Forecast Challenges of the 2012 Hurricane Season

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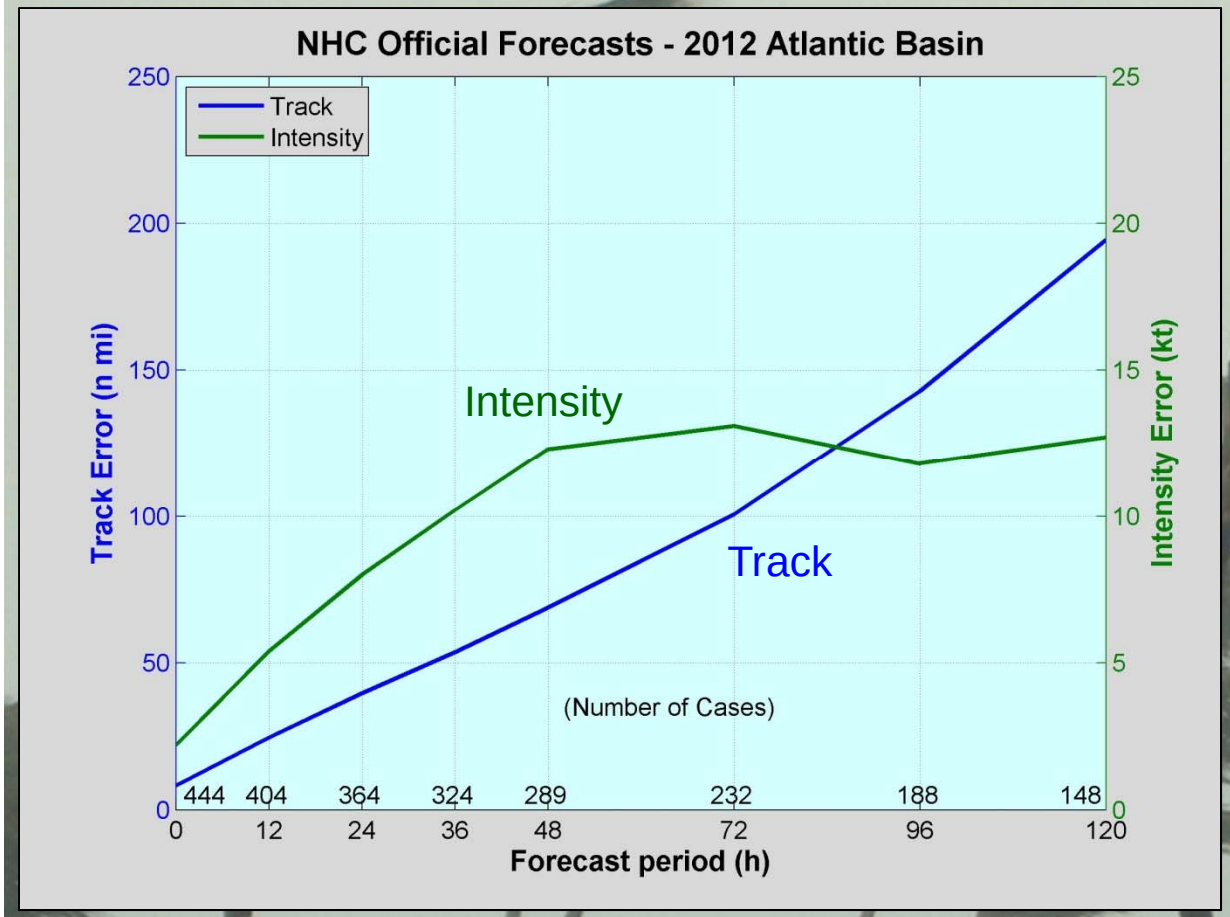
National Hurricane Center
Miami, Florida
28 March 2013

2012 Atlantic Verification

Good News- Lots of Accuracy Records Set

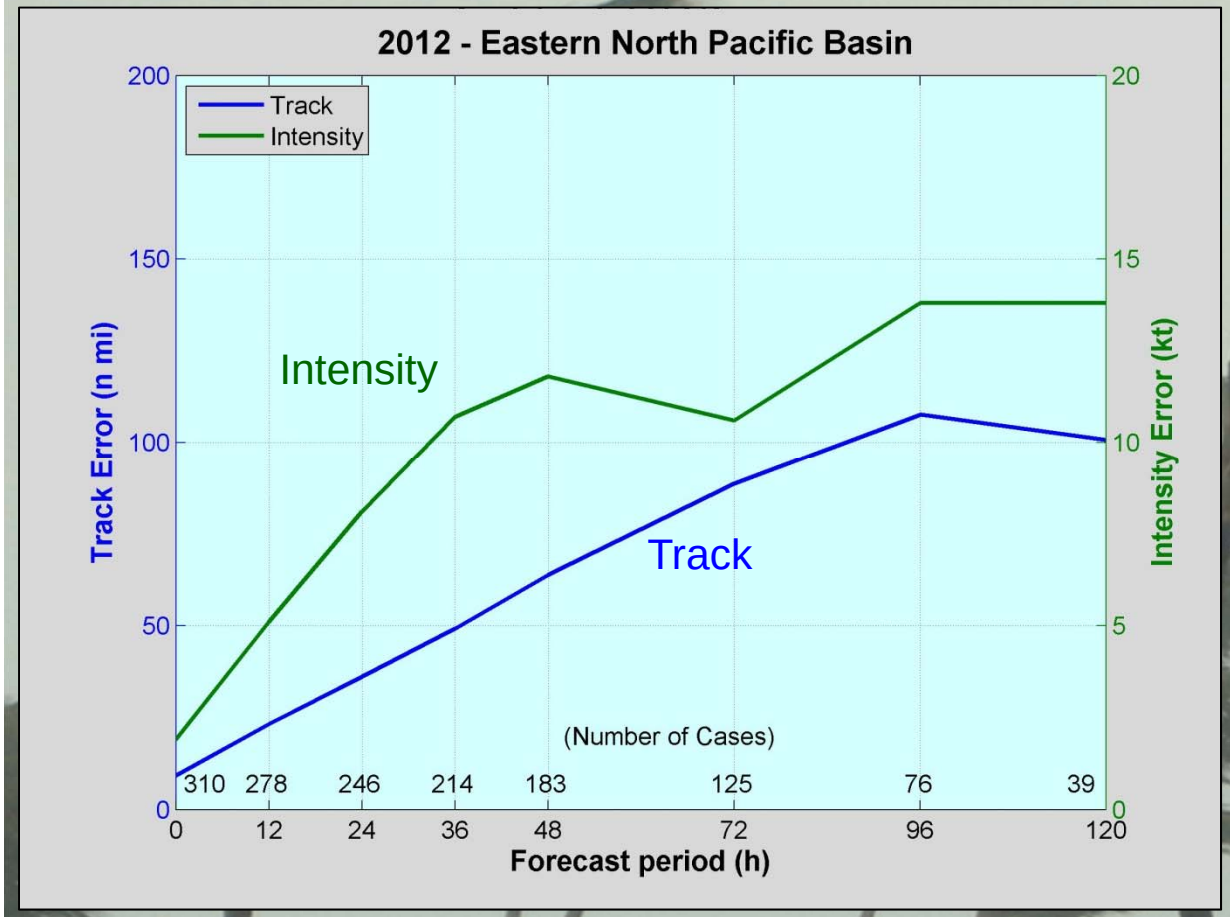


VT (h)	NT	TRACK (n mi)	INT (kt)
012	404	24.6	5.4
024	364	39.7	8.0
036	324	53.6	10.2
048	289	68.8	12.3
072	232	100.6	13.1
096	188	142.8	11.8
120	148	194.4	12.7

Values in red exceed all-time records.

2012 East Pacific Verification

Similar Success in the Eastern Pacific

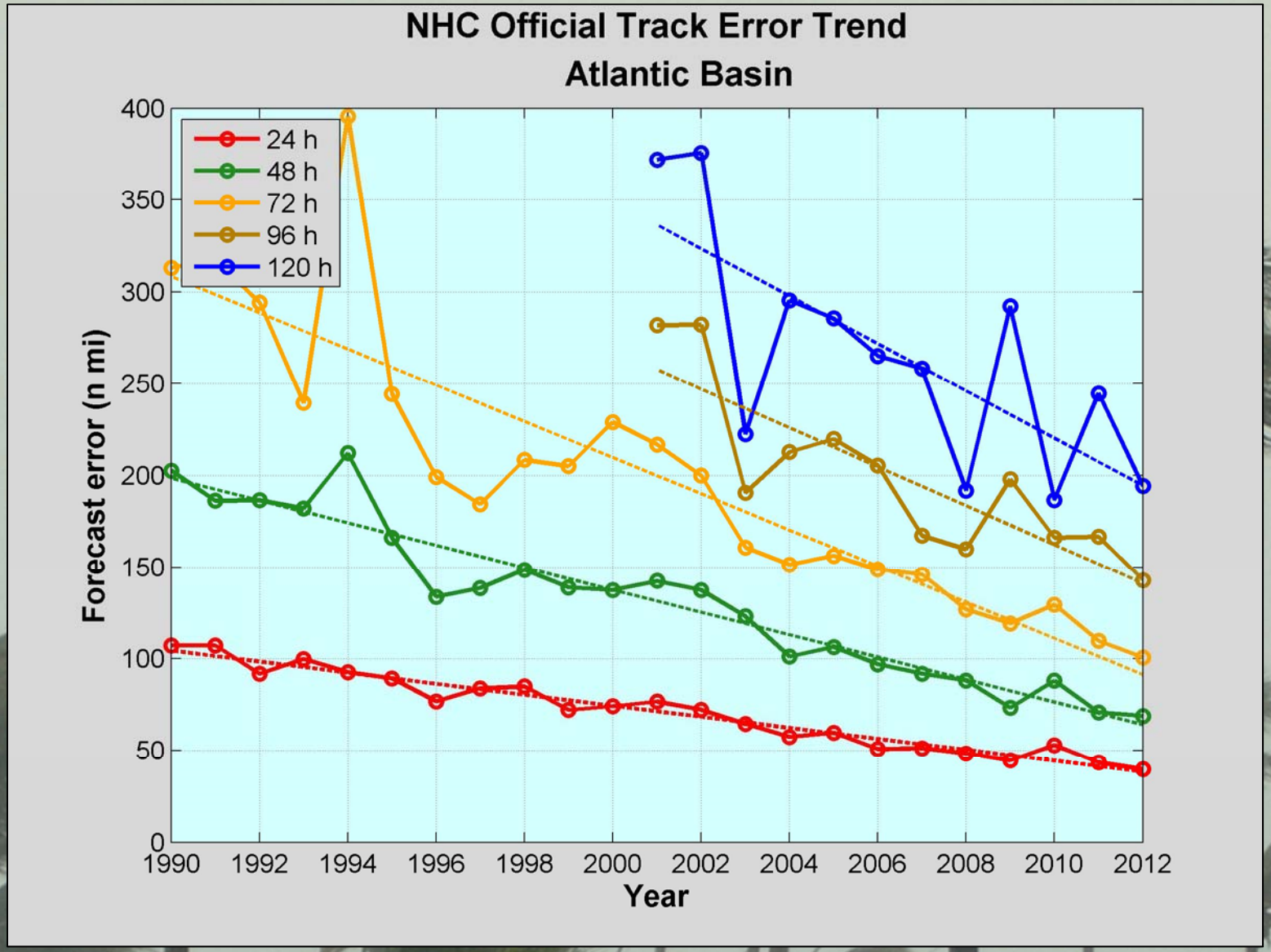


VT (h)	NT	TRACK (n mi)	INT (kt)
012	278	23.2	5.1
024	246	36.1	8.1
036	214	49.2	10.7
048	183	63.8	11.8
072	125	88.6	10.6
096	76	107.6	13.8
120	39	100.7	13.8

Values in red exceed all-time records.

NHC Atlantic Track Error Trends

Reduction in Track Errors Continues



Error Reduction since 1990

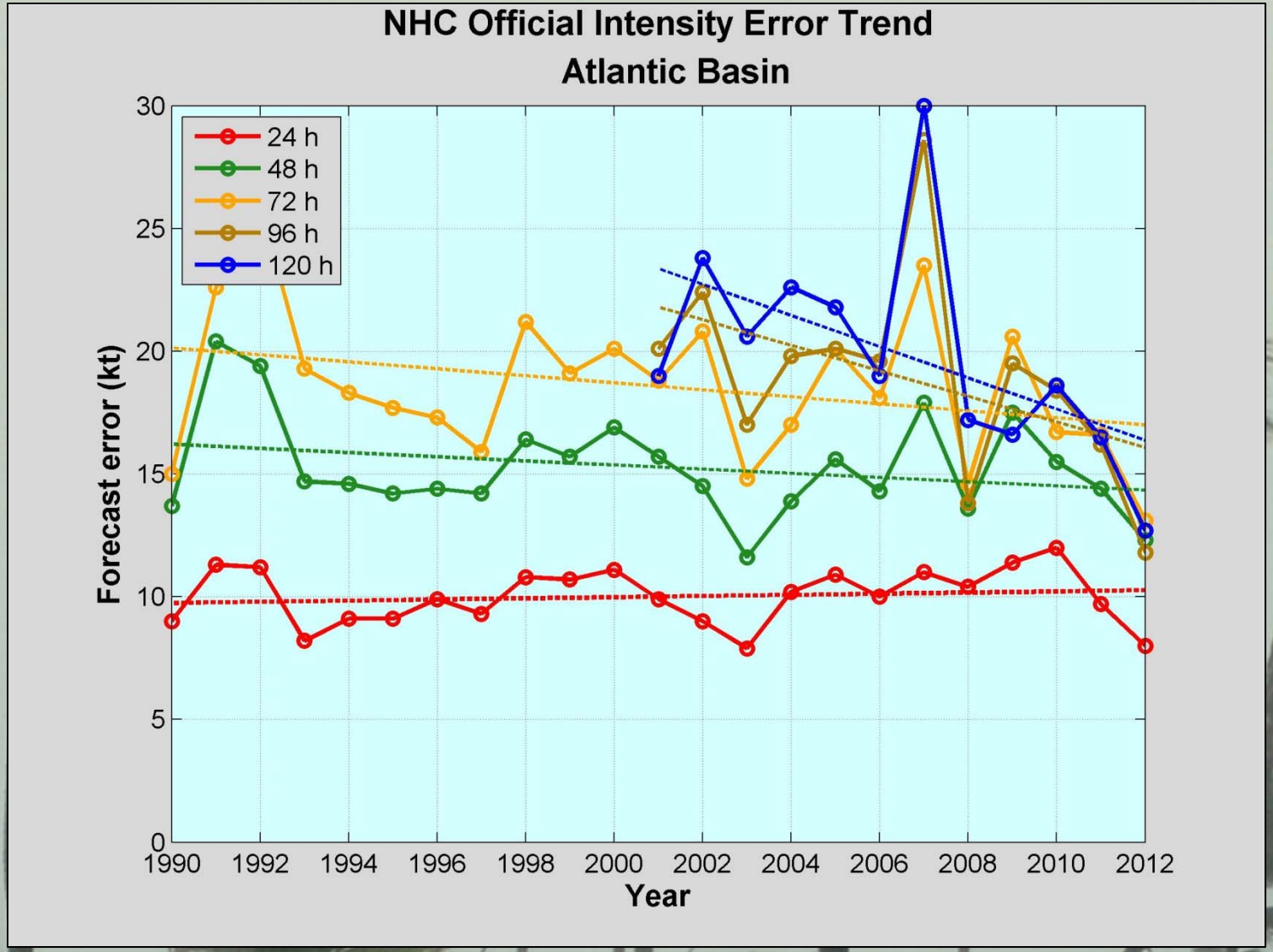
72 h: 67%

48 h: 65%

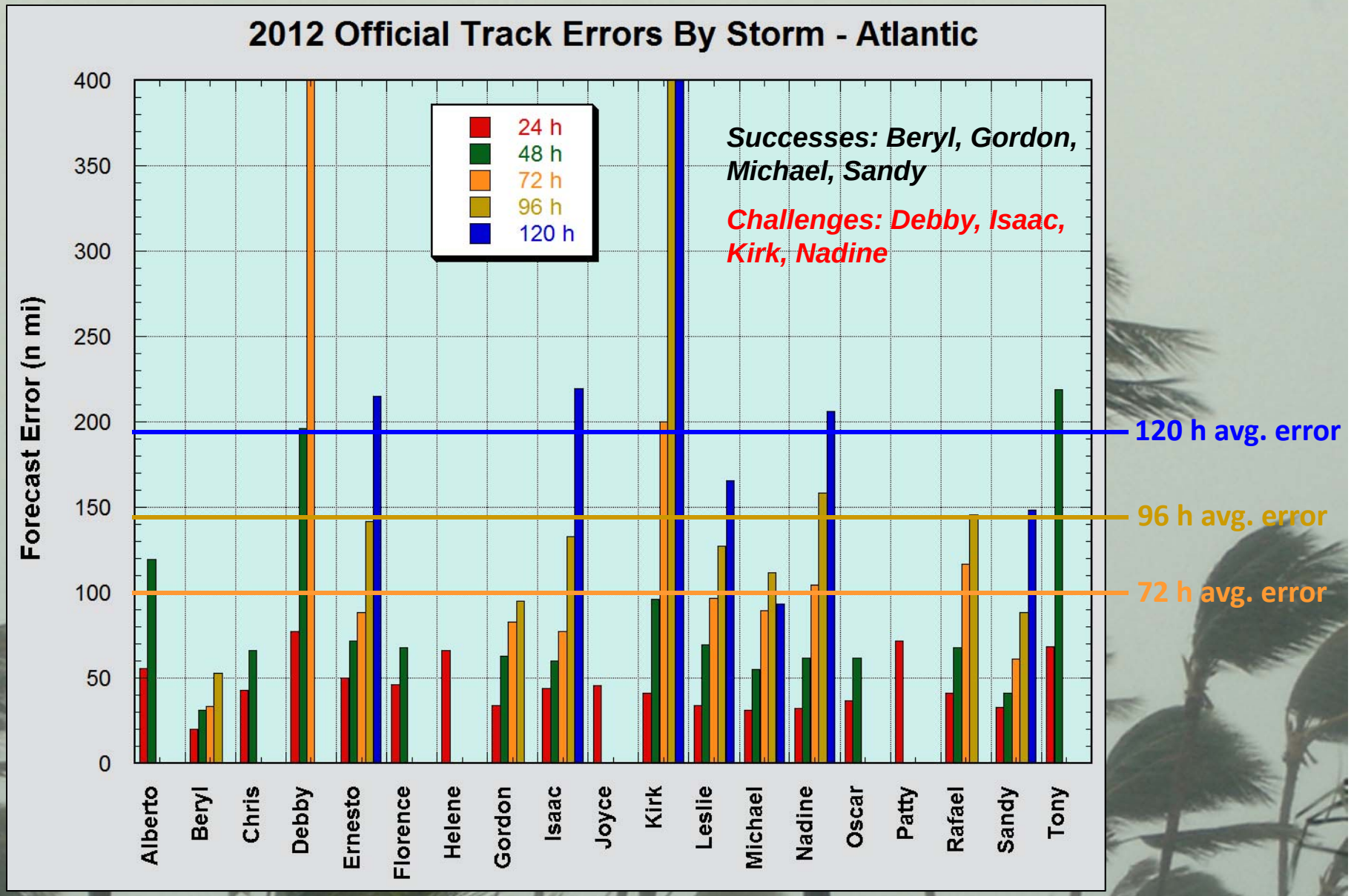
24 h: 58%

Atlantic Intensity Error Trends

Little Progress Overall - But a Very Recent Downward Trend

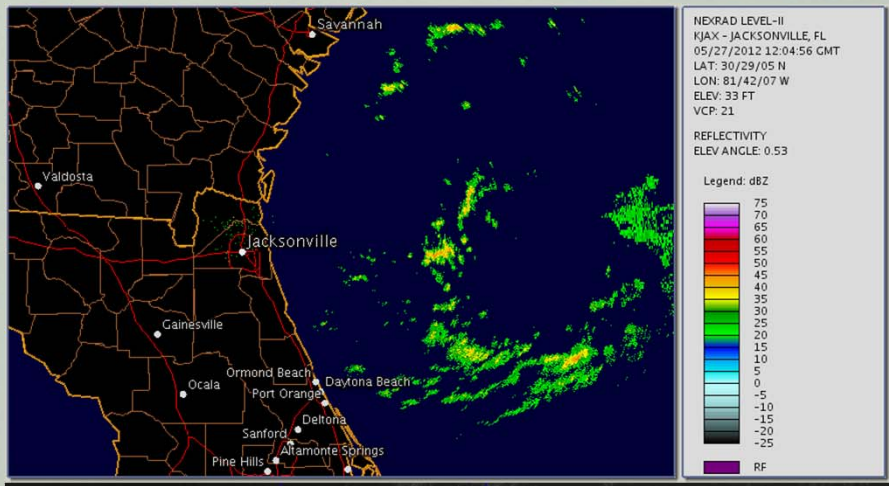


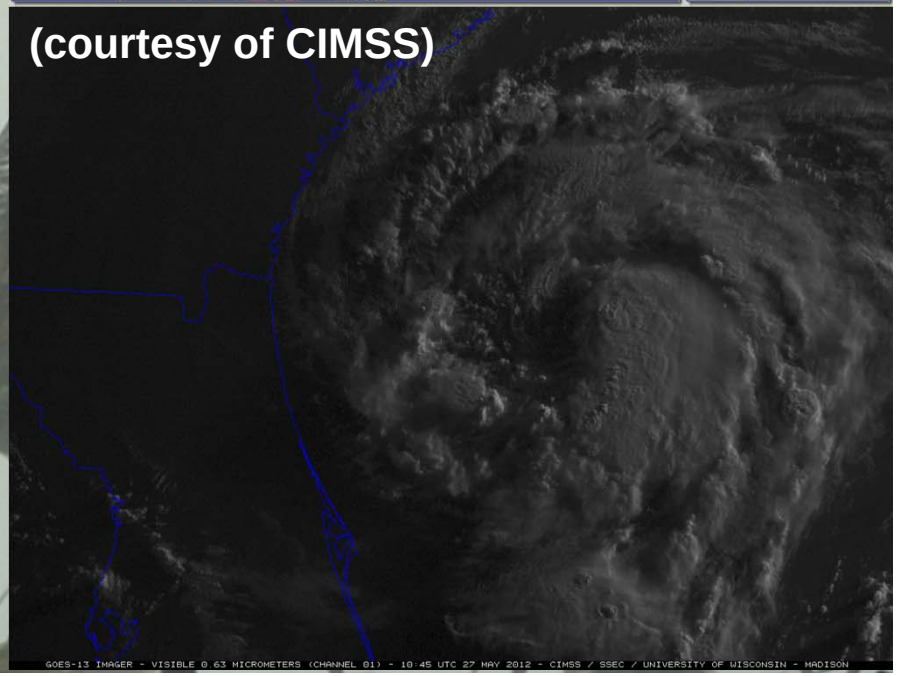
Still Some Forecast Challenges



NHC Faces Interesting Forecast Challenges Every Season

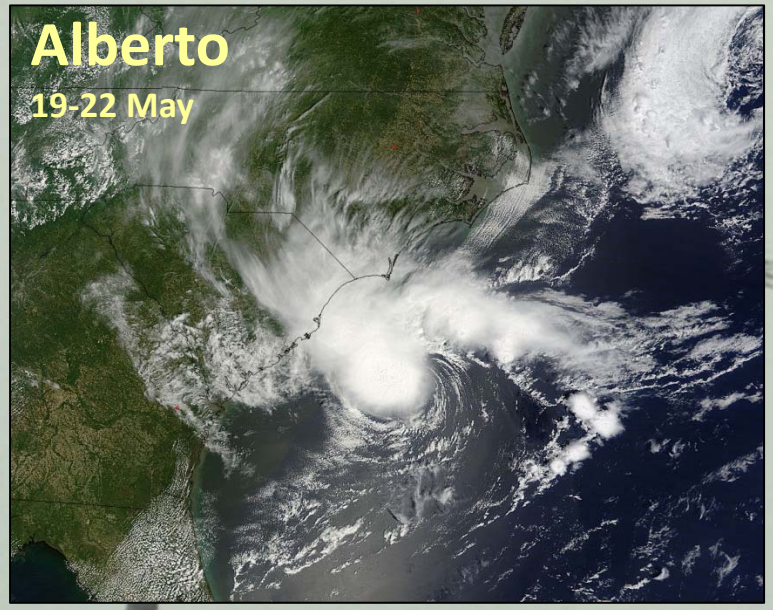
- Data and interpretation
- Systems with marginal and/or transitioning characteristics
- Does it develop or not (cyclogenesis issues)?
- Weak and poorly organized systems
- Divergent and/or poor model guidance
- Systems that rapidly intensify or don't intensify when forecast to
- Systems causing significant impacts to land areas
- Special problems in warnings and response
- Systems combining any or all of the above!

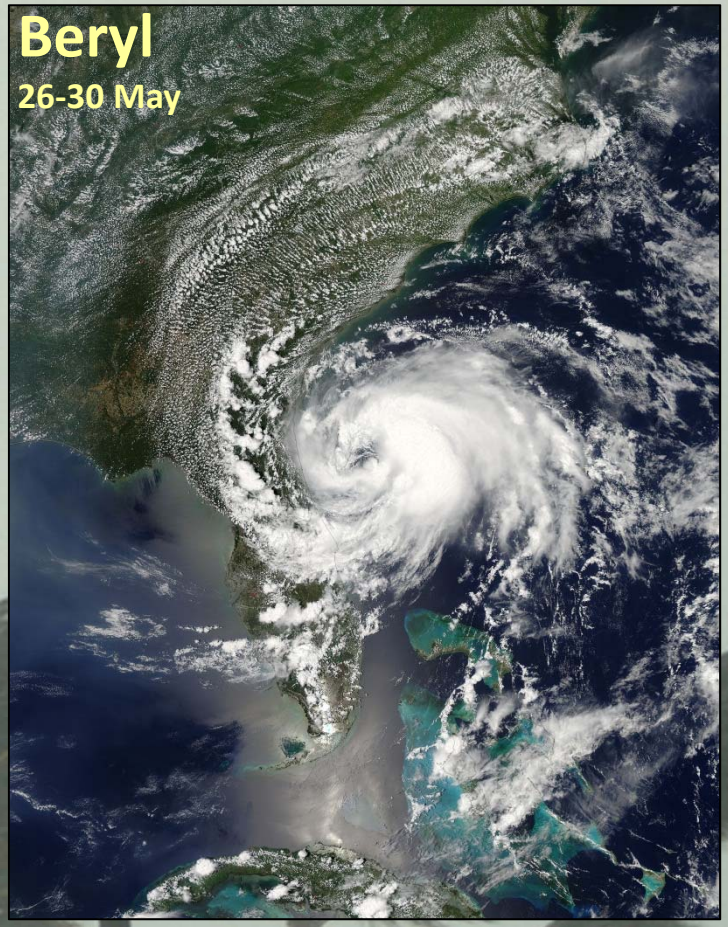




Pre-Season Forecast Challenge

Two Tropical Storms Form Before June 1st

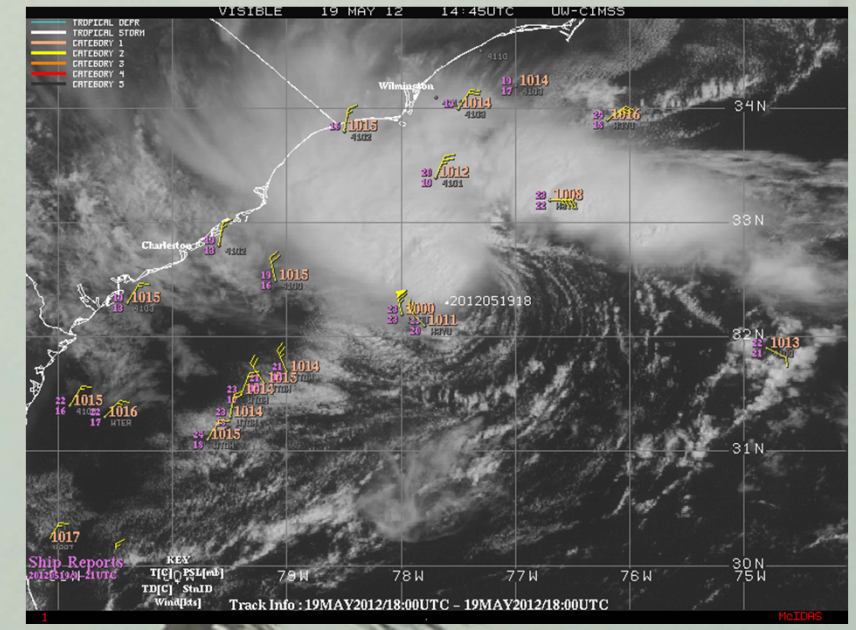


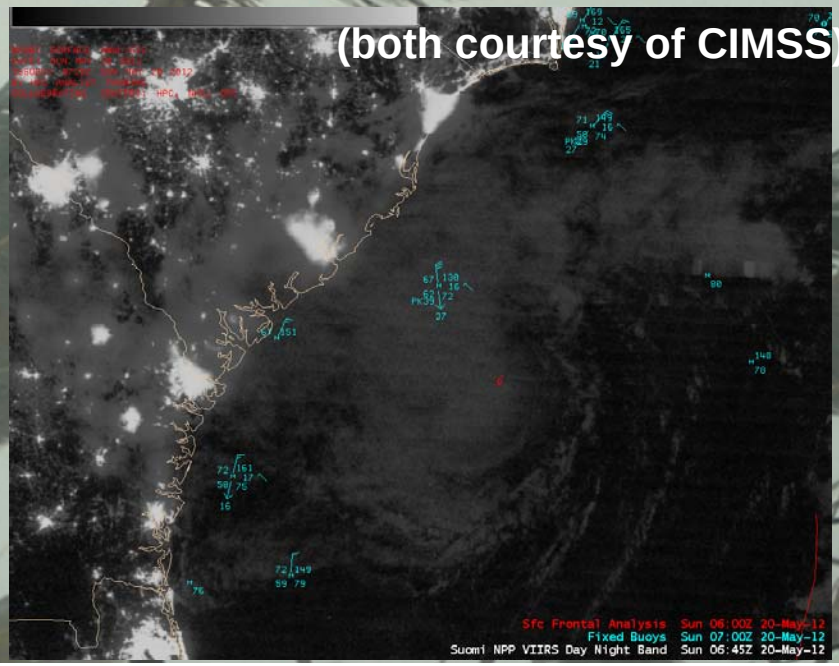


- **Both formed off the Southeast U.S. coast in May**
- **NHC issued Special Outlooks to discuss formation potential**
- **Beryl made landfall in NE Florida- strongest pre-season TC of record to make landfall in the U.S.**

Is it or isn't it- a tropical cyclone?

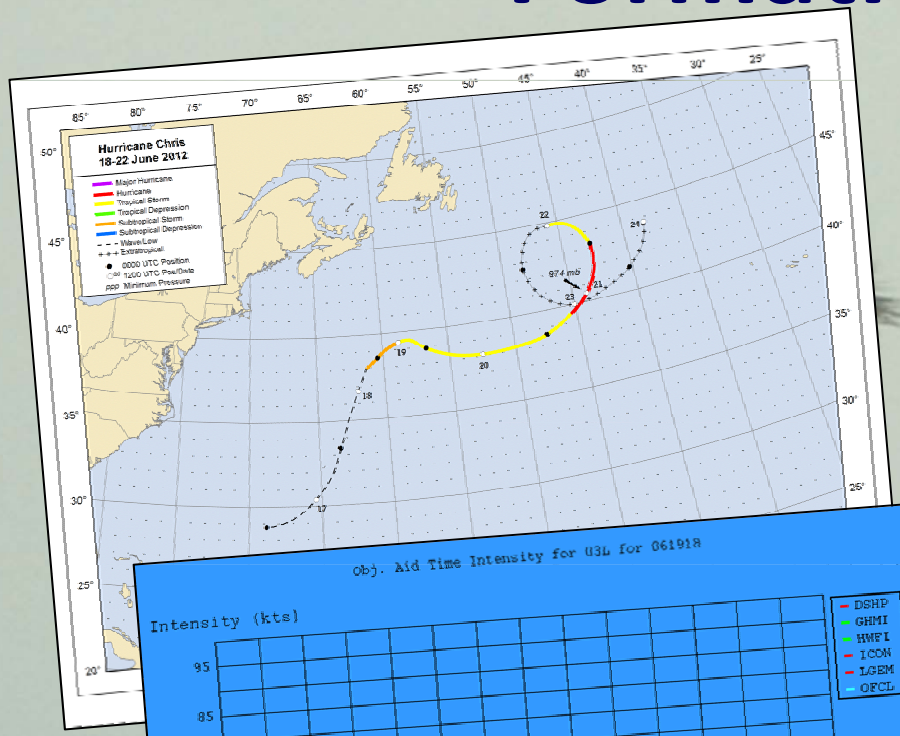
- A cut-off deep-layer low with gale/storm winds developed over the western Atlantic in May.
- Organized convection developed over a low-level circulation center with a relatively small radius of maximum winds.
- While the low seemed to lose frontal characteristics, very dry air was present in and near the circulation.
- The decision: Name the system Tropical Storm Alberto.

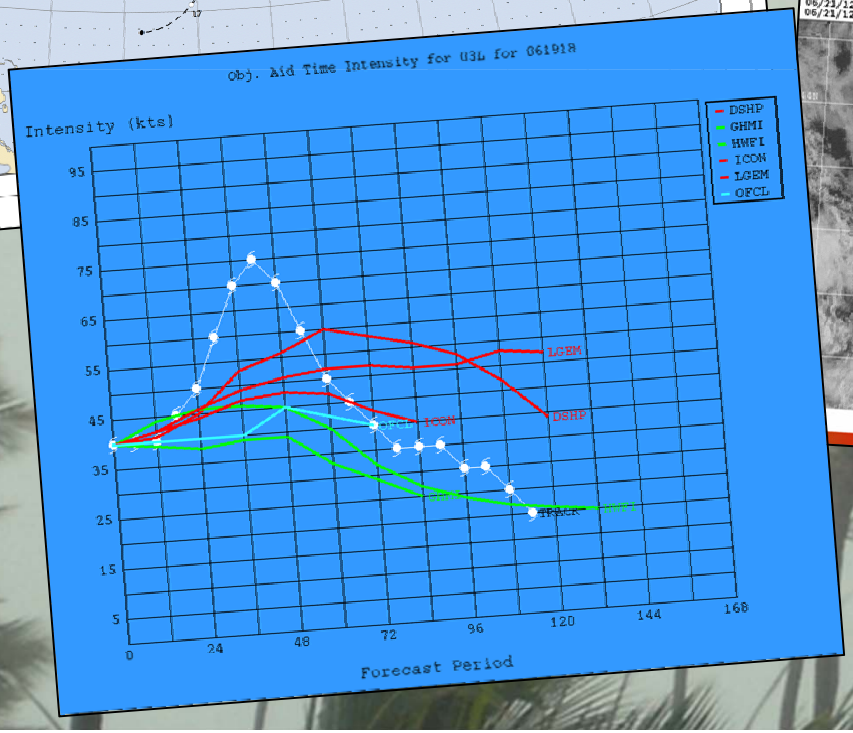


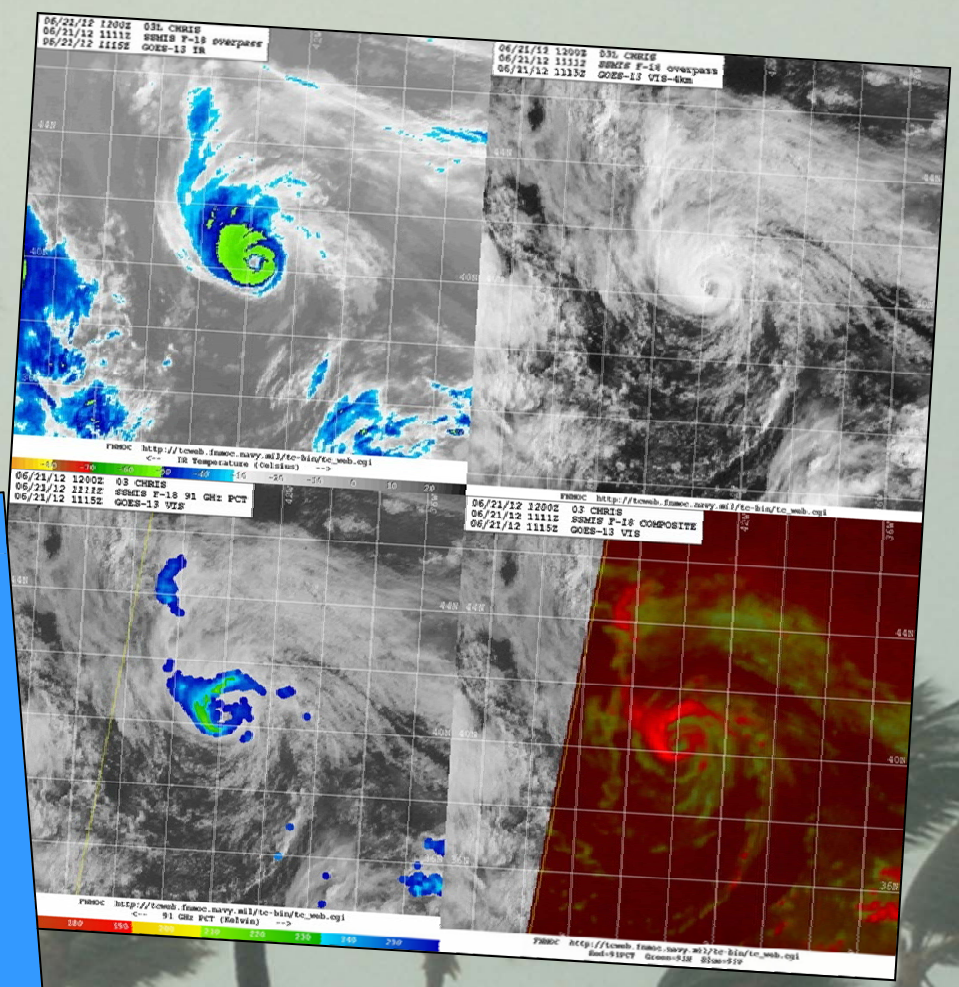


(both courtesy of CIMSS)

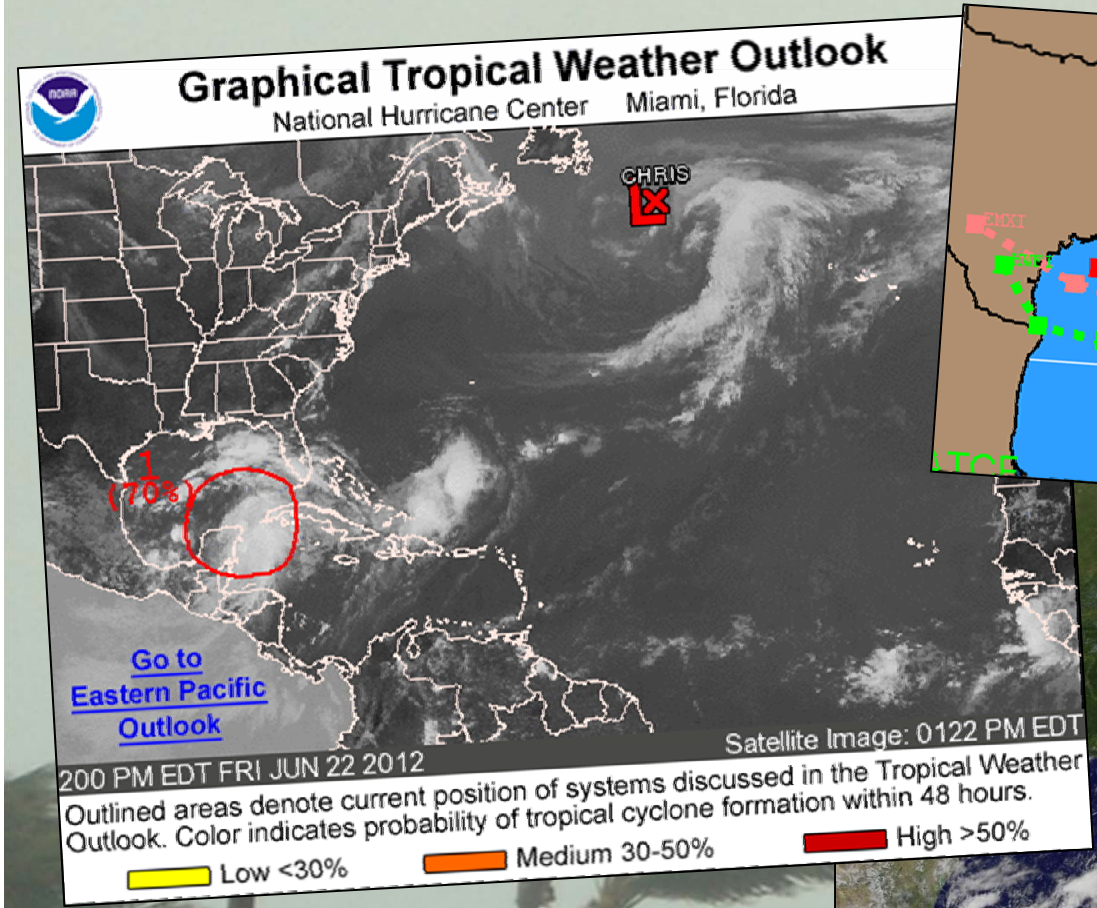
High Latitude Hurricane Formation in June

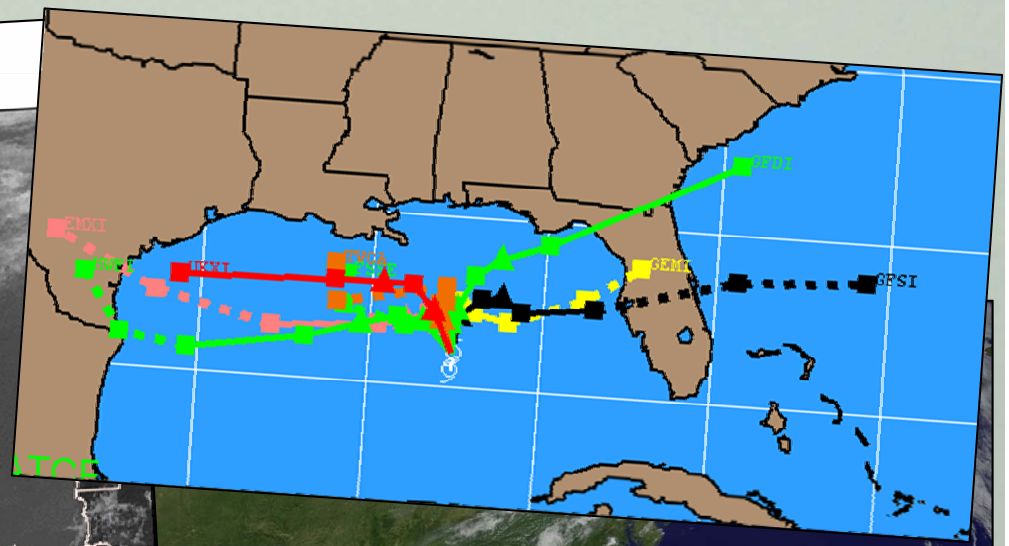


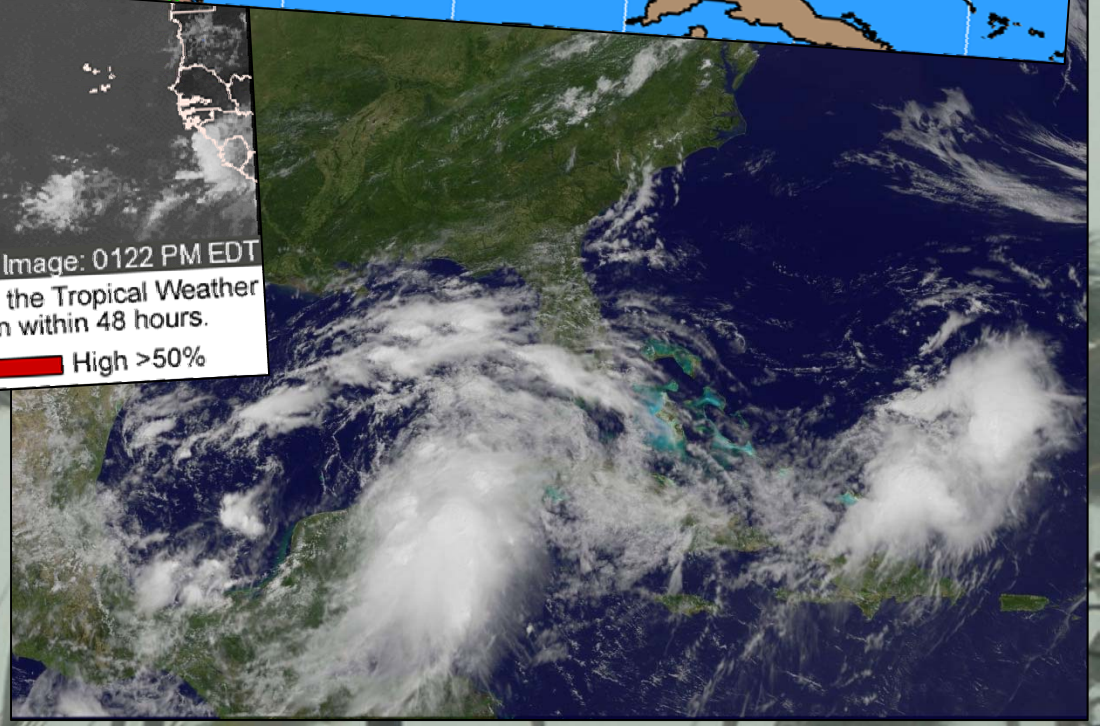




Debby- Formation well anticipated but where would it go

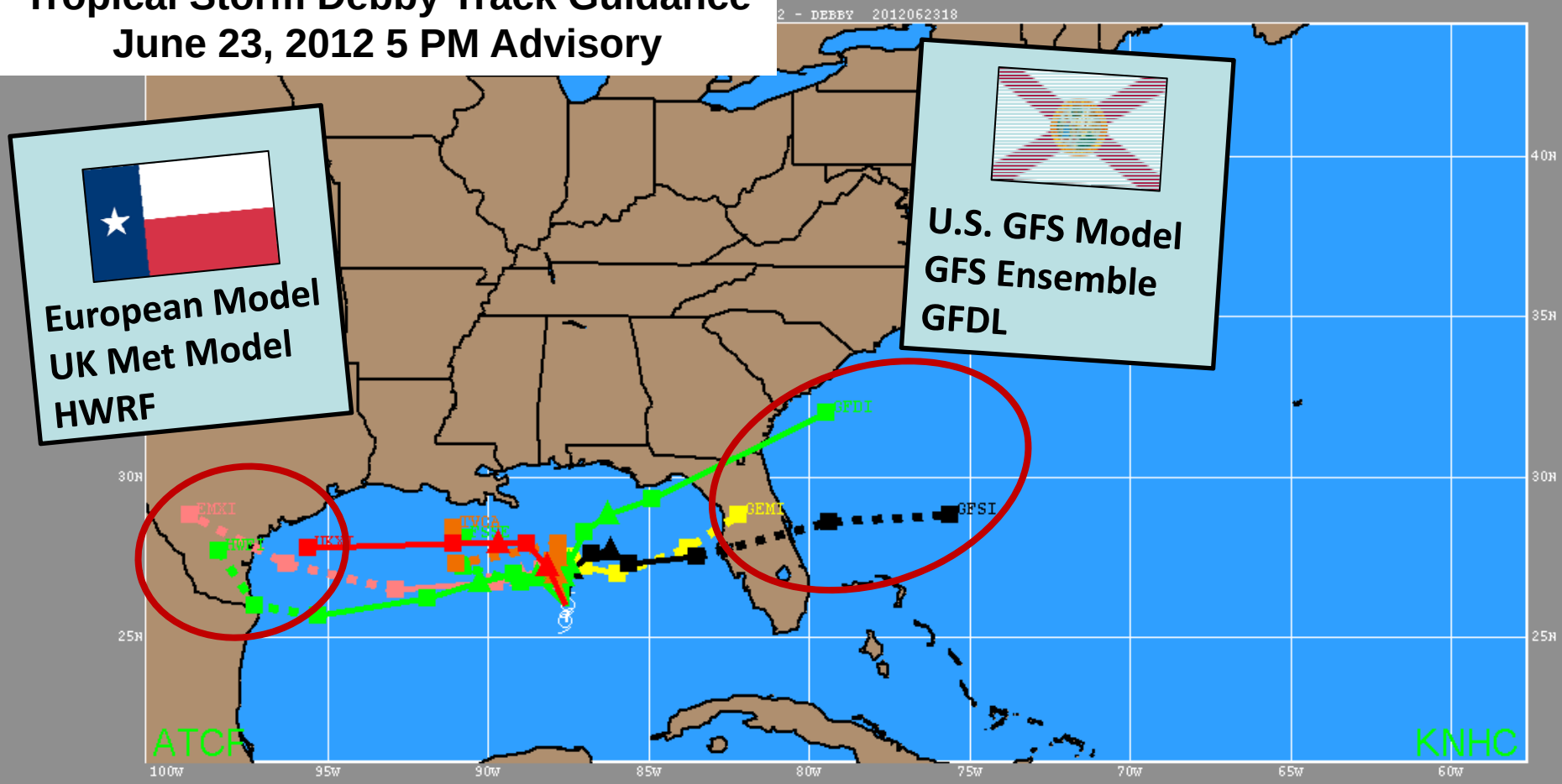




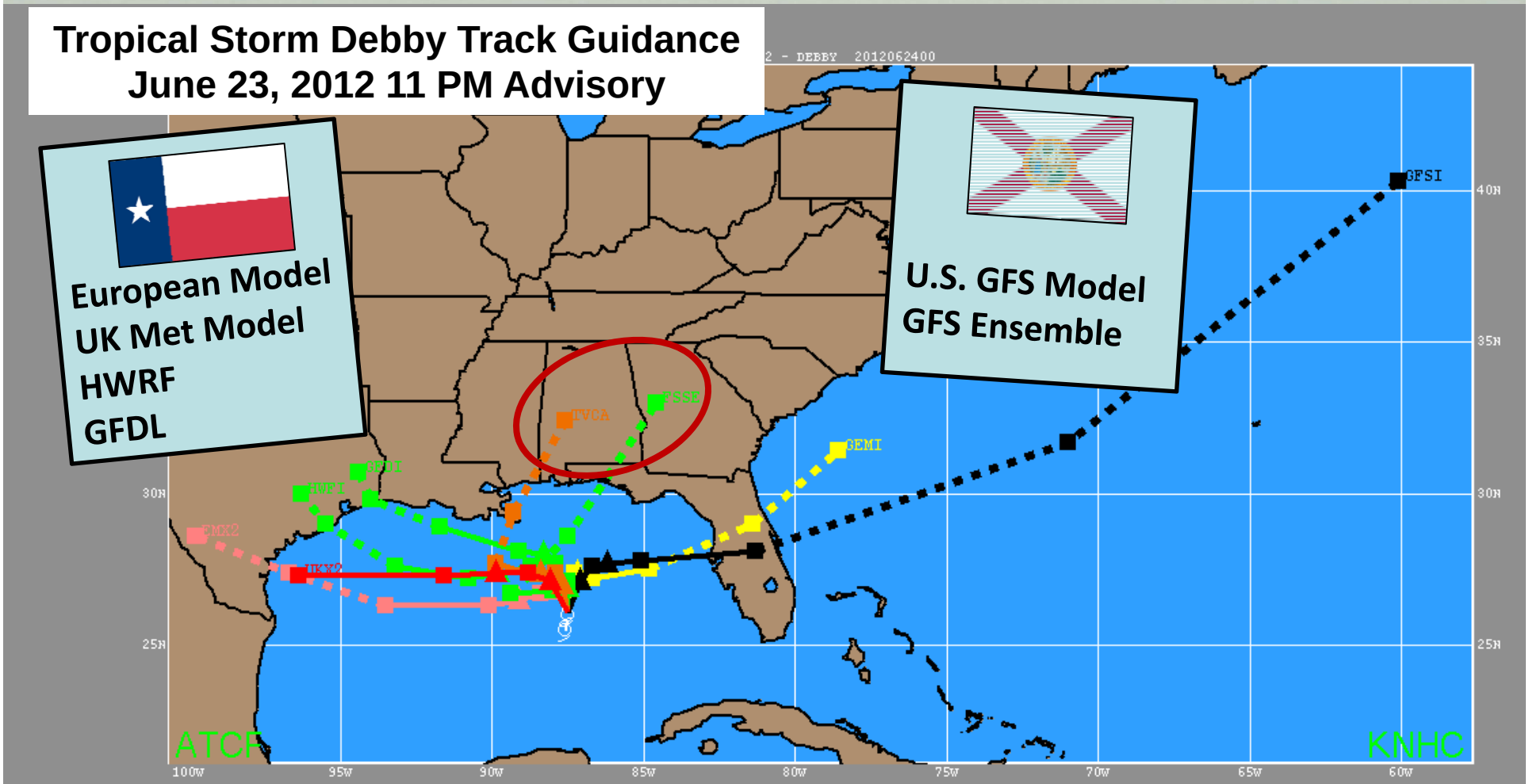


Debby Forms
Diverging Forecast Guidance
Texas or Florida?

Tropical Storm Debby Track Guidance
June 23, 2012 5 PM Advisory



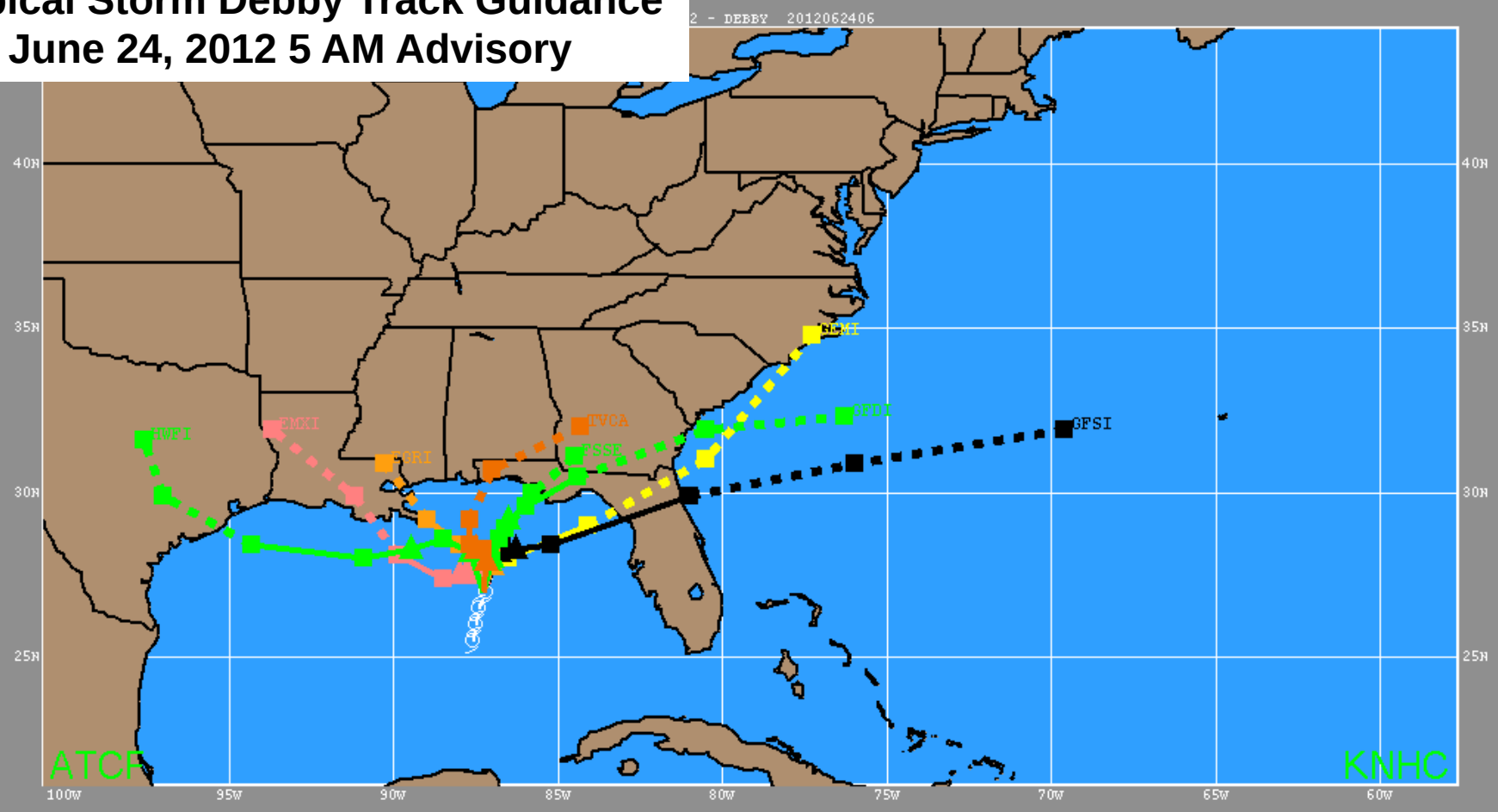
Debby Advisory #2
Still Texas or Florida



Consensus Models Split the Difference

Debby Advisory #3
ECMWF, UKMI, GFDL shift eastward

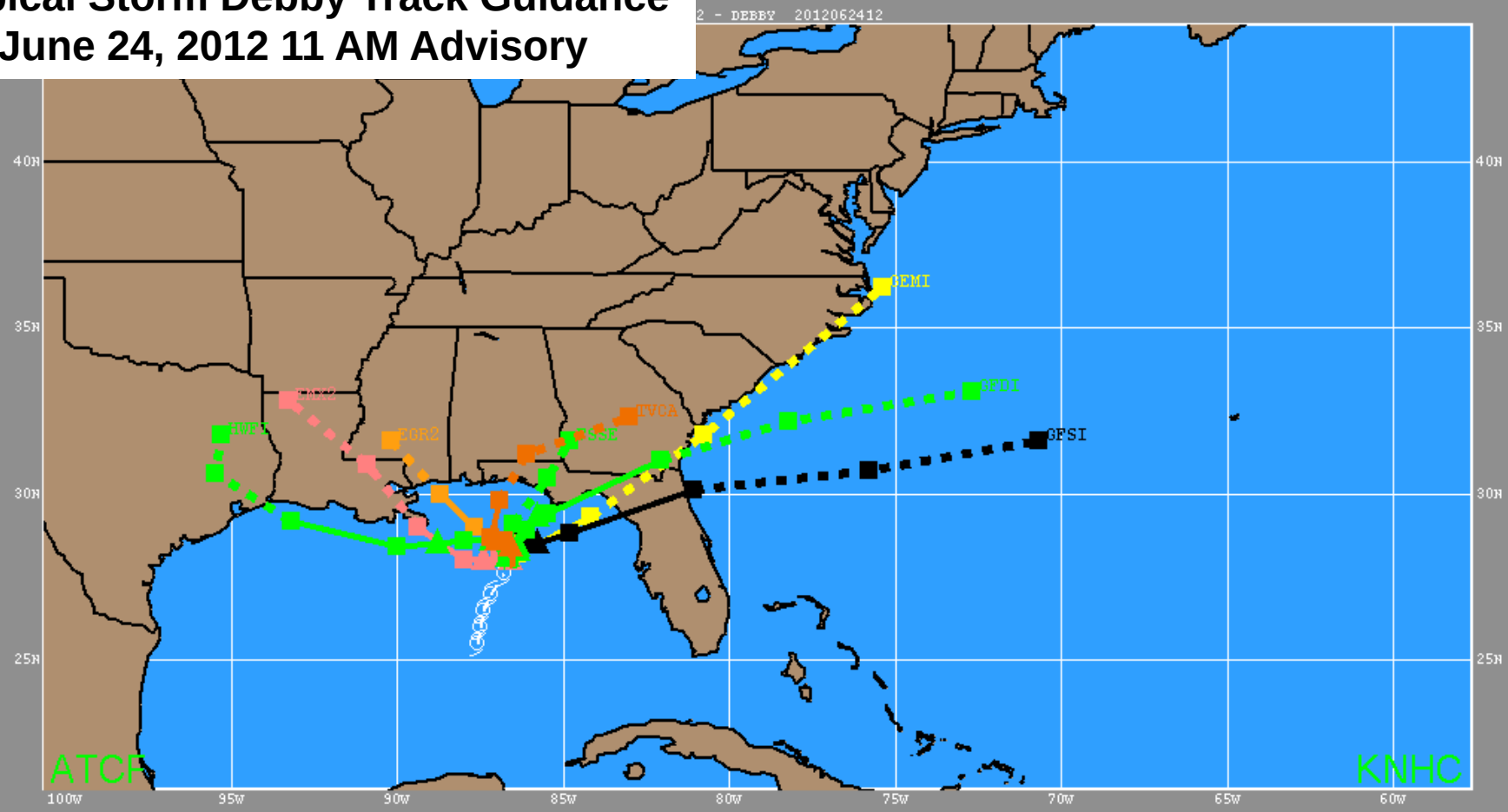
Tropical Storm Debby Track Guidance
June 24, 2012 5 AM Advisory



Debby Advisory #4

Landfall indicated in 2-3 days by all models, but from Louisiana to Florida

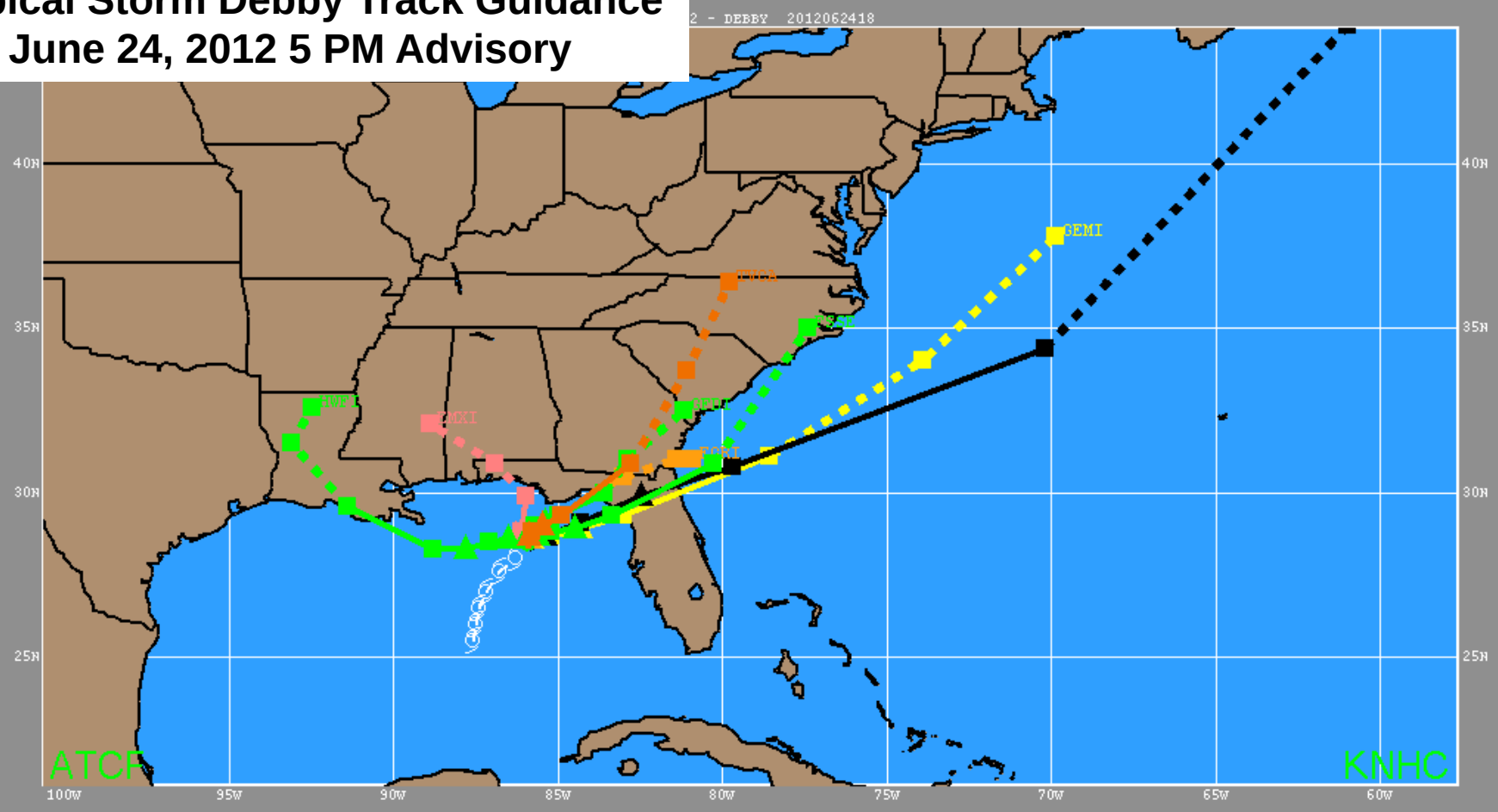
Tropical Storm Debby Track Guidance
June 24, 2012 11 AM Advisory



Debby Advisory #5

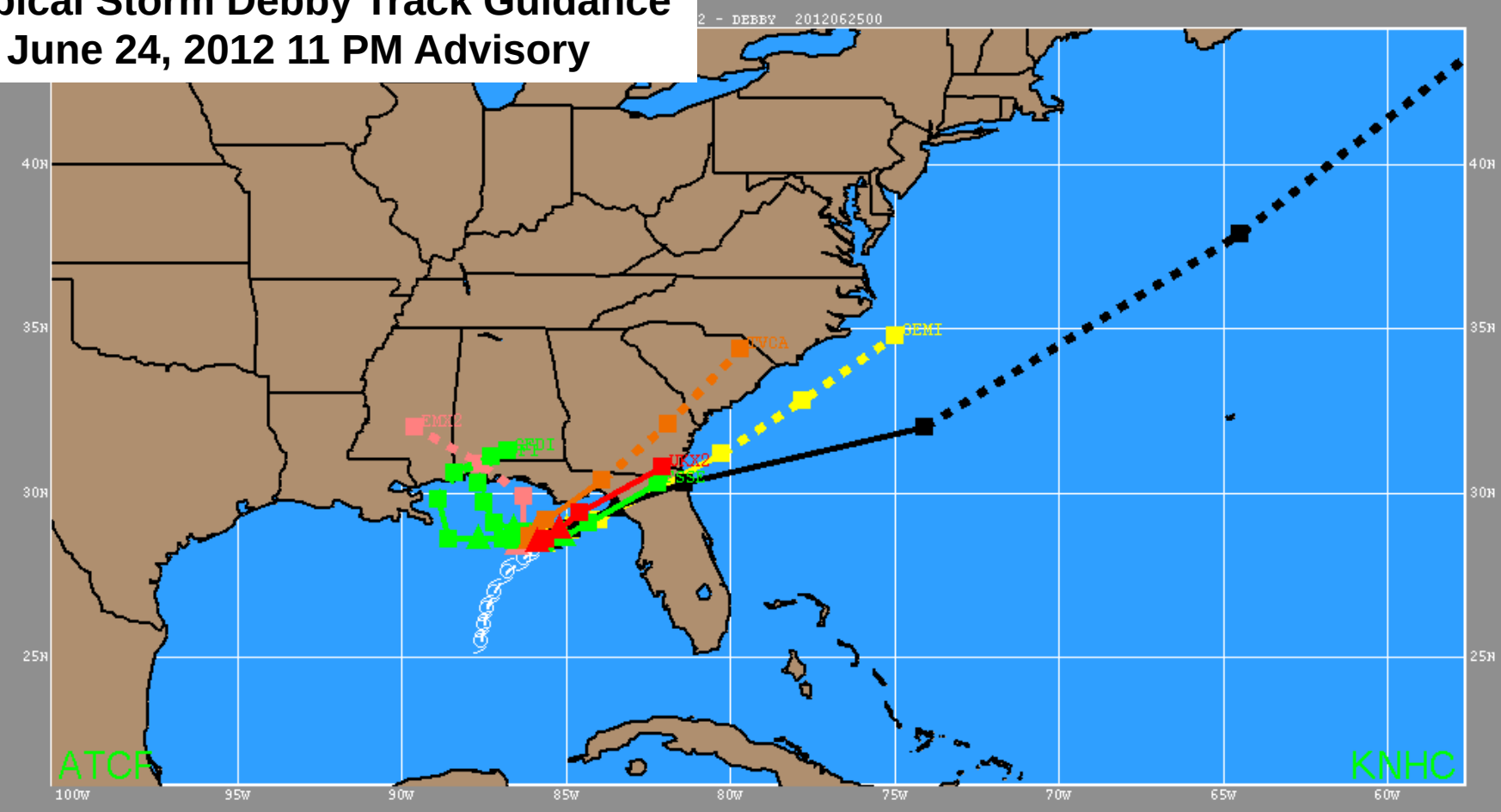
Only HWRF and ECMWF show more westward track

Tropical Storm Debby Track Guidance
June 24, 2012 5 PM Advisory



Debby Advisory #6

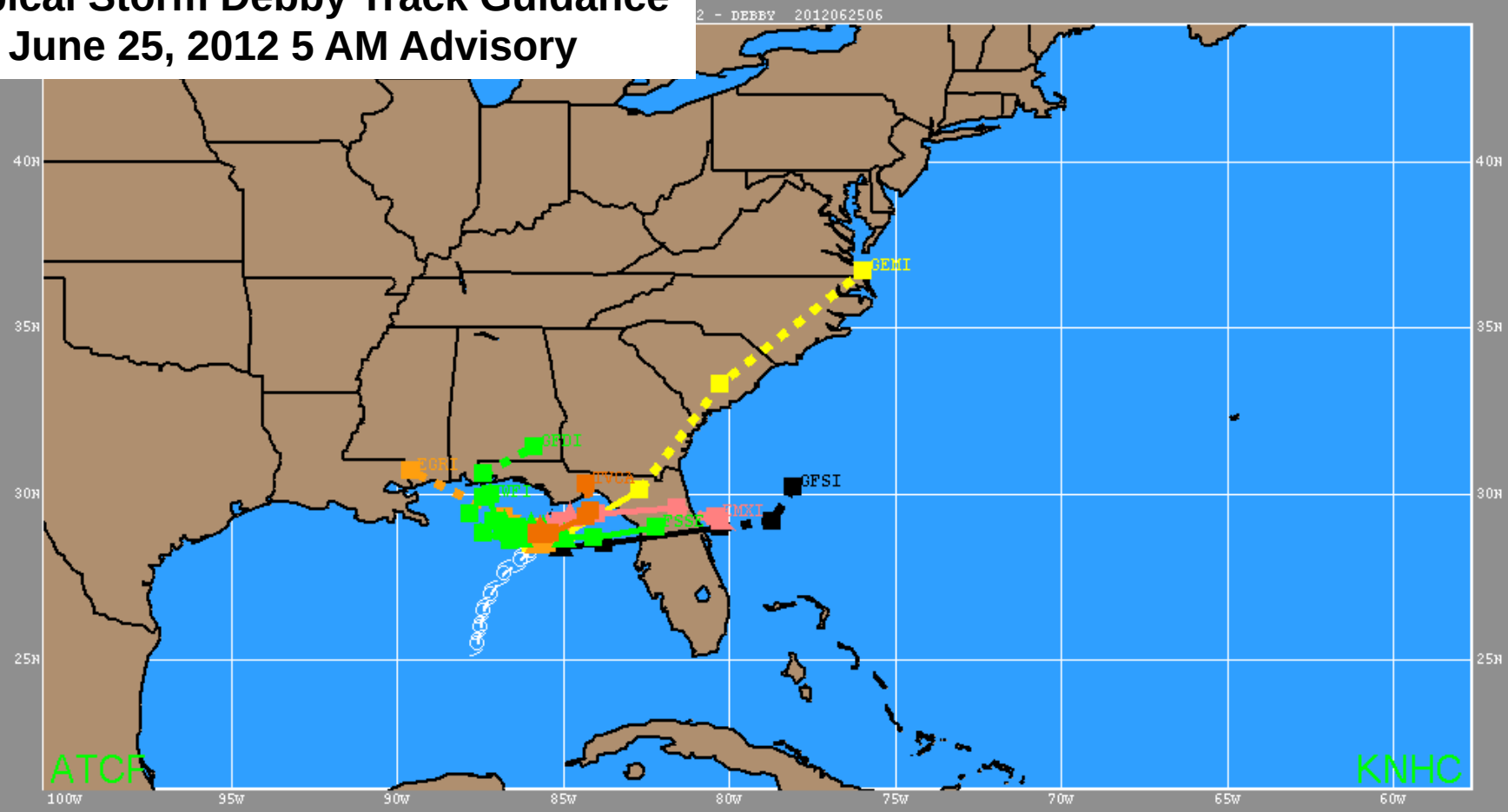
Tropical Storm Debby Track Guidance
June 24, 2012 11 PM Advisory



Debby Advisory #7

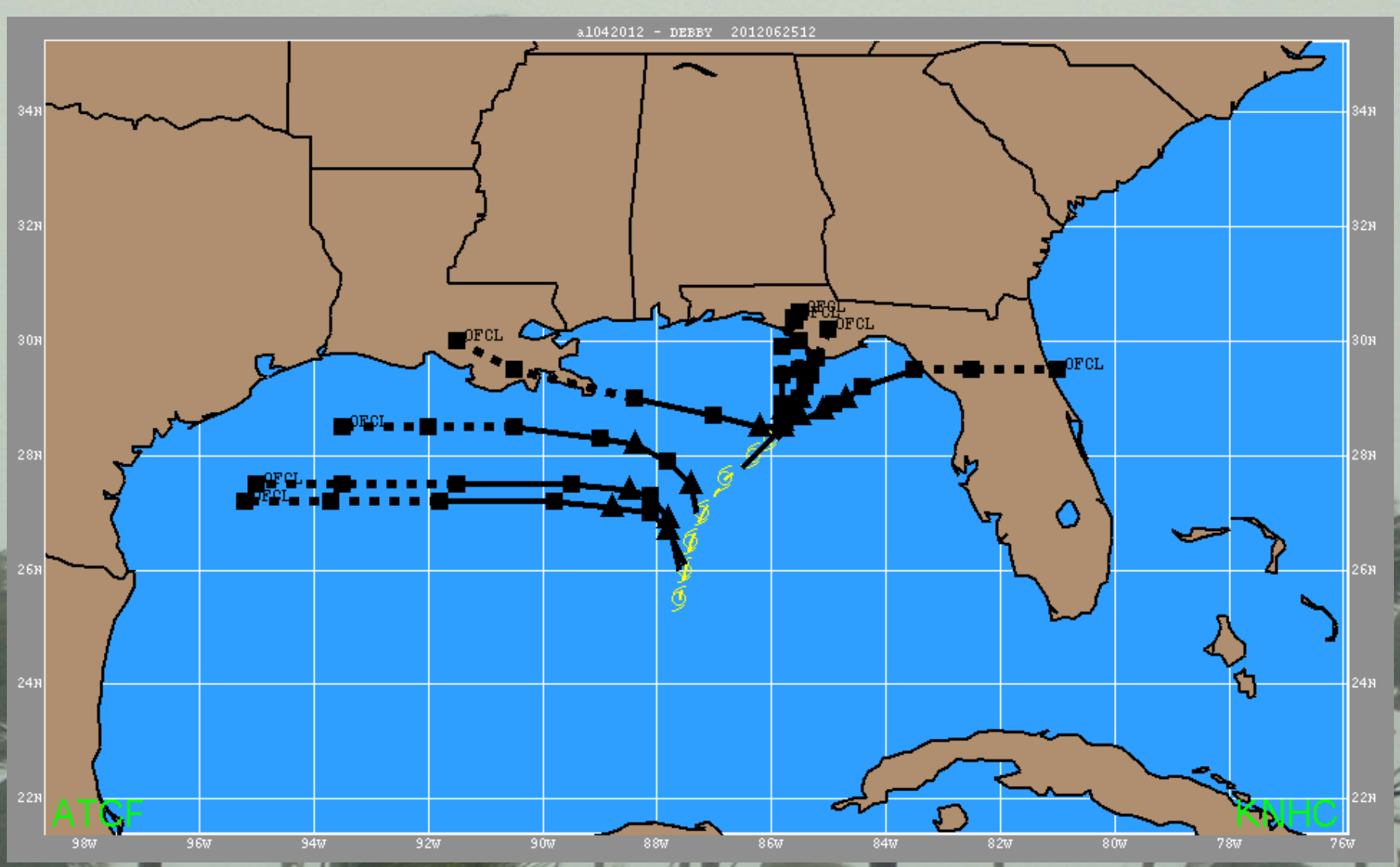
ECMWF shifts to Florida, finally agreement between GFS and ECMWF

Tropical Storm Debby Track Guidance
June 25, 2012 5 AM Advisory

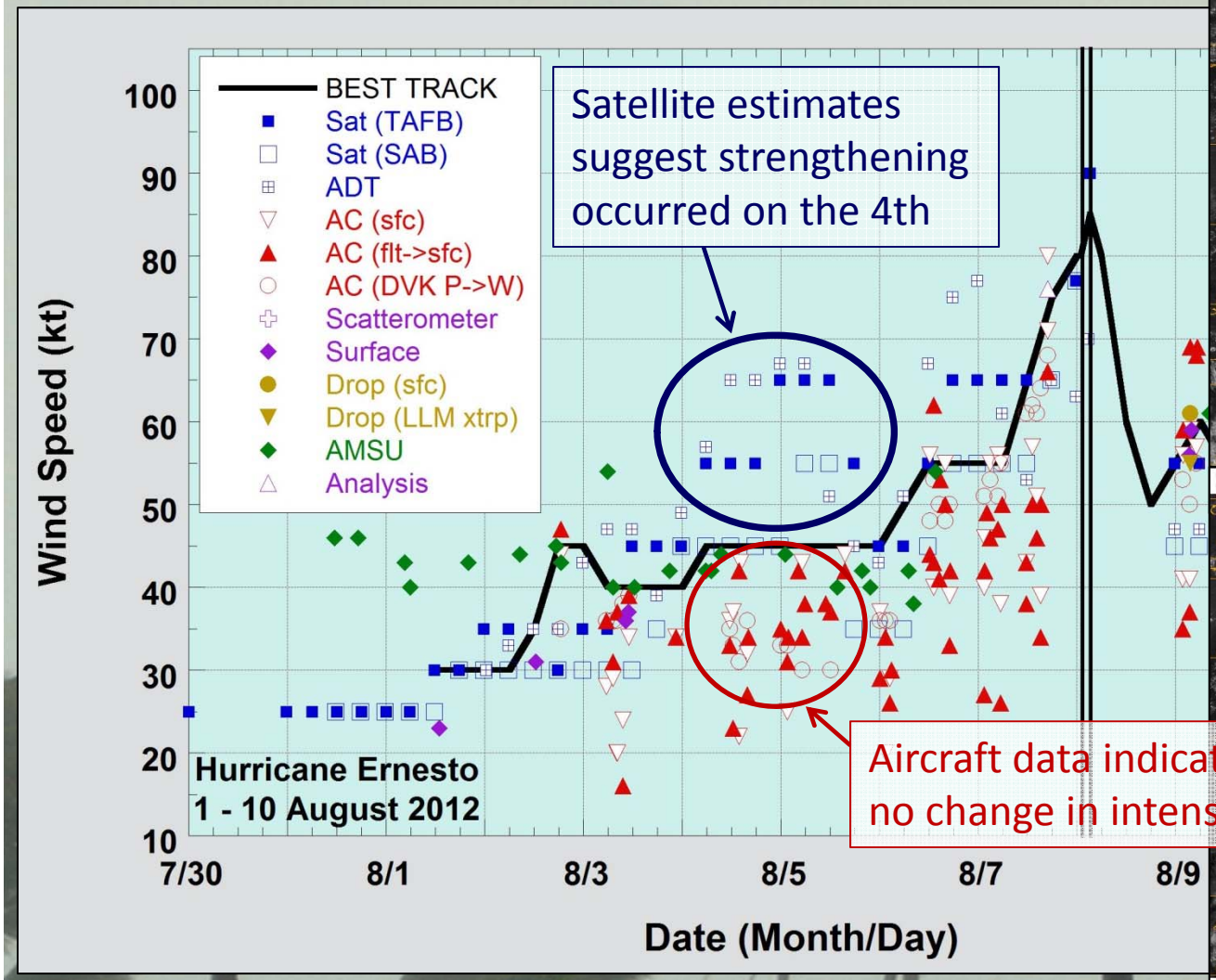


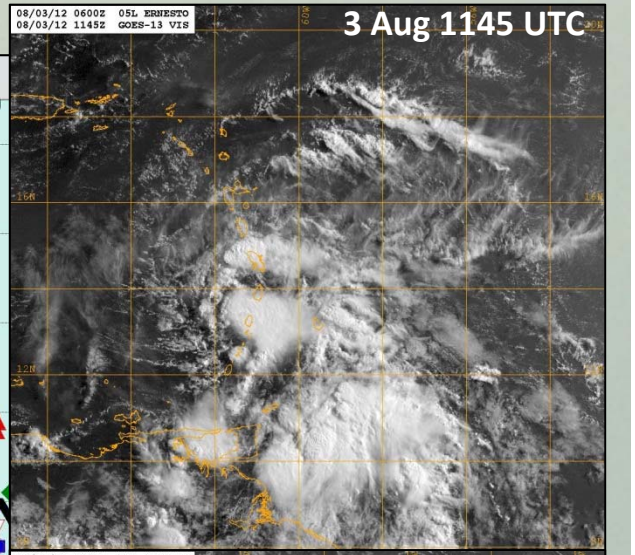
NHC Forecasts

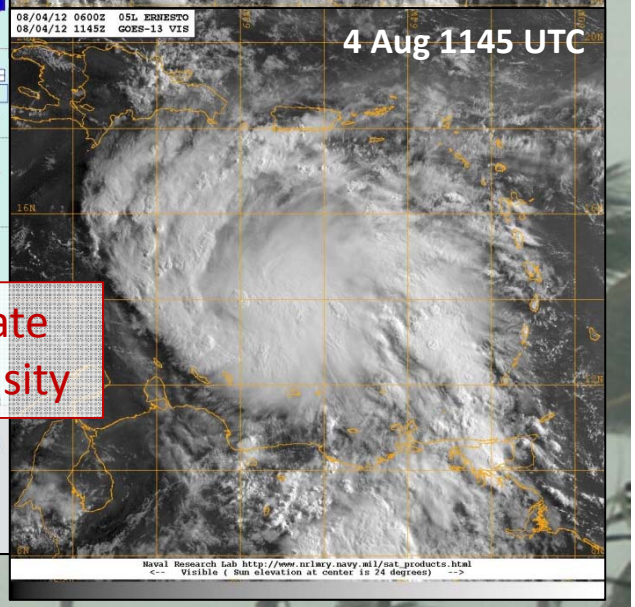
First 4 forecasts head toward Texas, shift toward Florida was required



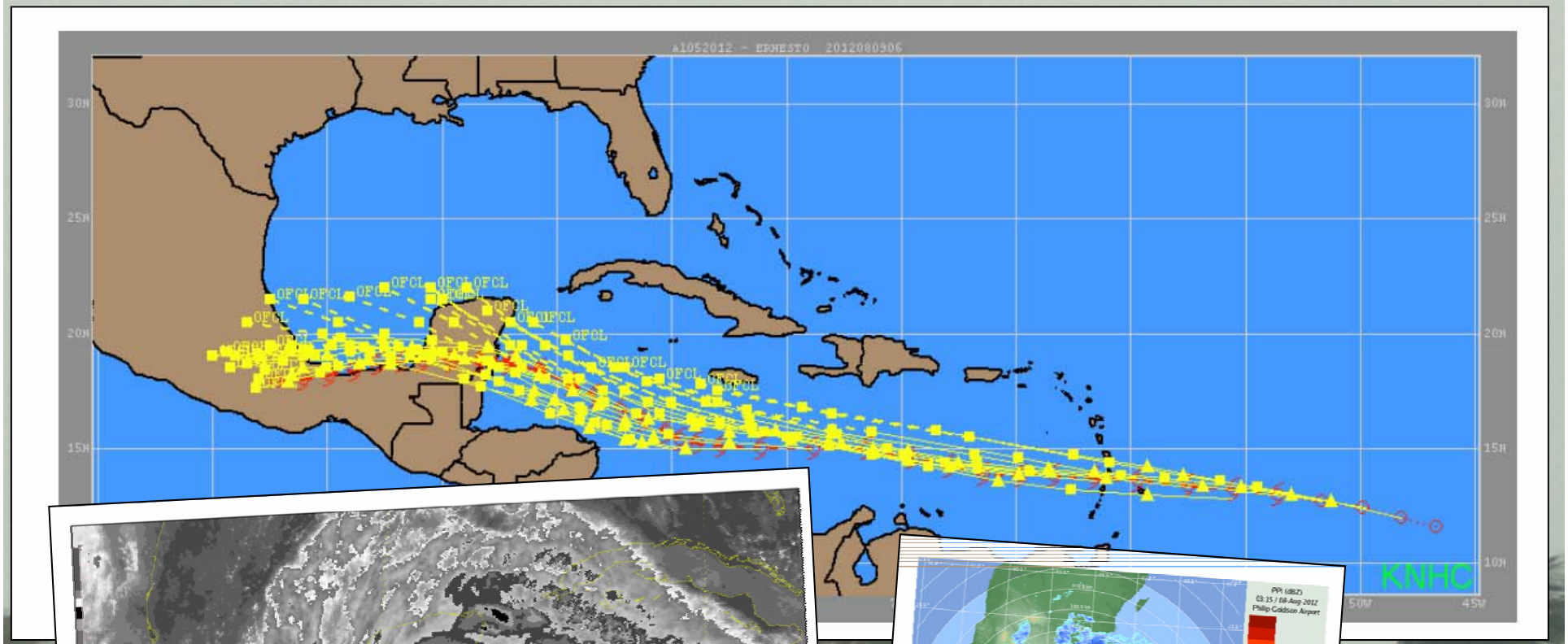
Ernesto- Improved satellite appearance, but no change in strength

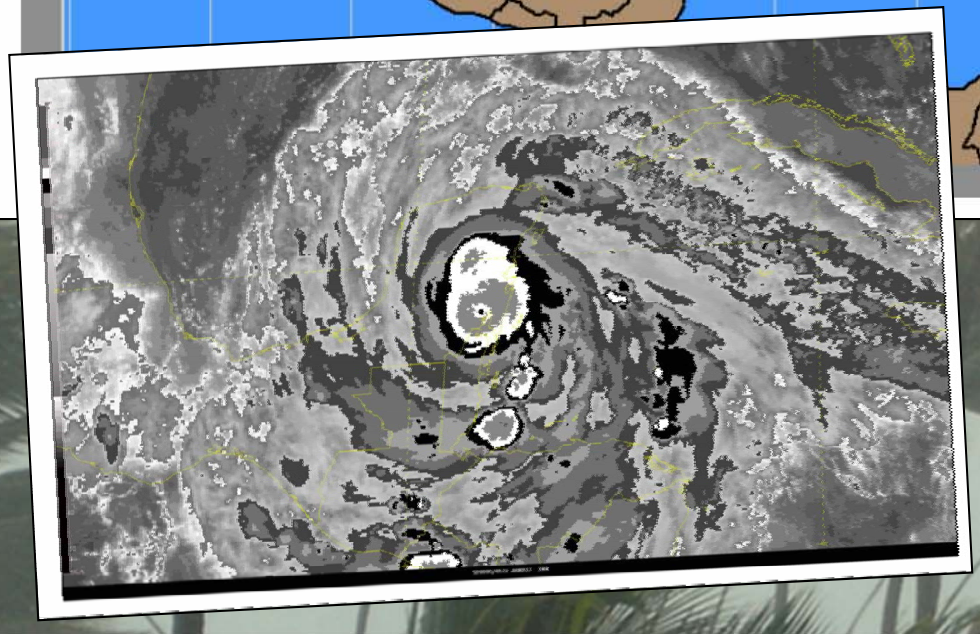


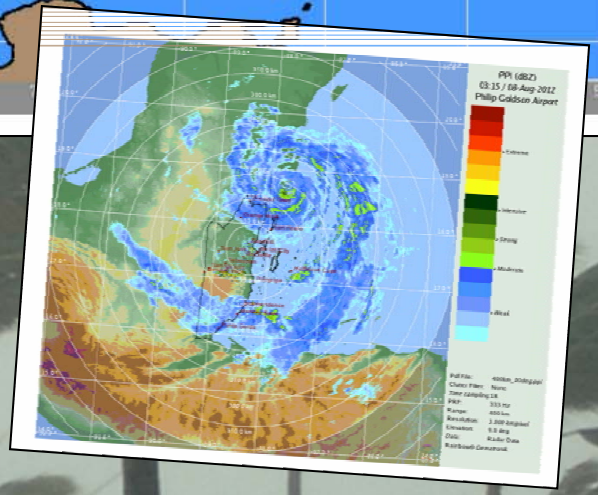




Track Guidance and NHC Forecasts for Ernesto Exhibited a Northward Bias

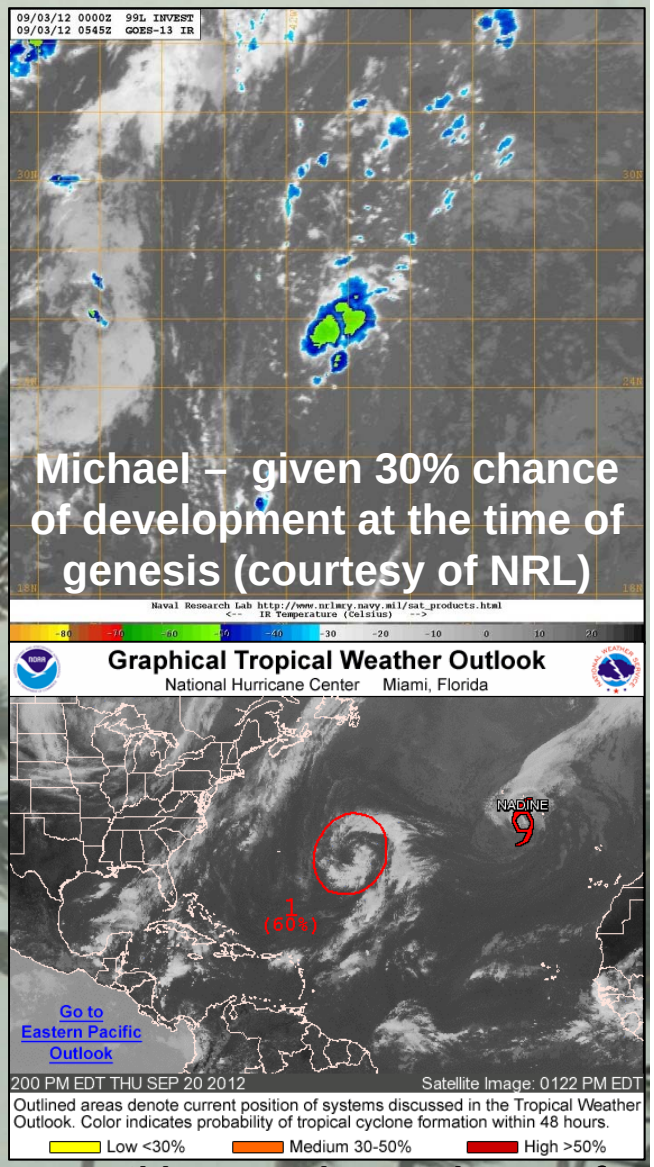






Will it or won't it develop

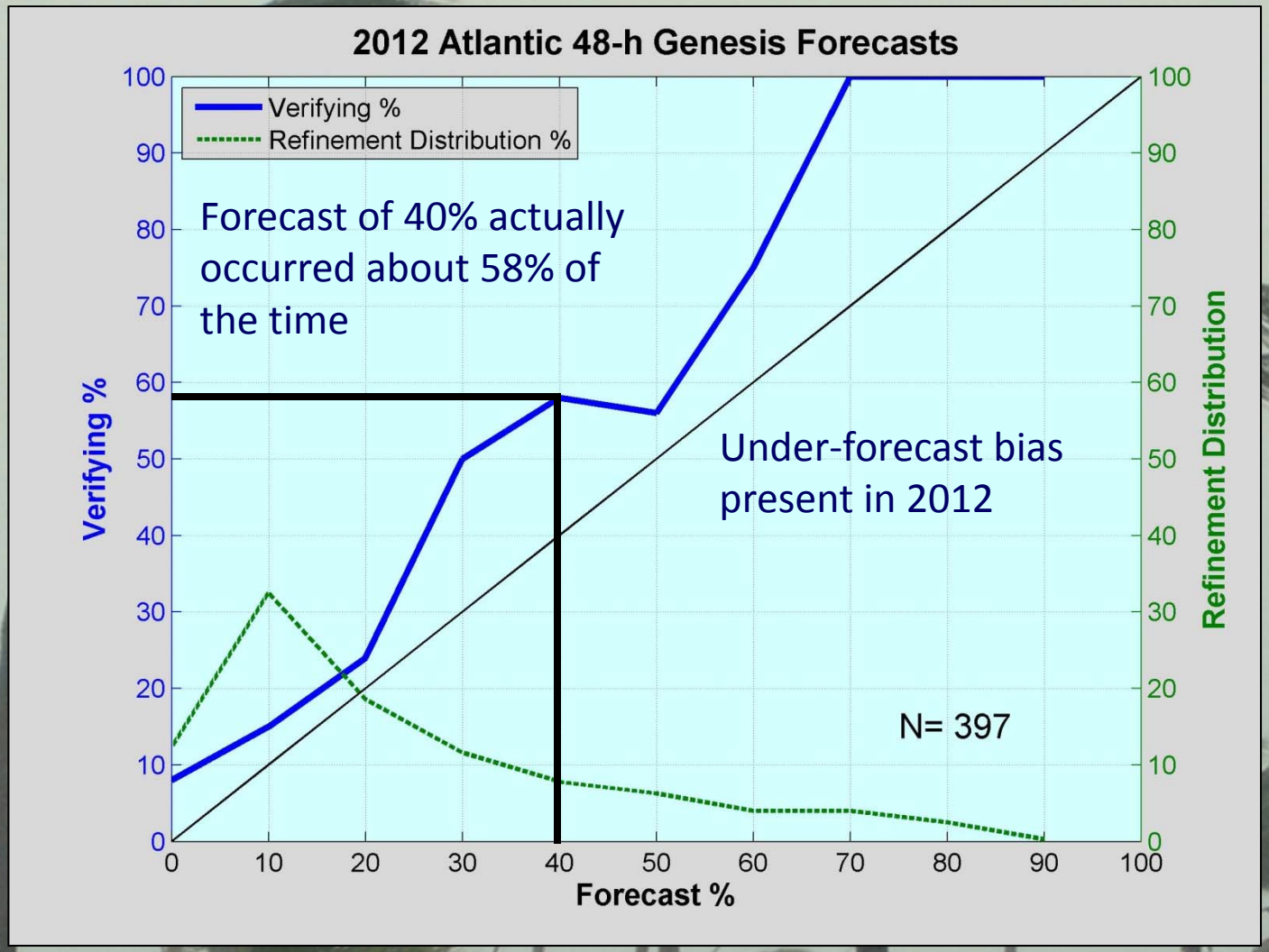
- There is little in the way of objective guidance for tropical cyclogenesis
- Numerical weather prediction models can do well in cases where the genesis is mainly synoptic scale. However, many genesis cases have a mesoscale component that the models have trouble with.
- The probabilities in the NHC Tropical Weather Outlook are ultimately based on forecaster judgment.



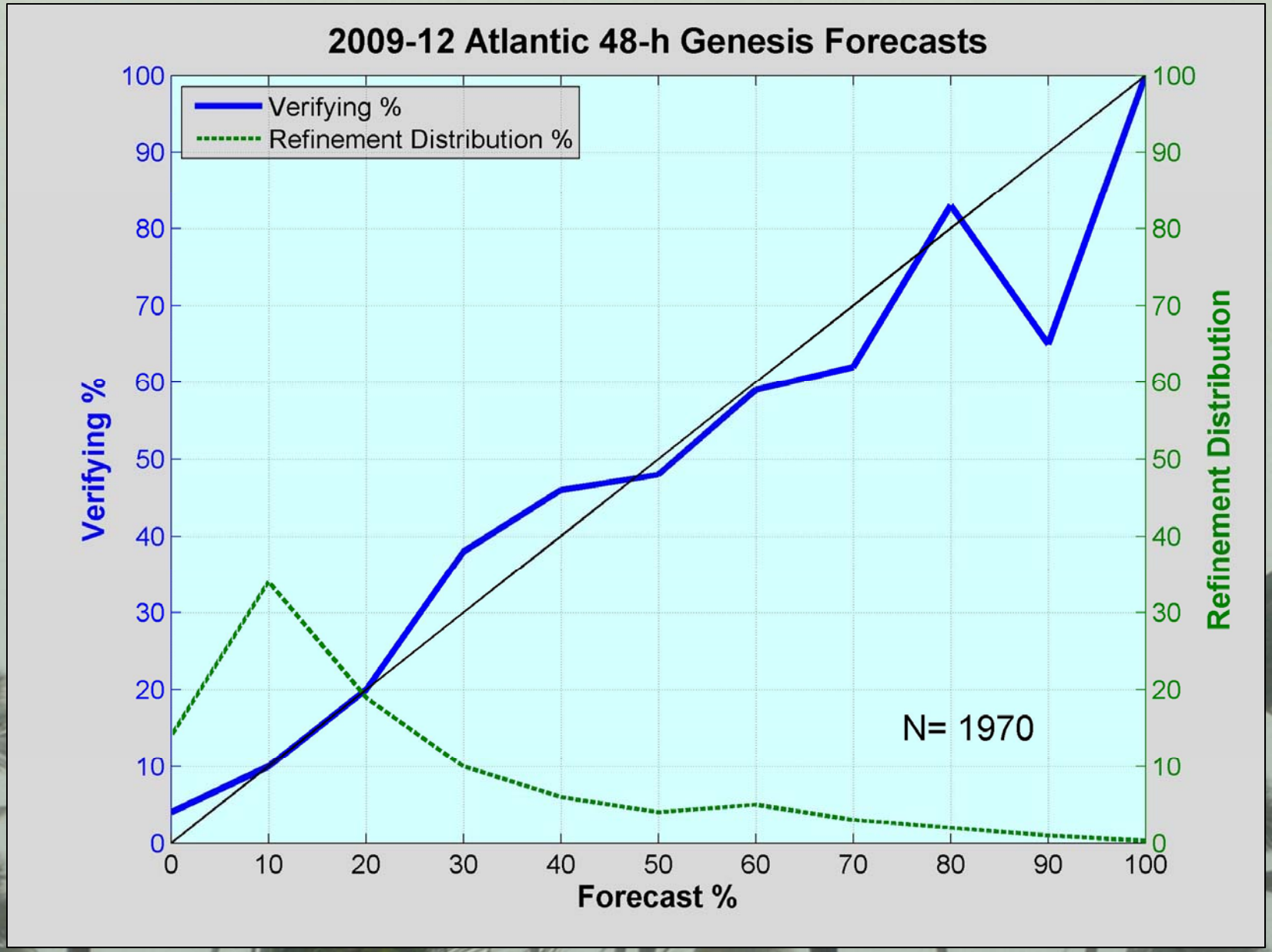
Possible ST with 60% chance of development – it didn't!

How did we do in 2012?

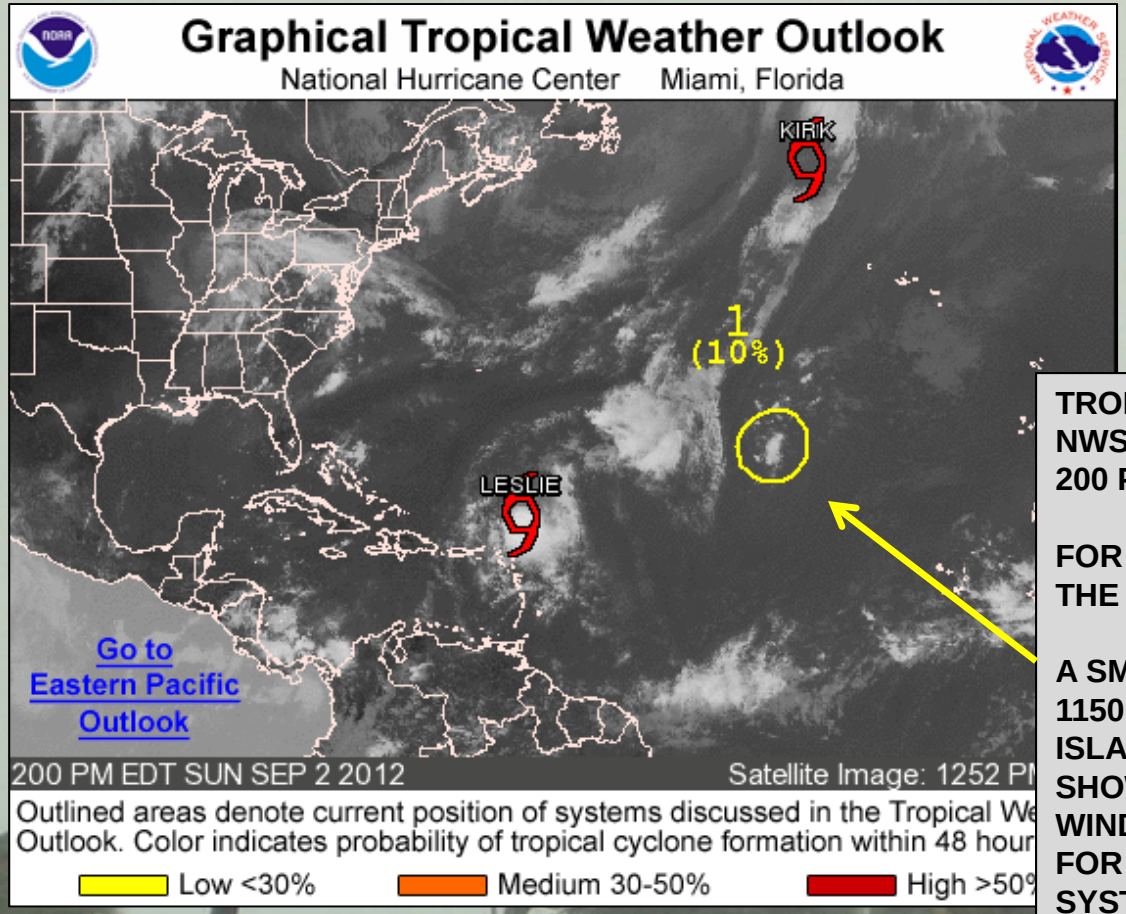
A bit of an under-forecast bias



NHC Genesis Probabilities 2009-12



Unexpected Genesis



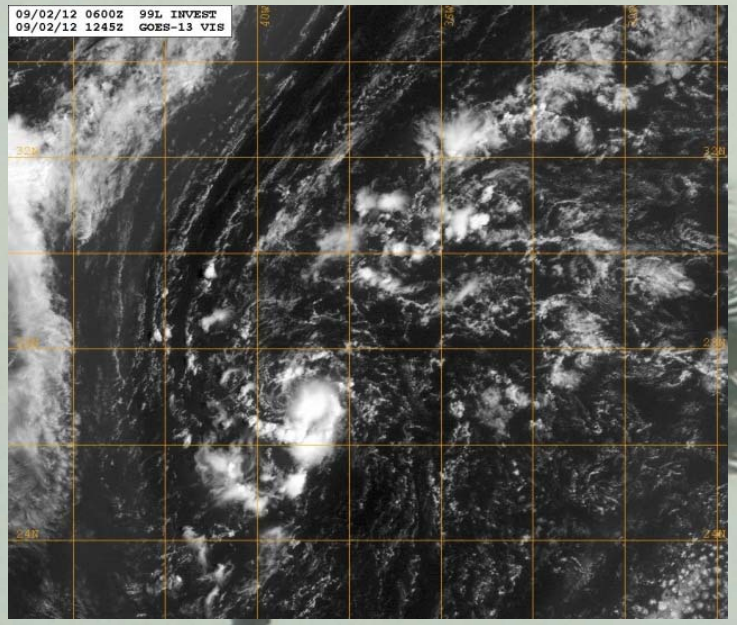
TROPICAL WEATHER OUTLOOK
NWS NATIONAL HURRICANE CENTER MIAMI FL
200 PM EDT SUN SEP 2 2012

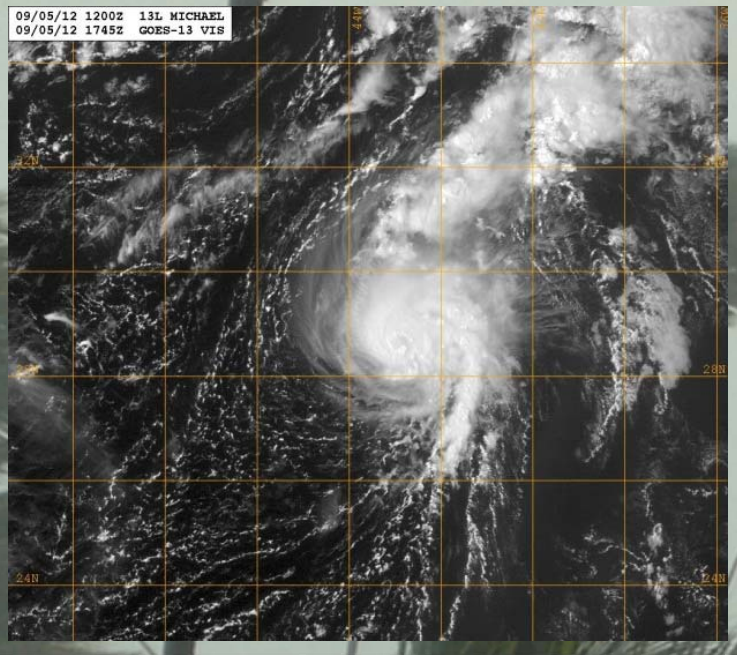
FOR THE NORTH ATLANTIC...CARIBBEAN SEA AND THE GULF OF MEXICO...

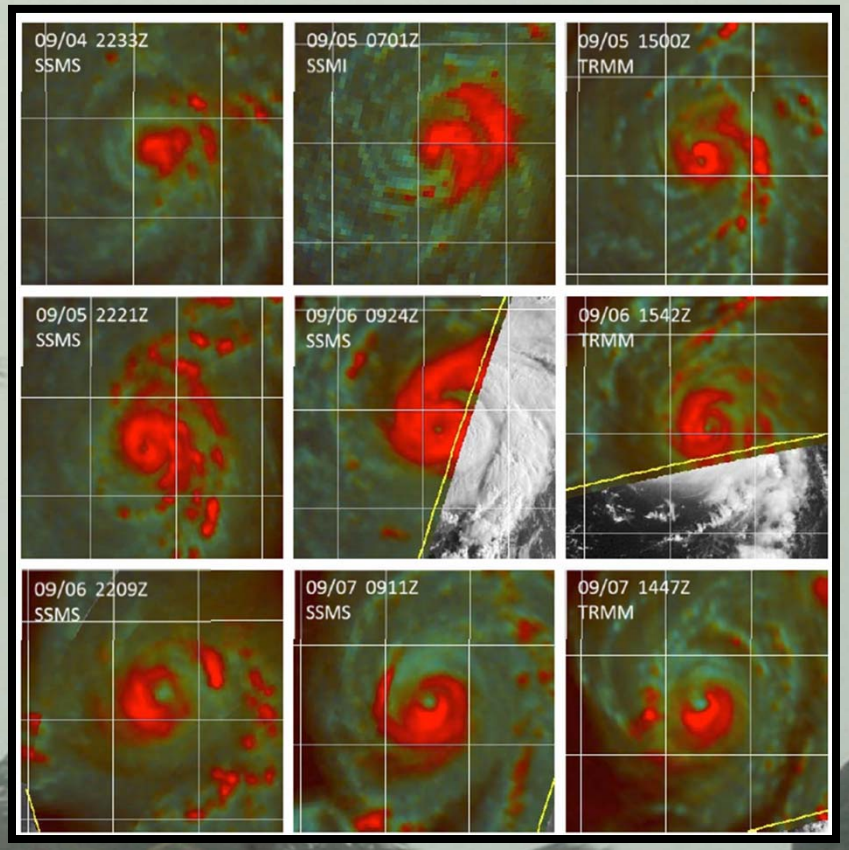
A SMALL LOW PRESSURE AREA LOCATED ABOUT 1150 MILES NORTHWEST OF THE CAPE VERDE ISLANDS IS PRODUCING DISORGANIZED SHOWERS AND THUNDERSTORMS. UPPER-LEVEL WINDS ARE EXPECTED TO REMAIN UNFAVORABLE FOR SIGNIFICANT DEVELOPMENT AND THIS SYSTEM HAS A LOW CHANCE...10 PERCENT...OF BECOMING A TROPICAL CYCLONE DURING THE NEXT 48 HOURS.

FORECASTER BROWN

Michael's Unexpected Genesis



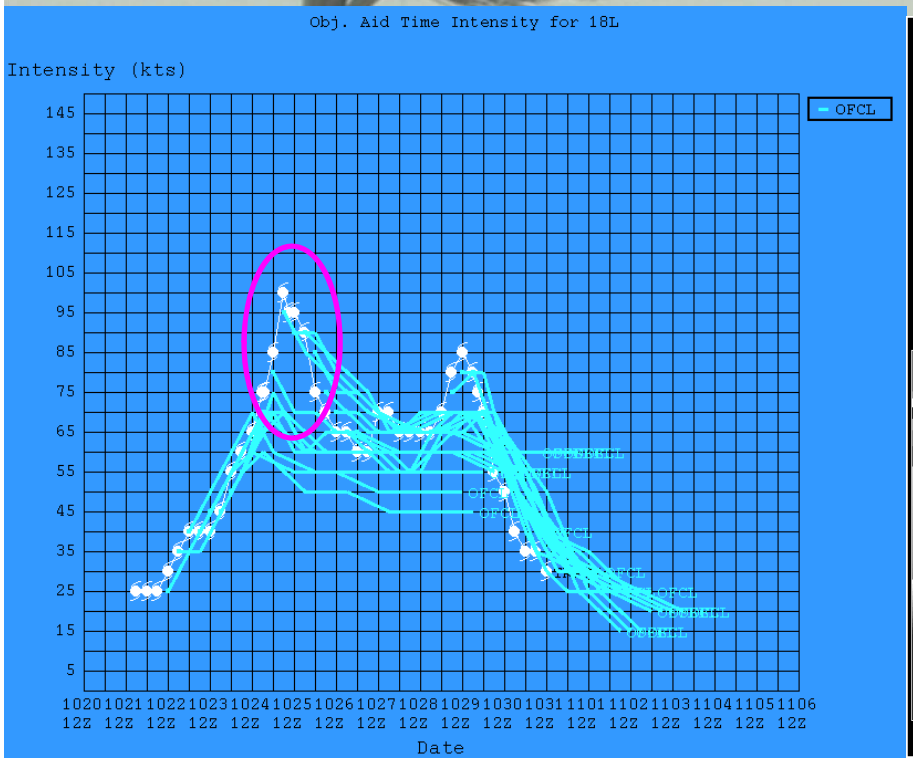


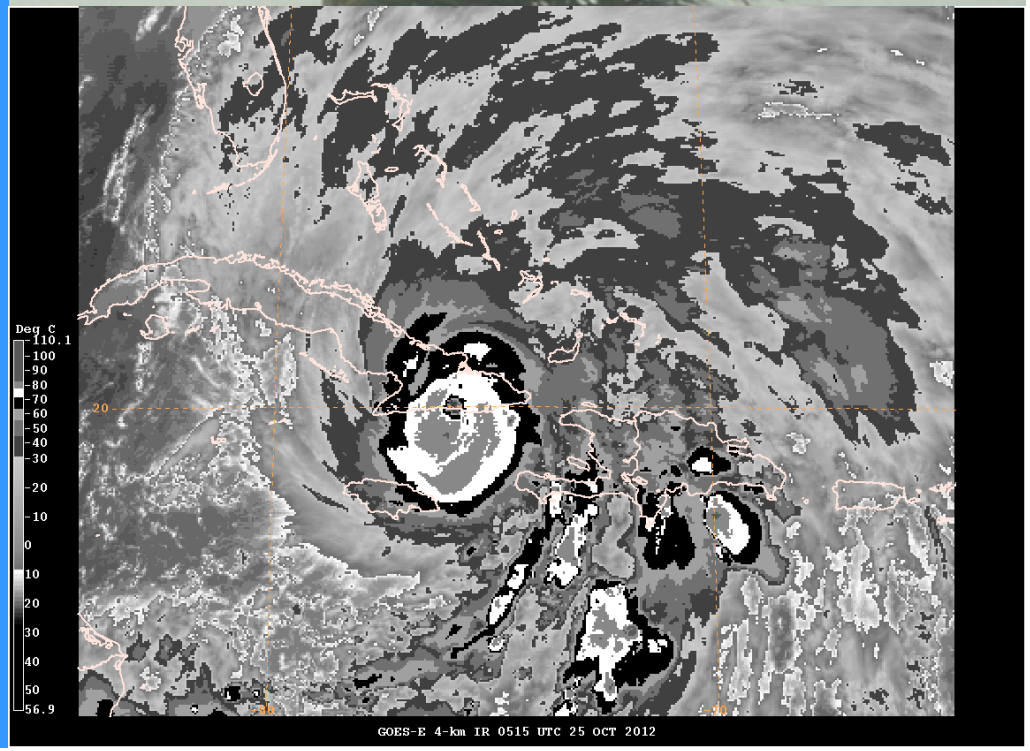


System became a tropical cyclone the next day and a major hurricane 4 days later!

Rapid Intensification: A Recurring Challenge

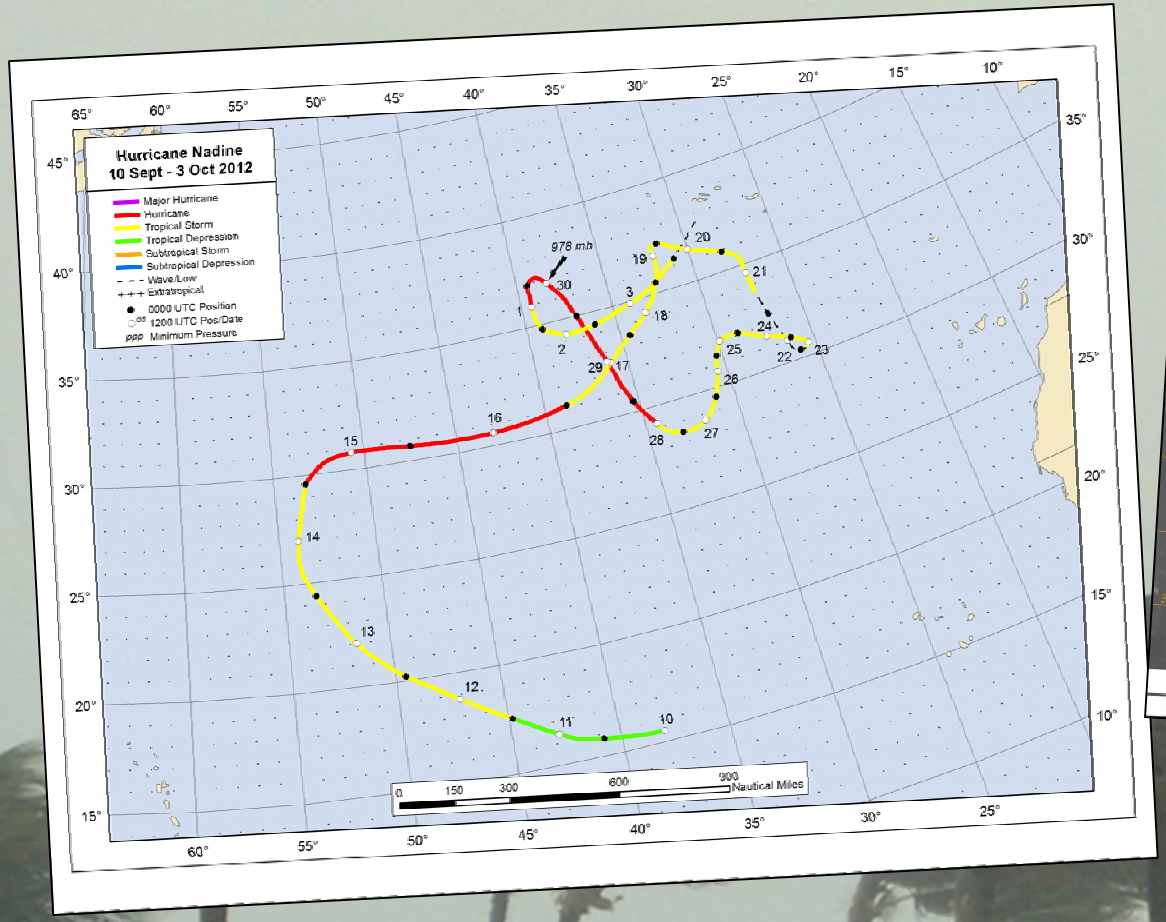
- Sandy intensified rapidly between Jamaica and Cuba, and this was poorly forecast.
- Despite ongoing efforts (e.g. the Hurricane Forecast Improvement Program), forecasting rapid intensification remains a major problem.

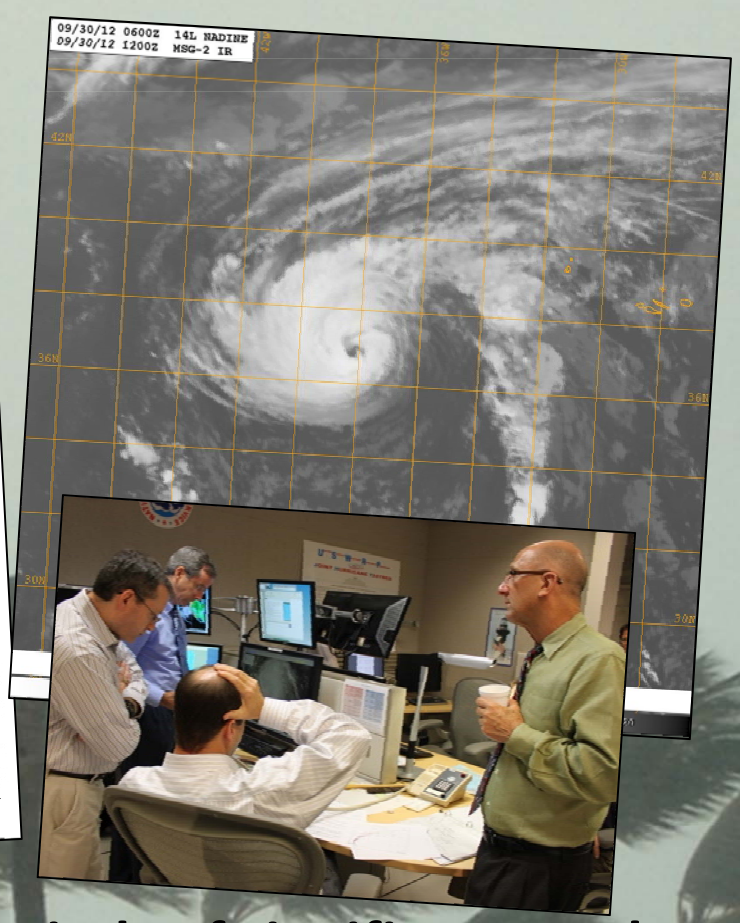




Nadine- Enough Said

22.5 days of loop-de-loop

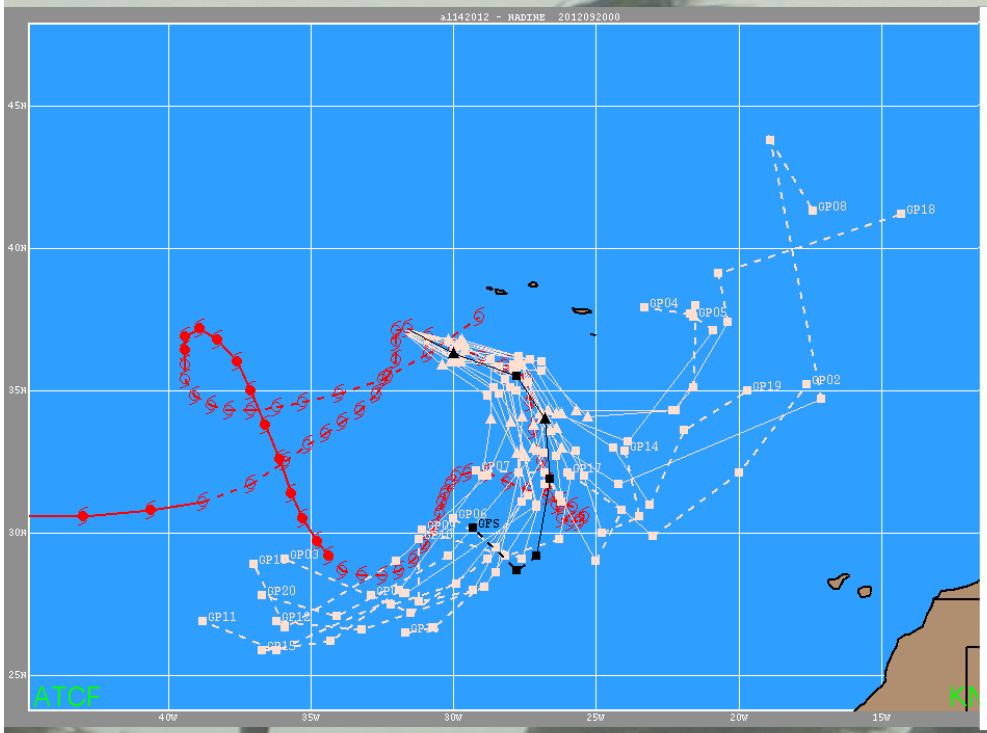




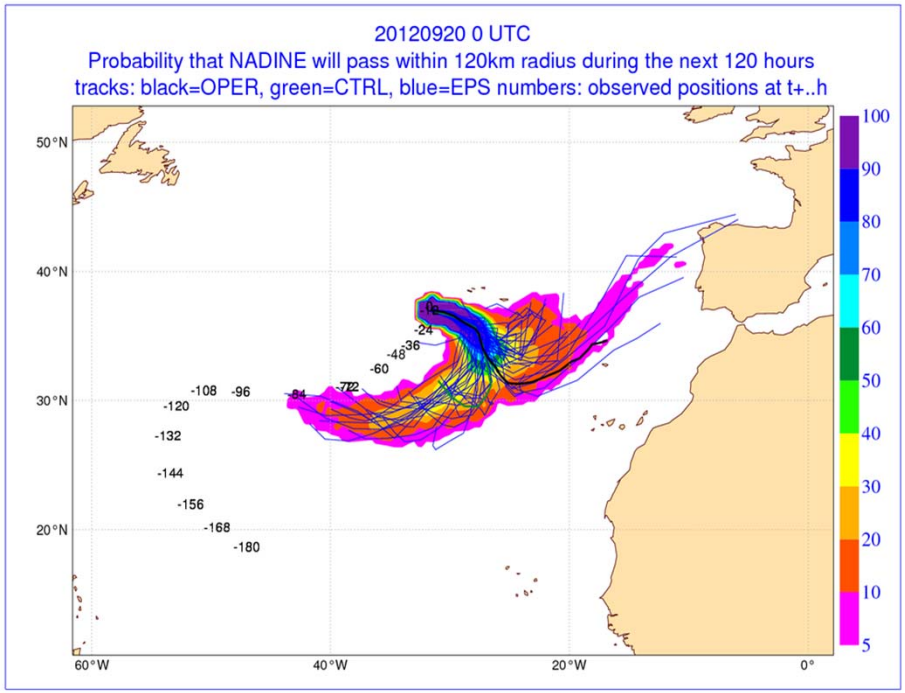
- **Nadine's forecast challenges included: periods of significant track forecast uncertainty, slow motion near Azores resulted in an extended period of watches/warnings, classification of the system on 21-23 September.**

Another Difficult Track Forecast

Ensemble Forecasts Sept 20- 0000 UTC



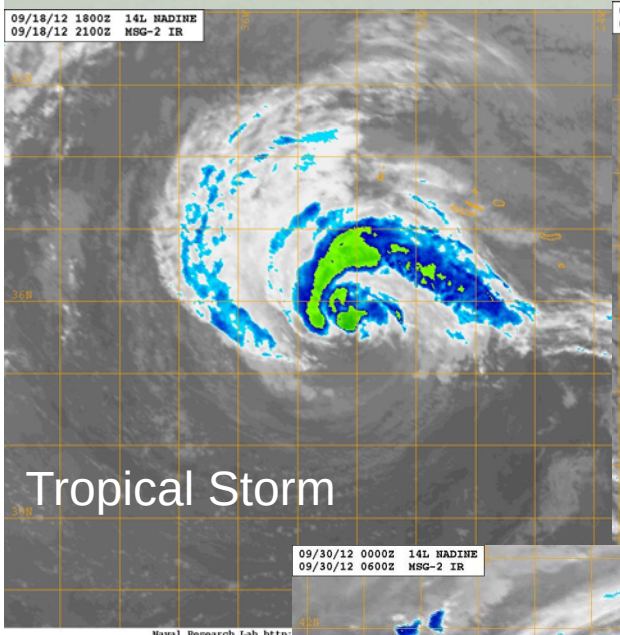
GFS

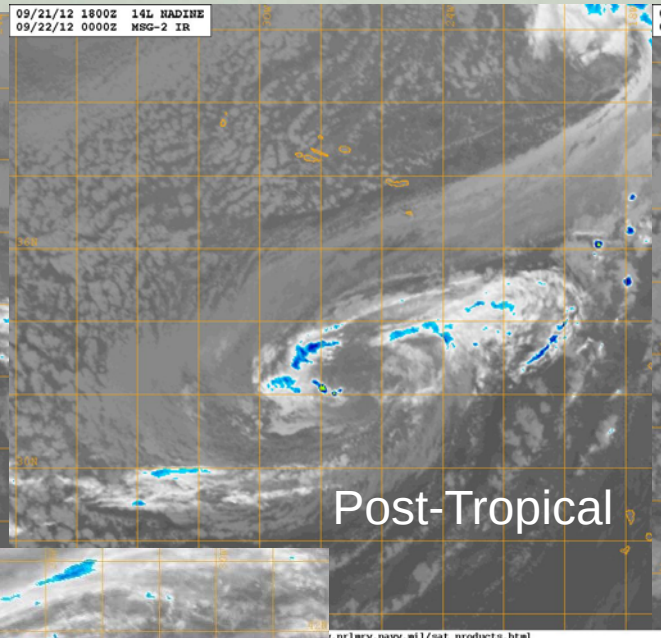


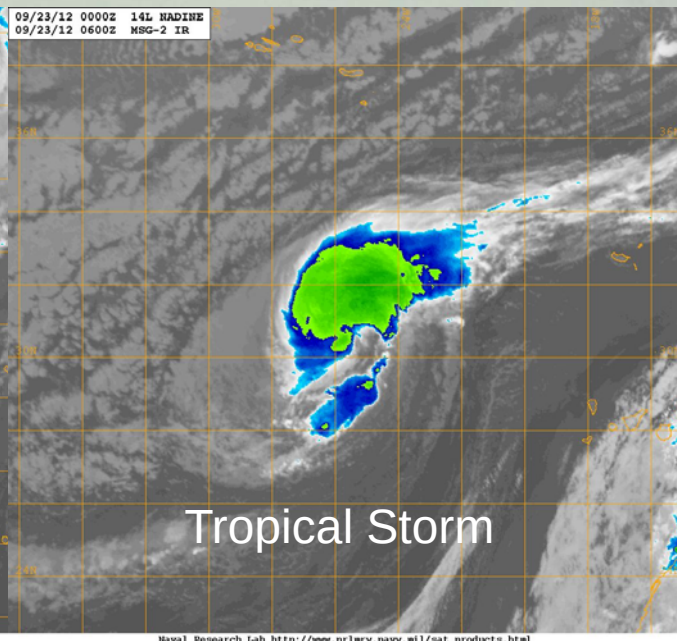
ECMWF

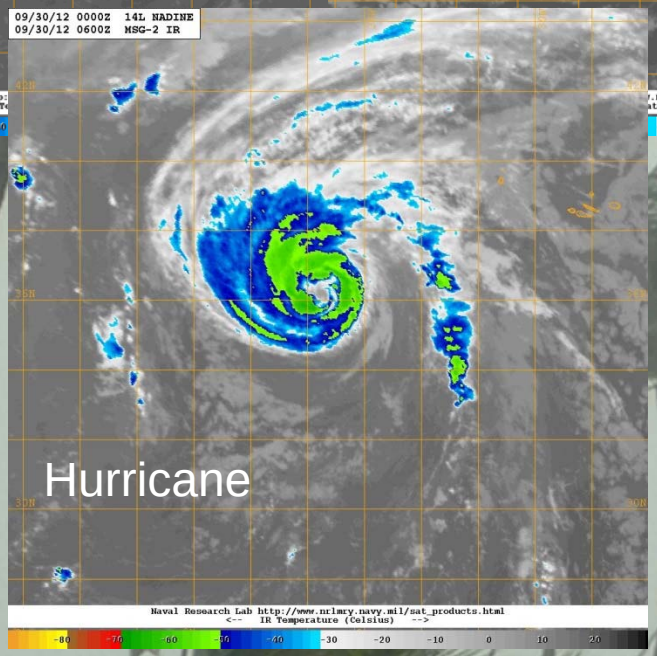
Bifurcation in ensemble tracks.
Operational GFS turns Nadine southwestward,
EC takes storm northeastward!

Classification of Nadine



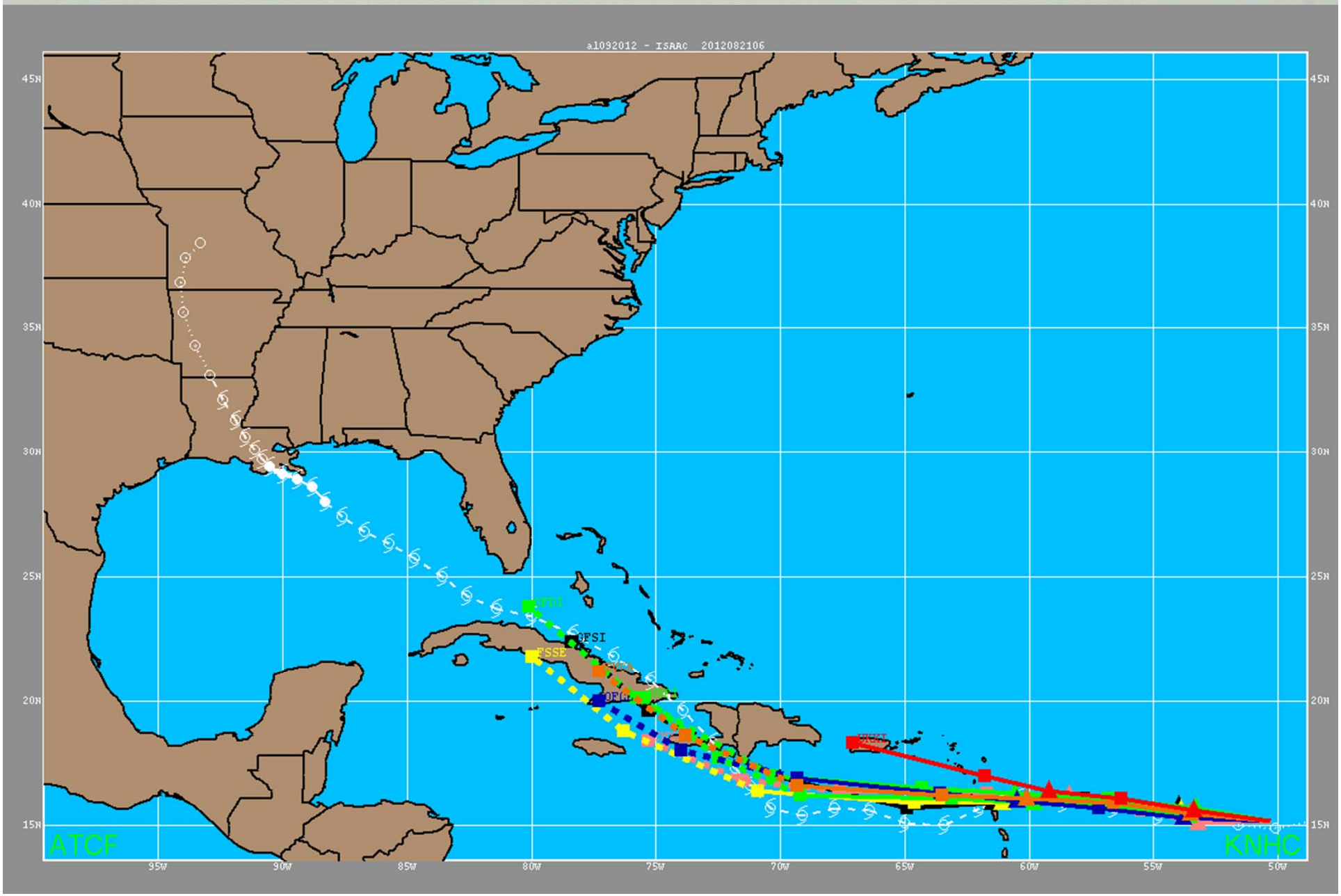




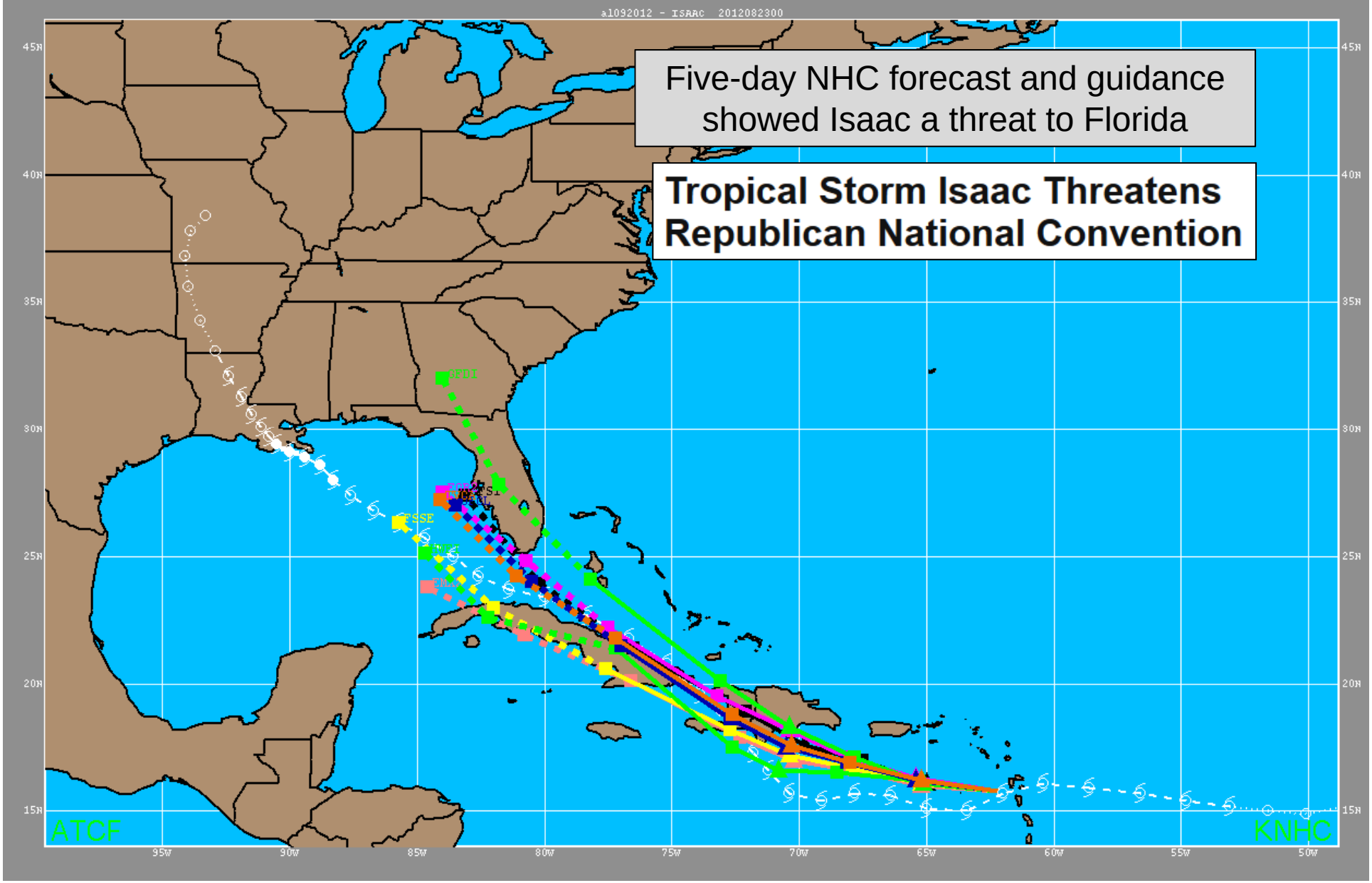


- **Nadine transitioned to a Post-Tropical cyclone after interacting with a front.**
- **The cyclone then moved southward and organized convection returned. Nadine became a TC again and a hurricane for the second time on 28 September.**

Isaac Track Guidance

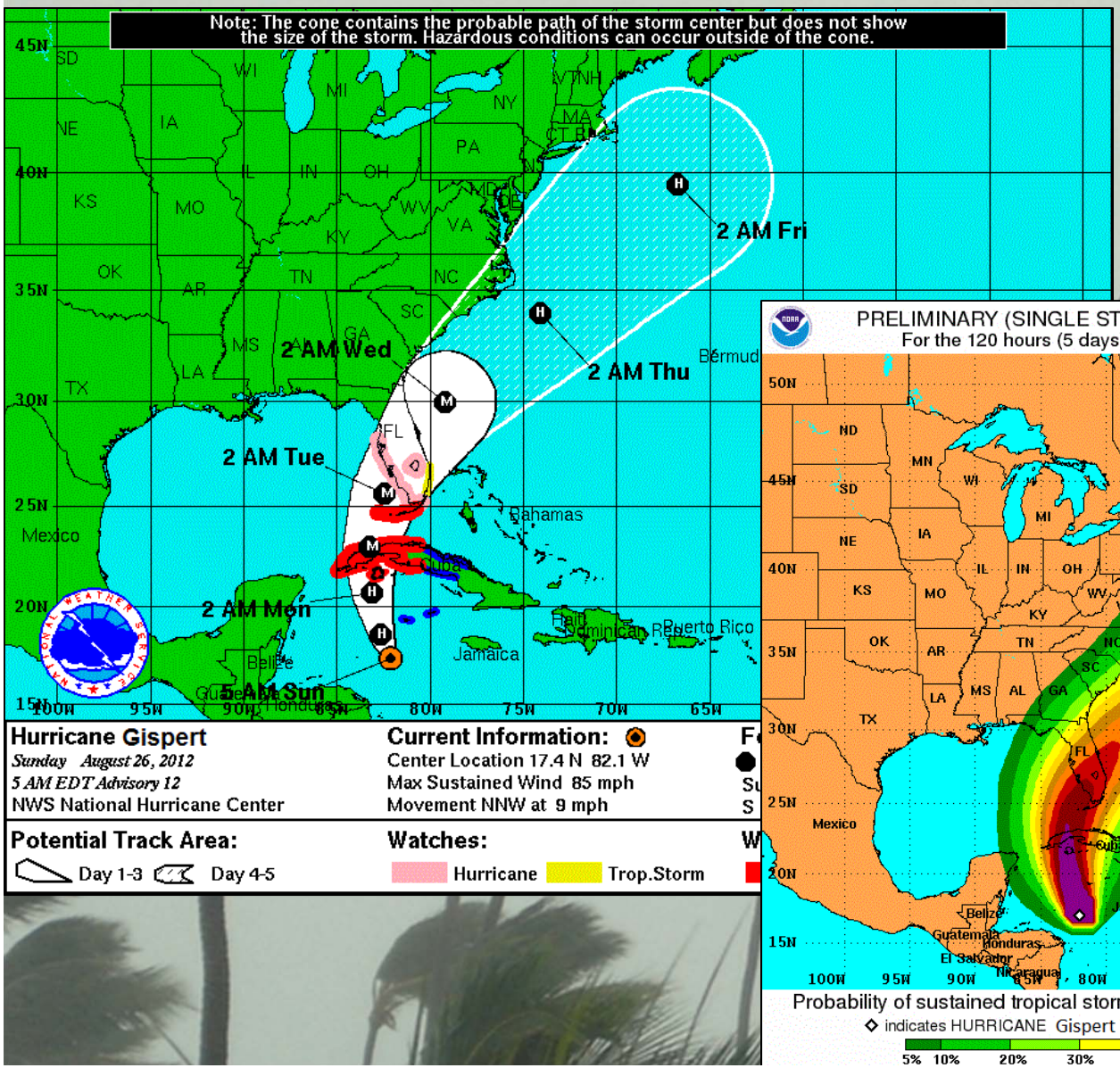


Isaac Track Guidance

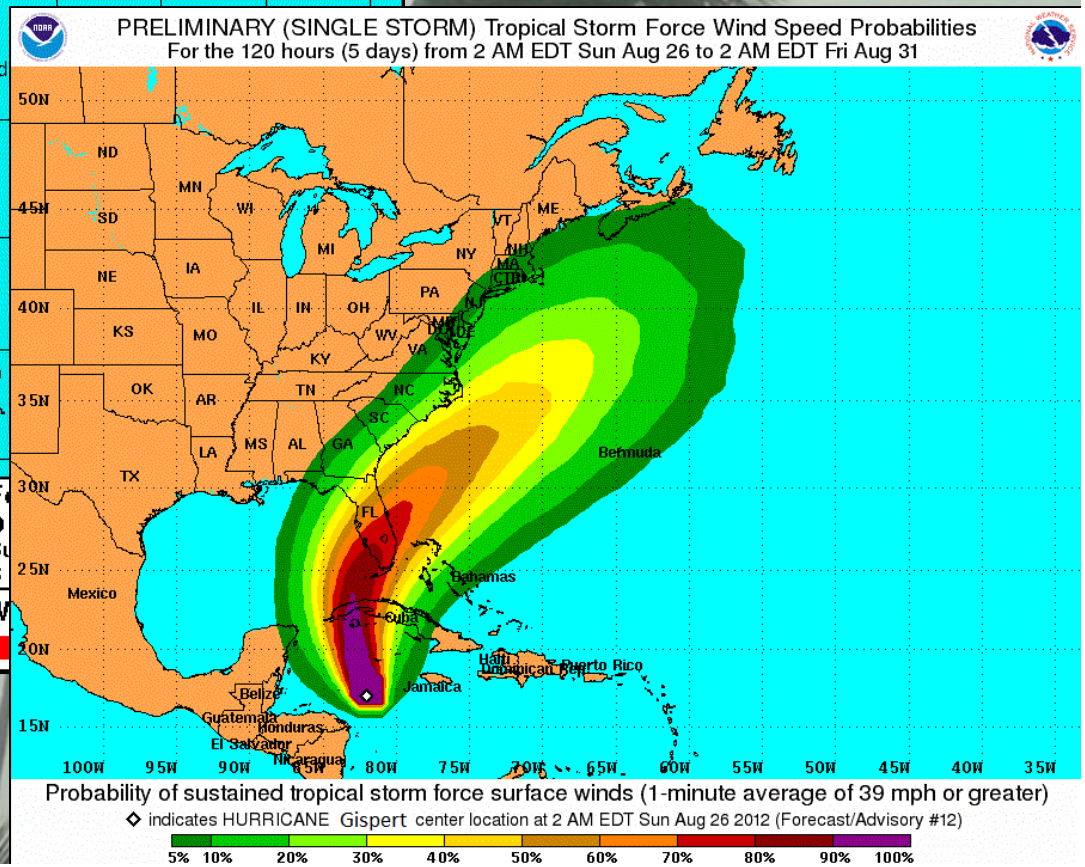


Careful What You Ask For

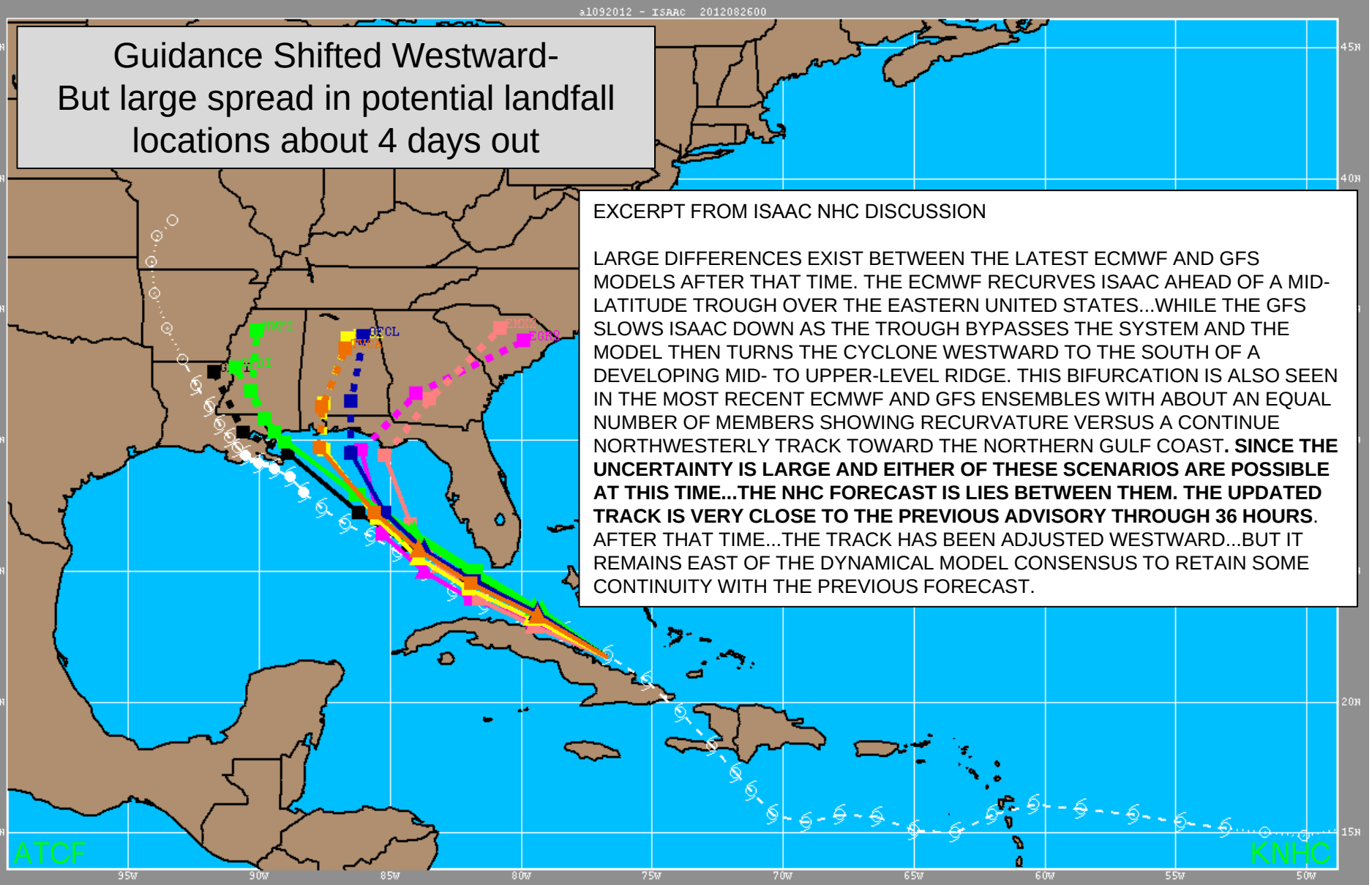
2012 State of Florida Exercise



State exercise had major hurricane impact on Tampa during RNC



Isaac Track Guidance



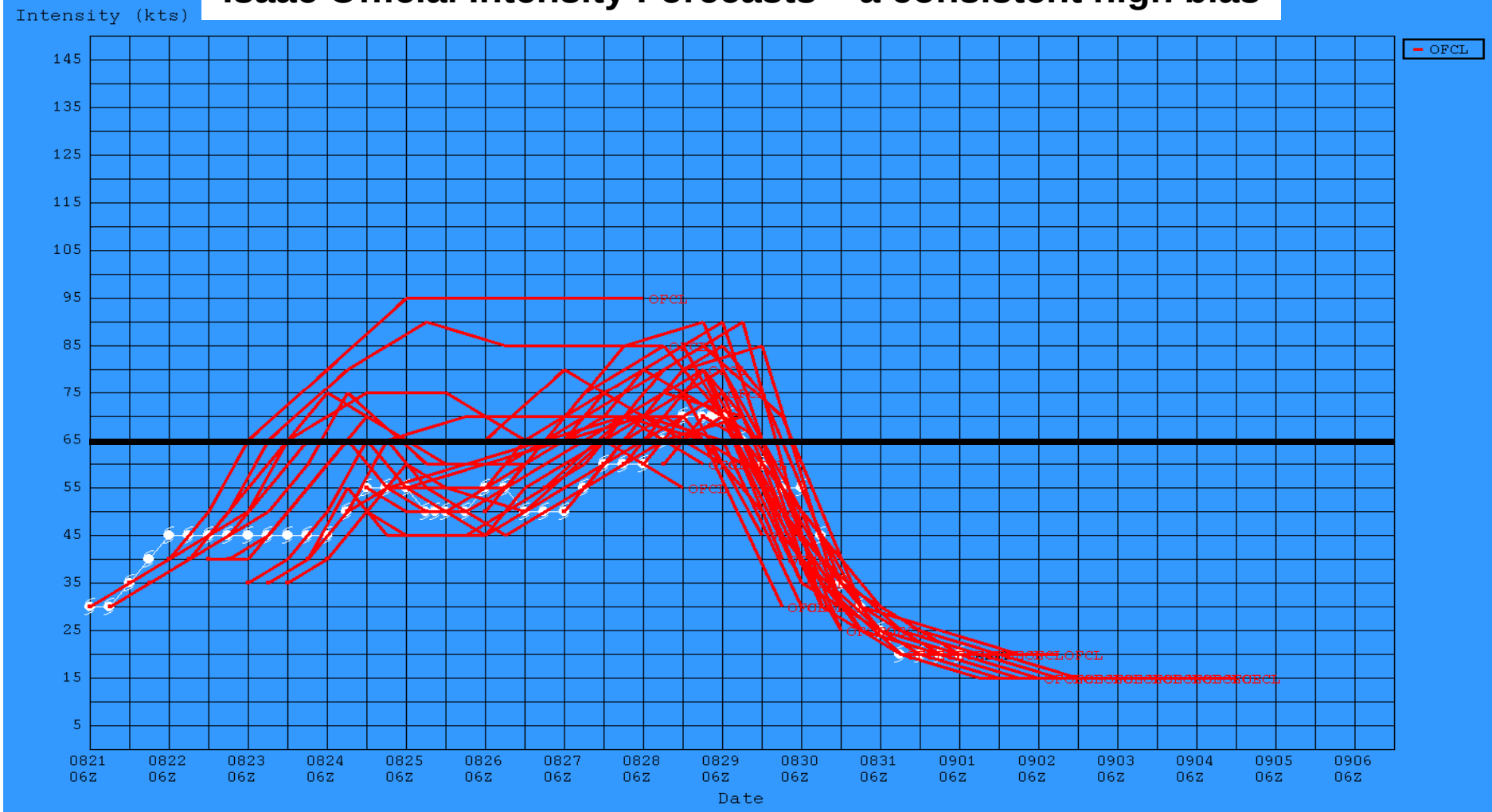
Guidance Shifted Westward-
But large spread in potential landfall locations about 4 days out

EXCERPT FROM ISAAC NHC DISCUSSION

LARGE DIFFERENCES EXIST BETWEEN THE LATEST ECMWF AND GFS MODELS AFTER THAT TIME. THE ECMWF RECURVES ISAAC AHEAD OF A MID-LATITUDE TROUGH OVER THE EASTERN UNITED STATES...WHILE THE GFS SLOWS ISAAC DOWN AS THE TROUGH BYPASSES THE SYSTEM AND THE MODEL THEN TURNS THE CYCLONE WESTWARD TO THE SOUTH OF A DEVELOPING MID- TO UPPER-LEVEL RIDGE. THIS BIFURCATION IS ALSO SEEN IN THE MOST RECENT ECMWF AND GFS ENSEMBLES WITH ABOUT AN EQUAL NUMBER OF MEMBERS SHOWING RECURVATURE VERSUS A CONTINUE NORTHWESTERLY TRACK TOWARD THE NORTHERN GULF COAST**. SINCE THE UNCERTAINTY IS LARGE AND EITHER OF THESE SCENARIOS ARE POSSIBLE AT THIS TIME...THE NHC FORECAST IS LIES BETWEEN THEM. THE UPDATED TRACK IS VERY CLOSE TO THE PREVIOUS ADVISORY THROUGH 36 HOURS**. AFTER THAT TIME...THE TRACK HAS BEEN ADJUSTED WESTWARD...BUT IT REMAINS EAST OF THE DYNAMICAL MODEL CONSENSUS TO RETAIN SOME CONTINUITY WITH THE PREVIOUS FORECAST.

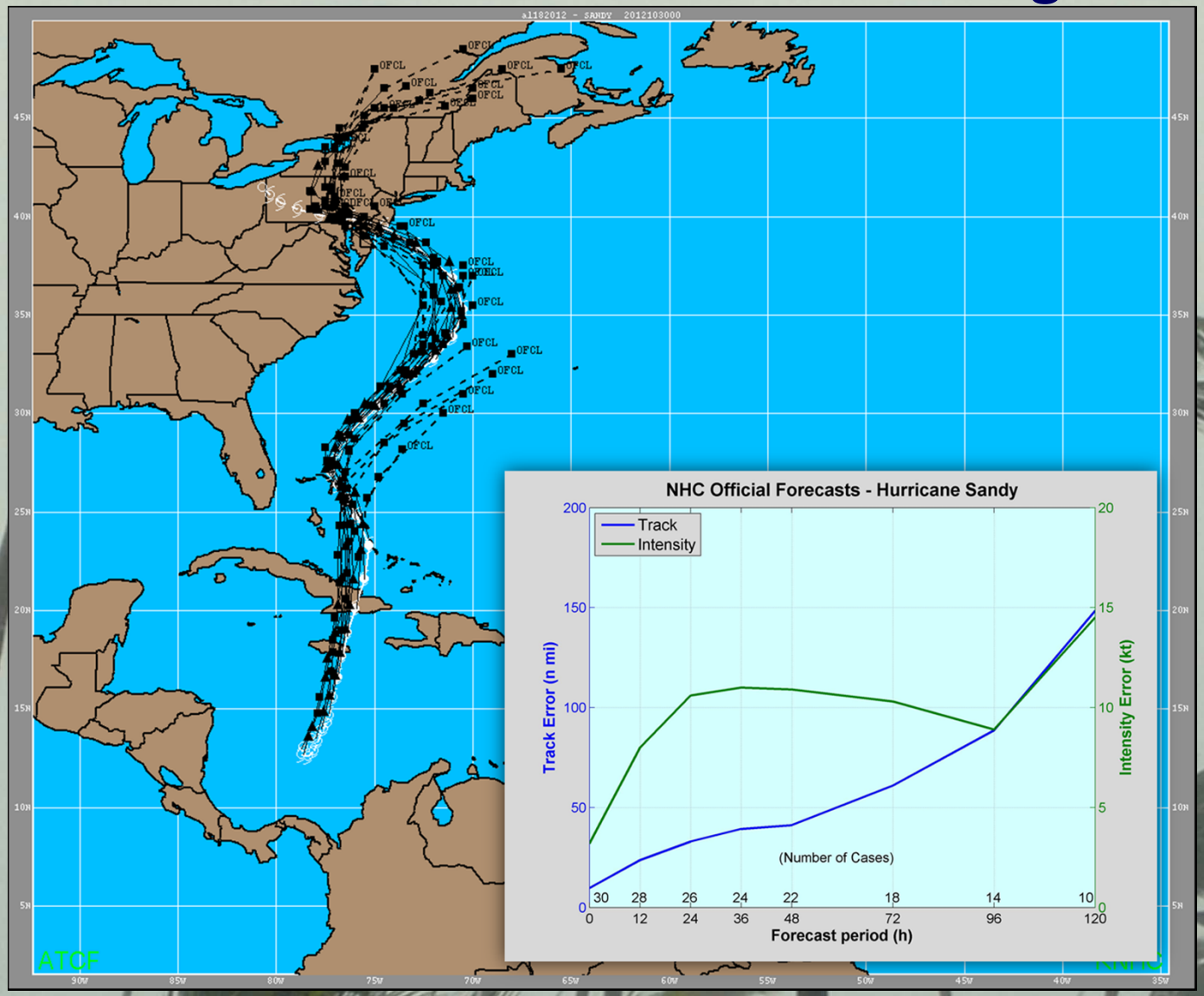
Over-Prediction of Intensity- Can Also Be a Problem

Isaac Official Intensity Forecasts – a consistent high bias



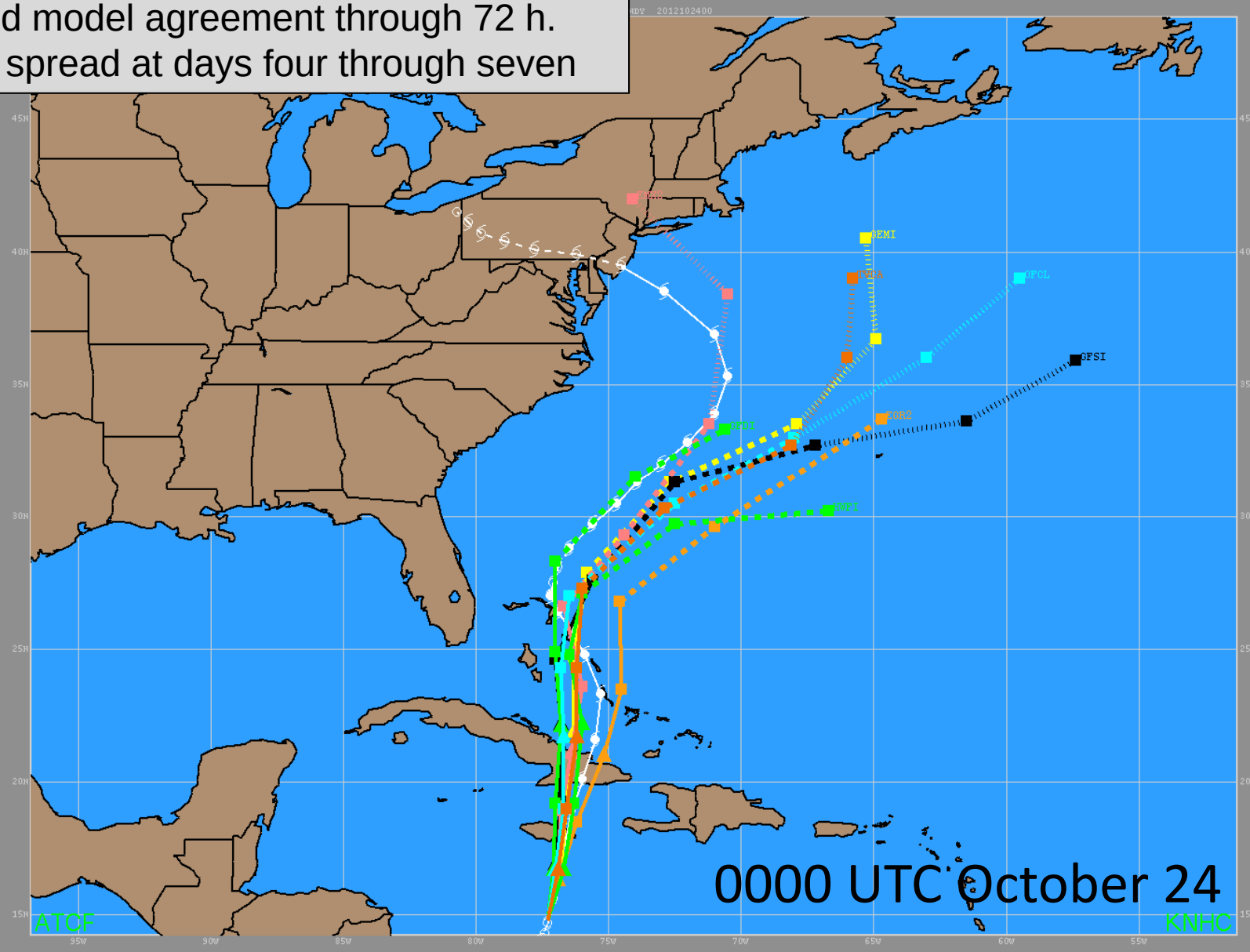
Many Challenges During Sandy

But the Track and Intensity Forecasts Were Better than Average



Sandy Track Guidance

Good model agreement through 72 h.
More spread at days four through seven



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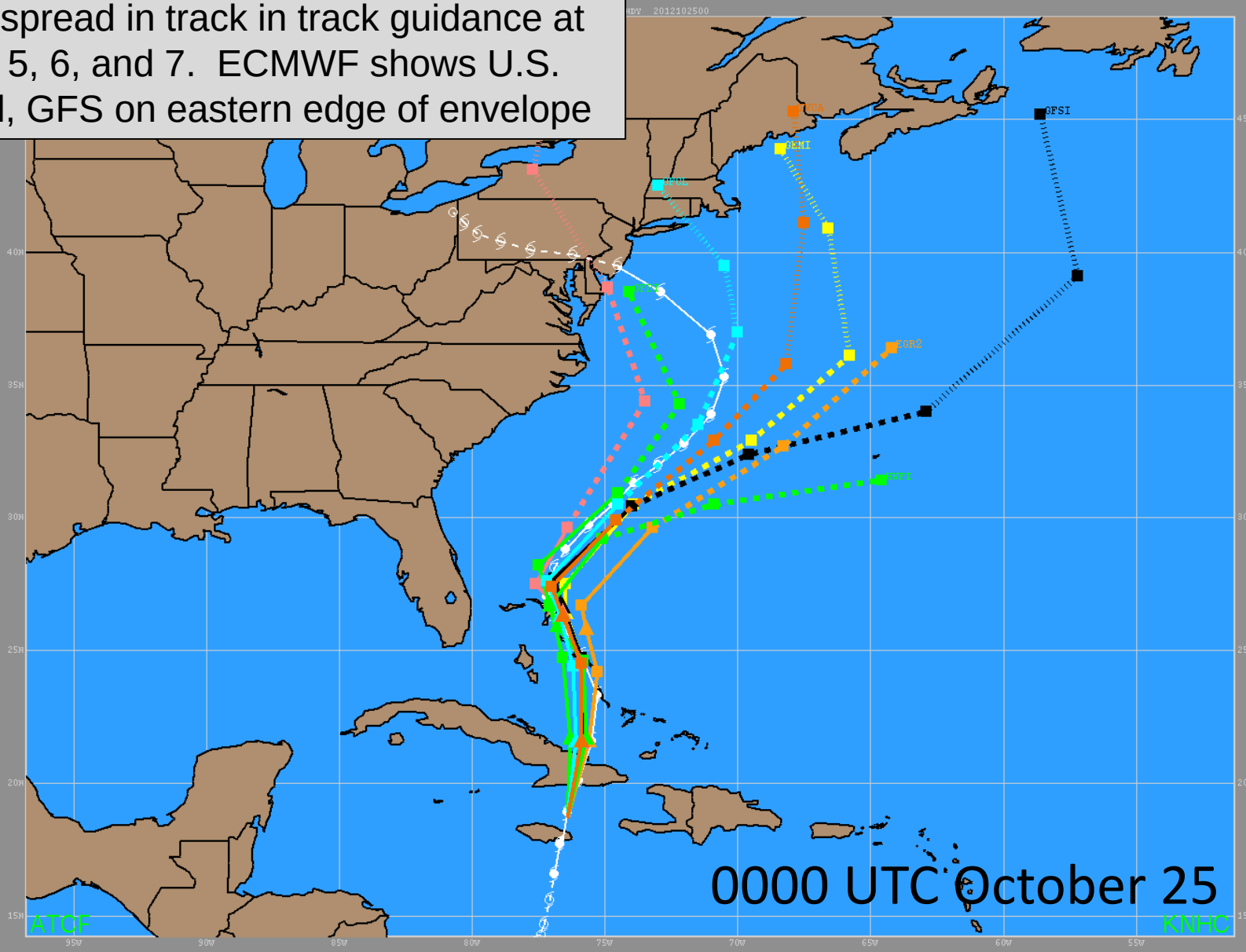
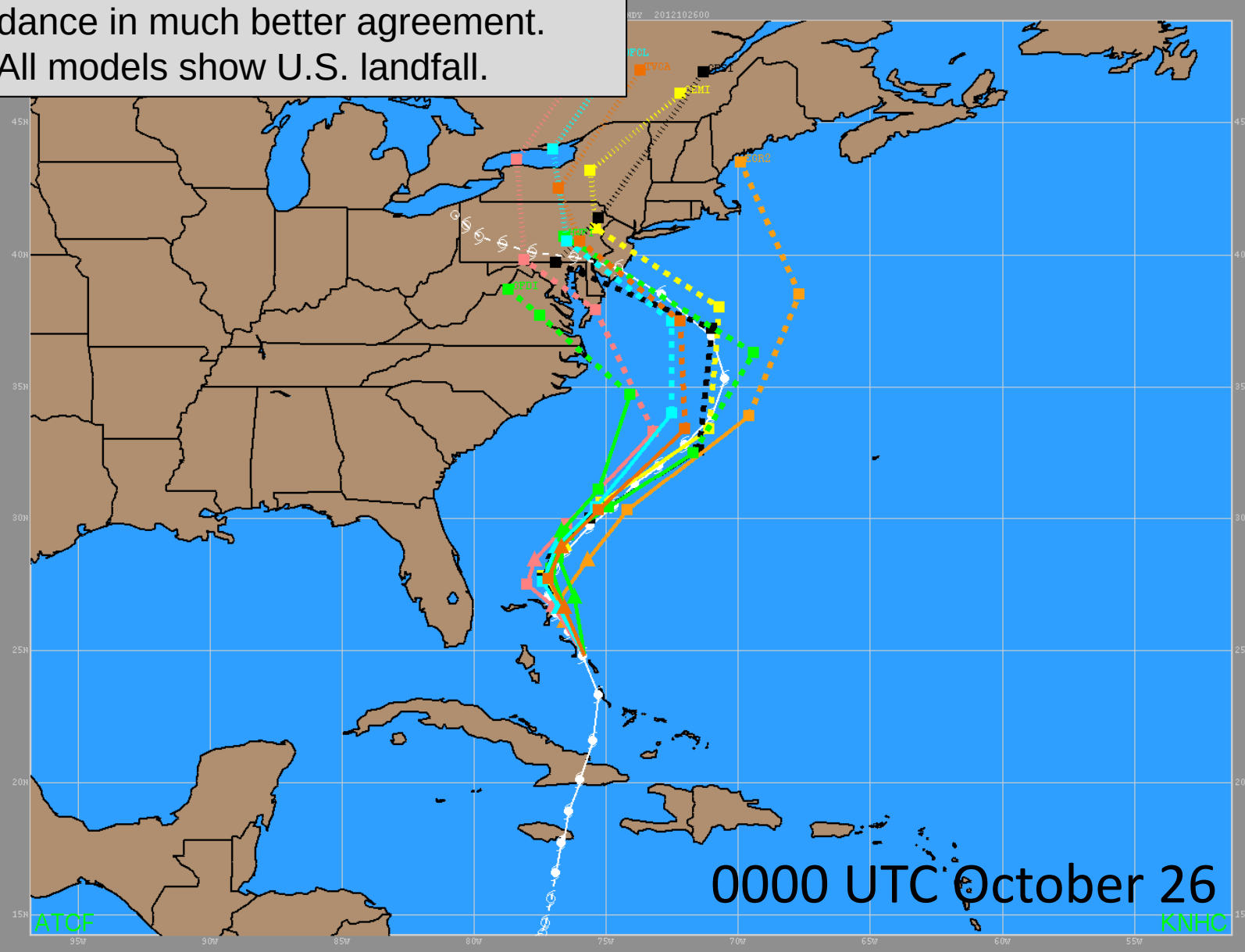
Sandy Track Guidance

Large spread in track in track guidance at days 5, 6, and 7. ECMWF shows U.S. landfall, GFS on eastern edge of envelope



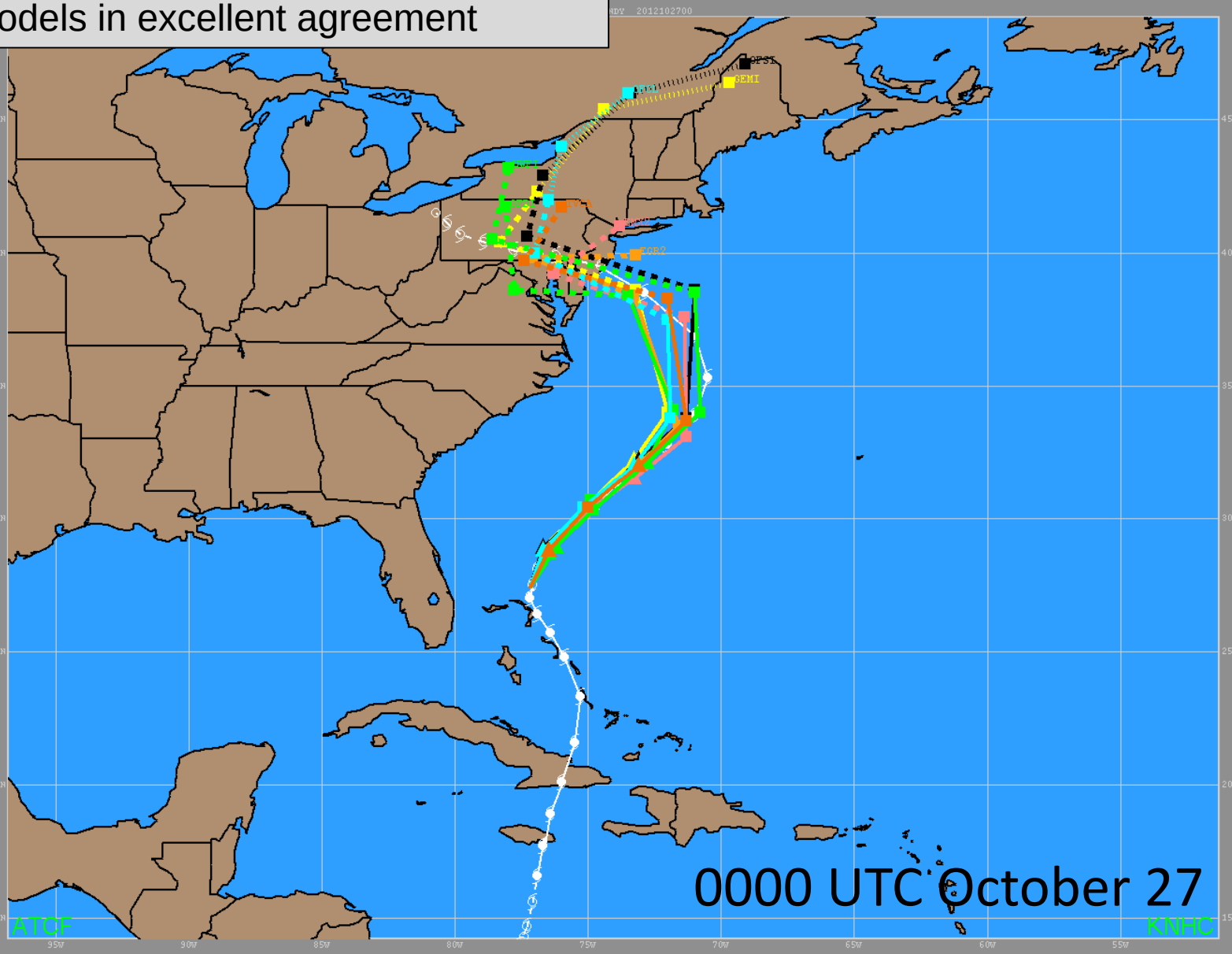
Sandy Track Guidance

Guidance in much better agreement.
All models show U.S. landfall.



Sandy Track Guidance

Models in excellent agreement



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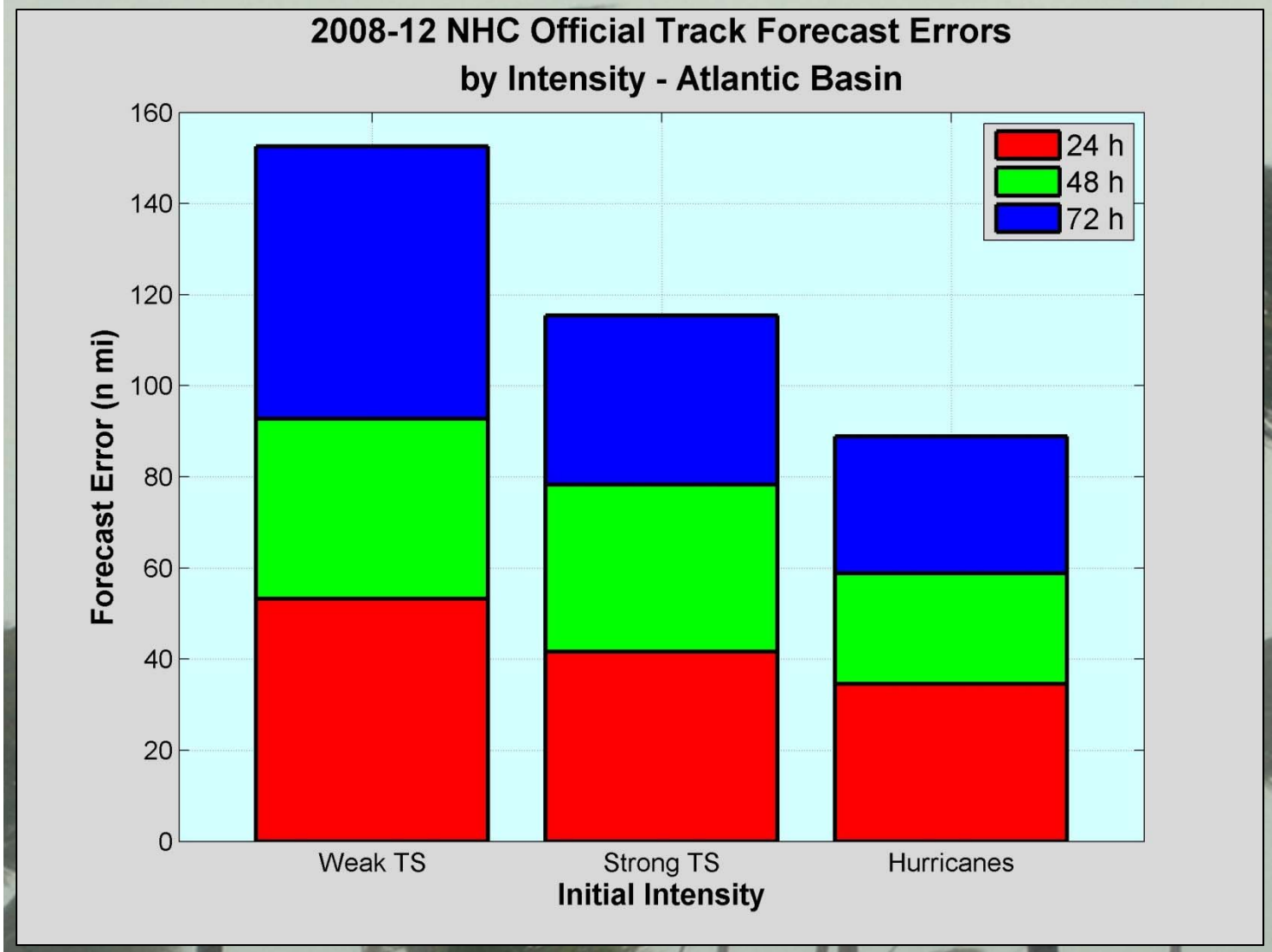
NHC Forecasts are Typically Better for Stronger Tropical Cyclones



As the initial intensity of the storm increases, NHC track errors on average get smaller.

Thanks for your time!

Questions?