Examination of Buoy 41009 Wave Data for Three Highly Erosive Hurricanes in east Central Florida—Sandy, Frances and Floyd

Introduction

The long duration of high surf caused by Hurricane Sandy in October 2012 produced severe beach erosion along some east central Florida beaches. This study examines wave data at buoy 41009 for this event along with two other hurricanes that produced significant erosion, Floyd and Frances.

Jensen Beach, Florida

Before Hurricane Sandy
10/21/12

After Hurricane Sandy
10/30/12

Analysis

Based on past events, the threshold for High Surf Advisories along east central Florida beaches is a wave height of 10 feet at buoy 41009. Fig. 1 shows a period over 72 hours (seven high tides) with wave heights above that threshold during Hurricane Sandy.

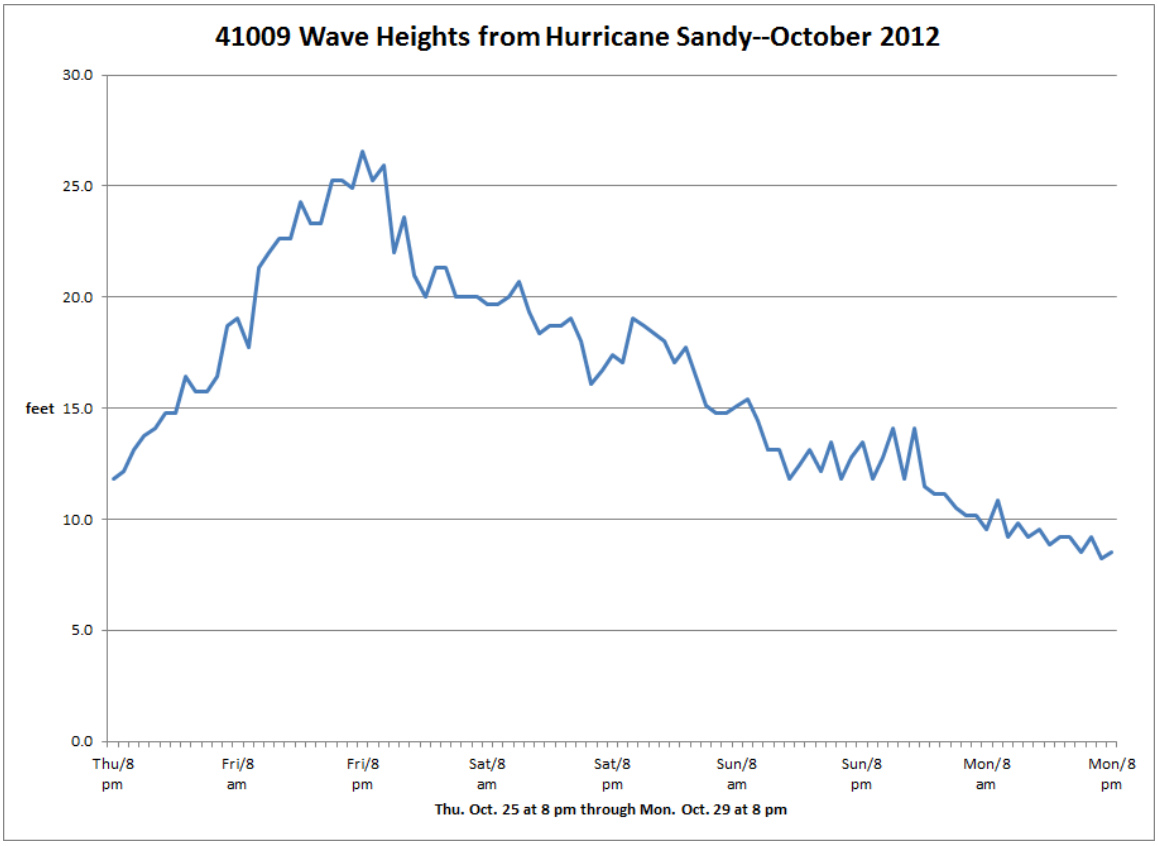

Fig. 1. Buoy 41009 wave heights during Hurricane Sandy.

However, wave height alone is not the best indicator of how much potential damage the surf will do to the beaches. For a given wave height, longer period waves will have more energy than shorter period waves.

Wave energy data for buoy 41009 has been available since 1996. Many erosion events have been analyzed and this study will compare Sandy's wave energy (Fig.2) to Hurricane Floyd (September 1999) and Hurricane Frances (September 2004).

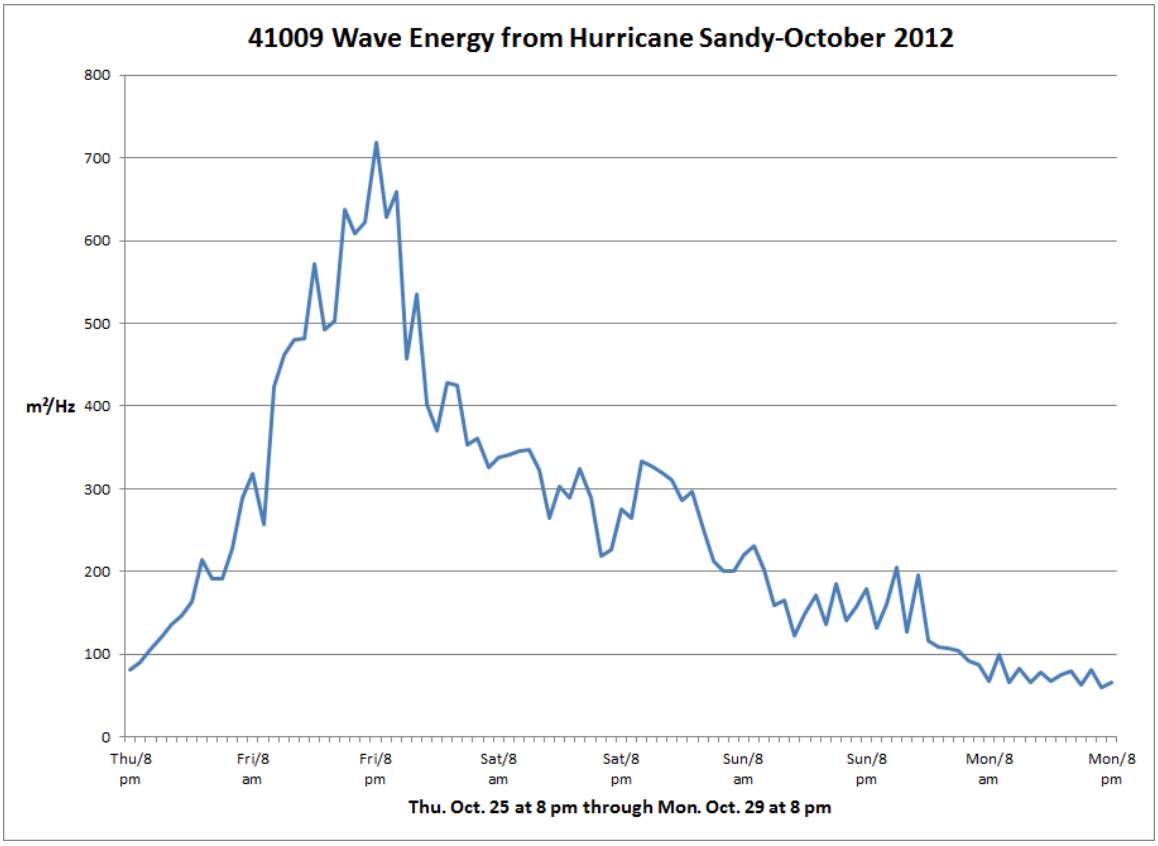

Fig. 2. Buoy 41009 peak wave energy (m²/Hz) during Hurricane Sandy.

Sandy was a strong Tropical Storm to Category 1 hurricane as it moved northward about 200 miles offshore east central Florida. The dominant wave periods during Hurricane Sandy were in the 12-16 second range. The computed wave energy was very high, with a peak of 717 m²/Hz. To put this value into proper context, the wave energy was computed for Hurricanes Floyd and Frances (Fig.3).

Frances was a category two hurricane as it moved slowly into the Treasure Coast. The peak wave energy was 636 m²/Hz. Though this value is lower than Sandy's wave energy, buoy 41009 went adrift during Frances, so the peak wave energy may have actually been higher.

Hurricane Floyd was Category 3 hurricane as the center passed 100-150 miles offshore east central Florida. This path was actually slightly closer to the east central Florida coast compared to Sandy, but its forward motion was a little faster. Therefore, the peak wave energy during Floyd was less, 599m m²/Hz.

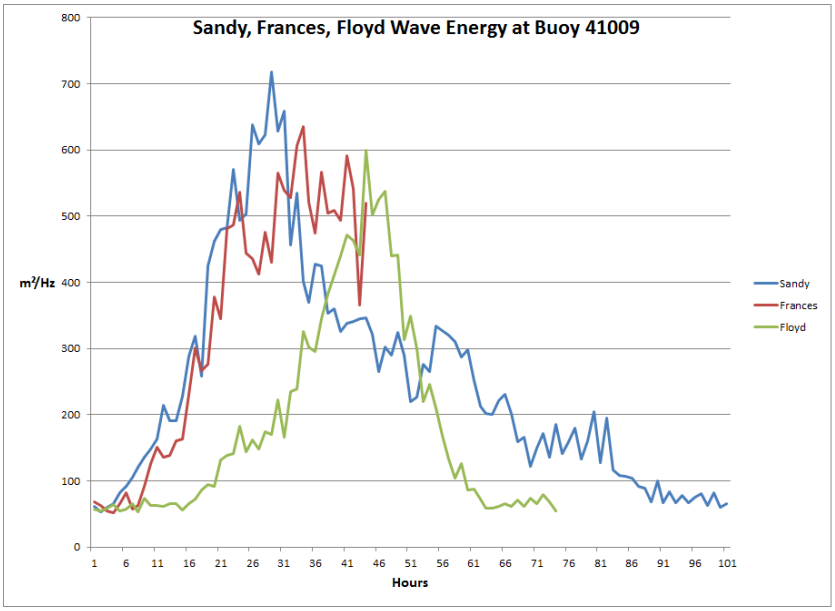

Fig. 3. Comparison of Buoy 41009 wave energy during three hurricanes which impacted east central Florida—Hurricane Floyd in 1999, Hurricane Frances in 2004 and Hurricane Sandy in 2012.

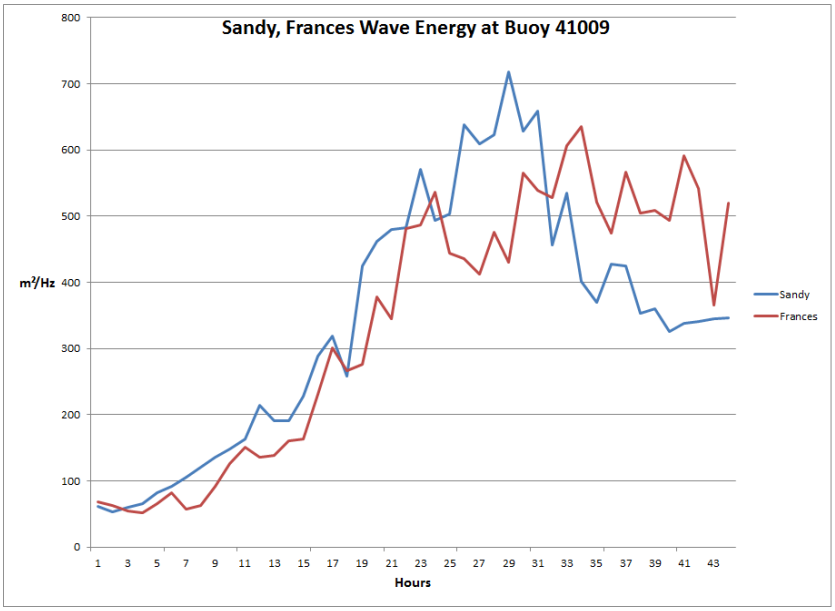

Fig 4. Comparison of Buoy 41009 wave energy during Hurricane Sandy and Hurricane Frances. Wave energy from Frances was similar to Sandy until the buoy failed.

Discussion

After Frances, Category three hurricane Jeanne followed a similar track three weeks later. Since Buoy 41009 went adrift during Frances, no wave data is available for Jeanne. One would surmise that the combination of those two events produced much more significant erosion than Sandy, especially along the Treasure Coast, where the 2004 hurricanes made landfall. Fig. 4 shows that for the period where buoy data was available during Frances, the total wave energy was very similar to Sandy's. However, it is readily apparent from Fig. 3 that Sandy's total wave energy was considerably higher than for Floyd, which was a major hurricane! The fact that Sandy, which never made landfall, could even come close to the wave energy produced by Frances, a stronger, landfalling hurricane, is remarkable.

This is attributable to the fact that Sandy moved northward, nearly parallel to the east central Florida coast. This produced a long duration of north to northeast winds. This wind trajectory has been shown to produce the most significant erosion along the east central Florida coast. Ekman pumping is maximized with this wind trajectory and also the northerly component to the wave direction causes the most effective scouring of sand from the beaches.

Another example of severe beach erosion that was caused by a long duration of strong north northeast winds is The Florida East Coast Thanksgiving Holiday Storm of 1984. A slow moving low pressure system in the northern Bahamas produced high surf for nine consecutive high tides. Damage caused by that storm along the east coast of Florida, in 2012 dollars, was nearly 200 million. It should be noted that the coastal population has grown tremendously since 1984, so a similar storm today would likely produce even greater losses. In contrast, Florida damage estimates from Hurricane Sandy were less than 100 million dollars. Sandy's damage was concentrated in the areas from Cape Canaveral southward, while the 1984 storm significantly affected the entire eastern coast of Florida.

Conclusion

While Hurricane Sandy produced extensive coastal damage in Florida, it was not the worst on record for a storm system that did not make landfall.

One point that Sandy reiterated is that the event duration is a critical factor in estimating the amount of erosion that a system will produce. Toward the end of a long event, wave heights that are below advisory/warning thresholds can produce significant erosion and coastal flooding. This has occurred in other long term events such as Tropical Storm Gordon in 1998, Hurricane Michelle in 2001 and Hurricane Noel in 2007. Basically, the peak wave energy can lower the beach's defenses and allow lower energy waves to impact the dune line. The longer this occurs, the more critical the erosion becomes. Hence, forecasters and emergency managers need to maintain situational awareness during large wave energy/long term events since warnings/advisories will often need to extend several high tide cycles after wave energy has peaked.

Randy Lascody/March 2013