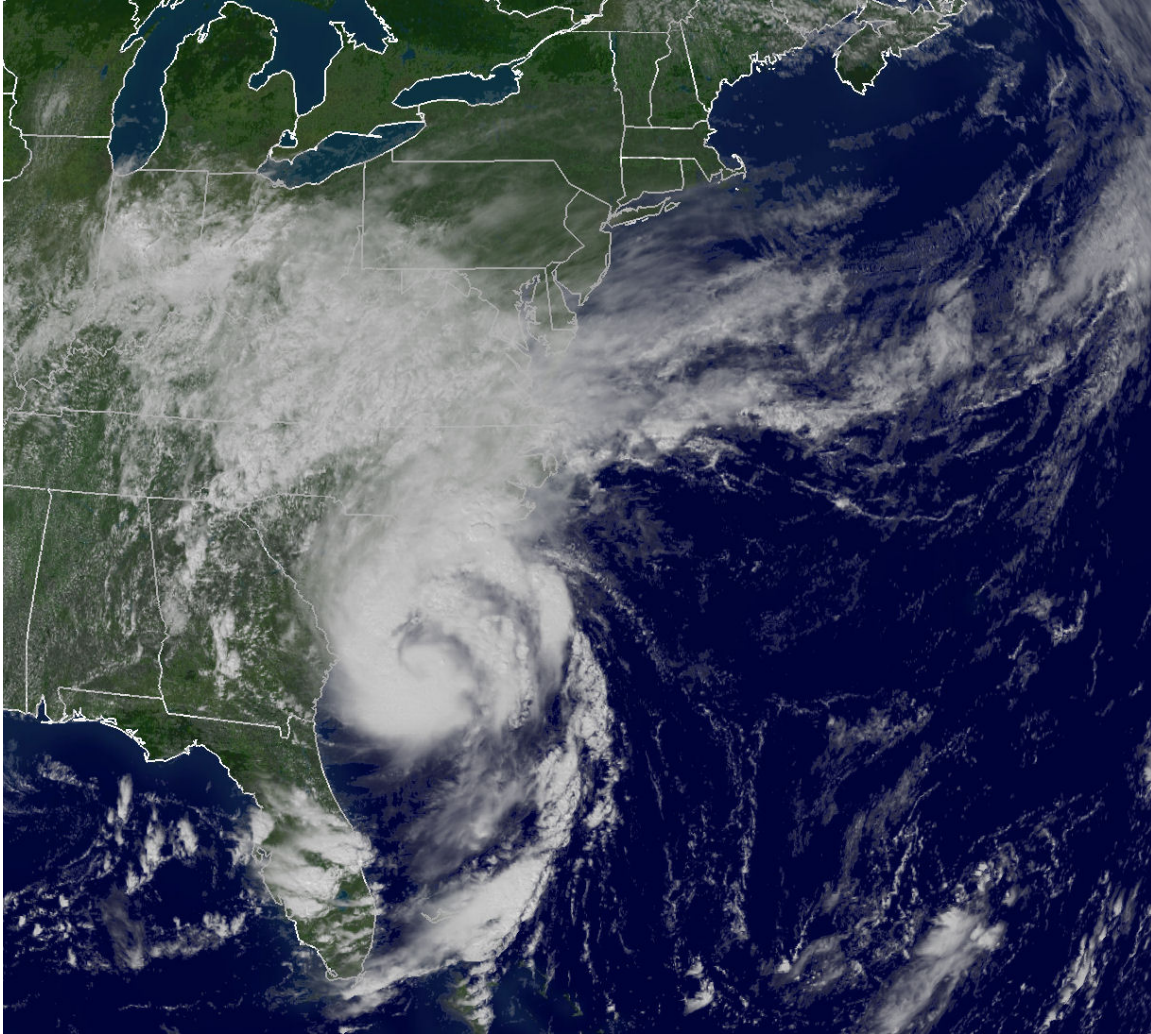


Tropical Storm ERNESTO Verified Water Level Report



Data contained within this report have undergone NOS Quality Assurance / Control

Revised October 07, 2006

noaa National Oceanic and Atmospheric Administration

U.S. DEPARTMENT OF COMMERCE

National Ocean Service

Center for Operational Oceanographic Products and Services

SUMMARY

The NOAA Center for Operational Oceanographic Products and Services (CO-OPS) maintains a network of water level stations along the United States coastline to closely monitor water level activity. Stations from Florida to Maryland recorded elevated water levels during Tropical Storm Ernesto. All observed water level elevations are referenced to the standard chart datum Mean Lower Low Water (MLLW), based on the National Tidal Datum Epoch 1983-2001 (see Appendix 3). This report summarizes the highest observed water levels, referred to as the Storm Tide, which is the sum of the storm surge and the astronomical tide. Differences between observed water level and the predicted tide are provided (Table 1 and Fig. 2) and plotted in meters (Fig. 3 – 14).

Tropical Storm Ernesto made the initial landfall on August 29 2300 GMT at Plantation Key with maximum sustained winds near 45 mph (75 km/hr) and, after crossing the Florida Bay, made the second landfall on August 30 0200 GMT over southwestern Miami-Dade County with maximum sustained winds near 45 mph (75 km/hr). Ernesto then headed northeastward and weakened to a tropical depression. After increasing strength over the Atlantic, northeast of Florida, the storm hit North Carolina near Long Beach on August 31 2300 GMT with the maximum sustained winds near 70 mph (115 km/hr), just shy of Category 1 hurricane status (Fig. 1).

Water levels were slightly elevated along the Florida Keys after the initial landfall. Naples, FL recorded the highest storm tide of 1.029 m (3.376 ft) above MLLW, which was 0.180 m (0.591 ft) above the predicted tide (Fig. 11). Water levels at Key West, Vaca Key and Virginia Key were all below 1.0 m. Water levels along the North Carolina coast and in the Chesapeake Bay were elevated to about 1.0 m above predicted after the North Carolina landfall. Wrightsville Beach, NC recorded the highest storm tide 1.901m (6.237 ft), 0.931 m (3.054 ft) above the predicted tide (Fig. 3).

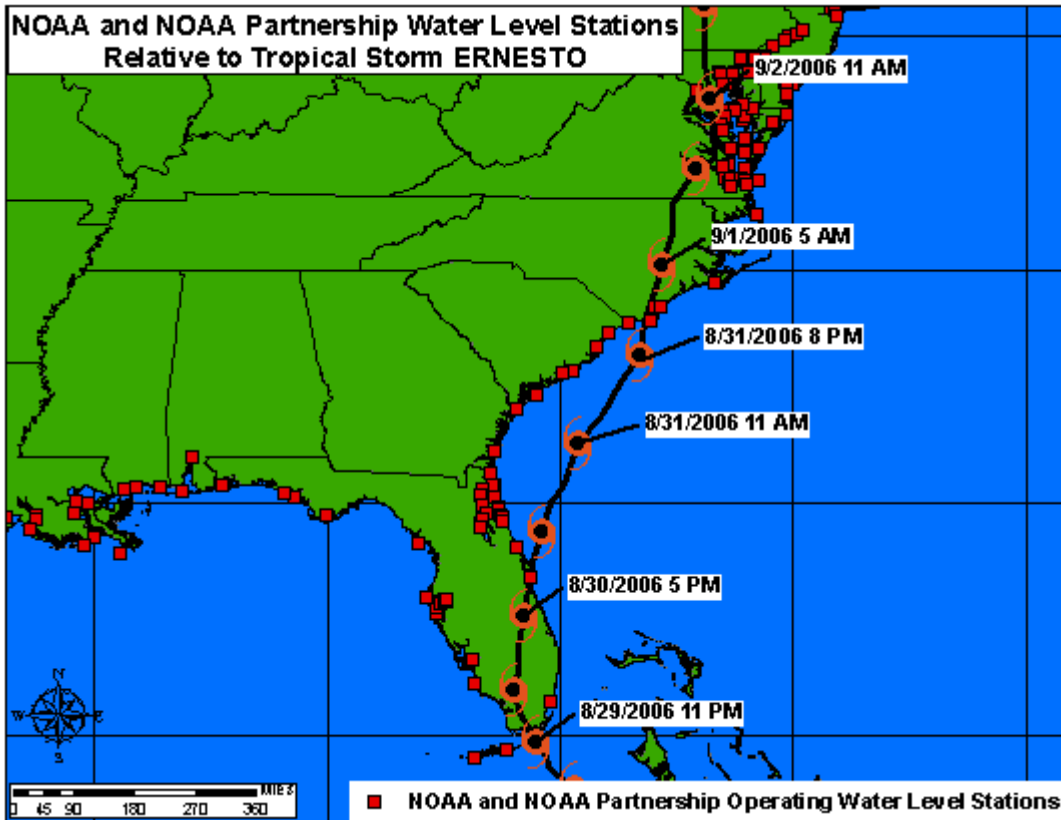


Figure 1. Path of Tropical Storm Ernesto relative to NOAA and NOAA Partnership water level stations.

Table 2. Maximum water levels in geographical order for Tropical Storm ERNESTO, August 2006.

Station Name	Station ID	Date & Time (GMT)	Max Water Level (Meters above MLLW)	Predicted Water Levels (m)	Difference (m)	Max Water Level (Feet above MLLW)	Predicted Water Levels (ft)	Difference (ft)
Key West	8724580	08-30-06 06:12	0.690	0.554	0.136	2.264	1.818	0.446
Vaca Key	8723970	08-30-06 12:00	0.638	0.259	0.379	2.093	0.850	1.243
Virginia Key	8723214	08-30-06 05:06	0.886	0.631	0.255	2.907	2.070	0.837
Naples	8725110	08-31-06 08:54	1.029	0.849	0.180	3.376	2.785	0.591
Springmaid Pier	8661070	08-31-06 18:06	1.764	1.54	0.224	5.787	5.052	0.735
Wrightsville Beach	8658163	09-01-06 04:06	1.901	0.97	0.931	6.237	3.182	3.054
Beaufort	8656483	09-01-06 04:42	1.373	0.767	0.606	4.505	2.516	1.988
¹ CBBT	8638863	09-01-06 18:54	1.693	0.858	0.835	5.555	2.815	2.740
Sewells Point	8638610	09-01-06 17:42	1.685	0.661	1.024	5.529	2.169	3.361
Kiptopeke	8632200	09-01-06 18:36	1.771	0.851	0.920	5.809	2.792	3.017
Yorktown	8637689	09-01-06 17:12	1.819	0.528	1.291	5.968	1.732	4.236
Solomon's Island	8577330	09-01-06 22:54	1.357	0.373	0.984	4.452	1.224	3.228

¹ Chesapeake Bay Bridge Tunnel

Differences between Maximum Observed Water Levels and the Predicted Related to TS ERNESTO

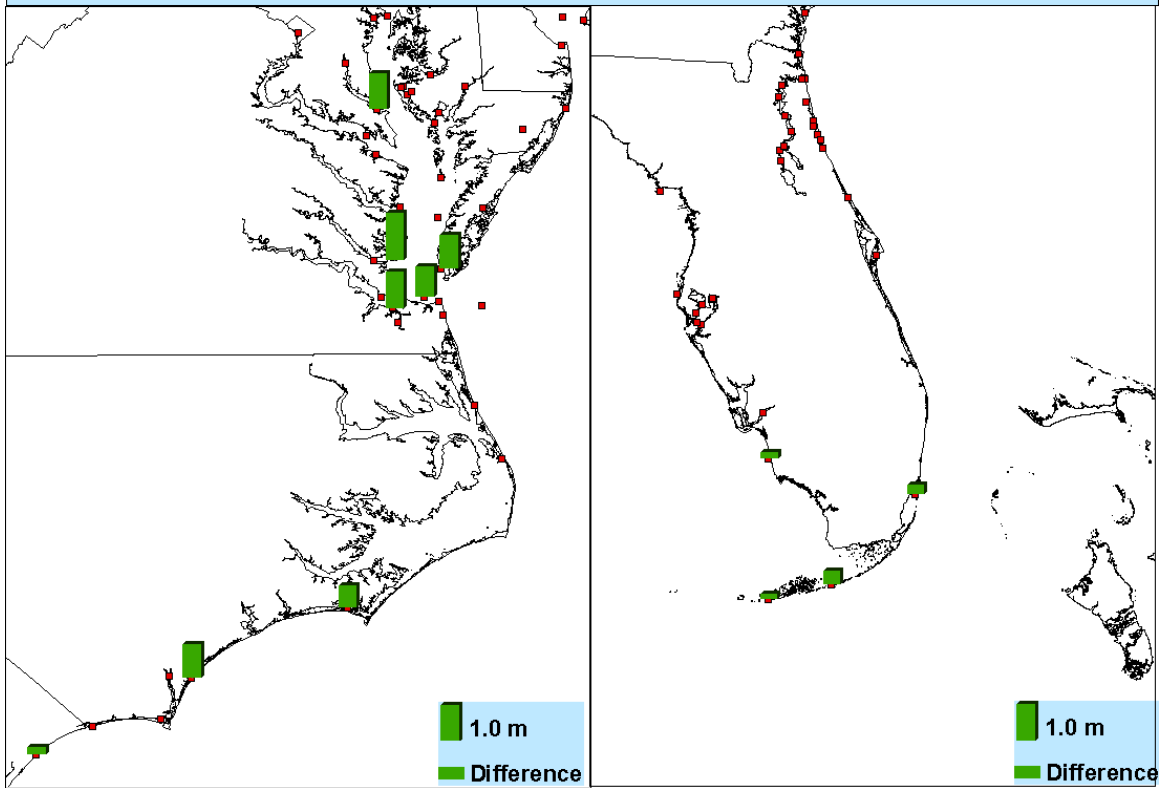


Figure 2. Differences between maximum observed water levels and the predicted for stations in Table 1.

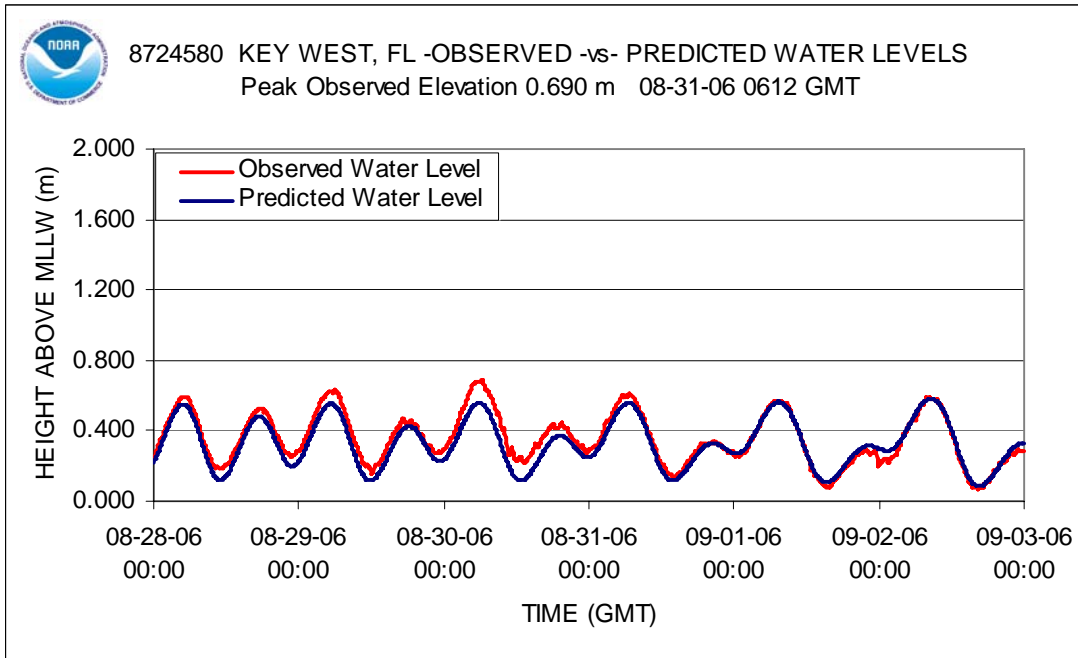


Figure 3. Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Key West, FL during Tropical Storm Ernesto.

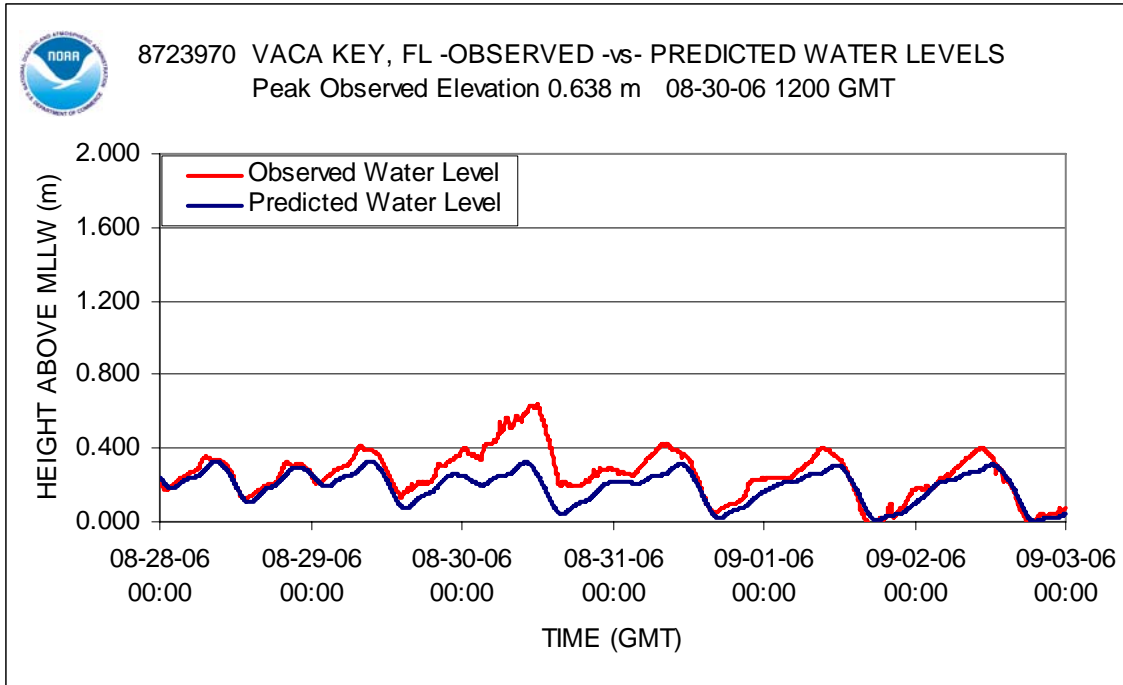


Figure 4. Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Vaca Key, FL during Tropical Storm Ernesto.

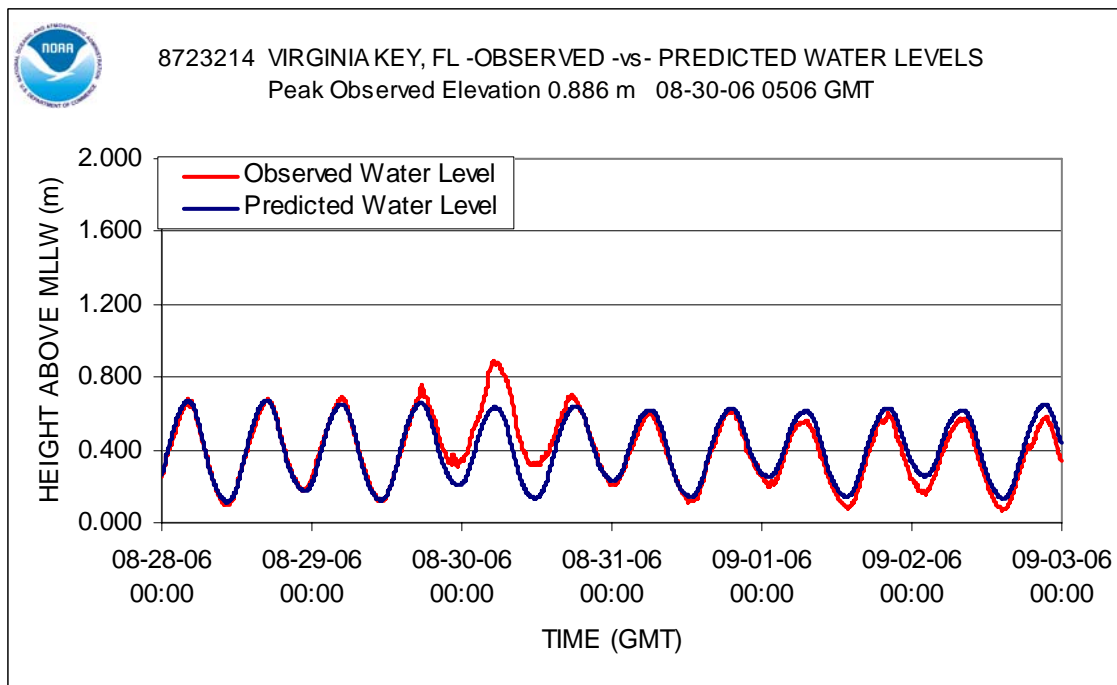


Figure 5. Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Virginia Key, VA during Tropical Storm Ernesto.

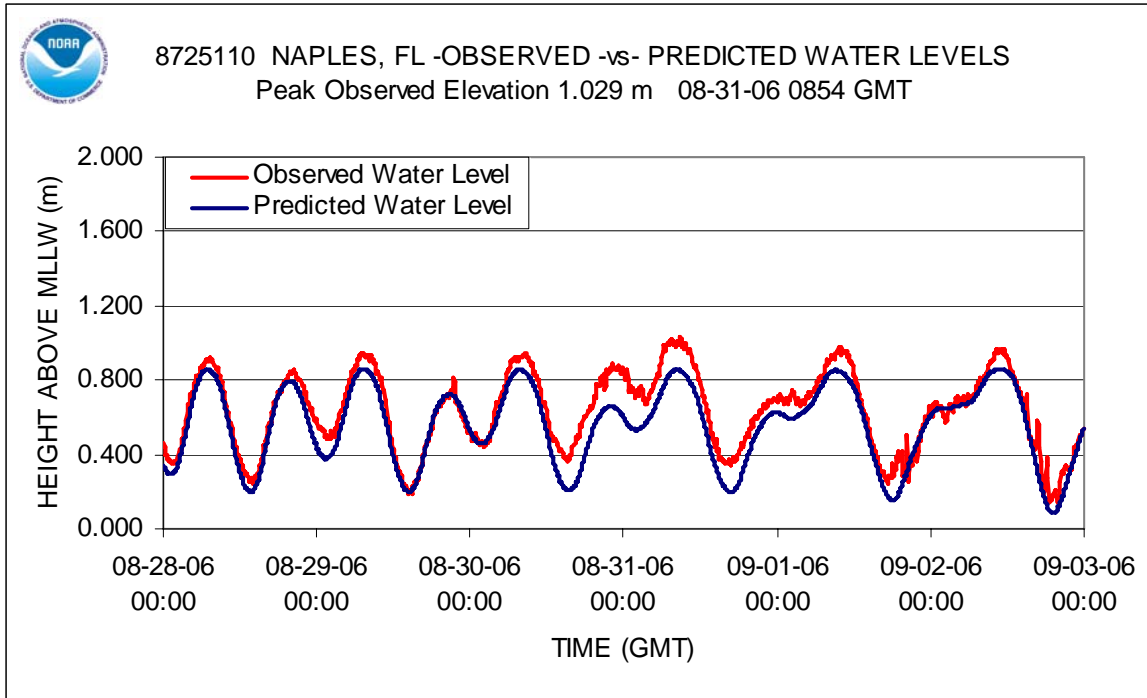


Figure 6. Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Naples, FL during Tropical Storm Ernesto.

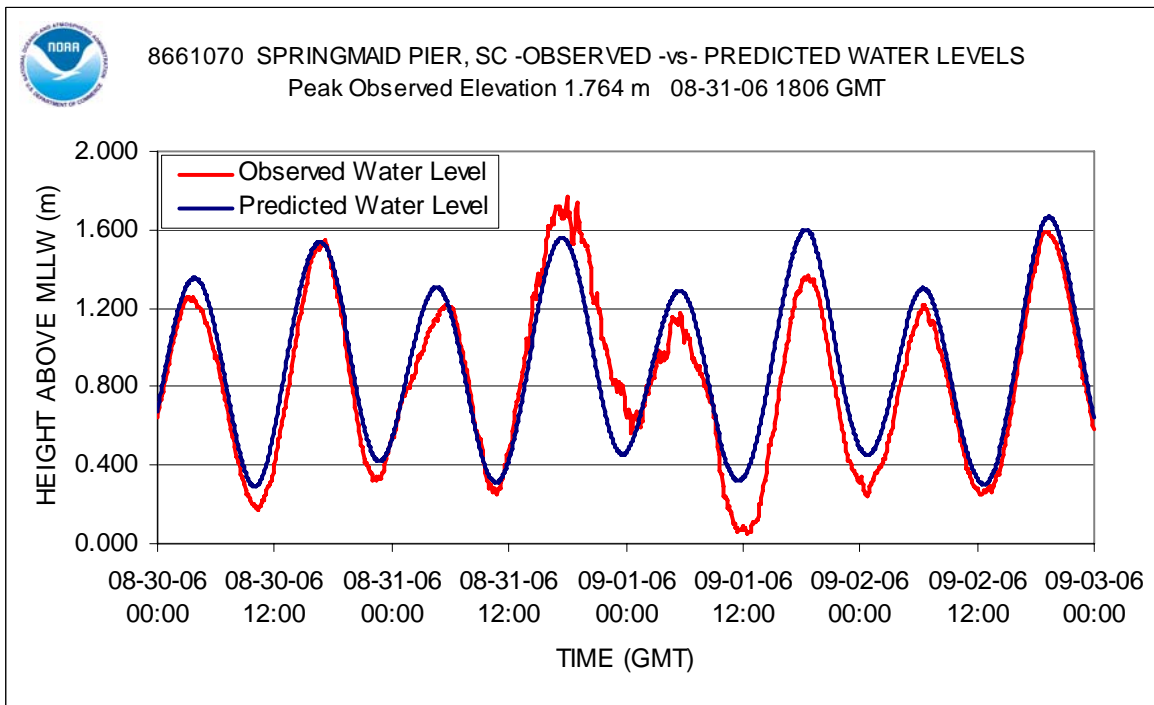


Figure 7. Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Springmaid Pier, SC during Tropical Storm Ernesto.

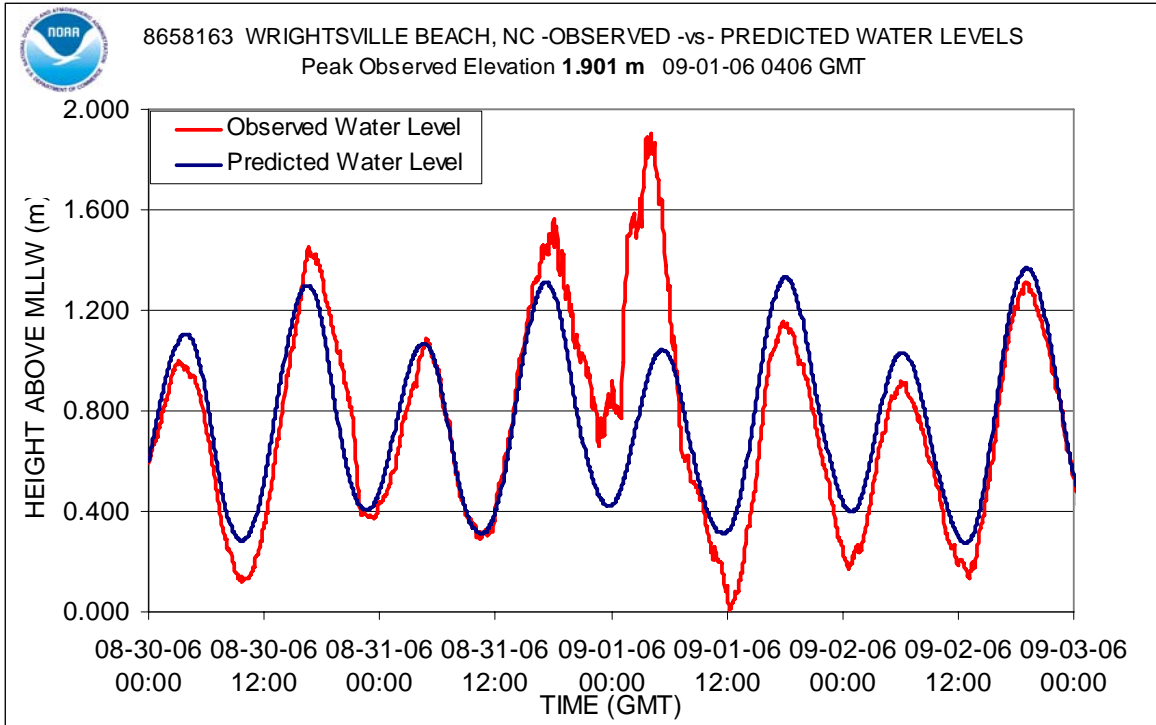


Figure 8. Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Wrightsville Beach, NC during Tropical Storm Ernesto.

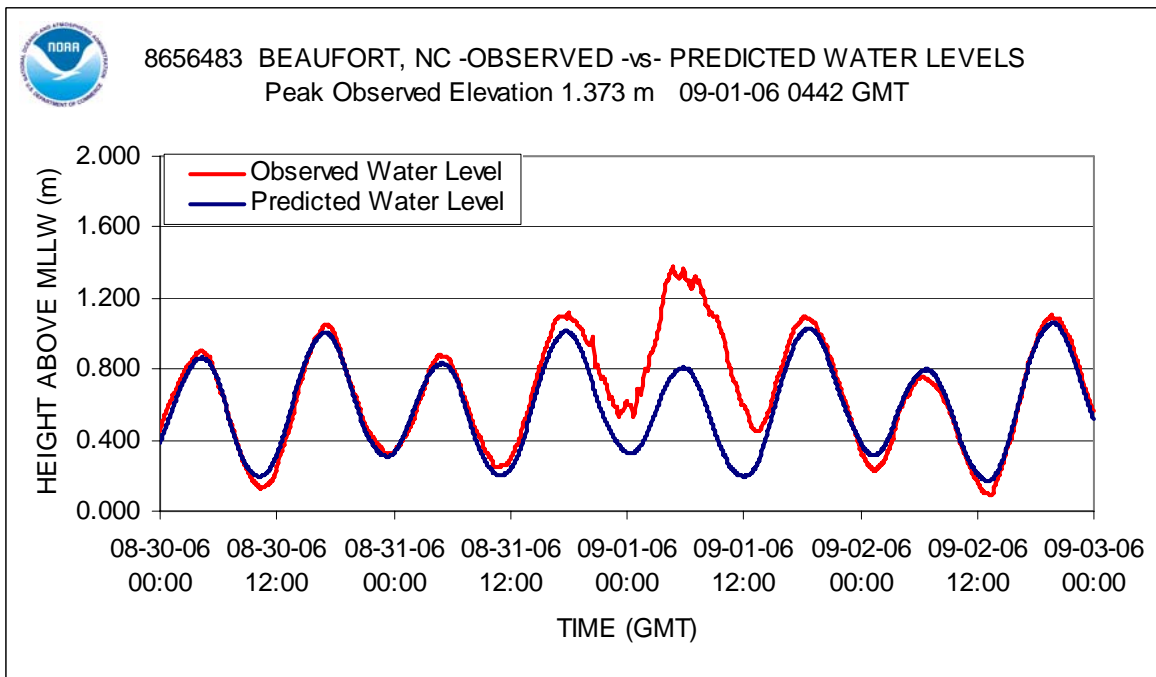


Figure 9. Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Beaufort, NC during Tropical Storm Ernesto.

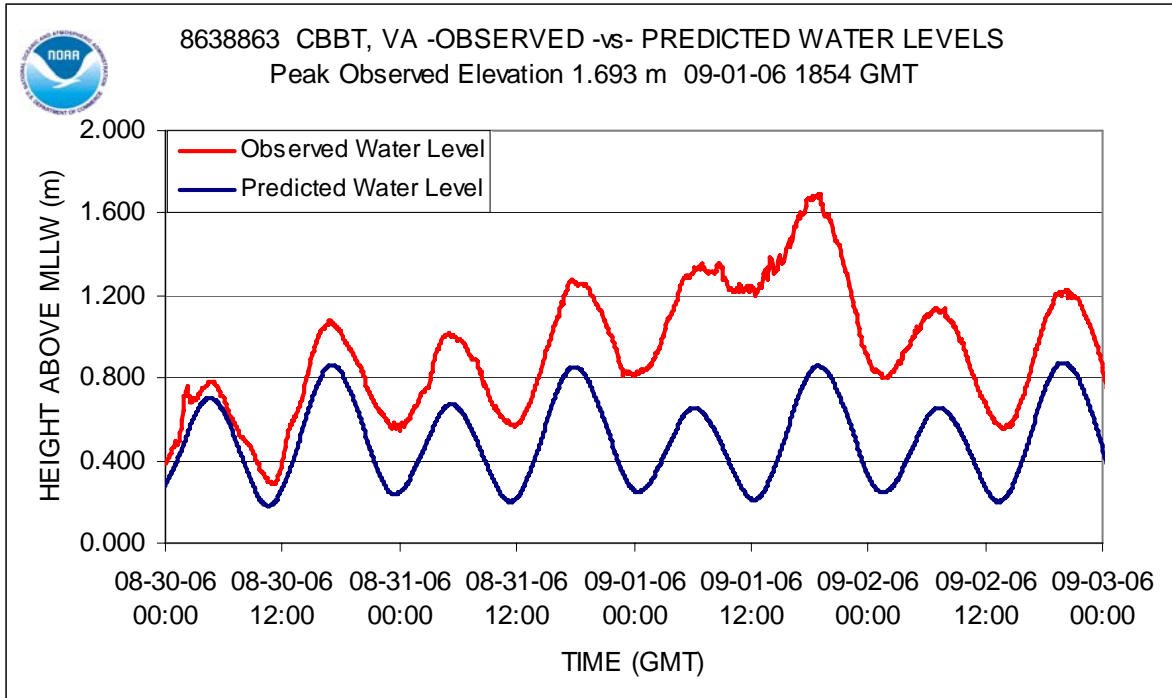


Figure 10. Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Chesapeake Bay Bridge Tunnel, VA during Tropical Storm Ernesto.

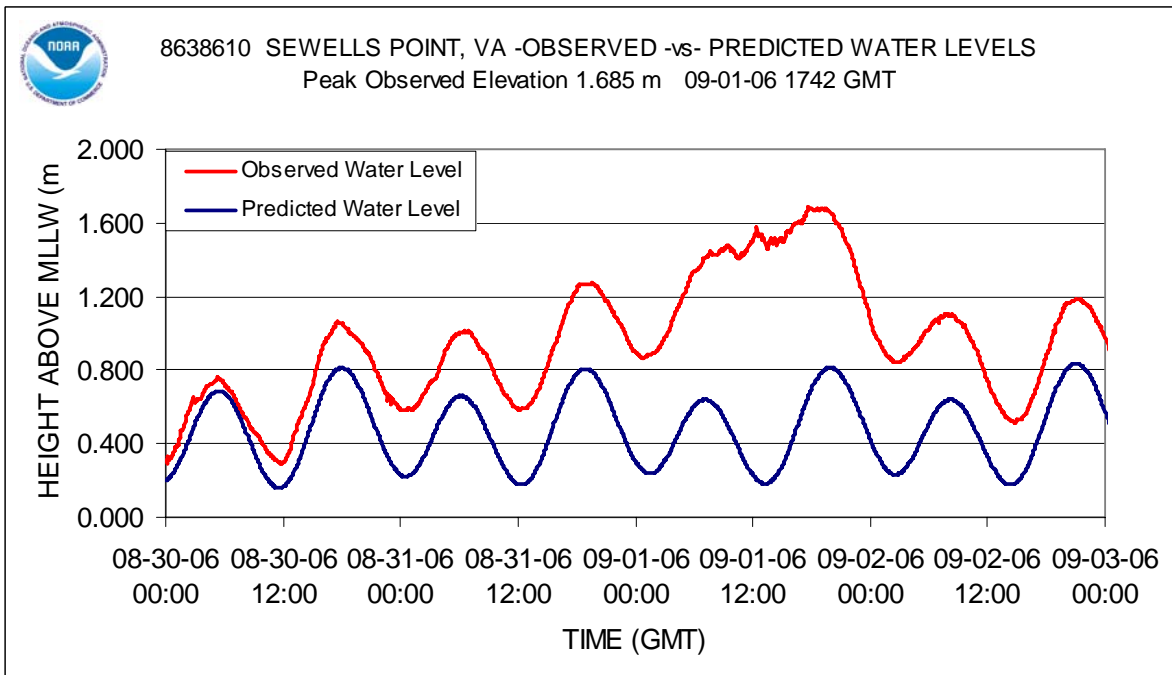


Figure 11. Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Sewells Point, VA during Tropical Storm Ernesto.

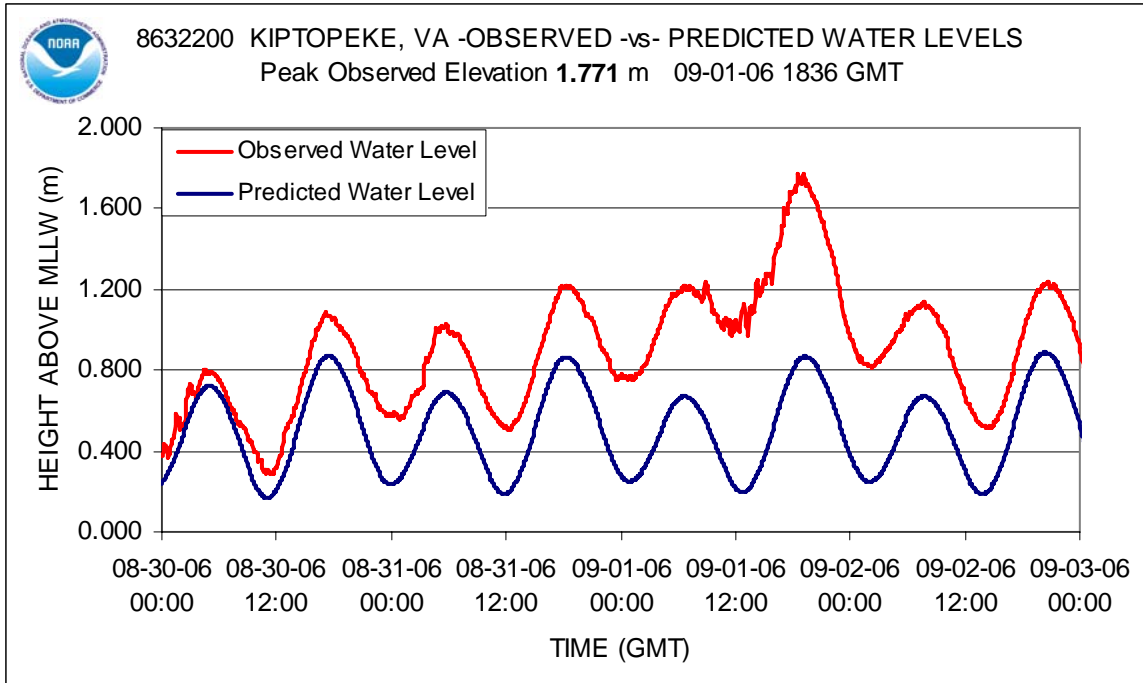


Figure 12. Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Kiptopeke, VA during Tropical Storm Ernesto.

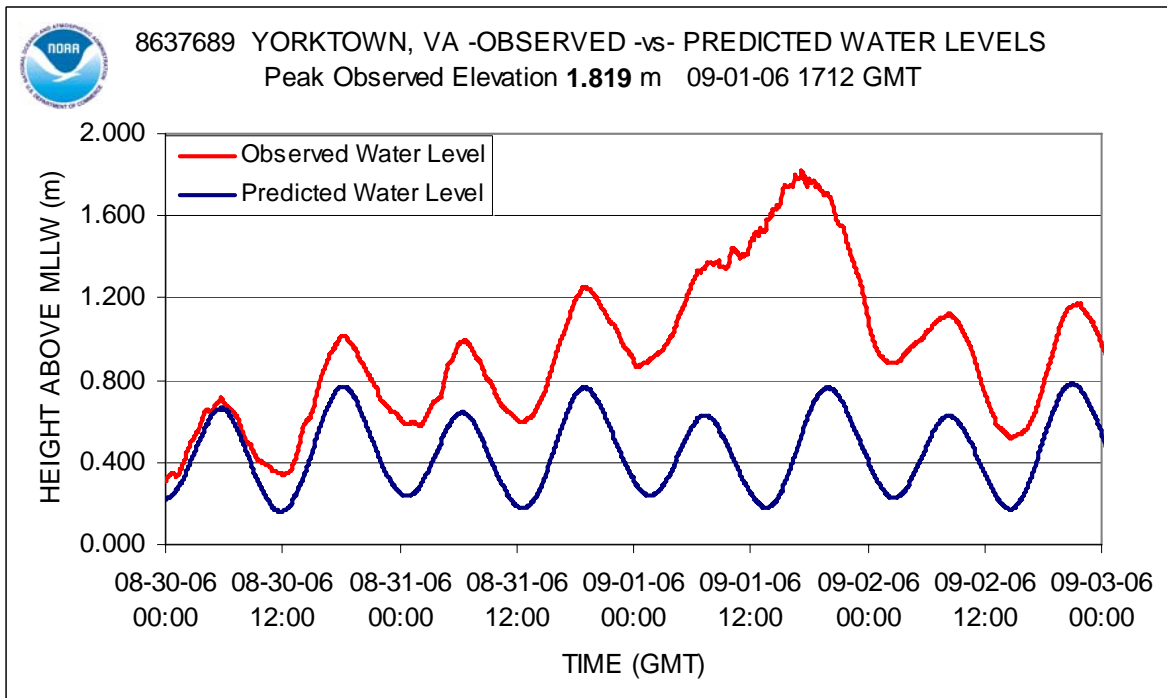


Figure 13. Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Yorktown, VA during Tropical Storm Ernesto.

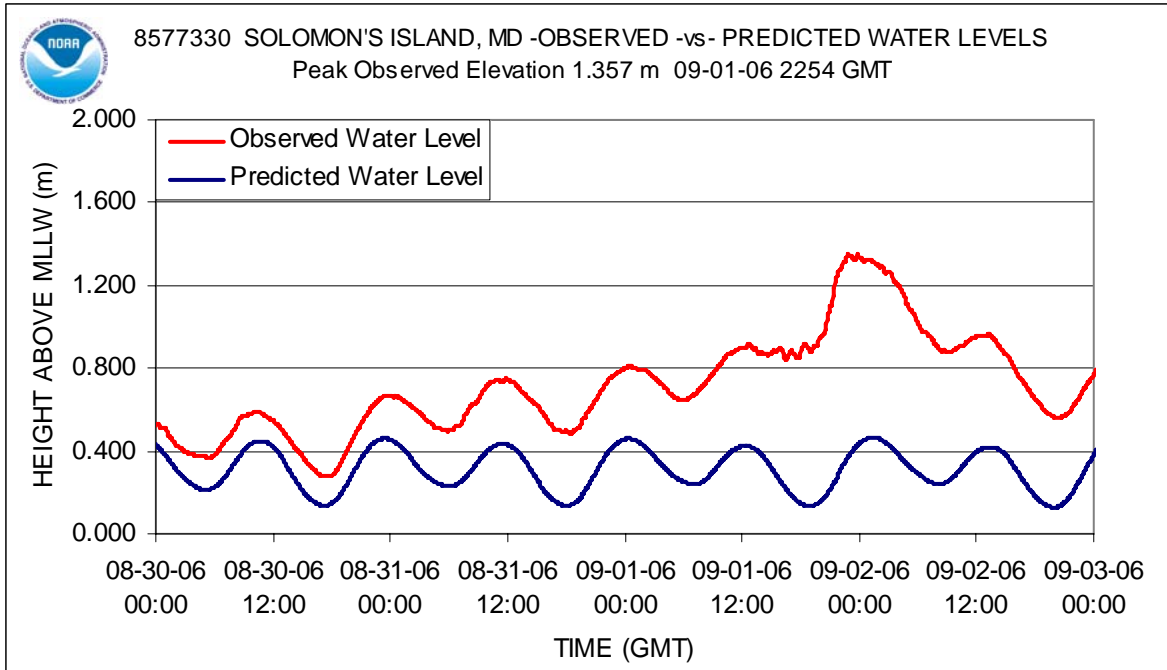


Figure 14. Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Solomon's Island, MD during Tropical Storm Ernesto.

APPENDIX 1

Station Name	Station ID	Latitude	Longitude
Solomans Island	8577330	38.32	-76.45
Kiptopeke	8632200	37.17	-75.99
Yorktown	8637689	37.23	-76.33
Sewells Point	8638610	36.95	-76.33
CBBT	8638863	36.97	-76.11
Beaufort	8656483	34.72	-76.67
Wrightsville Beach	8658163	34.21	-77.80
Springmaid Pier	8661070	33.66	-78.92
Virginia Key	8723214	25.73	-80.16
Vaca Key	8723970	24.71	-81.11
Key West	8724580	24.55	-81.81
Naples	8725110	26.13	-81.81

APPENDIX 2

Saffir-Simpson Scale for Hurricane Classification

	Wind Speed (Kts)	Wind Speed (MPH)	Pressure (mb)
Tropical Depression	20-34	23-38	
Tropical Storm	35-64	39-73	
Category 1	65-82	74-95	> 980
Category 2	83-95	96-110	965-979
Category 3	96-113	111-130	945-964
Category 4	114-135	131-155	920-944
Category 5	> 135	> 155	< 920

APPENDIX 3

EXCERPT FROM:

Tide and Current Glossary, NOAA National Ocean Service, Silver Spring, MD, 2000.

Bench mark (BM): A fixed physical object or mark used as reference for a horizontal or vertical datum. A tidal bench mark is one near a tide station to which the tide staff and tidal datums are referred. A primary bench mark is the principal mark of a group of tidal bench marks to which the tide staff and tidal datums are referred.

Chart datum: The datum to which soundings on a chart are referred. It is usually taken to correspond to a low-water elevation, and its depression below mean sea level is represented by the symbol Z. Since 1980, chart datum has been implemented to mean lower low water for all marine waters of the United States, its territories, Commonwealth of Puerto Rico, and Trust Territory of the Pacific Islands. See datum and National Tidal Datum Convention of 1980.

Datum (vertical): For marine applications, a base elevation used as a reference from which to reckon heights or depths. It is called a tidal datum when defined in terms of a certain phase of the tide. Tidal datums are local datums and should not be extended into areas which have differing hydrographic characteristics without substantiating measurements. In order that they may be recovered when needed, such datums are referenced to fixed points known as bench marks. See chart datum and bench marks.

Geodetic datum: See National Geodetic Vertical Datum of 1929 (NGVD 1929) and North American Vertical Datum of 1988 (NAVD 1988).

Mean Lower Low Water (MLLW): A tidal datum. The average of the lower low water height of each tidal day observed over the National Tidal Datum Epoch. See National Tidal Datum Epoch. For stations with shorter series, comparison of simultaneous observations with a control tide station is made in order to derive the equivalent datum of the National Tidal Datum Epoch.

North American Vertical Datum of 1988 (NAVD 1988): A fixed reference for elevations determined by geodetic leveling. The datum was derived from a general adjustment of the first-order terrestrial leveling nets of the United States, Canada, and Mexico. In the adjustment, only the height of the primary tidal bench mark, referenced to the International Great Lakes Datum of 1985 (IGLD 1985) local mean sea level height value, at Father Point, Rimouski, Quebec, Canada was held fixed, thus providing minimum constraint. NAVD 1988 and IGLD 1985 are identical. However, NAVD 1988 bench mark values are given in Helmert orthometric height units while IGLD 1985 values are in dynamic heights. See International Great Lakes Datum of 1985, National Geodetic Vertical Datum of 1929, and geopotential difference.

National Tidal Datum Convention of 1980: Effective November 28, 1980, the Convention: (1) establishes one uniform, continuous tidal datum system for all marine waters of the United States, its territories, Commonwealth of Puerto Rico, and Trust Territory of the Pacific Islands, for the first time in history; (2) provides a tidal datum system independent of computations based on type of tide; (3) lowers chart datum from mean low water to mean lower low water along the Atlantic coast of the United States; (4) updates the National Tidal Datum Epoch from 1941 through 1959, to 1960 through 1978; (5) changes the name Gulf Coast Low Water Datum to mean lower low water; (6) introduces the tidal datum of mean higher high water in areas of predominantly diurnal tides; and (7) lowers mean high water in areas of predominantly diurnal tides. See chart datum.

National Geodetic Vertical Datum of 1929 (NGVD 1929): A fixed reference adopted as a standard geodetic datum for elevations determined by leveling. The datum was derived for surveys from a general adjustment of the first-order leveling nets of both the United States and Canada. In the adjustment, mean sea level was held fixed as observed at 21 tide stations in the United States and 5 in Canada. The year indicates the time of the general adjustment. A synonym for Sea-level Datum of 1929. The geodetic datum is fixed and does not take into account the changing stands of sea level. Because there are many variables affecting sea level, and because the geodetic datum represents a best fit over a broad area, the relationship between the geodetic datum and local mean sea level is not consistent from one location to another in either time or space. For this reason, the National Geodetic Vertical Datum should not be confused with mean sea level. See North American Vertical Datum of 1988 (NAVD 1988).

National Tidal Datum Epoch: The specific 19-year period adopted by the National Ocean Service as the official time segment over which tide observations are taken and reduced to obtain mean values (e.g., mean lower low water, etc.) for tidal datums. It is necessary for standardization because of periodic and apparent secular trends in sea level. The present National Tidal Datum Epoch is 1960 through 1978. It is reviewed annually for possible revision and must be actively considered for revision every 25 years.

National Water Level Observation Network (NWLON): The network of tide and water level stations operated by the National Ocean Service along the marine and Great Lakes coasts and islands of the United States.

Storm Surge:

An abnormal rise in sea level accompanying a hurricane or other intense storm, and whose height is the difference between the observed level of the sea surface and the level that would have occurred in the absence of the cyclone. Storm surge is usually estimated by subtracting the normal or astronomic high tide from the observed storm tide

Storm Tide:

The actual level of sea water resulting from the astronomic tide combined with the storm surge

Storm surge: The local change in the elevation of the ocean along a shore due to a storm. The storm surge is measured by subtracting the astronomic tidal elevation from the total elevation. It typically has a duration of a few hours. Since wind generated waves ride on top of the storm surge (and are not included in the definition), the total instantaneous elevation may greatly exceed the predicted storm surge plus astronomic tide. It is potentially catastrophic, especially on low lying coasts with gently sloping offshore topography. See storm tide.

Storm tide: As used by the National Weather Service, NOAA, the sum of the storm surge and astronomic tide. See storm surge and tide.

Tide: The periodic rise and fall of a body of water resulting from gravitational interactions between Sun, Moon, and Earth. The vertical component of the particulate motion of a tidal wave. Although the accompanying horizontal movement of the water is part of the same phenomenon, it is preferable to designate this motion as tidal current. Same as astronomic tide.

Tide (water level) gauge: An instrument for measuring the rise and fall of the tide (water level).

For further information on tides, tidal predictions, tidal datums and related publications,
contact:

NOAA, National Ocean Service
CO-OPS, Products and Services N/OPS3
Attn: User Services
1305 East-West Highway
Silver Spring, MD 20190-3281

(301) 713-2877 Ext. 176
Fax: (301) 713-4437