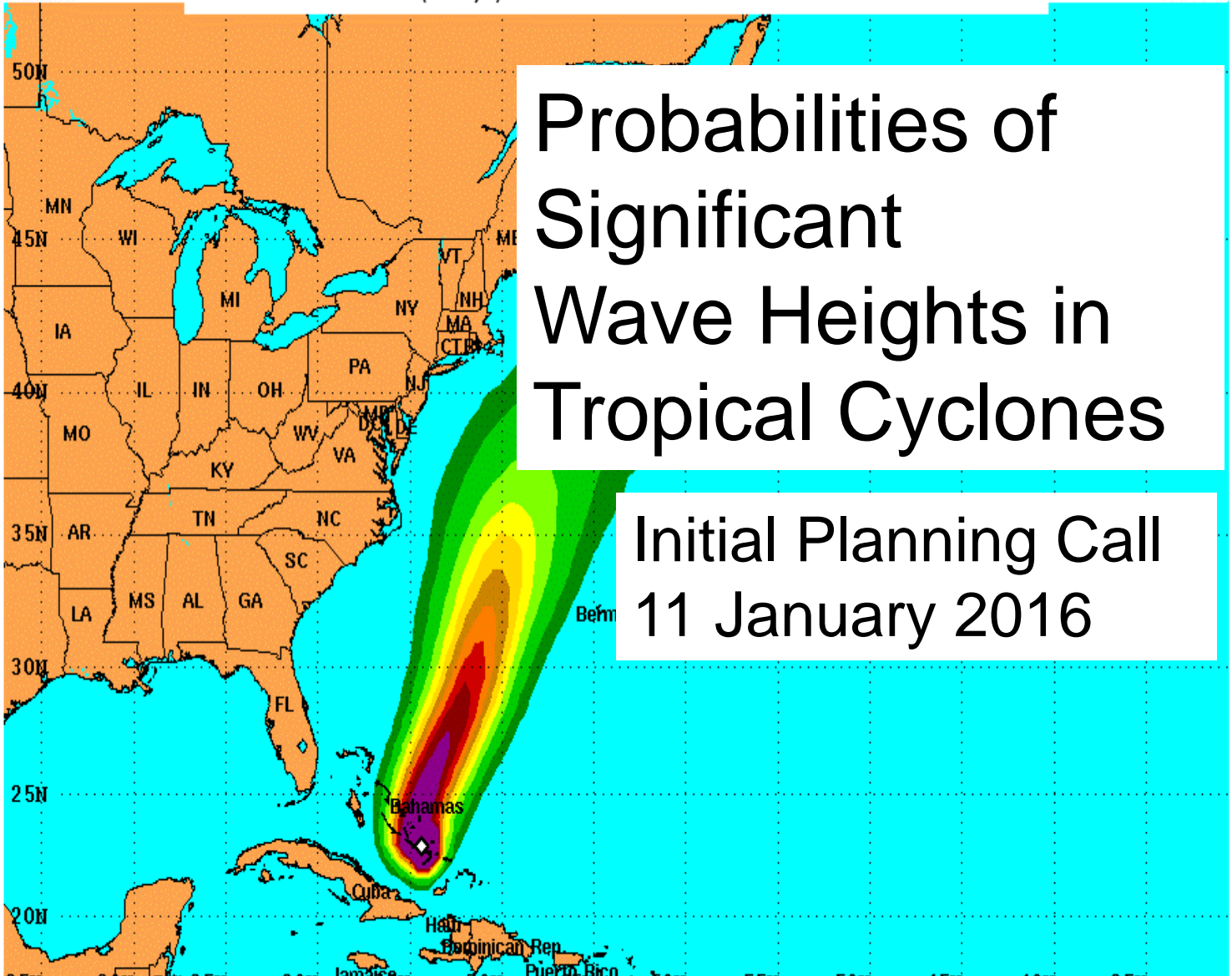




# 24-ft Wave Height Probabilities



For the 120 hours (5 days) from 8 PM EDT Thu Oct 1 to 8 PM EDT Tue Oct 6

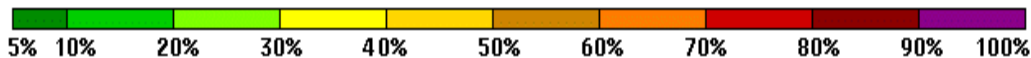


# Probabilities of Significant Wave Heights in Tropical Cyclones

## Initial Planning Call 11 January 2016

Probability of 24-ft Significant Wave Height (the average height of the highest 1/3 of the waves) from all tropical cyclones

◇ indicates HURRICANE JOAQUIN center location at 8 PM EDT Thu Oct 1 2015 (Forecast/Advisory #17)



# Topics for today's call:

1. Overview of concept
2. Team members confirmation
3. Possible support for project
4. Next steps...

# EL FARO

33 fatalities when it sank in Hurricane Joaquin (2015)



## EL FARO

33 fatalities when it sank in Hurricane Joaquin (2015)

## BOUNTY

2 fatalities when it sank in Hurricane Sandy (2012)

## FANTOME

31 fatalities when it sank in Hurricane Mitch (1998)



# Existing Wave Products for Tropical Cyclones

## High Seas and Offshores Text Forecasts

HIGH SEAS FORECAST  
NWS NATIONAL HURRICANE CENTER  
1030 UTC FRI OCT 02 2015

SUPERSEDED BY NEXT ISSUANCE IN 6 HOURS

SEAS GIVEN AS SIGNIFICANT WAVE HEIGHT...WHICH IS THE AVERAGE HEIGHT OF THE HIGHEST 1/3 OF THE WAVES. INDIVIDUAL WAVES MAY BE MORE THAN TWICE THE SIGNIFICANT WAVE HEIGHT.

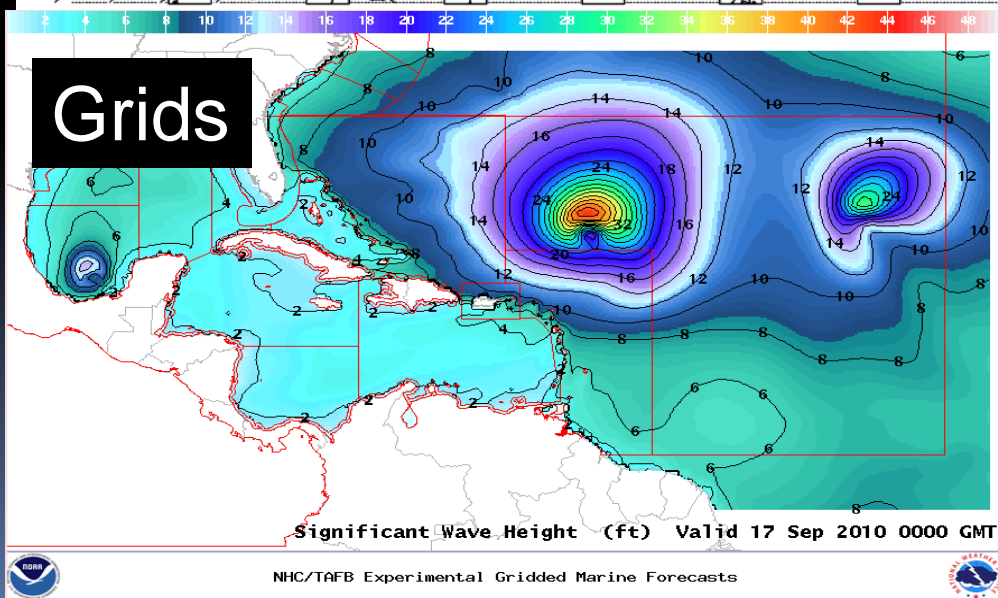
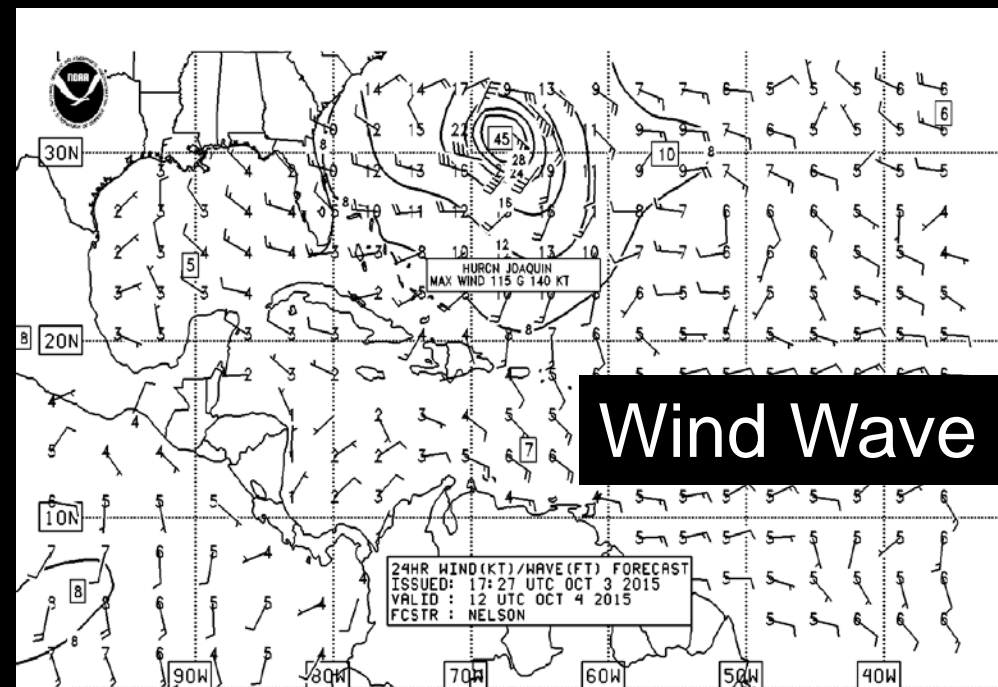
PAN PAN

ATLANTIC FROM 07N TO 31N W OF 35W INCLUDING CARIBBEAN SEA AND GULF OF MEXICO.

SYNOPSIS VALID 0600 UTC FRI OCT 02.  
24 HOUR FORECAST VALID 0600 UTC SAT OCT 03.  
48 HOUR FORECAST VALID 0600 UTC SUN OCT 04.

.WARNINGS.

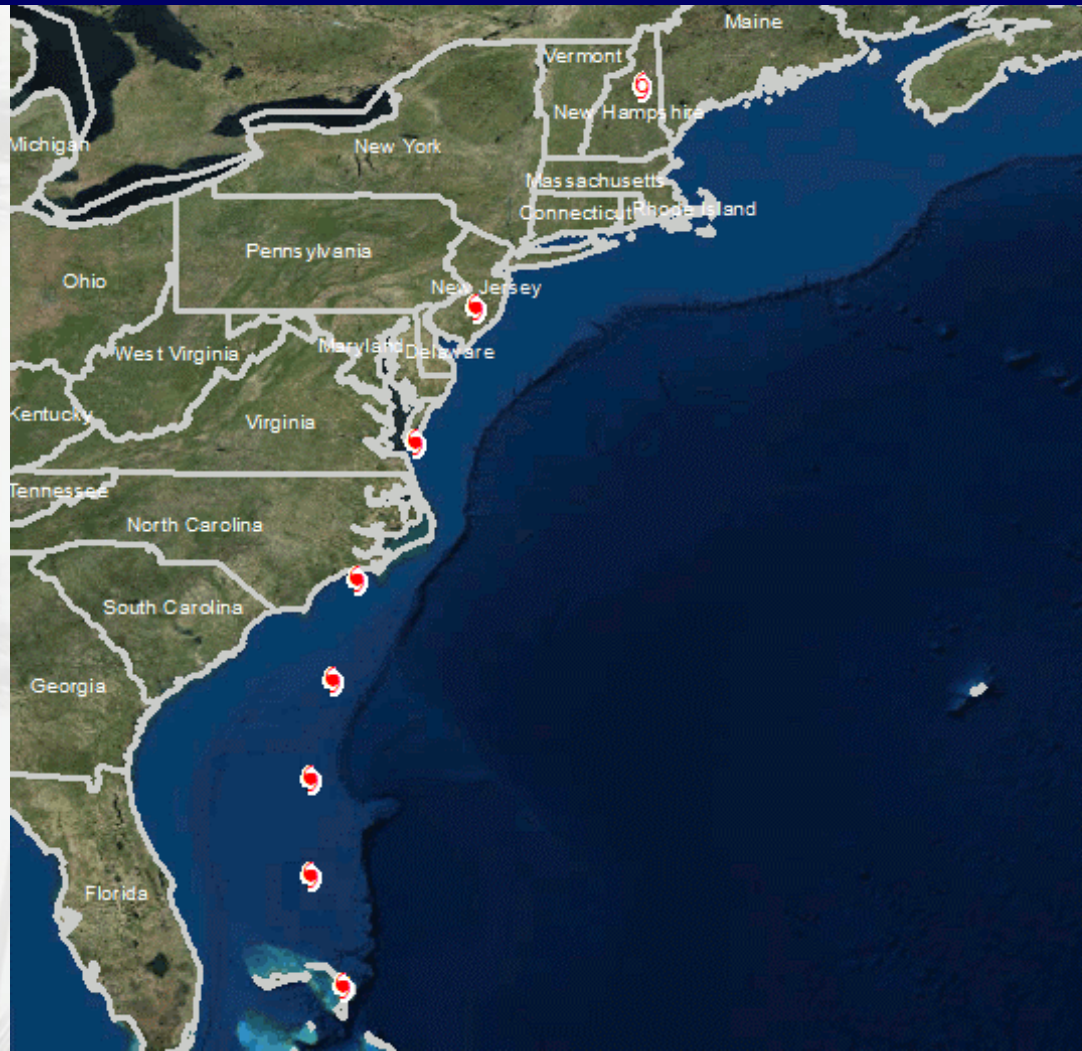
...HURRICANE WARNING...  
.HURRICANE JOAQUIN NEAR 23.3N 74.7W 935 MB AT 0900 UTC OCT 02 MOVING NW OR 315 DEG AT 3 KT. MAXIMUM SUSTAINED WINDS 115 KT GUSTS 140 KT. TROPICAL STORM FORCE WINDS WITHIN 160 NM W SEMICIRCLE...140 NM NE QUADRANT AND 180 NM SE QUADRANT. SEAS 12 FT OR GREATER WITHIN 400 NM NE QUADRANT...150 NM SE QUADRANT...120 NM SW QUADRANT...AND 300 NM NW QUADRANT WITH SEAS TO 39 FT. ELSEWHERE S OF 28N BETWEEN 70W AND 78W WINDS 20 TO 33 KT. SEAS 9 TO 12 FT. N OF 28N BETWEEN 70W AND 75W E WINDS 20 TO 25 KT SEAS 8 TO 10 FT. REMAINDER OF AREA N OF 21N BETWEEN 65W AND 78W AND OUTSIDE OF THE BAHAMAS WINDS 20 KT OR LESS. SEAS 8 TO 11 FT IN MIXED SWELL.



# Wind Speed Probabilities

*How are they generated?*

- **1,000 realistic alternative scenarios are created**
  - Official NHC forecast
  - Historical NHC track and intensity forecast errors
  - Climatology and persistence wind radii model
- **Weakening over land**
- ***Track model spread***  
Past NHC track forecast errors are correlated to the spread of track model guidance





# Wind Speed Probabilities

*How are they generated?*



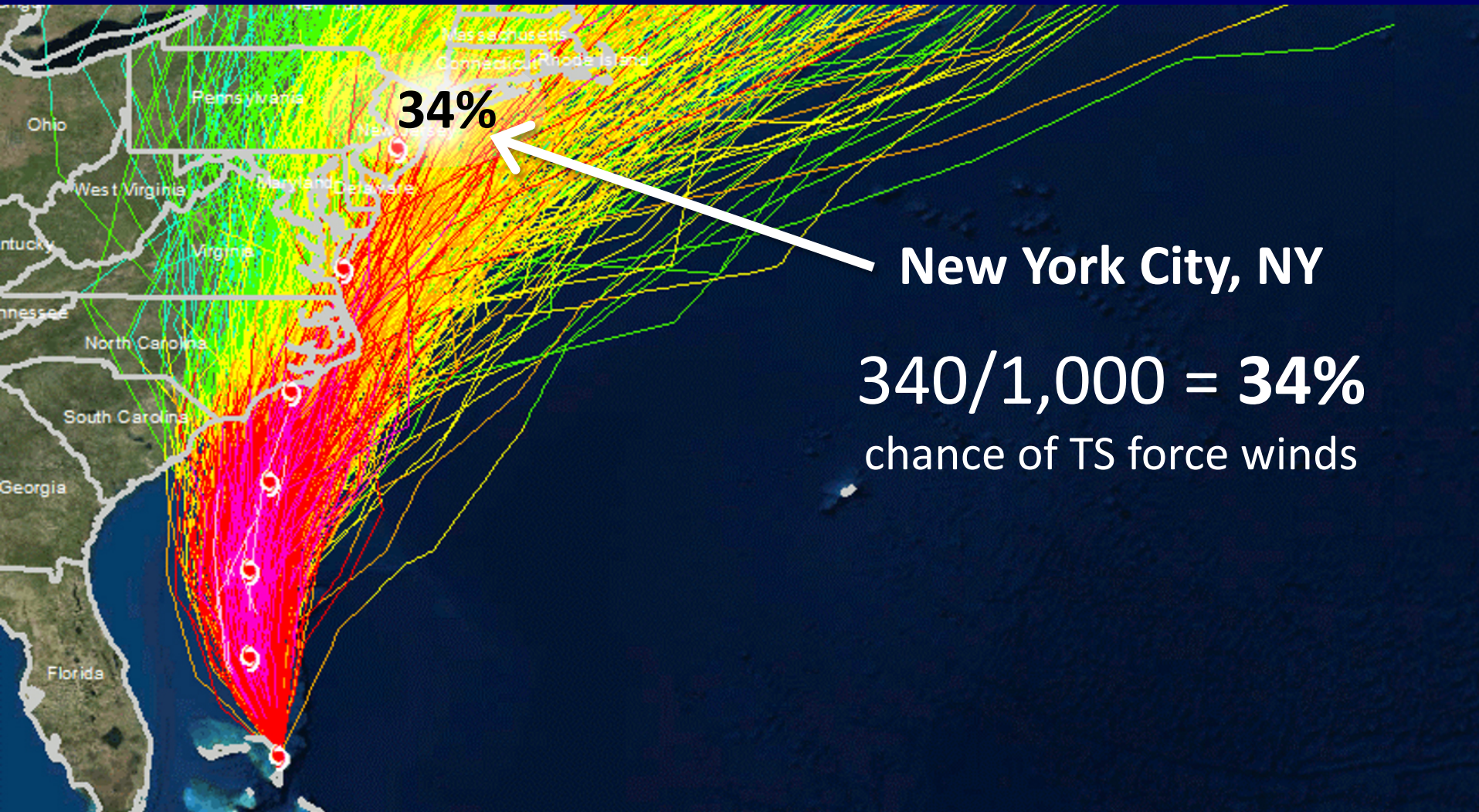
**New York City, NY**

340 of 1,000 scenarios produce tropical storm winds at that location.



# Wind Speed Probabilities

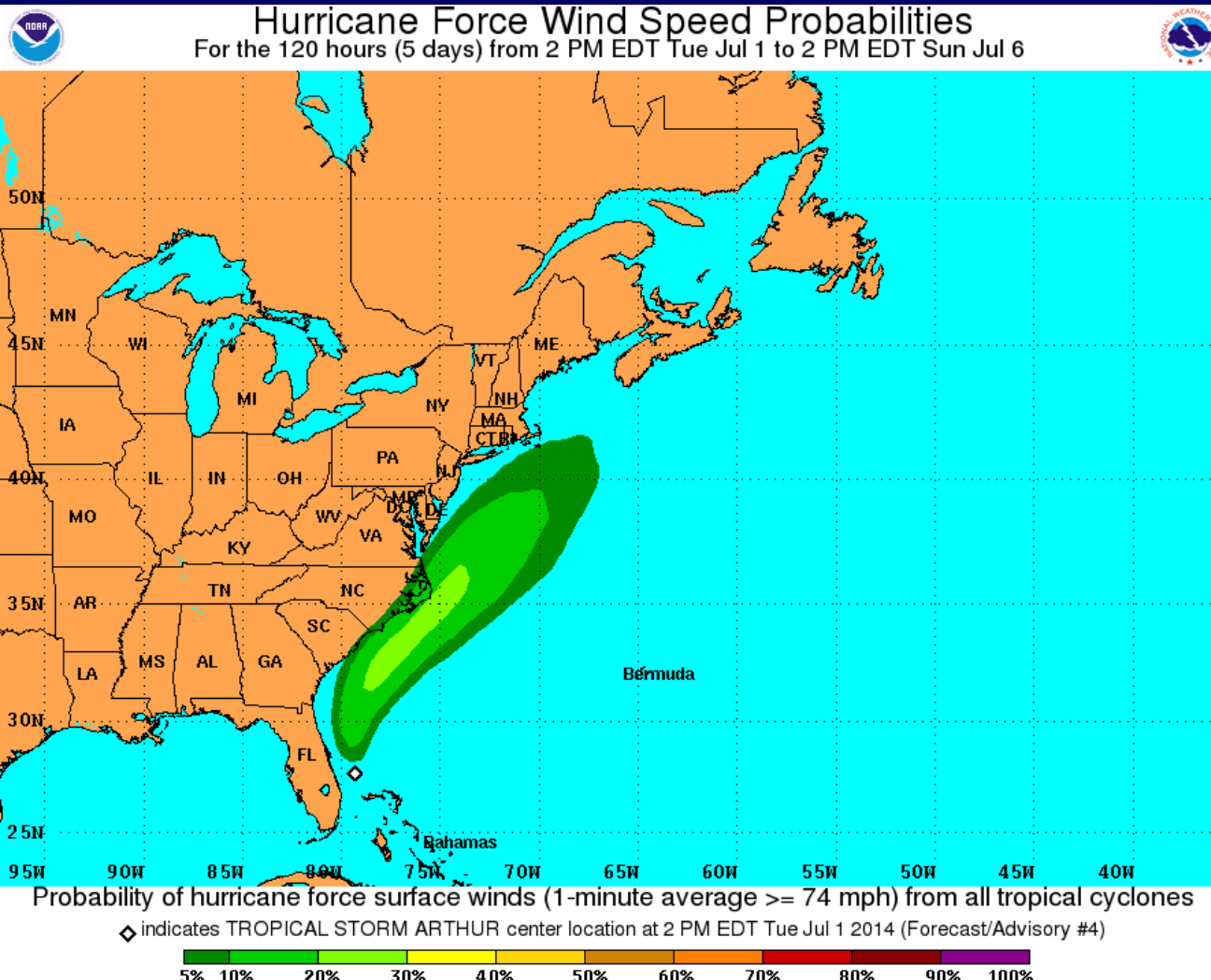
*How are they generated?*





# Wind Speed Probabilities

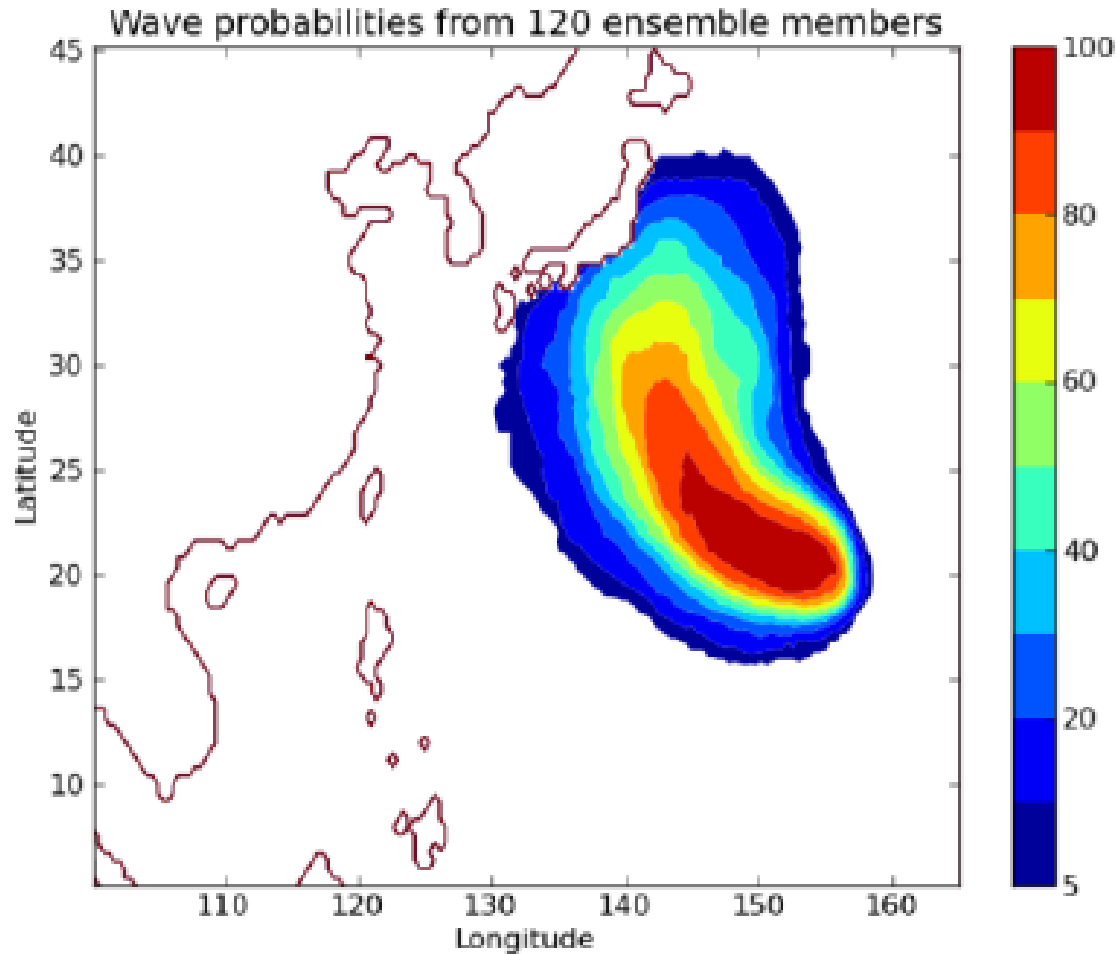
## Graphical Product



Depicts location-specific probabilities

- Tropical-storm-force
- 58 mph
- Hurricane-force

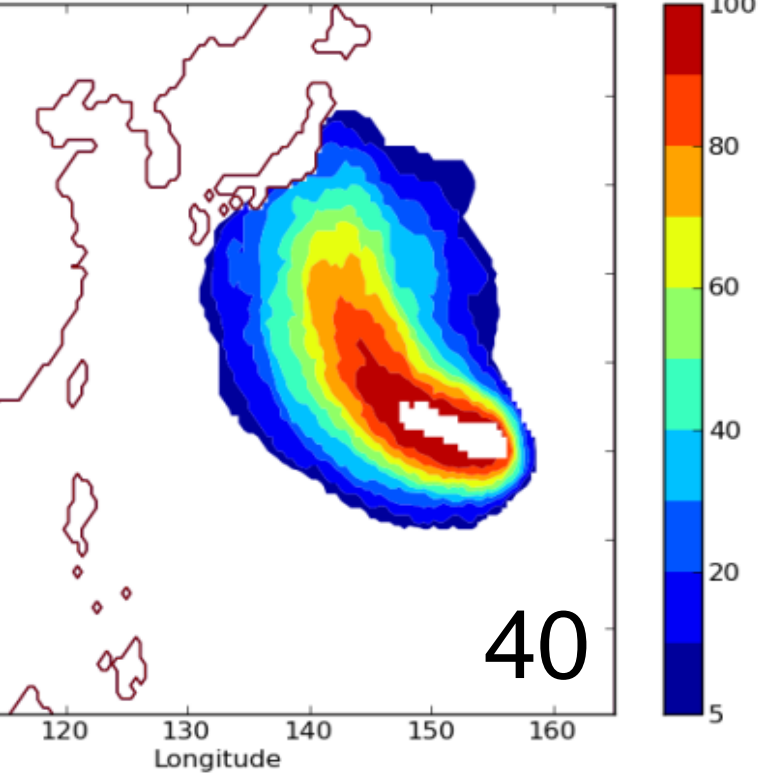
# Probability of 12' Significant Wave Heights



From Buck Sampson,  
Naval Research Laboratory

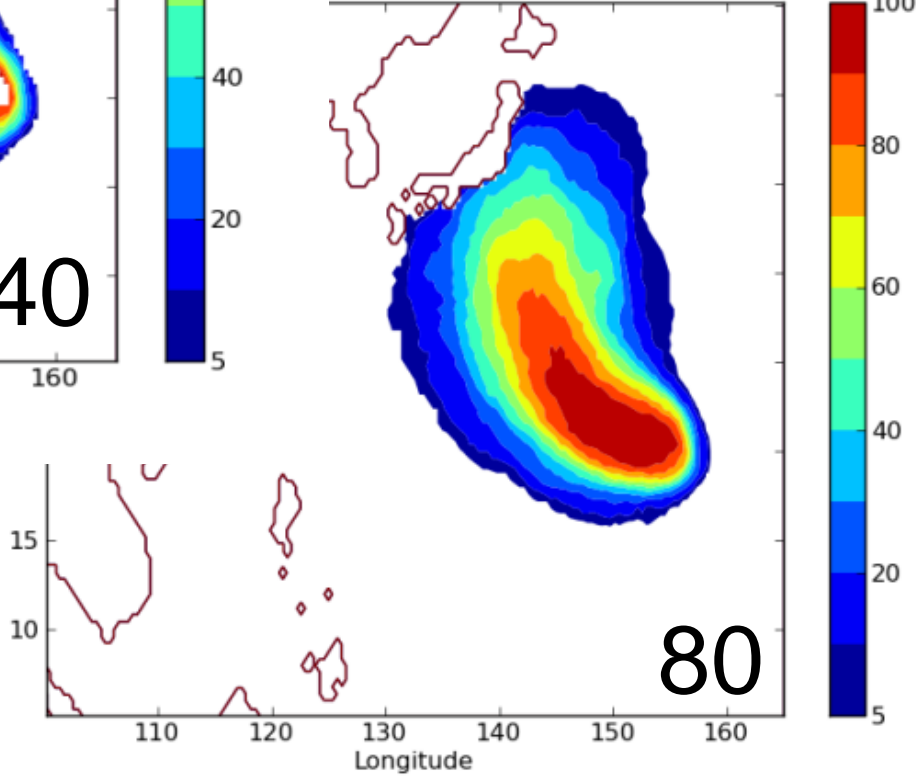


Probabilities from 40 ensemble members

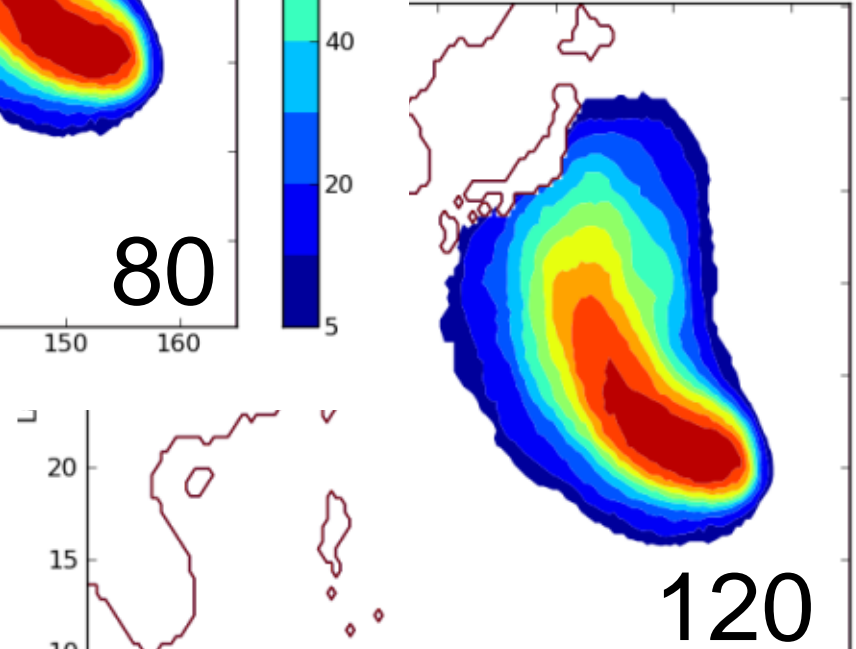


# Wave Height Probabilities Based on various ensemble sizes

Probabilities from 80 ensemble members



Probabilities from 120 ensemble members



From Buck Sampson,  
Naval Research Laboratory

# Conceptual Framework for Probabilities of Significant Wave Heights in Tropical Cyclones Product

1. Deterministic TC forecast issued by NHC/CPHC
2. Wind fields from 10s or 100s of Monte Carlo Wind Speed Probabilities simulated TCs obtained
3. Outside of TC wind field, use GFS winds as boundary conditions
4. These combined wind fields drive 10s or 100s of wave models
5. Empirically-derived probabilities of wave heights for various thresholds determined
6. Output automatically used for public products



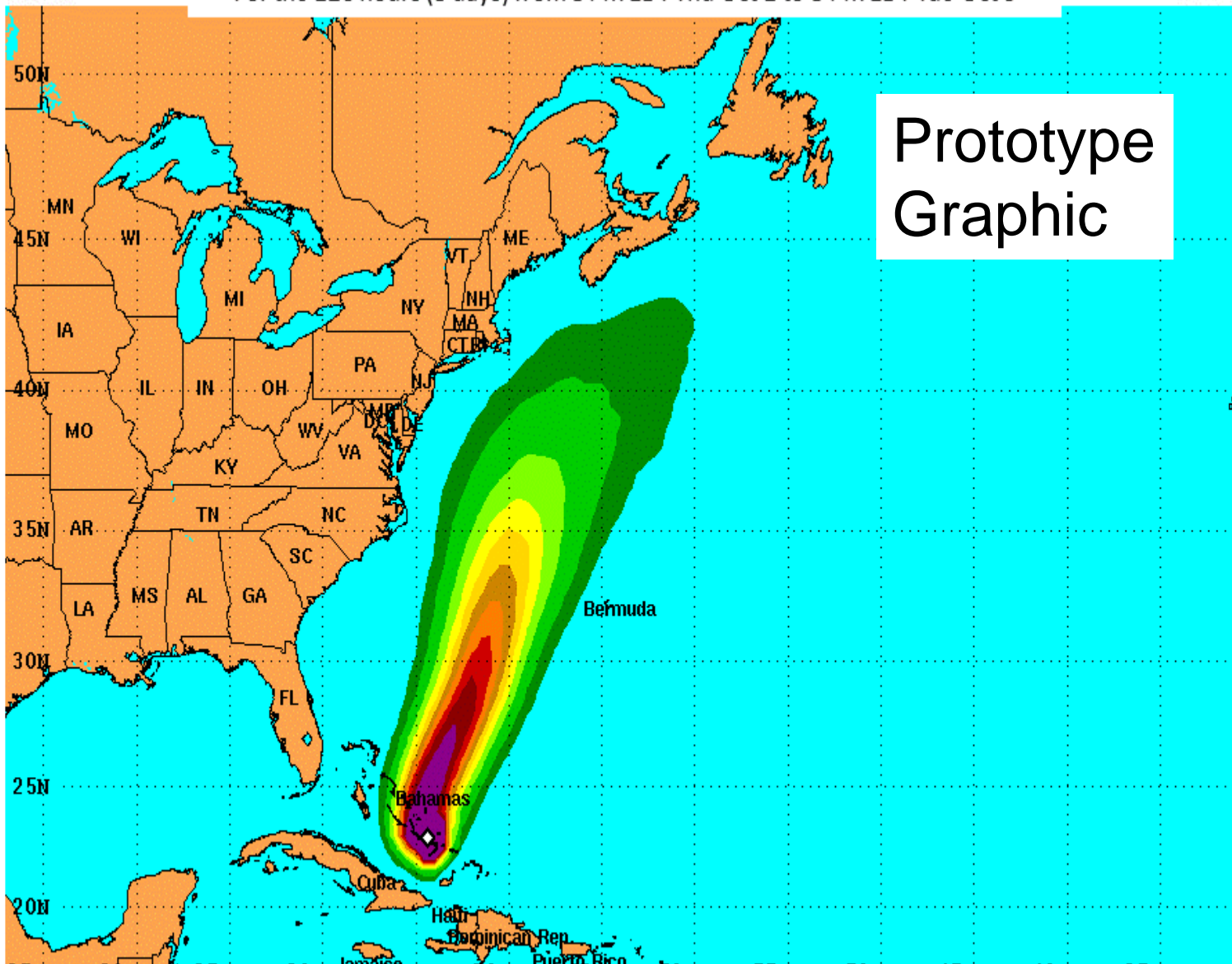


# 24-ft Wave Height Probabilities



For the 120 hours (5 days) from 8 PM EDT Thu Oct 1 to 8 PM EDT Tue Oct 6

Prototype  
Graphic



Probability of 24-ft Significant Wave Height (the average height of the highest 1/3 of the waves) from all tropical cyclones

◇ indicates HURRICANE JOAQUIN center location at 8 PM EDT Thu Oct 1 2015 (Forecast/Advisory #17)



**Key questions** that would need to be addressed while development is undertaken:

- 1) What ocean wave model could be run dozens or hundreds of times in a timely manner?
- 2) How many ensemble members (from the Monte Carlo wind speed probability program) would be needed to produce stable, smooth wave height probabilities?
- 3) What wave height thresholds (12', 18', 24', etc.) are most of interest to the open ocean mariners in and around hurricanes?
- 4) What interval time frame (6, 12, or 24 h) for the product is of most interest to the marine users?
- 5) How would multiple tropical cyclones be handled?