

Hurricane CHARLEY Preliminary Water Levels Report



Tide gauges (yellow) within the path (orange) of Hurricane Charley

*For the purpose of timely release, data contained within this report have undergone “limited” NOS Quality Assurance/Control; however, the data have not yet undergone final verification. All data subject to NOS verification.

**September 2004
Data Report**

noaa National Oceanic and Atmospheric Administration

U.S. Department of Commerce
National Ocean Service
Center for Operational Products and Services

CO-OPS Tide Gauge Data for Hurricane Charley

NOAA's Center for Operational Oceanographic Products and Services (CO-OPS) maintains a network of tide gauges along the Gulf Coast of the United States from Brownsville, TX eastward to Key West, FL, and northward along the East Coast to Eastport, ME. CO-OPS personnel actively maintain and monitor these gauges which provide useful information about water levels during storm events. During the hurricane season CO-OPS personnel pay close attention to gauges that are within the path of the storm. Data from these stations can be triggered to appear in storm surge mode in real-time on Tides-Online (<http://tidesonline.nos.noaa.gov>). Currently there are 12 tide stations operating in Virginia, 7 in North Carolina, 5 in South Carolina, 2 in Georgia, and 34 in Florida. Of the 34 stations in Florida, seven were triggered into storm surge mode on the West Coast and 2 on the East Coast to appear on Tides Online as Charley passed over the state. Four stations in North Carolina were set into storm surge mode, as was one in Georgia.

Maximum Water Levels and Storm Surge Values for Hurricane Charley

Charley was a very fast moving storm that did not have a lasting effect on the tides. Most of the storm surge disappeared within one tidal cycle. The tide gauges in South and North Carolina experienced the greatest amount of surge from Hurricane Charley. Storm Surge is equal to the observed water level above MLLW minus the predicted water level above MLLW. A comparison of storm surge values for the CO-OPS tide gauges within the path of the storm are listed below (Figure 1 & Table 1). Table 2 compares the maximum observed water levels for these gauges relative to station datum, MLLW, NAVD 88, and NGVD 29. The maximum water levels above MLLW for each station are further compared in Figure 2.

Maximum Observed Water Levels

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Station Name	Station ID	Latitude	Longitude	Date/Time GMT	Maximum Water Level Above Station Datum (m)	Maximum Observed Water Level Above MLLW (m)	Maximum Observed Water Level Above NAVD88 (m)	Maximum Observed Water Level Above NGVD 29 (m)
Fort Meyers,FL	8725520	26 38.8 N	81 52.3 W	08-13-04 23:06	2.638	1.309	0.991	1.349
Fernandina, FL	8720030	30 40.3 N	81 27.9 W	08-17-04 02:00	2.477	1.959	0.794	NA
St. Simons, GA	8677344	31 7.9 N	81 23.8 W	08-17-04 01:18	2.704	2.175	0.898	NA
Fort Pulaski,GA	8670870	32 2.0 N	80 54.1 W	08-19-04 02:30	3.363	2.297	1.062	1.350
Charleston, SC	8665530	32 46.9 N	79 55.5 W	08-18-04 01:48	2.599	1.756	0.799	1.098
Oyster Landing, SC	8662245	33 21.1 N	79 11.2 W	08-18-04 02:24	2.790	1.598	NA	NA
Springmaid Pier, SC	8661070	33 39.3 N	78 55.1 W	08-14-04 15:30	11.121	2.193	1.231	1.532
Sunset Beach, NC	8651370	33 51.9 N	78 30.4 W	08-14-04 16:18	4.156	2.498	NA	NA
Wilmington, NC	8658120	34 13.6 N	77 57.2 W	08-18-04 03:30	2.261	1.514	0.781	1.085
Beaufort, NC	8656483	34 43.2 N	76 40.2 W	08-14-04 23:36	1.759	1.197	0.564	0.857
Oregon Inlet, NC	8652587	35 47.7 N	75 32.9 W	08-14-04 23:00	1.517	0.714	0.512	0.617
Duck, NC	8651370	36 11.0 N	75 44.8 W	08-17-04 00:42	6.924	1.261	0.594	0.888
Ches. Bay Bridge,VA	8638863	36 58.0 N	76 6.8 W	08-15-04 00:36	9.118	1.414	NA	NA
Money Point, VA	8639348	36 46.7 N	76 18.1 W	08-15-04 01:06	8.083	1.495	0.938	1.185
Sewell's Point, VA	8638610	36 56.8 N	76 19.8 W	08-15-04 01:06	2.632	1.296	0.795	1.043
Kiptopeke, VA	8632200	37 10.0 N	75 59.3 W	08-15-04 00:30	2.393	1.288	0.708	0.959
Windmill, VA	8636580	37 36.9 N	76 17.4 W	08-15-04 02:12	1.269	0.580	0.291	0.543
Wachapreague, VA	8631044	37 36.4 N	75 41.2 W	08-15-04 01:30	2.274	1.569	NA	NA
Yorktown , VA	8637689	37 13.6 N	76 28.7 W	08-15-04 01:24	2.763	1.161	NA	NA
Lewisetta, VA	8635750	37 59.7 N	76 27.9 W	08-18-04 07:42	2.064	0.610	0.357	0.603

Table 1. Maximum Observed Water Levels referred to MLLW, NAVD 88, NGVD 29.

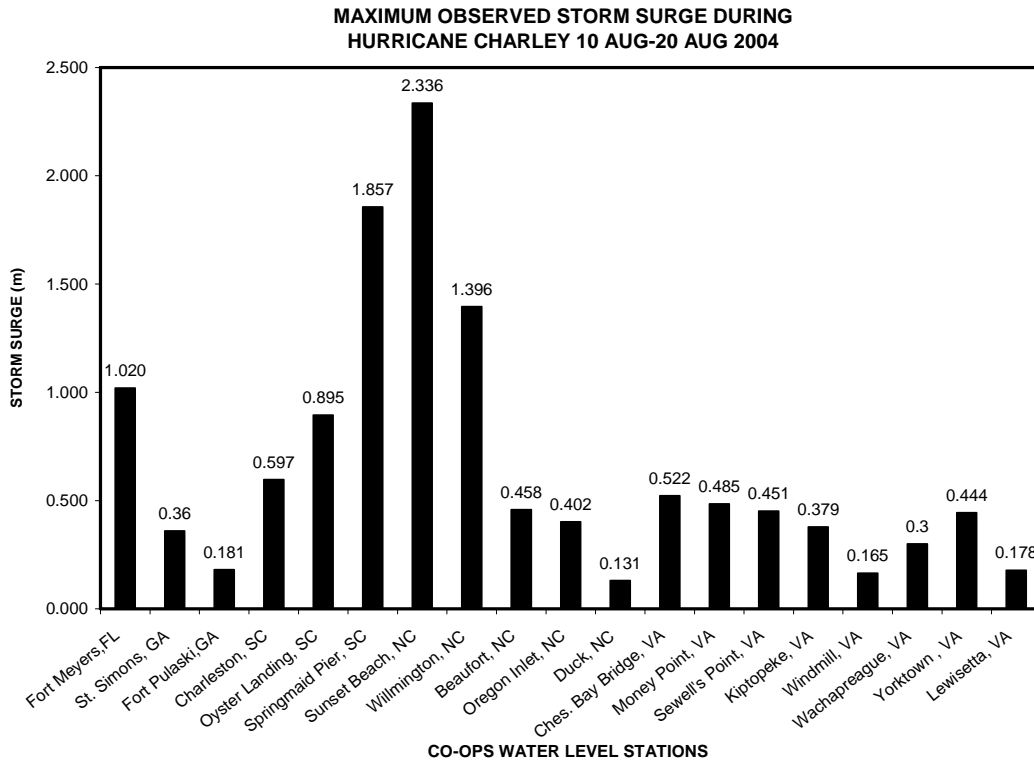


Figure 1. Maximum Observed Water Levels relative to MLLW for CO-OPS tide gauges during Hurricane Charley.

Maximum Storm Surge

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Station Name	Station ID	Latitude	Longitude	Date/Time GMT	Observed Water Level Above MLLW (m)	Predicted Water Levels (m)	Maximum Surge (m)
Fort Meyers,FL	8725520	26 38.8 N	81 52.3 W	08-13-04 22:54	1.304	0.284	1.020
St. Simons, GA	8677344	31 7.9 N	81 23.8 W	08-14-04 08:12	1.11	0.75	0.36
Fort Pulaski,GA	8670870	32 2.0 N	80 54.1 W	08-14-04 10:54	2.043	1.862	0.181
Charleston, SC	8665530	32 46.9 N	79 55.5 W	08-14-04 13:36	1.717	1.12	0.597
Oyster Landing, SC	8662245	33 21.1 N	79 11.2 W	08-14-04 16:18	1.286	0.391	0.895
Springmaid Pier, SC	8661070	33 39.3 N	78 55.1 W	08-14-04 15:30	2.193	0.336	1.857
Sunset Beach, NC	8659897	33 51.9 N	78 30.4 W	08-14-04 16:18	2.498	0.162	2.336
Willmington, NC	8658120	34 13.6 N	77 57.2 W	08-14-04 18:54	1.483	0.087	1.396
Beaufort, NC	8656483	34 43.2 N	76 40.2W	08-14-04 19:24	0.8	0.342	0.458
Oregon Inlet, NC	8652587	35 47.7 N	75 32.9 W	08-13-04 16:42	0.474	0.072	0.402
Duck, NC	8651370	36 11.0 N	75 44.8 W	08-17-04 07:12	0.177	0.046	0.131
Ches. Bay Bridge, VA	8638863	36 58 N	76 6.8 W	08-15-04 00:36	1.414	0.892	0.522
Money Point, VA	8639348	36 46.7 N	76 18.1 W	08-15-04 00:36	1.474	0.989	0.485
Sewell's Point, VA	8638610	36 56.8 N	76 19.8 W	08-15-04 00:30	1.285	0.834	0.451
Kiptopeke, VA	8632200	37 10.0 N	75 59.3 W	08-15-04 00:30	1.288	0.909	0.379
Windmill, VA	8636580	37 36.9 N	76 17.4 W	08-16-04 12:54	0.431	0.266	0.165
Wachapreague, VA	8631044	37 36.4 N	75 41.2 W	08-15-04 02:48	1.39	1.09	0.3
Yorktown , VA	8637689	37 13.6 N	76 28.7 W	08-15-04 01:24	1.164	0.72	0.444
Lewisetta, VA	8635750	37 59.7 N	76 27.9 W	08-13-04 12:00	0.364	0.186	0.178

Table 2. Storm Surge values for CO-OPS stations within the path of Hurricane Charley.

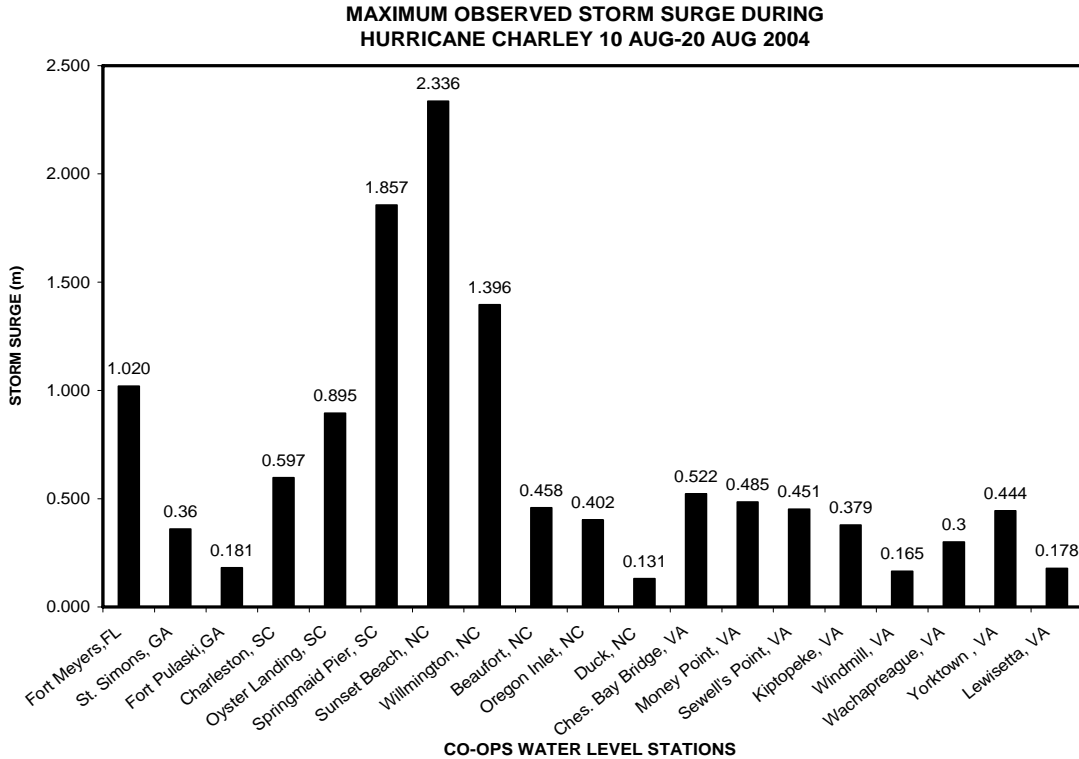


Figure 2. Maximum Observed Storm Surge for CO-OPS stations within the path of Hurricane Charley.

Hurricane Charley Storm Track and Progression

Charley was the third tropical depression of the 2004 Hurricane Season. The storm originated in the Windward Islands, 80km southeast of Grenada. An initial advisory for Charley was made Monday August 9, 2004 1345 EDT/1745Z, locating the depression at latitude 11.7 N and longitude 61.1 W. Maximum sustained winds were at 30 kt, with gusts increasing to 45 kt, and a minimum central pressure of 1011 mb. On Tuesday, August 10, the depression was 710 km southeast of Jamaica and was upgraded to a Tropical Storm (Figure 3). At this point, Charley was moving toward the west-northwest near 24 mph, with maximum sustained winds of 40 mph. Jamaica, the Caymen Islands, and Haiti issued Tropical Storm warnings at 1600 EDT/2100Z 08-10-04.

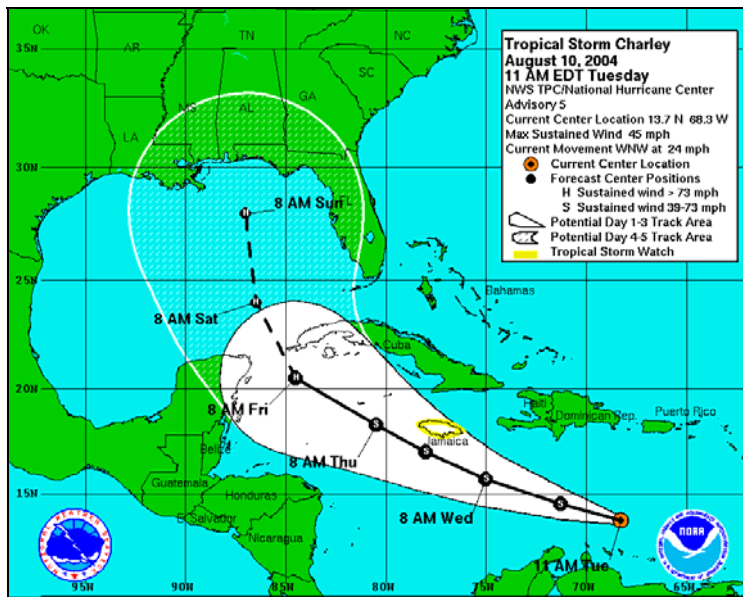


Figure 3. Projected Path of Tropical Storm Charley, Tuesday August 10 2004 1100 EDT/1500Z.

By Wednesday August 11, 2004 at 1400 EDT/1800Z, Charley had been upgraded from a Tropical Storm to a Category 1 Hurricane (according to the Saffir-Simpson scale). The eye of the hurricane was located at latitude 16.6 N and longitude 76.8 W, 90 miles south of Kingston, Jamaica (Figure 4). Warnings went into effect for Jamaica and extended northward up the coast of Florida towards Anna Maria Island. Charley's wind speed increased from 45 mph to 70 mph and was moving slower west-northwest at 18 mph.

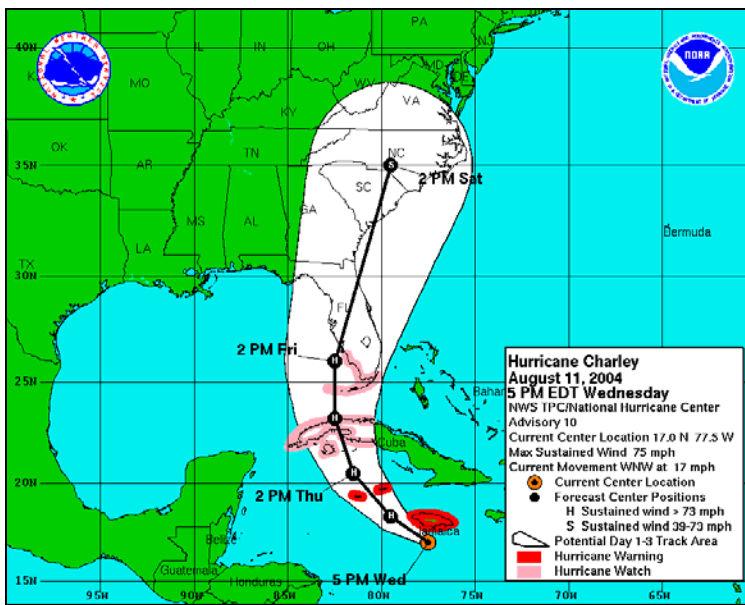


Figure 4. Projected path of Tropical Storm Charley, August 11, 2004 1100 EDT/1500Z.

On Thursday, August 12, at 0200 EDT/0600Z Charley was located at latitude 18 N and longitude 79.2 W with winds nearing 85 mph. As wind speed and gusts increased to

105 mph and above, Charley was labeled a Category 2 Hurricane at 2300 EDT/0300Z August 12, 2004 (Figure 5). Charley continued to move further north throughout Thursday and into Friday hitting Florida's western coast. The minimum central pressure was 975 mb.

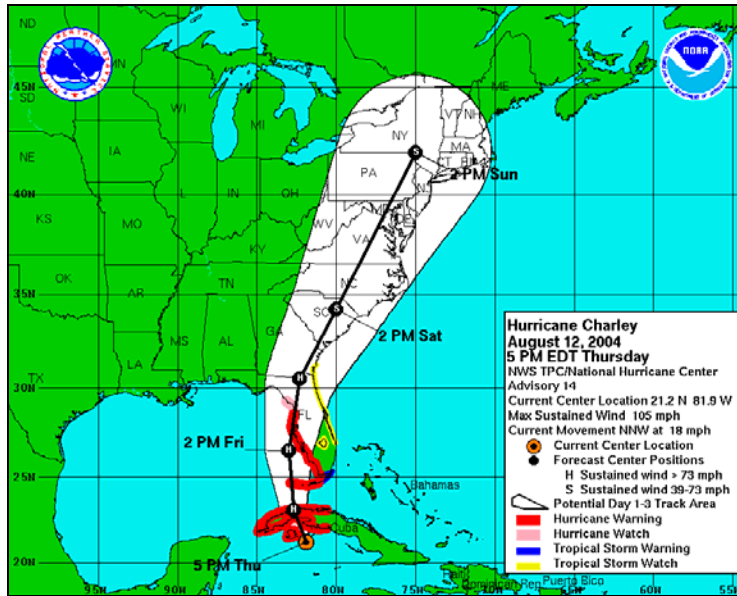


Figure 5. Projected Path of Hurricane Charley, Thursday August 12, 2004 1700 EDT/2100Z.

Gaining strength throughout Friday August 13 Charley amassed winds over 145 mph (Figures 6 & 7). At 1700 EDT/2100Z Charley made landfall as a Category 4 Hurricane. The center of the hurricane was located at latitude 26.9 N, longitude 82.2 W, 30 miles west-northwest of Ft. Myers, Florida.

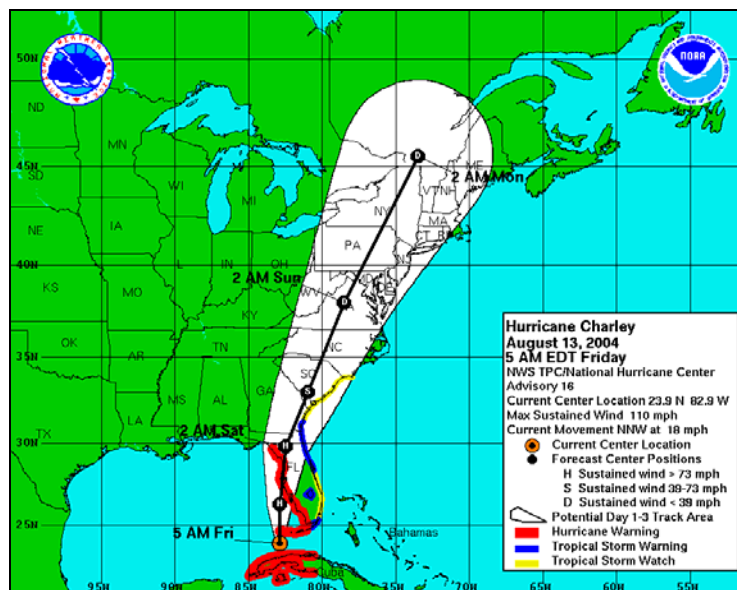


Figure 6. Charley makes landfall as a Category 4 Hurricane on Friday August 13, 2004 0500 EDT/0900Z.

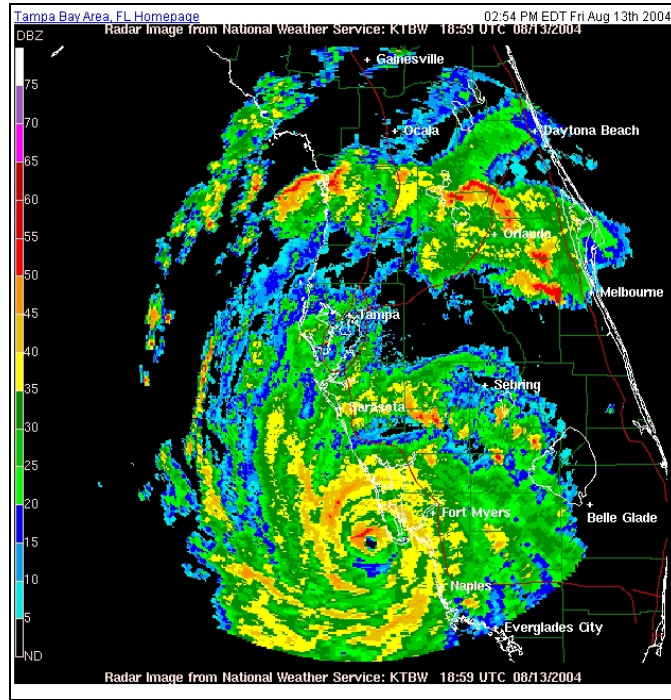


Figure 7. Radar Image of Hurricane Charley as a Category 4 Hurricane on Friday August 13, 2004 1454 EDT/1854Z.

As Charley made landfall the tide gauge at Fort Myers, FL recorded a peak elevation of 1.309m (4.29ft) above MLLW at 23:06 GMT 08-13-04 (Figure 8.) The maximum surge was 1.020m (3.35ft) above MLLW on 08-13-04 23:12 GMT (Figure 8.)

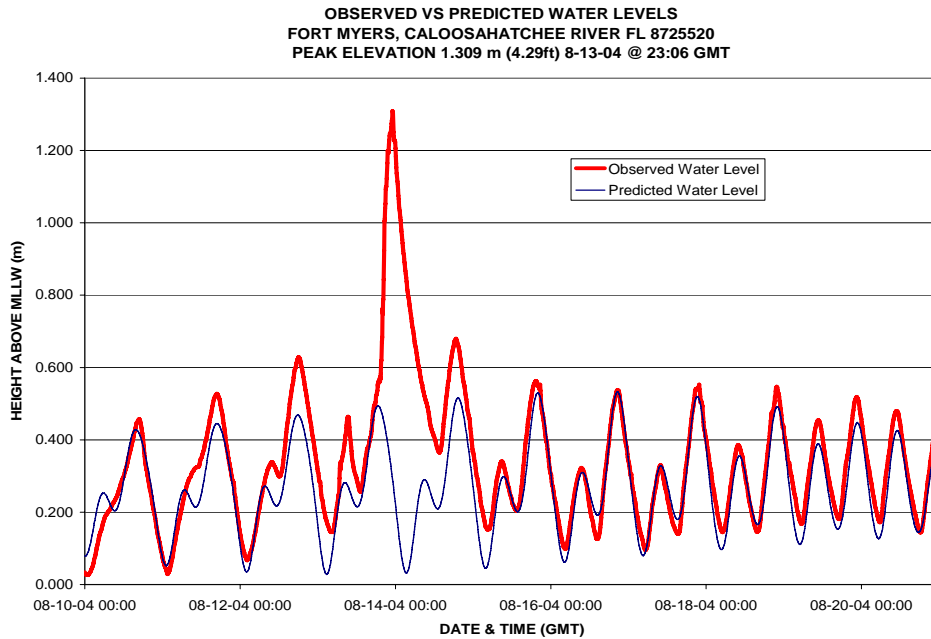


Figure 8. Observed vs. Predicted Water Levels at Fort Myers, FL

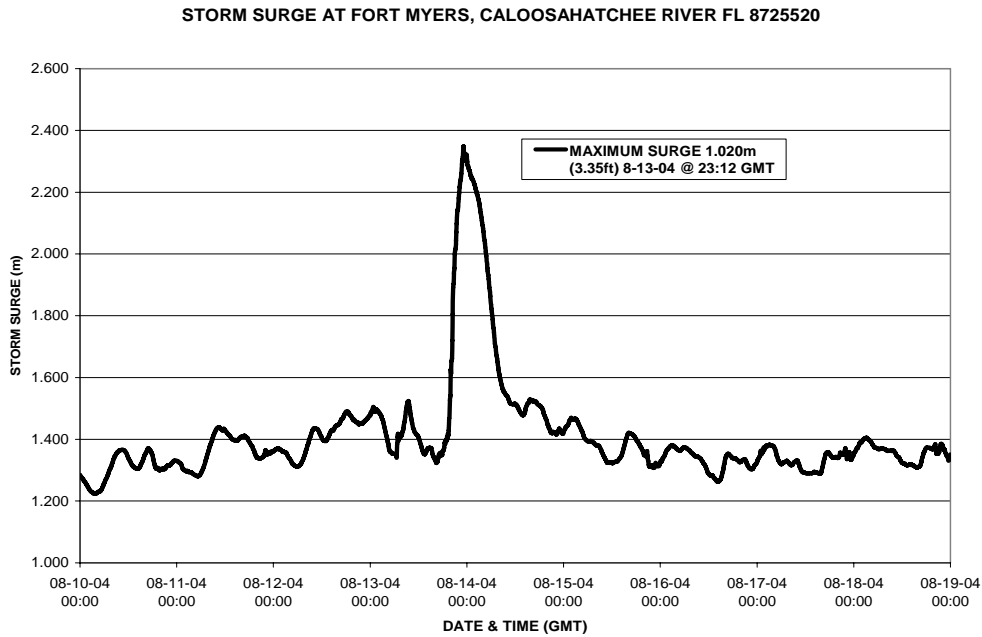


Figure 9. Storm Surge at Fort Myers, FL.

The gauge at Fort Myers was the only tide station to exhibit significant surge in the Gulf of Mexico. At the same time on the northeastern most tip of Florida the gauge at Fernandina Beach experienced receded water levels (Figure 10).

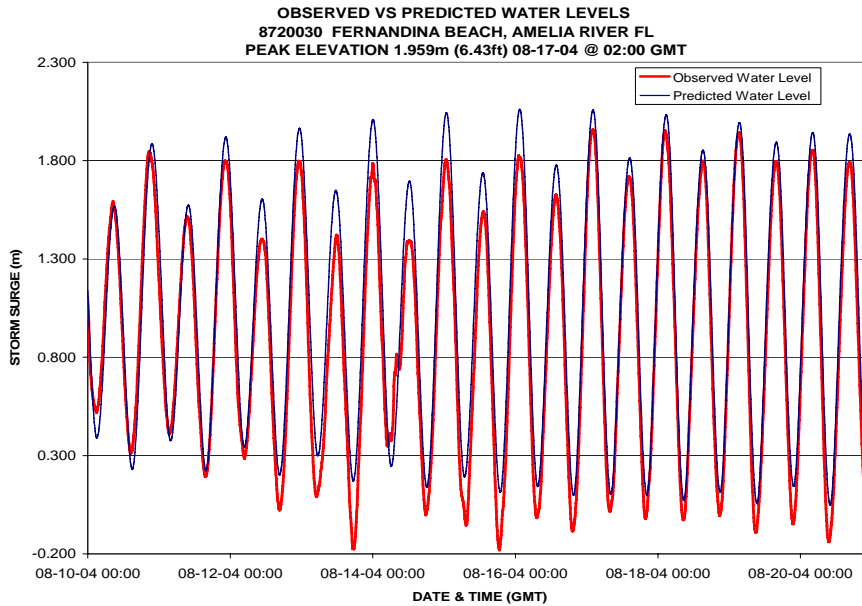


Figure 10. Observed vs. Predicted Water Levels at Fernandina Beach, FL.

As Charley continued to move rapidly north-northeast over the Florida peninsula it lost strength and eventually all warnings were discontinued for Florida by 2100 EDT/0100Z 08-13-04. Hurricane Charley had little effect on the tide gauges in Georgia before entering the Carolinas. Both gauges at Fort Pulaski and St. Simons, GA experienced no increase in water level, and as a result no surge (Figures 11 & 12).

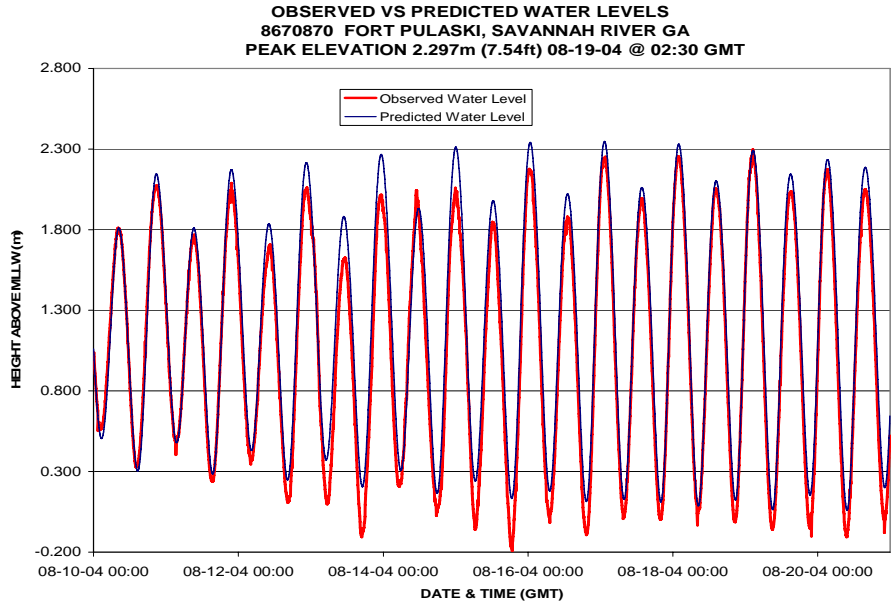


Figure 11. Observed vs. Predicted Water Levels for Fort Pulaski, GA.

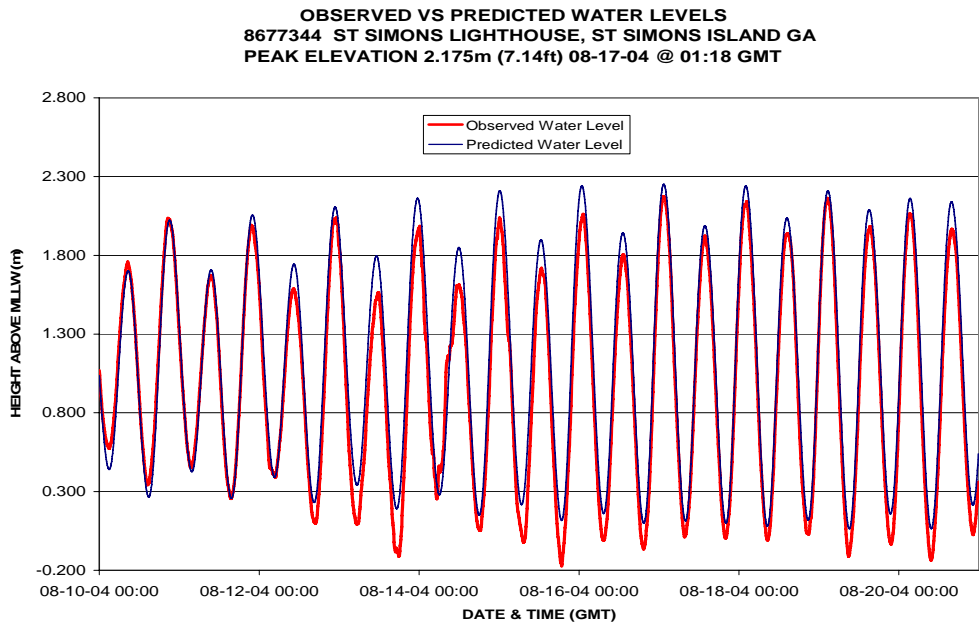


Figure 12. Observed vs. Predicted Water Levels for St. Simons, GA

On Saturday August 14, 2004 Charley was exiting Florida and heading for the Carolinas. At 0500 EDT/0900Z the hurricane was located at latitude 31.2 N and

longitude 80.5 W, 115 miles south southwest of Charleston, South Carolina. The tide gauge at Charleston, SC experienced a maximum surge of 0.597m (1.96ft) above MLLW on 8-14-04 at 13:36 GMT (Figure 14). The peak elevation for Charleston, SC was not recorded until four days later. On 8-18-04 at 01:36 GMT the maximum peak elevation was 1.756m (5.76ft) above MLLW (Figure 13).

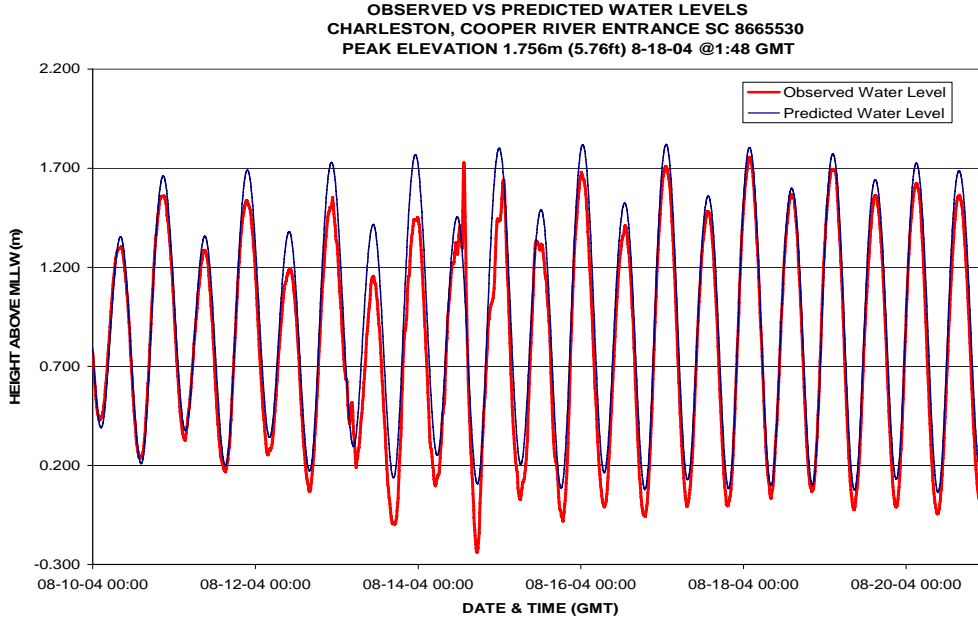


Figure 13. Observed vs. Predicted Water Levels for Charleston, SC.

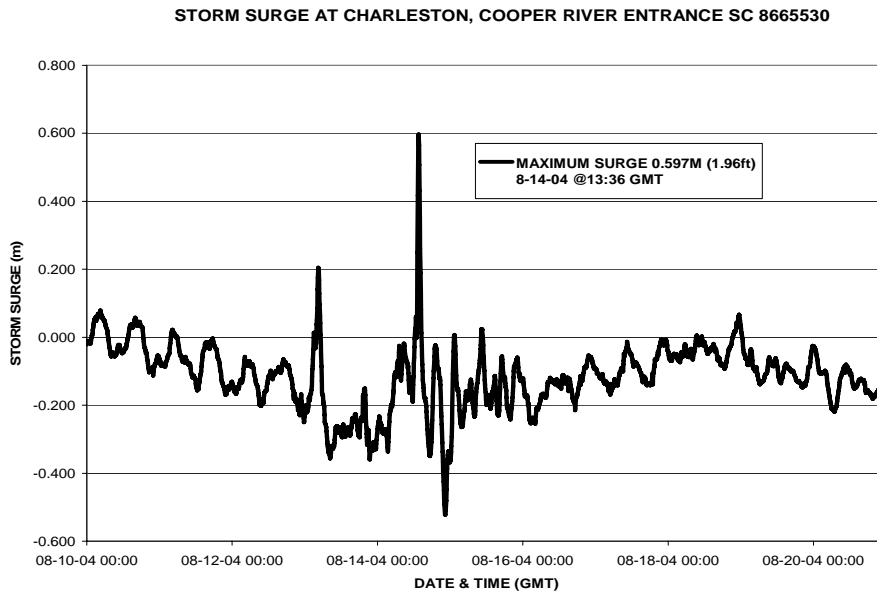


Figure 14. Storm Surge at Charleston, SC.

In addition to Charleston two other gauges in South Carolina recorded significant surge during Hurricane Charley. The maximum surge at Oyster Landing was 0.985m (2.94ft) above MLLW on 08-14-04 @ 16:18 GMT (Figure 16.) While the peak elevation

at Oyster Landing was 1.598m (5.25ft) above MLLW on 08-18-04 @ 2:24 GMT (Figure 15).

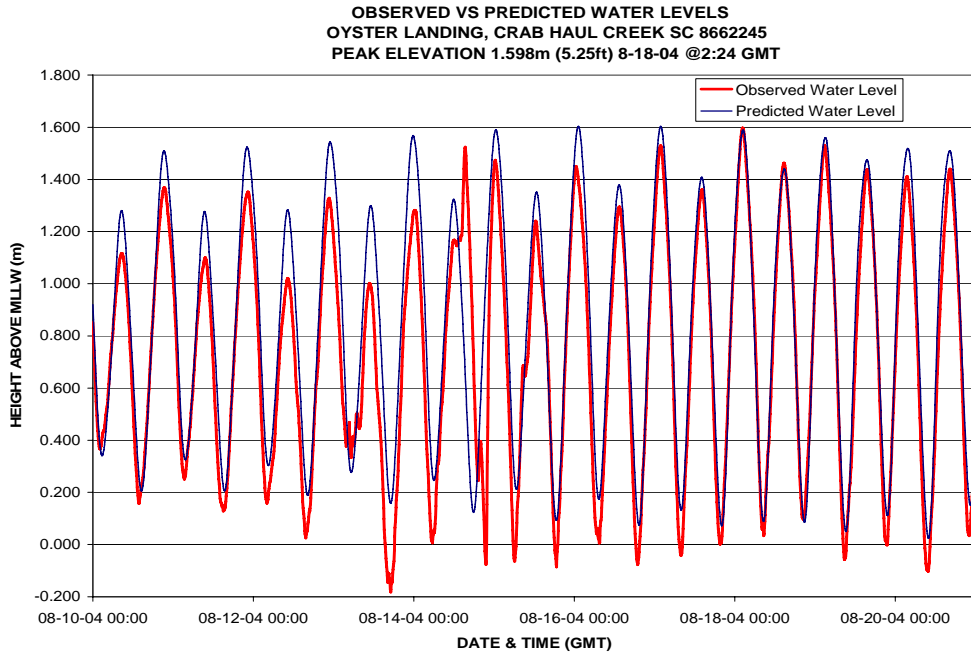


Figure 15. Observed vs. Predicted Water Levels at Oyster Landing, SC.

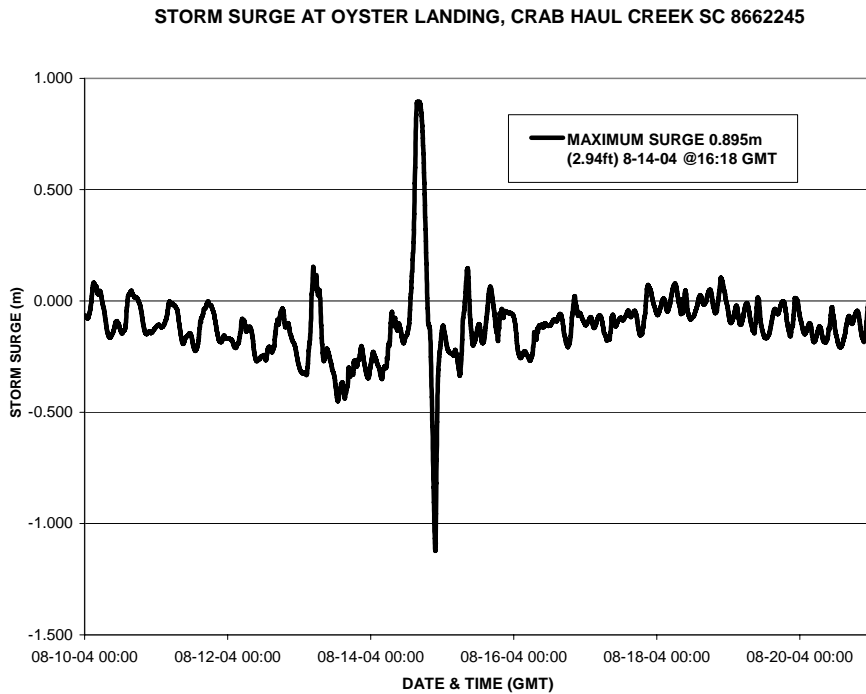


Figure 16. Storm Surge at Oyster Landing, SC.

The gauge at Springmaid Pier, SC recorded the second highest amount of surge as well as maximum water level during Hurricane Charley. The maximum surge was

1.857m (6.09ft) above MLLW on 08-14-04 @ 15:30 GMT (Figure 18), while the maximum water level was 2.193 m (7.20ft) above MLLW on 08-18-04 @ 15:30 GMT (Figure 17.)

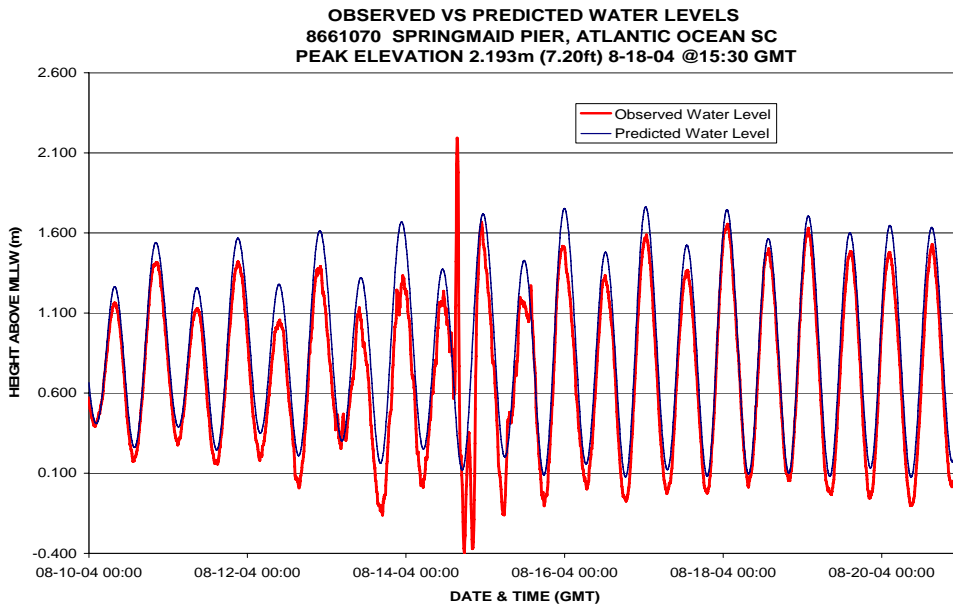


Figure 17. Observed vs. Predicted Water Levels for Springmaid Pier, SC

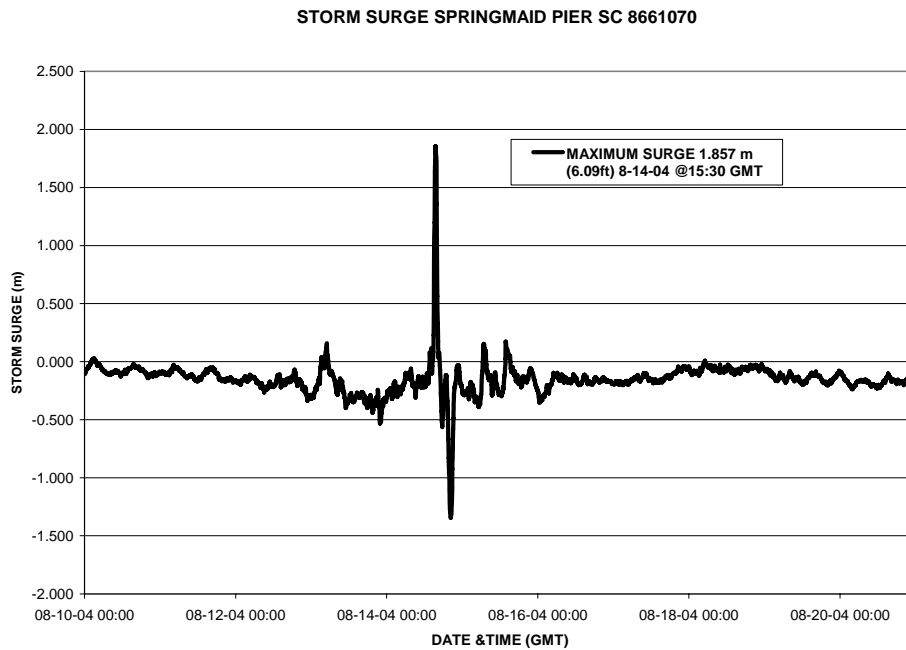


Figure 18. Storm Surge at Springmaid Pier, SC.

Hurricane Charley induced storm surge at five gages in North Carolina as it continued to head up the coast on Saturday August 14, 2004. The tide gauge at Sunset Beach Pier, NC experienced the greatest amount of storm surge and maximum water level for Hurricane Charley. Both of these maximums occurred simultaneously. The

maximum water level was 2.498m (8.20ft) above MLLW on 08-14-04 @ 16:18 GMT (Figure 19), while the storm surge was 2.336 m (7.66ft) above MLLW on 08-14-04 @ 16:18 GMT (Figure 20).

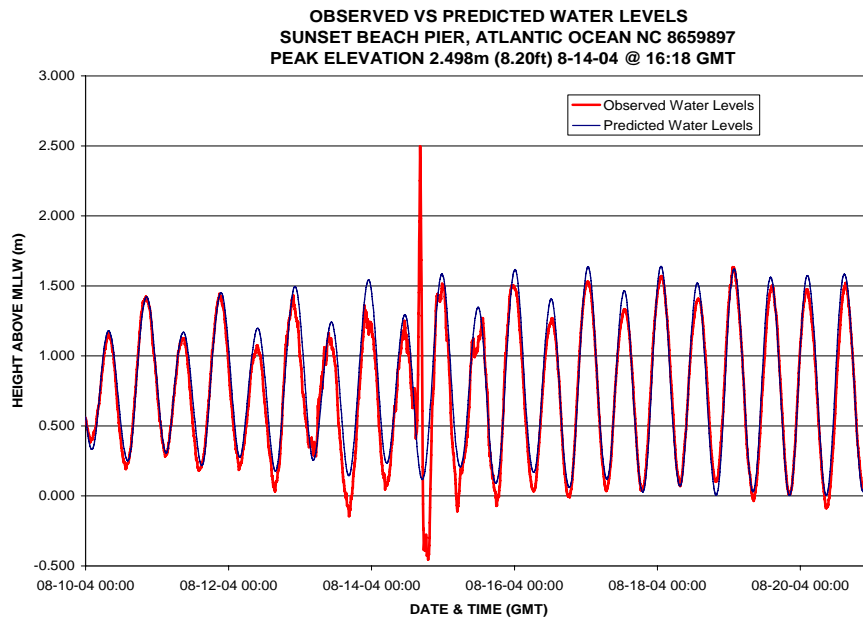


Figure 19. Observed vs. Predicted Water Levels for Sunset Beach Pier, NC.

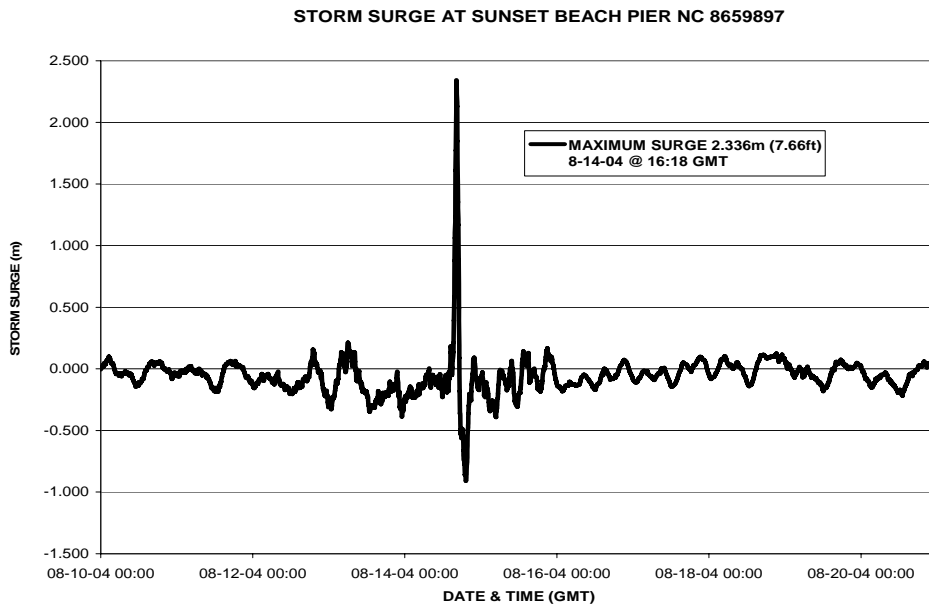


Figure 20. Storm Surge at Sunset Beach Pier, NC.

The tide gauge at Willimington, NC also exhibited a significant amount of surge of 1.396m (4.58ft) above MLLW on 8-14-04 @ 18:54 GMT (Figure 22) and a maximum observed water level of 1.514m (4.97ft) above MLLW on 08-18-04 @ 03:30 GMT (Figure 21). Willmington, NC was the last gauge on the east coast to experience surge over 1m. The gauges at Beaufort (Figure 23), Oregon Inlet (Figure 24), and Duck Pier NC (Figure 25) experienced elevated water levels, but no significant surge.

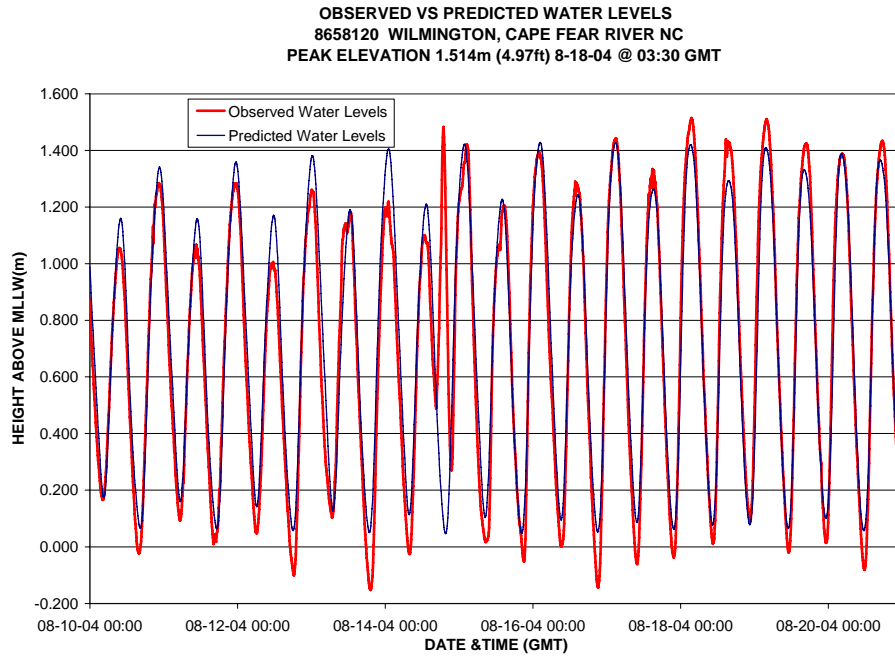


Figure 21. Observed vs. Predicted Water Levels for Willmington, NC.

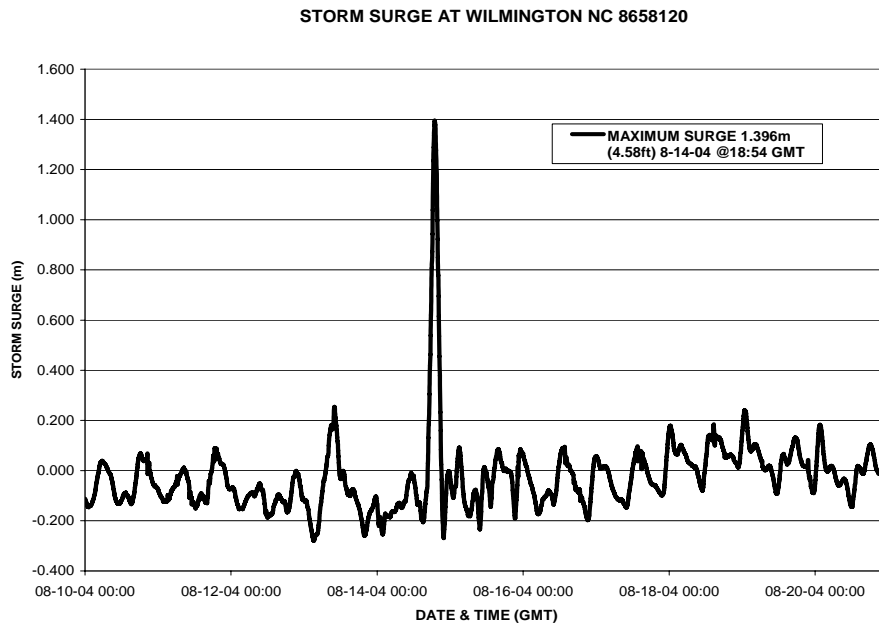


Figure 22. Storm Surge at Willmington, NC.

OBSERVED VS PREDICTED WATER LEVELS
8656483 BEAUFORT, DUKE MARINE LAB NC
PEAK ELEVATION 1.197m (3.93ft) 08-14-04 @ 23:36 GMT

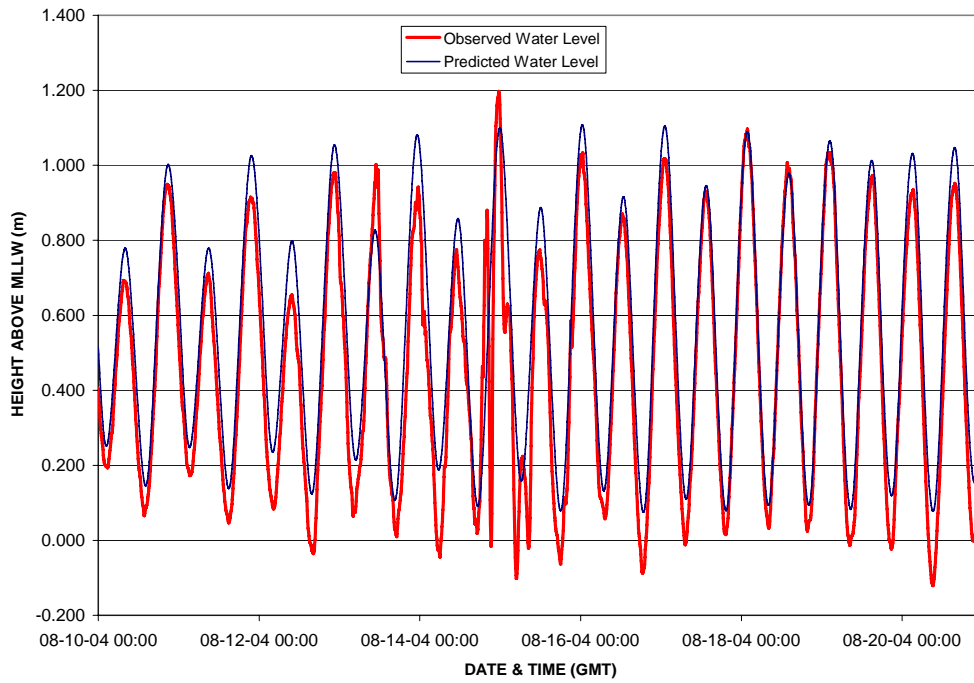


Figure 23. Observed vs. Predicted Water Levels for Beaufort, NC.

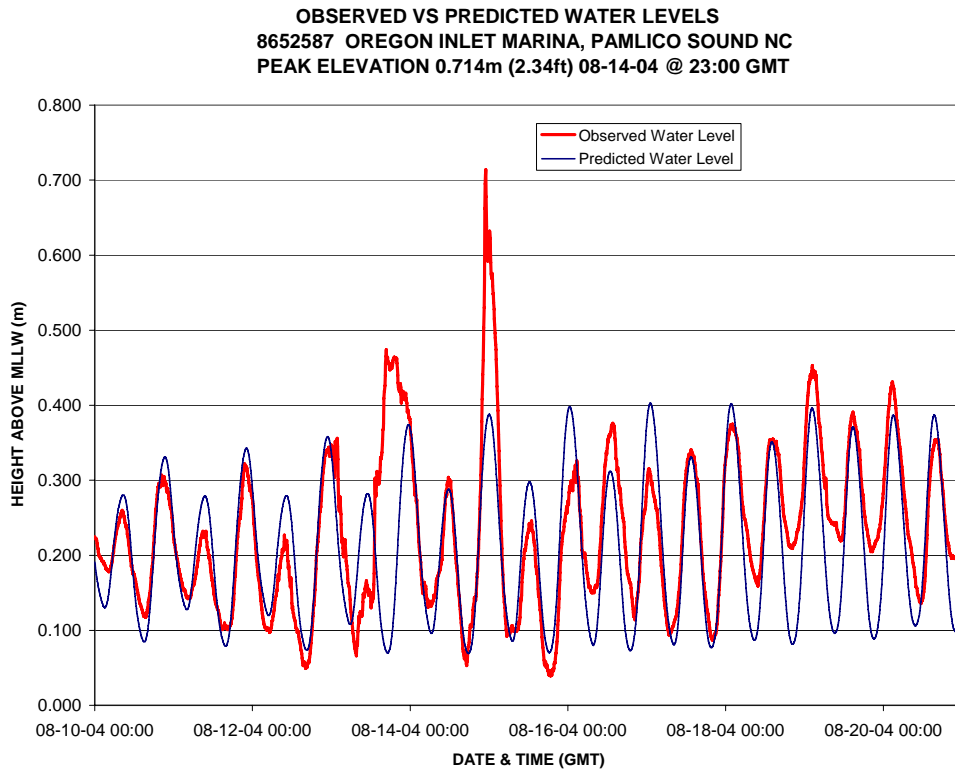


Figure 24. Observed vs. Predicted Water Levels for Oregon Inlet, NC.

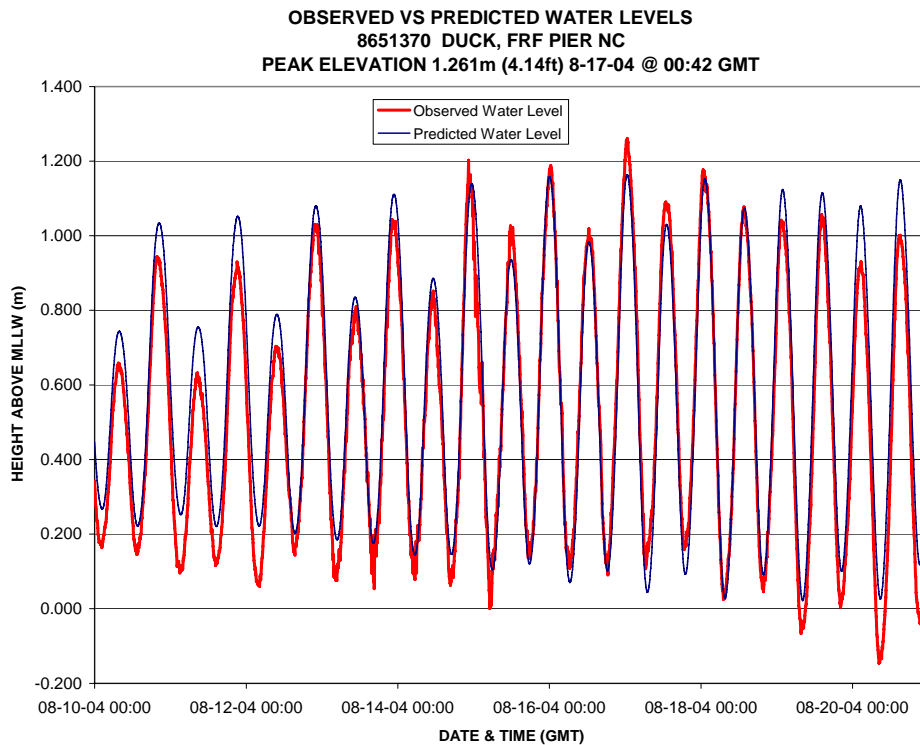


Figure 25. Observed vs. Predicted Water Levels for Duck Pier, NC.

Hurricane Charley weakened throughout Saturday August 14, 2004. The winds decreased to 40mph by late evening, just barely categorizing it as a tropical storm. At this point Charley had moved offshore of the Mid-Atlantic States. Eight tide gauges in Virginia experienced elevated water levels. The tide gauge at Chesapeake Bay Bridge, VA was the only gauge to record surge over half a meter (Figures 26 & 27). Observed vs. Predicted water levels are listed below for the other seven gauges in Virginia that did not demonstrate significant surge but did have elevated water levels (Figures 28-34).

On Sunday August 15, 2004 Charley had dissipated over New England. The center of the tropical depression was located at latitude 43 N and longitude 69 W, just east of Cape Cod, Massachusetts at 1100 EDT/1500Z. At this time all warnings for Charley were discontinued.

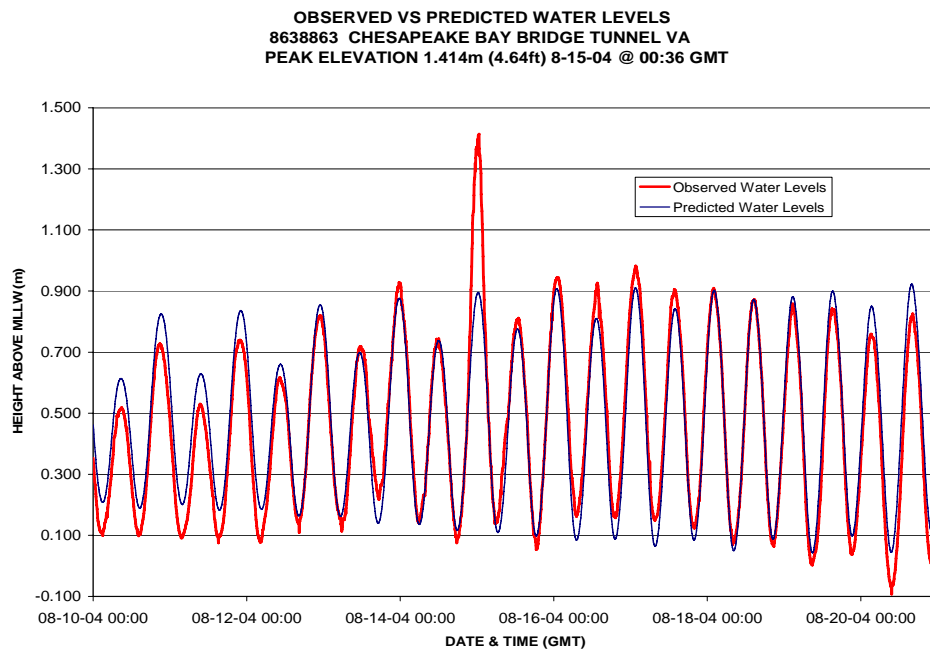


Figure 26. Observed vs. Predicted Water Levels for Chesapeake Bay Bridge Tunnel, VA.

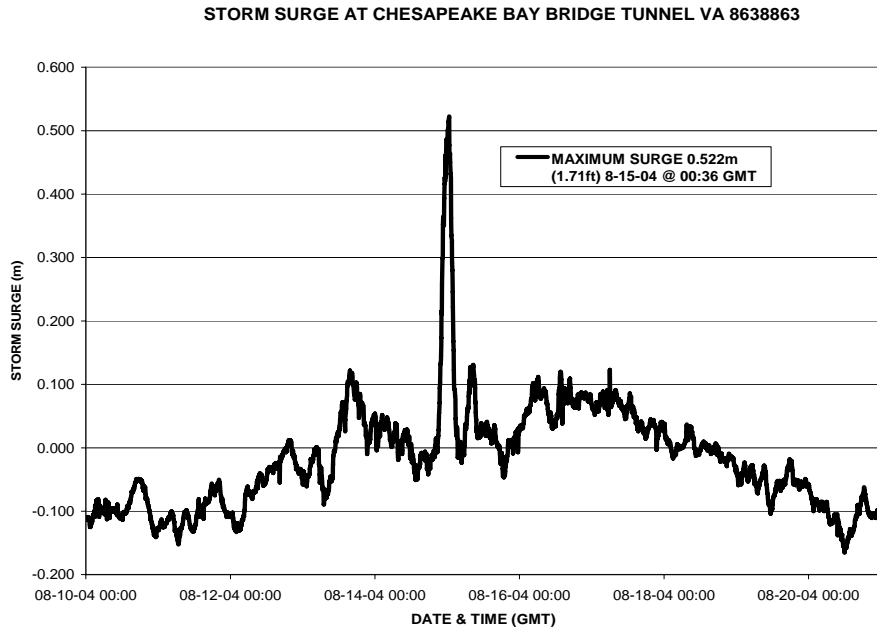


Figure 27. Storm Surge at Chesapeake Bay Bridge Tunnel, VA.

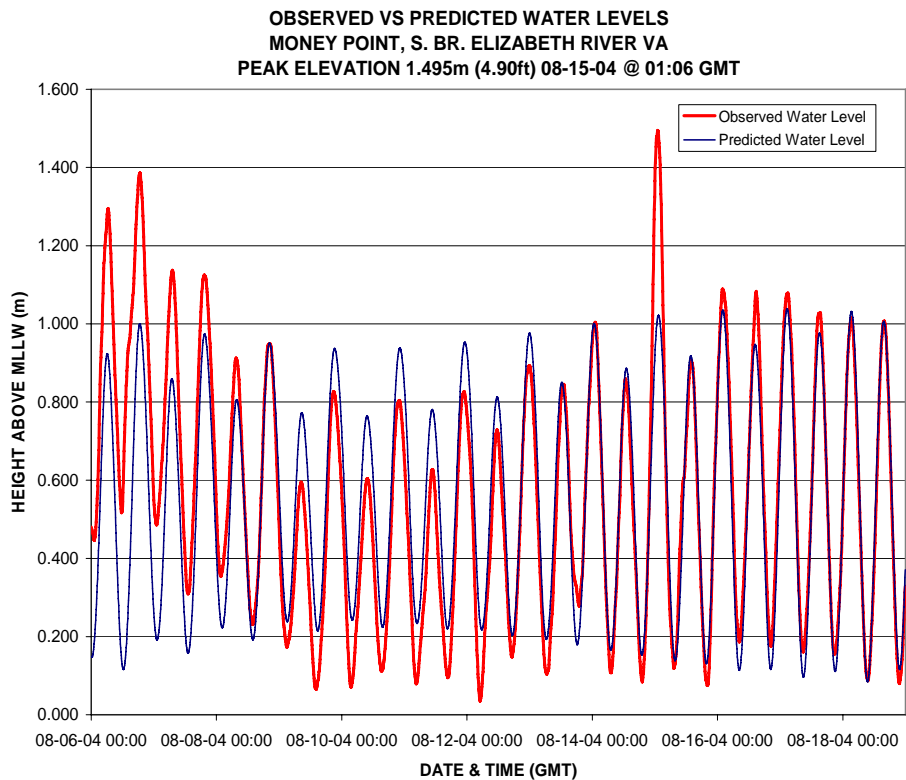


Figure 28. Observed vs. Predicted Water Levels for Money Point, VA.

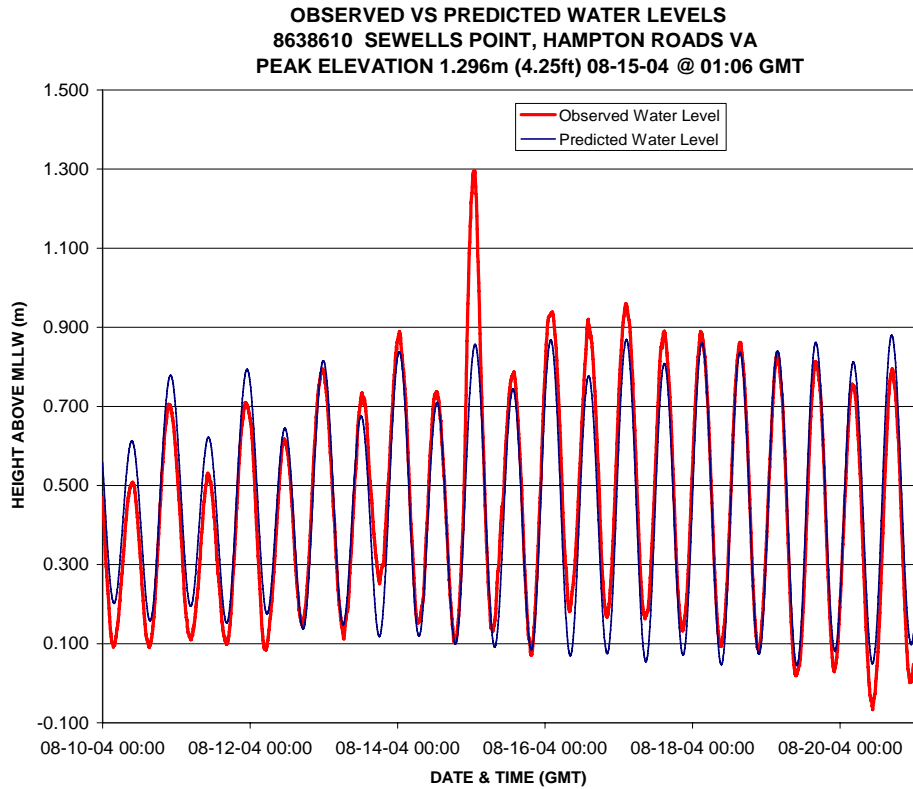


Figure 29. Observed vs. Predicted Water Levels for Sewells Point, VA.

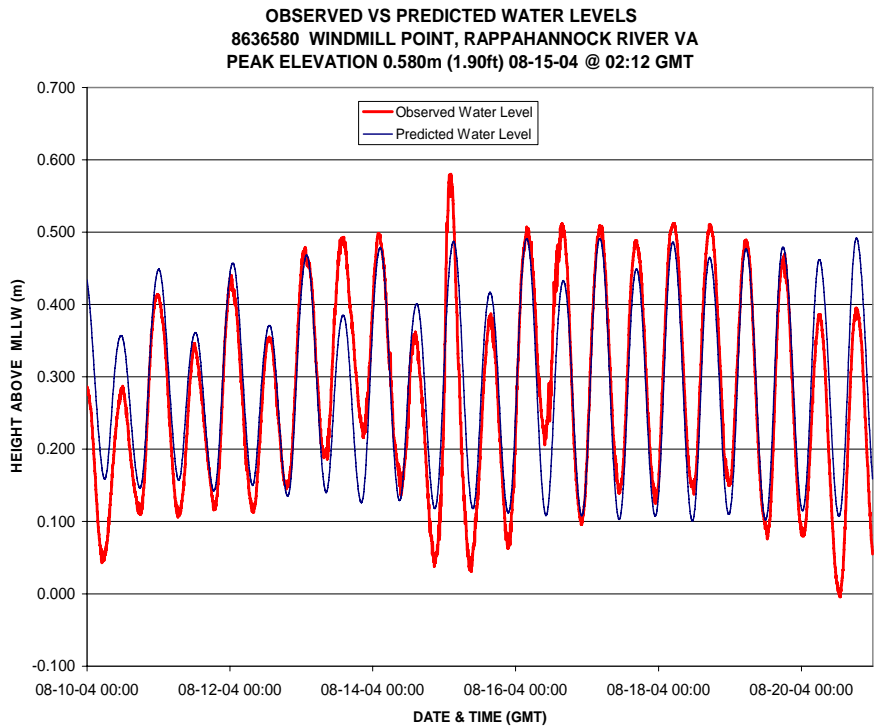


Figure 30. Observed vs. Predicted Water Levels for Windmill Point, VA.

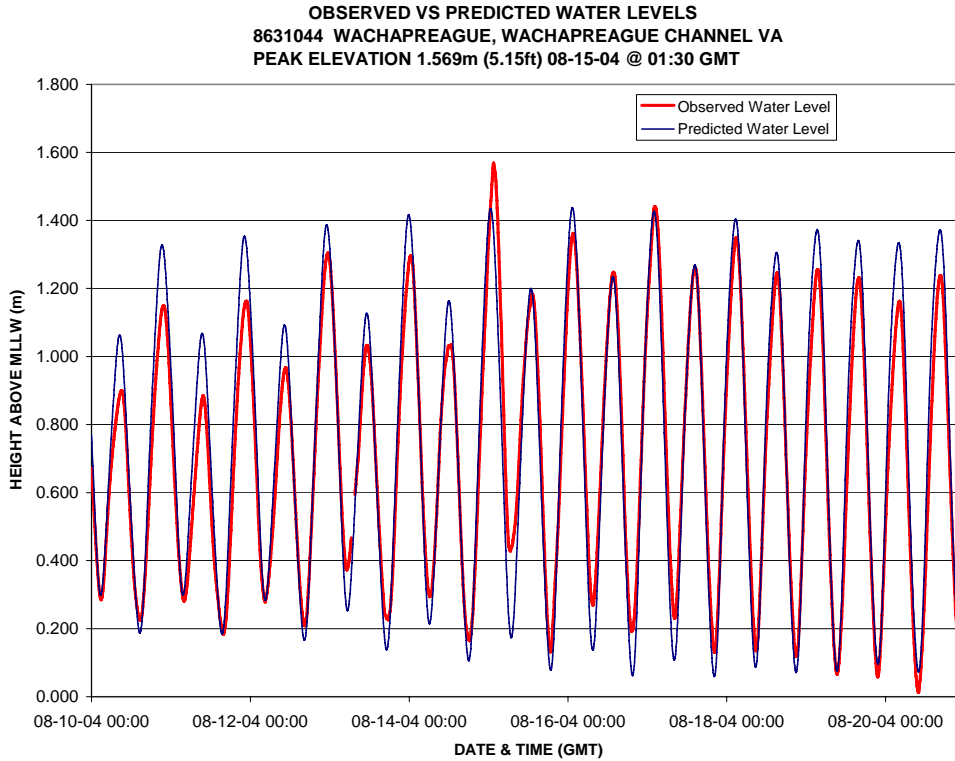


Figure 31. Observed vs. Predicted Water Levels for Wachapreague, VA.

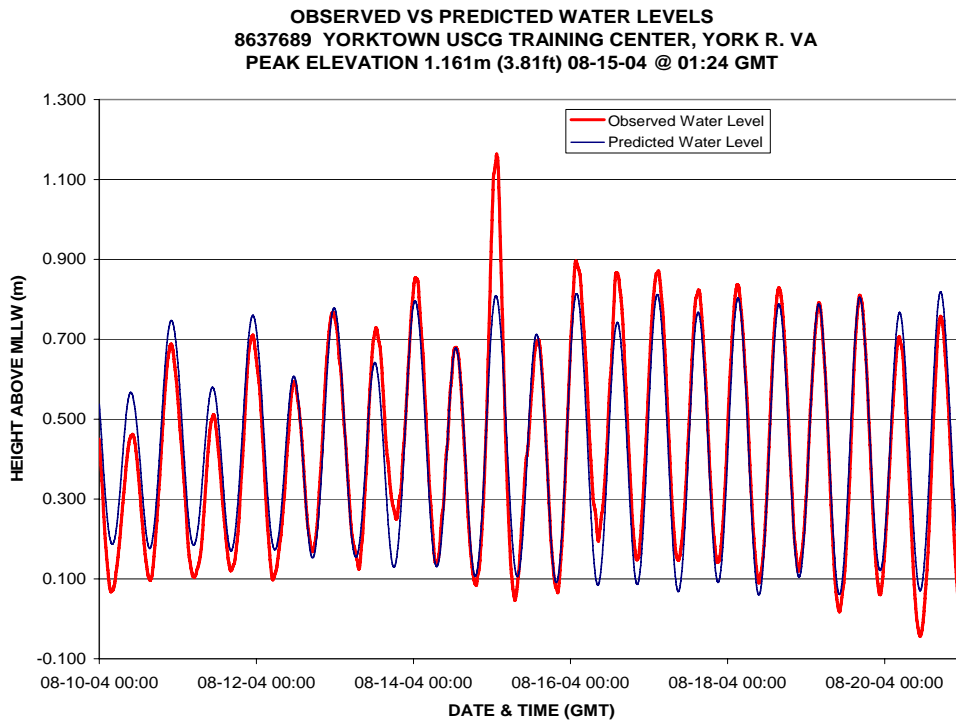


Figure 32. Observed vs. Predicted Water Levels for Yorktown, VA.

OBSERVED VS PREDICTED WATER LEVELS
8632200 KIPTOPEKE, CHESAPEAKE BAY VA
PEAK ELEVATION 1.288m (4.23ft) 08-15-04 @ 00:30 GMT

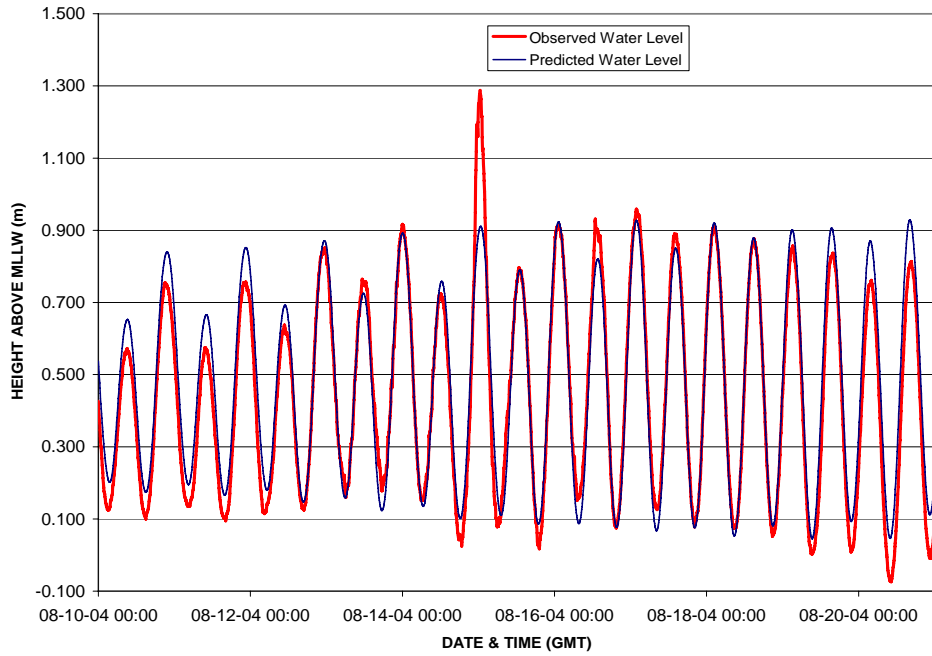


Figure 33. Observed vs. Predicted Water Levels for Kiptopeke, VA.

OBSERVED VS PREDICTED WATER LEVELS
8635750 LEWISSETTA, POTOMAC RIVER VA
PEAK ELEVATION 0.610m (2.00ft) 08-18-04 @ 07:42 GMT

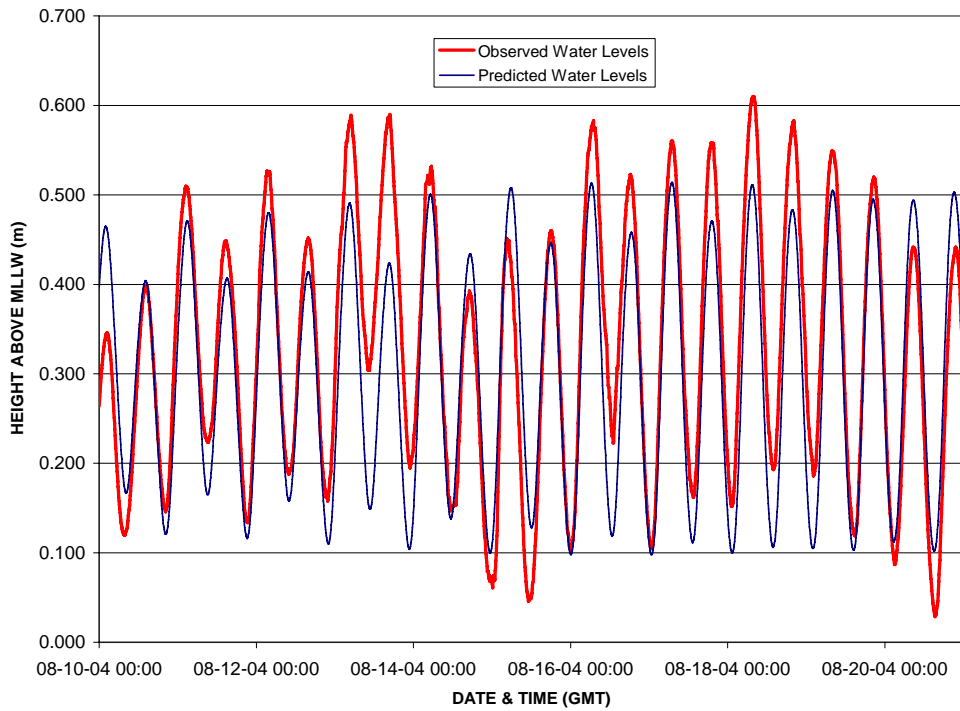


Figure 34. Observed vs. Predicted Water Levels for Lewisetta, VA.