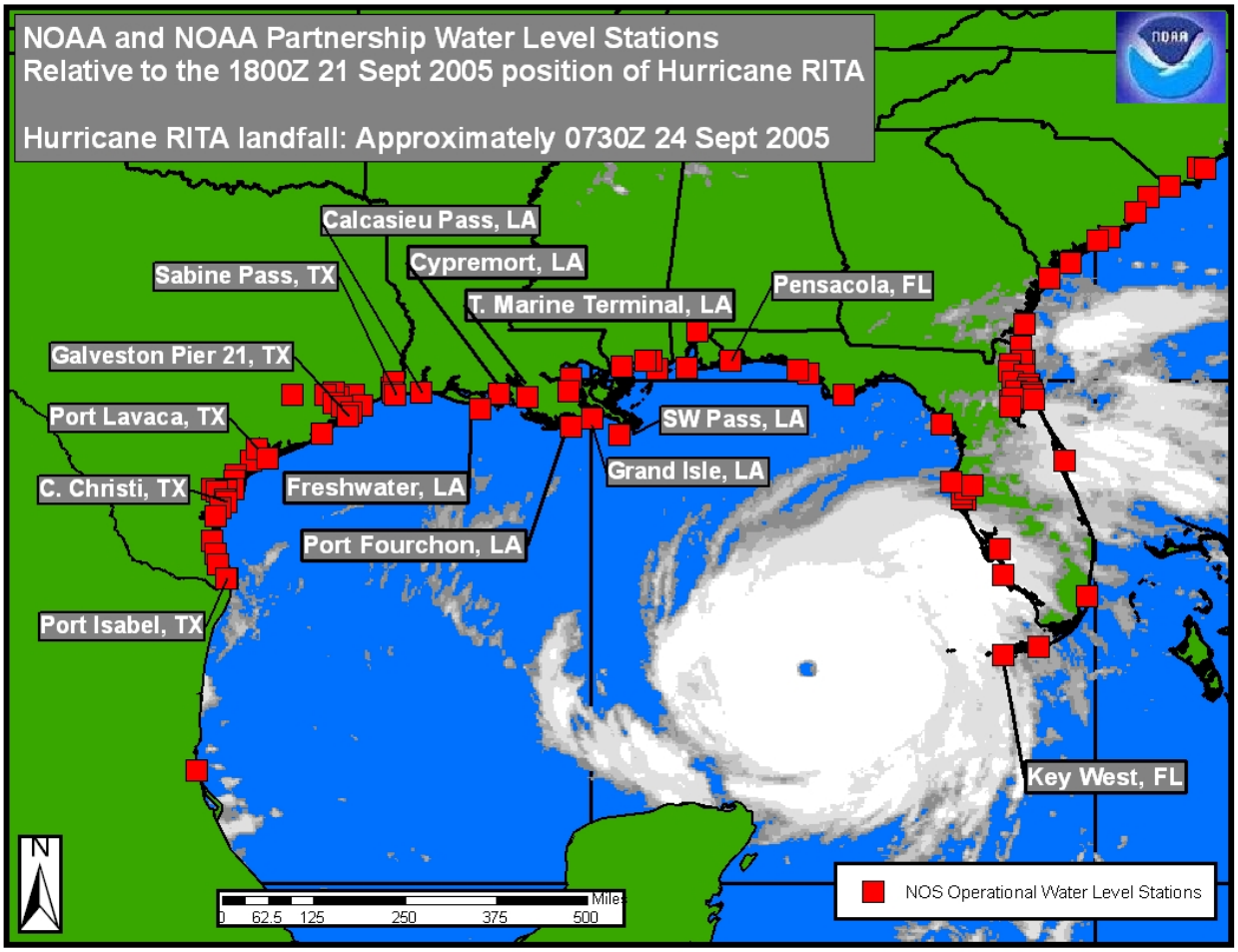
Hurricane Rita Preliminary Water Levels Report



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

October 14, 2005

noaa **National Oceanic and Atmospheric Administration**

U.S. DEPARTMENT OF COMMERCE
National Ocean Service
Center for Operational Oceanographic Products and Services

SUMMARY

Water Level stations operated by NOAA's National Ocean Service, Center for Operational Oceanographic Products and Services (CO-OPS) recorded elevated water levels during the landfall of Hurricane RITA from Vaca Key, FL to Port Isabel, TX. Station location information is contained in Appendix 1. All water level observations are measured above the standard chart datum Mean Lower Low Water (MLLW), based on the National Tidal Datum Epoch 1983-2001 (see Appendix 2). Water level heights are plotted in meters, and tabular values are given in both feet and meters. This report summarizes the highest observed water levels, referred to as the Storm Tide, which is the sum of the storm surge and the astronomic tide. Differences between observed water levels and predicted astronomical tides are also provided. For the purposes of this preliminary report, any occurrence of Storm Tide Anomoly is discounted.

Hurricane RITA made landfall on **24 September 2005 at 2:38 CDT (7:38 GMT)**, between Sabine Pass , TX and Johnson's Bayou, LA (Figure 1). RITA was the seventeenth named storm and second Category – 5 hurricane of the 2005 Atlantic hurricane season. The storm was the third most intense Atlantic hurricane on record reaching sustained winds of 175 mph and barometric pressure of 897 mb as it crossed the Gulf of Mexico on 21 September 2005 (Cover Image). At landfall near the border of Texas and Louisiana Rita was a Category – 3 hurricane with sustained winds of 120 mph and barometric pressure of 937 mb.

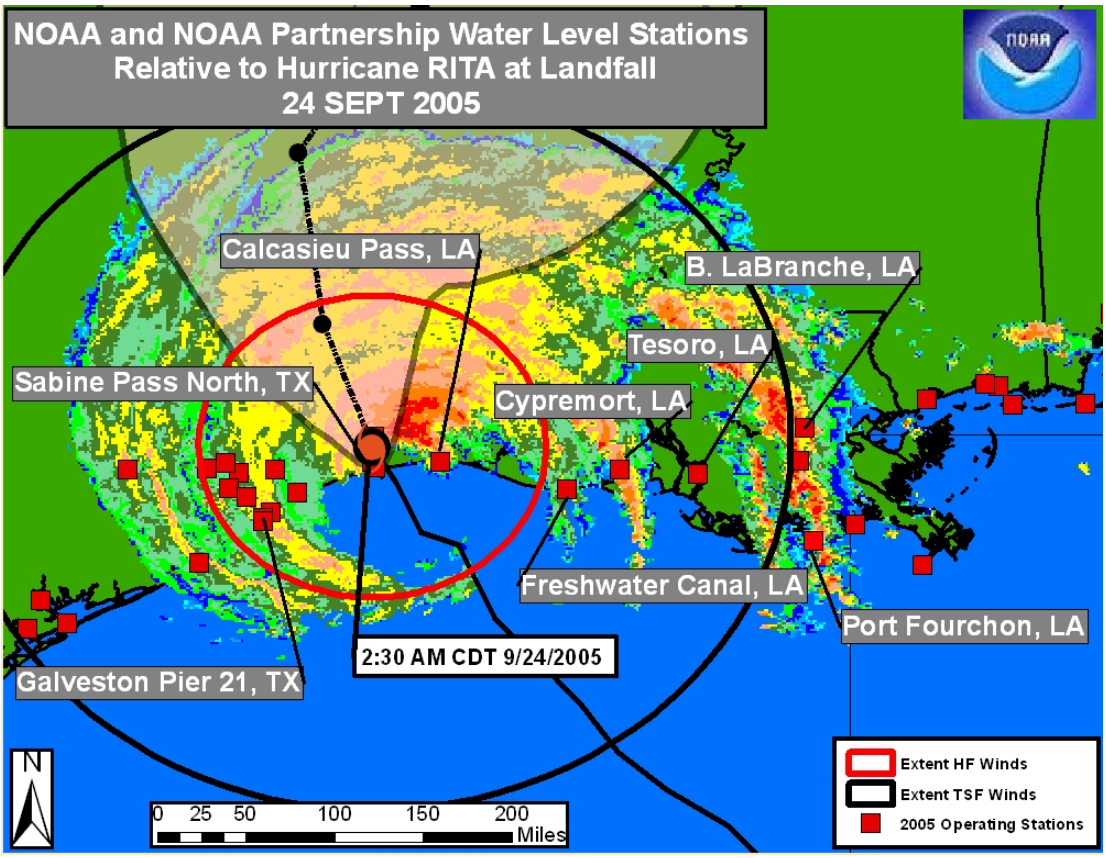


Figure 1: Regional overview of water level stations impacted by Hurricane RITA showing extent of hurricane and tropical storm force winds during landfall.

CO-OPS recorded initial elevated water levels as RITA passed just south of Key West, FL on 20 September 2005. The storm's major impact on Florida occurred in the greater Tampa Bay area elevating water levels at Cedar Key (1.827m, 5.99ft), Clearwater Beach (1.557m, 5.11ft) McKay Bay (1.375m, 4.51ft), Old Port Tampa (1.320m, 4.33ft), St Pete (1.292m, 4.24ft) and Naples (1.356m, 4.45ft).

During landfall on 24 September 2005 Sabine Pass, TX and Freshwater Canal, LA recorded the greatest storm tides of **1.942m (6.37ft)** and **1.872m (6.14ft)** above MLLW respectively. However, both water level sensors ceased transmitting on 24 September at approximately 0500 GMT and did not record maximum elevations (Table 1; Figure 3,4). The observed water levels above the predicted astronomical tides for those stations was 1.351m (4.43ft) and 1.500m (4.92ft)**.** Rollover Pass, TX **1.840m (6.04ft)** had the next highest storm tide, with successful sensor transmission during the Hurricane. The observed water level was 1.372m (4.50ft) above the predicted astronomical tide. Calcasieu Pass, LA, also damaged by the storm, recorded a storm tide of **1.652m (5.42ft).**

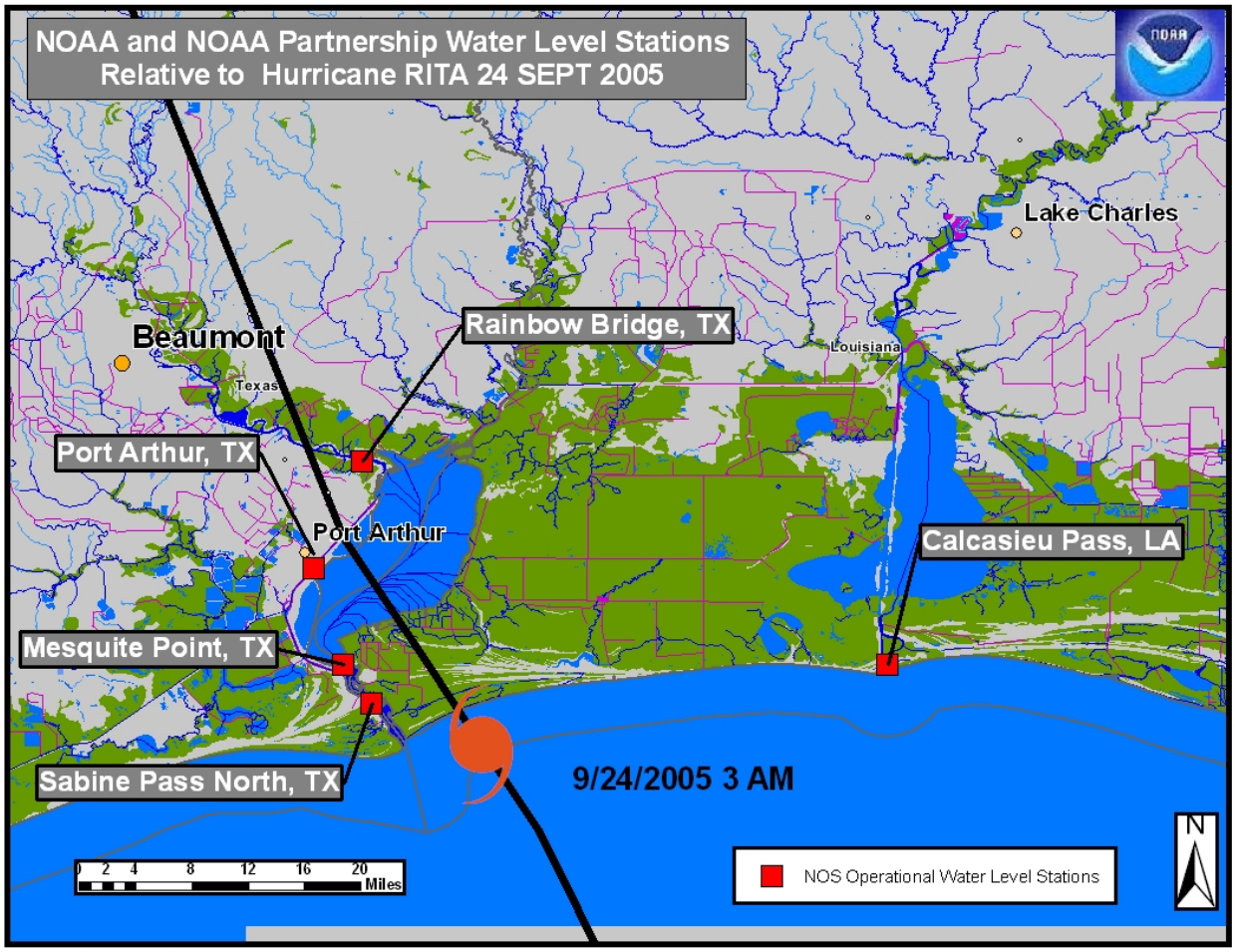


Figure 2: Track of Hurricane RITA and NOAA water level stations in the immediate vicinity of landfall between Sabine Pass, TX and Johnson's Bayou, LA on 24 September 2005 approx. 2:30 CDT.

Table 1: **Maximum water levels** for Hurricane RITA, September 2005.

*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.

Station Name	Station ID	Date & Time (GMT)	Max Water Level above MLLW (m)	Predicted Water Levels (m)	Difference (m)	Max Water Level above MLLW (ft)	Predicted Water Levels (ft)	Difference (ft)
[2]Sabine Pass North, TX	8770570	09-24-05 05:54	1.942	0.591	1.351	6.37	1.94	4.43
[1]Freshwater Canal, LA	8766072	09-23-05 23:12	1.872	0.372	1.500	6.14	1.22	4.92
Rollover Pass, TX	8770971	09-24-05 13:12	1.840	0.468	1.372	6.04	1.54	4.50
Cedar Key, FL	8727520	09-22-05 08:24	1.827	1.260	0.567	5.99	4.13	1.86
[1]Calcasieu Pass, LA	8768094	09-24-05 02:00	1.652	0.673	0.979	5.42	2.21	3.21
Tesoro Marine Terminal, LA	8764044	09-24-05 18:06	1.606	0.050	1.556	5.27	0.16	5.11
Clearwater Beach, FL	8726724	09-22-05 06:18	1.557	0.963	0.594	5.11	3.16	1.95
Corpus Christi, TX	8775870	09-24-05 00:54	1.543	0.552	0.991	5.06	1.81	3.25
Port Fourchon, LA	8762075	09-24-05 07:00	1.524	0.591	0.933	5.00	1.94	3.06
3E. Bank, B. Labranche, LA	8762372	09-24-05 18:12	1.511	0.137	1.374	4.96	0.45	4.51
Galveston Pleasure Pier, TX	8771510	09-23-05 03:42	1.428	0.757	0.671	4.69	2.48	2.20
Grand Isle, LA	8761724	09-24-05 06:54	1.428	0.489	0.939	4.69	1.60	3.08
Freeport, TX	8772440	09-24-05 05:12	1.380	0.645	0.735	4.53	2.12	2.41
Mckay Bay Entrance, FL	8726667	09-22-05 08:30	1.375	0.938	0.437	4.51	3.08	1.43
Port Arthur, TX	8770475	09-24-05 08:24	1.363	0.402	0.961	4.47	1.32	3.15
Naples, FL	8725110	09-21-05 20:06	1.356	0.856	0.500	4.45	2.81	1.64
Old Port Tampa, FL	8726607	09-22-05 08:12	1.320	0.903	0.417	4.33	2.96	1.37
St. Petersburg, FL	8726520	09-22-05 07:42	1.292	0.817	0.475	4.24	2.68	1.56
Virginia Key, FL	8723214	09-20-05 16:00	1.269	0.858	0.411	4.16	2.82	1.35
Port Manatee, FL	8726384	09-22-05 07:06	1.261	0.803	0.458	4.14	2.63	1.50
Dauphin Island, AL	8735180	09-23-05 08:18	1.233	0.520	0.713	4.05	1.71	2.34
Galveston Bay, N. Jetty, TX	8771341	09-25-05 07:24	1.231	0.621	0.610	4.04	2.04	2.00
Apalachicola, FL	8728690	09-22-05 10:30	1.216	0.581	0.635	3.99	1.91	2.08
Lower Bryant Landing, AL	8737373	09-25-05 11:06	1.188	0.606	0.582	3.90	1.99	1.91
Rainbow Bridge, TX	8770520	09-25-05 10:00	1.184	0.362	0.822	3.88	1.19	2.70
Galveston Pier 21, TX	8771450	09-23-05 13:24	1.161	0.439	0.722	3.81	1.44	2.37
SW Pass, LA	8760922	09-23-05 07:18	1.132	0.483	0.649	3.71	1.58	2.13
Pensacola, FL	8729840	09-23-05 07:00	1.119	0.576	0.543	3.67	1.89	1.78
Manchester, TX	8770777	09-25-05 13:06	1.117	0.580	0.537	3.66	1.90	1.76
Port Aransas, TX	8775237	09-24-05 11:00	1.096	0.392	0.704	3.60	1.29	2.31
Eagle Point, TX	8771013	09-23-05 15:12	1.088	0.423	0.665	3.57	1.39	2.18
Port Isabel, TX	8779770	09-24-05 06:06	1.085	0.559	0.526	3.56	1.83	1.72
Battleship TX. St. Park, TX	8770743	09-25-05 12:24	1.083	0.659	0.424	3.55	2.16	1.39
Morgans Point, TX	8770613	09-25-05 12:18	1.052	0.557	0.495	3.45	1.83	1.62
S. Padre Is. C.G Sta, TX	8779748	09-24-05 06:12	1.048	0.522	0.526	3.44	1.71	1.73
Key West, FL	8724580	09-21-05 03:00	1.047	0.673	0.374	3.44	2.21	1.23
Panama City Beach, FL	8729210	09-23-05 04:00	1.047	0.596	0.451	3.44	1.96	1.48
Panama City, FL	8729108	09-23-05 05:18	0.982	0.550	0.432	3.22	1.80	1.42
Texas State Aquarium, TX	8775296	09-24-05 14:18	0.867	0.260	0.607	2.84	0.85	1.99
W. Bank 1, B. Gauche, LA	8762482	09-25-05 18:30	0.769	0.062	0.707	2.52	0.20	2.32
Rockport, TX	8774770	09-24-05 14:00	0.757	0.208	0.549	2.48	0.68	1.80
Seadrift, TX	8773037	09-24-05 14:06	0.755	0.130	0.625	2.48	0.43	2.05
Packery Channel, TX	8775792	09-24-05 14:00	0.755	0.218	0.537	2.48	0.72	1.76
Fort Myers, FL	8725520	09-22-05 09:48	0.748	0.488	0.260	2.45	1.60	0.85
Vaca Key, FL	8723970	09-20-05 07:42	0.607	0.393	0.214	1.99	1.29	0.70
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[1] WL Station severely damaged by storm
[2] WL Station destroyed by storm
[3] Primary water level sensor malfunction

Table 2: **Maximum water levels in geographic order** for Hurricane RITA, September 2005.

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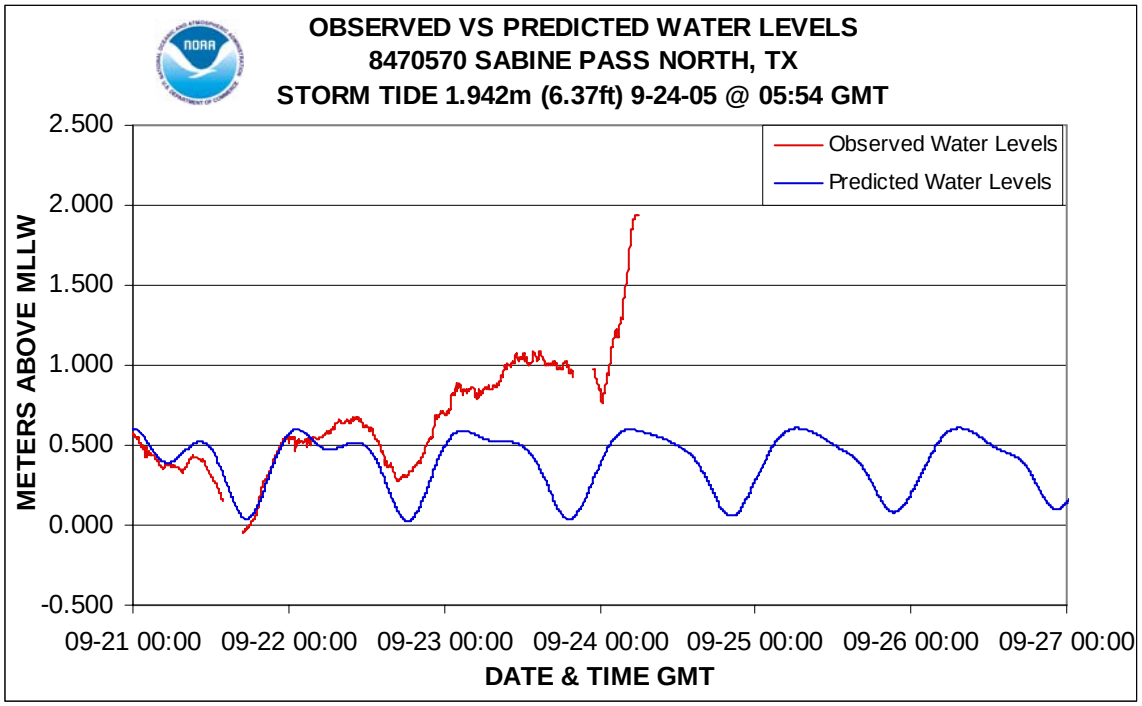

Figure 3: Time series of observed and predicted water above Mean Lower Low Water (MLLW) at Sabine Pass, TX, during Hurricane RITA.

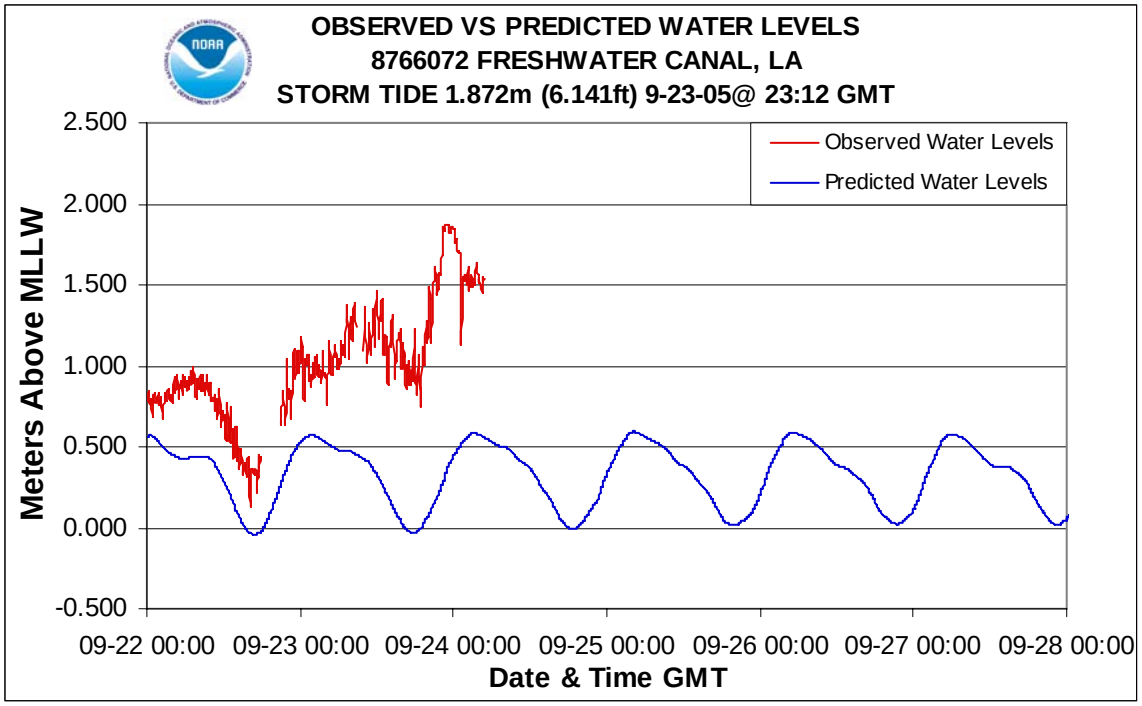

Figure 4: Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Freshwater Canal, LA, during Hurricane RITA.

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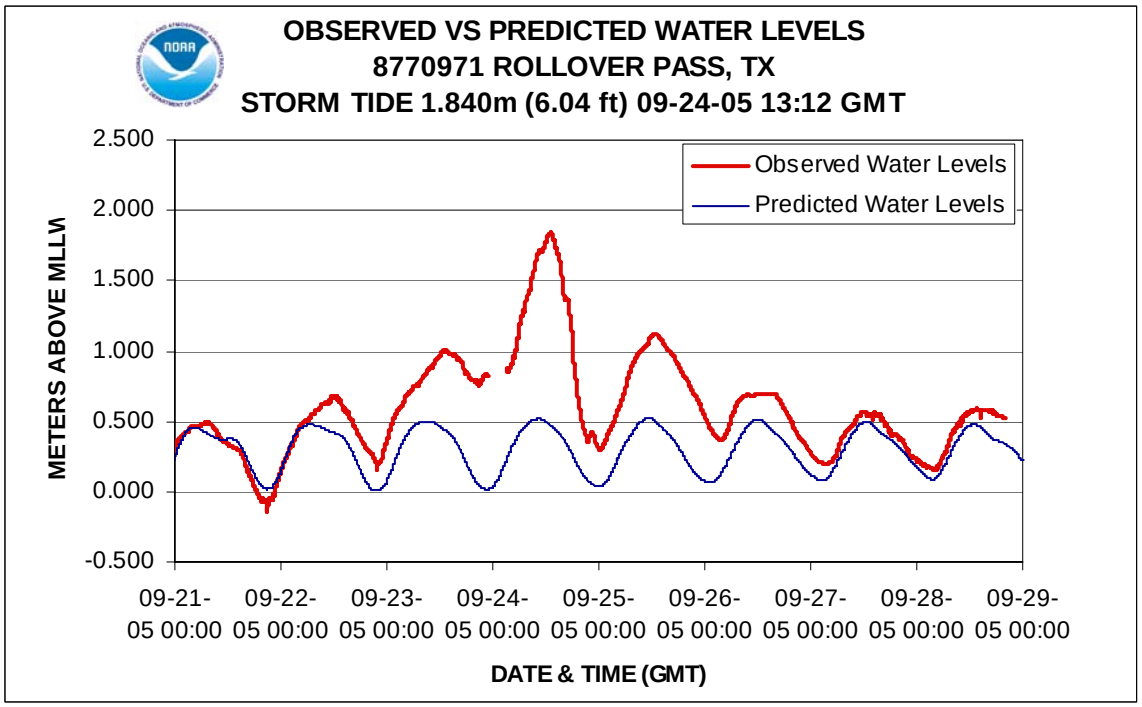

Figure 5: Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Rollover Pass, TX during Hurricane RITA.

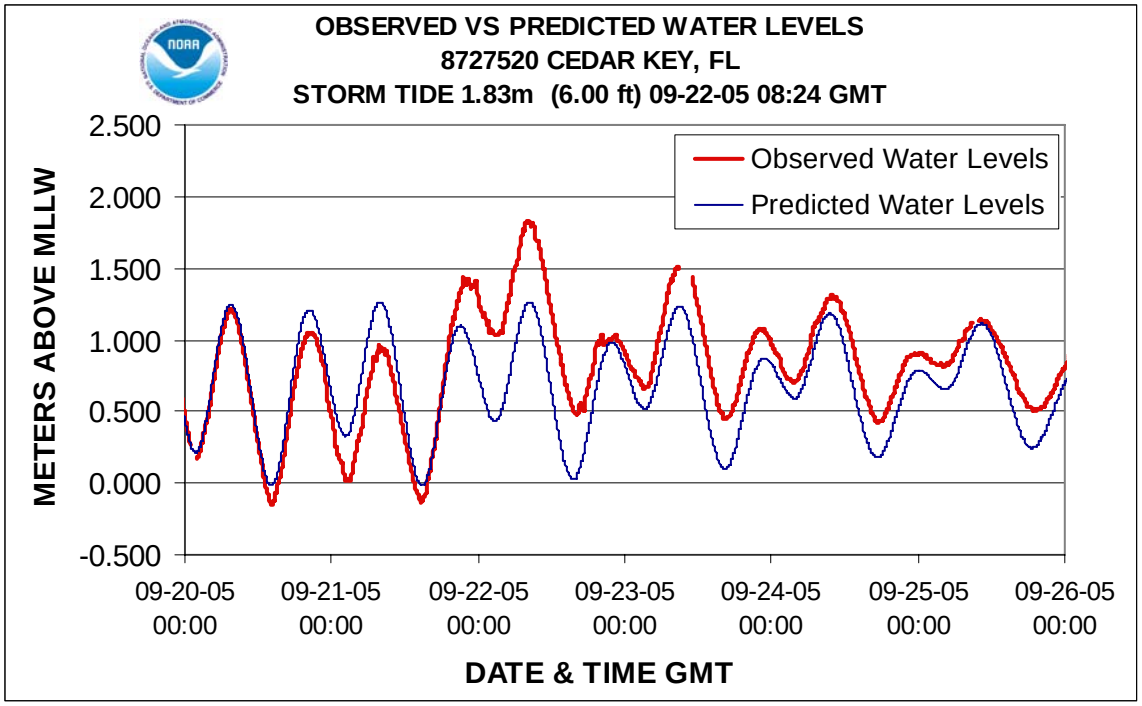

Figure 6: Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Cedar Key, FL during Hurricane RITA.

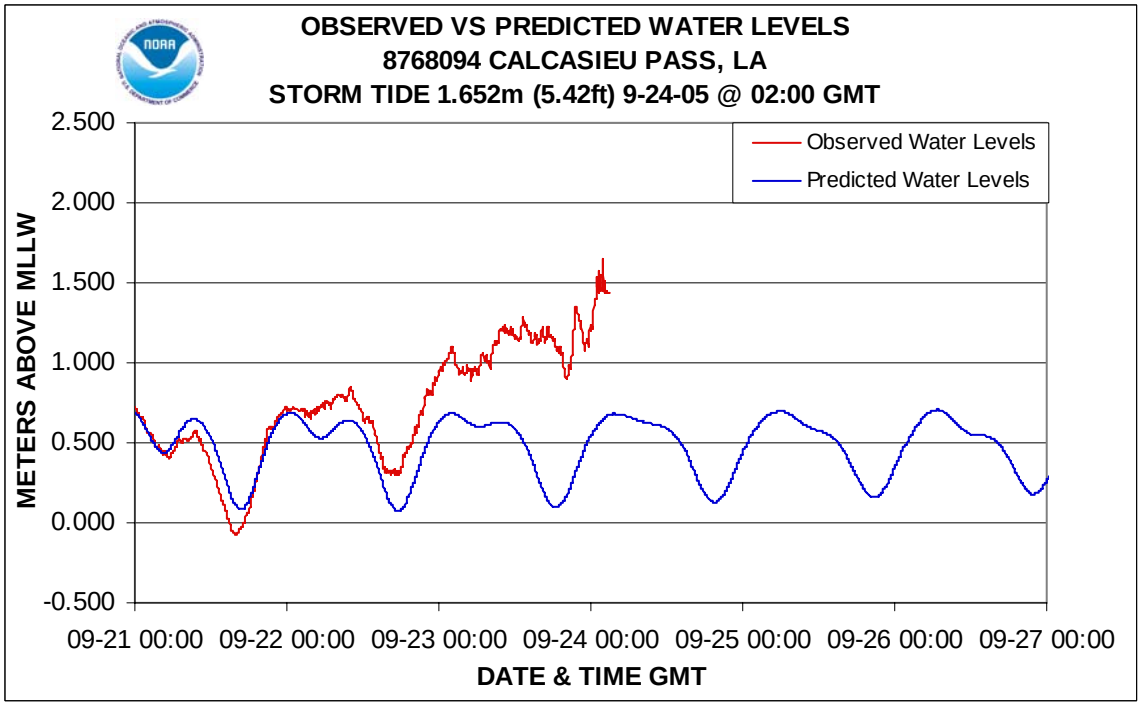

Figure 7: Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Calcasieu Pass,LA during Hurricane RITA.

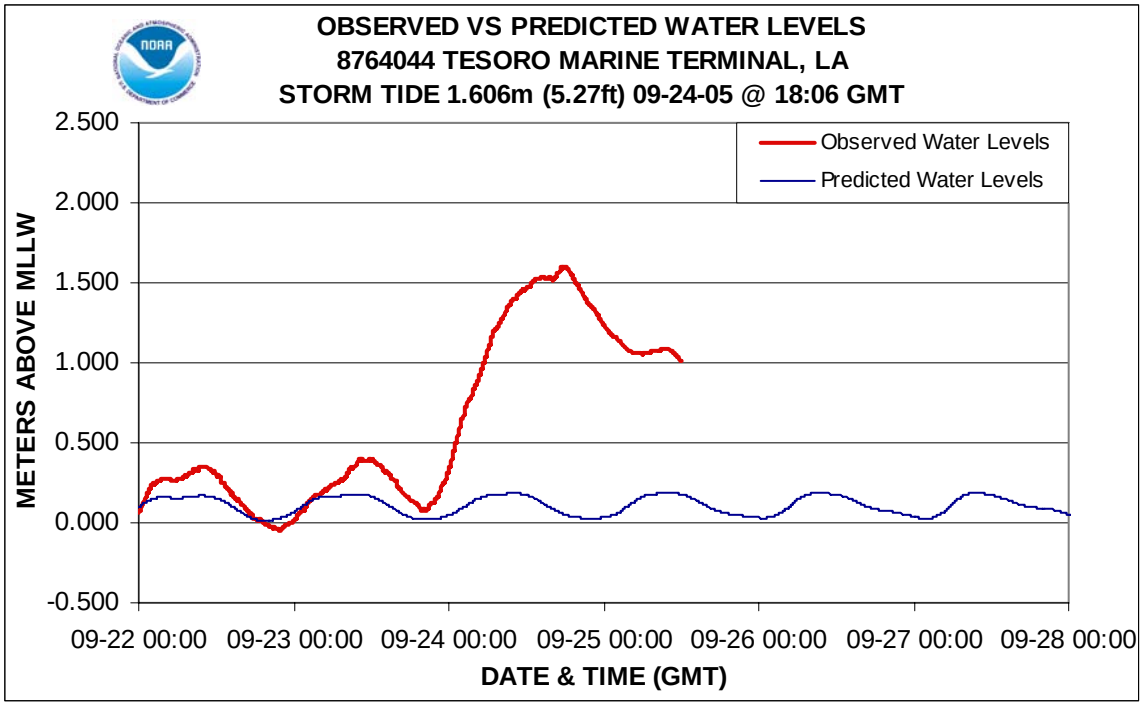

Figure 8: Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Tesoro Martine Terminal, LA, during Hurricane RITA.

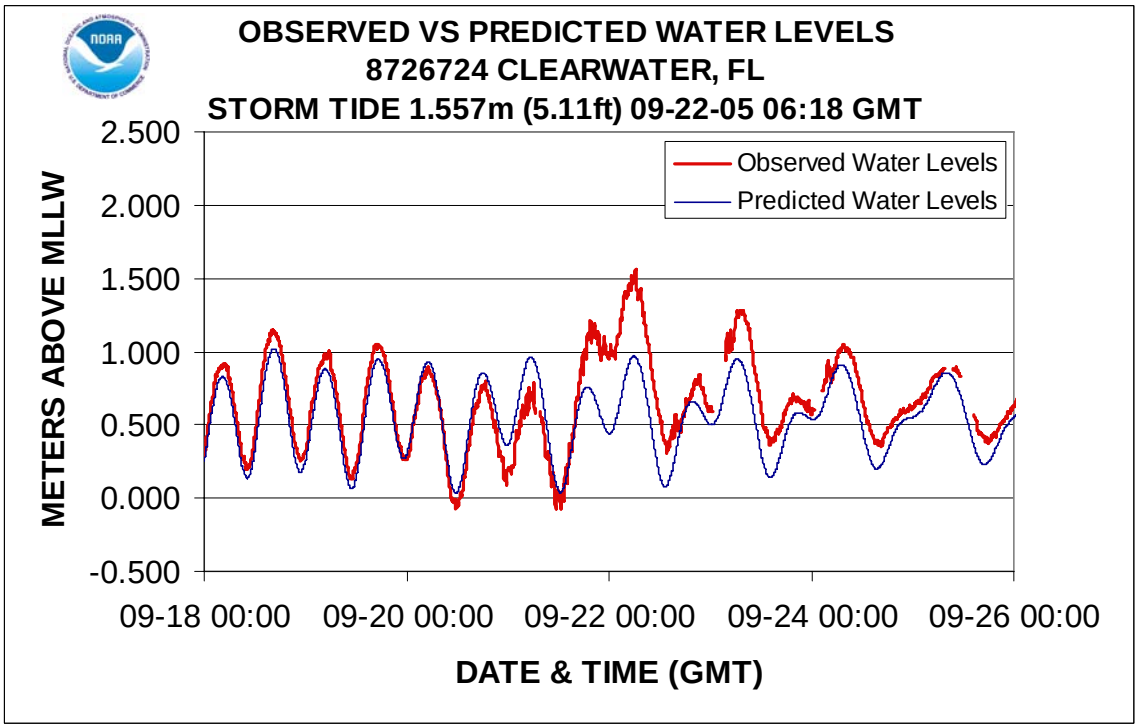

Figure 9: Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Clearwater, FL, during Hurricane RITA.

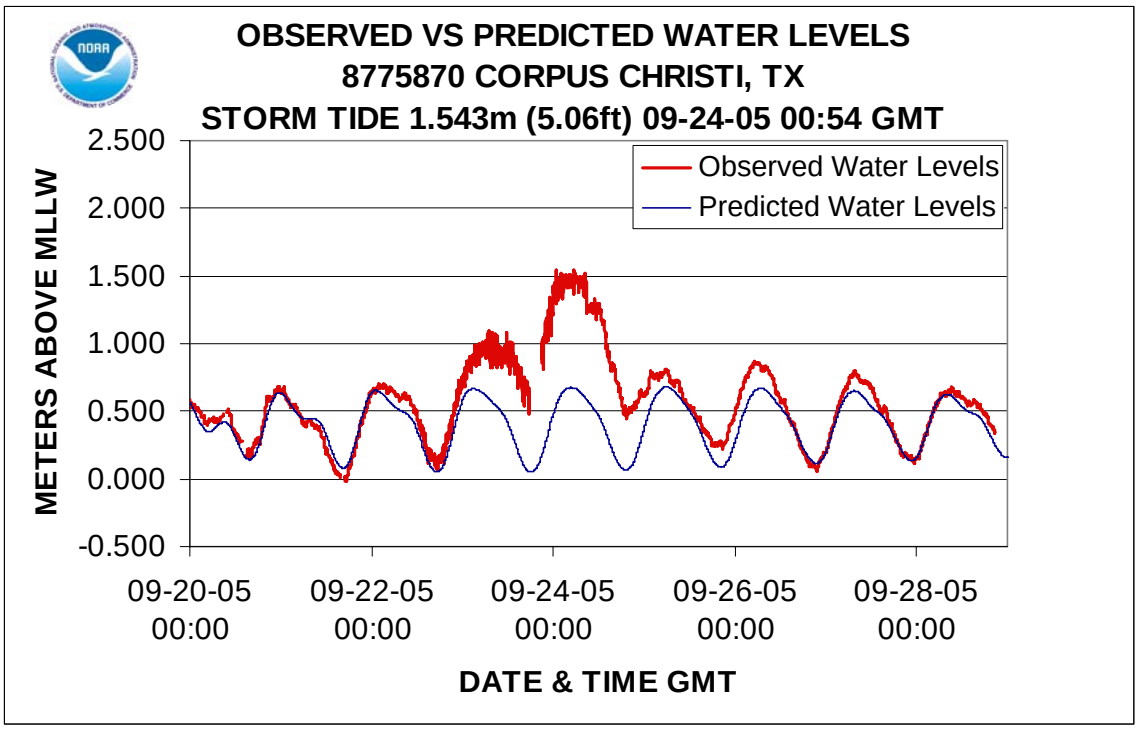

Figure 10: Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Corpus Christi, TX during Hurricane RITA.

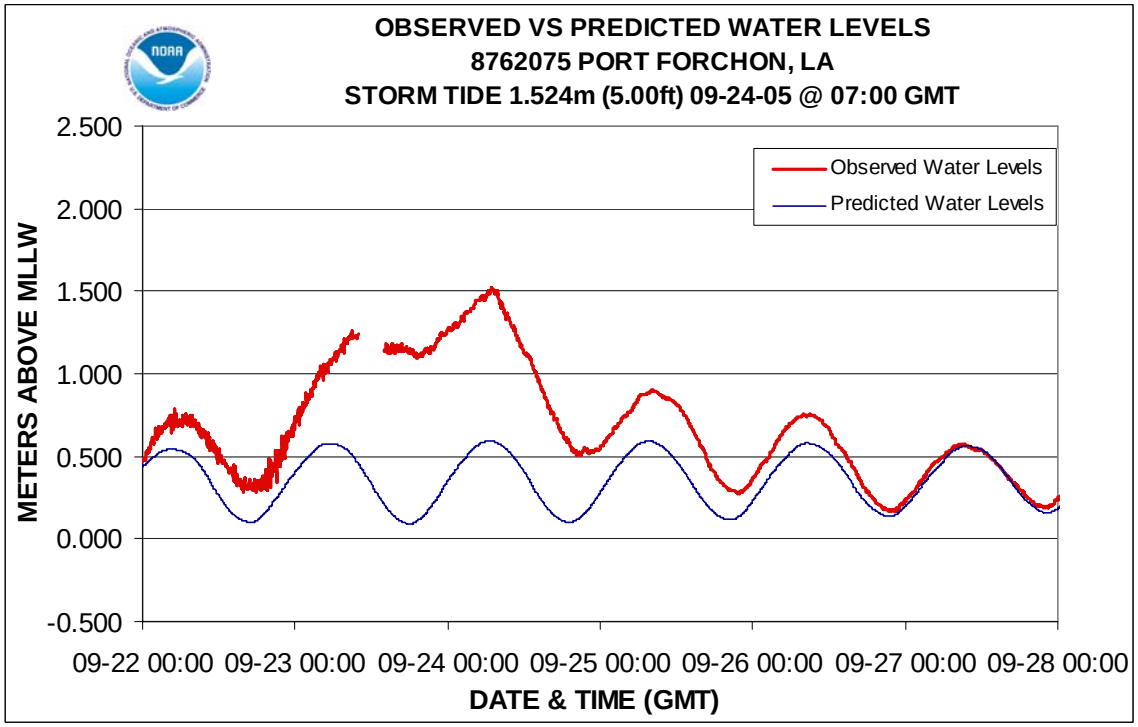

Figure 11: Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Port Fourchon, LA during Hurricane RITA.

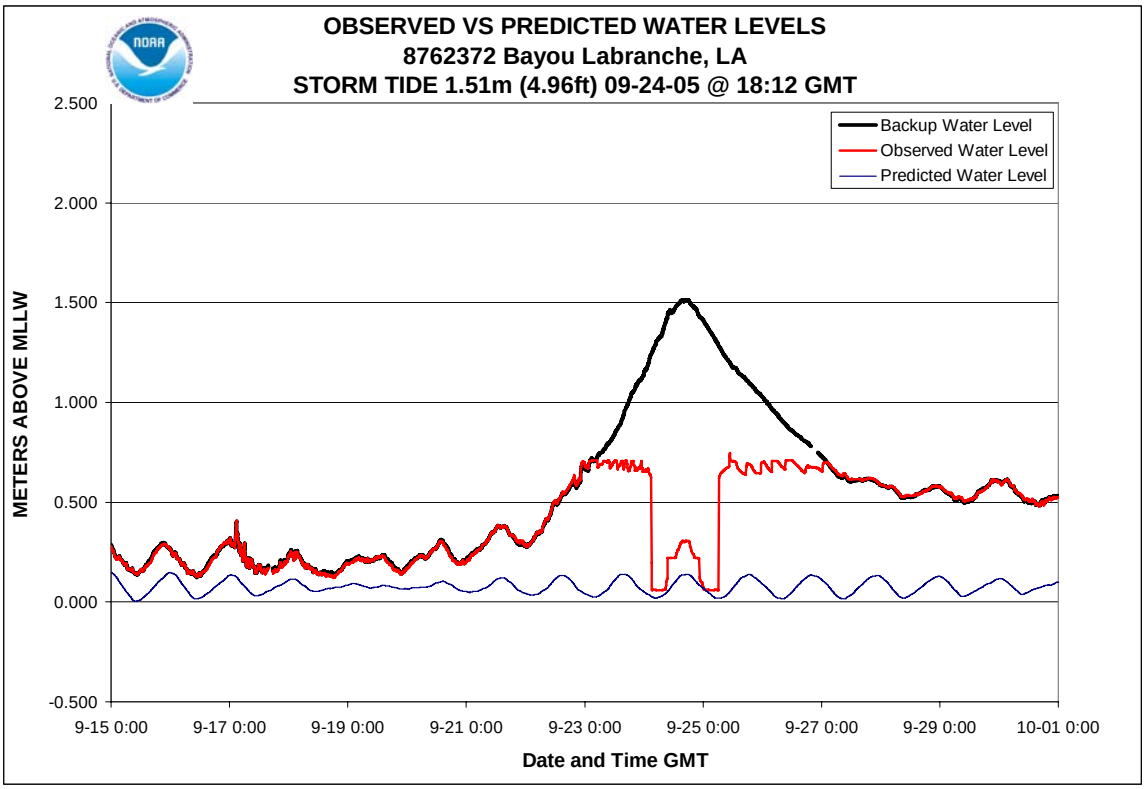

Figure 12: Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at East Bank, Bayou Labranche, LA during Hurricane RITA.

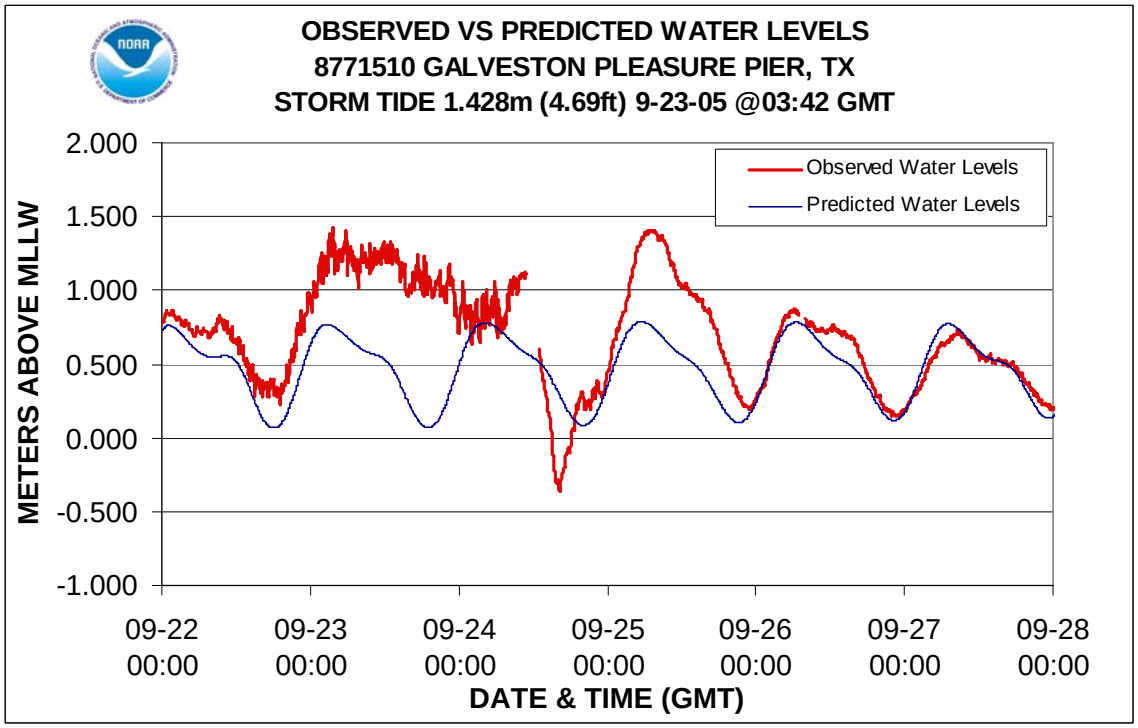

Figure 13: Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Galveston Pleasure Pier, TX during Hurricane RITA.

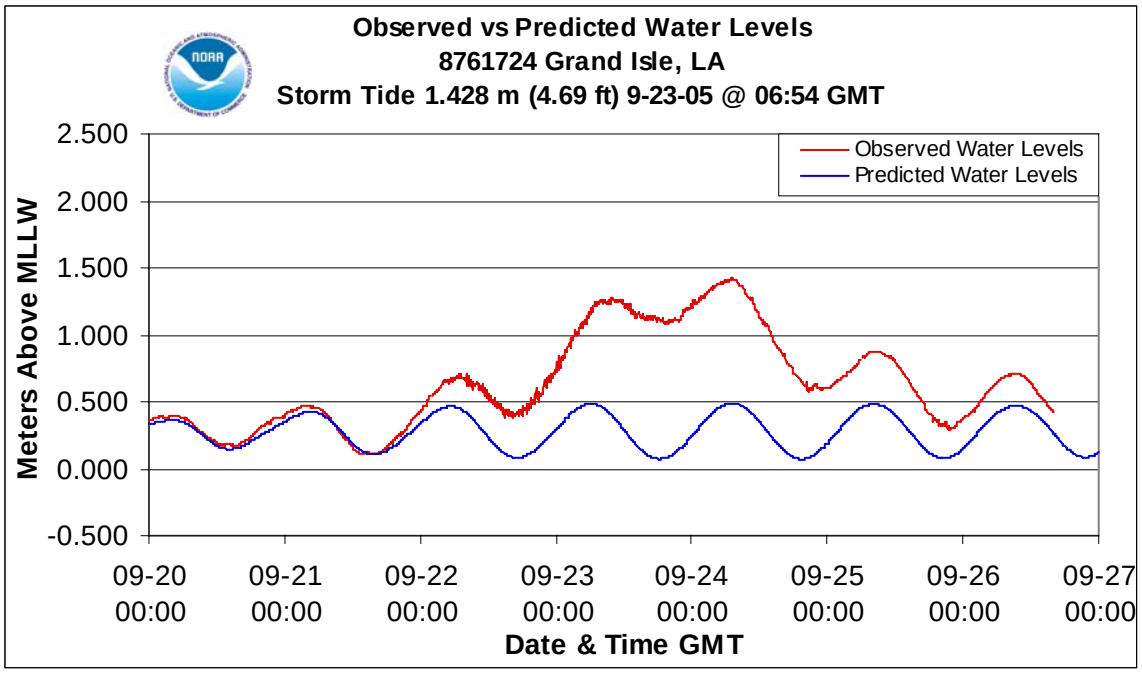

Figure 14: Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Grand Isle, LA during Hurricane RITA.

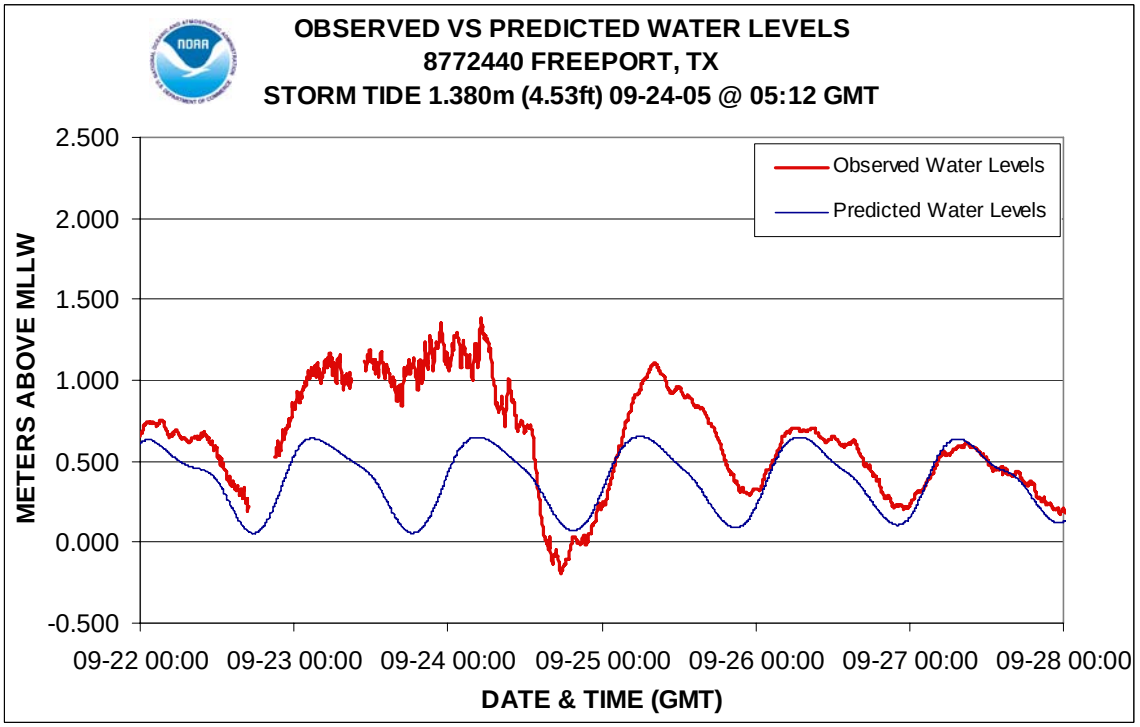

Figure 15: Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Freeport, TX during Hurricane RITA.

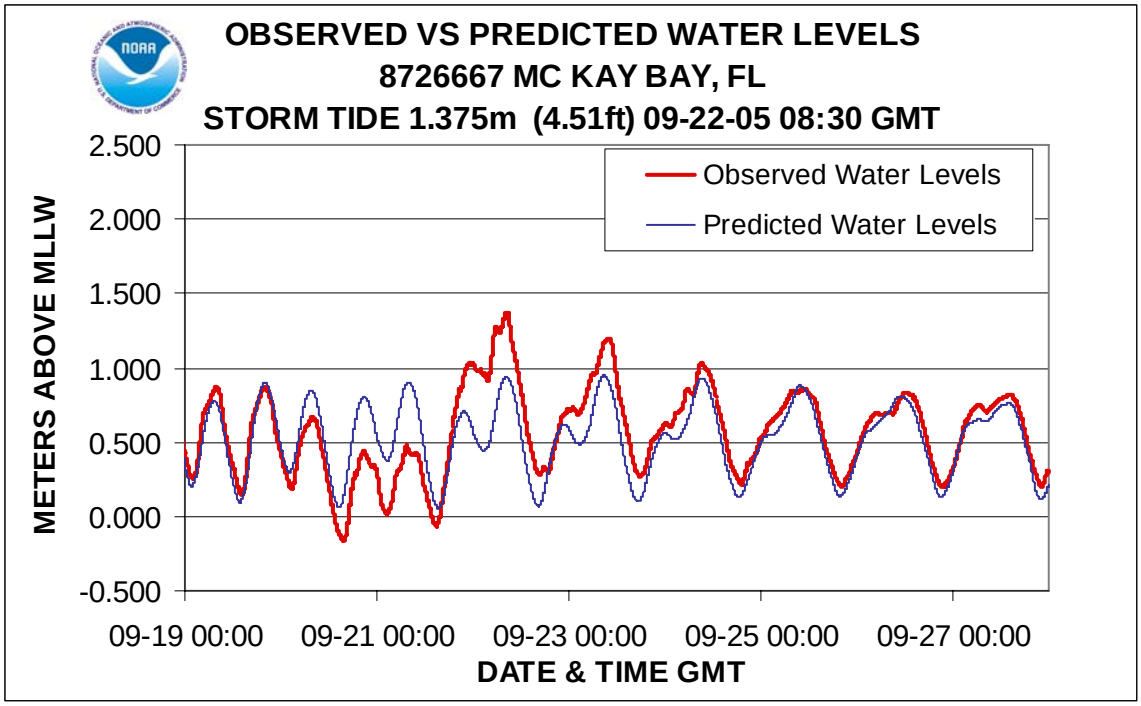

Figure 16: Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at McKay Bay, FL during Hurricane RITA.

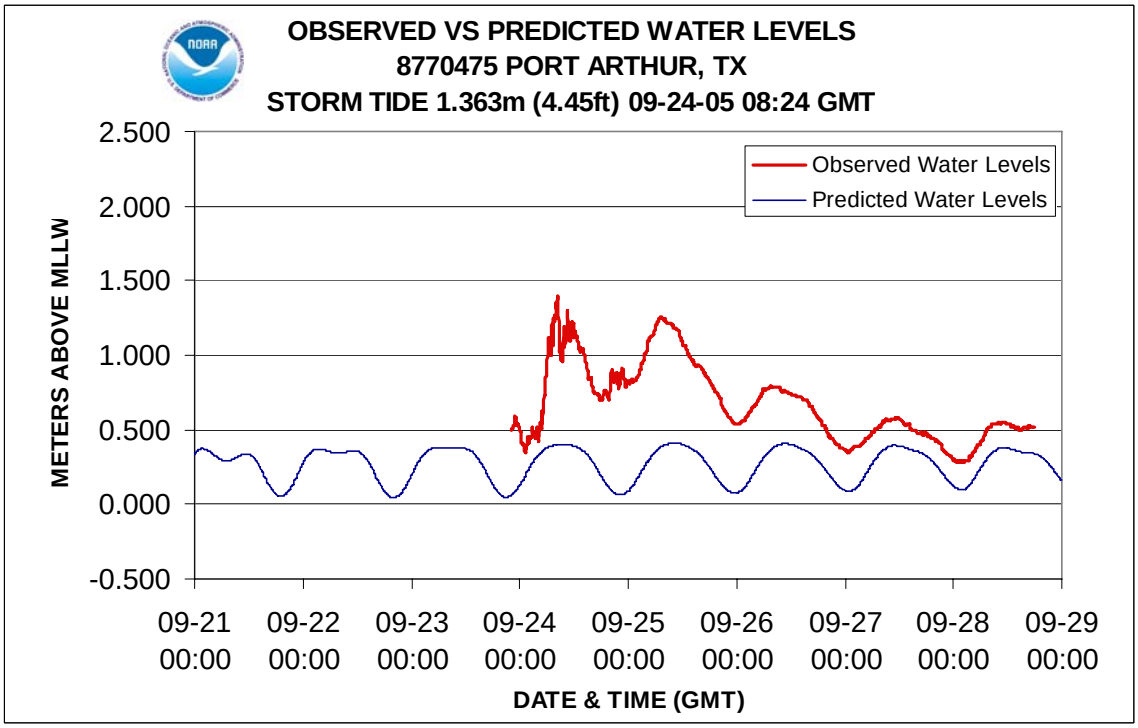

Figure 17: Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Port Arthur, TX, during Hurricane RITA.

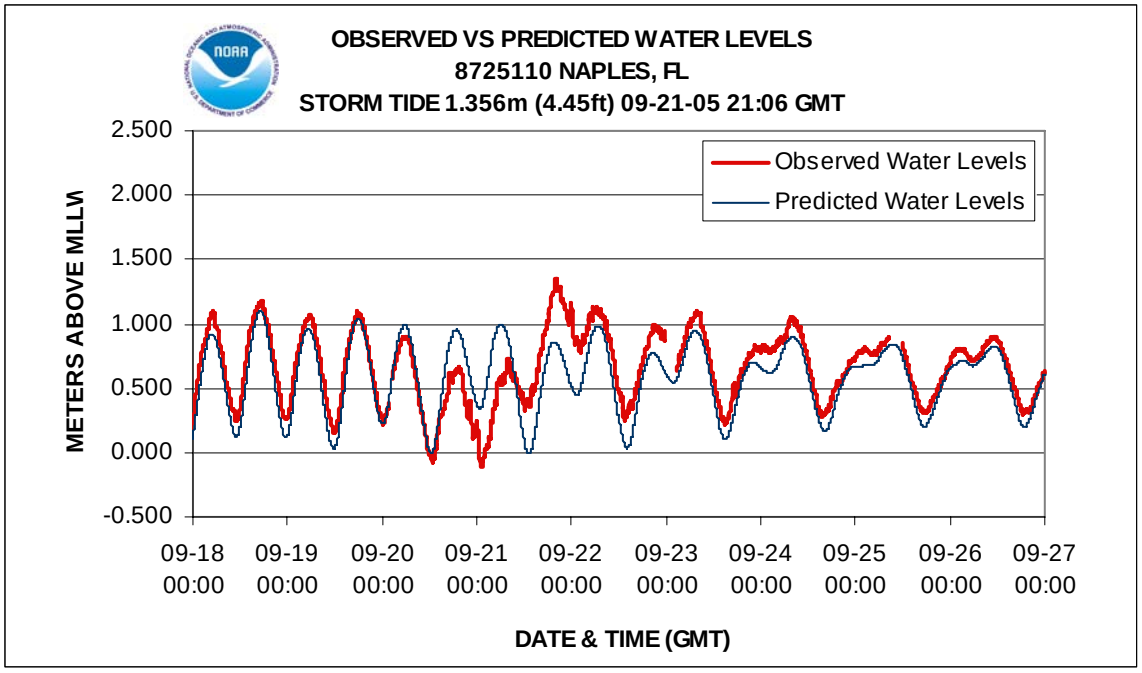

Figure 18: Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Naples, FL during Hurricane RITA.

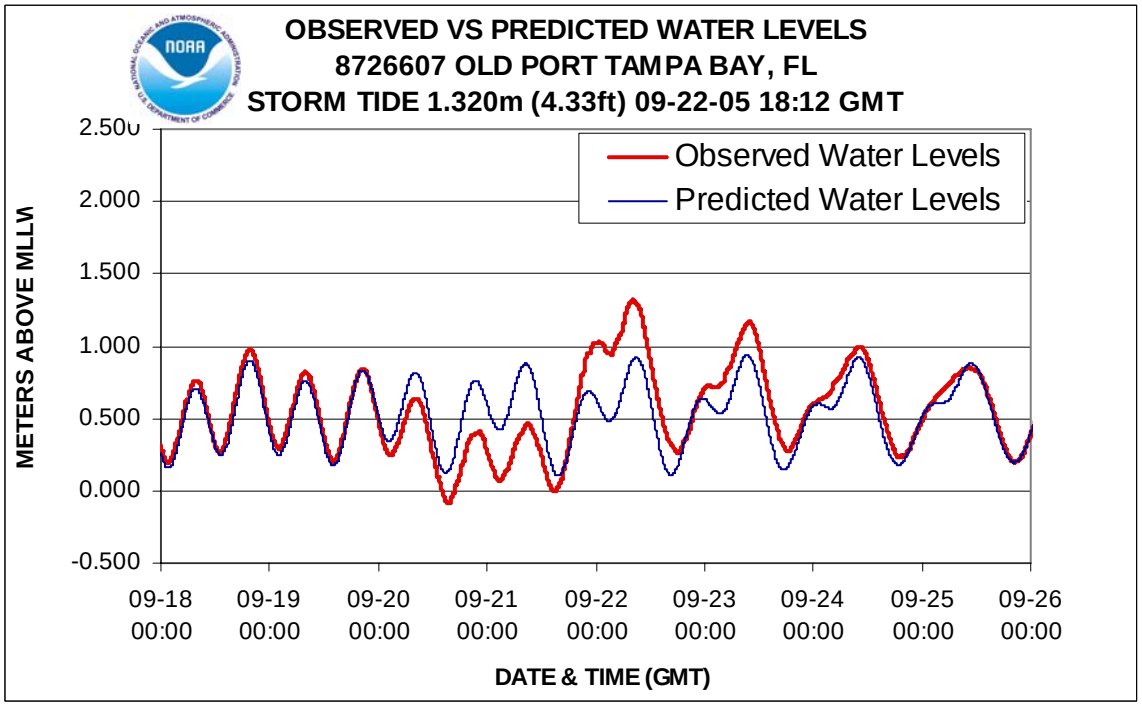

Figure 19: Time series of backup sensor data and predicted water levels above Mean Lower Low Water (MLLW) at Old Port Tampa, FL during Hurricane RITA.

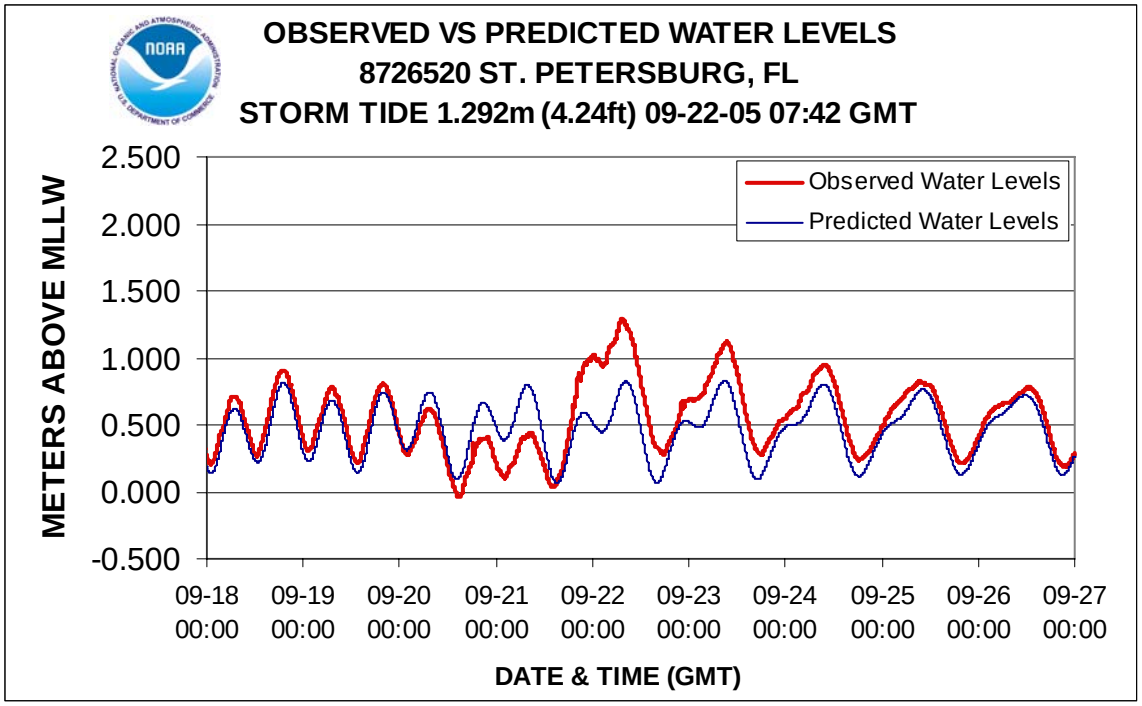

Figure 20: Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at St Pete, FL during Hurricane RITA.

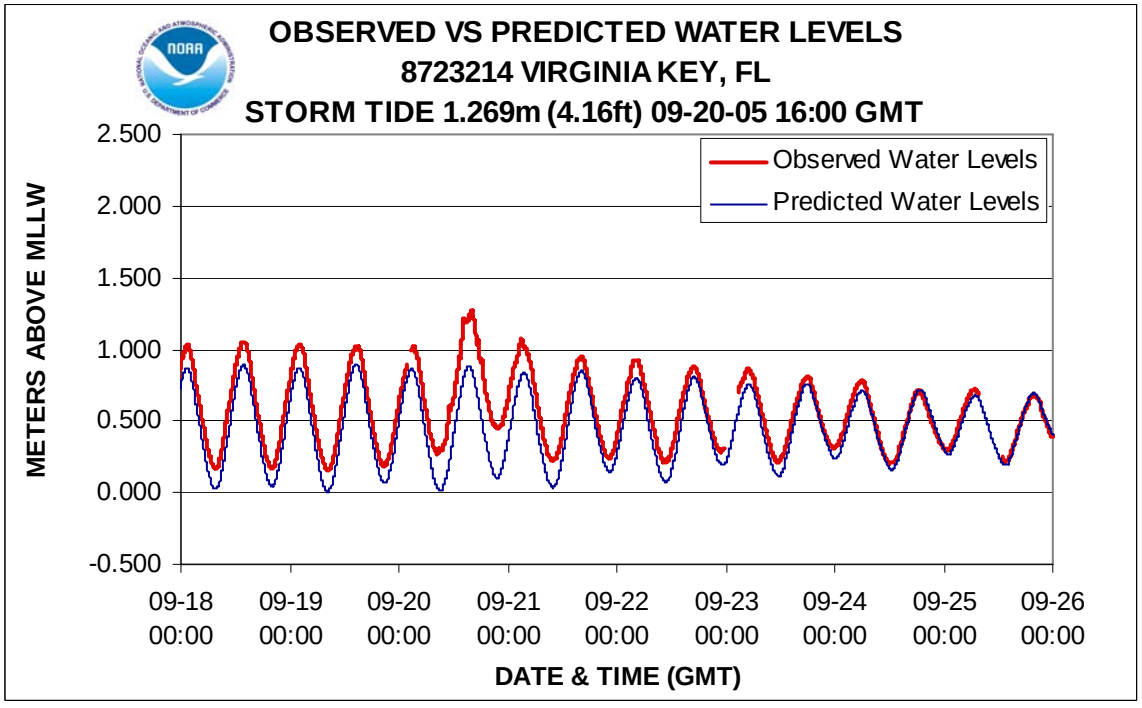

Figure 21: Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Virginia Key, FL during Hurricane RITA.

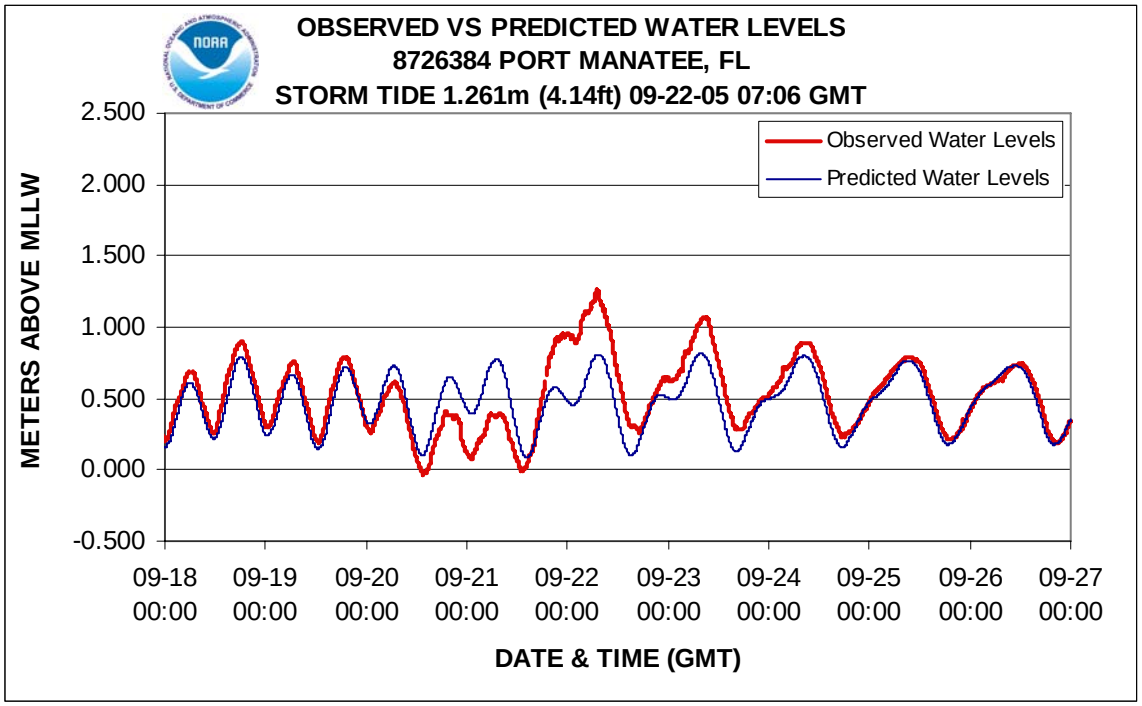

Figure 22: Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Port Manatee, FL during Hurricane RITA.

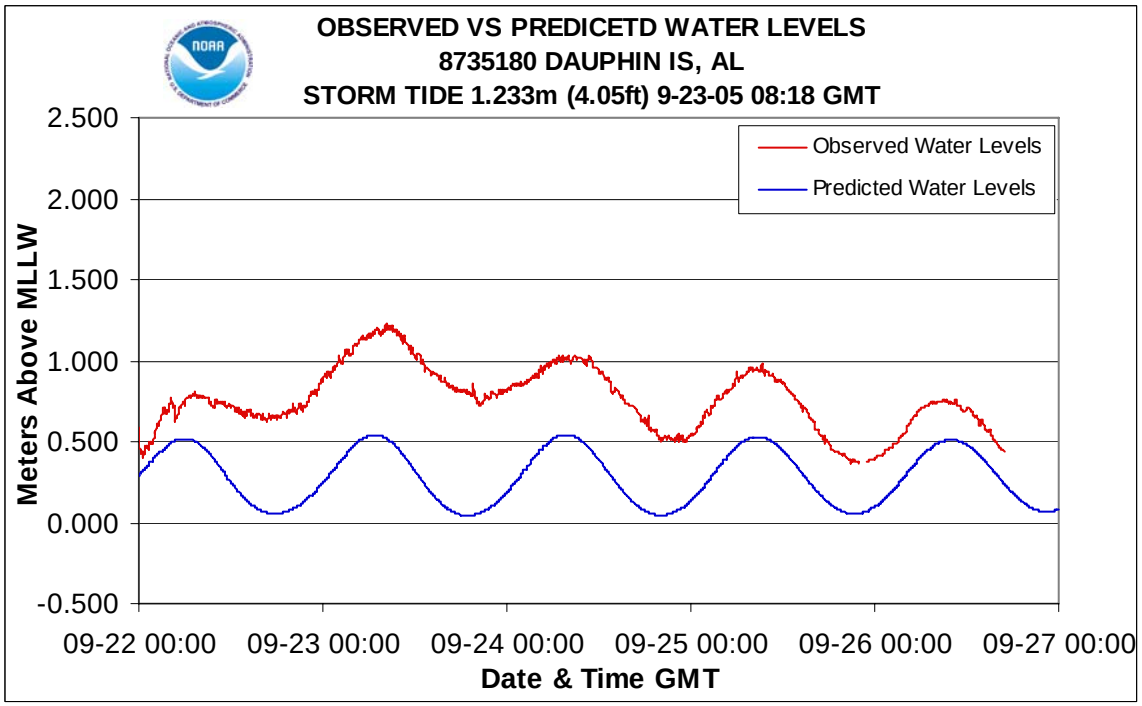

Figure 23: Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Dauphin Is, AL during Hurricane RITA.

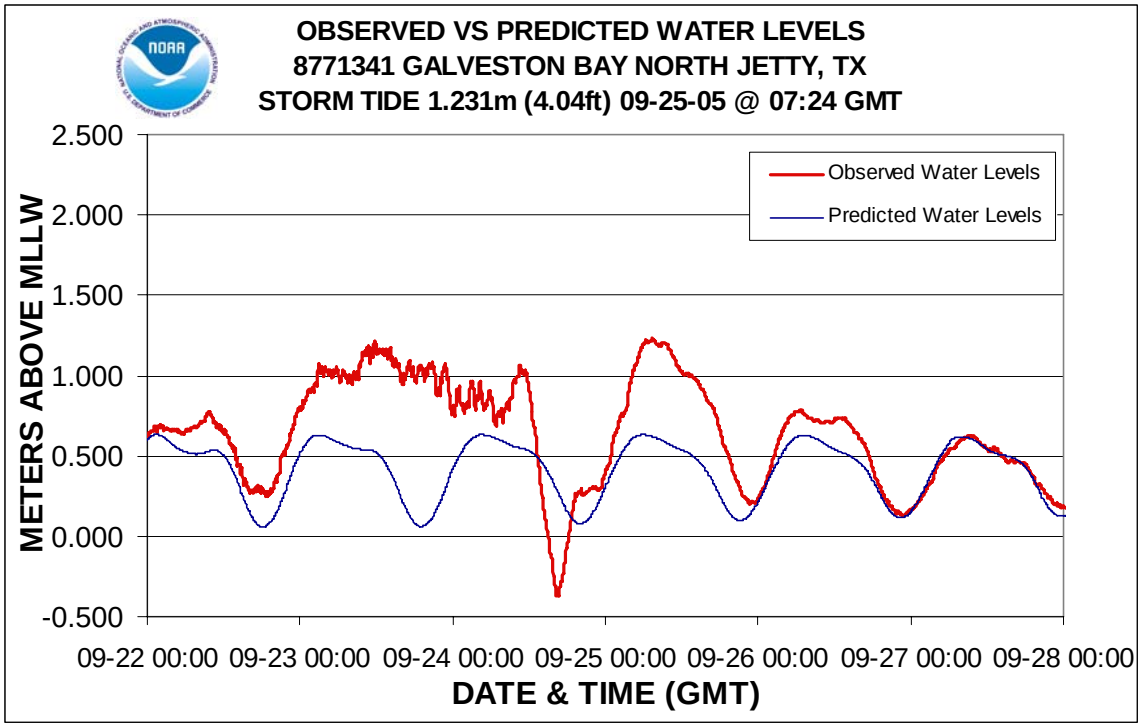

Figure 24: Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Galveston Bay, North Jetty, TX during Hurricane RITA.

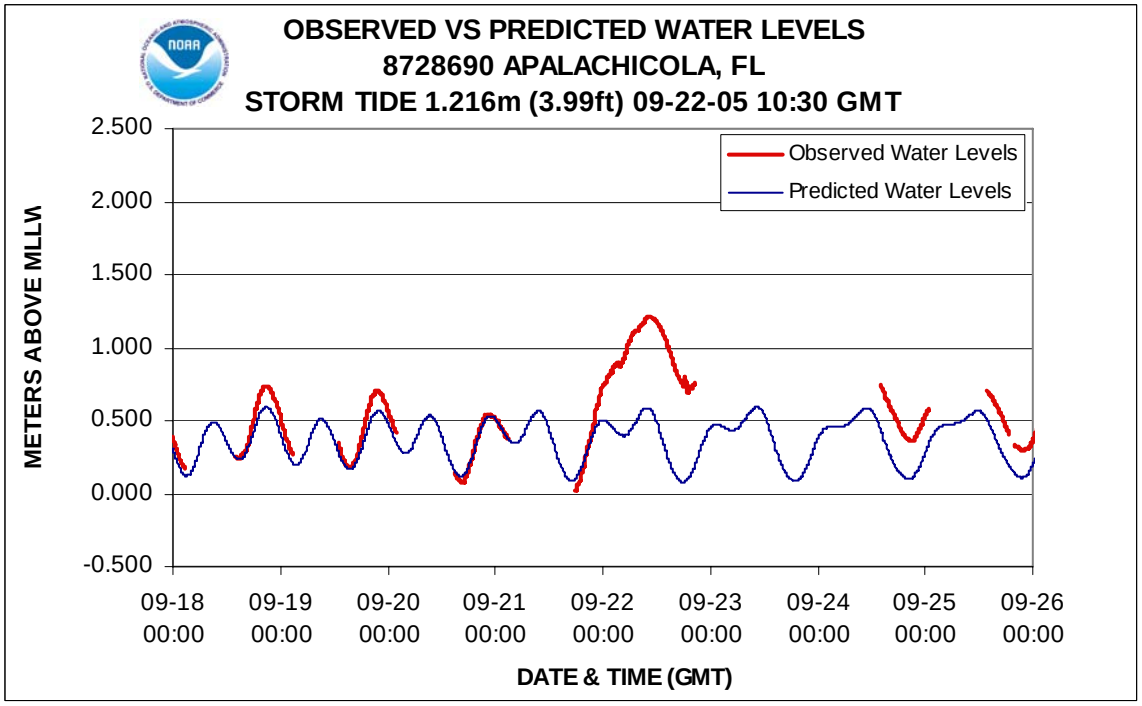

Figure 25: Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Apalachicola, FL during Hurricane RITA.

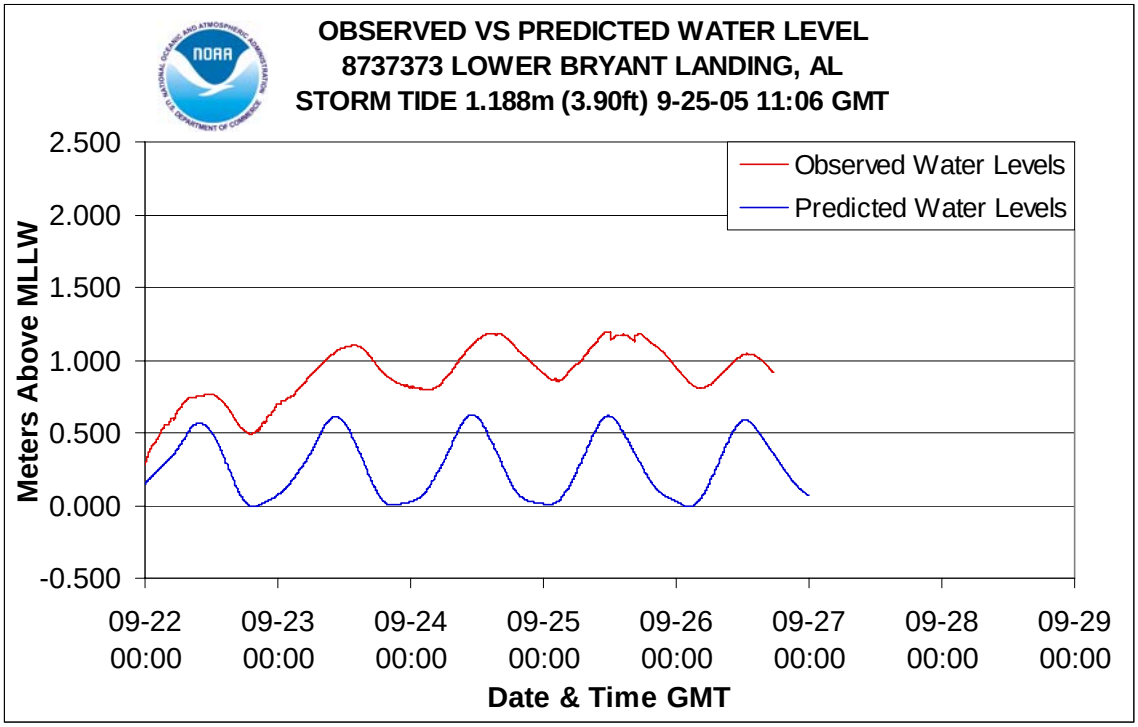

Figure 26: Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Lower Bryant Landing, AL during Hurricane RITA.

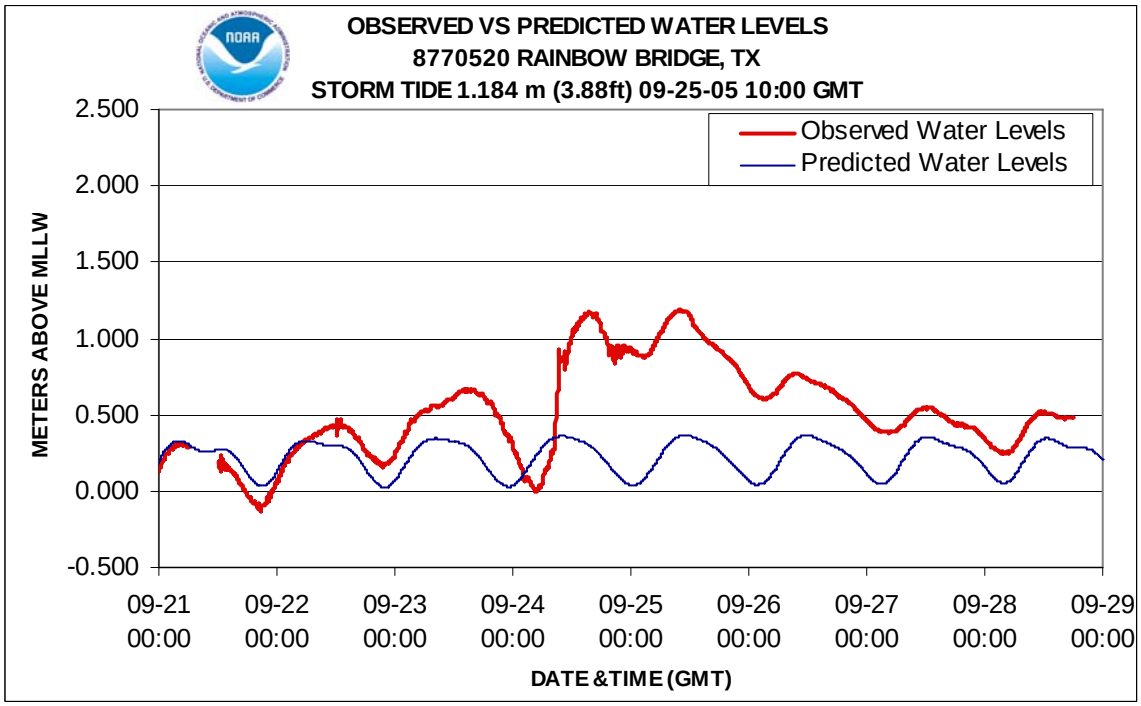

Figure 27: Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Rainbow Bridge, TX, during Hurricane RITA.

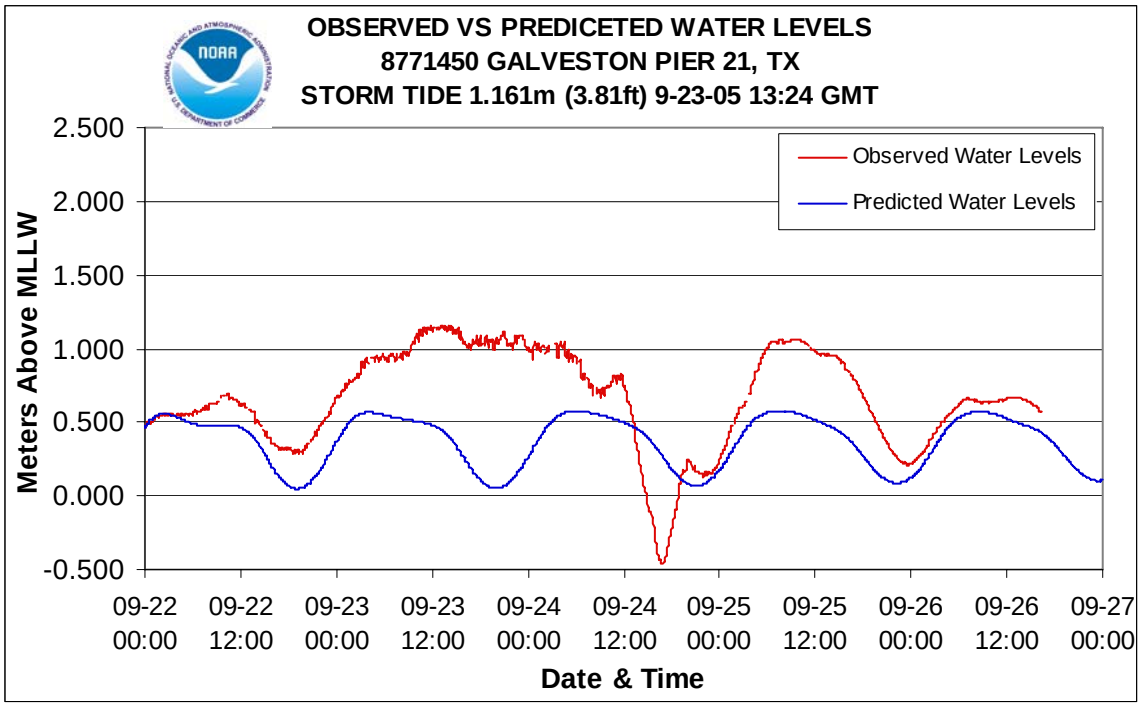

Figure 28: Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Galveston Pier 21, TX, during Hurricane RITA.

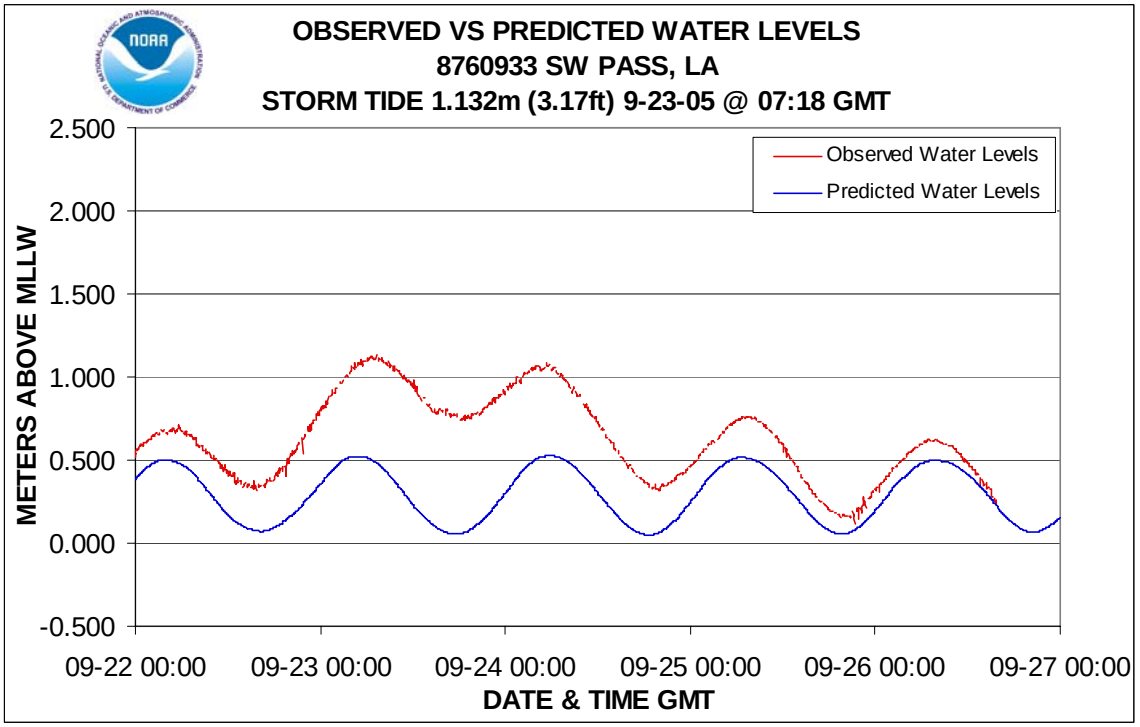

Figure 29: Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at SW Pass, LA during Hurricane RITA.

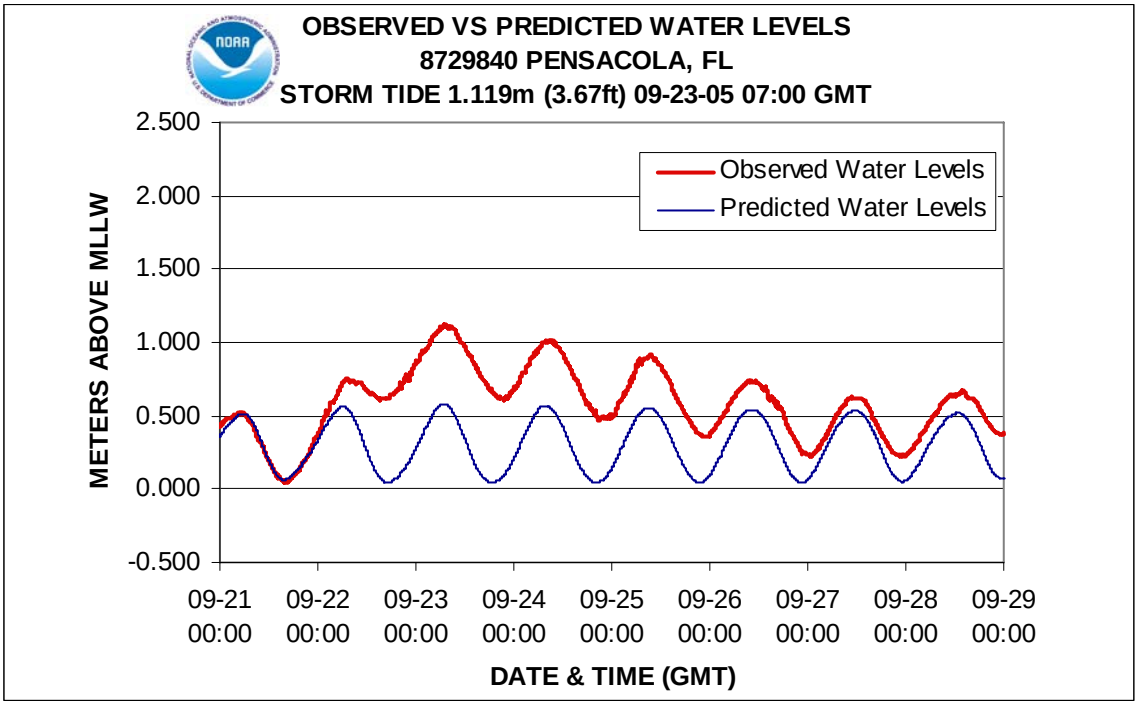

Figure 30: Time series of observed and predicted water levels above Mean Lower Low Water (MLLW) at Pensacola, FL during Hurricane RITA.

Appendix 1

Station Name	Station ID	Latitude N	Longitude W
Trident Pier, FL	8721604	28.42	-80.59
Virginia Key, FL	8723214	25.73	-80.16
Vaca Key, FL	8723970	24.71	-81.11
Key West, FL	8724580	24.55	-81.81
Naples, FL	8725110	26.13	-81.81
Fort Myers, FL	8725520	26.65	-81.87
Port Manatee, FL	8726384	27.64	-82.56
CCUT, FL	8726413	27.66	-82.62
St. Petersburg, FL	8726520	27.76	-82.63
Old Port Tampa, FL	8726607	27.86	-82.55
Mckay Bay Entrance, FL	8726667	27.91	-82.43
Clearwater Beach, FL	8726724	27.98	-82.83
Cedar Key, FL	8727520	29.14	-83.03
Apalachicola, FL	8728690	29.73	-84.98
Panama City, FL	8729108	30.15	-85.67
Panama City Beach, FL	8729210	30.21	-85.88
Pensacola, FL	8729840	30.40	-87.21
Dauphin Island, AL	8735180	30.25	-88.08
Lower Bryant Landing, AL	8737373	30.98	-87.87
SW Pass, LA	8760922	28.93	-89.41
Grand Isle, LA	8761724	29.26	-89.96
Port Fourchon, LA	8762075	29.12	-90.20
West Bank 1, Bayou Gauche, LA	8762482	29.78	-90.42
Tesoro Marine Terminal, LA	8764044	29.67	-91.24
Freshwater Canal, LA	8766072	29.55	-92.31
Calcasieu Pass, LA	8768094	29.77	-93.34
Port Arthur, TX	8770475	29.87	-93.93
Rainbow Bridge, TX	8770520	29.98	-93.88
Sabine Pass North, TX	8770570	29.73	-93.87
Morgans Point, TX	8770613	29.68	-94.99
Battleship Texas State Park, TX	8770743	29.76	-95.09
Manchester, TX	8770777	29.72	-95.25
Rollover Pass, TX	8770971	29.52	-94.51
Eagle Point, TX	8771013	29.48	-94.92
Galveston Bay, North Jetty, TX	8771341	29.36	-94.73
Galveston Pier 21, TX	8771450	29.31	-94.79
Galveston Pleasure Pier, TX	8771510	29.29	-94.79
Freeport, TX	8772440	28.95	-95.31
Seadrift, TX	8773037	28.41	-96.71
Rockport, TX	8774770	28.02	-97.05
Port Aransas, TX	8775237	27.84	-97.07
Texas State Aquarium, TX	8775296	27.81	-97.39
Packery Channel, TX	8775792	27.63	-97.24
Corpus Christi, TX	8775870	27.58	-97.22
Baffin Bay, TX	8776604	27.30	-97.41
Rincon Del San Jose, TX	8777812	26.83	-97.49
Port Mansfield, TX	8778490	26.57	-97.43
Arroyo Colorado, TX	8779038	26.35	-97.37
S. Padre Island C.G Station, TX	8779748	26.08	-97.18
Port Isabel, TX	8779770	26.06	-97.22

Appendix 2

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_0. 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 l9-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: 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:

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CO-OPS, Products and Services N/OPS3
Attn: User Services
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Silver Spring, MD 20190-3281

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