RESPONDING TO A RISING TIDE

Coastal Storm Hazards for Cape Cod

Bob Thompson
National Weather Service Taunton, MA

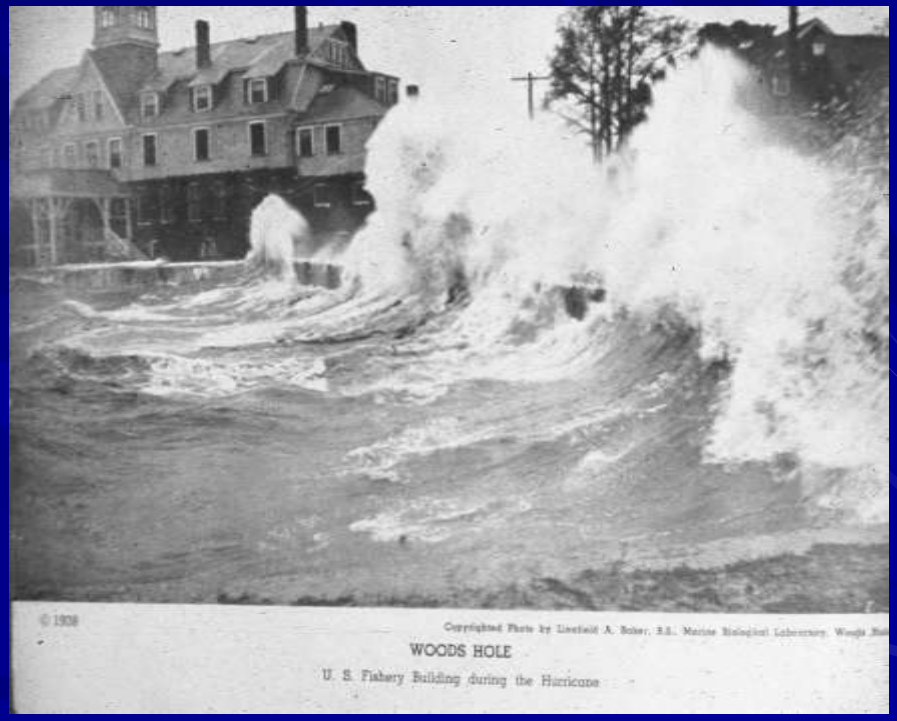
COASTAL STORMS

- **Types of coastal storms**
  - Tropical Cyclones (e.g. hurricanes)
    - Hurricane Bob – August 19, 1991
  - Extratropical Cyclones (e.g. nor'easters)
    - Perfect Storm – October 30, 1991
- **Impacts from Hurricanes and Nor'easters**
- **National Weather Service Resources**
- **Concluding Thoughts**

NEW ENGLAND HURRICANES

Low Frequency, High Impact!

- Category 3 hurricanes
  - Great Colonial Hurricane of 1635
  - Hurricane of 1815
  - Hurricane of 1869
  - Great New England hurricane of 1938
  - Carol in 1954
- Strong Category 2 hurricane
  - Great Atlantic Hurricane of 1944
  - Edna in 1954
- Last land-falling hurricane
  - Bob in August 1991



A Preparedness Challenge

- No Category 3 hurricanes have made landfall in southern New England since 1954
  - **And no hurricane at all since 1991**
- Buildup in coastal population and infrastructure presents a high risk for life and property
- Most New Englanders have not experienced a worst case scenario and many no hurricane at all!
  - **Inexperienced population!**

Category 5 – Winds > 155 mph
Category 4 – Winds 131-155 mph
Category 3 – Winds 111-130 mph
Category 2 – Winds 96-110 mph
Category 1 – Winds 74-95 mph

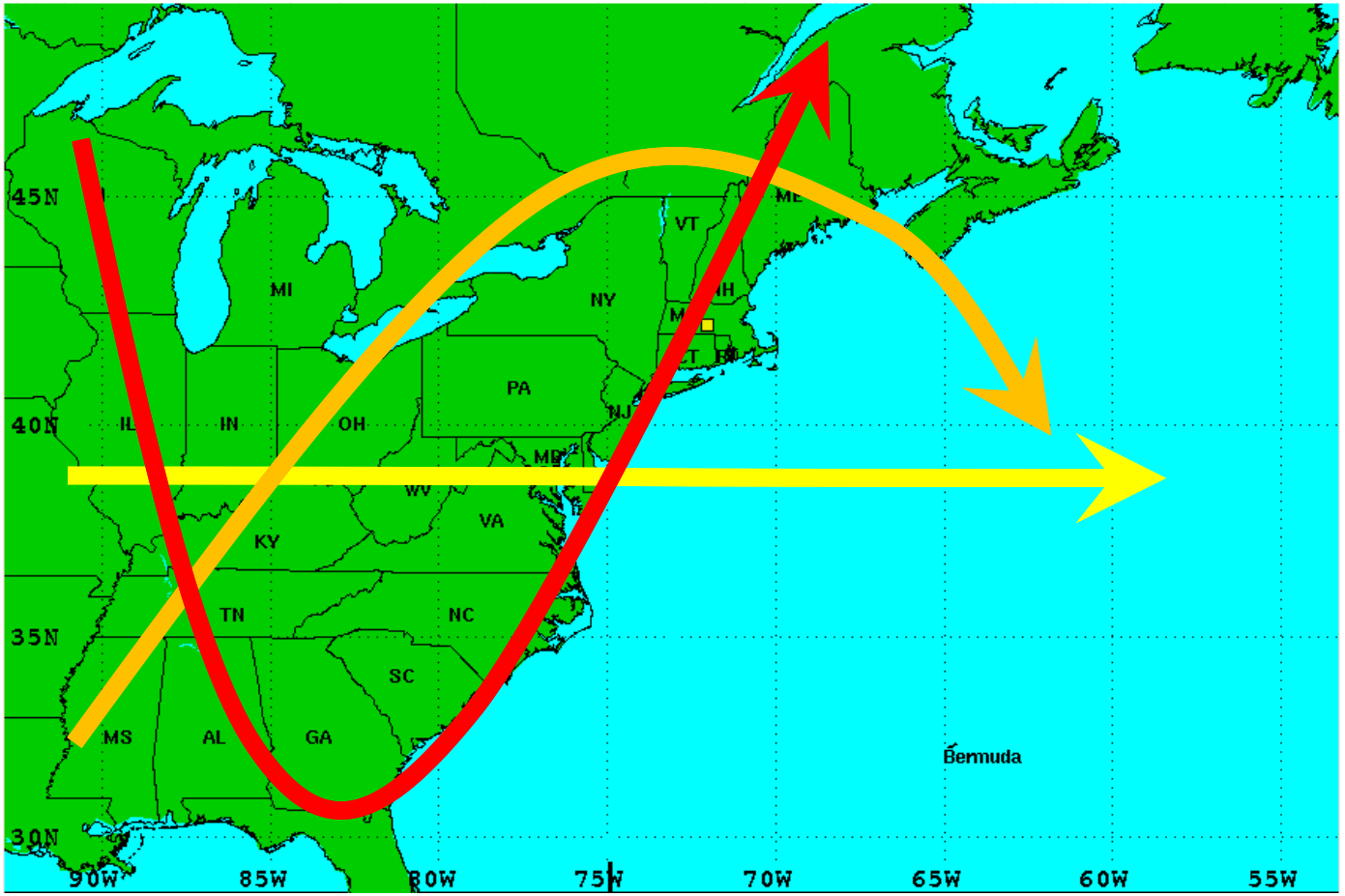
Destructive potential of wind increases by the square of the wind speed!
Storm surge not closely correlated with hurricane category

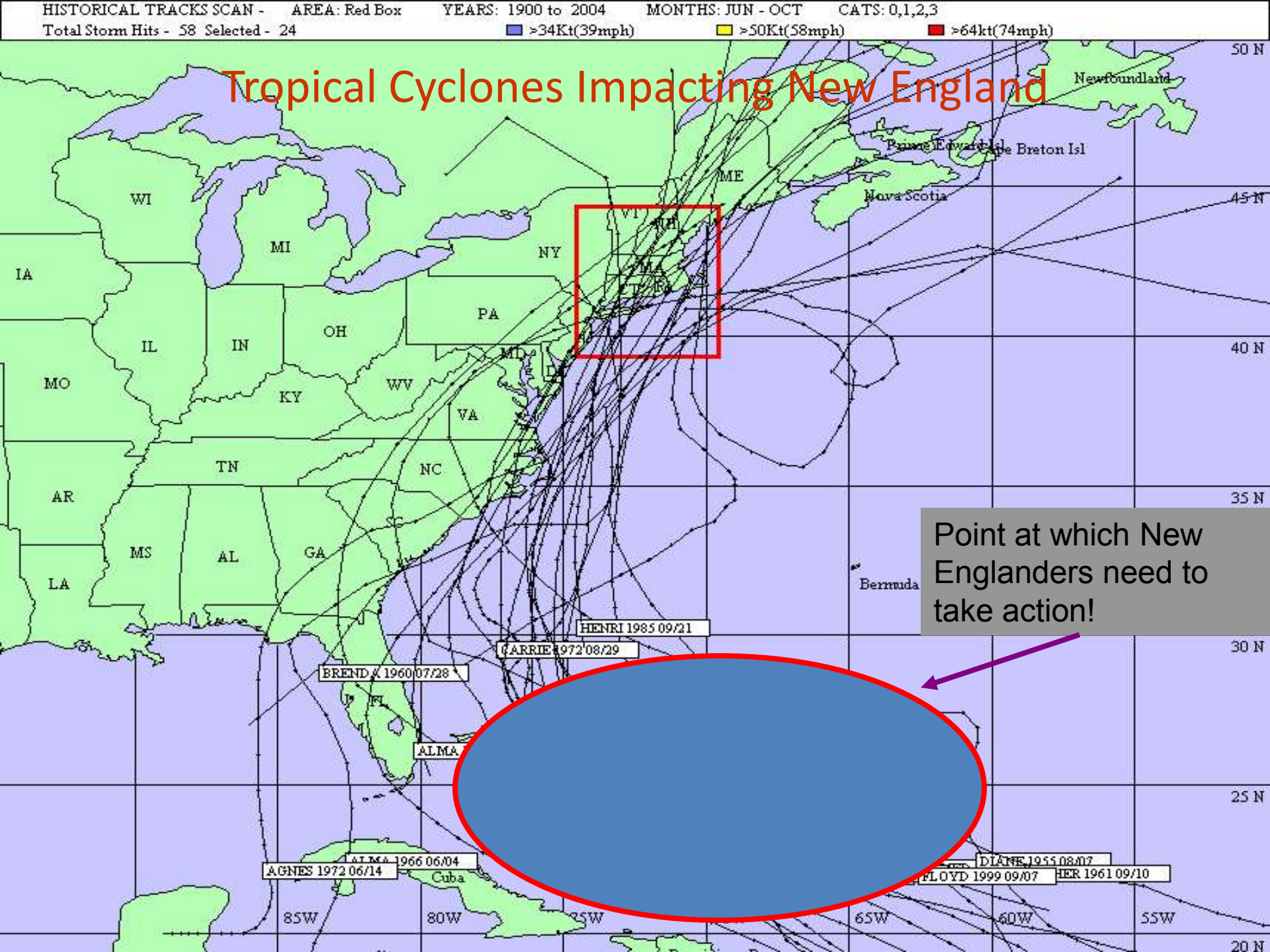
Saffir-Simpson Scale

Hurricanes Come in Different Flavors

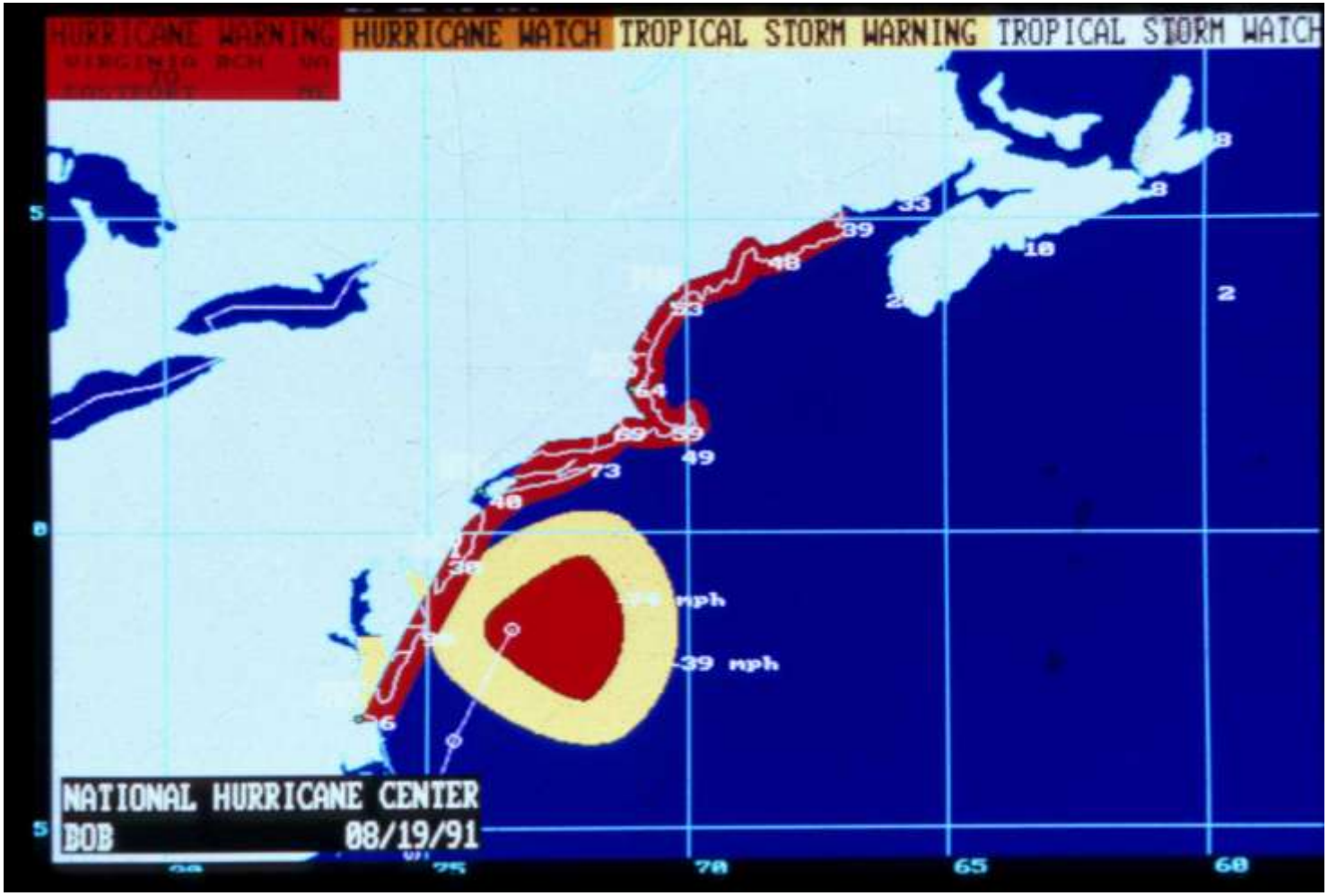
- **1938 or Carol Type Hurricanes**
  - **Most dangerous**
  - **Fast and furious**
- **Sandy Type Hybrid**
  - **May have tropical core but behaves like very severe nor'easter**
- **A Brusher - Earl or Edouard Type Hurricane**
  - **Brushes by coast**
  - **May be too close for comfort**
  - **Primary impacts may be rip currents and erosion**

Jet Stream Interaction




HISTORICAL TRACKS SCAN - AREA: Red Box YEARS: 1900 to 2004 MONTHS: JUN - OCT CATS: 0,1,2,3
Total Storm Hits - 58 Selected - 24
>34Kt(39mph)
>50Kt(58mph)
>64kt(74mph)
Tropical Cyclones Impacting New England
Point at which New Englanders need to take action!
HENRI 1985 09/21
CARRIE 1972 08/29
BRENDA 1960 07/28
ALMA
AGNES 1972 06/14
FLOYD 1999 09/07
Cuba
Bermuda
Newfoundland
Nova Scotia
50 N
45 N
40 N
35 N
30 N
25 N
20 N
85W
80W
75W
65W
60W
55W

Key on approach of first tropical storm force squalls – not the eye!



Hurricane Impacts

B. SCENE ON MILLERS RIVER AT WINCHENDON, MASS.
Courtesy of International News Photos.

WOODS HOLE

- Wind
- Flooding Rains
- **Coastal Flooding from Storm Surge and Waves**

History can be a Guide to Our Future!

Wind

1938 Hurricane damage in Keene, NH

Gusts to 60 mph during Bob

1938 Hurricane took down over a billion trees in New England - 91 million in just Windham County in northeast Connecticut

History can be a Guide to Our Future!

Flooding Rain

1938 Hurricane – Flooding in Winchendon

Tropical Storm Diane in 1955
Flash Flooding on route 44 in Putnam, CT

Photo: J. Brown

Tropical Storm Irene – Flash Flooding along the Deerfield River (and Conway Street) in Buckland

History can be a Guide to Our Future!

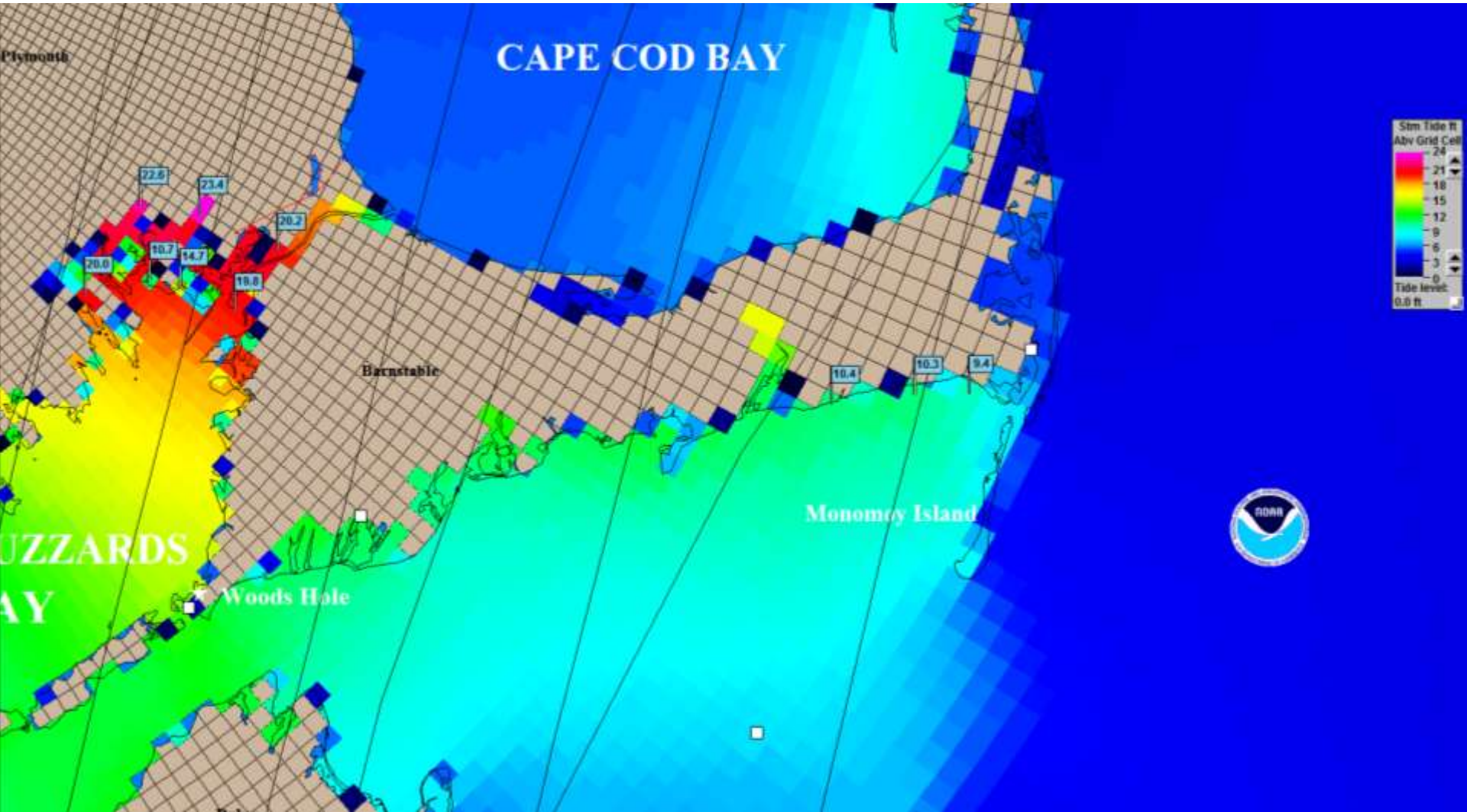
Flooding from Storm Surge

1938 Hurricane – 13 foot surge

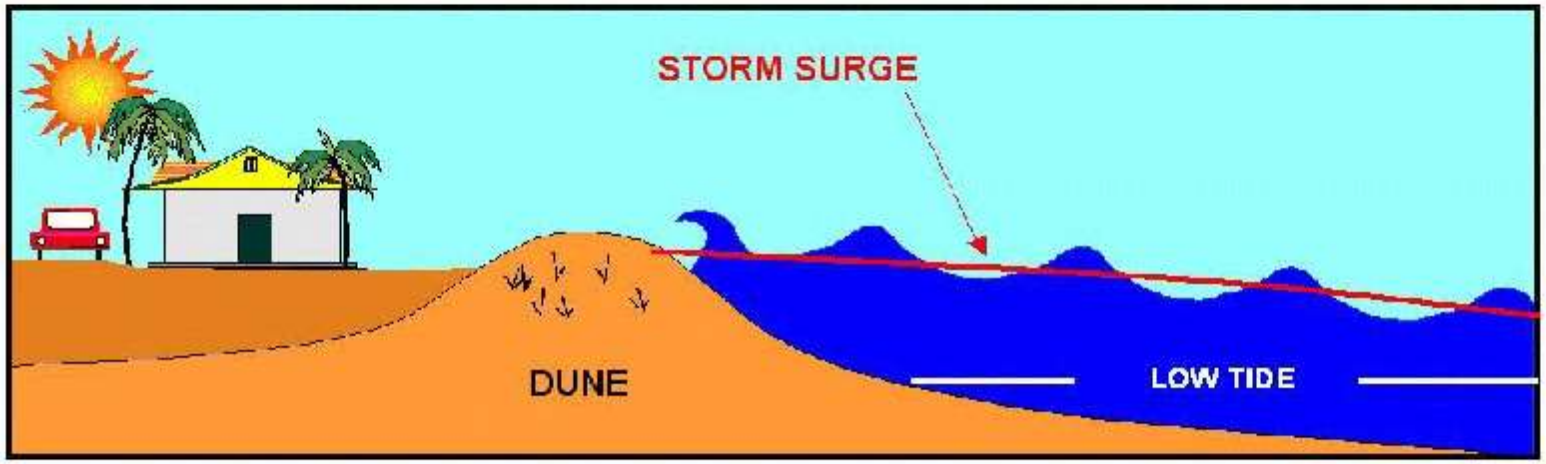
Hurricane Bob (1991) – 6 foot surge

Near worst case for Narragansett and Buzzards Bays

Storm Surge for Category 3 Hurricane moving NNE at 50 mph

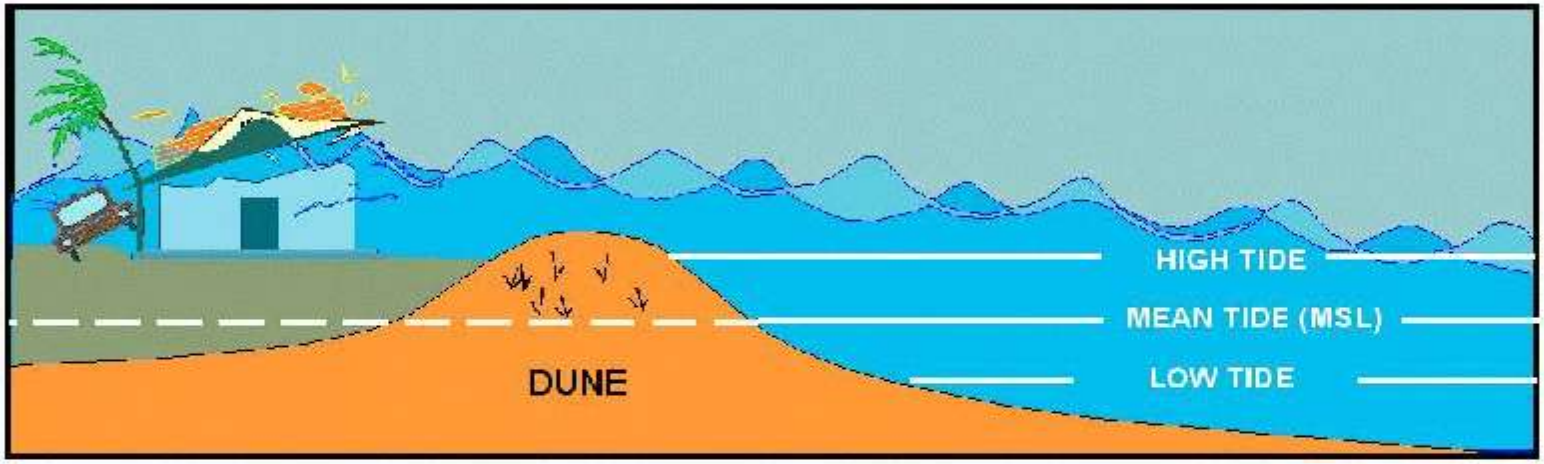


Storm Surge At Low Tide



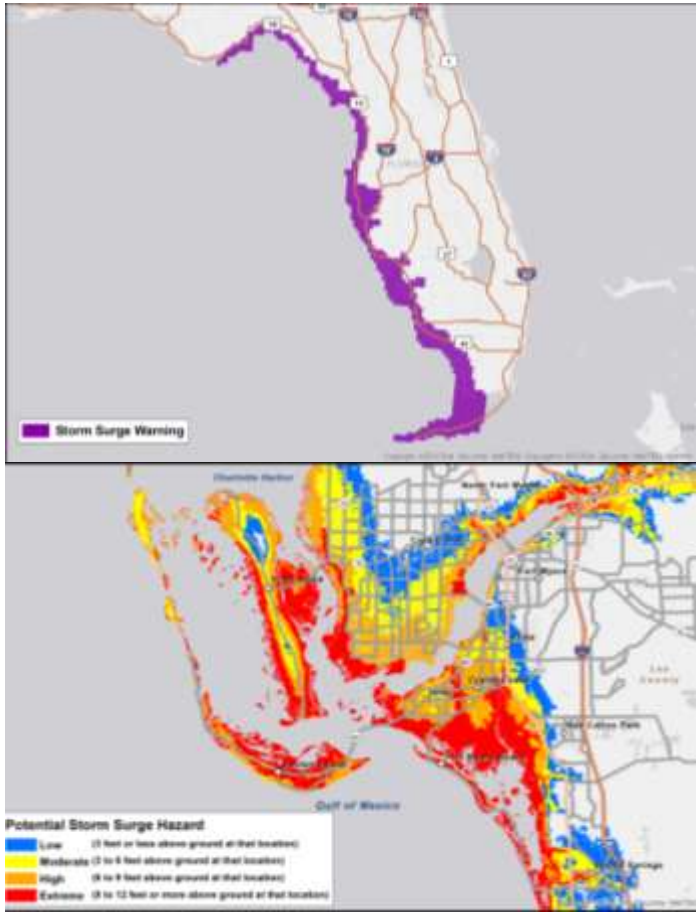
Timing of Storm Critical!

Storm Surge At High Tide



Timing of Storm Critical!

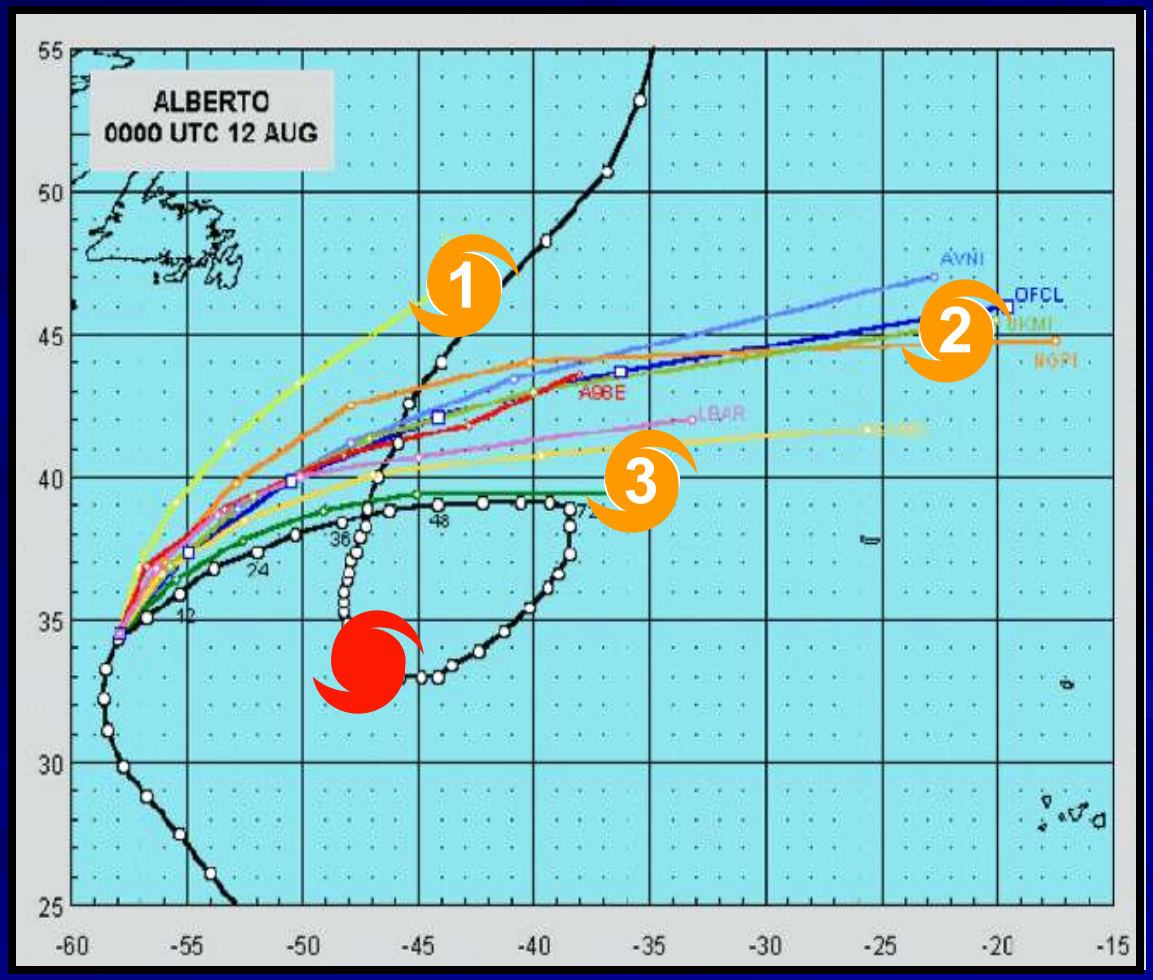
New Developments from National Hurricane Center



- **Storm Surge Warnings**
  - Explicit Storm Surge Warning
    - versus implicit by a Hurricane Warning
  - Recommended by social scientists

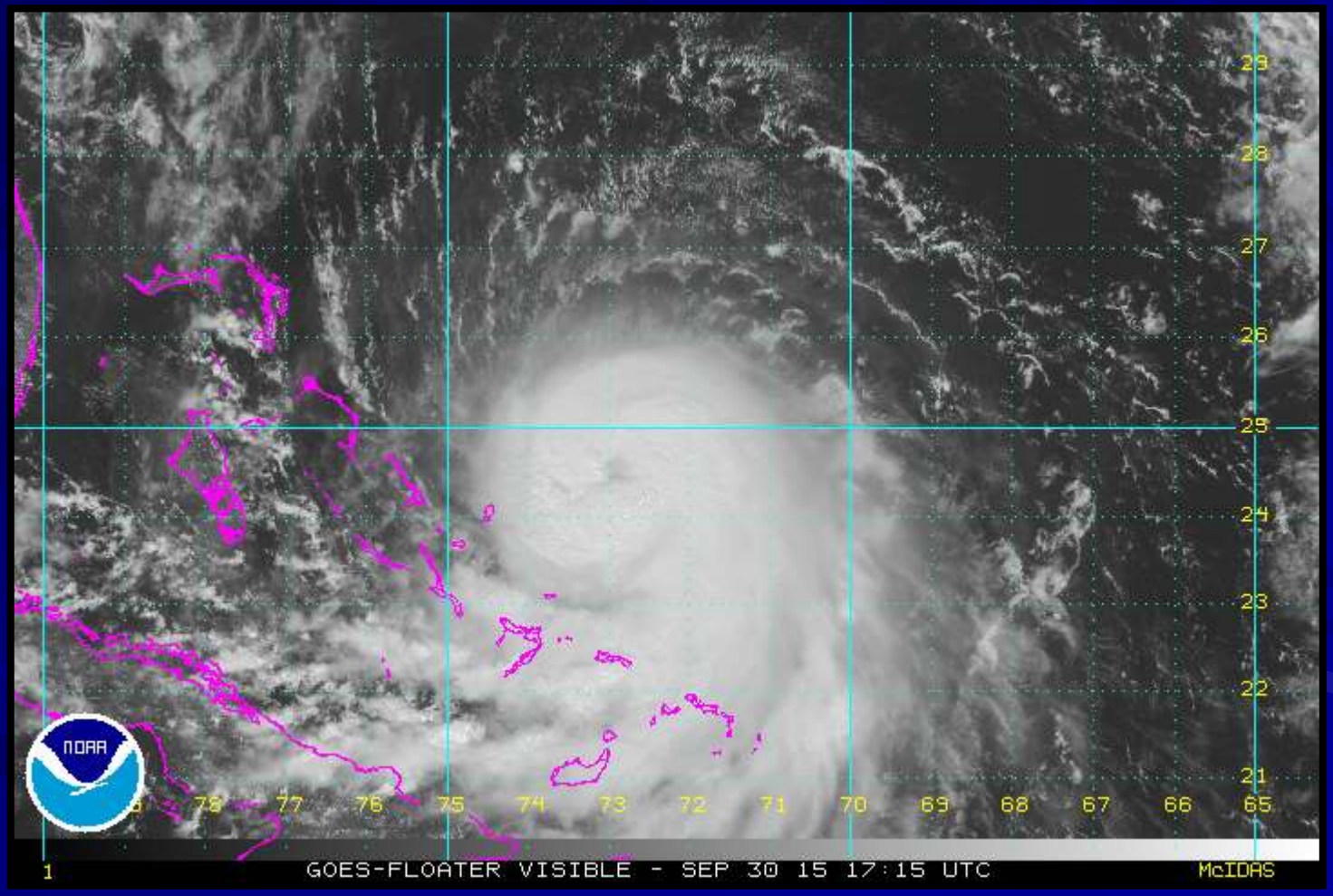
- **Inundation mapping**
  - Visualization of inundation **possible** from a specific storm
  - Represents plausible worst case scenario (10% exceedance)
  - **Depicts where risk too high *not* to take action**
  - Does not incorporate wave runup/overwash
  - Currently only for tropical cyclones

Why is forecasting hard?



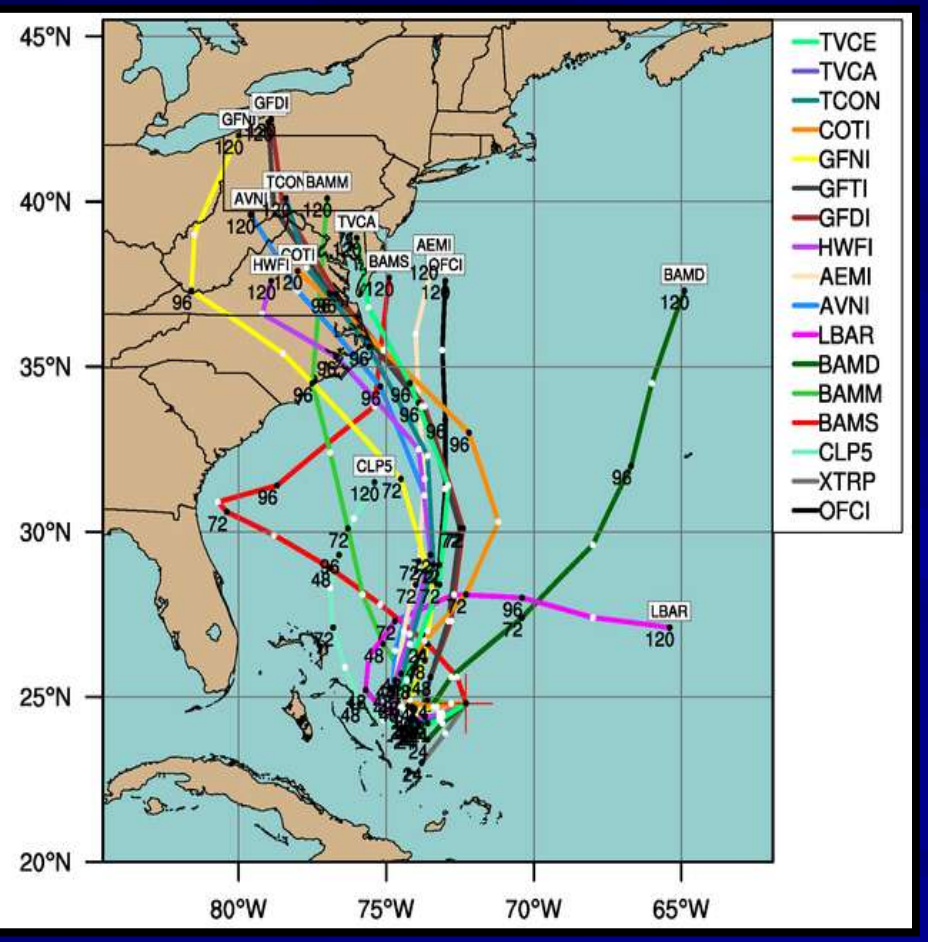
Hurricane Joaquin

115 PM EDT Wednesday September 30, 2015

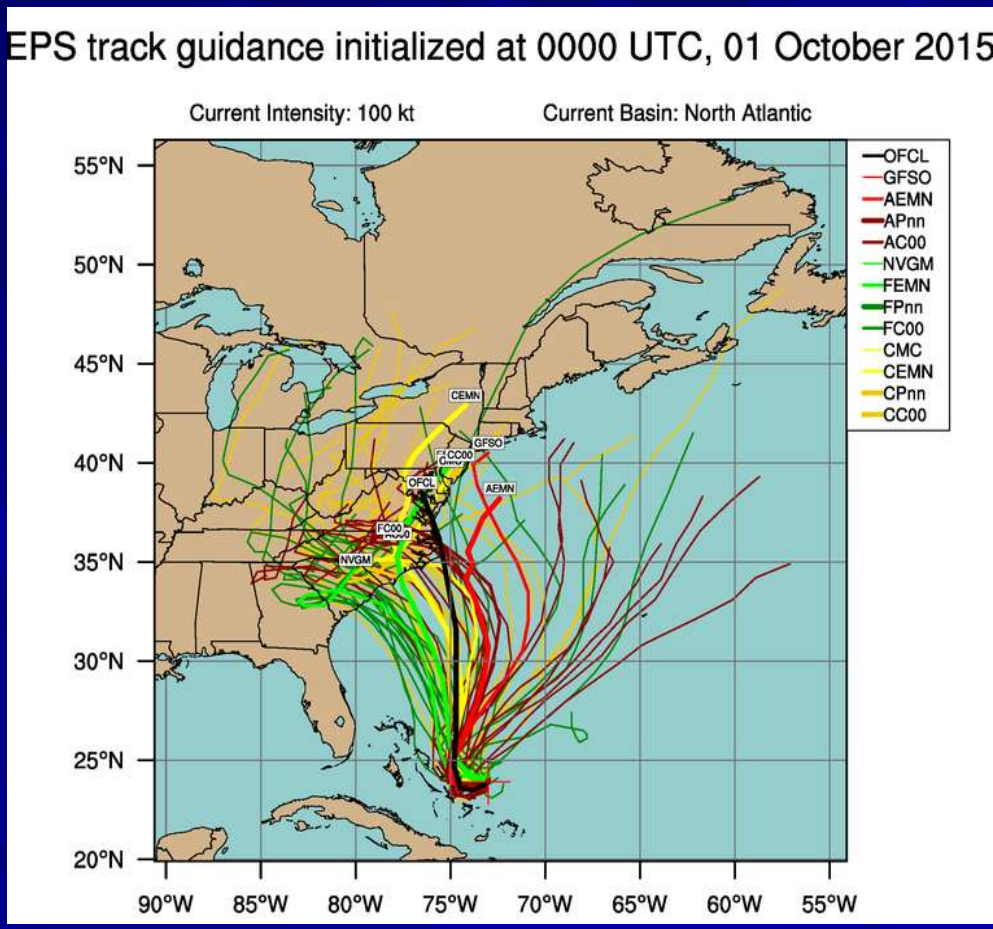


Why is forecasting hard?

Hurricane Joaquin



Wed Sept. 30 AM models

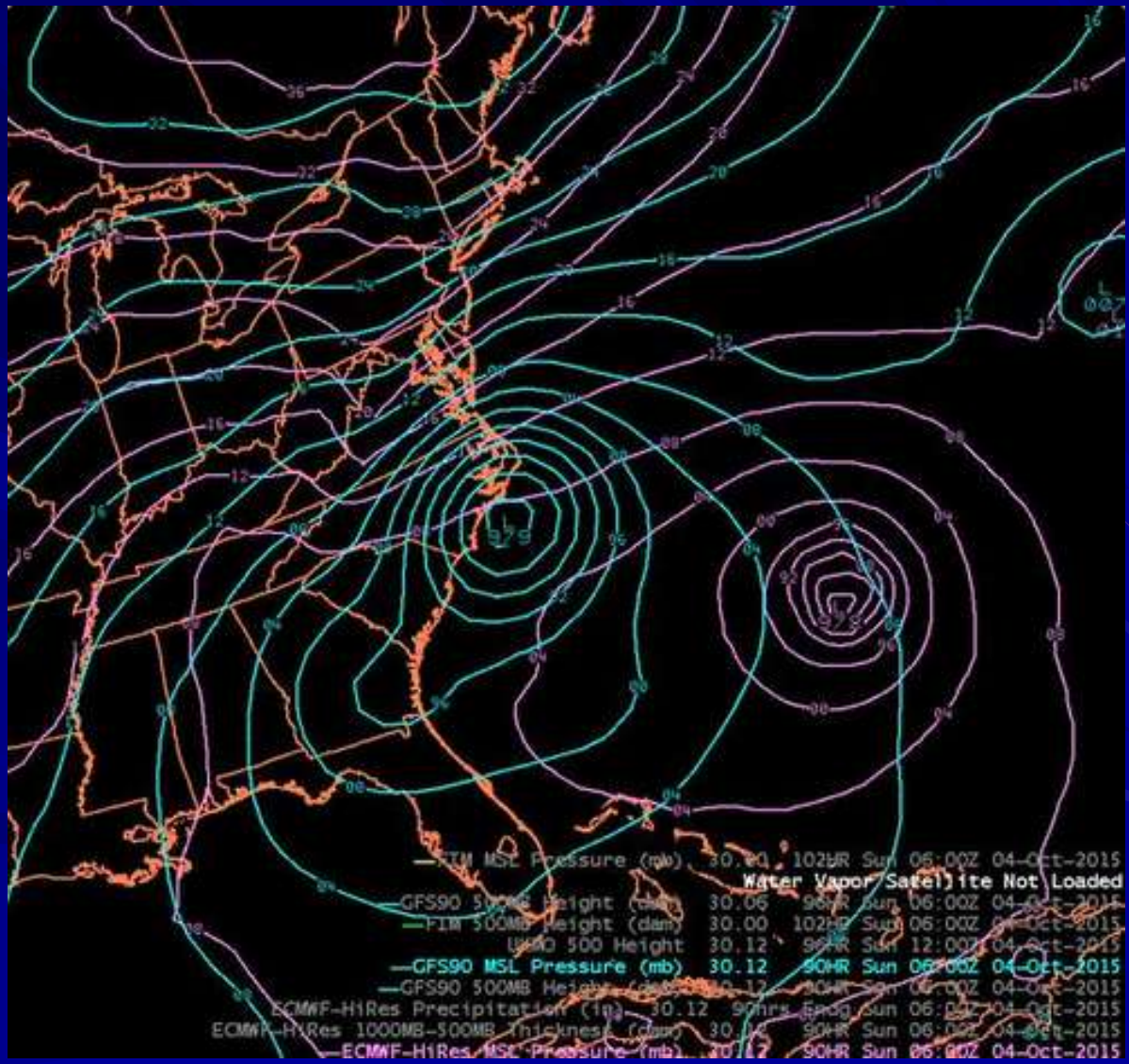


Wed Sept. 30 PM models

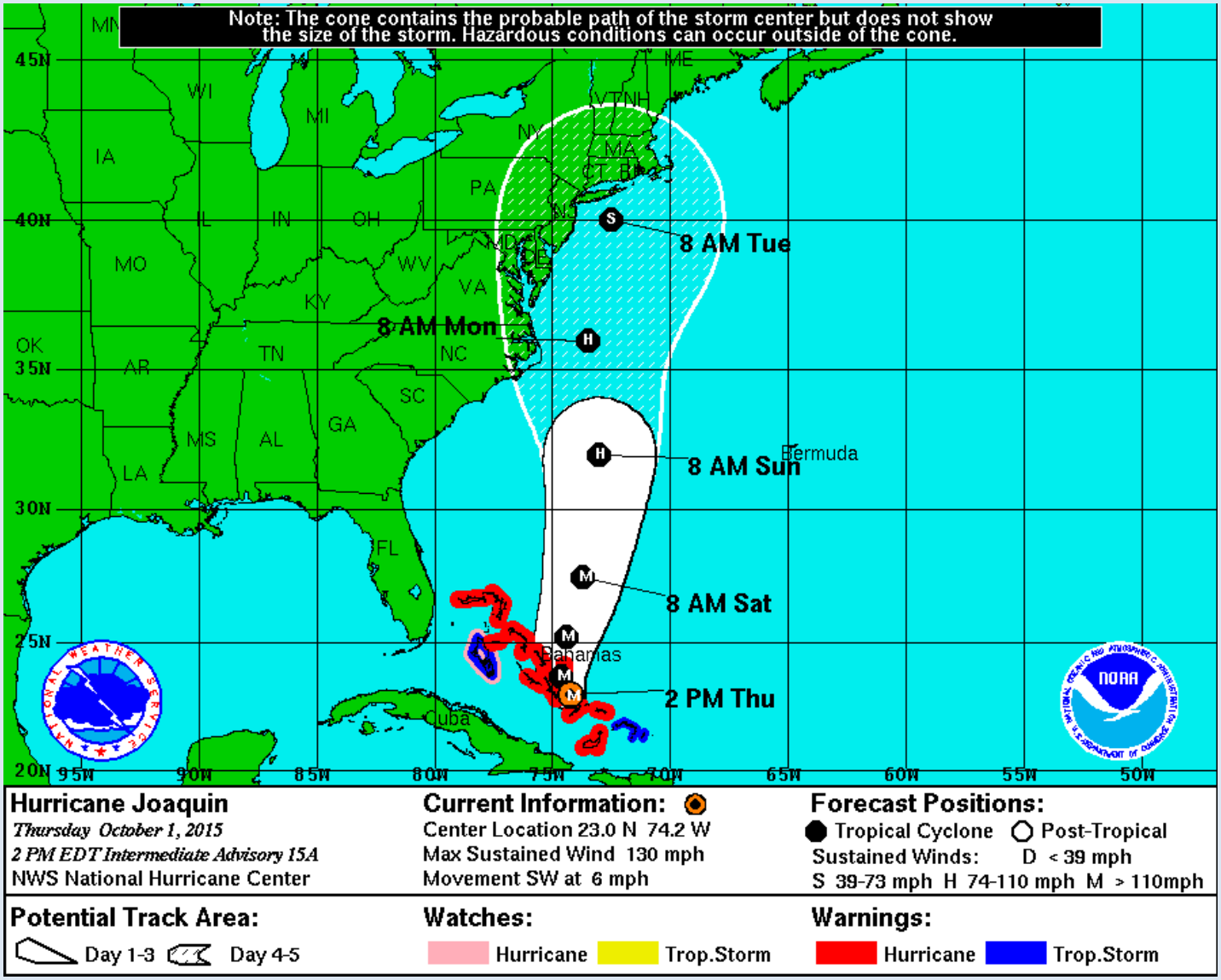
Joaquin Forecasts from Two Main Stream Global Models

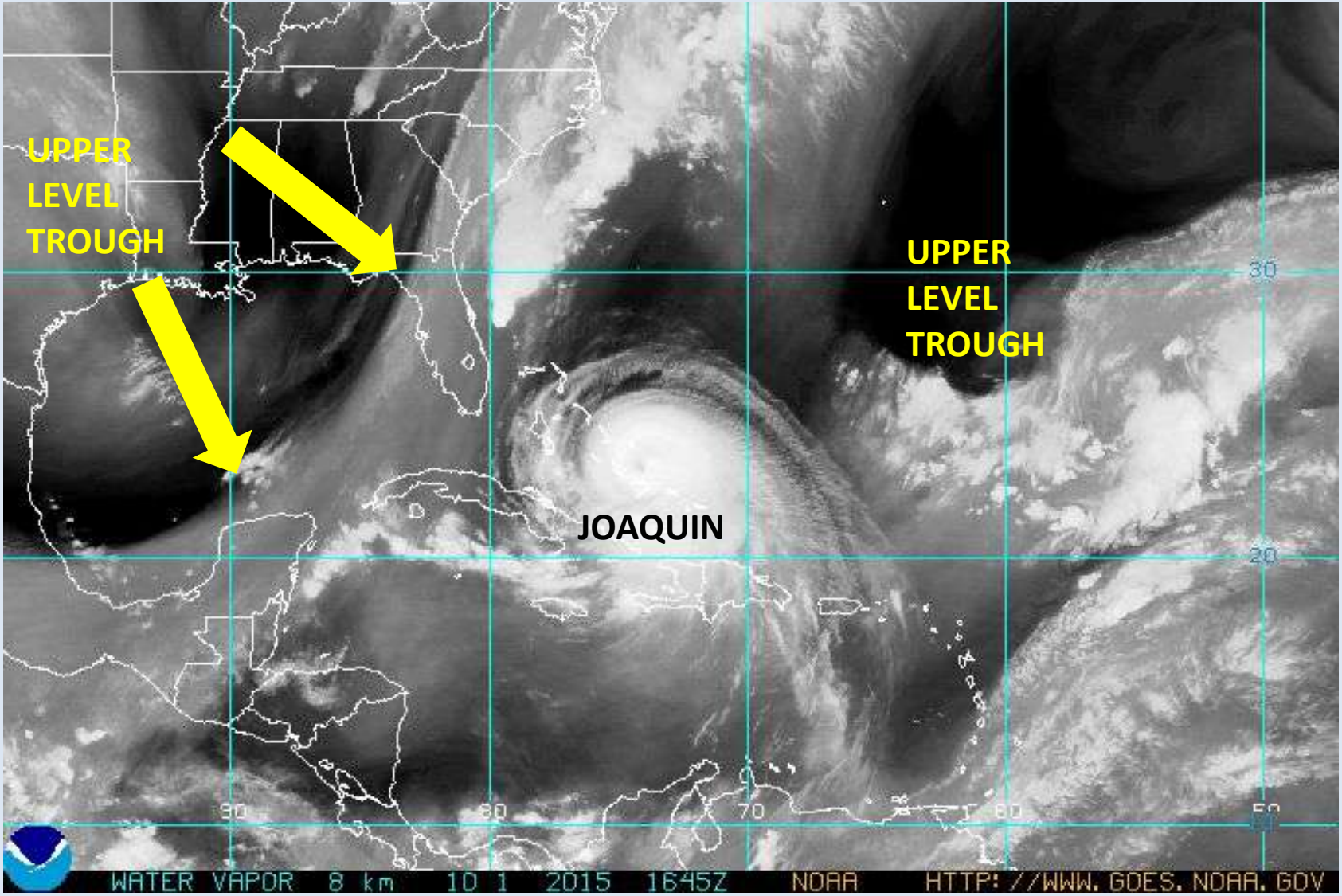
90 hour forecast from

- GFS Model
- ECMWF Model

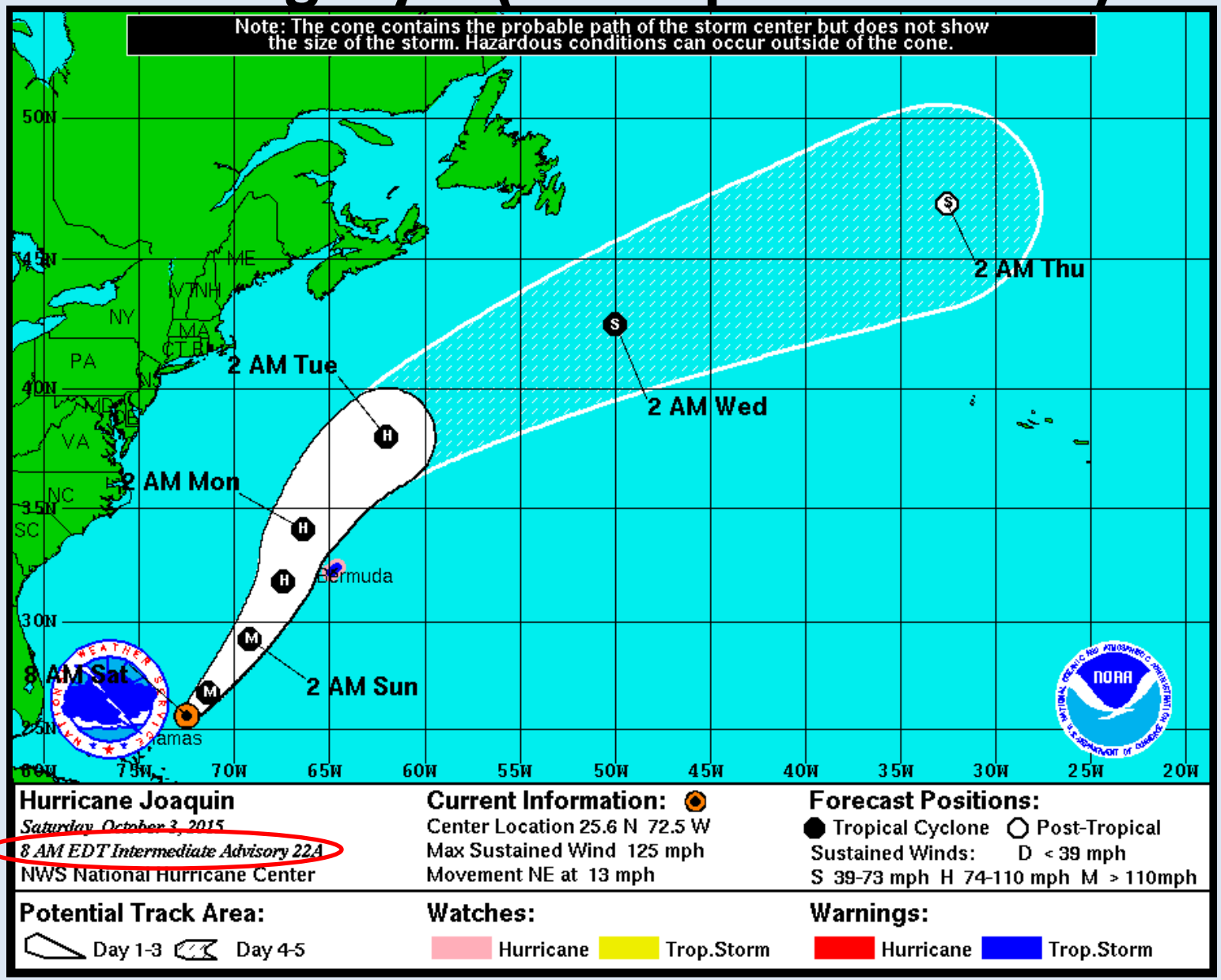


Major Hurricane Joaquin: Category 4 (130 mph sustained)

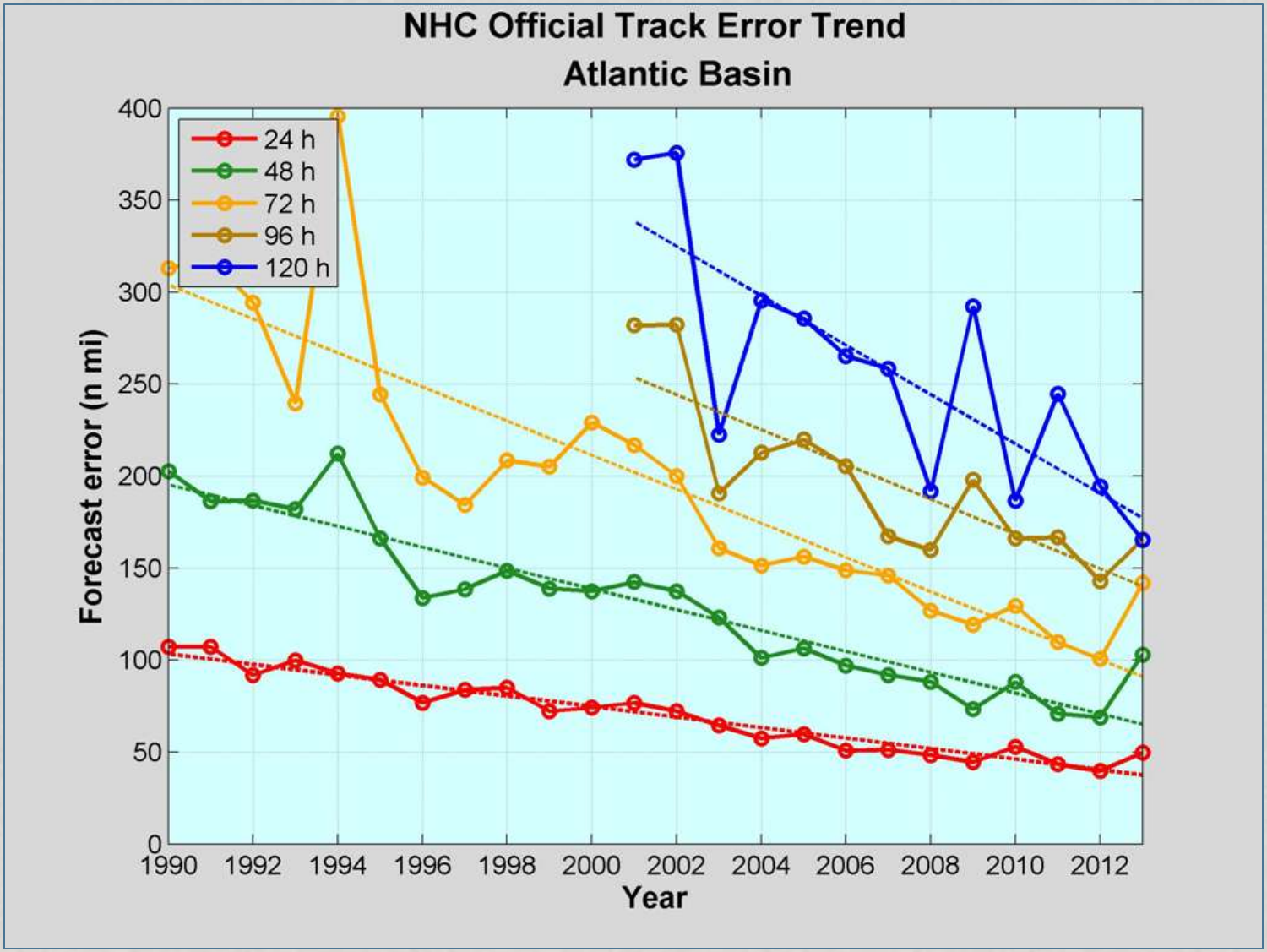



UPPER
LEVEL
TROUGH
UPPER
LEVEL
TROUGH
JOAQUIN
30
20
90
80
70
60
WATER VAPOR 8 km 10 1 2015 1645Z NOAA HTTP://WWW.GOES.NOAA.GOV

Powerful Hurricane Joaquin: Category 3 (125 mph sustained)



NHC Atlantic Track Error Trends



Error Reduction since 1990:

72 h: 67%

48 h: 65%

24 h: 58%

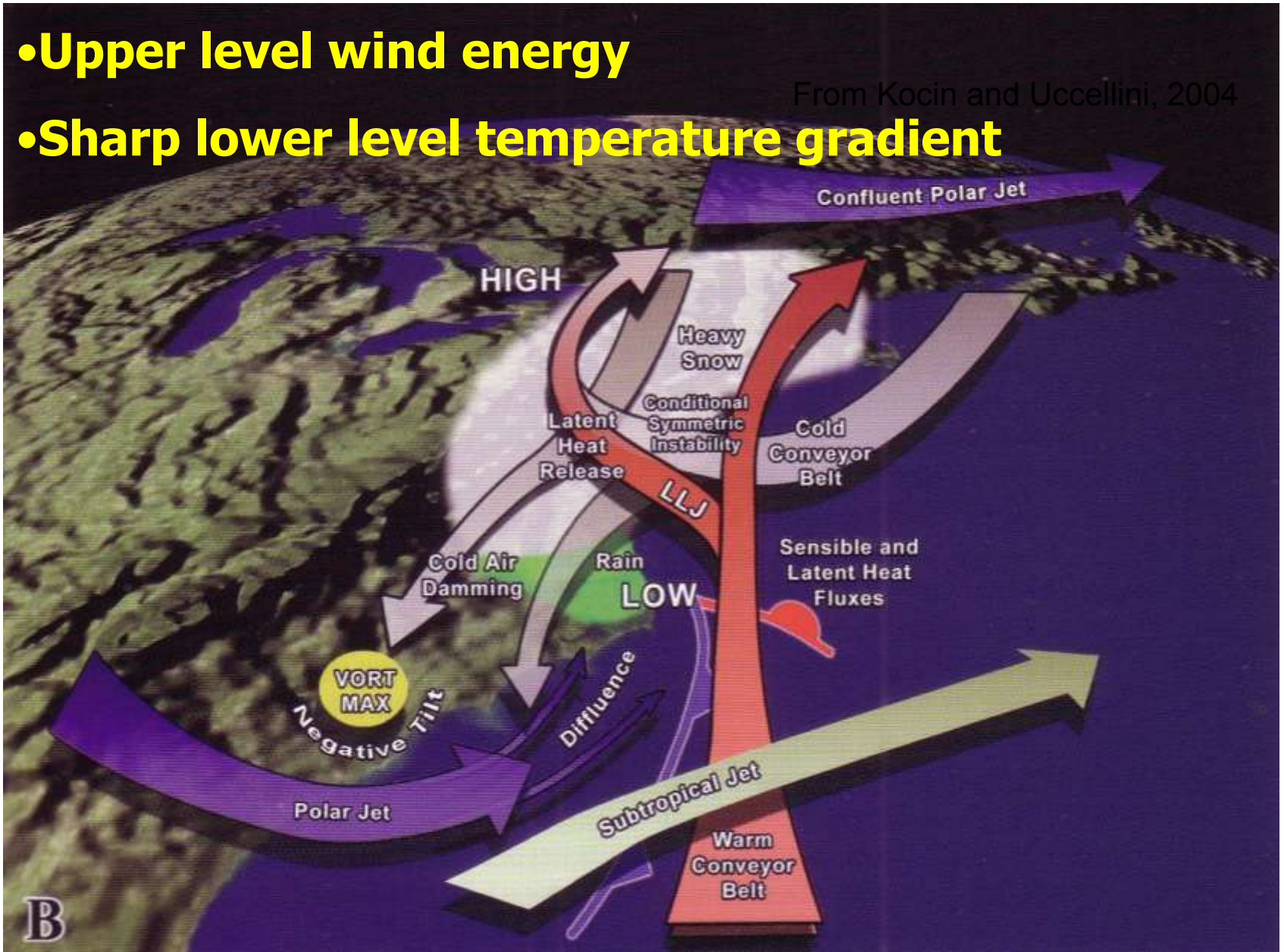
NOR'EASTER IMPACTS

January 27, 2015 morning Scituate, MA – courtesy Dave Laroche

Anatomy of a Major Nor'easter

- **Upper level wind energy**
- **Sharp lower level temperature gradient**

From Kocin and Uccellini, 2004

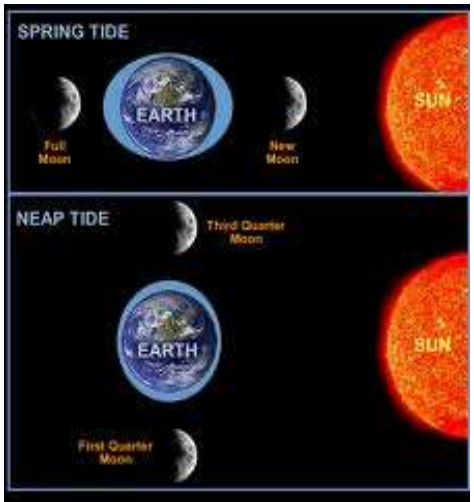


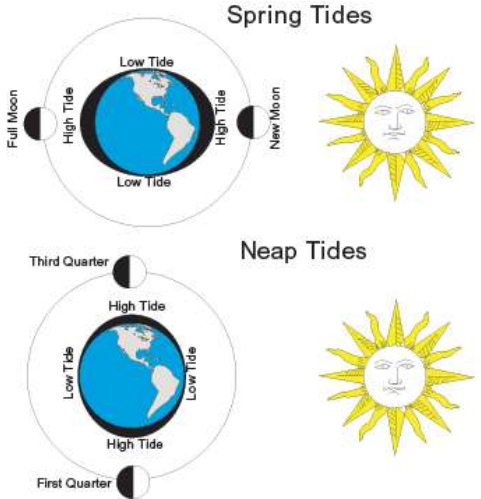
The Basics

- **Astronomical tide amplitude (Spring Tide?)**
- **Onshore wind speed**
- **Wind fetch (distance over water)**
- **Duration of strong winds headed toward shore**
- Angle of wave train to shoreline
- Storm motion with respect to shoreline
- Size of wind field
- Wave period
  - Long period waves potentially more damaging

ASTRONOMICAL TIDES

- Spring Tide
  - During full and new moons
  - Moon and sun gravitational forces in alignment
- Neap Tide
  - Quarter moon phases
  - Moon and sun gravitational forces offsetting

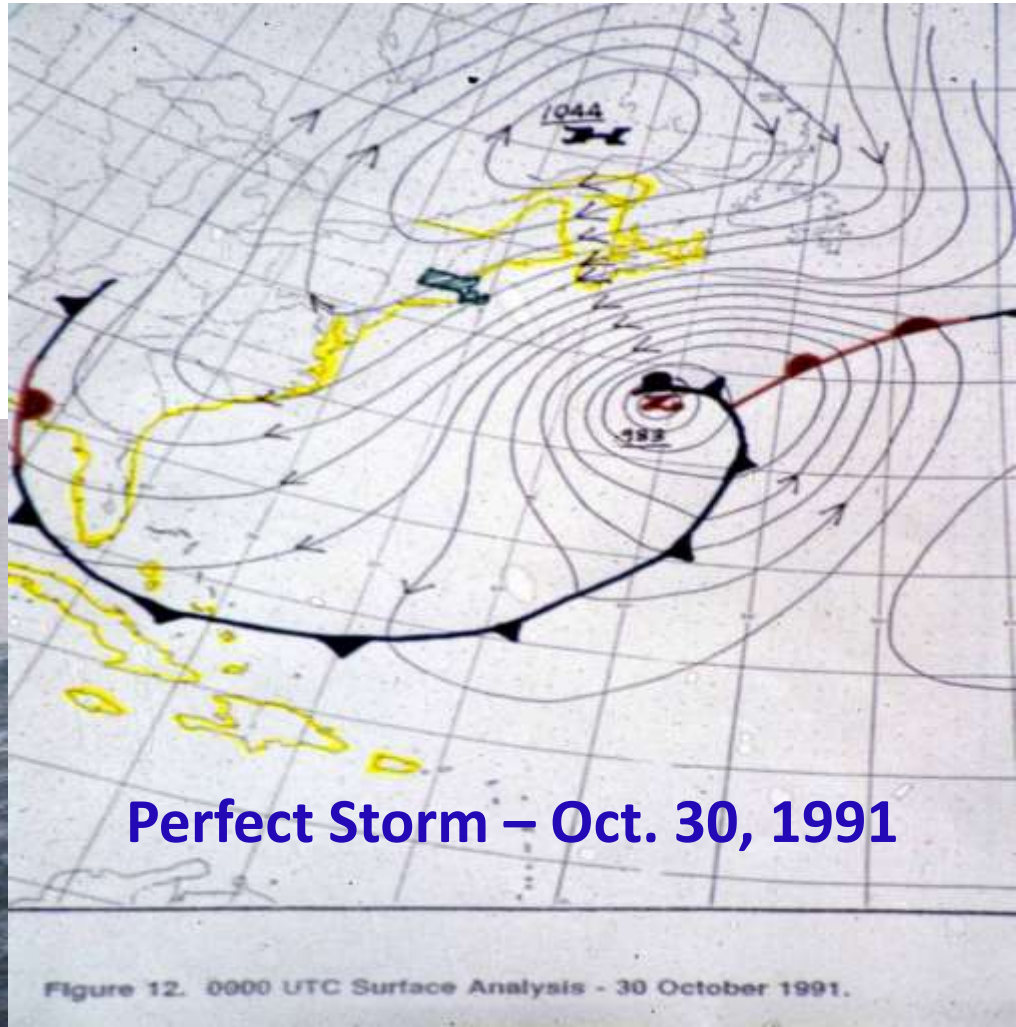




Storm Surge and Wave Heights

Determined by:

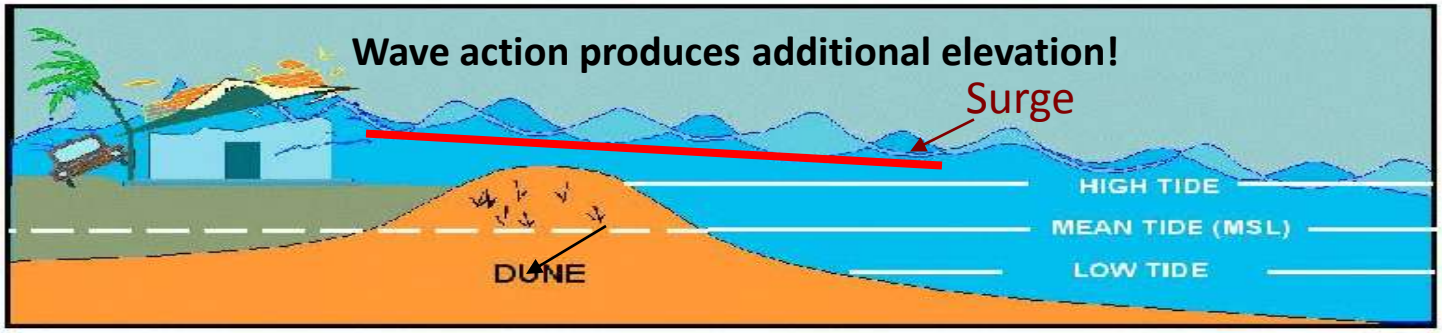
- **Wind Speed**
- **Wind Fetch**
- **Wind Duration**



Perfect Storm – Oct. 30, 1991

Figure 12. 0000 UTC Surface Analysis - 30 October 1991.

Hurricanes and Nor'easters both impact coastline with storm surge and waves



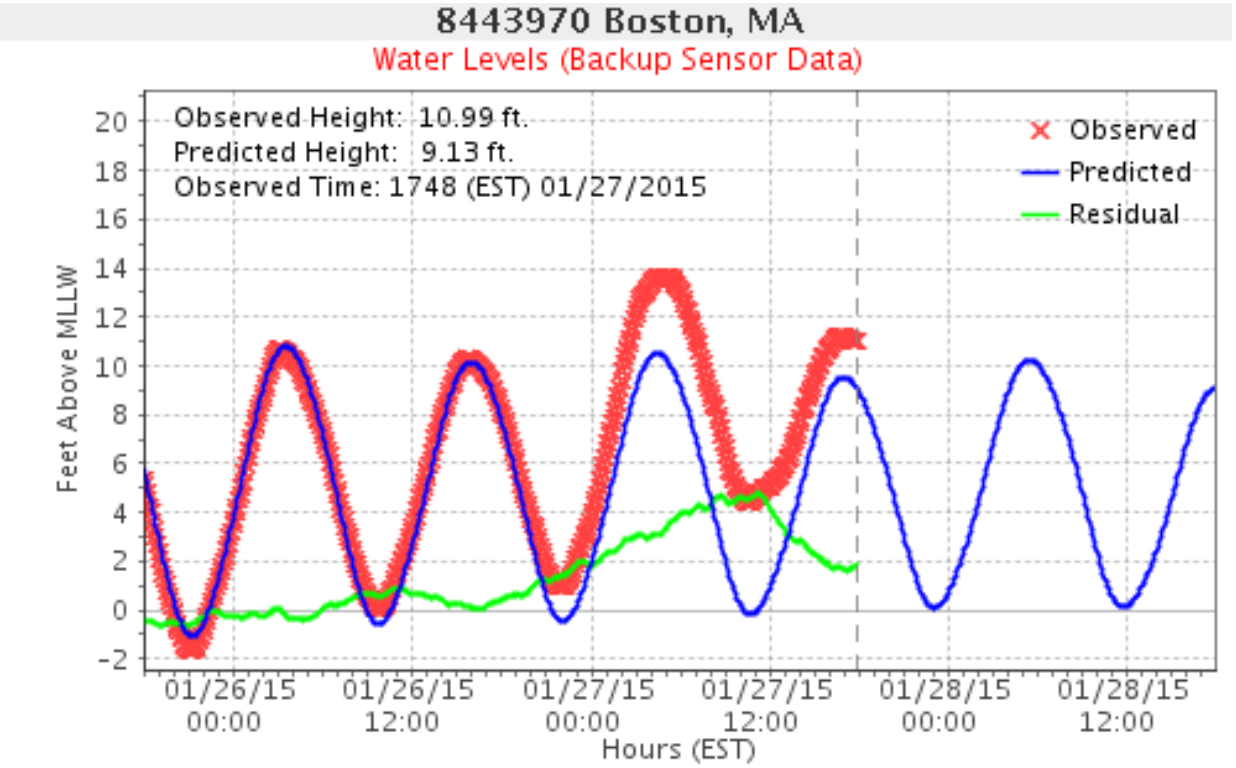
Coastal flooding and erosion result from storm surge on top of the astronomical tide and wave action on top of the storm tide.

Timing of the maximum storm surge is an important issue for those locations (e.g. New England) that have large tidal ranges.

Storm Tide (Total Still Water Level) = ***Astronomical Tide + Storm Surge***
Waves contribute the following:

- Add to water level behind barrier beach via ***overwash*** (from wave runup)
- Cause damage to structures (sea walls, docks, homes, etc.) via ***wave battery***
- Scour and transport beach sand via ***erosion***

Timing Matters!



January 27, 2015 High Tide at Boston

Storm Surge at max storm tide = **3.35 feet** (3.12 feet at time of actual astronomical high tide)

Max storm surge = **4.78 feet** (approx. 30 minutes after time of low tide)

WHAT IF…

- The storm was about 6 hours faster and peak surge occurred at high tide:
  - 10.5 + 4.78 = **storm tide of 15.28 feet MLLW**
  - **Just above record water level of 15.1 feet MLLW set during the 1978 Blizzard**
- The storm occurred the week before when we had a 12 foot MLLW astronomical tide:
  - **Potential storm tide near 16.8 feet (would bring us to unchartered territory)**

And WAVES MATTER!

Overwash

Splashover

Rule of thumb:

Along exposed coast, overwash and splashover can become important when waves about 10 miles offshore reach 20 feet or more

Wave Overwash

Wave Battery

And Erosion Can Be a Big Issue

Misquamicut Beach – Westerly, RI (2 days after Sandy)

Wave Run-up

- **Experimental program to help understand and forecast wave impact**
  - Empirical technique being applied to “hot spots”


Oct. 1991 “Perfect Storm” – Boston Globe

Input parameters (green only)	Feet	Meters
Beach Slope	0.03	
Deep water wave height	18.00	5.49
Deep water wave length	414.70	126.40
Deep water wave period	9.00	
Tide	11.7	3.57
Storm Surge	1.6	0.49
Dune Base Elevation	11.10	3.38
Dune Crest Elevation	13.57	4.14

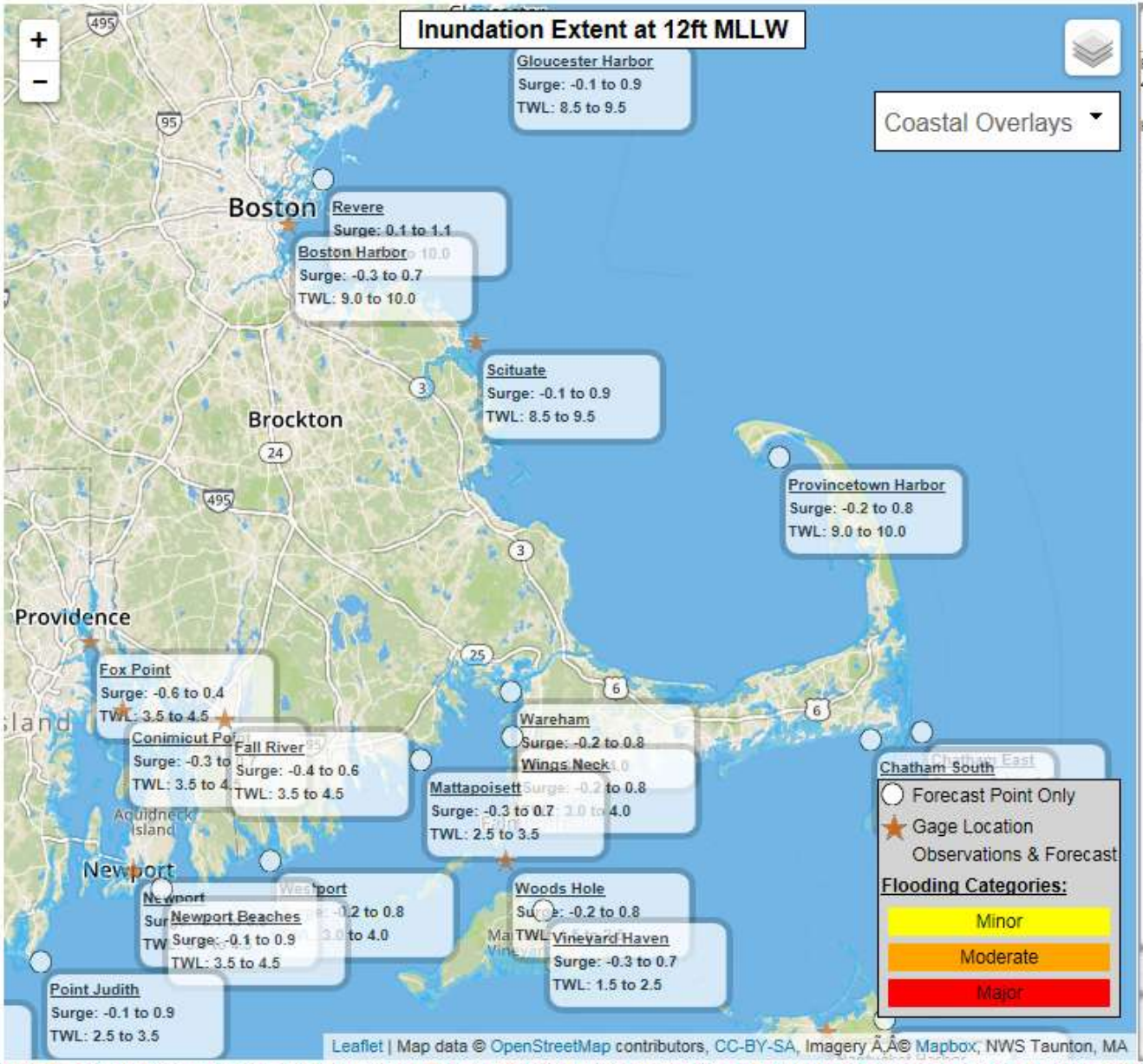
These are the individual output parameters	$R_{2\%}$	4.19	1.28
	Swash	3.19	0.97
	Setup	1.00	0.30

Include Tide + Surge		
R_{low}	14.30	4.36
R_{high}	17.49	5.33
$R_{2\%}$	4.188	1.28
Erosion	Expected	
Overwash	Expected	
Inundation	Expected	

weather.gov/boston

Coastal Flood Threat and Inundation Mapping

Boston, MA
Weather Forecast Office



Total Water Level Forecast

Forecast Issued:
400 PM EST TUE DEC 1 2015

High Tide Cycles

- 1st PM cycle
- (•) 2nd AM cycle
- 2nd PM cycle
- 3rd AM cycle
- 3rd PM cycle
- 4th AM cycle
- 4th PM cycle

Inundation Overlay
Total Water Level (MLLW)

18 ft

12 ft

4 ft

KML

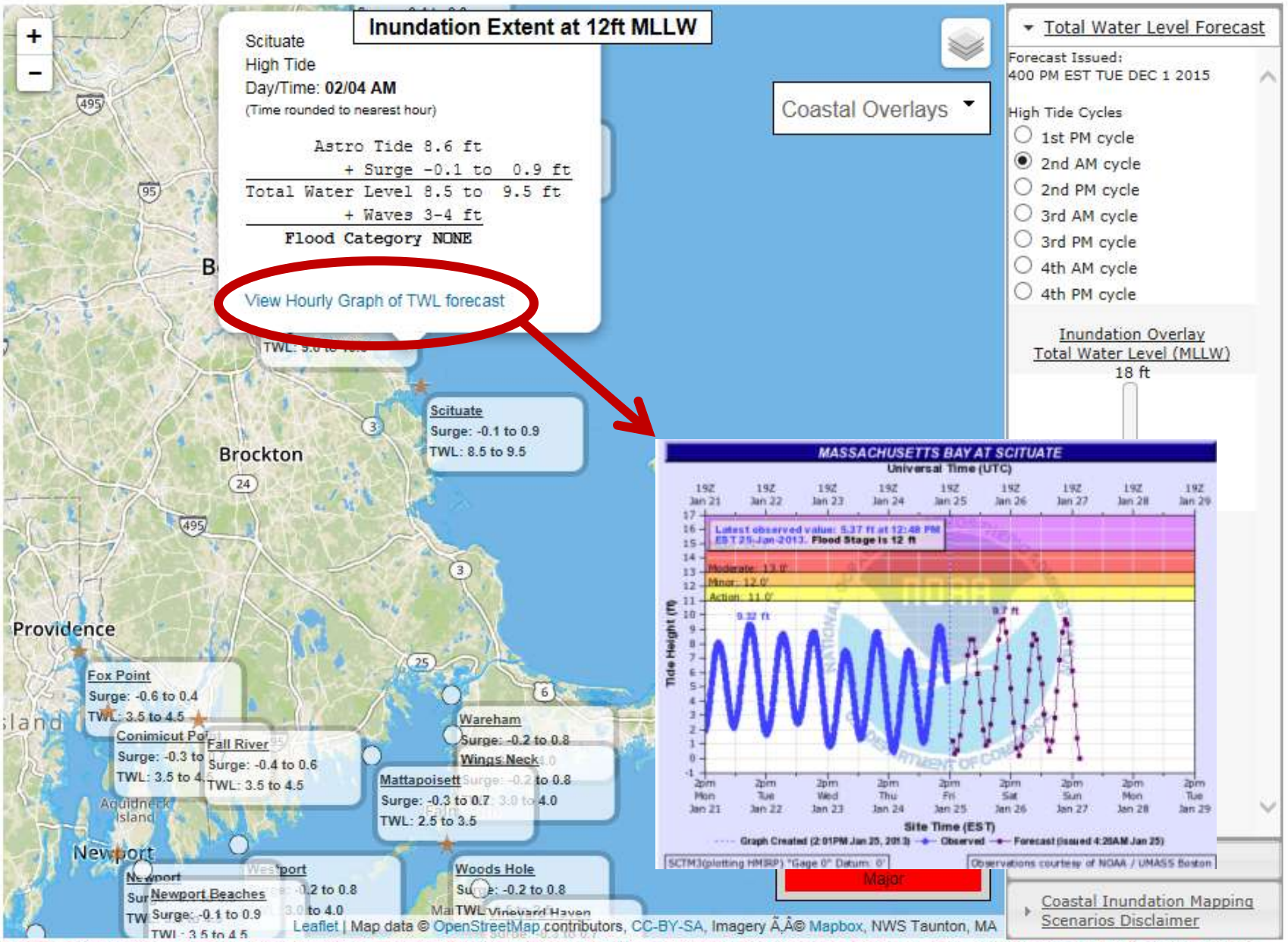
What is...?

Coastal Inundation Mapping Scenarios Disclaimer

NOTE: During times when the area is under a Tropical Storm/Hurricane Watch or Warning, the storm tide or total water level forecast will reflect a plausible worst case scenario (versus the usual most likely scenario).

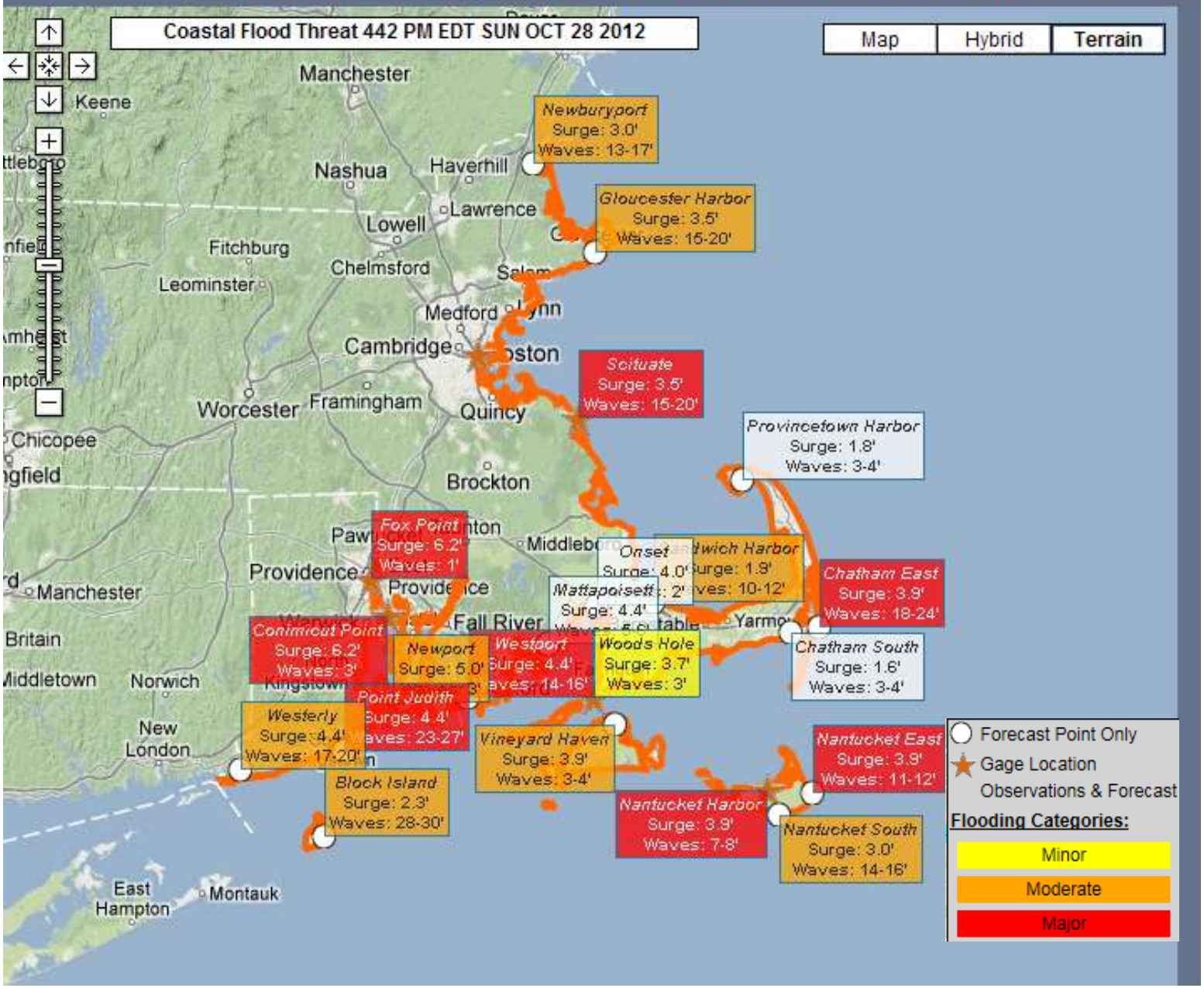
Coastal Flood Threat and Inundation Mapping

Boston, MA
Weather Forecast Office



NOTE: During times when the area is under a Tropical Storm/Hurricane Watch or Warning, the storm tide or total water level forecast will reflect a plausible worst case scenario (versus the usual most likely scenario).

Southeast New England Water Level Forecast & Coastal Flood Threat



COASTAL FLOOD HEADLINES

Extratropical Storms (e.g. Nor'easters)

- **Coastal Flood Watch**
  - Potential for moderate or greater coastal flooding
  - Generally 36 to 48 hours lead time
- **Coastal Flood Warning**
  - Moderate or major coastal flooding likely/expected
  - Generally 24 to 36 hours lead time
- **Coastal Flood Advisory**
  - Minor coastal flooding likely/expected
  - Generally 24 to 36 hours lead time

HEADLINE CRITERIA

- Minor – Coastal Flood Advisory
- Moderate or Major = Coastal Flood Warning

Minor

Moderate

Major

Coastal flood impacts appearing in TWLBOX are a function of water level and waves (derived from staff experience and local studies)

Scituate

Storm Tide	Wave Height					
	10	15	20	25	30	35
9.5	-	-	-	-	Minor	Minor
10.0	-	-	-	Minor	Minor	Minor-Mdt
10.5	-	Minor	Minor	Minor	Minor-Mdt	Moderate
11.0	Minor	Minor	Minor	Minor-Mdt	Moderate	Mdt-Major
11.5	Minor	Minor	Minor-Mdt	Moderate	Moderate	Mdt-Major
12.0	Minor	Minor-Mdt	Moderate	Moderate	Mdt-Major	Major
12.5	Minor-Mdt	Moderate	Moderate	Moderate	Mdt-Major	Major
13.0	Moderate	Moderate	Moderate	Mdt-Major	Major	Major
13.5	Moderate	Moderate	Mdt-Major	Major	Major	Major
14.0	Moderate	Mdt-Major	Major	Major	Major	Major
15.0	Mdt-Major	Major	Major	Major	Major	Major
15.0	Major	Major	Major	Major	Major	Major

Sandwich

Storm Tide	Wave Height					
	5	10	15	20	25	30
10.0	-	-	-	-	Minor	Minor
10.5	-	-	-	Minor	Minor	Minor-Mdt
11.0	-	-	Minor	Minor	Minor-Mdt	Moderate
11.5	-	Minor	Minor	Minor-Mdt	Moderate	Moderate
12.0	Minor	Minor	Minor-Mdt	Moderate	Moderate	Mdt-Major
12.5	Minor	Minor-Mdt	Moderate	Moderate	Mdt-Major	Major
13.0	Minor-Mdt	Moderate	Moderate	Mdt-Major	Major	Major
13.5	Moderate	Moderate	Mdt-Major	Major	Major	Major
14.0	Moderate	Mdt-Major	Major	Major	Major	Major
14.5	Mdt-Major	Major	Major	Major	Major	Major
15.0	Major	Major	Major	Major	Major	Major

Product Example

COASTAL HAZARD MESSAGE
NATIONAL WEATHER SERVICE TAUNTON MA
443 PM EST FRI FEB 8 2013

...COASTAL FLOOD WARNING FOR THE MASSACHUSETTS EAST FACING COASTLINE AROUND THE TIME OF THIS EVENINGS AND SATURDAY MORNINGS HIGH TIDES...

.A POWERFUL COASTAL STORM WILL PRODUCE MODERATE COASTAL FLOODING THIS EVENING AND MODERATE TO MAJOR COASTAL FLOODING SATURDAY MORNING ALONG WITH SEVERE EROSION IN SOME SPOTS. VERY LARGE WAVES ON TOP OF AN ABOVE NORMAL TIDE WILL LIKELY CAUSE A NUMBER OF VULNERABLE SHORE ROADS TO BECOME IMPASSABLE FOR A WHILE...AND MAY CAUSE DAMAGE TO HOMES ALONG THE IMMEDIATE SHORELINE FROM HULL TO SANDWICH DURING THE SATURDAY MORNING HIGH TIDE. VERY LARGE BREAKERS CRASHING ONTO THE SHORELINE MAY MAKE IT UNSAFE TO REMAIN IN SOME EXPOSED OCEAN FRONT HOMES.

MAZ007-015-016-019-022>024-090545-
/O.CON.KBOX.CF.W.0001.130209T0100Z-130209T1700Z/
EASTERN ESSEX MA-SUFFOLK MA-EASTERN NORFOLK MA-
EASTERN PLYMOUTH MA-BARNSTABLE MA-DUKES MA-NANTUCKET MA-
443 PM EST FRI FEB 8 2013

...COASTAL FLOOD WARNING REMAINS IN EFFECT FROM 8 PM THIS EVENING TO NOON EST SATURDAY...

* LOCATION...EAST FACING COASTLINE OF MASSACHUSETTS

* COASTAL FLOODING...MODERATE COASTAL FLOODING IS LIKELY FOR THIS EVENINGS HIGH TIDE AND MODERATE TO MAJOR COASTAL FLOODING IS LIKELY FOR THE SATURDAY MORNING HIGH TIDE...WITH THE MOST SEVERE IMPACT EXPECTED ALONG EAST AND NORTH FACING SHORELINES SOUTH OF BOSTON.

* TIMING...THIS EVENING AND SATURDAY MORNING HIGH TIDES

* IMPACTS...A NUMBER OF SHORE ROADS WILL LIKELY BECOME IMPASSABLE FOR A TIME FRIDAY EVENING. COASTAL FLOODING AROUND THE SATURDAY MORNING HIGH TIDE WILL LIKELY CAUSE NUMEROUS SHORE ROADS TO BECOME IMPASSABLE AND PUT SOME STRUCTURES AT RISK ALONG THE IMMEDIATE SHORE...ESPECIALLY THOSE VULNERABLE LOCATIONS SOUTH OF BOSTON FROM HULL TO SANDWICH. SEVERE BEACH EROSION WILL ALSO OCCUR IN SOME LOCATIONS...ESPECIALLY DURING THE SATURDAY MORNING HIGH TIDE. THE PRIMARY CONCERN WITH THE SATURDAY MORNING HIGH TIDE WILL BE VERY LARGE BREAKERS CRASHING ONTO THE SHORELINE.

SCITUATE

TOTAL TIDE /FT/	DAY/TIME	ASTRO TIDE /FT/	SURGE /FT/	WAVES /FT/	FLOOD CATEGORY
12.6	08/10 PM	9.8	2.8	10-17	MODERATE
13.4	09/10 AM	11.2	2.2	20-22	MAJOR
10.1	09/11 PM	10.1	0.0	9-10	NONE
11.3	10/11 AM	11.3	0.0	5-6	MINOR
10.0	11/12 AM	10.0	0.0	3	NONE
2.9	11/11 AM	2.9	0.0	2-3	NONE

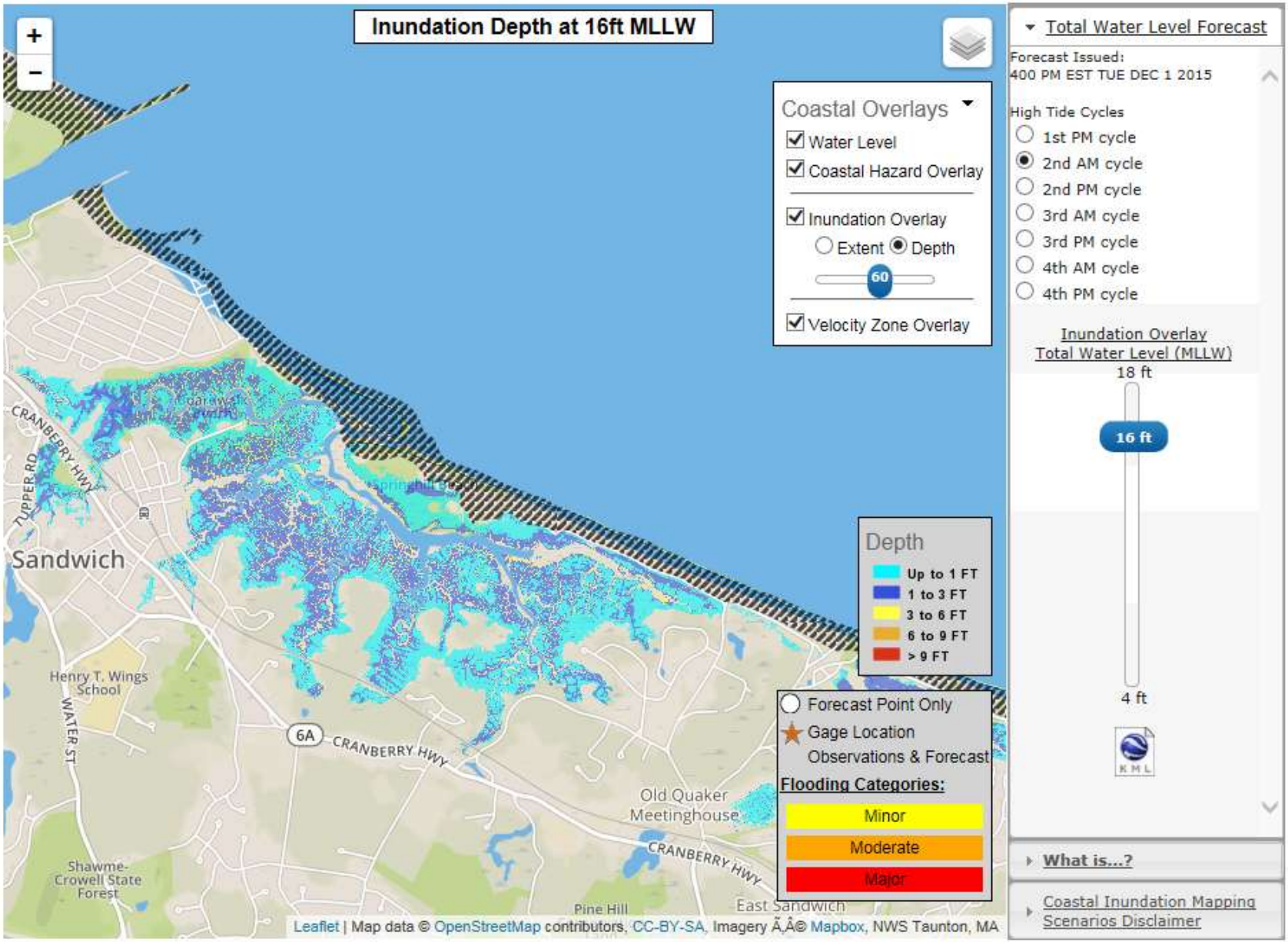
SANDWICH HARBOR

TOTAL TIDE /FT/	DAY/TIME	ASTRO TIDE /FT/	SURGE /FT/	WAVES /FT/	FLOOD CATEGORY
12.5	08/10 PM	9.4	3.1	7-11	MODERATE
15.2	09/10 AM	10.7	4.5	18-20	MAJOR
9.7	09/11 PM	9.7	0.0	6-7	NONE
10.8	10/11 AM	10.8	0.0	2-3	NONE
9.6	10/11 PM	9.6	0.0	1	NONE
6.1	11/11 AM	6.1	0.0	1-3	NONE

(Ctrl)

Coastal Flood Threat and Inundation Mapping

Boston, MA
Weather Forecast Office



Total Water Level Forecast

Forecast Issued:
400 PM EST TUE DEC 1 2015

High Tide Cycles

- 1st PM cycle
- 2nd AM cycle
- 2nd PM cycle
- 3rd AM cycle
- 3rd PM cycle
- 4th AM cycle
- 4th PM cycle

Inundation Overlay
Total Water Level (MLLW)

18 ft

16 ft

4 ft

KML

What is...?

Coastal Inundation Mapping Scenarios Disclaimer

NOTE: During times when the area is under a Tropical Storm/Hurricane Watch or Warning, the storm tide or total water level forecast will reflect a plausible worst case scenario (versus the usual most likely scenario).

weather.gov/boston

NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

HOME | FORECAST | PAST WEATHER | WEATHER SAFETY | INFORMATION CENTER | NEWS | SEARCH | ABOUT

Local forecast by "City, St" or ZIP code
Enter location ... Go
Location Help

News Headlines
- Click here for the latest winter weather information throughout the 2014-2015 winter season

Customize Your Weather.gov
City, ST
Enter Your City, ST or ZIP Code
Remember Me
Get Weather
Privacy Policy

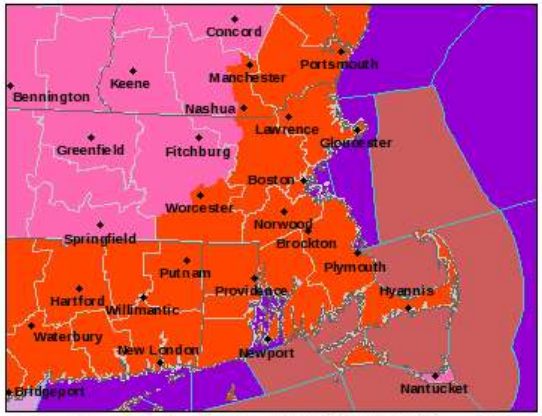
NWS Weather Forecast Office - Boston / Taunton, MA

Weather.gov > Boston, MA

Boston, MA
Weather Forecast Office

Current Hazards | Current Conditions | Radar | Forecasts | Rivers and Lakes | Climate and Past Weather | Local Programs

Click on the map below to zoom in.



Last Map Update: Mon, Jan. 26, 2015 at 5:56:08 pm EST

Watches, Warnings & Advisories

Zoom Out

- Hurricane Force Wind Warning
- Blizzard Warning
- Winter Storm Warning
- High Wind Warning
- Storm Warning
- Coastal Flood Warning
- Gale Warning
- Coastal Flood Advisory
- Hazardous Weather Outlook

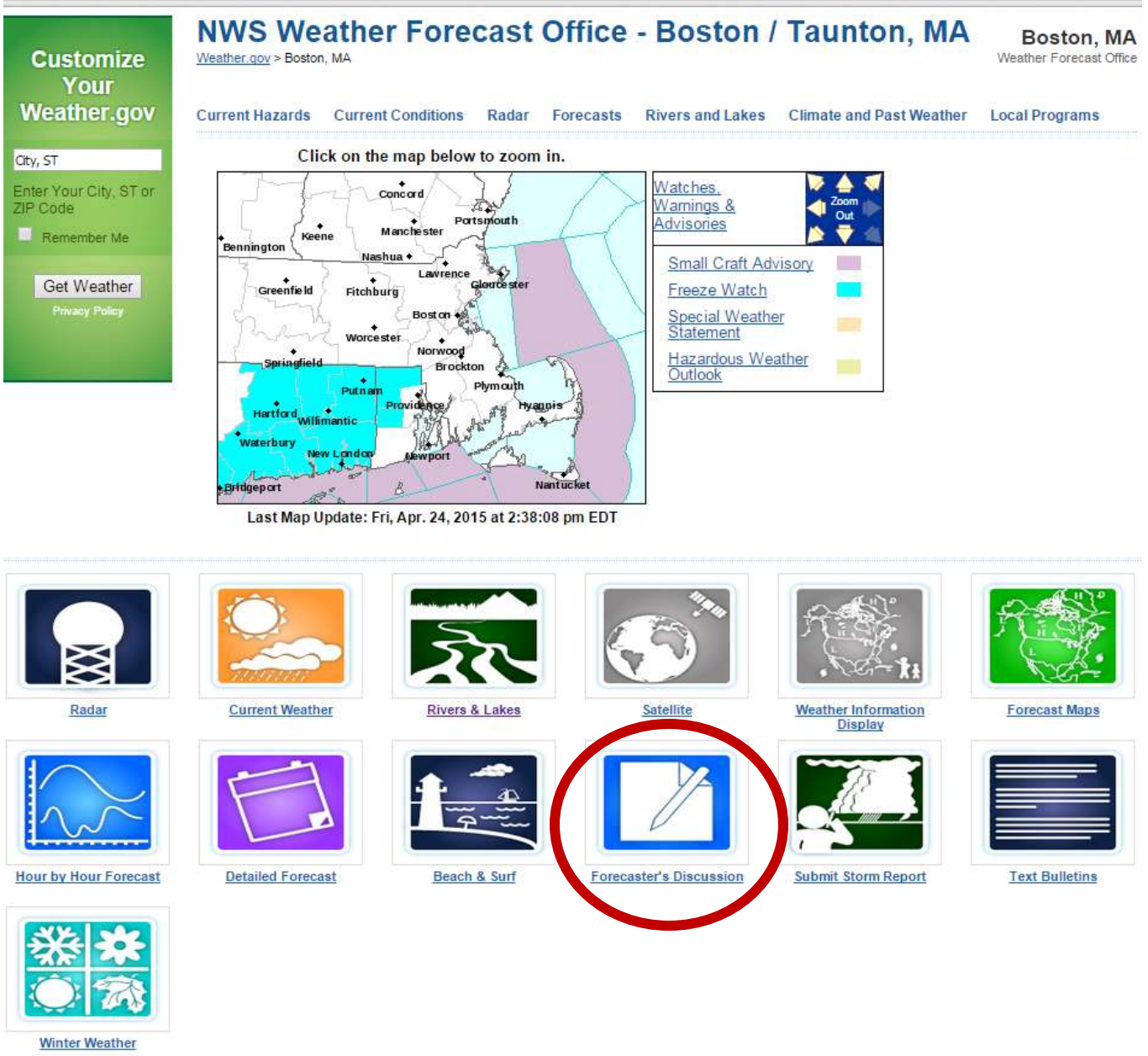





HAZARDOUS WEATHER OUTLOOK (HWO)

- **Issued every early morning**
- **Potential hazardous weather out to 7 days**
- **May be your first clue of a local concern!**
- **Threat evolution**
  - May not appear too ominous at first (especially if time period is greater than 5 days)
    - But let that be your signal for higher situational awareness
  - Monitor evolution of threat with time (e.g. increasing or decreasing threat)
- **Check HWO daily to maintain situational awareness**

weather.gov/boston



AREA FORECAST DISCUSSION (AFD)

- Explains the rationale behind the warning and forecast decisions (i.e., the “why” of the forecast)
- Favorite product for many broadcast meteorologists
- Confidence level and degree of uncertainty
- May indicate alternative scenarios possible
- A way to get inside our heads

Area Forecast Discussion issued early Friday morning March 18, 2016

.LONG TERM /SATURDAY NIGHT THROUGH THURSDAY/...

HIGHLIGHTS FOR LATE SEASON WINTER STORM POTENTIAL SUN PM/MON AM:

* SIGNIFICANT WINTER STORM STILL POSS FOR AT LEAST PART OF THE REGION
* LOW CONFIDENCE ON BEST CHANCE FOR SIGNIFICANT SNOWFALL
* WESTERN TRACK: SIGNIFICANT SNOW POTENTIAL ACROSS INTERIOR WITH DRY SLOT/PTYPE ISSUES ON THE COASTAL PLAIN
* EASTERN TRACK: LIGHTER SNOWFALL ACROSS THE INTERIOR WHILE SIGNIFICANT SNOW POTENTIAL OCCURS ACROSS EASTERN MA/RI

DETAILS...

SUNDAY INTO MONDAY....

A FAIRLY COLD AIRMASS WILL BE IN PLACE FOR LATE MARCH EARLY SUNDAY MORNING WITH HIGH PRESSURE ACROSS EASTERN CANADA. AT THE SAME TIME...A POTENT CLOSED UPPER LEVEL DISTURBANCE WILL BE APPROACHING FROM THE WEST AND INTERACT WITH NORTHERN STREAM ENERGY. THE STRENGTH AND TIMING OF THE ENERGY WILL DETERMINE THE STRENGTH/TRACK OF THE STORM AND WHERE HEAVIEST SNOWFALL OCCURS.

NORMALLY AS YOU GET CLOSER TO AN EVENT CONFIDENCE IN A GIVEN SCENARIO INCREASES...BUT THE OVERNIGHT MODEL RUNS ACTUALLY DID THE OPPOSITE. NOW THAT DOES OCCASIONALLY HAPPEN...PARTICULARLY WHEN THE MAIN EVENT IS STILL OUTSIDE 72 HOURS IN THE MODEL WORLD.

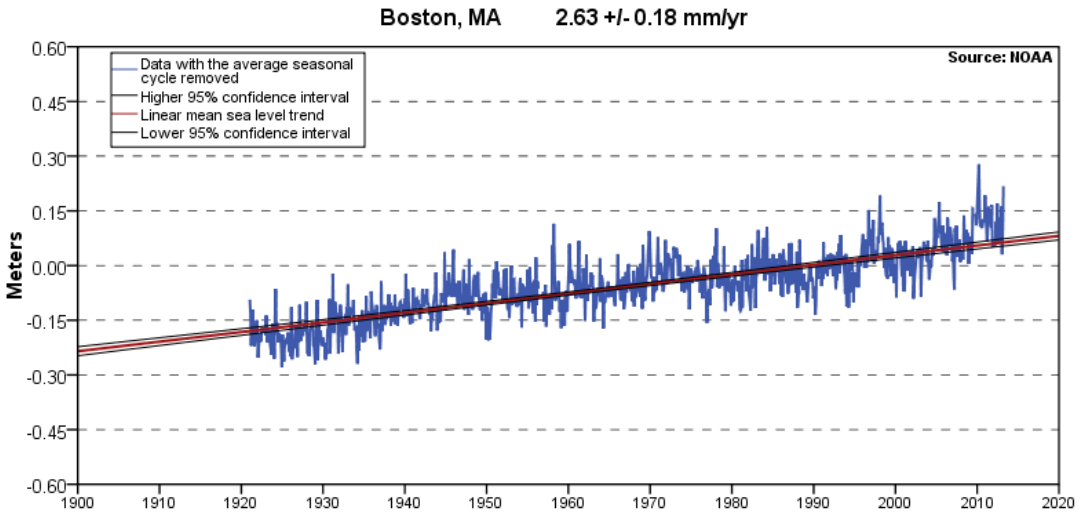
TO SUMMARIZE...THE EARLIER 12Z INTERNATIONAL MODELS SHOWED A RAPIDLY INTENSIFYING LOW PRESSURE SYSTEM PASSING NEAR THE CAPE/ISLANDS. THIS SCENARIO WOULD BRING A LARGE SWATH OF 6 TO 12+ INCHES OF SNOW ACROSS INTERIOR MA AND NORTHERN CT WITH THE HELP OF A POTENT BACK BACKBENT MID LEVEL WARM FRONT....WHILE MUCH OF EASTERN MA/RI WOULD RECEIVE A FRONT END THUMP OF HEAVY SNOW AND THEN HAVE DRY SLOT/PTYPE ISSUES. STRONG WIND GUSTS OF 40 TO 55 MPH WILL ALSO BE A CONCERN FOR A TIME ALONG THE COAST. MEANWHILE...THE 12Z AMERICAN MODELS SHOWED A WEAKER AND MORE PROGRESSIVE LOW PRESSURE SYSTEM CONFINING MOST OF THE SIGNIFICANT SNOW TO EASTERN MA/RI WITH LIGHTER SNOWS BACK INTO THE INTERIOR.

AT 00Z...THE NAM JOINED THE 12Z INTERNATIONAL MODELS SHOWING A POTENT SETUP FOR HEAVY SNOW ACROSS THE INTERIOR WITH A FRONT END THUMP FOLLOWED BY DRYSLOT/PTYPE ISSUES ON THE COASTAL PLAIN. HOWEVER...THE LATEST 00Z OPERATIONAL ECMWF WHICH HAD BEEN CONSISTENT TRENDED SIGNIFICANTLY FURTHER EAST AND WEAKER. THIS WOULD CONFINE SIGNIFICANT SNOW POTENTIAL TO EASTERN MA/RI WITH A LIGHTER SNOWFALL BACK INTO THE INTERIOR. THE ECMWF ENSEMBLES ALSO TRENDED FURTHER EAST...BUT THERE WAS STILL A LARGE SPREAD WITH SOME STILL SHOWING BIG HITS ACROSS THE INTERIOR...BUT MORE ACROSS EASTERN NEW ENGLAND. AS FOR THE GFS...IT REMAINED THE WEAKEST AND FURTHEST EAST SOLUTION BUT ITS INDIVIDUAL ENSEMBLE MEMBERS STILL SHOWED A LARGE POTENTIAL RANGE IN POSSIBLE OUTCOMES.

SO IN A NUTSHELL...A SIGNIFICANT WINTER STORM IS STILL POSSIBLE FOR AT LEAST A PORTION OF SOUTHERN NEW ENGLAND. THE MAIN QUESTION IS WHERE DOES THIS OCCUR. A LOT OF THE 00Z GUIDANCE...BUT CERTAINLY NOT ALL OF IT SHIFTED THE POTENTIAL OF HEAVIEST SNOW ACROSS EASTERN MA/RI. HOWEVER...THE INTERIOR BY NO MEANS IS OUT OF THE WOODS AS SOME OF THE GUIDANCE STILL HAS THE FOCUS OUT IN THAT REGION. THE SPREAD IN THE ENSEMBLES AND SUBTLE TIMING DIFFERENCES IN SHORTWAVE INTERACTION TELL US ITS TOO EARLY TO LOCK IN A SPECIFIC SCENARIO.

Looking to the Future

- Rising sea level
  - Expect more frequent coastal flooding
  - New record total water levels
  - Raises the impact stakes



STORMREADY

Boston – May 20, 2009

WeatherReady Nation Goals Include

- **Accurate and timely forecasts and warnings**
  - Integration of cutting edge science into operations
- **Understanding of and effective response to weather information by partners/customers**
  - Emphasis on Impact Decision Support Services

Impact Decision Support Services

- Supports WeatherReady Nation goal
  - Provide weather information that enables Americans to respond effectively to weather hazards and achieve high level of resilience
  - Information to enable effective decisions by officials
    - Public Safety
    - Preservation of natural and human resources
- Take on different forms
  - High Impact Storm
    - Blast emails (sometimes with Powerpoint Briefings), conference calls, Hazardous Weather Outlooks, Special Statements, social media posts, etc.
  - Special Event Support
    - Major such as July 3rd-4th Esplanade or Boston Marathon
    - Smaller but still with significant public safety risk
      - Regattas, concerts, sporting events, large flea markets, fairs, etc.

Take Away Thoughts

- Cape Cod vulnerable to both hurricanes and nor'easters
  - Hurricanes more extreme but nor'easters more frequent
  - Hurricanes usually greater threat to south side and nor'easters usually greater threat to east side
- Inexperienced population
- Warning => Risk Too High => Take Action if vulnerable
- Expect more frequent and severe coastal flooding and erosion episodes with continued sea level rise

PREPAREDNESS!

Assess Vulnerability, Make Plan, and Act on Plan before too late!

“Natural calamity strikes at just about the time that one forgets its terror.”

-- Japanese Proverb

Hurricane Edition

THE SUN

Local and Shore News

Vol. 46, No. 30 WESTERLY, R. I., FRIDAY SEPTEMBER 23, 1938 Price Three Cents

Misquamicut Wiped Out; Napatree Point Gone; 50 Dead; Scores Missing

Westerly Paralyzed by Tropical Hurricane; Cottages at Charlestown Beach and Quonochontaug Washed Away; 4 Dead, 4 Missing In Stonington

List of Dead and Missing

Perfect Storm of October 1991

Courtesy *Boston Globe*