

# Total Water Level Initiative and Probabilistic Snowfall Forecasts



*MV Times*



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# Coastal Storms

- **Two types**
  - Tropical Cyclones (tropical storms, hurricanes)
  - Extratropical Cyclones (nor'easters)
- **Coastal Flooding Impacts**
  - Due to water level (surge + tide) and waves



# Threat to Life

- Inexperienced population in southern New England
  - Last destructive nor'easter was December 1992
    - Not long after the destructive 1991 "Perfect Storm"
  - Last land falling hurricane was Bob in August 1991
  - Last land falling major hurricane was Carol in 1954
- Large number of rescues during January, 2018 Blizzard



# Threat to Property

- Move what can be moved (up or out)
- Secure what can't be moved



# Threat to Infrastructure

- **Potential impacts, especially in major urban areas**
  - Transportation, Communications, Energy
  - Sandy's impact on New York City is a wake up call!
- **Frequent salt water inundation from "minor" events can damage shoreline roads**

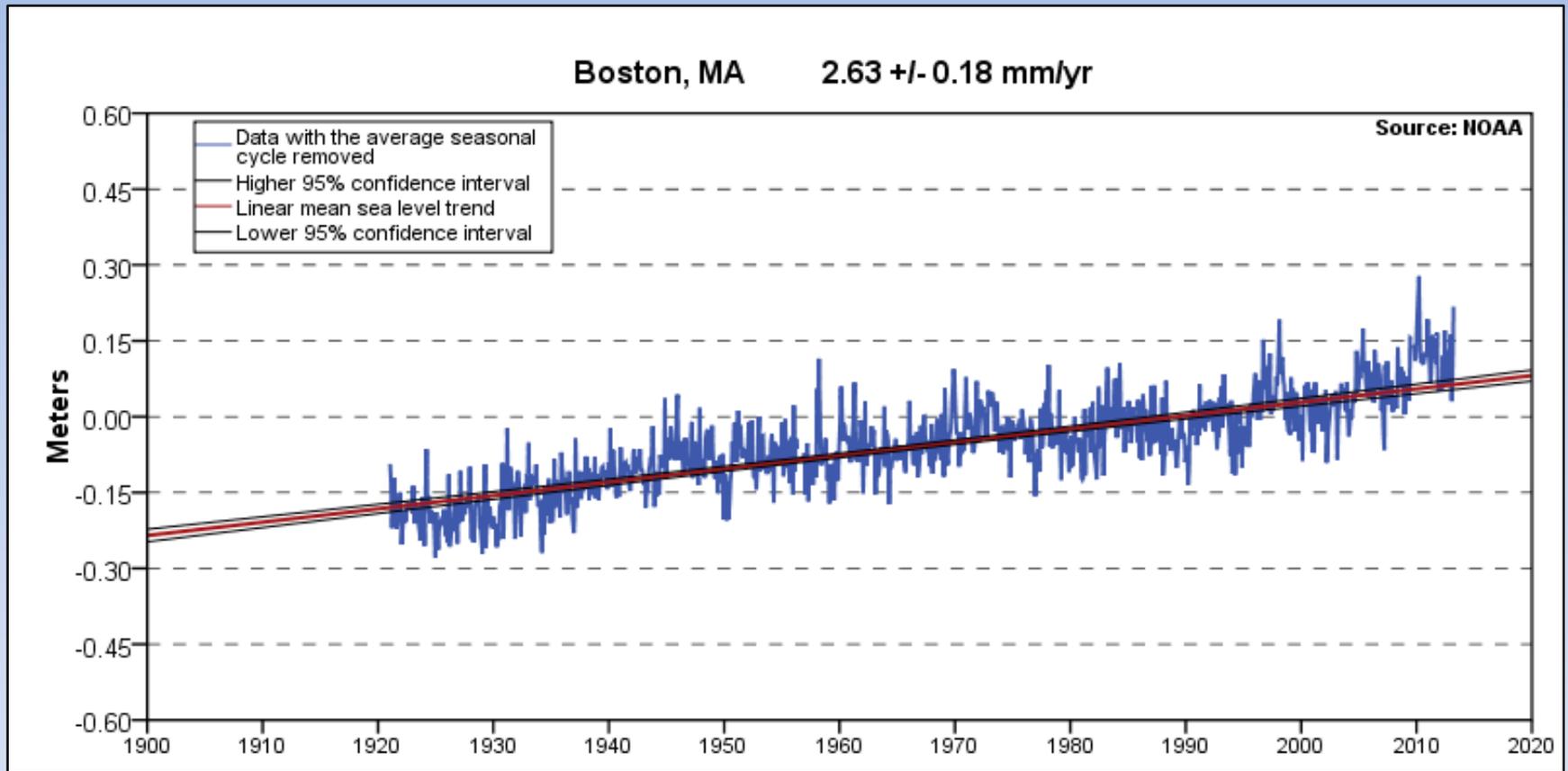


# Role of Large Waves

- Structural damage from wave battery
- Contribution to inundation via over wash
- Scouring/erosion

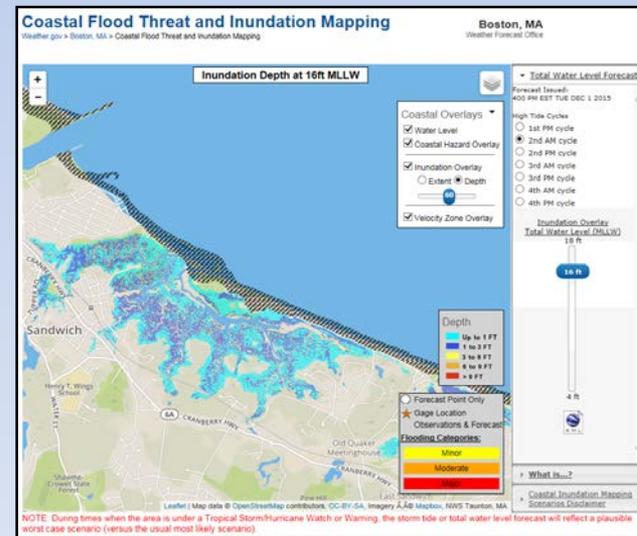
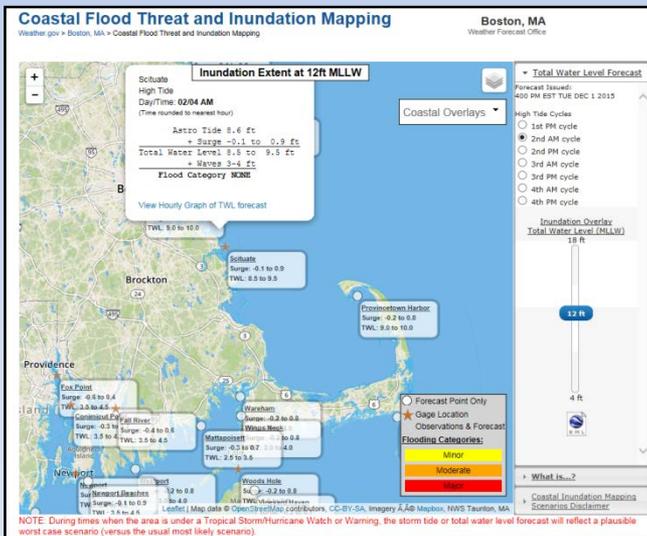


# Rising Sea Levels



# Recent Forecast Improvements

- Studies of past events to improve forecaster awareness and refine location-specific impacts
  - Daily Total Water Level forecasts
  - Wave Run-Up forecasts
  - Coastal Hazards web portal
- <https://www.weather.gov/box/coastal>



# Wave Run-Up Forecasts

- **Helps convey forecast wave impacts**
  - Waves contribute a significant amount to total water level during high impact events
  - Wave action is the ultimate cause of most structural damage and beach erosion



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	

```

MAZ019-060900-
SCITUATE SEAWALL - PLYMOUTH COUNTY
42.21N 70.72W CREST ELEV. 17.49 FT MLLW
420 PM EDT TUE JUN 5 2018

DATE      06/05/18
EDT HRLY 17 18 19 20 21 22 23 00 01 02 03 04
UTC HRLY 21 22 23 00 01 02 03 04 05 06 07 08

WND DIR   SE SE SE SE NE  N  N  N  N  N  N  N
WND SPD   6  5  4  4  3  3  4  4  5  6  6  6
WND GST                                14
WAVES     4  4  4  4  4  4  4  4  4  4  4  4
PERIOD    8  8  8  8  8  8  8  8  9  9  9  9
SETUP     0  0  0  0  0  0  0  0  0  0  0  0
RHIGH     4  4  4  3  3  2  2  2  2  3  3  4
EROSION   Y  Y  N  N  N  N  N  N  N  N  N  N
OVERWSH   N  N  N  N  N  N  N  N  N  N  N  N
INUNDTN   N  N  N  N  N  N  N  N  N  N  N  N
    
```

# Future Research and Development

- Improve mapping visualization (with NOAA Coastal Services Center)
  - Ability to view real-time Total Water Level forecasts
  - Incorporation of Wave Run-Up
- Update LIDAR maps along MA/RI coastline



# Probabilistic Snowfall Forecasts



# Background

- **Snowfall = Big Impacts**
  - School / government / business closures
  - Airport shutdowns/delays
  - Cost of plowing/treating roadways
  - Traffic accidents with injuries/fatalities
  - Power outages/damage



# Background

- Demand for more accurate snowfall forecasts has escalated in recent years
  - High sensitivity to winter hazards
  - Highways often run above capacity in fair weather



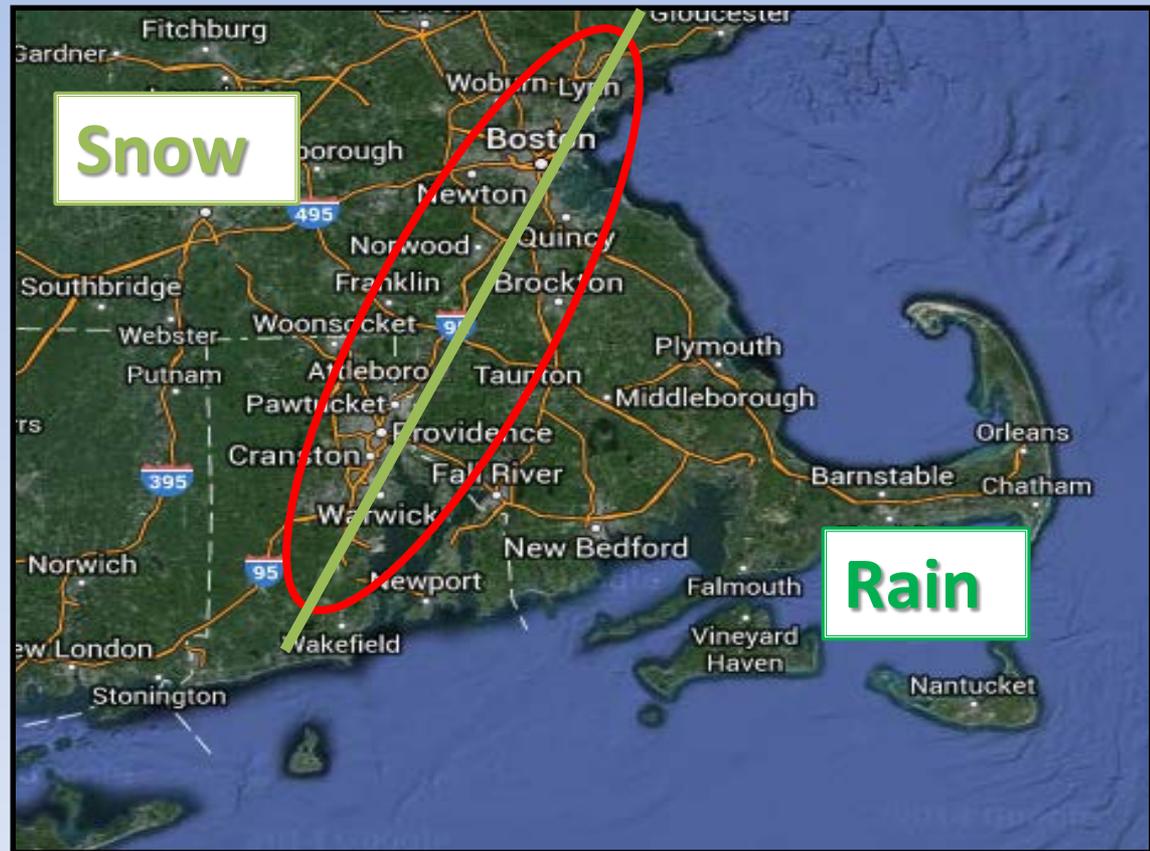
# Forecast Challenges

- Will it snow at all?
- How do we communicate forecast confidence?
- How do we show alternate scenarios?
- How do we include all impacts?



# Small Changes in Snow Forecasts Make a Big Difference

- Location of the Rain/Snow line
- Will snow from an offshore storm reach the coast?
- A 40-mile difference impacts 6.5 million people in the Boston to Providence corridor



# History

## Winter 2011-12:

- NWS Boston develops probabilistic snow forecasts as a result of a forecast “bust” in February, 2010.

## Winter 2012-2014:

- NWS Boston begins web-based probabilistic snow forecasts for 1, 4, 8, and 12” thresholds.
- NWS Baltimore/Washington expands the project by adding “best” and “worst” case scenarios.

## Winter 2014-15:

- “Northeast Corridor” NWS offices participate in a testbed based upon the new methodology.

## Winter 2015-Today:

- Project expands nationally.



# Probabilistic Snowfall Forecasts

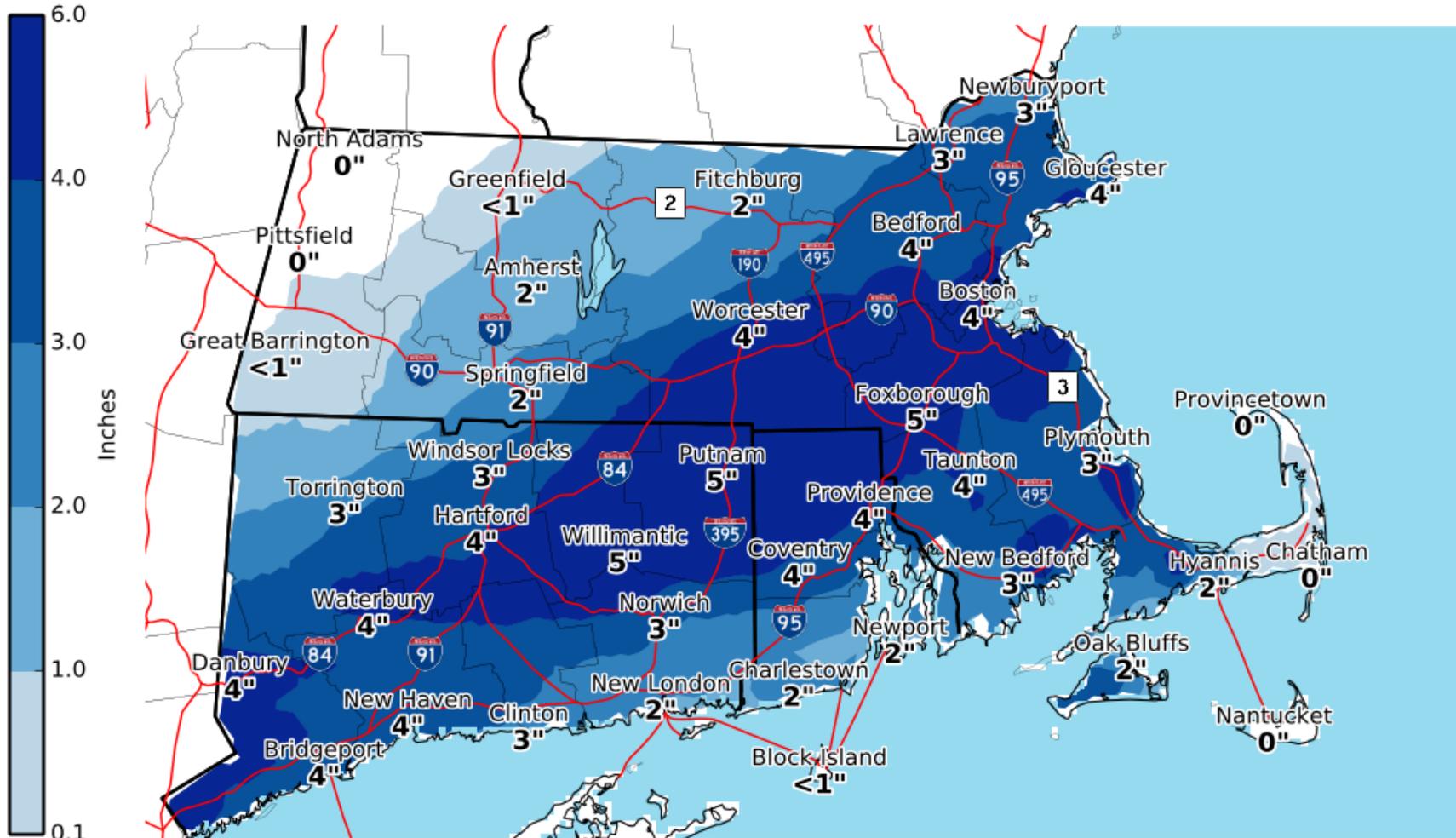
Includes new web-based forecasts:

- Minimum, Most Likely, and Maximum snowfall
  - Conveys range of possibilities and forecaster confidence
- Probability of exceeding certain thresholds
  - 0.1, 1, 2, 4, 6, 8, 12, and 18 inches
- Location-specific tables
  - Allows users to “drill down” to their community



# Minimum Snowfall: "Expect At Least This Much"

**Low End Amount - 9 in 10 Chance (90%) Of Higher Snowfall**  
Valid: Early Wednesday Into Early Thursday



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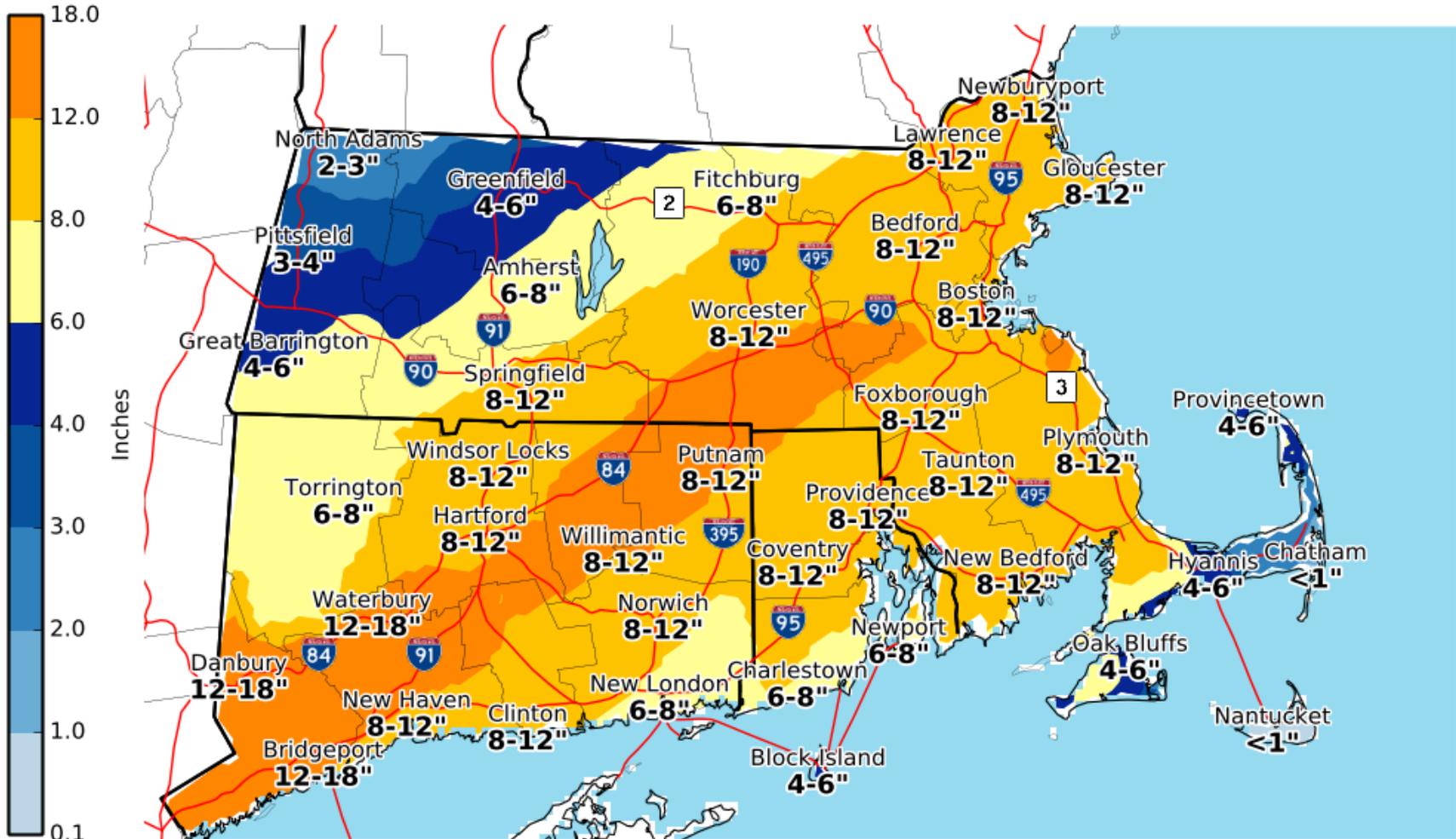
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# Most Likely Snowfall: Official NWS Forecast

**Expected Snowfall - Official NWS Forecast**  
Valid: Early Wednesday Into Early Thursday



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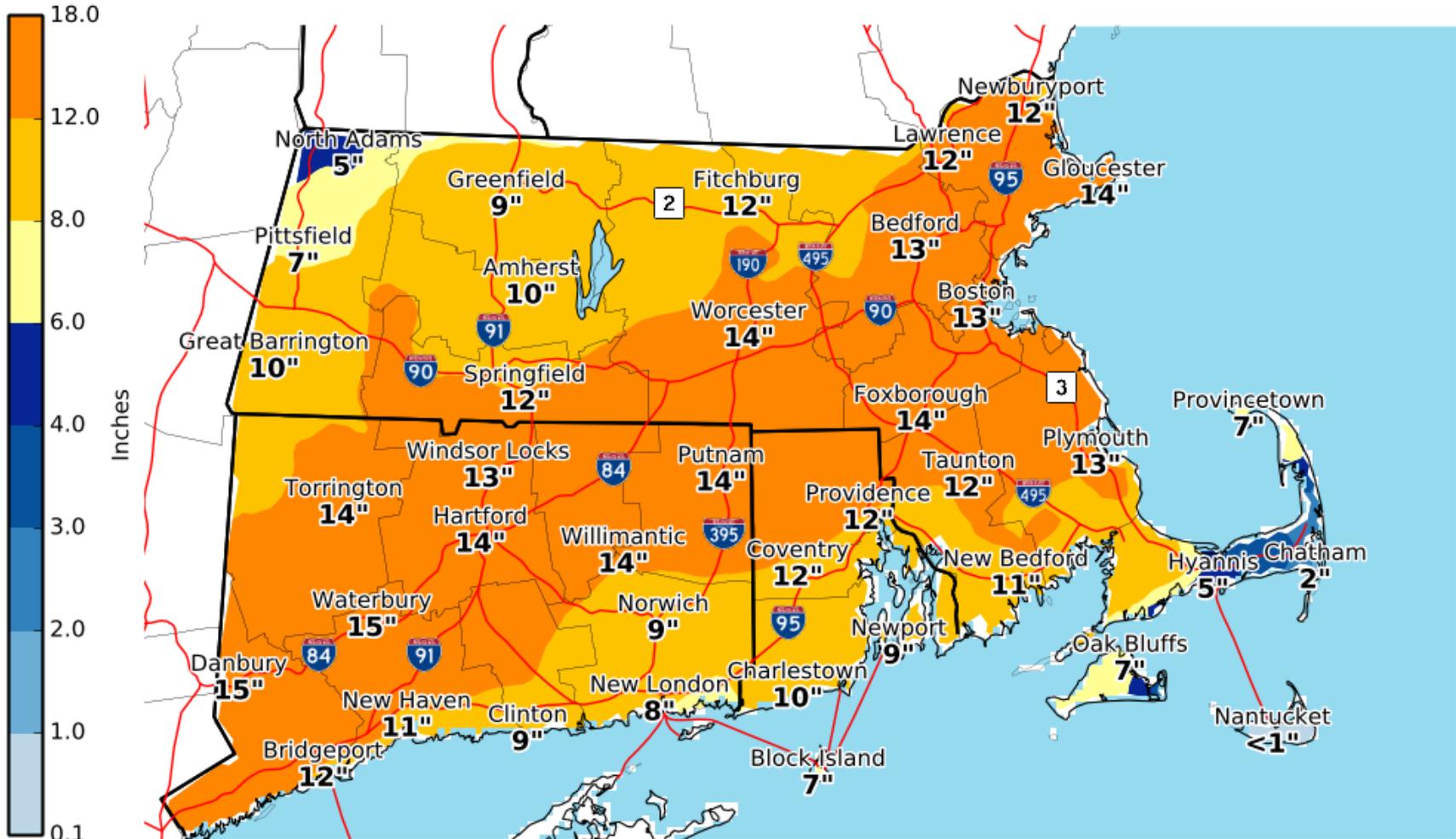
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# Maximum Snowfall: "Potential for This Much"

High End Amount - 1 in 10 Chance (10%) Of Higher Snowfall  
Valid: Early Wednesday Into Early Thursday



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# Probability of Exceedance



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# Location-Specific Tables

## Chance of Snow Accumulation Ranges

03/05/2013 1900 to 03/06/2013 2000 EST

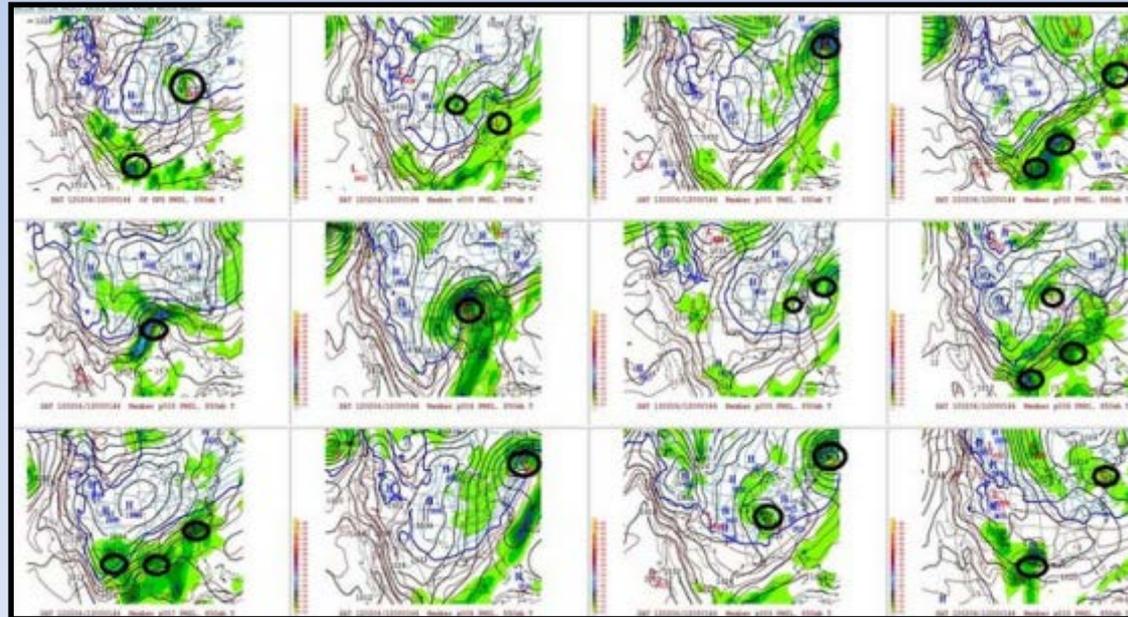
County:

Location	Min	Likely	Max	0"	T-1"	1-2"	2-4"	4-8"	8-12"	12-18"	>18"
Baltimore, MD	1	4-8	15	0%	9%	6%	17%	28%	21%	15%	4%
Bayard, WV	9	8-12	22	0%	0%	0%	1%	4%	47%	21%	27%
Charlottesville, VA	4	12-18	19	0%	6%	0%	4%	16%	25%	37%	12%
Frederick, MD	7	8-12	19	0%	0%	0%	1%	17%	38%	32%	12%
Fredericksburg, VA	0	4-8	14	11%	11%	6%	11%	25%	20%	13%	3%
Hagerstown, MD	8	8-12	19	0%	0%	0%	1%	13%	46%	26%	14%
Harrisonburg, VA	14	12-18	28	0%	0%	0%	0%	1%	6%	49%	44%
Leonardtown, MD	0	1-2	5	39%	3%	24%	20%	13%	1%	0%	0%
Martinsburg, WV	10	8-12	24	0%	0%	0%	0%	4%	50%	13%	33%
National Mall, DC	1	4-8	17	0%	9%	5%	11%	30%	19%	19%	7%
Staunton, VA	9	12-18	22	0%	0%	1%	0%	7%	19%	42%	31%
Winchester, VA	13	12-18	29	0%	0%	0%	0%	0%	6%	56%	38%



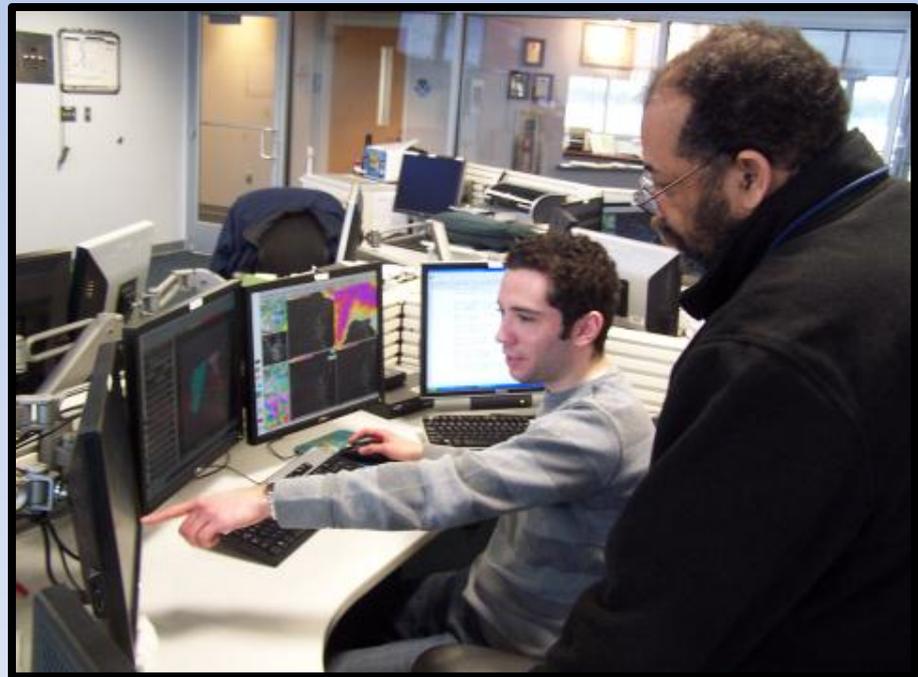
# The Science Behind the Process

- Probabilities derived from a 57-member ensemble run at the Weather Prediction Center (WPC)
- Consists of global and high-resolution models and ensembles
- Integrates forecaster's snowfall forecast



# Role of the Forecaster

- “Over the Loop” Process
- Model guidance can be adjusted to incorporate the forecaster’s knowledge and experience



# Benefits

Provides information that can be used to make decisions based upon a user's threshold

- Can plan for the "best" case, "worst" case, or "most likely" scenario
- Ideally, no "surprises" for anyone
- Less impact through better planning & decision making.



# User Feedback

**Ryan Jones, FEMA Region I National Preparedness:**

***“I really like those experimental graphics with probabilities for different amounts of snowfall. I understand they are still in testing and development, but they clearly convey some useful and easily understandable information.”***



# User Feedback

## Tufts University, Emergency Management Office:

- *Saved the university around \$100,000 due to better planning for openings, closings, and delays during record-breaking winter of 2014-15.*

## City of Boston Office of Emergency Management:

- *Relies on probability tables for decision-making.*
- *Saved city around \$2 million for planning associated with January 24, 2016 winter storm*



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