TECHNICAL NOTE:

CDIP wave observations in Superstorm Sandy

By

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Tropical Storm Sandy passed slowly along the eastern coast of the United States during the interval from 24 October to 31 October 2012. Extreme damage from this storm can be attributed, in part, to the coincident arrival of the storm surge with the highest tides of the month. Of greater importance is the unusually large diameter of the storm that resulted in long fetch lengths (the distance over which the wind was building the wave field) and that generated extreme wave heights. A complete record of these waves was acquired by the Coastal Data Information Program (CDIP). CDIP is an extensive network for monitoring waves along the coastlines of the United States that is funded by the U.S. Army Corps of Engineers (USACE) and, for certain sites, cost-shared with the U.S. Navy and the U.S. Integrated Ocean Observing System (IOOS). During the passage of the storm from Puerto Rico to offshore New England, the wave field it generated was measured by a series of Datawell Waverider buoys in the CDIP system at the locations shown in Figure 1. These 13 buoys cover a north-south distance of almost 1,700 miles. Each of the buoys reports its observations through periodic transmissions via satellite of 30-minute records of wave height and direction. The data streams provided by this data transmission system are converted into a variety of standardized data products by the CDIP organization at the Scripps Institution of Oceanography at the University of California, San Diego. These data are available in near-real time at http://cdip.ucsd.edu.

The total independence of this wave data gathering system from power outages made possible the remarkable performance of capturing all of this huge and violent storm. Using the traditional measure of wave intensity, H_s (significant wave height, defined as the average height of the one-third highest waves in a given interval of time — in this case, approximately 27 minutes), the evolution of the storm wave height at each of the 13 buoy locations is shown plotted against EDT in Figure 2. One surprising result of this display is that the growth of Sandy during its northern travel during the last week in October resulted in peaks in the wave height measured in the Gulf of Mexico (St. Petersburg on 29 October) and the eastern Caribbean (Rincon on 30 October) that occur on or after the date of the wave energy peak in New England (Jeffreys Ledge on 29 October).

Because of the unusually energetic waves developed by Sandy, it is interesting to determine the highest wave in each of the buoy records. These values for the 13 locations are shown in Table 1. It is interesting to note that there is not a strong correlation between these maximum wave heights and the H_s values in Figure 2. The largest single wave that was recorded by this array of buoys was at the Block Island, RI, site and was equivalent to the height of a five-story building. Oceanographers have traditionally argued about whether the height of the wave was the vertical distance between the trough that preceded the crest or the trough that followed it. In this data set, the height from the crest to the preceding trough yielded the higher value in ten of the 13 records. The three exceptions occurred at locations with midrange maxima. In the case of the Block Island maximum, measuring from the following trough would have reduced the height by approximately 0.9m. The leading trough to crest method is used by default in CDIP data products.

Table 1.

Maximum recorded wave heights during Sandy with time of occurrence. Significant wave height, peak period, and peak direction are also shown.

Station name	EDT hr DD-HH	Hs (m)	Tp (s)	Dp (degT)	Hmax (m)
Rincon, Puerto Rico	30-08	3.58	12.5	333	7.03
St. Petersburg (offshore), FL	29-10	3.56	9.1	323	6.85
Fort Pierce, FL	26-19	5.53	12.5	73	8.61
Cape Canaveral (nearshore), FL	26-12	2.96	15.4	115	3.88
Fernandina Beach, FL	26-18	3.48	14.3	126	5.83
Masonboro Inlet, ILM2, NC	27-20	3.40	13.3	113	6.16
New River Inlet, NC	27-07	2.69	13.3	144	4.43
Oregon Inlet, NC	28-18	7.90	14.3	82	13.41
Duck FRF 26m, NC	28-16	7.60	13.3	94	13.55
Cape Henry, VA	29-02	4.84	14.3	89	8.02
Cape Charles, VA	29-02	4.58	14.3	97	7.59
Block Island, RI	29-18	9.48	14.3	164	14.35
Jeffreys Ledge, NH	29-20	7.63	11.1	95	11.58

EDT hr: Eastern Daylight Time day and hour in October 2012 of the maximum H_s
Hs: Largest recorded significant wave height
Tp: Peak period corresponding to the given H_s
Dp: Peak direction (wave-from direction) for the given H_s
Hmax: Largest recorded trough-to-crest wave height

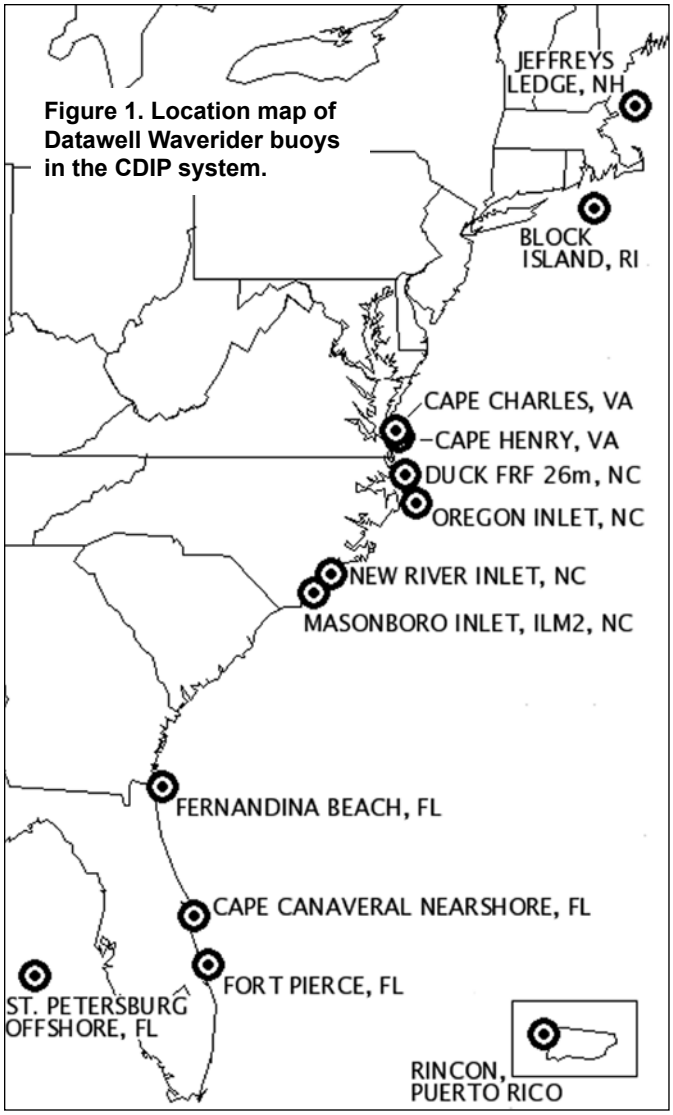
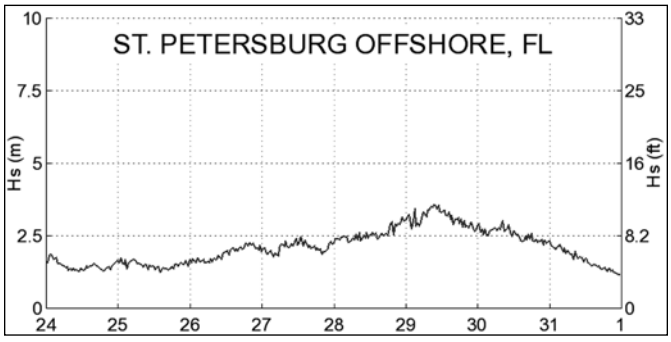
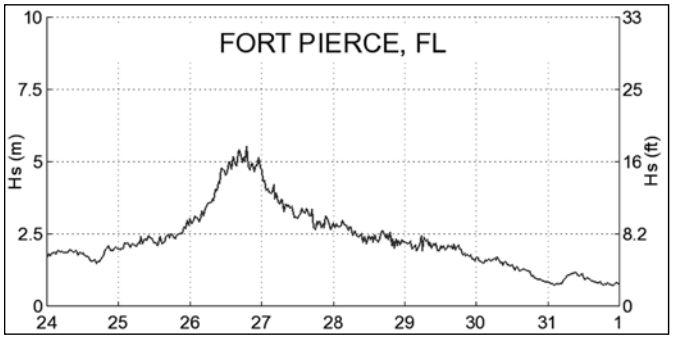
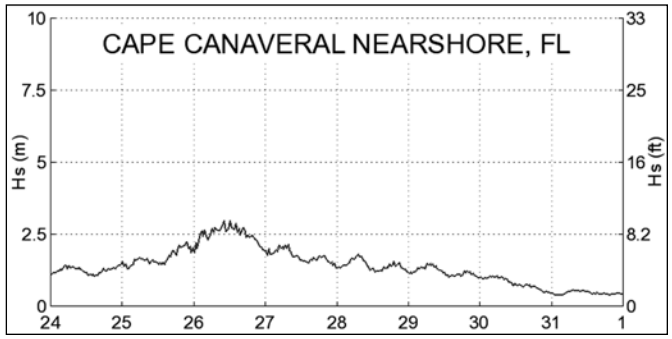


Figure 1. Location map of Datawell Waverider buoys in the CDIP system.







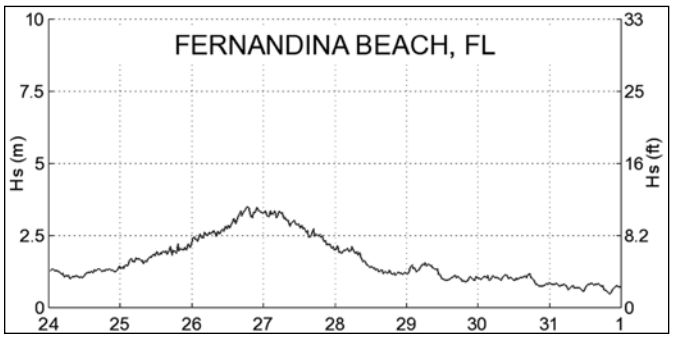
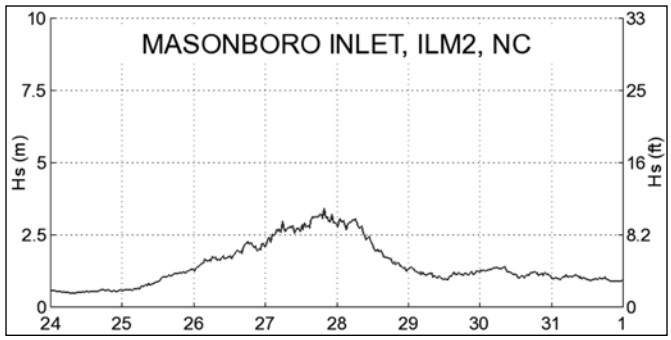
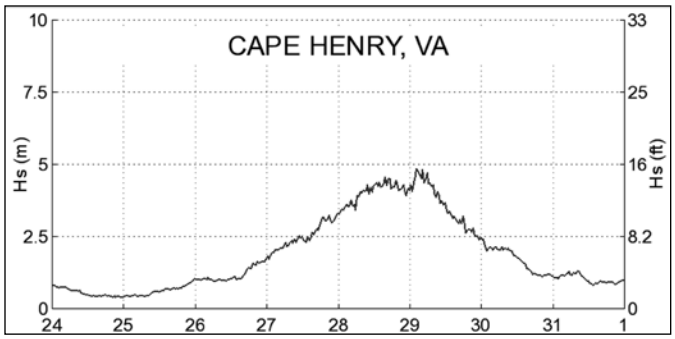
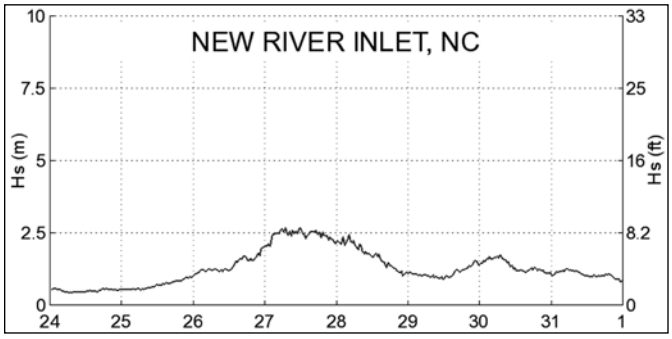
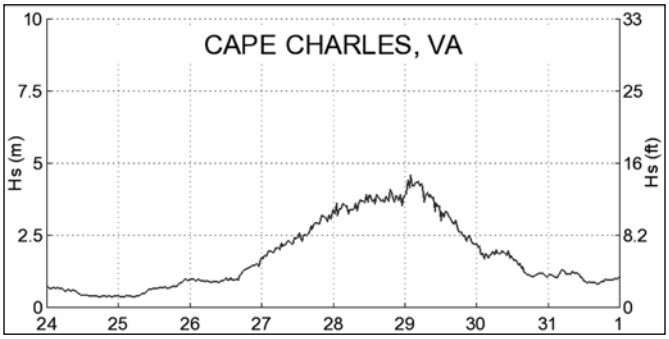


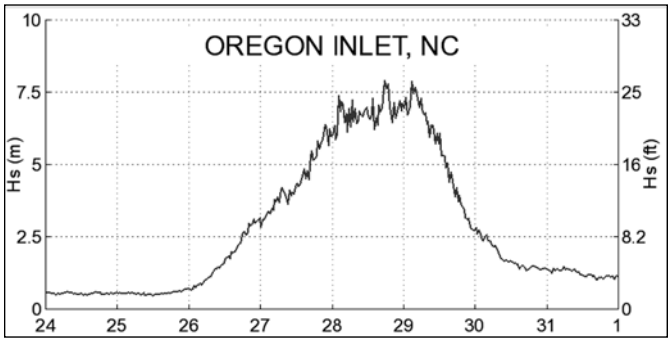
Figure 2 (left, above, and opposite page). Evolution of storm wave height at each of the 13 buoy locations 24-31 October 2012, plotted against EDT.

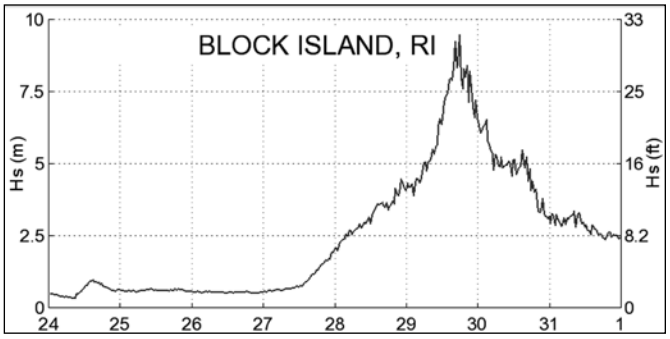

MASONBORO INLET, ILM2, NC
Hs (m)
Hs (ft)
10
7.5
5
2.5
0
33
25
16
8.2
0
24 25 26 27 28 29 30 31 1

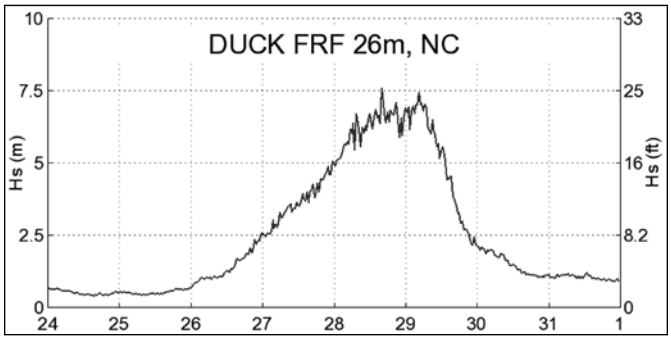

CAPE HENRY, VA
Hs (m)
Hs (ft)
10
7.5
5
2.5
0
33
25
16
8.2
0
24 25 26 27 28 29 30 31 1

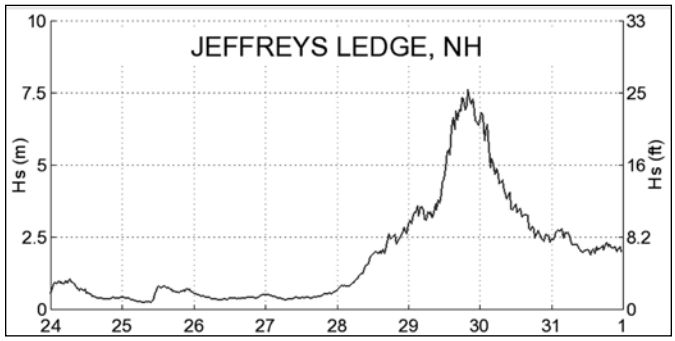

NEW RIVER INLET, NC
Hs (m)
Hs (ft)
10
7.5
5
2.5
0
33
25
16
8.2
0
24 25 26 27 28 29 30 31 1


CAPE CHARLES, VA
Hs (m)
Hs (ft)
10
7.5
5
2.5
0
33
25
16
8.2
0
24 25 26 27 28 29 30 31 1


OREGON INLET, NC
Hs (m)
Hs (ft)
10
7.5
5
2.5
0
33
25
16
8.2
0
24 25 26 27 28 29 30 31 1


BLOCK ISLAND, RI
Hs (m)
Hs (ft)
10
7.5
5
2.5
0
33
25
16
8.2
0
24 25 26 27 28 29 30 31 1


DUCK FRF 26m, NC
Hs (m)
Hs (ft)
10
7.5
5
2.5
0
33
25
16
8.2
0
24 25 26 27 28 29 30 31 1


JEFFREYS LEDGE, NH
Hs (m)
Hs (ft)
10
7.5
5
2.5
0
33
25
16
8.2
0
24 25 26 27 28 29 30 31 1