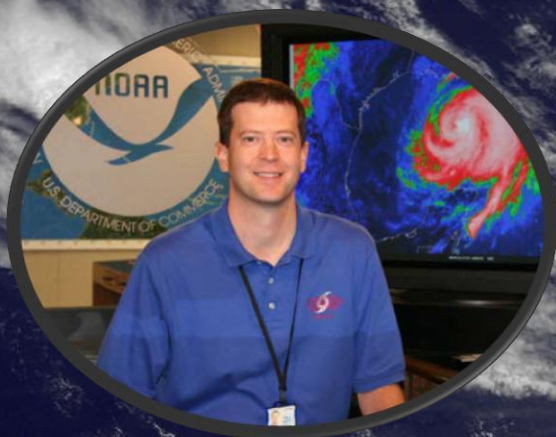


A Look Back at the 2012 Hurricane Season and a Look Ahead to 2013 & Beyond

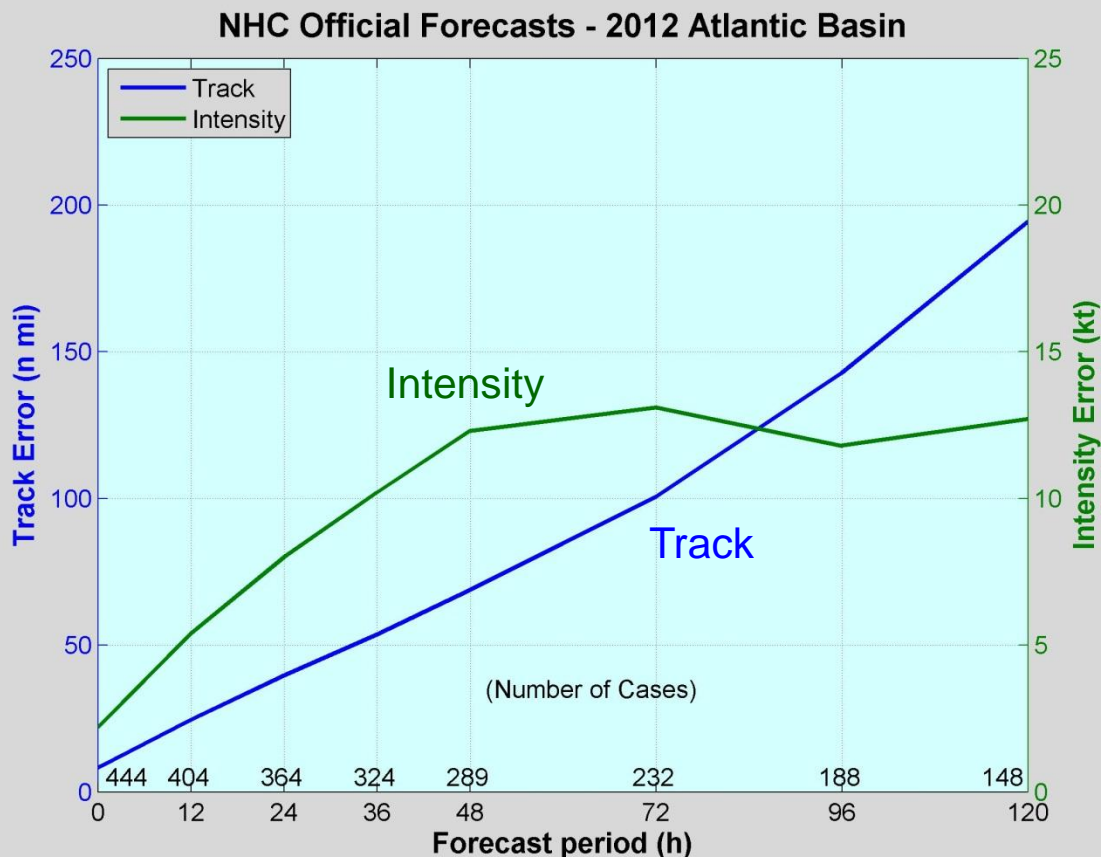


Daniel Brown
National Hurricane Center
Miami, Florida
24 April 2013



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.

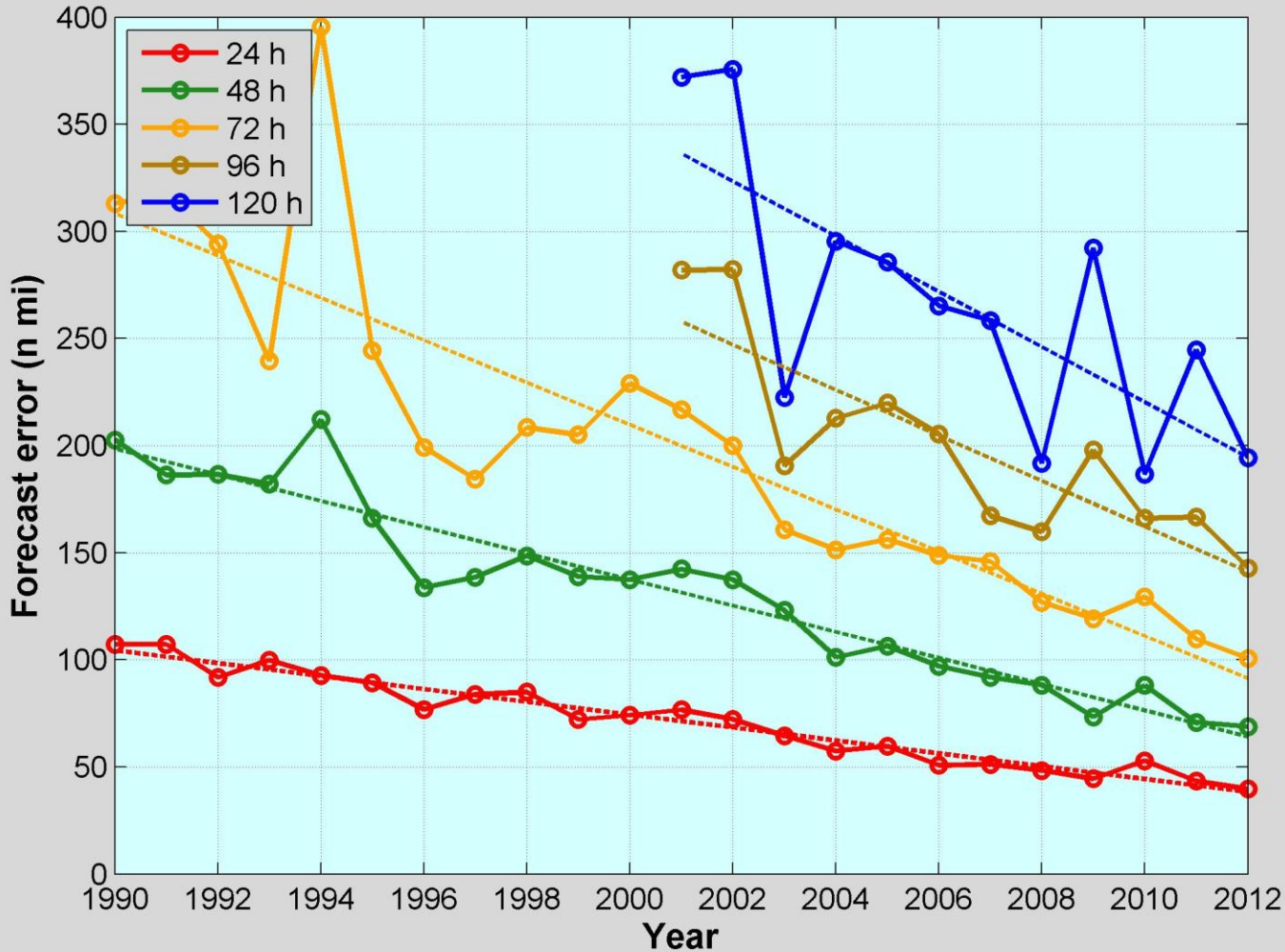


NHC Atlantic Track Error Trends



Reduction in Track Errors Continues

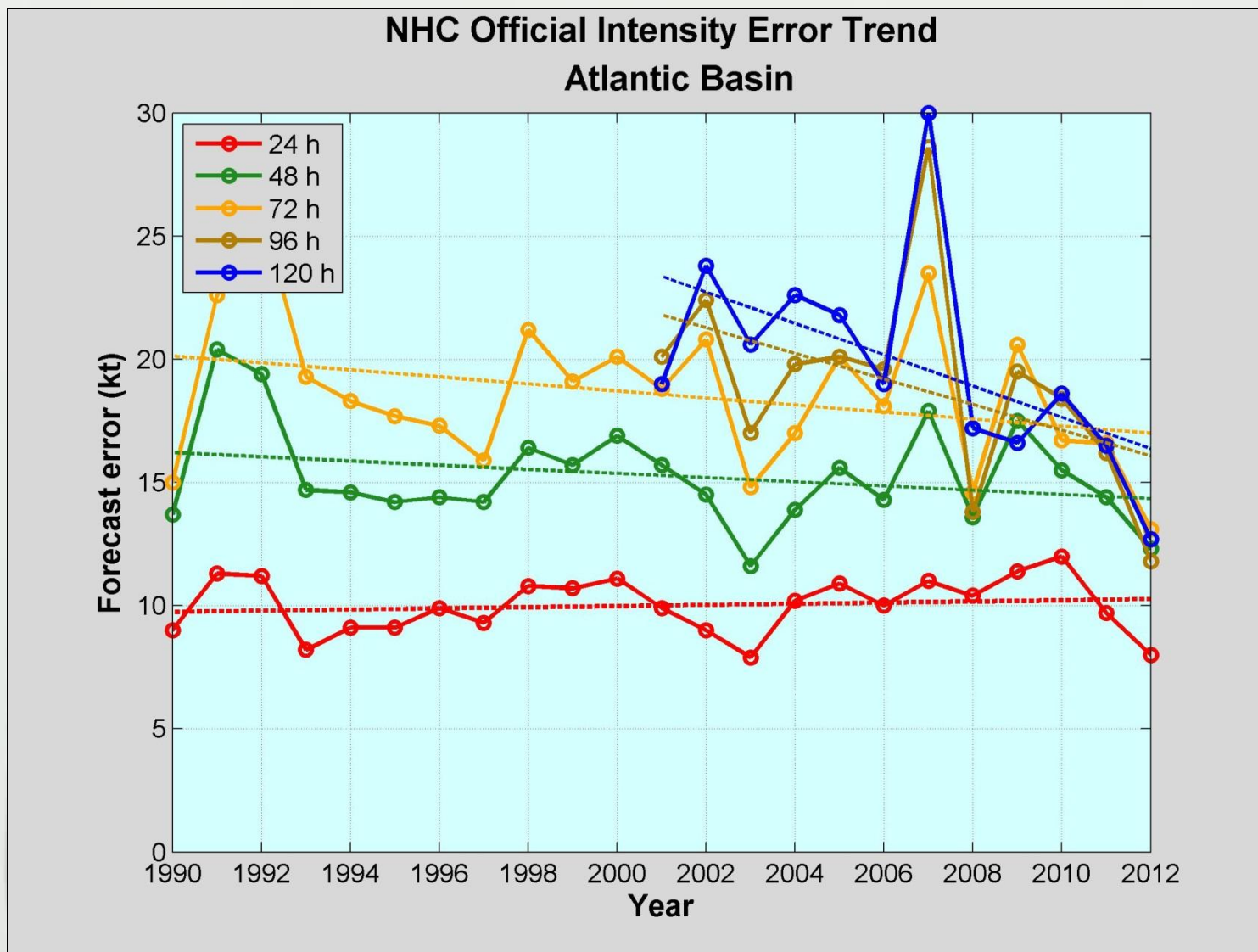
NHC Official Track Error Trend
Atlantic Basin





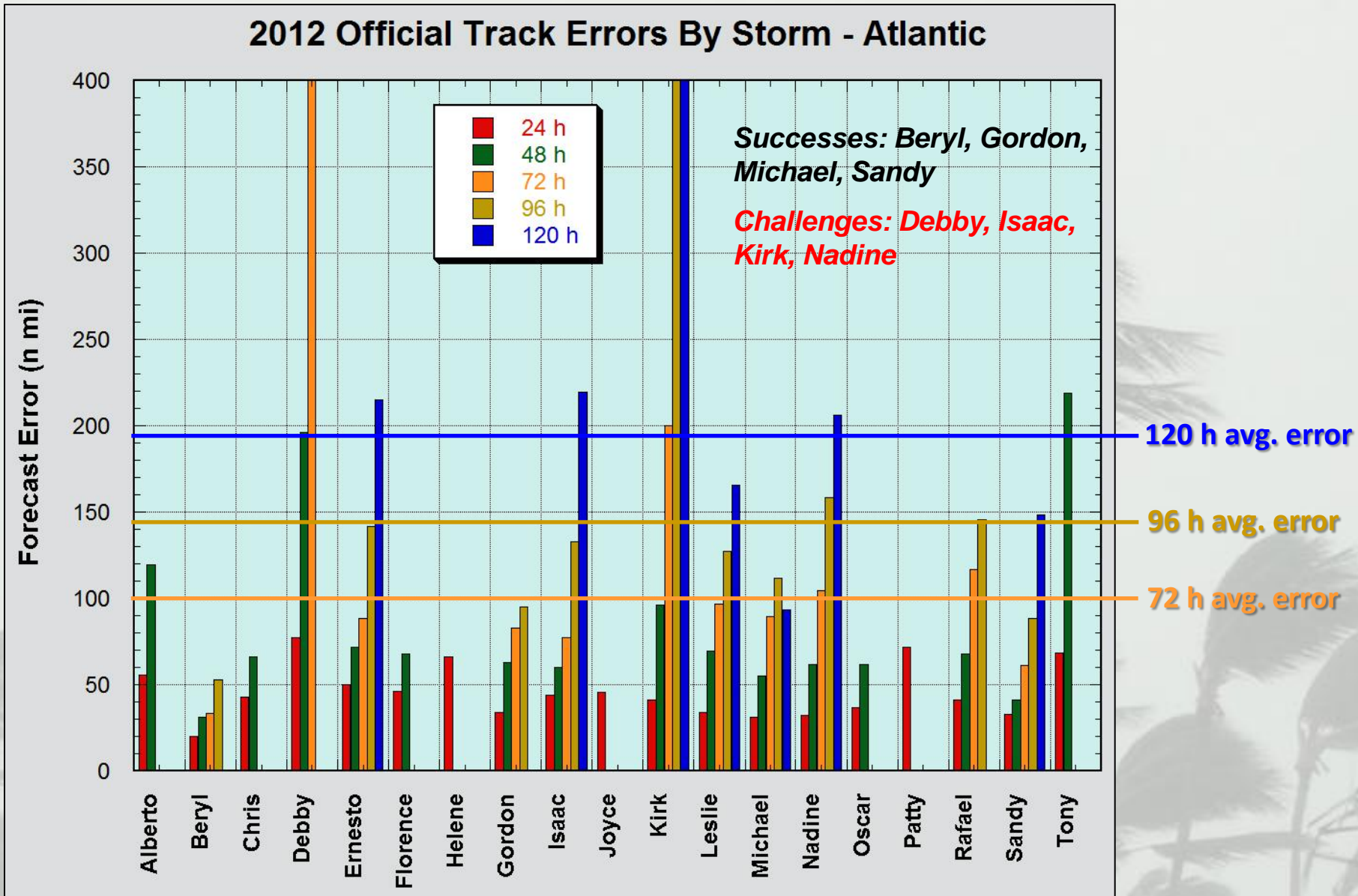
Atlantic Intensity Error Trends

Little Progress Overall - But a Very Recent Downward Trend





Still Some Forecast Challenges

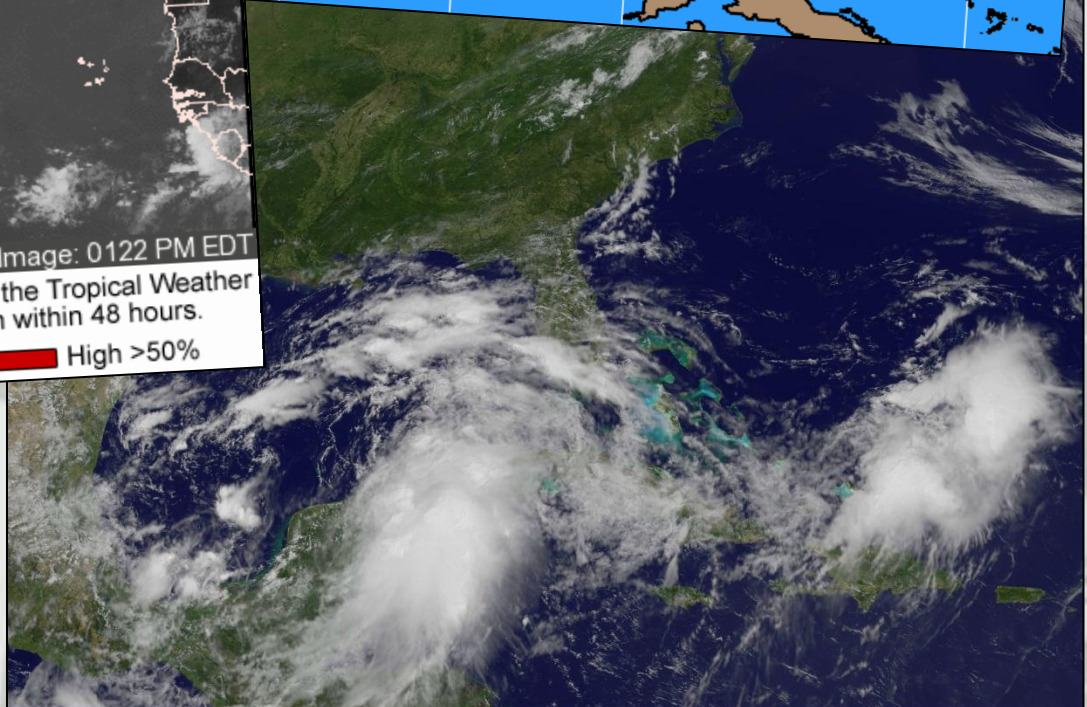
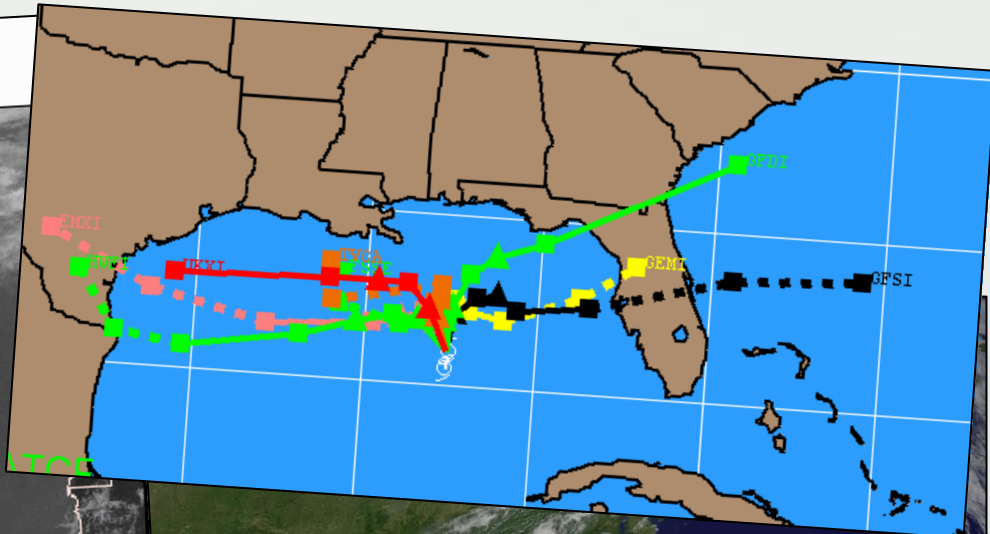
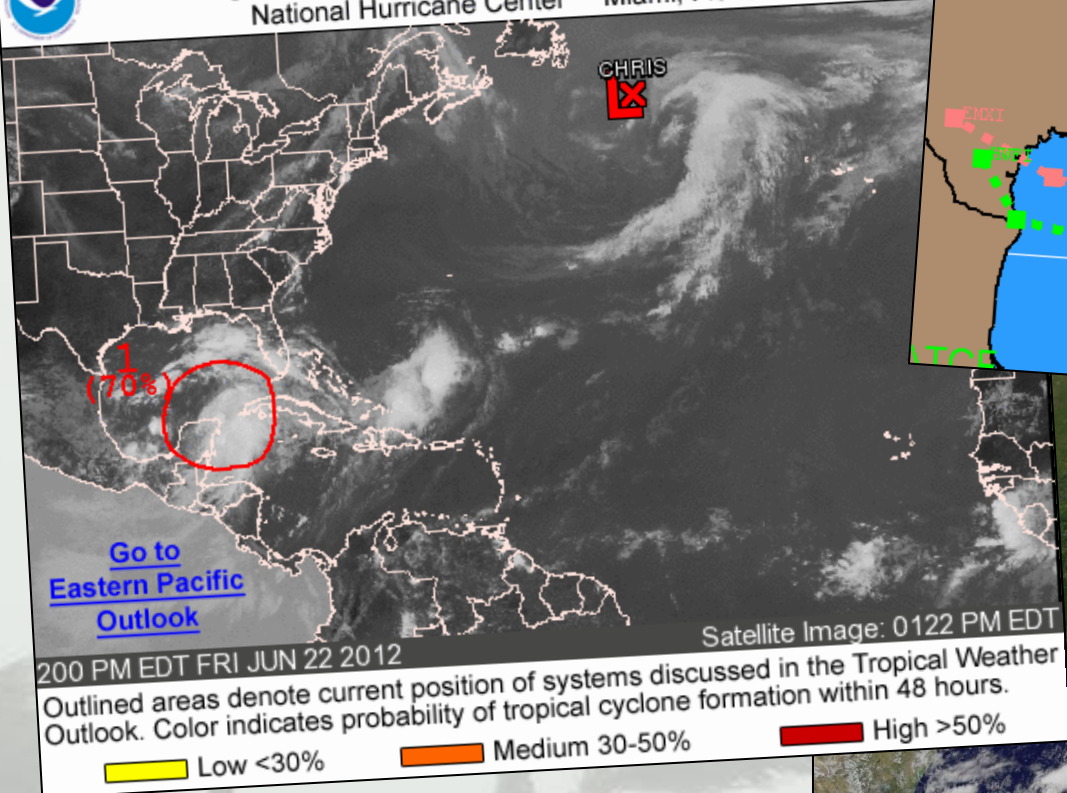


Debby- Formation well anticipated but where would it go



Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida





Debby Forms


Diverging Forecast Guidance

Texas or Florida?



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

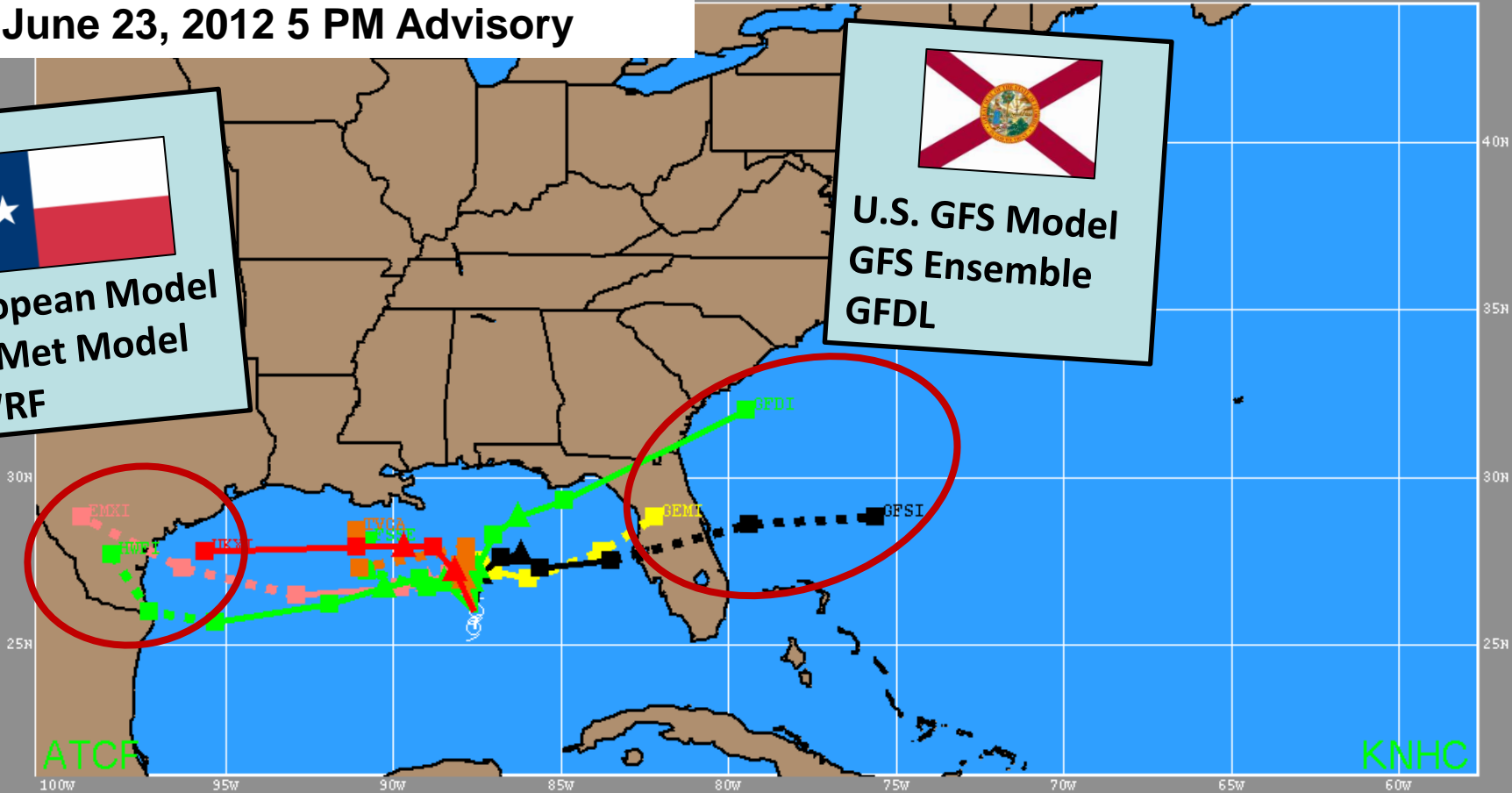
2 - DEBBY 2012062318



European Model
UK Met Model
HWRF



U.S. GFS Model
GFS Ensemble
GFDL






Debby Advisory #2 Still Texas or Florida




Tropical Storm Debby Track Guidance
June 23, 2012 11 PM Advisory

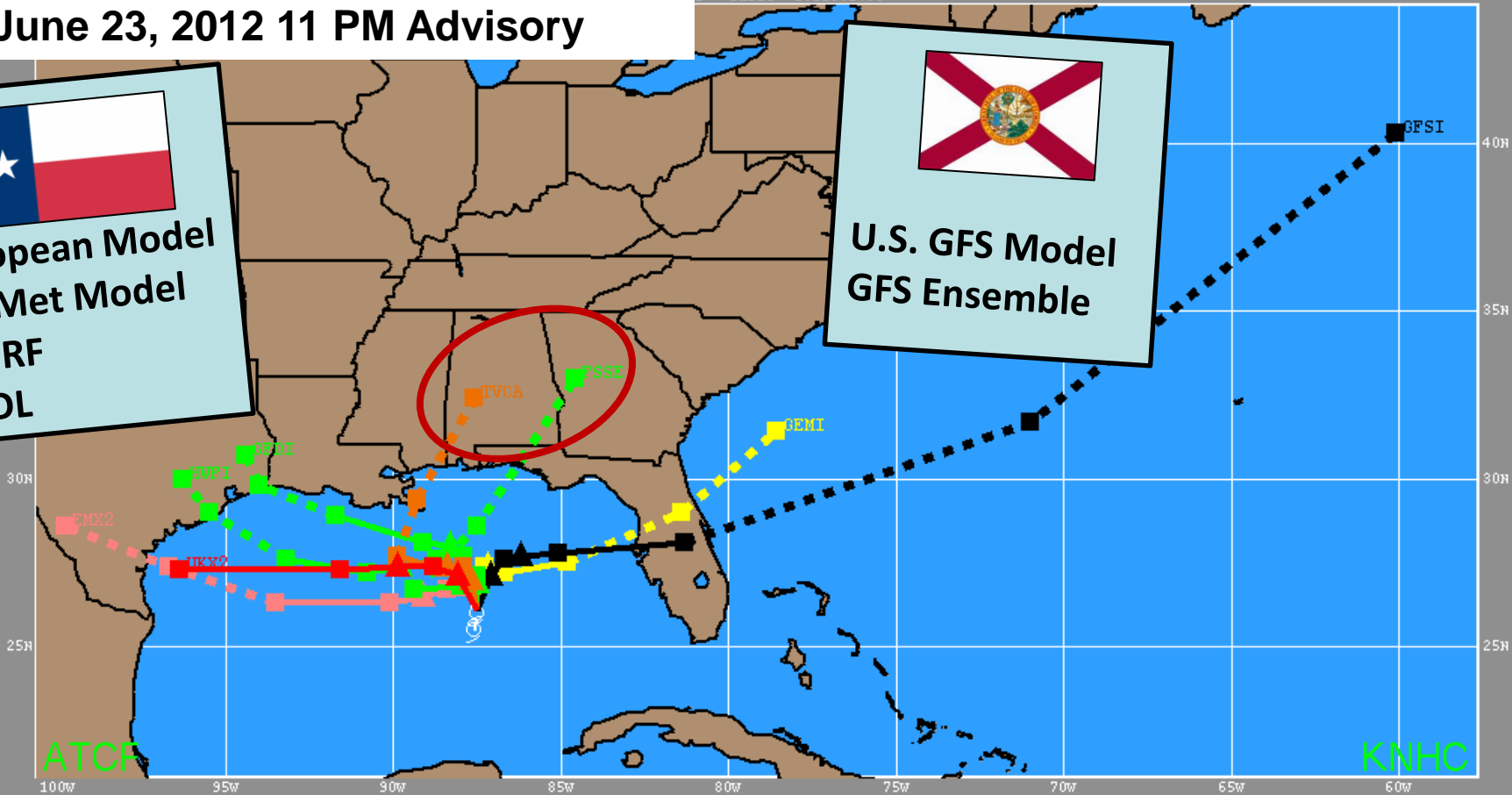
2 - DEBBY 2012062400



European Model
UK Met Model
HWRF
GFDL



U.S. GFS Model
GFS Ensemble



Consensus Models Split the Difference



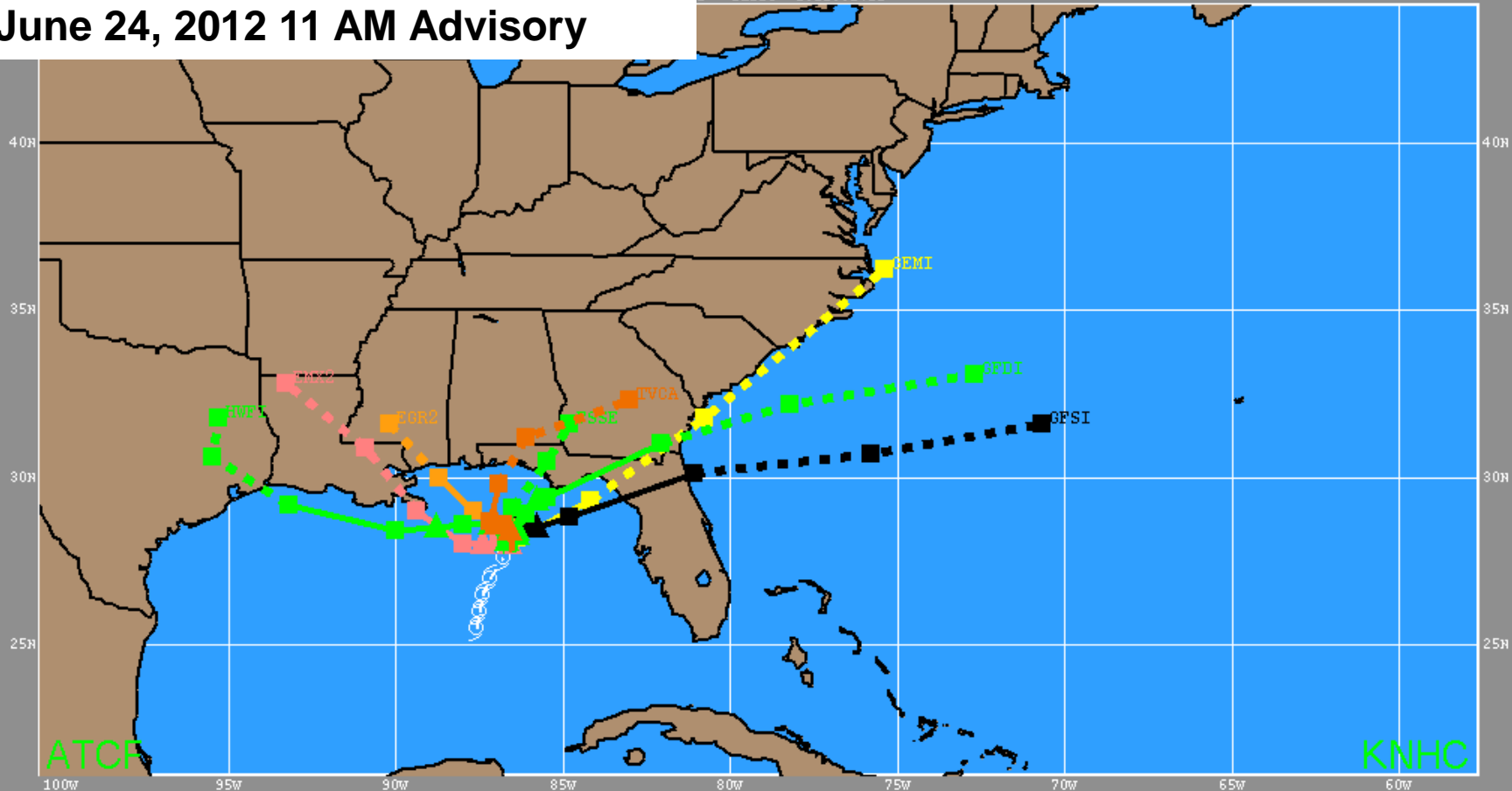
Debby Advisory #4

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

2 - DEBBY 2012062412



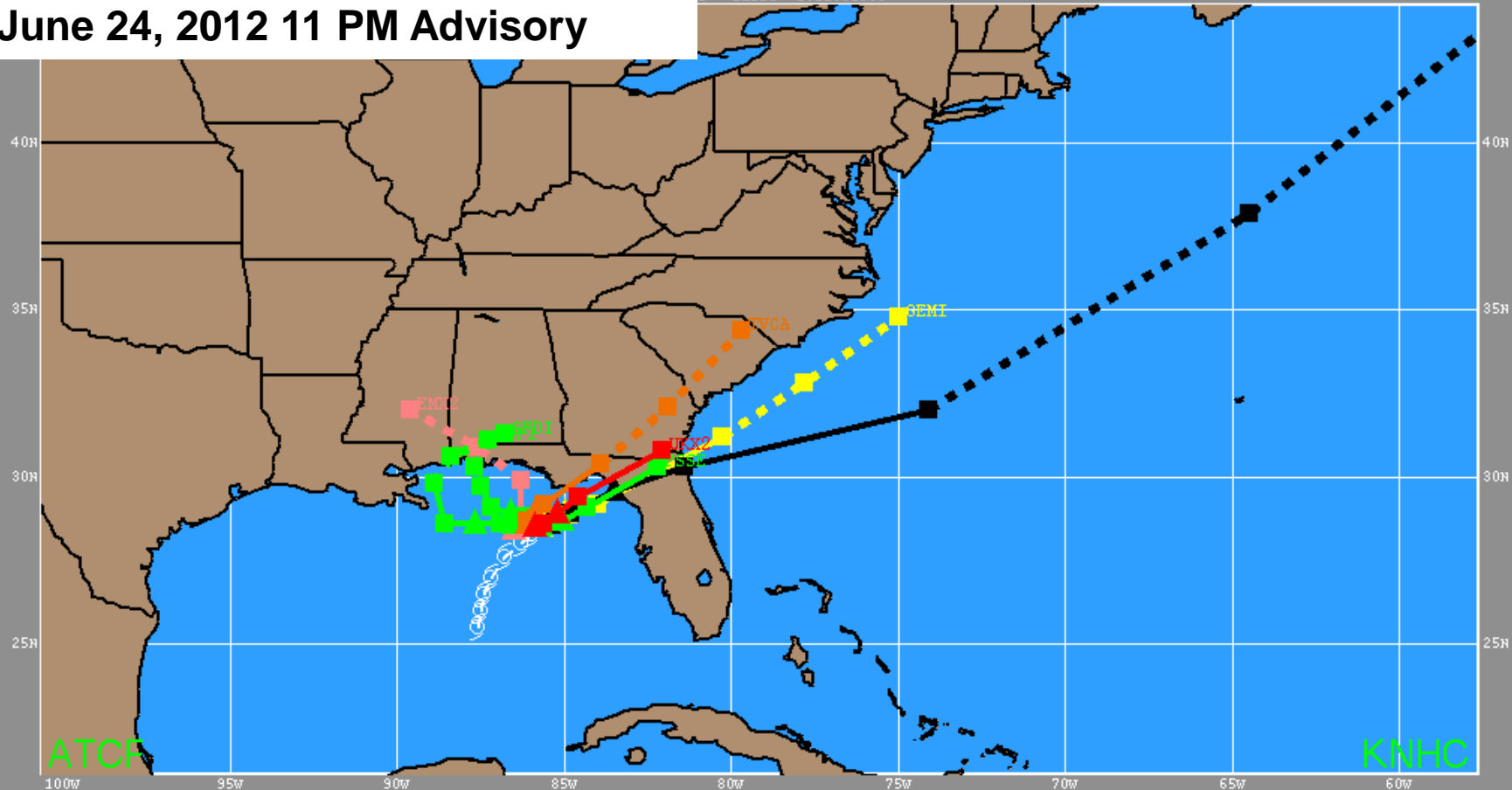


Debby Advisory #6



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

2 - DEBBY 2012062500

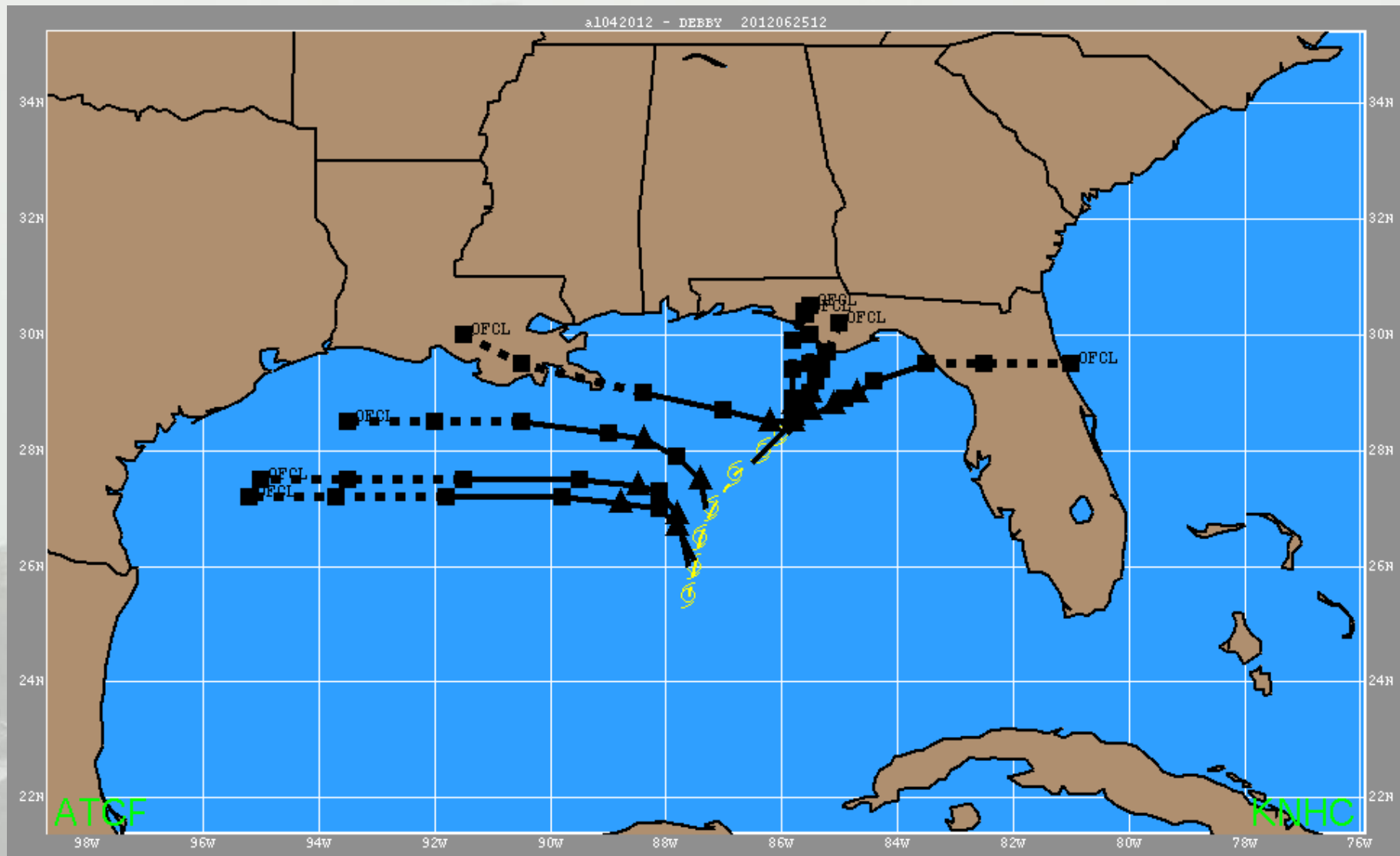




NHC Forecasts



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



Debby Tornadoes

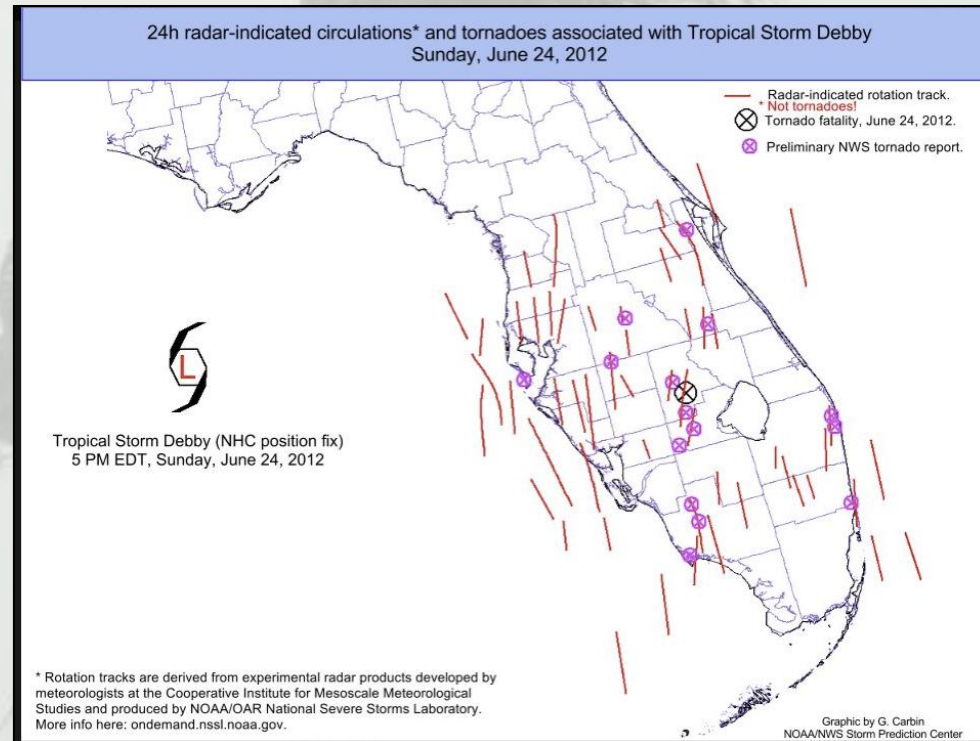
- 24 tornadoes reported in Florida
- Most occurred during an outbreak on June 24
- Strongest were EF-2s in Venus (Highlands Co.) and Winter Haven (Polk Co.)



St. Petersburg, FL (Oriana Sofia)



Lake Placid, FL (Skip Dent)



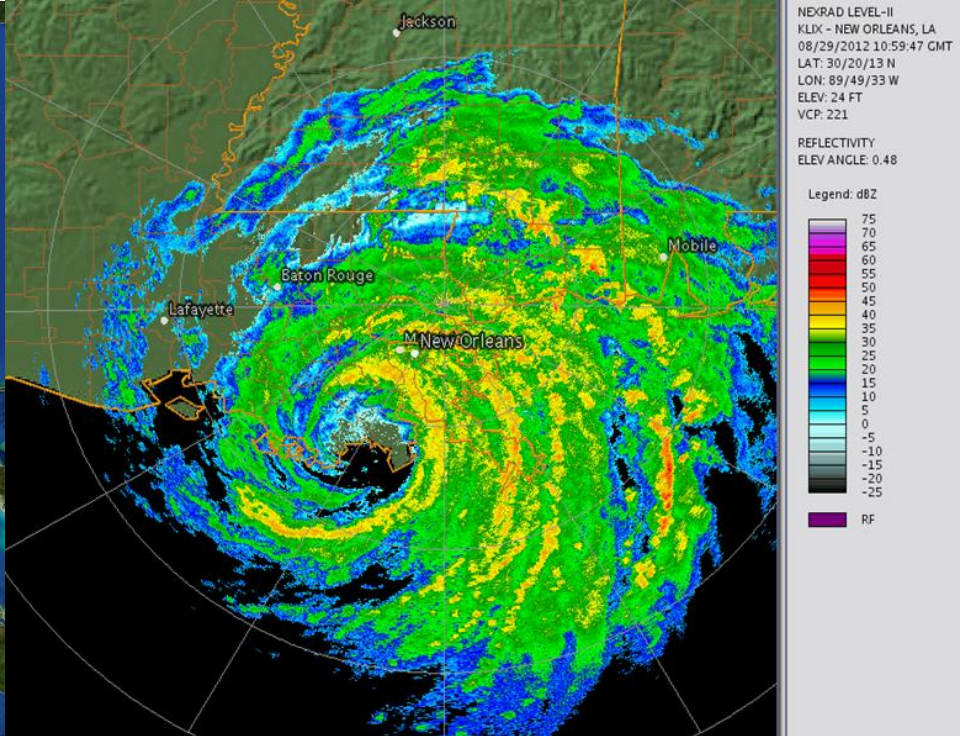
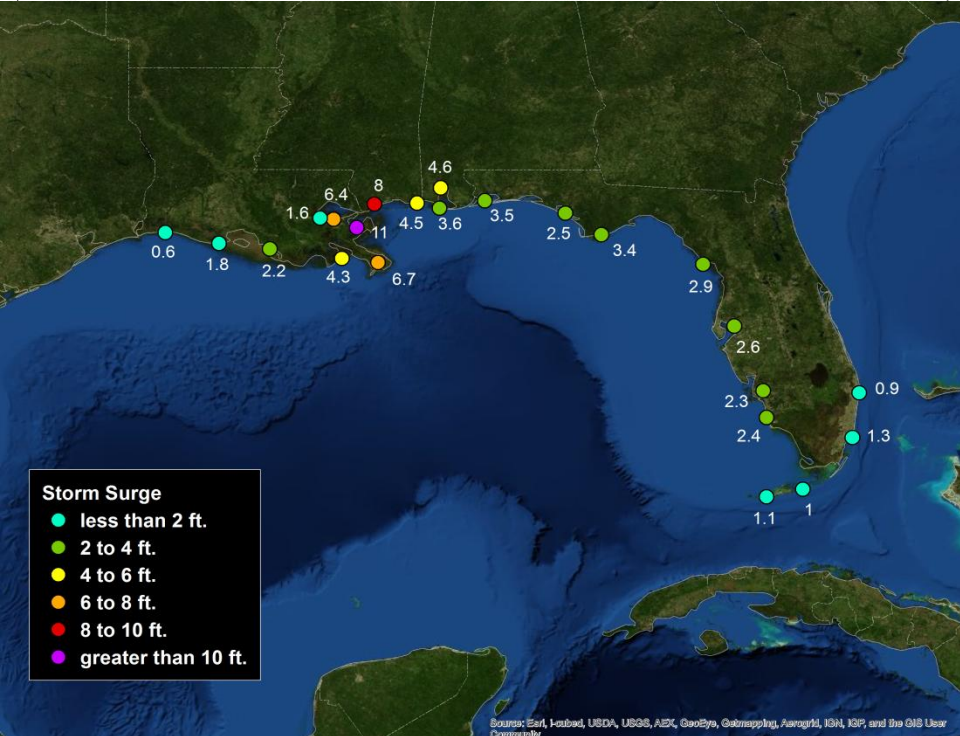
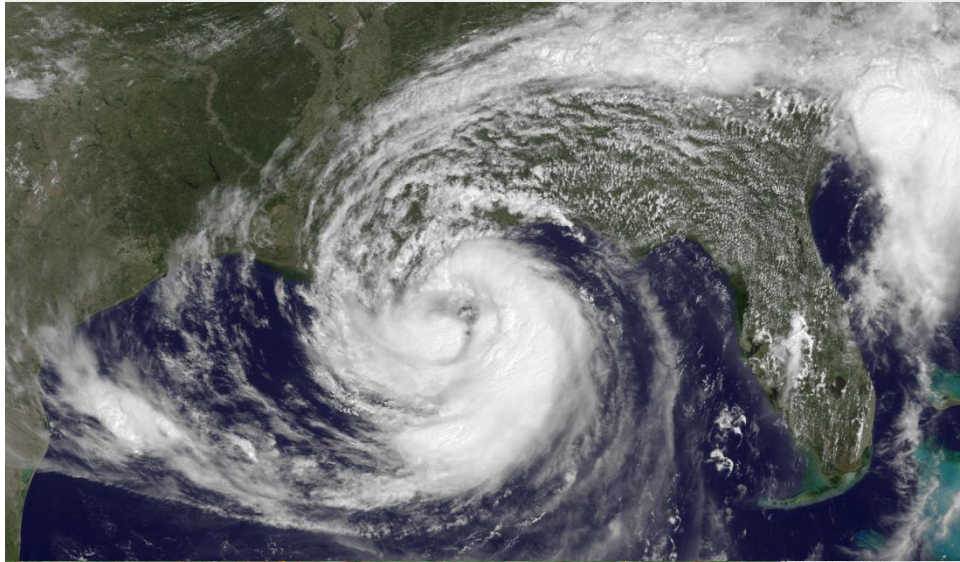
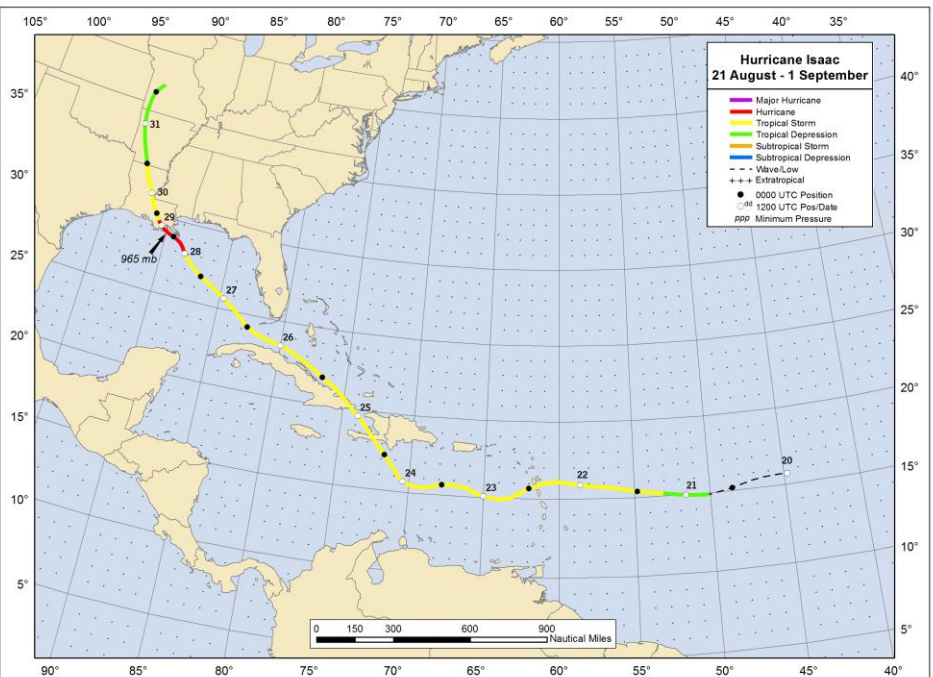


Debby Storm Surge:
2 to 4.5 ft *above*
normal levels

Inundation: 1 to 3 ft
above ground



Hurricane Isaac





Braithwaite, Louisiana (Twitter/JMLeblanc23)



Slidell, Louisiana (Michael DeMocker/Times-Picayune)



Laplace, Louisiana (Michael DeMocker/Times-Picayune)



Plaquemines Parish, Louisiana (Homeland Security Watch)

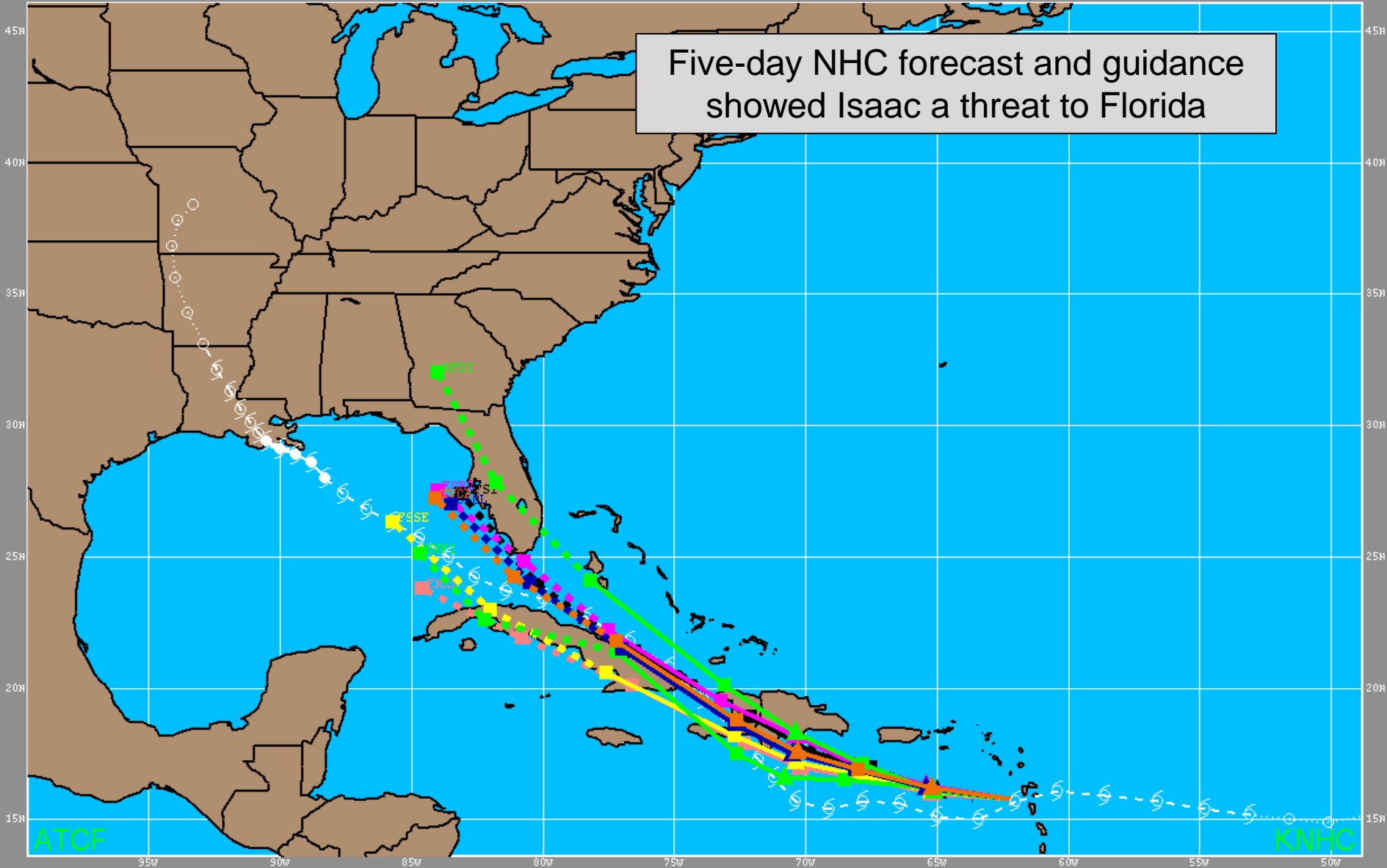


Isaac Track Guidance



a1092012 - ISRAAC 2012082300

Five-day NHC forecast and guidance showed Isaac a threat to Florida



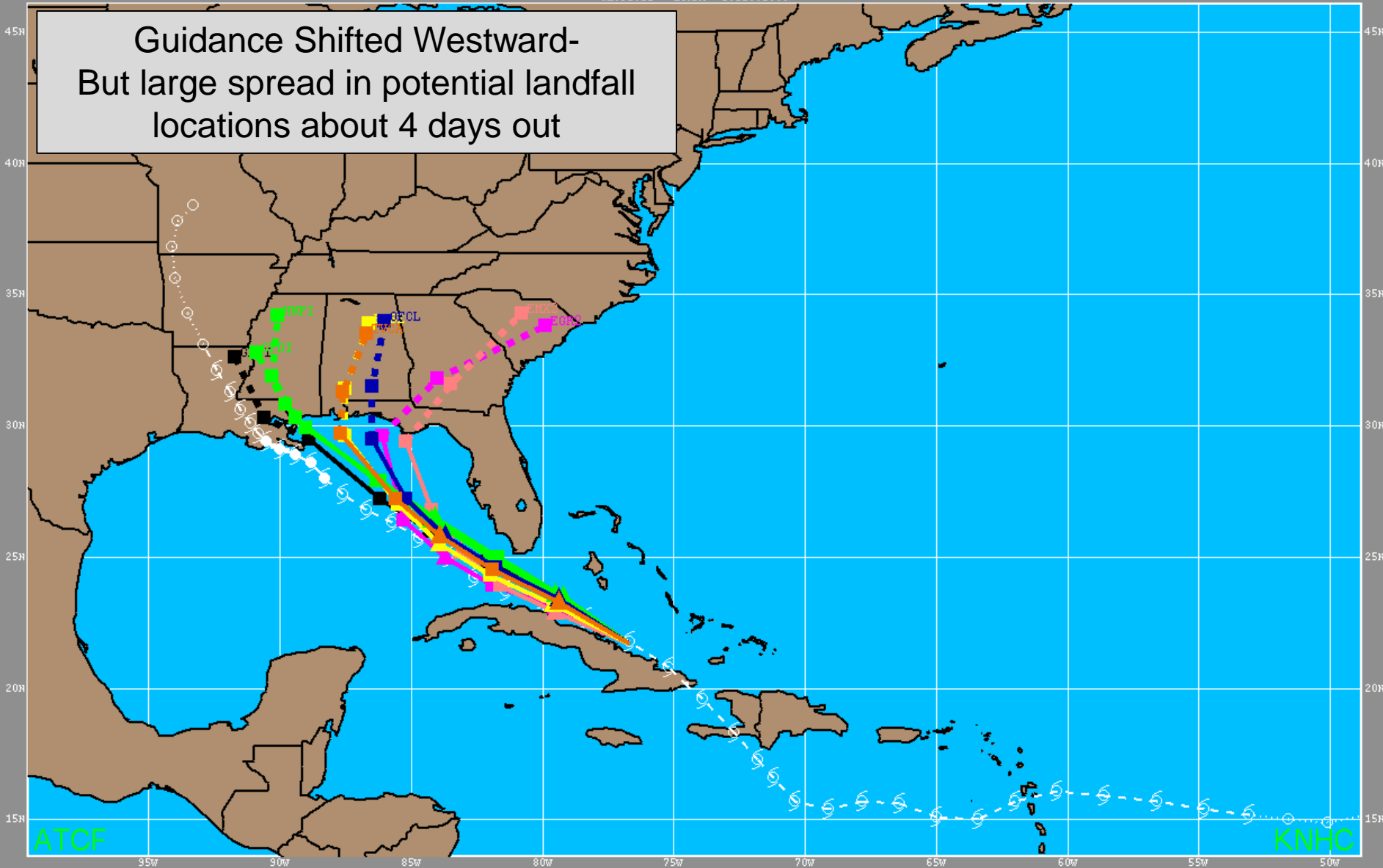


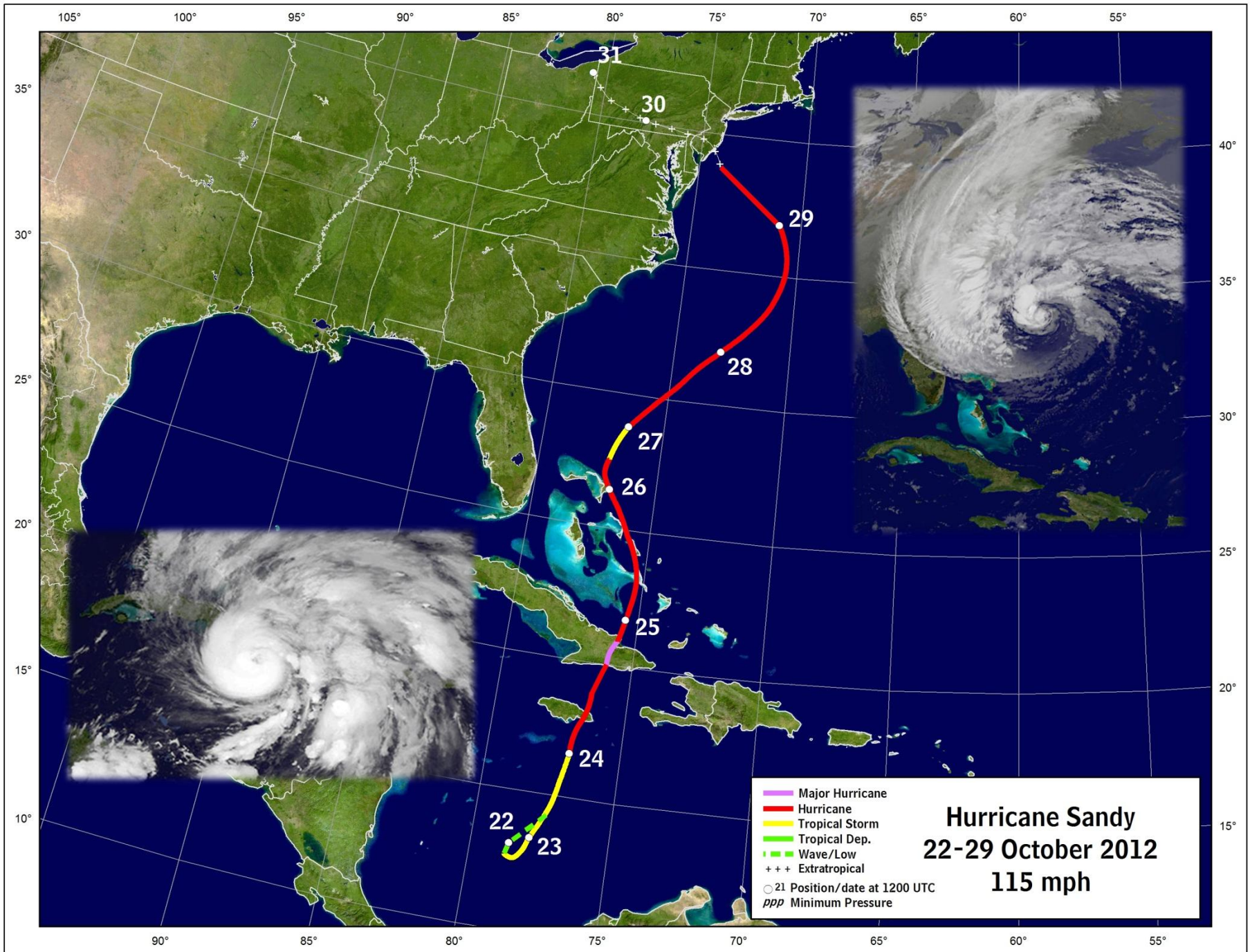
Isaac Track Guidance



a1092012 - ISRAAC 2012082600

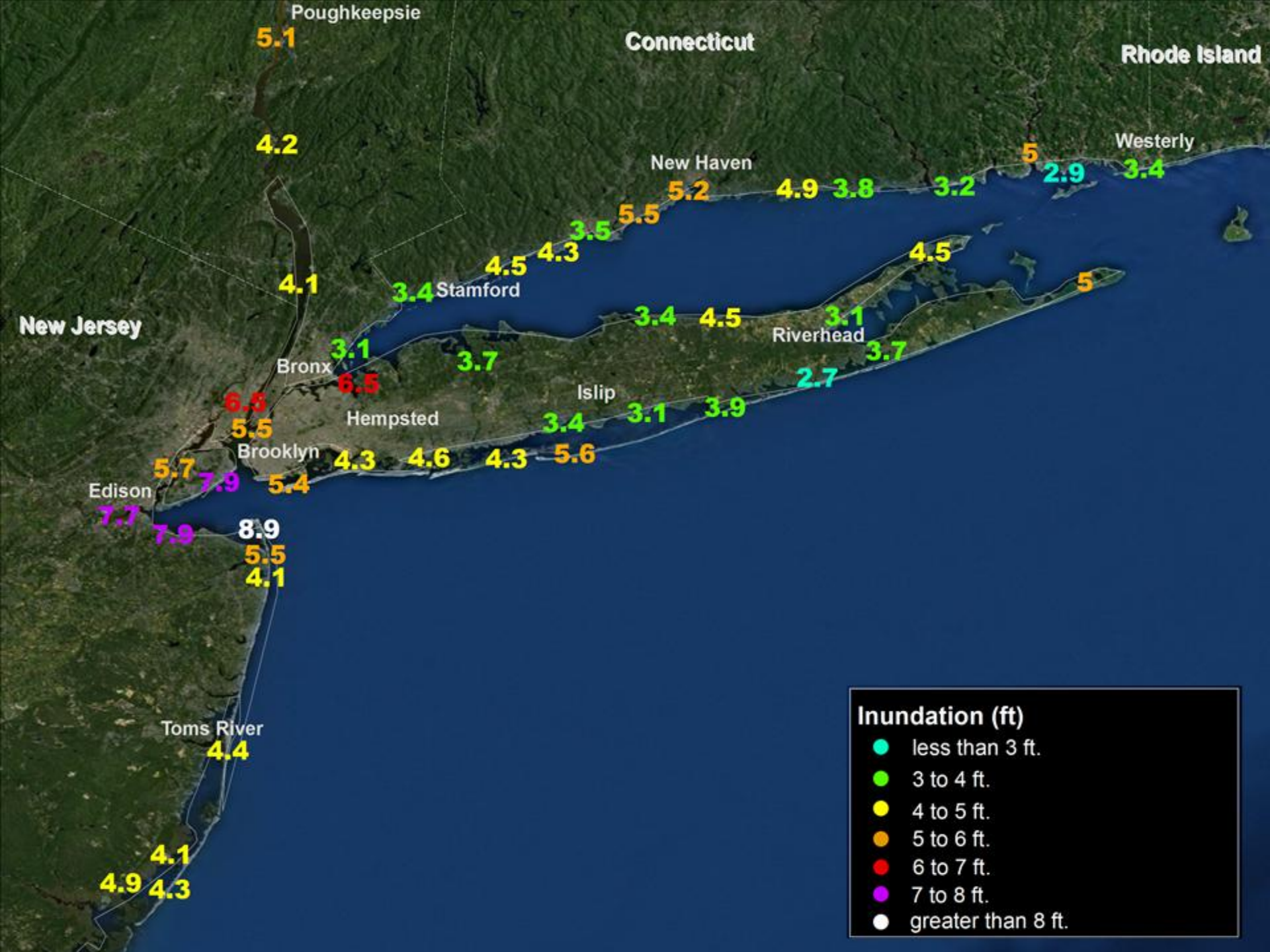
Guidance Shifted Westward-
But large spread in potential landfall
locations about 4 days out





Hurricane Sandy
22-29 October 2012
115 mph

- Major Hurricane
- Hurricane
- Tropical Storm
- Tropical Dep.
- Wave/Low
- +++ Extratropical
- 21 Position/date at 1200 UTC
- ppp Minimum Pressure





PATH station, Hoboken, NJ
AFP PHOTO / The Port Authority of New York & New Jersey



Harvey Cedars, Long Beach Island, New Jersey
(AP Photo/The Philadelphia Inquirer, Clem Murray)



Atlantic City, NJ (Tom Mihalek/Reuters)

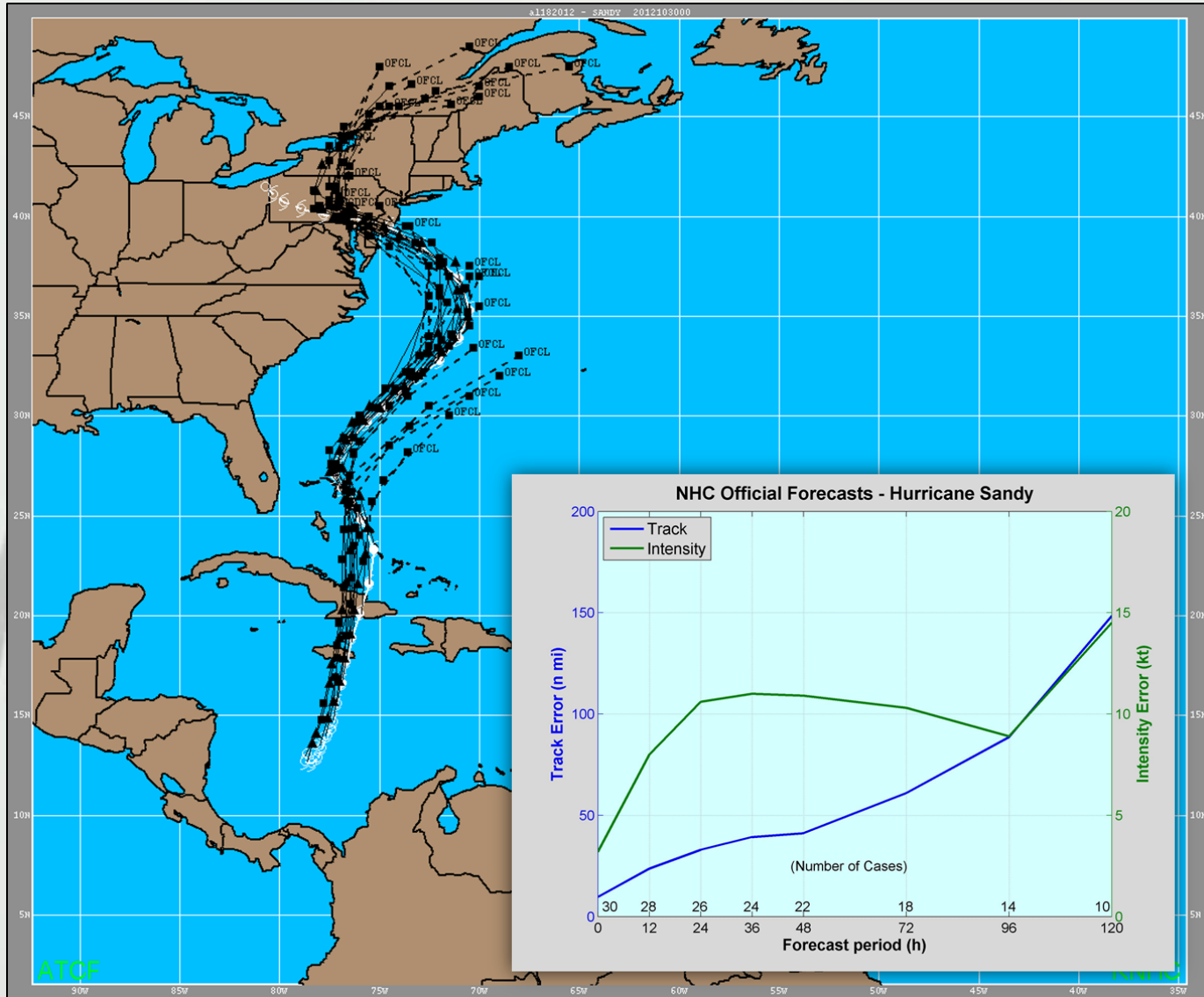


Union Beach, NJ (blog, Spleeness)



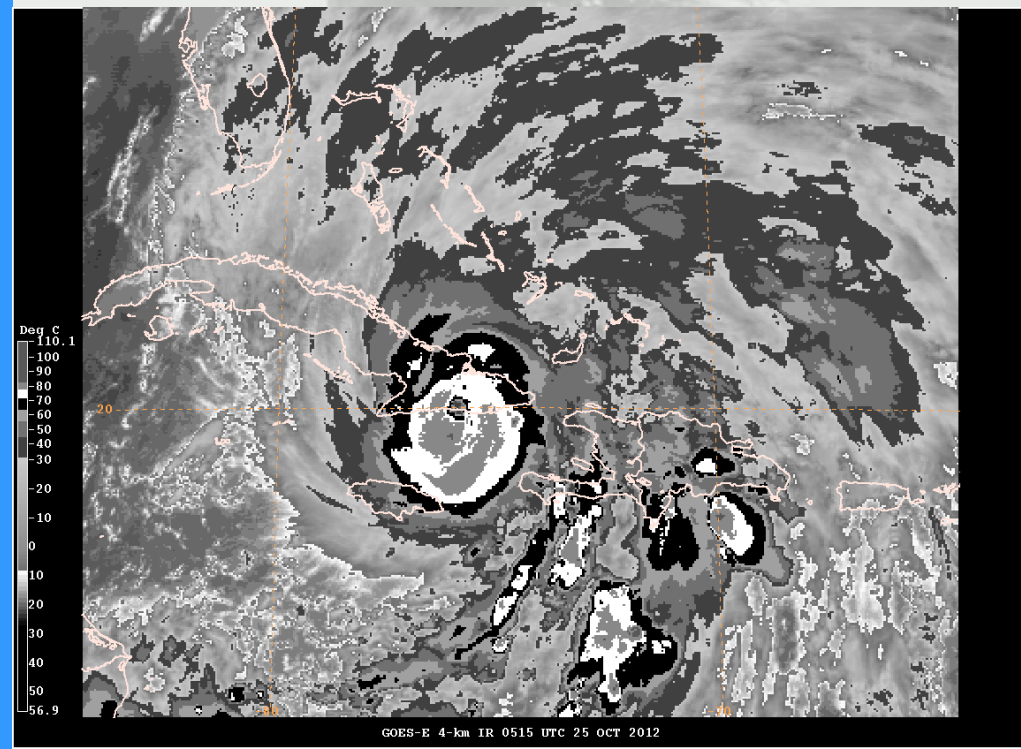
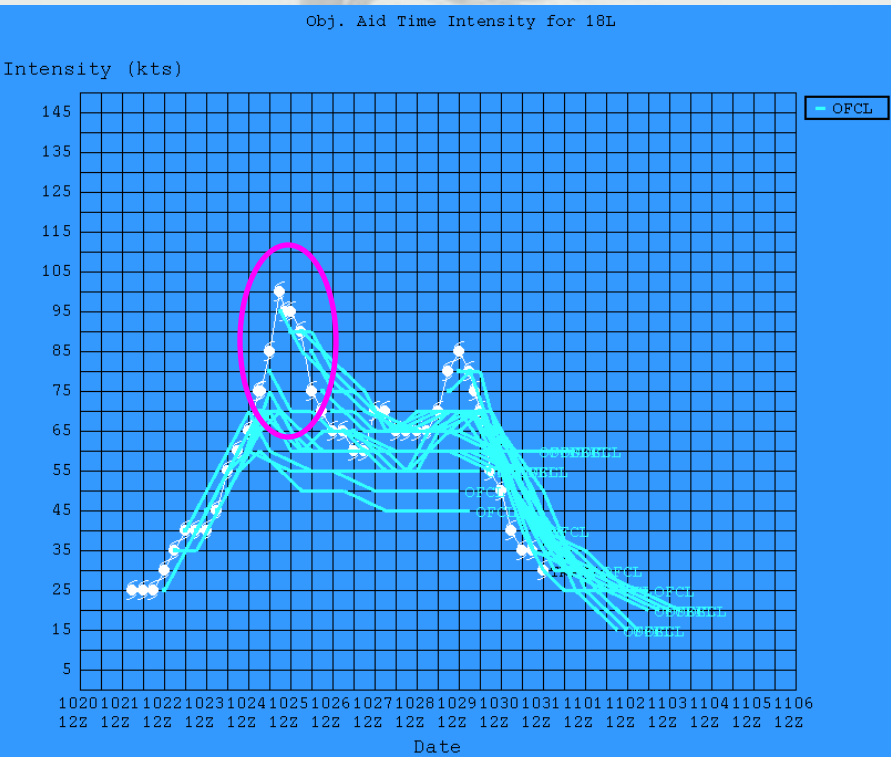
Many Challenges During Sandy

But the Track and Intensity Forecasts Were Better than Average



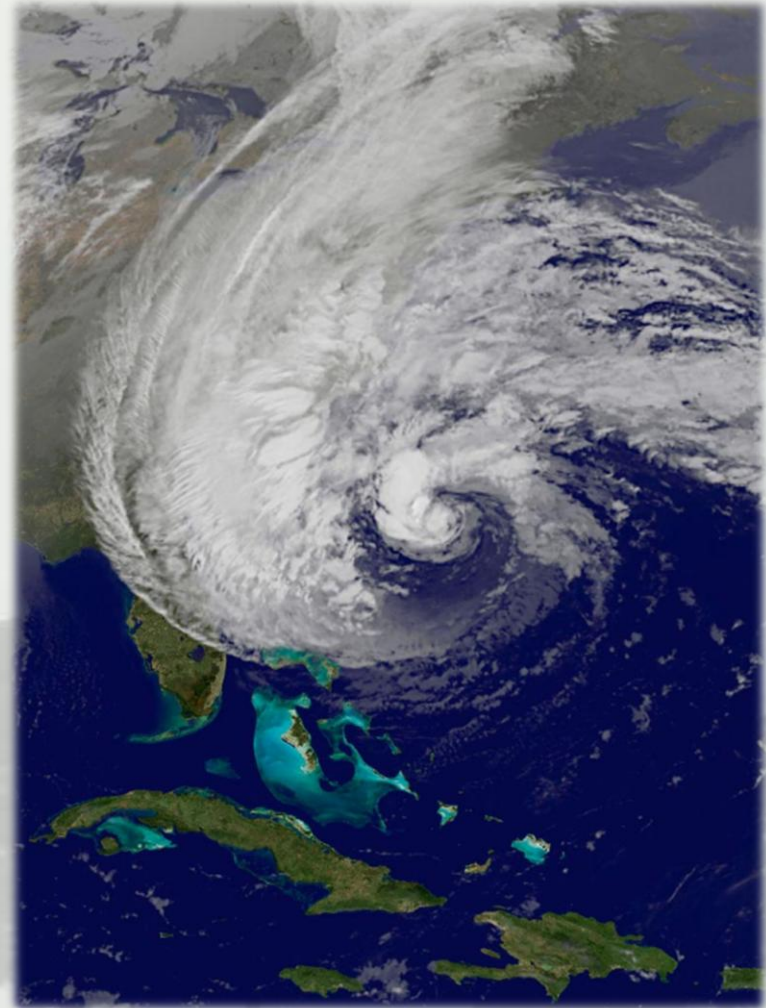
Rapid Intensification: A Recurring Challenge

- 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.



Warning Challenge in Sandy

- The dynamical models forecast Sandy to become extratropical before landfall, although the timing varied.
- **Once warnings are issued, it is difficult to switch between TC and non-TC warnings.**
- There were several combinations of possible warnings and storm evolution, all of which were problematic.
- TC warnings were eventually issued for coastal North Carolina, with non-TC warnings for the rest of the affected area.
- **During Sandy, the extratropical transition process did not reduce the threat at all!**

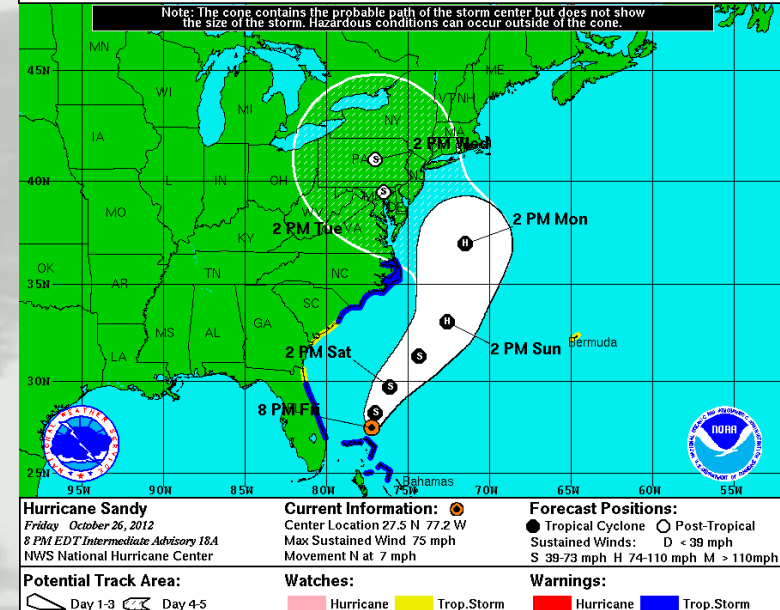
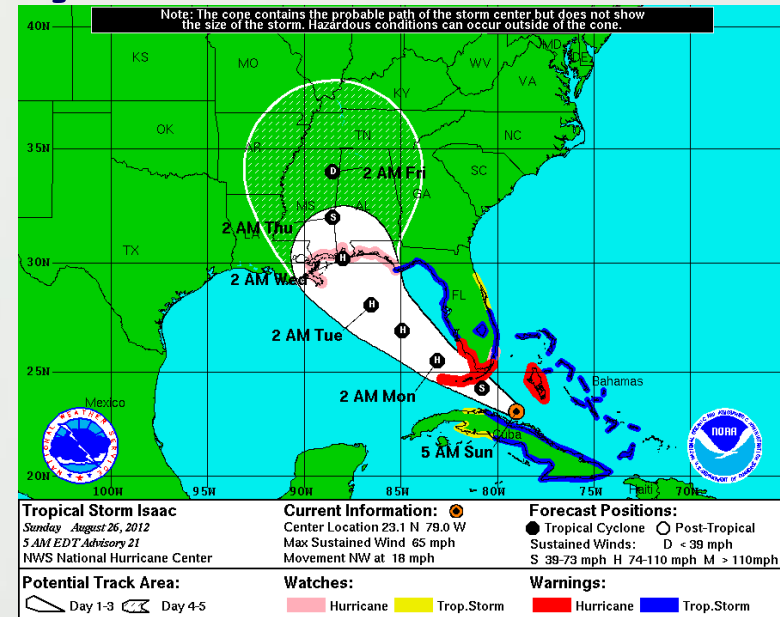




Meeting the Warning Challenges for 2013 and Beyond



- The NWS has broadened the tropical storm and hurricane watch and warning definitions to allow them to be used for post-tropical cyclones that pose a significant risk to life and property.
- NHC will have the option to continue advisory products on post-tropical cyclones that pose a risk to life/property and when the transfer of responsibility to another office would result in an unacceptable discontinuity in service.
- For several years, the NWS has been developing a **storm surge warning** that could be used independently of the expected winds and of the type of weather system producing it. This could be operational by 2015.



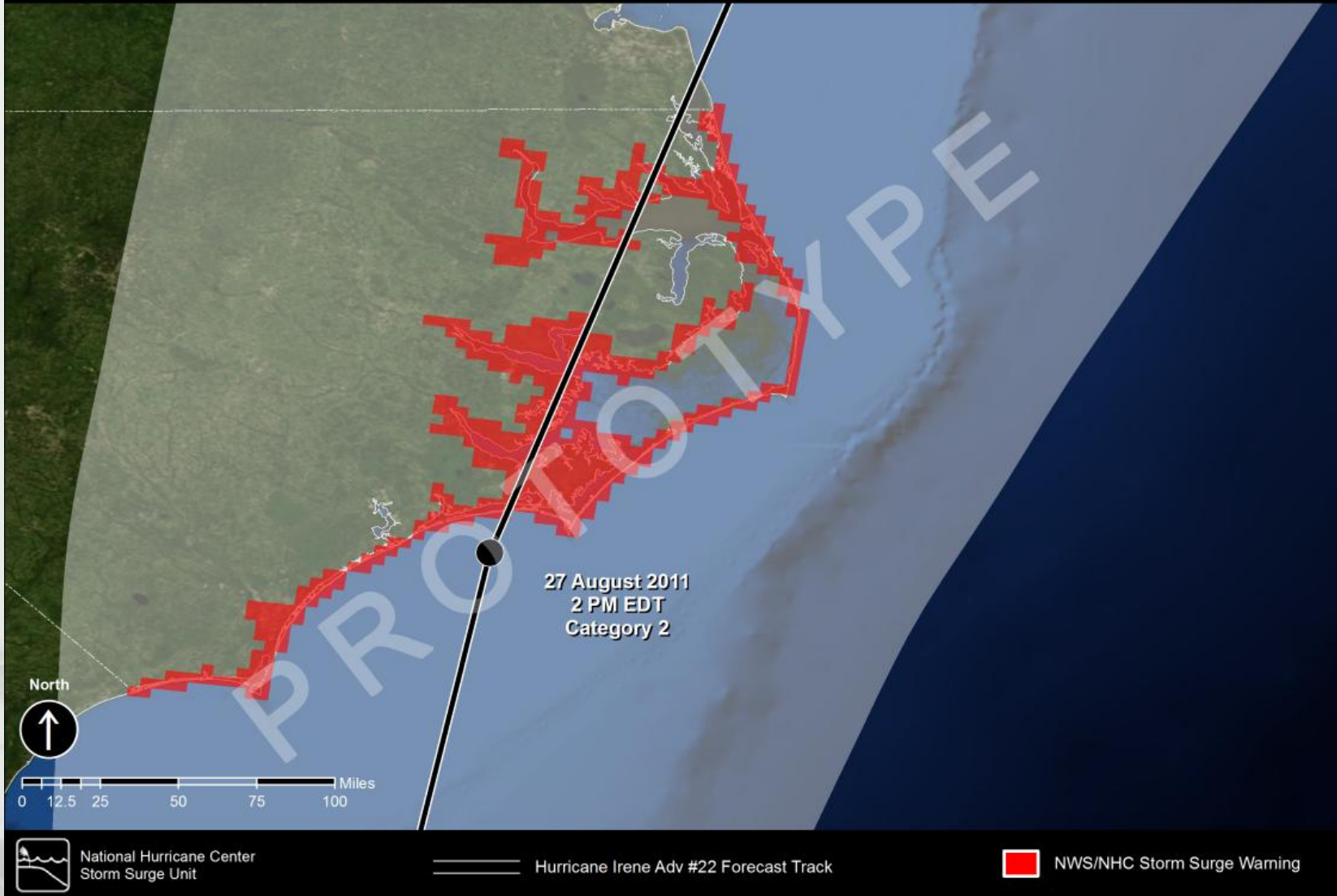


Prototype of Storm Surge Warning



Hurricane Irene, Advisory #22

Storm Surge Warning PROTOTYPE



27 August 2011
2 PM EDT
Category 2



National Hurricane Center
Storm Surge Unit



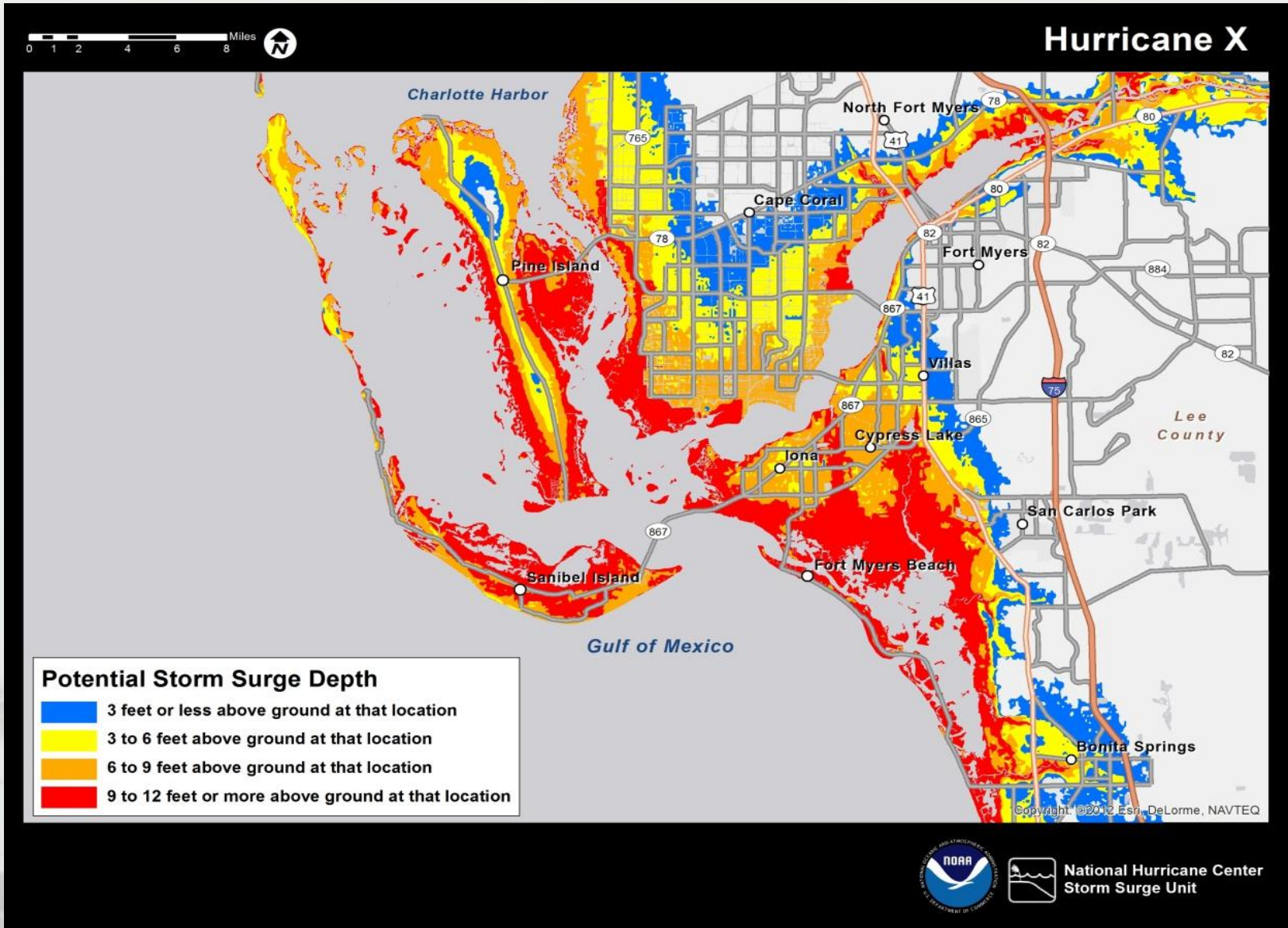
Hurricane Irene Adv #22 Forecast Track



NWS/NHC Storm Surge Warning



Potential Storm Surge Inundation Graphic





2013 Changes

- **Definitions of TS and hurricane watches/warnings have been broaden and issuance criteria of advisories have changed to allow NHC the option to use both for post-tropical cyclones that pose a significant threat to life and property (discussed a couple of slides ago)**
- **New use of NHC's Tropical Cyclone Update (TCU) product replaces need for Position Estimate (TCE)**
- **Planned extension of Tropical Weather Outlook to 5 days**
- **Cone size has again been reduced**



Tropical Cyclone Position Estimate

HURRICANE IRENE TROPICAL CYCLONE POSITION ESTIMATE
NWS NATIONAL HURRICANE CENTER MIAMI FL AL092011
1000 PM EDT SAT AUG 27 2011

AT 1000 PM EDT...0200 UTC...THE CENTER OF HURRICANE IRENE WAS LOCATED BY AN AIR FORCE RESERVE HURRICANE HUNTER AIRCRAFT AND NOAA DOPPLER WEATHER RADAR TO BE AT LATITUDE 37.1 NORTH... LONGITUDE 75.5 WEST.

...SUMMARY OF 1000 PM EDT INFORMATION...
LOCATION...37.1 N 75.5 W
ABC...276 MI...35 KM...N OF NEW YORK CITY
MAXIMUM SUSTAINED WINDS...80 MPH.
PRESENT MOVEMENT...NNE OR 20 DEGREES AT 16 MPH
MINIMUM CENTRAL PRESSURE...957 MB
\$\$
FORECASTER BRENNAN

DISCONTINUED
Information included in TCU

This product is issued between 2-hourly intermediate public advisories



Tropical Cyclone Update



This product is issued when:

- (1) the cyclone makes landfall
- (2) unexpected changes occur in the cyclone
- (3) to issue international watches and warnings
- (4) now used for 1-hourly position estimates instead of TCE

**TROPICAL STORM CLAUDETTE TROPICAL CYCLONE UPDATE
NWS TPC/NATIONAL HURRICANE CENTER MIAMI FL AL042009
1215 PM EDT SUN AUG 16 2009**

...DEPRESSION BECOMES TROPICAL STORM CLAUDETTE...

DATA FROM THE NOAA DOPPLER RADAR IN TALLAHASSEE FLORIDA INDICATE THAT SURFACE WINDS ASSOCIATED WITH THE DEPRESSION HAVE INCREASED TO 40 MPH...65 KM/HR...MAKING THE DEPRESSION TROPICAL STORM CLAUDETTE.

....SUMMARY OF 1215 PM AST INFORMATION...

LOCATION...28.7N 84.6W

MAXIMUM SUSTAINED WINDS...40 MPH

PRESENT MOVEMENT...NORTHWEST OR 320 DEGREES AT 14 MPH

MINIMUM CENTRAL PRESSURE...1011 MB

\$\$

FORECASTER ROBERTS/BRENNAN

How will the Outlook change in 2013?

Additional information about the 0 to 5 day formation potential will be included in the Text TWO



TROPICAL WEATHER OUTLOOK
NWS NATIONAL HURRICANE CENTER MIAMI FL
800 PM EDT WED OCT 10 2012

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

A VIGOROUS TROPICAL WAVE ACCOMPANIED BY A BROAD LOW PRESSURE SYSTEM IS LOCATED ABOUT 475 MILES EAST-SOUTHEAST OF THE WINDWARD ISLANDS. SHOWERS AND THUNDERSTORMS HAVE BECOME A LITTLE BETTER ORGANIZED THIS EVENING...AND REPORTS FROM BUOYS WELL NORTH OF THE CIRCULATION CENTER INDICATE TROPICAL-STORM-FORCE WINDS HAVE BEEN OCCURRING IN SOME OF THE HEAVIER SQUALLS. ALTHOUGH UPPER-LEVEL WINDS ARE CURRENTLY ONLY MARGINALLY FAVORABLE...SOME SLOW DEVELOPMENT OF THIS LARGE DISTURBANCE WILL BE POSSIBLE DURING THE NEXT COUPLE OF DAYS AS ENVIRONMENTAL CONDITIONS GRADUALLY BECOME MORE CONDUCTIVE. THIS

SYSTEM HAS A MEDIUM CHANCE...40 PERCENT...OF BECOMING A TROPICAL CYCLONE DURING THE NEXT 48 HOURS AS IT MOVES WEST-NORTHWESTWARD AT AROUND 15 MPH. REGARDLESS OF DEVELOPMENT, STRONG GUSTY WINDS AND

HEAVY RAINFALL ARE POSSIBLE ACROSS PORTIONS OF THE LESSER ANTILLES DURING THE NEXT COUPLE OF DAYS. ENVIRONMENTAL CONDITIONS COULD BECOME SLIGHTLY MORE FAVORABLE IN A FEW DAYS WHEN THE DISTURBANCE TURNS NORTHWESTWARD AND PASSES NEAR OR OVER THE NORTHEASTERN CARIBBEAN ISLANDS...AND EMERGES OVER THE WESTERN ATLANTIC IN A FEW DAYS. THIS

SYSTEM HAS A HIGH CHANCE...80 PERCENT...OF BECOMING A TROPICAL CYCLONE DURING THE NEXT 5 DAYS.

A WELL-DEFINED LOW PRESSURE SYSTEM LOCATED ABOUT 250 MILES EAST OF THE CENTRAL BAHAMAS HAS CONTINUED TO BECOME BETTER DEFINED OVER THE PAST SEVERAL HOURS. HOWEVER...ENVIRONMENTAL CONDITIONS ARE ONLY MARGINALLY CONDUCTIVE FOR DEVELOPMENT DURING THE NEXT DAY OR SO BEFORE THE LOW MERGES WITH A COLD FRONT THURSDAY NIGHT OR FRIDAY. THIS SYSTEM HAS A LOW CHANCE...20 PERCENT...OF BECOMING A TROPICAL CYCLONE DURING THE NEXT 48 HOURS AS IT MOVES LITTLE. ENVIRONMENTAL CONDITIONS WILL BECOME HOSTILE FOR ANY SIGNIFICANT DEVELOPMENT TO OCCUR BY FRIDAY AS THE LOW MOVES SOUTHWARD INTO A REGION OF STRONG UPPER-LEVEL WINDS. THIS SYSTEM HAS A LOW CHANCE...20 PERCENT... OF BECOMING A TROPICAL CYCLONE DURING THE NEXT 5 DAYS.

&&

AN EXPERIMENTAL 5-DAY FORMATION PROBABILITY IS ALSO INCLUDED IN THIS PRODUCT FOR THE 2013 HURRICANE SEASON.

FIVE-DAY FORMATION PROBABILITIES ARE EXPERIMENTAL IN 2012.

\$\$

FORECASTER STEWART

NNNN

THIS SYSTEM HAS A MEDIUM CHANCE...
40 PERCENT...OF BECOMING A TROPICAL
CYCLONE DURING THE NEXT 48 HOURS...

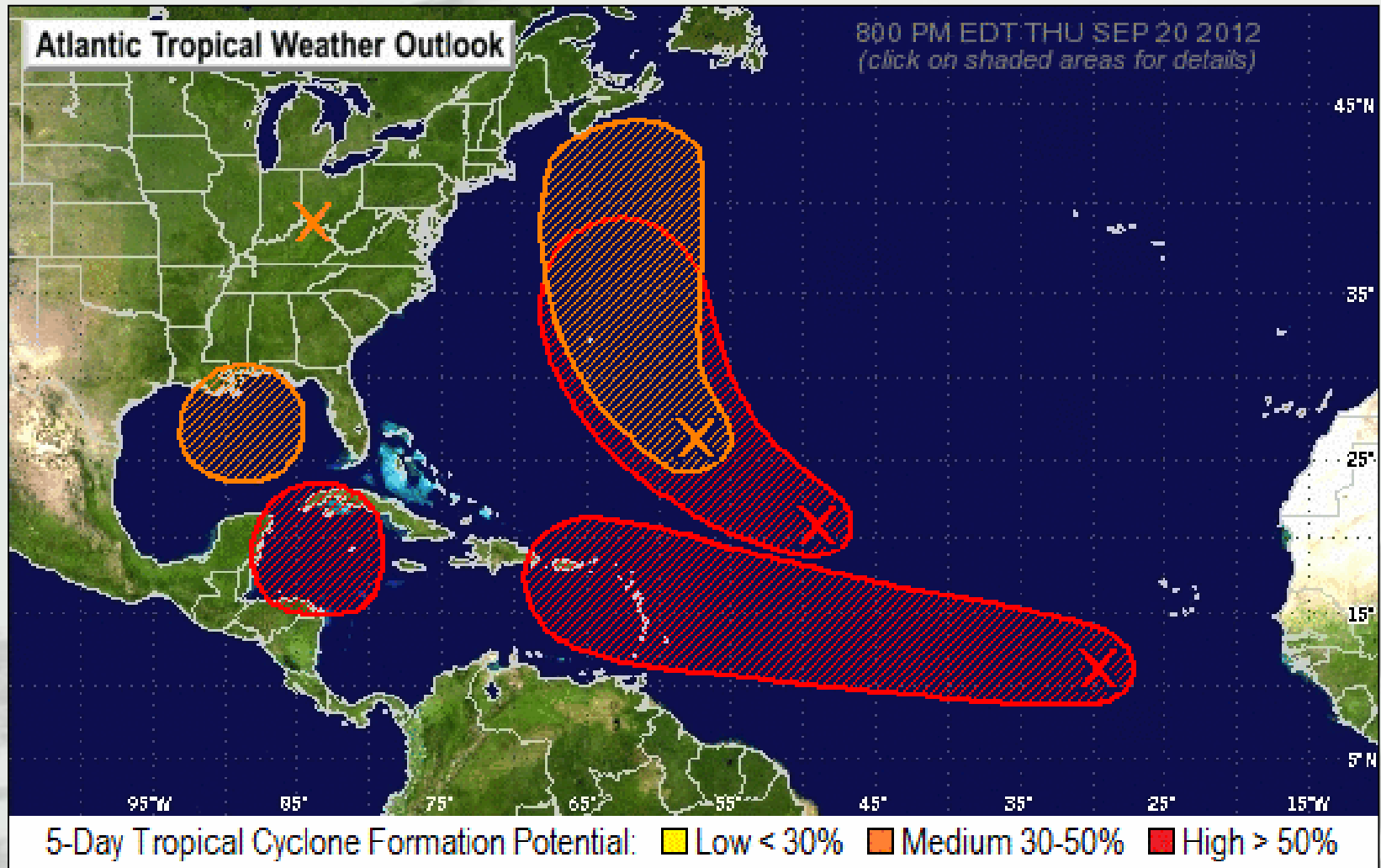
THIS SYSTEM HAS A HIGH CHANCE...
80 PERCENT...OF BECOMING A TROPICAL
CYCLONE DURING THE NEXT 5 DAYS.

- NHC still has some development and testing to complete.
- This addition to the TWO is not planned to occur until July or August.



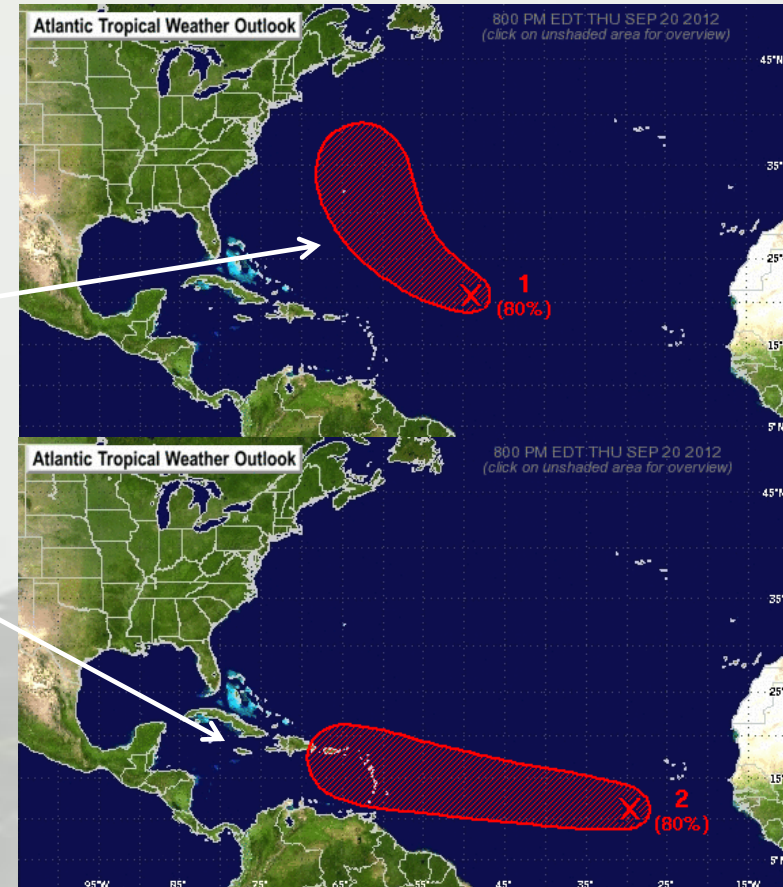
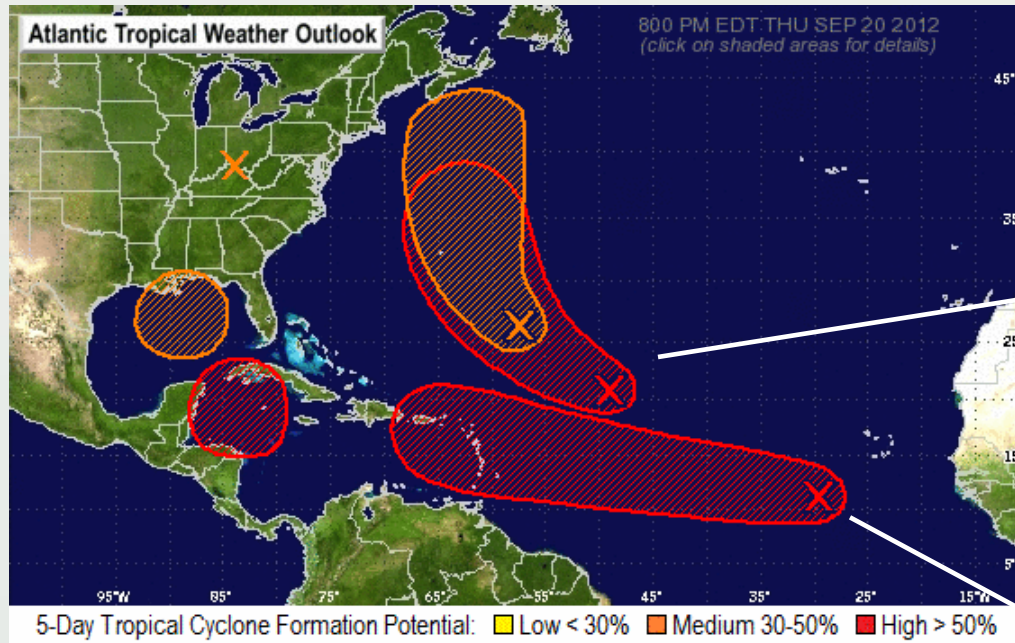
Prototype 5-day Graphic

Might be available sometime in 2013





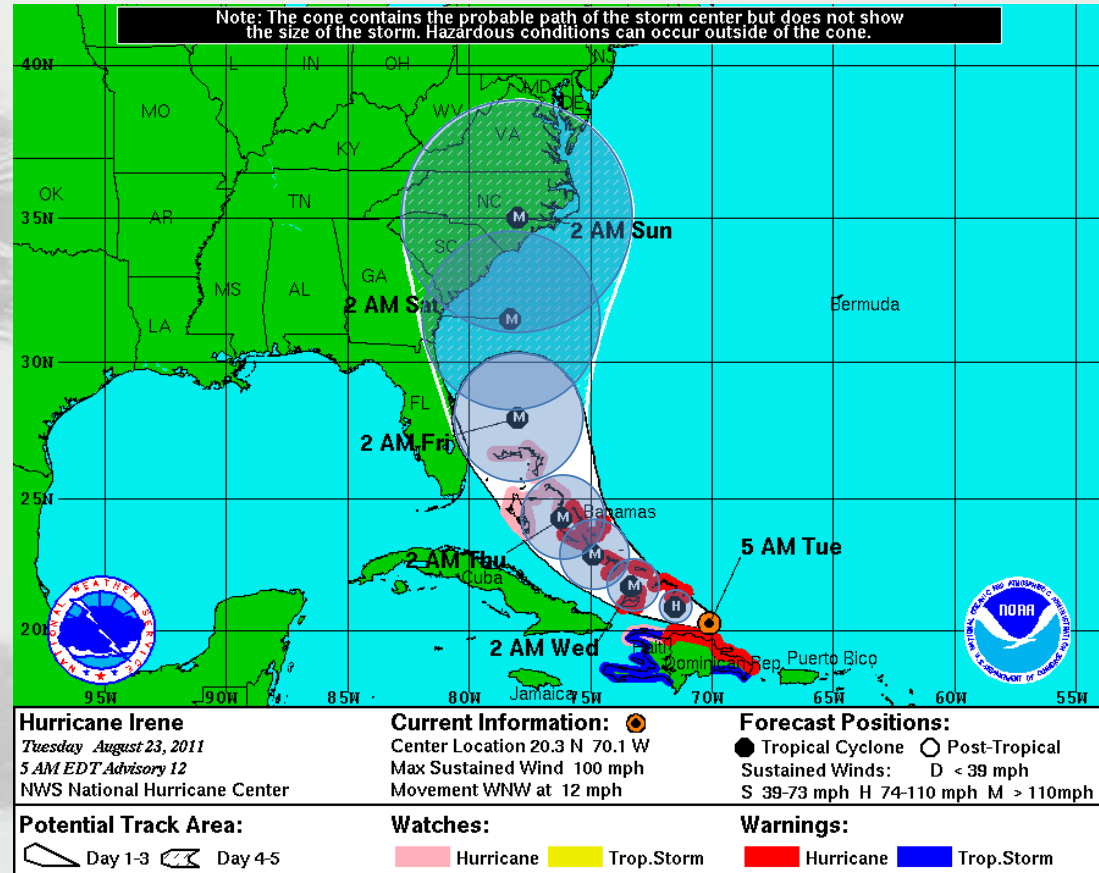
New Graphic Shows 5-day Potential Formation Area



- Overview graphic shows entire basin, with single disturbance graphics to aid in display when overlapping areas
- Indicates initial location of disturbance (X), if existing at issuance time
- Existing 2-day graphical Outlook will remain unchanged

NHC Forecast Cone

- Represents probable track of tropical cyclone center – but does not tell you anything about impacts!
- Formed by connecting circles centered on each forecast point (at 12, 24, 36 h, etc.)
- Size of the circles determined so that, for example, the actual storm position at 48 h will be within the 48-h circle 67% of the time





Atlantic Cone Radii – 2013 vs. 2012



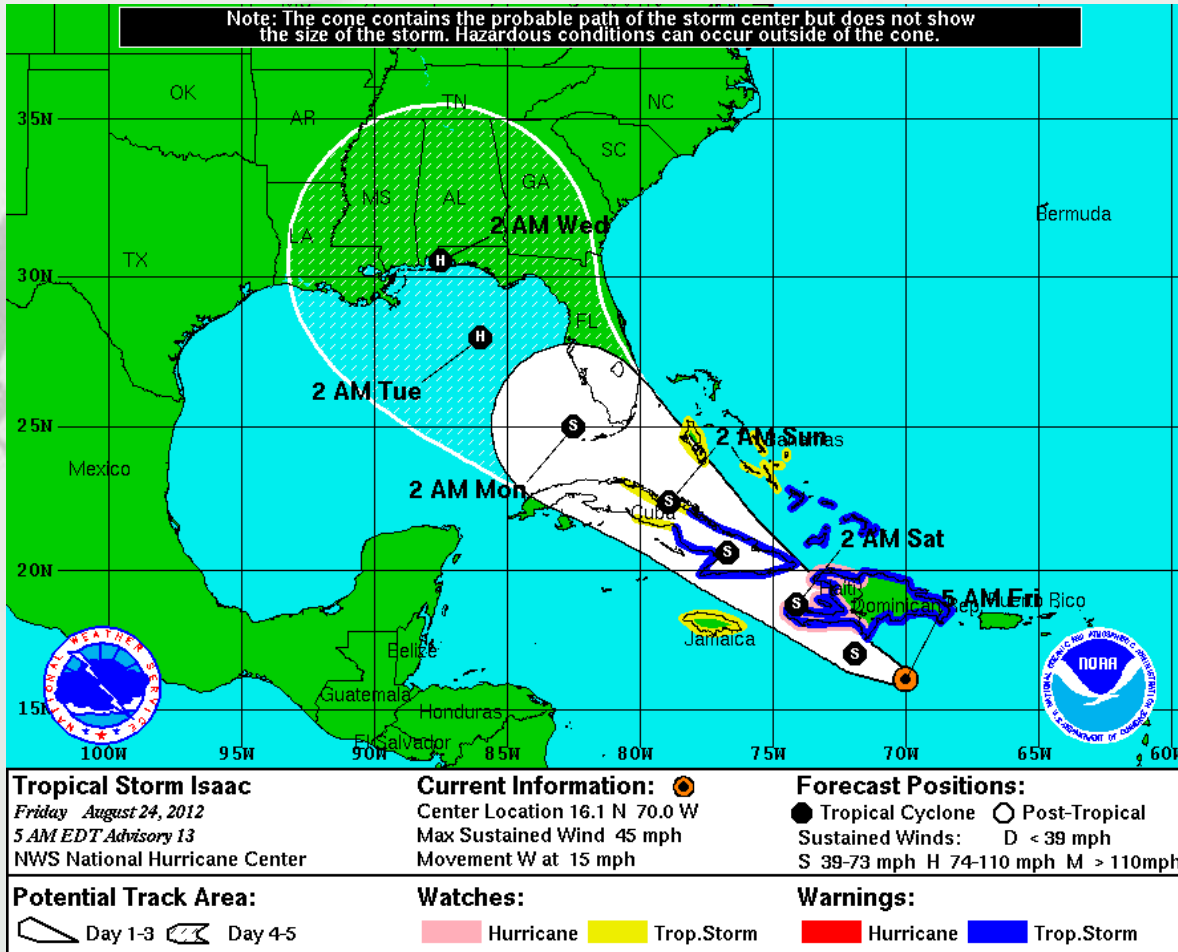
Improving track accuracy = smaller cone size

Forecast Period (h)	2012 Circle Radius (n mi) ('07 – '11 errors)	2013 Circle Radius (n mi) ('08 – '12 errors)	Percent Change
12	36	33	-8%
24	56	52	-7%
36	75	72	-4%
48	95	92	-3%
72	141	128	-9%
96	180	177	-2%
120	236	229	-3%

Storm size has not changed = more impacts outside cone

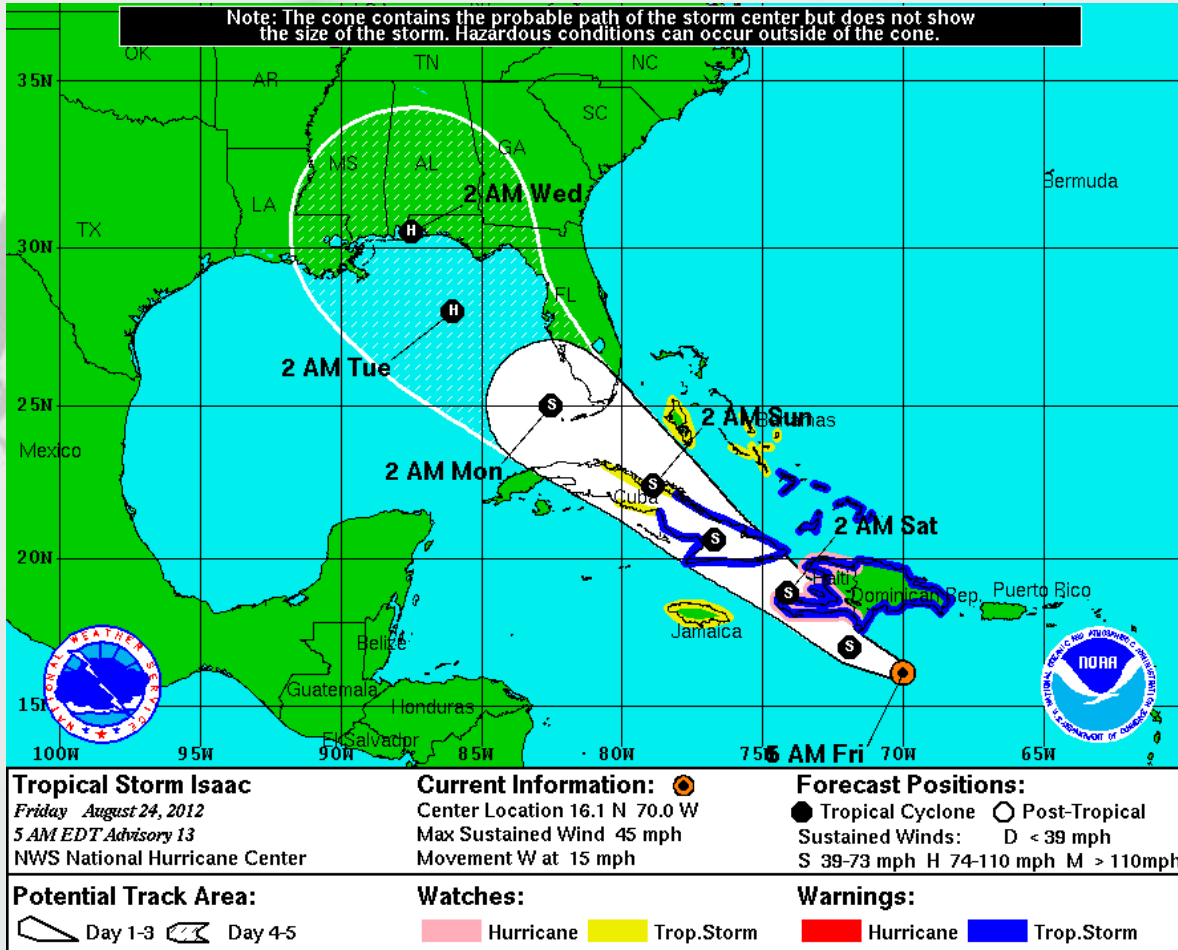


Isaac Advisory 13 with 2008 Cone





Isaac Advisory 13 with 2013 Cone

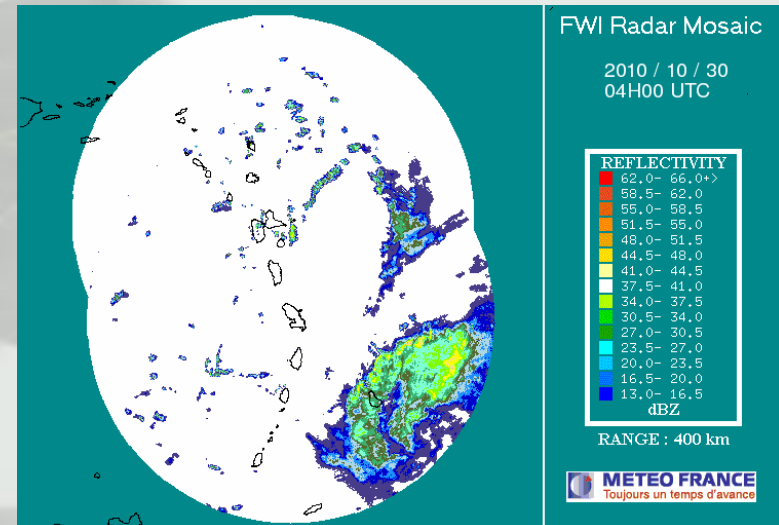
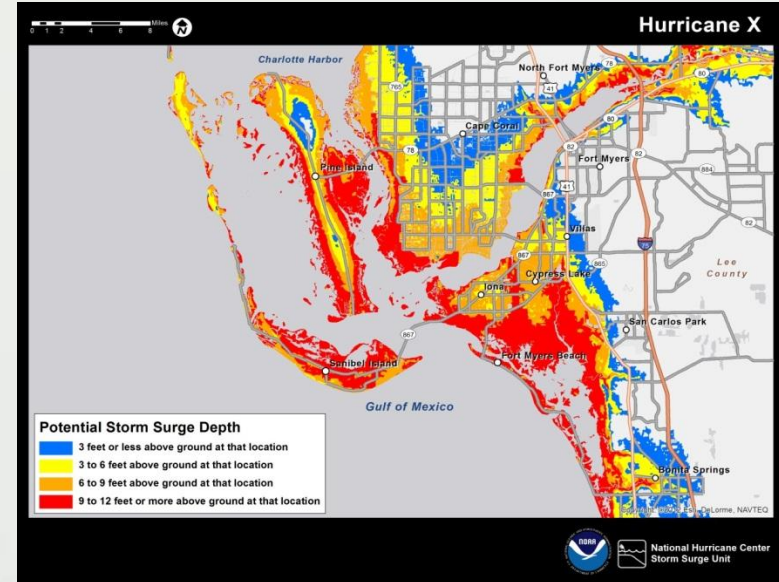




Other Potential NHC Forecast Enhancements- 2013 and Beyond

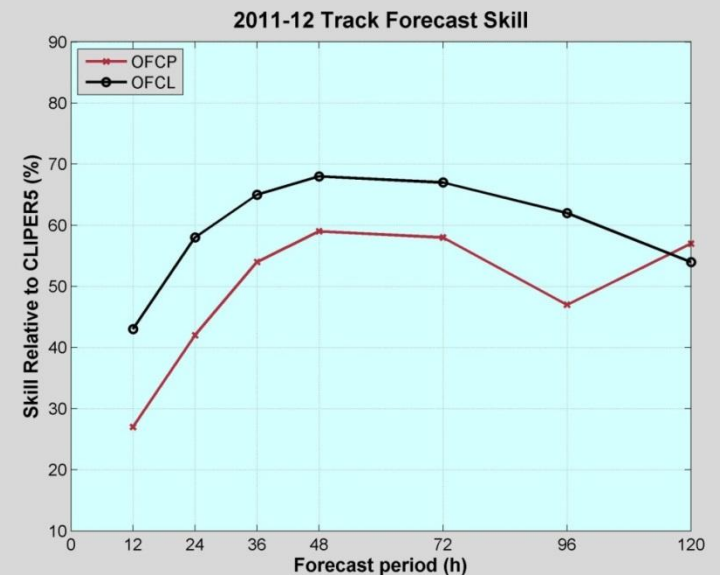
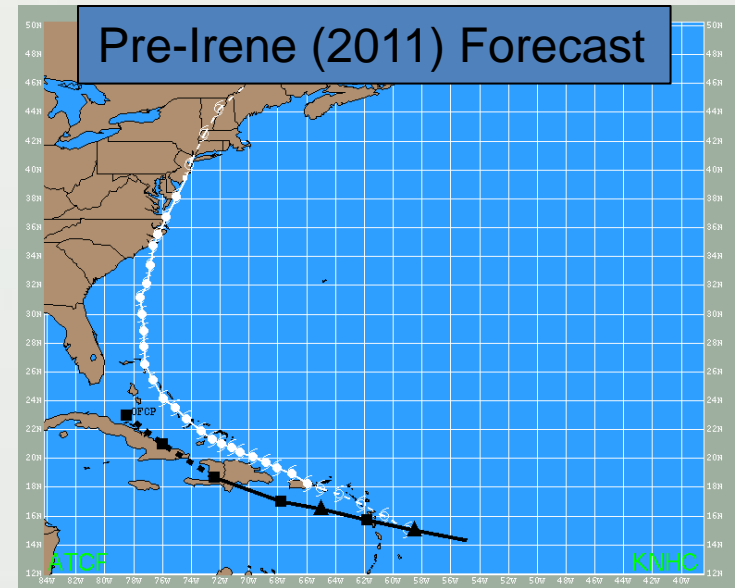


- Storm Surge Warning (2015) and Inundation Graphic
- Track and intensity forecasts for disturbances
 - Watches/Warning before formation
- Extension of tropical cyclone forecasts to 7 days



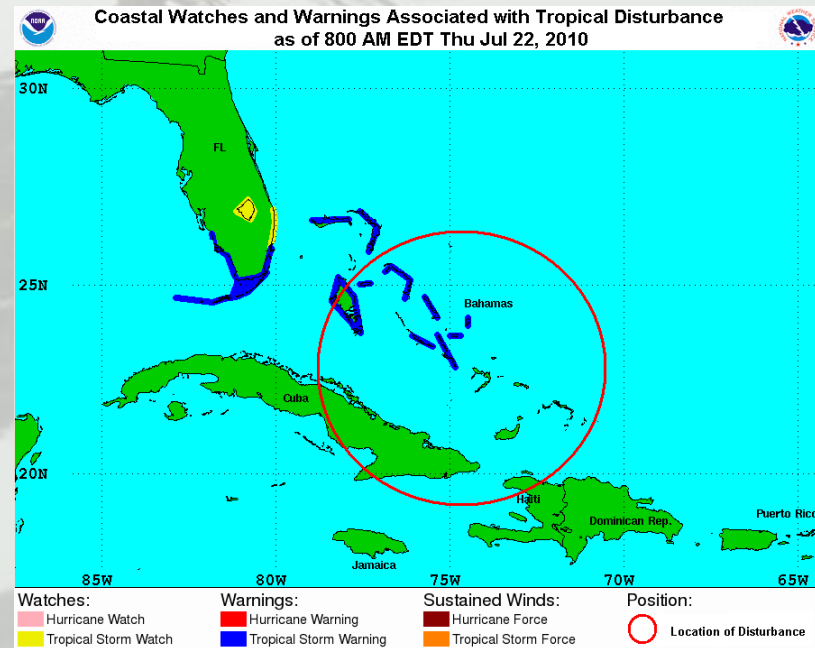
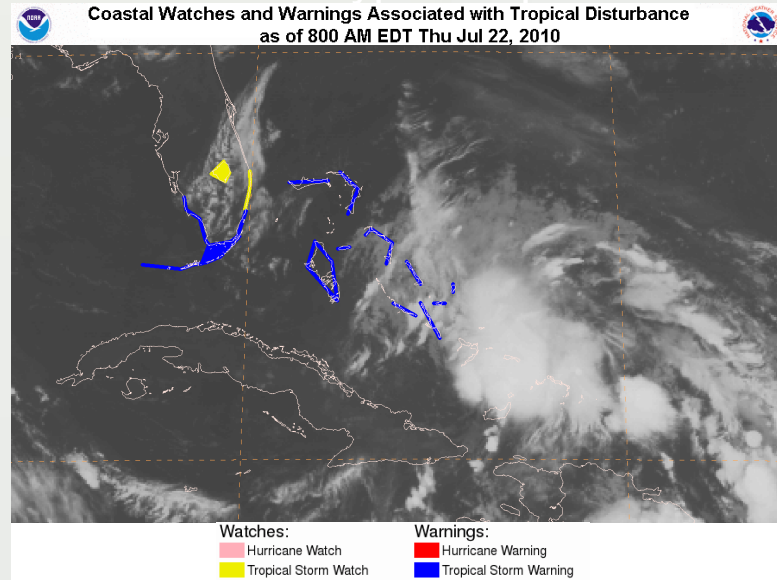
Pre-Tropical Cyclone Track & Intensity Forecasts

- **Motivation**: Issued for systems prior to genesis in support of the watch/warning process
- In 2011, the NHC began making forecasts only for tropical disturbances with a high chance of formation in the Tropical Weather Outlook
- Forecasts include predictions of track, intensity, wind radii, and system status (e.g. “TD/TS/HU”, or “DB”) out to 5 days



Watches and Warnings before Formation?

Prototype Graphics



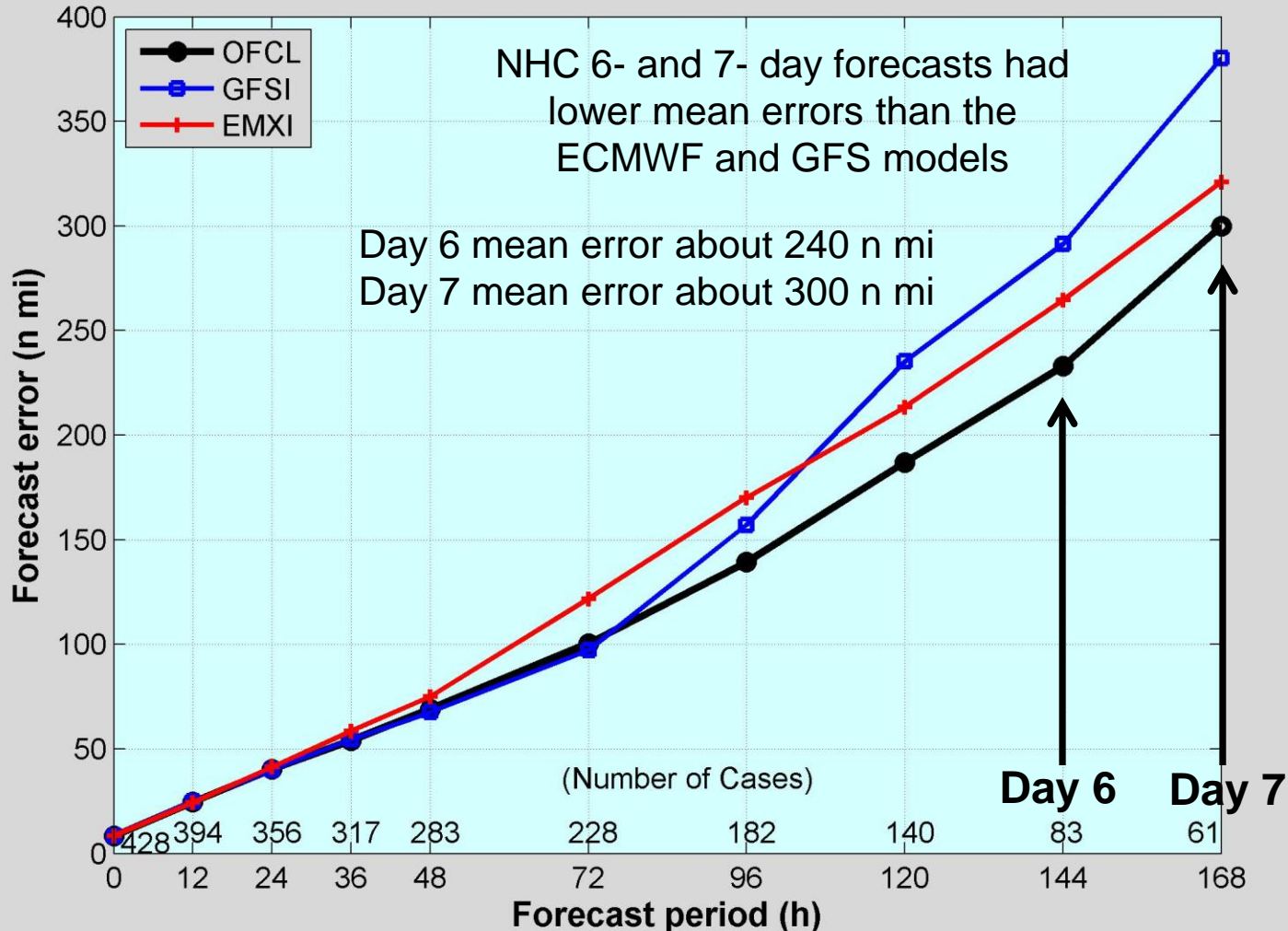
- NHC conducted an in-house experiment during the 2012 season by issuing Pre-TC watches/warnings
- Could take a few years to have enough cases to evaluate
- NHC exploring ways to issue and communicate pre-TC watches & warnings
 - Through graphical and text TWO?
 - Through advisory-like products?
 - New products?



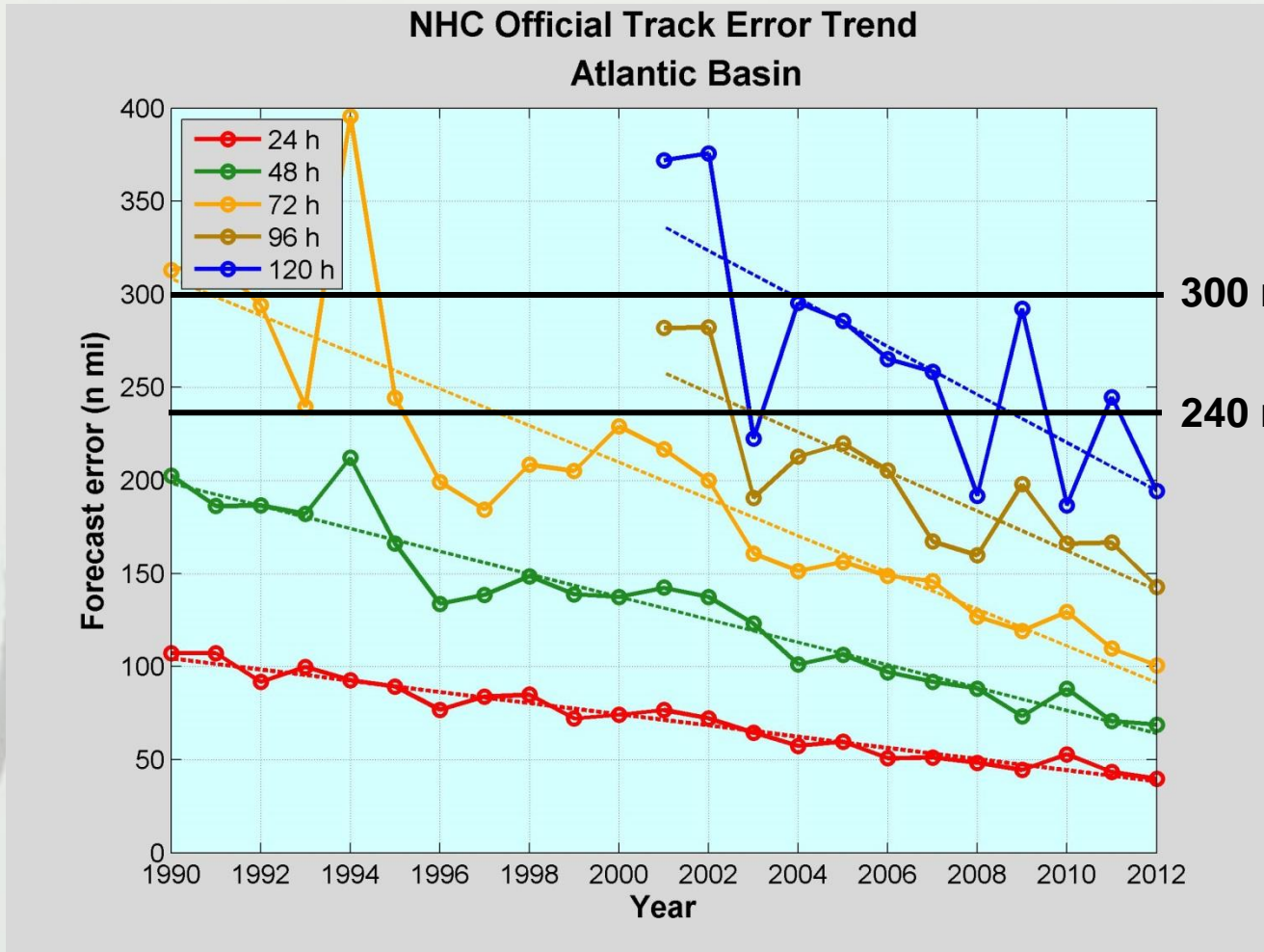
6- and 7-Day Track Forecasts

2012 NHC 6- and 7-day Track Forecast Verification

Track Forecast Skill (Early Models)
2012 - Atlantic Basin



6- and 7-day Forecasts



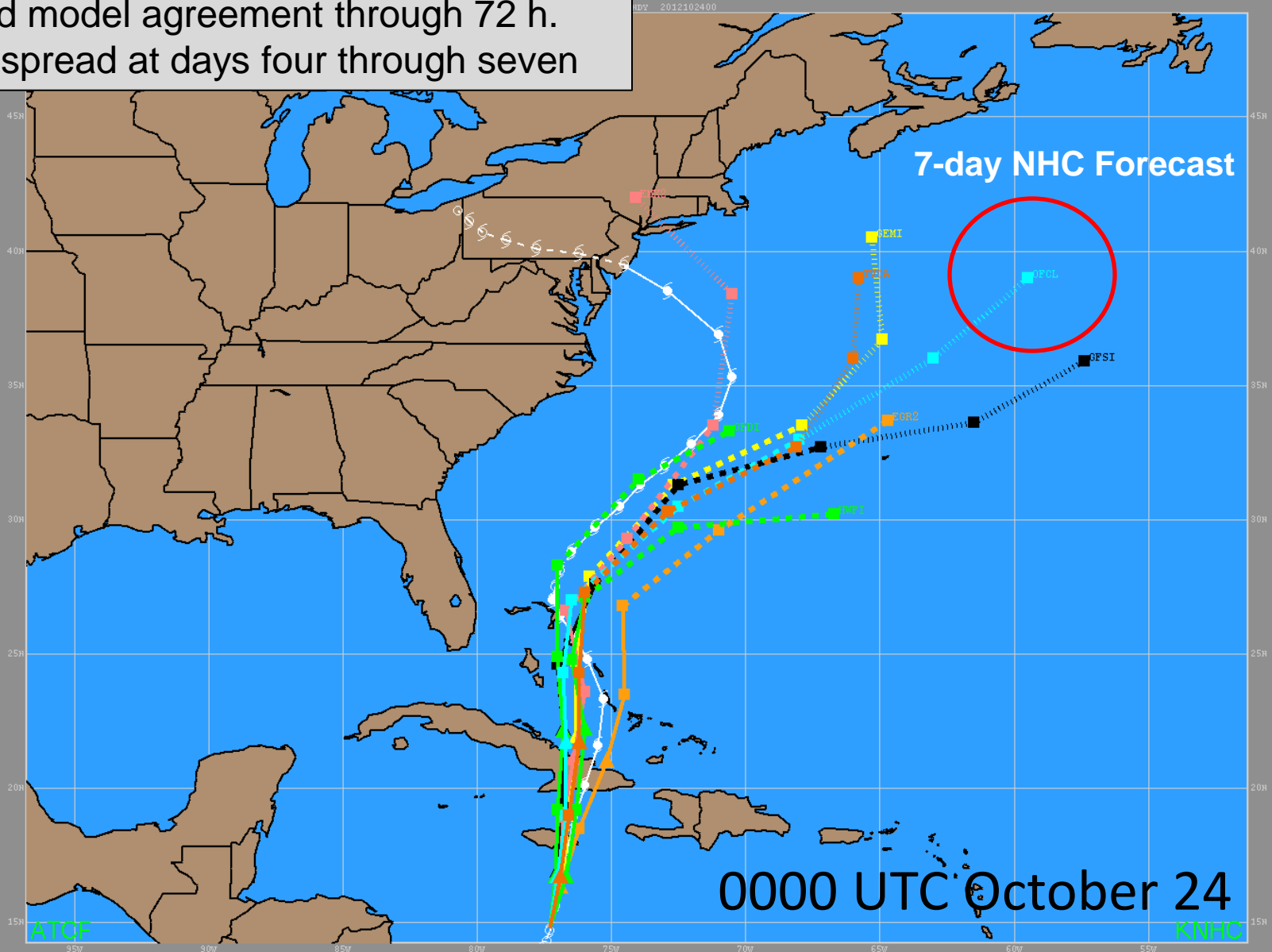
2012 verification results indicate the 6- and 7-day forecasts were about as good as NHC 4- and 5-day forecasts were when introduced a decade ago.



6- and 7-day Forecasts for Sandy Were Initially Out to Sea



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

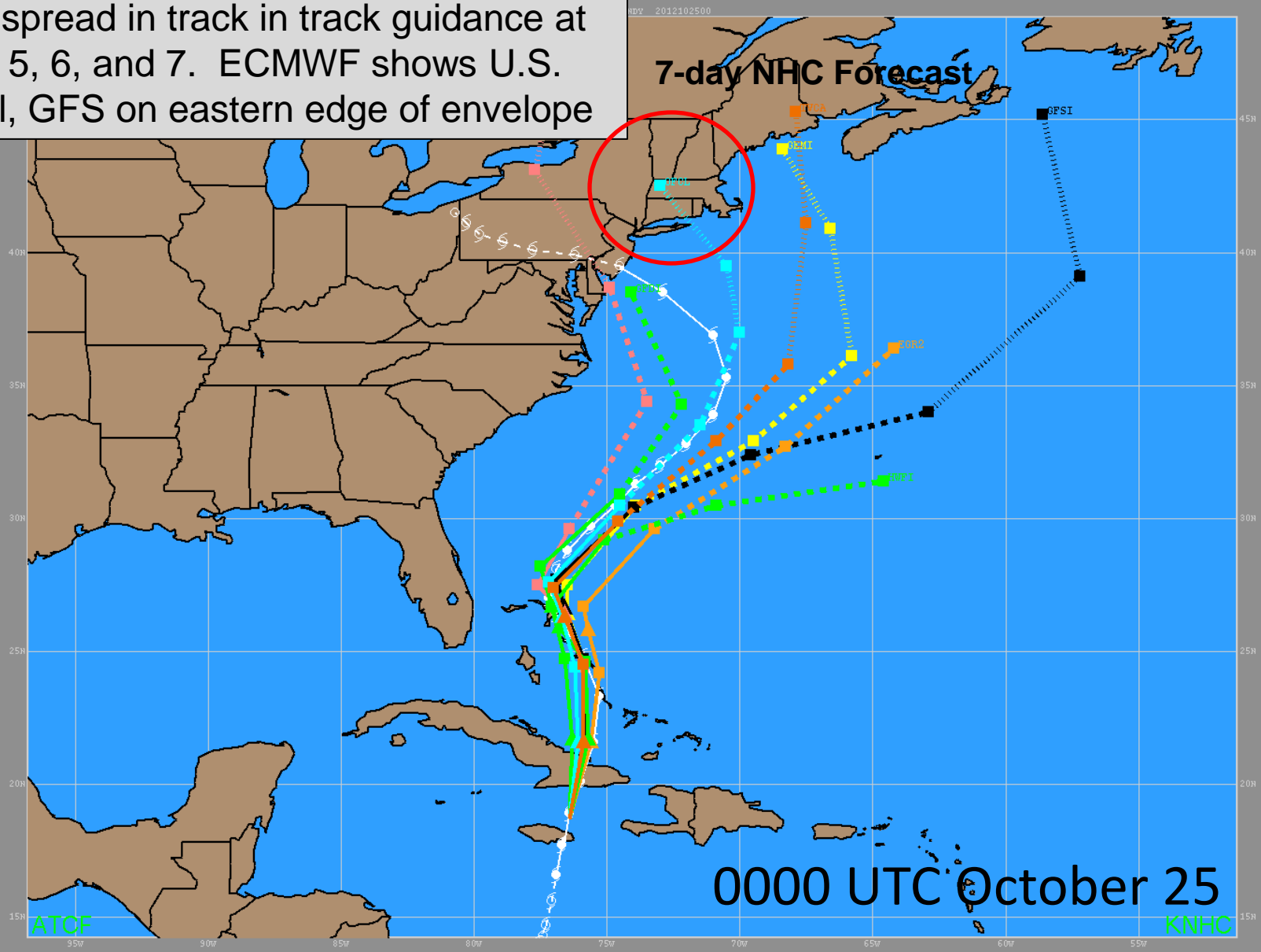




Forecasts Shifted Westward about 6 Days Before Landfall



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



0000 UTC October 25

ATCF

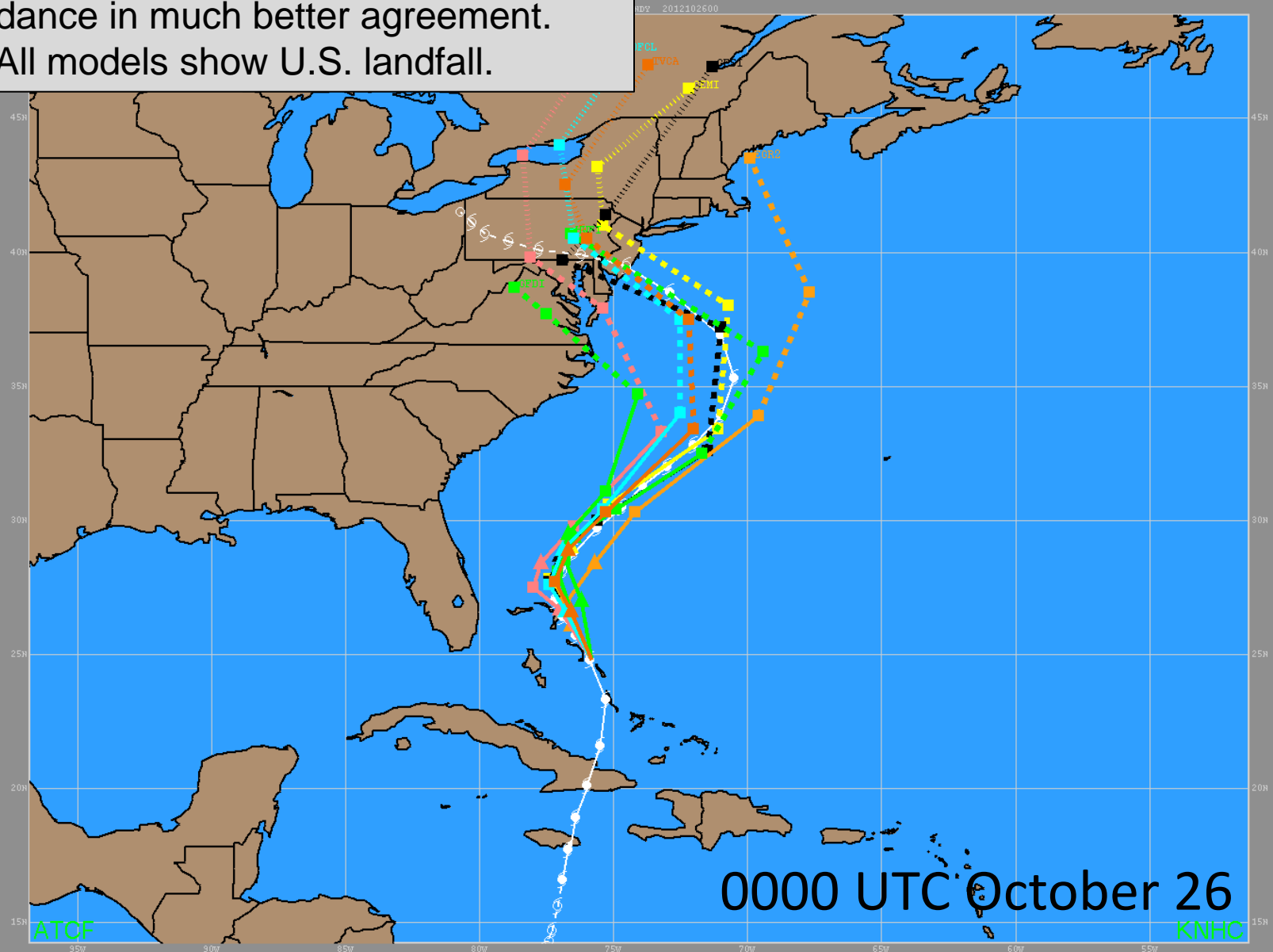
KNHC



Models in Better Agreement About 5-days from Landfall



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





Social Media and NHC



- NHC Facebook & Twitter feed began in 2011
- Hurricane Awareness Week- Public Service Announcements

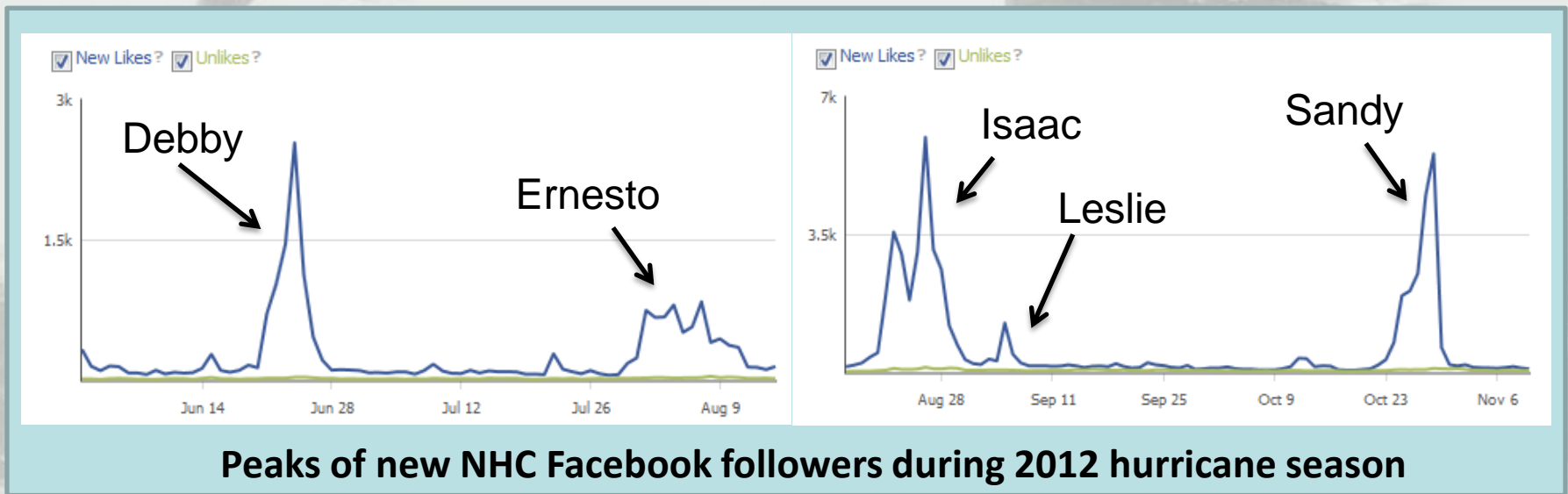




Social Media and NHC



- **Over 208,000 Facebook followers**
 - One of the most followed government Facebook pages
- **Currently over 111,000 Twitter followers**
- **Significantly increase of followers during hurricane threats**





Thanks for your time!



NHC Hurricane Forecasters

Brown

Roberts

Blake

Pasch

Beven

Landsea



Berg

Avila

Cangialosi

Kimberlain

Brennan

Stewart

Franklin

Questions?