

A probabilistic tropical cyclone genesis forecast guidance tool using global numerical models

Dan Halperin, Bob Hart, Henry Fuelberg, Josh Cossuth

VLab Forum

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Motivation

- National Hurricane Center (NHC) forecasters are interested in 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.
- **Our goal:** Develop an automated, objective TC genesis guidance product based on output from three global models (GFS, UKMET, CMC).

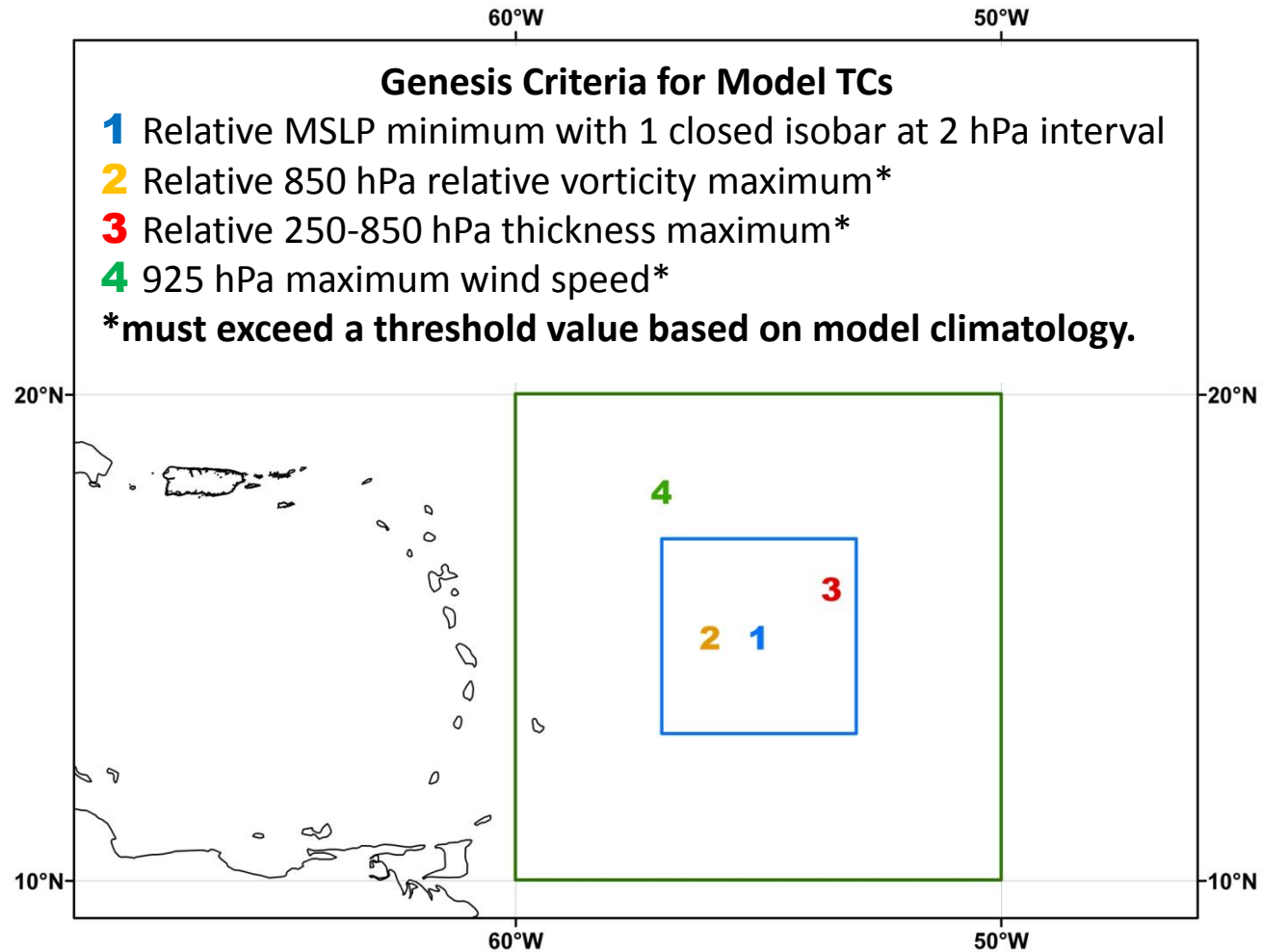
Guidance product requirements

- Provide probabilistic forecasts of TC genesis within 48 and 120 h.
- Cover the North Atlantic and eastern North Pacific basins.
- Products must be available at least 30 minutes prior to TWO issuance.
- Products must be formatted for quick/easy interpretation to accommodate the forecasters' time constraints.

Product development summary

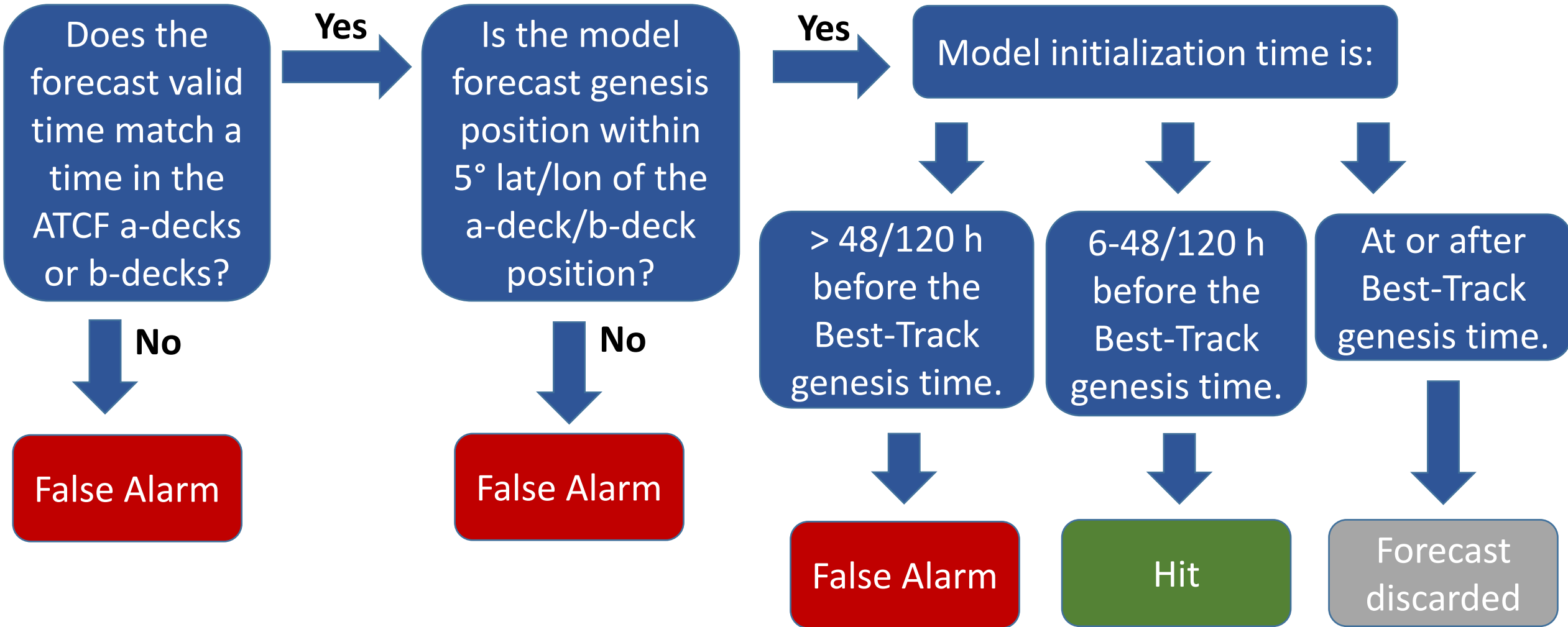
- Verified model-indicated TC genesis forecasts since 2004.
- Used logistic regression to calculate objective, bias-corrected TC genesis probabilities for real-time model-indicated TC genesis forecasts.
- Developed a separate logistic regression equation for each global model, basin, and forecast window.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

Methodology – TC genesis definition



Criteria 1-4 must be satisfied for 24 consecutive h in the forecast cycle

Methodology – Verification



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]

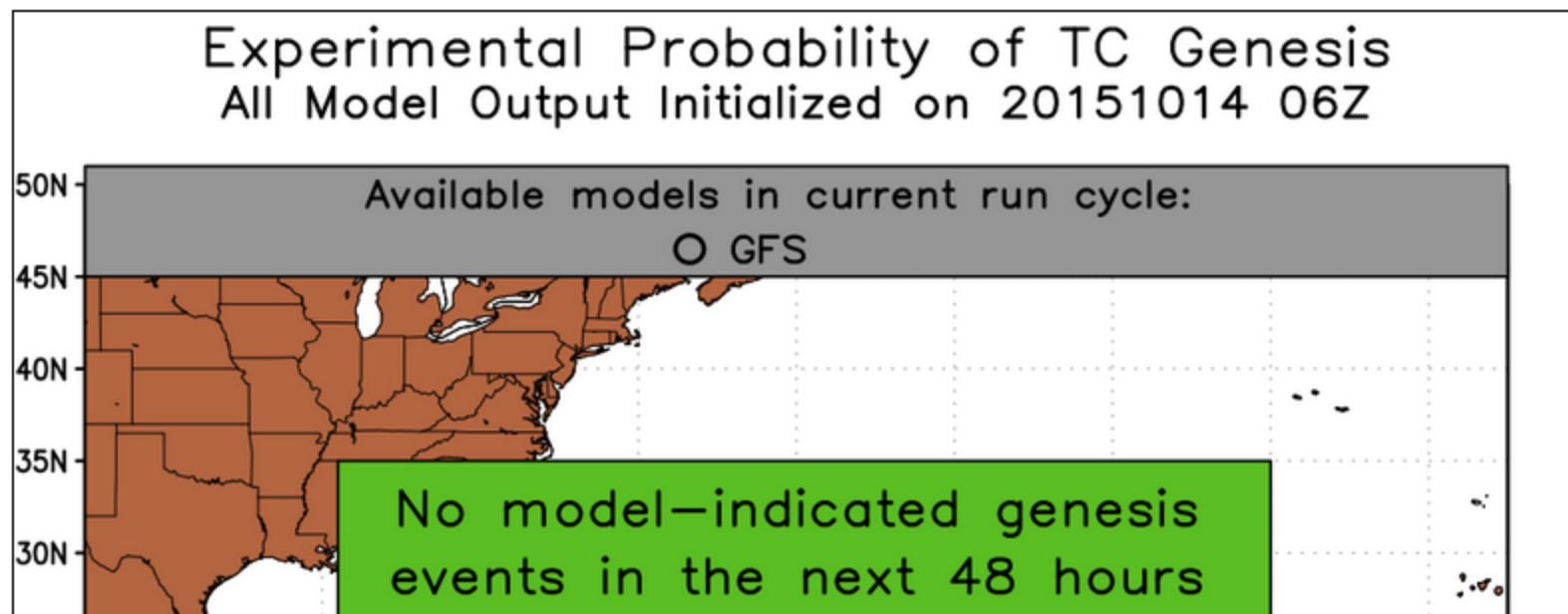
[GFS GRAPHIC]

[UKM GRAPHIC]

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

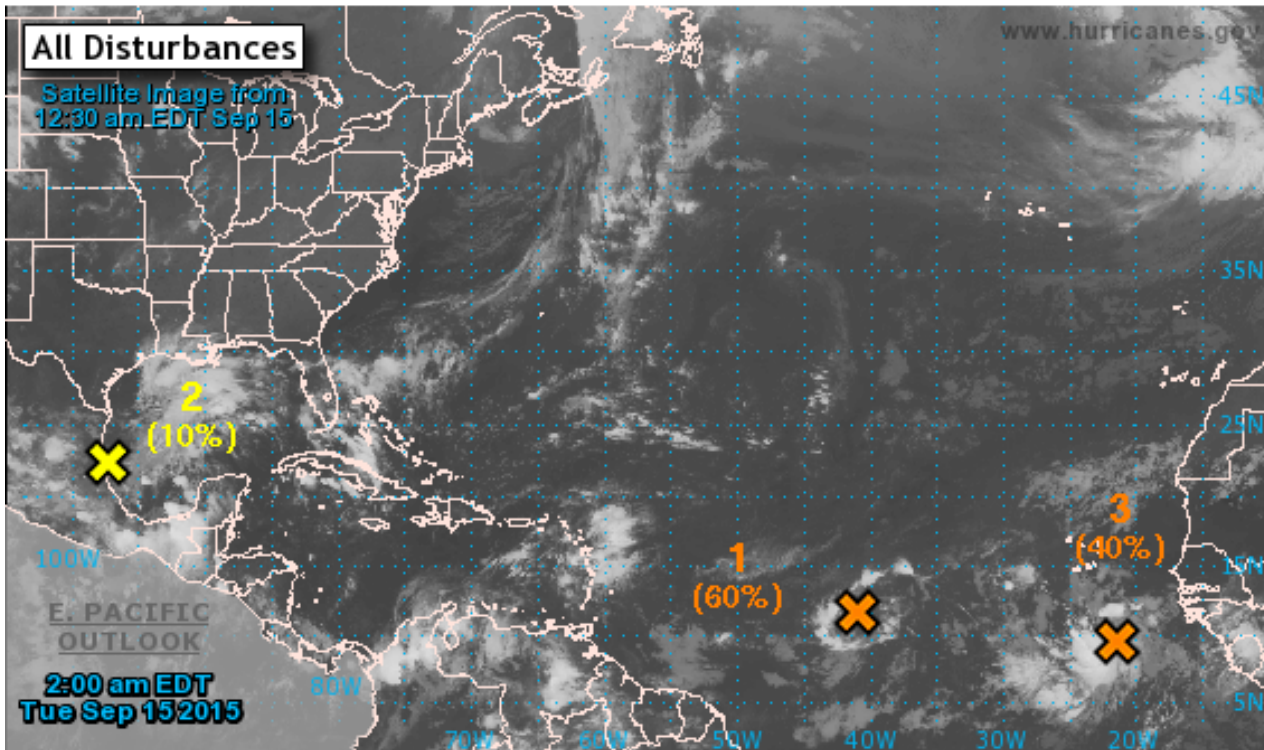
[[North Atlantic](#) | Eastern Pacific]









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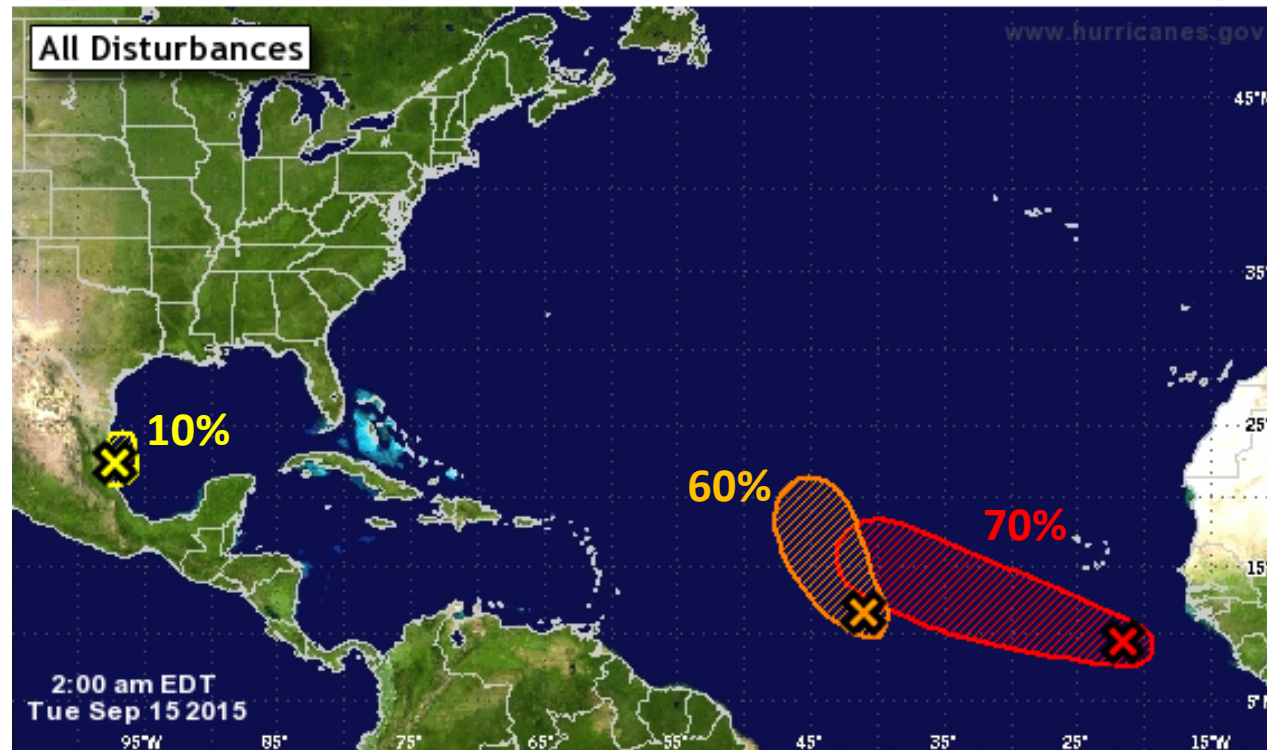
Case Study




 **Two-Day Graphical Tropical Weather Outlook**
National Hurricane Center Miami, Florida 



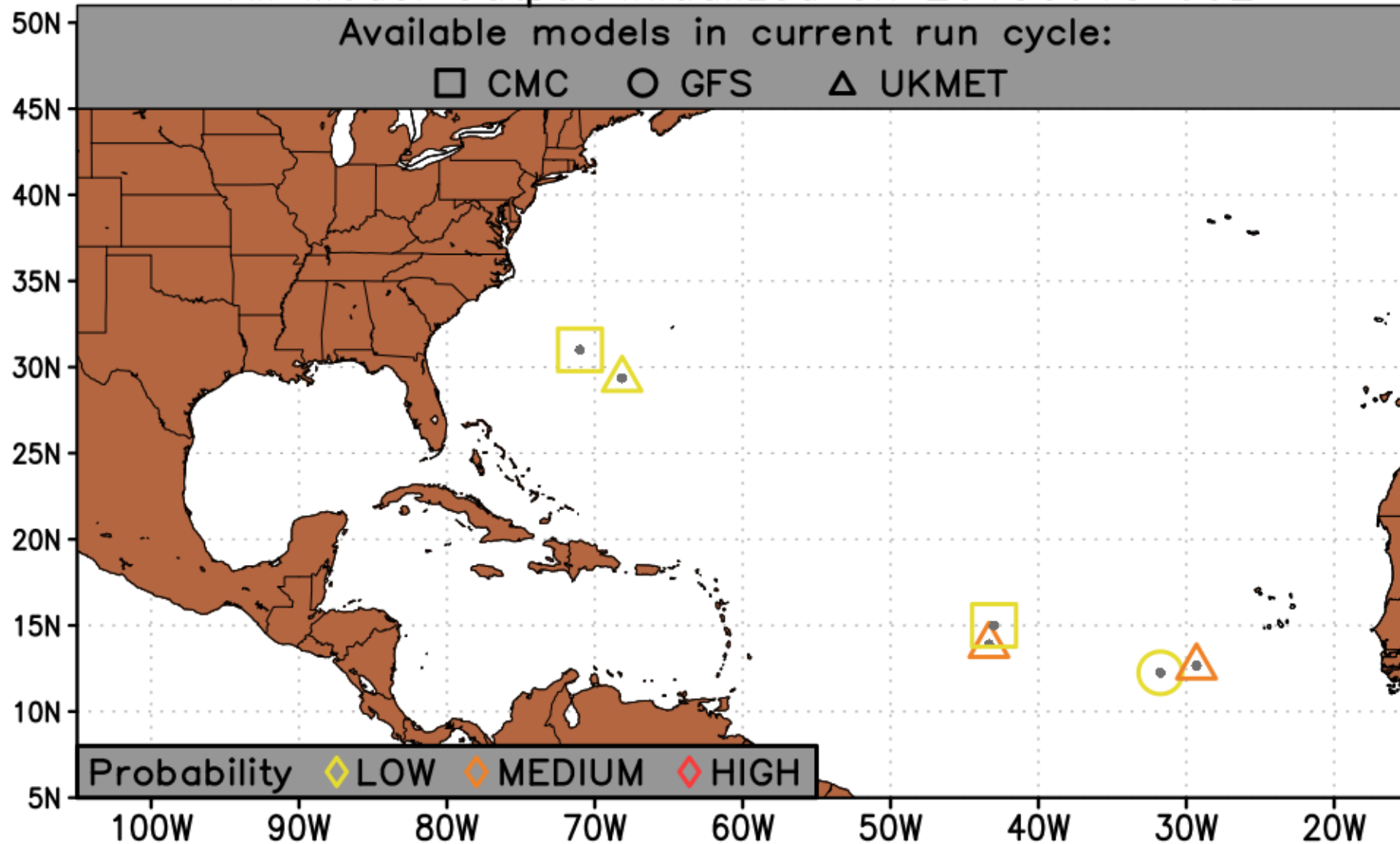
Current Disturbances and 2-Day Cyclone Formation Chance:  < 40%  40-60%  > 60%
Tropical or Sub-Tropical Cyclone:  Depression  Storm  Hurricane
 Post-Tropical Cyclone  Remnants

 **Five-Day Graphical Tropical Weather Outlook**
National Hurricane Center Miami, Florida 



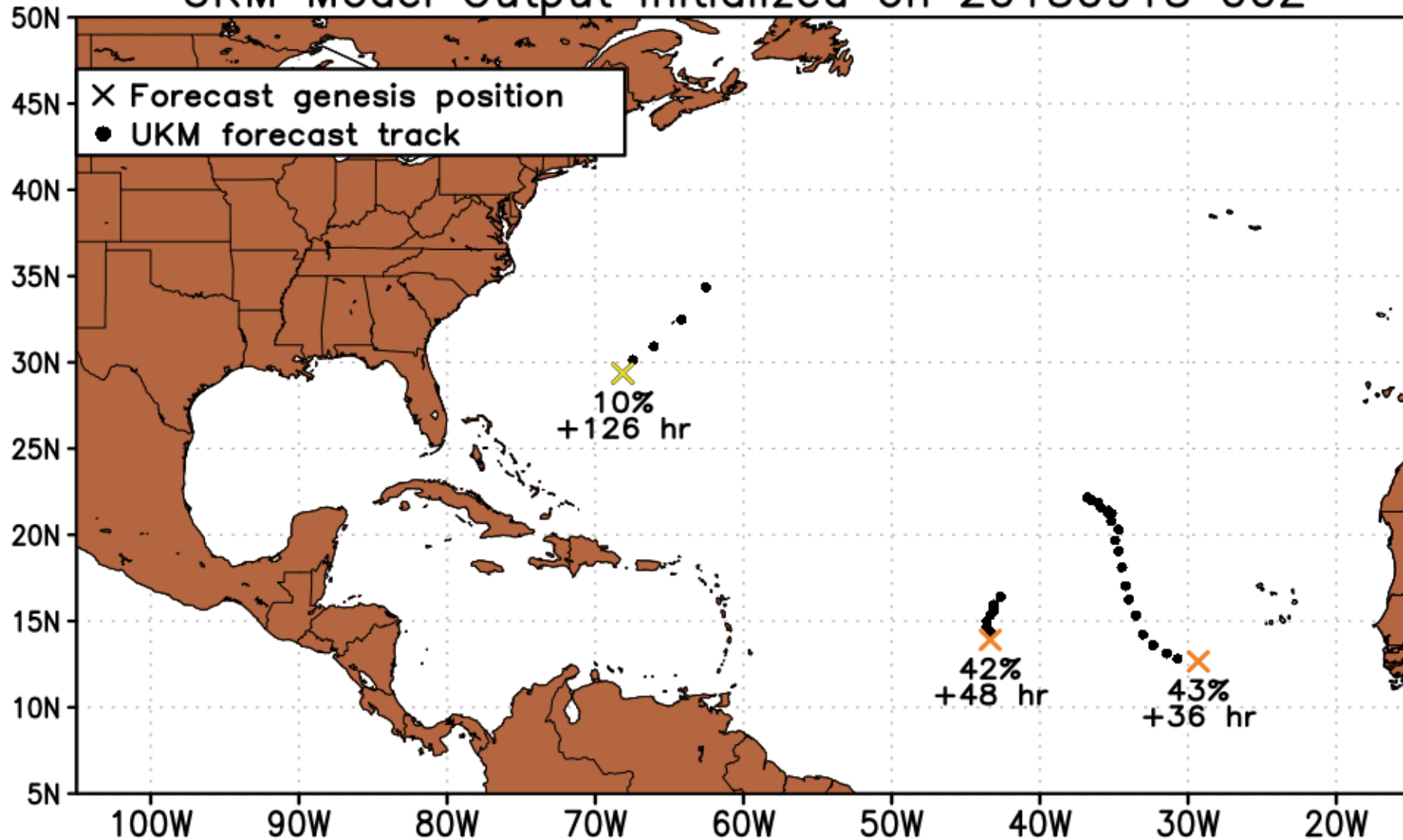
Tropical Cyclone Formation Potential for the 5-Day Period Ending 2:00 am EDT Sun Sep 20 2015
Chance of Cyclone Formation in 5 Days:  Low < 40%  Medium 40-60%  High > 60%
X indicates current disturbance location; shading indicates potential formation area.

Experimental Probability of TC Genesis at Anytime Within 48 Hours All Model Output Initialized on 20150915 00Z



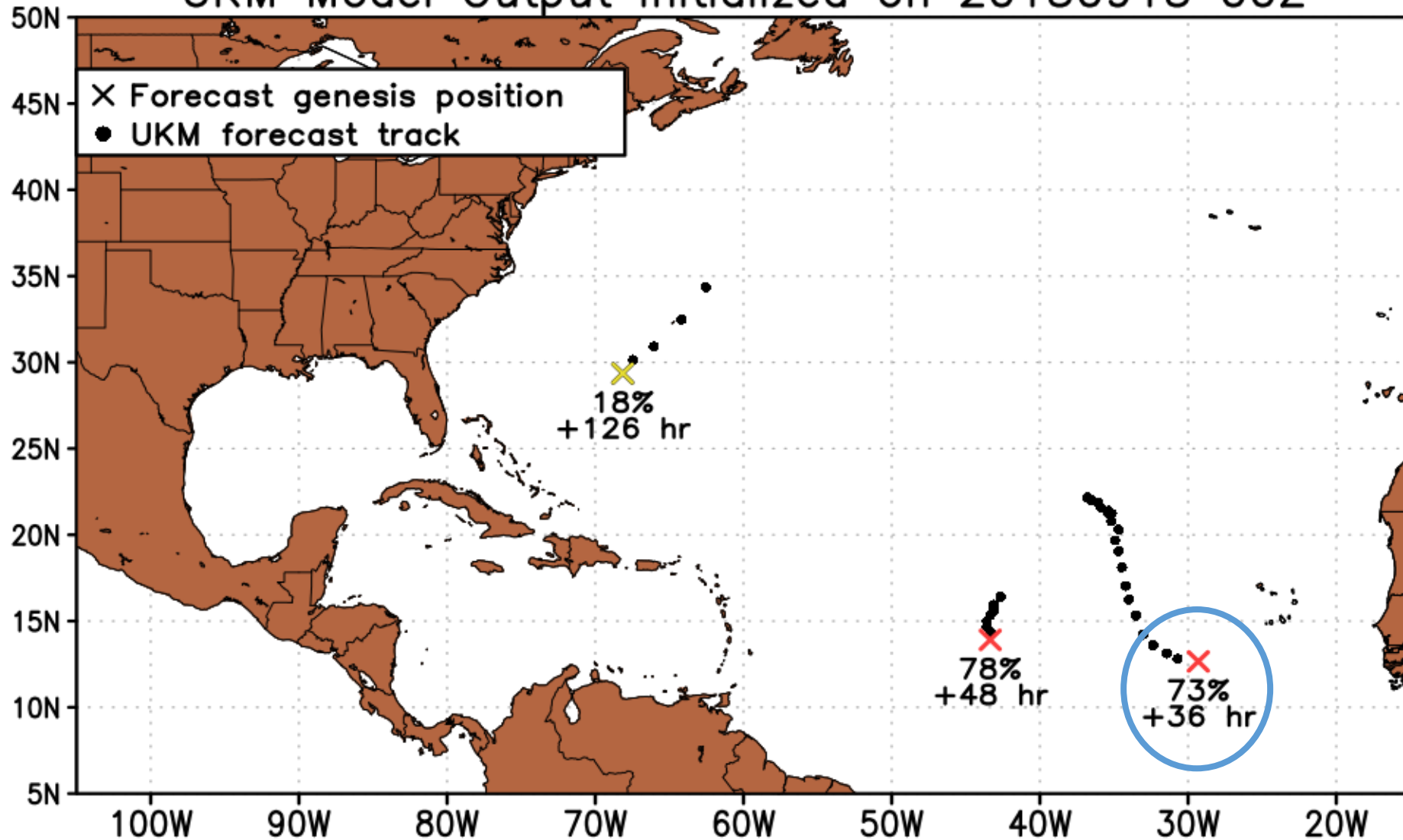
Experimental Probability of TC Genesis at Anytime Within 48 Hours

UKM Model Output Initialized on 20150915 00Z



Experimental Probability of TC Genesis at Anytime Within 120 Hours

UKM Model Output Initialized on 20150915 00Z



** 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

**** Tropical Disturbance #2 Information ****

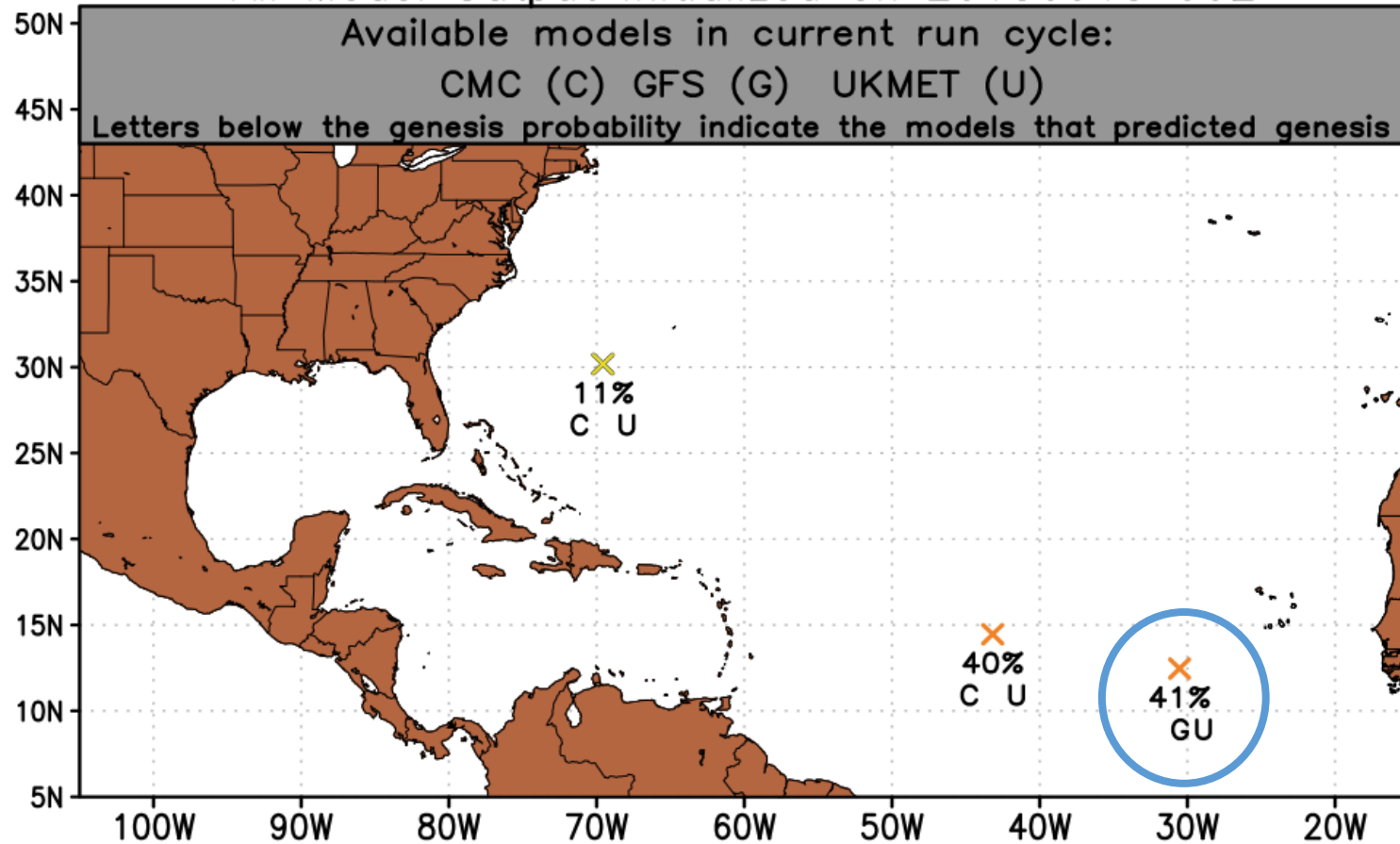
**** GFS output initialized 2015091500 ****

****GENESIS PREDICTED? YES, at forecast hour 60****

TIME (hr)	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
GEN PROB (%)			20												51
CRIT MET?	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
LAT (N)	N/A	11.25	11.50	11.75	12.25	12.50	13.00	13.50	14.00	14.25	14.75	15.00	15.25	15.50	16.00
LON (W)	N/A	29.00	30.00	30.80	31.80	32.50	33.30	34.00	34.80	35.50	36.30	37.30	38.50	39.30	40.30
925VMAX (m/s)	N/A	(14.61)	(15.78)	(15.70)	17.65	16.58	16.97	17.69	21.87	24.38	24.62	24.32	27.58	26.05	26.02
850RV (*10 ⁻⁵ 1/s)	N/A	26.04	24.55	22.29	20.33	19.67	17.89	19.06	22.88	34.78	32.53	26.51	38.59	33.23	26.25
H25-85 THCK (m)	N/A	9487	9484	9476	9481	9490	9486	9479	9479	9491	9487	9479	9478	9489	9479
SFC LH FLUX	N/A	152.78	160.26	174.45	172.48	161.52	150.34	147.25	141.78	136.15	131.53	137.98	141.31	133.79	131.60
850RVPERT	N/A	24.66	22.98	20.50	18.37	17.81	17.39	17.30	21.32	33.44	31.27	25.36	37.46	32.30	25.14
H2-85 SHEAR	N/A	10.12	11.11	12.32	12.77	12.51	12.74	13.72	14.22	14.18	14.58	15.47	15.12	13.09	12.66

() indicates that the threshold value was not met

Experimental Probability of TC Genesis
at Anytime Within 48 Hours
All Model Output Initialized on 20150915 00Z

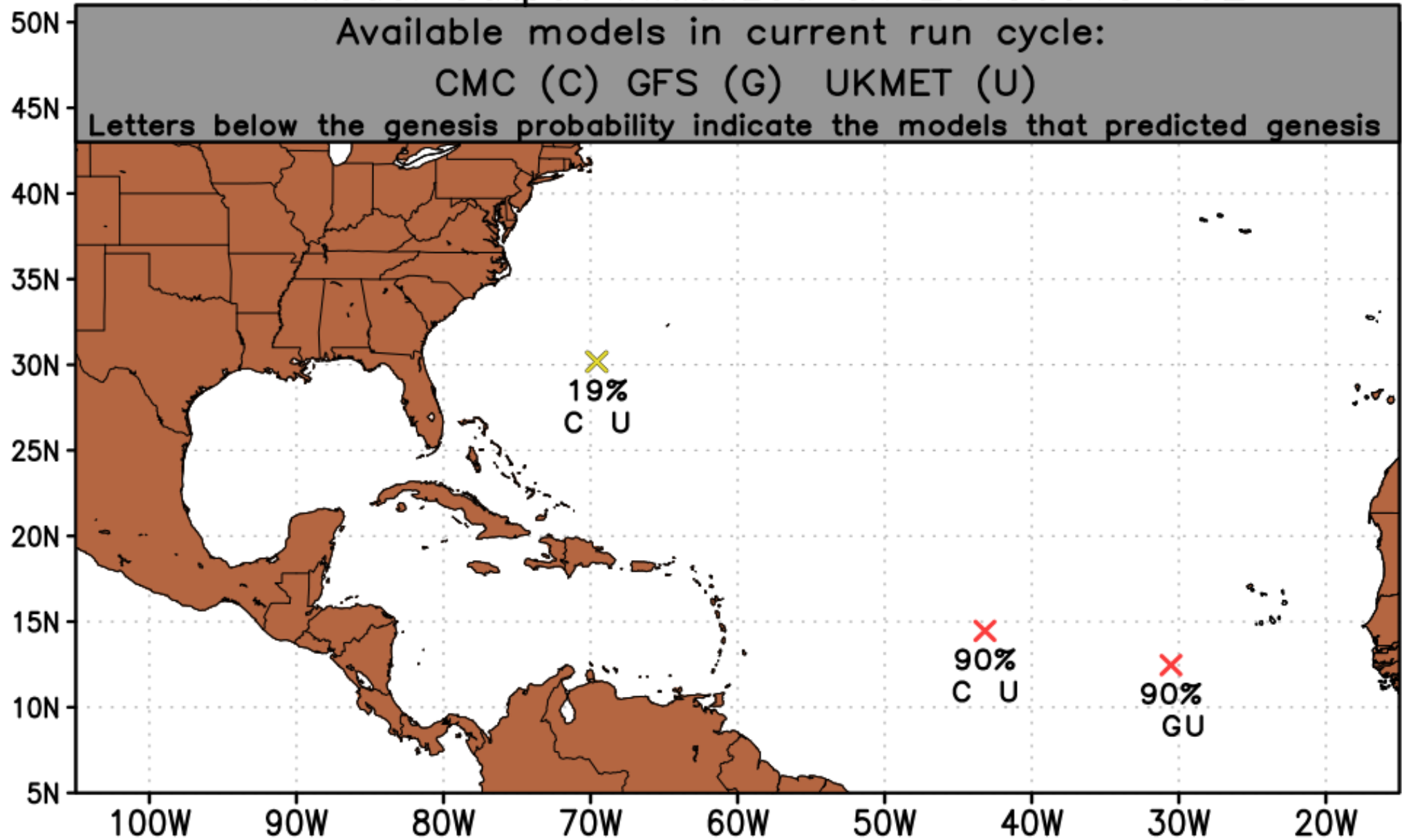


How to calculate consensus forecast:

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

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

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



**** TC Genesis Summary ****

**** Consensus output initialized 2015091500 ****

ID #	LAT (N)	LON (W)	PROB48 (%)	PROB120 (%)
1	12.46	30.60	41	90
2	14.46	43.20	40	90
3	30.18	69.60	11	19

**** TC Genesis Summary ****

**** UKM output initialized 2015091500 ****

ID #	FHR	LAT (N)	LON (W)	PROB48 (%)	PROB120 (%)
1	36	12.66	29.40	43	73
2	48	13.91	43.40	42	78
3	126	29.36	68.20	10	18

**** TC Genesis Summary ****

**** GFS output initialized 2015091500 ****

ID #	FHR	LAT (N)	LON (W)	PROB48 (%)	PROB120 (%)
1	60	12.25	31.80	20	51

**** TC Genesis Summary ****

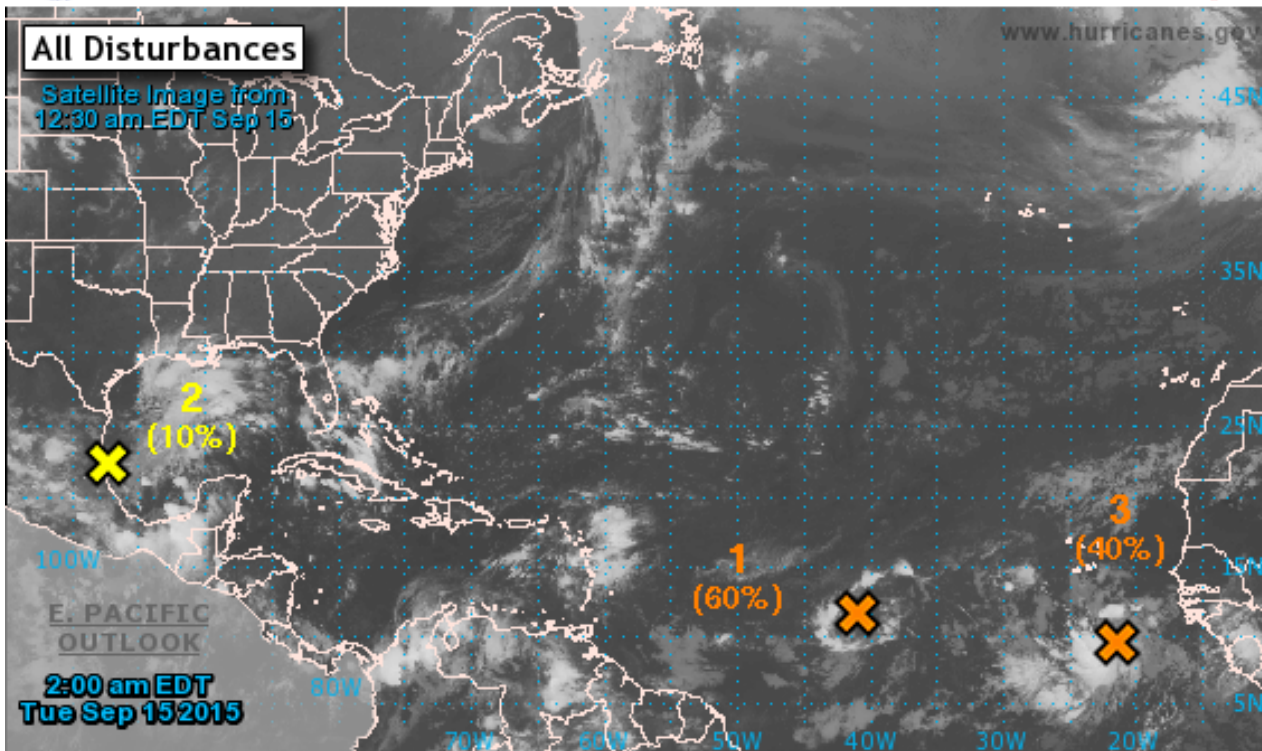
**** CMC output initialized 2015091500 ****

ID #	FHR	LAT (N)	LON (W)	PROB48 (%)	PROB120 (%)
1	54	15.00	43.00	19	46
2	126	31.00	71.00	2	6



Two-Day Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



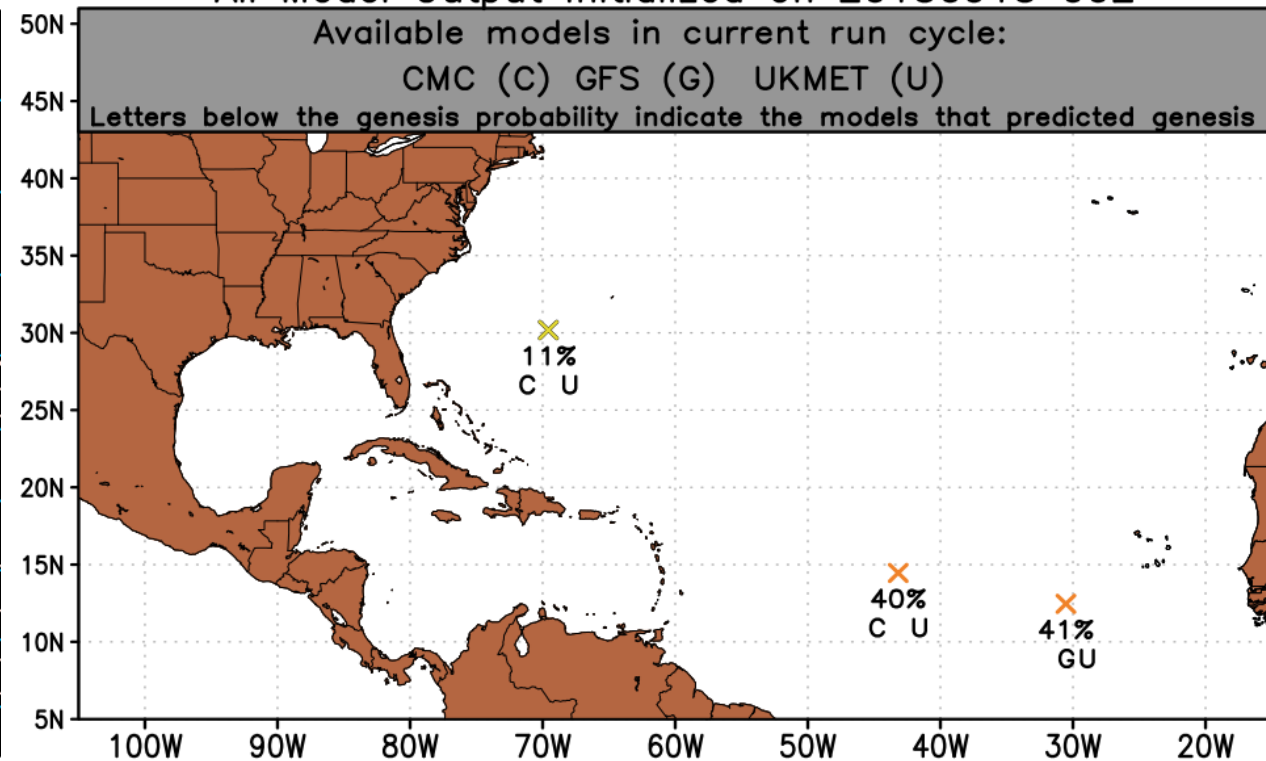
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Tropical or Sub-Tropical Cyclone: Depression Storm Hurricane

Post-Tropical Cyclone Remnants

Experimental Probability of TC Genesis at Anytime Within 48 Hours

All Model Output Initialized on 20150915 00Z

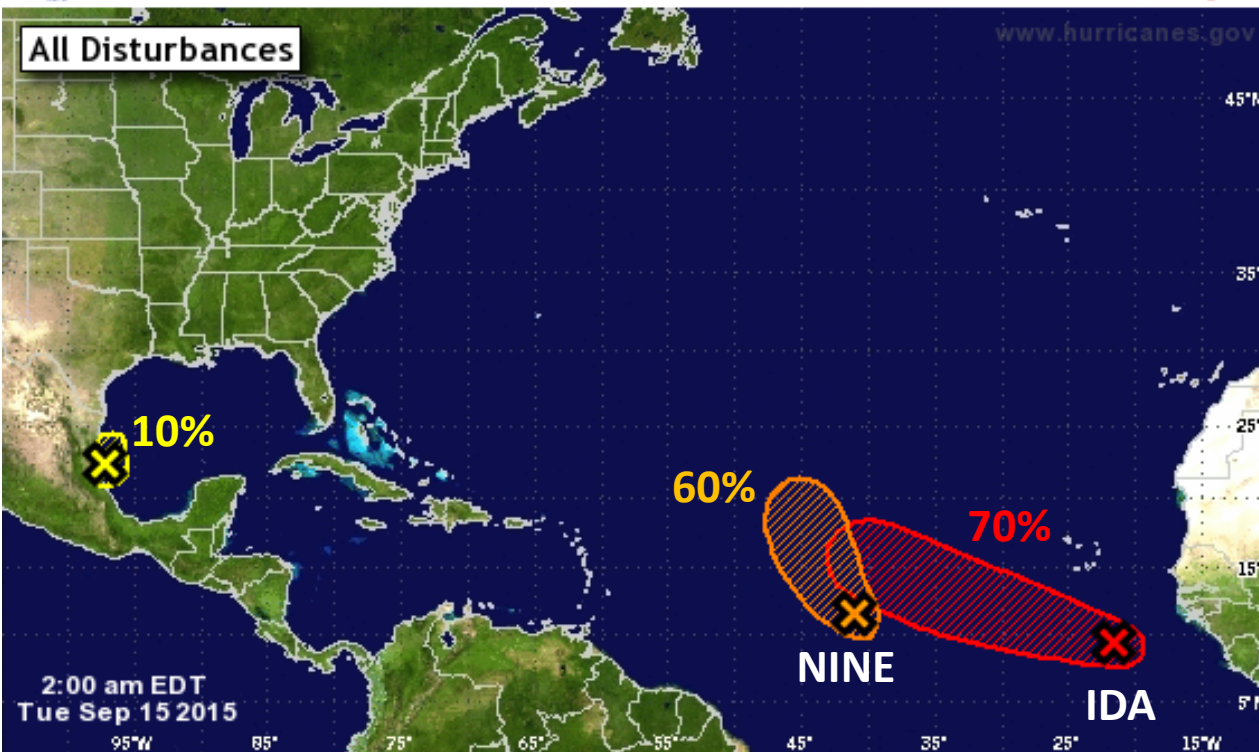


<http://moe.met.fsu.edu/modelgen>



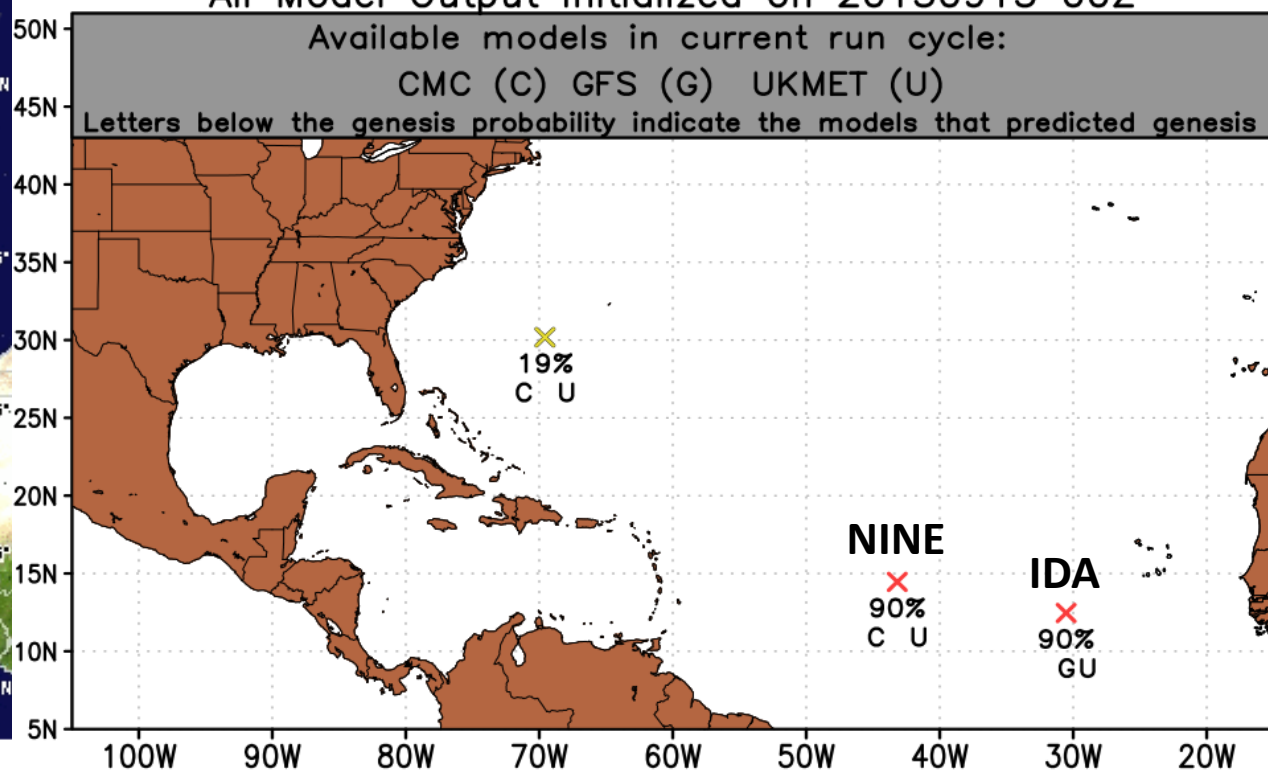
Five-Day Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



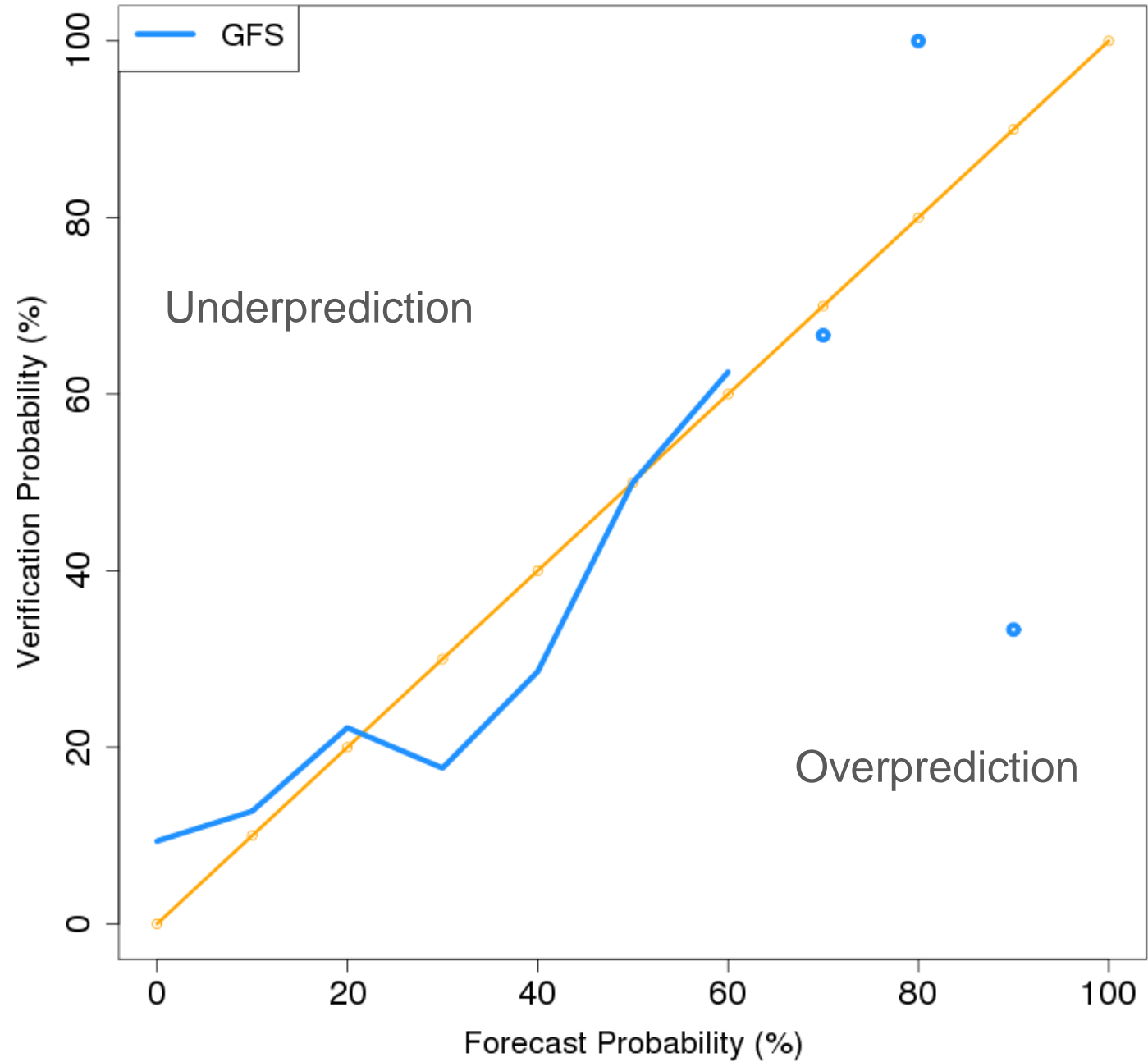
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 Chance of Cyclone Formation in 5 Days: ■ Low < 40% ■ Medium 40-60% ■ High > 60%
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Experimental Probability of TC Genesis at Anytime Within 120 Hours All Model Output Initialized on 20150915 00Z

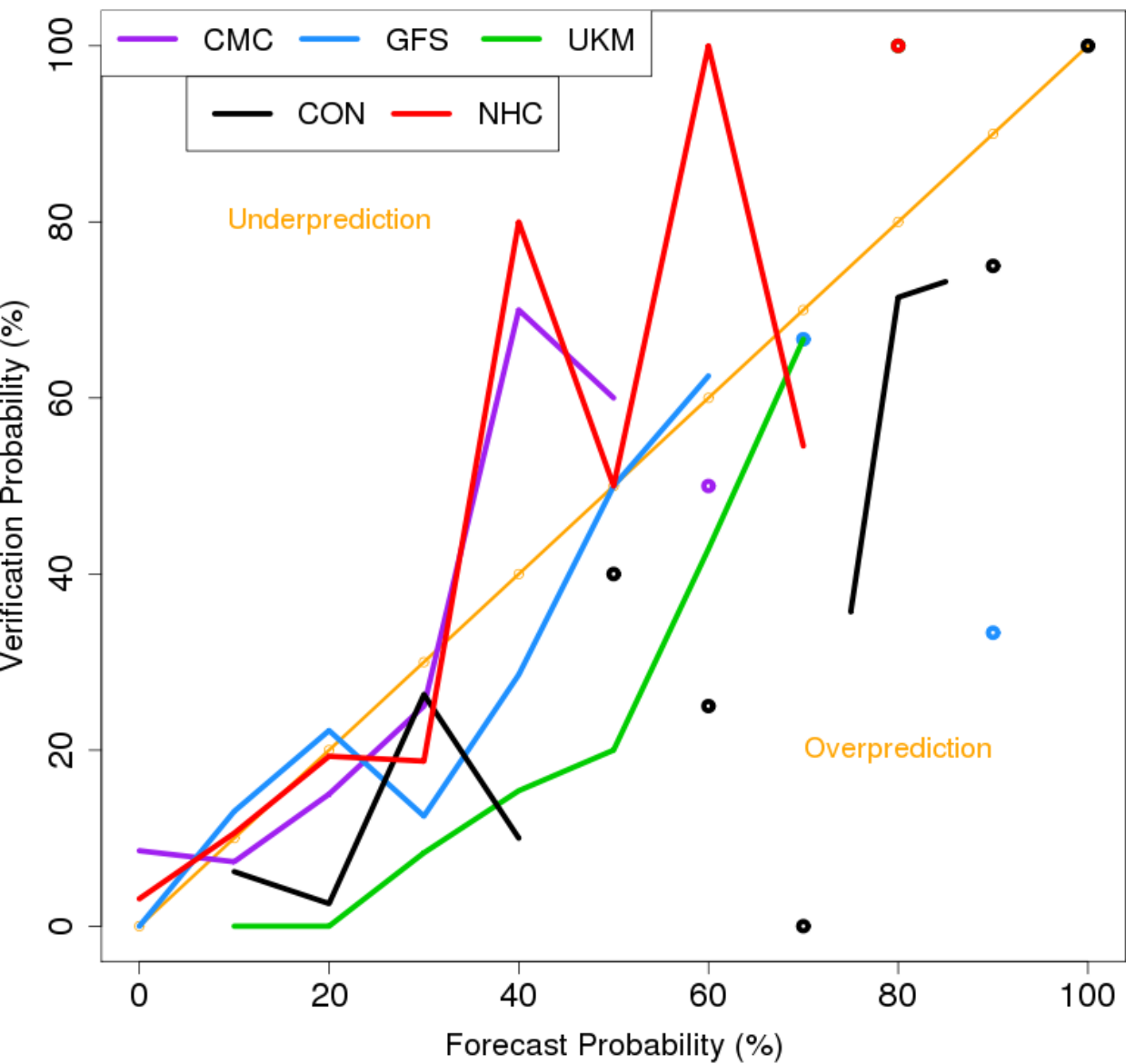


<http://moe.met.fsu.edu/modelgen>

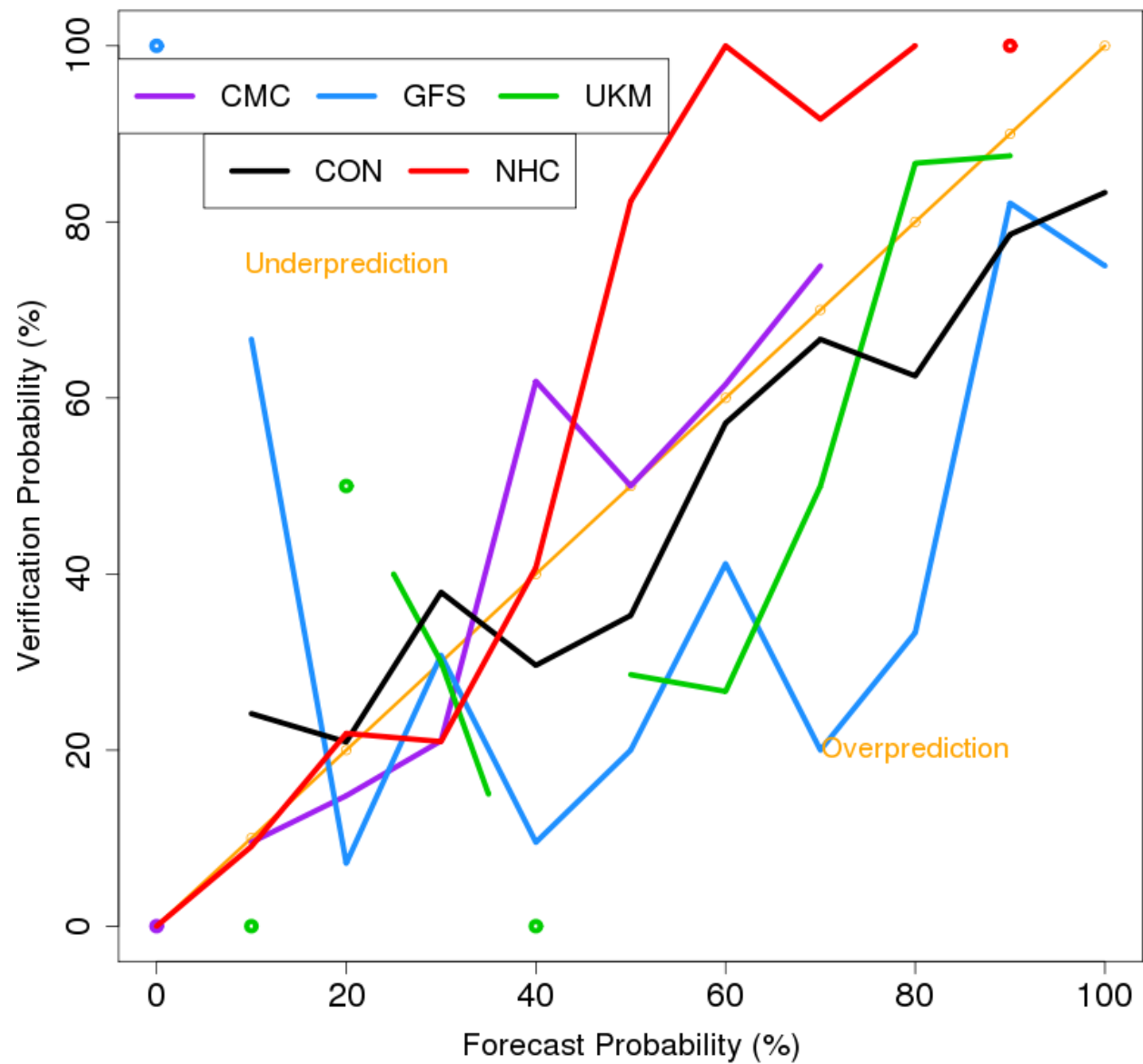
2014 NATL 48 h verification



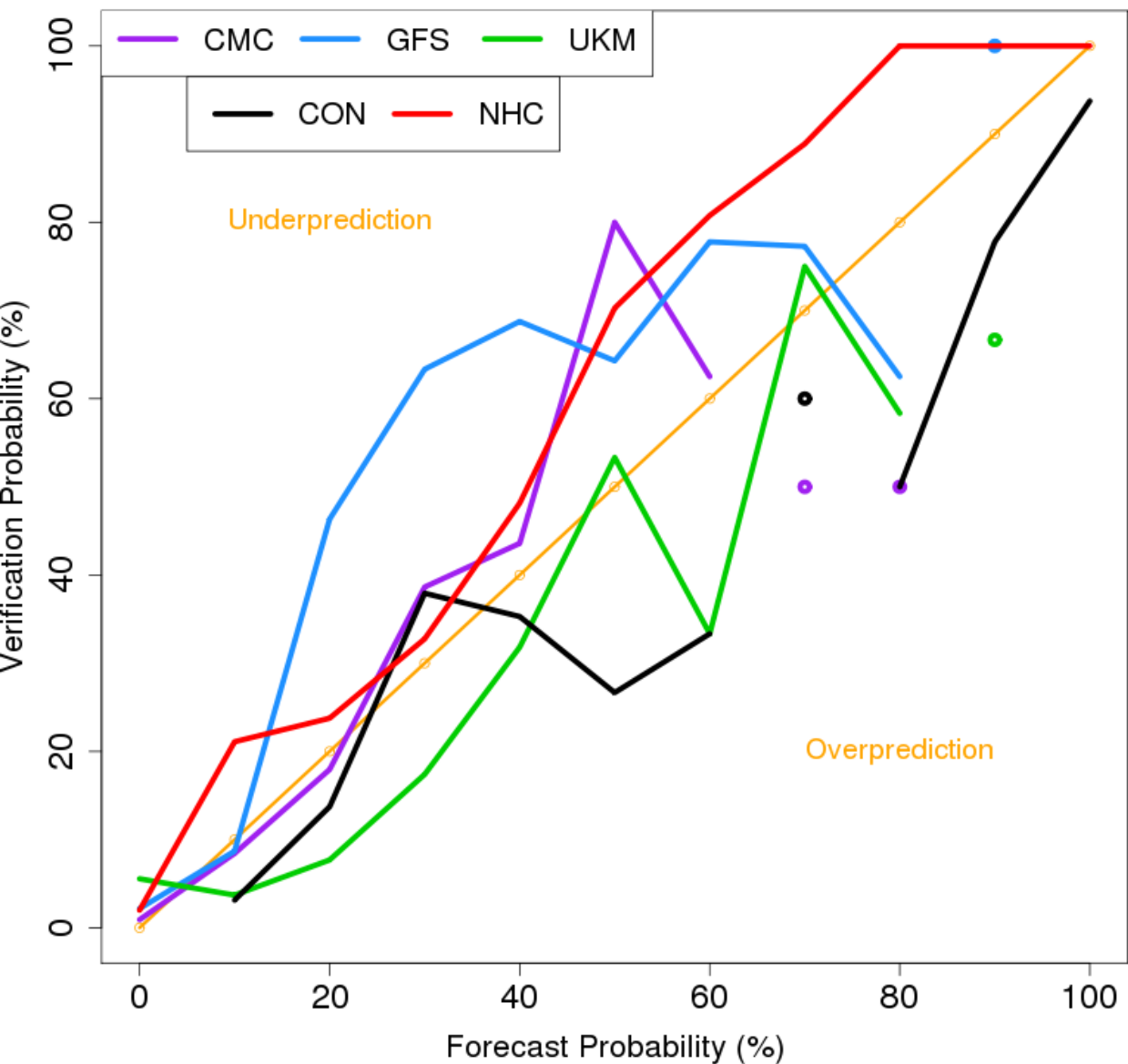
2014 NATL 48 h Forecast Verification (non-homogeneous)



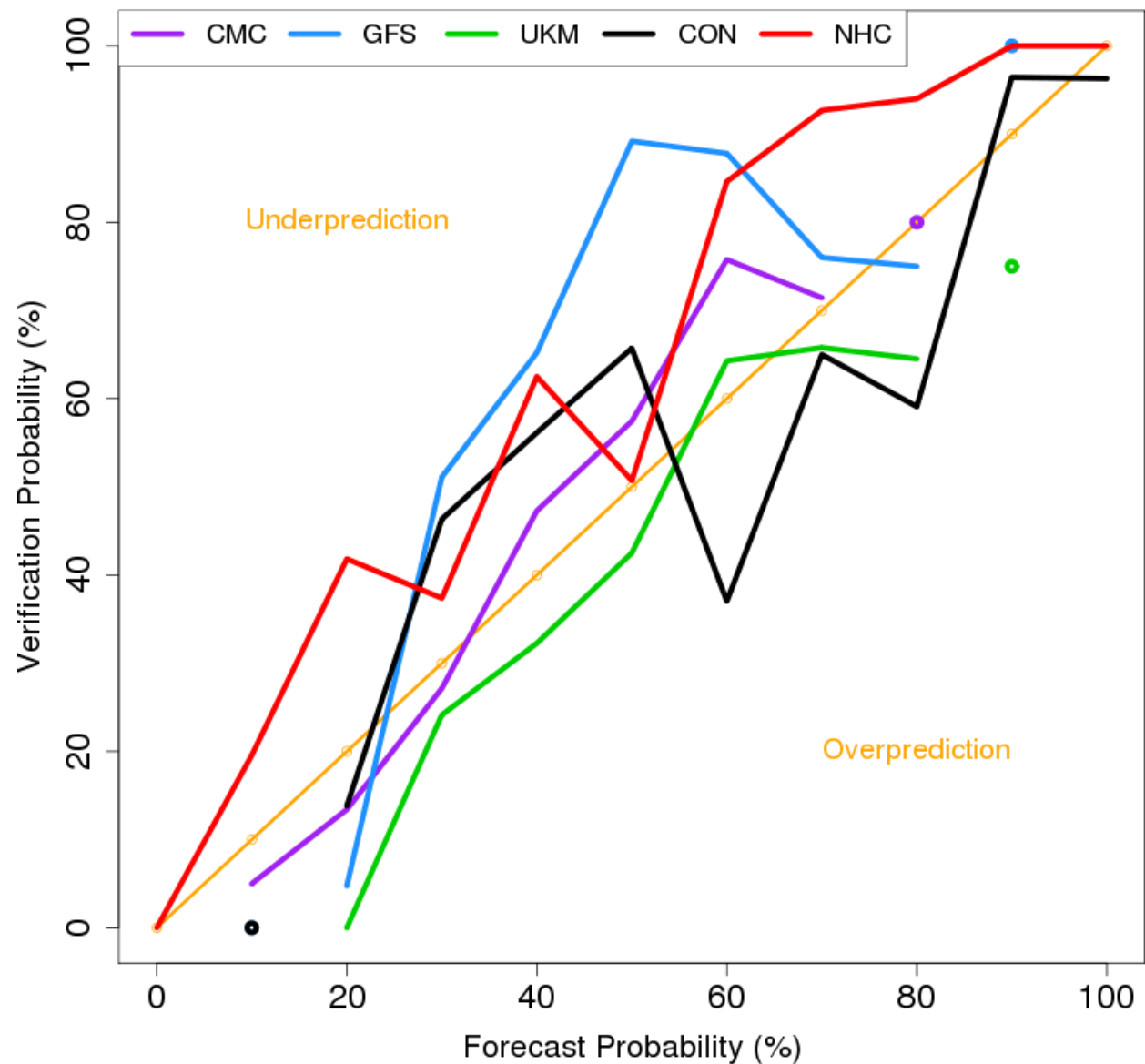
2014 NATL 120 h Forecast Verification (non-homogeneous)



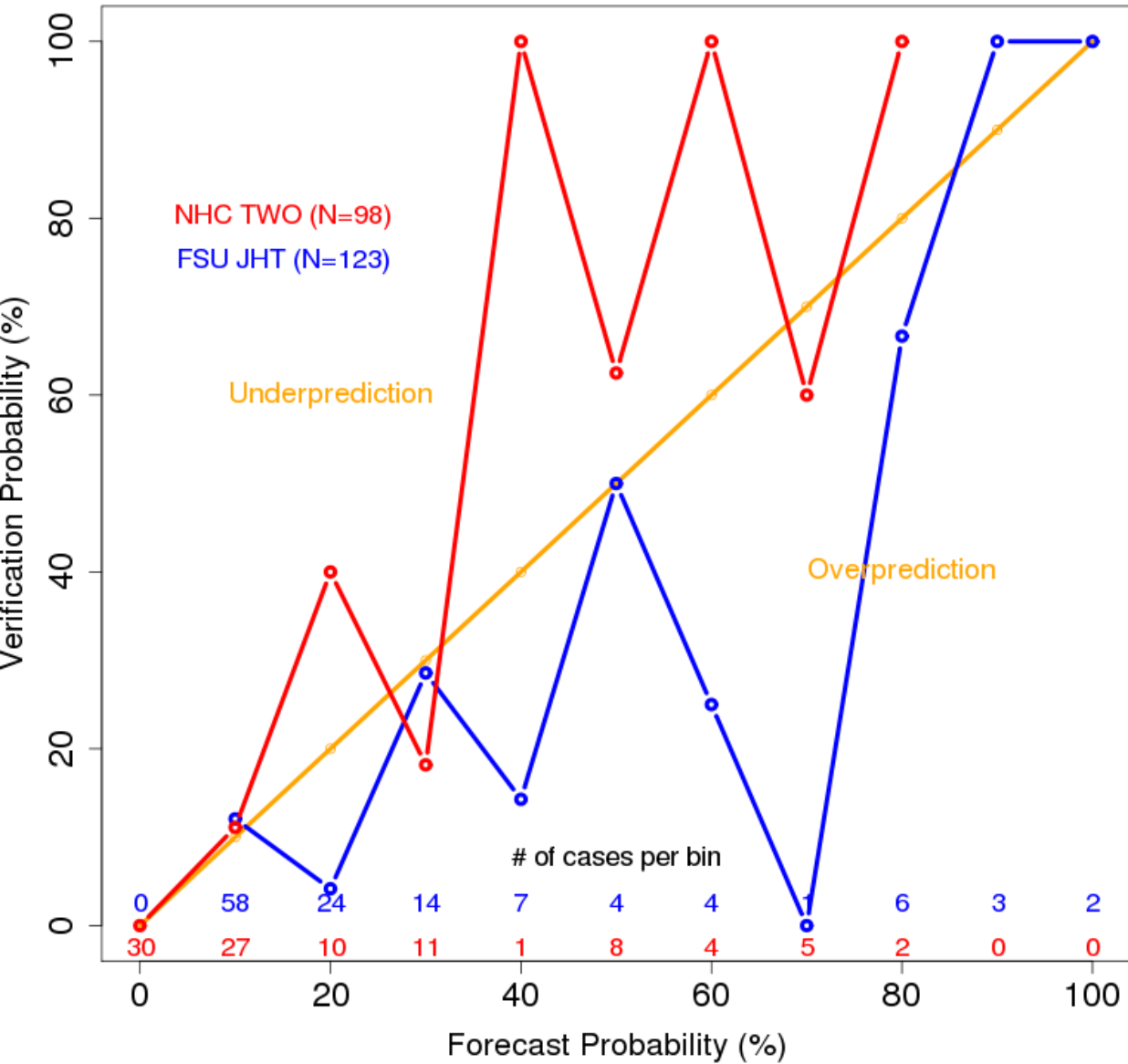
2014 EPAC 48 h Forecast Verification (non-homogeneous)



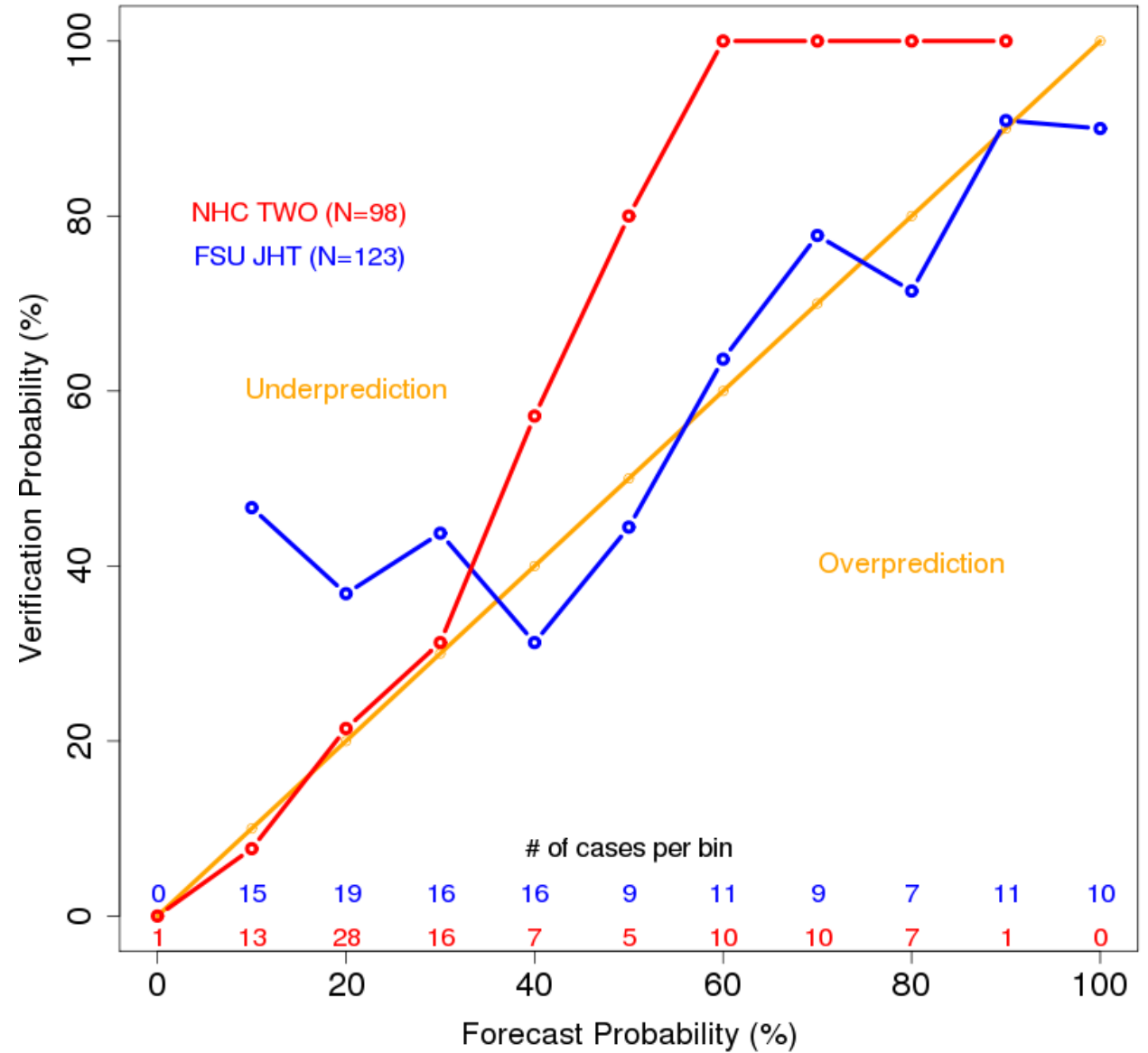
2014 EPAC 120 h Forecast Verification (non-homogeneous)



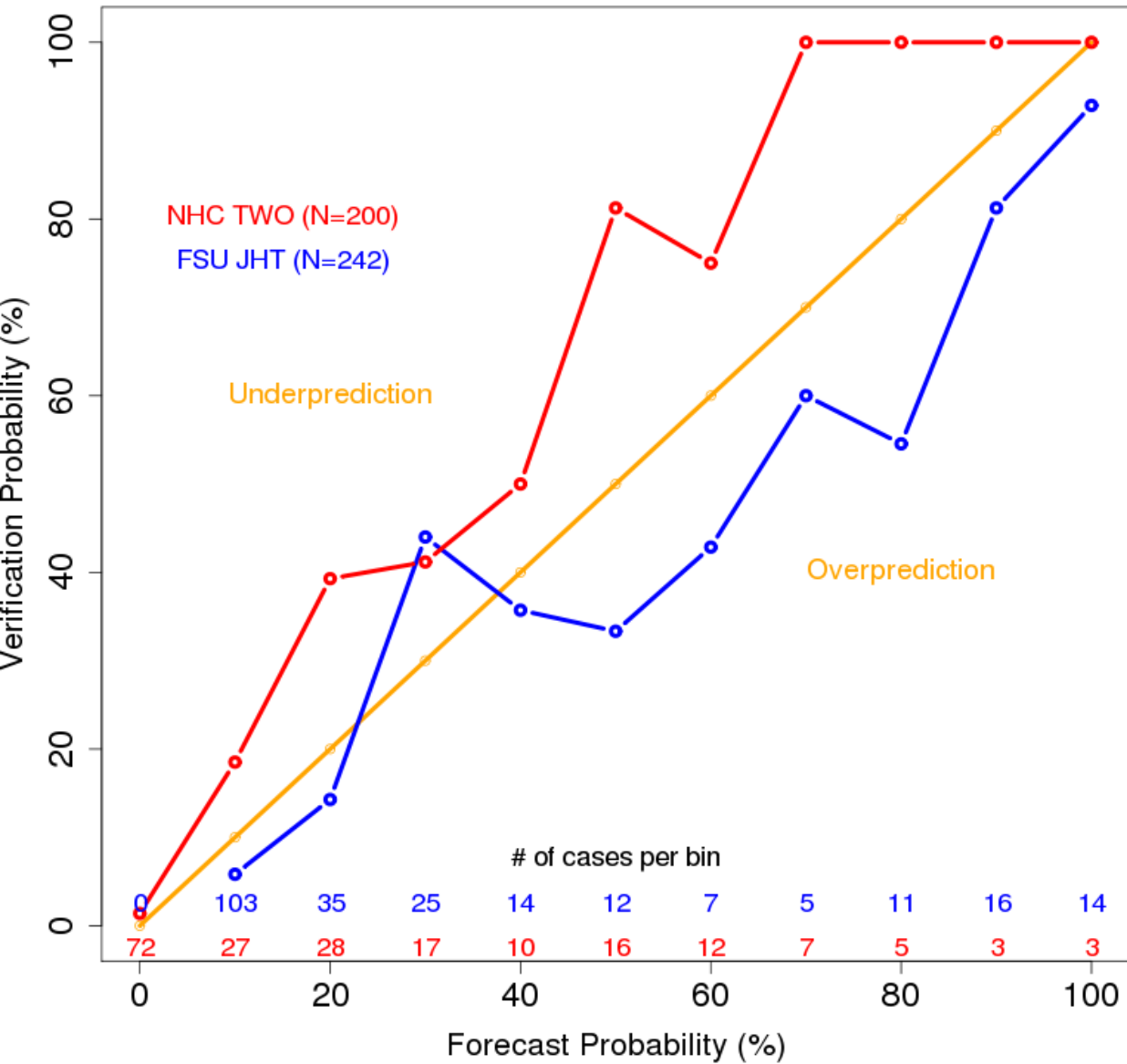
2014 NATL 48 h NHC TWO & FSU Consensus Verification (homogeneous)



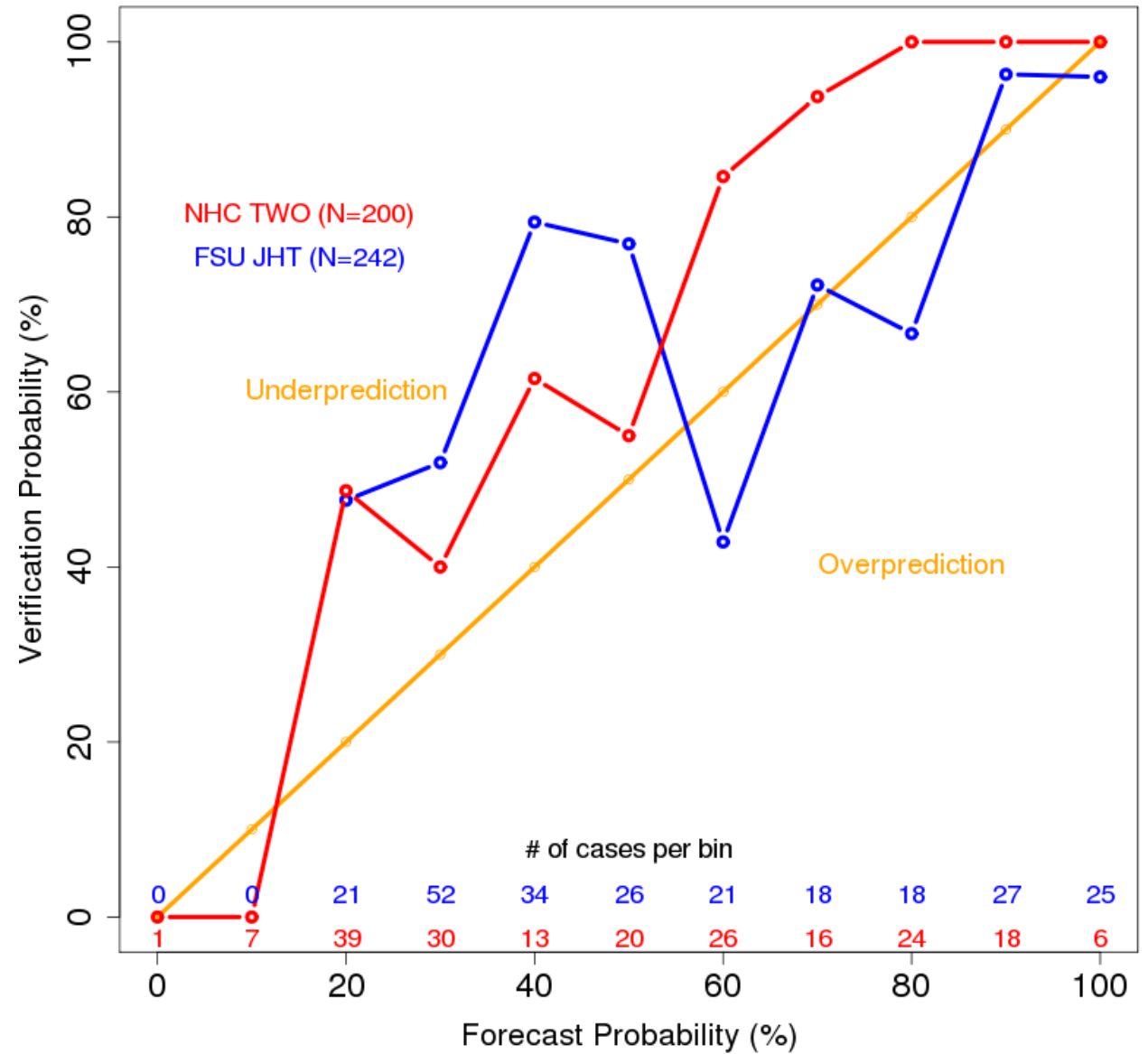
2014 NATL 120 h NHC TWO & FSU Consensus Verification (homogeneous)



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



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



Project status

- Guidance products currently are being evaluated by NHC.
- Nearly all components are compatible with NHC's IT platform.
 - Plans in place to convert the few incompatible scripts to a suitable language.
- Decision for project implementation expected in early 2016.

Summary

- Historical model-indicated TC genesis events were verified since 2004.
- These forecasts served as the training set for logistic regression equations that provide TC genesis probabilities in real-time.
- 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.

Acknowledgements

- Joint Hurricane Testbed points of contact Eric Blake, Todd Kimberlain, Chris Landsea, Craig Mattocks, Richard Pasch.
- Joint Hurricane Testbed (NOAA Grant).

Questions?

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