

Introduction to the NHC Forecast Process

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National Hurricane Conference
L311 – Hurricane Readiness for Coastal Communities
Orlando, Florida
26 March 2011

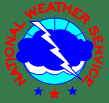




NHC Six-Hour Forecast Cycle



Time (HR : MIN)	Event
00:00	Issue Tropical Weather Outlook Issue Intermediate Public Advisory (if necessary) Synoptic time / cycle begins
00:45	Receive satellite fix data
01:00	Initialize models
01:10	Receive model guidance and <i>prepare forecast</i>
02:00	NWS / DOD hotline coordination
03:00	Advisory deadline
03:15	FEMA conference call
06:00	New cycle begins



Why are advisories issued at 5 am, 11 am, 5 pm, and 11 pm EDT?

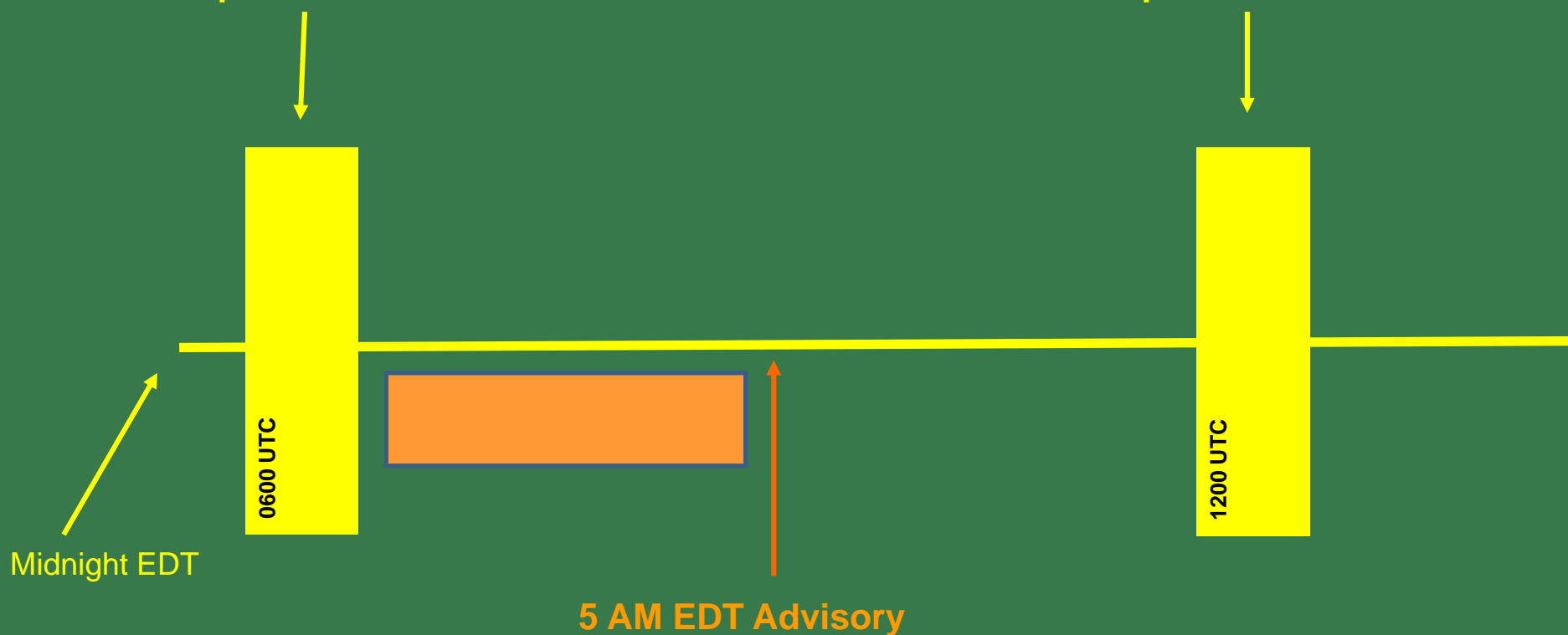
- Advisory cycle tied to UTC or “Z” time
- Synoptic times- 0000, 0600, 1200, and 1800 UTC.
 - Additional surface and ship data available at these times.
 - Upper-air observations (balloon launches) occur around 0000 and 1200 UTC.
- Synoptic times are the starting points or initial times of the forecasts
- Approximately 3 hours is needed to compose and coordinate the forecast package
 - This was reduced by an hour in the 1980s.



Timeline of NHC Tropical Cyclone Advisories and Tropical Weather Outlooks

2 AM EDT
Tropical Weather Outlook

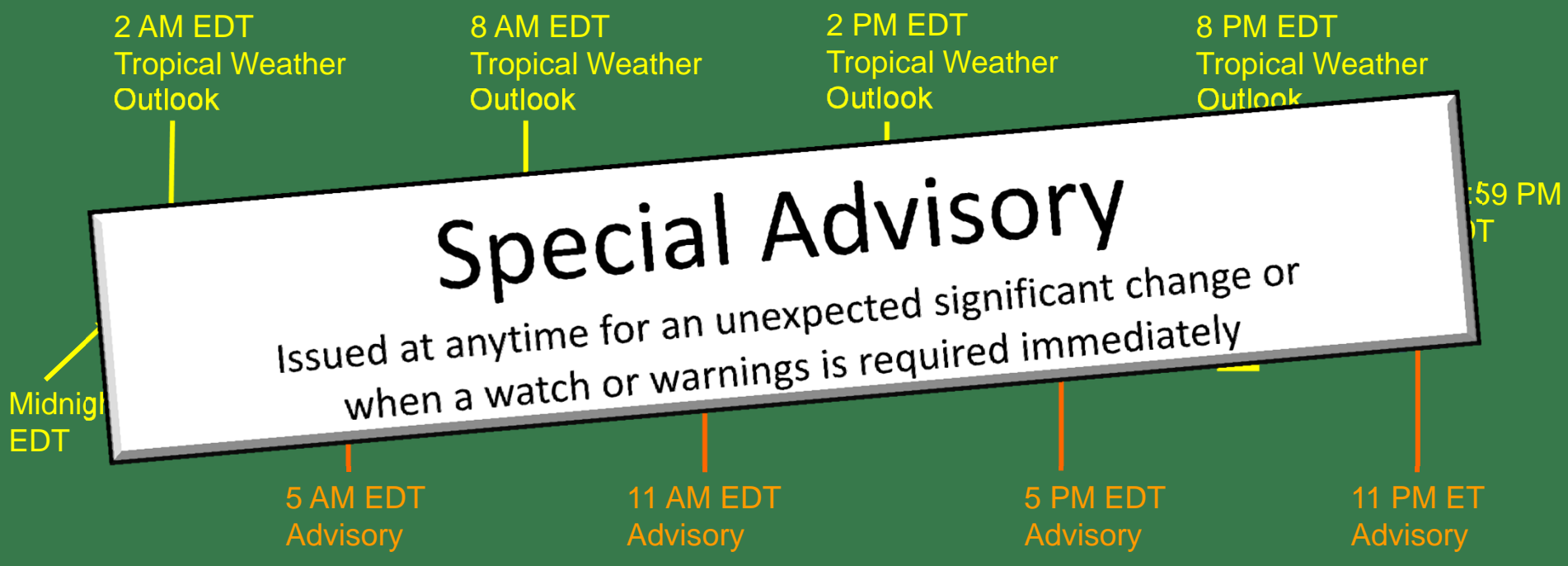
8 AM EDT
Tropical Weather Outlook



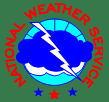
 = Advisory Preparation Time



Timeline of NHC Tropical Cyclone Advisories and Tropical Weather Outlooks

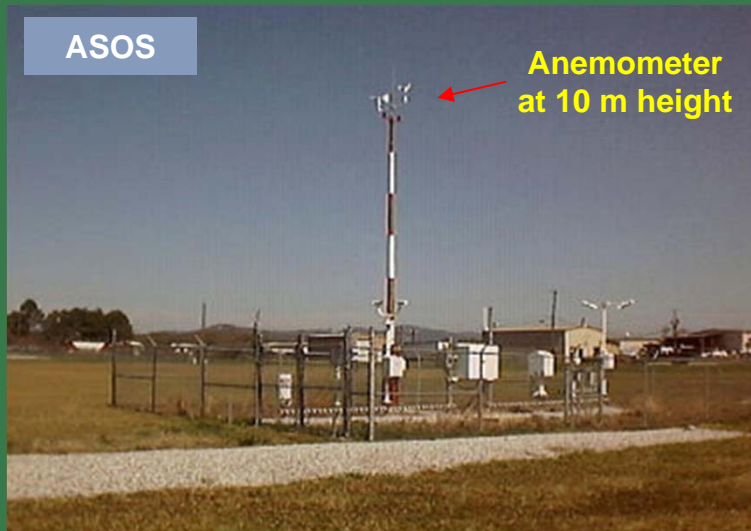


 = Advisory Preparation Time



What do we mean by maximum sustained winds? Tropical Cyclone Intensity

ASOS



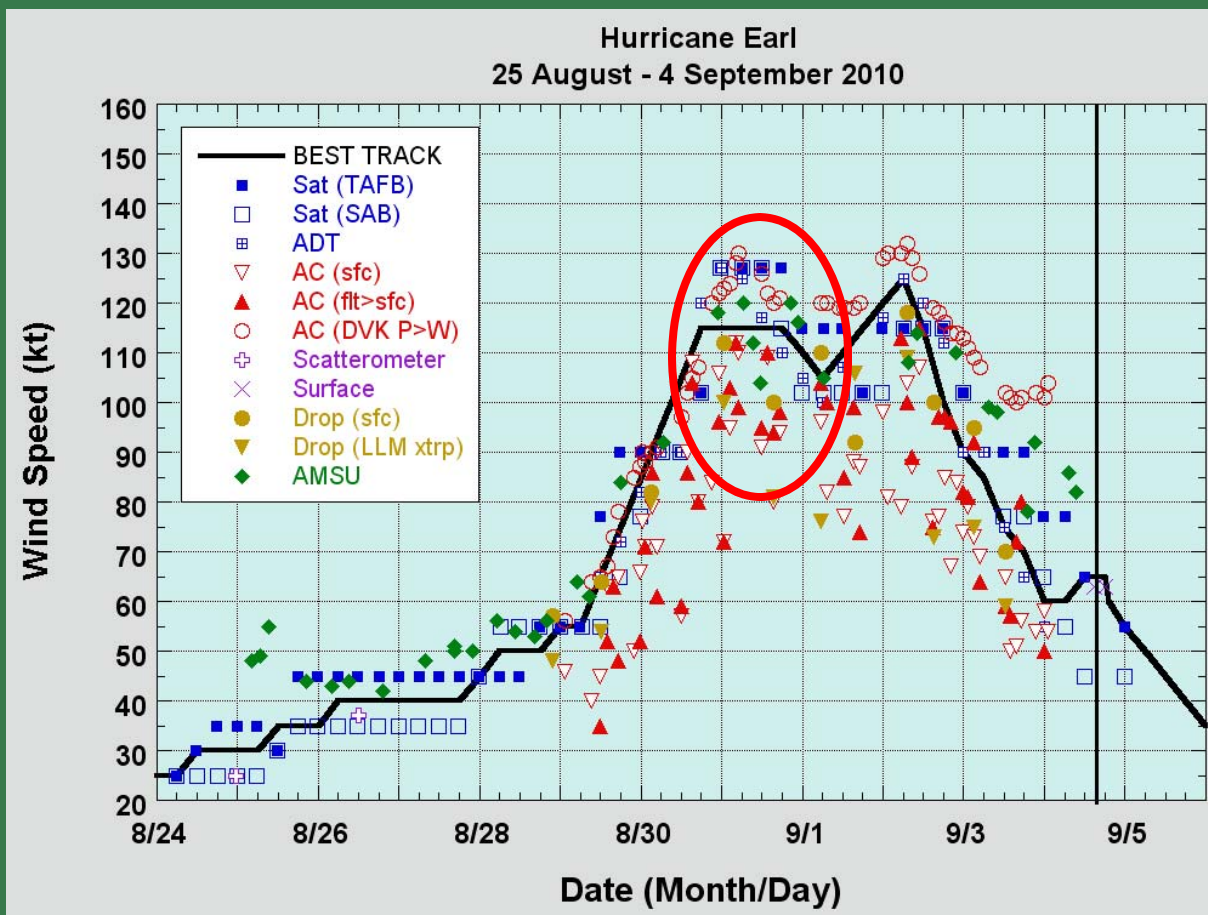
Maximum sustained winds:

Strongest wind speed averaged during a 1-minute period at an altitude of 10 m (33 ft), associated with the circulation of the tropical cyclone at a given point in time

- Usually estimated, rarely directly measured
- Central pressure is correlated with intensity, but pressure-wind relationships has variability



Dealing with Conflicting Intensity Estimates



Earl's intensity (black) and intensity estimates the forecaster receives

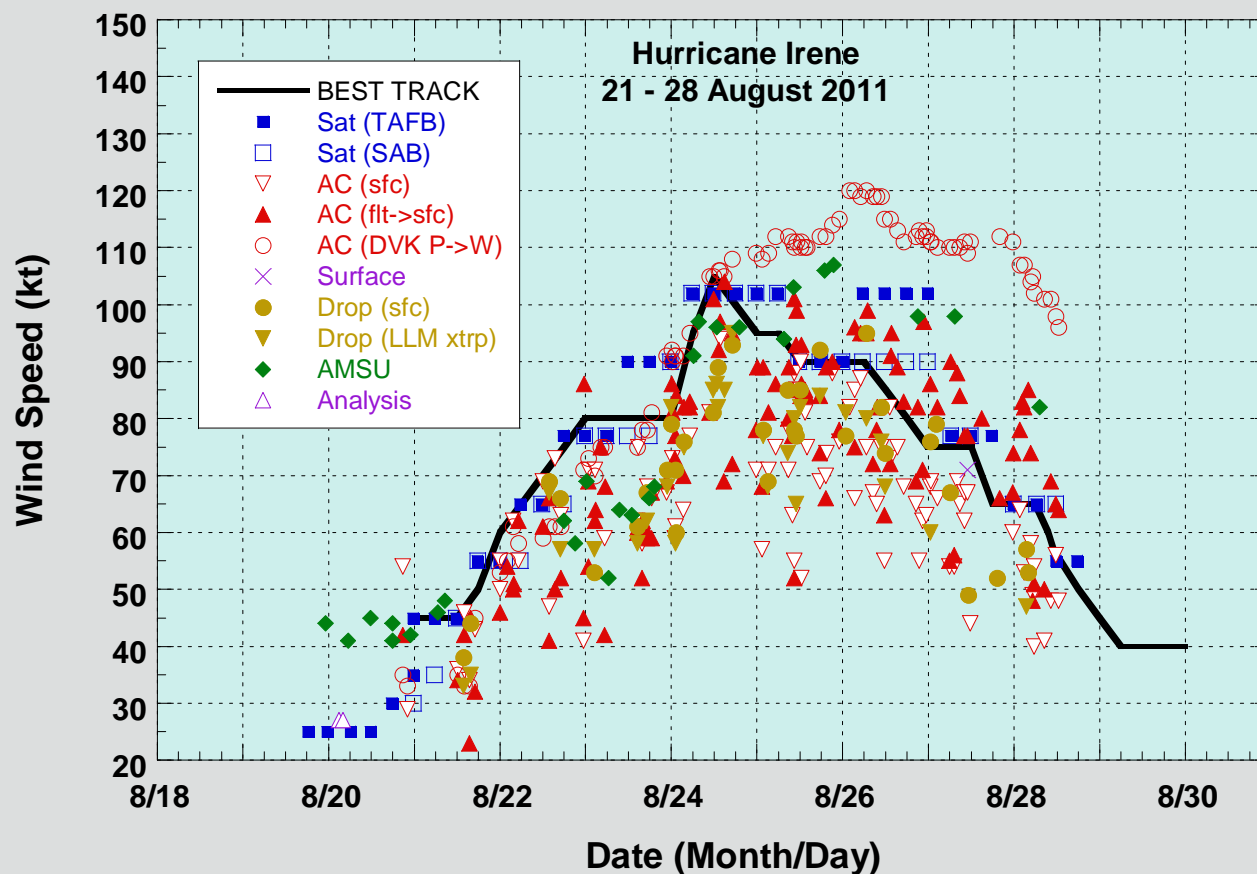
HURRICANE EARL DISCUSSION NUMBER 30
NWS TPC/NATIONAL HURRICANE CENTER MIAMI FL AL072010
500 PM EDT WED SEP 01 2010

VISIBLE SATELLITE IMAGES INDICATE THAT THE EYE HAS BECOME VERY DISTINCT... WITH OBJECTIVE T-NUMBERS OSCILLATING AROUND 6.0 FOR THE PAST FEW HOURS. AN AIR FORCE PLANE MEASURED FLIGHT-LEVEL WINDS OF 138 KNOTS AND A MINIMUM PRESSURE OF 941 MB IN THE LAST FIX. HOWEVER...SFMR MEASUREMENTS WERE A LITTLE LOWER. **A COMPROMISE OF THESE DATA SUPPORTS AN INITIAL INTENSITY OF 115 KNOTS.**

NHC Discussion mentions the "compromise"



Dealing with Conflicting Intensity Estimates



Irene's intensity (black) and intensity estimates the forecaster receives

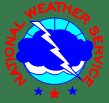
HURRICANE IRENE DISCUSSION NUMBER 24
NWS TPC/NATIONAL HURRICANE CENTER MIAMI FL AL092011
500 AM EDT FRI AUG 26 2011

THE MAXIMUM FLIGHT-LEVEL WINDS AT 700 MB WERE **109 KT** ABOUT 75 N MI EAST-NORTHEAST OF THE CENTER...AND THE MAXIMUM SURFACE WINDS REPORTED FROM THE STEPPED FREQUENCY MICROWAVE RADIOMETER WERE **87 KT**. BASED ON THESE DATA...**THE INTENSITY ESTIMATE IS REDUCED TO 95 KT...WHICH IS ALSO BETWEEN THE SATELLITE INTENSITY ESTIMATES OF 102 KT FROM TAFB ANND 90 KT FROM SAB.** THE AIRCRAFT DATA INDICATE THAT A 20 N MI WIDE EYE IS PRESENT AND THAT THE CENTRAL PRESSURE REMAINS NEAR 942 MB.

NHC Discussion mentions the compromise

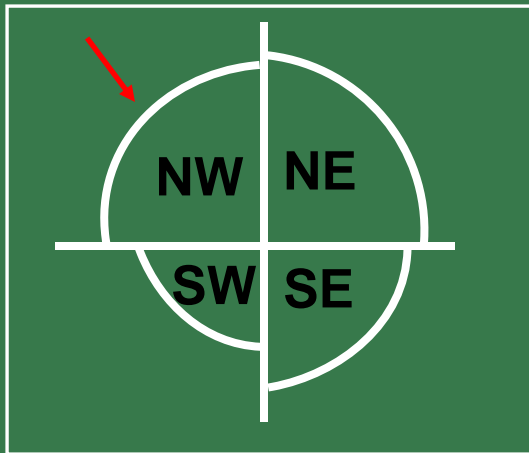


How big is the storm?



Tropical Cyclone Wind Radii

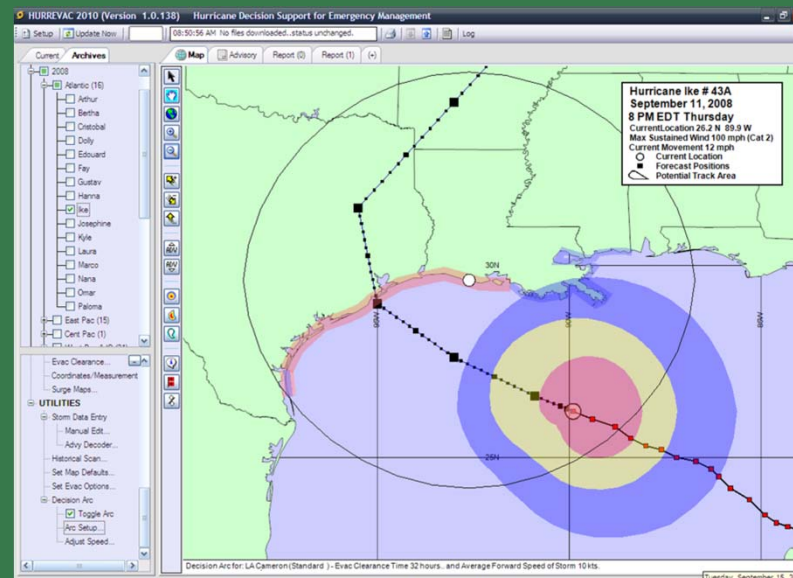
radii represent the largest distance from center in particular quadrant



leads to an inherent over-estimate of radii, especially near land

-NHC estimates cyclone “size” via wind radii in four quadrants

• Wind radius = Largest distance from the center of the tropical cyclone of a particular sustained surface wind speed threshold (e.g., 34, 50, 64 kt) somewhere in a particular quadrant (NE, SE, SW, NW) surrounding the center and associated with the circulation at a given point in time



Wind radii in Hurrevac

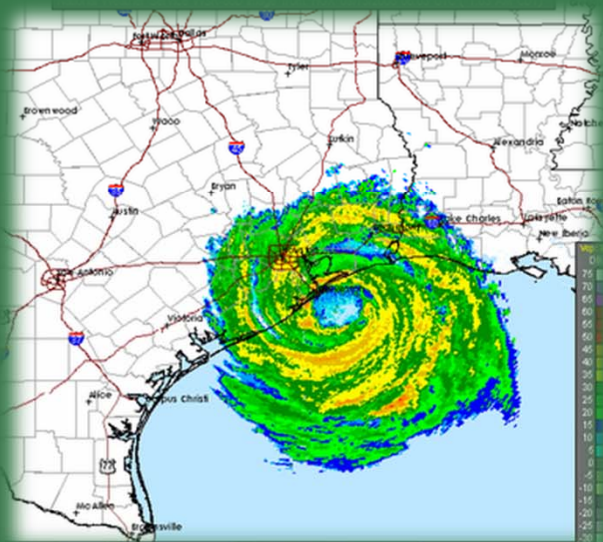
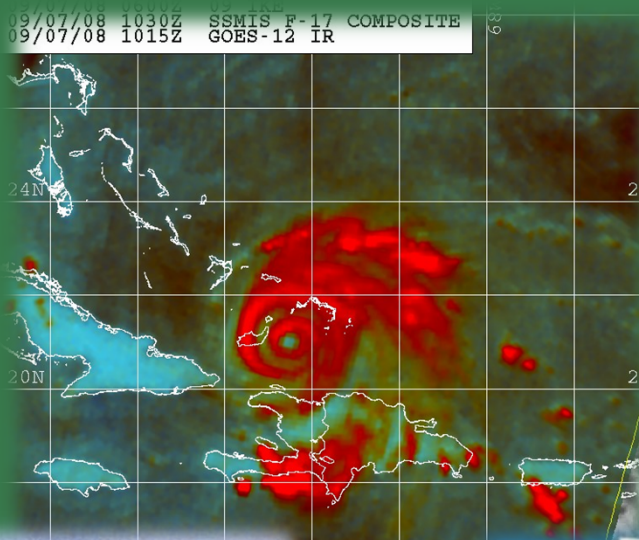


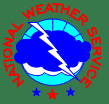
00:00

Synoptic time / cycle begins

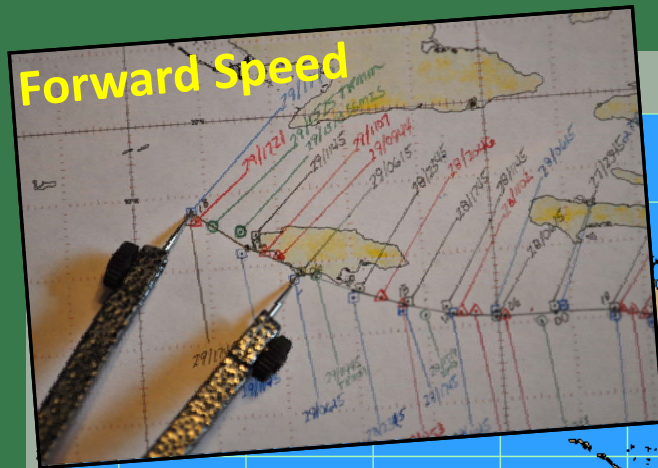


Hurricane specialist analyzes available observations





Determining Initial Location & Motion



ATCF SIMULATOR



1:00

Initialize models



After determining the center, strength, motion, and size of the tropical cyclone, the hurricane specialist gives that information to a supercomputer to run the models

⌚ Initialize computer models

Prepare Compute Data - FEMASE at712008

71 2008 North Atlantic - FEMASE

Date-Time-Group: 2008091318

	Lat (deg)	Lon (deg)	Max Wind (kt)	Dir (deg)	Spd (kt)
Past 24 hr:	35.4	N 73.3	W 120		
Past 12 hr:	38.6	N 73.7	W 120	343	18
Current:	43.1	N 75.6	E 120	345	21

Eye Diameter: 0 nm

Max Wind Radius: 25 nm

Vertical Extent of Circulation: Deep >400 mb

Central Pressure: 940 mb

Outermost Closed Isobar: 1008 mb

Radius Outermost Closed Isobar: 150 nm

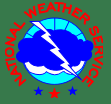
Speed/Quadrant	NE (nm)	SE (nm)	SW (nm)	NW (nm)
34 kt:	175	150	140	175
50 kt:	125	100	75	125
64 kt:	50	40	30	50

Buttons: Help, OK, Cancel

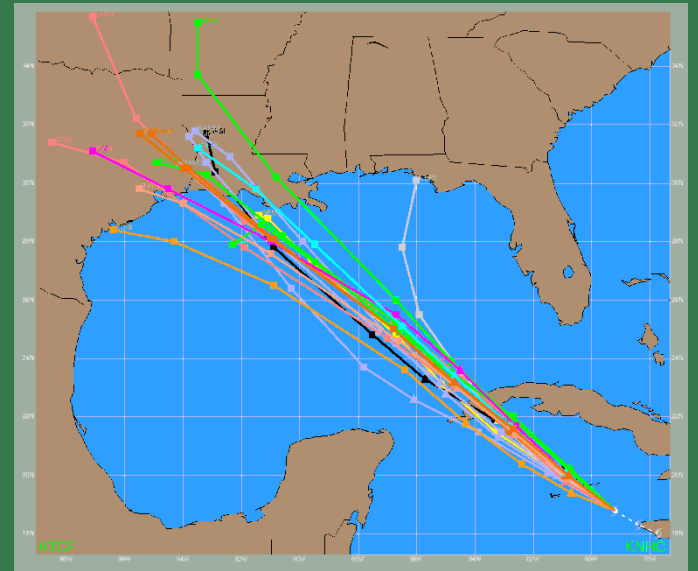
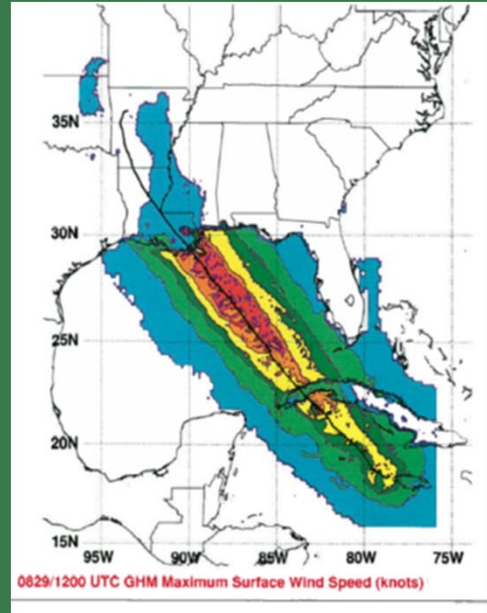
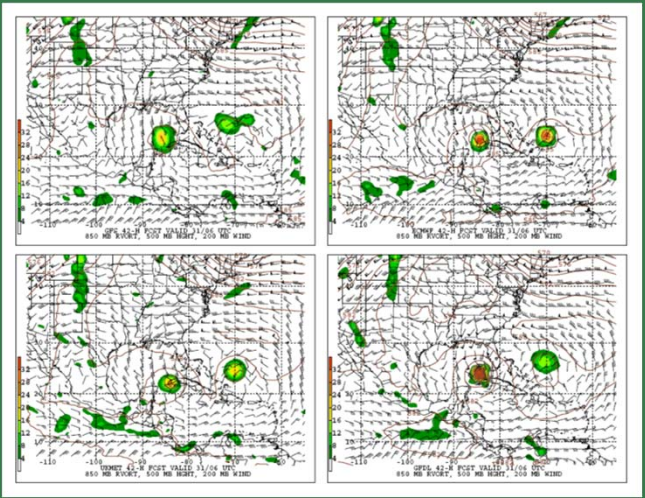


1:10

Receive model guidance and prepare forecast



- Analyze and QC computer models
- Prepare track, intensity, and wind radii forecasts



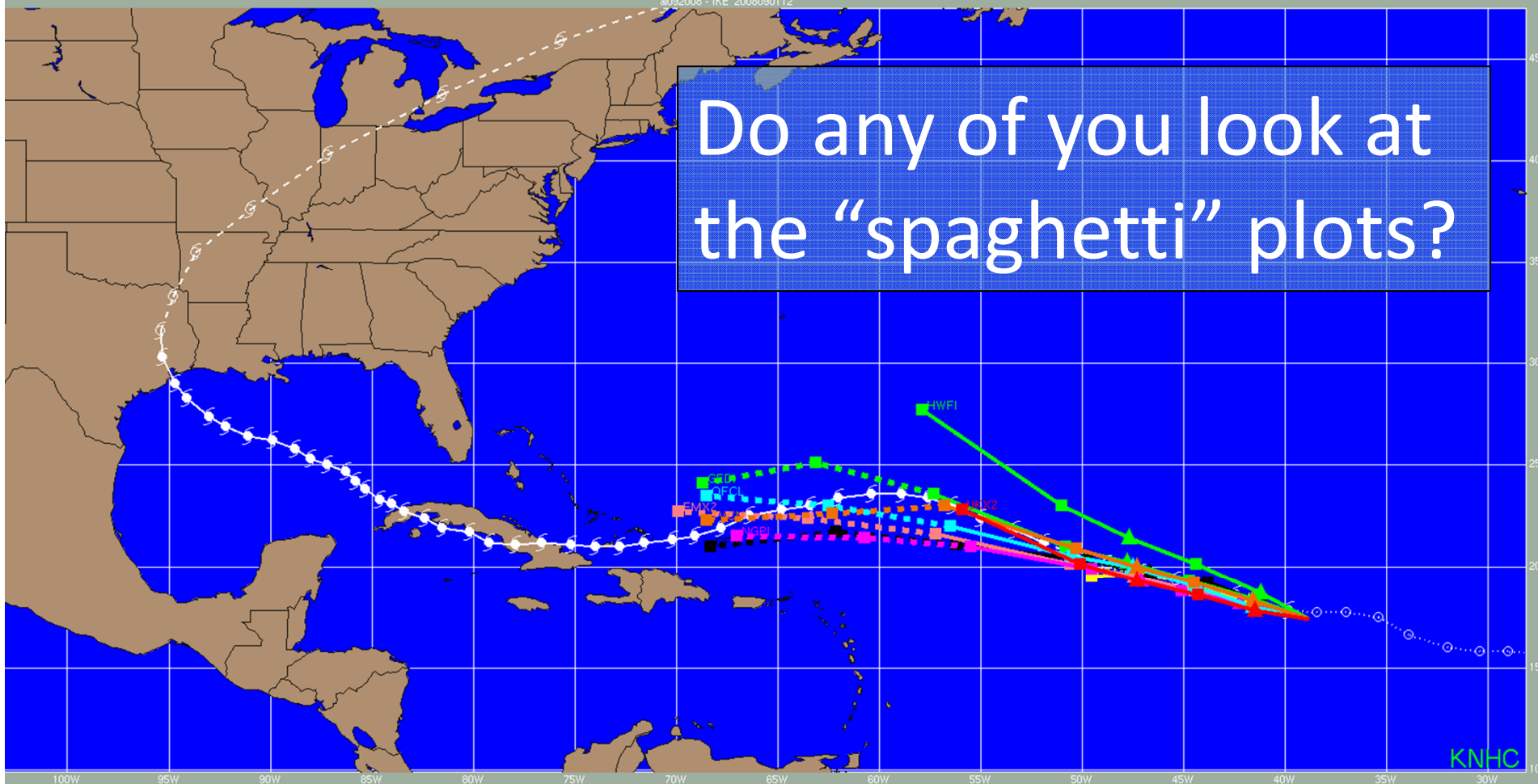


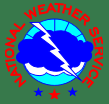
Computer Models are the Basis of NHC Track and Intensity Forecasts



092008 - IKE 2008090112

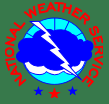
Do any of you look at the “spaghetti” plots?





Hierarchy of TC Track Models

- **Statistical**
- *CLIPER (Climatology-Persistence)*
 - Know NOTHING about current state of atmosphere
- **Simplified Dynamical (Trajectory)**
- *BAMD, BAMM, BAMS*
 - Follow cork in stream analogy, where the cork (the hurricane) is not allowed to have any impact on the stream
- **Dynamical models – General characteristics**
- *GFS, ECMWF, UKMET, GFDL, HWRF, NOGAPS*
 - Most sophisticated models available
 - Solve fundamental physical equations of the atmosphere and include wide range of physical processes



Hierarchy of TC Track Models

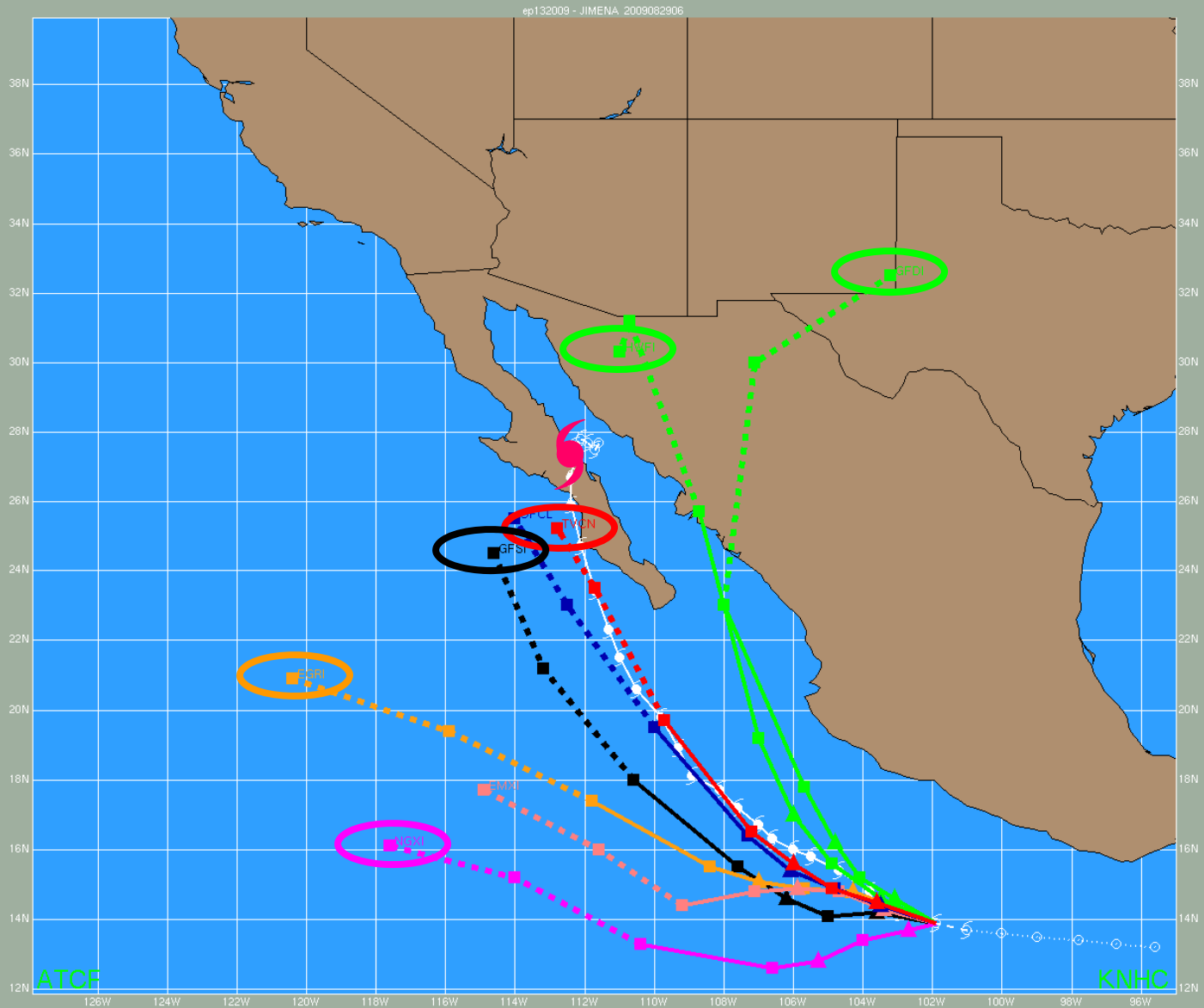
- **Consensus**

- *GUNA, TCOA, TCCN, TVCA, TVCC, FSSE*

- Not actual models, but combinations of other models (two heads are better than one)
 - Can be a simple average (e.g., TVCA is a simple average of GFDL, HWRF, GFDN, ECMWF, UKMET, and GFS)
 - Can be more complicated, where past performance is used to try to come up with an optimal combination and/or to correct model biases (“corrected consensus”)
- Consensus models generally outperform the individual models that make them up

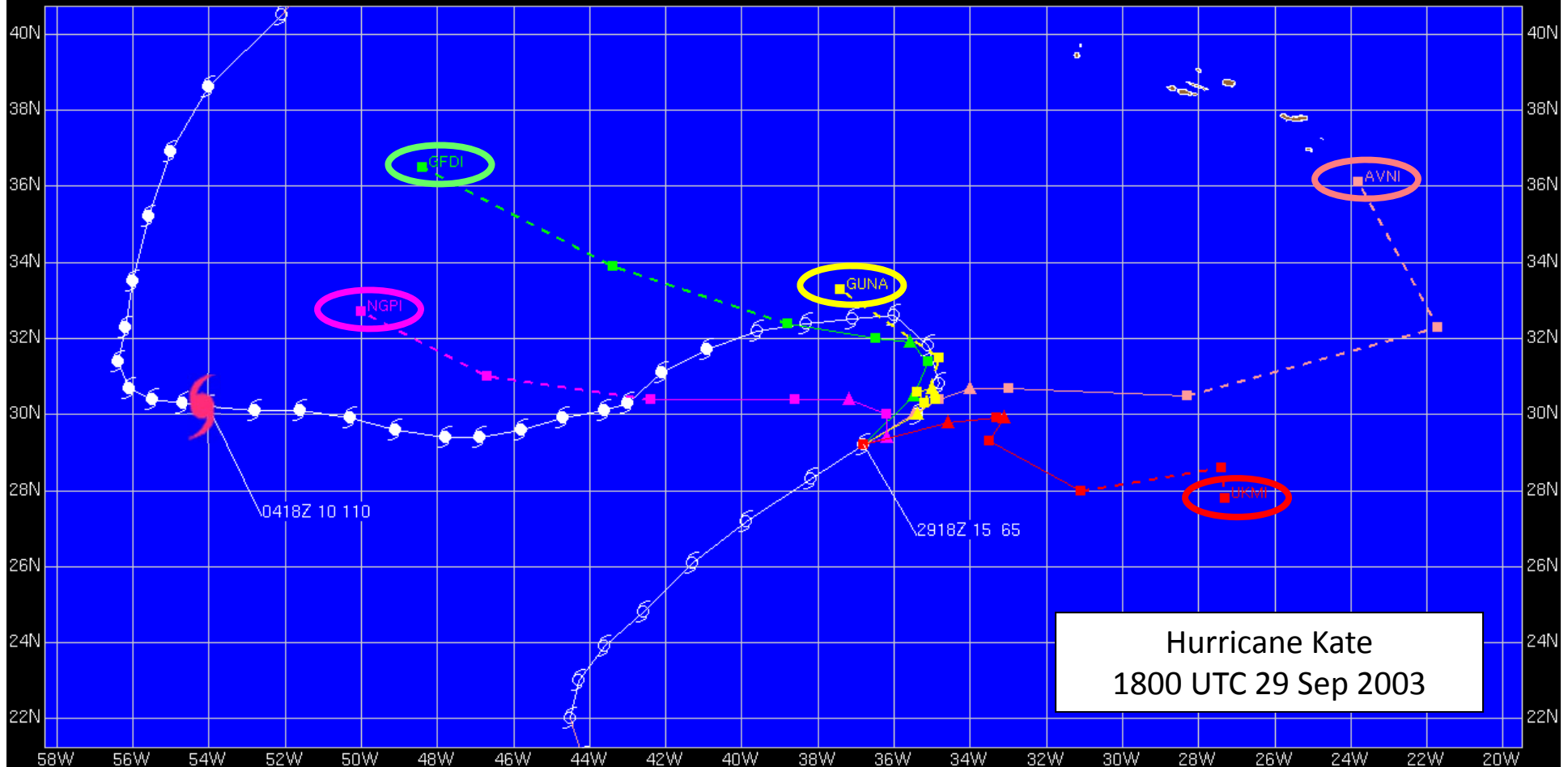
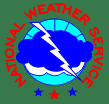


Power of Consensus





Consensus- Doesn't always work...



- Doesn't work when model scenarios are completely different
- Sometimes the forecaster might want to exclude certain models and form a "selective consensus", if the discrepancies among the models can be resolved
- Resolving these discrepancies is very difficult



Considerations of Track Forecasts



**Don't Make Any Sudden Moves!
(unless you really, really have to)**

- Previous official forecast exerts a strong constraint on the current forecast
 - Can damage credibility by making big changes from one forecast to the next, and then having to go back to the original

Windshield Wiper

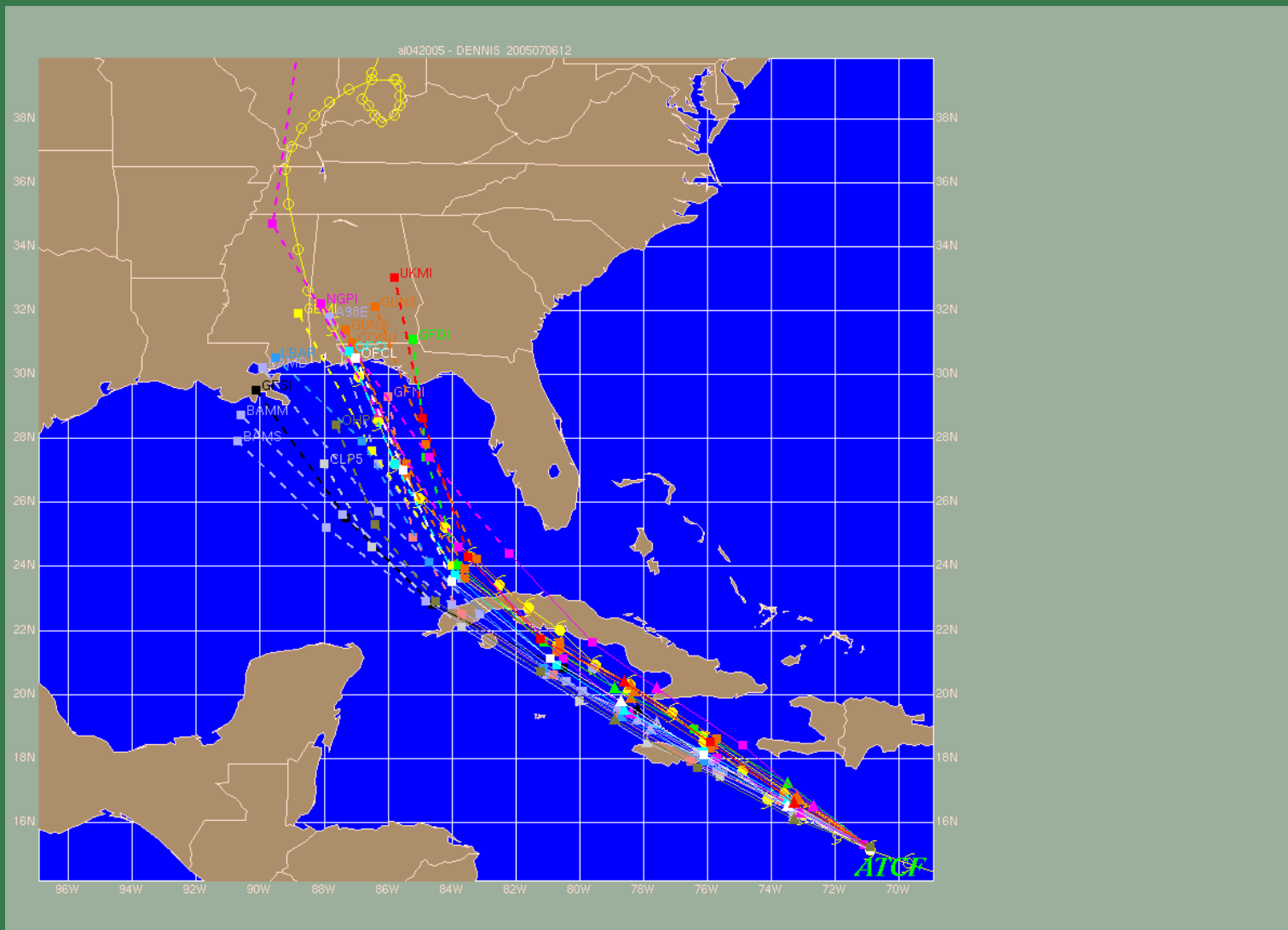


Tromboning

- Consequently, changes to the previous forecast normally made in small increments
- We also strive for continuity within a given forecast
 - Gradual changes in direction or speed from 12 to 24 to 36 h, etc.



Dennis Guidance 6 July 1200 UTC



Official forecast near model consensus in extreme western FL panhandle.



Dennis Guidance 6 July 1800 UTC



Guidance shifts sharply westward toward New Orleans. Official forecast nudged westward into AL.



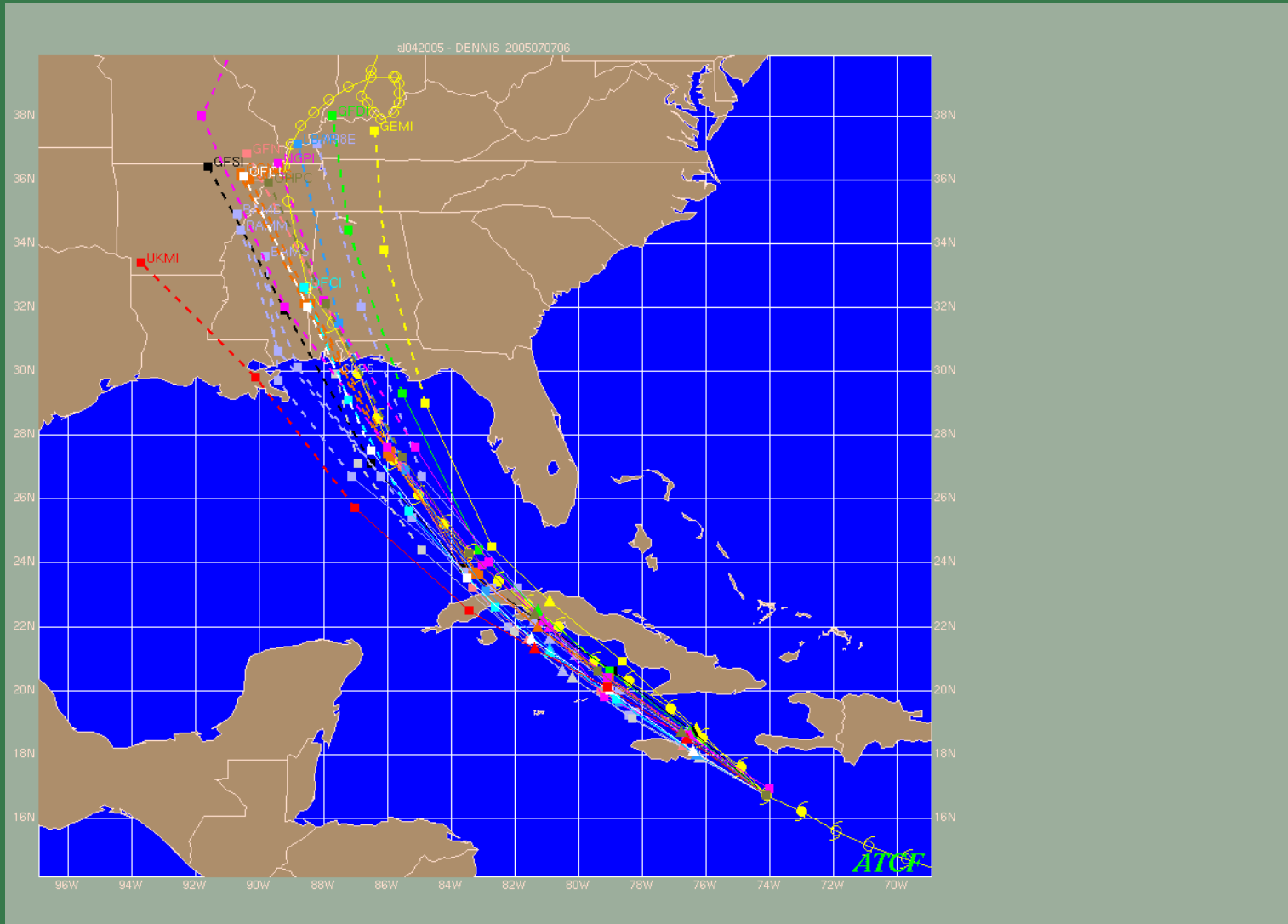
Dennis Guidance 7 July 0000 UTC



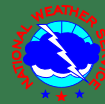
Little overall change to guidance, but NGPI shifts slightly eastward.
Little change in official forecast.



Dennis Guidance 7 July 0600 UTC



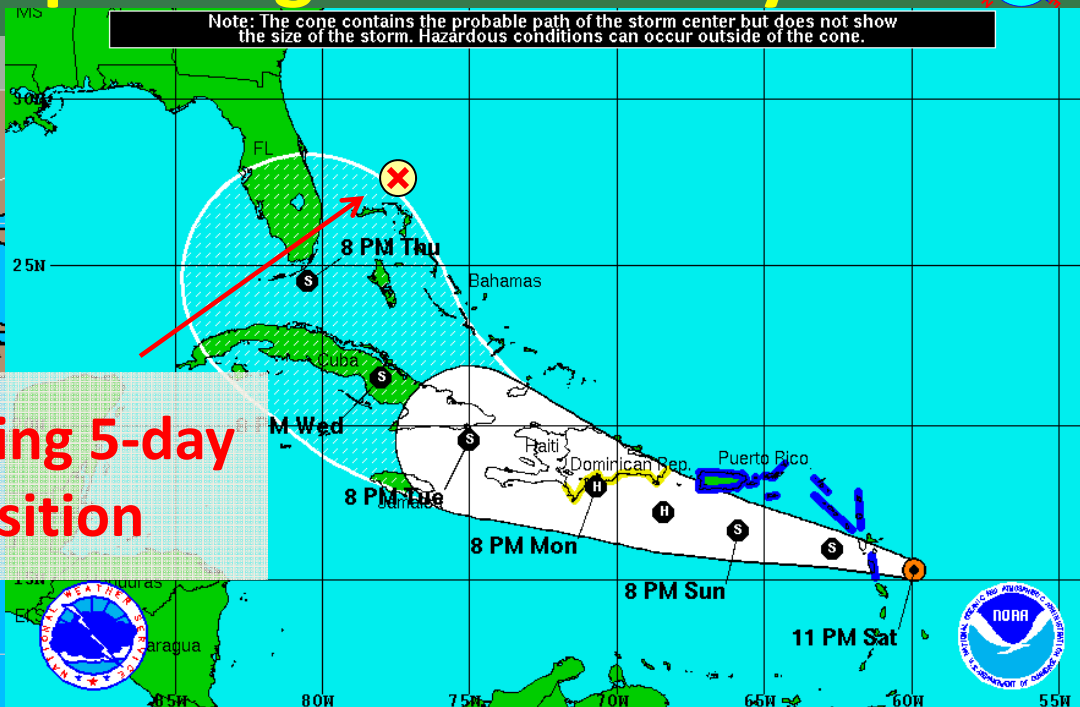
Rest of the guidance shifts sharply eastward, leaving official forecast near the center of the guidance envelope (and very close to the actual track of Dennis).



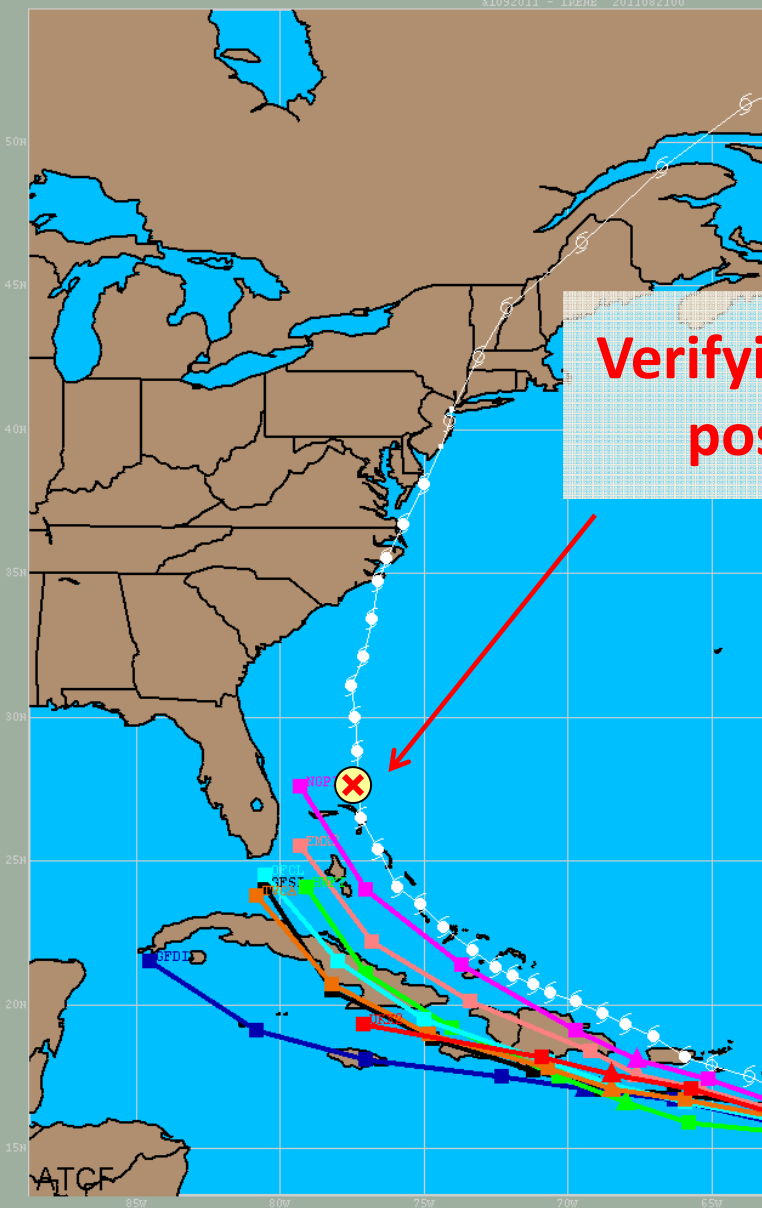
NHC Forecasts and Model Guidance for Hurricane Irene



Irene Guidance 11 pm Aug 20 - Advisory #2



Verifying 5-day position



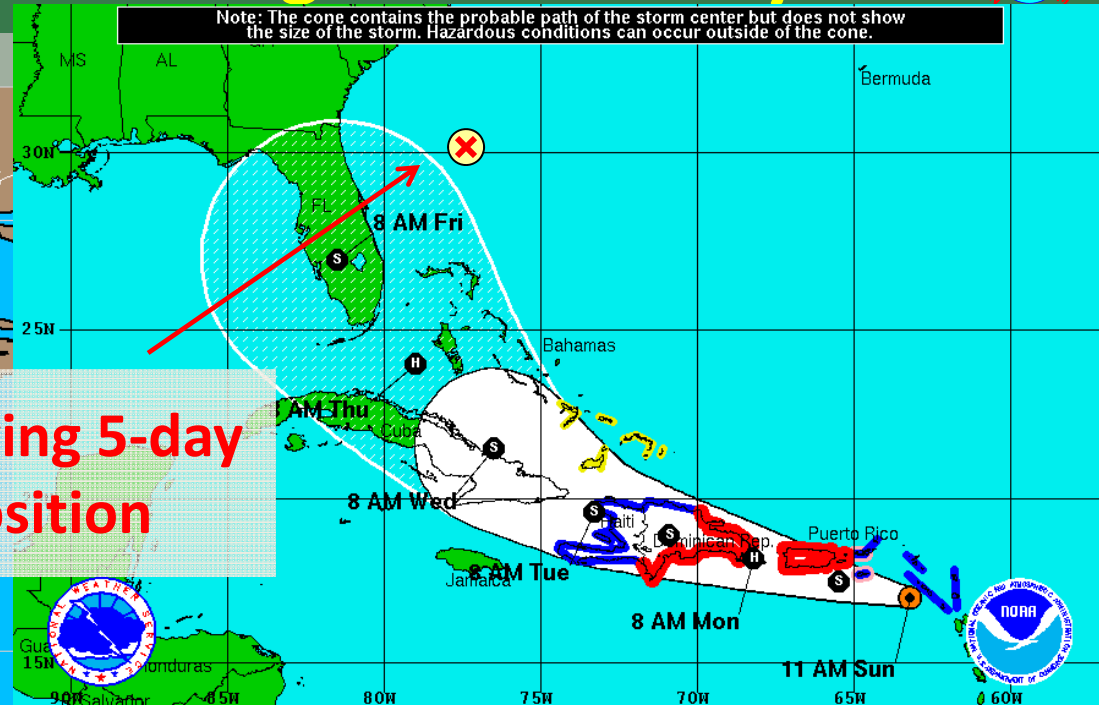
Tropical Storm Irene Saturday August 20, 2011 11 PM EDT Advisory 2 NWS National Hurricane Center	Current Information: Center Location 15.3 N 59.9 W Max Sustained Wind 50 mph Movement W at 22 mph	Forecast Positions: ● Tropical Cyclone ○ Post-Tropical Sustained Winds: D < 39 mph S 39-73 mph H 74-110 mph M > 110mph
Potential Track Area: ▨ Day 1-3 ▨ Day 4-5	Watches: ■ Hurricane ■ Trop.Storm	Warnings: ■ Hurricane ■ Trop.Storm

EXCERPT FROM NHC DISCUSSION

AFTER THAT TIME...A MID-LATITUDE TROUGH MOVING OFFSHORE OF THE SOUTHEASTERN UNITED STATES SHOULD CAUSE A WEAKNESS IN THE SUBTROPICAL RIDGE. HOW MUCH OF A WEAKNESS IS STILL UP FOR DEBATE...HOWEVER...WITH A VARIETY OF MODEL SOLUTIONS SHOWING LARGE TRACK SPREAD AT THE END OF THE FORECAST PERIOD..... THE GUIDANCE HAS SHIFTED SOMEWHAT TO THE WEST IN THE LATER PERIODS...AND IT SEEMS REASONABLE TO SHIFT THE NHC FORECAST IN THAT DIRECTION.



Irene Guidance 11 am Aug 21 - Advisory #4



Verifying 5-day position

Tropical Storm Irene
 Sunday August 21, 2011
 11 AM EDT Advisory 4
 NWS National Hurricane Center

Current Information:
 Center Location 17.0 N 63.2 W
 Max Sustained Wind 50 mph
 Movement WNW at 20 mph

Forecast Positions:
 ● Tropical Cyclone ○ Post-Tropical
 Sustained Winds: D < 39 mph
 S 39-73 mph H 74-110 mph M > 110mph

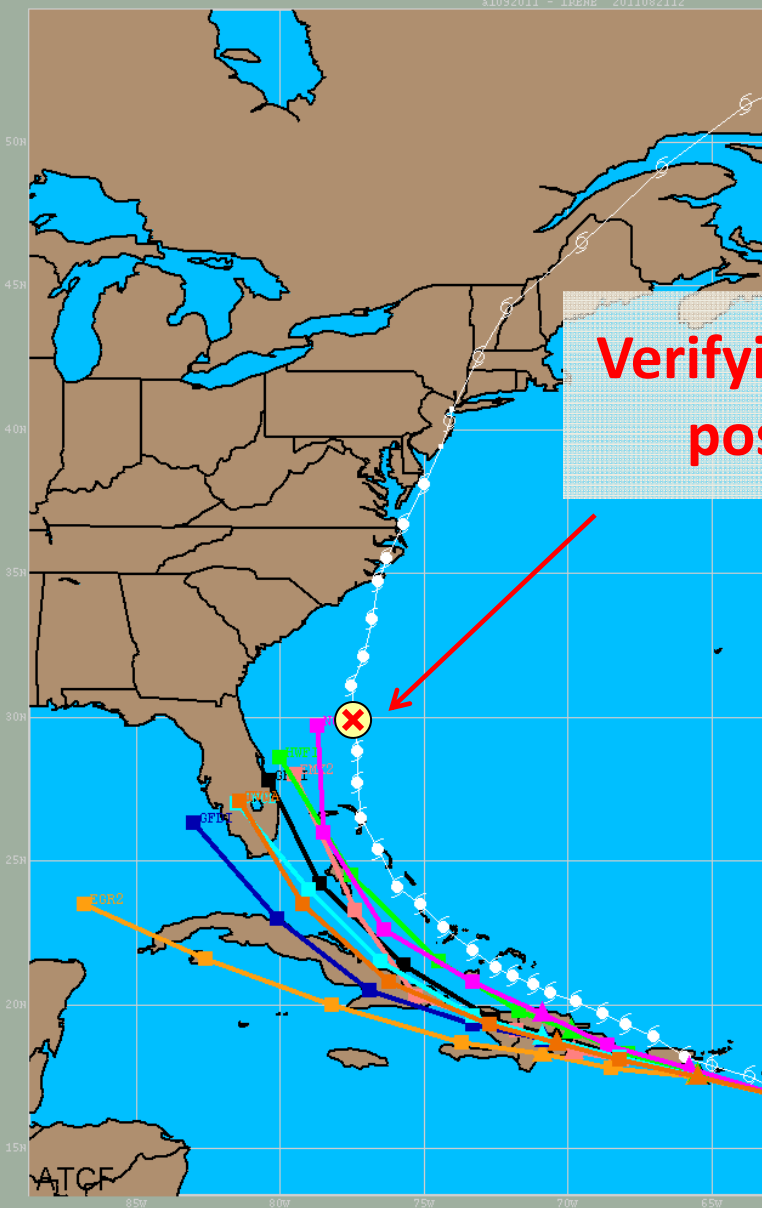
Potential Track Area:
 Day 1-3 Day 4-5

Watches:
 Hurricane Trop.Storm

Warnings:
 Hurricane Trop.Storm

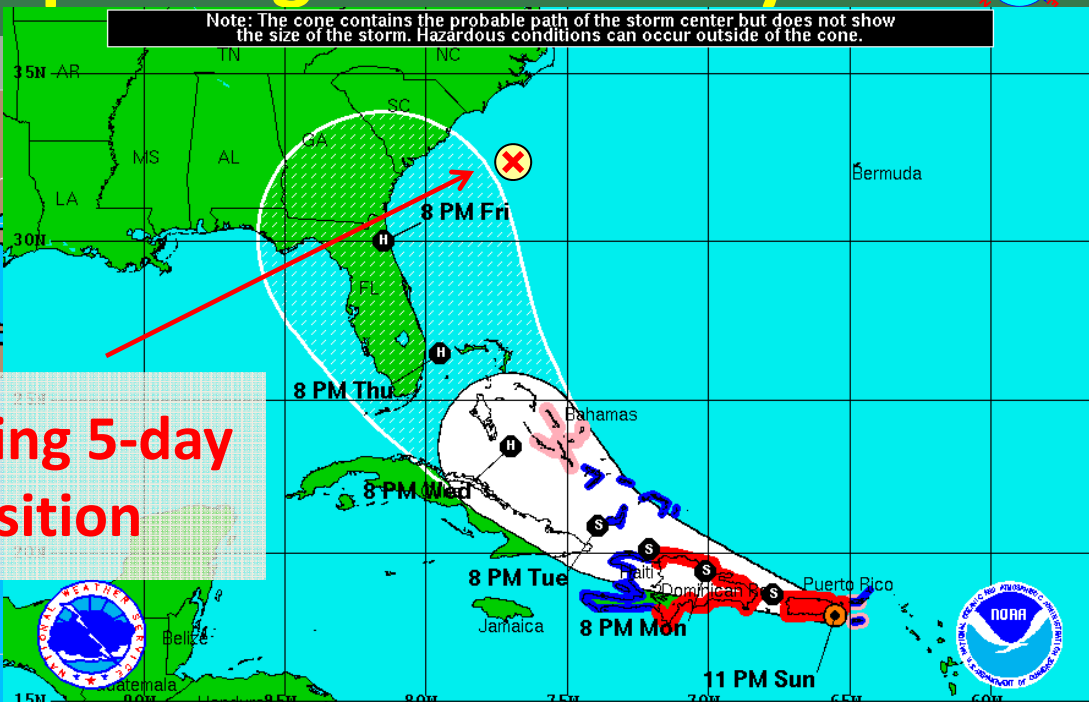
EXCERPT FROM NHC DISCUSSION

THERE IS A FAIR AMOUNT OF SPREAD IN THE TRACK GUIDANCE MODELS...ESPECIALLY AT DAYS 4 TO 5. FOR EXAMPLE...THE GFDL MODEL TAKES IRENE TO THE WEST OF THE FLORIDA PENINSULA WHILE THE HWRF MODEL TAKES IT THROUGH THE NORTHWESTERN BAHAMAS. **INTERESTS IN FLORIDA ARE ADVISED NOT TO FOCUS ON THE EXACT FORECAST TRACK BECAUSE OF THE INHERENT UNCERTAINTIES IN LONGER-RANGE FORECASTS.**



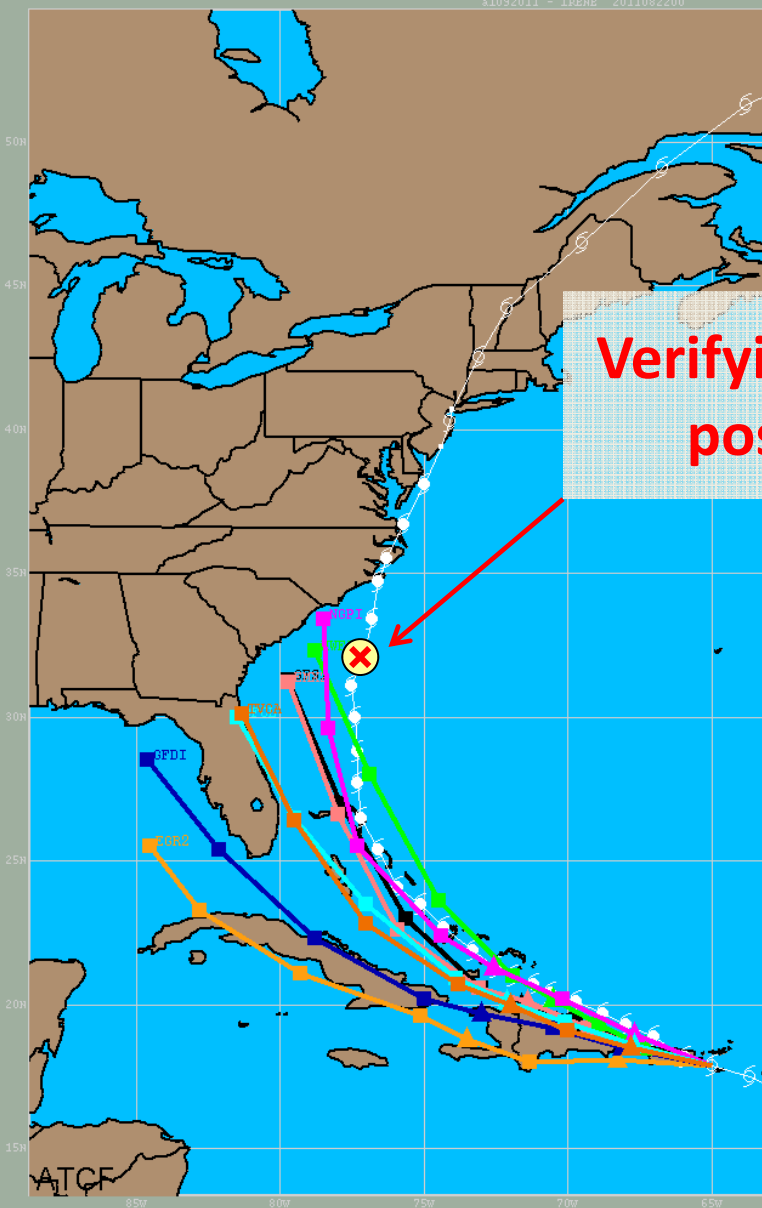


Irene Guidance 11 pm Aug 21 - Advisory #6



Note: The cone contains the probable path of the storm center but does not show the size of the storm. Hazardous conditions can occur outside of the cone.

Verifying 5-day position



Tropical Storm Irene
 Sunday August 21, 2011
 11 PM EDT Advisory 6
 NWS National Hurricane Center

Current Information: ● Tropical Cyclone ○ Post-Tropical
 Center Location 17.9 N 65.5 W
 Max Sustained Wind 70 mph
 Sustained Winds: D < 39 mph

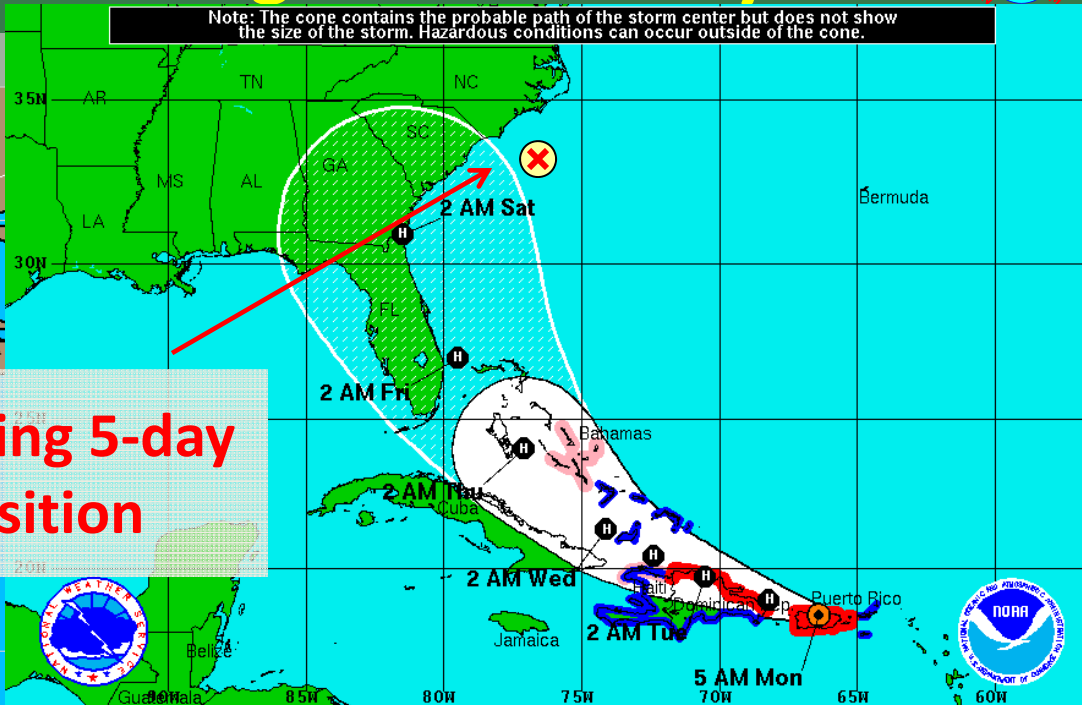
Potential Track A
 Day 1-3

EXCERPT FROM NHC DISCUSSION

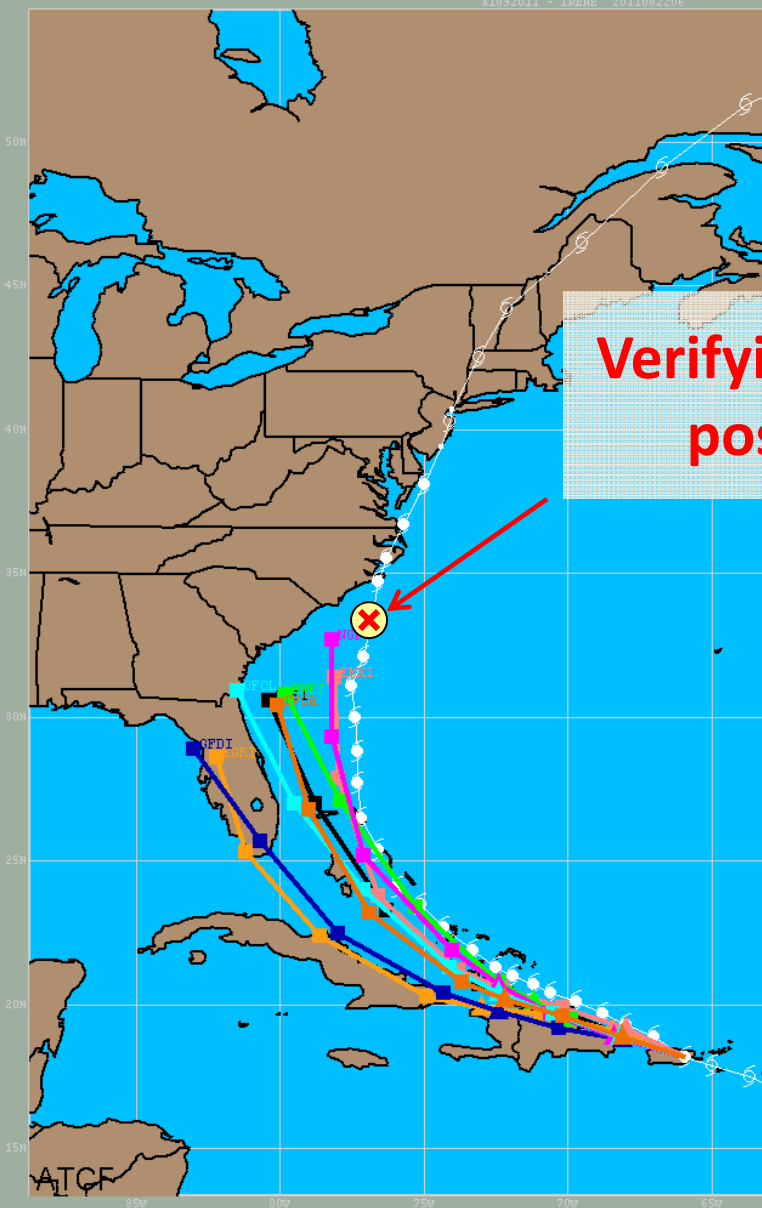
MOST OF THE GUIDANCE...WITH THE EXCEPTION OF THE GFDL AND UKMET...ARE IN RELATIVELY GOOD AGREEMENT ON TURNING IRENE NORTHWESTWARD INTO THE BREAK IN THE RIDGE IN 2 OR 3 DAYS. HOWEVER...SIGNIFICANT SPREAD REMAINS IN THE SHARPNESS OF THIS TURN IN THE MODEL SUITE. FOR THIS CYCLE THE CONSENSUS TRACK MODELS HAVE SHIFTED BACK A LITTLE TO THE LEFT...WITH THE GFS...ECMWF...AND HWRF MODELS ON THE EAST SIDE OF THE GUIDANCE ENVELOPE AND THE AFOREMENTIONED UKMET AND GFDL FARTHER WEST. **THE OFFICIAL FORECAST HAS BEEN NUGGED TO THE RIGHT...TOWARD BUT STILL TO THE LEFT OF THE MODEL CONSENSUS...AND LIES CLOSE TO THE FIM MODEL PROVIDED BY THE HURRICANE FORECAST IMPROVEMENT PROJECT.**



Irene Guidance 5 am Aug 22 - Advisory #7



Verifying 5-day position



Hurricane Irene Monday August 22, 2011 5 AM EDT Advisory 7 NWS National Hurricane Center	Current Information: Center Location 18.4 N 66.4 W Max Sustained Wind 75 mph Movement WNW at 12 mph	Forecast Positions: ● Tropical Cyclone ○ Post-Tropical Sustained Winds: D < 39 mph S 39-73 mph H 74-110 mph M > 110mph
Potential Track Area: Day 1-3 Day 4-5	Watches: Hurricane Trop.Storm	Warnings: Hurricane Trop.Storm

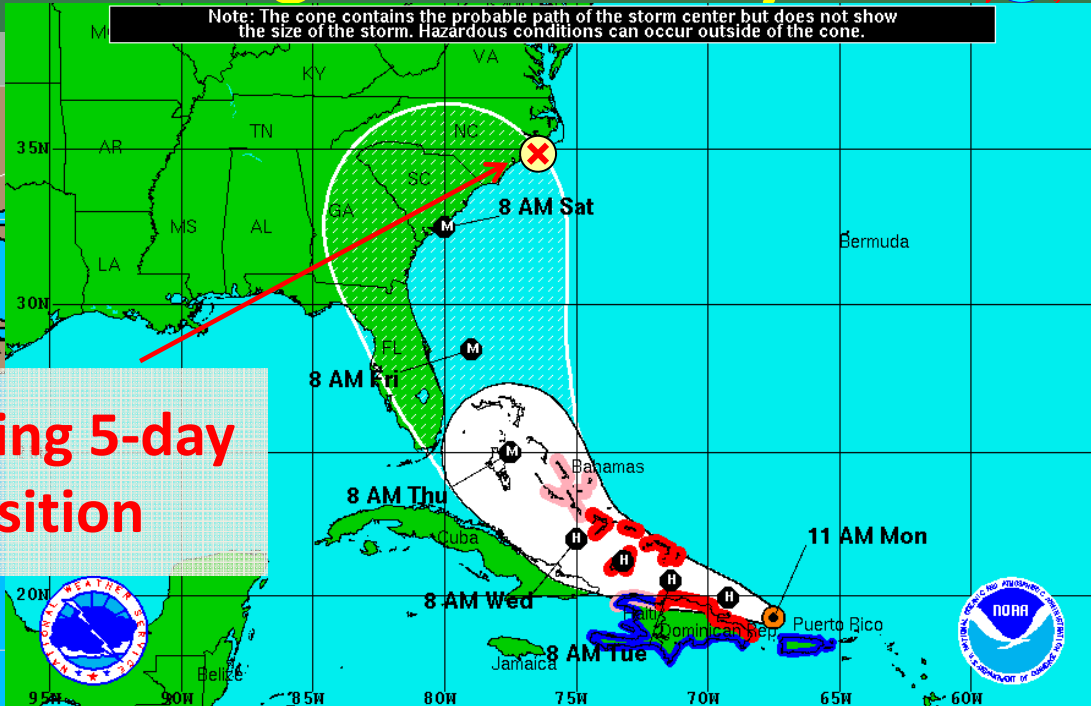
EXCERPT FROM NHC DISCUSSION

.THE GLOBAL MODELS DIVERGE ON THE SPECIFICS OF HOW LARGE A BREAK OR WEAKNESS IN THE SUBTROPICAL RIDGE DEVELOPS OVER FLORIDA AND THE SOUTHEASTERN U.S. AT 72 HOUR AND BEYOND...WHICH WILL ALLOW IRENE TO MOVE NORTHWESTWARD..... AS A RESULT...THE OFFICIAL FORECAST TRACK WAS ONLY SHIFTED SLIGHTLY TO THE EAST OF THE PREVIOUS TRACK AND IS NEAR THE CONSENSUS MODELS TVCN AND TVCA.

KNHC



Irene Guidance 11 am Aug 22 - Advisory #8



Hurricane Irene
 Monday August 22, 2011
 11 AM EDT Advisory 8
 NWS National Hurricane Center

Current Information:
 Center Location 19.2 N 67.5 W
 Max Sustained Wind 80 mph
 Movement WNW at 13 mph

Forecast Positions:
 ● Tropical Cyclone ○ Post-Tropical
 Sustained Winds: D < 39 mph
 S 39-73 mph H 74-110 mph M > 110mph

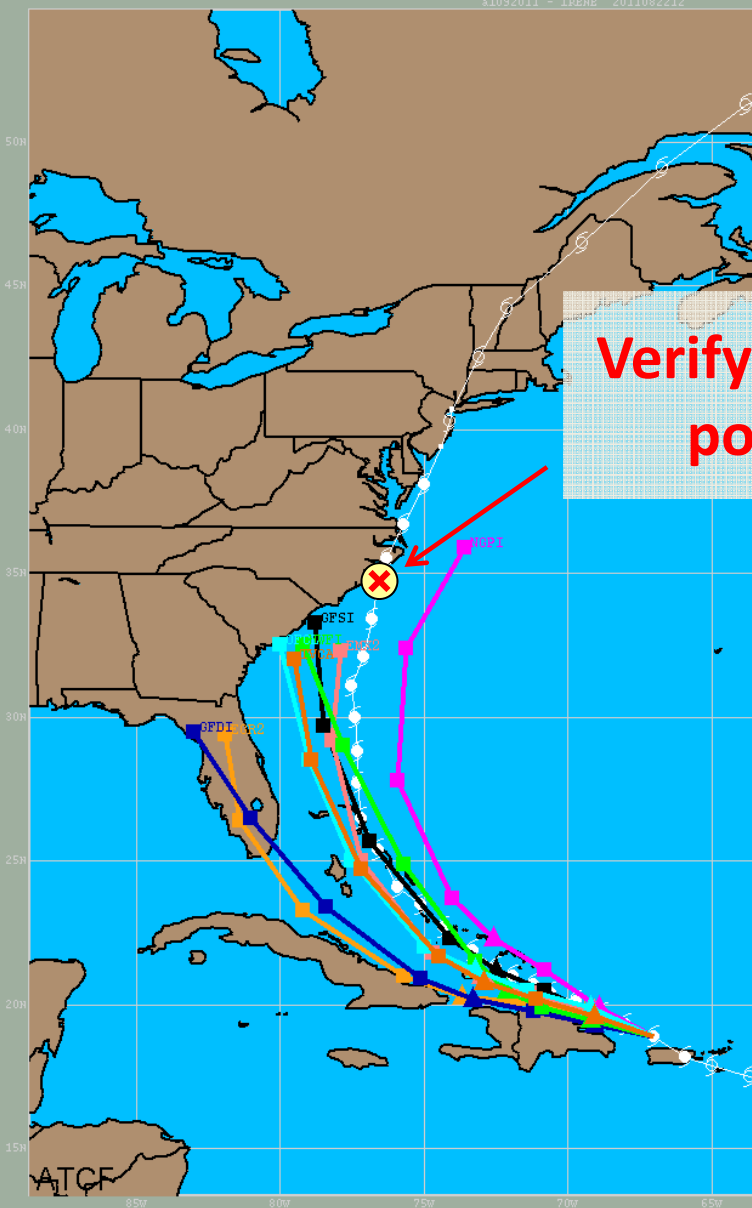
Verifying 5-day position

Potential Track A
 Day 1-3

EXCERPT FROM NHC DISCUSSION

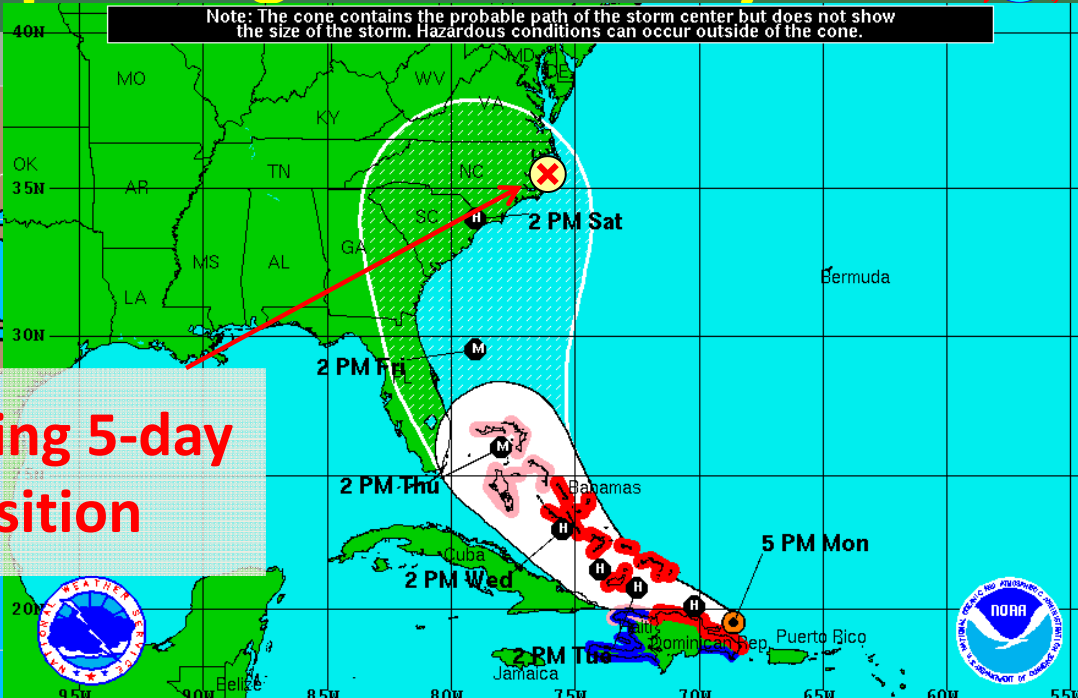
MOST OF THE GLOBAL MODELS SHOW THE GRADUAL DEVELOPMENT A LARGE UPPER TROUGH ALONG THE UNITED STATES EAST COAST. THIS PATTERN WILL INDUCE A MORE NORTHWESTWARD AND THEN NORTHWARD TRACK THROUGH THE FORECAST PERIOD WITH A DECREASE IN FORWARD SPEED. BASED ON THE LATEST GUIDANCE... **THE OFFICIAL TRACK FORECAST HAS BEEN SHIFTED TO THE EAST...BUT STILL REMAINS SLIGHTLY WEST OF THE MODEL CONSENSUS.**

DO NOT TO FOCUS ON THE EXACT FORECAST TRACK...ESPECIALLY AT DAYS 4 TO 5...SINCE THE MOST RECENT 5-YEAR AVERAGE ERRORS AT THOSE FORECAST TIMES ARE 200 AND 250 MILES...RESPECTIVELY.



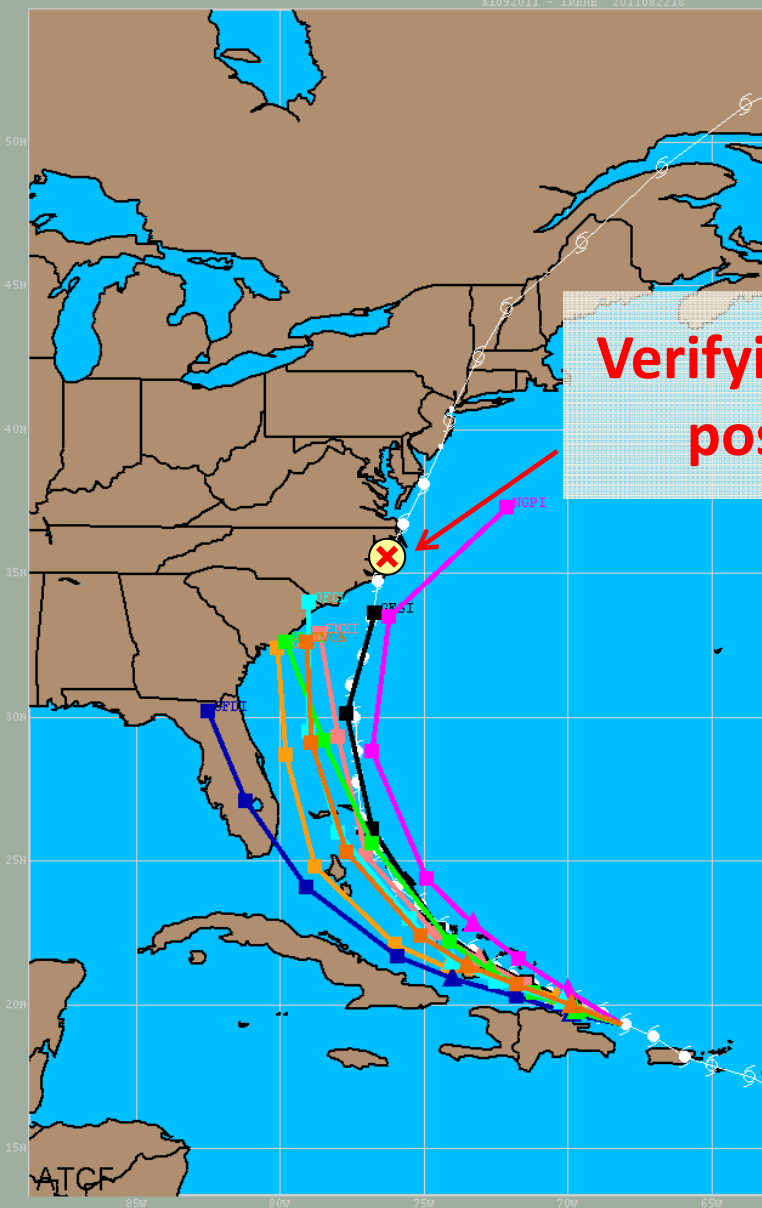


Irene Guidance 5 pm Aug 22 - Advisory #9



Note: The cone contains the probable path of the storm center but does not show the size of the storm. Hazardous conditions can occur outside of the cone.

Verifying 5-day position



Hurricane Irene
 Monday August 22, 2011
 5 PM EDT Advisory 9
 NWS National Hurricane Center

Current Information: ●
 Center Location 19.5 N 68.6 W
 Max Sustained Wind 80 mph
 Movement WNW at 13 mph

Forecast Positions:
 ● Tropical Cyclone ○ Post-Tropical
 Sustained Winds: D < 39 mph
 S 39-73 mph H 74-110 mph M > 110mph

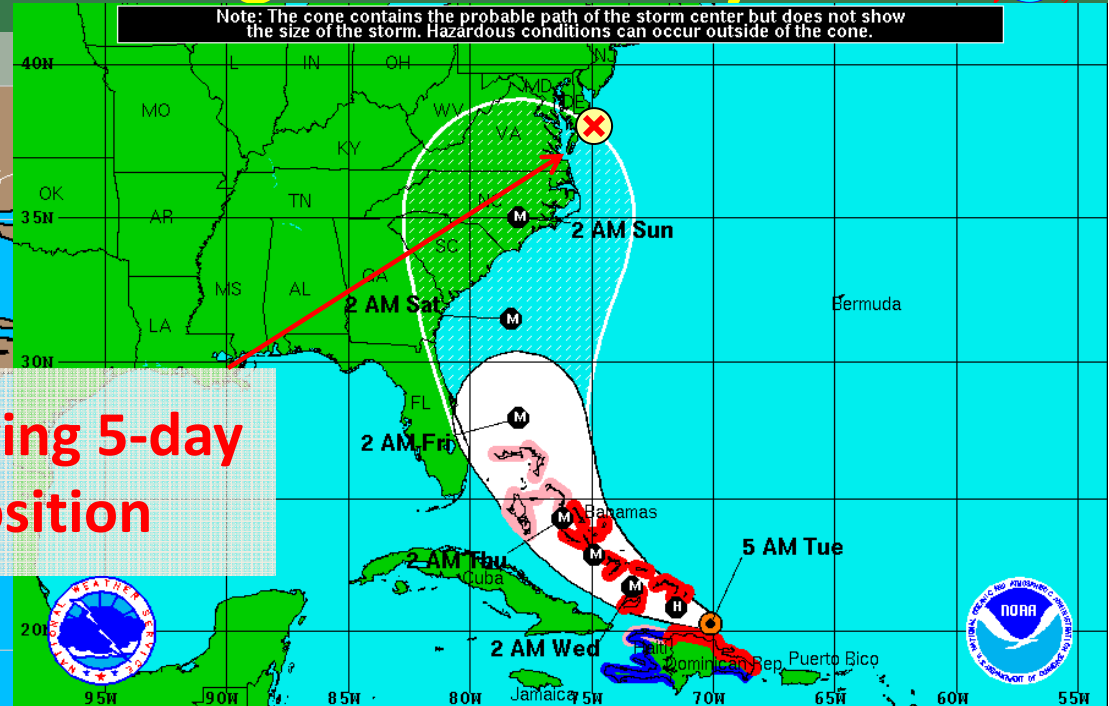
Potential Track A
 Day 1-3

EXCERPT FROM NHC DISCUSSION

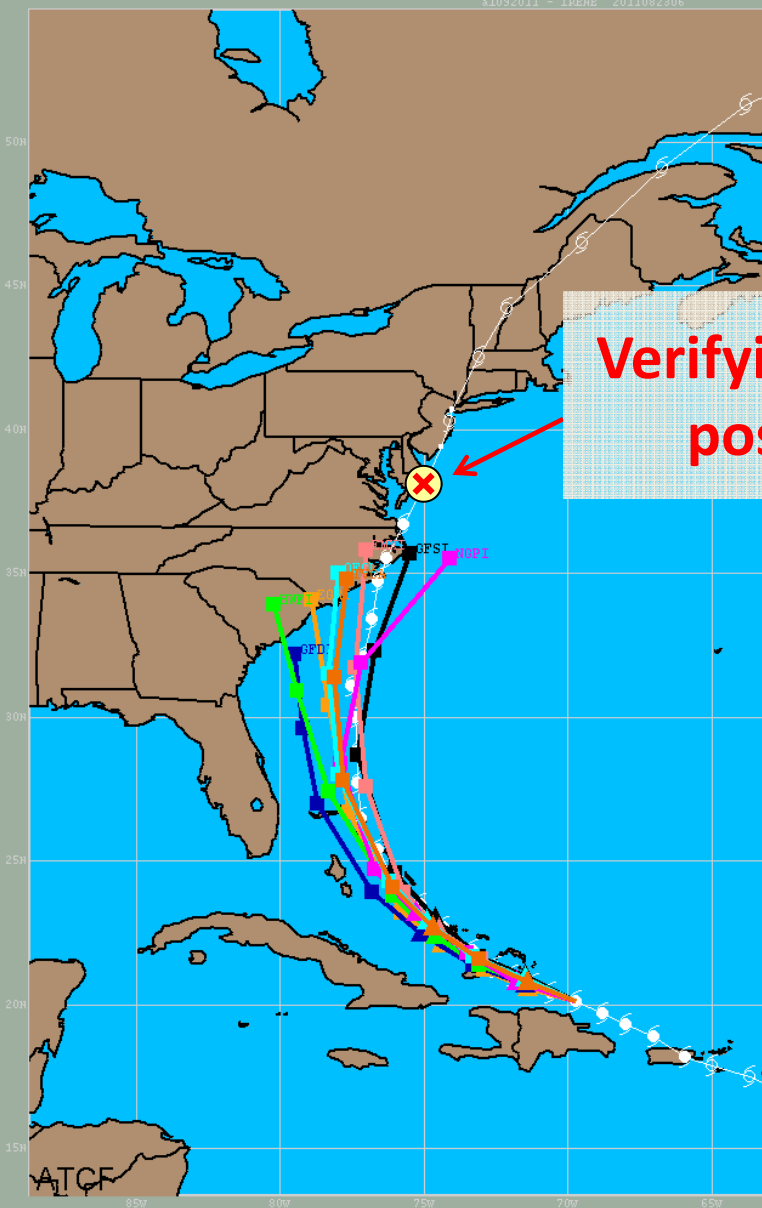
THE FUTURE TRACK WILL DEPEND ON THE DEVELOPMENT OF A LARGE MID- TO UPPER-LEVEL TROUGH ALONG THE EAST COAST OF THE UNITED STATES. THIS PATTERN WILL INDUCE A GRADUAL NORTHWESTWARD AND THEN NORTHWARD TRACK THROUGH THE FORECAST PERIOD WITH A SLIGHT DECREASE IN FORWARD SPEED. **THERE IS MORE CONFIDENCE IN THE FORECAST SINCE MOST OF THE TRACK MODELS... WITH THE EXCEPTION OF THE GFDL...HAVE NOW FOLLOWED THE LEAD OF THE ECMWF MODEL.** THE GUIDANCE IS NOW IN BETTER AGREEMENT IN TURNING IRENE NORTHWARD ALONG 78 OR 79 DEGREES LONGITUDE. **ALTHOUGH IT IS STILL TOO EARLY TO BE CERTAIN...THE GUIDANCE TREND CONTINUES TO LESSENS THE THREAT TO SOUTH FLORIDA BUT INCREASES THE THREAT TO THE CAROLINAS.**



Irene Guidance 5 am Aug 23 - Advisory #12



Verifying 5-day position



Hurricane Irene Tuesday August 23, 2011 5 AM EDT Advisory 12 NWS National Hurricane Center	Current Information: Center Location 20.3 N 70.1 W Max Sustained Wind 100 mph Movement WNW at 12 mph	Forecast Positions: ● Tropical Cyclone ○ Post-Tropical Sustained Winds: D < 39 mph S 39-73 mph H 74-110 mph M > 110mph
Potential Track Area: Day 1-3 Day 4-5	Watches: Hurricane Trop Storm	Warnings: Hurricane Trop Storm

EXCERPT FROM NHC DISCUSSION

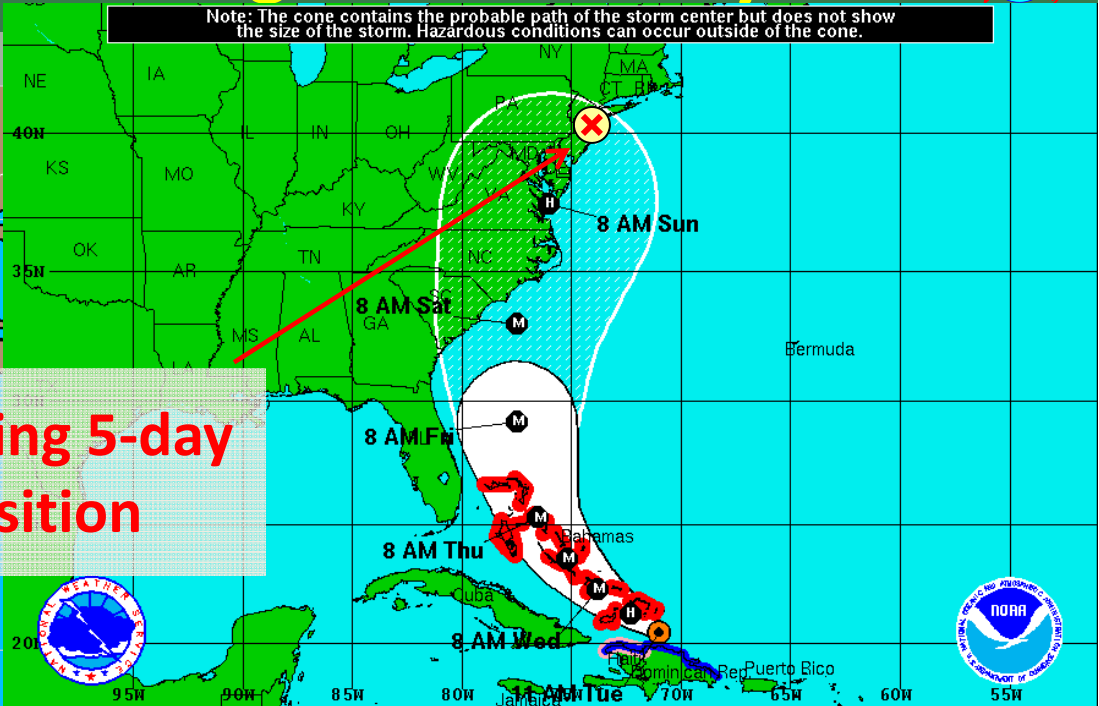
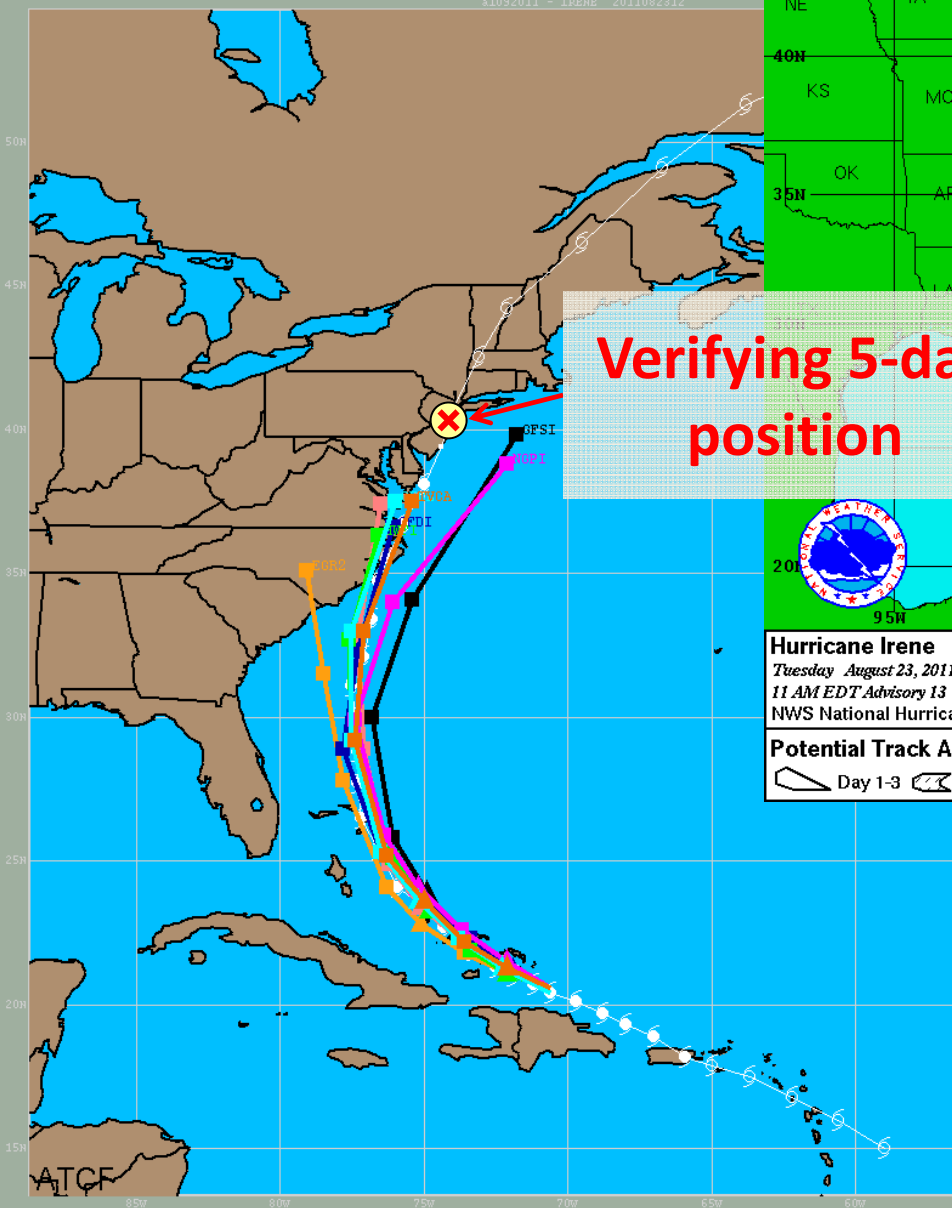
THE 23/00Z G-IV JET AIRCRAFT AND AIR FORCE C-130 DROPSONDE DATA APPEAR TO HAVE SETTLED DOWN THE MODELS...AND THERE IS CONSIDERABLY LESS DIFFERENCE AMONG THE VARIOUS MODEL SOLUTIONS NOW. THE OVERWHELMING CONSENSUS IS THAT IRENE WILL GRADUALLY TURN NORTHWESTWARD OVER THE NEXT 2-3 DAYS AND THEN MOVE NORTHWARD THROUGH A DEVELOPING BREAK IN THE SUBTROPICAL RIDGE OVER THE SOUTHEASTERN UNITED STATES. THE OFFICIAL FORECAST TRACK IS SIMILAR TO THE PREVIOUS ADVISORY AND LIES VERY CLOSE TO CONSENSUS MODELS TVCN AND TVCA.



Irene Guidance 11 am Aug 23 - Advisory #13



Note: The cone contains the probable path of the storm center but does not show the size of the storm. Hazardous conditions can occur outside of the cone.



Hurricane Irene
 Tuesday August 23, 2011
 11 AM EDT Advisory 13
 NWS National Hurricane Center

Potential Track Area
 Day 1-3

Current Information:
 Center Location 20.5 N 71.0 W
 Max Sustained Wind 100 mph

Forecast Positions:
 Tropical Cyclone ● Sustained Winds: D < 39 mph
 Post-Tropical ○ Sustained Winds: D < 39 mph

EXCERPT FROM NHC DISCUSSION

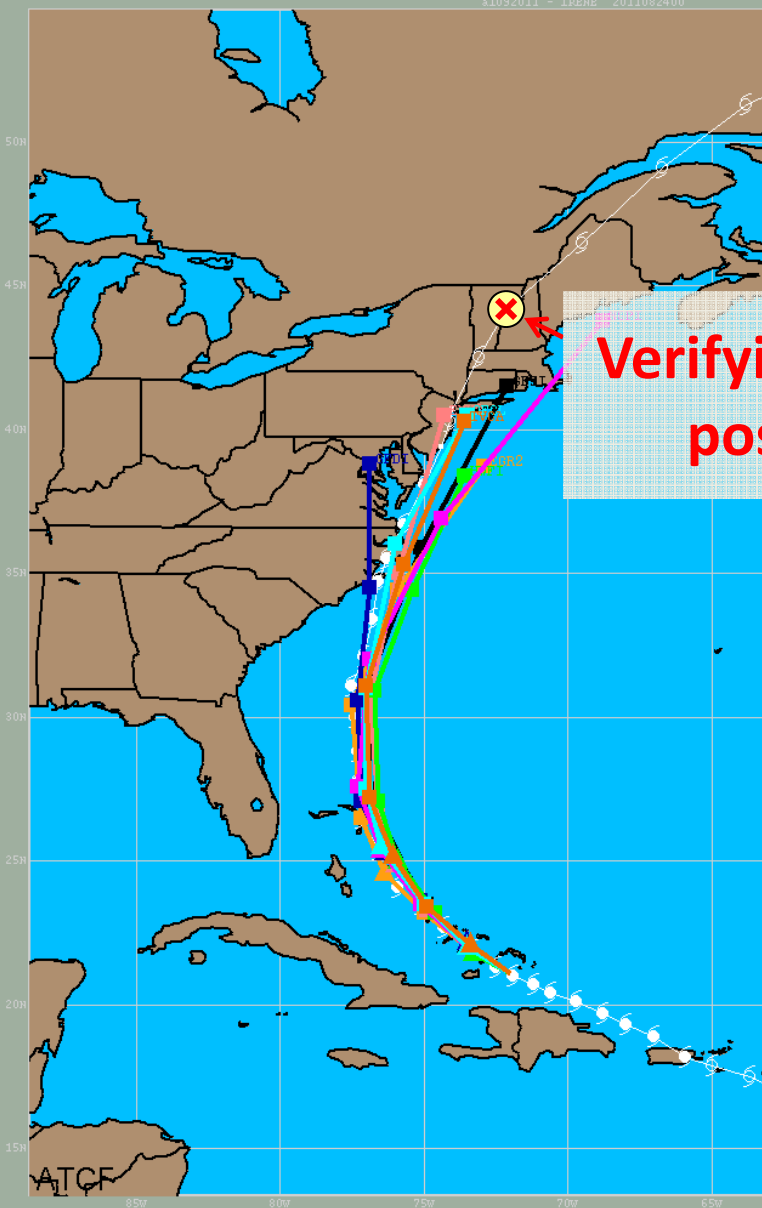
...AND THE TRACK GUIDANCE IS IN EXCELLENT AGREEMENT DURING THE FIRST 48 HOURS. LATER IN THE FORECAST PERIOD IRENE IS FORECAST TO TURN NORTHWARD AS IT ROUNDS THE WESTERN PORTION OF THE RIDGE. **THE SPREAD IN THE GUIDANCE INCREASES BY DAY THREE...RANGING FROM THE COASTAL MID-ATLANTIC STATES TO WELL OFFSHORE...WITH THE UKMET ALONG THE LEFT SIDE AND THE GFS/NOGAPS ALONG THE RIGHT SIDE OF THE GUIDANCE ENVELOPE.** THE UPDATED TRACK IS CLOSEST TO THE ECMWF AND IS A LITTLE LEFT OF THE MULTI-MODEL CONSENSUS. IT IS IMPORTANT TO REMIND USERS NOT TO FOCUS ON THE EXACT FORECAST TRACK...ESPECIALLY AT DAYS 4 AND 5...SINCE THE MOST RECENT 5-YEAR AVERAGE ERRORS AT THOSE FORECAST TIMES ARE 200 AND 250 MILES...RESPECTIVELY.



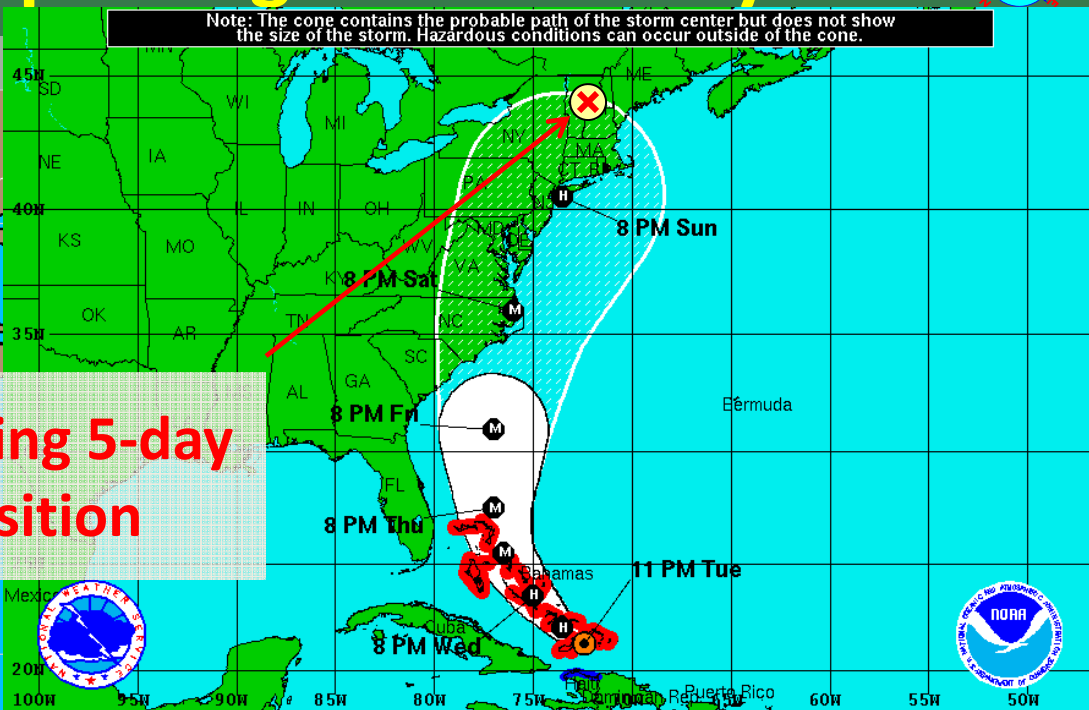
Irene Guidance 11 pm Aug 23 - Advisory #15



Note: The cone contains the probable path of the storm center but does not show the size of the storm. Hazardous conditions can occur outside of the cone.



Verifying 5-day position



Hurricane Irene Tuesday August 23, 2011 11 PM EDT Advisory 15 NWS National Hurricane Center	Current Information: Center Location 21.3 N 72.4 W Max Sustained Wind 90 mph Movement WNW at 9 mph	Forecast Positions: ● Tropical Cyclone ○ Post-Tropical Sustained Winds: D < 39 mph S 39-73 mph H 74-110 mph M > 110mph
Potential Track Area: Day 1-3 Day 4-5	Watches: Hurricane Trop.Storm	Warnings: Hurricane Trop.Storm

EXCERPT FROM NHC DISCUSSION

THE TRACK GUIDANCE IS IN BETTER AGREEMENT TONIGHT AND EVEN THE STUBBORN GFDL WHICH PREVIOUSLY INSISTED ON BRINGING IRENE TOWARD FLORIDA HAS NOW SHIFTED EASTWARD AND HAS JOINED THE OTHER DYNAMICAL MODELS. THIS INCREASES THE CONFIDENCE IN THE TRACK FORECAST EVEN MORE.

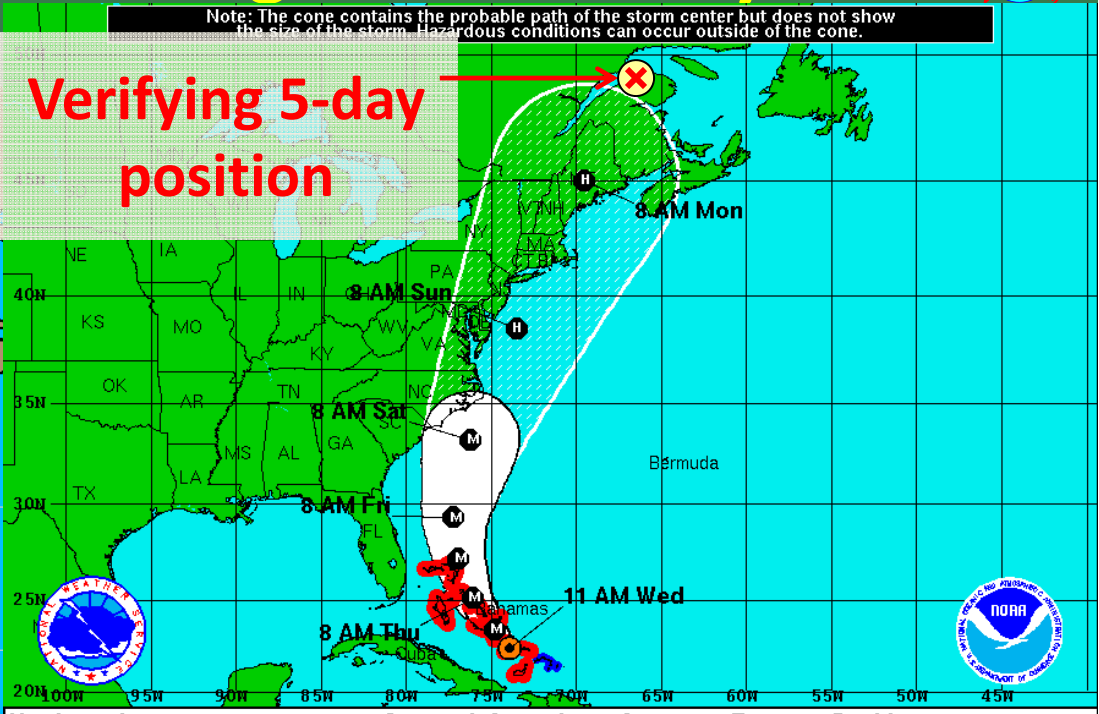
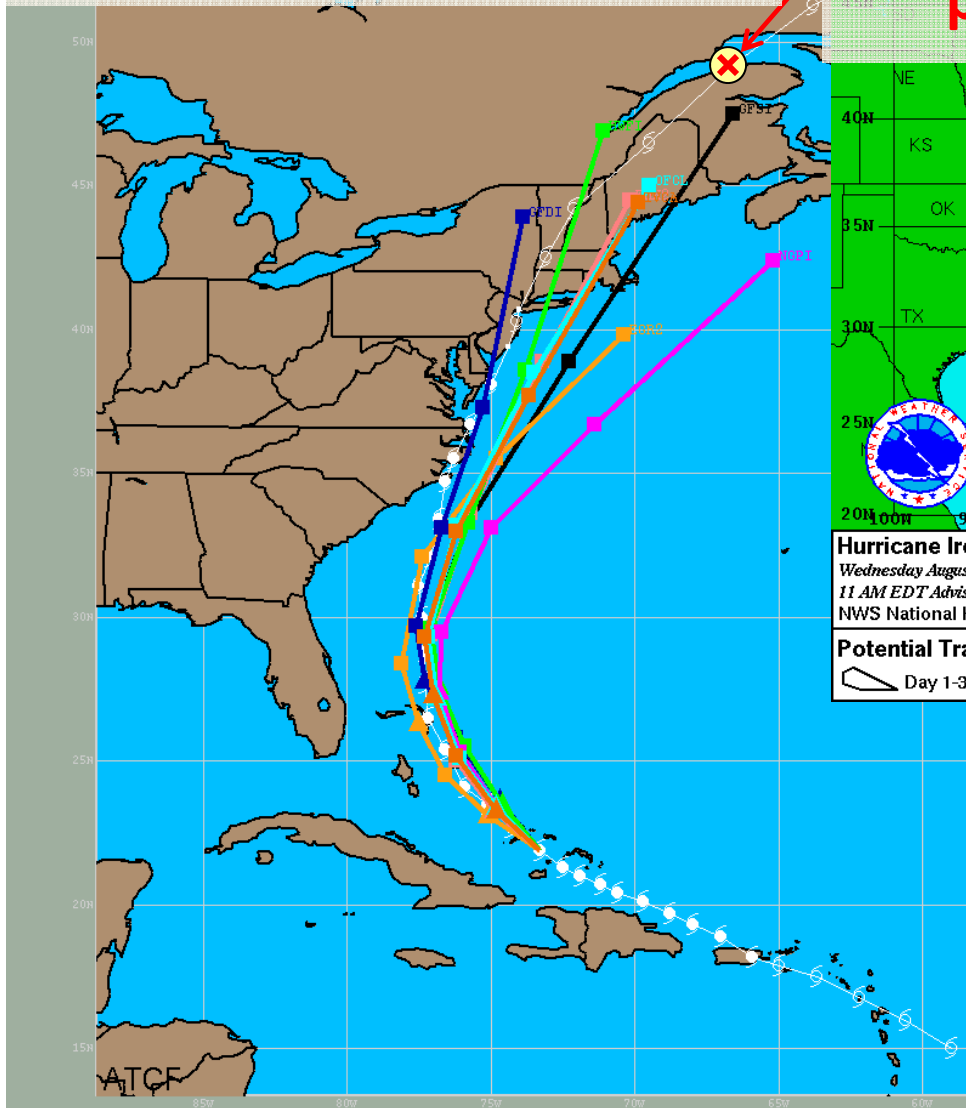
KNHC



Irene Guidance 11 am Aug 24 - Advisory #17



Yikes- Guidance shifts eastward- farther offshore



Hurricane Irene
 Wednesday August 24, 2011
 11 AM EDT Advisory 17
 NWS National Hurricane

Potential Track Ar
 Day 1-3

EXCERPT FROM NHC DISCUSSION

THE MODEL GUIDANCE REMAINS IN EXCELLENT AGREEMENT FOR THE FIRST 2-3 DAYS. AFTER THAT TIME...THERE IS SOME QUESTION AS TO WHETHER OR NOT IRENE CONTINUES ON A NORTH-NORTHEAST HEADING OR TURNS BACK TOWARD THE NORTH AHEAD OF A MID-LATITUDE TROUGH APPROACHING THE GREAT LAKES REGION. THE GFDL AND HWRF MODELS REMAIN ALONG THE WEST SIDE OF THE GUIDANCE ENVELOPE AND SHOW A TRACK OVER OR VERY CLOSE TO THE MID-ATLANTIC COAST. THE UKMET AND NOGAPS ARE ALONG THE EASTERN SIDE AND KEEP THE CORE OF THE HURRICANE WELL OFFSHORE. GIVEN THE TYPICAL MODEL AND OFFICIAL TRACK ERRORS...BOTH SCENARIOS ARE VIABLE OPTIONS AT THIS TIME...AND USERS ARE ONCE AGAIN REMINDED NOT TO FOCUS ON SPECIFIC FORECAST POINTS THREE TO FIVE DAYS DOWNSTREAM.

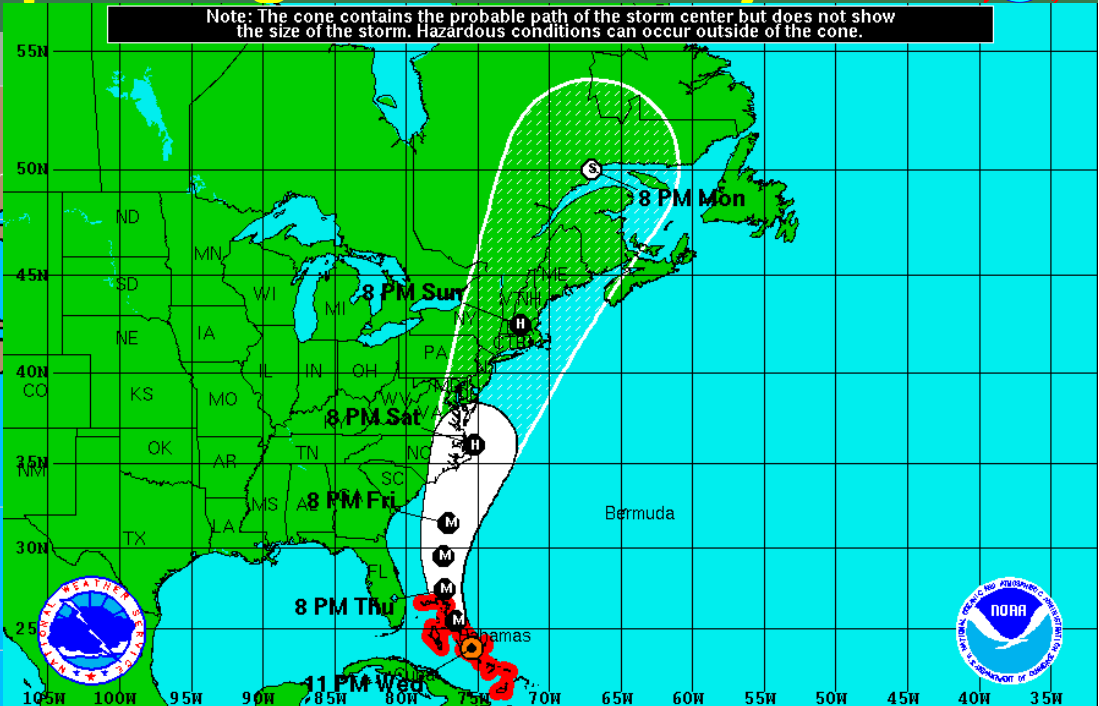
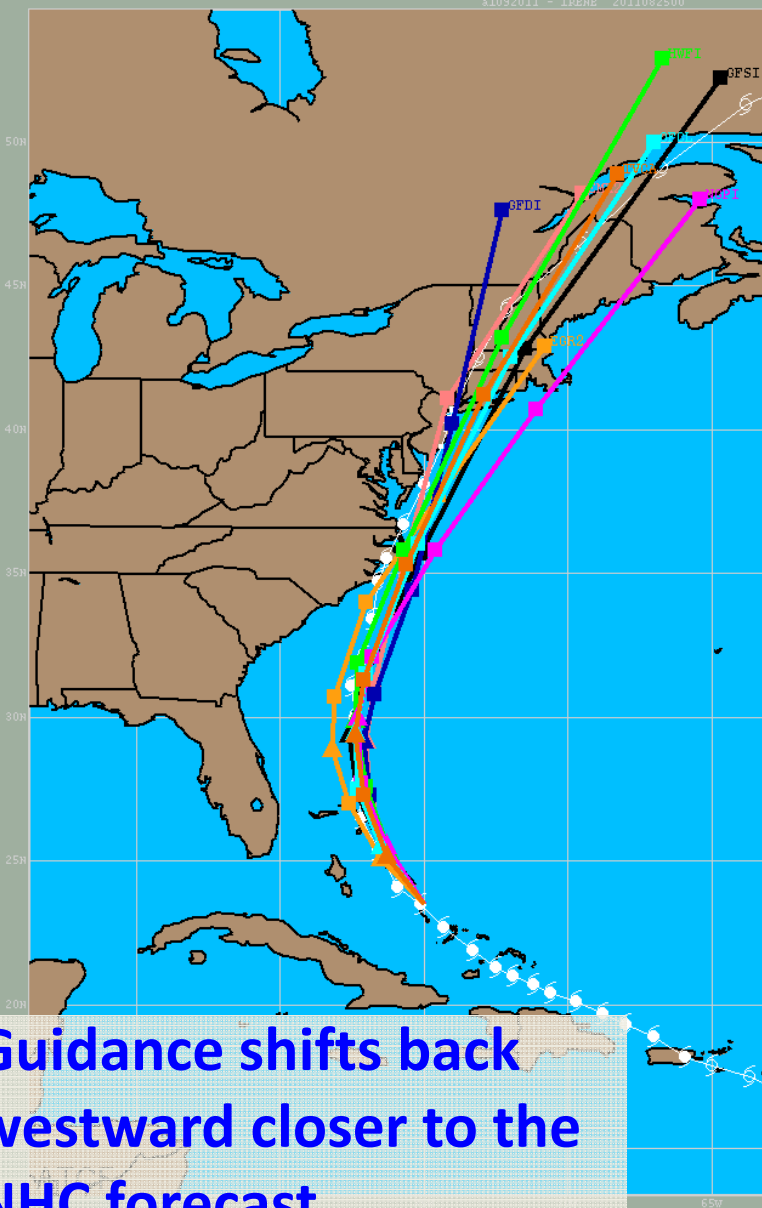
Note: The cone contains the probable path of the storm center but does not show the size of the storm. Hazardous conditions can occur outside of the cone.



Irene Guidance 11 pm Aug 24 - Advisory #19



Note: The cone contains the probable path of the storm center but does not show the size of the storm. Hazardous conditions can occur outside of the cone.



Hurricane Irene Wednesday August 24, 2011 11 PM EDT Advisory 19 NWS National Hurricane Center	Current Information: Center Location 23.8 N 75.4 W Max Sustained Wind 120 mph Movement NW at 12 mph	Forecast Positions: ● Tropical Cyclone ○ Post-Tropical Sustained Winds: D < 39 mph S 39-73 mph H 74-110 mph M > 110mph
Potential Track Area: Day 1-3	Watches:	Warnings:

EXCERPT FROM NHC DISCUSSION

THE DEVELOPMENT OF THE LARGE TROUGH ALONG THE EAST COAST OF THE UNITED STATES IS MATERIALIZING AS PREDICTED BY THE GLOBAL MODELS. THIS STEERING PATTERN WILL FORCE IRENE TO TURN TOWARD THE NORTH-NORTHWEST AND THE NORTH WITH A SLIGHT INCREASE IN FORWARD SPEED OVER THE NEXT FEW DAYS. THE LATEST GUIDANCE HAS CHANGED VERY LITTLE...AND PERHAPS THE ONLY DIFFERENCE IS THAT THE GFS SHIFTED 30 N MI TO THE WEST...TOWARD THE ECMWF SOLUTION DURING THE LAST PORTION OF THE FORECAST. THIS DOES NOT RESULT IN A SIGNIFICANT CHANGE OF THE OFFICIAL FORECAST TRACK FROM THE PREVIOUS ONE.

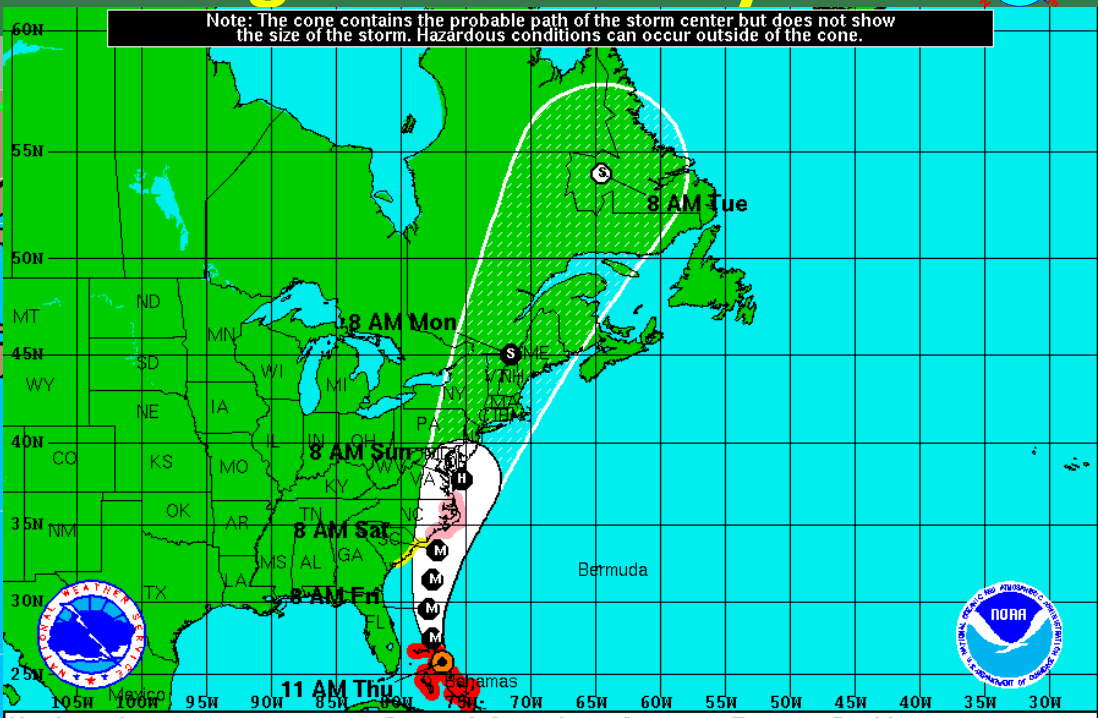
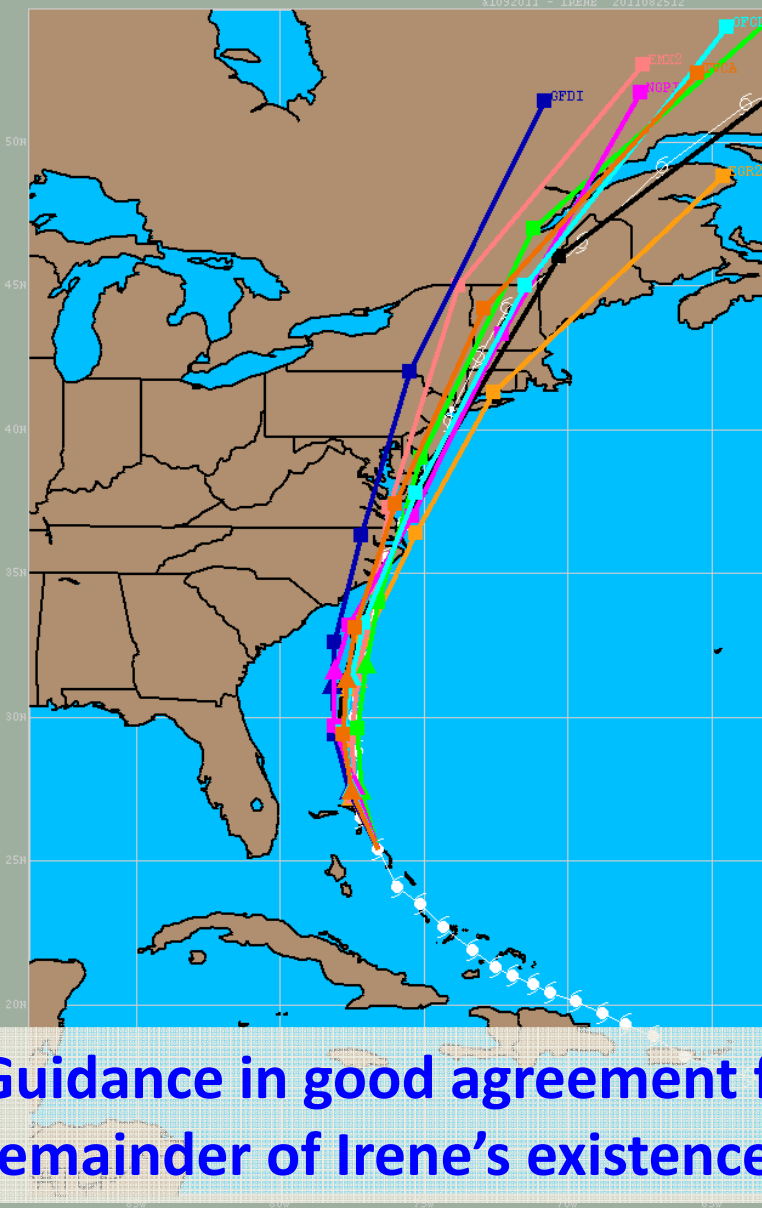
Guidance shifts back westward closer to the NHC forecast



Irene Guidance 11 am Aug 25 - Advisory #21



Note: The cone contains the probable path of the storm center but does not show the size of the storm. Hazardous conditions can occur outside of the cone.



Hurricane Irene Thursday August 25, 2011 11 AM EDT Advisory 21 NWS National Hurricane Center	Current Information: Center Location 25.9 N 76.8 W Max Sustained Wind 115 mph Movement NNW at 13 mph	Forecast Positions: ● Tropical Cyclone ○ Post-Tropical Sustained Winds: D < 39 mph S 39-73 mph H 74-110 mph M > 110mph
Potential Track Area: Day 1-3 Day 4-5	Watches: Hurricane Trop.Storm	Warnings: Hurricane Trop.Storm

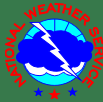
EXCERPT FROM NHC DISCUSSION

THE GUIDANCE ENVELOPE HAS SHIFTED A LITTLE WESTWARD ON THIS CYCLE...AND THE NEW OFFICIAL TRACK HAS BEEN NUDGED WEST AS WELL. THE NEW FORECAST LIES BETWEEN THE GFS AND ECMWF...AND IS A LITTLE RIGHT OF THE TVCA CONSENSUS. SINCE IRENE IS SUCH A LARGE TROPICAL CYCLONE...SIGNIFICANT IMPACTS ARE LIKELY ALONG THE UNITED STATES EAST COAST REGARDLESS OF THE EXACT TRACK IT TAKES.

Guidance in good agreement for remainder of Irene's existence



Intensity Forecasting

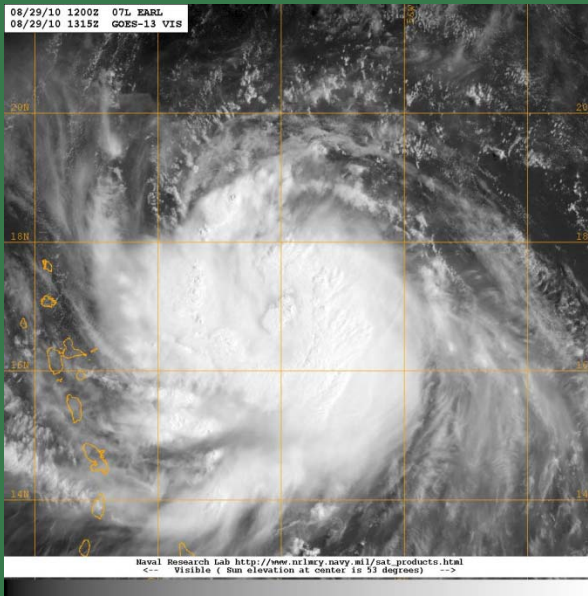
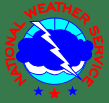


More complex multi-scale problem

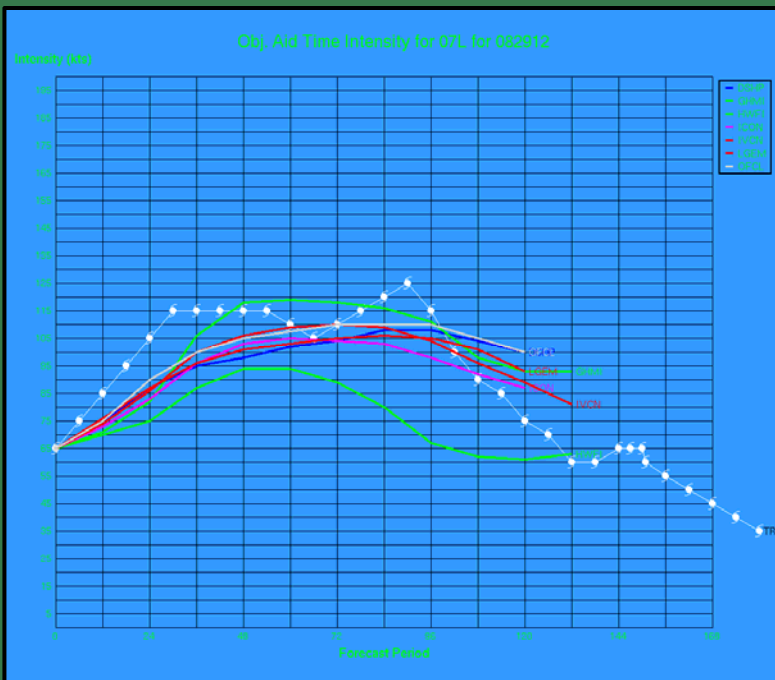
- Intensity Guidance:
 - Statistical (SHIPS/LGEM) and Dynamical (GFLD/HWRF) models
 - Consensus (ICON and FSSE) models
- Intensity forecasting more difficult than track forecasting
- Best intensity models are statistical, which do not predict rapid changes very well
- Dynamical models can predict rapid intensity changes, but not reliably



Intensity Forecasting

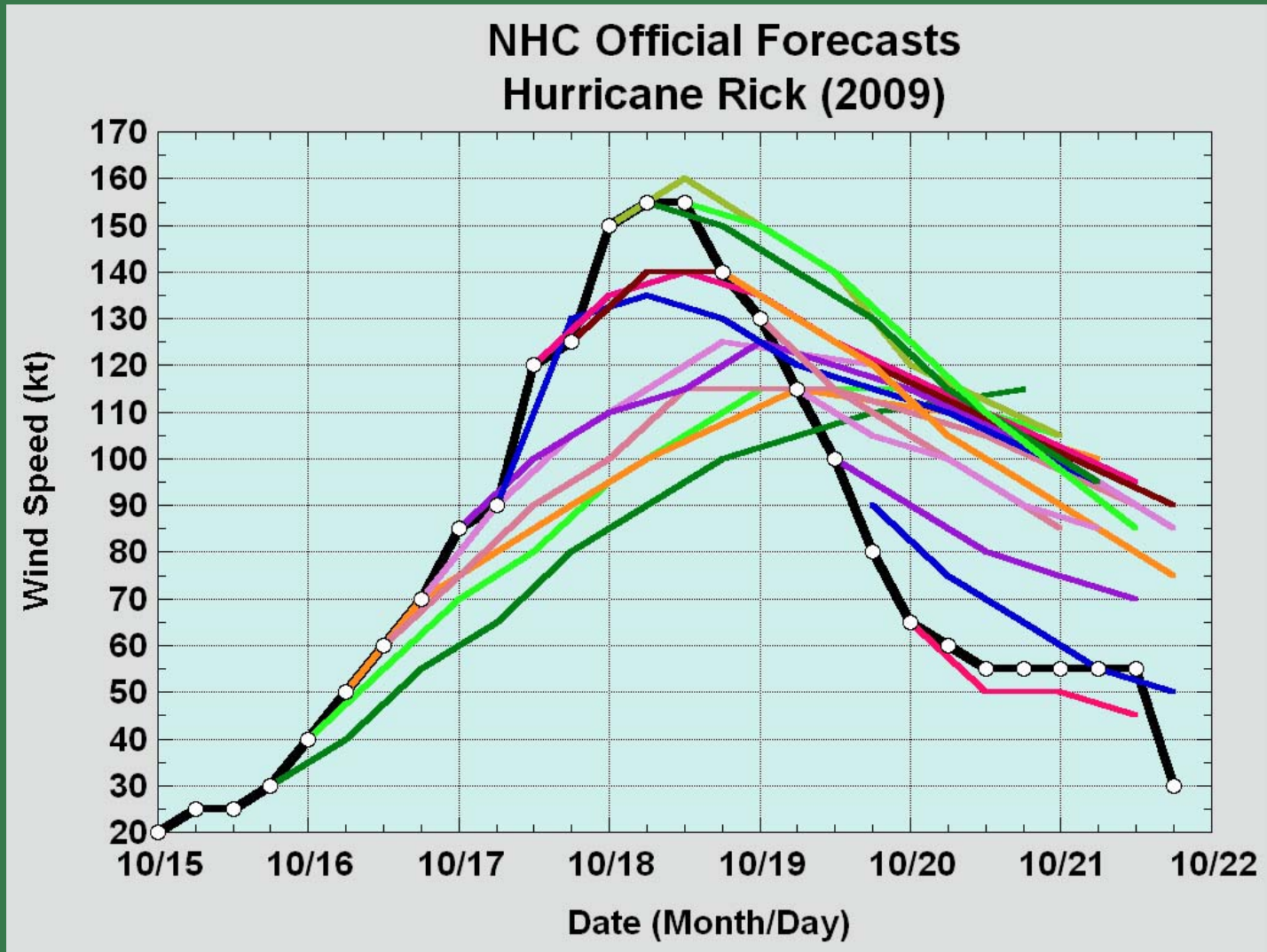


- Similar considerations as for track apply with respect to continuity
- NHC intensity forecasts tend to be conservative; rapid intensity changes are rarely forecast
- Modest changes in track can result in significant differences in SST, vertical wind shear, land interaction, and other environmental factors that affect intensity





Predicting Rapid Changes in Intensity

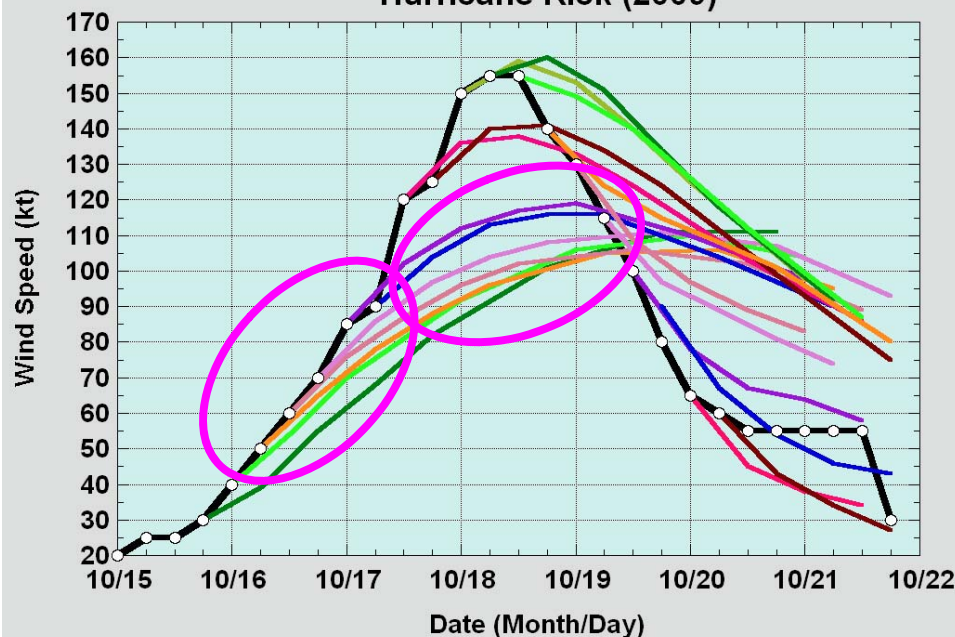


Or Not

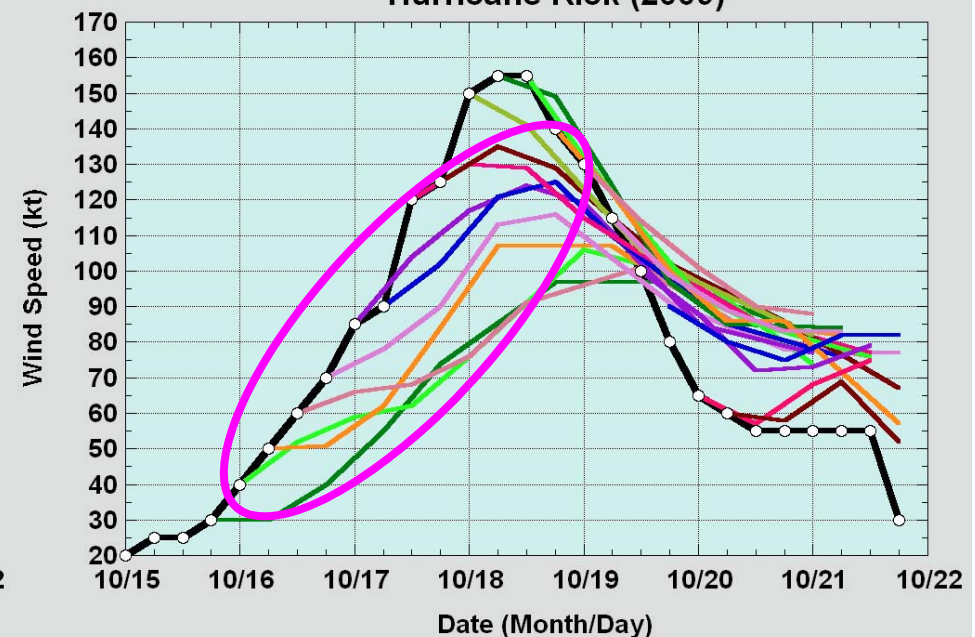


Guidance also has Difficulty Predicting Rapid Changes in Strength

Decay SHIPS (DSHP) Forecasts
Hurricane Rick (2009)



GFDL (GHMI) Forecasts
Hurricane Rick (2009)



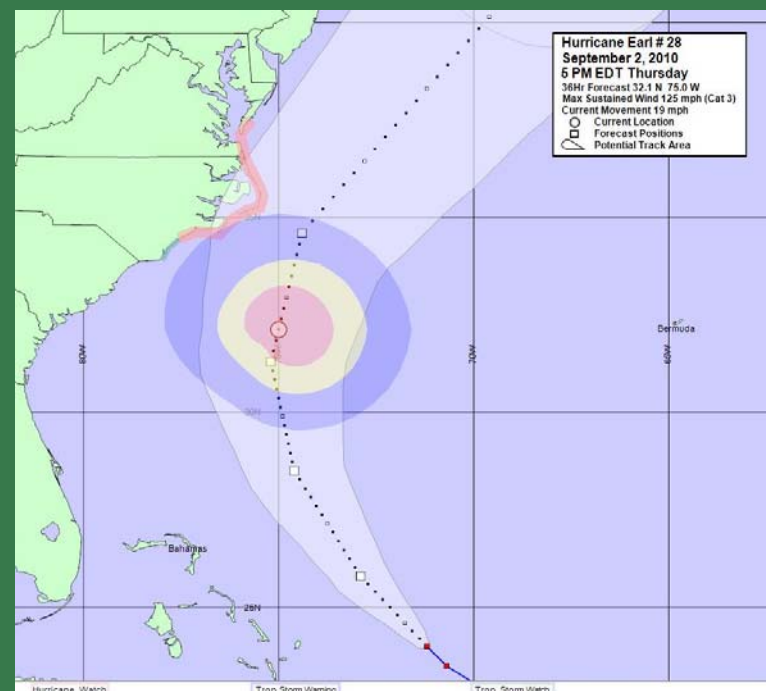
- Decay-SHIPS showed some signal for first period of rapid intensification but badly under-forecast later intensification to cat 4/5
- GFDL can forecast more variability, but suffered from a low bias throughout Rick's life



Wind Radii (Size) Forecasting



- Very little guidance available
 - essentially limited to climatology and persistence models
- Empirical ideas
 - Is the storm strengthening or weakening?
 - Is persistence appropriate, or are conditions changing?
 - Is the storm becoming extratropical, causing the wind field to expand?
 - Will all or part of the circulation be passing over land, such that the radii could decrease?
 - Is the system accelerating, such that the storm could become more asymmetric?





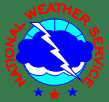
2:00

NWS / DOD Coordination Call



Coordinate and determine watches/ warnings





What do tropical storm and hurricane watches and warnings mean?

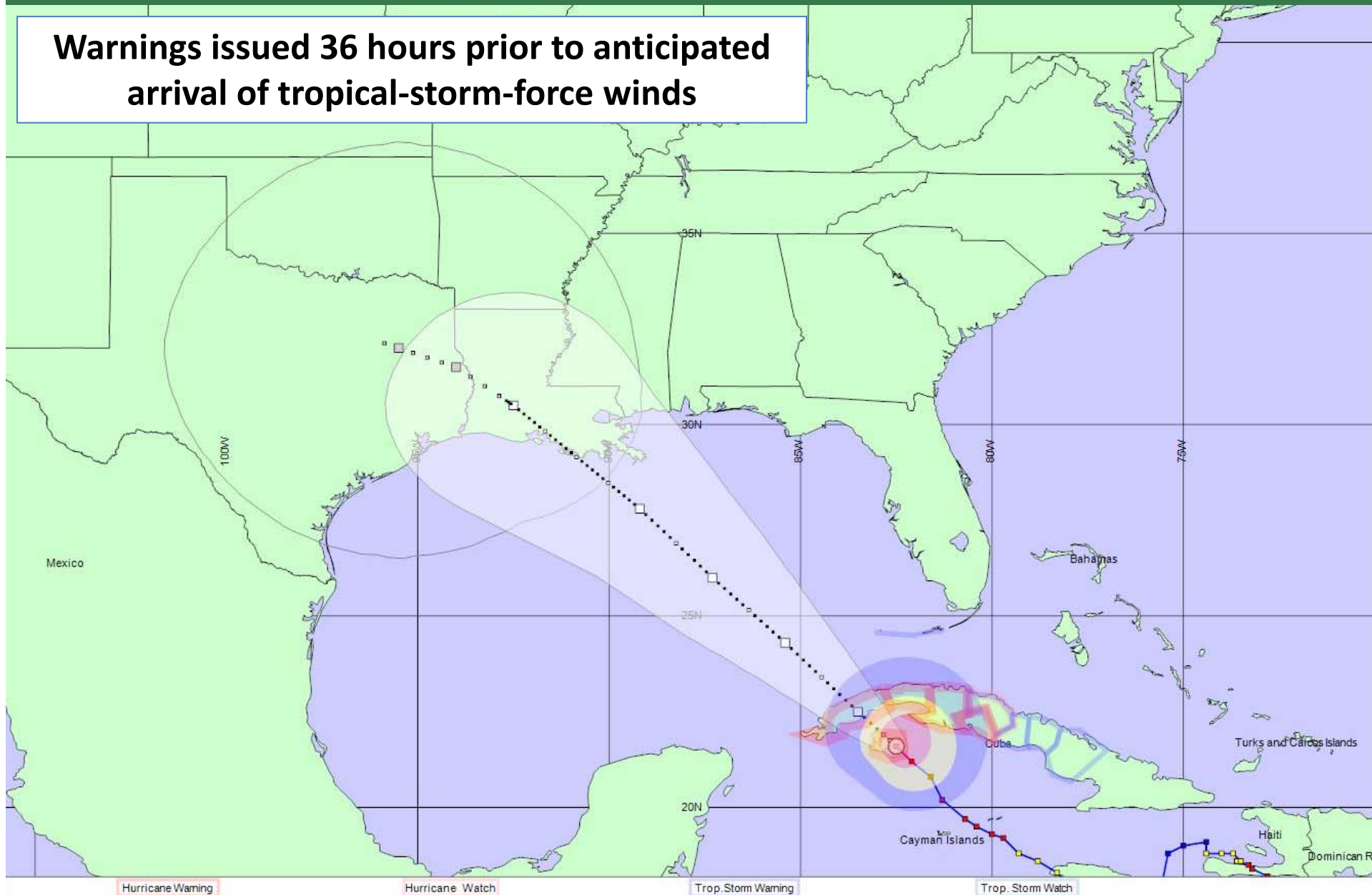
- Lead time of tropical storm and hurricane watches and warnings are tied to the anticipated arrival time of tropical-storm-force winds
 - *Watches issued 48 hours prior to arrival of TS winds*
 - *Warnings issued 36 hours prior to arrival of TS winds*
- Watch means that the conditions are possible somewhere within the watch area
- Warning means that the conditions are expected somewhere within the warning area



Issuing Warnings



Warnings issued 36 hours prior to anticipated arrival of tropical-storm-force winds



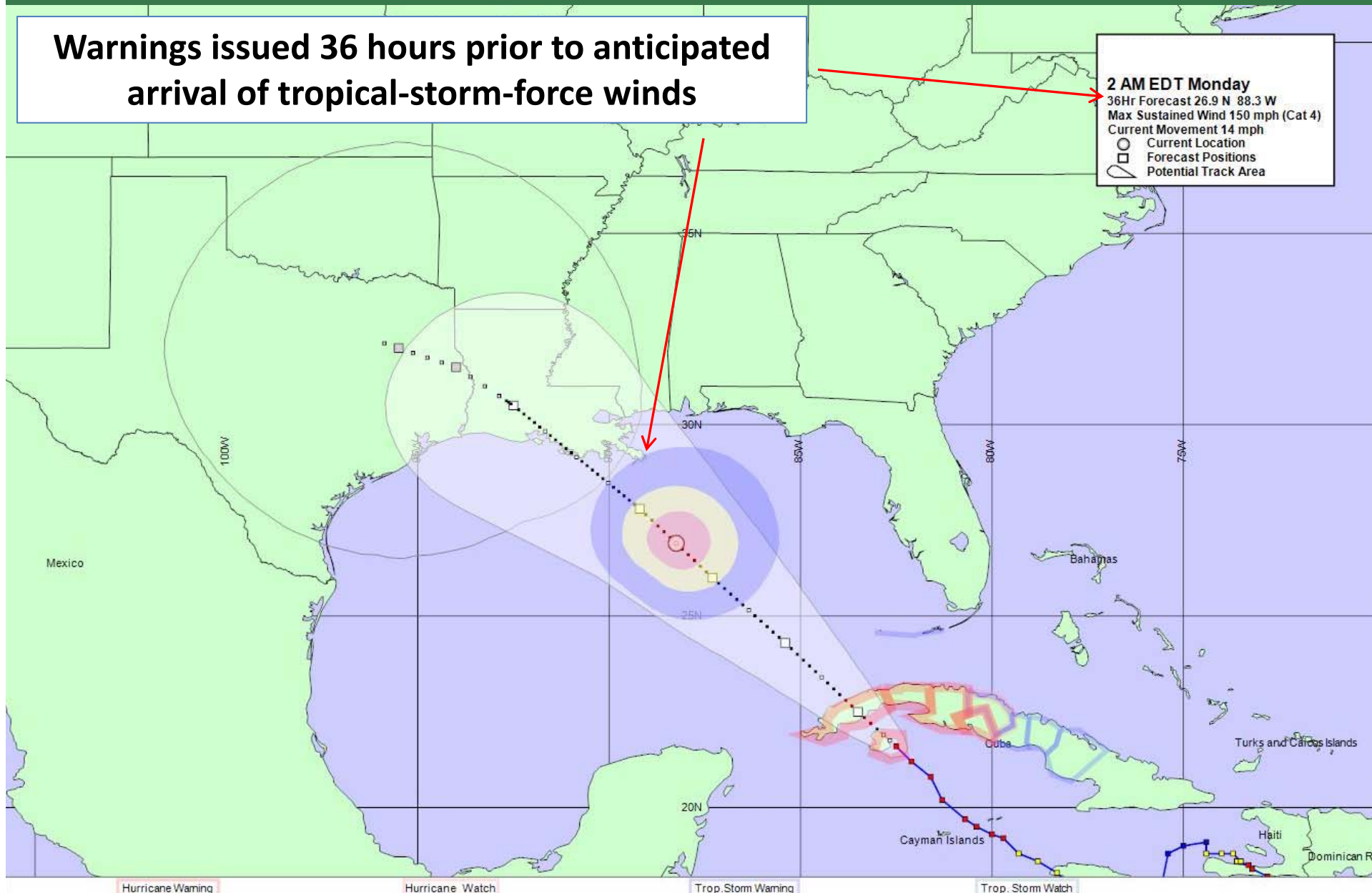


Issuing Warnings



Warnings issued 36 hours prior to anticipated arrival of tropical-storm-force winds

2 AM EDT Monday
36Hr Forecast 26.9 N 88.3 W
Max Sustained Wind 150 mph (Cat 4)
Current Movement 14 mph
○ Current Location
□ Forecast Positions
Potential Track Area



Hurricane Warning

Hurricane Watch

Trop. Storm Warning

Trop. Storm Watch

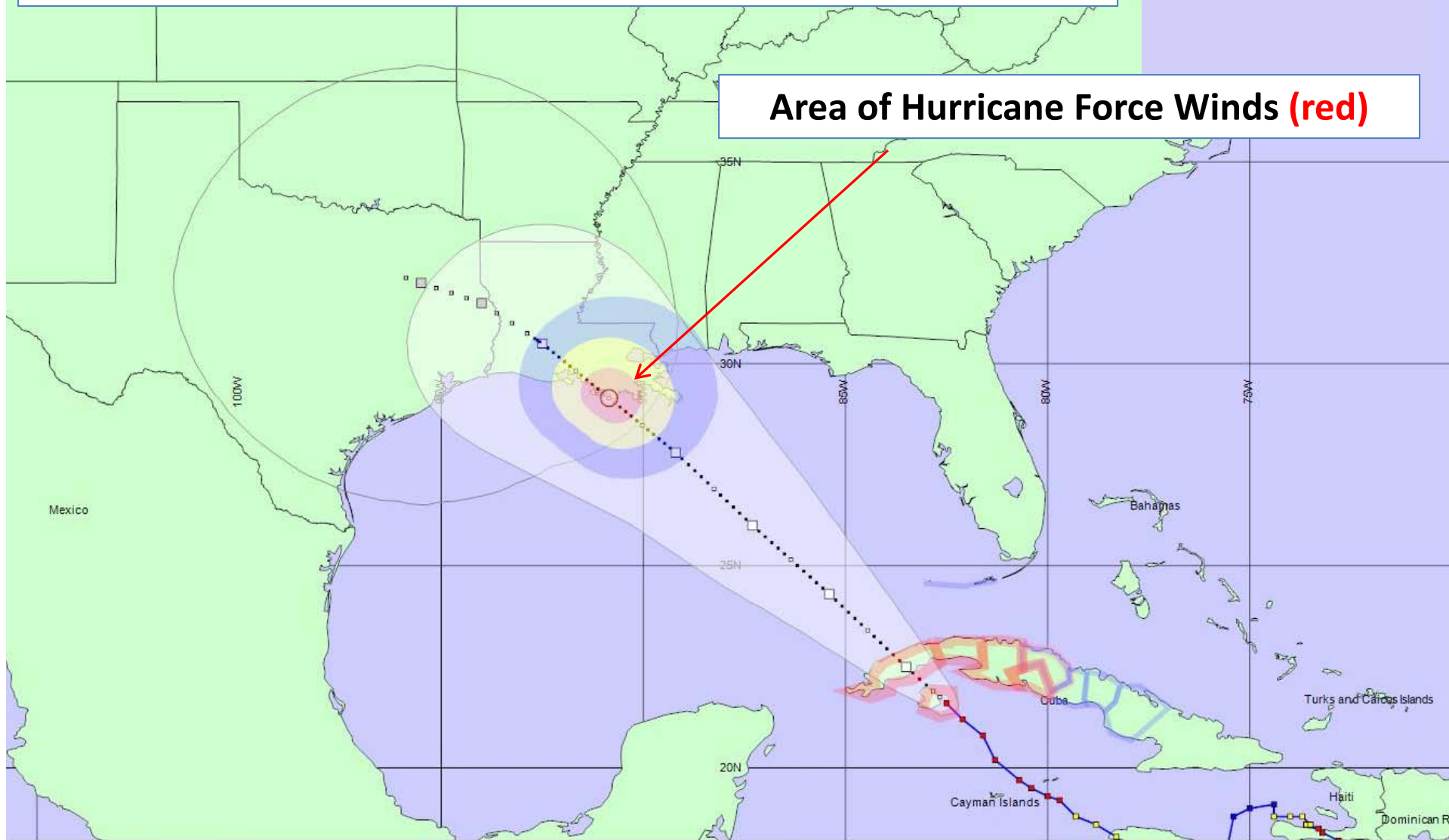


Issuing Warnings



What area would you issue a hurricane warning for?

Area of Hurricane Force Winds (red)



Hurricane Warning

Hurricane Watch

Trop. Storm Warning

Trop. Storm Watch



Issuing Warnings



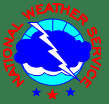
What area would you issue a hurricane warning for?

Must account for track and size (wind radii) uncertainties when issuing watches or warnings





Issuing Warnings – Storm Approaching at an Acute Angle



What area would you issue a hurricane warning for?





Issuing Warnings – Storm Approaching at an Acute Angle



What area would you issue a hurricane warning for?





International Coordination

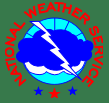
World MET. ORGANIZATION - Regional Association IV Coordination





2:00

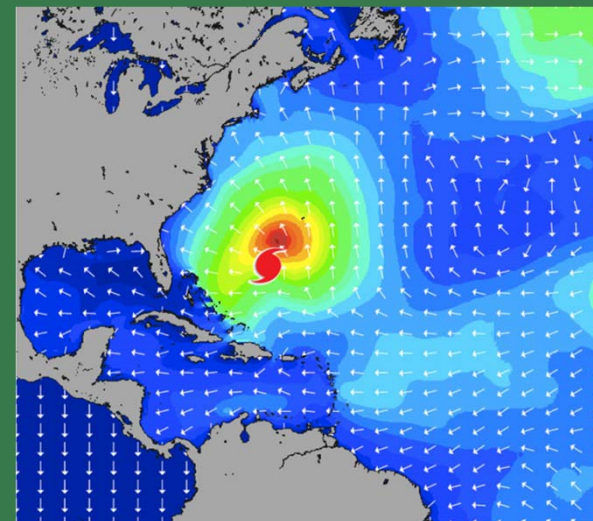
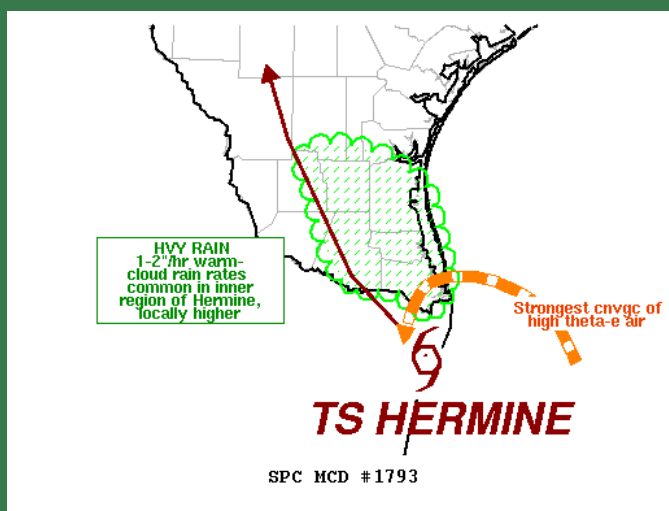
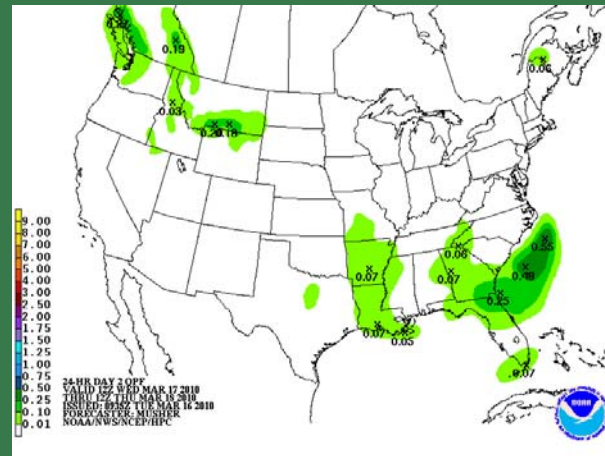
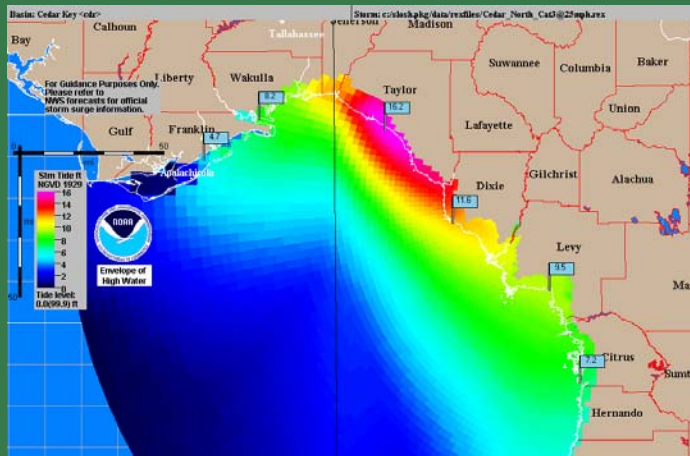
NWS / DOD Coordination Call



Coordinate and determine watches/ warnings



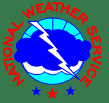
Coordinate storm surge, rainfall, tornado, rip current hazards



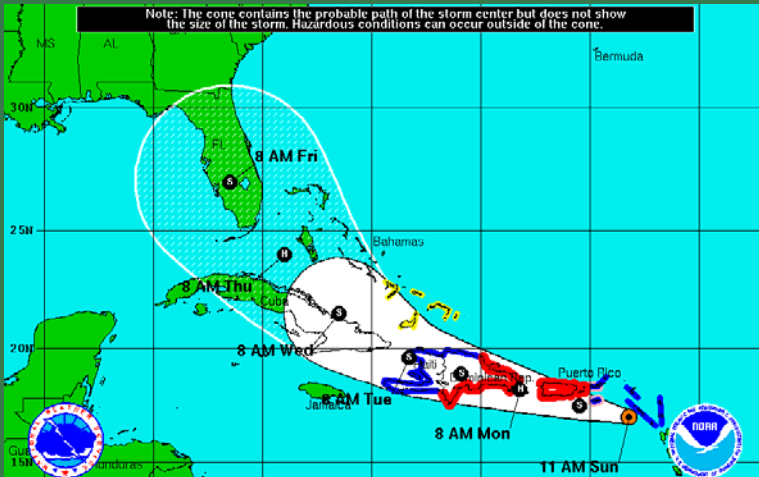


3:00

Advisory deadline



Prepare and issue forecast products

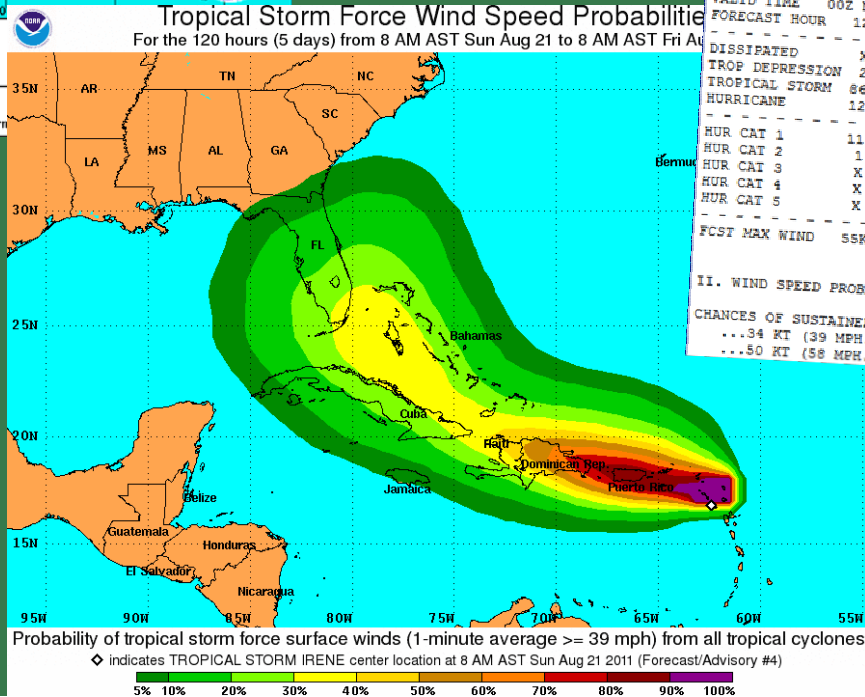


Tropical Storm Irene
 Sunday August 21, 2011
 11 AM EDT Advisory #4
 NWS National Hurricane Center

Current Information:
 Center Location 17.0 N 63.2 W
 Max Sustained Wind 50 mph
 Movement WNW at 20 mph

Potential Track Area:
 Day 1-3 Day 4-5

Watches:
 Hurricane Trop. Storm



ZCZC MIAFWSAT4 ALL
 TTA000 KNHC DDHMM

TROPICAL STORM IRENE WIND SPEED PROBABILITIES NUMBER 4
 NWS NATIONAL HURRICANE CENTER MIAMI FL AL092011
 1500 UTC SUN AUG 21 2011

AT 1500Z THE CENTER OF TROPICAL STORM IRENE WAS LOCATED NEAR
 LATITUDE 17.0 NORTH...LONGITUDE 63.2 WEST WITH MAXIMUM SUSTAINED
 WINDS NEAR 45 KTS...50 MPH...85 KM/H.

2 INDICATES COORDINATED UNIVERSAL TIME (GREENWICH)
 ATLANTIC STANDARD TIME (AST)...SUBTRACT 4 HOURS FROM Z TIME
 EASTERN DAYLIGHT TIME (EDT)...SUBTRACT 4 HOURS FROM Z TIME
 CENTRAL DAYLIGHT TIME (CDT)...SUBTRACT 5 HOURS FROM Z TIME

I. MAXIMUM WIND SPEED (INTENSITY) PROBABILITY TABLE

CHANCES THAT THE MAXIMUM SUSTAINED (1-MINUTE AVERAGE) WIND SPEED OF
 THE TROPICAL CYCLONE WILL BE WITHIN ANY OF THE FOLLOWING CATEGORIES
 AT EACH OFFICIAL FORECAST TIME DURING THE NEXT 5 DAYS.
 PROBABILITIES ARE GIVEN IN PERCENT. X INDICATES PROBABILITIES LESS
 THAN 1 PERCENT.

--- MAXIMUM WIND SPEED (INTENSITY) PROBABILITIES ---

VALID TIME	00Z MON	12Z MON	00Z TUE	12Z TUE	12Z WED	12Z THU	12Z FRI
FORECAST HOUR	12	24	36	48	72	96	120
DISSIPATED	X	1	2	11	14	14	18
TROP DEPRESSION	2	5	12	31	25	10	10
TROPICAL STORM	86	58	65	50	50	45	46
HURRICANE	12	37	21	8	11	30	26
HUR CAT 1	11	31	17	7	10	23	21
HUR CAT 2	1	4	3	1	1	5	4
HUR CAT 3	X	1	1	X	X	2	1
HUR CAT 4	X	X	X	X	X	X	X
HUR CAT 5	X	X	X	X	X	X	X
FCST MAX WIND	55KT	65KT	50KT	45KT	50KT	65KT	50KT

II. WIND SPEED PROBABILITY TABLE FOR SPECIFIC LOCATIONS

CHANCES OF SUSTAINED (1-MINUTE AVERAGE) WIND SPEEDS OF AT LEAST
 ...34 KT (39 MPH... 63 KPH)...
 ...50 KT (58 MPH... 93 KPH)...



3:15

EM Conference Calls and Media Interviews



Hurricane Liaison Team



Media Interviews

