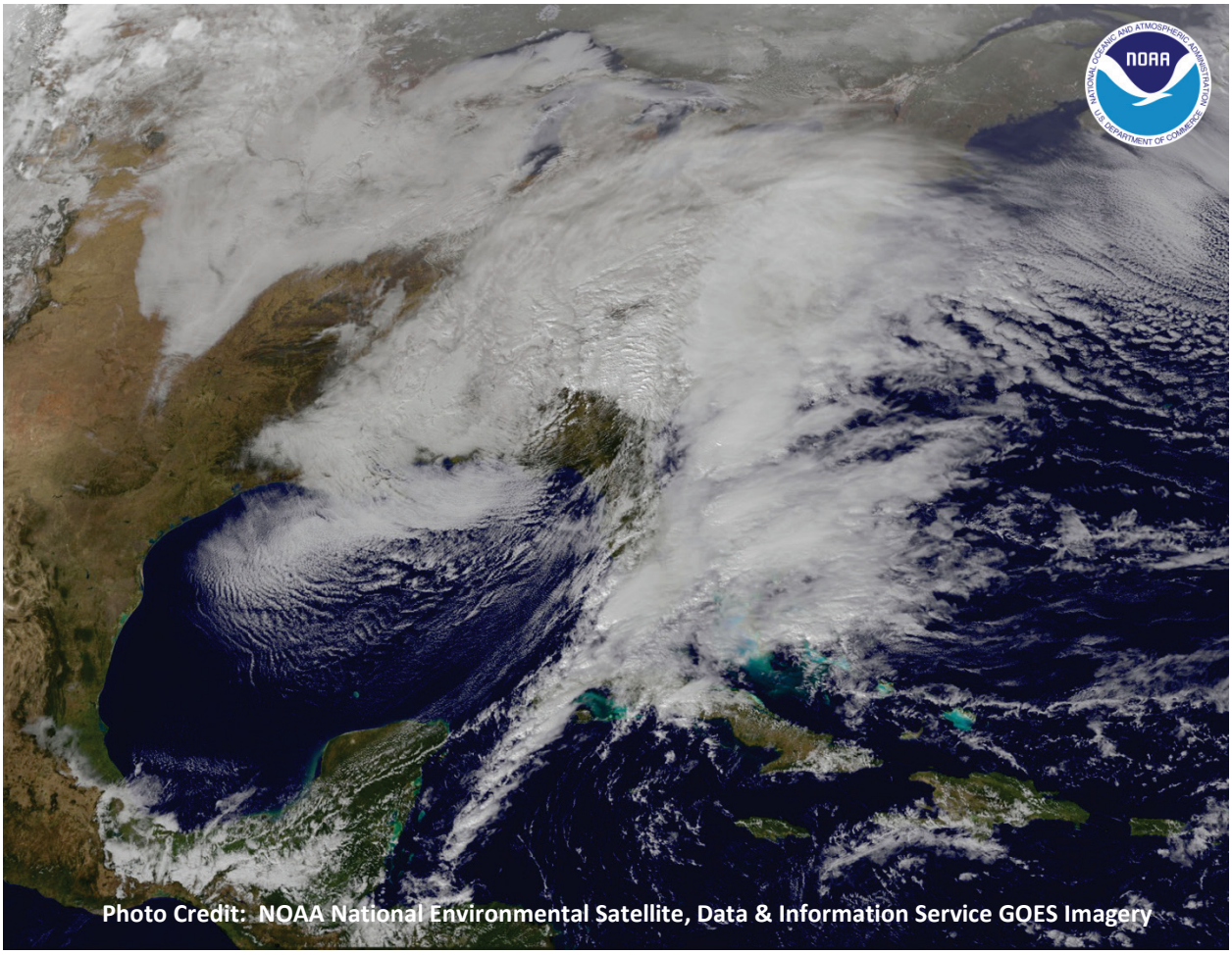
JANUARY 2016 NOR'EASTER



Silver Spring, Maryland
June 2016

noaa National Oceanic and Atmospheric Administration

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

JANUARY 2016 NOR'EASTER

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June 2016

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Overview

The National Oceanic and Atmospheric Administration (NOAA) Center for Operational Oceanographic Products and Services (CO-OPS) maintains a network of oceanographic and meteorological stations along the United States coastlines and Great Lakes to monitor water levels, winds (speed, direction and gusts), barometric pressure, and air/water temperature. This report documents the elevated water levels, high winds and reduced barometric pressures recorded at stations along the East Coast of the U.S. from Georgia to Maine during the January 22-24, 2016 Nor'easter.

Station information and locations are contained in Figures 2-4 and Appendices 1 & 2. Tidal stations are referenced to Mean Higher High Water (MHHW), based on the National Tidal Datum Epoch 1983-2001 (Appendix 3). In addition, at several locations along the U.S. coast, water levels are provided relative to a geodetic reference datum, the North American Vertical Datum of 1988 (NAVD88), to assist in relating water levels to coastal inundation estimates.

Table 1 provides storm tide elevations and predicted tide elevations for stations affected by the January 2016 Nor'easter by geographic region. Where available, water level elevations relative to NAVD88 are also presented, along with the residuals at the time of the maximum storm tides. Maximum storm surge levels are summarized in Table 2, ranked by amplitude. Storm tides are the maximum observed water level elevations during a storm passage (Figure1). Residuals are the elevation differences between observed water levels and predicted tides. Storm surge is the residual caused directly by the storm during its passage. Table 3 provides maximum wind speeds, wind gusts, and minimum barometric pressures observed at the stations during the January 2016 Nor'easter.

In addition, the report highlights stations which have exceeded historical recorded maximum water levels as a result of the January 2016 Nor'easter (Figure 5). The historical recorded maximum water levels are the maximum water elevations measured throughout a high tide cycle for the entire historical period. A complete high tide cycle is required to apply a best fit curve to the observations and calculate the maximum tide elevation. These historical records may not have included the highest water levels measured at a station during an event if a complete high tide cycle was not measured due to station/sensor damage (Appendix 3).

Individual time series graphs are provided for each station (Figures 6 – 64). For comparison and context, the historical recorded maximum water levels are displayed on the graphs, where available.

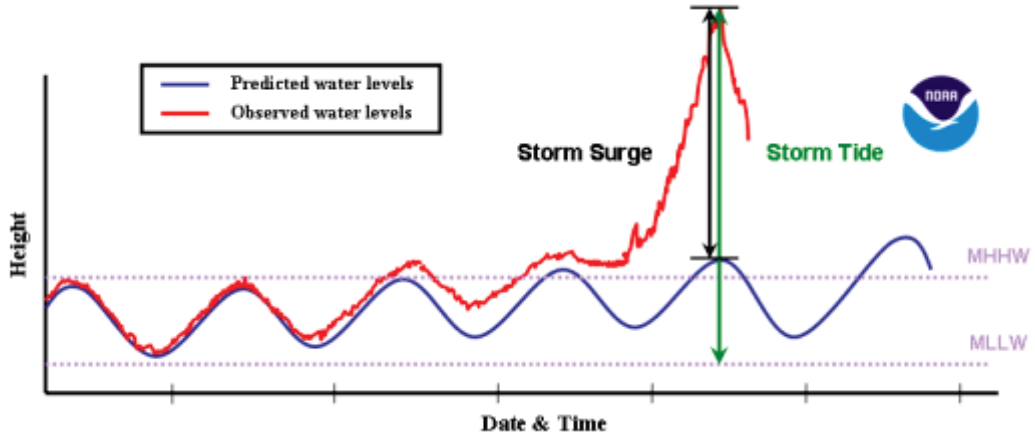

Figure 1: Storm tides are the maximum observed water level elevations measured by a water level station during a storm event.

January Nor'easter Summary

On January 21, 2016 a low pressure system developed over Central Texas and moved eastward across central Louisiana and the eastern Gulf Coast states ahead of a cold front. As the low pressure system moved across the region, it intensified and brought moderate rain and thunderstorms to the Gulf Coast states, along with light to moderate snow in higher elevations, such as northeastern Arkansas, northwest Mississippi, and southwest Tennessee. Over the next 24 hours, the low pressure system weakened as it moved into Central Georgia, where it met a recently developed low pressure system off the coast of North Carolina. A stationary front was located between both systems; however on January 22nd, the low pressure system over North Carolina intensified, igniting a major winter storm which impacted most of the eastern U.S. coast and elevated water levels in some locations to historic levels. The January Nor'easter continued northeast over the next two days affecting areas from western and northern Virginia through Maine and brought with it heavy snow and wind gusts of over 30.0 m/s (60.0 kts) at some locations. On January 24, 2016, water levels returned to normal predicted tide levels at most locations, and coastal winds diminished as the storm curved eastward and moved over the open Atlantic Ocean.

Although most of the eastern seaboard was affected by this storm, the most significant water level impacts were felt along the Atlantic coast of Virginia, within Delaware Bay and the along the New Jersey shoreline. The maximum storm surge/residual from Virginia to New Jersey ranged from 1.262 to 1.648 m (4.14 to 5.41 ft.) above normal tide levels with the highest value of 1.648 m (5.41 ft.) measured at Wachapreague, VA on 1/23/2016 09:06 GMT. Most of these peak values did not coincide with high tide, which spared the coast from experiencing even higher water levels and worse flooding during the storm. Even though the peak water level recorded during the storm was not at high tide, the maximum storm tide for this region reached 1.407 m (4.62 ft.) above MHHW at Lewes, DE on 1/23/2016 13:12 GMT. Flooding was reported in and around Atlantic City, NJ where the storm tide reached 1.044 m (3.43 ft.) above MHHW on 1/23/2016 12:36 GMT. Farther north, the storm tide at Kings Point, NY reached a height of 1.104 m (3.62 ft.) above MHHW on 1/23/2016 16:06 GMT.

The greatest impacts from the storm were observed in Delaware Bay. Ship John Shoal, NJ, Cape May, NJ, and Lewes, DE, had some of the highest total water levels and residuals during the Nor'easter and all three stations exceeded historical maximum levels that were set during Hurricane Sandy in 2012. Ship John Shoal, NJ had a storm tide of 1.002 m (3.29 ft.) above MHHW on 1/23/2016 14:48 GMT, breaking the historical maximum value of 0.969 m (3.18 ft.) above MHHW previously set on 10/30/2012. Cape May, NJ measured the next highest storm tide in Delaware Bay, reaching 1.077 m (3.62 ft.) above MHHW on 1/23/2016 13:30 GMT, breaking the historical maximum value of 1.050 m (3.44 ft.) above MHHW previously set on 10/29/2012. Finally, the peak water level at Lewes, DE (referenced above) exceeded the historical maximum value of 1.392 m (4.57 ft.) previously set on 10/30/2012. Lewes, DE also recorded the second highest storm surge/residual value along the East Coast of 1.647 m (5.40 ft.) above normal tide levels on 1/23/2016 17:42 GMT.

The highest wind speed recorded at NOS water level stations from Fort Pulaski, Georgia to Maine during the January 2016 Nor'easter was 26.3 m/s (51.0 kts) at Lewes, DE on 1/23/2016 11:24 GMT. The highest wind gust also was recorded at Lewes, DE and measured 32.4 m/s (63.0 kts) on 1/23/2016 11:18 GMT. The minimum barometric pressure recorded was 987.4 mb at Wachapreague, VA on 1/23/2016, 18:12 GMT.

More information, data and storm reports can be found at the CO-OPS website, http://tidesandcurrents.noaa.gov. Storm reports are located under the Publications section of the webpage.

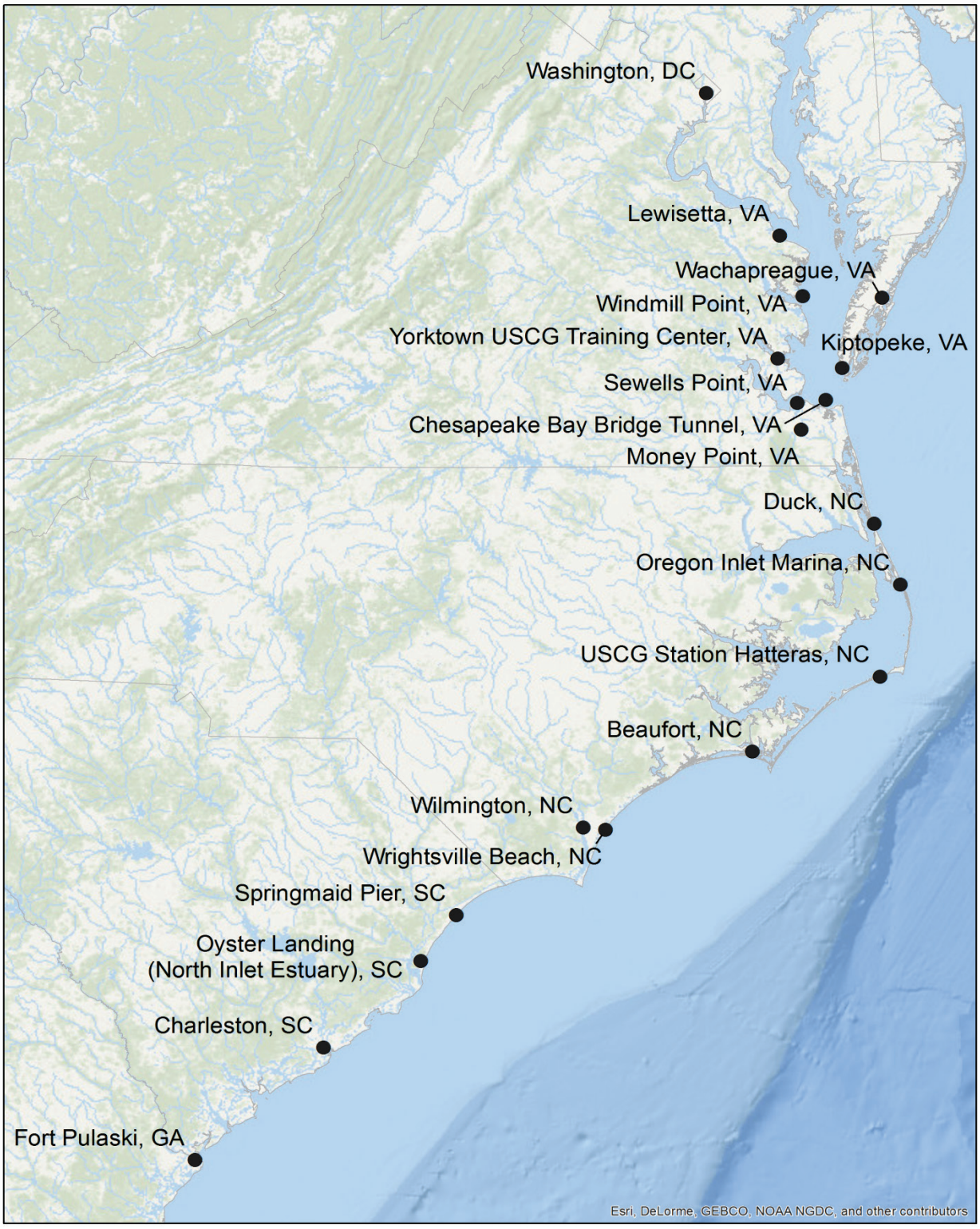

Figure 2: NOS stations located along the coast of northern coast of Georgia to Washington, DC.

Figure 3: NOS stations located along the coast of southern Maryland to New York City.

Figure 4: NOS stations located along the coast of New York to Maine.

Table 1a: Maximum recorded water levels for the January 2016 Nor'easter, referenced to MHHW and NAVD88 (where available). Storm Tide represents the total observed water level during a storm passage and storm surge represents the maximum observed water level minus the predicted astronomical tide (residual). Stations where the historical maximum water level was exceeded are highlighted in gray.

Station Name	Station ID	Date & Time (GMT)	Storm Tide (m, MHHW)	Predicted (m, MHHW)	Storm Surge/ Residual (m)	Storm Tide (m, NAVD88)	Storm Tide (ft, MHHW)	Predicted (ft, MHHW)	Storm Surge/ Residual (ft)	Storm Tide (ft, NAVD88)
Fort Pulaski, GA	8670870	1/22/2016 11:12	0.350	0.044	0.306	1.402	1.15	0.14	1.01	4.60
Charleston, SC	8665530	1/22/2016 11:42	0.324	0.051	0.273	1.124	1.06	0.17	0.89	3.69
Oyster Landing (N. Inlet Estuary), SC	8662245	1/22/2016 12:18	0.350	-0.040	0.390	1.086	1.15	-0.13	1.28	3.56
Springmaid Pier, SC	8661070	1/22/2016 23:54	0.376	-0.244	0.620	1.121	1.23	-0.80	2.03	3.68
Wrightsville Beach, NC	8658163	1/22/2016 23:42	0.415	-0.260	0.675	0.954	1.36	-0.85	2.21	3.13
Wilmington, NC	8658120	1/23/2016 1:42	0.313	-0.082	0.395	n/a	1.03	-0.27	1.30	n/a
Beaufort, NC	8656483	1/22/2016 23:30	0.434	-0.227	0.661	n/a	1.42	-0.74	2.16	n/a
USCG Station Hatteras, NC	8654467	1/24/2016 3:42	0.573	-0.136	0.709	n/a	1.88	-0.45	2.33	n/a
Oregon Inlet Marina, NC	8652587	1/23/2016 13:06	0.428	-0.039	0.467	0.573	1.40	-0.13	1.53	1.88
Duck, NC	8651370	1/24/2016 12:12	0.720	0.027	0.693	1.177	2.36	0.09	2.27	3.86
Money Point, VA	8639348	1/24/2016 2:42	0.769	-0.187	0.956	n/a	2.52	-0.61	3.13	n/a
Chesapeake Bay Bridge Tunnel, VA	8638863	1/23/2016 10:42	0.860	-0.197	1.057	n/a	2.82	-0.65	3.47	n/a
Sewells Point, VA	8638610	1/23/2016 13:54	0.772	0.000	0.772	1.121	2.53	0.00	2.53	3.68
Yorktown USCG Training Center, VA	8637689	1/23/2016 14:24	0.628	-0.096	0.724	n/a	2.06	-0.31	2.37	n/a
Windmill Point, VA	8636580	1/23/2016 16:06	0.520	-0.085	0.605	n/a	1.71	-0.28	1.99	n/a
Lewisetta, VA	8635750	1/23/2016 18:00	0.281	-0.100	0.381	0.487	0.92	-0.33	1.25	1.60
Kiptopeke, VA	8632200	1/23/2016 13:24	0.796	-0.016	0.812	1.112	2.61	-0.05	2.66	3.65
Wachapreague, VA	8631044	1/23/2016 12:54	1.333	0.040	1.293		4.37	0.13	4.24	
Washington, D.C.	8594900	1/22/2016 23:24	-0.117	-0.093	-0.024	0.424	-0.38	-0.31	-0.08	1.39
Solomons Island, MD	8577330	1/23/2016 18:06	0.032	-0.138	0.170	0.222	0.10	-0.45	0.56	0.73
Annapolis, MD	8575512	1/22/2016 21:36	-0.179	-0.123	-0.056	0.024	-0.59	-0.40	-0.18	0.08
Baltimore, MD	8574680	1/22/2016 22:30	-0.183	-0.128	-0.055	0.069	-0.60	-0.42	-0.18	0.23
Chesapeake City, MD	8573927	1/24/2016 17:00	-0.203	-0.248	0.045	n/a	-0.67	-0.81	0.15	n/a
Tolchester Beach, MD	8573364	1/22/2016 23:00	-0.191	-0.142	-0.049	n/a	-0.63	-0.47	-0.16	n/a
Cambridge, MD	8571892	1/22/2016 19:36	-0.186	-0.113	-0.073	0.099	-0.61	-0.37	-0.24	0.32
Bishops Head, MD	8571421	1/23/2016 16:54	0.065	-0.153	0.218	0.309	0.21	-0.50	0.72	1.01
Ocean City Inlet, MD	8570283	1/23/2016 14:30	0.737	-0.178	0.915	0.989	2.42	-0.58	3.00	3.24
Lewes, DE	8557380	1/23/2016 13:12	1.407	0.074	1.333	2.024	4.62	0.24	4.38	6.64
Reedy Point, DE	8551910	1/23/2016 16:18	0.581	-0.138	0.719	1.456	1.91	-0.45	2.36	4.78
Delaware City, DE	8551762	1/23/2016 16:18	0.834	-0.179	1.013	n/a	2.74	-0.59	3.33	n/a

Table 1b: Maximum recorded water levels for the January 2016 Nor'easter, referenced to MHHW and NAVD88 (where available). Storm Tide represents the total observed water level during a storm passage and storm surge represents the maximum observed water level minus the predicted astronomical tide (residual). Stations where the historical maximum water level was exceeded are highlighted in gray.

Station Name	Station ID	Date & Time (GMT)	Storm Tide (m, MHHW)	Predicted (m, MHHW)	Storm Surge/ Residual (m)	Storm Tide (m, NAVD88)	Storm Tide (ft, MHHW)	Predicted (ft, MHHW)	Storm Surge/ Residual (ft)	Storm Tide (ft, NAVD88)
Newbold, PA	8548989	1/23/2016 19:42	0.495	-0.127	0.622	n/a	1.62	-0.42	2.04	n/a
Philadelphia, PA	8545240	1/23/2016 18:24	0.626	-0.201	0.827	1.720	2.05	-0.66	2.71	5.64
Burlington, Delaware River, NJ	8539094	1/23/2016 19:30	0.526	-0.145	0.671	n/a	1.73	-0.48	2.21	n/a
Ship John Shoal, NJ	8537121	1/23/2016 14:48	1.002	-0.025	1.027	n/a	3.29	-0.08	3.37	n/a
Cape May, NJ	8536110	1/23/2016 13:30	1.077	0.021	1.056	1.817	3.53	0.07	3.46	5.96
Atlantic City, NJ	8534720	1/23/2016 12:36	1.044	-0.013	1.057	1.650	3.42	-0.04	3.46	5.41
Sandy Hook, NJ	8531680	1/24/2016 1:06	0.810	-0.191	1.001	1.545	2.66	-0.63	3.29	5.07
Bergen Point West Reach, NY	8519483	1/23/2016 13:12	0.765	0.014	0.751	n/a	2.51	0.05	2.46	n/a
The Battery, NY	8518750	1/23/2016 13:00	0.725	0.029	0.696	1.420	2.38	0.10	2.28	4.66
Kings Point, NY	8516945	1/23/2016 16:06	1.104	0.122	0.982	n/a	3.62	0.40	3.22	n/a
Montauk, NY	8510560	1/24/2016 13:42	0.646	-0.036	0.682	0.938	2.12	-0.12	2.24	3.08
Bridgeport, CT	8467150	1/23/2016 15:48	0.764	0.035	0.729	1.824	2.51	0.11	2.40	5.98
New Haven, CT	8465705	1/23/2016 15:54	0.744	0.012	0.732	n/a	2.44	0.04	2.40	n/a
New London, CT	8461490	1/24/2016 14:18	0.579	-0.030	0.609	0.948	1.90	-0.10	2.00	3.11
Quonset Point, RI	8454049	1/24/2016 13:00	0.547	0.078	0.469	n/a	1.79	0.26	1.53	n/a
Providence, RI	8454000	1/24/2016 13:06	0.444	0.130	0.314	1.165	1.46	0.43	1.03	3.82
Conimicut Light, RI	8452944	1/24/2016 13:18	0.496	0.095	0.401	n/a	1.63	0.31	1.32	n/a
Newport, RI	8452660	1/24/2016 12:48	0.567	0.063	0.504	1.119	1.86	0.21	1.65	3.67
Nantucket Island, MA	8449130	1/24/2016 16:48	0.613	0.022	0.591	n/a	2.01	0.07	1.94	n/a
Woods Hole, MA	8447930	1/24/2016 13:42	0.577	0.020	0.557	0.834	1.89	0.06	1.83	2.74
Chatham, MA	8447435	1/24/2016 17:18	0.686	0.128	0.558	1.609	2.25	0.42	1.83	5.28
Fall River, MA	8447386	1/24/2016 13:18	0.513	0.099	0.414	n/a	1.68	0.32	1.36	n/a
Boston, MA	8443970	1/24/2016 16:00	0.629	0.187	0.442	2.082	2.06	0.61	1.45	6.83
Fort Point, NH	8423898	1/24/2016 16:12	0.552	0.175	0.377	1.896	1.81	0.57	1.24	6.22
Wells, ME	8419317	1/24/2016 16:24	0.545	0.214	0.331	n/a	1.79	0.70	1.09	n/a
Portland, ME	8418150	1/24/2016 16:12	0.504	0.187	0.317	1.922	1.65	0.61	1.04	6.30
Bar Harbor, ME	8413320	1/24/2016 15:48	0.550	0.293	0.257	n/a	1.80	0.96	0.84	n/a
Cutler Farris Wharf, ME	8411060	1/24/2016 15:48	0.574	0.357	0.217	2.712	1.88	1.17	0.71	8.90
Eastport, ME	8410140	1/24/2016 15:54	0.581	0.408	0.173	3.426	1.91	1.34	0.57	11.24

Table 2a: Maximum recorded storm surge(residual) ranked by amplitude for the January 2016 Nor'easter. Storm Surge (Residual) represents the maximum observed water level (storm tide) minus predicted astronomical tide levels. Stations where the historical maximum water level was exceeded are highlighted in gray.

Station Name	Station ID	Date & Time GMT	Storm Surge (Residual)	
			in Meters	in Feet
Wachapreague, VA	8631044	1/23/2016 9:06	1.648	5.41
Lewes, DE	8557380	1/23/2016 17:42	1.647	5.40
Cape May, NJ	8536110	1/23/2016 17:42	1.488	4.88
Money Point, VA	8639348	1/23/2016 7:12	1.467	4.81
Bergen Point West Reach, NY	8519483	1/23/2016 18:48	1.378	4.52
Ship John Shoal, NJ	8537121	1/23/2016 20:12	1.376	4.51
Kiptopeke, VA	8632200	1/23/2016 7:12	1.369	4.49
Sandy Hook, NJ	8531680	1/23/2016 18:06	1.365	4.48
Kings Point, NY	8516945	1/23/2016 23:00	1.344	4.41
The Battery, NY	8518750	1/23/2016 18:24	1.312	4.30
Atlantic City, NJ	8534720	1/23/2016 17:54	1.296	4.25
Sewells Point, VA	8638610	1/23/2016 6:12	1.268	4.16
Ocean City Inlet, MD	8570283	1/23/2016 17:24	1.262	4.14
Chesapeake Bay Bridge Tunnel, VA	8638863	1/23/2016 7:48	1.202	3.94
Delaware City, DE	8551762	1/23/2016 17:30	1.141	3.74
Bridgeport, CT	8467150	1/23/2016 19:30	1.079	3.54
Yorktown USCG Training Center, VA	8637689	1/23/2016 6:24	1.066	3.50
New Haven, CT	8465705	1/23/2016 21:06	1.033	3.39
Chatham, MA	8447435	1/24/2016 9:48	1.002	3.29
Philadelphia, PA	8545240	1/24/2016 0:12	1.001	3.28
Newbold, PA	8548989	1/24/2016 2:00	0.981	3.22
Reedy Point, DE	8551910	1/23/2016 21:42	0.954	3.13
Montauk, NY	8510560	1/23/2016 17:54	0.926	3.04
Burlington, Delaware River, NJ	8539094	1/24/2016 1:36	0.903	2.96
Duck, NC	8651370	1/24/2016 4:48	0.868	2.85
Nantucket Island, MA	8449130	1/24/2016 9:06	0.828	2.72
Oyster Landing (N. Inlet Estuary), SC	8662245	1/22/2016 17:24	0.825	2.71
New London, CT	8461490	1/23/2016 20:06	0.820	2.69
Boston, MA	8443970	1/24/2016 8:36	0.779	2.55
USCG Station Hatteras, NC	8654467	1/24/2016 3:42	0.709	2.33
Beaufort, NC	8656483	1/23/2016 0:42	0.705	2.31
Newport, RI	8452660	1/24/2016 5:12	0.702	2.30
Woods Hole, MA	8447930	1/24/2016 4:30	0.684	2.25
Fall River, MA	8447386	1/24/2016 5:12	0.680	2.23

Table 2b: Maximum recorded storm surge (residual) ranked by amplitude for the January 2016 Nor'easter. Storm Surge (Residual) represents the maximum observed water level (storm tide) minus predicted astronomical tide levels. Stations where the historical maximum water level was exceeded are highlighted in gray.

Station Name	Station ID	Date & Time GMT	Storm Maximum (Residual)	
			in Meters	in Feet
Quonset Point, RI	8454049	1/24/2016 4:54	0.679	2.23
Wrightsville Beach, NC	8658163	1/22/2016 23:42	0.675	2.21
Windmill Point, VA	8636580	1/23/2016 8:12	0.650	2.13
Conimicut Light, RI	8452944	1/24/2016 5:12	0.637	2.09
Wells, ME	8419317	1/24/2016 10:24	0.633	2.08
Providence, RI	8454000	1/24/2016 5:42	0.623	2.05
Springmaid Pier, SC	8661070	1/22/2016 23:54	0.620	2.03
Eastport, ME	8410140	1/24/2016 21:00	0.607	1.99
Cutler Farris Wharf, ME	8411060	1/23/2016 22:48	0.592	1.94
Oregon Inlet Marina, NC	8652587	1/23/2016 19:24	0.590	1.94
Fort Point, NH	8423898	1/24/2016 9:06	0.577	1.89
Lewisetta, VA	8635750	1/23/2016 13:48	0.559	1.83
Bishops Head, MD	8571421	1/23/2016 11:36	0.544	1.78
Charleston, SC	8665530	1/22/2016 17:18	0.510	1.67
Fort Pulaski, GA	8670870	1/22/2016 18:30	0.506	1.66
Portland, ME	8418150	1/24/2016 10:30	0.501	1.64
Bar Harbor, ME	8413320	1/24/2016 10:12	0.500	1.64
Wilmington, NC	8658120	1/23/2016 2:48	0.436	1.43
Solomons Island, MD	8577330	1/23/2016 13:00	0.401	1.32
Cambridge, MD	8571892	1/23/2016 13:12	0.303	0.99
Chesapeake City, MD	8573927	1/23/2016 18:24	0.204	0.67
Washington, DC	8594900	1/24/2016 19:18	0.075	0.25
Annapolis, MD	8575512	1/23/2016 2:30	0.032	0.10
Tolchester Beach, MD	8573364	1/22/2016 18:12	0.019	0.06
Baltimore, MD	8574680	1/22/2016 18:12	0.012	0.04

Table 3a: Maximum recorded wind speed, wind gust and minimum barometric pressure for the January 2016 Nor'easter.

Station Name	Station ID	Maximum Wind Speed			Maximum Wind Gust			Minimum Atmospheric Pressure	
		Date & Time GMT	m/sec	knots	Date & Time GMT	m/sec	knots	Date & Time GMT	mbar
Fort Pulaski, GA	8670870	1/23/2016 16:36	13.2	25.5	1/26/2016 20:06	16.6	32.3	1/27/2016 4:48	1002.8
Charleston, SC	8665530	1/22/2016 11:00	10.8	21.0	1/23/2016 15:12	13.2	25.7	1/23/2016 0:36	999.3
Oyster Landing (N. Inlet Estuary), SC	8662245	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Springmaid Pier, SC	8661070	1/22/2016 12:48	14.7	28.6	1/22/2016 11:54	17.0	33.0	1/23/2016 0:18	998.4
Wrightsville Beach, NC	8658163	1/22/2016 19:18	18.0	35.0	1/22/2016 19:18	19.7	38.3	1/23/2016 1:54	994.6
Wilmington, NC	8658120	n/a	n/a	n/a	n/a	n/a	n/a	1/23/2016 1:48	996.6
Beaufort, NC	8656483	1/23/2016 2:36	14.4	28.0	1/23/2016 2:42	17.0	33.0	1/23/2016 4:18	991.3
USCG Station Hatteras, NC	8654467	1/24/2016 4:12	17.1	33.2	1/24/2016 2:30	20.0	38.9	1/23/2016 4:54	990.7
Oregon Inlet Marina, NC	8652587	1/23/2016 22:30	12.7	24.7	1/24/2016 1:54	17.5	34.0	1/23/2016 7:24	989.2
Duck, NC	8651370	1/23/2016 0:18	17.9	34.8	1/23/2016 0:36	20.3	39.5	1/23/2016 7:42	988.1
Money Point, VA	8639348	1/23/2016 6:12	8.4	16.3	1/23/2016 7:18	14.5	28.2	1/23/2016 8:18	991.0
Chesapeake Bay Bridge Tunnel, VA	8638863	1/23/2016 5:24	23.4	45.5	1/23/2016 8:24	27.7	53.8	1/23/2016 8:24	989.0
Sewells Point, VA	8638610	n/a	n/a	n/a	n/a	n/a	n/a	1/23/2016 8:30	991.1
Yorktown USCG Training Center, VA	8637689	1/23/2016 4:30	16.9	32.9	1/23/2016 4:42	21.6	42.0	1/23/2016 8:36	991.9
Windmill Point, VA	8636580	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Lewisetta, VA	8635750	1/23/2016 22:30	12.2	23.8	1/23/2016 20:30	18.8	36.6	1/23/2016 18:24	994.1
Kiptopeke, VA	8632200	1/23/2016 20:54	19.8	38.5	1/24/2016 0:18	24.6	47.8	n/a	n/a
Wachapreague, VA	8631044	1/23/2016 8:00	24.1	46.8	1/23/2016 8:00	29.7	57.7	1/23/2016 18:12	987.4
Washington, DC	8594900	1/23/2016 21:18	10.3	19.9	1/23/2016 17:00	15.0	29.1	1/23/2016 18:30	1000.4
Solomons Island, MD	8577330	1/23/2016 20:12	15.5	30.1	1/23/2016 20:30	21.2	41.2	n/a	n/a
Annapolis, MD	8575512	n/a	n/a	n/a	n/a	n/a	n/a	1/23/2016 18:18	998.3
Baltimore, MD	8574680	1/23/2016 18:24	13.4	26.0	1/23/2016 17:54	20.2	39.3	1/23/2016 17:54	1000.1
Chesapeake City, MD	8573927	1/23/2016 10:36	12.7	24.7	1/23/2016 10:36	18.3	35.6	1/23/2016 18:42	999.0
Tolchester Beach, MD	8573364	1/23/2016 22:06	16.2	31.5	1/23/2016 20:42	19.8	38.5	1/23/2016 18:54	999.5
Cambridge, MD	8571892	1/23/2016 19:06	14.4	28.0	1/23/2016 6:12	19.1	37.1	1/23/2016 19:00	993.9
Bishops Head, MD	8571421	1/23/2016 7:06	15.4	30.0	1/23/2016 7:18	21.7	42.2	1/23/2016 18:54	990.8
Ocean City Inlet, MD	8570283	1/24/2016 3:24	15.6	30.3	1/23/2016 7:06	25.4	49.4	1/23/2016 18:06	988.9
Lewes, DE	8557380	1/23/2016 11:24	26.3	51.0	1/23/2016 11:18	32.4	63.0	1/23/2016 12:48	993.5
Brandywine Shoal Light, DE	8555889	1/23/2016 12:18	26.1	50.7	1/23/2016 11:36	32.0	62.2	1/23/2016 19:00	993.6
Reedy Point, DE	8551910	n/a	n/a	n/a	n/a	n/a	n/a	1/23/2016 19:12	998.9
Delaware City, DE	8551762	1/24/2016 3:12	8.7	16.9	1/24/2016 1:54	12.6	24.5	1/23/2016 19:06	998.7

Table 3b: Maximum recorded wind speed, wind gust and minimum barometric pressure in geographic order for the January 2016 Nor'easter.

Station Name	Station ID	Maximum Wind Speed			Maximum Wind Gust			Minimum Atmospheric Pressure	
		Date & Time GMT	m/sec	knots	Date & Time GMT	m/sec	knots	Date & Time GMT	mbar
Newbold, PA	8548989	1/23/2016 11:18	10.0	19.4	1/23/2016 11:00	16.9	32.9	1/23/2016 18:54	1001.0
Philadelphia, PA	8545240	n/a	n/a	n/a	n/a	n/a	n/a	1/23/2016 19:12	999.8
Burlington, Delaware River, NJ	8539094	1/23/2016 11:06	9.8	19.0	1/23/2016 13:06	16.0	31.1	1/23/2016 19:42	1000.1
Ship John Shoal, NJ	8537121	1/23/2016 10:12	22.5	43.7	1/23/2016 10:12	26.0	50.5	1/23/2016 19:06	995.7
Cape May, NJ	8536110	1/23/2016 10:54	14.6	28.4	1/23/2016 8:18	26.0	50.5	1/23/2016 19:00	993.4
Atlantic City, NJ	8534720	n/a	n/a	n/a	n/a	n/a	n/a	1/23/2016 19:12	994.0
Sandy Hook, NJ	8531680	1/23/2016 13:00	14.9	29.0	1/23/2016 13:48	20.6	40.0	1/23/2016 17:00	1001.3
Bergen Point West Reach, NY	8519483	n/a	n/a	n/a	n/a	n/a	n/a	1/23/2016 17:24	1002.4
The Battery, NY	8518750	n/a	n/a	n/a	n/a	n/a	n/a	1/23/2016 17:36	1000.6
Kings Point, NY	8516945	1/24/2016 0:54	13.6	26.4	1/23/2016 14:36	17.8	34.6	1/23/2016 18:00	1001.7
Montauk, NY	8510560	n/a	n/a	n/a	n/a	n/a	n/a	1/24/2016 1:36	1001.0
Bridgeport, CT	8467150	1/23/2016 18:42	11.6	22.5	1/23/2016 18:42	17.2	33.4	1/23/2016 18:48	1002.6
New Haven, CT	8465705	1/24/2016 6:06	13.7	26.6	1/24/2016 2:06	19.1	37.1	1/23/2016 19:12	1002.9
New London, CT	8461490	1/26/2016 16:06	6.9	13.4	1/23/2016 15:54	11.7	22.7	1/24/2016 1:48	1002.5
Quonset Point, RI	8454049	1/23/2016 15:30	16.6	32.3	1/23/2016 15:30	20.9	40.6	1/24/2016 4:30	1002.4
Providence, RI	8454000	1/23/2016 17:06	12.4	24.1	1/23/2016 15:36	18.3	35.6	1/24/2016 4:36	1002.9
Conimicut Light, RI	8452944	1/23/2016 17:30	15.0	29.2	1/23/2016 16:24	20.1	39.1	1/24/2016 4:48	1003.5
Newport, RI	8452660	1/24/2016 6:18	13.1	25.5	1/24/2016 7:54	18.7	36.4	1/24/2016 4:18	1001.7
Nantucket Island, MA	8449130	1/24/2016 0:24	17.5	34.0	1/23/2016 19:42	23.5	45.7	1/24/2016 5:06	998.8
Woods Hole, MA	8447930	n/a	n/a	n/a	n/a	n/a	n/a	1/24/2016 4:36	999.9
Chatham, MA	8447435	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Fall River, MA	8447386	n/a	n/a	n/a	n/a	n/a	n/a	1/24/2016 4:36	1003.0
Boston, MA	8443970	n/a	n/a	n/a	n/a	n/a	n/a	1/24/2016 4:48	1005.2
Fort Point, NH	8423898	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Wells, ME	8419317	1/24/2016 6:42	11.2	21.8	1/27/2016 21:18	15.4	29.9	1/26/2016 22:18	1006.9
Portland, ME	8418150	n/a	n/a	n/a	n/a	n/a	n/a	1/27/2016 1:48	1006.0
Bar Harbor, ME	8413320	1/21/2016 15:00	13.1	25.5	1/26/2016 20:54	18.1	35.2	1/27/2016 5:36	1004.1
Cutler Farris Wharf, ME	8411060	1/27/2016 3:54	9.2	17.9	1/21/2016 17:30	14.2	27.6	1/27/2016 4:30	1004.1
Eastport, ME	8410140	1/24/2016 6:00	13.1	25.5	1/26/2016 20:06	17.1	33.2	1/27/2016 4:48	1002.8

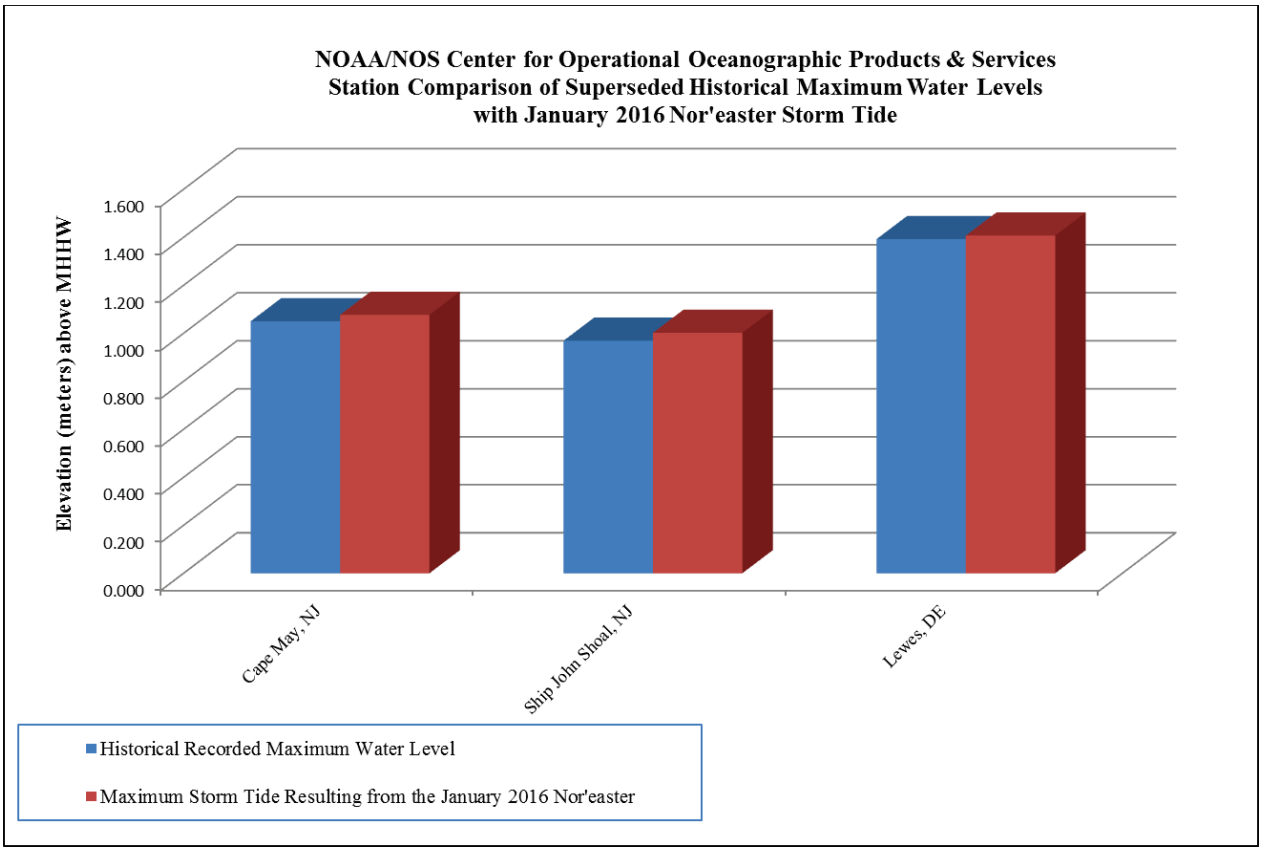

Figure 5: Stations that exceeded historical recorded maximum water levels during the January 2016 Nor'easter.

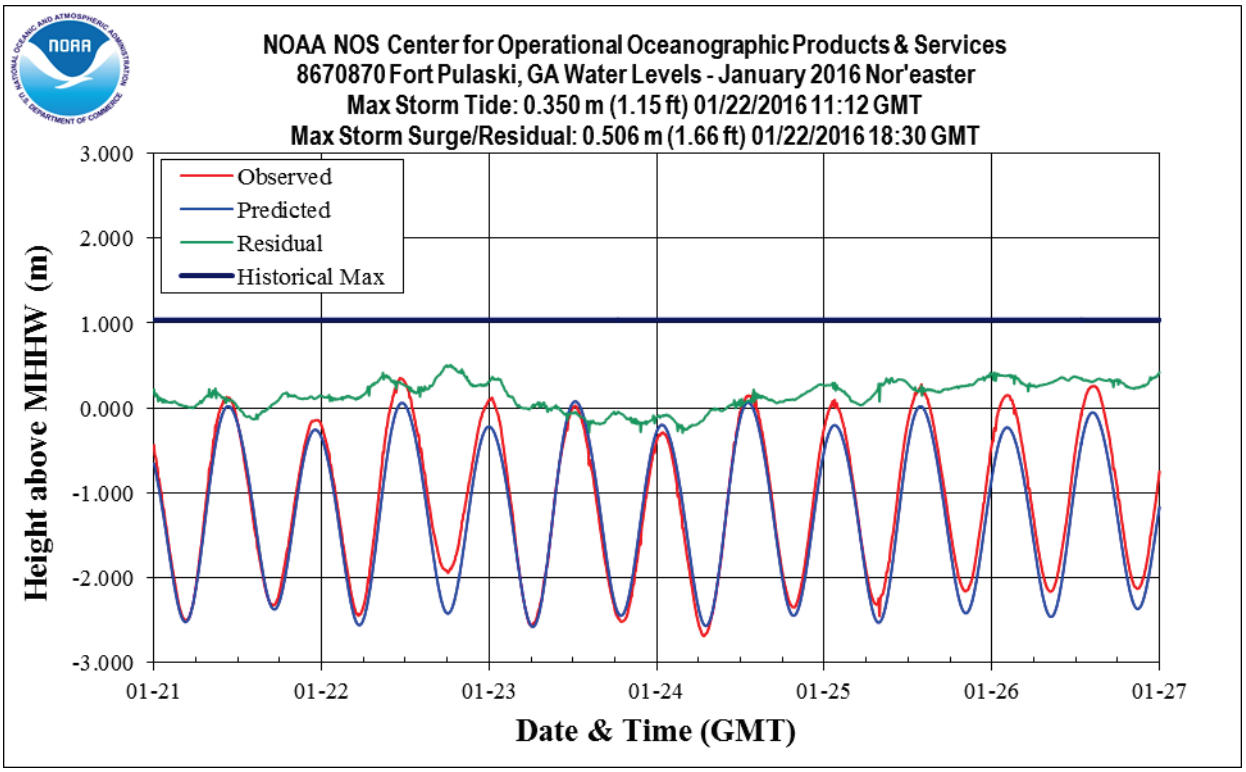

Figure 6: Water levels above Mean Higher High Water (MHHW) at Fort Pulaski, GA. A line denoting the Historical Maximum Water Level value is displayed.

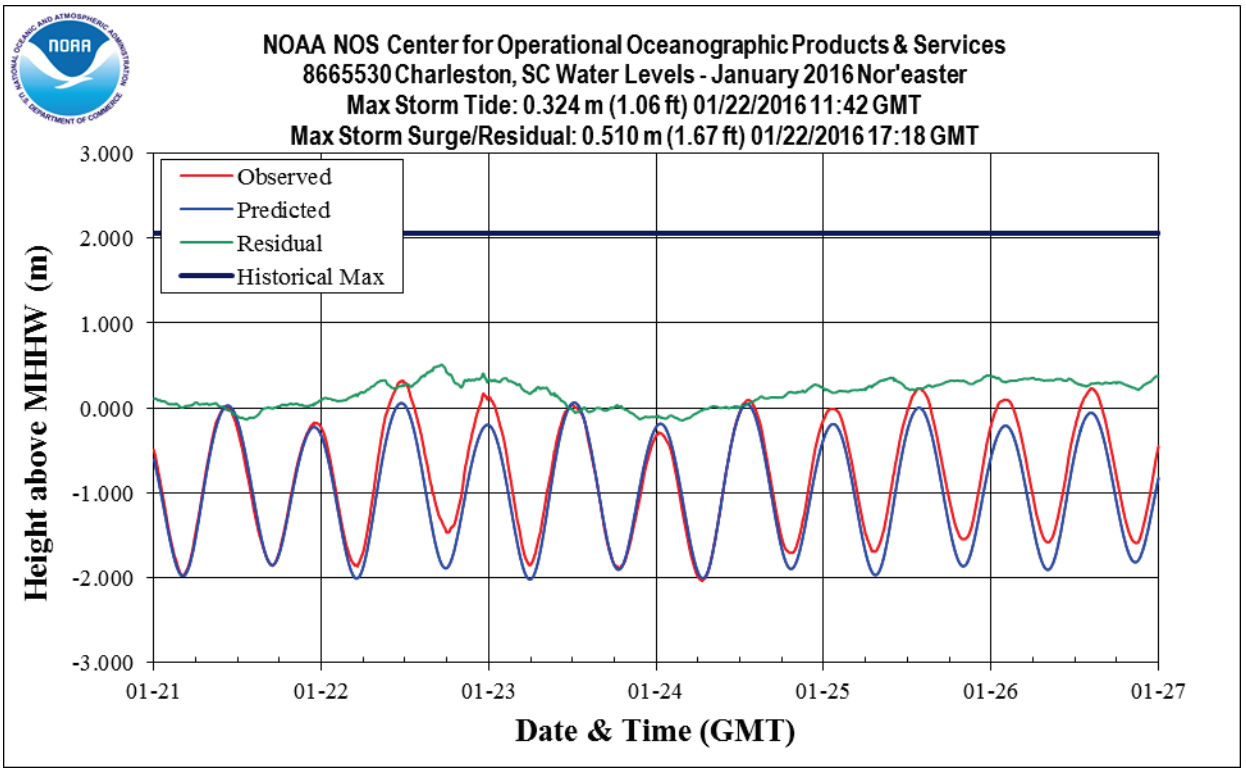

Figure 7: Water levels above Mean Higher High Water (MHHW) at Charleston, SC. A line denoting the Historical Maximum Water Level value is displayed.

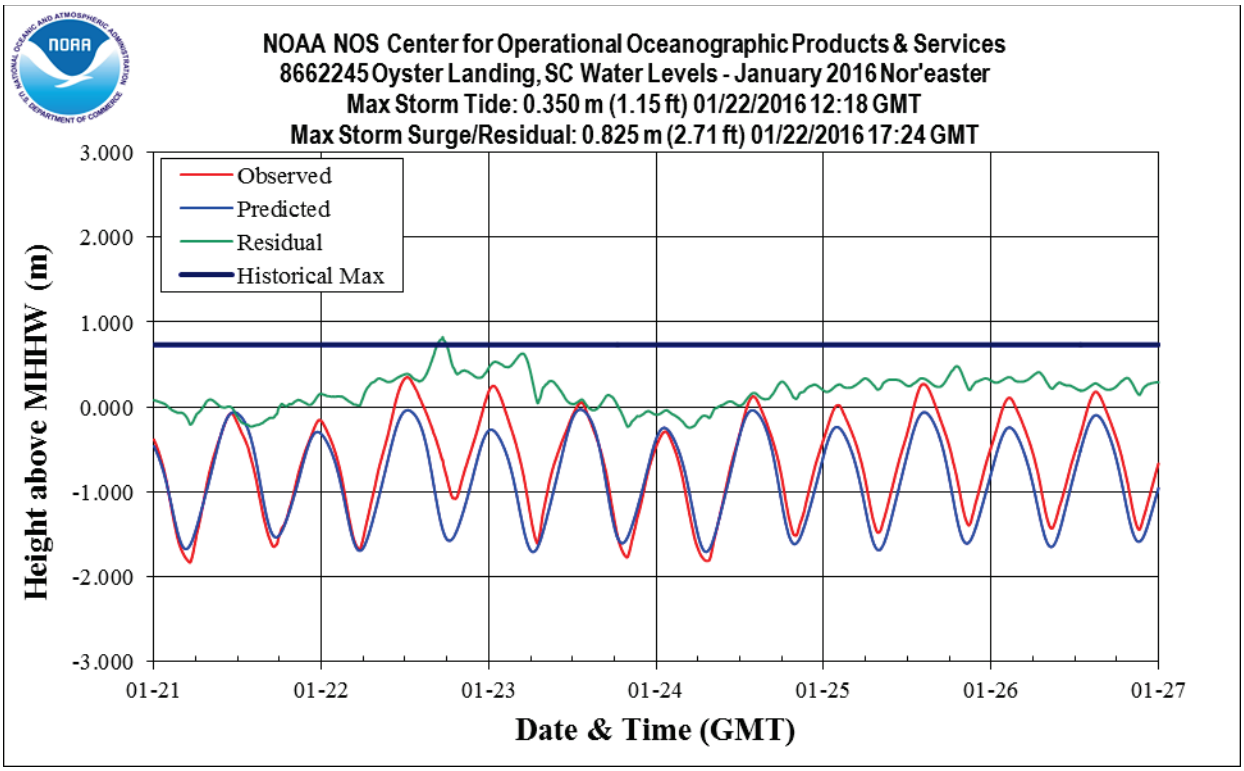

Figure 8: Water levels above Mean Higher High Water (MHHW) at Oyster Landing, SC. A line denoting the Historical Maximum Water Level value is displayed.

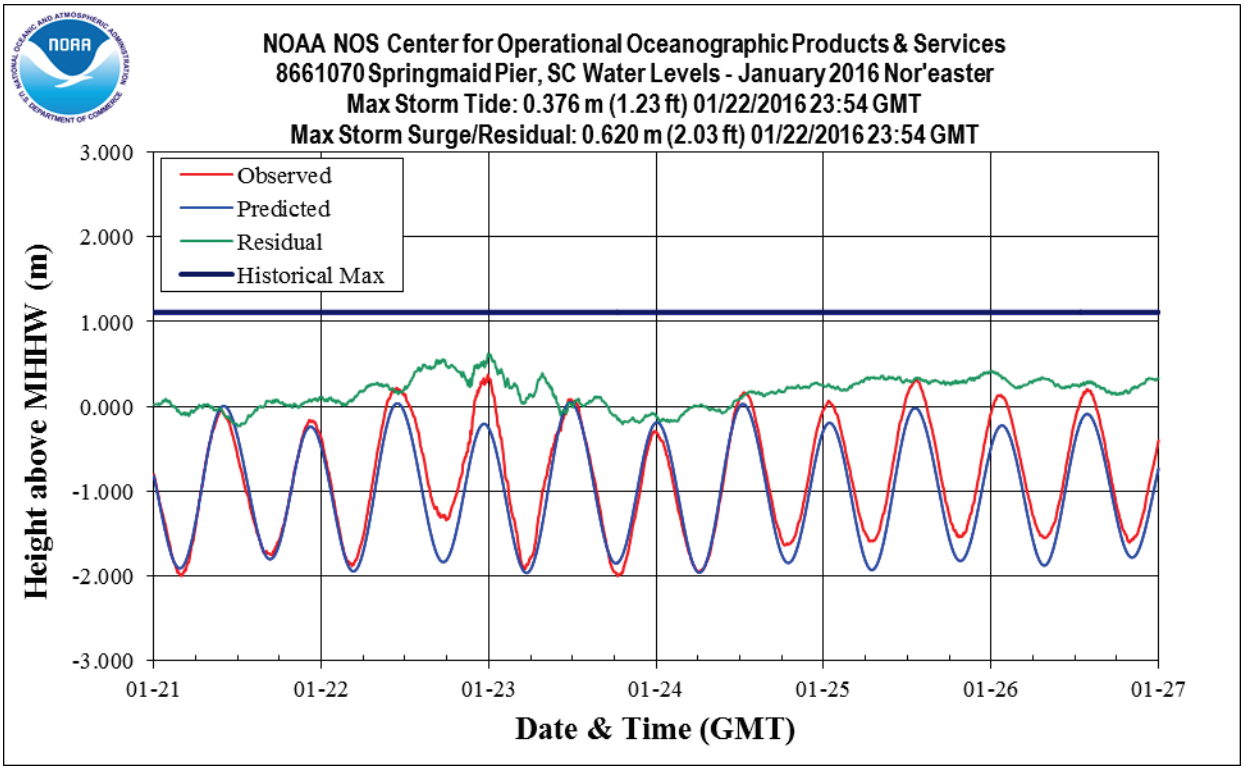

Figure 9: Water levels above Mean Higher High Water (MHHW) at Springmaid Pier, SC. A line denoting the Historical Maximum Water Level value is displayed.

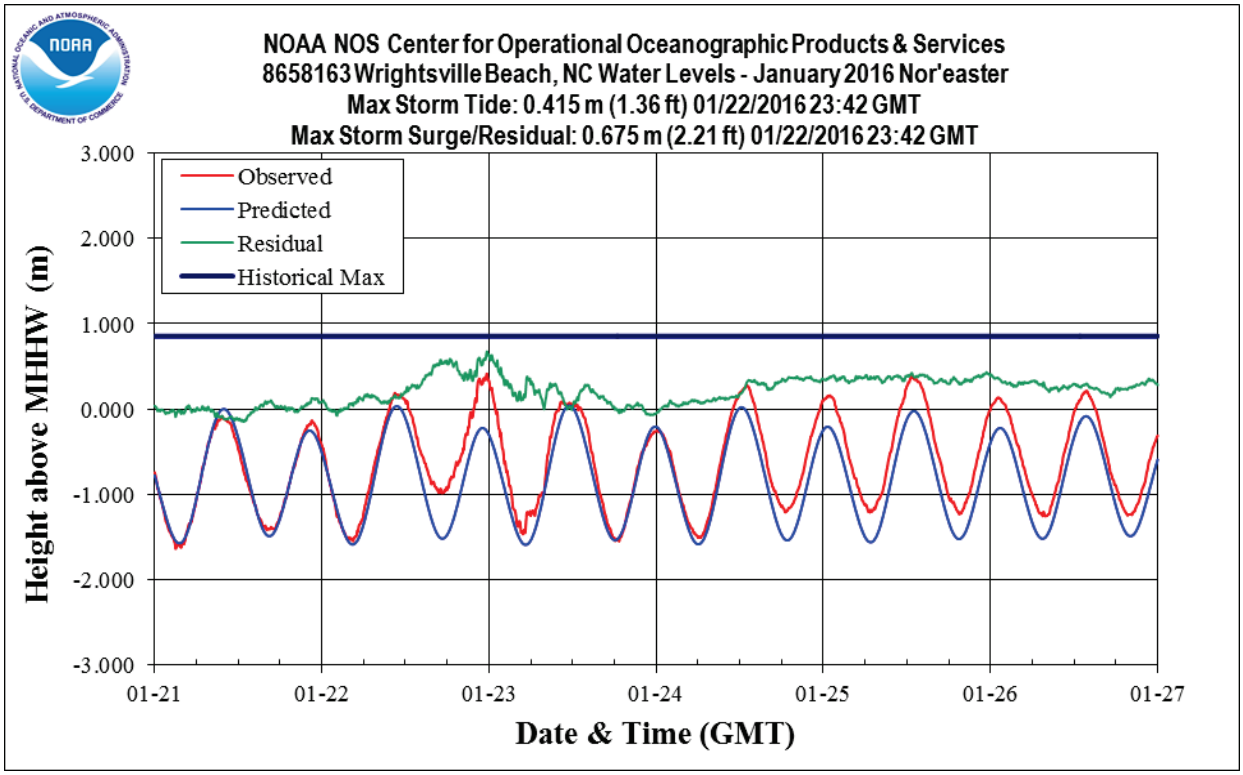

Figure 10: Water levels above Mean Higher High Water (MHHW) at Wrightsville Beach, NC. A line denoting the Historical Maximum Water Level value is displayed.

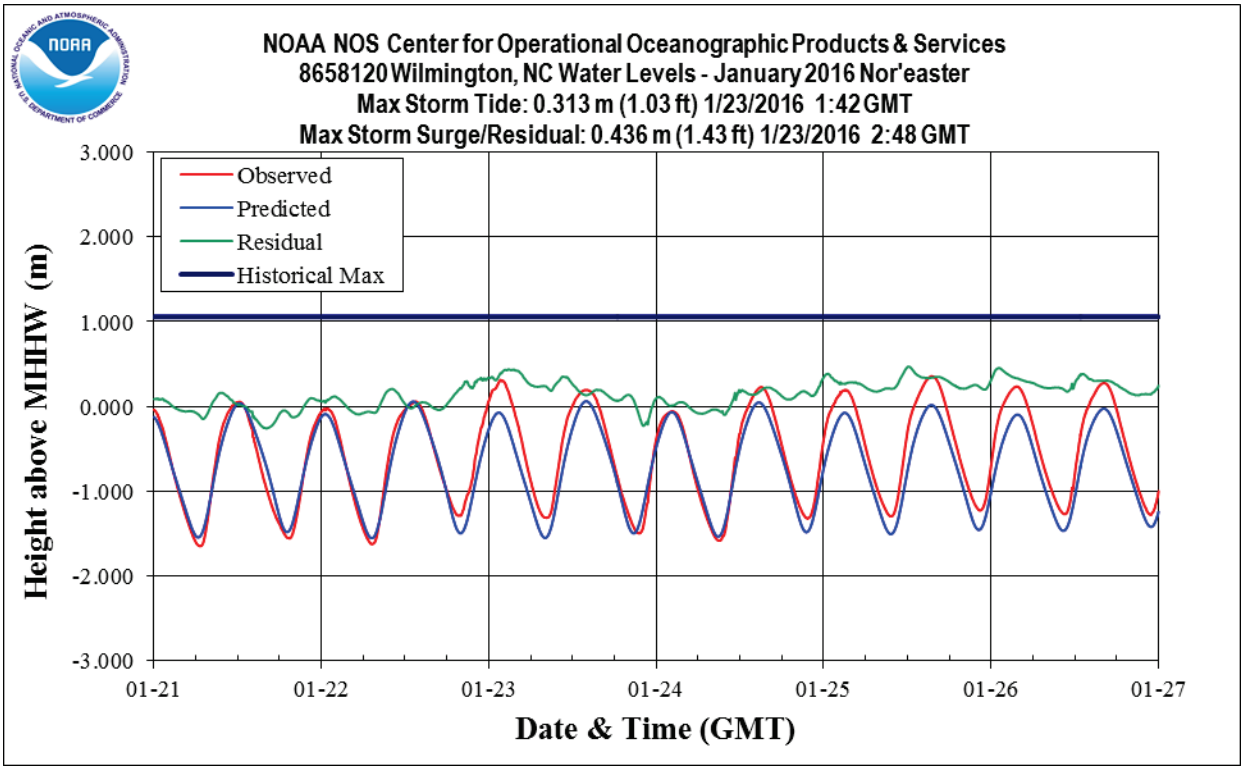

Figure 11: Water levels above Mean Higher High Water (MHHW) at Wilmington, NC. A line denoting the Historical Maximum Water Level value is displayed. Peak storm tide and residual values for this report are taken during the January 2016 Nor'easter. Higher water levels were observed in the days following this storm event due to a second weather system that passed through the region.

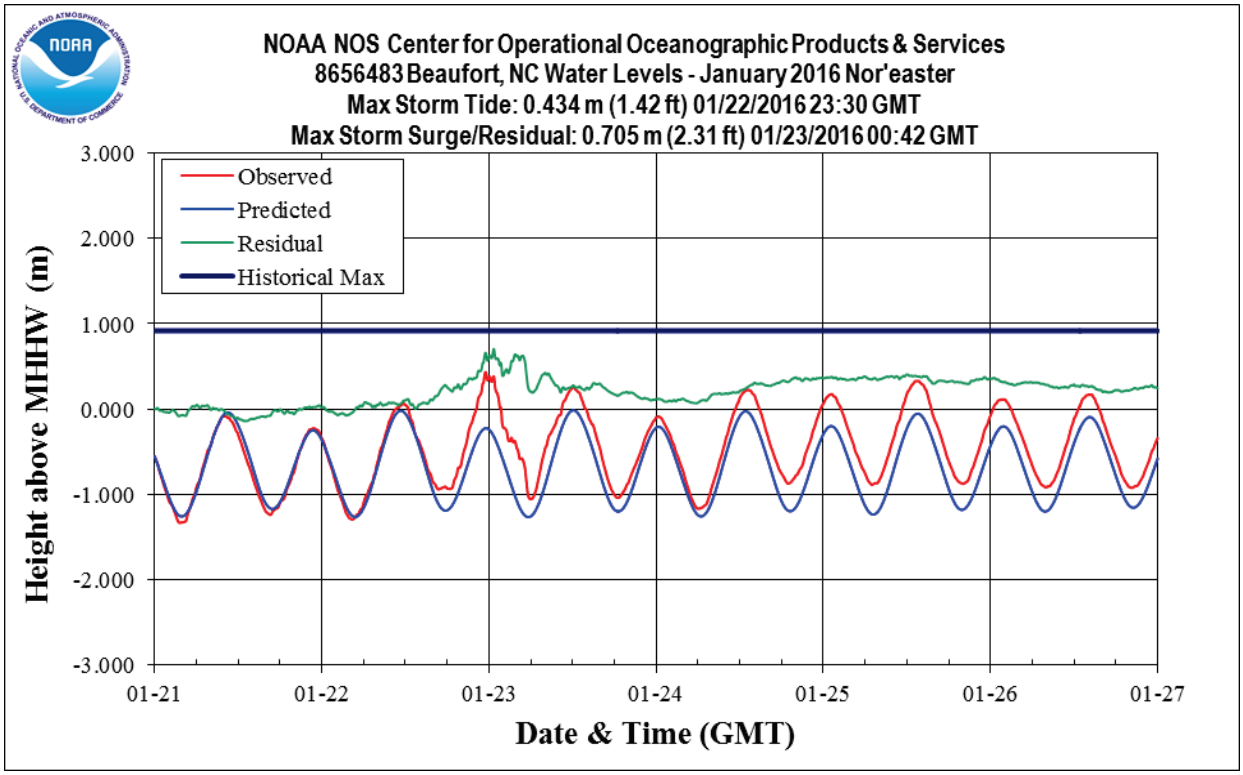

Figure 12: Water levels above Mean Higher High Water (MHHW) at Beaufort, NC. A line denoting the Historical Maximum Water Level value is displayed.

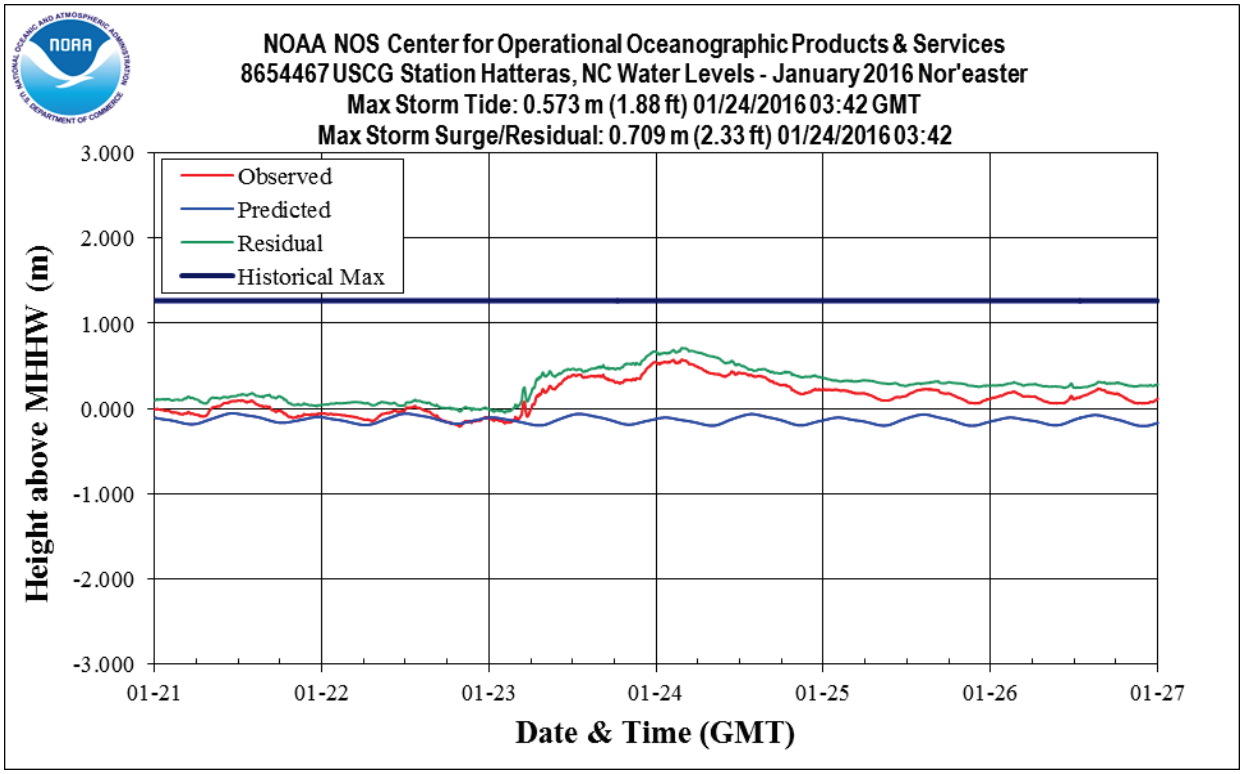

Figure 13: Water levels above Mean Higher Highw Water (MHHW) at USCG Station Hatteras, NC. A line denoting the Historical Maximum Water Level value is displayed.

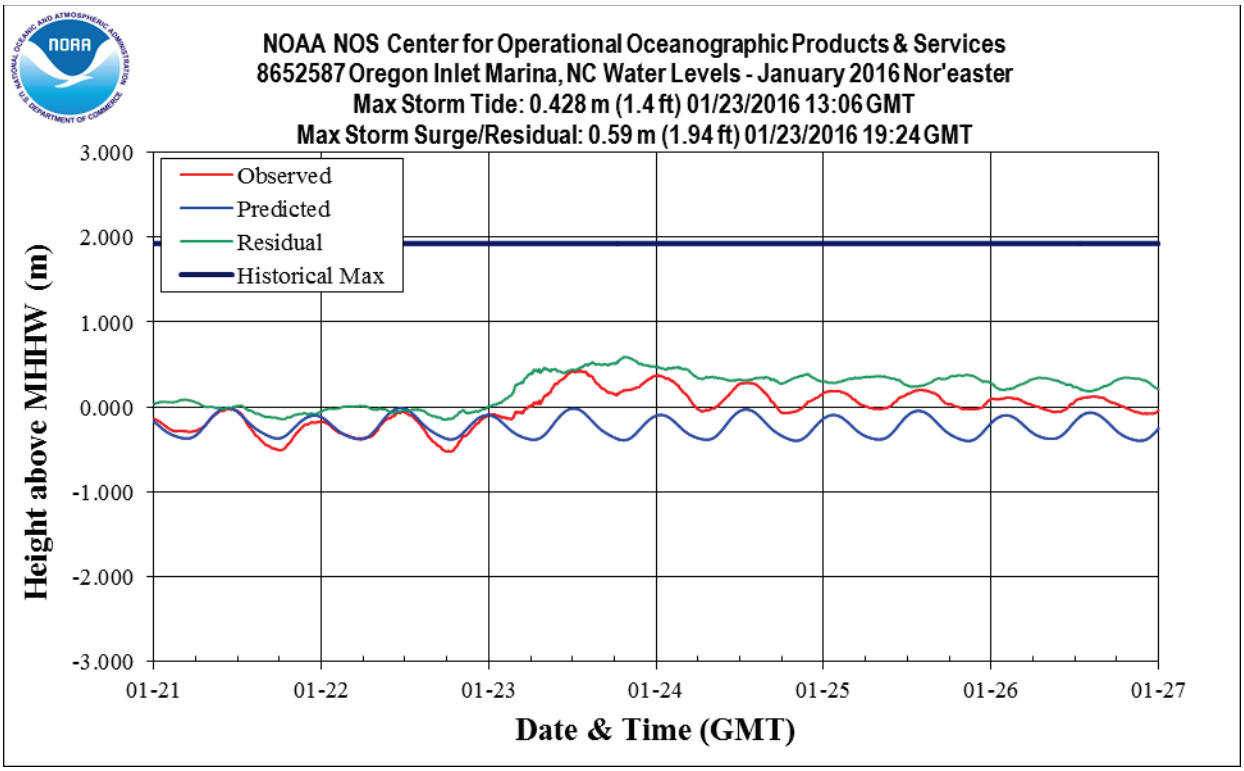

Figure 14: Water levels above Mean Higher High Water (MHHW) at Oregon Inlet Marina, NC. A line denoting the Historical Maximum Water Level value is displayed.

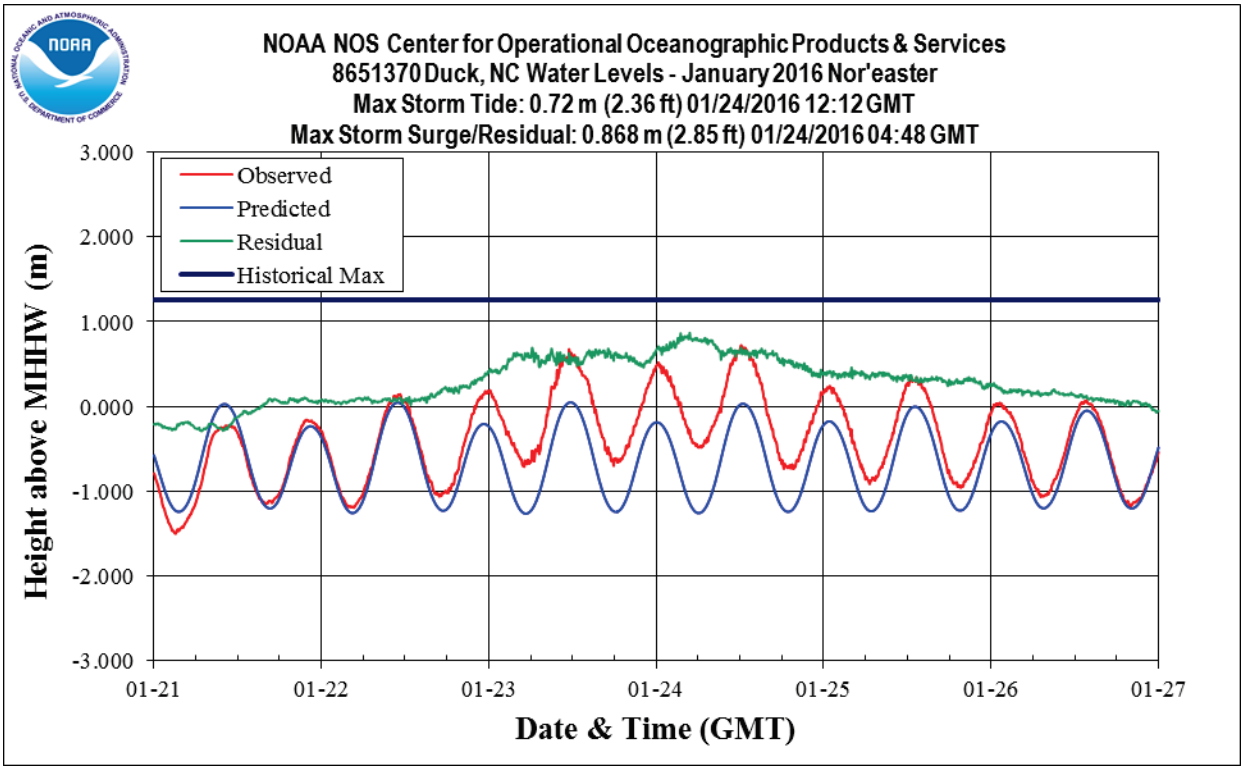

Figure 15: Water levels above Mean Higher High Water (MHHW) at Duck, NC. A line denoting the Historical Maximum Water Level value is displayed.

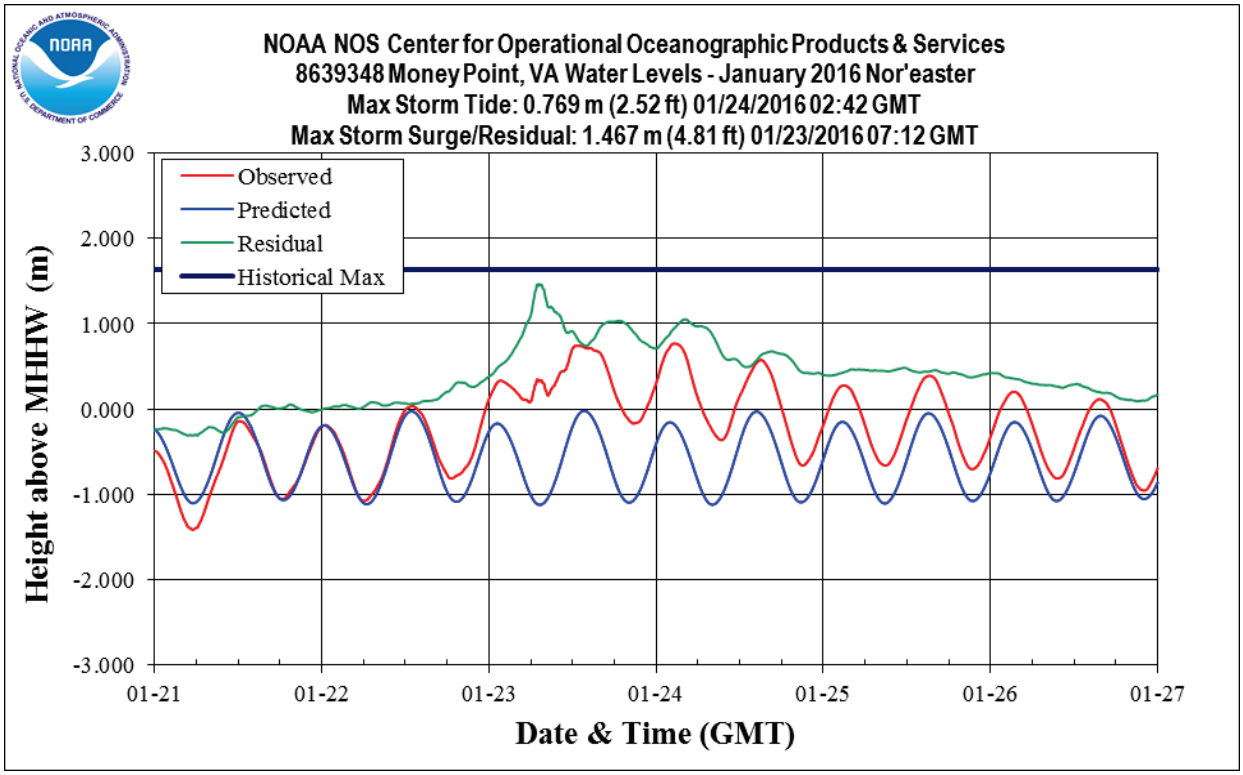

Figure 16: Water levels above Mean Higher High Water (MHHW) at Money Point, VA. A line denoting the Historical Maximum Water Level value is displayed.

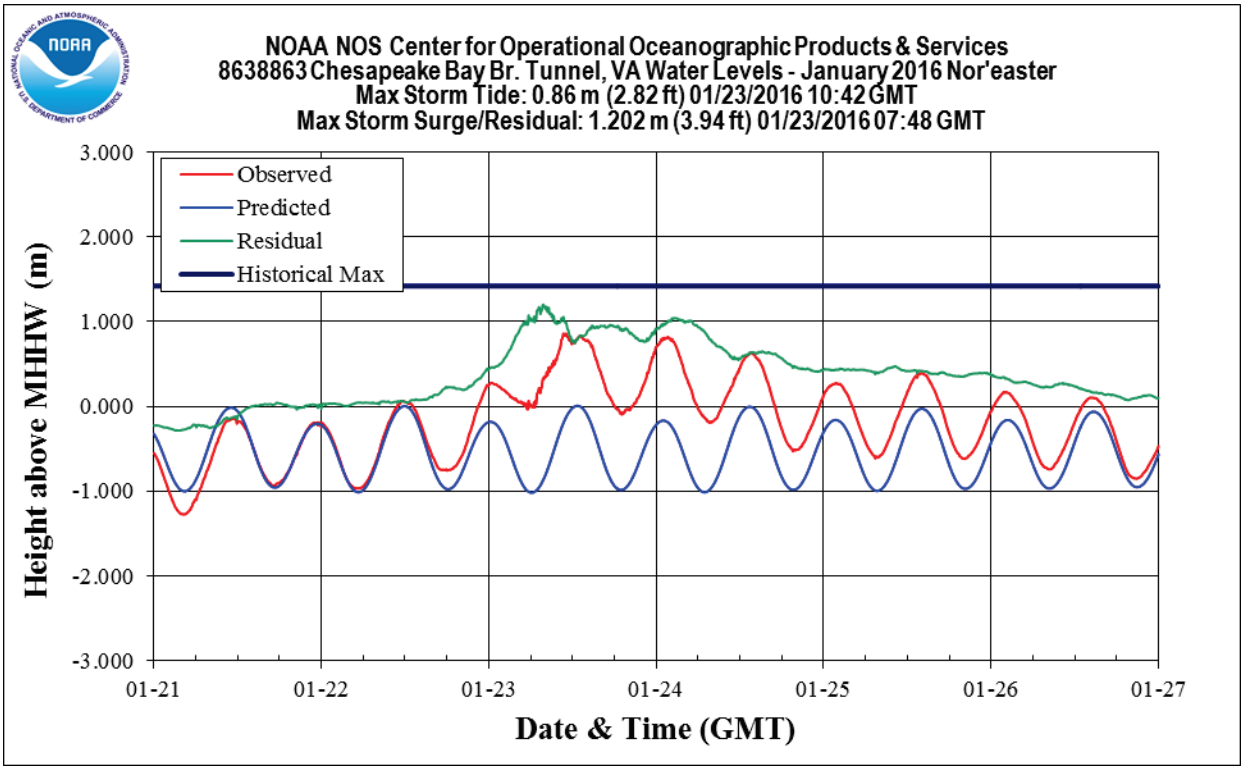

Figure 17: Water levels above Mean Higher High Water (MHHW) at Chesapeake Bay Bridge Tunnel, VA. A line denoting the Historical Maximum Water Level value is displayed.

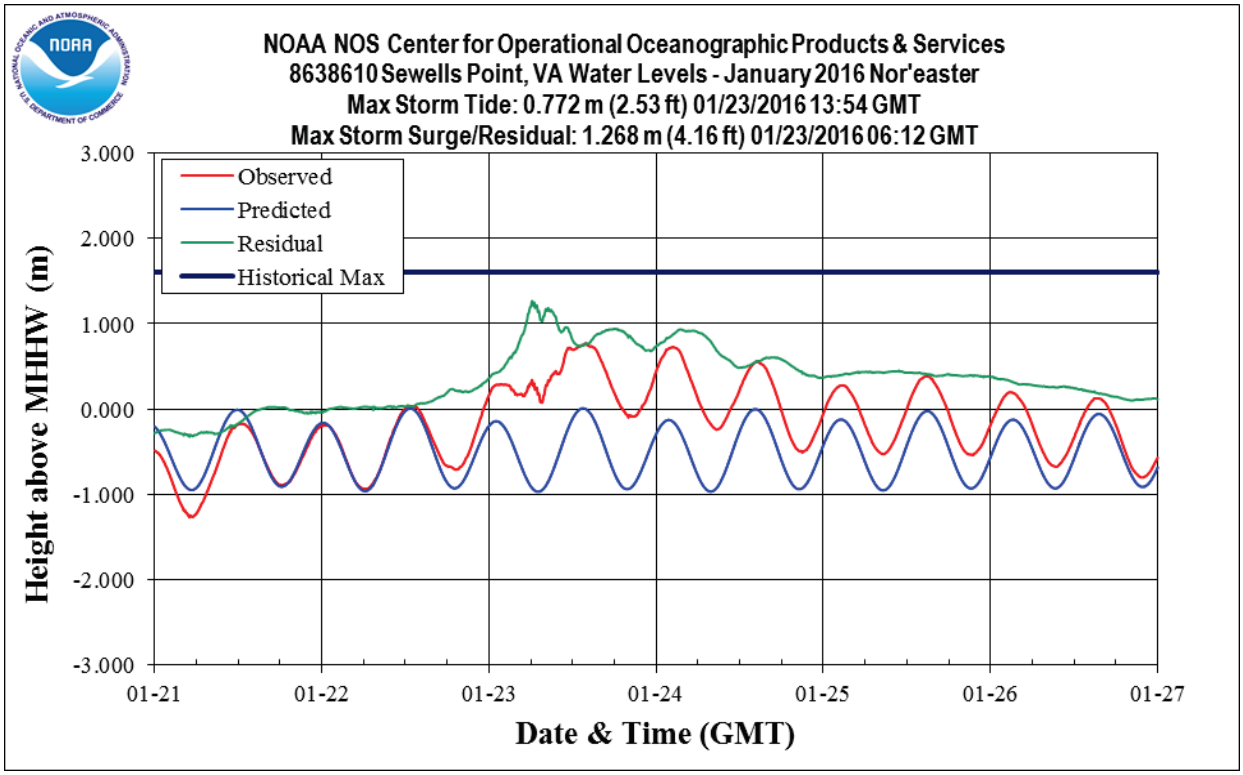

Figure 18: Water levels above Mean Higher High Water (MHHW) at Sewells Point, VA. A line denoting the Historical Maximum Water Level value is displayed.

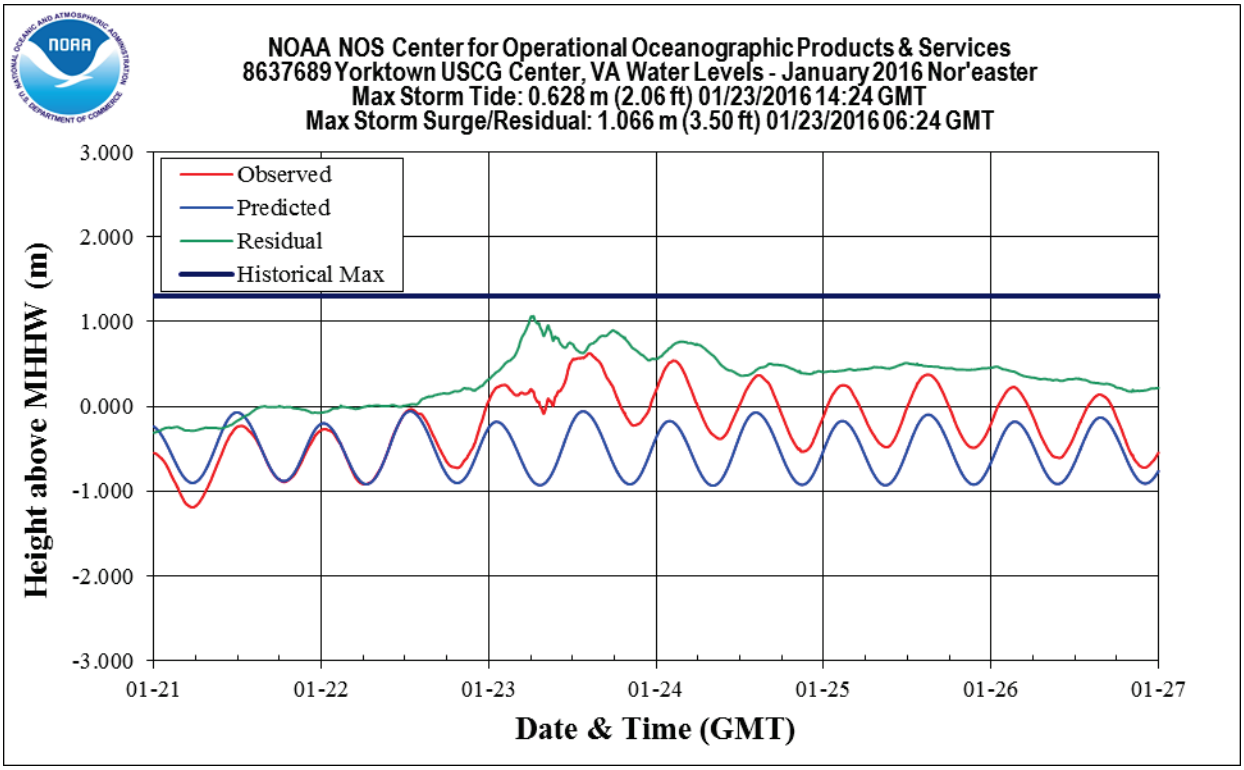

Figure 19: Water levels above Mean Higher High Water (MHHW) at Yorktown USCG Training Center, VA. A line denoting the Historical Maximum Water Level value is diplayed.

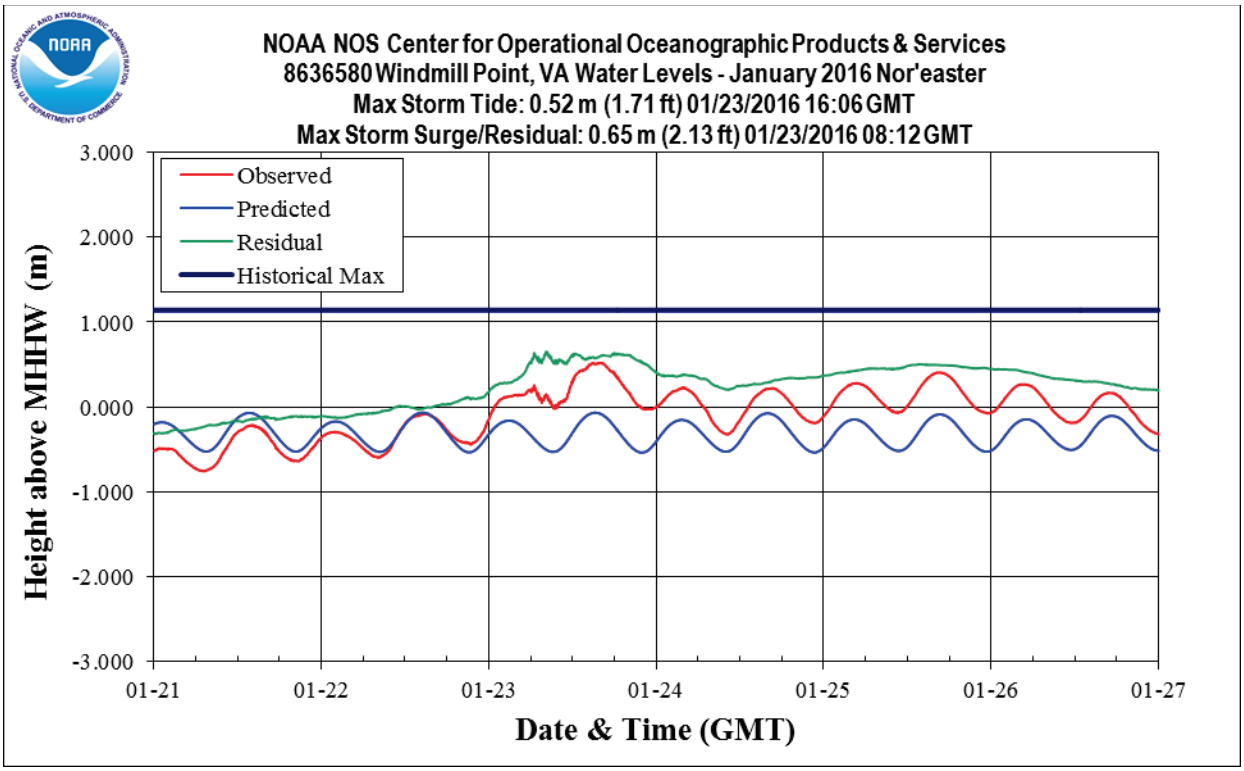

Figure 20: Water levels above Mean Higher High Water (MHHW) at Windmill Point, VA. A line denoting the Historical Maximum Water Level value is displayed.

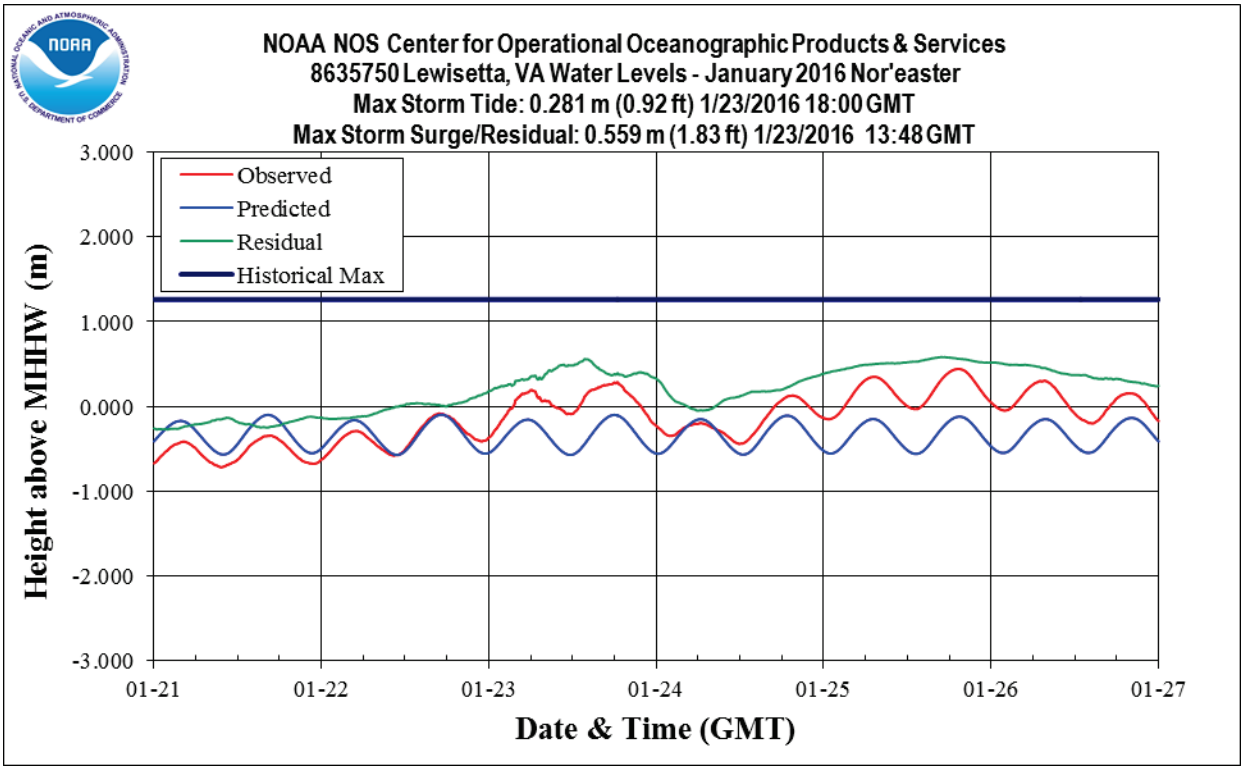

Figure 21: Water levels above Mean Higher High Water (MHHW) at Lewisetta, VA. A line denoting the Historical Maximum Water Level value is displayed. Peak storm tide and residual values for this report are taken during the January 2016 Nor'easter. Higher water levels were observed in the days following this storm event due to a second weather system that passed through the region.

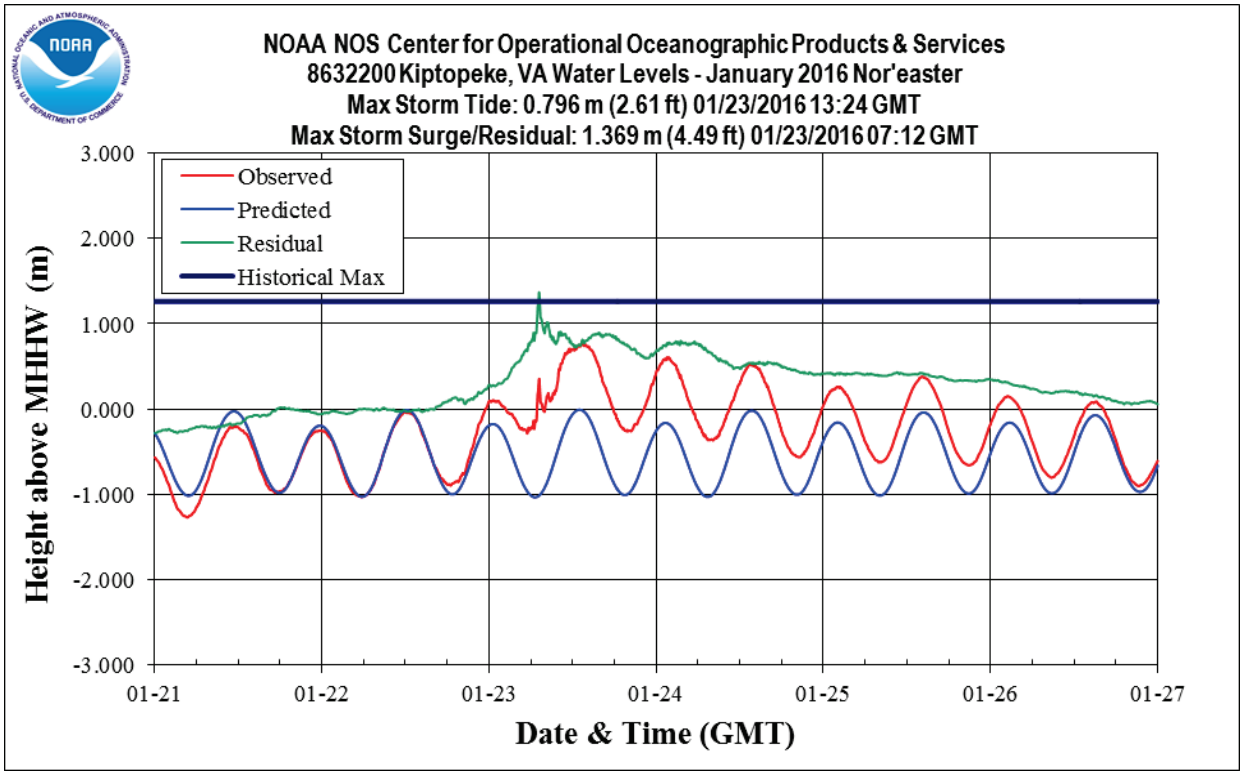

Figure 22: Water levels above Mean Higher High Water (MHHW) at Kiptopeke, VA. A line denoting the Historical Maximum Water Level value is displayed.

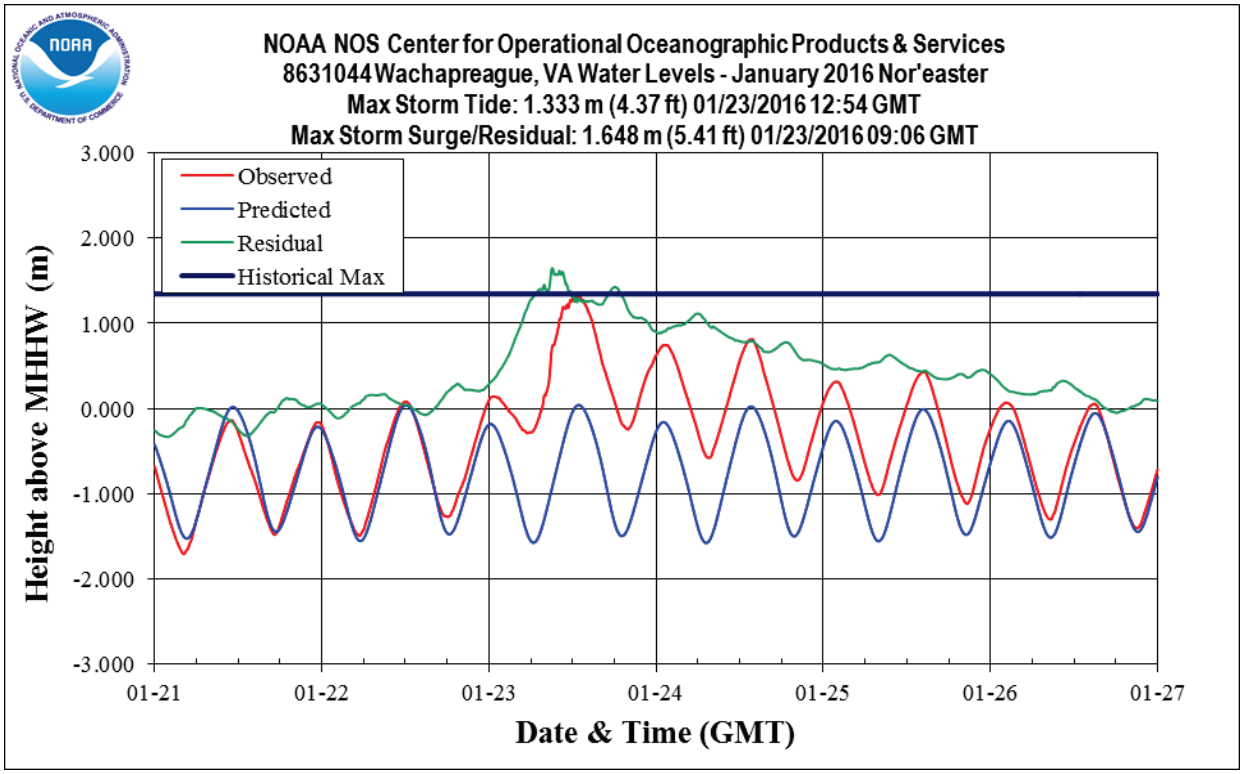

Figure 23:Water levels above Mean Higher High Water (MHHW) at Wachapreague, VA. A line denoting the Historical Maximum Water Level value is displayed.

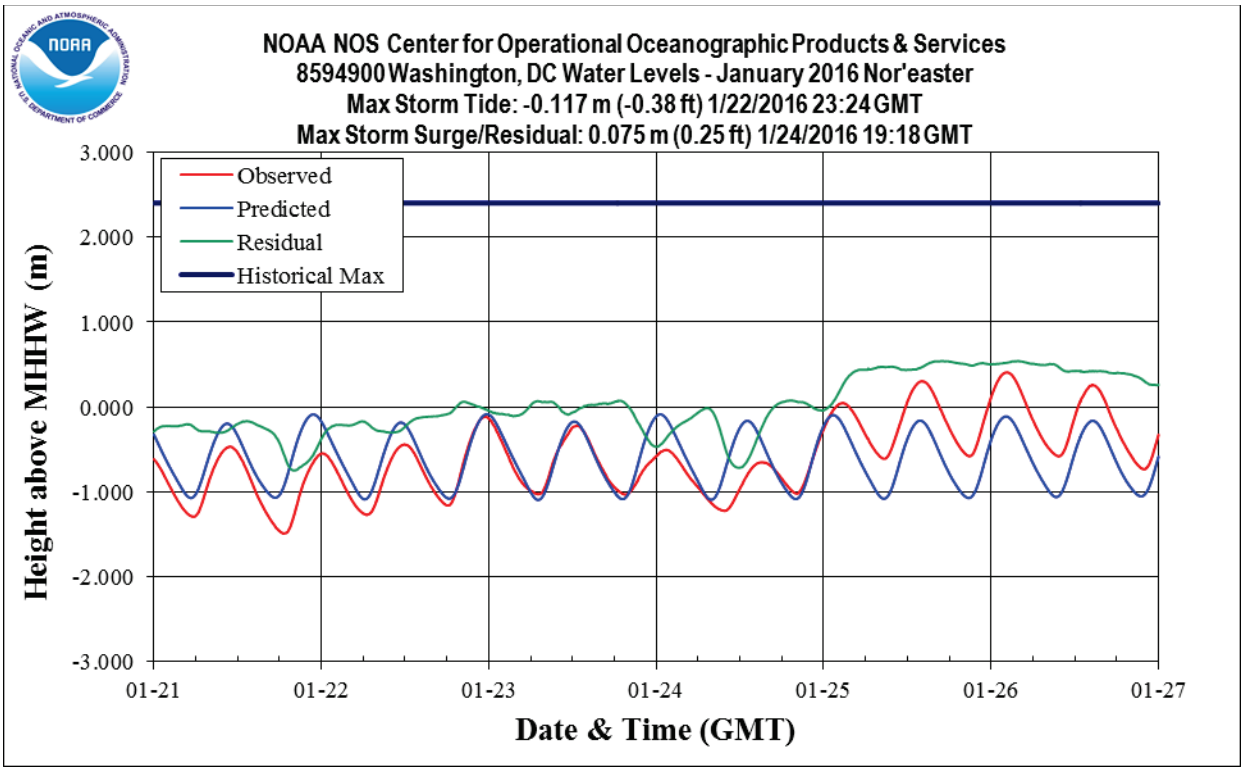

Figure 24: Water levels above Mean Higher High Water (MHHW) at Washington, DC. A line denoting the Historical Maximum Water Level is displayed. Peak storm tide and residual values for this report are taken during the January 2016 Nor'easter. Higher water levels were observed in the days following this storm event due to a second weather system that passed through the region.

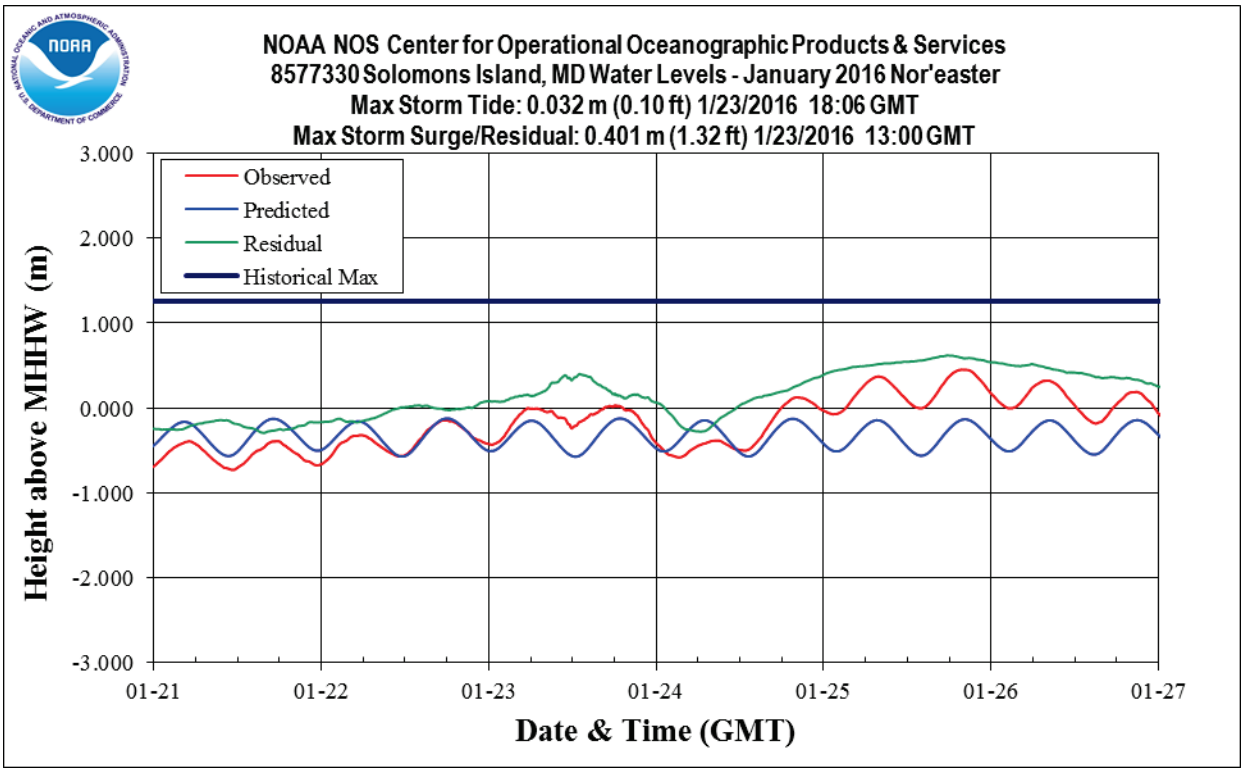

Figure 25: Water levels above Mean Higher High Water (MHHW) at Solomons Island, MD. A line denoting the Historical Maximum Water Level value is displayed. Peak storm tide and residual values for this report are taken during the January 2016 Nor'easter. Higher water levels were observed in the days following this storm event due to a second weather system that passed through the region.

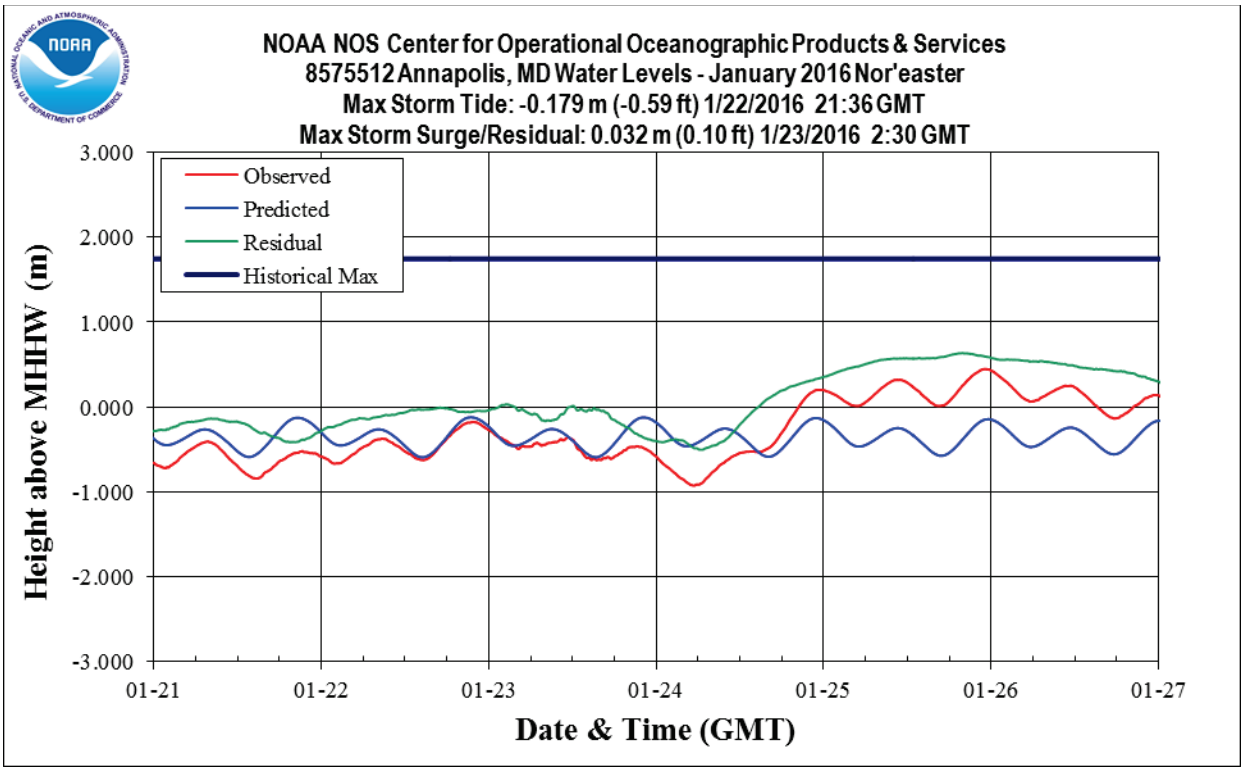

Figure 26: Water levels above Mean Higher High Water (MHHW) at Annapolis, MD. A line denoting the Historical Maximum Water Level value is displayed. Peak storm tide and residual values for this report are taken during the January 2016 Nor'easter. Higher water levels were observed in the days following this storm event due to a second weather system that passed through the region.

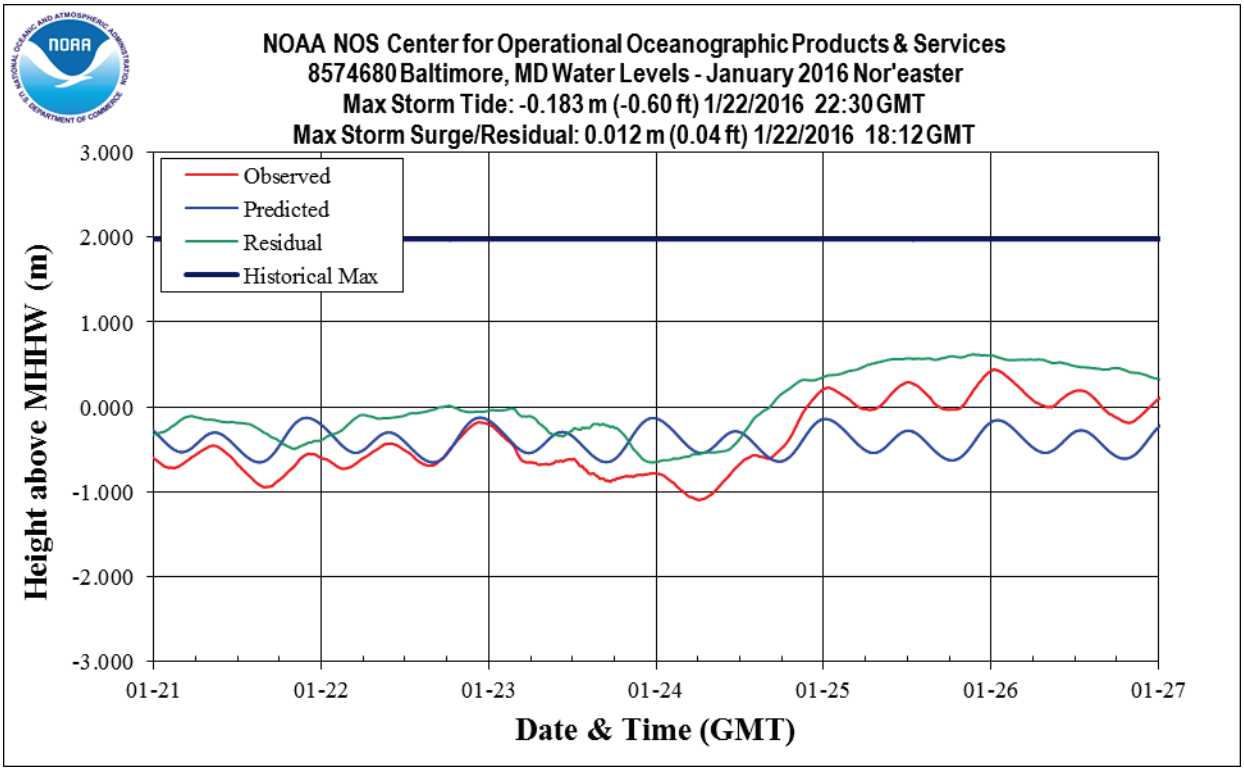

Figure 27: Water levels above Mean Higher High Water (MHHW) at Baltimore, MD. A line denoting the Historical Maximum Water Level value is displayed. Peak storm tide and residual values for this report are taken during the January 2016 Nor'easter. Higher water levels were observed in the days following this storm event due to a second weather system that passed through the region.

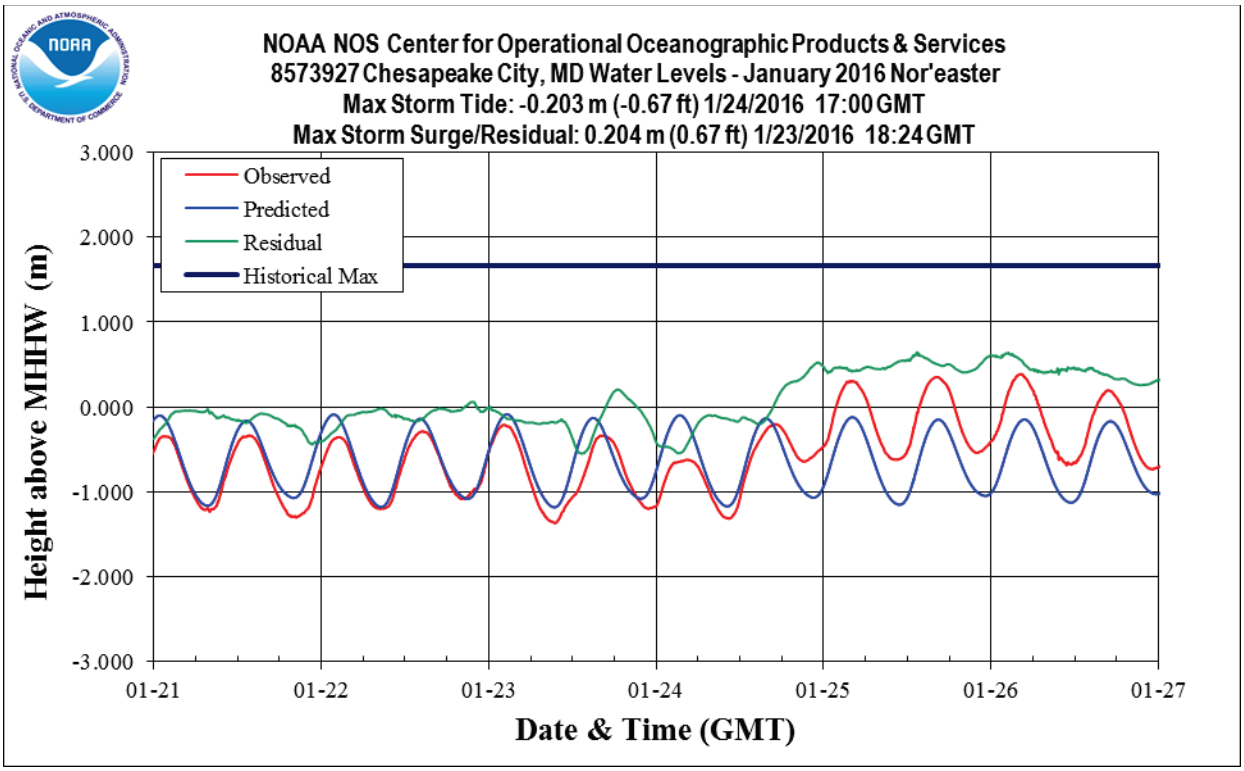

Figure 28: Water levels above Mean Higher High Water (MHHW) at Chesapeake City, MD. A line denoting the Historical Maximum Water Level value is displayed. Peak storm tide and residual values for this report are taken during the January 2016 Nor'easter. Higher water levels were observed in the days following this storm event due to a second weather system that passed through the region.

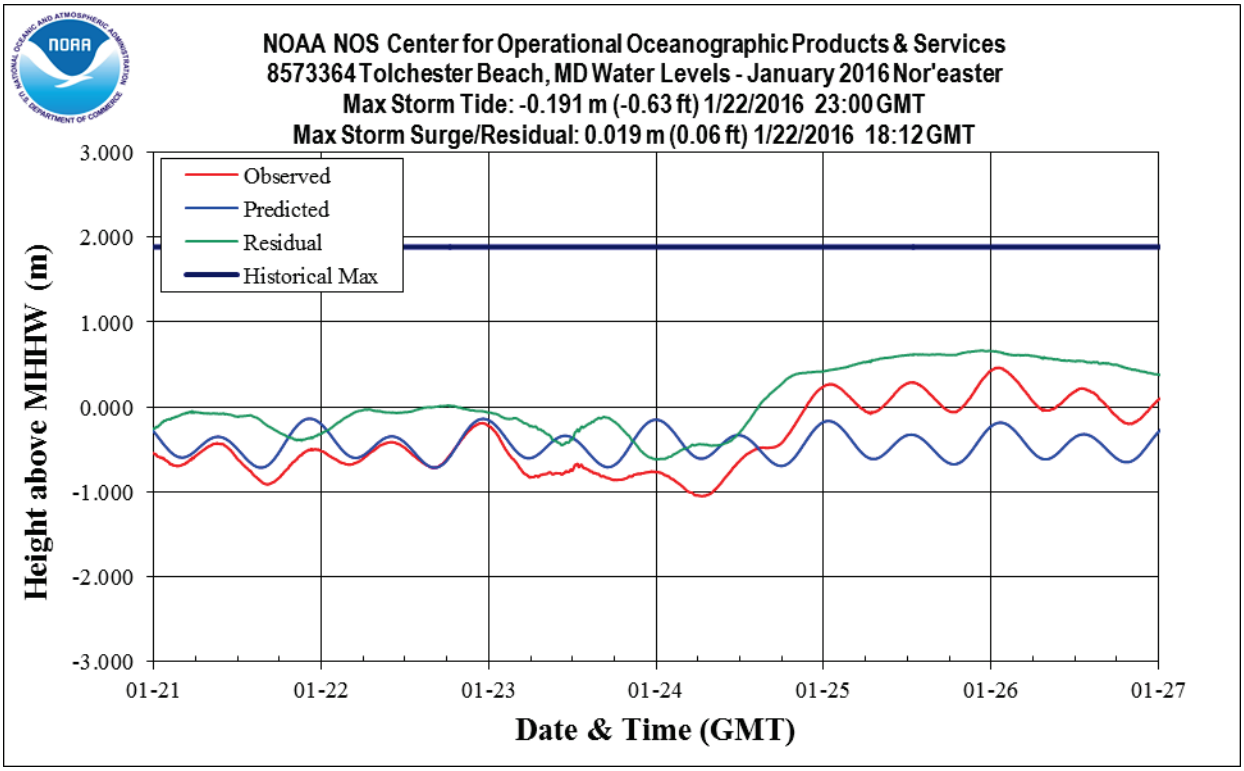

Figure 29: Water levels above Mean Higher High Water (MHHW) at Tolchester Beach, MD. A line denoting the Historical Maximum Water Level value is displayed. Peak storm tide and residual values for this report are taken during the January 2016 Nor'easter. Higher water levels were observed in the days following this storm event due to a second weather system that passed through the region.

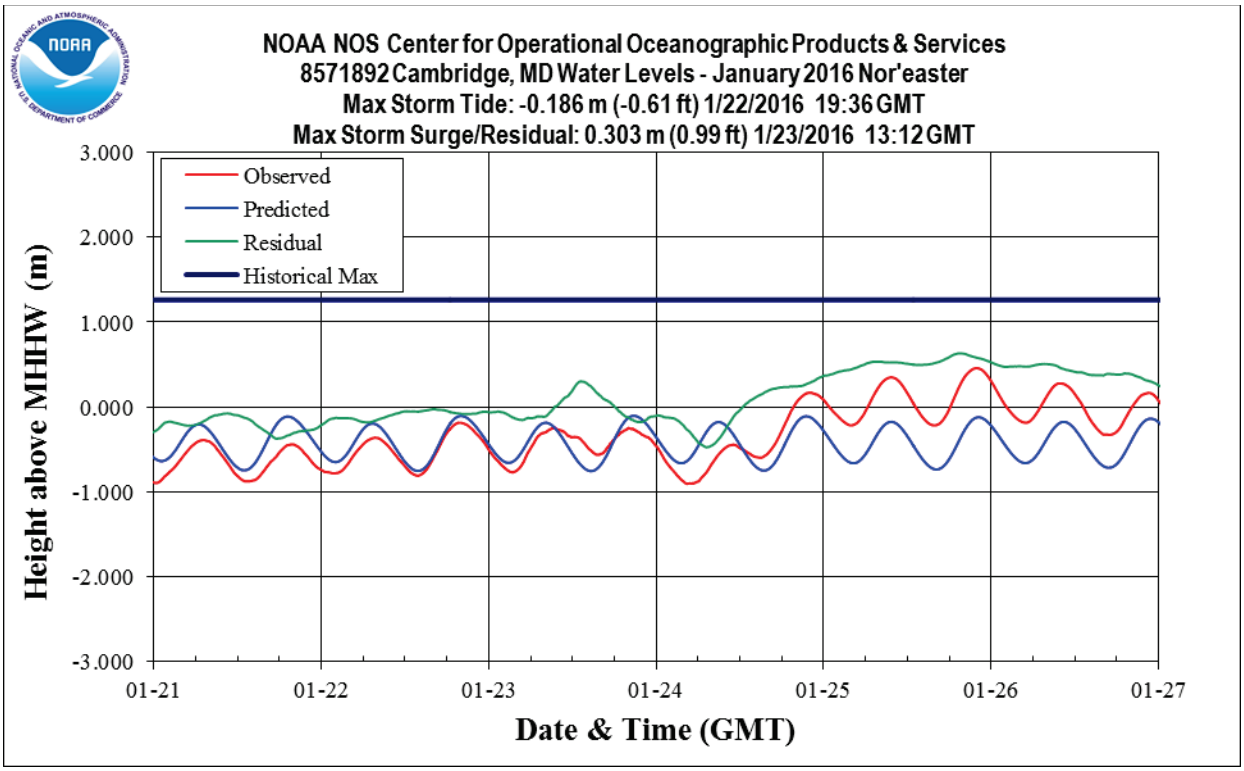

Figure 30: Water levels above Mean Higher High Water (MHHW) at Cambridge, MD. A line denoting the Historical Maximum Water Level value is displayed. Peak storm tide and residual values for this report are taken during the January 2016 Nor'easter. Higher water levels were observed in the days following this storm event due to a second weather system that passed through the region.

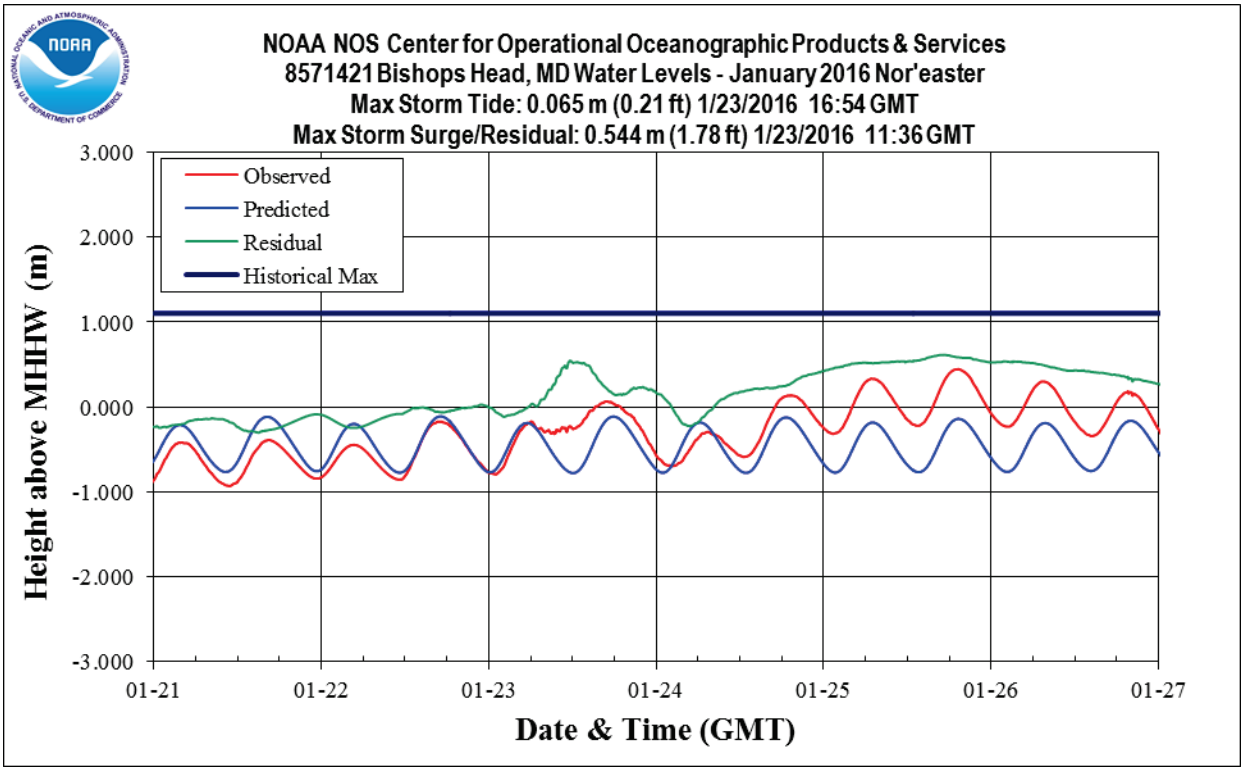

Figure 31: Water levels above Mean Higher High Water (MHHW) at Bishops Head, MD. A line denoting the Historical Maximum Water Level value is displayed. Peak storm tide and residual values for this report are taken during the January 2016 Nor'easter. Higher water levels were observed in the days following this storm event due to a second weather system that passed through the region.

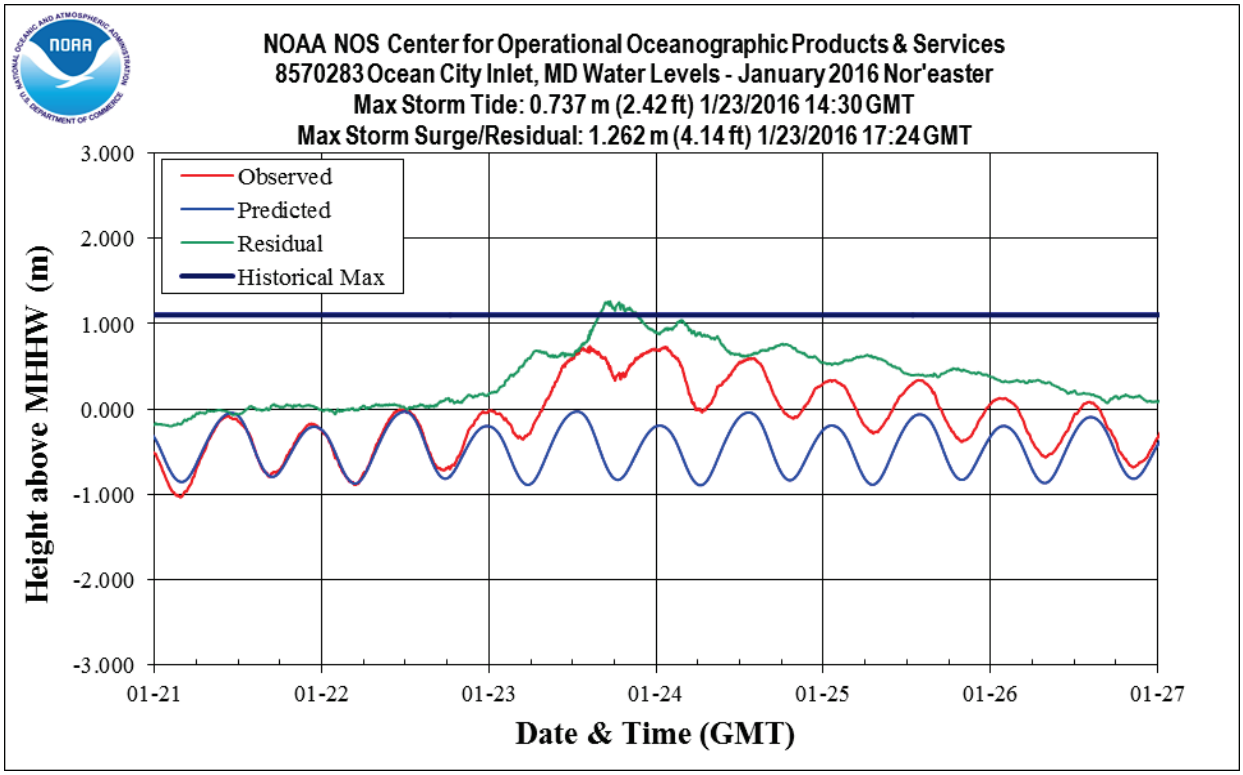

Figure 32: Water levels above Mean Higher High Water (MHHW) at Ocean City Inlet, MD. A line denoting the Historical Maximum Water Level value is displayed.

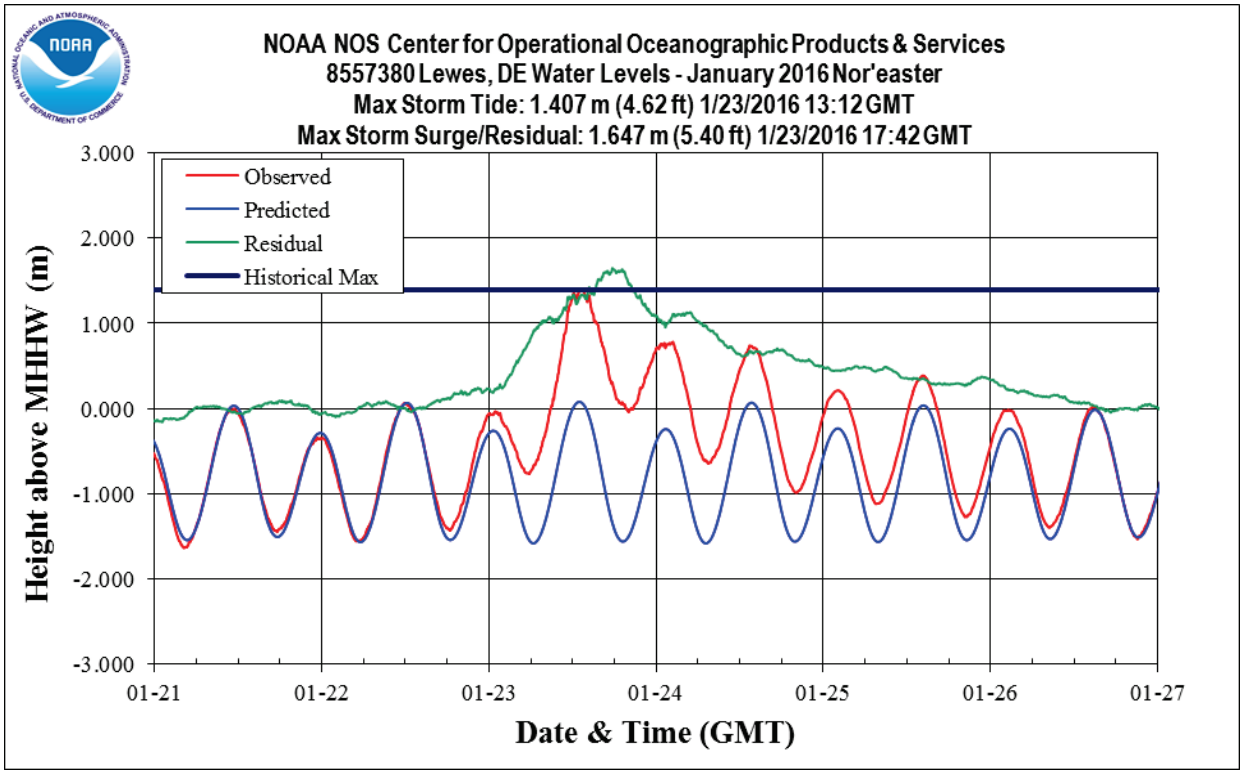

Figure 33: Water levels above Mean Higher High Water (MHHW) at Lewes, DE. A line denoting the Historical Maximum Water Level value is displayed. Maximum recorded water level value exceeded the historical maximum value.

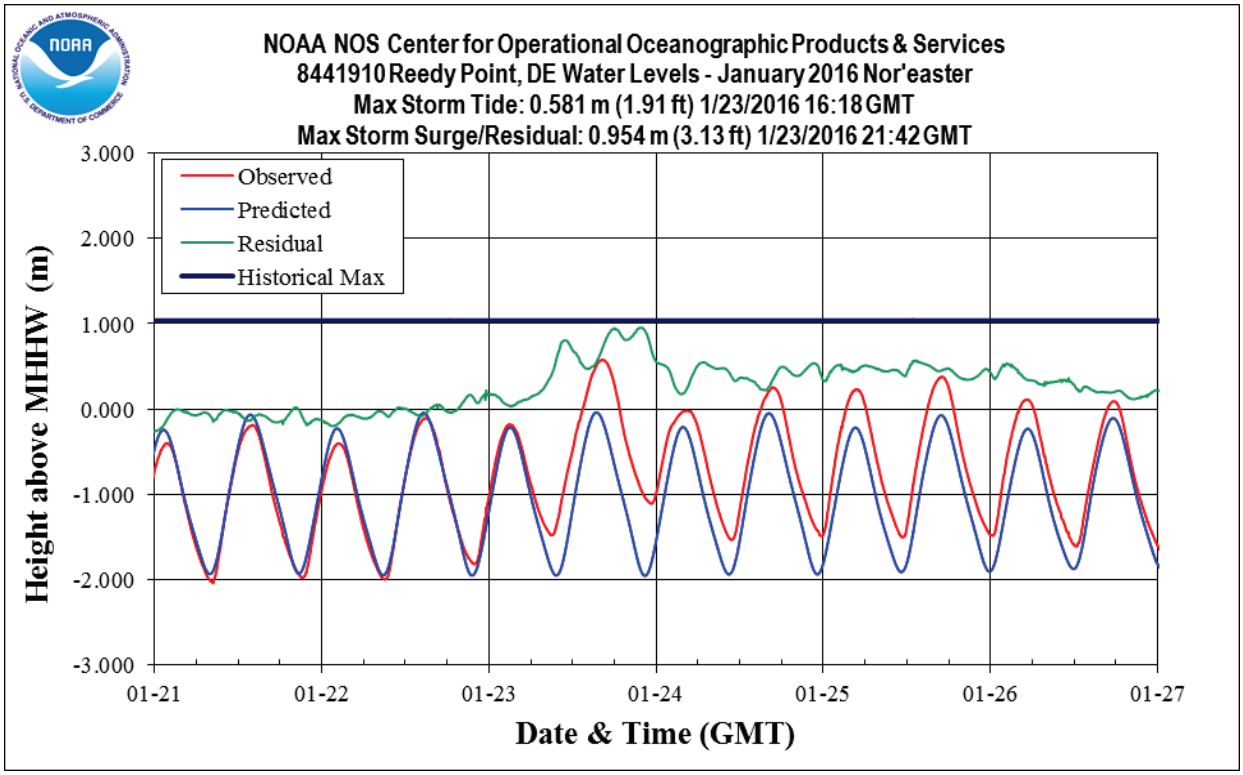

Figure 34: Water levels above Mean Lower Low Water (MHHW) at Reedy Point, DE. A line denoting the Historical Maximum Water Level value is displayed.

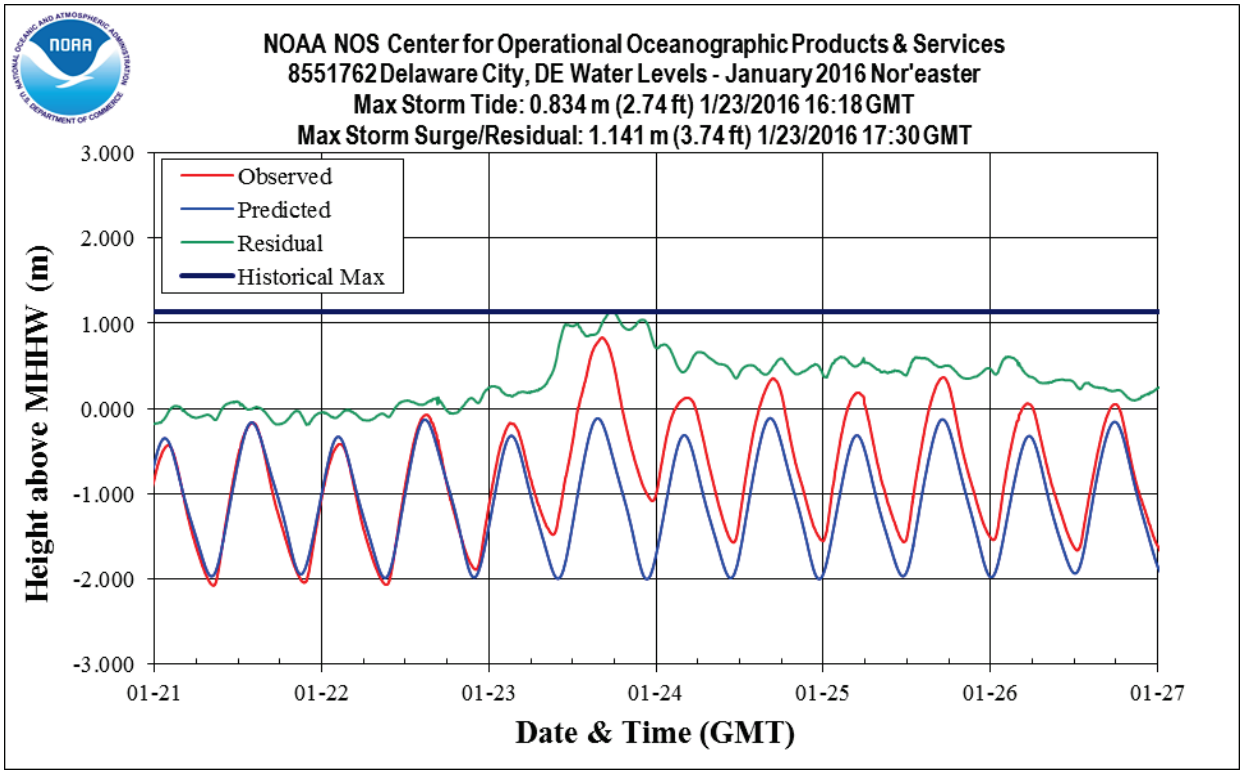

Figure 35: Water levels above Mean Higher High Water (MHHW) at Delaware City, DE. A line denoting the Historical Maximum Water Level value is displayed.

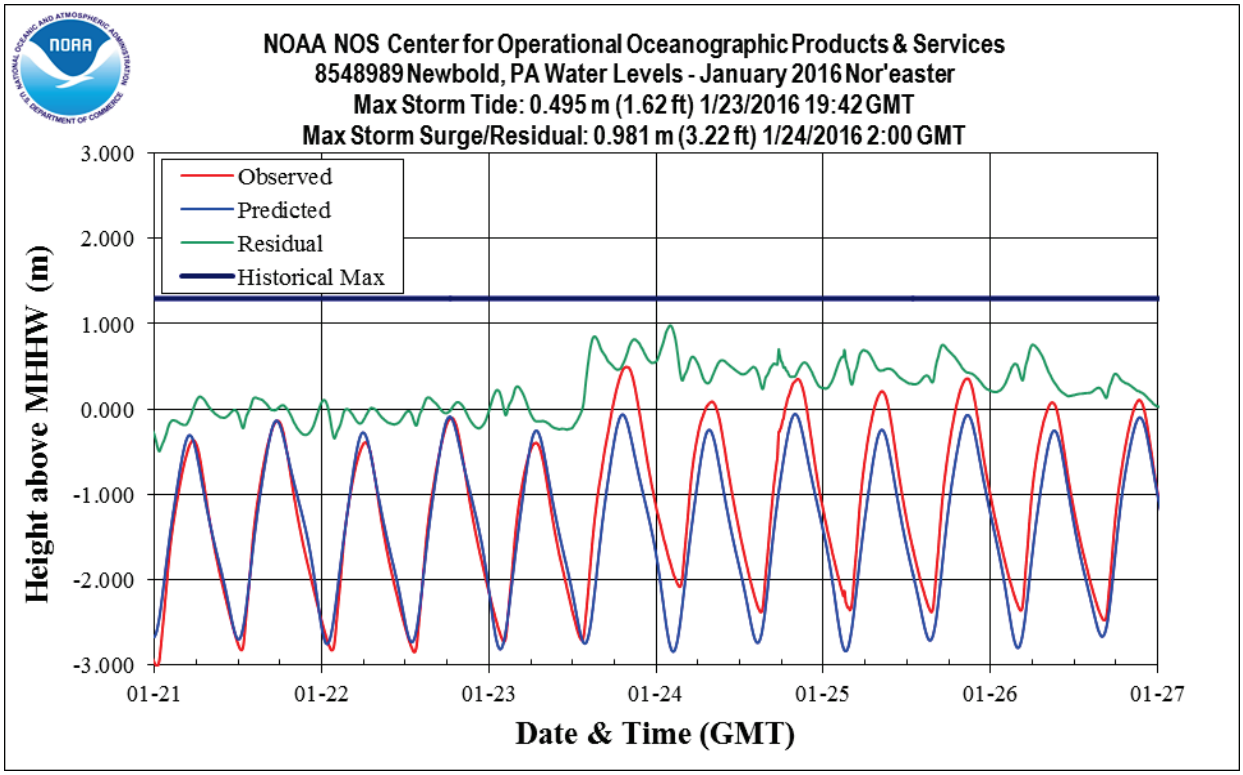

Figure 36: Water levels above Mean Higher High Water (MHHW) at Newbold, PA. A line denoting the Historical Maximum Water Level value is displayed.

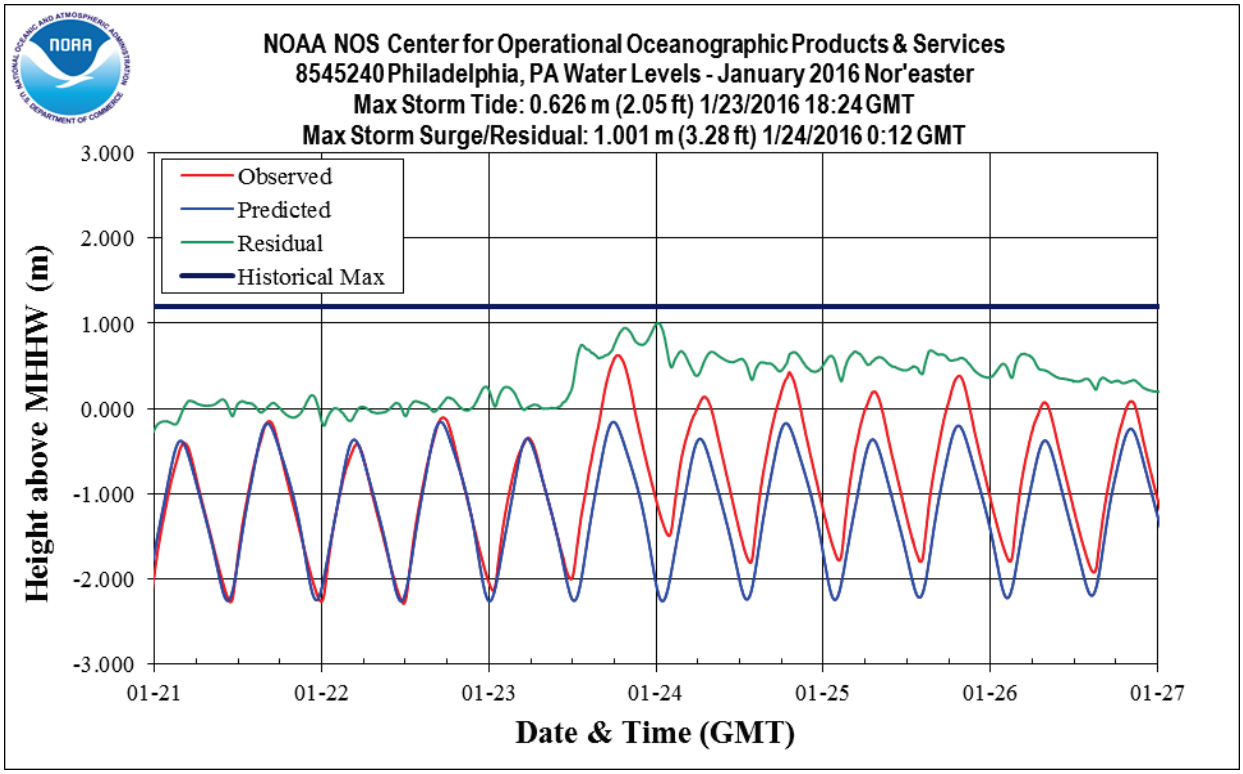

Figure 37: Water levels above Mean Higher High Water (MHHW) at Philadelphia, PA. A line denoting the Historical Maximum Water Level value is displayed.

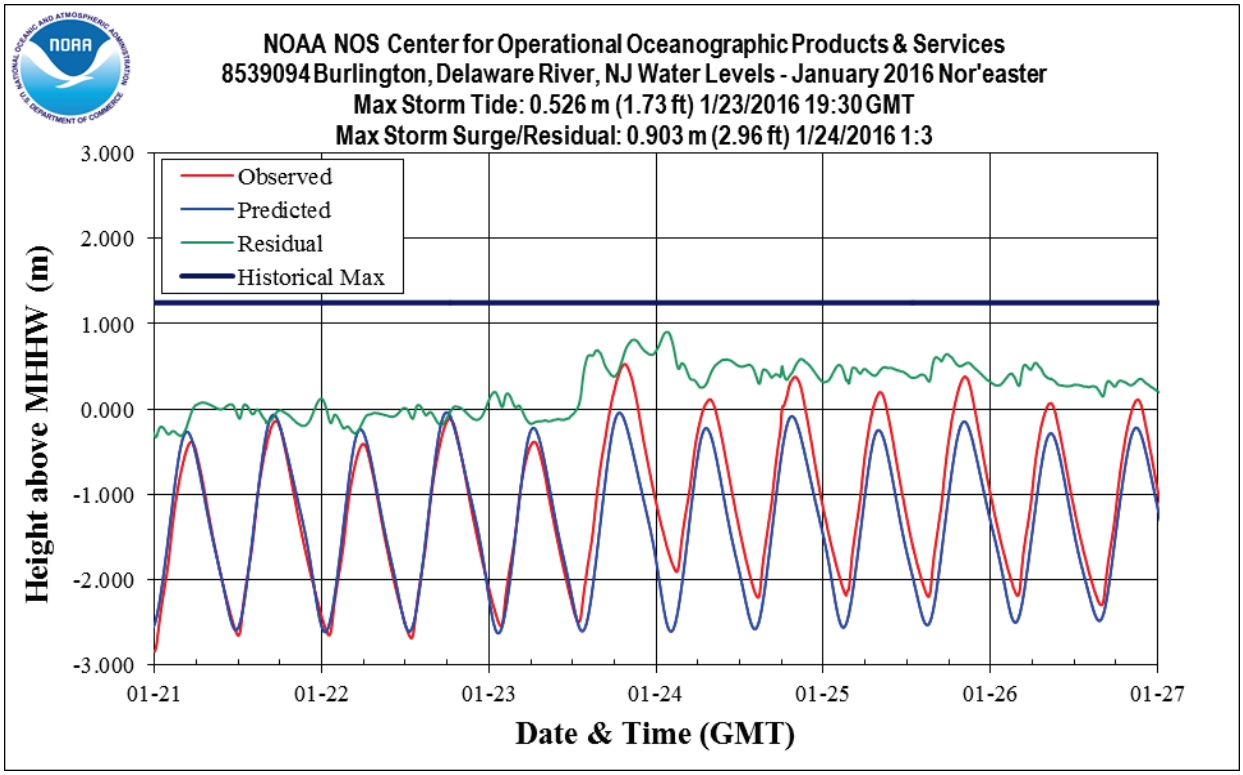

Figure 38: Water levels above Mean Higher High Water (MHHW) at Burlington, Delaware River, NJ. A line denoting the Historical Maximum Water Level value is displayed.

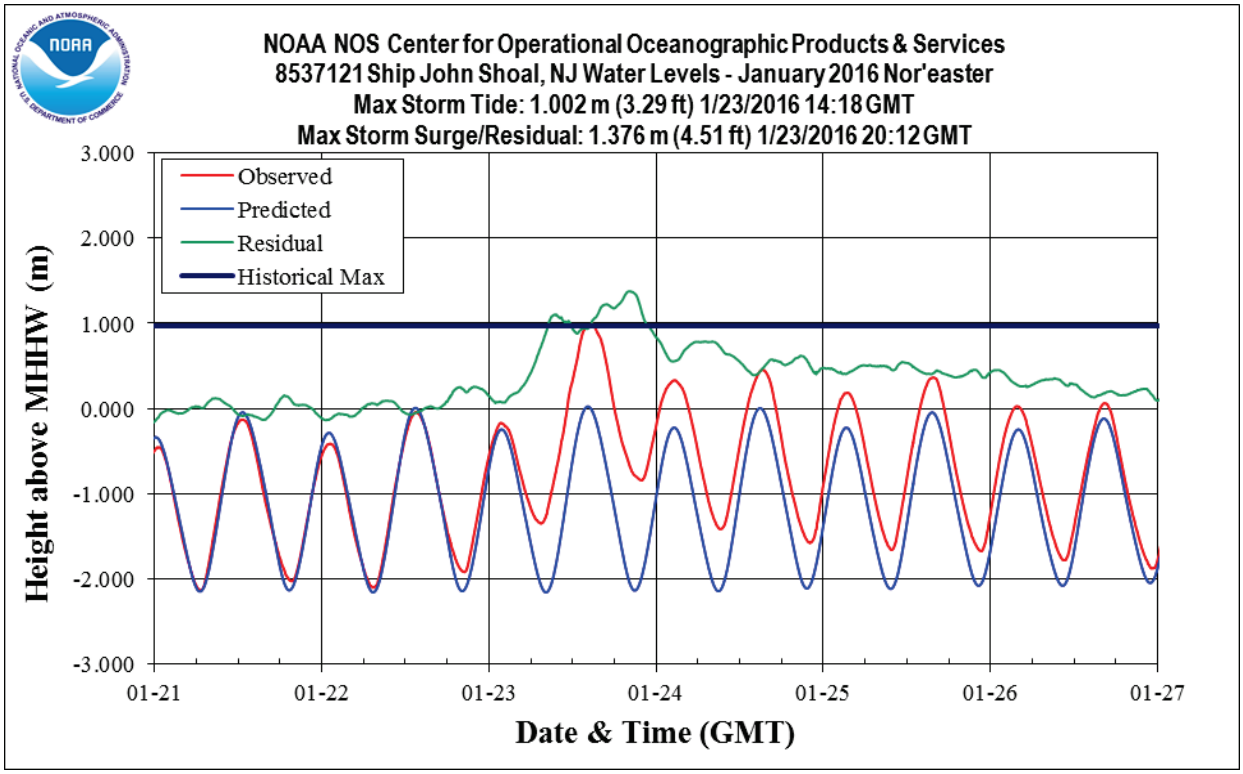

Figure 39: Water levels above Mean Higher High Water (MHHW) at Ship John Shoal, NJ. A line denoting the Historical Maximum Water Level value is displayed. Maximum recorded water level value exceeded the historical maximum value.

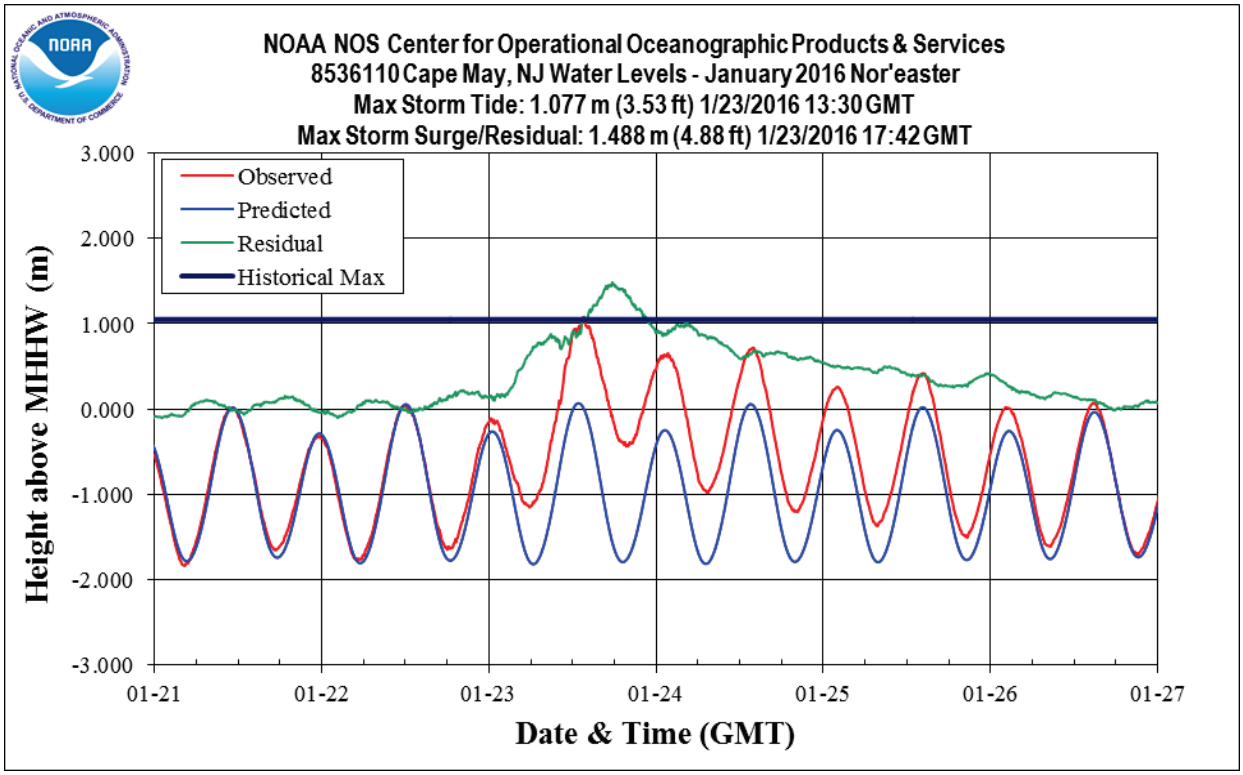

Figure 40: Water levels above Mean Higher High Water (MHHW) at Cape May, NJ. A line denoting the Historical Maximum Water Level value is displayed. Maximum recorded water level value exceeded the historical maximum value.

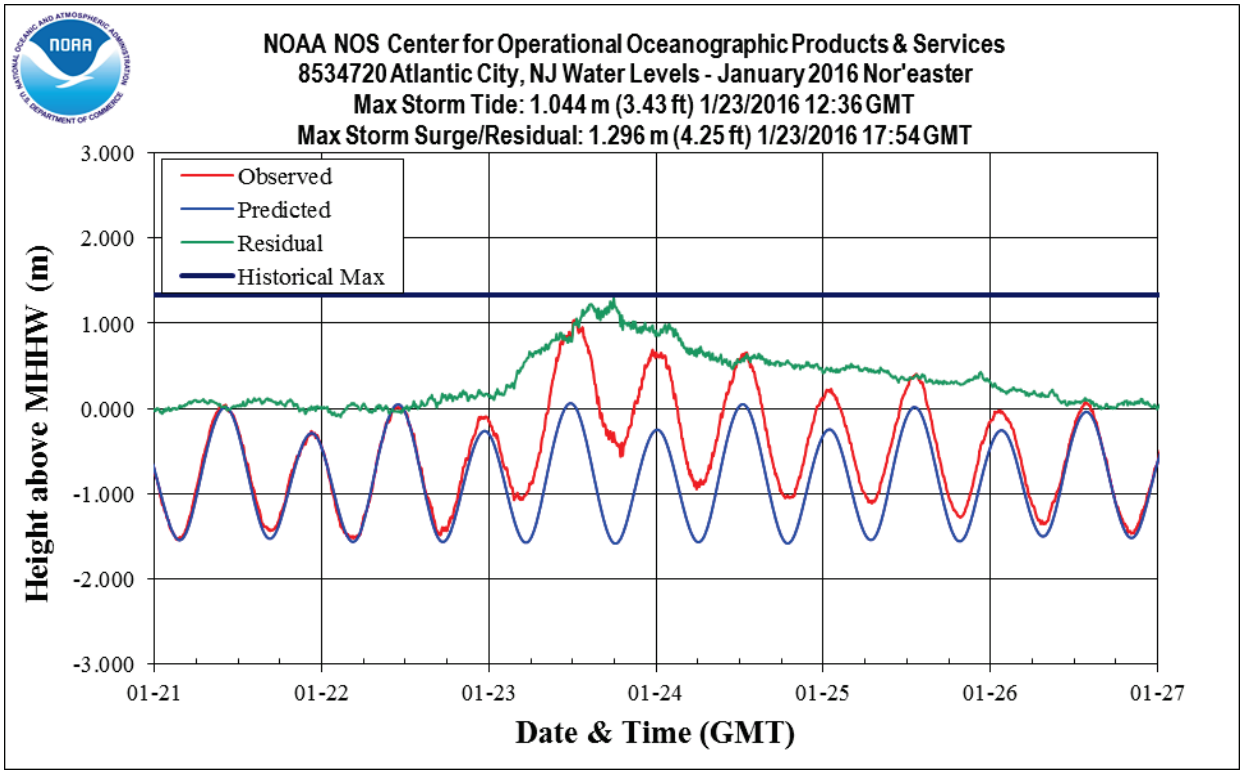

Figure 41: Water levels above Mean Higher High Water (MHHW) at Atlantic City, NJ. A line denoting the Historical Maximum Water Level value is displayed.

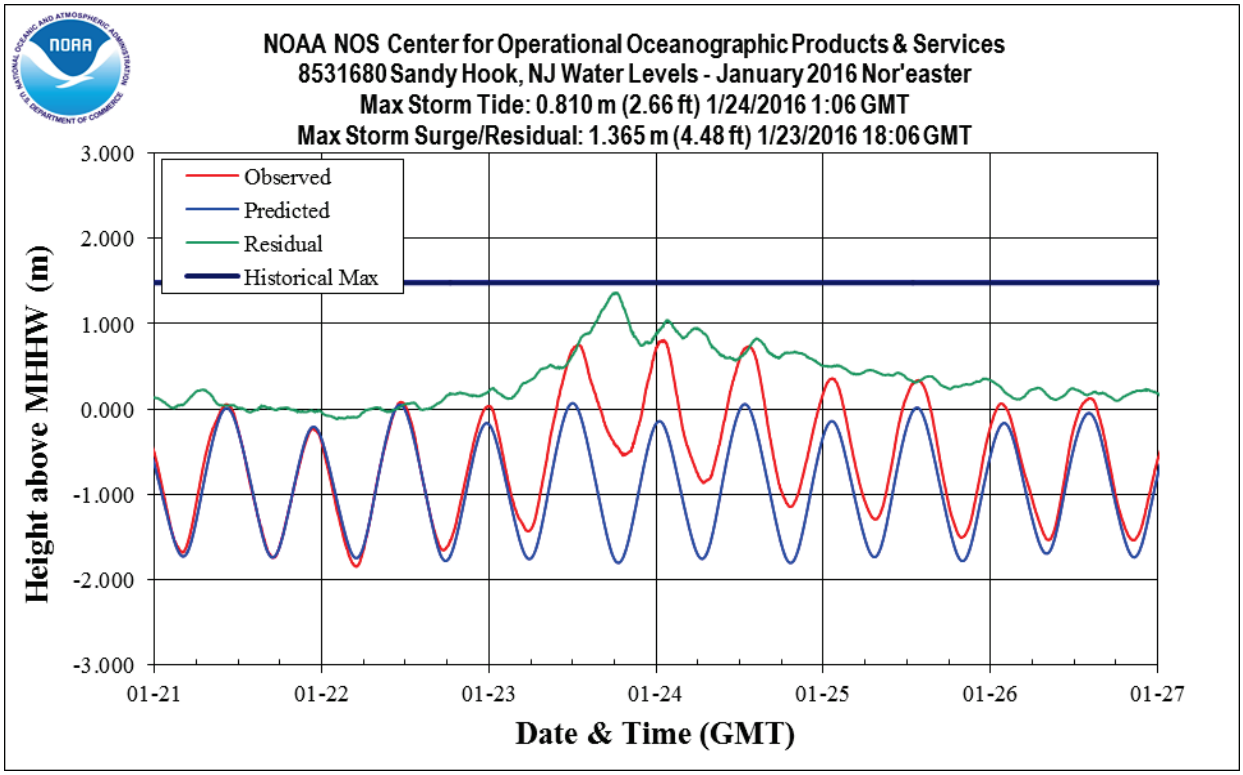

Figure 42: Water levels above Mean Higher High Water (MHHW) at Sandy Hook, NJ. A line denoting the Historical Maximum Water Level value is displayed.

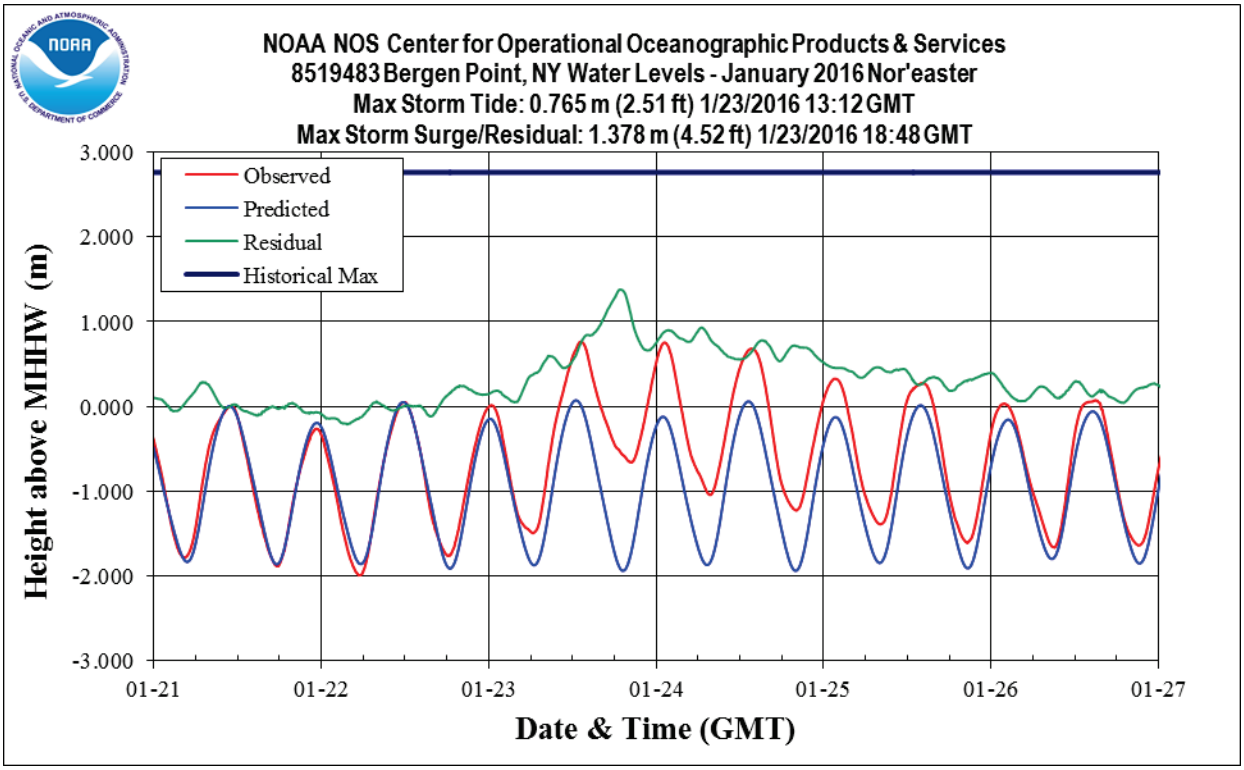

Figure 43: Water levels above Mean Higher High Water (MHHW) at Bergen Point West Reach, NY. A line denoting the Historical Maximum Water Level value is displayed.

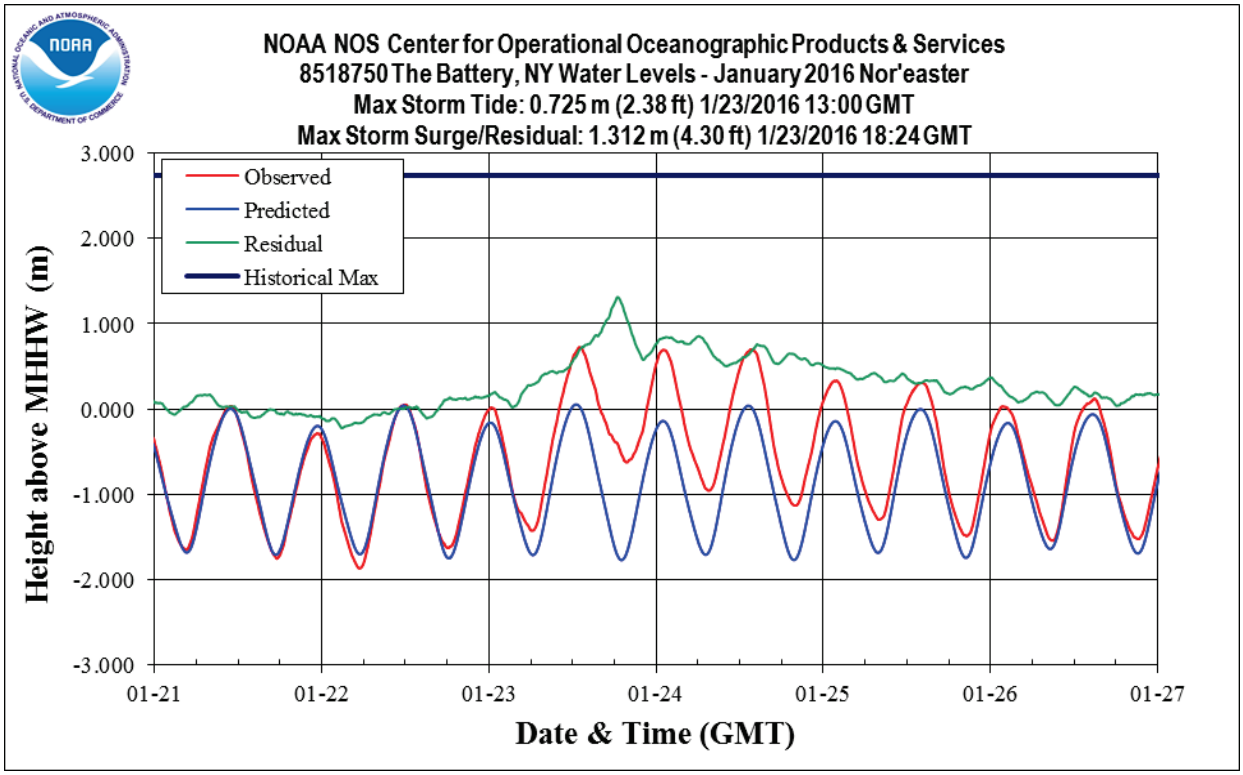

Figure 44: Water levels above Mean Higher High Water (MHHW) at The Battery, NY. A line denoting the Historical Maximum Water Level value is displayed.

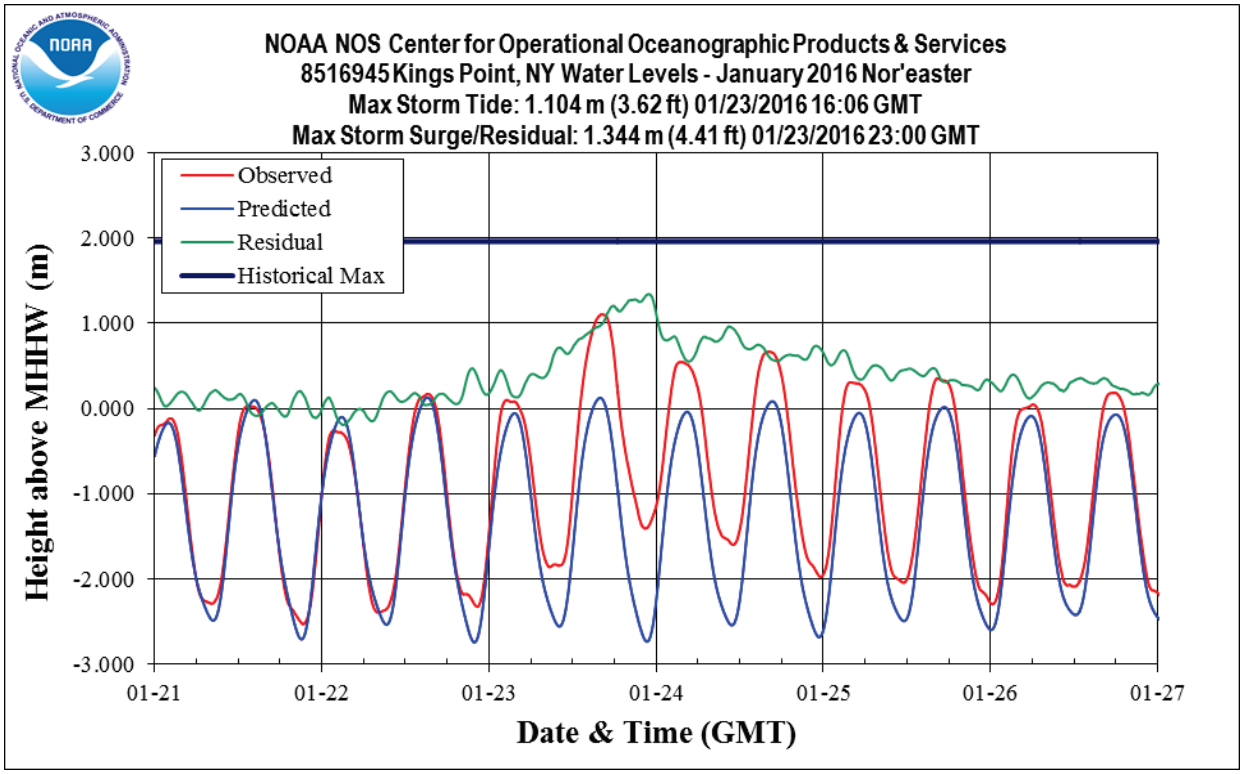

Figure 45: Water levels above Mean Higher High Water (MHHW) at Kings Point, NY. A line denoting the Historical Maximum Water Level value is displayed.

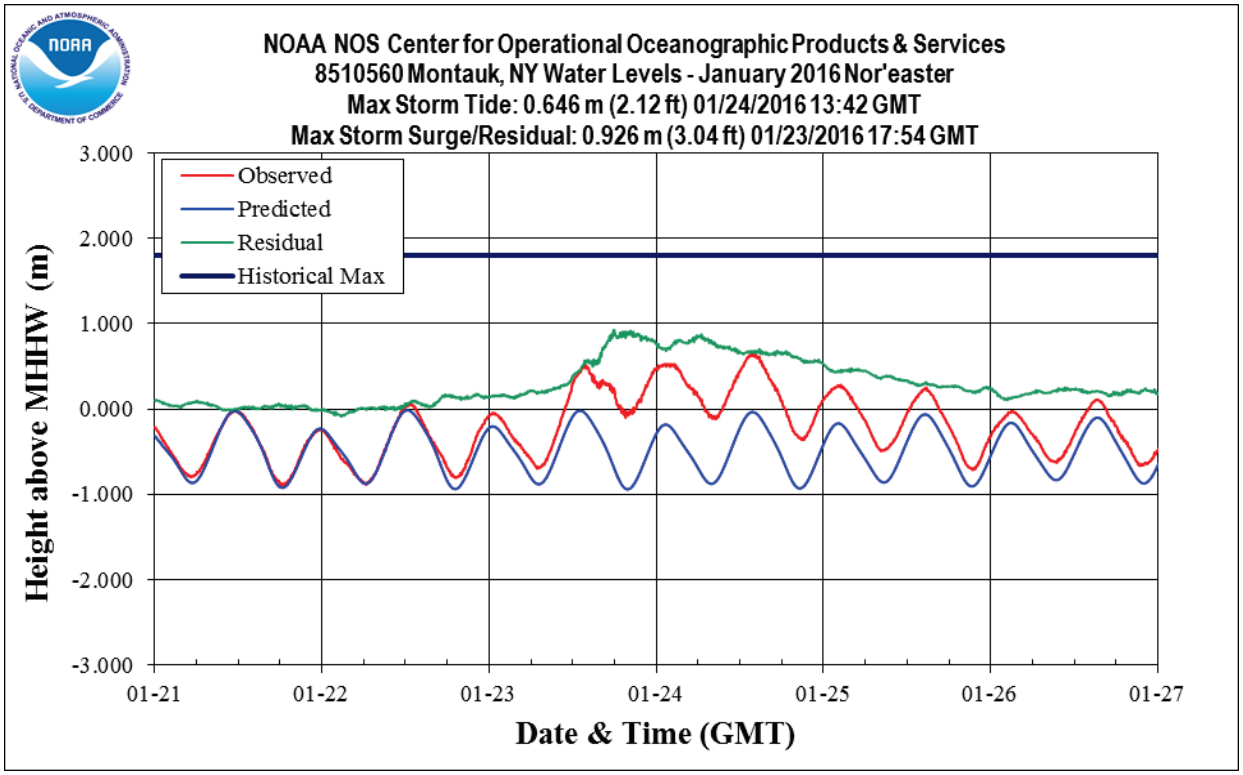

Figure 46: Water levels above Mean Higher High Water (MHHW) at Montauk, NY. A line denoting the Historical Maximum Water Level value is displayed.

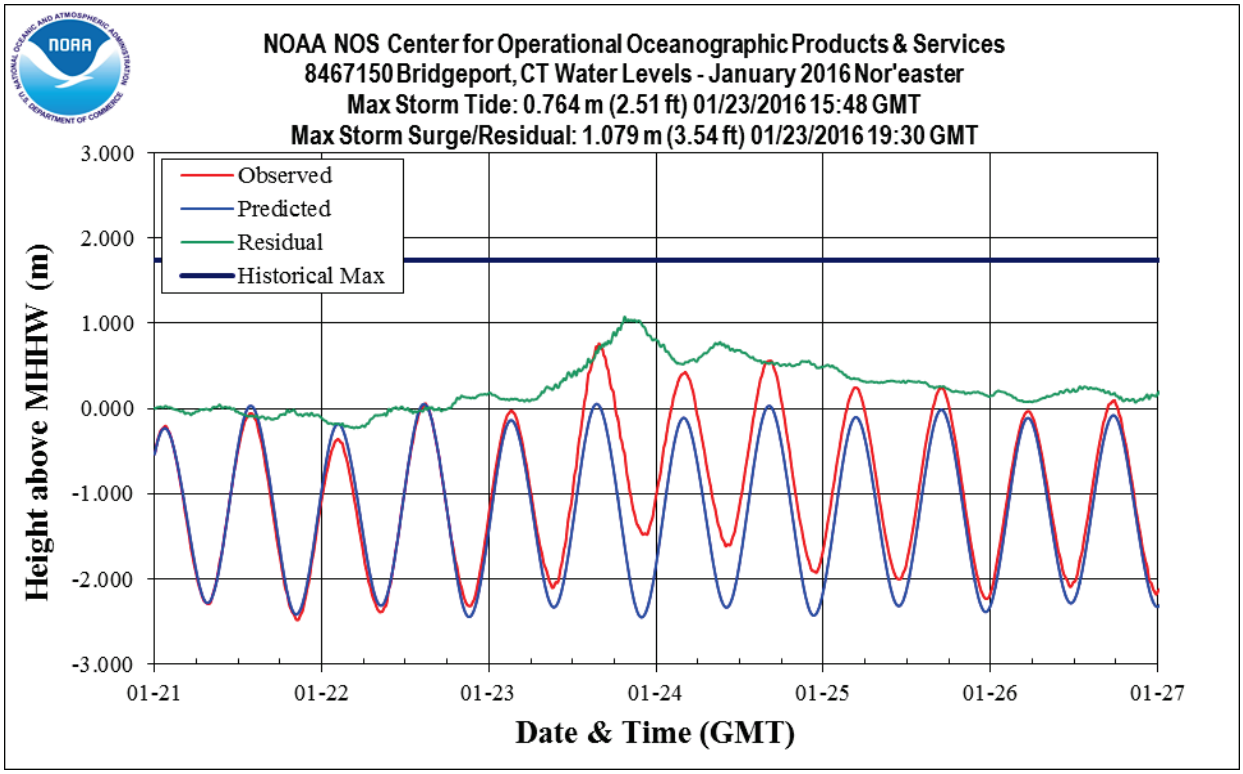

Figure 47: Water levels above Mean Higher High Water (MHHW) at Bridgeport, CT. A line denoting the Historical Maximum Water Level value is displayed.

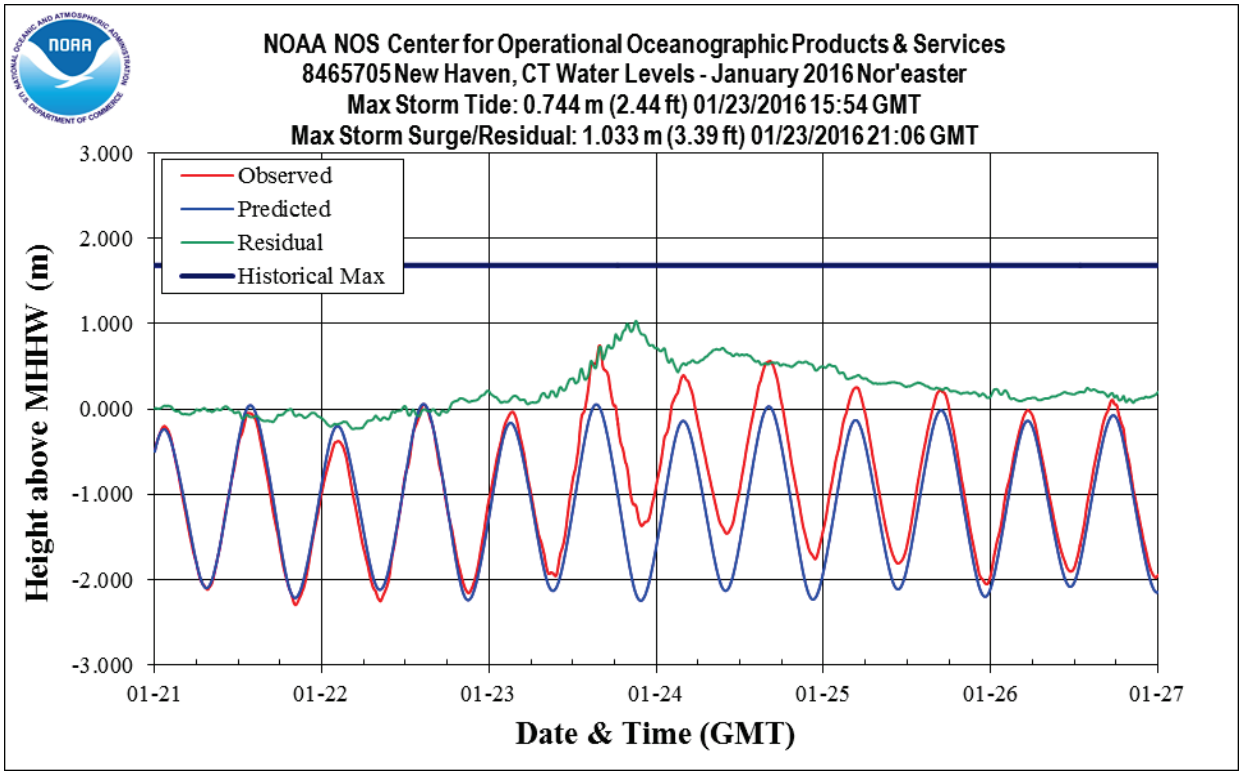

Figure 48: Water levels above Mean Higher High Water (MHHW) at New Haven, CT. A line denoting the Historical Maximum Water Level value is displayed.

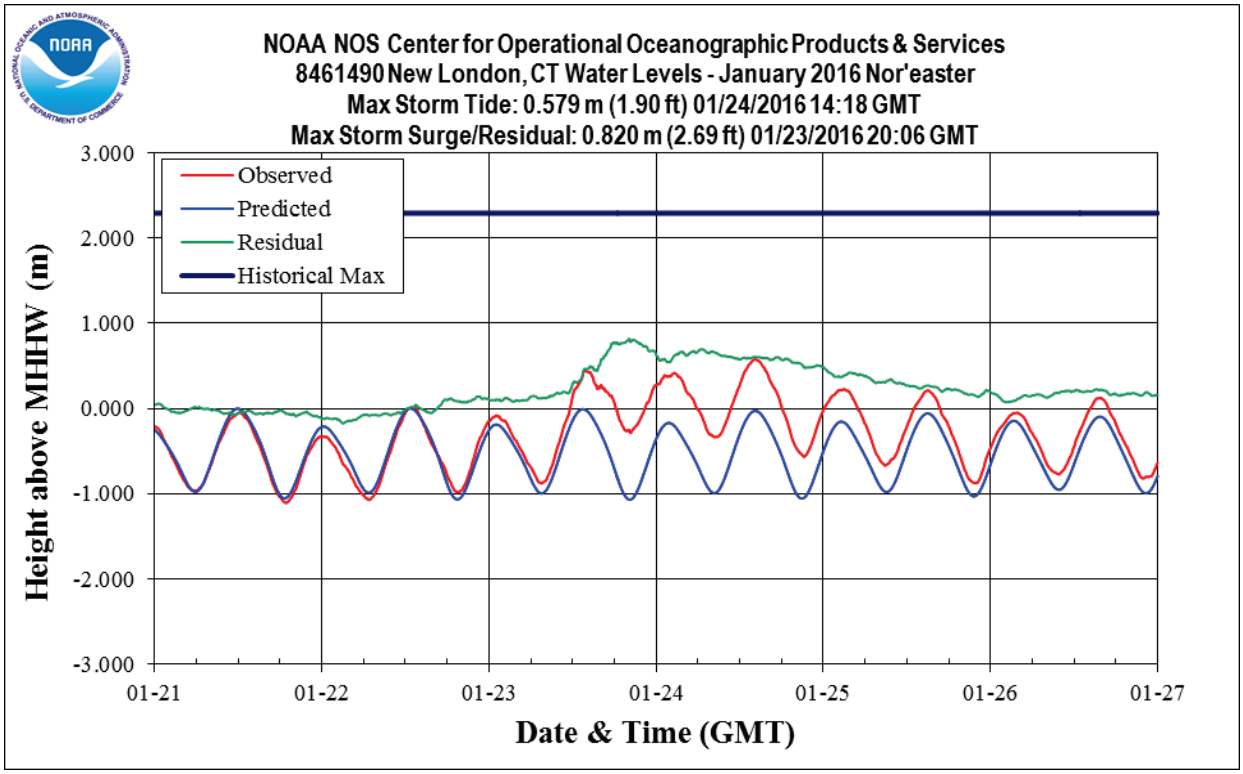

Figure 49: Water levels above Mean Higher High Water (MHHW) at New London, CT. A line denoting the Historical Maximum Water Level value is displayed.

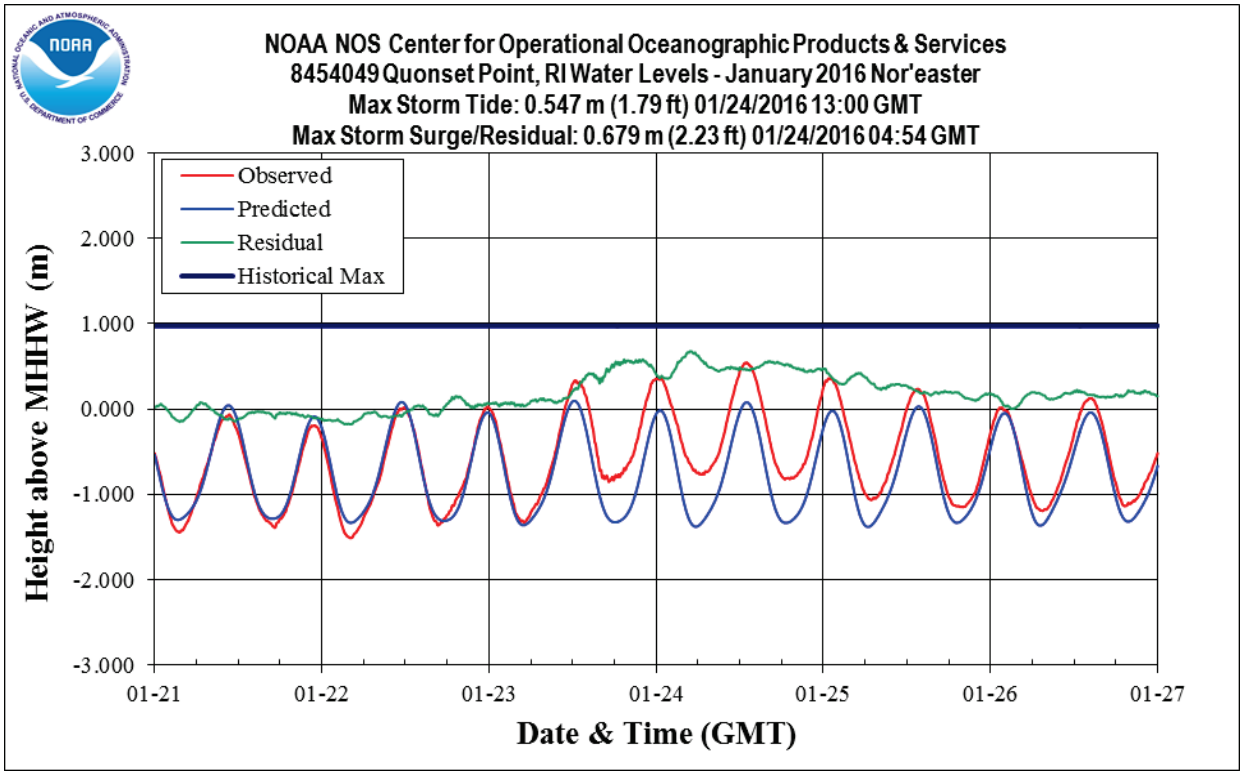

Figure 50: Water levels above Mean Higher High Water (MHHW) at Quonset Point, RI. A line denoting the Historical Maximum Water Level value is displayed.

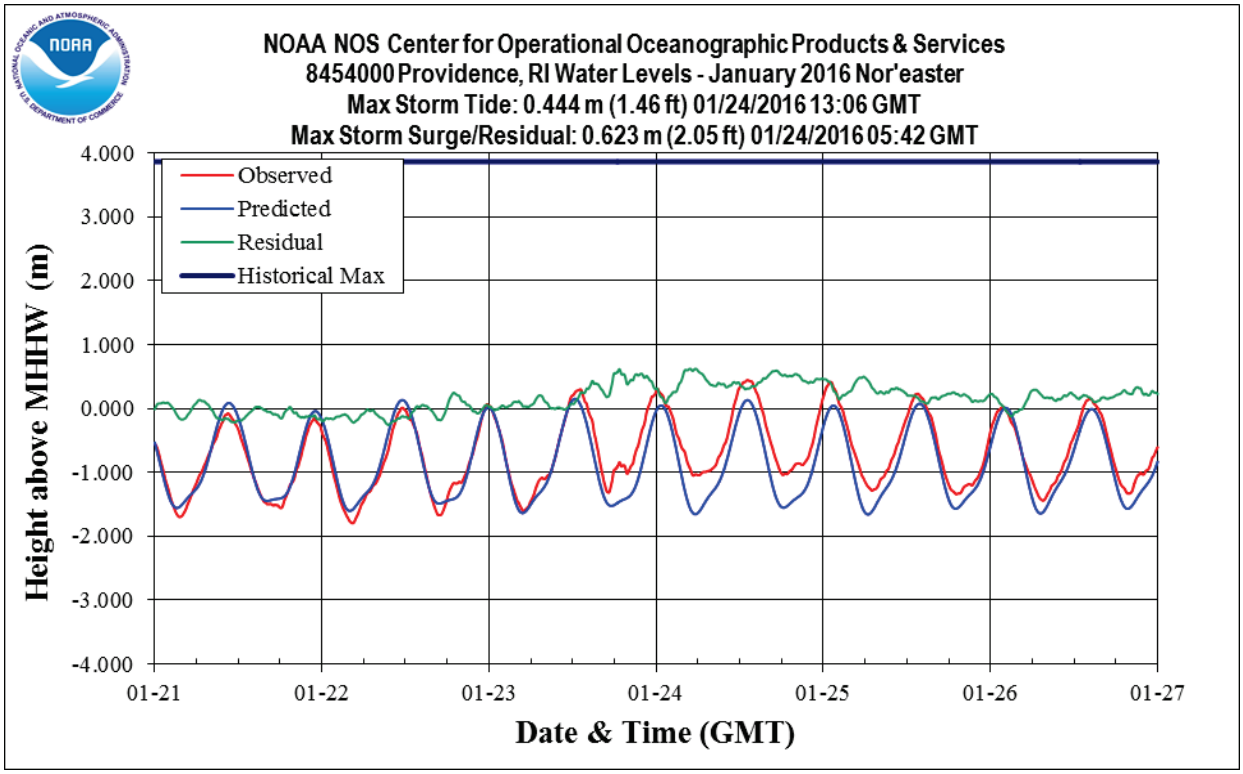

Figure 51: Water levels above Mean Higher High Water (MHHW) at Povidence, RI. A line denoting the Historical Maximum Water Level value is displayed. Note the increased scale due to the larger Historical Maximum Water Level value at this station.

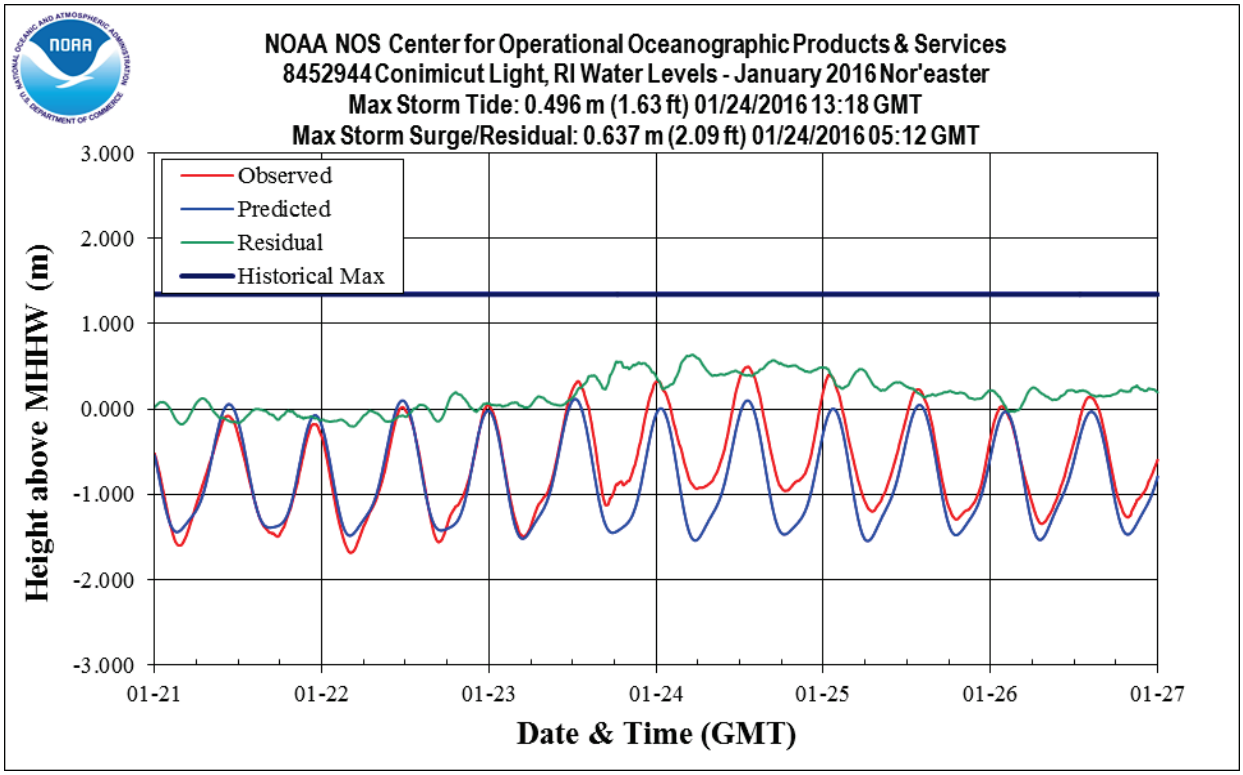

Figure 52: Water levels above Mean Higher High Water (MHHW) at Conimicut Light, RI. A line denoting the Historical Maximum Water Level value is displayed.

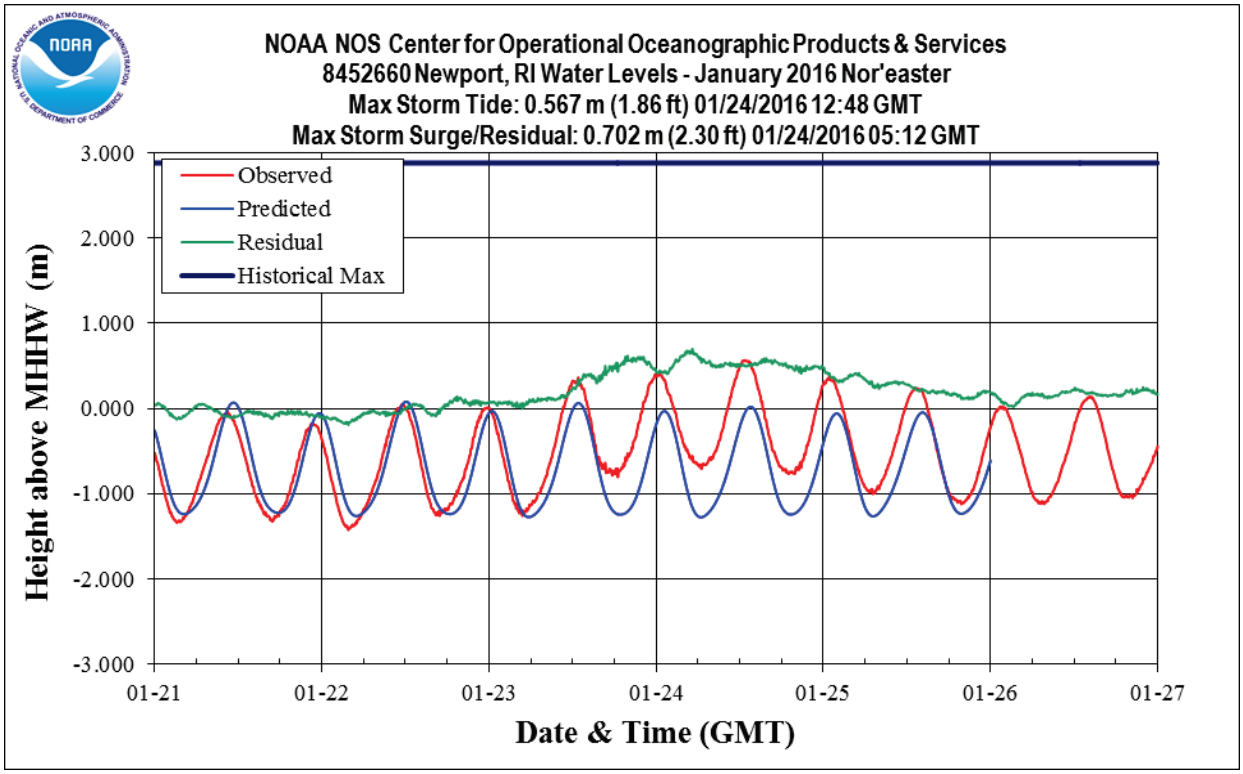

Figure 53: Water levels above Mean Higher High Water (MHHW) at Newport, RI. A line denoting the Historical Maximum Water Level value is displayed.

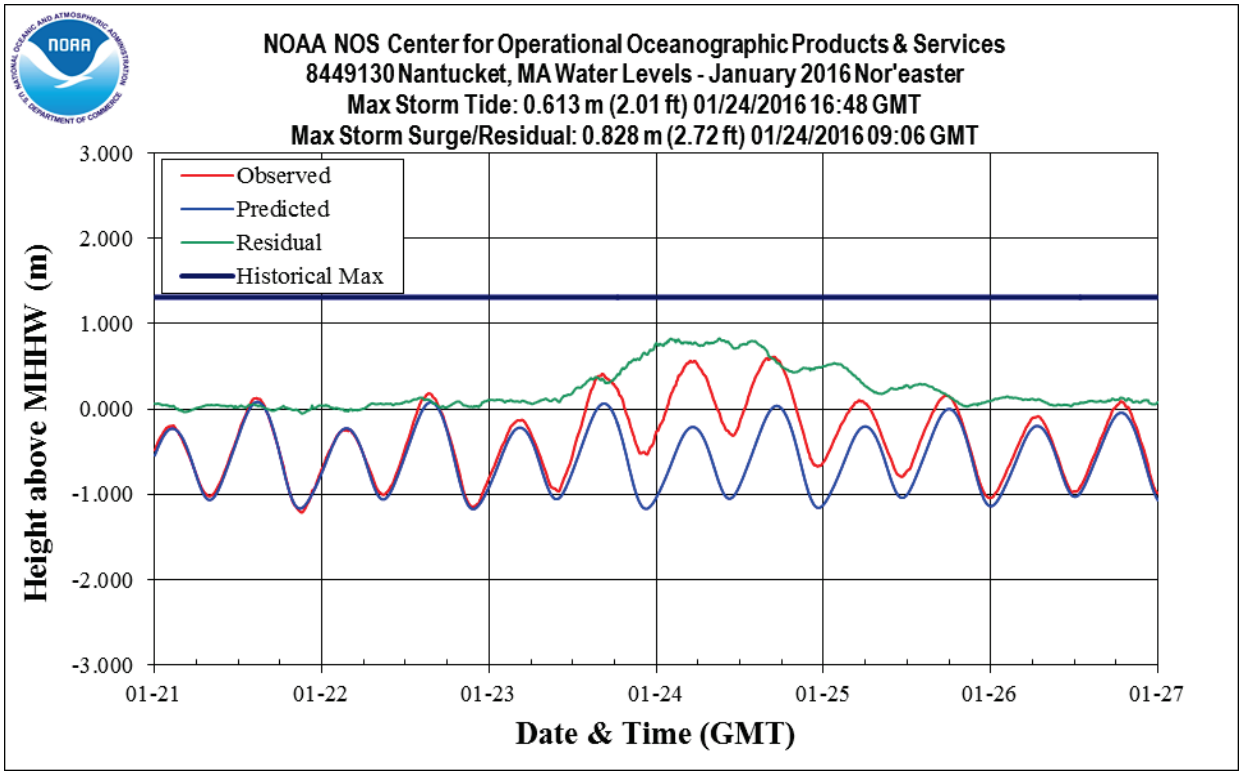

Figure 54: Water levels above Mean Higher High Water (MHHW) at Nantucket, MA. A line denoting the Historical Maximum Water Level value is displayed.

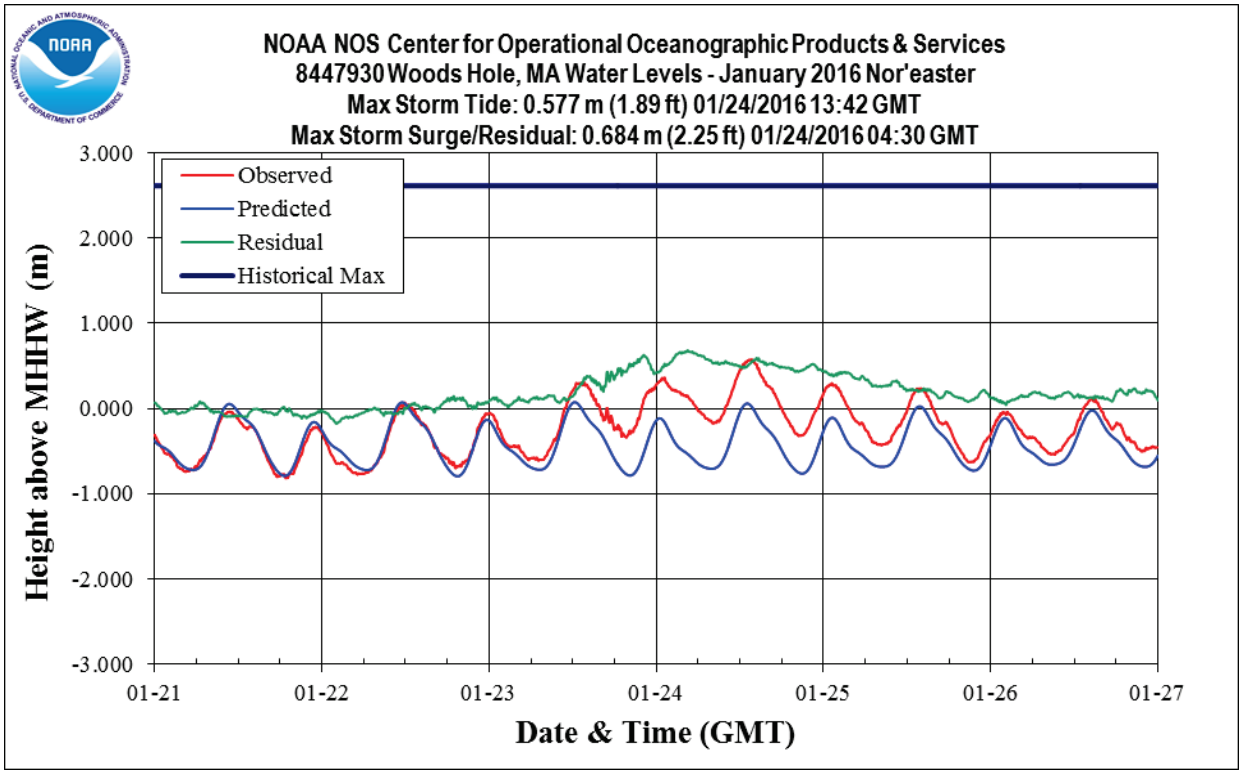

Figure 55: Water levels above Mean Higher High Water (MHHW) at Woods Hole, MA. A line denoting the Historical Maximum Water Level value is displayed.

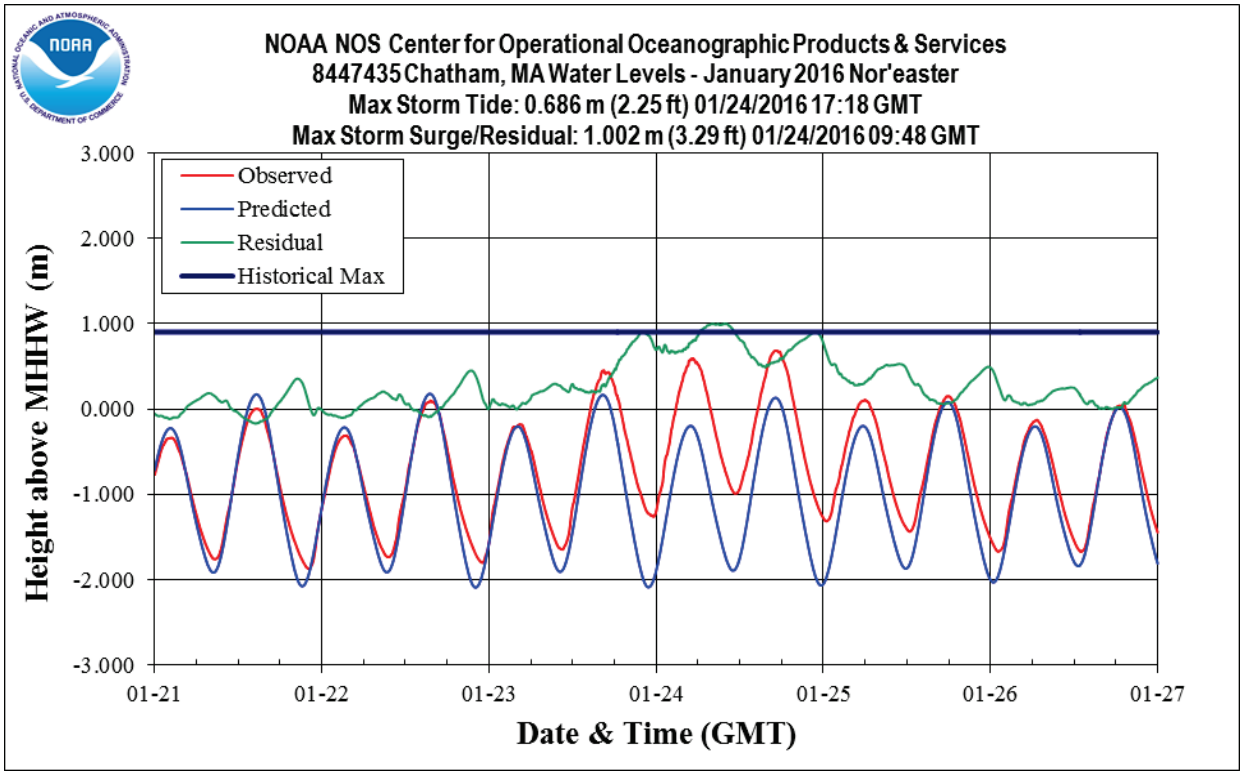

Figure 56: Water levels above Mean Higher High Water (MHHW) at Chatham, MA. A line denoting the Historical Maximum Water Level value is displayed.

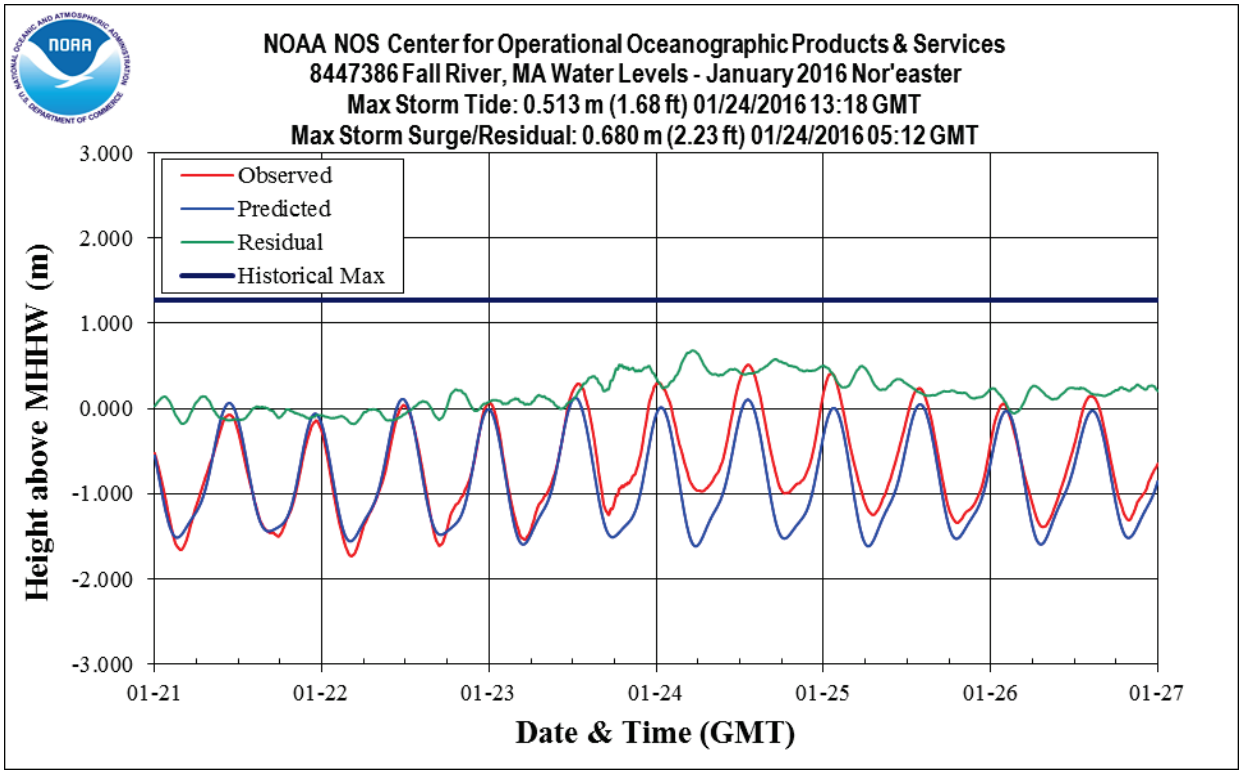

Figure 57: Water levels above Mean Higher High Water (MHHW) at Fall River, MA. A line denoting the Historical Maximum Water Level value is displayed.

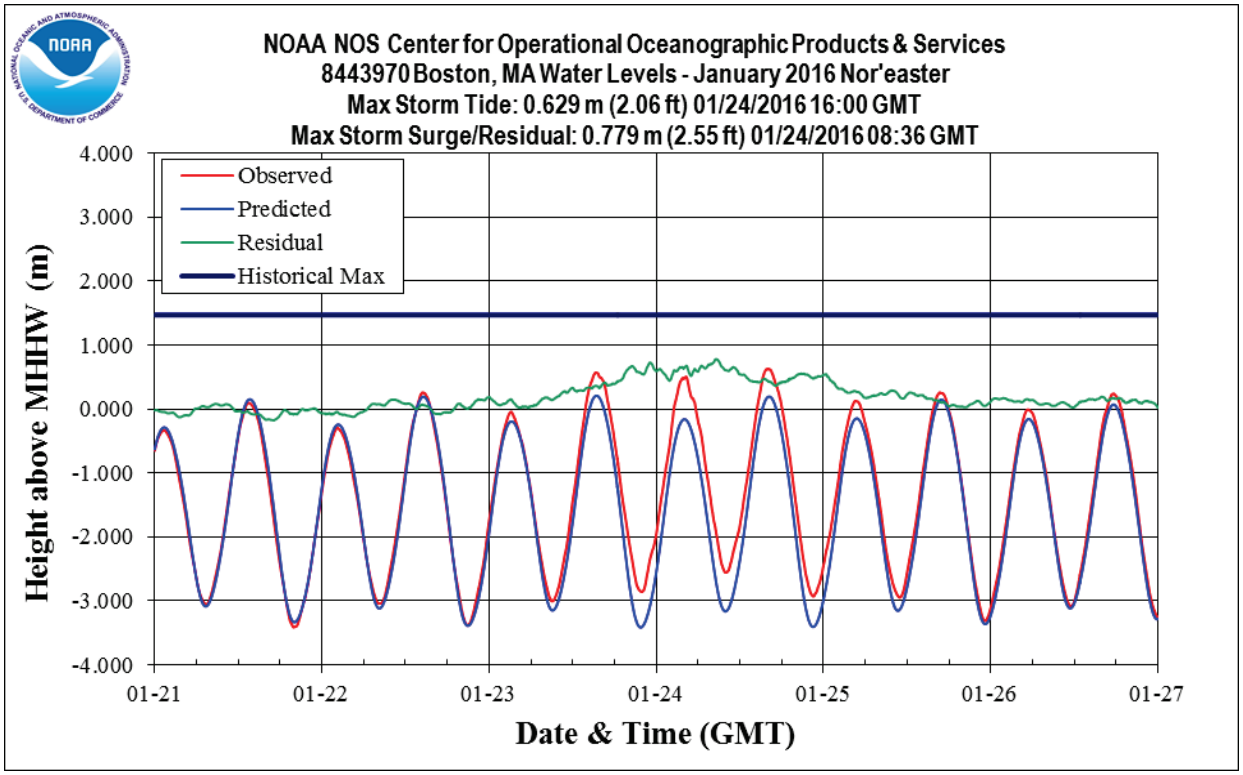

Figure 58: Water levels above Mean Higher High Water (MHHW) at Boston, MA. A line denoting the Historical Maximum Water Level value is displayed. Note the increase scald due to the larger tidal range at this location.

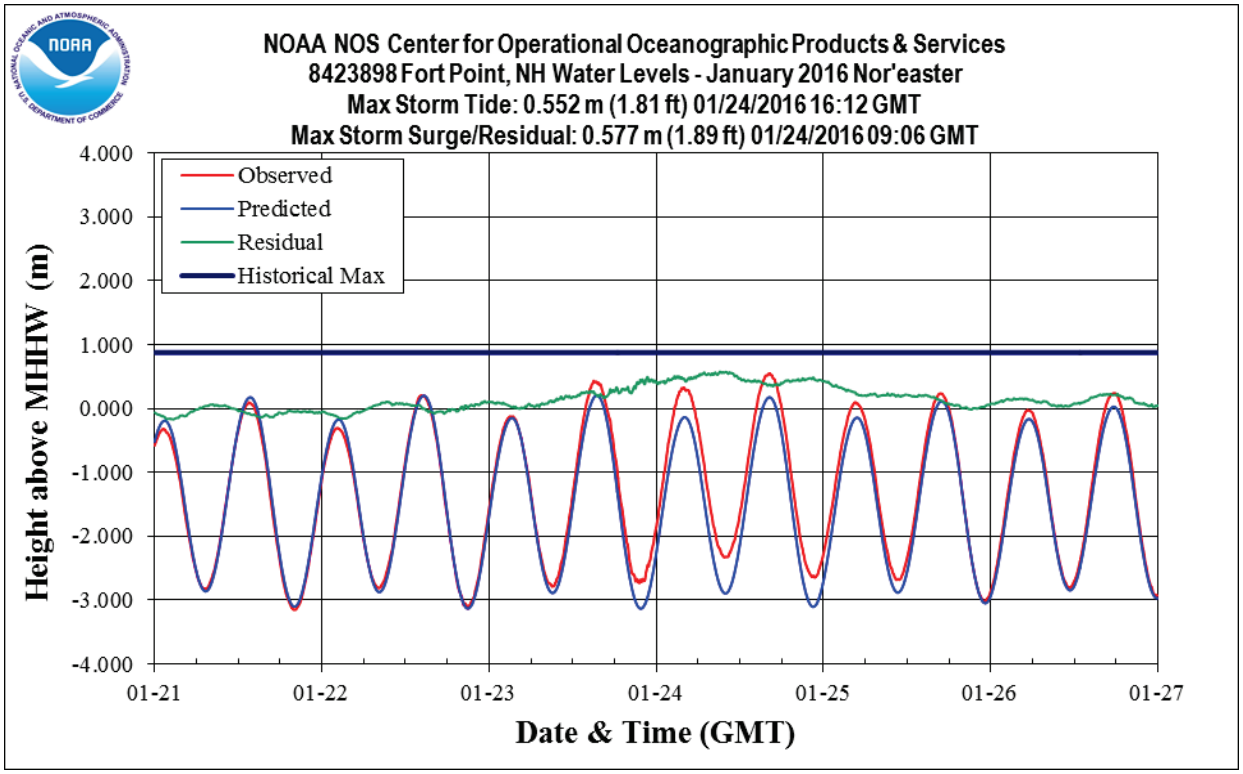

Figure 59: Water levels above Mean Higher High Water (MHHW) at Fort Point, NH. A line denoting the Historical Maximum Water Level value is displayed. Note the inclreased scale due to the larger tidal range at this location.

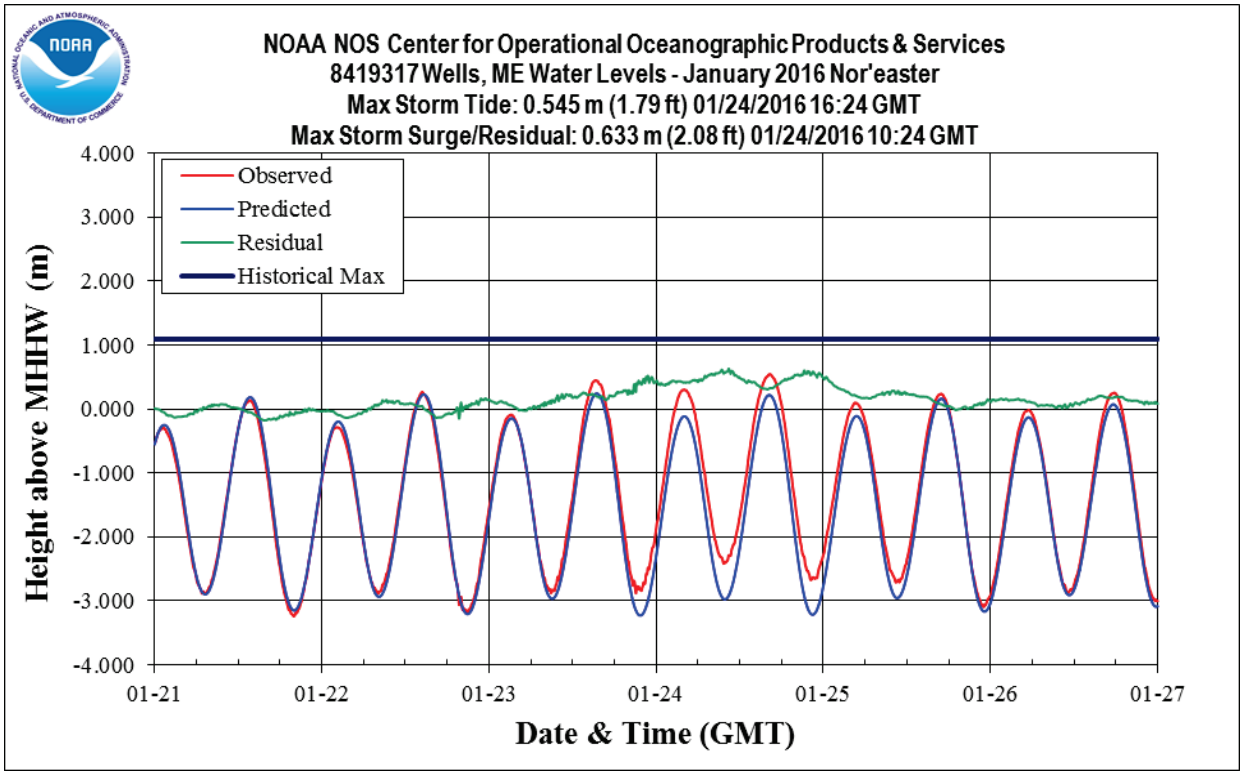

Figure 60: Water levels above Mean Higher High Water (MHHW) at Wells, ME. A line denoting the Historical Maximum Water Level value is displayed. Note the increased scale due to the larger tidal range at this location.

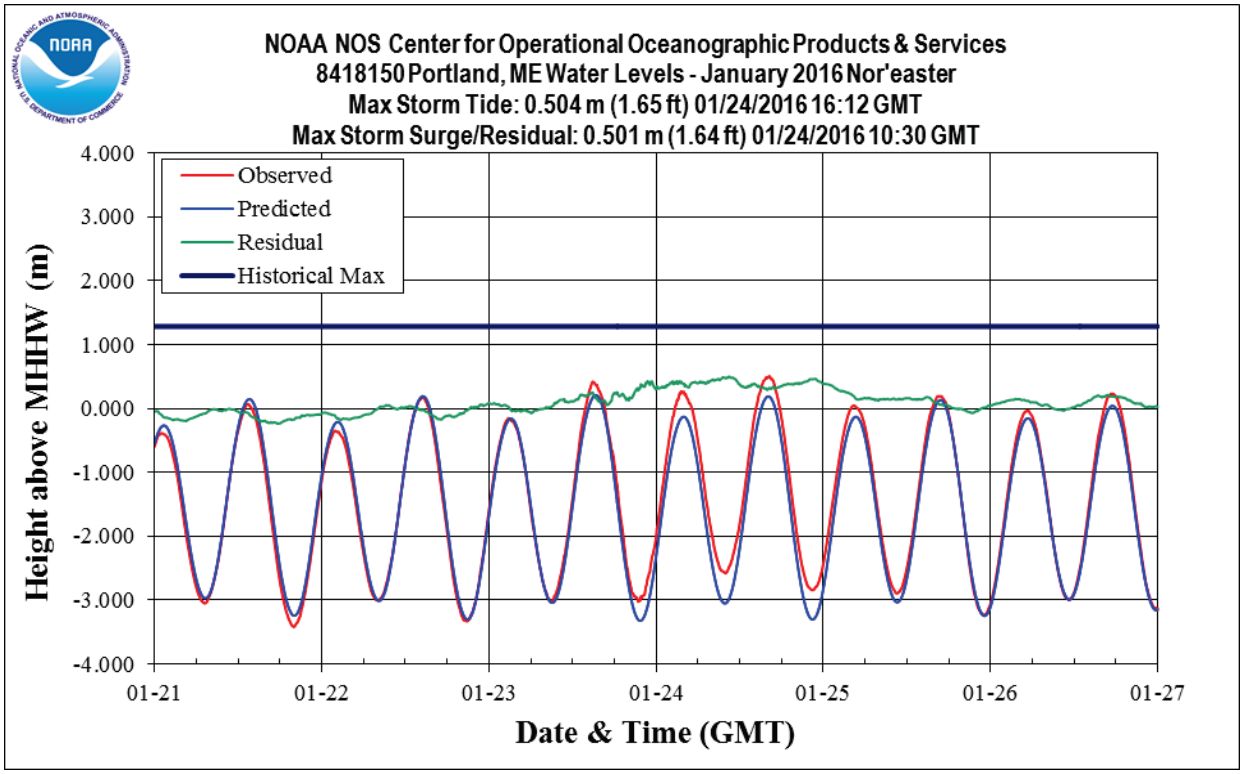

Figure 61: Water levels above Mean Higher High Water (MHHW) at Portland, ME. A line denoting the Historical Maximum Water Level value is displayed. Note the increased scale due to the larger tidal range at this location.

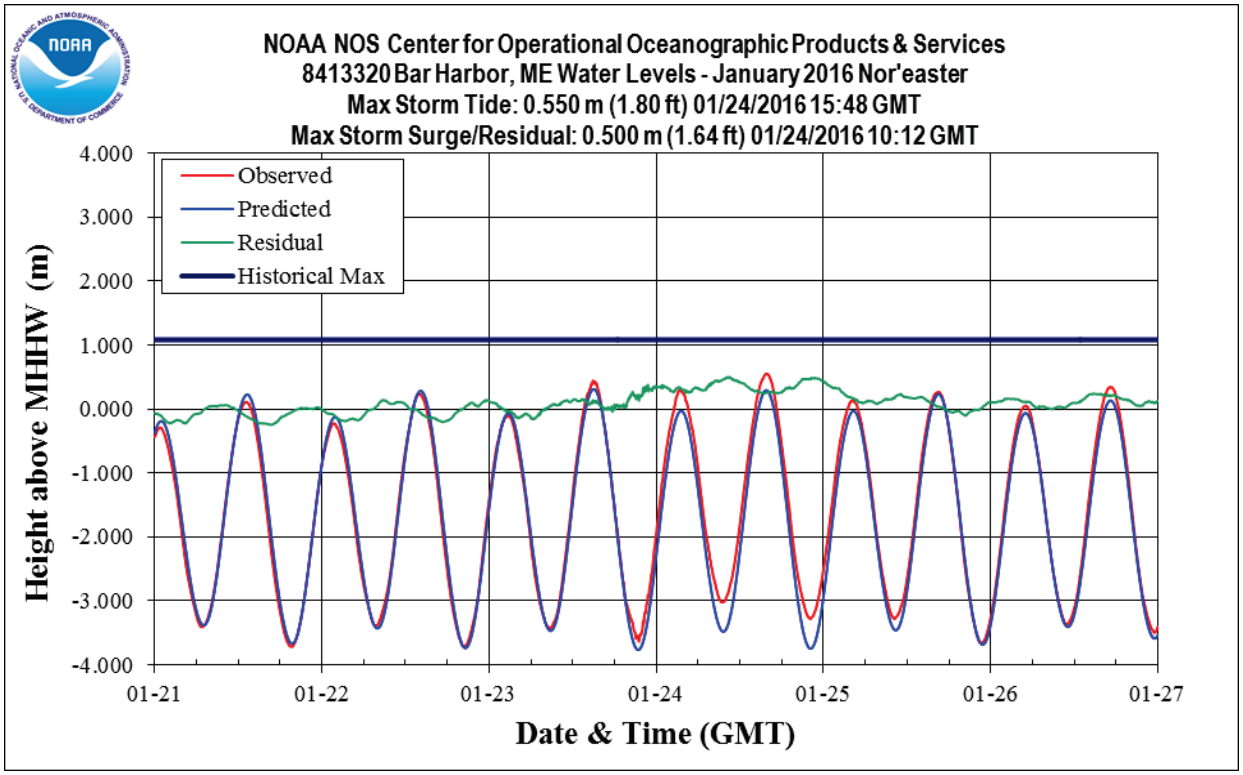

Figure 62: Water levels above Mean Higher High Water (MHHW) at Bar Harbor, ME. A line denoting the Historical Maximum Water Level value is displayed. Note the increased scale due to the larger tidal range at this location.

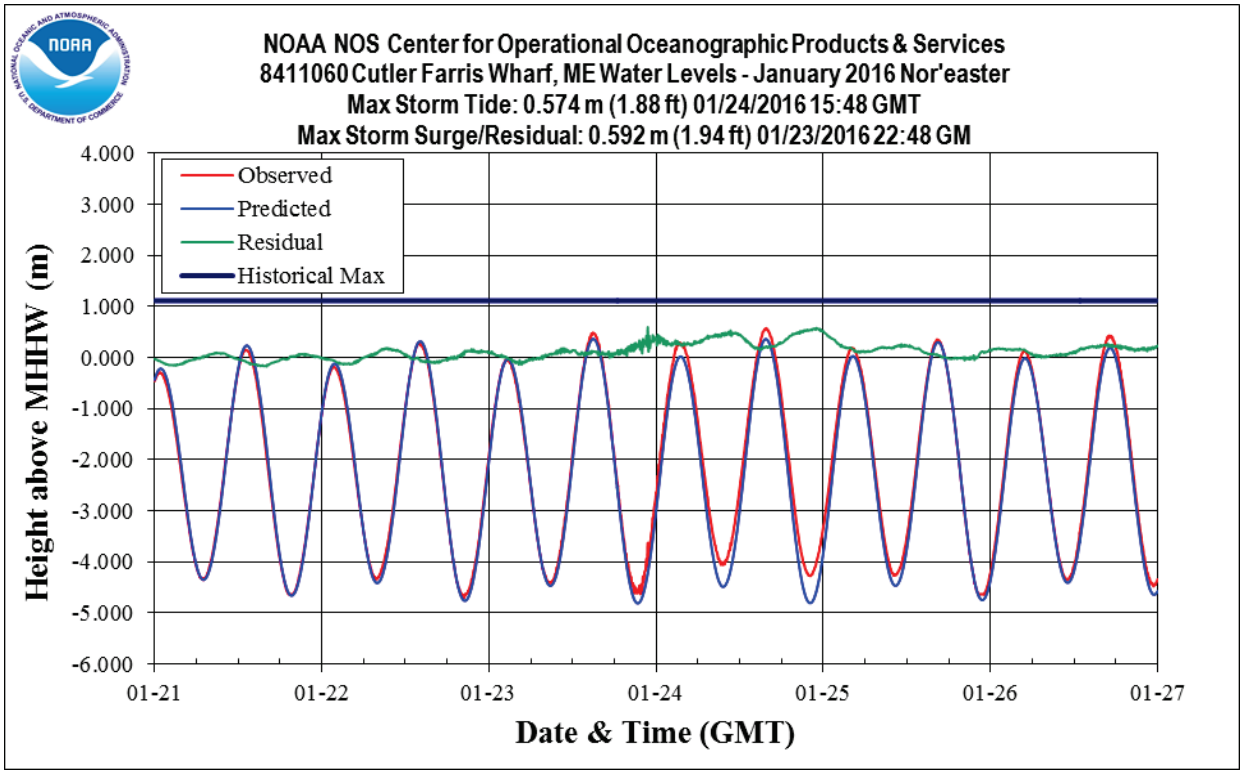

Figure 63: Water levels above Mean Higher High Water (MHHW) at Cutler Farris Wharf, ME. A line denoting the Historical Maximum Water Level value is displayed. Note the increased scale due to the larger tidal range at this location.

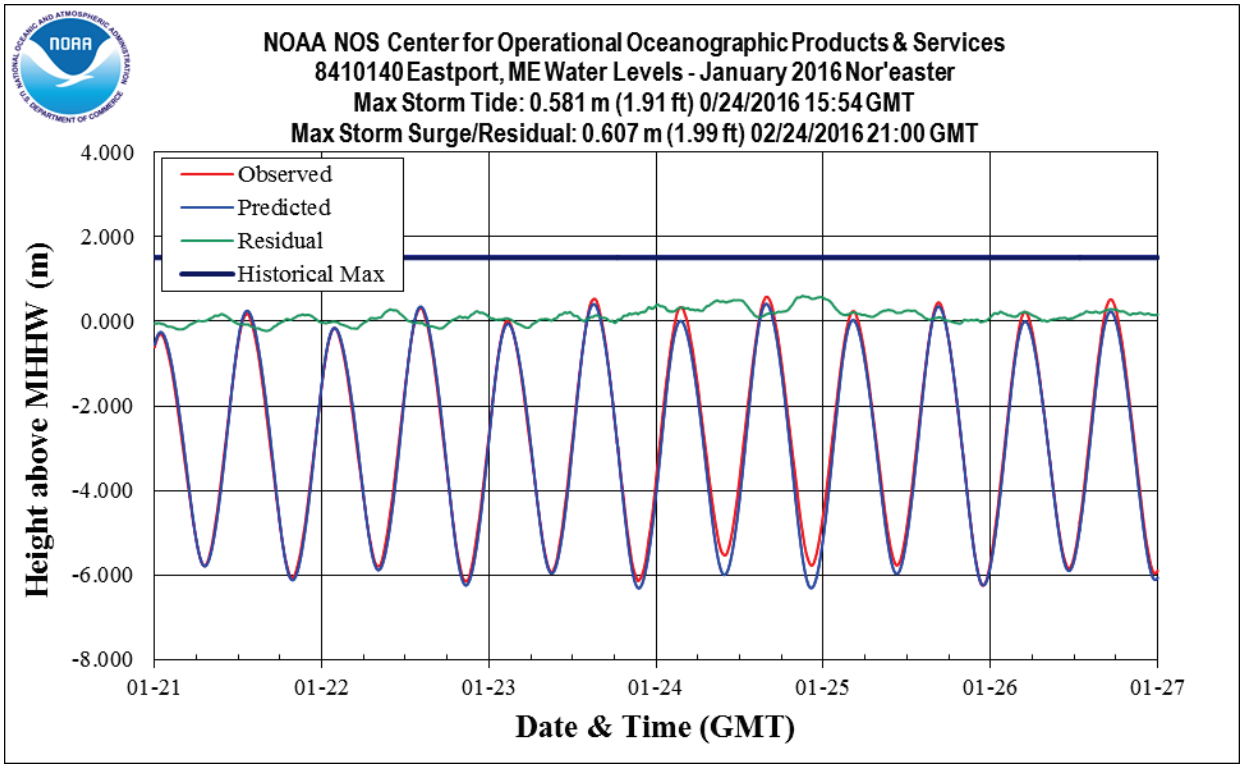

Figure 64: Water levels above Mean Higher High Water (MHHW) at Eastport, ME. A line denoting the Historical Maximum Water Level value is displayed. Note the increased scale due to the larger tidal range at this location.

Acknowledgements:

This report represents the cumulative efforts of personnel of the Center for Operational Oceanographic Products and Services (CO-OPS). We would like to thank the Oceanographic Division's Data Processing Team who were responsible for the processing, analysis and verification of the data incorporated into this report. We would like to thank the Continuous Operational Real-Time Monitoring System (CORMS) team who performed an around the clock thorough QA/QC assessment on all real-time data. We would like to thank the Field Operations Division personnel who operated and maintain all stations to ensure that a reliable and robust source of real-time data was readily available. We would like to thank Paul Fanelli, who took time to help edit this report, and provide valuable insight into the content of the report.

Appendix 1: Contact Information

For further information or updates on the Storm Technical Reports and Storm QuickLook product, contact:

Storm QuickLook
Center for Operational Oceanographic Products and Services (CO-OPS)
1305 East-West Highway
Silver Spring, MD 20910-3281
Phone: (240) 533-0580
Fax: (301) 713-4437
E-mail: Storm QuickLook (tide.predictions@noaa.gov)

Appendix 2: Station Locations

Station Name	Station ID	Latitude N	Longitude W
Fort Pulaski, GA	8670870	32.03330	-80.90170
Charleston, SC	8665530	32.78170	-79.92500
Oyster Landing (N. Inlet Estuary), SC	8662245	33.35170	-79.18670
Springmaid Pier, SC	8661070	33.65500	-78.91830
Wrightsville Beach, NC	8658163	34.21330	-77.78670
Wilmington, NC	8658120	34.22670	-77.95330
Beaufort, NC	8656483	34.72000	-76.67000
USCG Station Hatteras, NC	8654467	35.20864	-75.70417
Oregon Inlet Marina, NC	8652587	35.79500	-75.54830
Duck, NC	8651370	36.18333	-75.74667
Money Point, VA	8639348	36.77830	-76.30170
Chesapeake Bay Bridge Tunnel, VA	8638863	36.96667	-76.11333
Sewells Point, VA	8638610	36.94667	-76.33000
Yorktown USCG Training Center, VA	8637689	37.22667	-76.47833
Windmill Point, VA	8636580	37.61620	-76.29000
Lewisetta, VA	8635750	37.99611	-76.46444
Kiptopeke, VA	8632200	37.16519	-75.98844
Wachapreague, VA	8631044	37.60778	-75.68583
Washington, DC	8594900	38.87333	-77.02167
Solomons Island, MD	8577330	38.31667	-76.45167
Annapolis, MD	8575512	38.98328	-76.48156
Baltimore, MD	8574680	39.26667	-76.57833
Chesapeake City, MD	8573927	39.52670	-75.81000
Tolchester Beach, MD	8573364	39.21333	-76.24500
Cambridge, MD	8571892	38.57330	-76.06830
Bishops Head, MD	8571421	38.22000	-76.03830
Ocean City Inlet, MD	8570283	38.32833	-75.09167
Lewes, DE	8557380	38.78169	-75.12000
Reedy Point, DE	8551910	39.55831	-75.57331
Delaware City, DE	8551762	39.58170	-75.58830
Newbold, PA	8548989	40.13670	-74.75170
Philadelphia, PA	8545240	39.93333	-75.14167
Burlington, Delaware River, NJ	8539094	40.08170	-74.86970

Appendix 2: Station Locations (continued)

Station Name	Station ID	Latitude N	Longitude W
Ship John Shoal, NJ	8537121	39.30500	-75.37500
Cape May, NJ	8536110	38.96833	-74.96000
Atlantic City, NJ	8534720	39.35500	-74.41830
Sandy Hook, NJ	8531680	40.46690	-74.00940
Bergen Point West Reach, NY	8519483	40.63670	-74.14170
The Battery, NY	8518750	40.70060	-74.01420
Kings Point, NY	8516945	40.81030	-73.76490
Montauk, NY	8510560	41.04830	-71.96000
Bridgeport, CT	8467150	41.17330	-73.18170
New Haven, CT	8465705	41.28330	-72.90830
New London, CT	8461490	41.36139	-72.08997
Quonset Point, RI	8454049	41.58680	-71.41100
Providence, RI	8454000	41.80710	-71.40120
Conimicut Light, RI	8452944	41.71670	-71.34330
Newport, RI	8452660	41.50500	-71.32670
Nantucket Island, MA	8449130	41.28500	-70.09670
Woods Hole, MA	8447930	41.52330	-70.67170
Chatham, MA	8447435	41.68847	-69.95108
Fall River, MA	8447386	41.70430	-71.16410
Boston, MA	8443970	42.35480	-71.05340
Fort Point, NH	8423898	43.07170	-70.71170
Wells, ME	8419317	43.32000	-70.56331
Portland, ME	8418150	43.65670	-70.24670
Bar Harbor, ME	8413320	44.39170	-68.20500
Cutler Farris Wharf, ME	8411060	44.65670	-67.21000
Eastport, ME	8410140	44.90460	-66.98290

Appendix 3: Definitions

Excerpts From: *Tide and Current Glossary, NOAA National Ocean Service, Silver Spring, MD, 2000 (http://www.tidesandcurrents.noaa.gov/publications/glossary2.pdf), Tidal Datums homepage (http://www.tidesandcurrents.noaa.gov/datum_options.html) and the Storm QuickLook Frequently Asked Questions homepage (http://www.tidesandcurrents.noaa.gov/quicklook_faqs.shtml)*

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.

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: The NOAA National Geodetic Survey defines a geodetic datum as: "A set of constants used for calculating the coordinates of points on the Earth." In surveying and geodesy, a datum is a reference point on the earth's surface against which position measurements are made, and an associated model of the shape of the earth for computing positions. Horizontal datums are used for describing a point on the earth's surface, in latitude and longitude. Vertical datums are used to measure elevations or underwater depths.

Historical Recorded Maximum Tide Level: The maximum tide elevation measured by a water level station with a continuous time series throughout a high tide cycle. A complete cycle is required to calculate the maximum tide elevation, using a best fit curve of the observations. These historical records may not have included the highest water levels measured at a station during an event if a complete high tide cycle was not measured due to station/sensor damage. See storm tides.

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.

Mean Higher High Water (MHHW): A tidal datum. The average of the higher high water height of each tidal day observed over the 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.

Mean Sea Level (MSL): A tidal datum. The arithmetic mean of hourly heights observed over the National Tidal Datum Epoch. Shorter series are specified in the name; e.g. monthly mean sea level and yearly mean sea level.

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 1983 through 2001. It is reviewed annually for possible revision and must be actively considered for revision every 25 years.

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.

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 NTDE is 1983 through 2001 and is actively considered for revision every 20-25 years. Tidal datums in certain regions with anomalous sea level changes (Alaska, Gulf of Mexico) are calculated on a Modified 5-Year Epoch.

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.

Neap tides: Tides of decreased range occurring semimonthly as the result of the Moon being in quadrature (first or last quarters).

Non-tidal: Water levels may be classified as tidal or non-tidal. Water bodies with little or no range in tide and where the rise and fall of the water surface can no longer be practically measured in a predictable rhythm due to masking of the tide by hydrologic, wind, or other effects are non-tidal.

Range of tide: The difference in height between consecutive high and low waters. The mean range is the difference in height between mean high water and mean low water. The great diurnal range or diurnal range is the difference in height between mean higher high water and mean lower low water. For other ranges see spring, neap, perigean, apogean, and tropic tides; and tropic ranges.

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. Same as astronomic tide.

Tide (water level) gauge: An instrument for measuring the rise and fall of the tide (water level). Water levels may be classified as tidal and non-tidal.

Spring tides: Tides of increased range occurring semimonthly as the result of the Moon being new or full.

Storm Surge/Residual: The onshore rush of sea or lake water caused by the high wind and the low pressure centers associated with a land falling hurricane or other intense storm. The amplitude of the storm surge at any given location is dependent upon the orientation of the coast line with the storm track, the intensity, size and speed of the storm, and the local bathymetry. In practice, storm surge is usually estimated by subtracting the normal or astronomical tide from the observed storm tide at tide stations. This difference between observed storm tides and astronomical tide can have other components such as regional elevated mean sea levels in the Gulf of Mexico due to the Loop Current, elevated sea levels on the West Coast due to El Niño Southern Oscillation (ENSO), or local elevated sea levels due to river runoff in tidal rivers.

Storm Tide: The maximum water level elevation measured by a water level station during storm events. Depending on location, the storm tide is the potential combination of storm surge, local astronomical tide, regional sea level variations and river runoff during storm events. 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 astronomical tide. It is potentially catastrophic, especially on low lying coasts with gently sloping offshore topography.