

Experimental tropical cyclone genesis forecast guidance products using global models

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Motivation

- National Hurricane Center (NHC) forecasters are interested in tropical cyclone (TC) genesis guidance products for the Tropical Weather Outlook (TWO).
- Global models are an important piece of guidance for TC genesis, but interpreting the raw forecast output can be subjective.
- **Funded JHT research goal:** Develop an automated, objective TC genesis guidance product based on output from three global models (GFS, UKMET, CMC).

Product development summary

- Verified model-indicated TC genesis forecasts since 2004.
- Used logistic regression to calculate objective, bias-corrected TC genesis probabilities for real-time model-indicated TC genesis forecasts.
- Developed a separate logistic regression equation for each global model, basin, and forecast window.
- Developed a consensus probability.

2014 Predictors

GFS

NATL120	EPAC120
(-) forecast hour	(-) forecast hour
(+) year	(+) latitude
(-) longitude	(+) sfc LH flux
(+) PWAT	(-) 850 mb ζ perturbation
(+) sfc LH flux	
(+) 600 mb RH perturbation	

UKM

NATL120	EPAC120
(-) forecast hour	(-) forecast hour
(-) longitude	(+) latitude
(-) latitude	

CMC

NATL120	EPAC120
(-) forecast hour	(-) forecast hour
(-) latitude	(+) latitude
(-) longitude	(+) 1000-700 mb Γ
	(-) 850 mb divg

MOE Tropical Cyclone Genesis Portal

[Dvorak-based Genesis Potential | [Model-indicated Genesis Potential](#) | TCGENGIFS Model Output]

Experimental tropical cyclone genesis probabilities based upon global model output

[**0-48 HR
OUTLOOK**]

[SUMMARY]

[CMC GRAPHIC]

[GFS GRAPHIC]

[UKM GRAPHIC]

[CONSENSUS]

[**0-120 HR
OUTLOOK**]

[SUMMARY]

[CMC GRAPHIC]

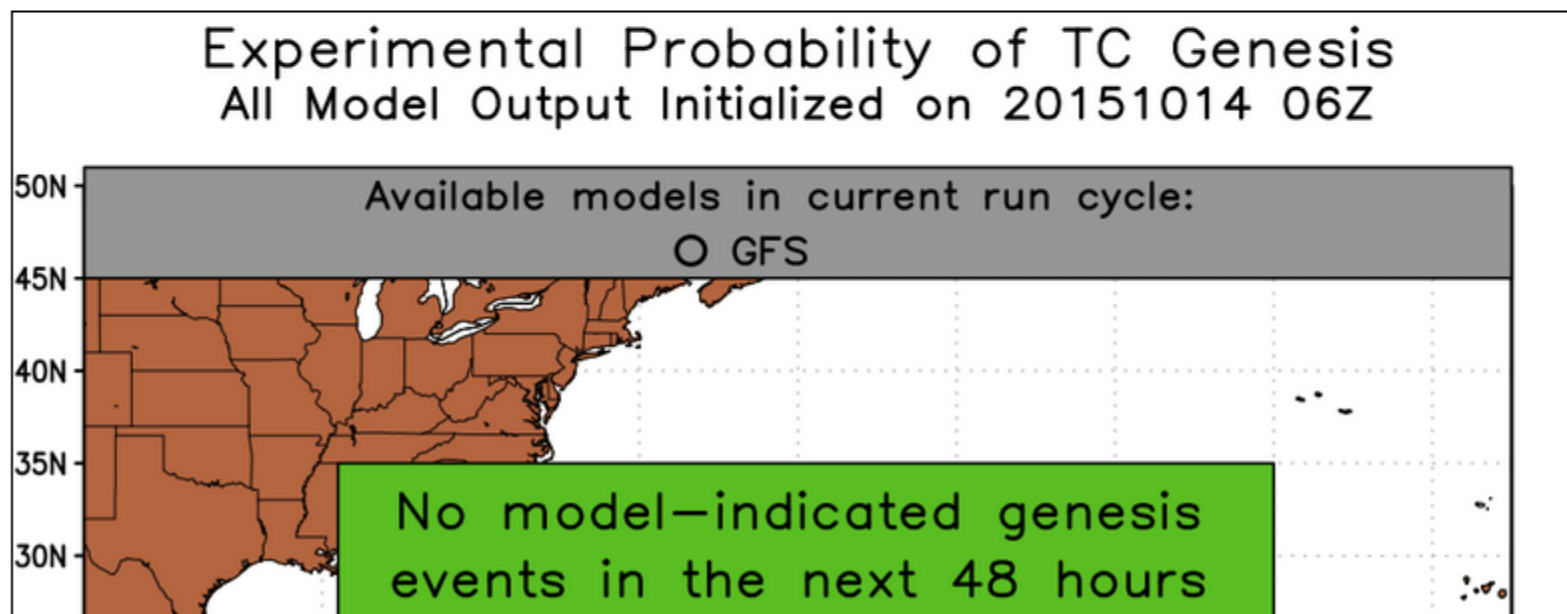
[GFS GRAPHIC]

[UKM GRAPHIC]

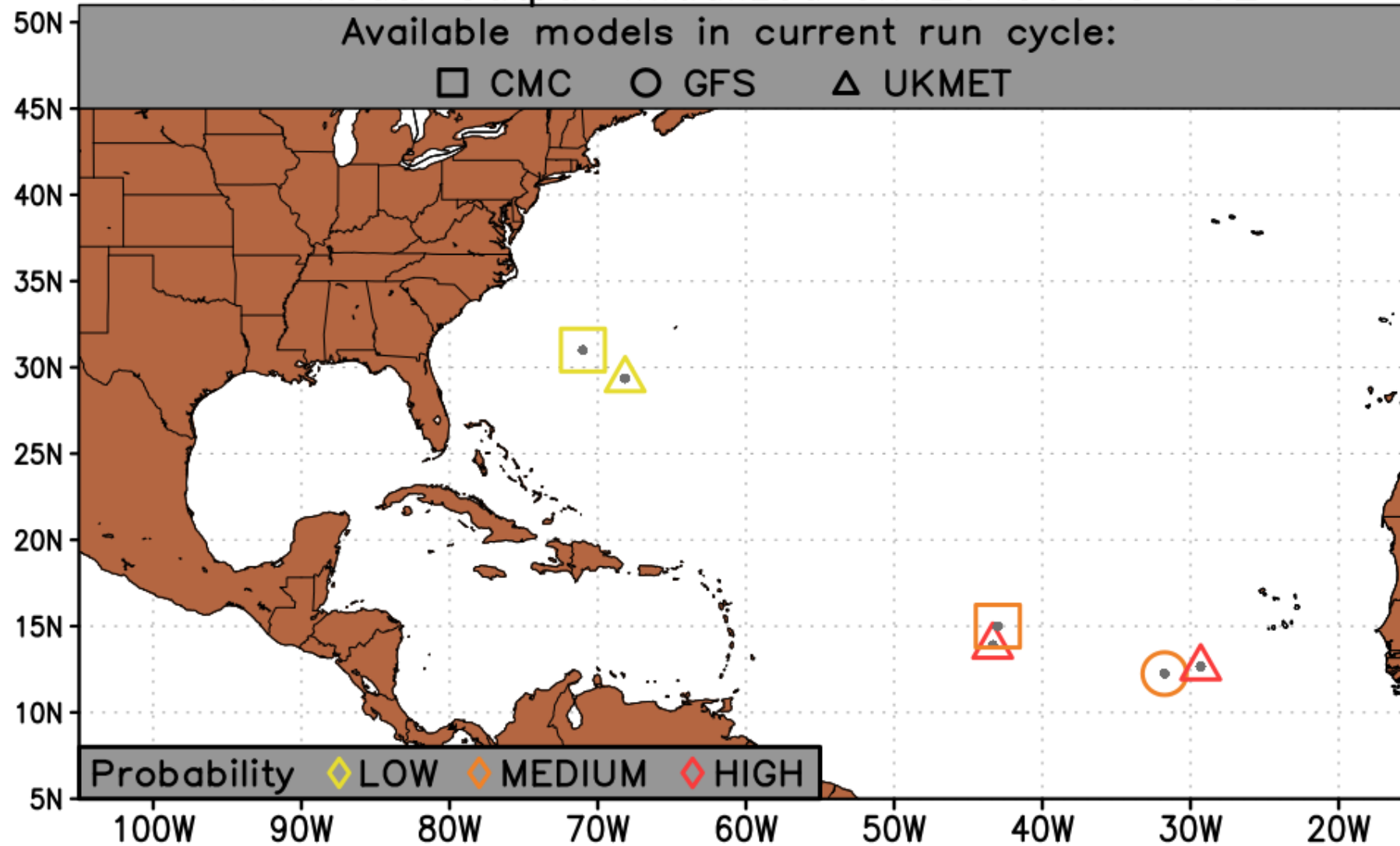
[Click here for a list of recent updates to this website](#)

[[North Atlantic](#) | Eastern Pacific]

Last updated: Wed Oct 14 15:35:06 UTC 2015



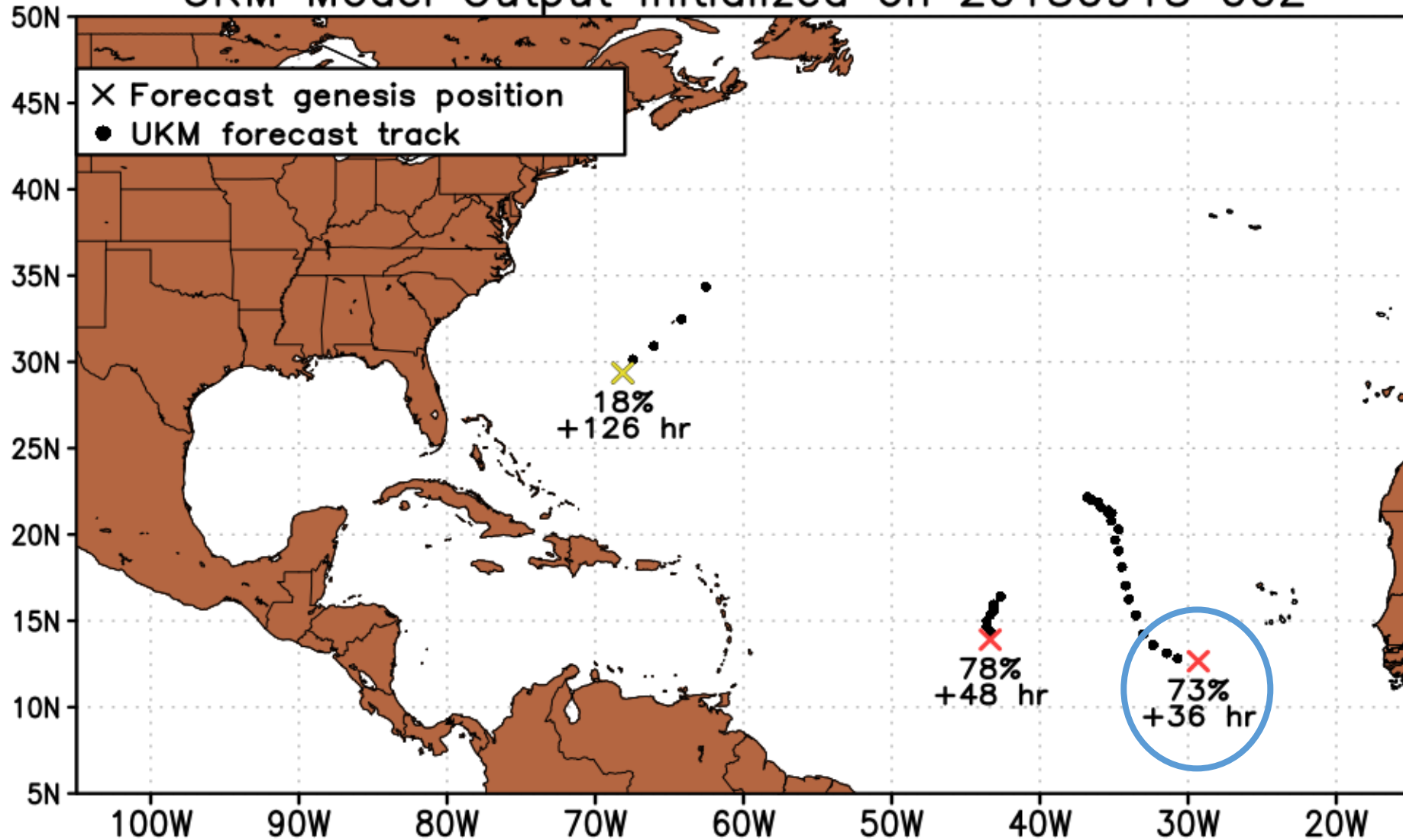
Experimental Probability of TC Genesis at Anytime Within 120 Hours All Model Output Initialized on 20150915 00Z



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

Experimental Probability of TC Genesis at Anytime Within 120 Hours

UKM Model Output Initialized on 20150915 00Z

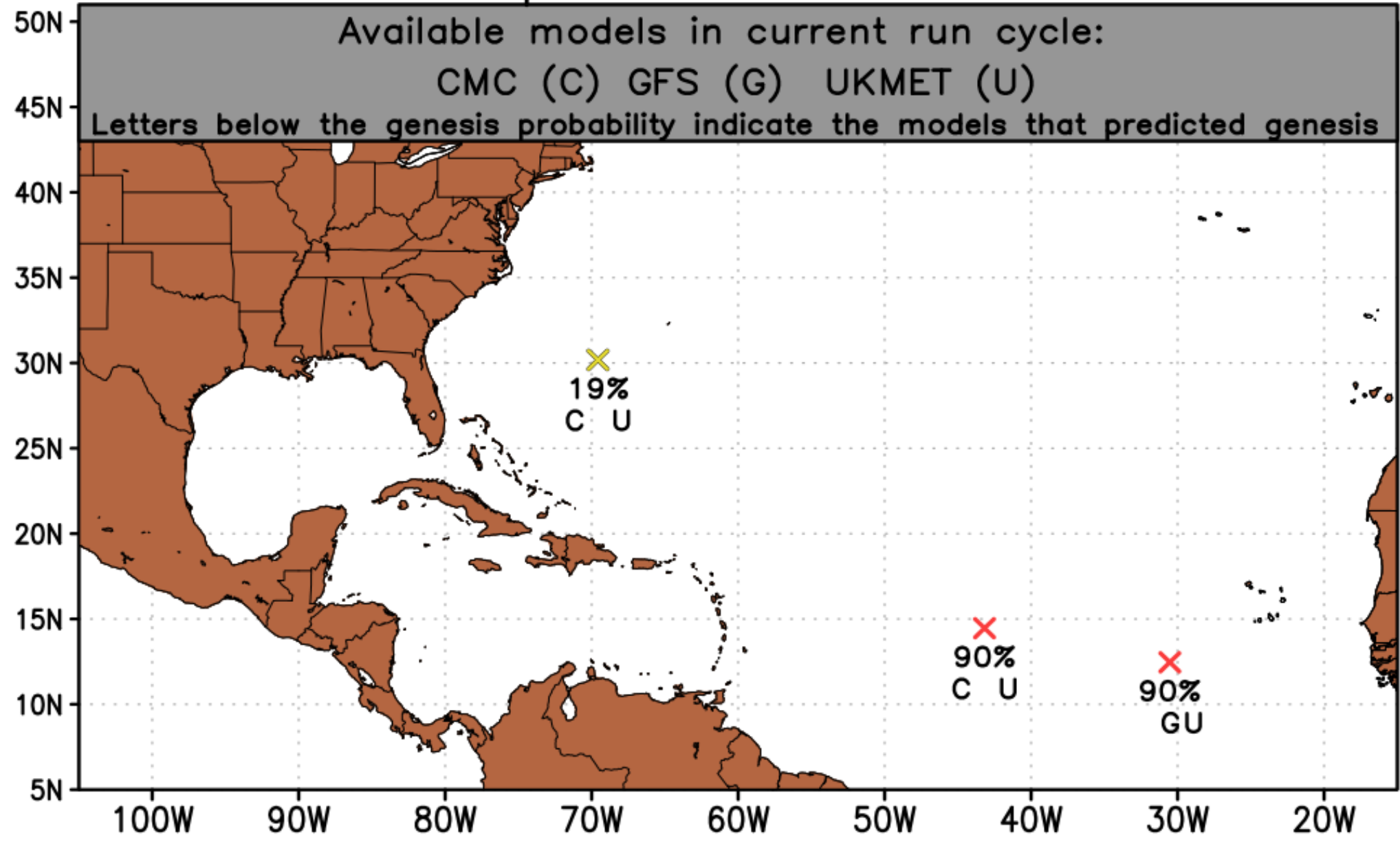


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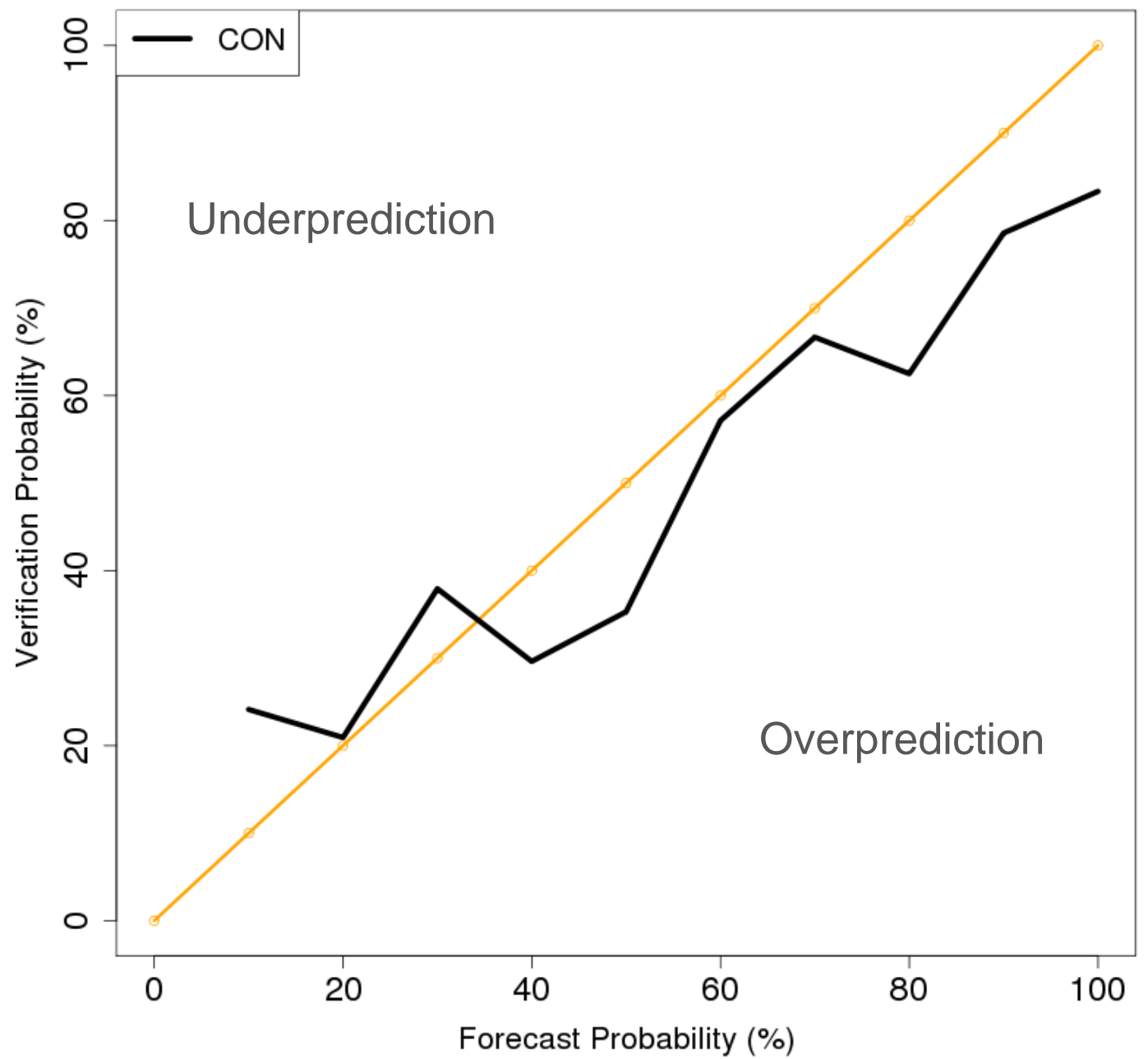
** TC Genesis Summary for UKMAL9018**

INIT TIME	FHR	LAT (N)	LON (W)	PROB48 (%)	PROB120 (%)
15091812	0	12.66	37.10	N/A	N/A
15091800	12	13.29	36.60	65	86
15091712	24	13.60	37.50	56	84
15091700	36	13.44	36.80	47	79
15091612	18	11.73	31.90	58	73
15091600	30	12.51	32.20	49	75
15091512	42	12.98	31.70	40	73
15091500	36	12.66	29.40	43	73
15091412	42	12.51	28.90	38	69
15091400	36	11.42	27.20	42	58
15091312	42	11.26	26.30	37	51
15091300	54	11.10	28.00	30	42
15091212	90	11.88	32.90	14	38

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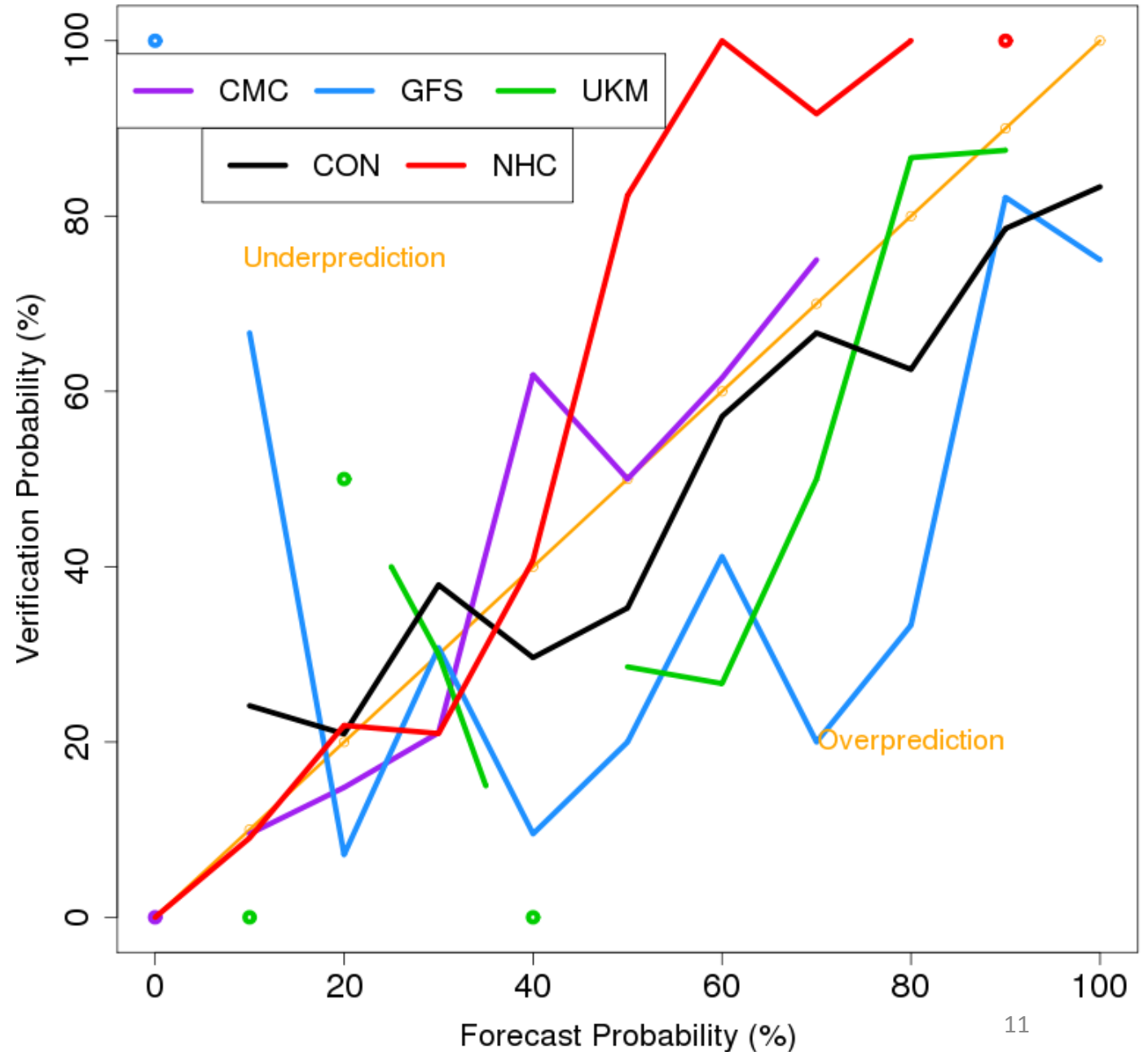


2014 NATL 120 h Forecast Verification



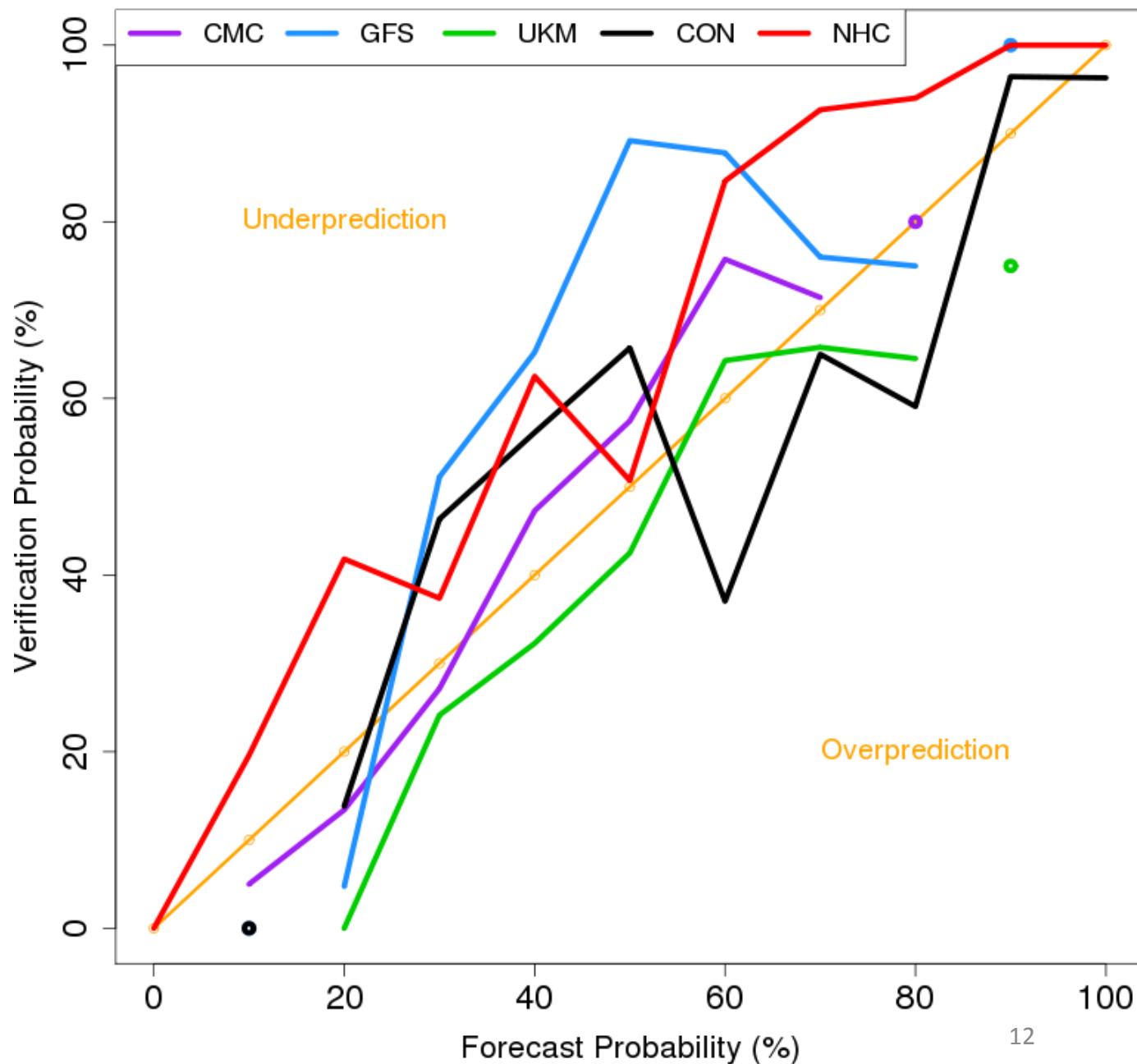
2014 NATL 120 h Forecast Verification (non-homogeneous)

- **NHC** well calibrated at lower probability bins, underpredicts at higher bins.
- **CON** and **CMC** fairly well calibrated.
- **GFS** and **UKM** overpredict at most probability bins.

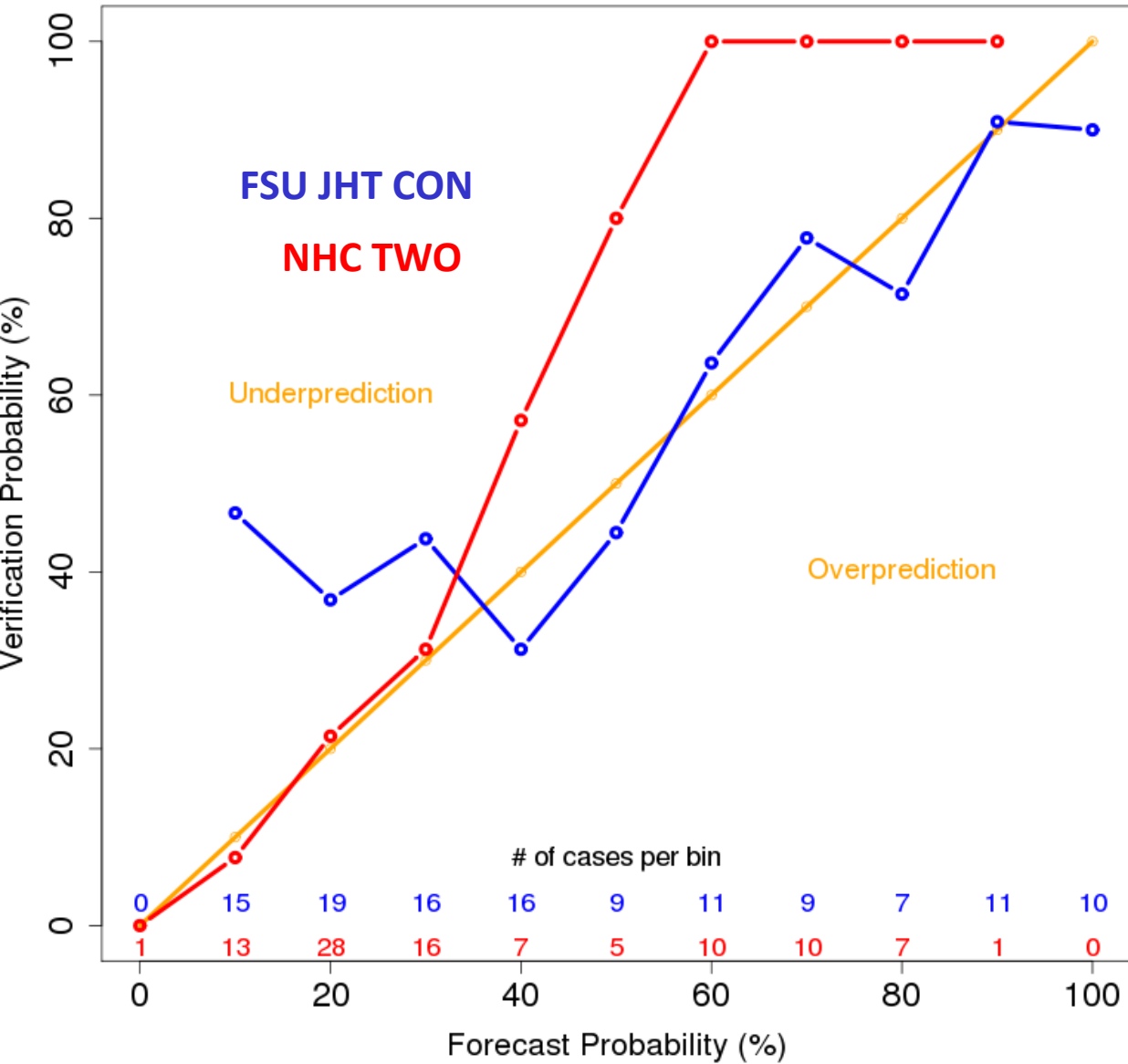


2014 EPAC 120 h Forecast Verification (non-homogeneous)

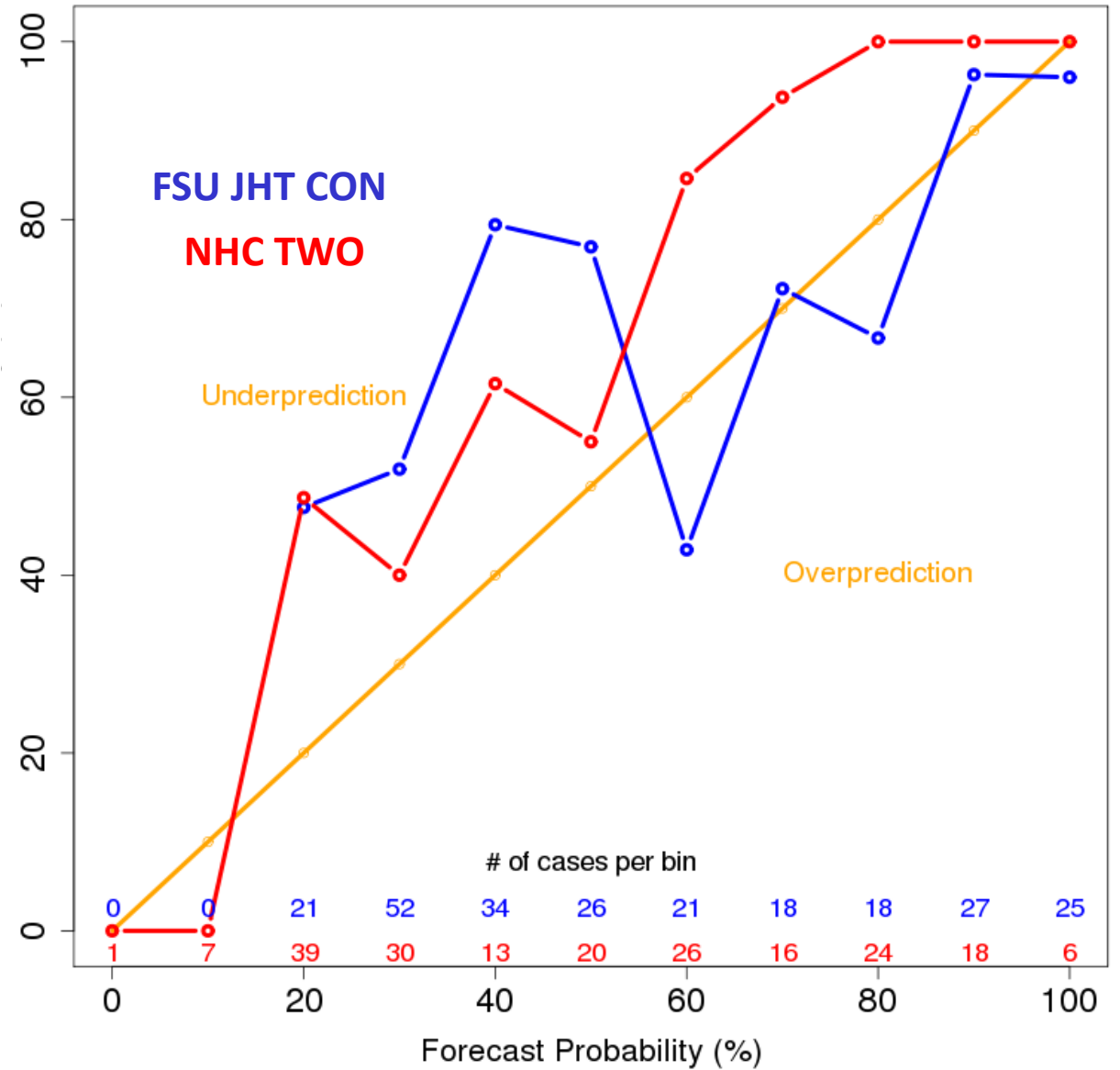
- **NHC** and **GFS** underpredict at most probability bins.
- **UKM** and **CMC** fairly well calibrated.
- **CON** underpredicts at lower probability bins, overpredicts at higher probability bins.



2014 NATL 120 h NHC TWO & FSU Consensus Verification (homogeneous)



2014 EPAC 120 h NHC TWO & FSU Consensus Verification (homogeneous)



Operational considerations

- Covers NHC's entire area of responsibility.
- Products are formatted for quick/easy interpretation to accommodate the forecasters' time constraints.
- Products typically are available at least 30 minutes prior to TWO issuance.
 - Late/missing products usually the result of issues obtaining model data locally (e.g., bandwidth issues). Should not be an issue if product is transitioned to NHC's IT infrastructure.
- Currently working with JHT staff to ensure code is compatible with NHC's IT platform.

Operational considerations

- Strengths

- Does not need existing disturbance at the initial time to generate forecast.
- Technique can be applied to other models and basins.
- Provides generally well-calibrated guidance.

- Planned enhancements

- Add ECMWF to the guidance suite if product is chosen for operational implementation.
- Modify genesis criteria to better detect TCs with baroclinic origins.

Summary

- Logistic regression equations were developed to provide TC genesis probabilities for real-time model-indicated TC genesis events.
- Several text and graphical products currently are available to the Hurricane Specialist Unit.
- 2014 verification shows that the guidance products are fairly well-calibrated and provide the most additional value at the higher forecast probability bins at the 120 h forecast window.
- Decision on operational implementation at NHC expected in early 2016.

Acknowledgements

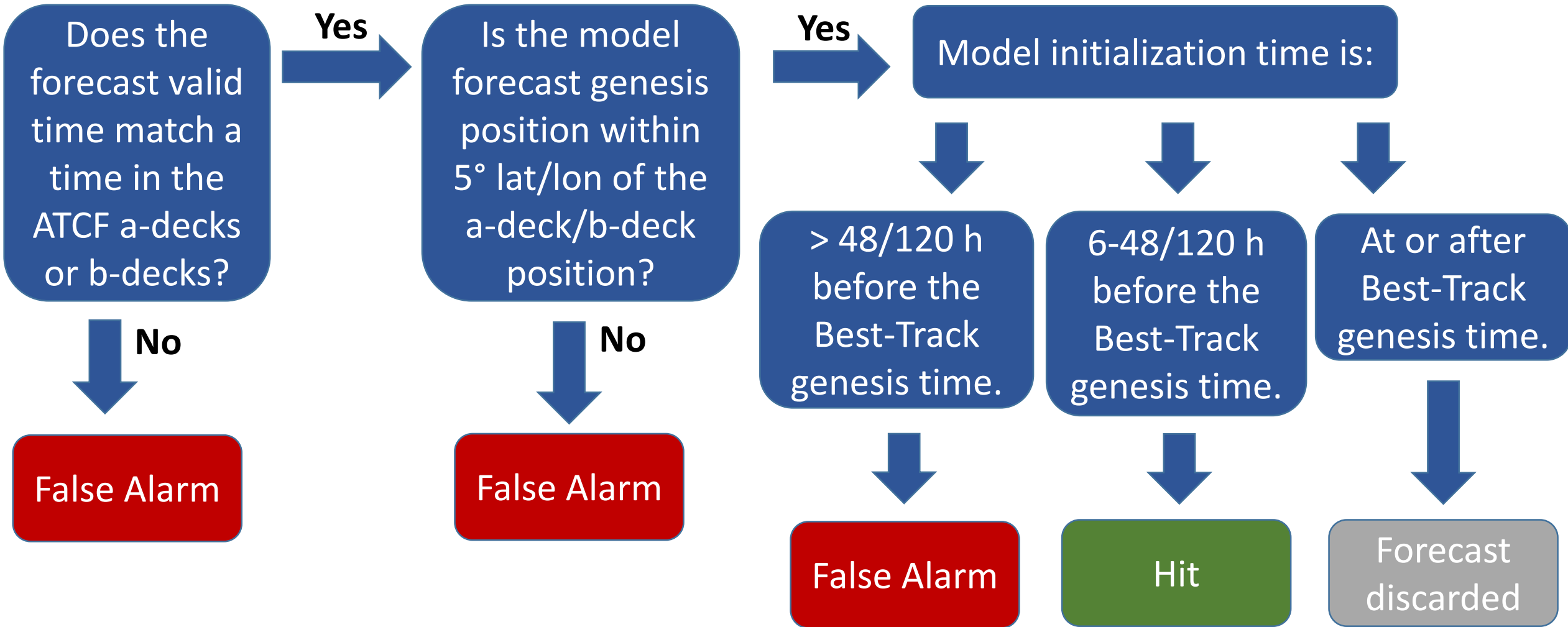
- Joint Hurricane Testbed points of contact Eric Blake, Todd Kimberlain, Chris Landsea, Craig Mattocks, Richard Pasch.
- Joint Hurricane Testbed (NOAA Grant).
- Ryan Torn and HFIP for travel support.

Questions?

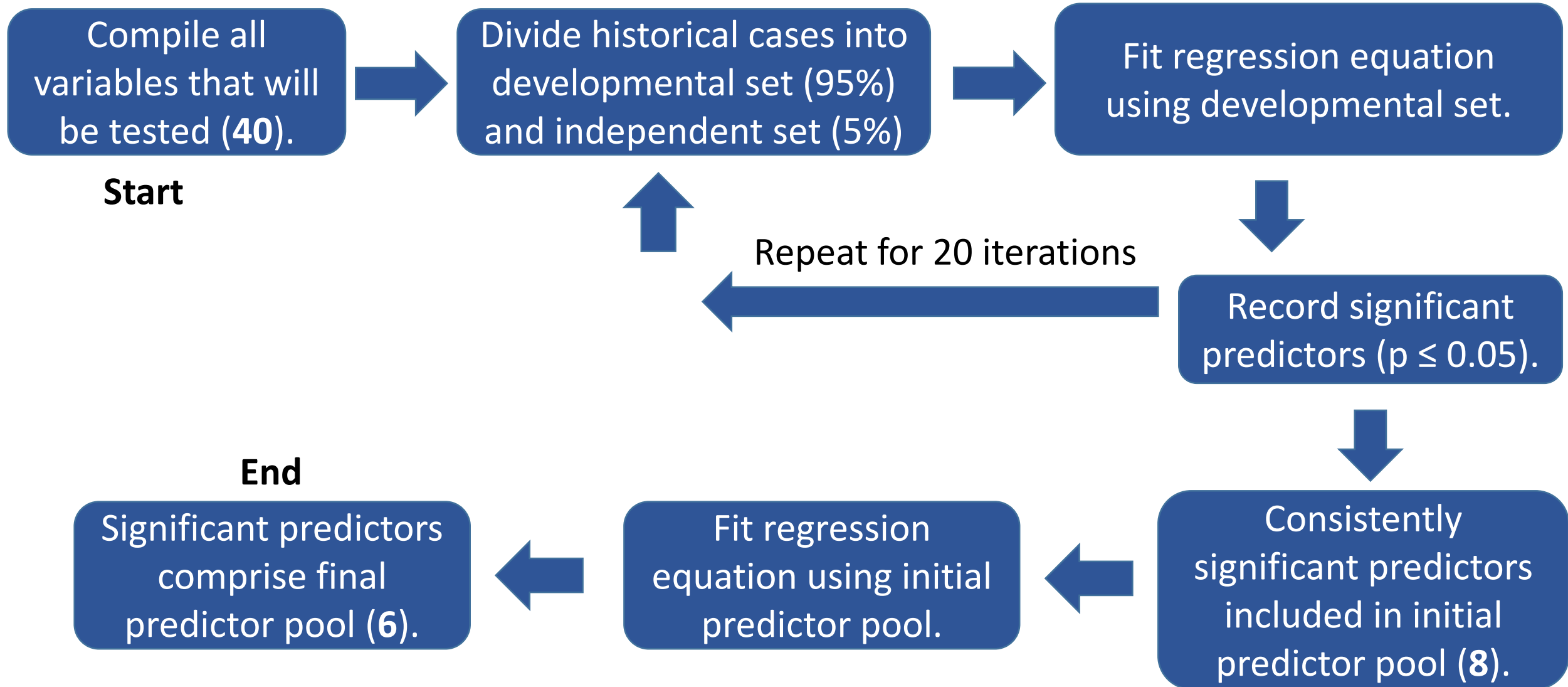
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Backup Slides

Methodology – Verification



Predictor selection



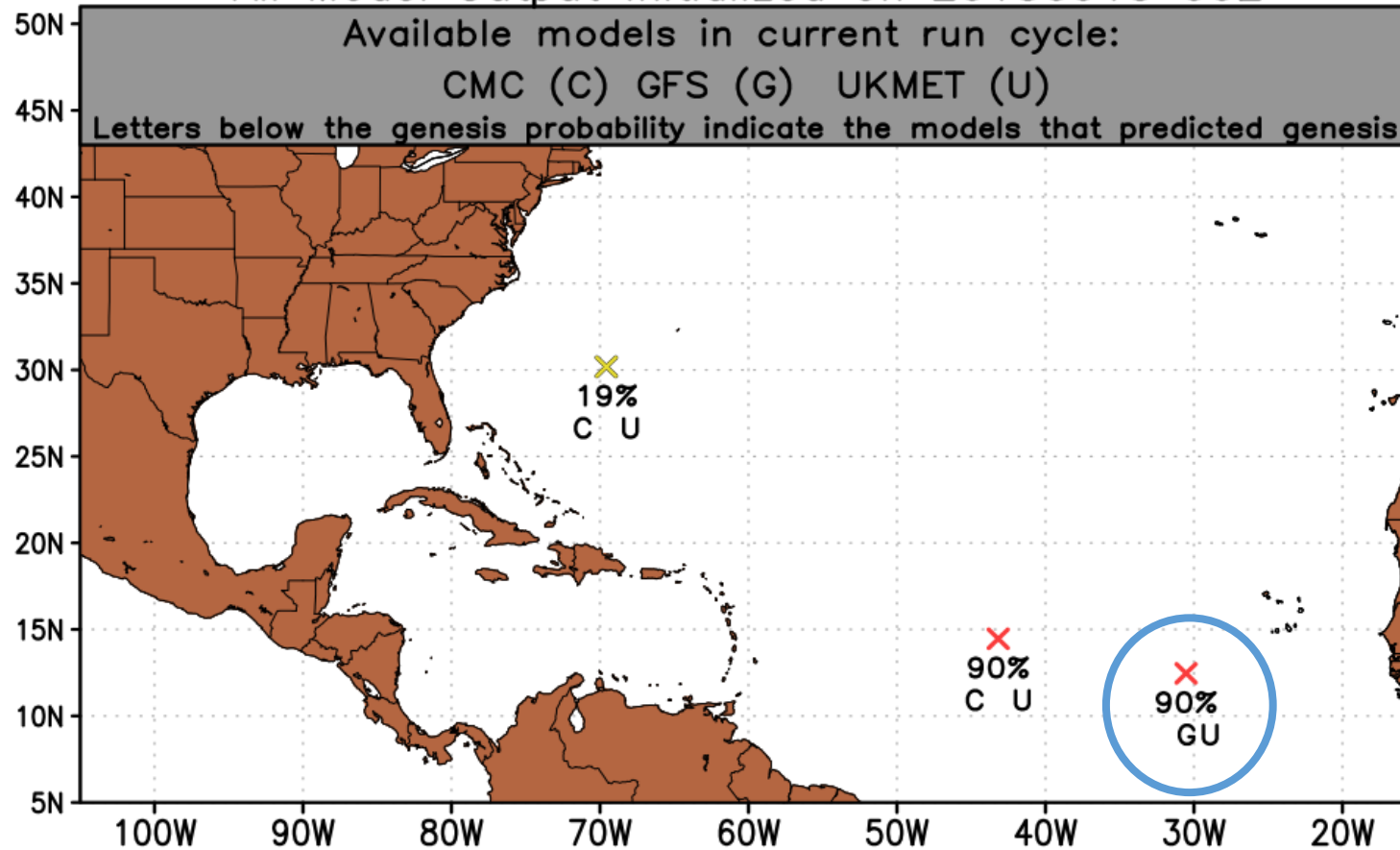
Statistical model development

- Use multiple logistic regression to generate probabilistic genesis forecasts.
- Select predictors using backward elimination.
- Cross-validate selected predictors.
- Develop separate equations for each model, basin, and forecast window (12 total).

$$\beta = -110.8 - 0.039 \times \text{FHR} + 0.013 \times \text{THCK} - 0.03 \times \text{LON}$$

$$P(\text{Gen}) = \frac{e^{\beta}}{1 + e^{\beta}}$$

Experimental Probability of TC Genesis
at Anytime Within 120 Hours
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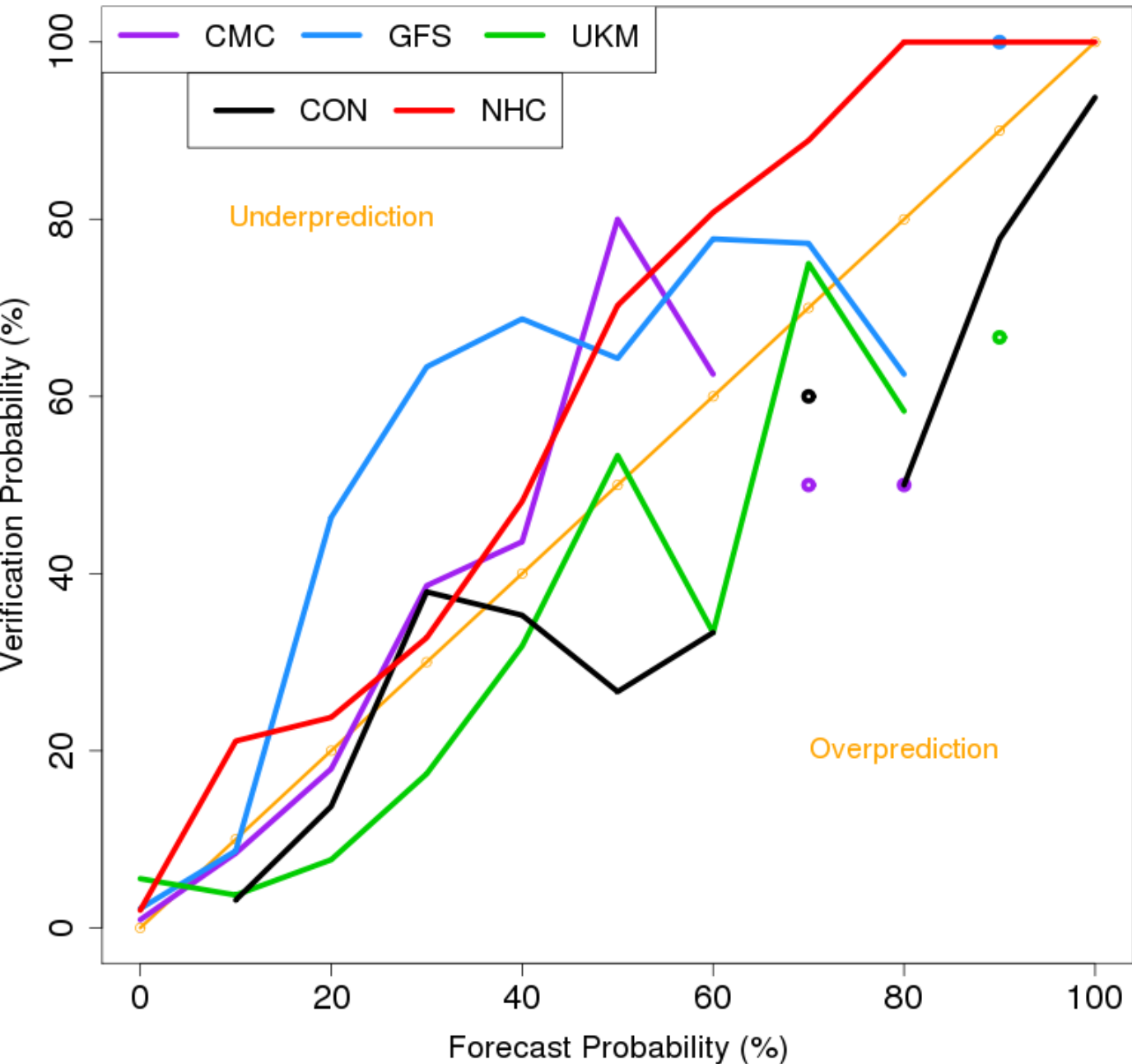


How to calculate consensus forecast:

$$\beta = \beta_0 + \beta_1[P(\text{CMC})] + \beta_2[P(\text{GFS})] + \beta_3[P(\text{UKM})]$$

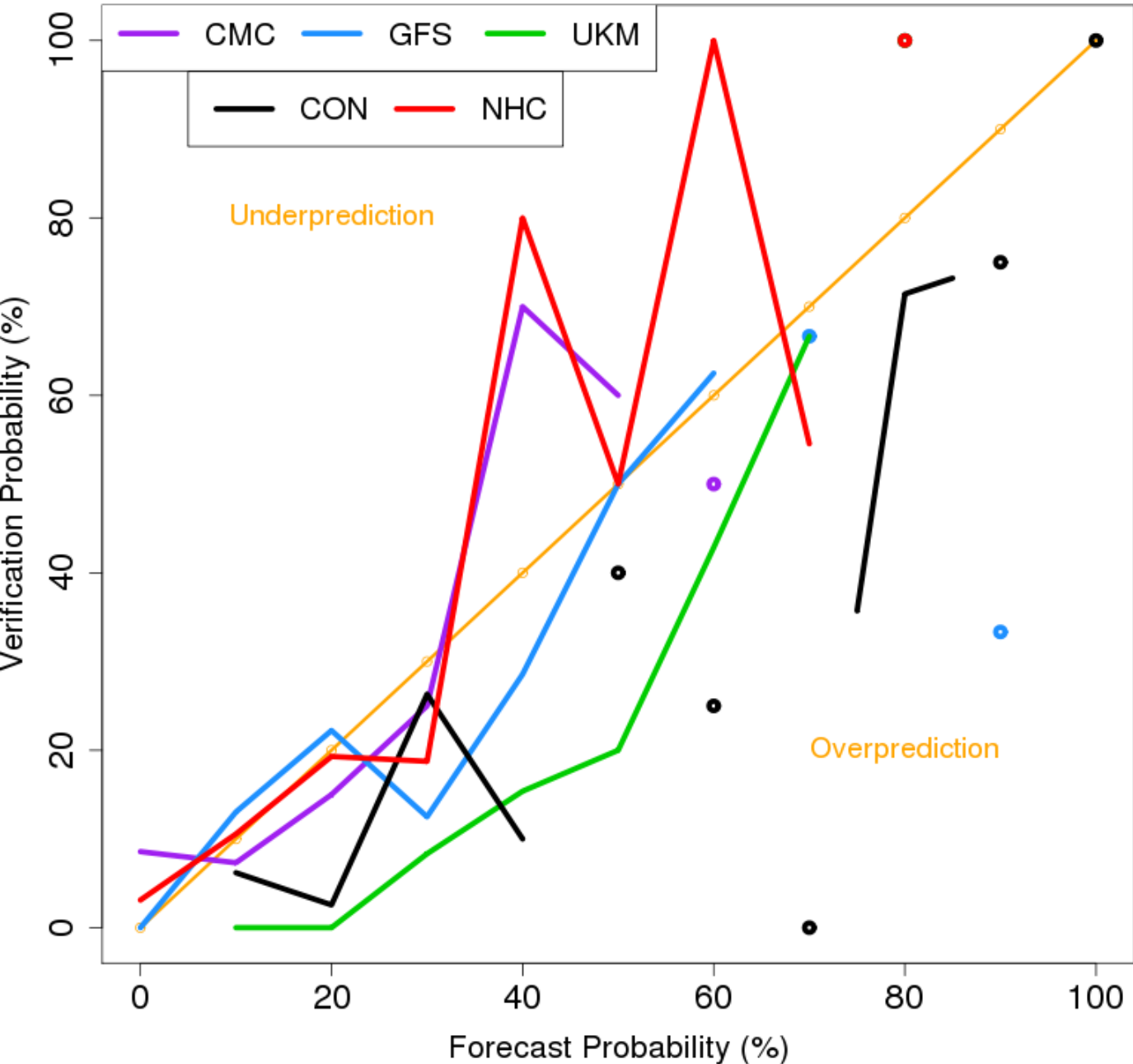
$$\beta = \beta_0 + \beta_1(0) + \beta_2(0.20) + \beta_3(0.43)$$

2014 EPAC 48 h Forecast Verification (non-homogeneous)



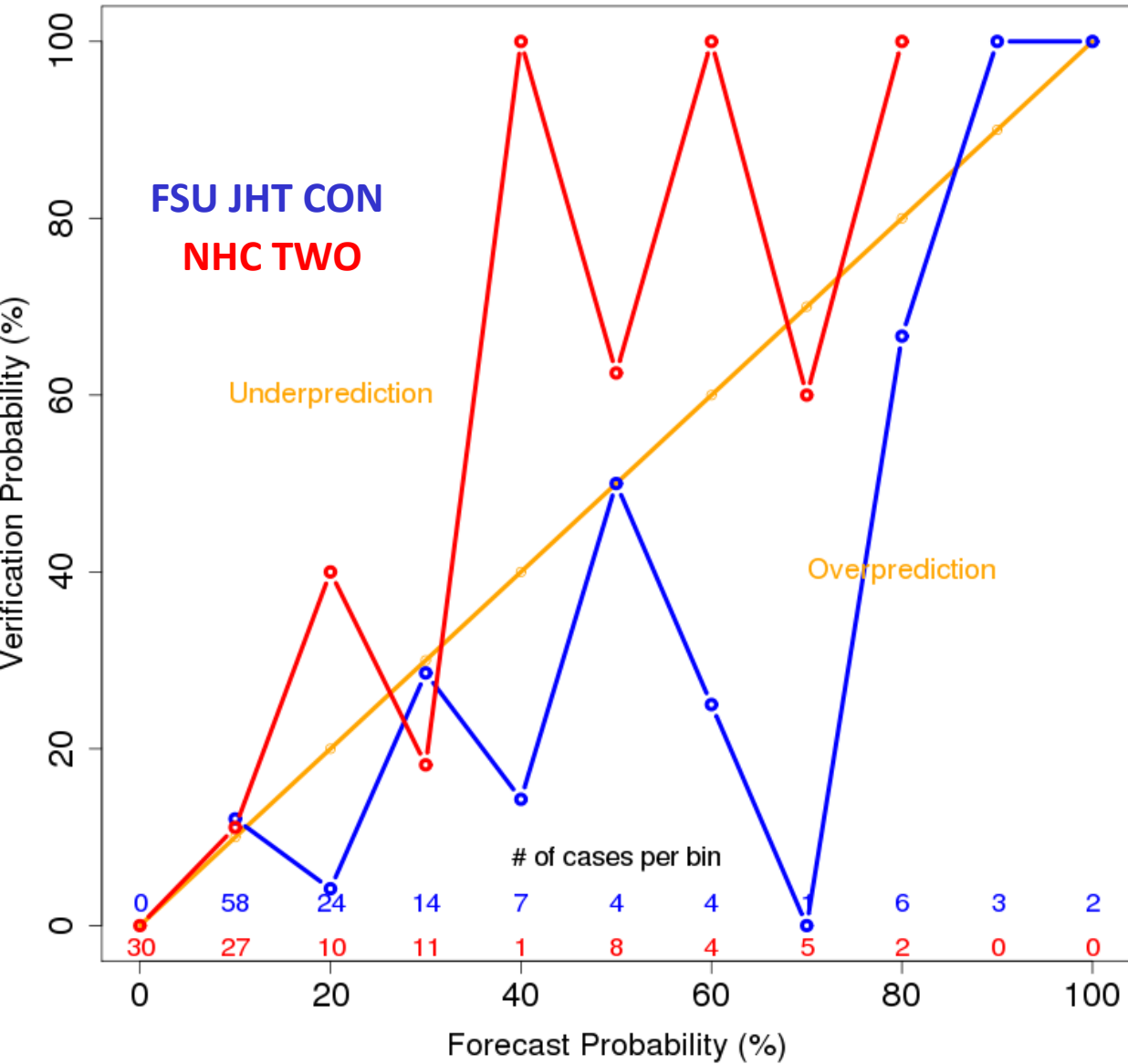
- **NHC** and **GFS** underpredict at most probability bins.
- **CMC** well calibrated.
- **CON** and **UKM** overpredict at most probability bins.
- Small sample size (points/breaks in lines) at higher forecast probability bins.

2014 NATL 48 h Forecast Verification (non-homogeneous)

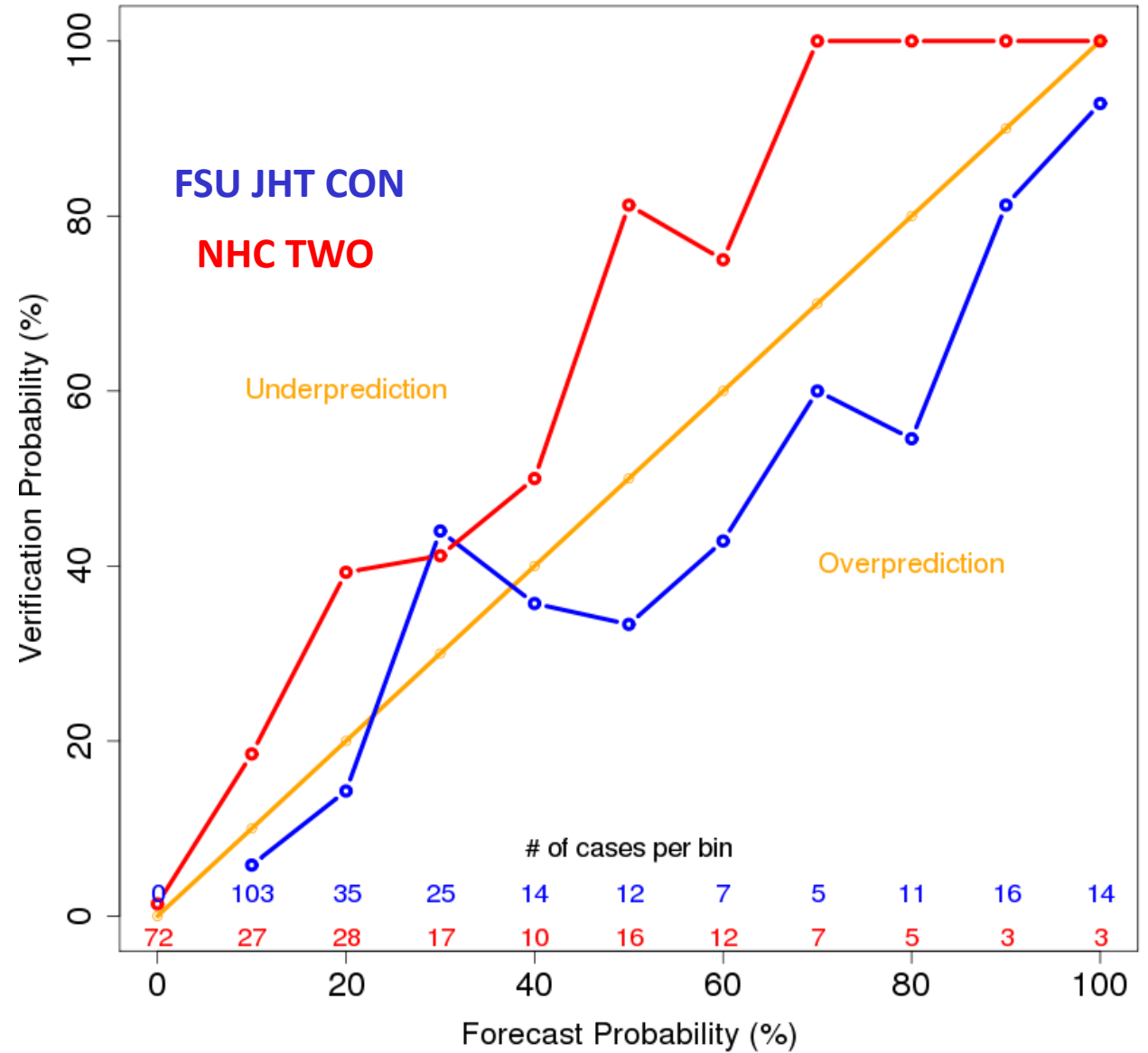


- **NHC**, **GFS**, and **CMC** well calibrated at lower probability bins.
- **NHC** and **CMC** underpredict at higher probability bins.
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2014 NATL 48 h NHC TWO & FSU Consensus Verification (homogeneous)



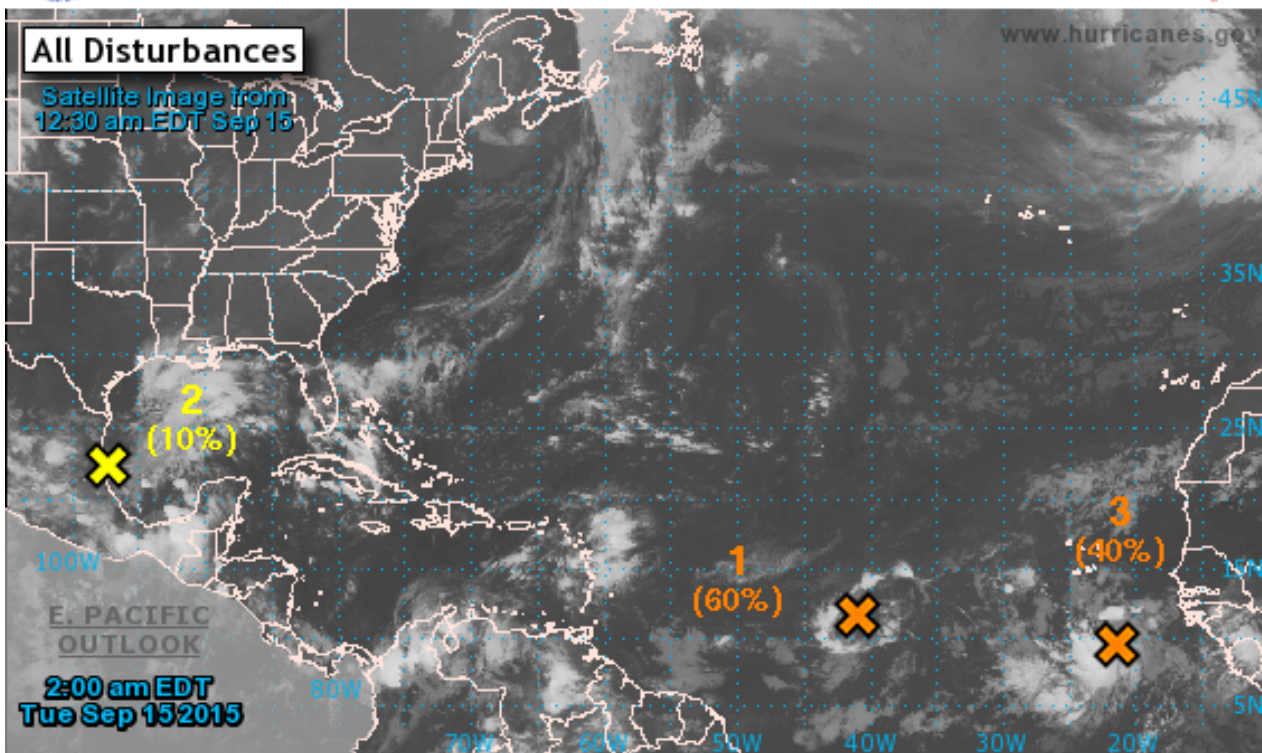
2014 EPAC 48 h NHC TWO & FSU Consensus Verification (homogeneous)





Two-Day Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



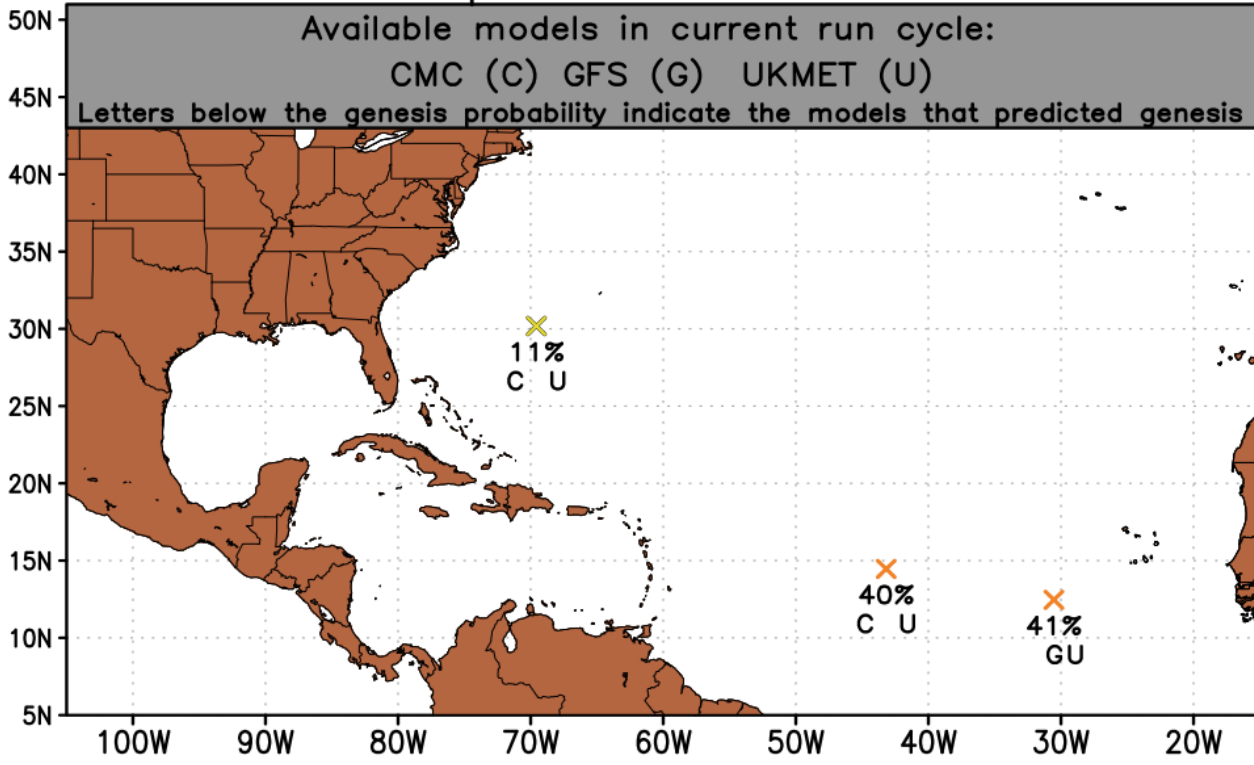
Current Disturbances and 2-Day Cyclone Formation Chance: < 40% 40-60% > 60%

Tropical or Sub-Tropical Cyclone: Depression Storm Hurricane

Post-Tropical Cyclone Remnants

Experimental Probability of TC Genesis at Anytime Within 48 Hours

All Model Output Initialized on 20150915 00Z

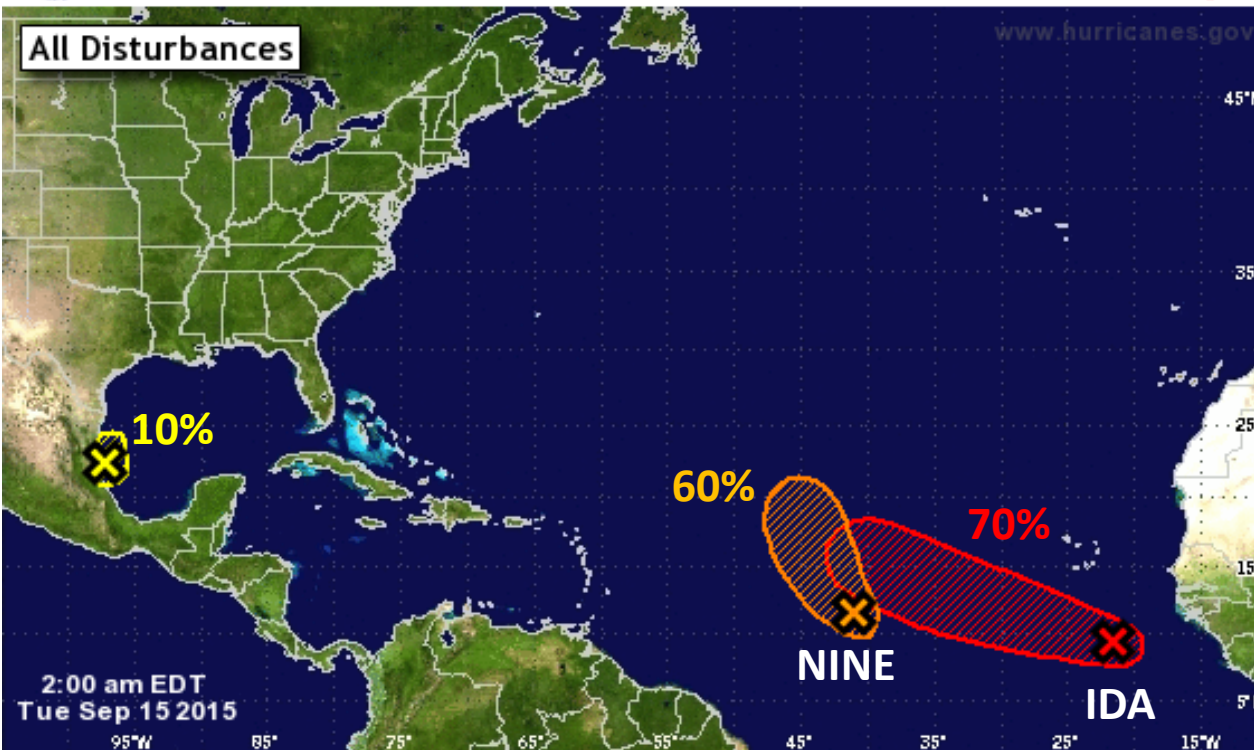


<http://moe.met.fsu.edu/modelgen>



Five-Day Graphical Tropical Weather Outlook

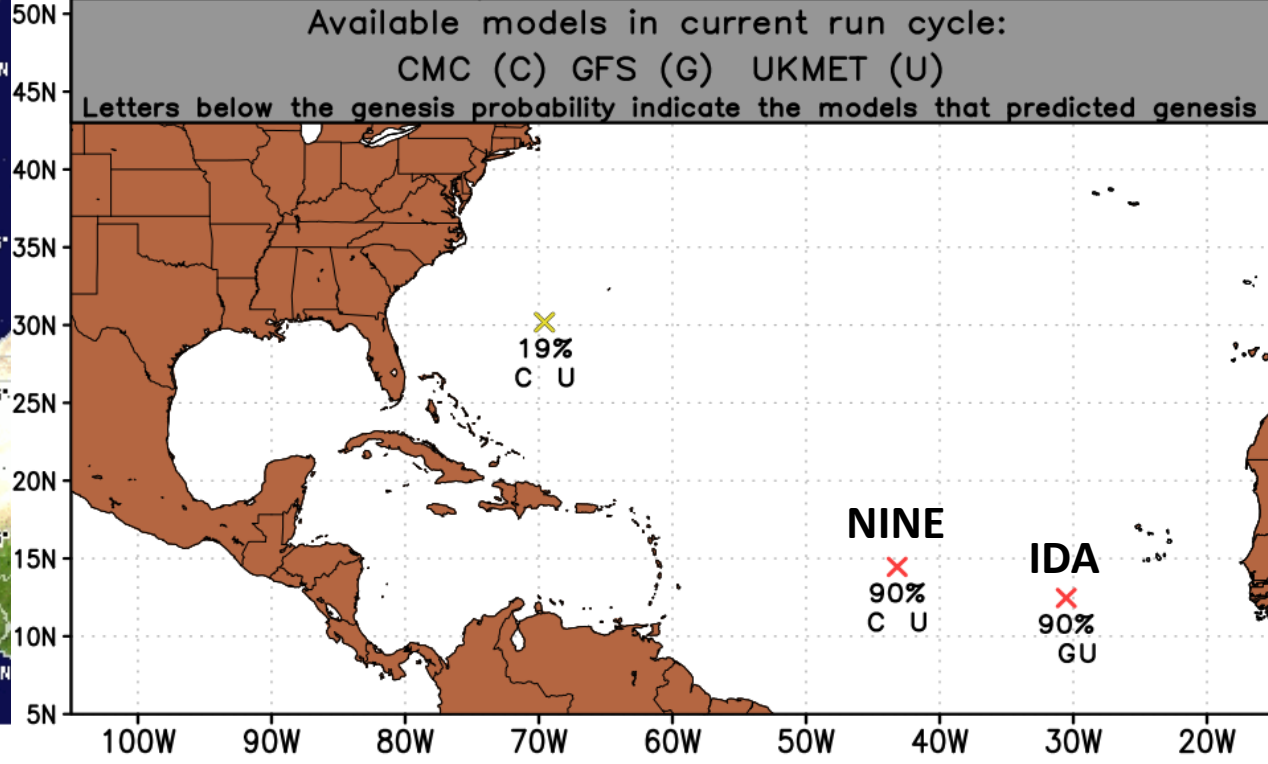
National Hurricane Center Miami, Florida



Tropical Cyclone Formation Potential for the 5-Day Period Ending 2:00 am EDT Sun Sep 20 2015
 Chance of Cyclone Formation in 5 Days: ■ Low < 40% ■ Medium 40-60% ■ High > 60%
 X indicates current disturbance location; shading indicates potential formation area.

Experimental Probability of TC Genesis at Anytime Within 120 Hours

All Model Output Initialized on 20150915 00Z



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