 UTC 8th	60hr	ΔT = -28hr	32hr
UKM	00 UTC 7th	36hr	ΔT = -1hr	35hr

Verification: 06 UTC 7th   **Verification: 42hr**   **Verification: 42hr**
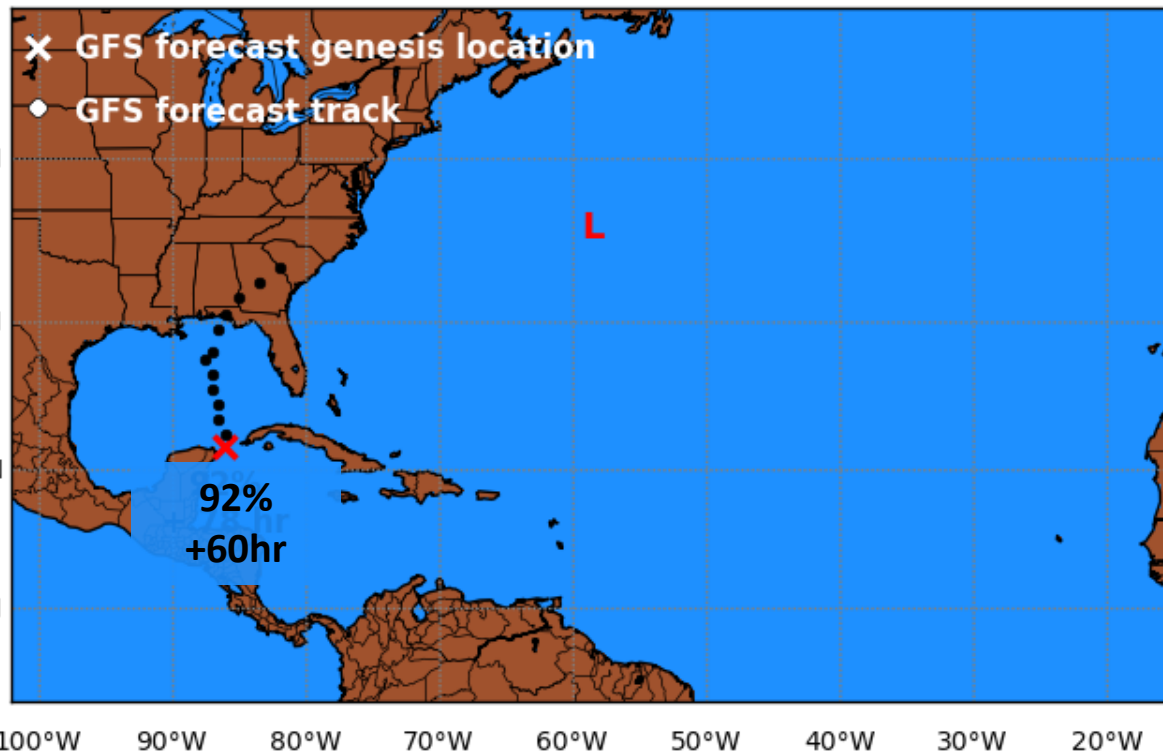
Feedback requested on incorporation of timing adjustment into TCLOGG website graphics.   Below is one proposed example using the case of Michael (2018):

Options include displaying only the corrected forecast hour (e.g., just +47hr here) or both the unadjusted forecast hour (+60hr) and the adjusted timing together (right figure).
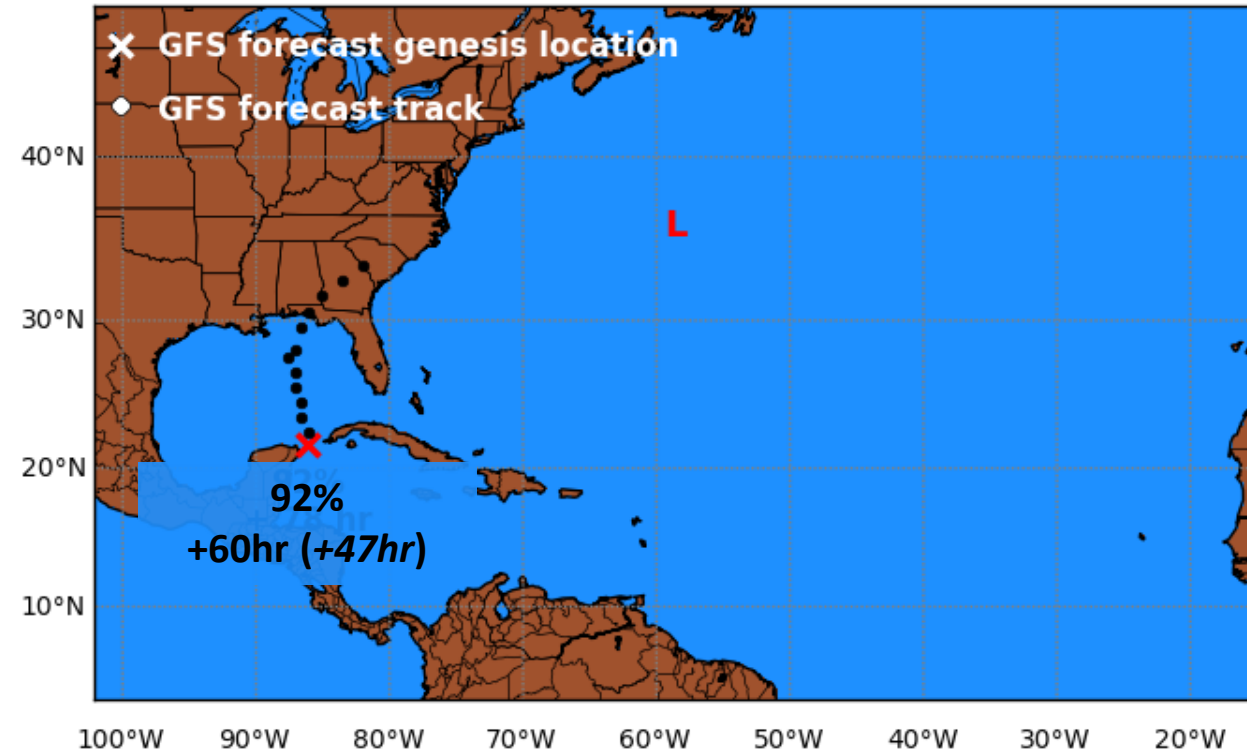
Current version

Proposed version

Updated Readiness Levels (RLs) in consultation with JHT POCs:

Component	Project Start RL	Current RL	Status
Existing TCLOGG components	6	7/8	Implemented by Alan Brammer at NHC
GFS Switch PRMSL to MSLET	6	7/8	Implemented by Alan Brammer at NHC
Seven-day genesis guidance	6	7/8	Implemented by Alan Brammer at NHC
Separation of guidance into 0-48 and 54-120 h equations.	5	7/8	
Most likely time of genesis	3	4/5	Planned for Year 2 of project
Guidance based on GEFS	3	3	Planned for Year 3 of project

Remaining Plans through June 2021

- Re-calibrate all regression equations

- Develop initial set of regression equations for genesis timing correction (Completed)

- Perform independent testing of new developmental regression equations for genesis timing correction (Ongoing)

- Implement initial set of regression equations for genesis timing correction into experimental TCLOGG web page at FSU (April-May)
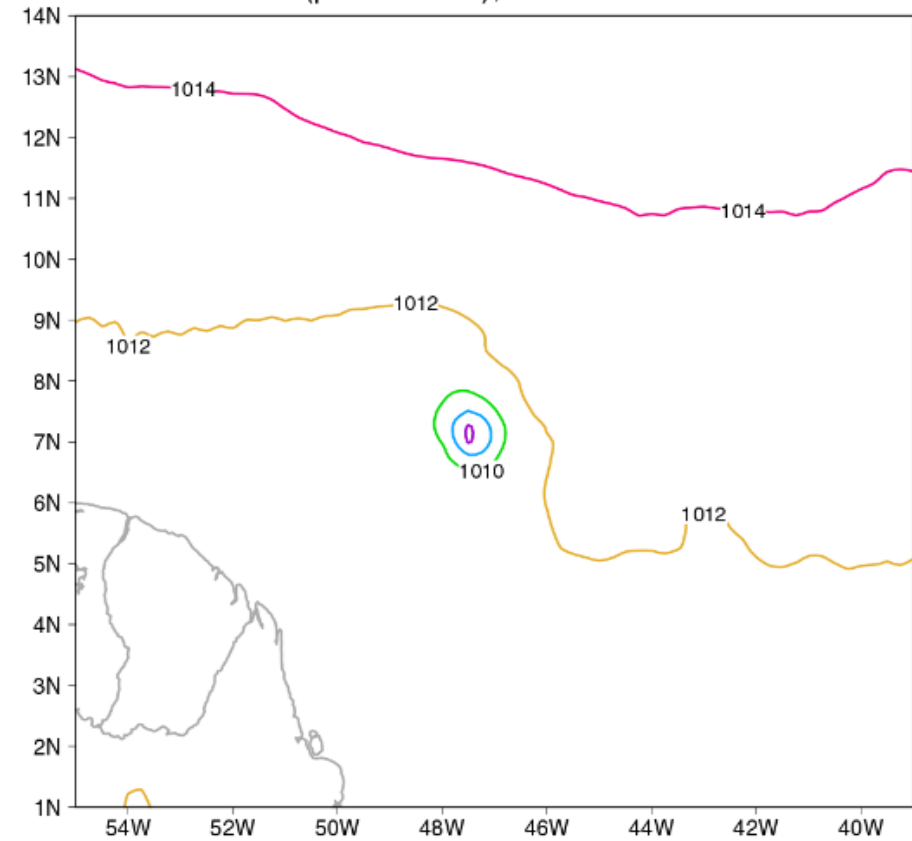
Extra slides

The GFS sea-level pressure variable used by TCLOGG was changed from PRMSL to MSLET. Expectedly, this has increased TC detection in the GFS.

1200UTC 18 June 2017 0.25° GFS Analysis SLP (PRMSL, hPa) of INVEST92L (pre-TC Bret); Minimum value: 1010.6hPa
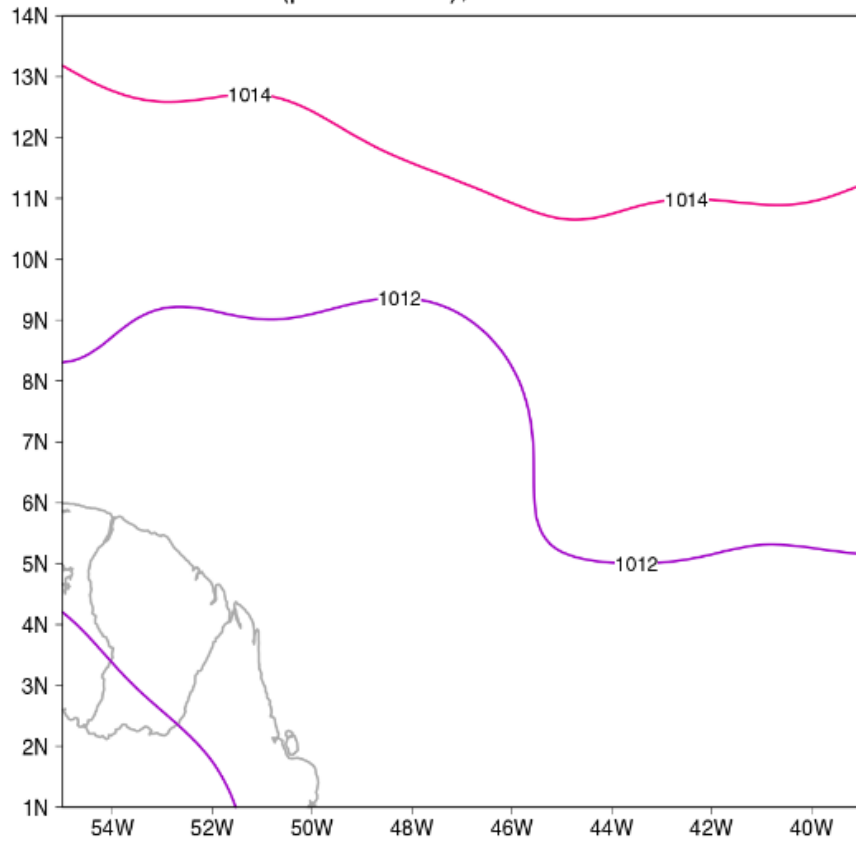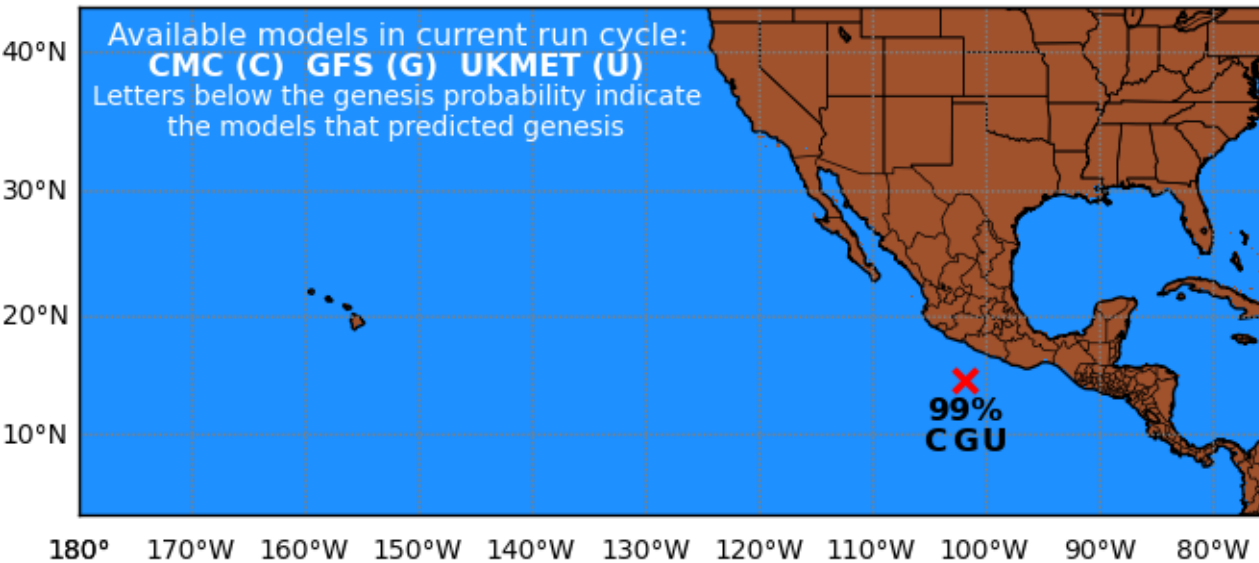
1200UTC 18 June 2017 0.25° GFS Analysis SLP (MSLET, hPa) of INVEST92L (pre-TC Bret); Minimum value: 1005.8hPa

0-120 h regression equations were split into 0-48 h and 54-120 h equations, then nonlinearly combined to create a 0-120 h genesis probability.

The goal is to avoid the following scenario where Pr(48) > Pr(120):

Experimental 0-48 h TC genesis probability
CON model output initialized 2017-06-24 12Z

Available models in current run cycle:
CMC (C) GFS (G) UKMET (U)
Letters below the genesis probability indicate
the models that predicted genesis

99%
C G U

http://moe.met.fsu.edu/modelgen

Experimental 0-120 h TC genesis probability
CON model output initialized 2017-06-24 12Z

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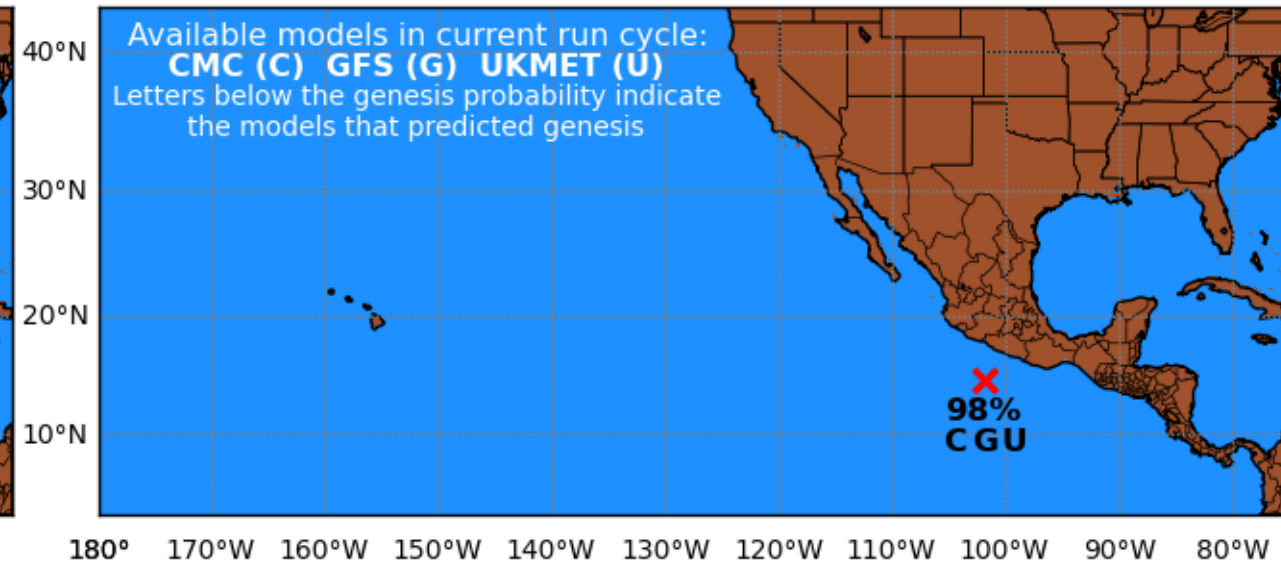
ECMWF-based guidance, five-model consensus guidance, and 7 day probabilities were implemented in 2019.
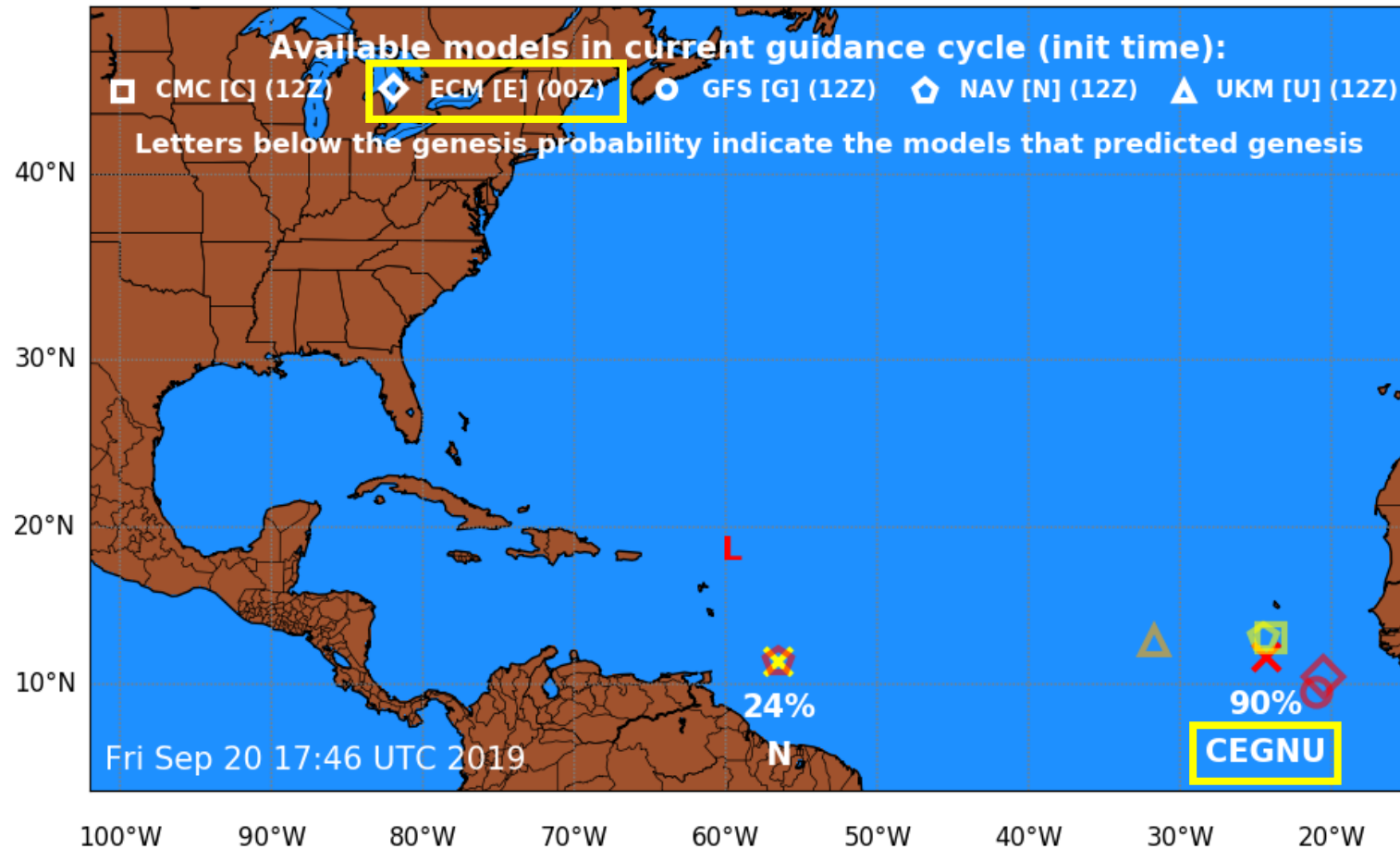
Season-to-date TC genesis forecast verification

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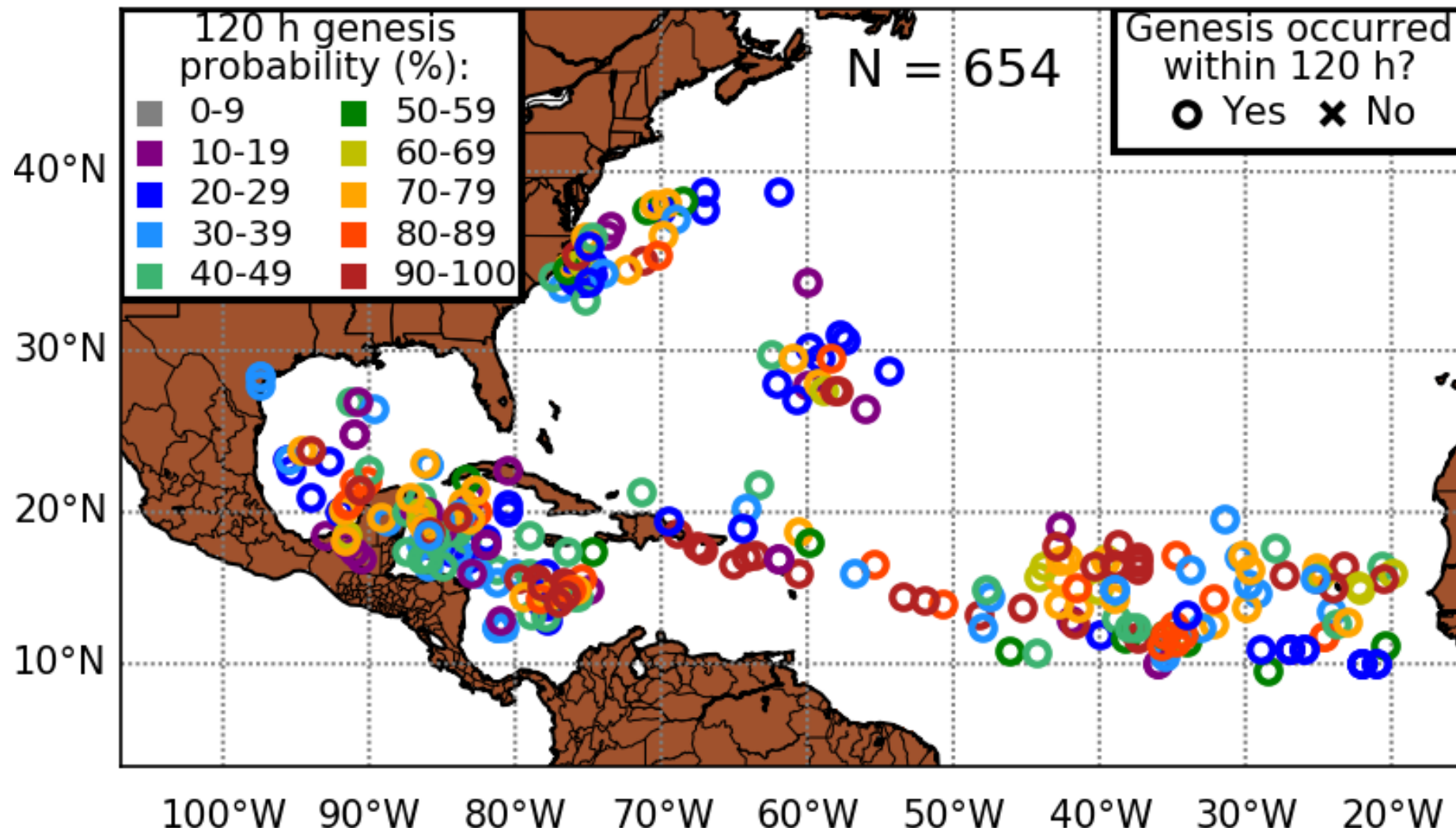
Improved TCLOGG guidance for timing of genesis to improve confidence

Initial attempts at multiple linear regression for predicting the timing error
and regression performance (in-sample)

NATL	Forecasted Lat	Vorticity Max	Vort. 850 Pert.	Wind Speed Max	Thick. Pert.	Julian Delta	Avg 850 Div.	Shear Avg.	700 RH Pert.	Julian Delta^2	Julian Delta^3	Wind Speed Max ^2	Forecast Hour
GFS	+	+	+	+	-	-	-	+	-	+	-	+	+
CMC	+	+	+	+	+	+	-	+	-	-	-	-	-
ECM	+	+	+	+	-	+	-	-	-	-	-	-	-
NAV	+	+	+	+	-	+	-	-	-	-	-	-	-
UKM	+	+	+	-	+	-	-	■	■	+	-	-	-
EPAC													
GFS	+	+	+	-	+	-	-	-	+	-	-	-	-
CMC	+	+	+	-	-	+	-	-	+	-	-	-	-
ECM	+	+	+	-	+	+	+	-	-	-	-	-	-
NAV	+	+	-	+	+	-	+	+	-	-	+	-	-
UKM	+	-	-	+	+	-	+	■	■	-	+	-	-

NATL	Vars	Adjusted r^2	Adjusted R
GFS	7	0.415	0.644
CMC	7	0.433	0.658
ECM	5	0.453	0.673
NAV	5	0.281	0.530
UKM	5	0.385	0.620
EPAC			
GFS	5	0.188	0.434
CMC	5	0.234	0.484
ECM	6	0.369	0.607
NAV	7	0.531	0.729
UKM	5	0.224	0.473