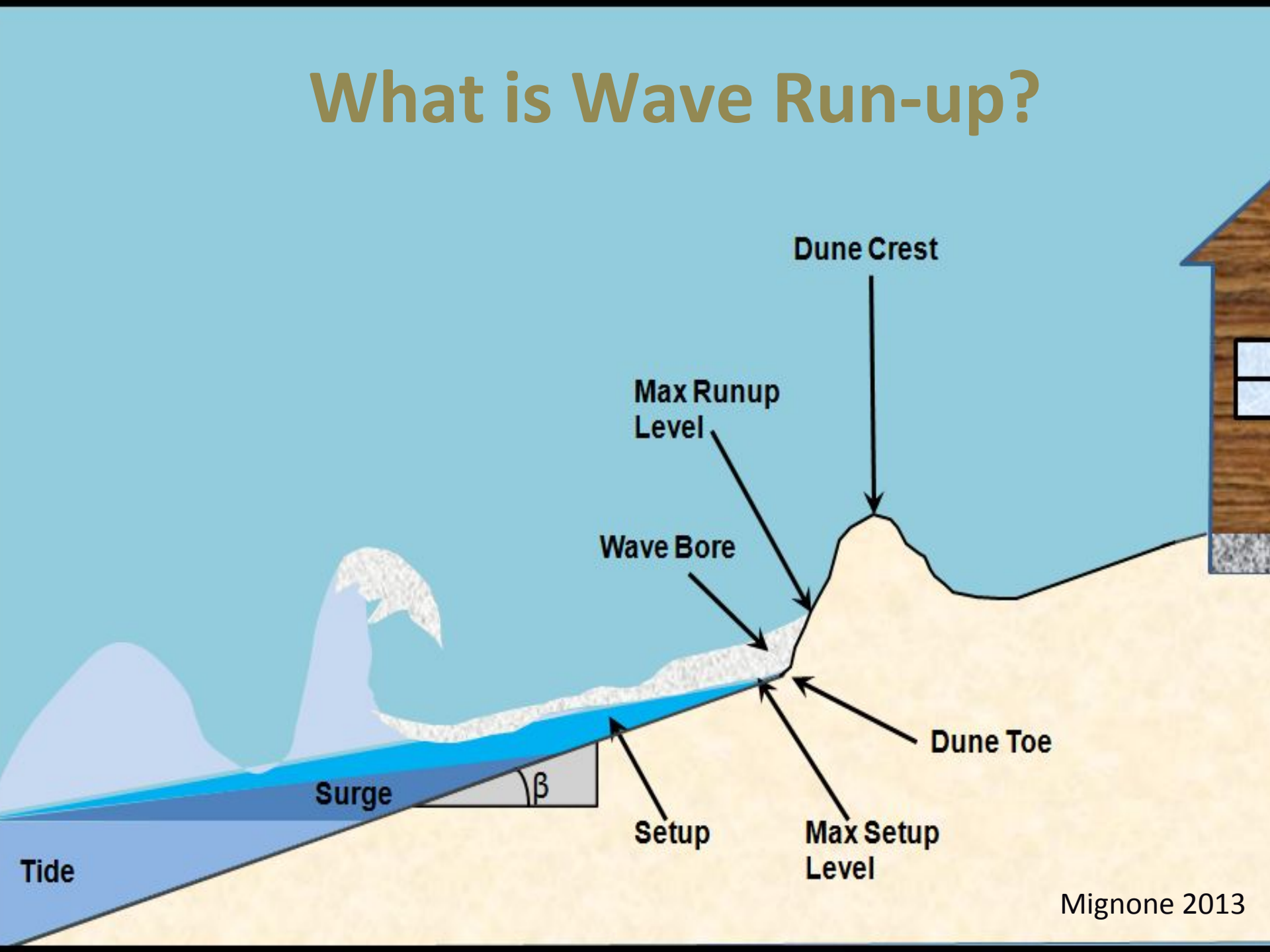
Powerful Storms, Battering Waves

2019 Beaches Conference

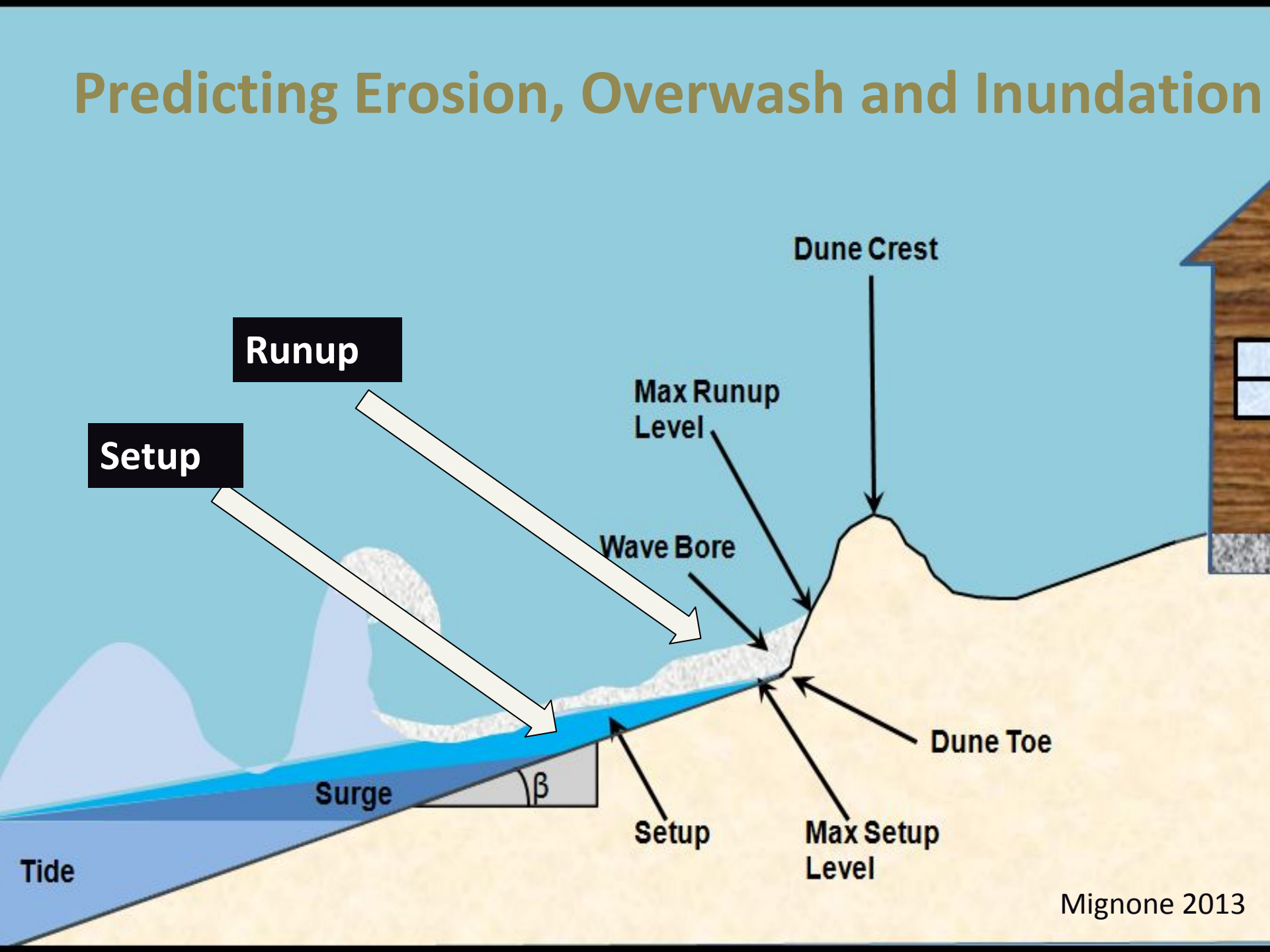
John Cannon, National Weather Service
Tom Shyka, NERACOOS

What is Wave Run-up?



Mignone 2013

Predicting Erosion, Overwash and Inundation



Coastal Flooding Toolkit

- Developed in partnership with NWS forecast offices
- Delivers wave run up forecast for sites throughout New England
- Integrates key forecasts and observations of water level, waves and winds

NERACOOS Coastal Flooding Toolkit

The NERACOOS Coastal Flooding toolkit provides forecasts and observations to help prepare for and respond to coastal flooding events.

Please visit the National Weather Service for official coastal forecasts, warnings.

Beach Erosion and Flooding Forecast
This experimental forecast predicts the highest point that waves will reach at specific coastal locations

Buoy Observations and Forecasts
This tool allows you to view wind and wave data and forecasts from the various ocean buoys and stations

Water Level Observations and Forecast
This product displays forecast and observed water levels at locations with water level gauges

Observation and Forecast Map
This map displays the location of wave run-up forecast sites, water level gauges and buoys

The Coastal Flooding Toolkit should be not be solely relied upon to make important decisions about hazard response. NERACOOS provides these forecasts and observations "as is" but assumes no legal liability or responsibility resulting from the use of this information.

Available Tools

- NERACOOS Coastal Flooding Toolkit
- Beach Erosion and Flooding Forecast
- Buoy Observations
- Water Level
- Observation and Forecast Map

al Flooding Toolkit

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Choose a Beach

- Roque Bluffs, ME
- Popham Beach ME
- Ferry Beach Ecology School, Saco ME
- Camp Ellis, Saco ME
- Mile Stretch Road Biddeford, ME
- Jenness NH
- Hampton NH
- Salisbury, MA
- Newburyport, MA
- Duxbury, MA

NERACOOS Coastal Flooding Toolkit

Beach Erosion and Flooding Forecast

LOCATION: JENNESS BEACH

WAVE MODEL: WAVE WATCH III GLOBAL WAVE MODEL

Location: Jenness Beach

Inundation Threshold: 8.88 ft
Erosion Threshold: 6.41 ft

Forecast through: Monday, 12/10 4:00AM

Date/Time	Impact	Max WL
12/3 8:00 am		5.23 ft
12/3 9:00 pm		4.35 ft
12/4 9:00 am		5.05 ft
12/4 9:00 pm		4.04 ft
12/5 10:00 am		5.27 ft
12/5 10:00 pm		4.44 ft
12/6 11:00 am		5.08 ft

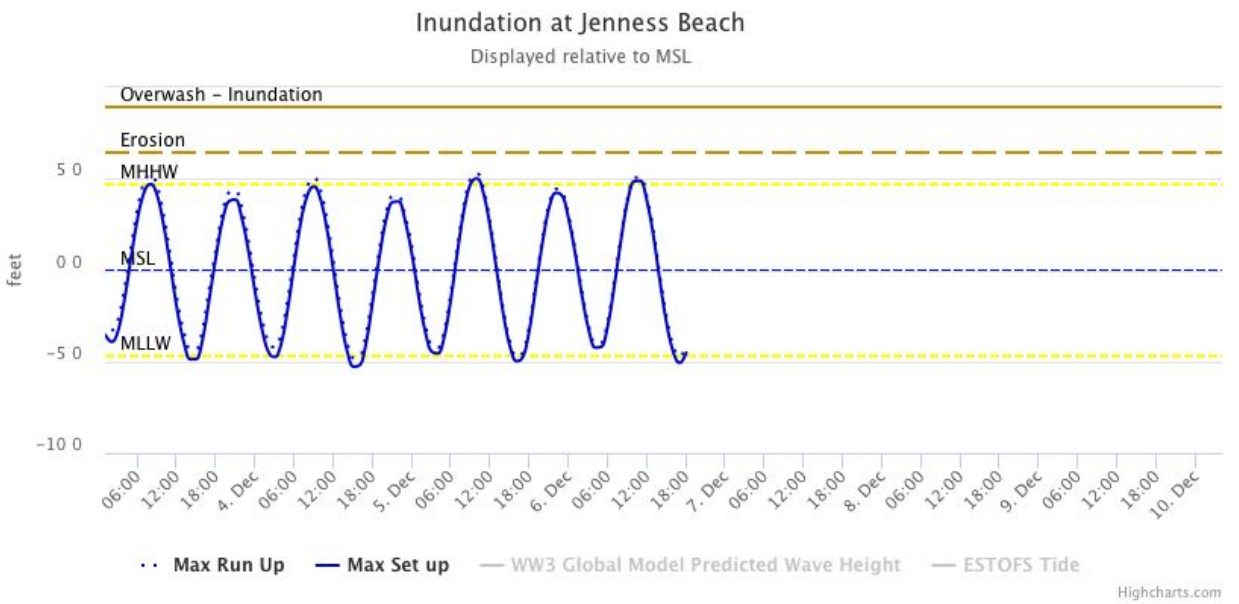
Impact Marker Key

No Impact | Erosion | Overwash | Inundation

Peak Forecast - Last 3 High Tides			
Date/ Time	12/5 10:00 am	12/5 10:00 pm	12/6 11:00 am
Wave Height	0.92 ft	0.69 ft	1.61 ft
Tide	5.15 ft	4.11 ft	5.12 ft

Models Used
Wave: Wave Watch III Global Wave Model
Tide: ESTOFS Tide

Relative To MSL



NERACOOS Coastal Flooding Toolkit

Beach Erosion and Flooding Forecast

LOCATION: CAMP ELLIS BEACH

WAVE MODEL: WAVE WATCH III GLOBAL WAVE MODEL

Location: Camp Ellis Beach

Inundation Threshold: 17.03 ft
Erosion Threshold: 12.00 ft

Forecast through: Tuesday, 3/6 4:00AM

Date/Time	Impact	Max WL
2/28 10:00 am		11.49 ft
2/28 10:00 pm		10.69 ft
3/1 11:00 am		11.82 ft
3/1 11:00 pm		12.55 ft
3/2 12:00 pm		17.23 ft
3/3 12:00 am		17.76 ft
3/3 12:00 pm		16.4 ft

Impact Marker Key

No Impact | Erosion | Overwash | Inundation

Peak Forecast - Last 3 High Tides

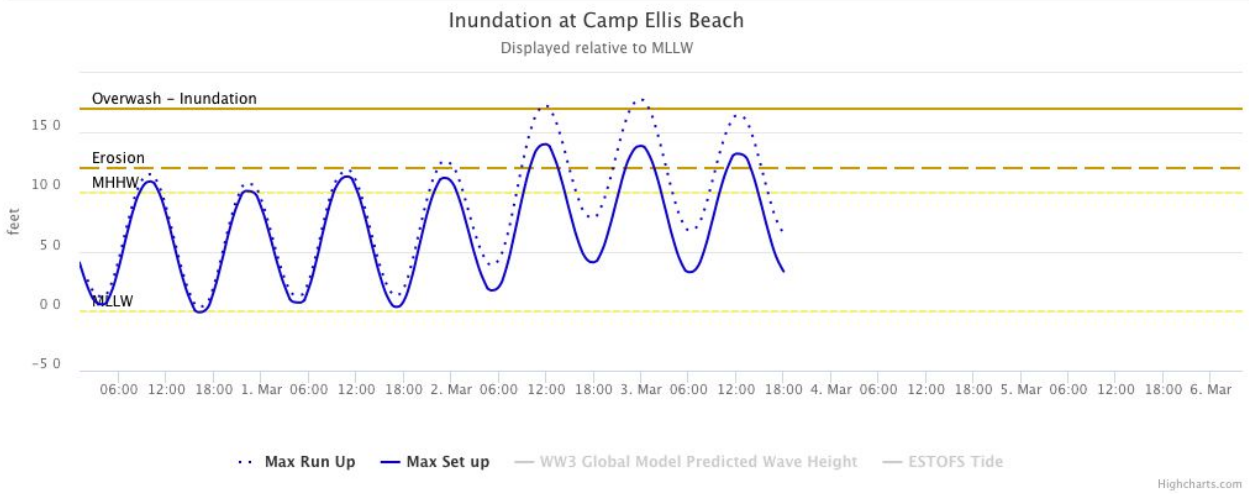
Date/ Time	3/2 12:00 pm	3/3 12:00 am	3/3 12:00 pm
Wave Height	16.83 ft	17.75 ft	13.35 ft
Tide	10.43 ft	10.11 ft	10.35 ft

Models Used

Wave: Wave Watch III Global Wave Model

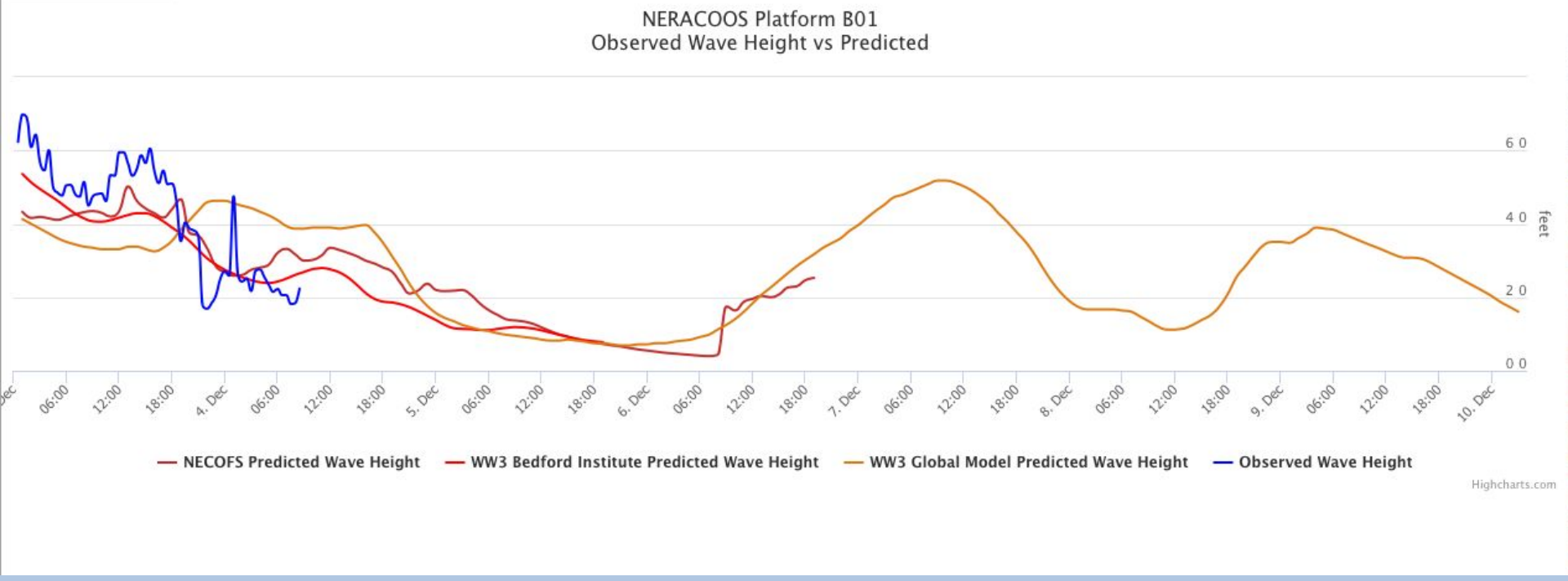
Tide: ESTOFS Tide

Relative To MLLW



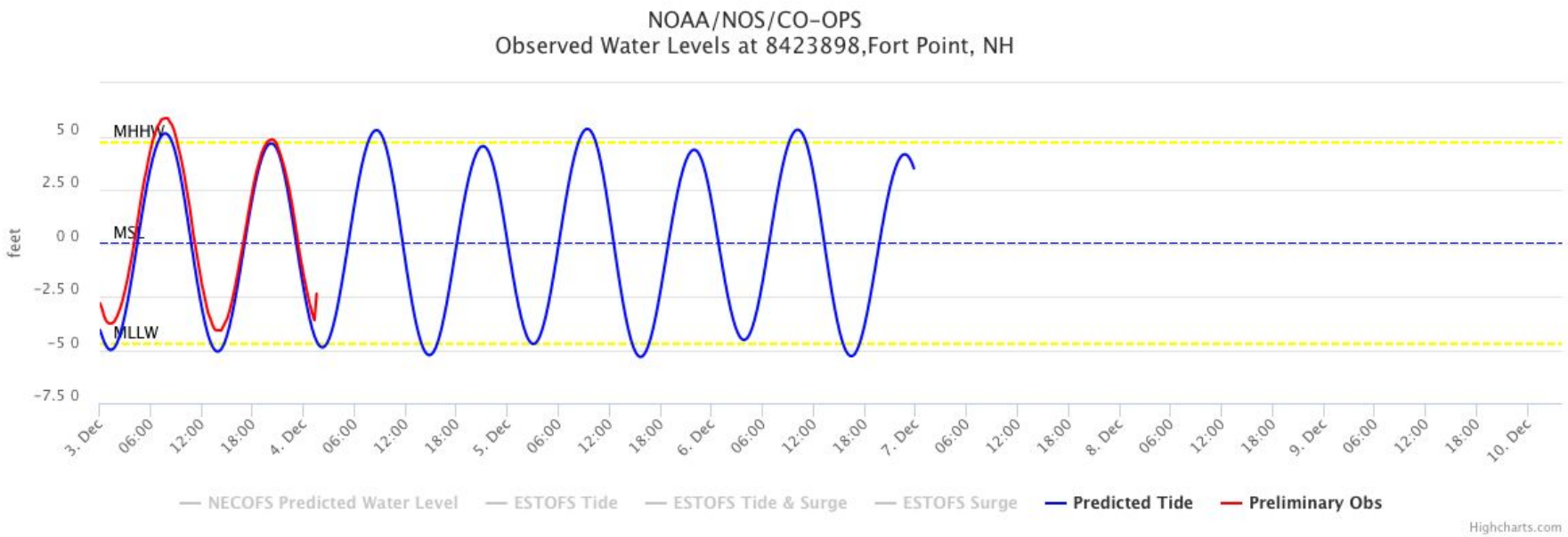
Platform Observations

LOCATION: B01



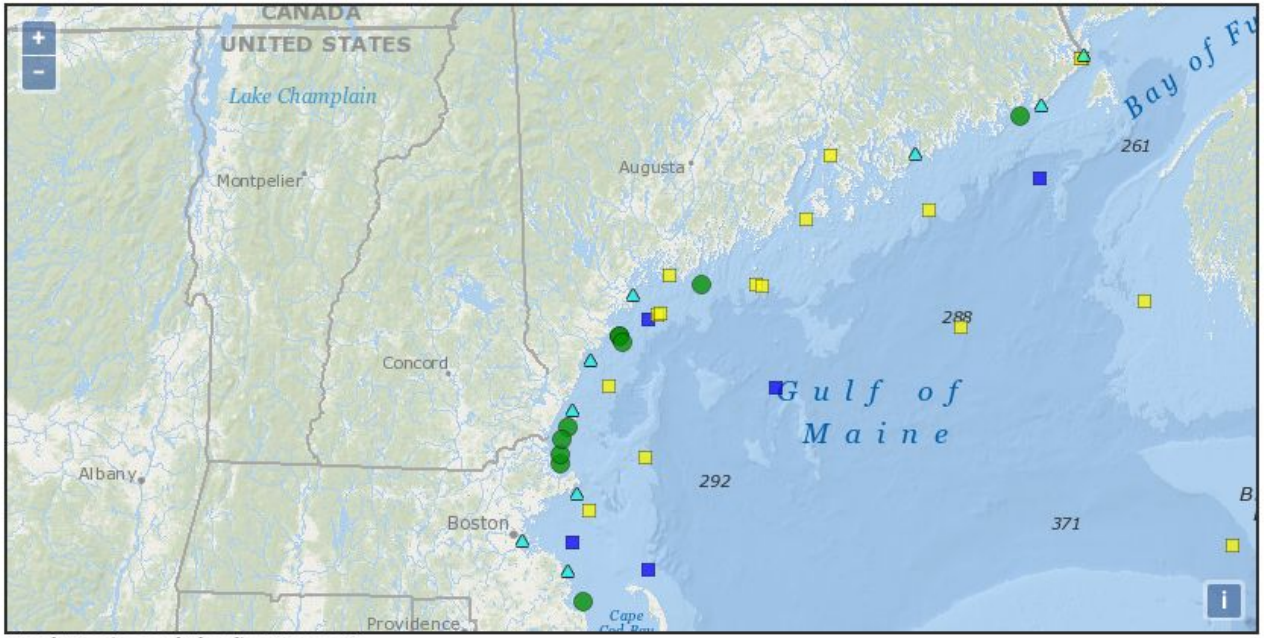
Station Observations

Relative To MSL Location FORT POINT, NH



Date	Day of Week	Time	Predicted (ft)	High/Low
12/2/2018	Sunday	7:18 PM	4.78	H
12/3/2018	Monday	1:24 AM	-5.01	L
12/3/2018	Monday	7:47 AM	5.15	H
12/3/2018	Monday	1:57 PM	-5.08	L
12/3/2018	Monday	8:16 PM	4.69	H
12/4/2018	Tuesday	2:16 AM	-4.89	L
12/4/2018	Tuesday	8:38 AM	5.3	H
12/4/2018	Tuesday	2:52 PM	-5.26	L
12/4/2018	Tuesday	9:10 PM	4.55	H

Observation and Forecast Map



MAP OPTIONS

Legend

Beach Forecast Impact Markers	Buoys and Tide Gauge Platforms
No Impact	NERACOOS Buoys
Erosion	NOAA Buoys
Overwash	Water Level Stations
Inundation	

Beach Erosion and Flooding Forecast
The impact markers for the beach locations will update based on the forecast. Click the marker to view the forecast.

Observation Stations
Click a buoy to view the sensor observations and model forecast data.

Click a tide gauge station to view the tide observations and water level forecast data.

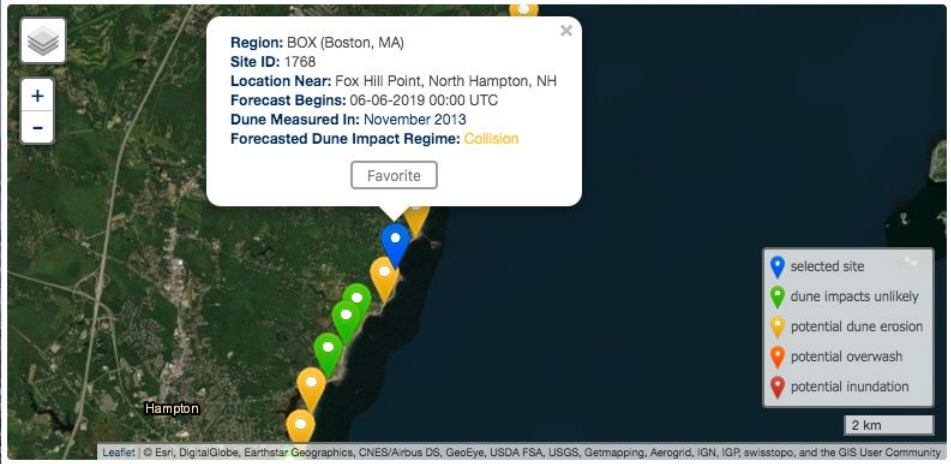
USGS Total Water Level and Coastal Change Forecast Viewer

science for a changing world

Regions | Favorites

Show Most Recent Forecast | Select Forecast Date

Single-site Details | Regional Overview



▸ Regional Coastal Change Forecast

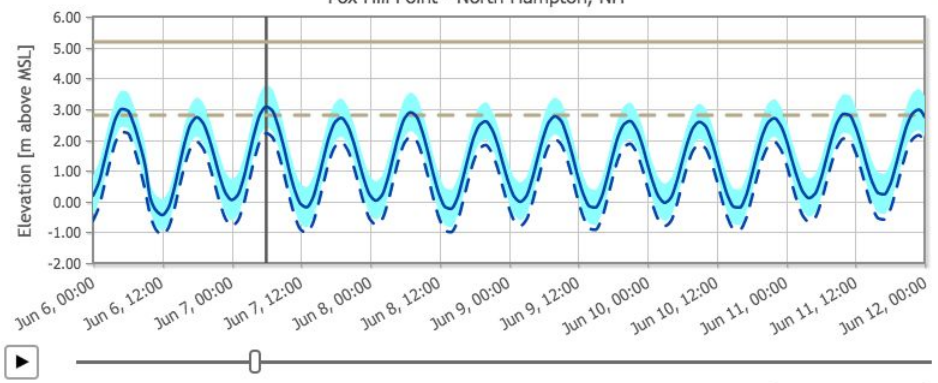
▸ Potential Dune Erosion - 36 Site(s)

Tell us how you use this viewer!

Submit A User Story

For official forecast information visit the National Weather Service.

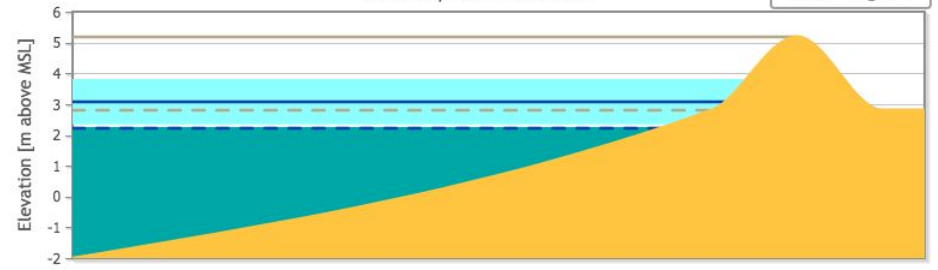
Fox Hill Point - North Hampton, NH



▶

June 7th, 2019 06:00 UTC

Chart Legend



Time of Peak TWL [UTC]	Tide + Surge @ Peak TWL [m]	Wave runup @ Peak TWL [m]	Peak TWL [m]	Dune Toe Elev. [m]	Dune Crest Elev. [m]
06-07-2019 06:00	1.57	1.5	3.07	2.8	5.18

Recent Major Coastal Storms:

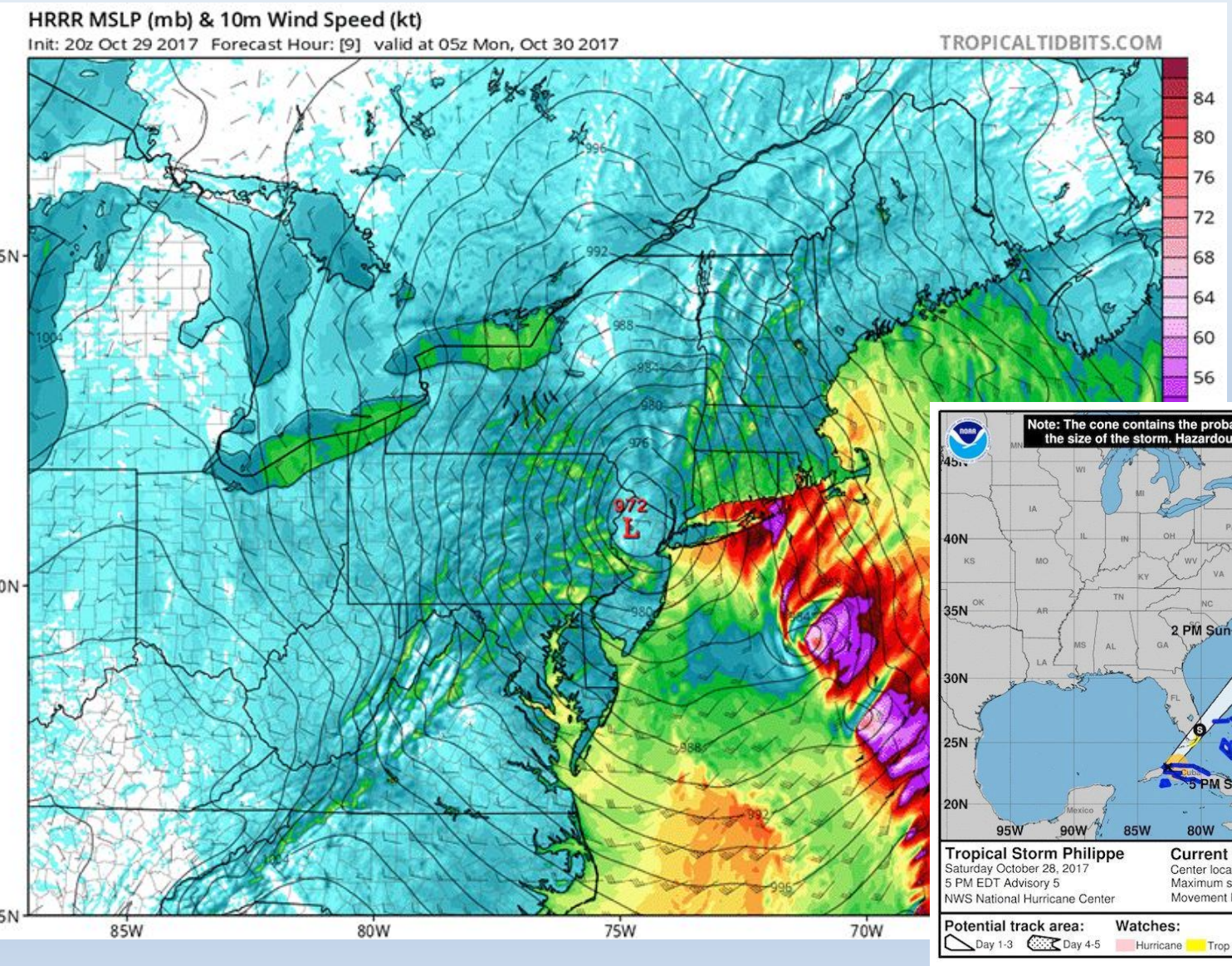
Forecasting Erosion, Splash-over and Inundation

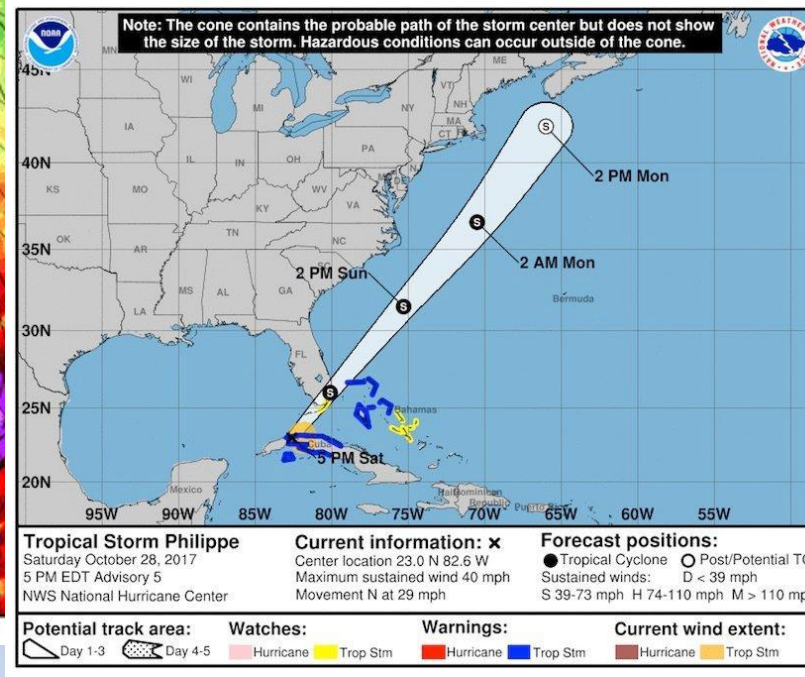
- An active storm track returns
- 3 Unique storms and dune profiles
  - October 30th, 2017
  - January 4th, 2018
  - March 3rd, 2018

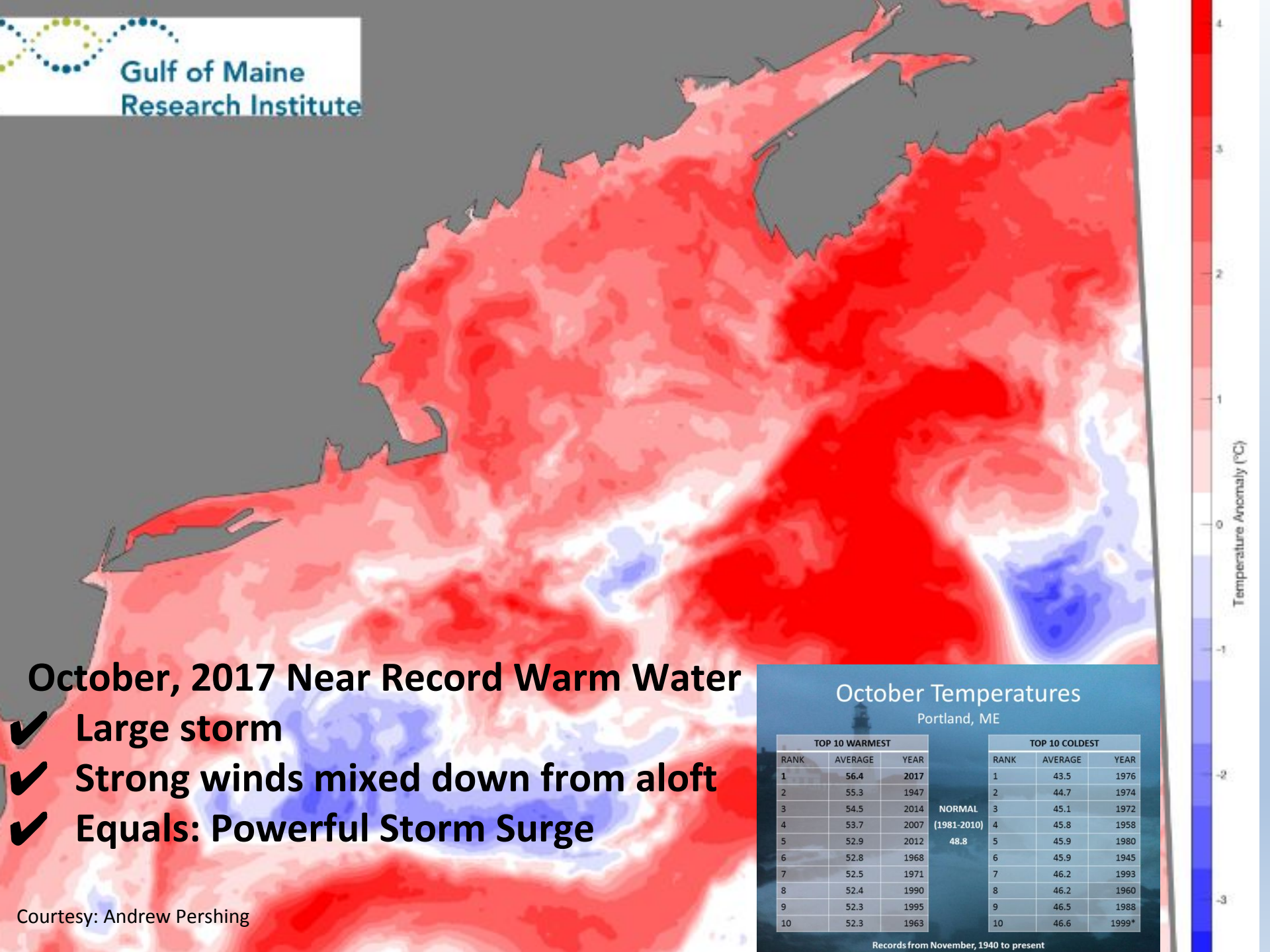
Photo: Cathleen Stackpole

October 30, 2017 “Outlier”

<u>Low</u> astronomical tides/High Wind & Storm Surge Event







October, 2017 Near Record Warm Water

- ✔ Large storm
- ✔ Strong winds mixed down from aloft
- ✔ Equals: Powerful Storm Surge

Courtesy: Andrew Pershing

October Temperatures

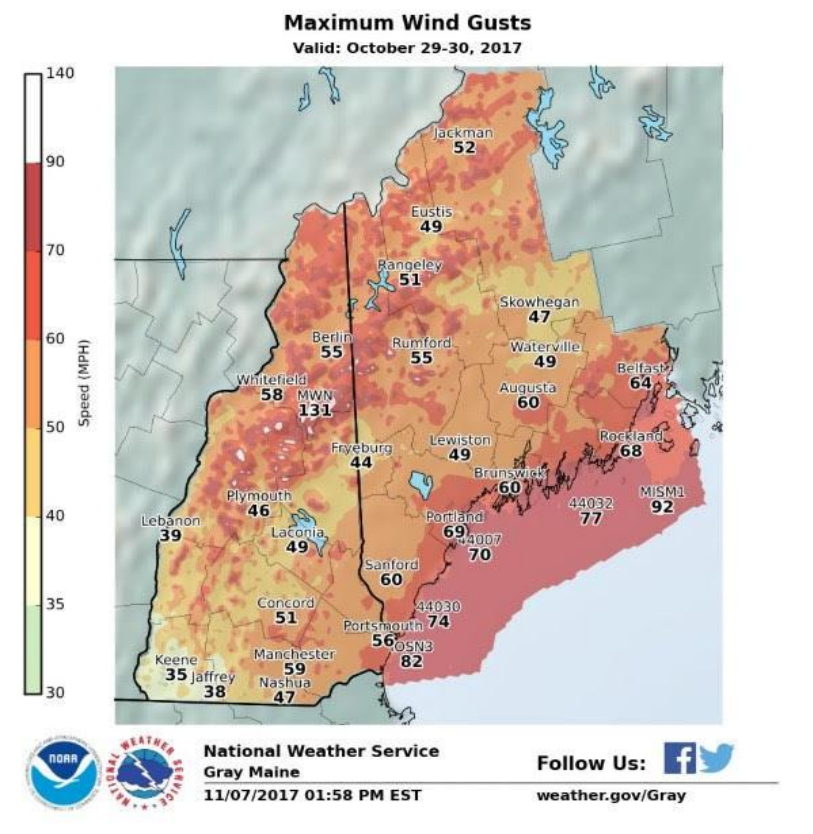
Portland, ME

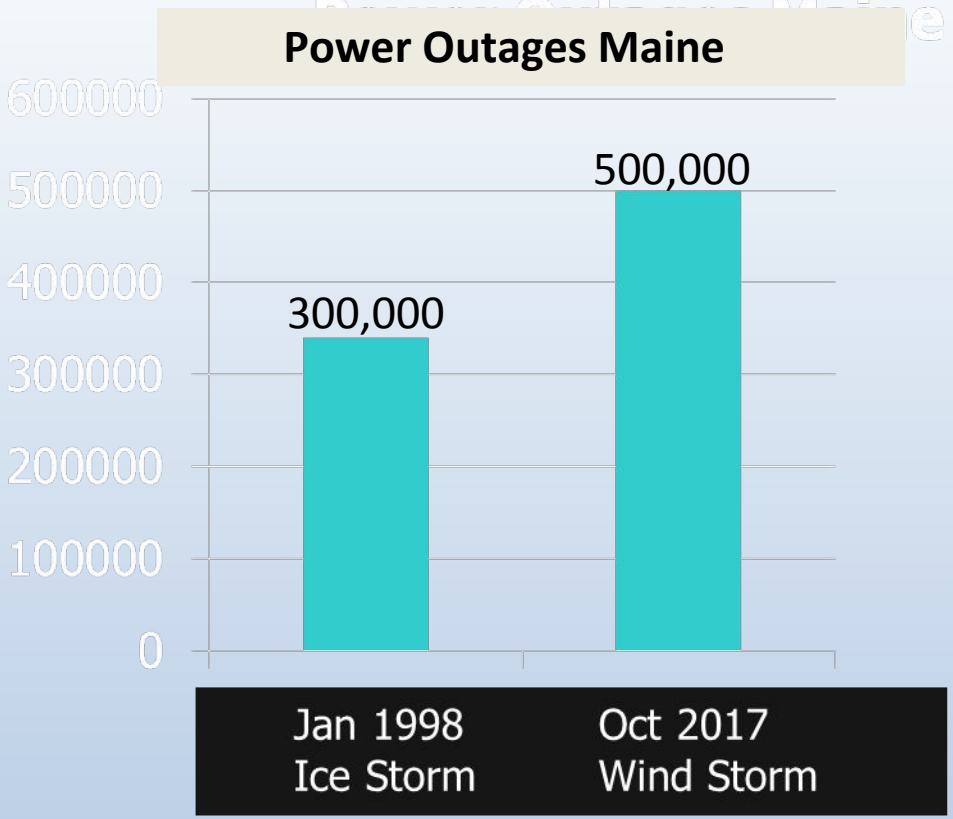
TOP 10 WARMEST		
RANK	AVERAGE	YEAR
1	56.4	2017
2	55.3	1947
3	54.5	2014
4	53.7	2007
5	52.9	2012
6	52.8	1968
7	52.5	1971
8	52.4	1990
9	52.3	1995
10	52.3	1963

NORMAL (1981-2010) 48.8

TOP 10 COLDEST		
RANK	AVERAGE	YEAR
1	43.5	1976
2	44.7	1974
3	45.1	1972
4	45.8	1958
5	45.9	1980
6	45.9	1945
7	46.2	1993
8	46.2	1960
9	46.5	1988
10	46.6	1999*

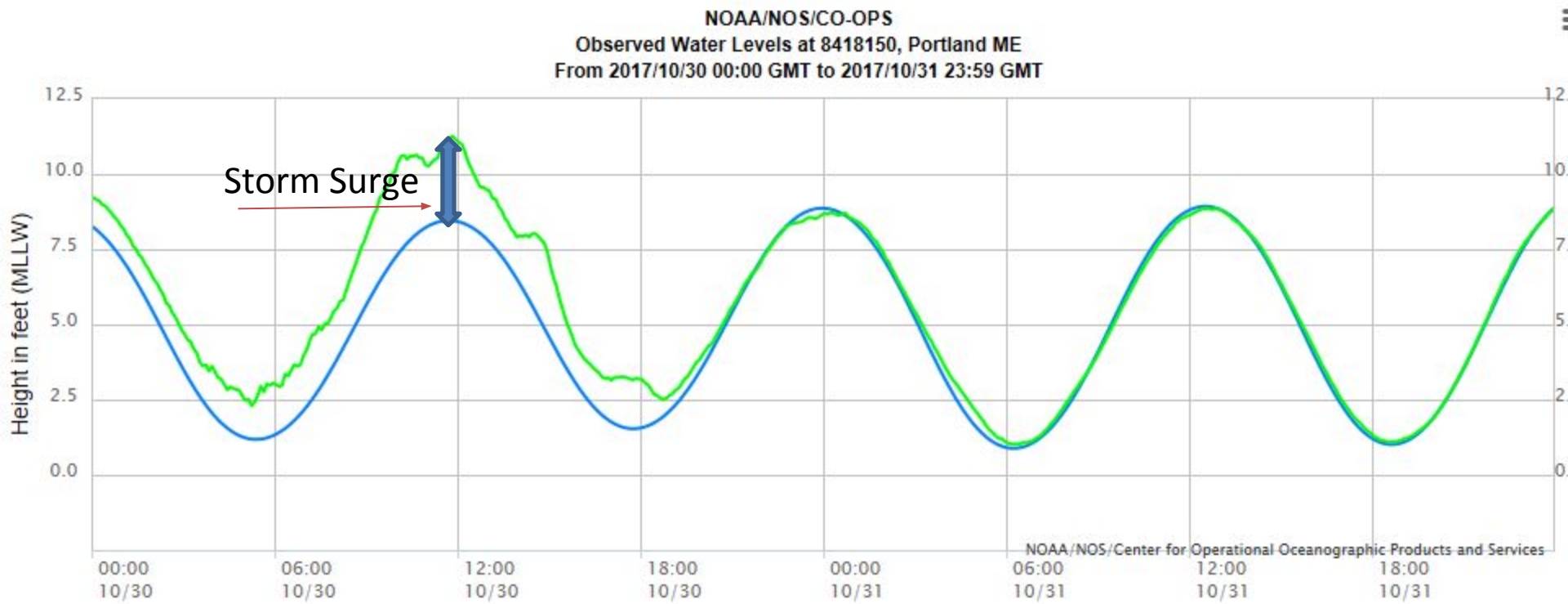
Records from November, 1940 to present


Maximum Wind Gusts
Valid: October 29-30, 2017
Speed (MPH)
140
90
70
60
50
40
35
30
Jackman 52
Eustis 49
Rangeley 51
Skowhegan 47
Berlin 55
Rumford 55
Waterville 49
Belfast 64
Whitefield 58
MWN 131
Augusta 60
Fryeburg 44
Lewiston 49
Rockland 68
Brunswick 60
Plymouth 46
44032 77
MISM1 92
Lebanon 39
Laconia 49
Portland 69
44007 70
Sanford 60
Concord 51
44030 74
Portsmouth 56
OSN3 82
Keene 35
Manchester 59
Jaffrey 38
Nashua 47
National Weather Service
Gray Maine
11/07/2017 01:58 PM EST
Follow Us:
weather.gov/Gray


Power Outages Maine
600000
500000
400000
300000
200000
100000
0
300,000
500,000
Jan 1998
Ice Storm
Oct 2017
Wind Storm


Warren, N.H.
Oct. 30
Tom Babbit

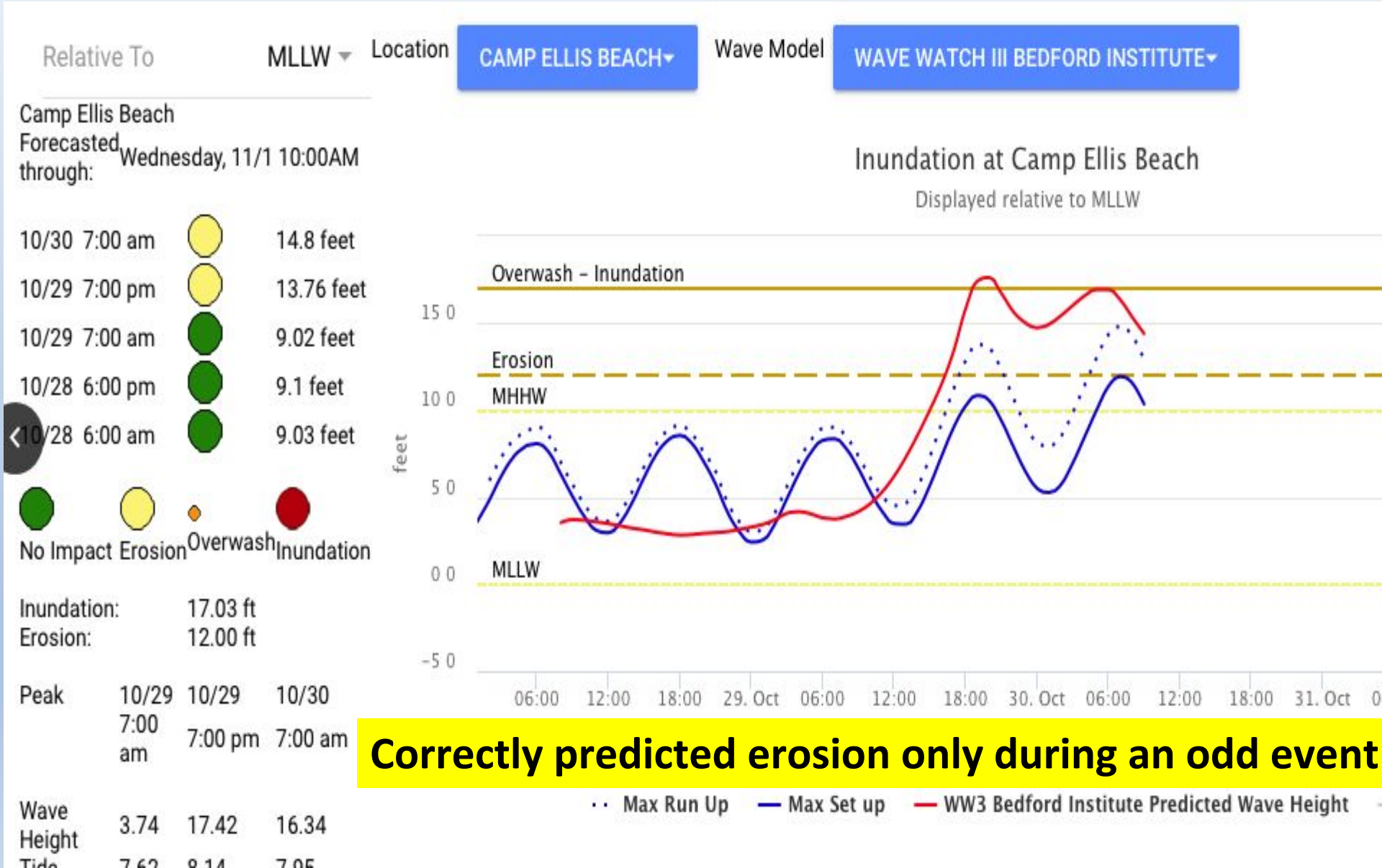
Storm Surge 2.81 feet/But low Astro tides



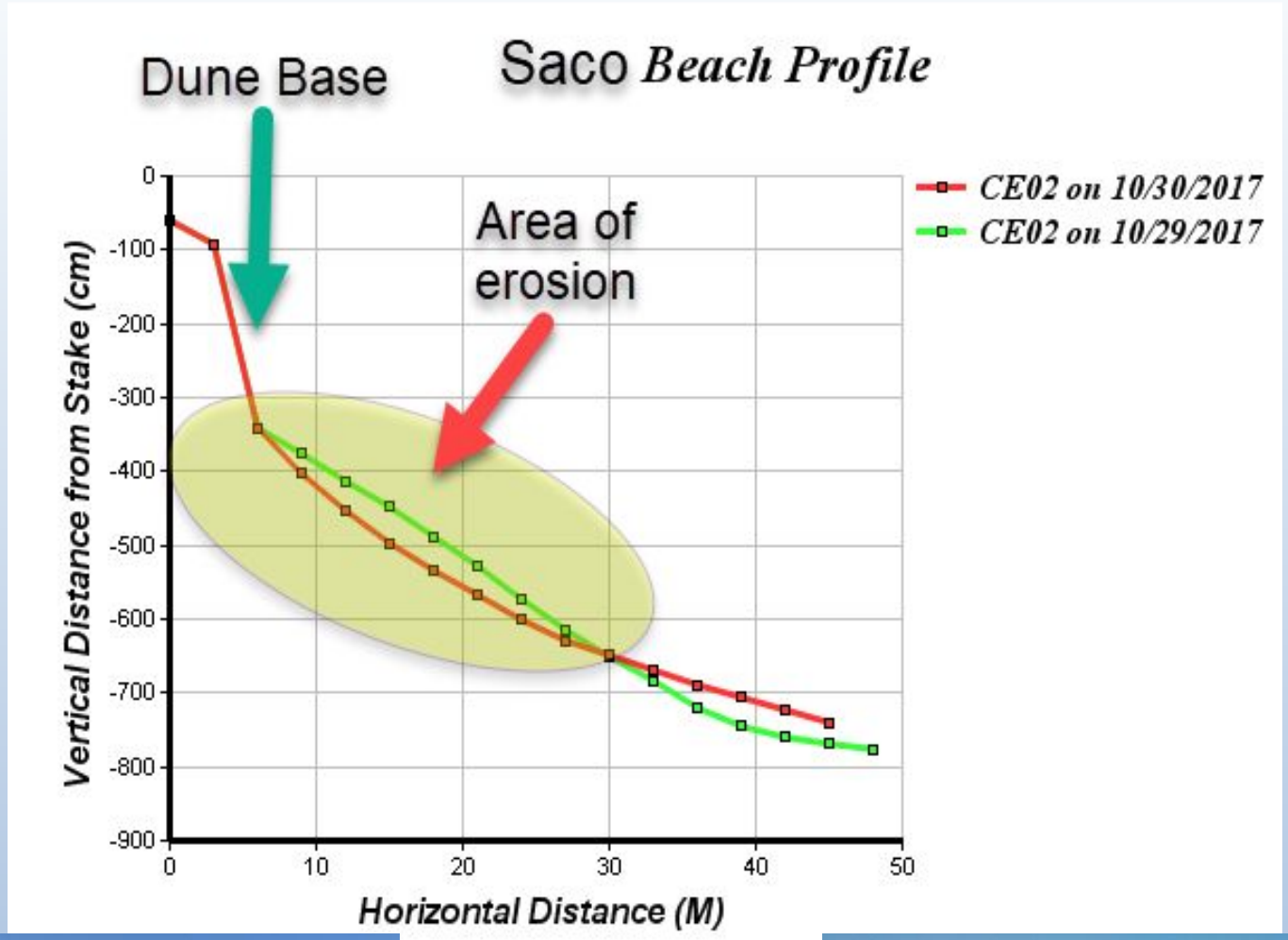
TOP 18 STORM SURGES AT PORTLAND (Reference Height MLLW: 1912-2018)

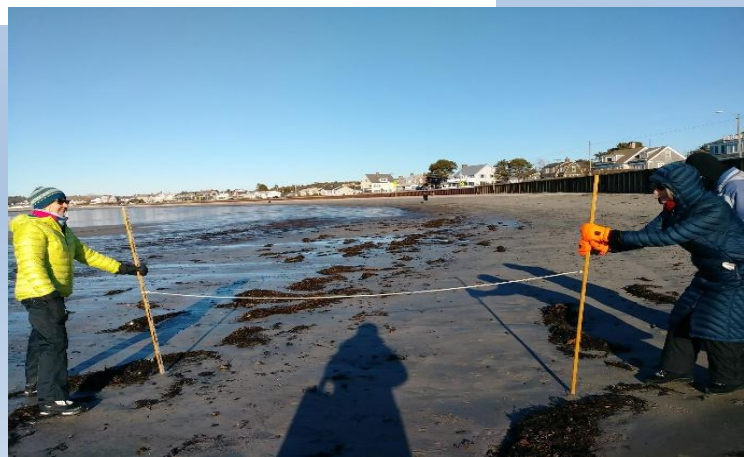
1. 4.3' – Mar 3, 1947
2. 4.1' – Mar 1, 1914
3. 3.9' - Dec 14, 1917
4. 3.6' – Feb 19, 1972
5. 3.5' – Nov 26, 1950
   3.5' – Feb 7, 1978 (Blizzard of 78')
   3.5' – Oct 30, 1991 (Perfect Storm)
8. 3.3' – Nov 30, 1945
   3.3' – Aug 31, 1954
10. 3.2' – Dec 2, 1942
11. 3.1' – Mar 16, 1956
12. 3.0' – Jan 15, 1940
    3.0' – Feb 7, 1951
14. 2.9' – Nov 13, 1925
15. 2.8' – Oct 30, 2017
    2.8' – Dec 9, 2009
17. 2.7' – Apr 16, 2007 (Patriot's Day Storm)
18. 2.7' – Feb 25, 2010

NERACOOS Wave Run-up Output



Correctly predicted erosion only during an odd event


Saco Beach Profile
Dune Base
Area of erosion
CE02 on 10/30/2017
CE02 on 10/29/2017
Vertical Distance from Stake (cm)
0
-100
-200
-300
-400
-500
-600
-700
-800
-900
0
10
20
30
40
50
Horizontal Distance (M)



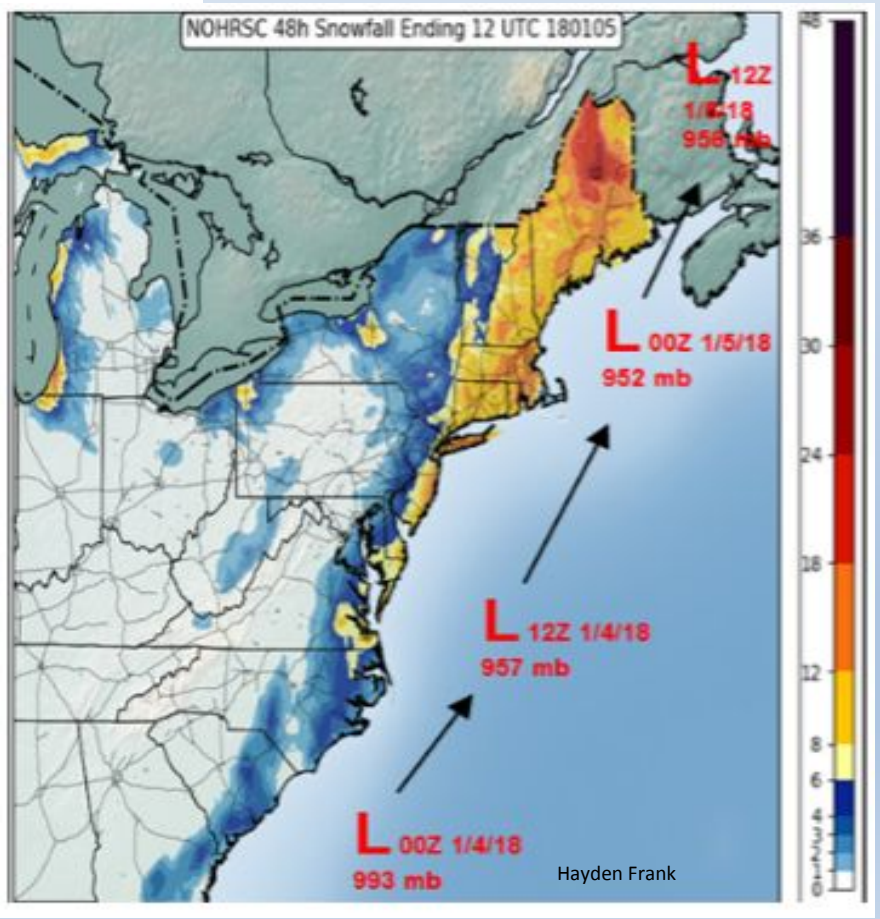
January 4, 2018

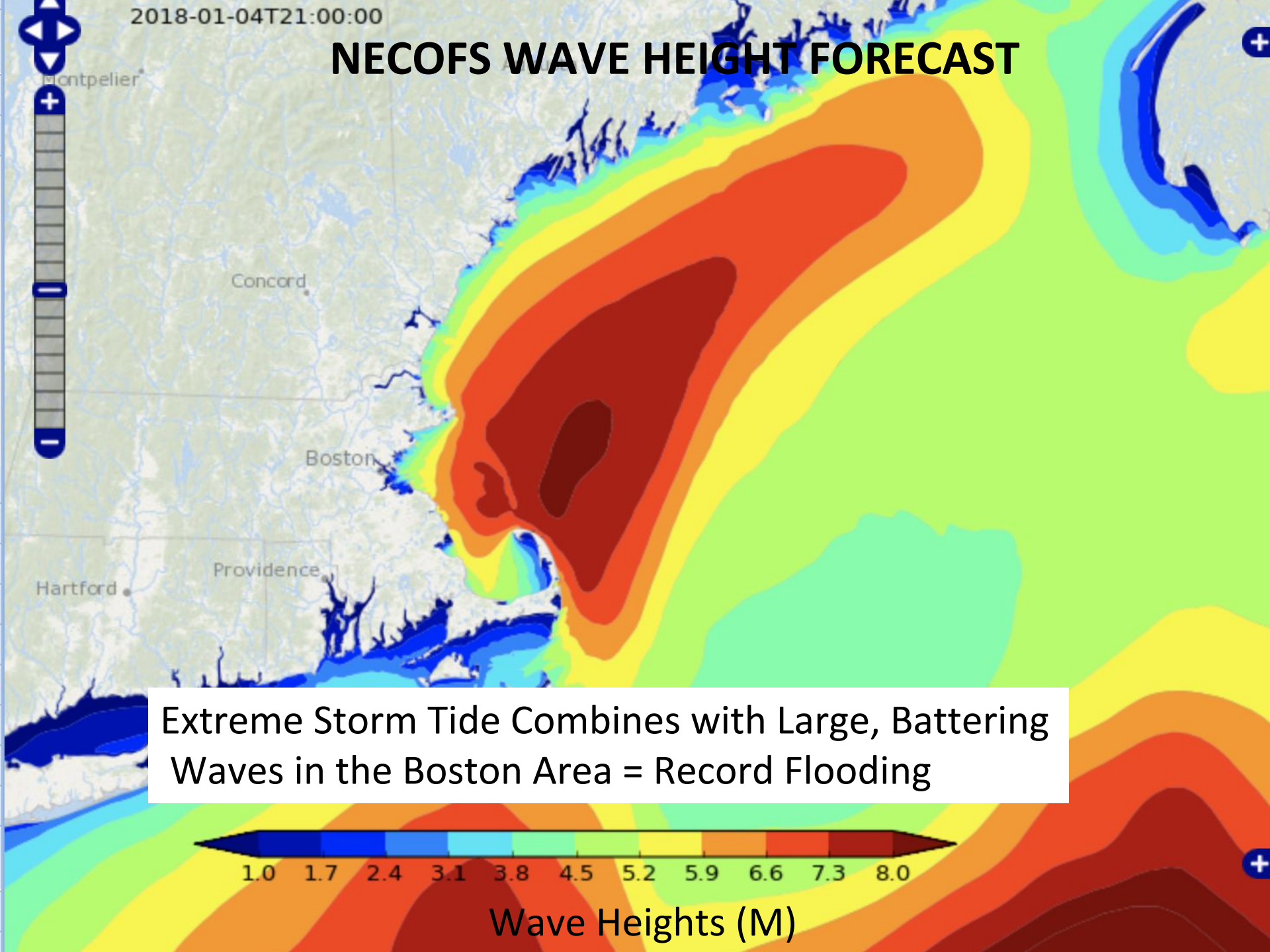
Near all-time Record High Storm Tide Event

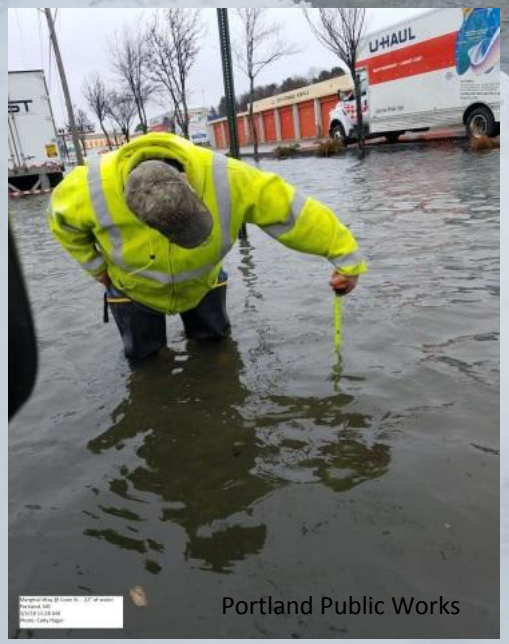
TOP 20+ STORM TIDES AT PORTLAND (Reference Height MLLW: 1912-2018)

1. 14.17' - Feb 7, 1978 (Blizzard Of "78")
2. 13.98' - Jan 9, 1978
3. 13.79' – Jan 4, 2018 (storm surge 2.23')
4. 13.40' - Dec 4, 1990
5. 13.31' – Mar 16, 1976
6. 13.29' – Nov 20, 1945
   13.29' – Nov 30, 1945
8. 13.28' – Apr 16, 2007 (Patriot's Day Storm)
9. 13.18' – Jan 2, 1987
   13.18' – Oct 30, 1991 (Perfect Storm)
11. 13.17' – Mar 2, 2018
12. 13.09' – Apr 7, 1978
    13.09' – Dec 29, 1959
    13.09' – Feb 19, 1972
15. 13.07' – Jan 28, 1979
16. 13.03' – Jun 3, 2012
17. 13.00' – Jun 4, 2012
18. 12.96' – May 25, 2017
19. 12.92' - Jan 2, 2010
20. 12.90' – Apr 17, 2007
21. 12.90' – Mar 3, 2018
22. 12.80' – Dec 3, 1986

"Bombogenesis"



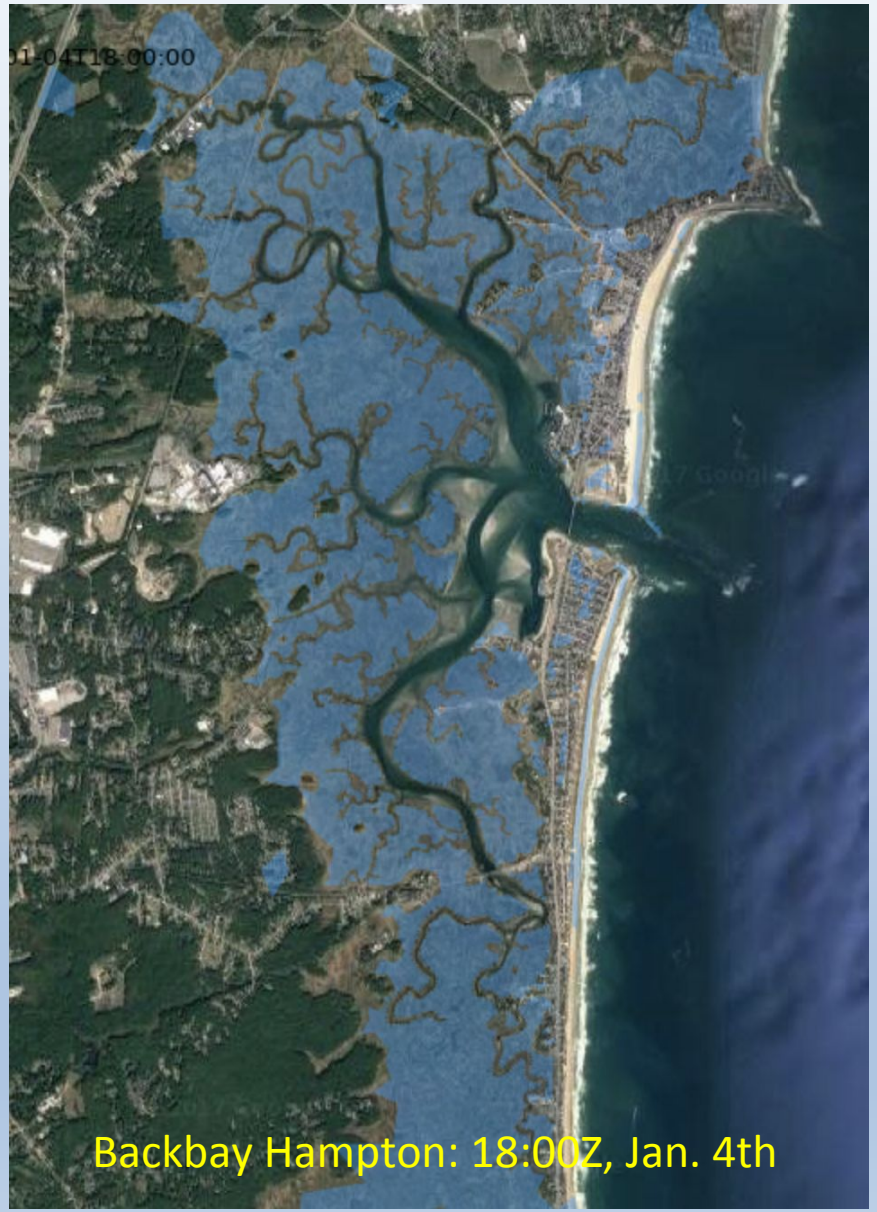

2018-01-04T21:00:00
NECOFS WAVE HEIGHT FORECAST
Montpelier
Concord
Boston
Providence
Hartford
Extreme Storm Tide Combines with Large, Battering Waves in the Boston Area = Record Flooding
1.0 1.7 2.4 3.1 3.8 4.5 5.2 5.9 6.6 7.3 8.0
Wave Heights (M)



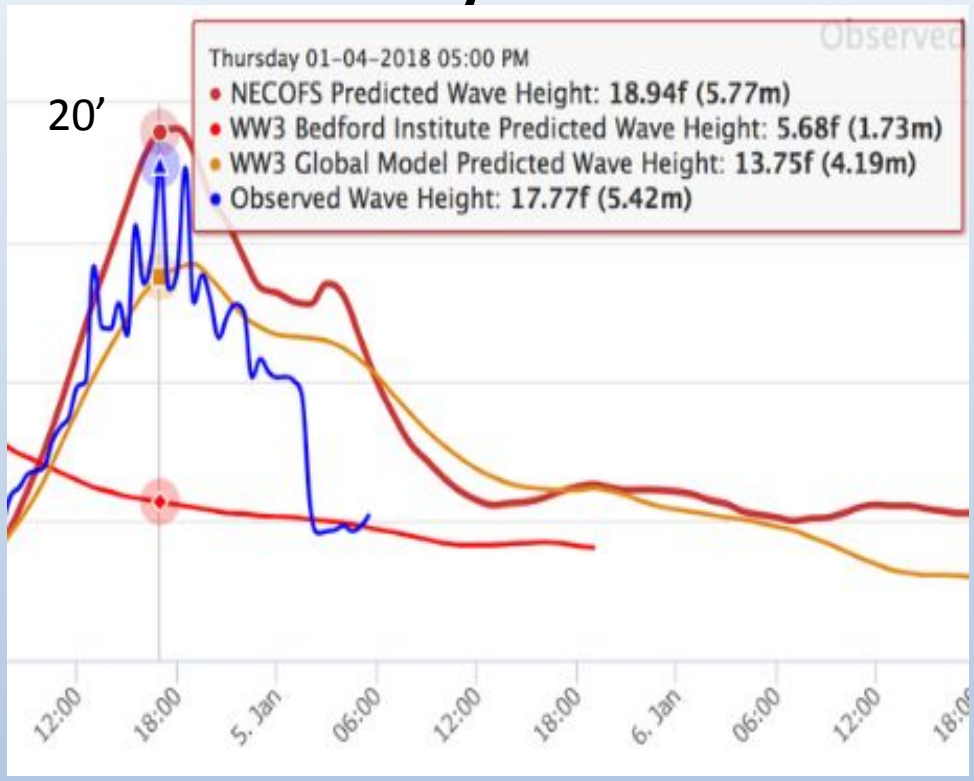
Portland Public Works

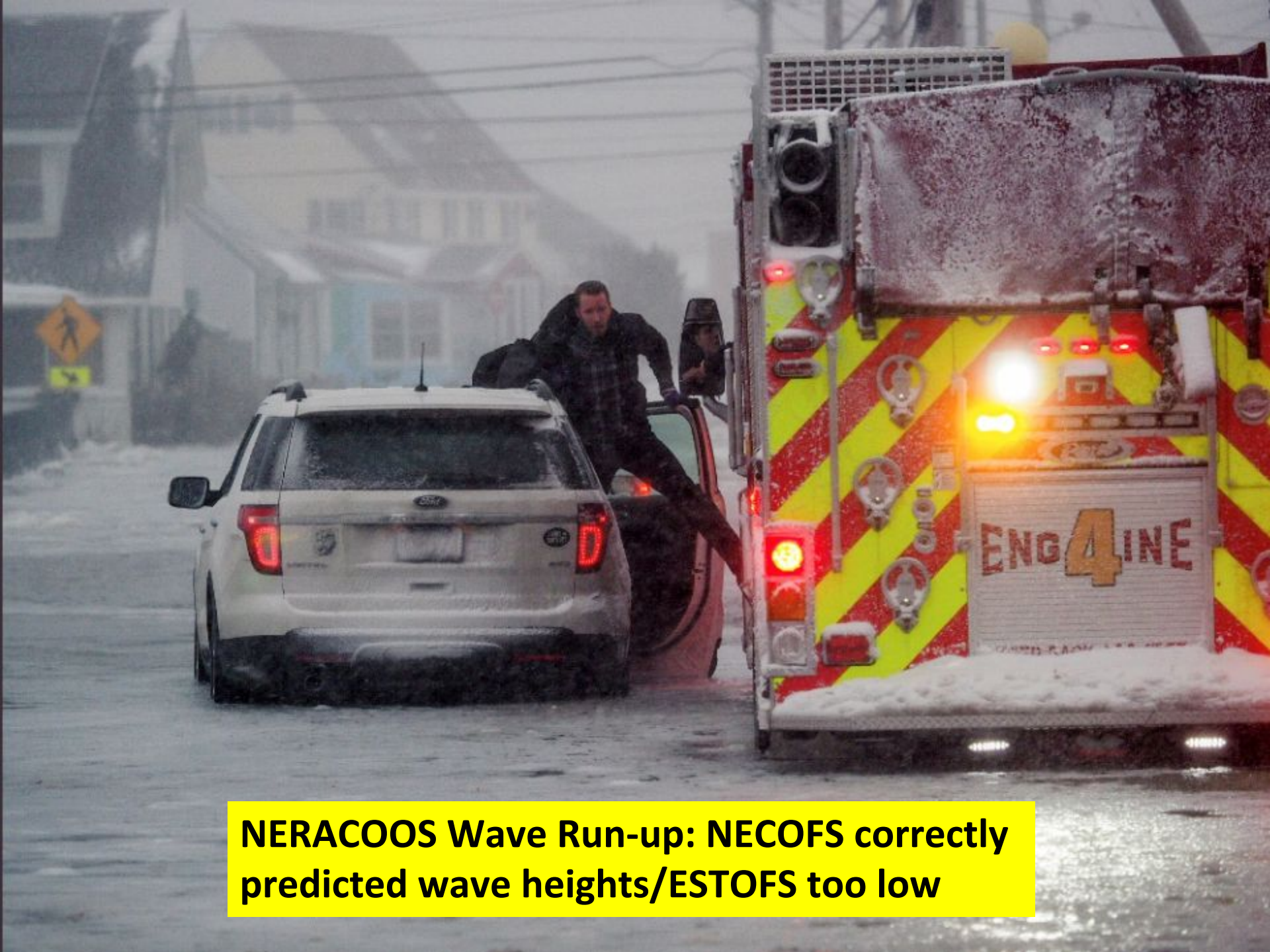
Photo by Tom Shyka, Portland ME

NECOFS Inundation Forecast



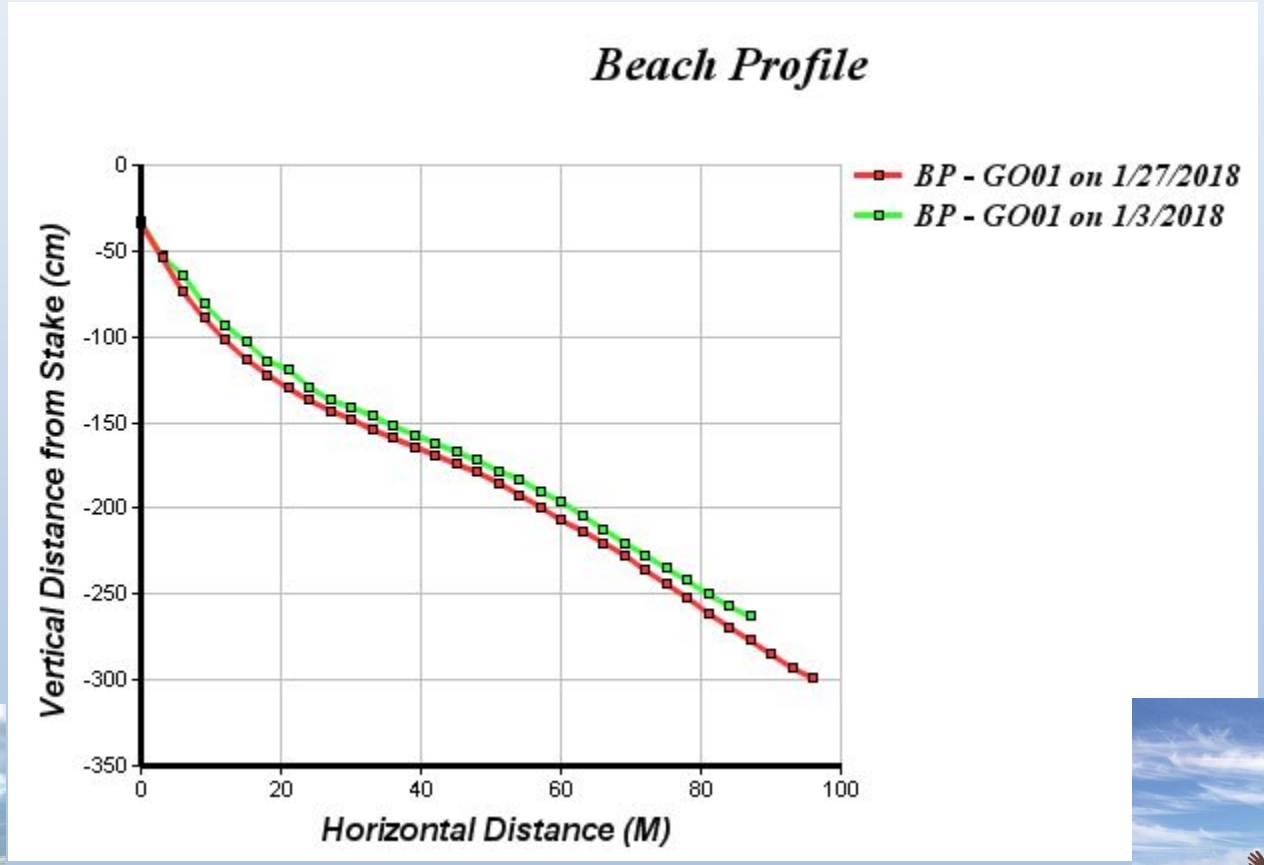
Buoy “B”





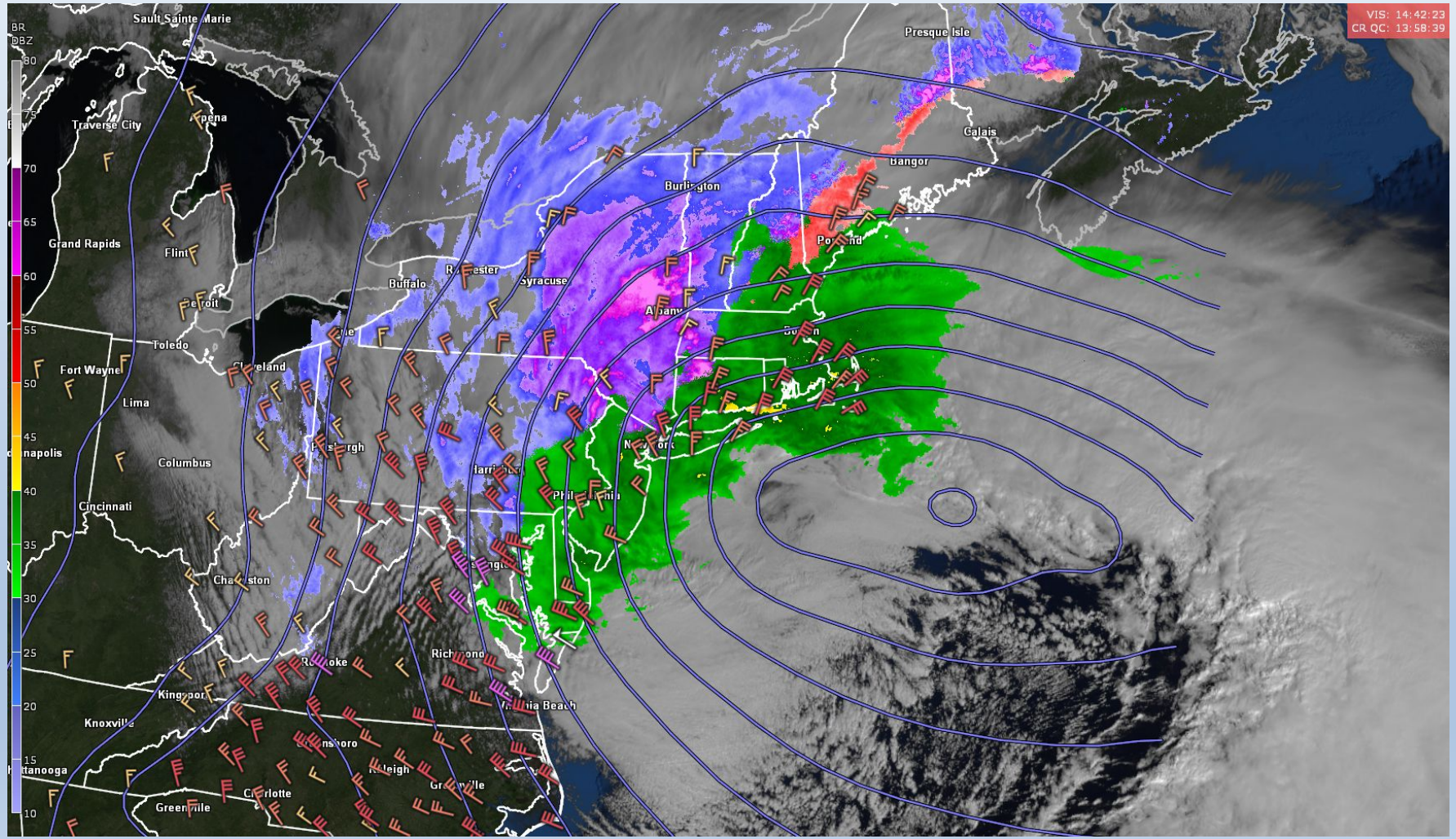
NERACOOS Wave Run-up: NECOFS correctly predicted wave heights/ESTOFS too low

Little Change to Beach Profiles

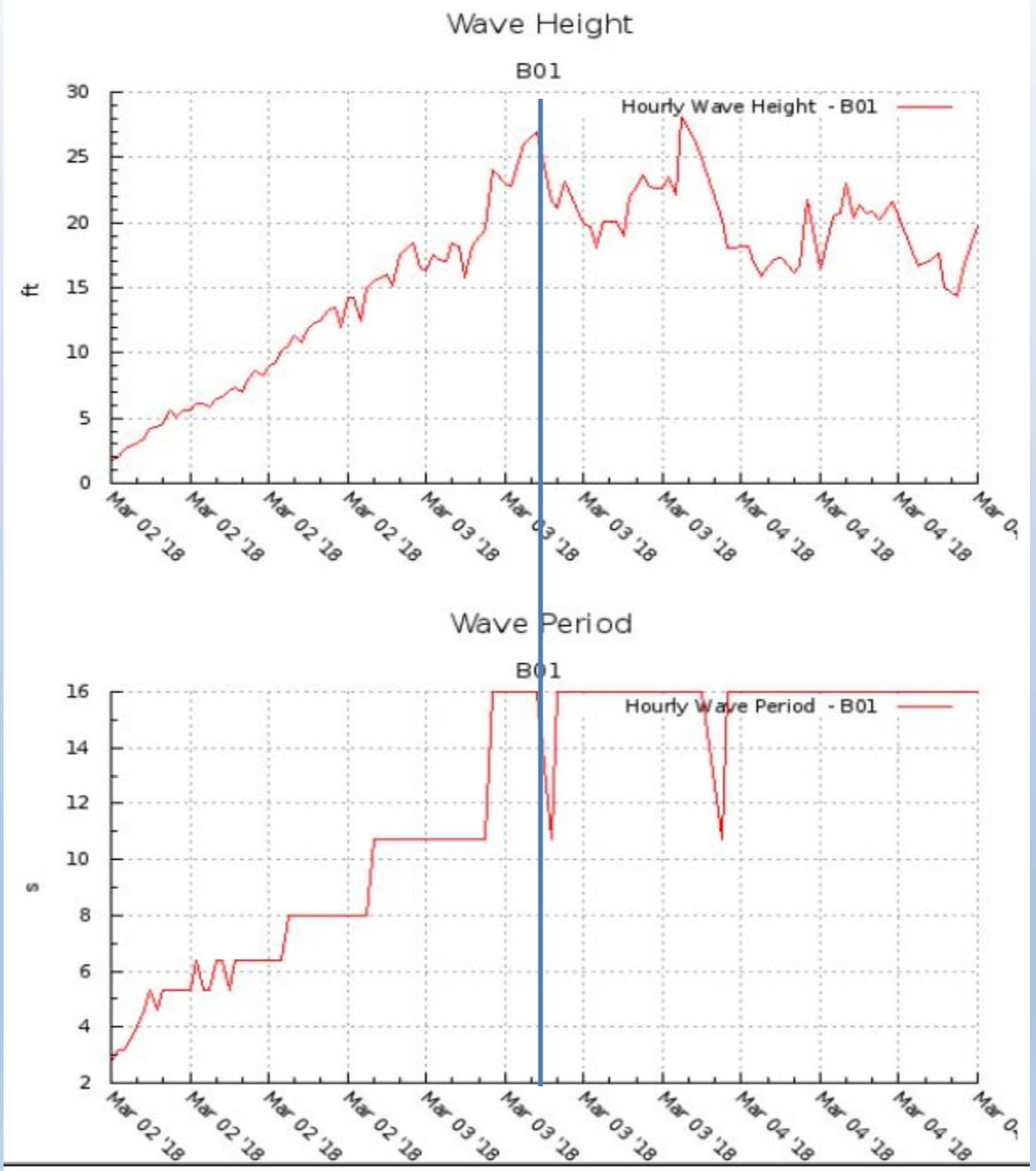


March 3, 2018

Extremely Large, Long Period Wave Event



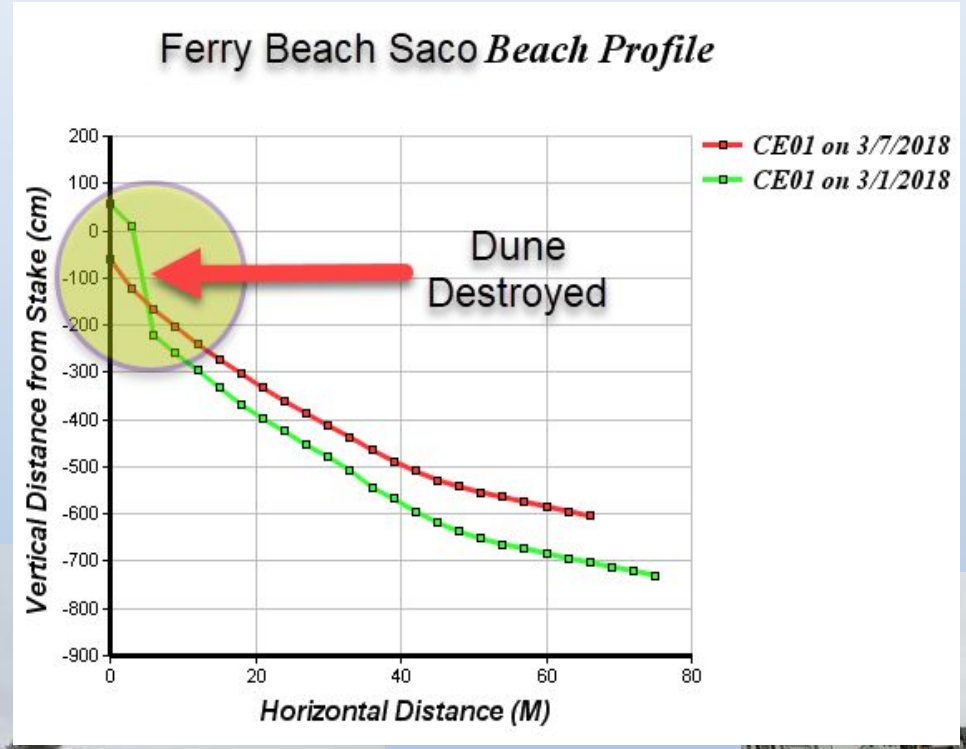
* This is the "<u>boulders are going into the road" tide</u> as reported by local EMA! Major dune erosion and structural damage over several tide cycles.




3000 years old


YORK POLICE DEPARTMENT/FACEBOOK
Revolutionary War

Ferry Beach "Storm Based" Dune Survey: March 1st Followed by March 7th



Before the storm

After the storm

NERACOOS Coastal Flooding Toolkit

Beach Erosion and Flooding Forecast

LOCATION: JENNESS BEACH

WAVE MODEL: WAVE WATCH III GLOBAL WAVE MODEL

Location: Jenness Beach

Inundation Threshold: 13.57 ft
Erosion Threshold: 11.10 ft

Forecast through: Thursday, 3/8 4:00AM

Date/Time	Impact	Max WL
3/2 12:00 pm		14 ft
3/3 12:00 am		14.14 ft
3/3 1:00 pm		13.55 ft
3/4 1:00 am		12.88 ft
3/4 1:00 pm		12.44 ft
3/5 1:00 am		12.16 ft

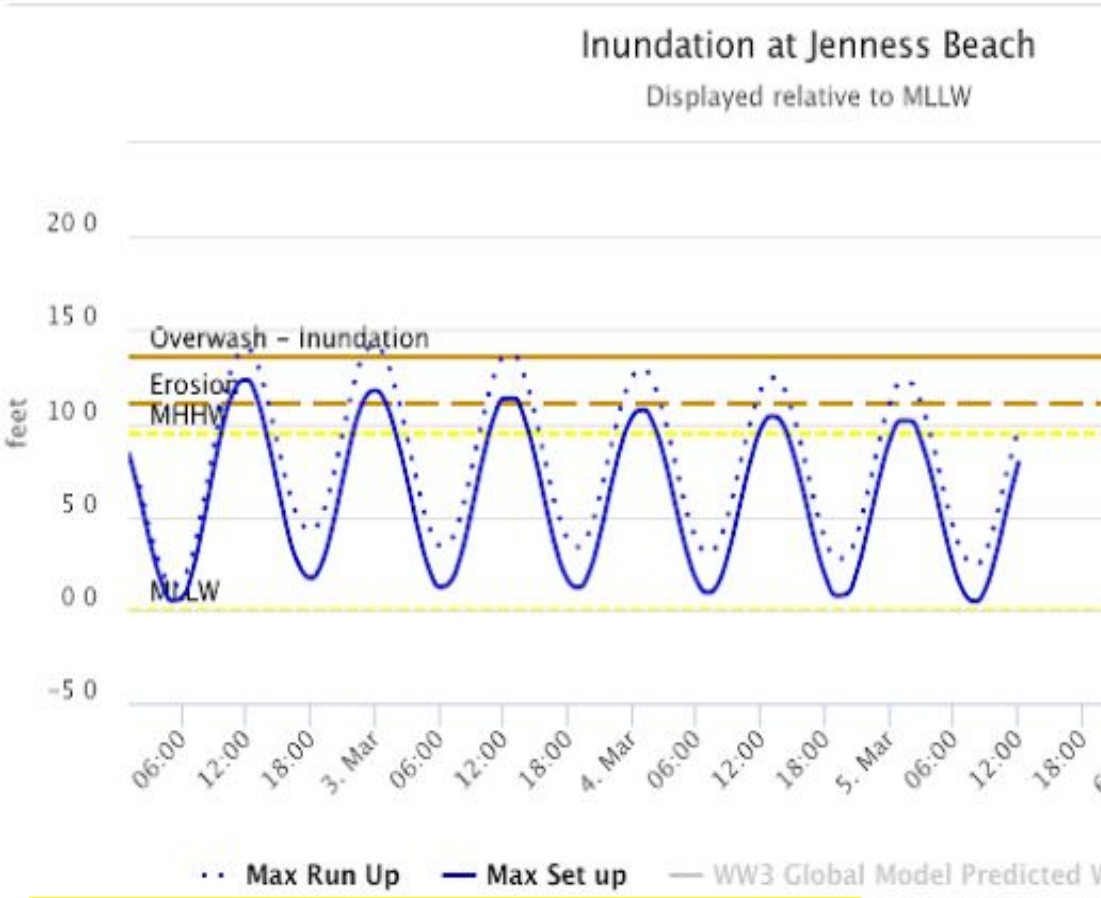
Impact Marker Key

No Impact | Erosion | Overwash | Inundation

Peak Forecast - Last 3 High Tides

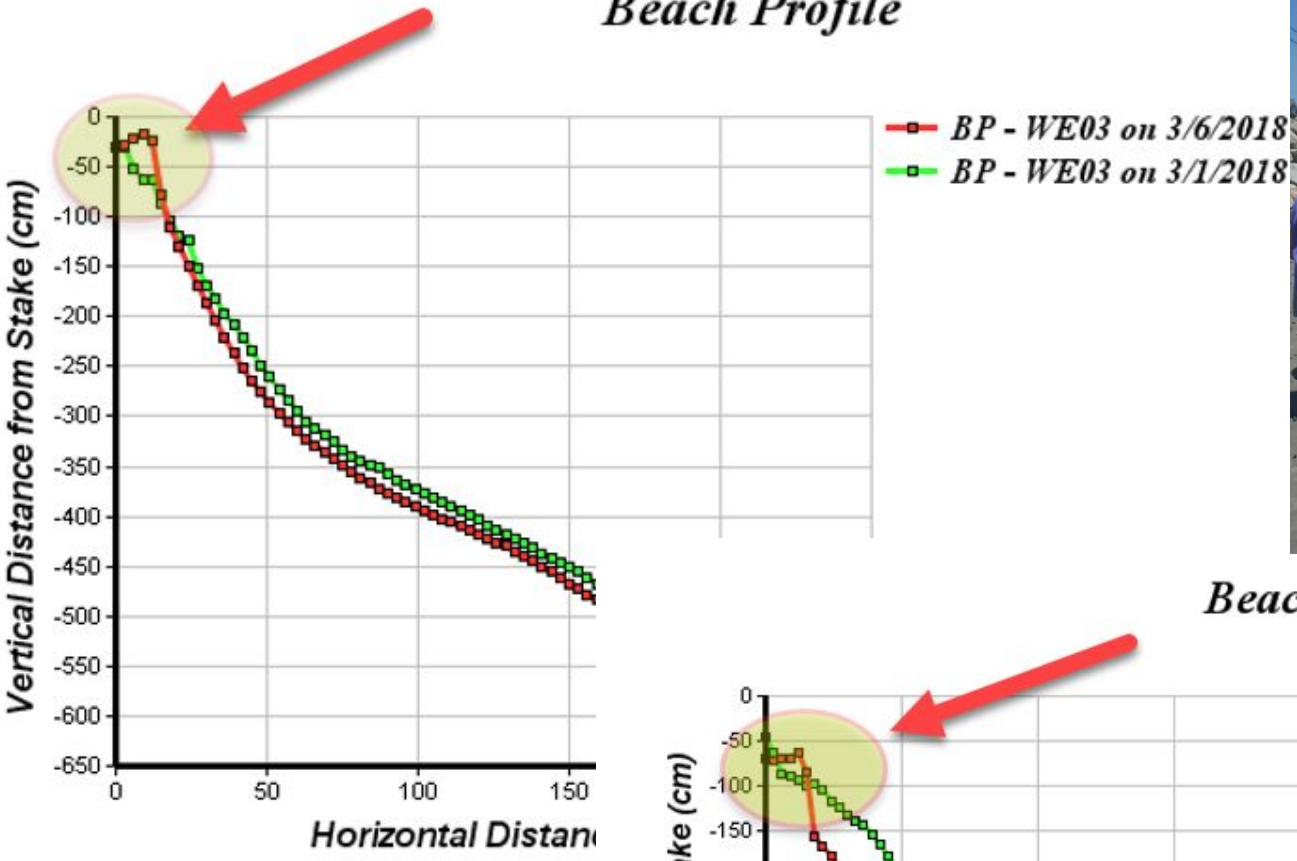
Date/ Time	3/4 1:00 am	3/4 1:00 pm	3/5 1:00 am

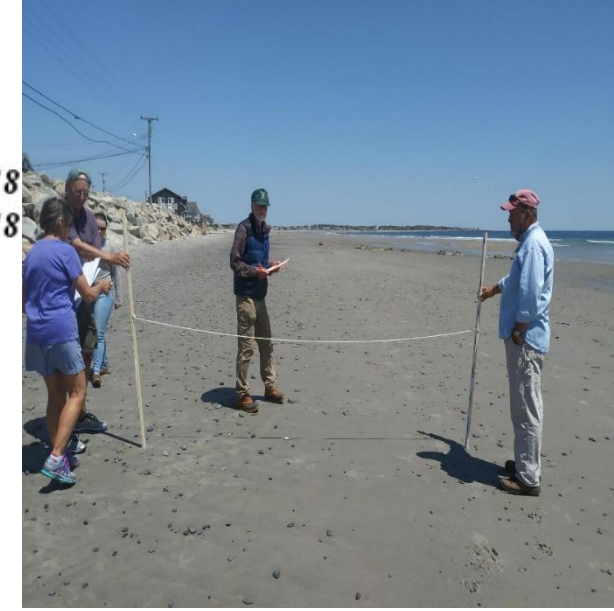
Relative To

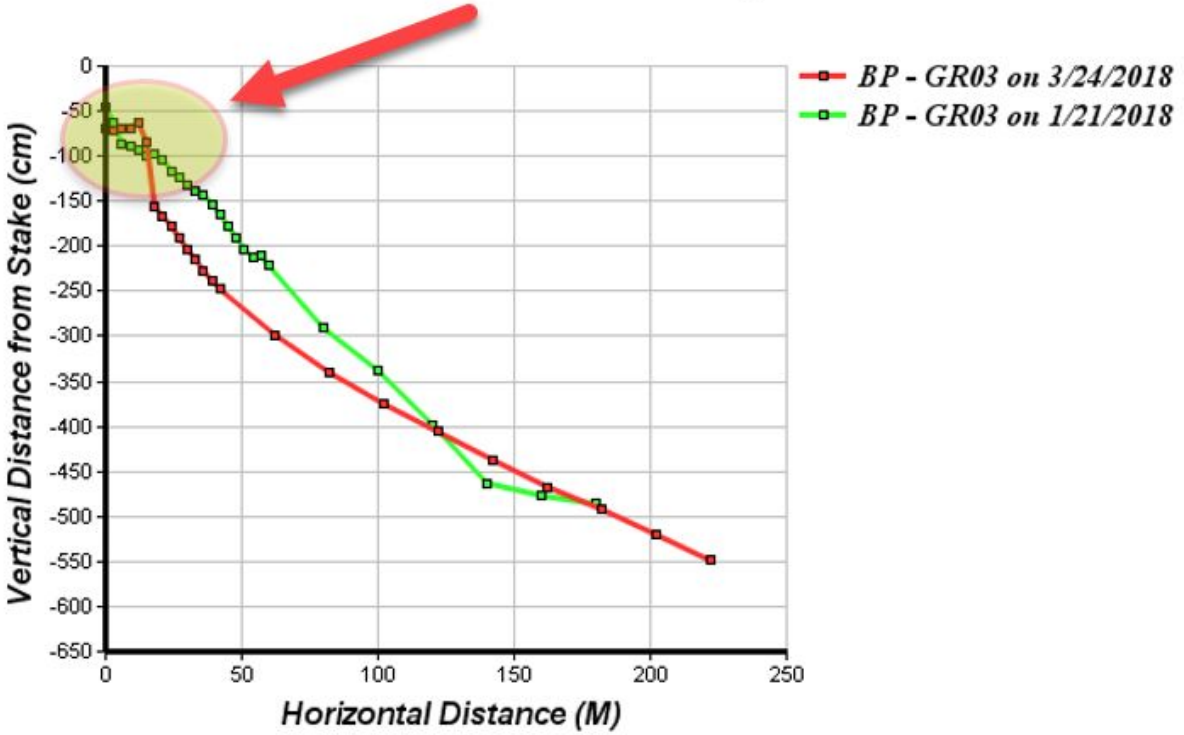


Correctly predicted repeated erosion over many tide cycles

Landward Deposition of Sediment Associated With Long Period Waves


Beach Profile
BP - WE03 on 3/6/2018
BP - WE03 on 3/1/2018
Vertical Distance from Stake (cm)
0
-50
-100
-150
-200
-250
-300
-350
-400
-450
-500
-550
-600
-650
0
50
100
150
Horizontal Distanc




Beach Profile
BP - GR03 on 3/24/2018
BP - GR03 on 1/21/2018
Vertical Distance from Stake (cm)
0
-50
-100
-150
-200
-250
-300
-350
-400
-450
-500
-550
-600
-650
0
50
100
150
200
250
Horizontal Distance (M)

NERACOOS Wave Runup Output Performance

- Your products elicit storm responses! Performed very well!
- Future goal: NERACOOS wave run-up “alerts” are automatically *<u>pushed</u>* via e-mail to NWS Situational Awareness Operations PCs when criteria are met!

Thank You Beach Profilers!!!