



BX®

OUTER BANX • NC

OBX-STOCK INC.04



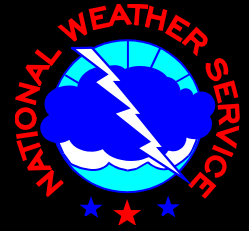
Future

Present

Past

Questions:

- * How many of you know the flood risk of your home?
- * How many of you have Flood Insurance?
- * How many know what wind speed your home was built to resist?
- * How many of you have a Family Action Plan in case of disaster?



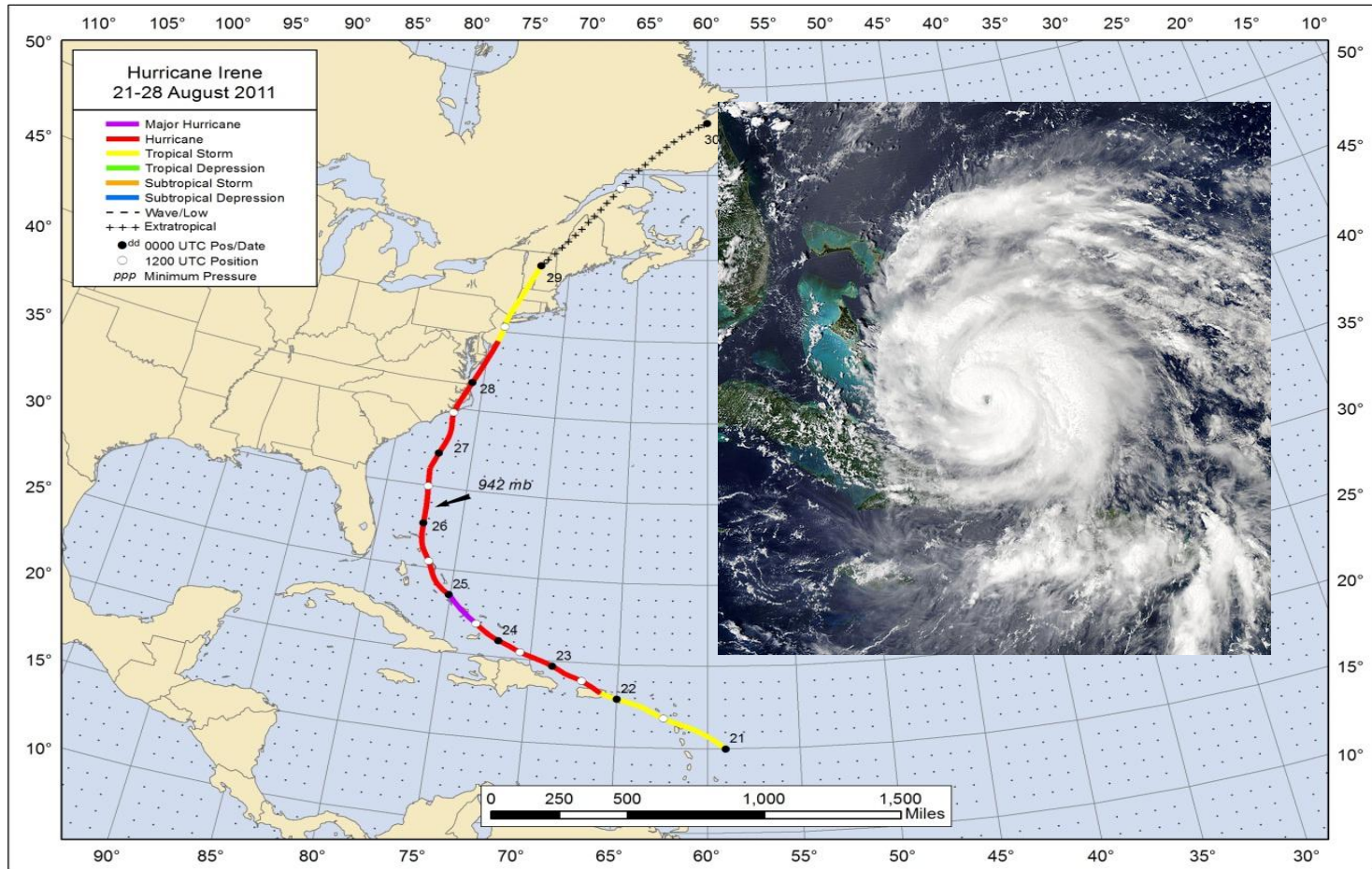
NHC MISSION

**To save lives, mitigate property loss,
and improve economic efficiency
by issuing the best
watches, warnings, forecasts and analyses of
hazardous tropical weather, and by
increasing understanding of these hazards**

NHC VISION

**To be America's calm, clear and trusted
voice in the eye of the storm,
and, with our partners,
enable communities to be safe
from tropical weather threats**

Hurricane Forecast Improvement Project



HFIP OVERVIEW

10-year program with
“stretch” forecast
improvement goals.

Began in fiscal year 2009

Focus on improving
numerical weather
prediction model forecast
guidance



Drivers for HFIP

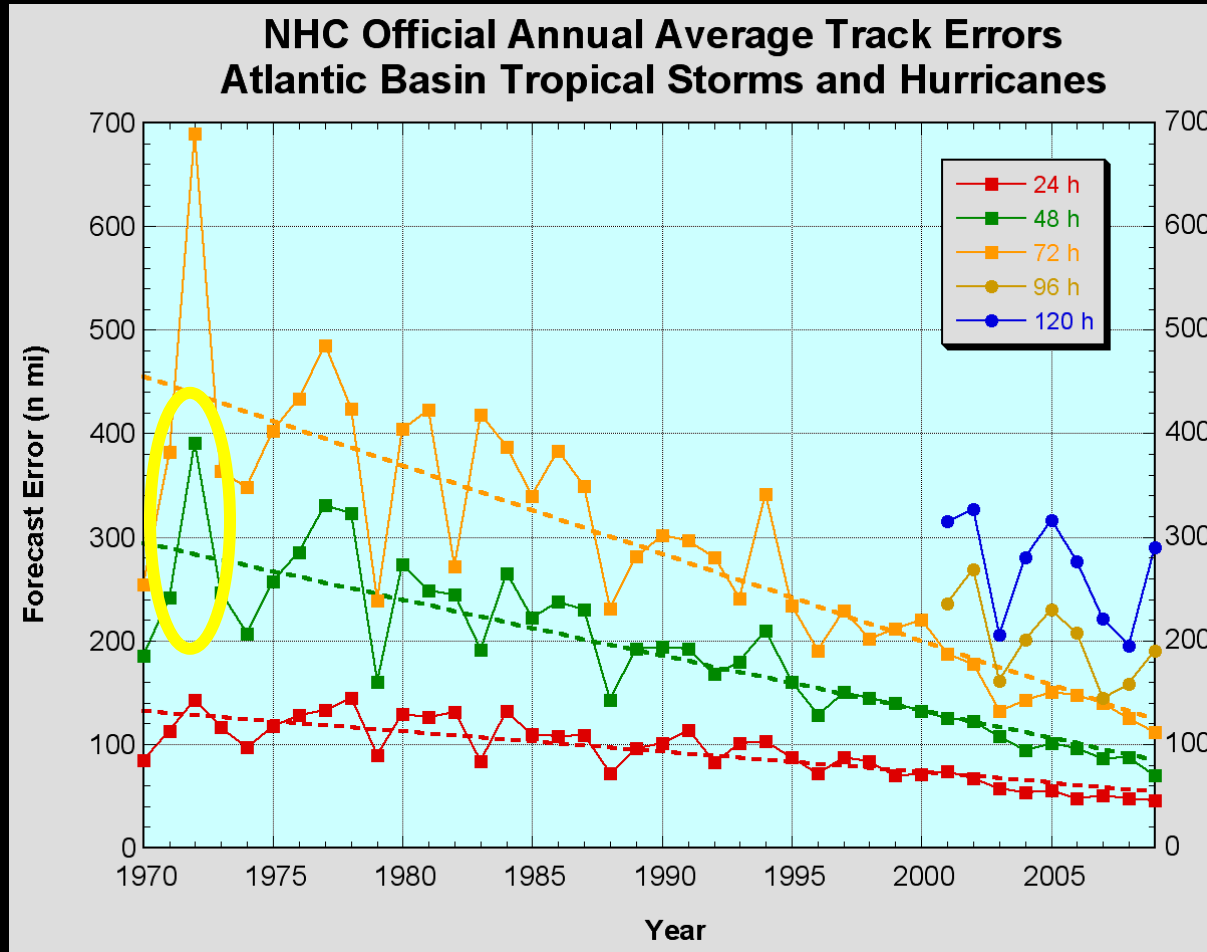
- **Lives:** More than 50% of U.S. population lives within 50 miles of coast -180 million people visit the coast annually
- **Property:** annual U.S. tropical cyclone losses now average about \$10 billion - **double about every ten years**
- **Forecasts:** Hurricane track forecasts have improved greatly; intensity forecasts have not
- **Research:** Tropical cyclone research under-resourced and not well-coordinated



Importance of accurate track forecast

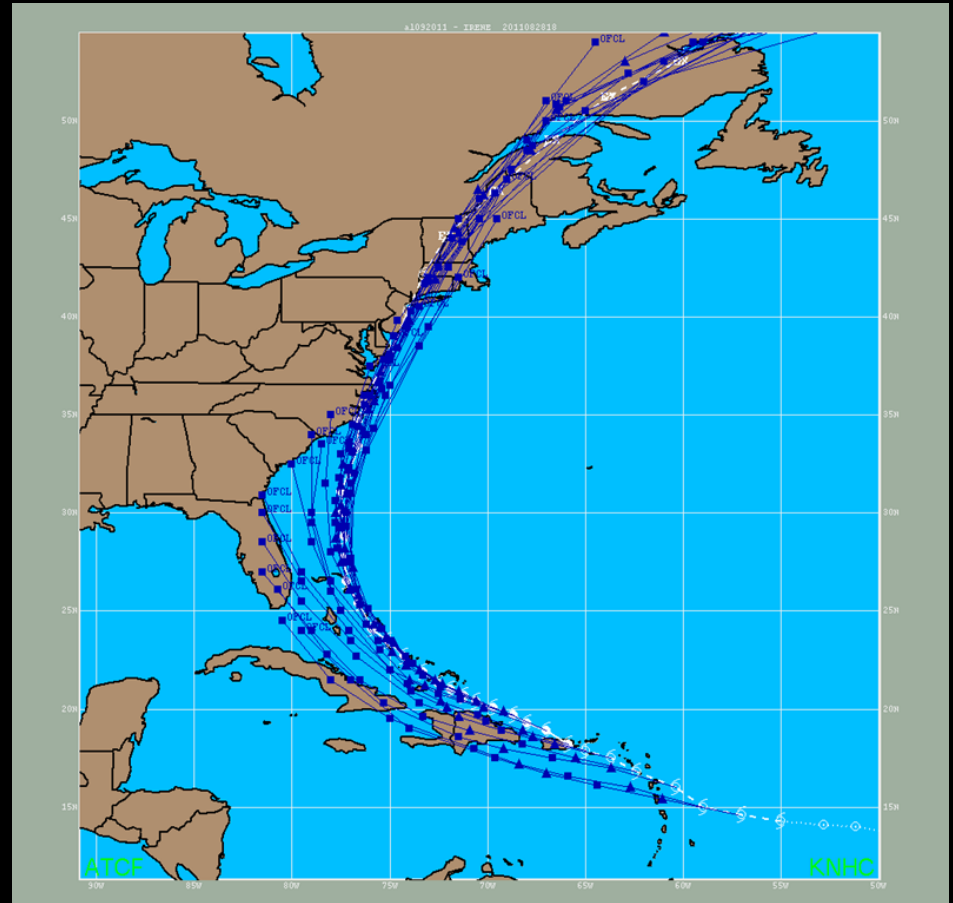
- Key to evacuation decision is ***where and when***
- ***Location of impacts*** tied closely to track of center
- ***Decision confidence*** increases with increasing ***forecast confidence***

Success story in hurricane forecasting



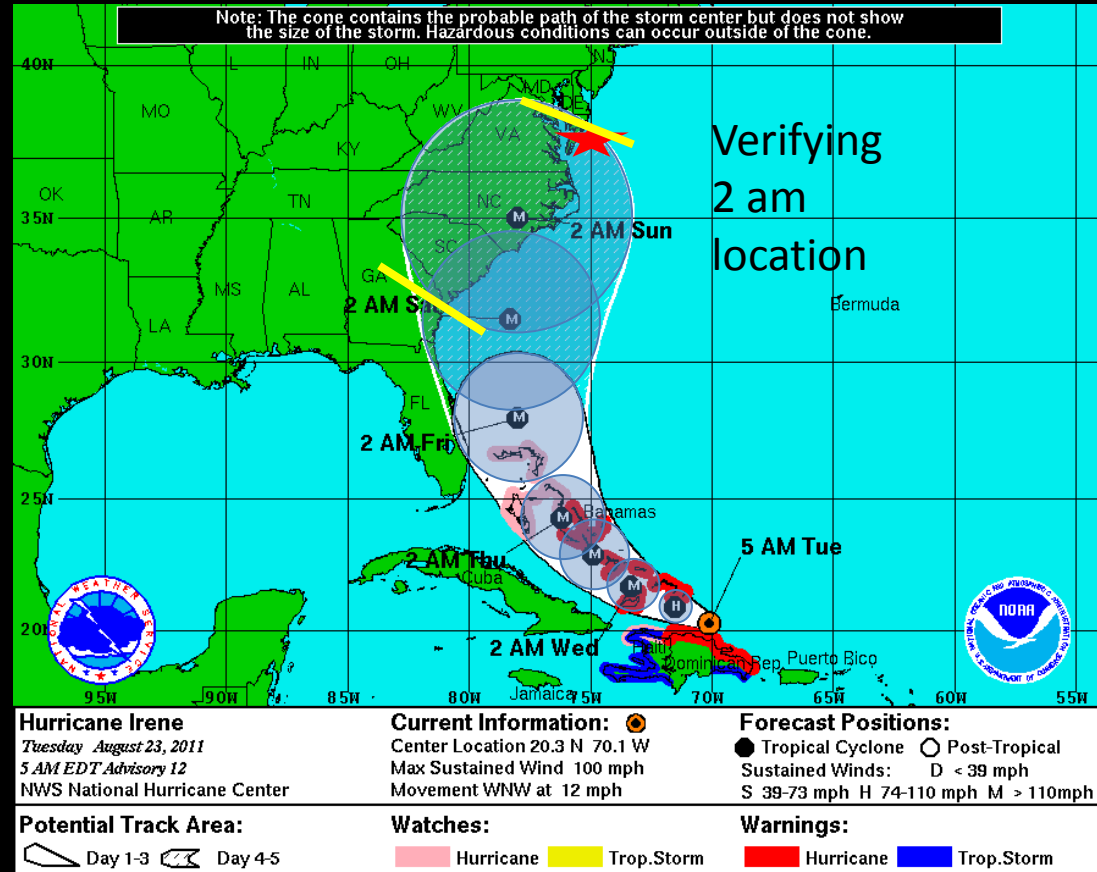
Irene track forecast skill

- **Excellent cross track skill**
- **Too slow along track**



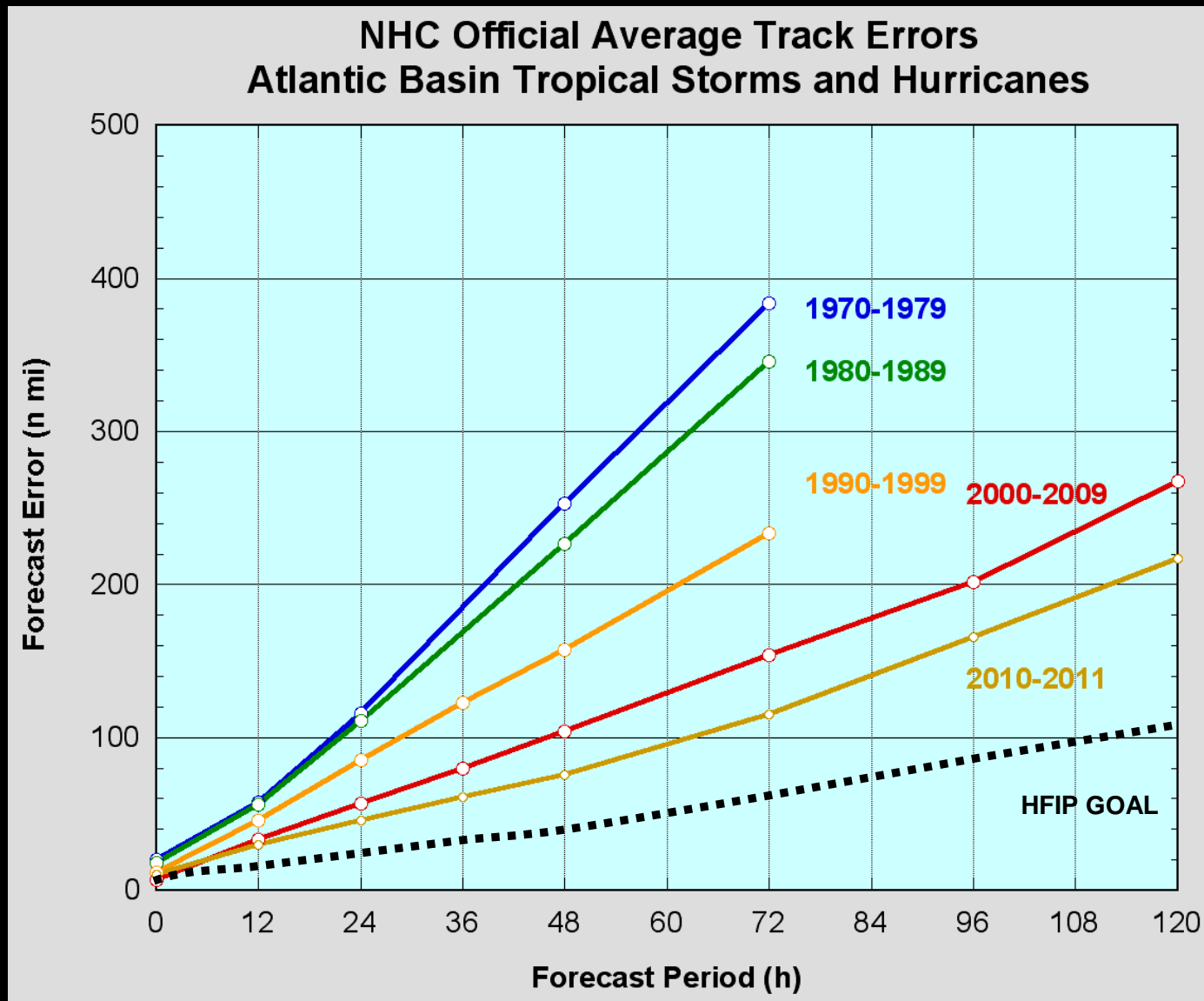
NHC Forecast Cone

- Represents probable track of tropical cyclone *center*
- 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



HFIP 10-year Forecast Goals:

1) Reduce average track error by 50%

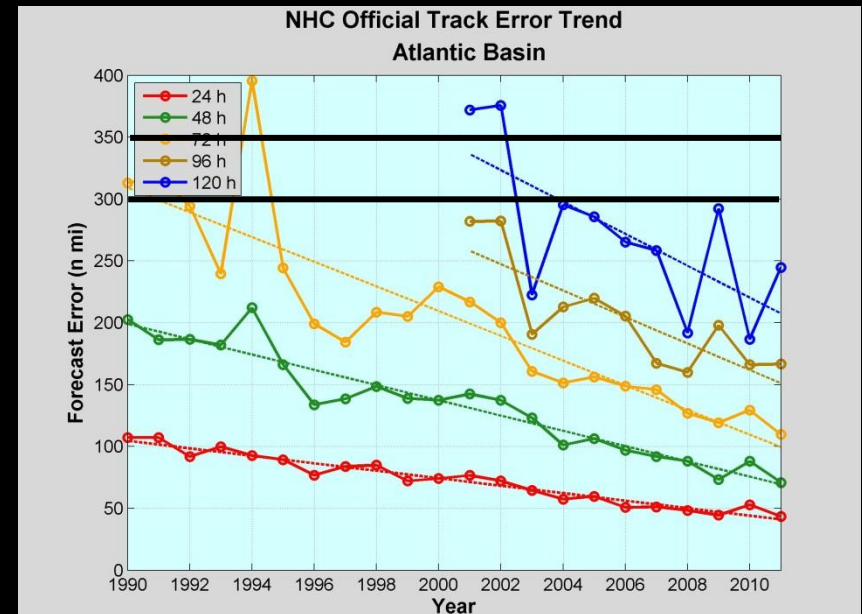
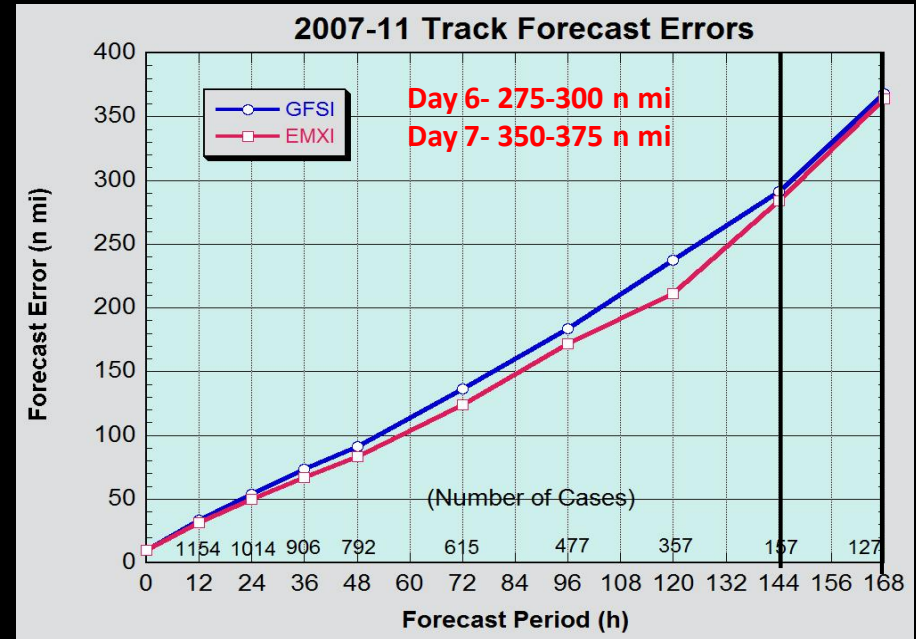




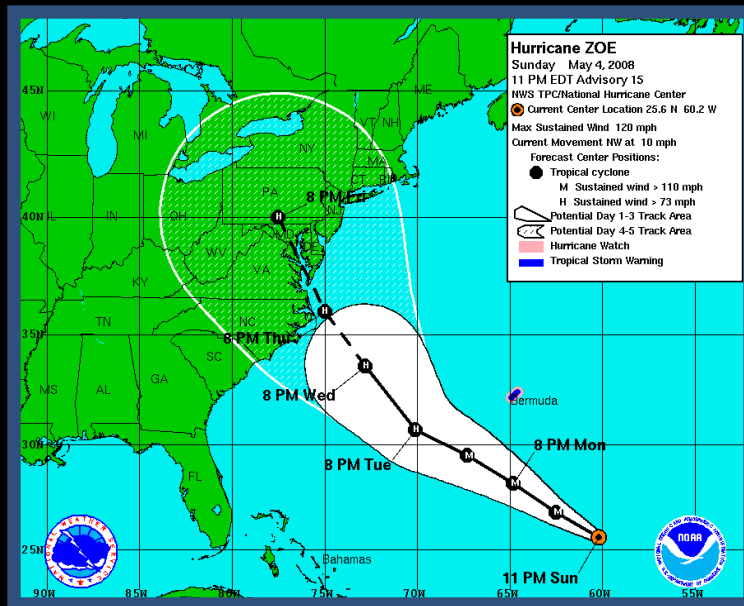
6- and 7-day Forecasts



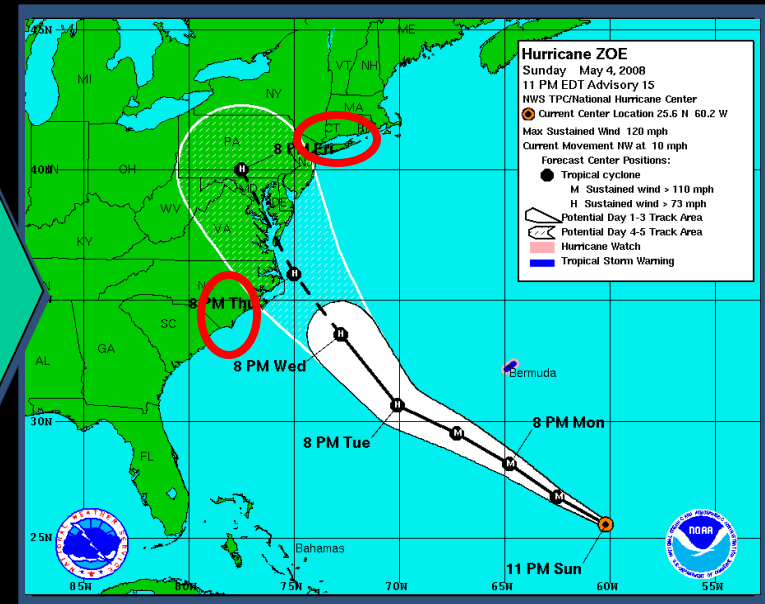
- NHC is evaluating 6- and 7-day numerical model guidance
 - Preliminary results indicate 6-day numerical model forecasts are about as good as NHC 3-day forecasts were in the early-mid 1990s
- NHC is developing capability to issue 6- and 7-day forecasts
- NHC is planning to produce in-house 6- and 7-day forecasts in 2012 for evaluation
- Need at least two seasons to develop error statistics for uncertainty



Implications for Achieving Track Goal



50%
reduced
forecast
errors



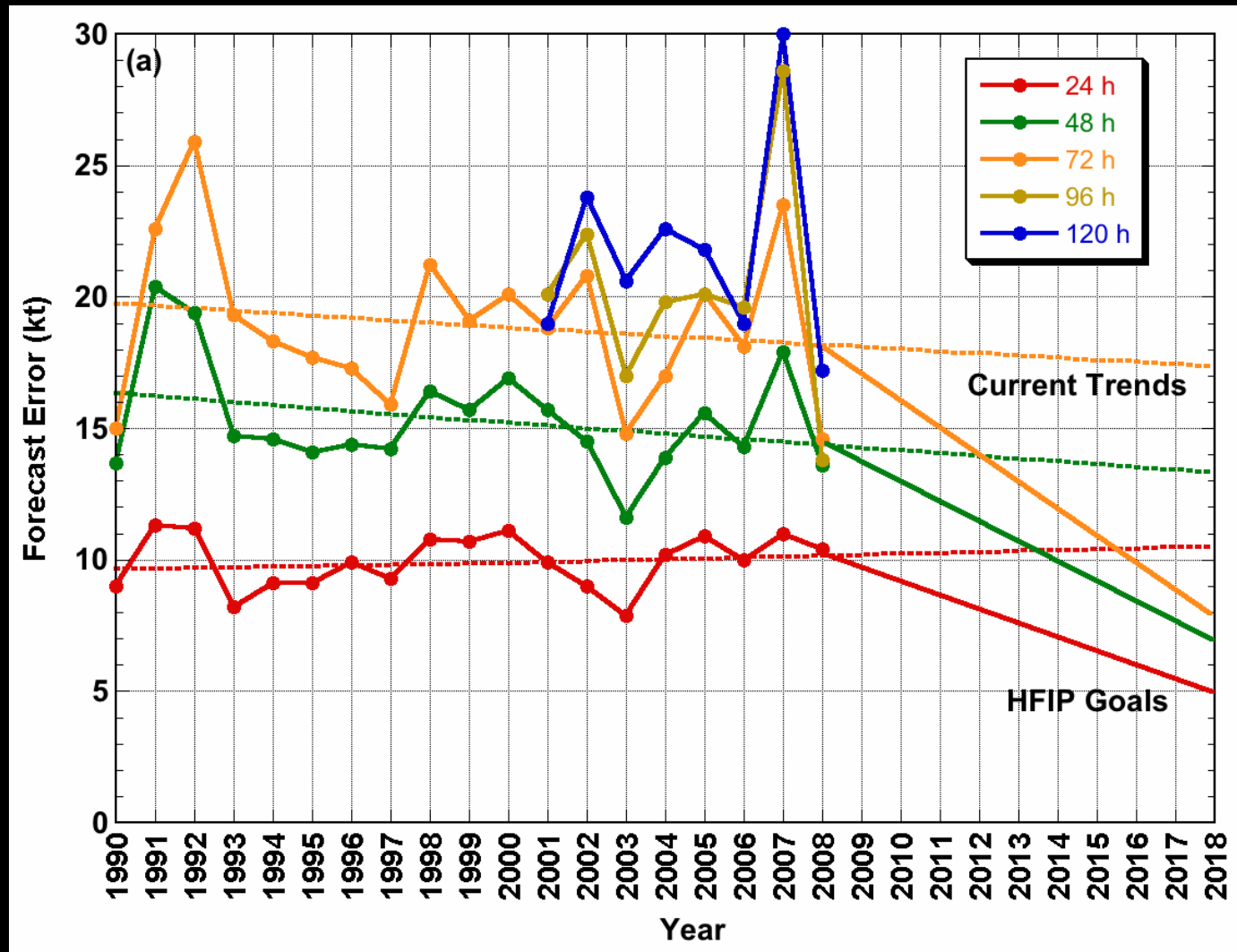
- Provide more accurate and more consistent forecast information to protect life and property
- Likely reduction in *lateral extent* of area at risk (i.e., needing preparation, including possible evacuation)

Lesson taught

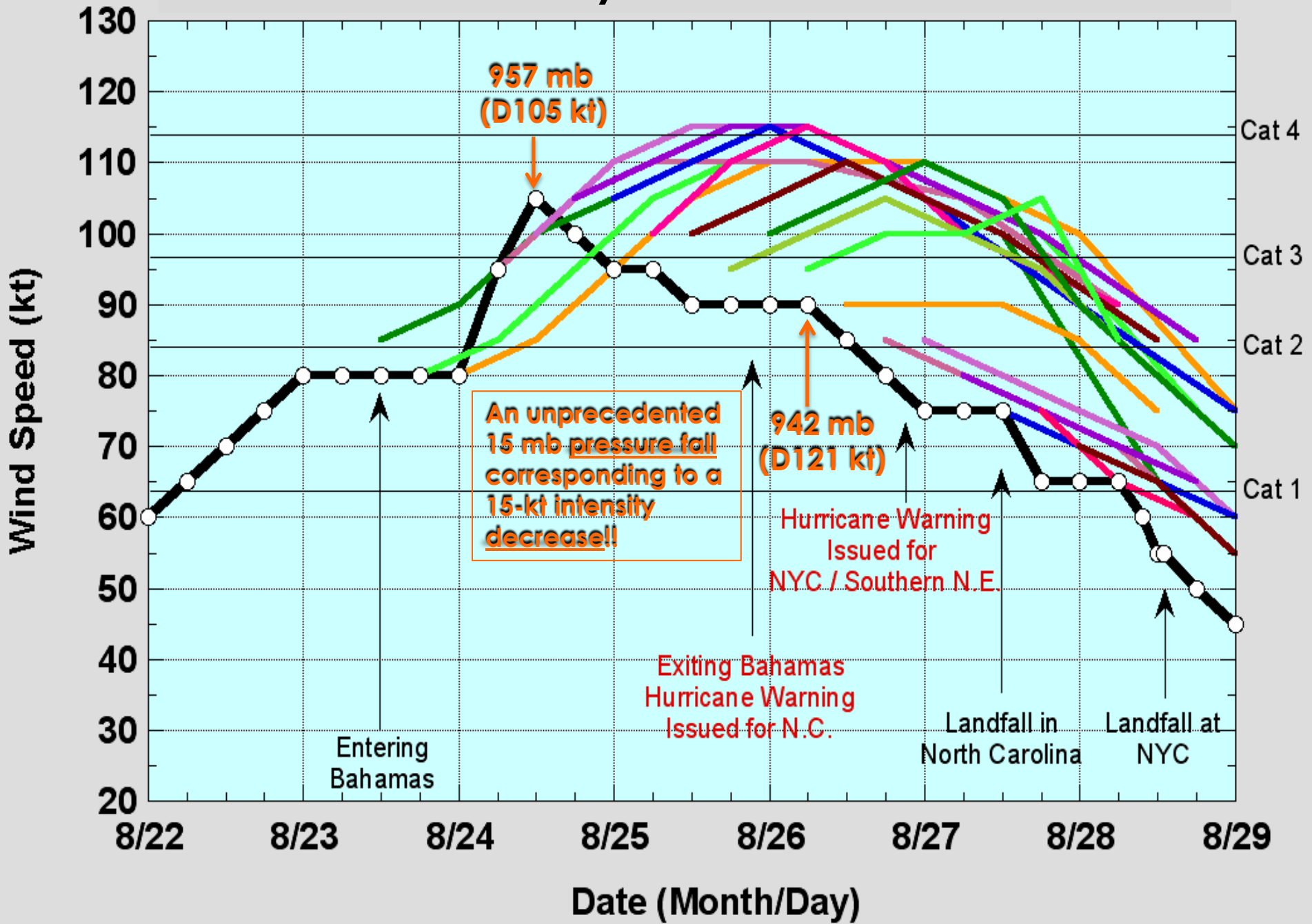
- Even a “good” track forecast has uncertainty – particularly beyond 72 hours
- For Northeast U.S. storms, the uncertainty in timing can be much greater than uncertainty in location
- Need to consider uncertainty when establishing decision time line

HFIP 10-year Forecast Goals:

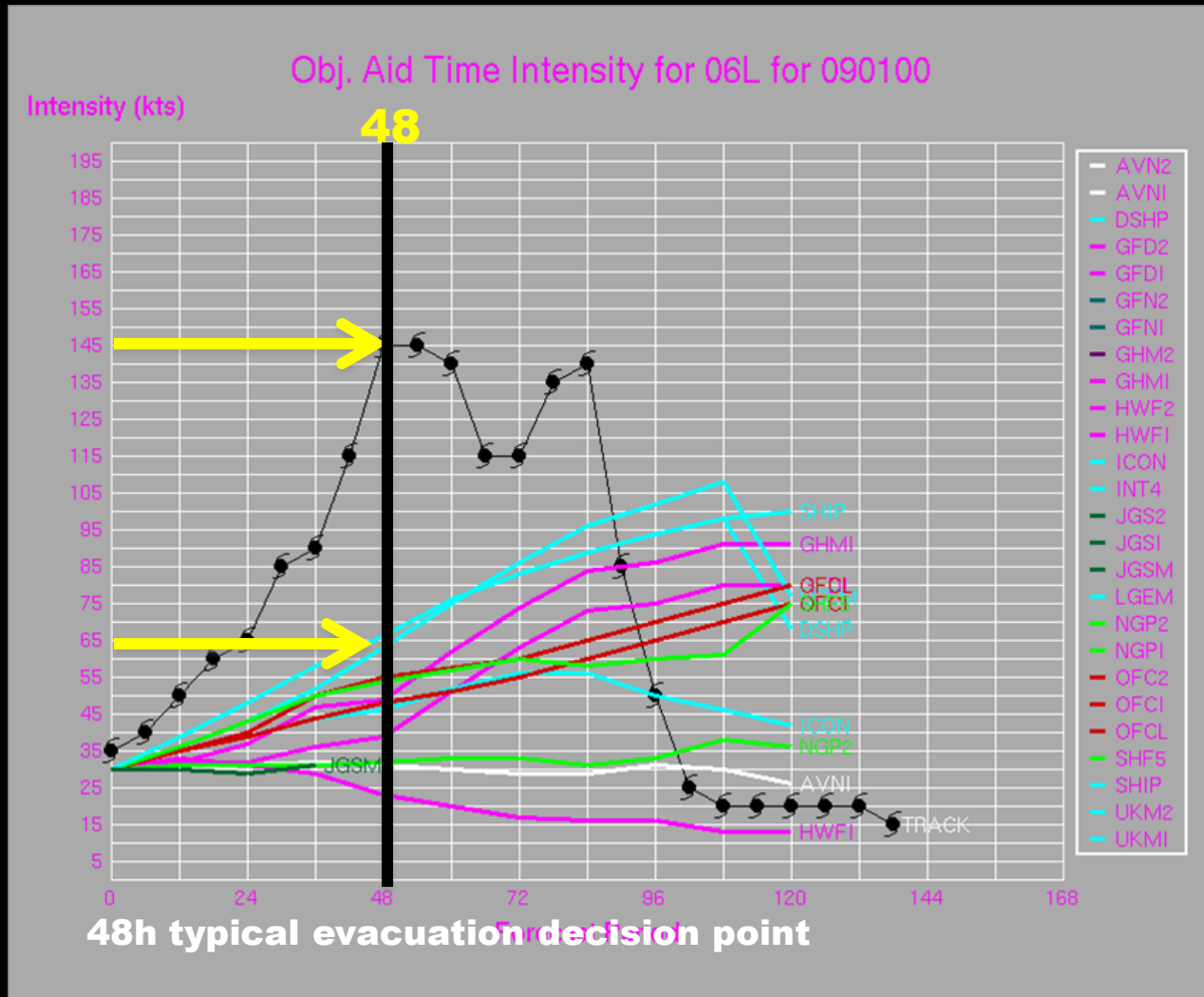
2) Reduce average intensity error by 50%



NHC Official Intensity Forecasts – Hurricane Irene

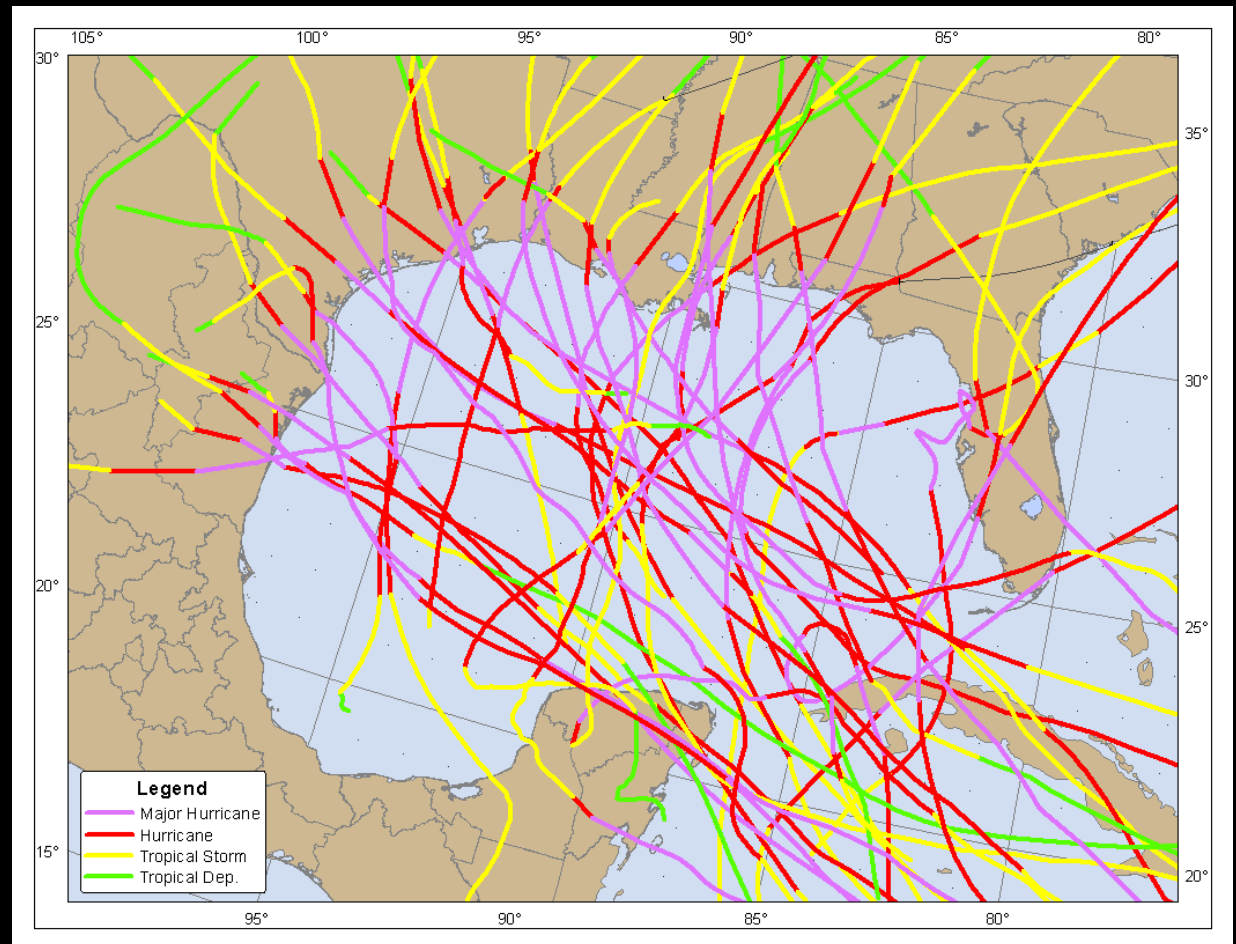


Our biggest challenge – Rapid change in intensity



Rapid Intensification (>30kt/24h) to Cat 3 or greater in the Gulf of Mexico

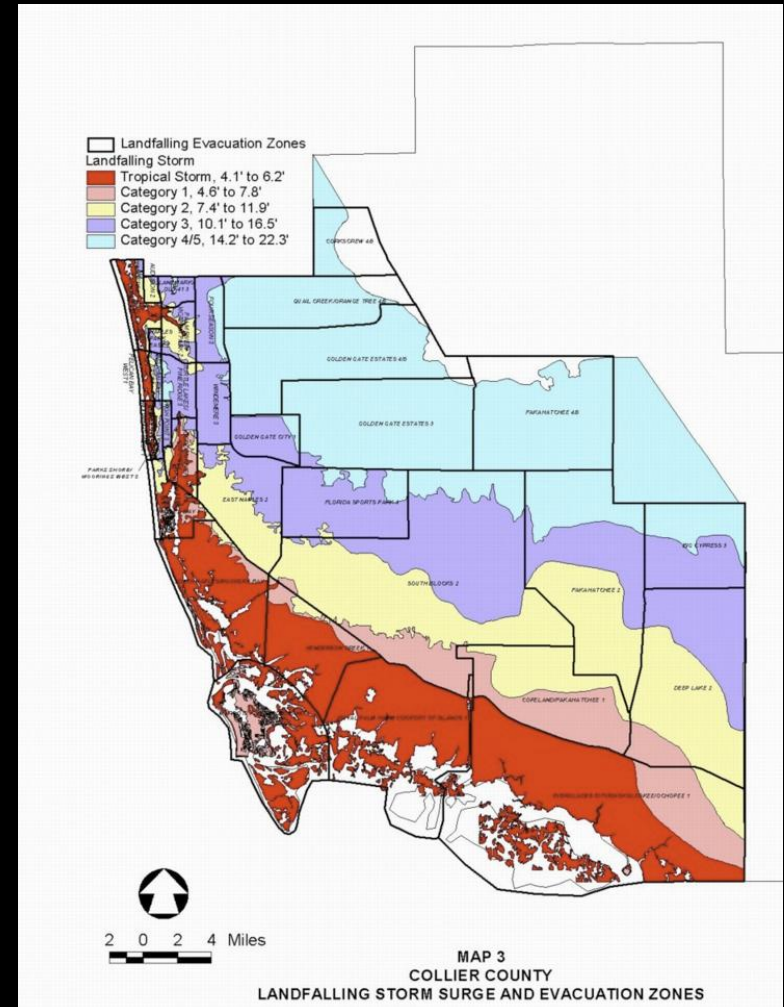
- **Katrina**
- **Rita**
- **Charley**
- **Alicia**
- **Celia**
- **Camille**



Implication for Achieving Intensity Goal

Current lack of intensity forecast skill forces decision makers to plan to move people for at least one Category higher storm than forecast.

Successful outcome HFIP: reduction in the *inland extent* of evacuation.



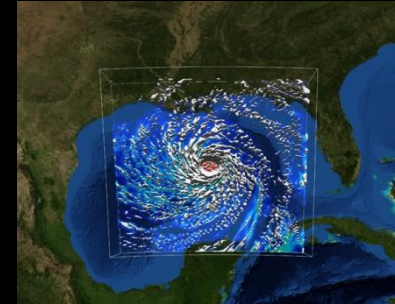
HFIP Overall Strategy

- Improve numerical simulation (forecast) models
- Demonstrate benefits of much greater computational capabilities
- Develop applications for forecasters (and “end users”)

Advances Required

Science

- Higher spatial resolution models
- Improve physics in global and hurricane models
- Improve observing systems and strategies for data sampling at higher resolution
- Improve high resolution data assimilation into models
- Better Initialization of model vortex
- Incorporate ocean-atmosphere interactions
- Improve ensemble model systems



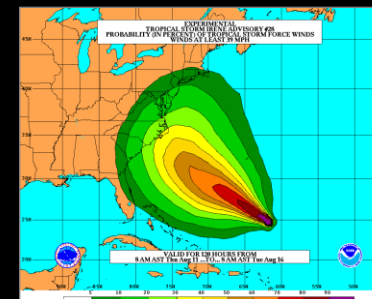
Information Technology

- Increase computing power - run advanced hurricane-scale and global-scale models to demonstrate need for additional operational supercomputing capability
- Enhance Information technology infrastructure for inter-agency data exchange



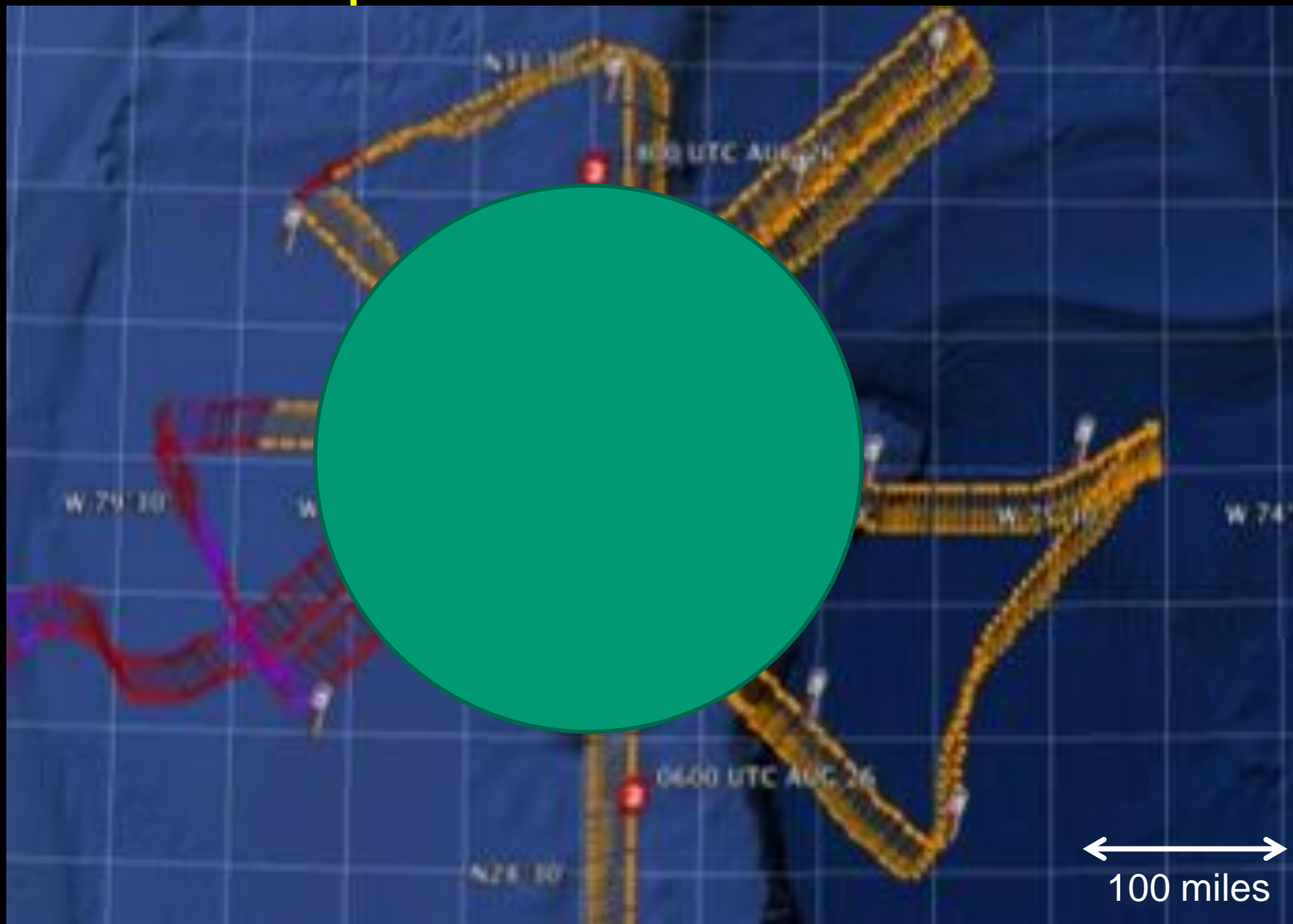
“Product” Enhancements for...

- Forecasters
- “End Users” ...integrate socio-economic expertise



HFIP Promising Early Results

Example: Use of inner-core data

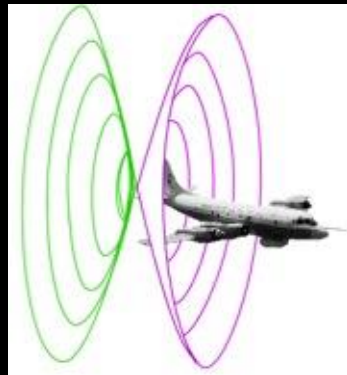


HFIP Promising Early Results

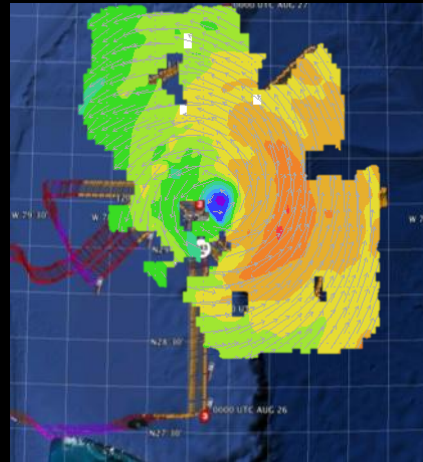
Example: Use of inner-core data



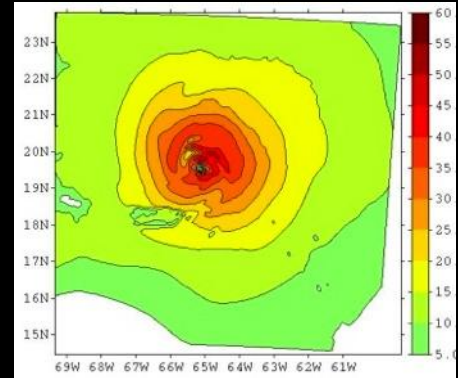
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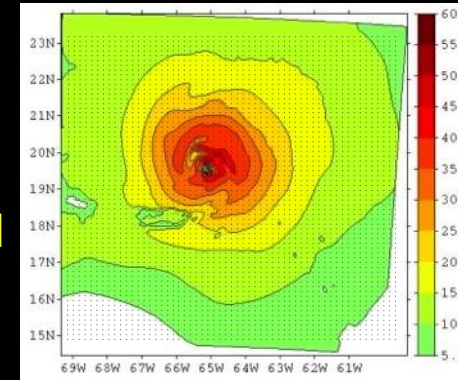
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“Superobs”

Improved high resolution regional forecast

←

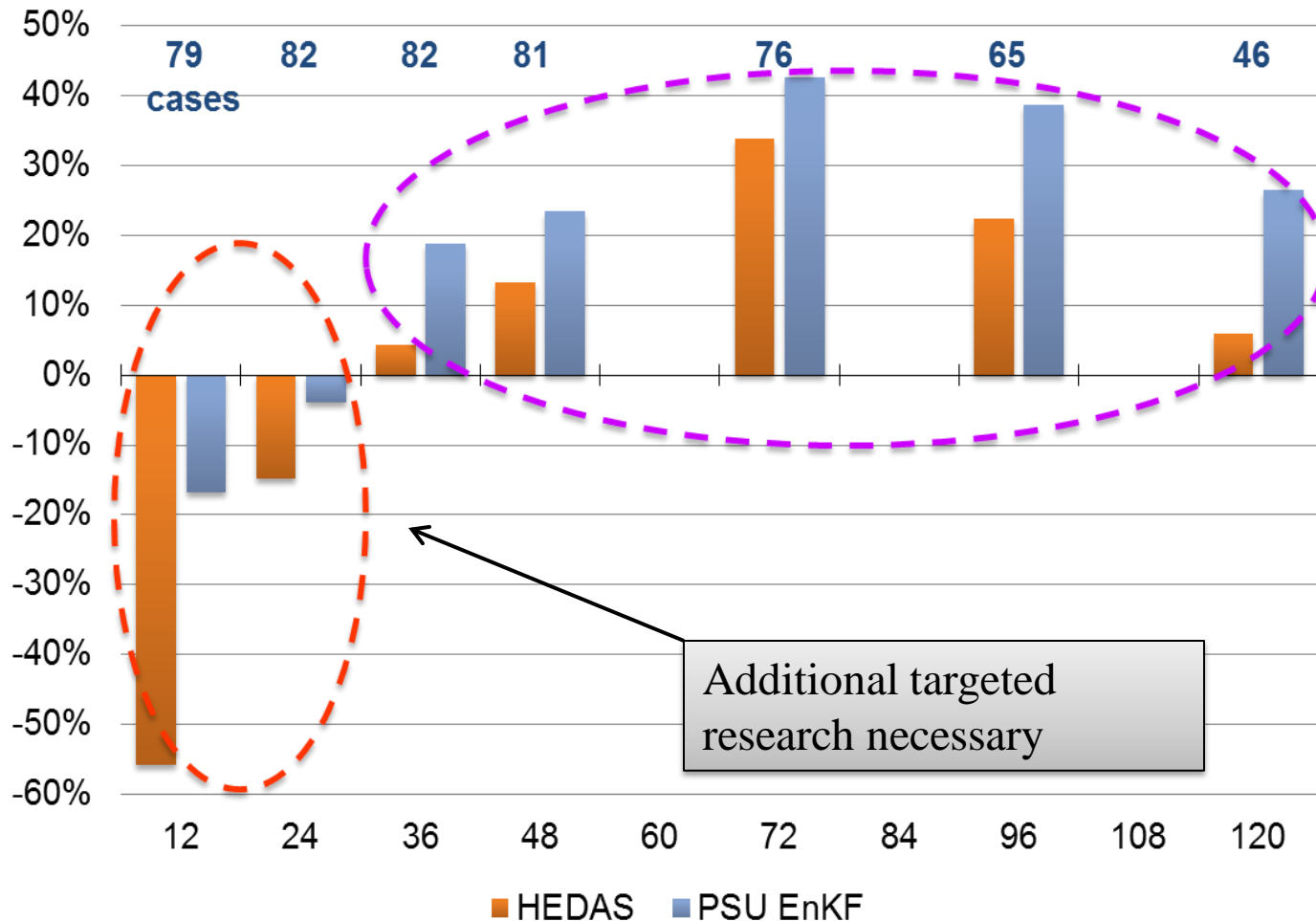
Improved initial condition in storm core region

←

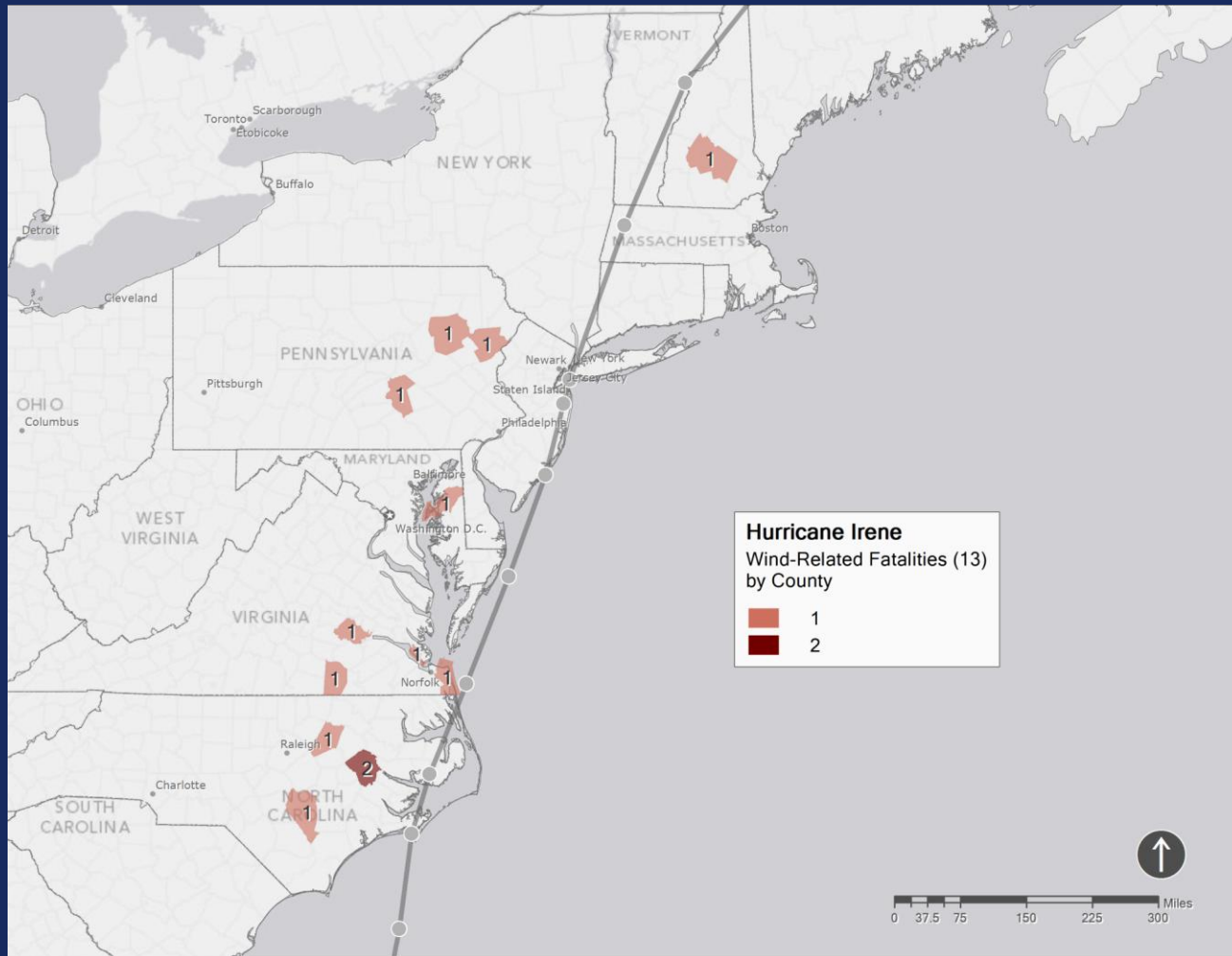
Data assimilation into models

←

IMPACT OF HIGH RESOLUTION DATA NEAR THE STORM CENTER

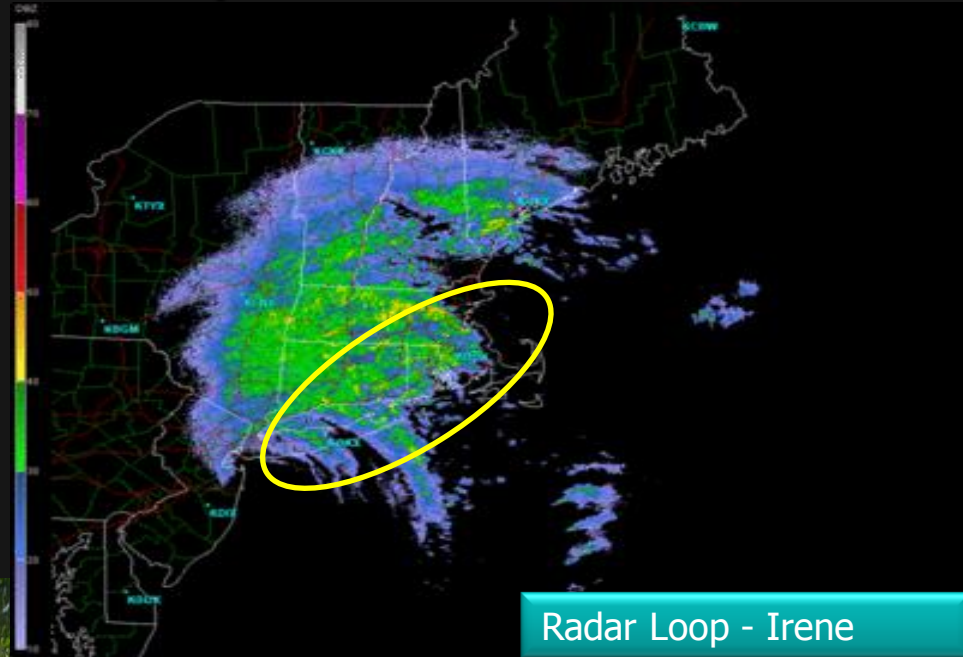


Irene impacts - wind



Irene wind impact

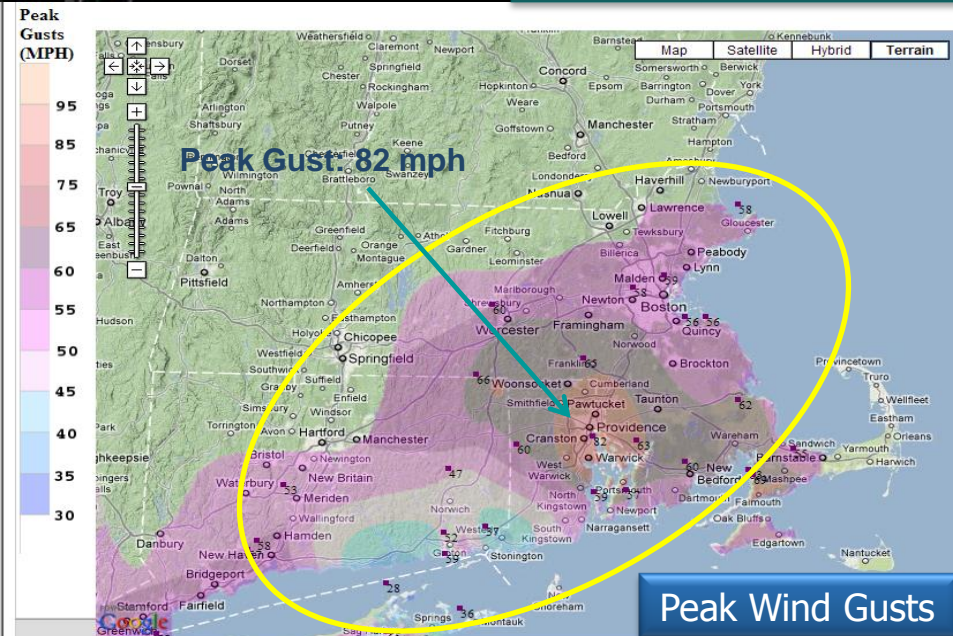
- RI and CT Hardest Hit
 - 340,000 and 775,000 customers lost power, respectively
 - Widespread damage to trees and power grid
 - Some areas without power >7 days
 - Impacted municipality water services



Warwick, RI
S. Milne, AP



North Kingstown, RI
S. Turner, Newport Patch

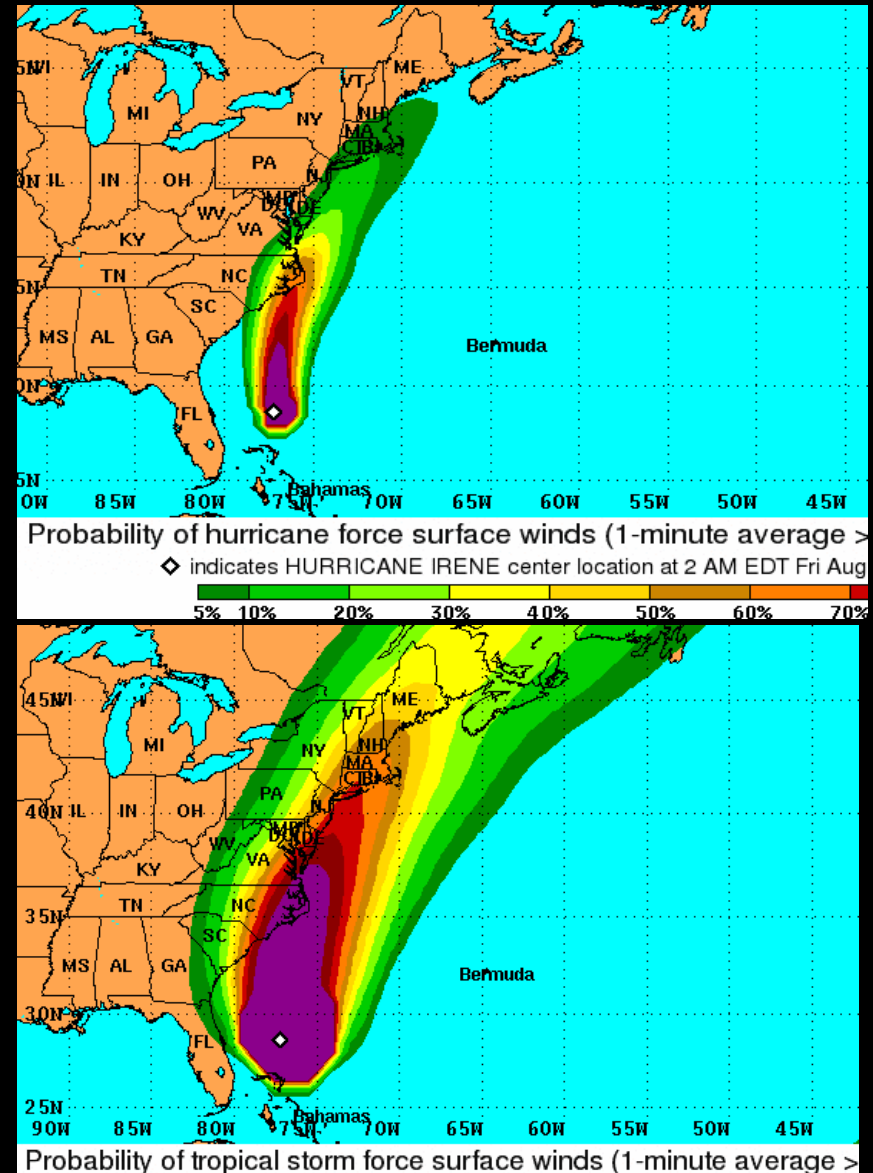
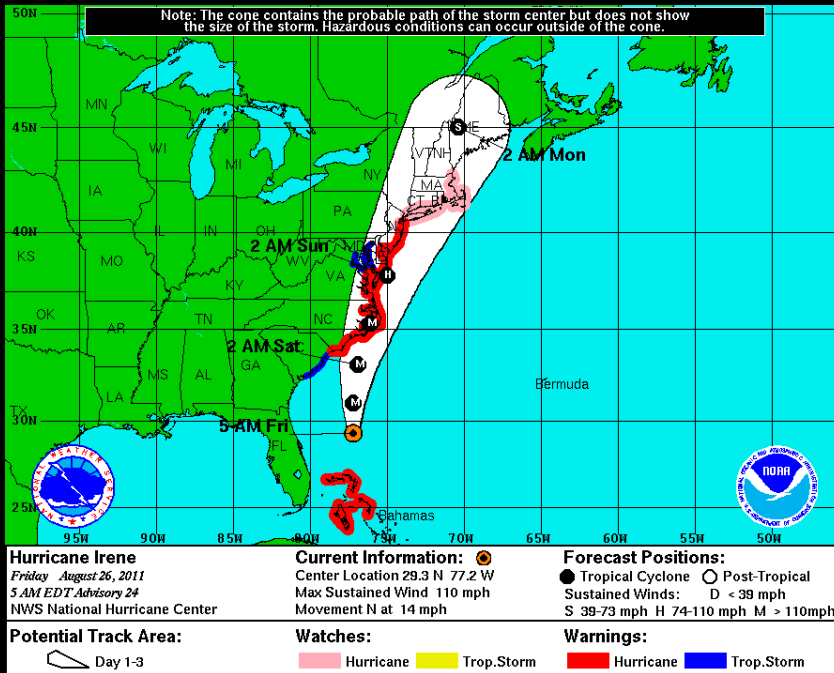


Lesson taught (again...)

No such thing as “Justa”
Tropical Storm
(or “justa” category 1)

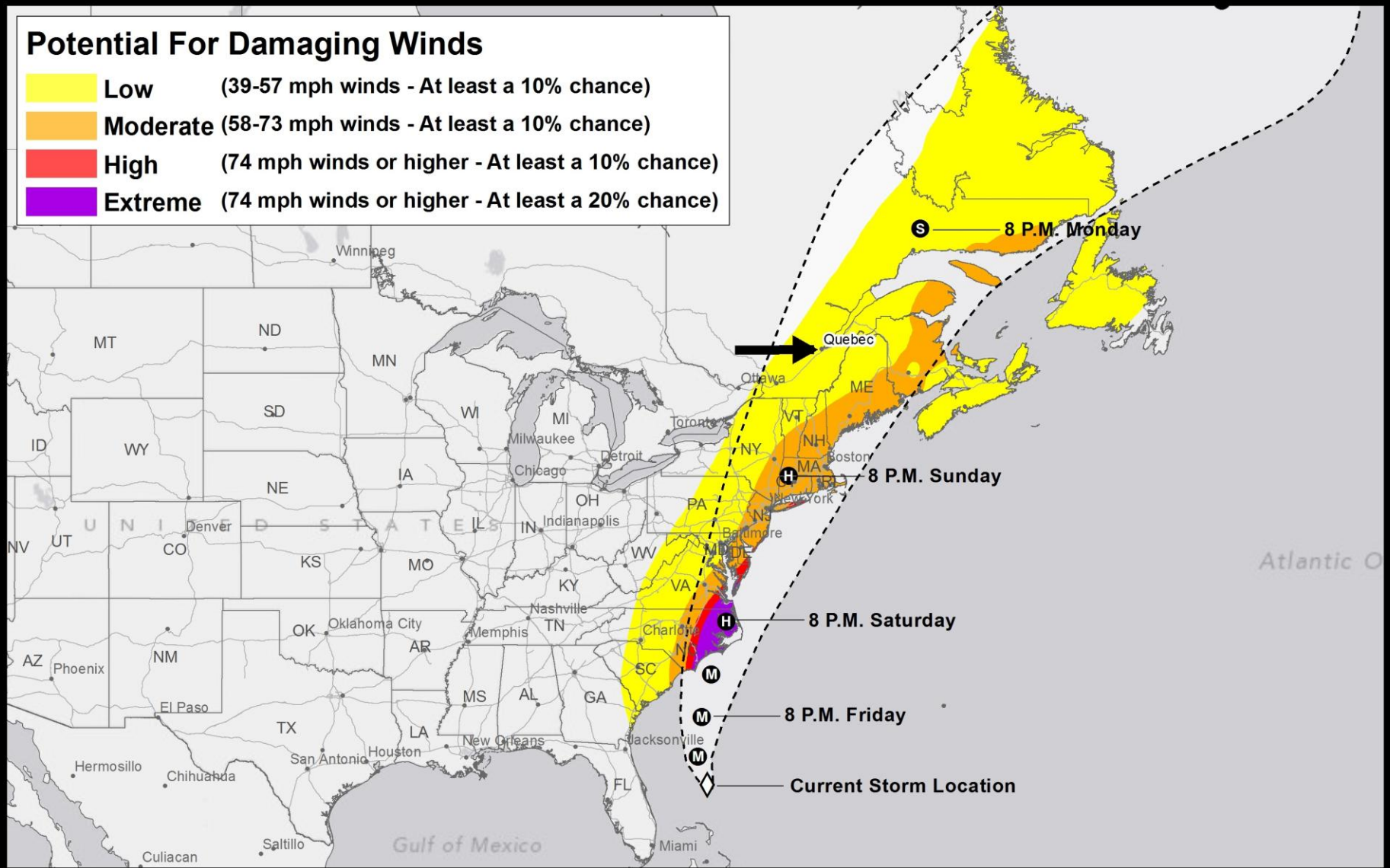
Conveying Uncertainty

Wind chances when
Hurricane
Watch/Warning issued



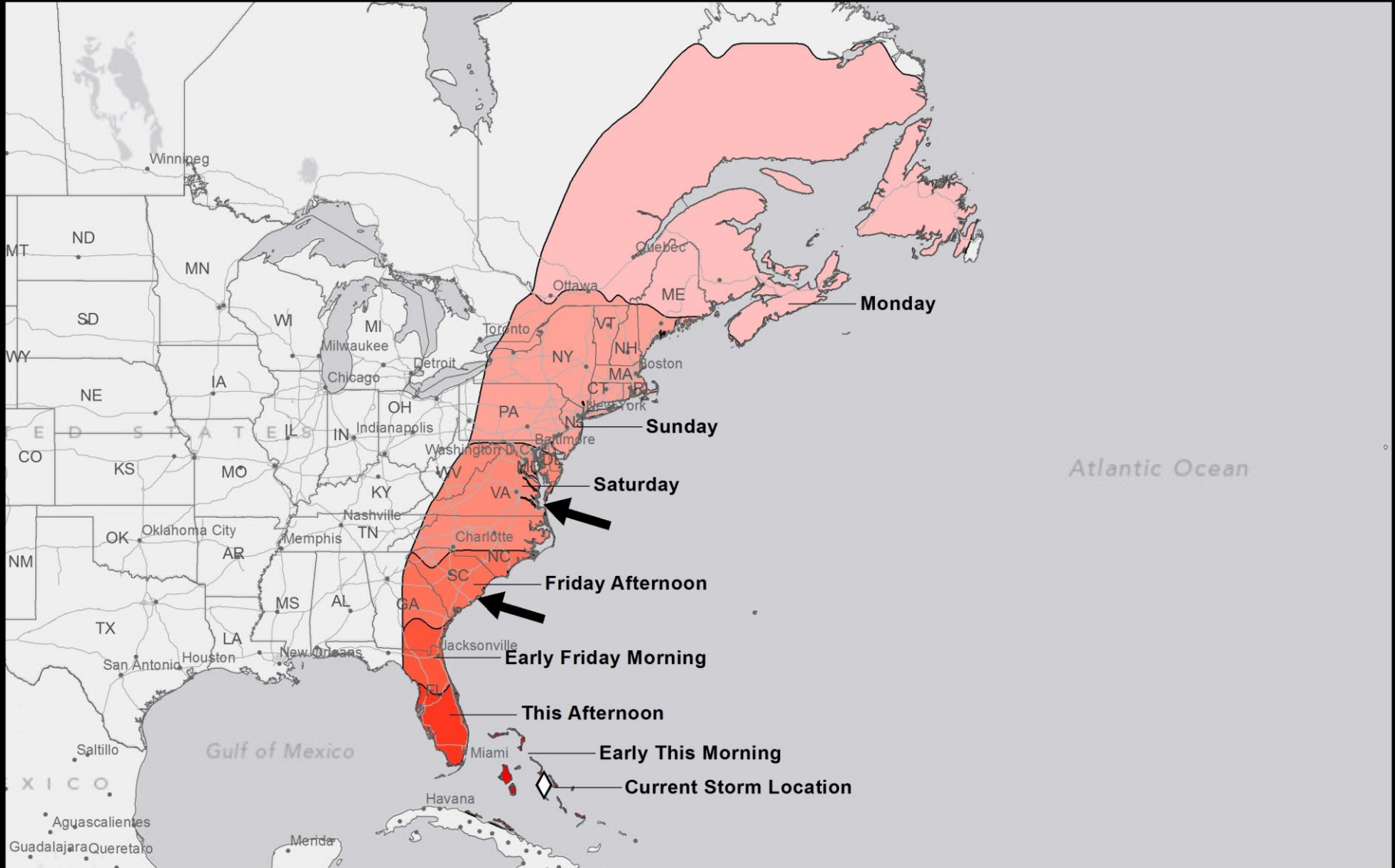
Potential For Damaging Winds

- Low** (39-57 mph winds - At least a 10% chance)
- Moderate** (58-73 mph winds - At least a 10% chance)
- High** (74 mph winds or higher - At least a 10% chance)
- Extreme** (74 mph winds or higher - At least a 20% chance)



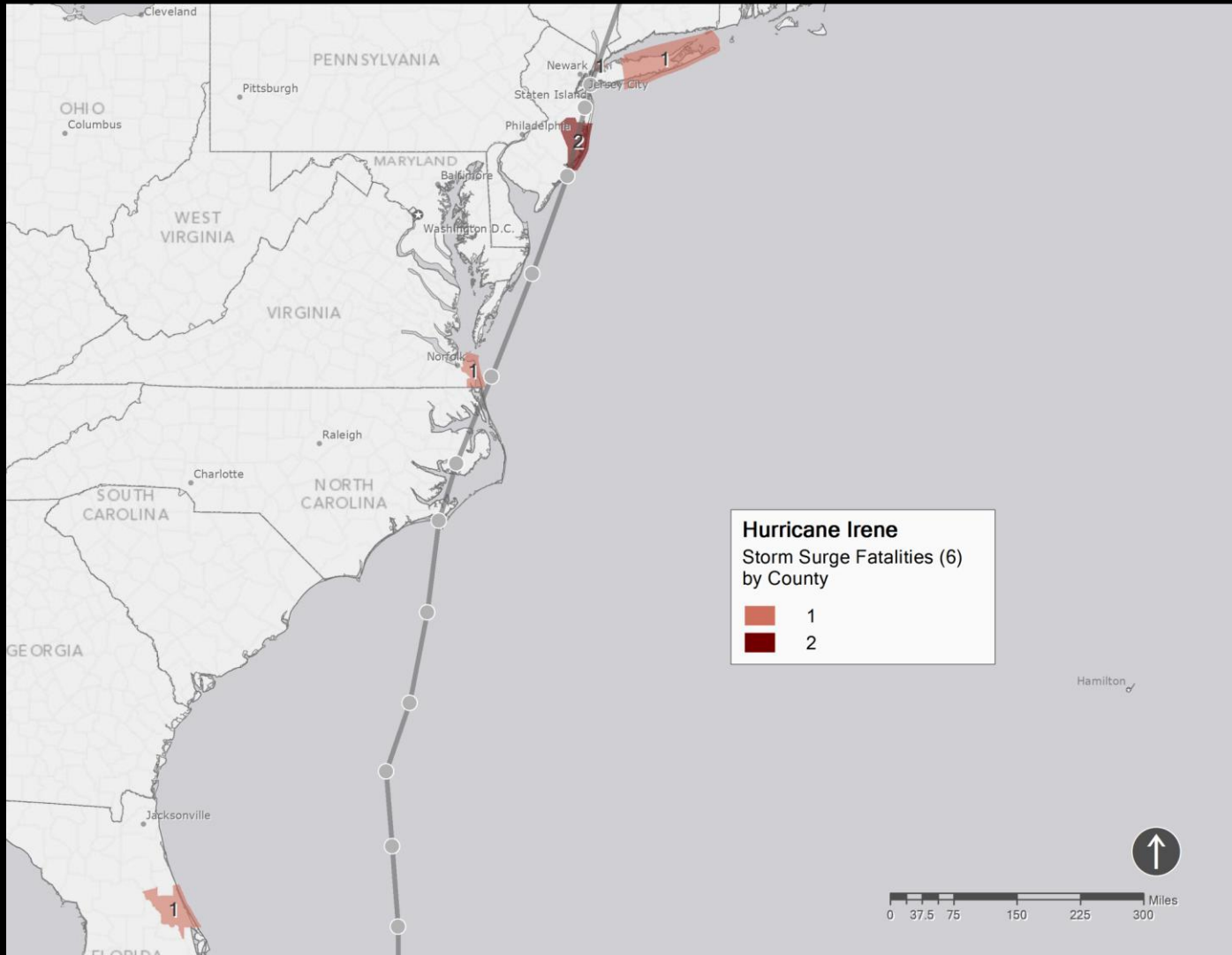
Note: the area enclosed by the forecast cone will not match the area that is at risk for strong winds

Forecast Points
 = Tropical Storm
 = Hurricane
 = Major Hurricane
 Forecast Error Cone



Preparation Completion Times (Expected Arrival of 39 mph Winds)

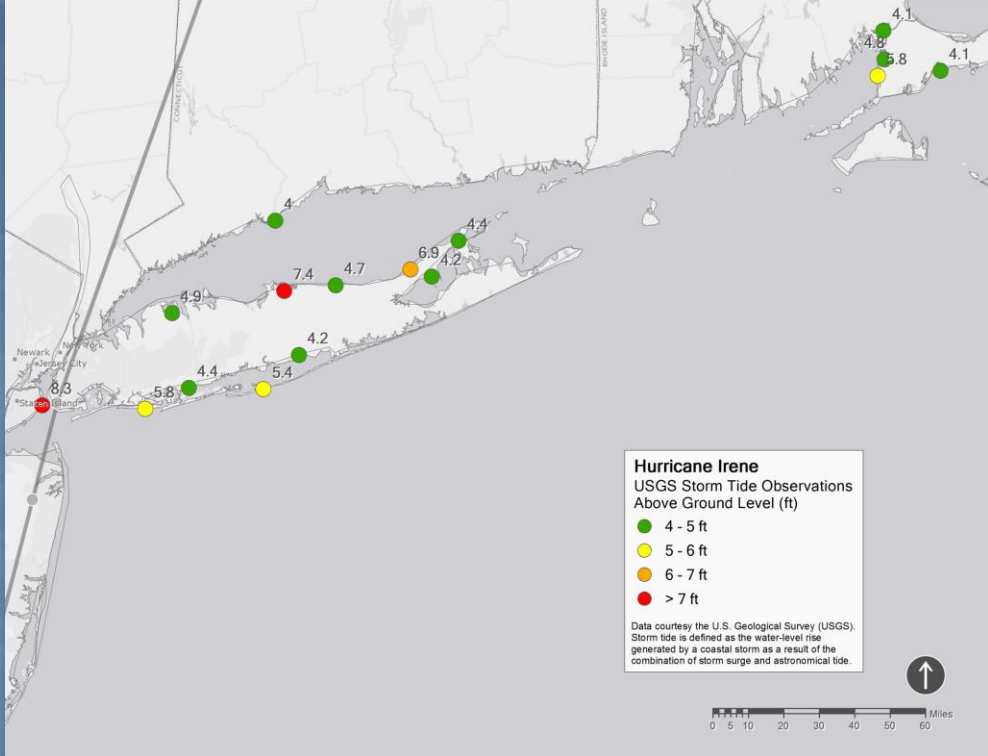
Irene Impacts - surge





Location: Avon, NC (Dare County)

East Haven, Connecticut



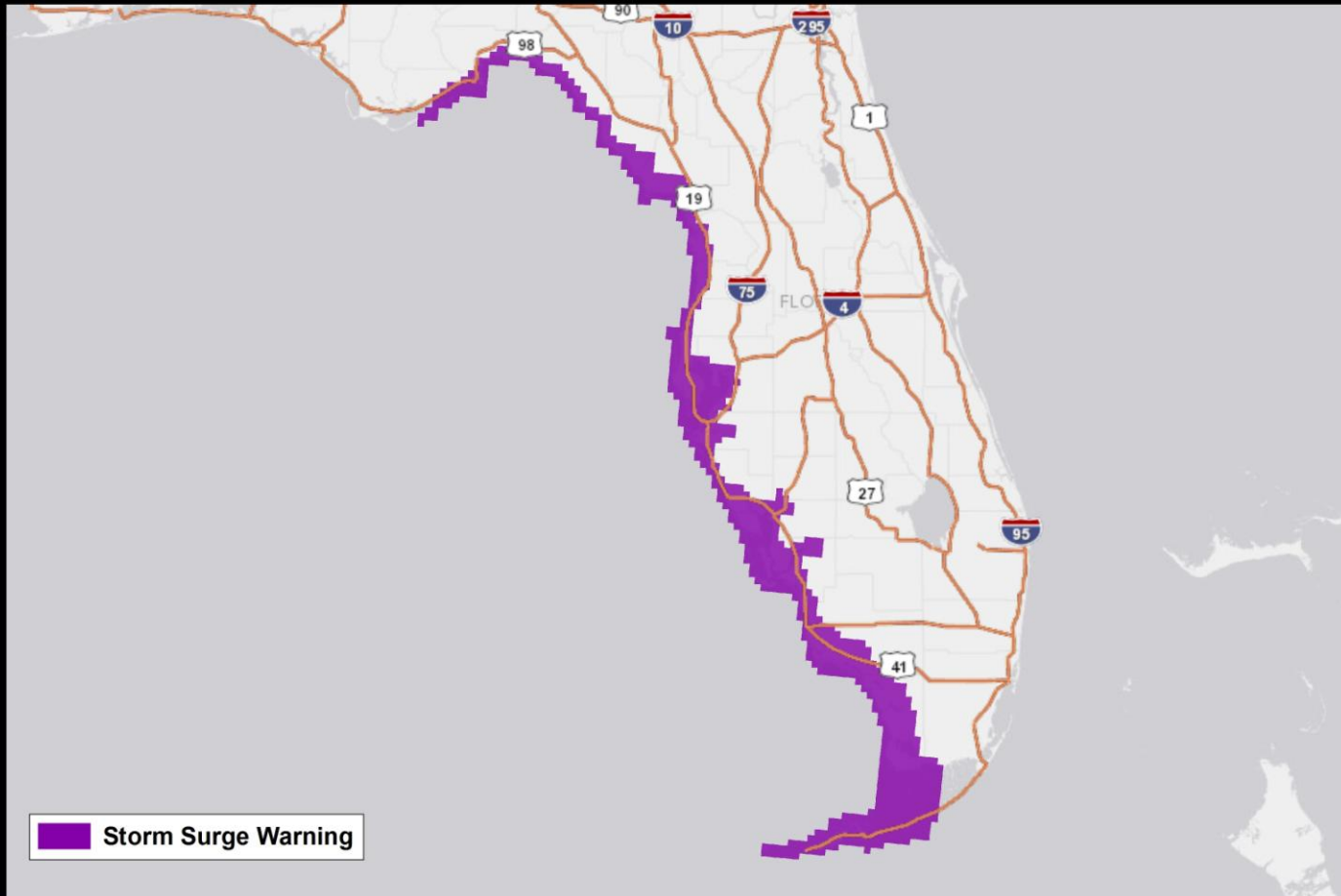
Lesson taught

- Many (most) people do not understand storm surge
- NWS and partners are making significant changes in how we convey the threat
- Considerable education will be needed to improve public understanding

First pass surge graphics from FL focus EMs, NWS, Media



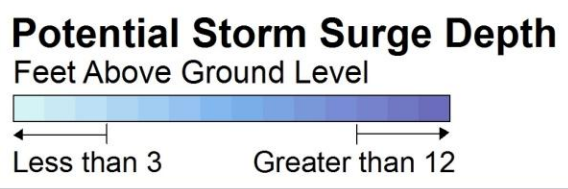
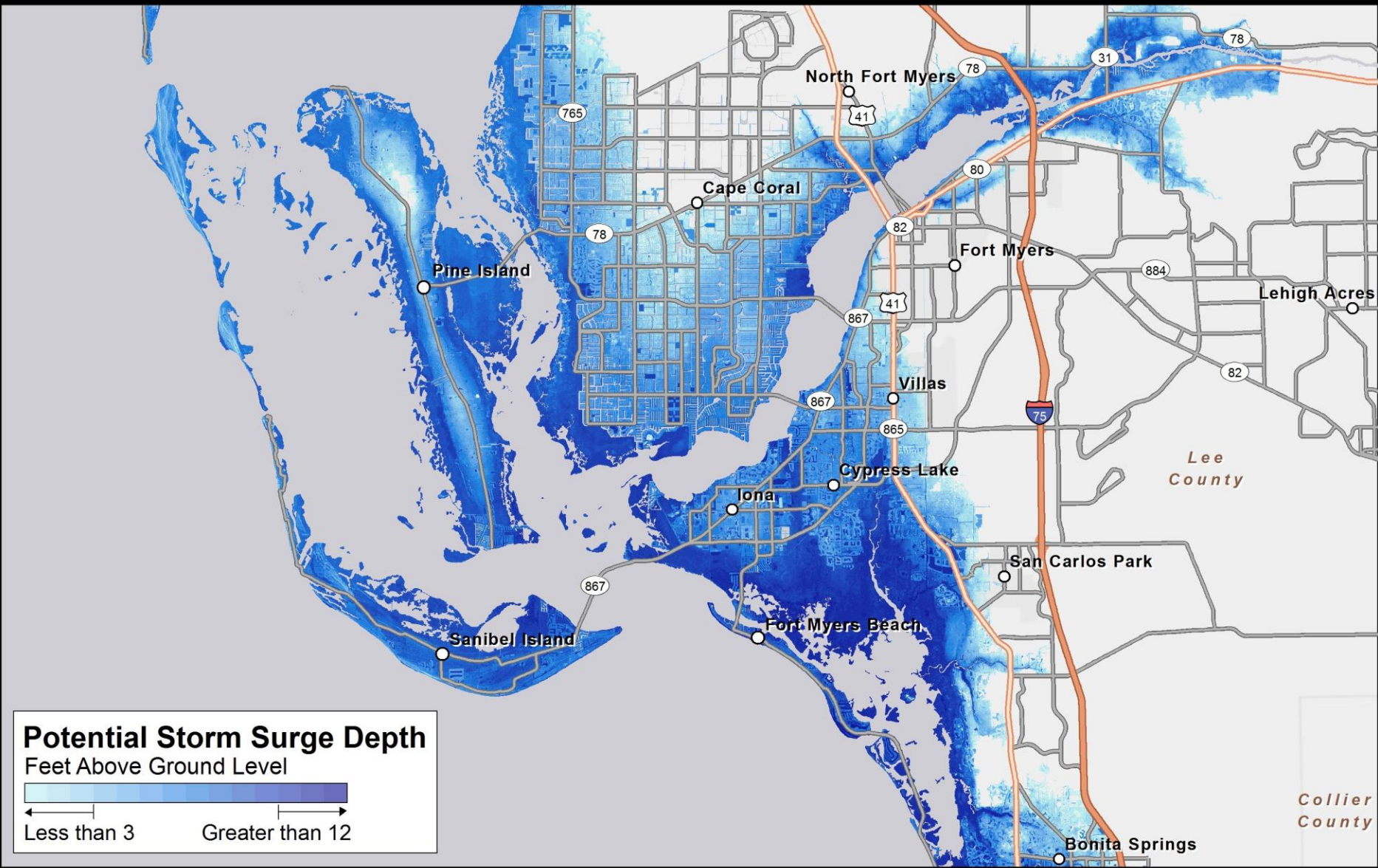
Hurricane X
Storm Surge Warning



 Storm Surge Warning

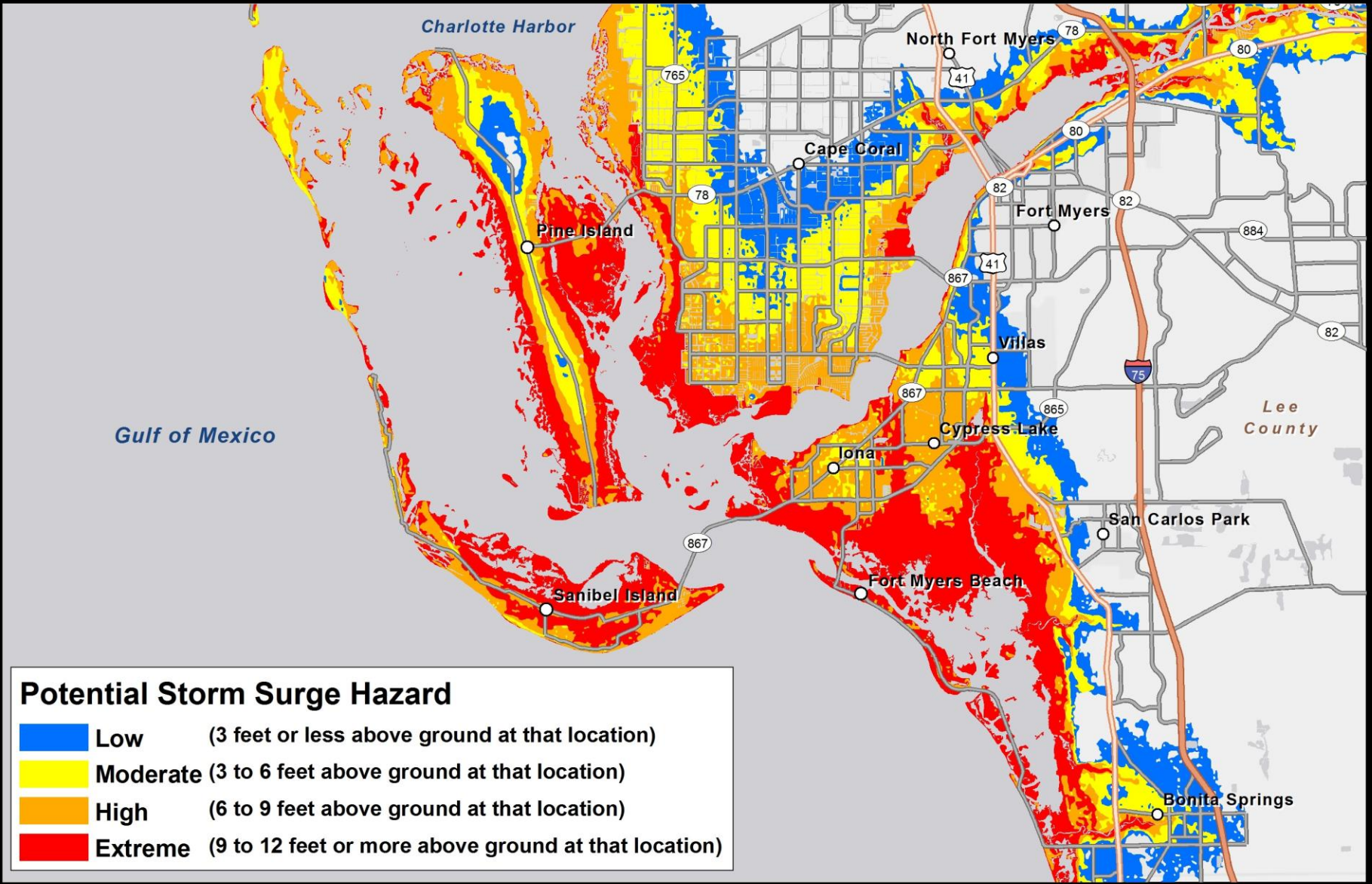


Hurricane X



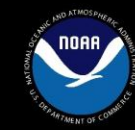


Hurricane X



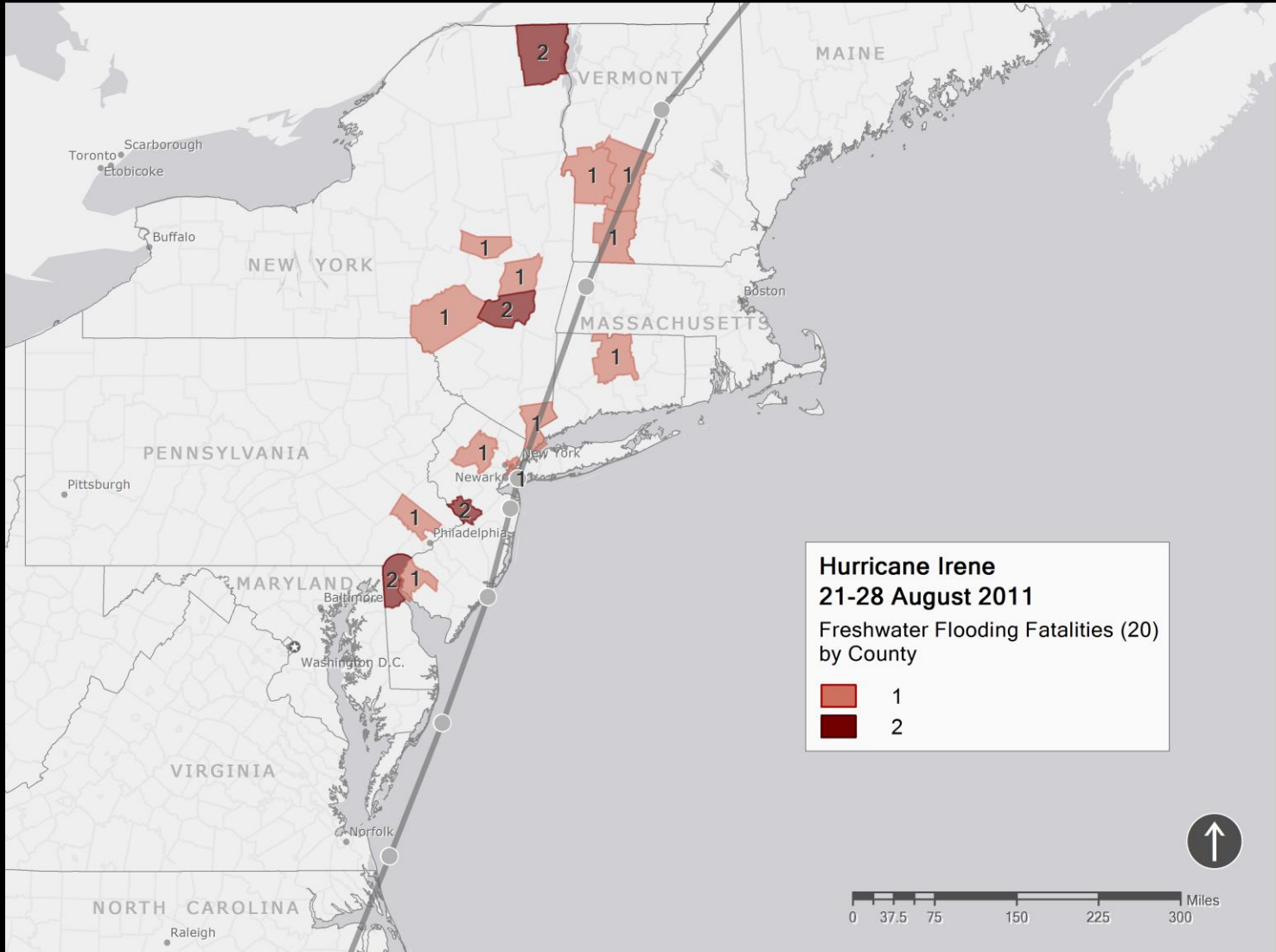
Potential Storm Surge Hazard

- Low** (3 feet or less above ground at that location)
- Moderate** (3 to 6 feet above ground at that location)
- High** (6 to 9 feet above ground at that location)
- Extreme** (9 to 12 feet or more above ground at that location)



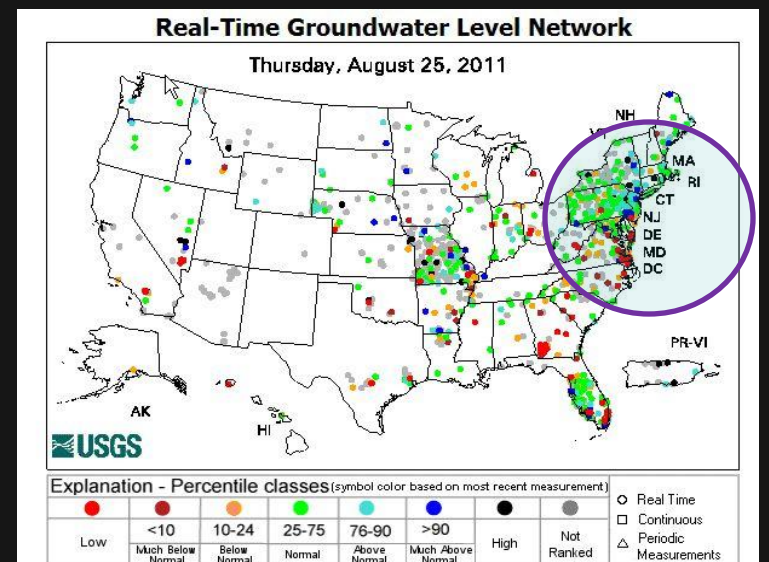
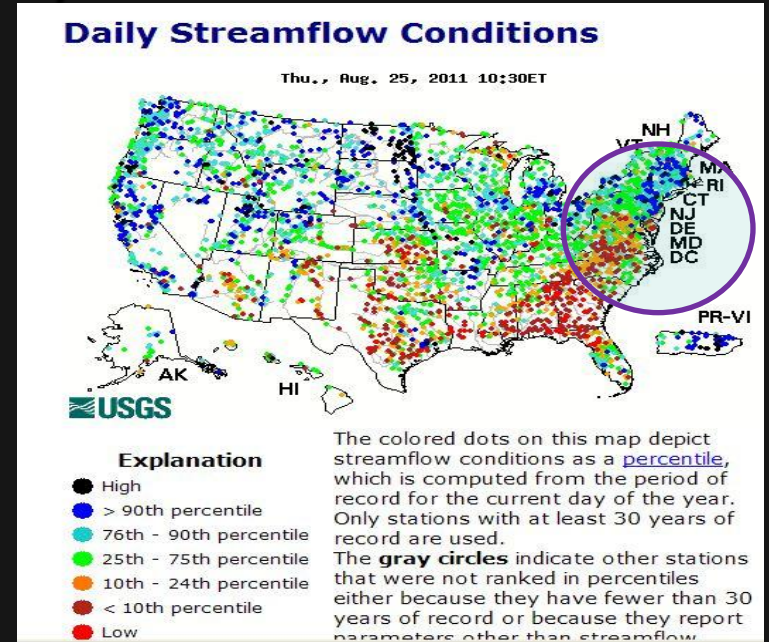
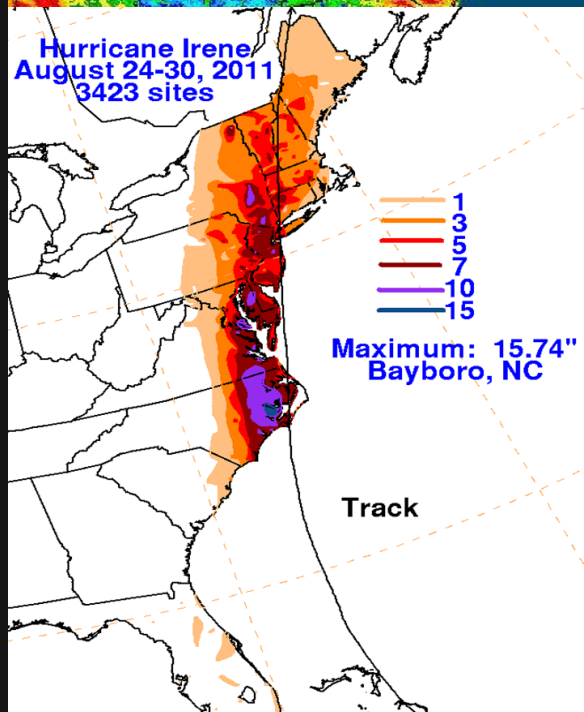
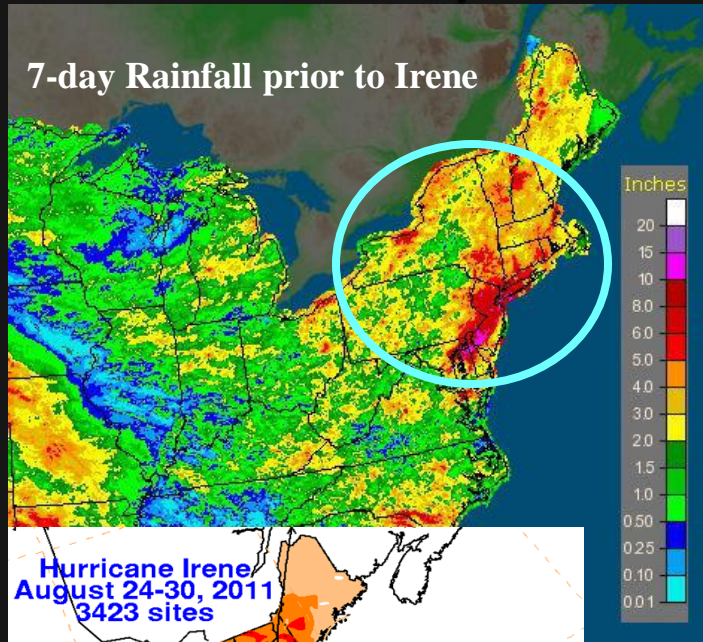
National Hurricane Center
Storm Surge Unit

Irene impacts - rain



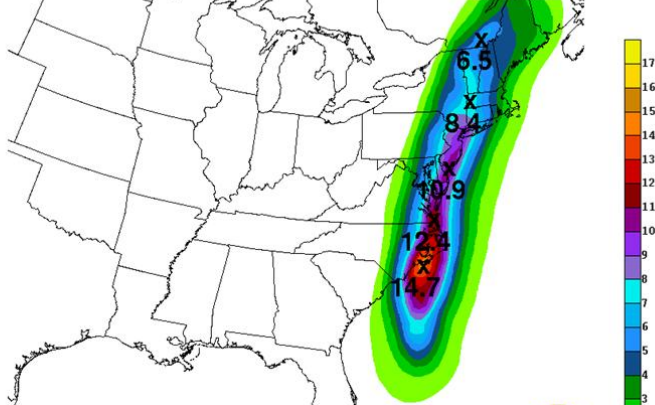
Antecedent Conditions

Setup is extremely important!!

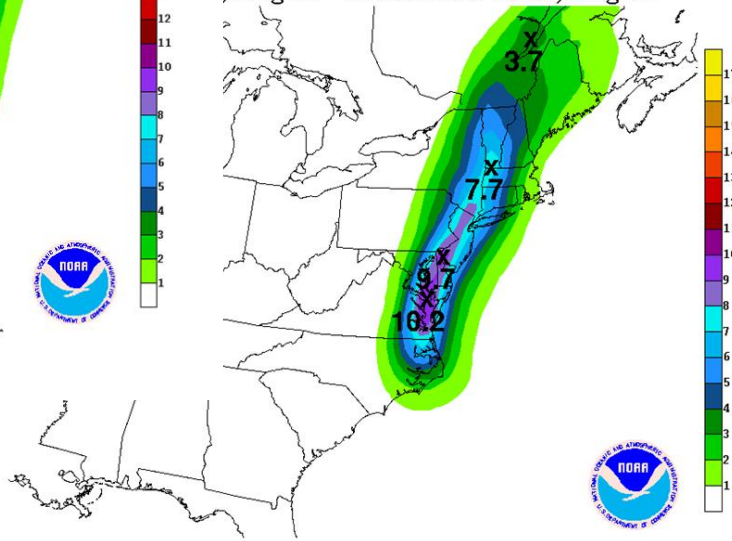


Rainfall forecast consistently highlighted the threat

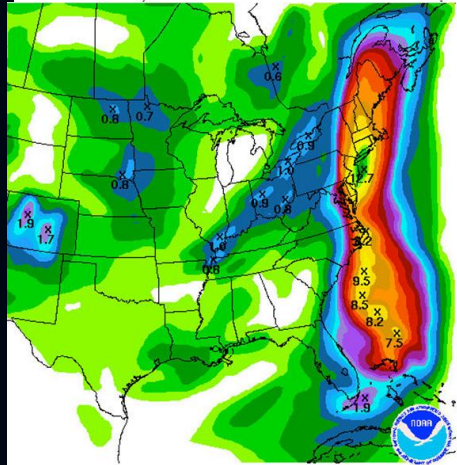
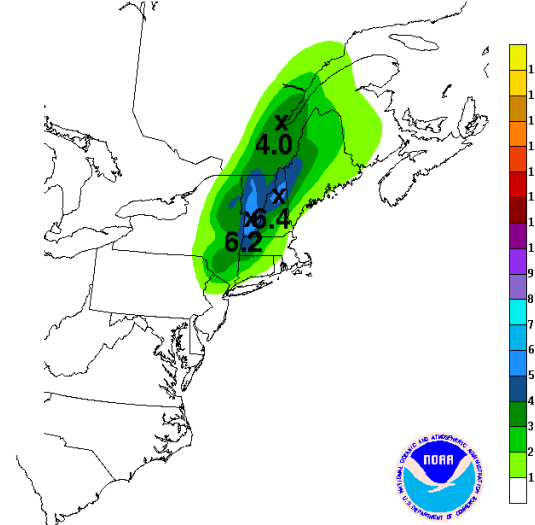
HPC 3-Day Rainfall Forecast
8 a.m. EDT Fri., Aug. 26 - 8 a.m. EDT Mon., Aug. 29



2-Day Rainfall Forecast
Aug. 27 - 8 a.m. EDT Mon., Aug. 29



1-Day Rainfall Forecast
Aug. 28 - 8 a.m. EDT Mon., Aug. 29



Lesson Taught

- People are unaware of the degree of flood risk they face
 - Irene rainfall and flood forecasts quite accurate
 - Social Science assessment indicates many impacted citizens “had no idea”
 - Are officials (NWS, OEM) properly conveying risk?
 - Are mainstream media properly conveying risk

Or...

Denial



Is not just a River in Africa!

- * A major hurricane or flood at your location is a rare event – low probability of occurrence but high probability of severe impact - *Outliers*
- * Denial - a *natural* human response to above
- * Uncertainty – even 2 days before landfall – track, intensity, size, impact – combined with denial leads to *inaction*
- * If uneducated about the threat – *RE*active rather than *PRO*active response by the public (Rita evacuation in Houston)

Lesson not learned:

The 100 Year Event does not mean absolute protection

	10 year	25 year	50 year	100 year	500
1 yr	10%	4%	2%	1%	.2%
10	65	34	18	10	
20	88	56	33	18	
30	96	71	45	26	6
50	99	87	64	39	

One more lesson
taught...

Things you should have learned
about us meteorologists

When a Specialist says:

“A nice wave moved off
Africa yesterday...”

You should be thinking...

“We’ll be dealing with
a Cat 4 by the
weekend”

When a Specialist says:

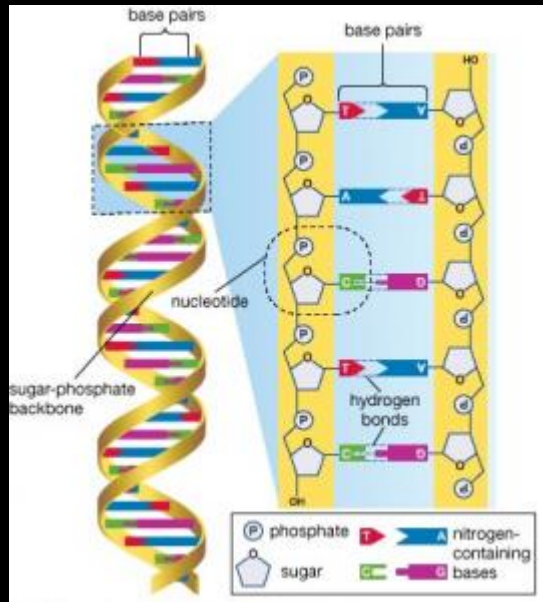
“The environment
around Hurricane
Xavier looks bad”

You should be thinking...

“Miller Time”

The “Defective Gene” theory of meteorology

Normal Human Gene



Meteorologist Gene



...the question that
remains to be
answered...

Will these lessons be
learned?

2012 Atlantic hurricane season ~~starts in just 7 days...~~



Has already begun...are you ready?