NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

August 19, 2013

Group Chairman's Factual Report

METEOROLOGY

DCA13LM003

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A. ACCIDENT

Location: Approximately 100 miles southeast of Cape Hatteras, North Carolina
Date: October 29, 2012
Time: About 0426 eastern daylight time (0826 UTC[1])
Ship: Tall ship HMS Bounty

B. METEOROLOGY GROUP

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National Transportation Safety Board
Operational Factors Division, AS-30
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C. SUMMARY

On October 29, 2012 at approximately 0430 eastern daylight time the tall ship HMS Bounty capsized after being hit by a large wave and storm conditions associated with Hurricane Sandy. The ship had been taking on water which the pumps could not keep up with and ultimately failed during the hours prior including all electrical and motor power. Of the 16 crew members, 14 were rescued by the United States Coast Guard after several hours in the water. One crew member was located hours later who had not survived and the Captain of the ship was never located and was presumed lost.

The ship had set sail from New London, Connecticut on late in the afternoon of October 25, 2012 on a voyage bound for St. Petersburg, Florida. The Captain was aware of Hurricane Sandy's potential track and current strength and was planning to get enough sea room in order to adjust Bounty's course as the Hurricane moved north. At approximately 2130 EDT on October 28, 2012, the Bounty Organization contacted the Coast Guard after being notified by the ship that they had lost power and were taking on water and were located approximately 90 miles southeast of Cape Hatteras, North Carolina.

D. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's (NTSB) Senior Meteorologist was not on scene for this investigation and conducted the meteorology phase of the investigation from the Washington D.C. office, collecting data from official National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) sources including the National Climatic Data Center (NCDC), the National Hurricane Center (NHC), and the Oceanic Prediction Center (OPC). All times are eastern daylight time (EDT) based upon the 24 hour clock, local time is +4 hours to UTC, and UTC=Z. Directions are referenced to true north and distances in nautical

[1] UTC – is an abbreviation for Coordinated Universal Time.

miles. Heights are above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles.

The accident site is based on the United States Coast Guard position at latitude 33.9560° N and longitude 73.9086° W.

E. FACTUAL INFORMATION

1.0 Synoptic Situation

The synoptic or large scale migratory weather systems influencing the area were documented using standard NWS charts issued by the National Center for Environmental Prediction (NCEP) and the Ocean Prediction Center (OPC) located in Camp Springs, Maryland, and the National Hurricane Center (NHC) in Coral Gables, Florida. These are the base products used in describing weather features and in the creation of forecasts and warnings.

1.1 Surface Analysis Chart

The NWS western Atlantic Surface Analysis Chart for 0800 EDT (1200Z) on October 29, 2012 is included as figure 1 with the approximate accident site indicated. The chart depicted Hurricane Sandy's 1100 EDT (1500Z) position at latitude 37.5° N and longitude 71.5° W to the northeast of the accident position with a central pressure of 943-millibars (mb) or hectopascals (hPa), maximum winds associated with the storm were at 80 knots gusting to 100 knots, with the storm moving northwestward towards 330° at 16 knots. A strong pressure gradient was indicated by the isobars plotted on the chart and showed Hurricane Sandy interacting with a warm front that was wrapping around the storm and extending east-southeast across the Atlantic. Another stationary to cold front was depicted extending through New England into the mid-Atlantic region and southward into the Atlantic to the west of the hurricane and the accident site. The chart implied strong westerly winds over the accident site with tropical storm to hurricane force conditions.

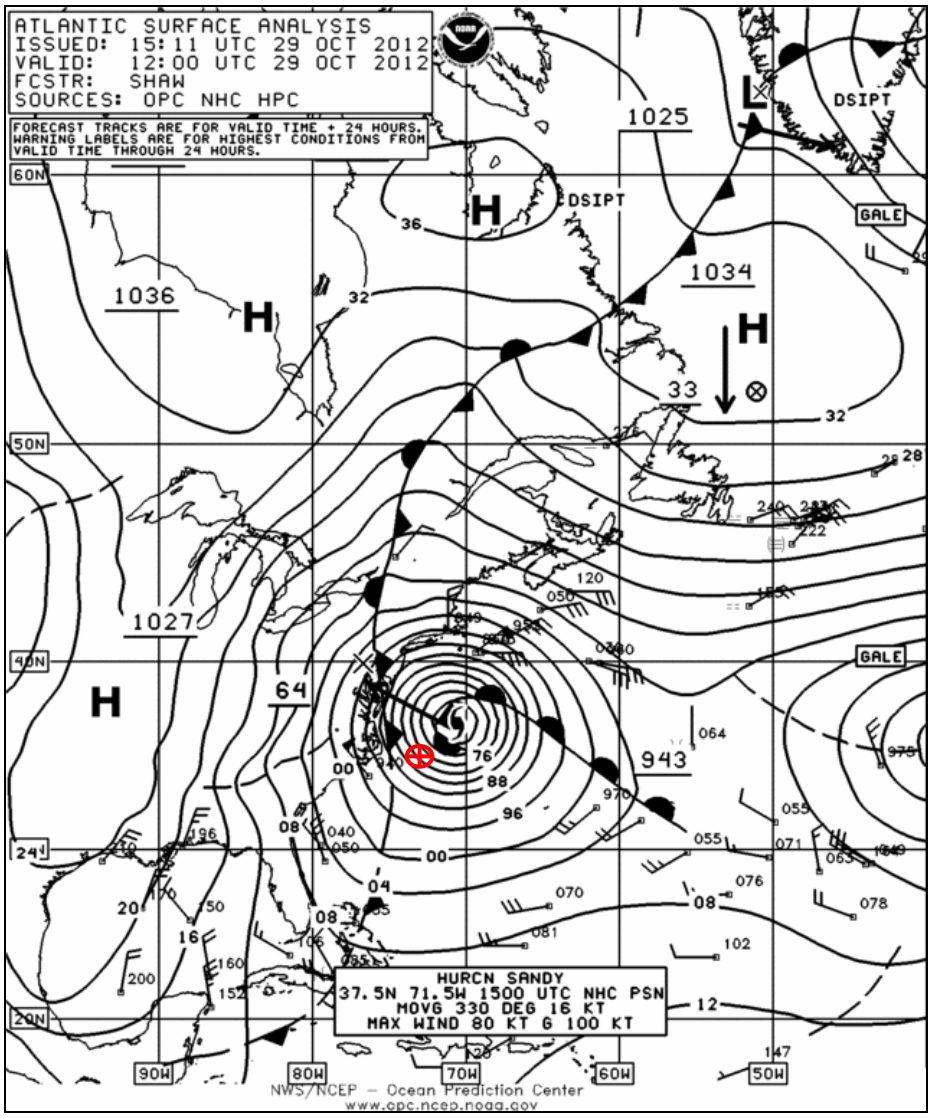

Figure 1 - NWS West Atlantic Surface Analysis for 0800 EDT

1.2 Hurricane Sandy Advisories

The NWS National Hurricane Center (NHC) Forecast Advisory number 26 issued at 1700 EDT (2100Z) on October 28, 2012 was as follows:

ZCZC MIATCMAT3 ALL
TTAA00 KNHC DDHHMM CCA

HURRICANE SANDY FORECAST/ADVISORY NUMBER 26...CORRECTED
NWS NATIONAL HURRICANE CENTER MIAMI FL AL182012
2100 UTC SUN OCT 28 2012

CORRECTED STATUS AT 36 HOURS

CHANGES IN WATCHES AND WARNINGS WITH THIS ADVISORY...

THE TROPICAL STORM WARNING HAS BEEN DISCONTINUED FROM SURF CITY NORTH CAROLINA SOUTHWARD.

SUMMARY OF WATCHES AND WARNINGS IN EFFECT...

A TROPICAL STORM WARNING IS IN EFFECT FOR...
** NORTH OF SURF CITY TO DUCK NORTH CAROLINA*
** PAMLICO AND ALBEMARLE SOUNDS*
** BERMUDA*

IN ADDITION...HURRICANE-FORCE WINDS ARE EXPECTED ALONG PORTIONS OF THE COAST BETWEEN CHINCOTEAGUE VIRGINIA AND CHATHAM MASSACHUSETTS. THIS INCLUDES THE TIDAL POTOMAC FROM COBB ISLAND TO SMITH POINT...THE MIDDLE AND UPPER CHESAPEAKE BAY...DELAWARE BAY...AND THE COASTS OF THE NORTHERN DELMARVA PENINSULA...NEW JERSEY...THE NEW YORK CITY AREA...LONG ISLAND...CONNECTICUT...AND RHODE ISLAND.

TROPICAL-STORM-FORCE WINDS ARE EXPECTED NORTH OF CHATHAM TO MERRIMACK RIVER MASSACHUSETTS...THE LOWER CHESAPEAKE BAY...AND SOUTH OF CHINCOTEAGUE TO DUCK NORTH CAROLINA...THE NORTHERN ENDPOINT OF THE TROPICAL STORM WARNING.

OTHER COASTAL AND INLAND WATCHES AND WARNINGS ARE IN EFFECT FOR THESE AREAS. PLEASE SEE STATEMENTS FROM LOCAL NATIONAL WEATHER SERVICE FORECAST OFFICES.

HURRICANE CENTER LOCATED NEAR 33.4N 71.3W AT 28/2100Z
POSITION ACCURATE WITHIN 20 NM

PRESENT MOVEMENT TOWARD THE NORTHEAST OR 50 DEGREES AT 13 KT

ESTIMATED MINIMUM CENTRAL PRESSURE 952 MB
MAX SUSTAINED WINDS 65 KT WITH GUSTS TO 80 KT.
64 KT..... 0NE 0SE 150SW 0NW.
50 KT..... 0NE 150SE 200SW 150NW.
34 KT.....450NE 330SE 330SW 270NW.
12 FT SEAS..480NE 660SE 660SW 480NW.
WINDS AND SEAS VARY GREATLY IN EACH QUADRANT. RADII IN NAUTICAL MILES ARE THE LARGEST RADII EXPECTED ANYWHERE IN THAT QUADRANT.

REPEAT...CENTER LOCATED NEAR 33.4N 71.3W AT 28/2100Z
AT 28/1800Z CENTER WAS LOCATED NEAR 32.8N 71.9W

FORECAST VALID 29/0600Z 35.0N 70.6W
MAX WIND 65 KT...GUSTS 80 KT.
64 KT... 0NE 60SE 150SW 100NW.
50 KT... 60NE 150SE 200SW 150NW.
34 KT...450NE 330SE 330SW 330NW.

FORECAST VALID 29/1800Z 37.7N 71.8W
MAX WIND 70 KT...GUSTS 85 KT.
64 KT... 60NE 100SE 100SW 60NW.
50 KT...120NE 180SE 200SW 160NW.
34 KT...400NE 360SE 360SW 270NW.

FORECAST VALID 30/0600Z 39.5N 74.8W...POST-TROPICAL
MAX WIND 65 KT...GUSTS 80 KT.
64 KT... 60NE 60SE 30SW 30NW.
50 KT...120NE 120SE 60SW 60NW.
34 KT...360NE 360SE 330SW 150NW.

FORECAST VALID 30/1800Z 40.2N 76.7W...POST-TROP/EXTRATROP
MAX WIND 50 KT...GUSTS 60 KT.
50 KT...120NE 120SE 30SW 0NW.
34 KT...300NE 360SE 200SW 170NW.

FORECAST VALID 31/1800Z 42.7N 76.8W...POST-TROP/EXTRATROP
MAX WIND 35 KT...GUSTS 45 KT.
34 KT... 80NE 80SE 0SW 80NW.

EXTENDED OUTLOOK. NOTE...ERRORS FOR TRACK HAVE AVERAGED NEAR 175 NM

ON DAY 4 AND 225 NM ON DAY 5...AND FOR INTENSITY NEAR 20 KT EACH DAY

OUTLOOK VALID 01/1800Z 44.7N 75.5W...POST-TROP/EXTRATROP
MAX WIND 30 KT...GUSTS 40 KT.

OUTLOOK VALID 02/1800Z 45.6N 71.4W...POST-TROP/EXTRATROP
MAX WIND 25 KT...GUSTS 35 KT.

REQUEST FOR 3 HOURLY SHIP REPORTS WITHIN 300 MILES OF 33.4N 71.3W

NEXT ADVISORY AT 29/0300Z

$$
FORECASTER STEWART/ROBERTS

At the time the tall ship MHS Bounty was located approximately 156 miles west-northwest or 290° azimuth from the position of the hurricane. The advisory warned that tropical storm warnings were in effect for the North Carolina coast to Bermuda, and that hurricane force winds were expected to begin to impact the mid-Atlantic coast from Chincoteague, Virginia to Chatham, Massachusetts. The advisory provided Hurricane Sandy's current position, movement to the northeast at 13 knots, pressure, and current winds at 65 knots gusting to 80 knots. The advisory also warned that hurricane force winds extended 150 miles southwest of the storms center.

The next NWS NHC's Public Advisory issued at 2000 EDT on October 28, 2012 prior to the ship contacting the Coast Guard was as follows:

ZCZC MIATCPAT3 ALL
TTAA00 KNHC DDHHMM

BULLETIN
HURRICANE SANDY INTERMEDIATE ADVISORY NUMBER 26A
NWS NATIONAL HURRICANE CENTER MIAMI FL AL182012
800 PM EDT SUN OCT 28 2012

...SANDY EXPECTED TO BRING LIFE-THREATENING STORM SURGE FLOODING TO
THE MID-ATLANTIC COAST...INCLUDING LONG ISLAND SOUND AND NEW YORK
HARBOR...
...WILL BRING COASTAL HURRICANE WINDS AND HEAVY APPALACHIAN SNOWS...

SUMMARY OF 800 PM EDT...0000 UTC...INFORMATION

LOCATION...34.0N 70.9W
ABOUT 280 MI...450 KM ESE OF CAPE HATTERAS NORTH CAROLINA
ABOUT 485 MI...780 KM SSE OF NEW YORK CITY
MAXIMUM SUSTAINED WINDS...75 MPH...120 KM/H
PRESENT MOVEMENT...NE OR 45 DEGREES AT 15 MPH...24 KM/H
MINIMUM CENTRAL PRESSURE...950 MB...28.05 INCHES

WATCHES AND WARNINGS

CHANGES WITH THIS ADVISORY...NONE.

SUMMARY OF WATCHES AND WARNINGS IN EFFECT...

A TROPICAL STORM WARNING IS IN EFFECT FOR...
** NORTH OF SURF CITY TO DUCK NORTH CAROLINA*
** PAMLICO AND ALBEMARLE SOUNDS*
** BERMUDA*

IN ADDITION...HURRICANE-FORCE WINDS ARE EXPECTED ALONG PORTIONS OF

THE COAST BETWEEN CHINCOTEAGUE VIRGINIA AND CHATHAM MASSACHUSETTS. THIS INCLUDES THE TIDAL POTOMAC FROM COBB ISLAND TO SMITH POINT... THE MIDDLE AND UPPER CHESAPEAKE BAY...DELAWARE BAY...AND THE COASTS OF THE NORTHERN DELMARVA PENINSULA...NEW JERSEY...THE NEW YORK CITY AREA...LONG ISLAND...CONNECTICUT...AND RHODE ISLAND.

TROPICAL-STORM-FORCE WINDS ARE EXPECTED NORTH OF CHATHAM TO MERRIMACK RIVER MASSACHUSETTS...THE LOWER CHESAPEAKE BAY...AND SOUTH OF CHINCOTEAGUE TO DUCK NORTH CAROLINA...THE NORTHERN ENDPOINT OF THE TROPICAL STORM WARNING.

OTHER COASTAL AND INLAND WATCHES AND WARNINGS ARE IN EFFECT FOR THESE AREAS. PLEASE SEE STATEMENTS FROM LOCAL NATIONAL WEATHER SERVICE FORECAST OFFICES.

FOR STORM INFORMATION SPECIFIC TO YOUR AREA IN THE UNITED STATES...INCLUDING POSSIBLE INLAND WATCHES AND WARNINGS...PLEASE MONITOR PRODUCTS ISSUED BY YOUR LOCAL NATIONAL WEATHER SERVICE FORECAST OFFICE. FOR STORM INFORMATION SPECIFIC TO YOUR AREA OUTSIDE THE UNITED STATES...PLEASE MONITOR PRODUCTS ISSUED BY YOUR NATIONAL METEOROLOGICAL SERVICE.

DISCUSSION AND 48-HOUR OUTLOOK

AT 800 PM EDT...0000 UTC...THE CENTER OF HURRICANE SANDY WAS LOCATED NEAR LATITUDE 34.0 NORTH...LONGITUDE 70.9 WEST. SANDY IS MOVING TOWARD THE NORTHEAST NEAR 15 MPH...24 KM/H...AND THIS GENERAL MOTION IS EXPECTED TO CONTINUE THIS EVENING. A TURN TO THE NORTH AND THEN THE NORTHWEST IS EXPECTED TONIGHT AND EARLY MONDAY. ON THE FORECAST TRACK...THE CENTER OF SANDY IS FORECAST TO BE NEAR THE MID-ATLANTIC COAST MONDAY NIGHT.

MAXIMUM SUSTAINED WINDS ARE NEAR 75 MPH...120 KM/H...WITH HIGHER GUSTS. SANDY IS EXPECTED TO TRANSITION INTO A FRONTAL OR WINTERTIME LOW PRESSURE SYSTEM PRIOR TO LANDFALL. HOWEVER...THIS TRANSITION WILL NOT BE ACCOMPANIED BY A WEAKENING OF THE SYSTEM...AND IN FACT...A LITTLE STRENGTHENING IS POSSIBLE DURING THIS PROCESS. SANDY IS EXPECTED TO WEAKEN AFTER MOVING INLAND.

HURRICANE-FORCE WINDS EXTEND OUTWARD UP TO 175 MILES...280 KM...FROM THE CENTER...AND TROPICAL-STORM-FORCE WINDS EXTEND OUTWARD UP TO 520 MILES...835 KM. A NATIONAL OCEAN SERVICE STATION AT CAPE HATTERAS RECENTLY REPORTED SUSTAINED WINDS OF 47 MPH...76 KM/H... WITH A GUST TO 56 MPH...91 KM/H...AND THE NORFOLK NAVAL AIR STATION RECENTLY REPORTED SUSTAINED WINDS OF 40 MPH...65 KM/H...AND A WIND GUST OF 49 MPH...80 KM/H.

THE MINIMUM CENTRAL PRESSURE BASED ON DATA FROM TWO NOAA AIR FORCE RESERVE HURRICANE HUNTER AIRCRAFT IS 950 MB...28.05 INCHES.

HAZARDS AFFECTING LAND

WIND...TROPICAL STORM CONDITIONS ARE ALREADY OCCURRING OVER COASTAL NORTH CAROLINA AND SOUTHEASTERN VIRGINIA. GALE FORCE WINDS ARE EXPECTED TO ARRIVE ALONG PORTIONS OF THE MID-ATLANTIC COAST LATER TODAY...AND REACH LONG ISLAND AND SOUTHERN NEW ENGLAND BY MONDAY MORNING. WINDS OF HURRICANE FORCE COULD REACH THE MID-ATLANTIC STATES...INCLUDING LONG ISLAND...BY LATE MONDAY.

STORM SURGE...THE COMBINATION OF AN EXTREMELY DANGEROUS STORM SURGE AND THE TIDE WILL CAUSE NORMALLY DRY AREAS NEAR THE COAST TO BE FLOODED BY RISING WATERS. THE WATER COULD REACH THE FOLLOWING DEPTHS ABOVE GROUND IF THE PEAK SURGE OCCURS AT THE TIME OF HIGH TIDE...

NC NORTH OF SURF CITY INCLUDING PAMLICO/ALBEMARLE SOUNDS...4 TO 6 FT
SE VA AND DELMARVA INCLUDING LOWER CHESAPEAKE BAY...2 TO 4 FT
UPPER AND MIDDLE CHESAPEAKE BAY...1 TO 3 FT
LONG ISLAND SOUND...RARITAN BAY...AND NEW YORK HARBOR...6 TO 11 FT

ELSEWHERE FROM OCEAN CITY MD TO THE CT/RI BORDER...4 TO 8 FT
CT/RI BORDER TO THE SOUTH SHORE OF CAPE COD INCLUDING BUZZARDS BAY AND NARRAGANSETT BAY...3 TO 6 FT
CAPE COD TO THE MA/NH BORDER INCLUDING CAPE COD BAY...2 TO 4 FT
MA/NH BORDER TO THE U. S./CANADA BORDER...1 TO 3 FT

SURGE-RELATED FLOODING DEPENDS ON THE RELATIVE TIMING OF THE SURGE AND THE TIDAL CYCLE...AND CAN VARY GREATLY OVER SHORT DISTANCES. GIVEN THE LARGE WIND FIELD ASSOCIATED WITH SANDY...ELEVATED WATER LEVELS COULD SPAN MULTIPLE TIDE CYCLES RESULTING IN REPEATED AND EXTENDED PERIODS OF COASTAL AND BAYSIDE FLOODING. IN ADDITION... ELEVATED WATERS COULD OCCUR FAR REMOVED FROM THE CENTER OF SANDY. FURTHERMORE...THESE CONDITIONS WILL OCCUR REGARDLESS OF WHETHER SANDY IS A TROPICAL OR POST-TROPICAL CYCLONE. FOR INFORMATION SPECIFIC TO YOUR AREA...PLEASE SEE PRODUCTS ISSUED BY YOUR LOCAL NATIONAL WEATHER SERVICE OFFICE.

RAINFALL...RAINFALL TOTALS OF 3 TO 6 INCHES ARE EXPECTED OVER FAR NORTHEASTERN NORTH CAROLINA WITH ISOLATED MAXIMUM TOTALS OF 8 INCHES POSSIBLE. RAINFALL AMOUNTS OF 4 TO 8 INCHES ARE EXPECTED OVER PORTIONS OF THE MID ATLANTIC STATES...INCLUDING THE DELMARVA PENINSULA...WITH ISOLATED MAXIMUM AMOUNTS OF 12 INCHES POSSIBLE. RAINFALL AMOUNTS OF 1 TO 3 INCHES WITH ISOLATED MAXIMUM AMOUNTS OF 5 INCHES ARE POSSIBLE FROM THE SOUTHERN TIER OF NEW YORK STATE NORTHEASTWARD THROUGH NEW ENGLAND.

SNOWFALL...SNOW ACCUMULATIONS OF 2 TO 3 FEET ARE EXPECTED IN THE MOUNTAINS OF WEST VIRGINIA...WITH LOCALLY HIGHER TOTALS TONIGHT THROUGH TUESDAY NIGHT. SNOWFALL OF 1 TO 2 FEET IS EXPECTED IN THE MOUNTAINS OF SOUTHWESTERN VIRGINIA TO THE KENTUCKY BORDER... WITH 12 TO 18 INCHES OF SNOW POSSIBLE IN THE MOUNTAINS NEAR THE NORTH CAROLINA/TENNESSEE BORDER.

SURF...DANGEROUS SURF CONDITIONS WILL CONTINUE FROM FLORIDA THROUGH THE MID-ATLANTIC STATES FOR THE NEXT COUPLE OF DAYS AND SPREAD INTO THE NORTHEASTERN STATES LATER TODAY.

NEXT ADVISORY

NEXT COMPLETE ADVISORY...1100 PM EDT.

$$
FORECASTER BEVEN

The advisory indicated that Hurricane Sandy was located approximately 170 miles east of the Bounty's last position and that the system was beginning to transition into a frontal or winter time low pressure system and had strengthened slightly. The advisory warned that hurricane force conditions extended outwards to 175 miles and tropical storm force winds in excess of 50 knots to 520 miles and were already occurring along the coastal sections of North Carolina and Virginia.

The NWS HPC graphic produce of surface wind field of Hurricane Sandy for 0500 EDT on October 29, 2012 or at the approximate time of the capsizing was depicted in figure 2, with the approximate position of the HMS Bounty indicated.

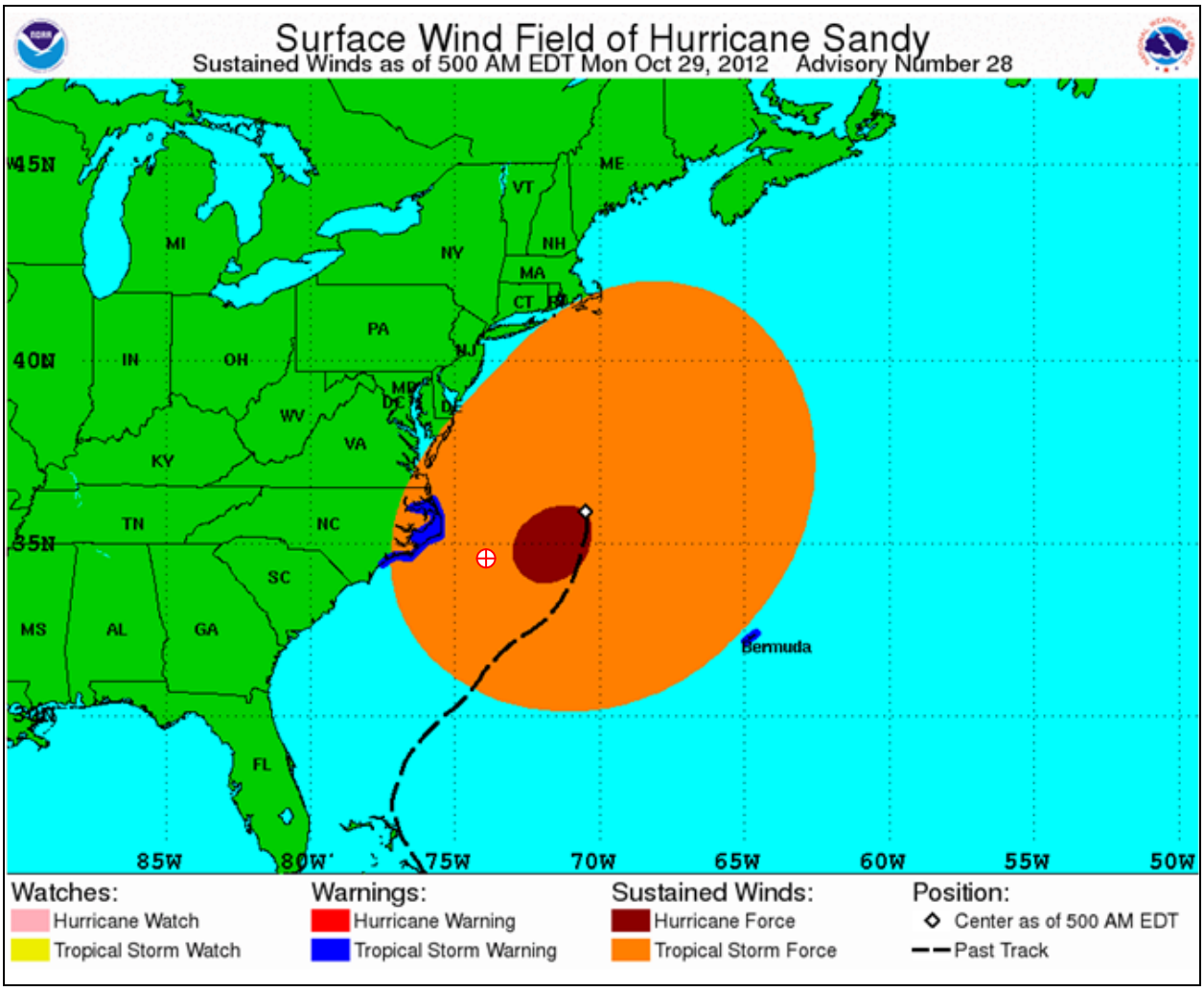

Figure 2 - NWS HPC 0500 EDT Wind Field of Hurricane Sandy

1.3 NWS 500-mb Analysis Chart

The NWS 500-mb Atlantic upper air analysis chart for 0800 EDT (1200Z) on October 29, 2012 is included as figure 3 depicting the conditions in the mean atmosphere. The chart depicted a strong high pressure system off Newfoundland to the north with two cut off upper level lows over the eastern United States west of the accident site and the other in the mid-Atlantic to the east, which formed what is referred to as an "Omega block[2]". A band of 50 knot and greater winds were depicted circulating around the upper level low's and extended down to the Florida border to the south of the accident site, which were associated with the jet stream.

[2] Omega blocks are so-named because the height fields associated with them resemble the uppercase Greek letter omega "Ω". The typical pattern for these is low-high-low, arranged in the west–east direction. These blocks are a large-scale pattern in the pressure field that are nearly stationary, effectively "blocking" or redirecting migratory cyclones. These blocks can remain in place for several days or even weeks, causing the areas affected by them to have the same kind of weather for an extended period of time.

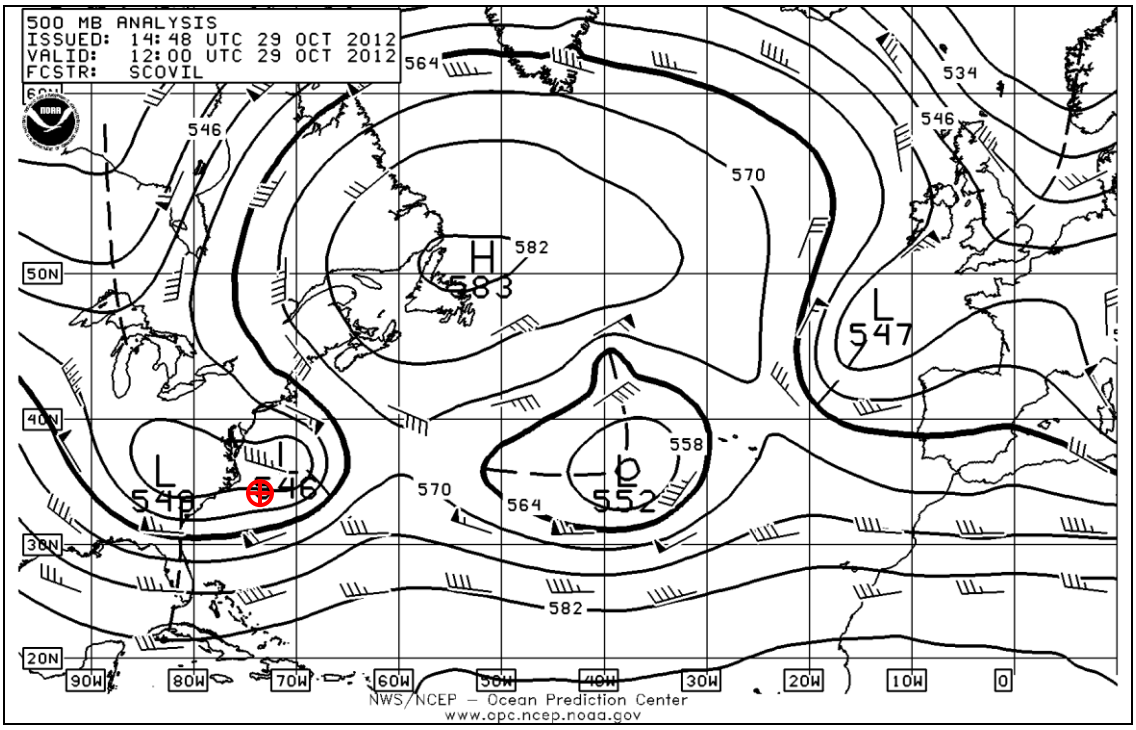

Figure 3 - NWS Atlantic 500-mb Analysis for 0800 EDT

1.4 Sea State Analysis Chart

Figures 4 and 5 are the NWS National Hurricane Centers (NHC) and Ocean Prediction Centers (OPC) Atlantic Sea State Analysis Charts valid at 0800 EDT with the approximate accident site noted. The chart depicted the significant wave heights or the average height of one third of the waves over the area between 24 and 27 feet in the vicinity of the accident site with the prevailing swell direction from west-northwest, or Beaufort scale[3] 9 conditions or a "strong gale". The center of Hurricane Sandy had a significant wave height of 42 feet.

[3] Beaufort scale is an empirical measure that relates wind speed to observed conditions at sea or on land.

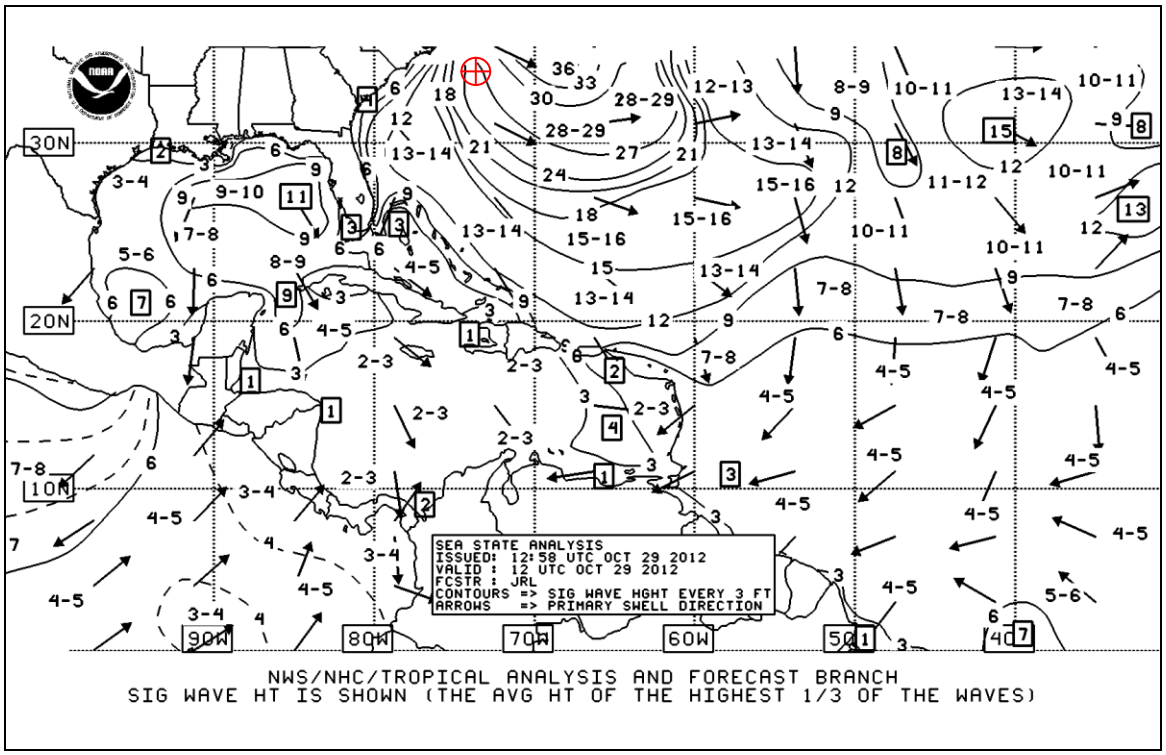

Figure 4- NHC Sea State Analysis for 0800 EDT

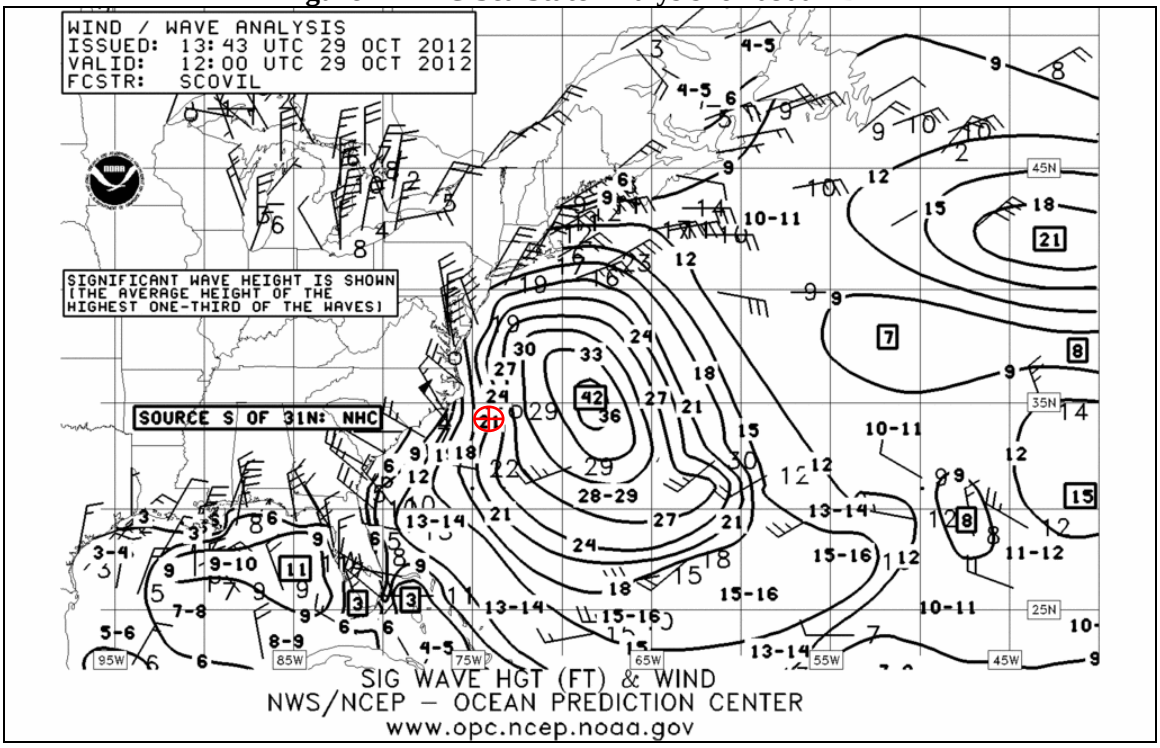

Figure 5 - OPC Wind and Wave Analysis for 0800 EDT

2.0 Buoy Data

The closest NOAA weather observing buoy was from East Hatteras Buoy, station number 41001 located approximately 150 miles east of Cape Hatteras, North Carolina, and 73 miles east-

northeast from the accident site at latitude 34.561° N and longitude 72.631° W. At 0150 EDT (0550Z) the station reported its highest sustained wind of the day from 285° at 57 knots gusting to 71 knots, with wave heights of 30 feet, or Beaufort scale 10 to 11 storm conditions. At 0350 EDT (0750Z) or approximately 1/2 hour prior to the HMS Bounty's capsizing the station reported the following conditions:

Wind (WDIR/WSPD):	293° at 46 knots gusting to 66 knots
Significant Wave Height (WVHT):	30 feet
Dominant Wave Period (DWP):	9.6 seconds
Average Wave Period (APD):	9.64 seconds
Mean Wave Direction (MWD):	258°
Atmosphere Pressure (PRES):	973.7-hPa
Air Temperature (ATMP):	21.7° C (71° F)
Water Temperature (WTMP):	26.3° C (79° F)

This was the last reliable wind report and wave height provided by the station as after 0450 EDT East Hatteras buoy began reporting missing data. The next observation was as follows:

Wind (WDIR/WSPD):	Missing data
Significant Wave Height (WVHT):	Missing data
Dominant Wave Period (DWP):	Missing data
Average Wave Period (APD):	Missing data
Mean Wave Direction (MWD):	Missing data
Atmosphere Pressure (PRES):	973.3-hPa
Air Temperature (ATMP):	21.2° C (70° F)
Water Temperature (WTMP):	26.2° C (79° F)

The raw station data for the period from October 28-29, 2012 was as follows:

#YY	MM	DD	hh	mm	WDIR	WSPD	GST	WVHT	DPD	APD	MWD	PRES	ATMP	WTMP
#yr	mo	dy	hr	mn	degT	m/s	m/s	m	sec	sec	deg	hPa	degC	degC
2012	10	28	00	50	79	20.6	25.4	7.45	11.43	8.70	137	991.8	23.2	26.4
2012	10	28	01	50	80	21.1	27.1	7.28	11.43	8.82	103	991.0	23.9	26.5
2012	10	28	02	50	78	20.7	27.3	8.32	12.12	9.59	131	990.4	23.4	26.4
2012	10	28	03	50	77	20.0	24.6	8.80	12.12	9.64	113	989.8	22.9	26.4
2012	10	28	04	50	74	21.7	28.0	8.39	12.12	9.35	92	987.8	23.2	26.3
2012	10	28	05	50	74	18.7	24.4	8.51	12.12	9.72	116	987.7	23.3	26.4
2012	10	28	06	50	78	20.2	25.0	8.42	12.12	9.47	103	985.8	23.9	26.4
2012	10	28	07	50	76	20.0	24.4	9.17	12.12	9.76	112	984.3	24.1	26.5
2012	10	28	08	50	76	20.8	25.6	9.06	12.90	9.96	136	982.9	24.2	26.4
2012	10	28	09	50	72	19.9	25.4	**9.92**	12.90	10.14	99	981.7	24.1	26.4
2012	10	28	10	50	66	20.6	25.6	8.37	12.12	9.44	100	980.5	24.4	26.4
2012	10	28	11	50	75	20.2	**26.1**	8.29	12.12	9.44	132	980.1	24.7	26.4
2012	10	28	12	50	75	18.5	23.5	9.14	12.12	9.76	89	980.0	25.1	26.5
2012	10	28	13	50	73	18.1	25.5	8.04	12.12	9.50	109	979.0	24.2	26.5
2012	10	28	14	50	74	18.9	24.9	9.04	12.12	9.64	84	977.5	24.4	26.6
2012	10	28	15	50	70	17.7	23.0	9.41	12.90	10.08	93	976.0	24.3	26.6
2012	10	28	16	50	63	17.2	21.5	7.83	12.12	9.30	110	974.5	24.3	26.7
2012	10	28	17	50	62	16.4	20.3	8.75	12.90	9.87	96	973.2	24.4	26.7
2012	10	28	18	50	55	15.1	20.1	8.62	12.12	9.61	103	971.9	25.1	26.7
2012	10	28	19	50	48	14.4	19.2	7.79	12.90	9.67	80	970.7	25.3	26.6
2012	10	28	20	50	54	14.2	22.0	6.43	13.79	8.99	80	969.8	24.6	26.6
2012	10	28	21	50	53	14.8	19.5	7.65	12.90	9.63	88	969.9	25.9	26.6
2012	10	28	22	50	46	12.9	17.9	8.04	12.12	9.78	97	970.1	24.8	26.5
2012	10	28	23	50	27	14.6	18.7	8.16	12.90	9.86	75	969.6	25.2	26.5
2012	10	29	00	50	15	11.7	14.7	7.18	12.12	9.64	75	970.1	25.4	26.4

2012	10	29	01	50	8	11.3	14.1	6.54	12.12	9.37	82	970.4	25.7	26.4
2012	10	29	02	50	359	10.0	12.9	6.64	12.90	9.80	62	970.7	25.2	26.4
2012	10	29	03	50	337	8.5	11.3	5.45	10.81	8.88	67	970.7	25.3	26.3
2012	10	29	04	50	320	10.7	13.7	5.86	11.43	9.14	74	971.0	25.0	26.4
2012	10	29	05	50	285	28.5	35.4	6.04	12.12	8.33	66	970.6	20.6	26.4
2012	10	29	06	50	292	26.7	33.5	99.00	99.00	99.00	999	971.8	21.0	26.3
2012	10	29	07	50	293	23.8	33.0	9.14	12.12	9.64	258	973.7	21.7	26.3
2012	10	29	08	50	999	99.0	99.0	99.00	99.00	99.00	999	973.3	21.2	26.2
2012	10	29	09	50	999	99.0	99.0	8.82	12.12	9.47	310	973.6	21.4	26.2
2012	10	29	10	50	999	99.0	99.0	8.81	11.43	9.66	323	978.2	22.2	26.1
2012	10	29	11	50	999	99.0	99.0	8.88	12.12	9.96	332	979.3	21.8	26.1
2012	10	29	12	50	999	99.0	99.0	9.26	12.12	10.24	327	981.0	20.6	26.1
2012	10	29	13	50	999	99.0	99.0	**10.10**	12.12	10.04	331	982.4	20.9	26.1

3.0 Satellite Data

The Geostationary Operational Environmental Satellite number 13 (GOES-13) data was obtained and displayed on the National Transportation Safety Board's Man-computer Interactive Data Access System (McIDAS) workstation. Both the infrared long wave and visible band imagery were obtained surrounding the time of the accident. The infrared long wave imagery (band 4) at a wavelength of 10.7 microns (μm) provided standard satellite image with radiative cloud top temperatures with a resolution of 4 km.

Figure 6 is the GOES-13 infrared image at 2X magnification at 0425 EDT with a standard MB temperature enhancement curve applied to highlight the higher and colder clouds associated with deep convective clouds, and the location of the HMS Bounty and Hurricane Sandy are both indicated. At the time of the capsizing Hurricane Sandy was located approximately 190 mile northeast of the HMS Bounty, with a define eye wall with enhanced clouds. The image depicted a band of low stratiform clouds obscuring the accident site with spiral rain bands to the north. The image indicated that no heavy precipitation was occurring at the time of the capsizing, but low broken to overcast cloud layer was present.

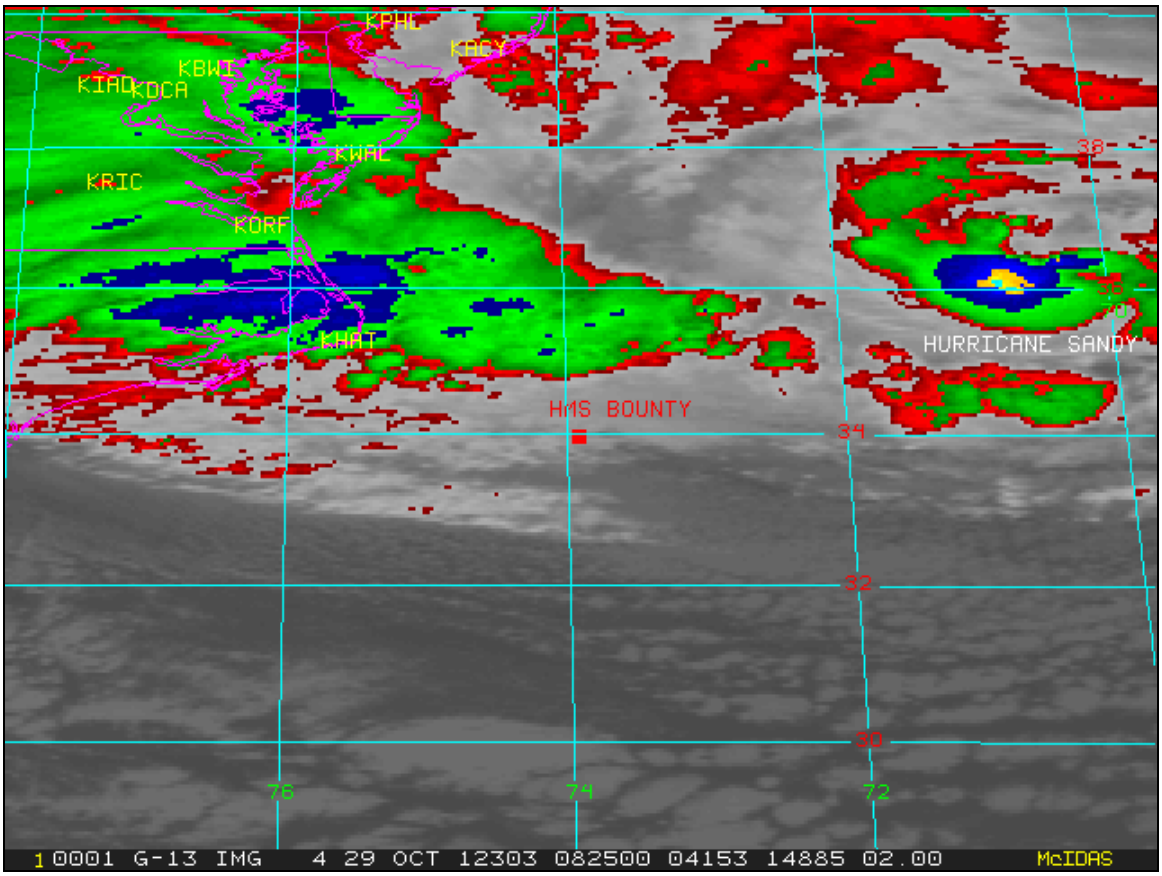

Figure 6 - GOES-13 infrared image at 0425 EDT

3.1 High Resolution MODIS Imagery

A very high resolution satellite image (MODIS) polar orbiting satellite image with 1 kilometer or .54 nautical mile resolution for the afternoon of October 28, 2012 was also downloaded to show the impact of Hurricane Sandy over the region and is included as figure 7. The red arrow approximates the HMS Bounty's route and position during the period and was located within a large area of enhanced convection located on the western and northwestern side of Hurricane Sandy and indicates that significant rain squalls were encountered with the spiral rain bands during this period.

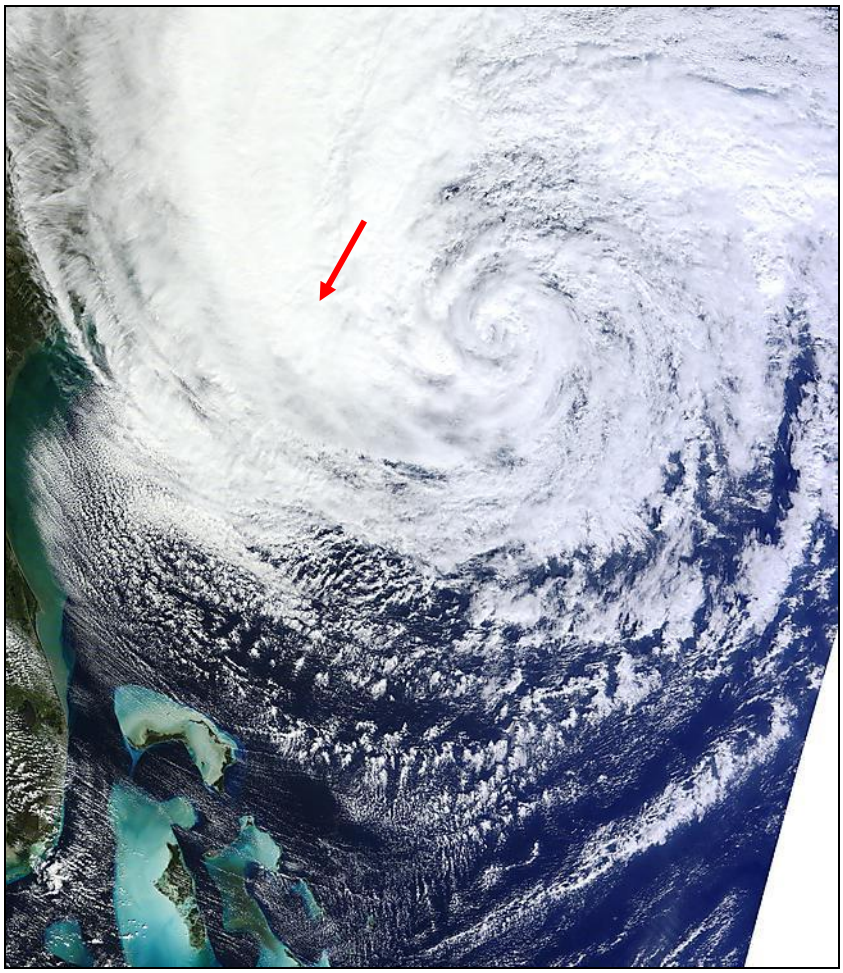

Figure 7- MODIS image on the afternoon of October 28, 2012

3.2 Oceansat Wind Image

An image from the Indian Space Research Organizations (ISRO) Oceansat-2 radar scatterometer depicts the wind field over the Atlantic at 0000 EDT on October 29, 2012. Figure 8 depicts the image depicts wind speeds at approximately 33 feet over the ocean surface with wind speeds over 35 knots (30 mph) are in depicted in yellow, above 43 knots (40 mph) in orange, and above 52 knots (50 mph) in dark red. The image shows the wind field in Hurricane Sandy moving away from the eyewall outward on the western side of the storm as the storm begins to take on extratopical characteristics and interacting with the frontal system to the north. The highest winds in Hurricane Sandy were not located within the typical eyewall region surrounding the eye or in the front right sector of the storm, but in the left side and front or the western sector. This is also one of the reasons the storm had such a significant storm surge and caused such an extensive area of damage along the coast. The image also shows that the strongest winds associated with Hurricane Sandy were encountered on the western side of the storm as it passed and that a strong westerly band of sustained winds in excess of 50 knots impacted the HMS Bounty.

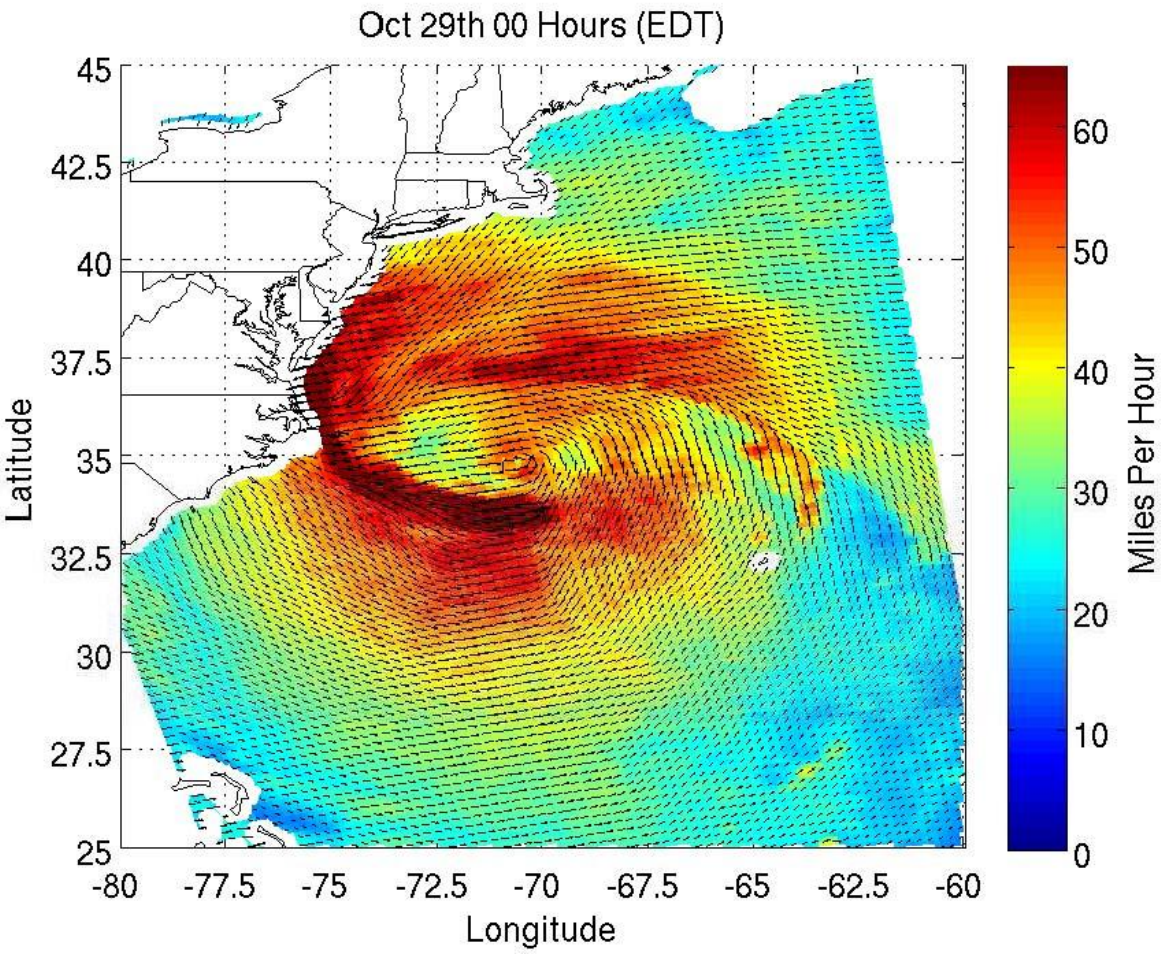

Figure 8- Indian Oceansat-2 image of the winds at 0000 EDT October 29, 2012

4.0 North Atlantic Marine Weather Discussion (MWD)

The NWS North Atlantic Marine Weather Discussion (MWD) describes expected warnings over areas in the offshore waters of the Atlantic Ocean and is used for coordination with other NWS Forecast Offices. The narrative may highlight wind speeds and wave heights in relation to current forecasts and computer model guidance. The MWD issued at 1511 EDT on October 28, 2012 was as follows:

AGNT40 KWNM 281911 2012302 1911
MIMATN
MARINE WEATHER DISCUSSION
NWS OCEAN PREDICTION CENTER WASHINGTON DC
300 PM EDT SUN 28 OCT 2012
.FORECAST DISCUSSION: MAJOR FEATURES/WINDS/SEAS/SIGNIFICANT
.WEATHER FOR NORTH ATLANTIC OCEAN W OF 50W FROM 30N TO 50N.
NOTE: ISSUANCE OF NEW ENGL AND MID ATLC OFFSHORE WATER FORECASTS
WILL BE DELAYED UNTIL 21Z NHC ADVISORY IS AVAILABLE.
LATEST NHC FORECAST WAS CONSISTENT WITH PREVIOUS ADVISORIES WITH TRACK OF HURCN SANDY...AND ALSO MAINTAINS SANDY AS TRPCL CYCLONE THRU 36HRS. ADJUSTED HEADLINES OVER NEW ENGL WATERS TO STORM/HURCN FORCE WIND WARNINGS TO BE CONSISTENT WITH COASTAL WFOS AND ALSO ACCOUNT FOR POST TRPCL TRANSITION AS INDICATED BY EARLIER

NHC ADVISORIES. HOWEVER THIS EXTRATROPICAL TRANSITION HAS LITTLE BEARING ON THE FACT THAT SANDY WILL REMAIN A DANGEROUS STORM WITH HURCN FORCE WINDS...LIFE THREATENING STORM SURGE AND HEAVY RAINFALL.
.
12Z GFS WAS CONSISTENT WITH ITS PREVIOUS RUN AND REMAINS FASTER THAN 12Z UKMET/ECMWF AND ALSO OFFICIAL NHC FORECAST...MAINLY AT 24 HRS AND BEYOND.
OVERALL DO NOT ANTICIPATE THAT THERE WILL BE MUCH CHANGE NEEDED FROM PREVIOUSLY
FORECAST WARNINGS. AT 15Z SHIP REPORTING 60 KT AND 47 FT WITHIN GLF STREAM WAS LIKELY A GOOD OB. WILL BE ADJUSTING 12Z MULTIGRID WAVEWATCH III SIG WV HGTS ASSOC WITH SANDY ABOUT 6 TO 8 FT OR HIGHER.
.
WILL BE UPDATING STORM SURGE DETAILS BELOW BASED ON NHC CONFERENCE CALL AND ADVISORY IN AN UPDATED MARINE DISCUSSION TO FOLLOW SHORTLY.
.
EXTRATROPICAL STORM SURGE GUIDANCE...WILL BE UPDATED VIA NEW PUBLIC NHC ADVISORY. STORM SURGE...THE COMBINATION OF A DANGEROUS STORM SURGE AND THE TIDE WILL CAUSE NORMALLY DRY AREAS NEAR THE COAST TO BE FLOODED BY RISING WATERS. THE WATER COULD
REACH THE FOLLOWING DEPTHS ABOVE GROUND IF THE PEAK SURGE OCCURS AT THE TIME OF HIGH TIDE...
.
NC NORTH OF SURF CITY INCLUDING PAMLICO/ALBERMARLE SNDS...4 TO 6FT
SE VA AND DELMARVA INCLUDING LOWER CHESAPEAKE BAY...2 TO 4 FT.
UPPER AND MIDDLE CHESAPEAKE BAY...1 TO 3 FT.
LONG ISLAND SOUND...RARITAN BAY...AND NEW YORK HARBOR...6 TO 11 FT.
ELSEWHERE FROM OCEAN CITY MD TO THE CT/RI BORDER...4 TO 8 FT.
CT/RI BORDER TO THE SOUTH SHORE OF CAPE COD INCLUDING BUZZARDS BAY AND ARRAGANSETT...3 TO 6 FT.
.
SURGE-RELATED FLOODING DEPENDS ON THE RELATIVE TIMING OF THE SURGE AND THE TIDAL CYCLE...AND CAN VARY GREATLY OVER SHORT DISTANCES. GIVEN THE LARGE WIND FIELD ASSOCIATED WITH SANDY...ELEVATED WATER LEVELS COULD SPAN MULTIPLE TIDE CYCLES
RESULTING IN REPEATED AND EXTENDED PERIODS OF COASTAL AND BAYSIDE FLOODING.
IN ADDITION... ELEVATED WATERS COULD OCCUR FAR REMOVED FROM THE CENTER OF SANDY. FURTHERMORE...THESE CONDITIONS WILL OCCUR REGARDLESS OF WHETHER SANDY IS A TROPICAL OR POST-TROPICAL CYCLONE. FOR INFORMATION SPECIFIC TO YOUR AREA...PLEASE SEE PRODUCTS ISSUED BY YOUR LOCAL NATIONAL WEATHER SERVICE WASHINGTON DC
.WARNINGS/FORECAST CONFIDENCE...PRELIMINARY AND MAY BE AMENDED BASED ON LATEST NHC ADVISORY. ANY CHANGES WILL BE COORDINATED THROUGH AWIPS 12 PLANET CHAT OR BY TELEPHONE:
.NT1 NEW ENGLAND WATERS
.GULF OF MAINE...STORM...TNGT INTO TUE.
.GEORGES BANK...STORM...TNGT INTO TUE.
.S OF NEW ENGLAND...HURCN FORCE WIND MON INTO MON NGT.
.NT2 MID ATLC WATERS
.HUDSON CNYN TO BALT CNYN...HURN...MON INTO MON NGT.
.BALT CNYN TO HAGUE LINE...HURCN...TNGT INTO MON NGT.
.BALT CNYN TO HATTERAS CNYN...HURCN...TNGT INTO MON.
.HATTERAS CNYN TO CAPE FEAR...HURCN...TNGT.
.CAPE FEAR TO 31N...HURCN...TNGT.
.FORECASTER CLARK. OCEAN FORECAST BRANCH.

The focus of the discussion was on Hurricane Sandy, which remained a dangerous storm with hurricane force winds, life threatening storm surge, and heavy rain. At 1100 EDT ship report in the Gulf Stream reported winds of 60 knots and 47 foot seas. Hurricane force conditions prevailed over the oceanic region to the Cape Hatteras area.

5.0 Off Shore Forecast

The NWS Off Shore Forecast issued at 2248 EDT on October 28, 2012 prior to the capsizing was as follows:

FZNT22 KWBC 290248 2012303 0249
OFFNT2
OFFSHORE WATERS FORECAST
NWS OCEAN PREDICTION CENTER WASHINGTON DC
1100 PM EDT SUN OCT 28 2012
W CENTRAL N ATLC CONTINENTAL SHELF AND SLOPE WATERS BEYOND 20 NM
TO 250 NM OFFSHORE...INCLUDING S OF GEORGES BANK FROM 1000 FM TO 250 NM OFFSHORE.

SEAS GIVEN AS SIGNIFICANT WAVE HEIGHT...WHICH IS THE AVERAGE HEIGHT OF THE HIGHEST 1/3 OF THE WAVES. INDIVIDUAL WAVES MAY BE MORE THAN TWICE THE SIGNIFICANT WAVE HEIGHT.
ANZ089-290900-
1100 PM EDT SUN OCT 28 2012
.SYNOPSIS FOR MID ATLC WATERS...HURRICANE SANDY WAS CENTERED NEAR 34.5N 70.5W AT 11 PM TONIGHT WITH MAXIMUM SUSTAINED WINDS 65 KT AND GUSTS TO 80 KT. SANDY WILL TRACK N TO NEAR 36.4N 70.9W BY 8 AM MON...AND TO 38.7N 73.2W BY 8 PM MON NIGHT...AND THEN
INLAND TO 39.8N 75.8W BY 8 AM TUE AT WHICH TIME SANDY WILL BECOME POST-TROPICAL. POST-TROPICAL SANDY WILL THEN SLOWLY TRACK N LATER TUE THROUGH THU AND APPROACH THE SAINT LAWRENCE RIVER VALLEY FRI. A COLD FRONT WILL MOVE E THROUGH THE WATERS FRI. SEE THE LATEST NATIONAL HURRICANE CENTER ADVISORY FOR HURRICANE SANDY.
$$
.OVERNIGHT...E TO NE WINDS 40 TO 55 KT...BECOMING N TO NW AND INCREASING TO 55 TO 70 KT. SEAS 25 TO 38 FT...EXCEPT W OF 1000 FM 20 TO 26 FT. RAIN WITH VSBY OCCASIONALLY LESS THAN 1 NM. A CHANCE OF TSTMS.
.MON...WINDS BECOMING W TO SW 50 TO 70 KT...EXCEPT OVER SE PORTION DIMINISHING TO 40 TO 50 KT. SEAS 25 TO 38 FT...EXCEPT W OF 1000 FM 18 TO 28 FT. RAIN BECOMING SCATTERED SHOWERS LATE.
.MON NIGHT...SW WINDS DIMINISHING TO 35 TO 45 KT...EXCEPT NW PORTION TO 50 KT. SEAS SUBSIDING TO 16 TO 23 FT...HIGHEST NE. ISOLATED SHOWERS.
....

$$
ANZ086-AMZ170-290900-
HATTERAS CANYON TO CAPE FEAR OUT TO 34N 71W TO 32N 73W.
1100 PM EDT SUN OCT 28 2012
...HURRICANE WARNING...
.OVERNIGHT...W TO NW WINDS 50 TO 65 KT...EXCEPT W OF 75W 40 TO 50 KT. SEAS 24 TO 38 FT...EXCEPT W OF 75W 14 TO 24 FT. NUMEROUS SHOWERS AND ISOLATED TSTMS ENDING.
.MON...W TO NW WINDS DIMINISHING TO 30 TO 40 KT. SEAS SUBSIDING TO 15 TO 24 FT...EXCEPT W OF 75W TO 10 TO 15 FT.
.MON NIGHT...W TO SW WINDS DIMINISHING TO 25 TO 35 KT. SEAS SUBSIDING TO 13 TO 17 FT...EXCEPT W OF 75W TO 8 TO 13 FT. A CHANCE OF SHOWERS.
....
$$

The forecast for the Cape Hatteras to Cape fear area extended over the Bounty's position at the time and the accident location. The forecast warned of Hurricane Sandy providing the current position and strength of the storm at 65 knots gusting to 80 knots, moving northward. The forecast expected winds west to northwest at 50 to 65 knots, with seas of 24 to 36 feet, and numerous rain showers and isolated thunderstorms which were expected to end in the morning.

6.0 High Seas Forecast

The NWS High Seas Forecast issued at 1807 EDT on October 28, 2012 follows and provided a 48 hour forecast for the region as well as the initial conditions based on surface analysis, satellite analysis, and the sea conditions expected with significant tropical and Extratropical storm systems. Current warnings in effect are as included in the product. The forecast was as follows:

FZNT01 KWBC 282207 2012302 2208
HSFAT1
HIGH SEAS FORECAST FOR METAREA IV
NWS OCEAN PREDICTION CENTER WASHINGTON DC
2230 UTC SUN OCT 28 2012
CCODE/2:31:04:11:00/AOW+AOE/NWS/CCODE
SUPERSEDED BY NEXT ISSUANCE IN 6 HOURS
SEAS GIVEN AS SIGNIFICANT WAVE HEIGHT...WHICH IS THE AVERAGE HEIGHT OF THE HIGHEST 1/3 OF THE WAVES. INDIVIDUAL WAVES MAY BE MORE THAN TWICE THE SIGNIFICANT WAVE HEIGHT
PAN PAN
NORTH ATLANTIC NORTH OF 31N TO 67N AND WEST OF 35W
SYNOPSIS VALID 1800 UTC OCT 28
24 HOUR FORECAST VALID 1800 UTC OCT 29
48 HOUR FORECAST VALID 1800 UTC OCT 30

.WARNINGS.
...HURRICANE WARNING...
.HURRICANE SANDY NEAR 33.4N 71.3W 952 MB AT 2100 UTC OCT 28
MOVING NE OR 050 DEG AT 13 KT. MAXIMUM SUSTAINED WINDS 65 KT GUSTS 80 KT. TROPICAL STORM FORCE WINDS WITHIN 330 NM S SEMICIRCLE...450 NM NE QUADRANT AND 270 NM NW QUADRANT. SEAS 12 FT OR GREATER WITHIN 480 NM N SEMICIRCLE AND 660 NM S SEMICIRCLE
WITH SEAS TO 47 FT.
.24 HOUR FORECAST HURRICANE SANDY NEAR 37.7N 71.8W. MAXIMUM SUSTAINED WINDS 70 KT GUSTS 85 KT. TROPICAL STORM FORCE WINDS WITHIN 360 NM S SEMICIRCLE...400 NM NE QUADRANT AND 270 NM NW QUADRANT. SEAS 12 FT OR GREATER WITHIN 540 NM NE...1200 NM
SE...600 NM SW AND 240 NM NW QUADRANTS WITH SEAS TO 47 FT.
.48 HOUR FORECAST POST TROPICAL SANDY NEAR 40.2N 76.7W 970 MB. WITHIN 240 NM SE QUADRANT OVER FORECAST WATERS WINDS 35 TO 50 KT. SEAS 15 TO 25 FT. ELSEWHERE WITHIN 660 NM S...660 NM SE AND 360 NM E QUADRANTS WINDS 25 TO 40 KT. SEAS 12 TO 22 FT.
.72 HOUR FORECAST POST TROPICAL SANDY NEAR 42.7N 76.8W. MAXIMUM SUSTAINED WINDS 35 KT.
.EXTENDED OUTLOOK...USE FOR GUIDANCE ONLY...ERRORS MAY BE LARGE.
.96 HOUR FORECAST POST TROPICAL SANDY NEAR 44.7N 75.5W. MAXIMUM SUSTAINED WINDS 30 KT.
.120 HOUR FORECAST POST TROPICAL SANDY NEAR 45.6N 71.4W. MAXIMUM SUSTAINED WINDS 25 KT. FORECAST WINDS IN AND NEAR ACTIVE TROPICAL CYCLONES SHOULD BE USED WITH CAUTION DUE TO UNCERTAINTY IN FORECAST TRACK...SIZE AND INTENSITY.
...GALE WARNING...
.LOW 36N44W 990 MB MOVING E 15 KT. S OF 34N BETWEEN 42W AND 48W...ALSO WITHIN 180 NM N OF A LINE FROM 44N49W TO 40N35W WINDS 25 TO 35 KT. SEAS 9 TO 16 FT. ELSEWHERE BETWEEN 40N AND 50N E OF 60W...ALSO WITHIN 420 NM W AND 300 NM W SEMICIRCLES OVER FORECAST WATERS WINDS 20 TO 30 KT. SEAS 8 TO 13 FT.
.
.24 HOUR FORECAST LOW 36N37W 991 MB. FROM 39N TO 45N E OF 50W WINDS 25 TO 40 KT. SEAS 12 TO 23 FT. ALSO S OF 34N E OF 43W WINDS WINDS 25 TO 35 KT. SEAS 10 TO 16 FT. ELSEWHERE FROM 40N TO 48N E OF 60W WINDS 20 TO 30 KT. SEAS 8 TO 13 FT.
.48 HOUR FORECAST LOW 35N33W 991 MB. BETWEEN 240 NM AND 540 NM NW QUADRANT WINDS 25 TO 40 KT. SEAS 14 TO 24 FT. ELSEWHERE S OF 44N E OF 47W WINDS 20 TO 30 KT. SEAS 8 TO 15 FT.
...GALE WARNING...
.24 HOUR FORECAST FROM 58N TO 61N BETWEEN 37W AND 43W WINDS 25 TO 35 KT. SEAS TO 12 FT.
.48 HOUR FORECAST WITHIN 120 NM W AND SW OF A LINE FROM 61N45W TO 57N39W WINDS 25 TO 35 KT. SEAS 9 TO 13 FT. ELSEWHERE N OF A LINE FROM 60N49W TO 49N35W WINDS 20 TO 30 KT. SEAS TO 10 FT.
.
.SYNOPSIS AND FORECAST.
.EXCEPT WHERE NOTED WITH HURRICANE SANDY FROM 31N TO 44N W OF 62W WINDS 20 TO 33 KT. SEAS TO 12 FT.
.24 HOUR FORECAST EXCEPT WHERE NOTED WITH HURRICANE SANDY FROM 31N TO 48N W OF 60W WINDS 20 TO 33 KT. SEAS TO 12 FT.
.48 HOUR FORECAST EXCEPT WHERE NOTED WITH POST-TROPICAL SANDY S OF 50N W OF 62W WINDS 20 TO 33 KT. SEAS TO 12 FT.
.48 HOUR FORECAST FROM 40N TO 48N BETWEEN 58W AND 63W WINDS 20 TO 30 KT. SEAS 12 TO 20 FT. .DENSE FOG. VSBY OCCASIONALLY LESS THAN 1 NM FROM 44N TO 59N BETWEEN 46W AND 56W.
.24 HOUR FORECAST DENSE FOG FROM 49N TO 55N BETWEEN 50W AND 55W.
.48 HOUR FORECAST DENSE FOG FROM 51N TO 55N BETWEEN 51W AND 55W.
.HIGH 58N48W 1034 MB MOVING SW 10 KT.
.24 HOUR FORECAST HIGH 54N51W 1034 MB.
.48 HOUR FORECAST HIGH 52N52W 1033 MB.
.FORECASTER SHAW. OCEAN PREDICTION CENTER.
NATIONAL HURRICANE CENTER MIAMI FL
.FORECASTER LEWITSKY. NATIONAL HURRICANE CENTER.

The High Seas Forecast had an “Pan Pan” alert to identify an urgent marine information broadcast for the area and warned of Hurricane Sandy and provided details and movement of the storm and indicated that tropical storm force winds greater than 50 knots extended 330 miles in a south semicircle from the storm and up to 450 miles in the northeast quadrant of the storm, and 270 miles in the northwest quadrant. Seas were expected to be 12 feet or greater within 450 miles of the storm and up to 47 feet with the hurricane.

7.0 Pre-departure Weather Conditions

The NWS marine weather forecasts and charts available prior to departure from New London, Connecticut are included below in figures 9 through 16, from current data on October 25, 2012 through 96 hour forecast on 0800 EDT October 29, 2012. The charts indicated Hurricane Sandy had formed and was moving across Jamaica moving northward, the synoptic conditions also depicted a stationary front over the Mid-Atlantic States which could potentially block or draw the hurricane into the region. The NWS Ocean Prediction Center's (OPC) High Winds and Danger Areas Chart (figure 12) highlight the most of the eastcoast of the United States from the Bahamas to the Bermuda region for hazardous conditions. Hurricane Sandy's track was consistent and the final 96 hour forecast was within 92 miles of its actual position, with the intensity slightly off.

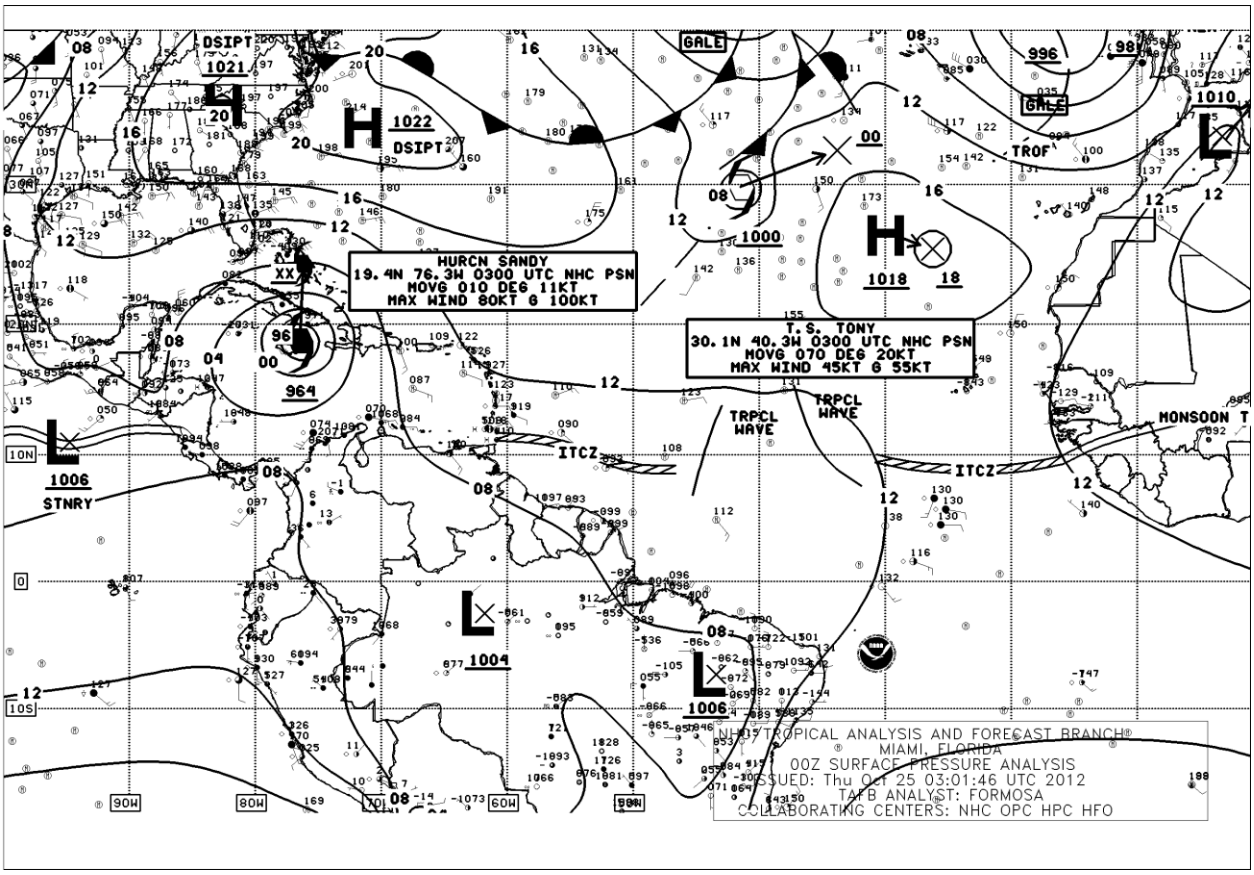

Figure 9- Surface Analysis on October 25, 2012

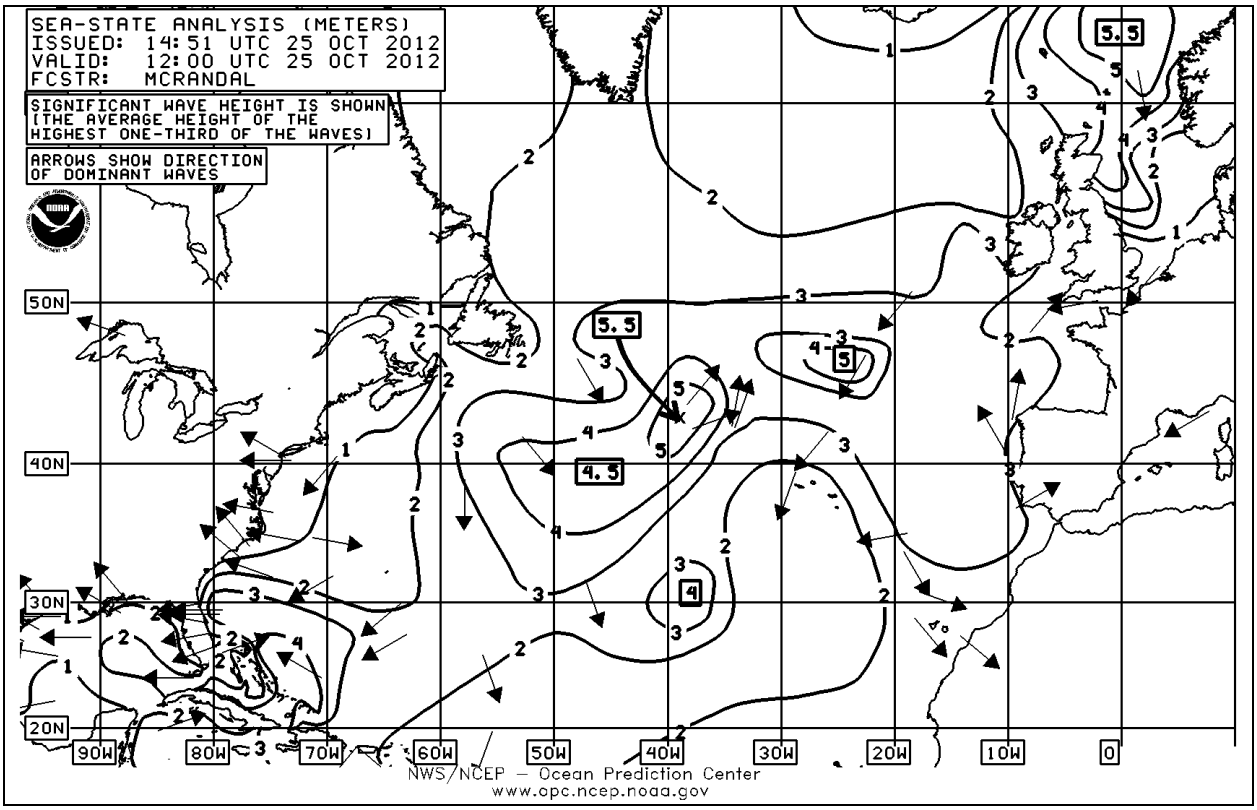

Figure 10 - Significant wave height analysis on October 25, 2012

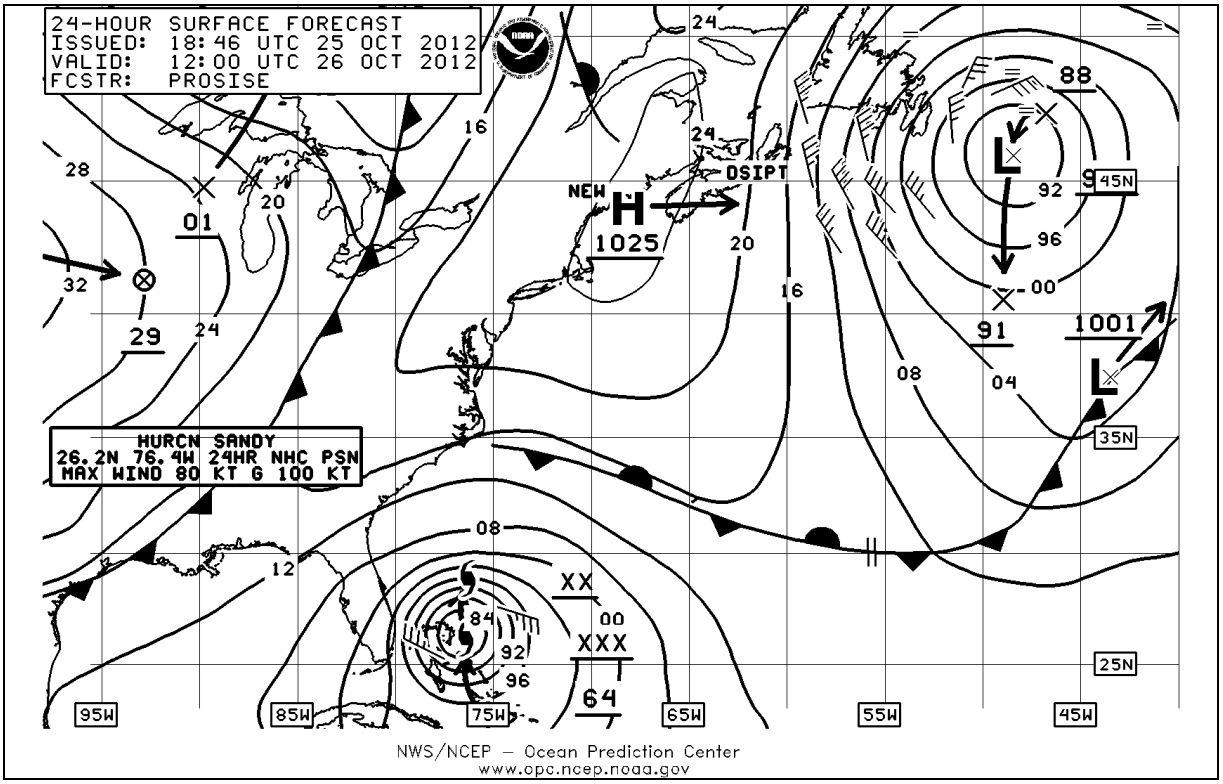

Figure 11 - NWS 24-hour surface forecast on October 25, 2012

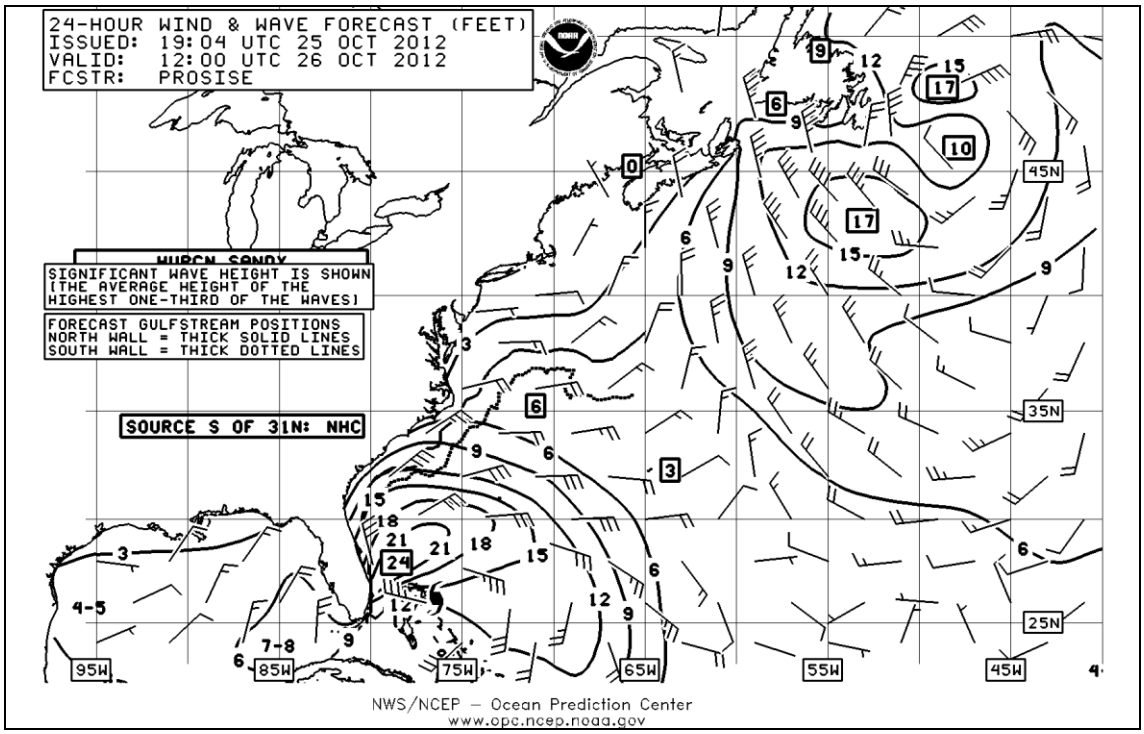

Figure 12- 24 hour Atlantic Wind & Wave Forecast

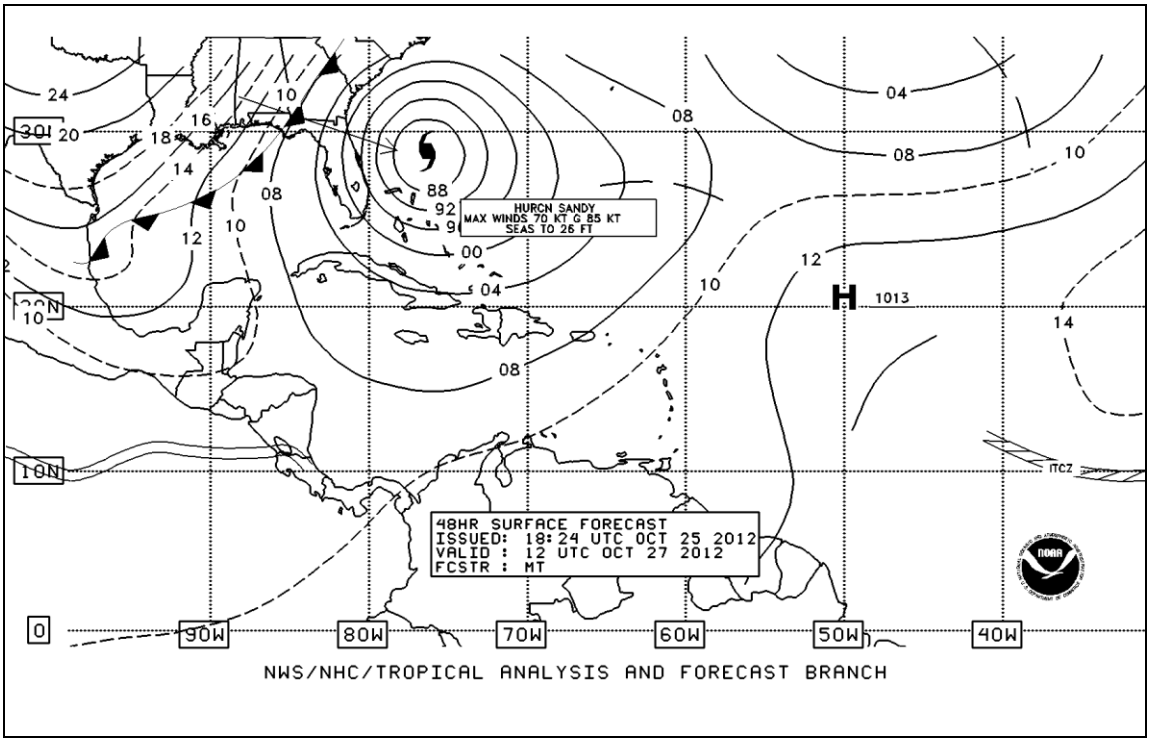

Figure 13 – 48 hour topical analysis

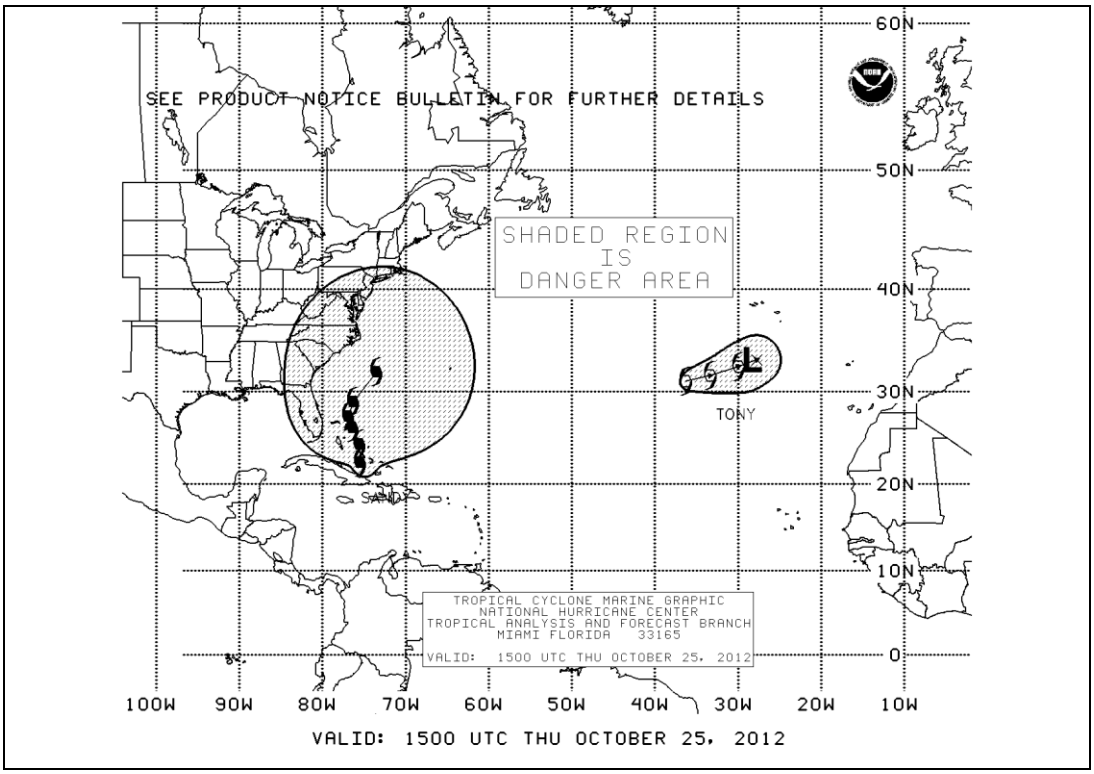

Figure 14 – OPC 48 hour High Winds & Danger Areas

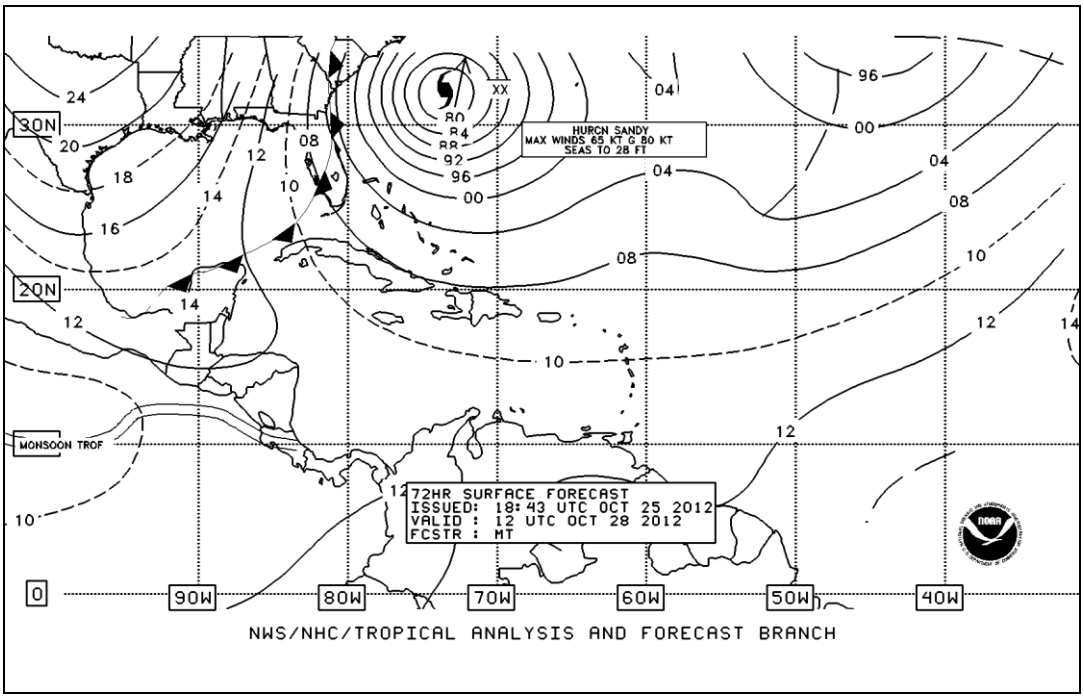

Figure 15 – 72 hour surface forecast valid for 0800 EDT on October 28, 2012

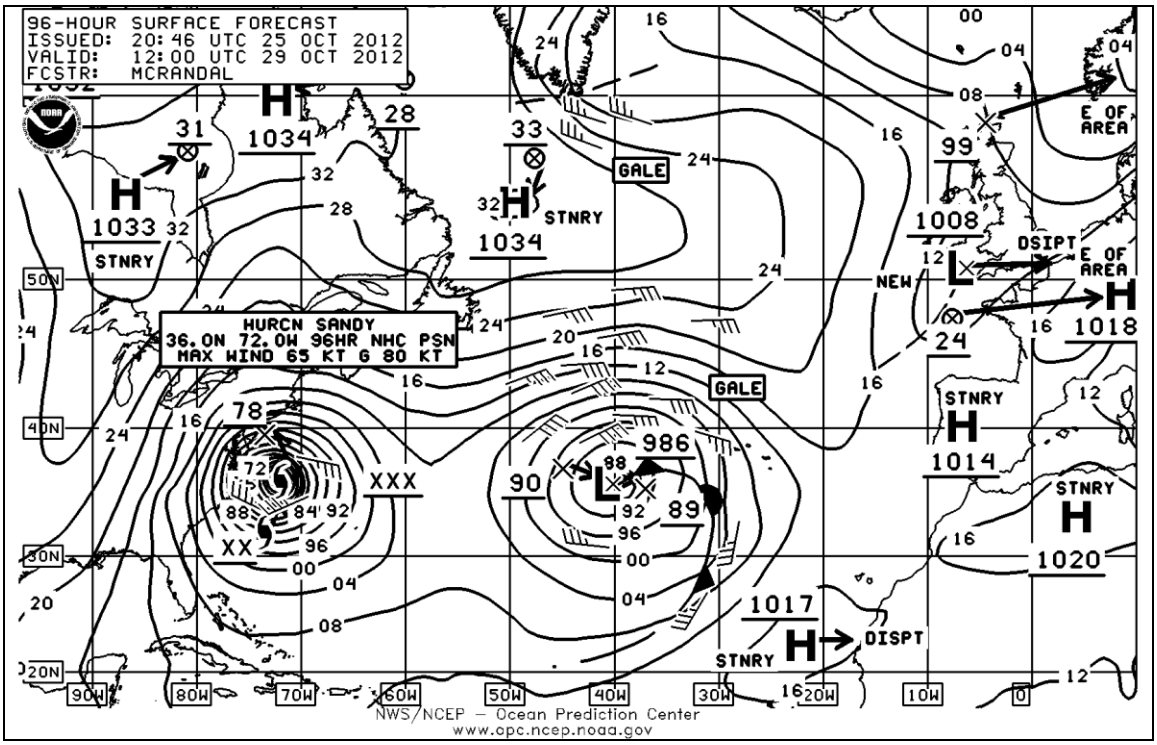

Figure 16 – NWS 96 hour Surface Forecast valid for 0800 EDT on October 29, 2012

8.0 Track of the HMS Bounty

The figure 17 is a plot of the HMS Bounty's position reports as obtained from sailwx.com, with the final plot the location based on the position reported by the U.S. Coast Guard.

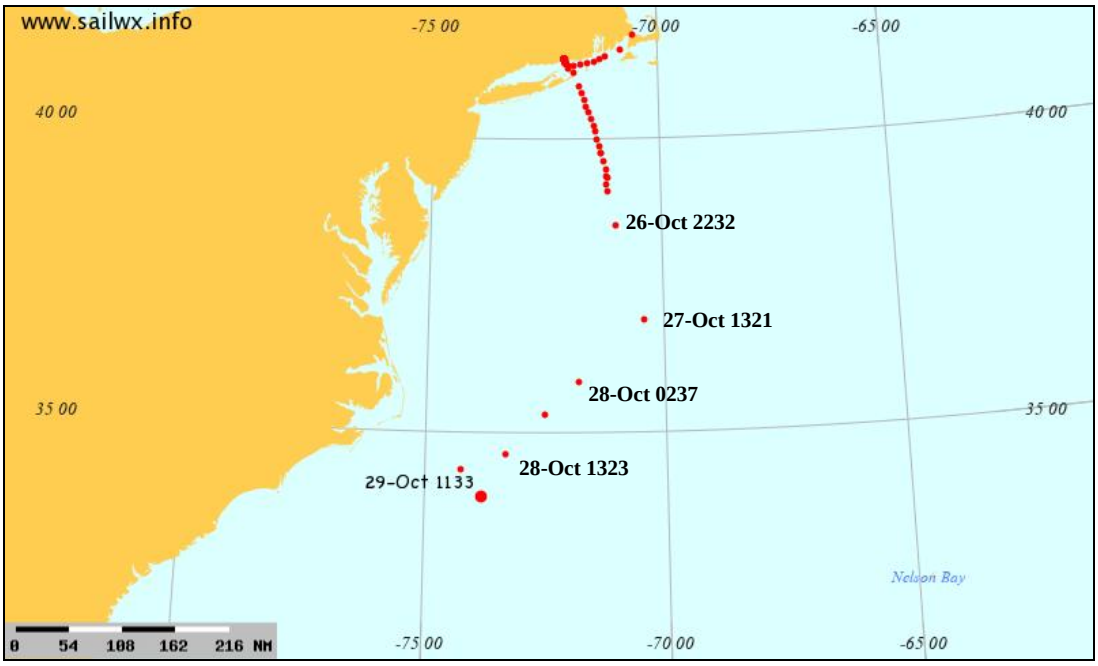

Figure 17 - Position reports of the HMS Bounty

Date	Time (EDT)	Position (lat/long)	Average Speed (KT)
OCT 25	1531	41° 21'N 072° 05'W	0
	1633	41° 17'N 072° 05'W	3.8
	1733	41° 16'N 072° 03'W	1.7
	1833	41° 18'N 072° 04'W	1.6
	1928	41° 21'N 072° 05'W	4.0
	2233	41° 18'N 072° 04'W	3.7
	2333	41° 12'N 072° 00'W	6.7
OCT 26	0033	41° 07'N 071° 53'W	7.1
	0234	40° 53'N 071° 46'W	7.5
	0333	40° 46'N 071° 36'W	7.3
	0435	40° 39'N 071° 40'W	7.1
	0533	40° 33'N 071° 37'W	6.9
	0633	40° 26'N 071° 34'W	6.9
	0733	40° 20'N 071° 31'W	6.9
	0833	40° 13'N 071° 28'W	6.9
	0932	40° 07'N 071° 25'W	6.8
	1032	39° 59'N 071° 23'W	7.4
	1133	39° 52'N 071° 21'W	7.7
	1234	39° 45'N 071° 18'W	7.8
	1333	39° 37'N 071° 15'W	
	1432	39° 29'N 071° 12'W	8.4
	1533	39° 21'N 071° 11'W	8.1
	1627	39° 14'N 071° 12'W	8.2
	1731	39° 06'N 071° 11'W	7.6
	2232	38° 32'N 071° 00'W	6.9
OCT 27	1321	36° 55'N 070° 25'W	6.8
OCT 28	0237	35° 51'N 071° 49'W	7.0
	1031	35° 19'N 072° 31'W	5.9
	1323	34° 38'N 073° 21'W	19.1
	1808	34° 22'N 074° 15'W	10.3
OCT 29	1133	33° 54'N 073° 50'W	2.0

9.0 History of Hurricane Sandy

Hurricane Sandy developed from an easterly tropical wave moving westward across the Caribbean Sea south of Hispaniola during the week of October 20-22, 2012. The system quickly became a tropical depression on October 22, and within 6 hours became the eighteenth named storm of the season and strengthened to hurricane intensity by October 24, 2012. Upon strengthening, Hurricane Sandy made a northward turn and made landfall in eastern Jamaica. Sandy then further intensified into a category 2 hurricane over the waters north of Jamaica and slammed into eastern Cuba as a Category 3[4] major hurricane with winds of 100 knots. Sandy quickly weakened back to a category 1 storm while moving through the central and northwestern Bahamas. Sandy then began to take on a slight northwestward motion near the northern Bahamas parallel to the coast of the southeastern United States, and reached a secondary peak

[4] Category 3 on the Saffir-Simpson hurricane wind scaled based on post storm analysis.

intensity of 85 knots while it turned northwestward towards the Mid-Atlantic States. It is during this time frame that the offshore Atlantic waters were heavily impacted by Sandy's passing when the radius of tropical storm force winds roughly doubled and the Bounty accident occurred. During the evening of October 29, 2012 Hurricane Sandy weakened slightly and made landfall near as a post-tropical cyclone near Brigantine, New Jersey with 70 knot maximum sustained winds. Because of the systems merger with a mid-latitude frontal system and low pressure system, Sandy size was tremendous and drove a catastrophic storm surge of 8 to12 feet into the New Jersey and New York coastline and caused it's most significant damage.

While Sandy was not the strongest hurricane on record for the region, it was one of the largest in terms of size and area impacted and became the second largest and costliest Atlantic hurricane to hit the United States since 1900[5] with an estimated $50 billion dollars in damage, surpassed only by Hurricane Katrina in 2005. It was the eighteenth named storm of the season and the tenth hurricane of the 2012 Atlantic hurricane season. There were at least 147 direct deaths[6] recorded across the Atlantic basin associated with Hurricane Sandy, with 72 of these fatalities occurring in the mid-Atlantic and northeastern United States. This is the greatest number of U.S. direct fatalities related to a tropical cyclone outside of the southern states since Hurricane Agnes in 1972. An additional 87 deaths were also indirectly related to the storm as a result of extensive power outages during cold weather, due to hypothermia, carbon monoxide poisoning, car accidents and storm cleanup removing fallen trees.

Hurricane Sandy affected at least 24 states during the period from October 22-31, 2012, from Florida to Maine, and west to Michigan and Wisconsin, with the most severe damage from the catastrophic storm surge occurring along the New Jersey and New York coastline. In addition to the high winds from the storm, heavy rain, coastal flooding, and heavy wet snow occurred with the storm inland. Figure 18 is a plot of Sandy's track during this period.

[5] When not adjusted for inflation, population and wealth normalization. Sandy ranks sixth when accounting for those factors.

[6] This figure includes the 2 fatalities from the HMS Bounty sinking.

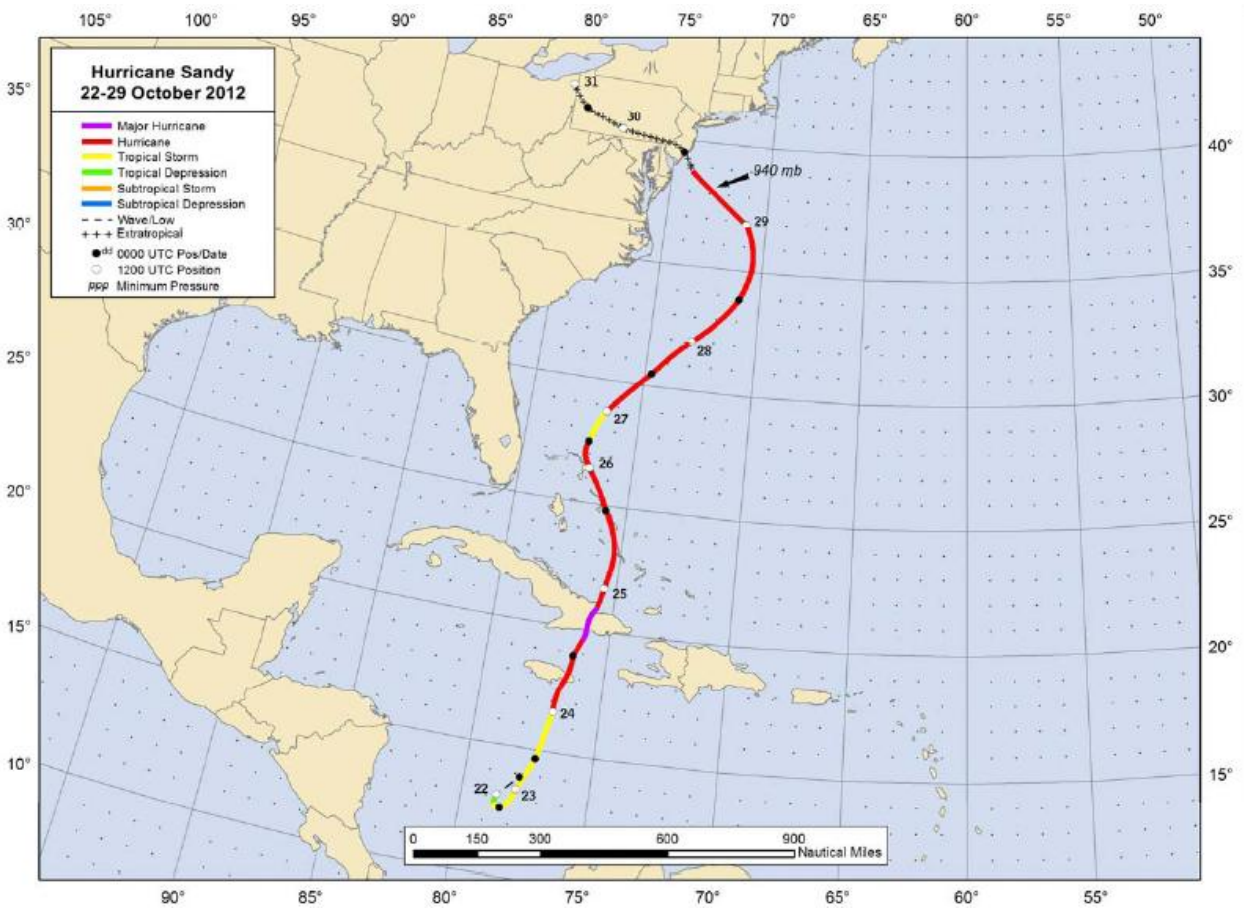

Figure 18- Hurricane Sandy track 22-29 October 2012

The following table provides the date and time of the NWS HPC position of Hurricane Sandy as she developed as a Tropical Depression (TD), and Tropical Storm (TS) stages, the Saffir-Simpson Intensity (TD-Tropical Depression, TS-Tropical Storm), pressure, sustained and peak gusts, and the general movement of the hurricane.

Date	Time (EDT)	Advisory	Lat. (°N)	Long. (°W)	Cat	Pressure (mb)	Wind (KT)	Movement (KT)
OCT 22	1100	1	13.5	78.0	TD	1003	25G35	SW 4
22	1700	2	12.5	78.5	TS	999	35G45	stationary
22	2300	3	12.7	78.6	TS	998	40G50	stationary
23	0500	4	13.3	78.6	TS	998	40G50	N 3
23	1100	5	13.8	77.8	TS	993	45G55	NNE 4
23	1700	6	14.3	77.6	TS	993	45G55	NNE 5
23	2300	7	15.2	77.2	TS	989	50G60	NNE 9
24	0500	8	16.3	77.0	TS	986	60G75	N 12
24	1100	9	17.1	76.7	1	973	70G85	NNE 11
24	1700	10	18.3	76.6	1	970	70G85	N 12
24	2300	11	19.4	76.3	1	954	80G100	N 11
25	0500	12	20.9	75.8	2	960	90G105	N 15
25	1100	13	22.4	75.5	2	964	90G110	N 14
25	1700	14	24.5	75.6	2	963	90G110	N 17

25	2300	15	25.3	76.1	1	968	80G90	NNW 11
26	0500	16	26.3	76.9	1	968	70G85	NNW 11
26	1100	17	26.7	76.9	1	970	70G80	N 5
26	1700	18	27.3	77.1	1	971	65G75	N 6
26	2300	19	27.7	77.1	1	969	65G75	N 5
27	0500	20	28.6	76.7	1	969	60G70	NNE 9
27	1100	21	29.0	76.0	1	958	65G80	NNE 8
27	1700	22	30.2	75.2	1	961	65G80	NE 11
27	2300	23	30.9	74.3	1	960	65G80	NE 12
28	0500	24	35.9	70.5	1	946	65G80	N 11
28	1100	25	32.5	72.6	1	951	65G80	NE 12
28	1700	26	33.4	71.3	1	952	65G80	NE 13
28	2300	27	34.5	70.5	1	950	65G80	NE 12
29	**0500**	**28**	**35.9**	**70.5**	**1**	**946**	**75G90**	**N 13**
29	0800	28A	36.8	71.1	1	946	75G90	NNW 18
29	1100	29	37.5	71.5	1	943	80G100	NNW 16
29	1700	30	38.8	74.4	1	940	80G100	NNW 24
30	0300	31	39.8	75.4	1	952	65G80	NW 16

9.1 Hurricane Sandy Structure

Sandy was an extraordinary large hurricane with regards to its radius of maximum winds. As noted in the summary above, after passing the Bahamas the structure of Hurricane Sandy changed and was unusual in that the normal maximum winds were not found on the ride side of the hurricane or more specifically in the northeast quadrant of the storm relative to its movement, as depicted in figure 19, but were located in the western section of the storm. The radius of maximum winds was very large, over 100 miles and the strongest winds were located in the western (left) semicircle of the cyclone. This change in structure was likely due to the interaction of the system with the approaching upper level trough and frontal system, which likely enhanced convection over the region between the coast and the storms center. Figure 20 is the probabilities of wind speeds of 50 knots and greater at 0200 EDT on October 29, 2012, with depicts an extensive area of winds of 50 knots with a larger region of higher winds on the western side of the hurricane. The accident site is located on the edge of the 90 percent probability of 50 knots.

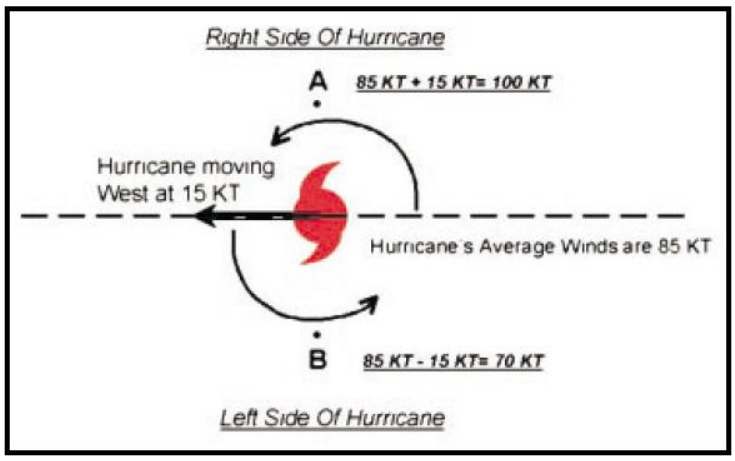

Figure 19 - Effects of tropical storm motion and winds

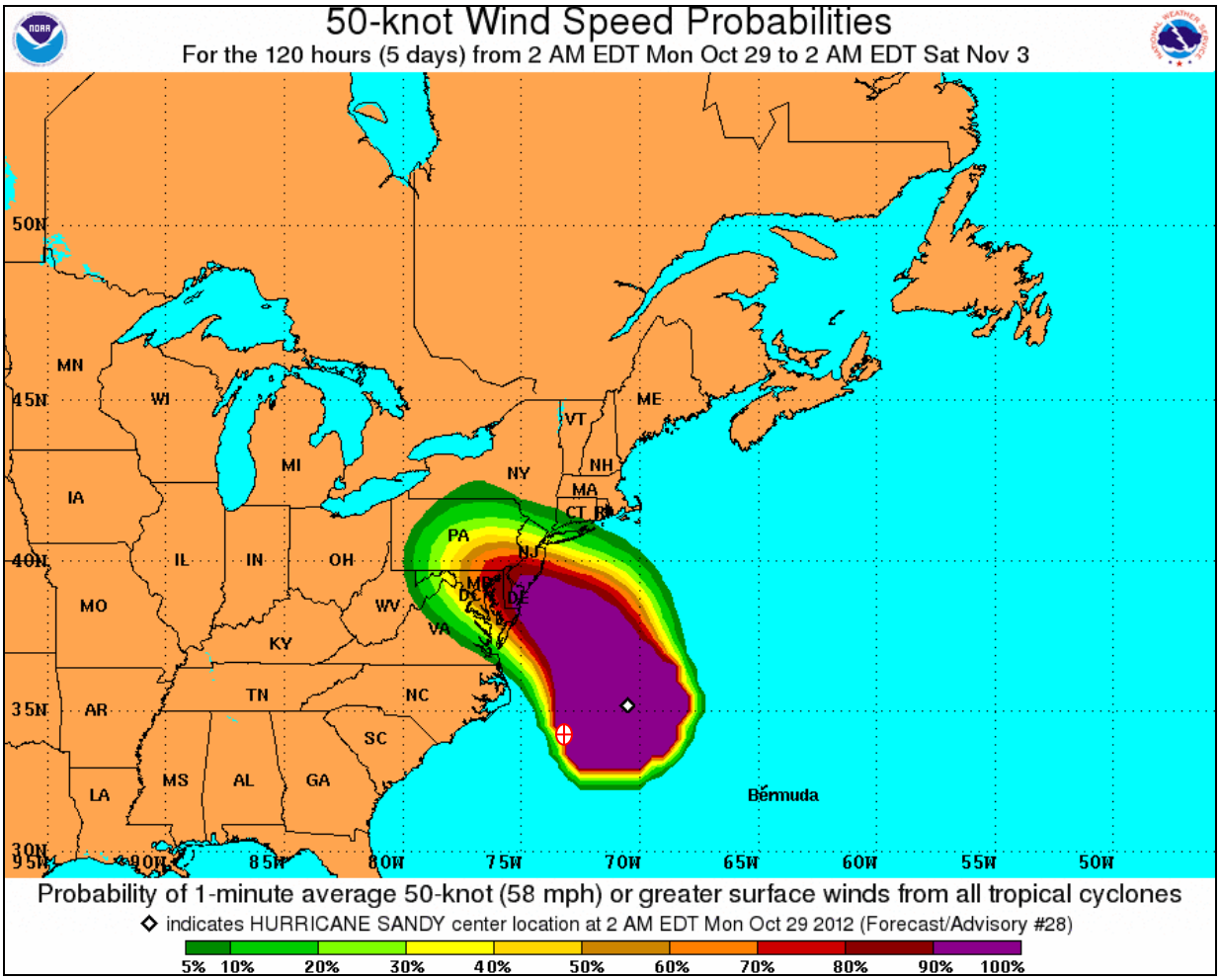

Figure 20 – NWS Probability of 50 knot winds or greater at the time of the capsizing

The National Hurricane Center's advisories during this period further indicated that the hurricane force winds of 64 knots and the wind driven waves varied in each quadrant with the storm were observed strongest in the southwest sector of the storm along with the seas greater than 12 feet extending some 840 miles, which also extended over the Bounty's route during the evening of October 28 and the morning hours on the October 29, 2012 when the ship capsized.

9.2 Saffir-Simpson Hurricane Scale

Atlantic hurricanes are typically categorized according to the strength of their winds using the Saffir-Simpson Hurricane Wind Scale, which is a scale 1 to 5 categorization based on the hurricane's intensity. The scale provides examples of the type of damage and impacts in the United States associated with winds of the indicated intensity. The scale is broken down by wind as follows:

Category	Wind Speed	Wind Damage
1	64-82 KT	Very dangerous winds will produce some damage
2	83-95 KT	Extremely dangerous winds will cause extensive damage
3	96-112 KT	Devastating damage will occur
4	113-136 KT	Catastrophic damage will occur
5	>137 KT	Catastrophic damage will occur

Hurricanes reaching category 3 strength and greater are typically referred to as major hurricanes, and those reaching category 5 referred to as super storms especially in the Pacific were they are referred to as "Super Typhoons" due to the extremely danger and devastation they cause.

9.3 NWS Hurricane Track Guidance

The official NWS National Hurricane Centers forecast track with weather warnings current at the departure of departure on October 25, 2012 is included as figure 21, with the accident site added as a encircled cross located approximately 100 miles west of the forecast path of the center of Hurricane Sandy's track. The accident site was also within the storms region of uncertainty path indicated in white, and within 150 miles of the forecast track of the center of the storm.

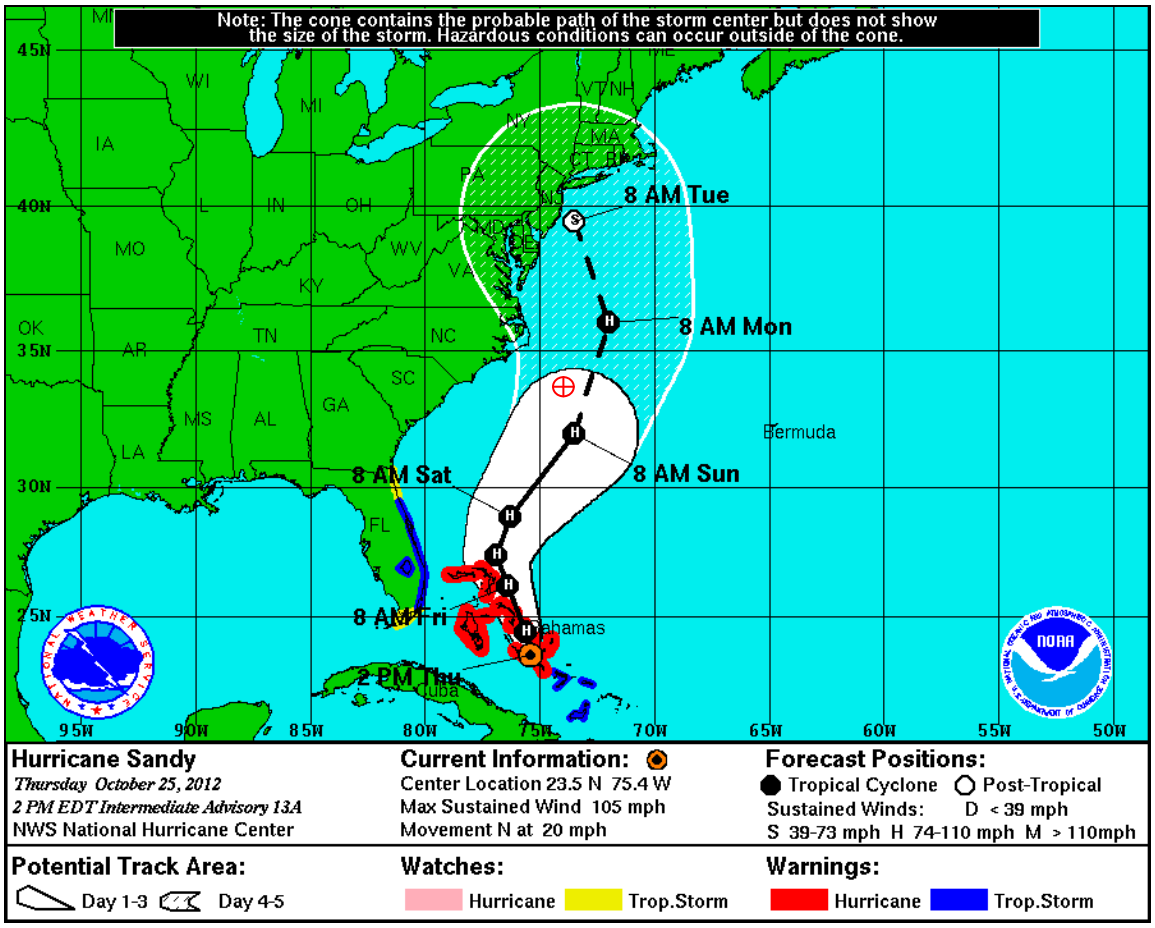

Figure 21 – Hurricane Sandy track current at departure on 25 October

The NWS Hurricane Forecast Center track guidance from various track models were basically consistent, taking Sandy on a course across the Bahamas, but largely deviated largely thereafter. Some models were tracking Sandy out to sea upon exiting the Bahamas, while others tracked Sandy onto the Delaware or New Jersey coast, as depicted in figure 22. The black track is the actual track.

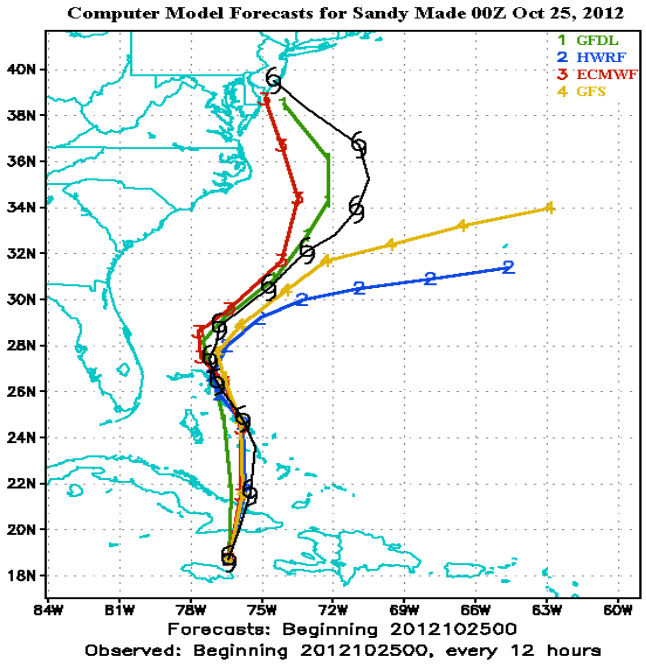

Figure 22- Various model track guidance for Hurricane Sandy

Figure 23 depicts the model performance associated with Hurricane Sandy. The best model was the European (ECMWF) especially beyond 72 hours.

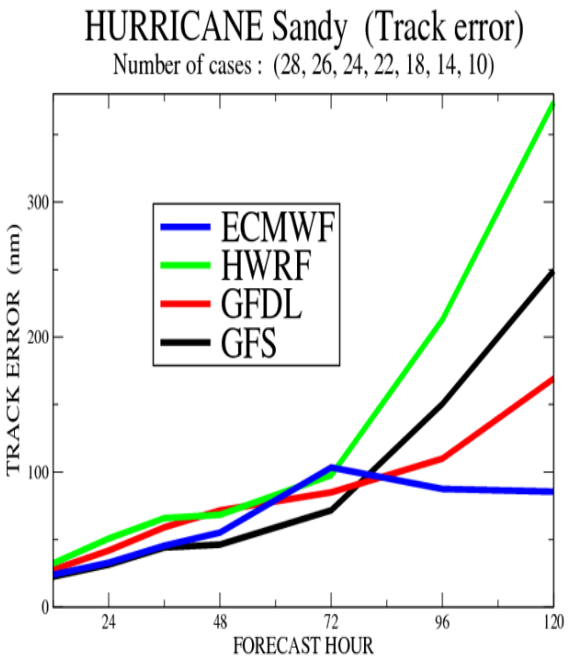

Figure 23 – various track guidance errors

The folowing table are the official NHC track forecast errors in nautical miles for Hurricane Sandy and the mean 5 year average track errors. Official errors that are smaler than the 5 year means are shown in bold type. The overall track errors were found to below the mean official

mean for the previous 5 year period at all time periods, and approxiamtely 50 percent better than the long-term mean from 48 to 96 hours. At the time of departure from New London, Conneticut the error was less than 100 miles for the storm center.

	Forecast Period (hours)						
	12	24	36	48	72	96	120
Official Track	**23.9**	**33.2**	**39.6**	**41.6**	**61.3**	**88.3**	**149.9**
Forecasts	28	26	24	22	18	14	10
Mean Track (2007-11)	30.4	48.4	65.9	83.1	124.1	166.5	213.4

The current hurricane forecast track errors are much smaller than the original Maritime "1-2-3 rule" developed in the 1960's to estimate the position errors which basically stated that the average error was 100 miles in 24 hours, 200 miles in 48 hours, and 300 miles in 72 hours.

10.0 Gulf Stream Analysis

The NWS Ocean Prediction Center's high resolution analysis of the Gulf Stream and currents in the western Atlantic Ocean on October 29 is provided as figure 24 with the approximate location of the HMS Bounty noted east of the core of the Gulf Stream.

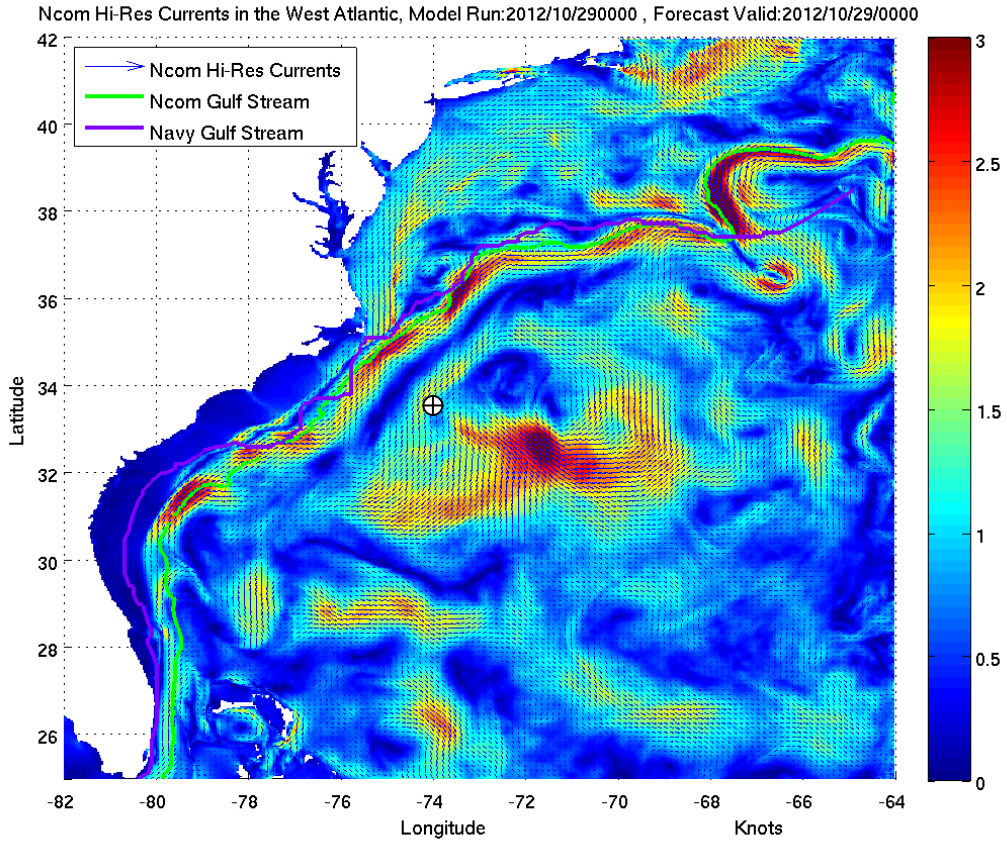

Figure 24 - Gulf Stream forecast for October 29, 2012

11.0 Astronomical Data

The United Stated Naval Observatory website provided the following astronomical data for the location of the capsizing of the Bounty on October 29, 2012:

<u>Moon</u>	
Moonrise	1722 EDT on October 28, 2012
Moonset	0700 EDT
<u>Sun</u>	
Beginning of civil twilight	0647 EDT
Sunrise	0713 EDT
Sun transit	1239 EDT
Sunset	1805 EDT
End of civil twilight	1831 EDT

At the time of the capsizing at 0426 EDT the Moon was approximately 34° above the horizon at an azimuth of 264°, and was 100 percent illumination with a Full Moon on October 29, 2012. The Sun was more than 15° below the horizon at the time.

12.0 Beaufort Scale

The Beaufort scale typically used prior to the Saffir-Simpson scale ranking of hurricanes is included below in the following chart to describe the conditions observed with wind speed and sea conditions (figures 25 and 26):

Figure 25 – Beaufort Scale 0 to 11 conditions

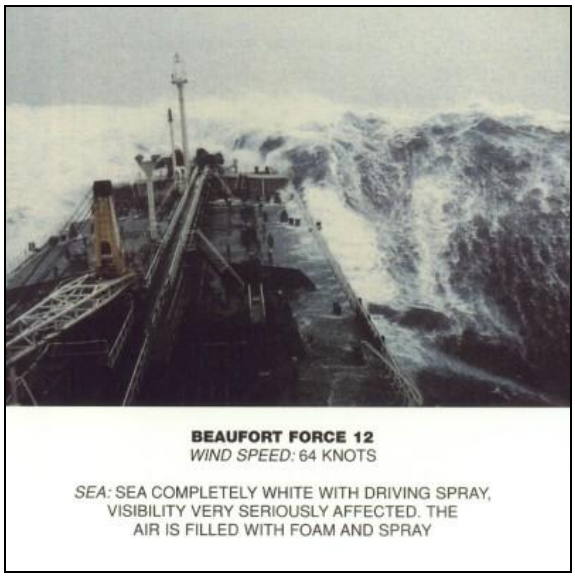

Figure 25 - Beaufort scale 12 conditions

13.0 Significant Wave Height

Throughout this report the standard ocean wave forecast charts and forecast bulletins used the term significant wave height, which is defined by the World Meteorological Organization (WMO) and used by the NWS. Ocean waves are made up of an entire spectrum of waves and the waves can vary quite a bit for a given wind speed and fetch. Significant wave height is defined as the average height of the highest one-third of the waves in a wave spectrum. Figure 27 shows a typical wave spectrum distribution. This distribution shows that for a given wavy ocean surface the most probable wave height and mean wave height a person would encounter would be lower than the significant wave height, with statistically a much smaller chance of encountering a wave whose height is larger than the significant wave height.

For example, figures 3 and 4 indicated a significant wave height of 24 feet in the vicinity of the HMS Bounty capsizing. Given that height, the mean wave height encountered by a vessel for that wave spectrum would be 15 feet with the most probable wave height encountered would be 12 feet. However, the highest 10 percent of waves within that wave spectrum would be 30 feet and the highest 1 percent of waves would be around 40 feet high. The highest wave a vessel could encounter with a significant wave height of 24 feet would be 48 feet. Therefore given a significant wave height forecast or observation of 24 feet a vessel will encounter mostly waves around 12 feet high, but should be prepared for waves as high as 48 feet. Note the significant wave height associated with Hurricane Sandy's center was 42 feet, which implied waves as high as 84 feet.

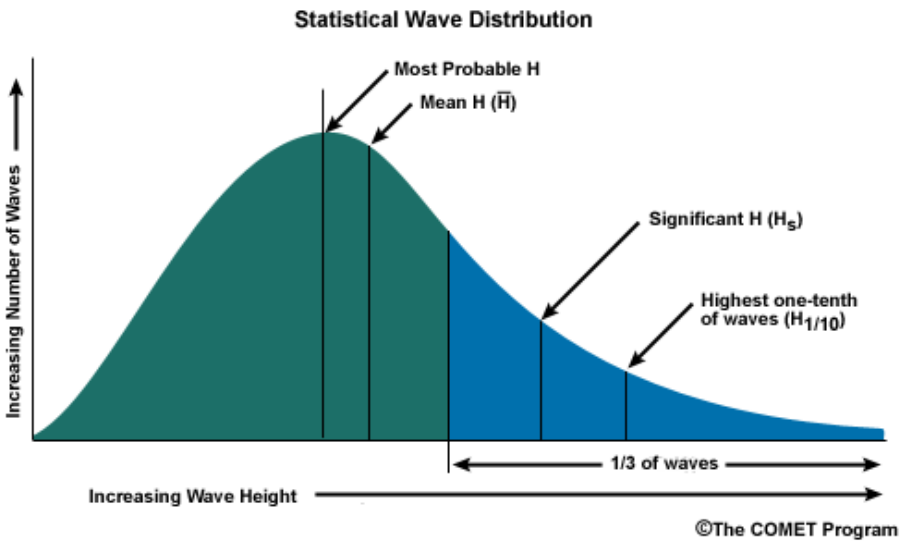

Figure 26 - Significant Wave Heights

Hs = X
H (mean) = 0.64 X Hs
H (most probable) = slightly less than H
H1/10 (10% waves) = 1.27 X Hs
Hmax (highest potential waves) = 2 X Hs

14.0 NHC Advisories

The NWS National Hurricane Center (NHC) issued multiple products regarding tropical cyclones and storms. The following breaks down the various products provided:

14.1 Tropical Cyclone Public Advisory (TCP)

The Tropical Cyclone Public Advisory contains a list of all current watches and warning on a tropical or subtropical cyclone. It provides the cyclone position in terms of latitude and longitude coordinates and distance from a selected land point, maximum wind speeds (mph), minimum pressure of the storm, and its current motion. The advisory may also include information on potential storm tides, rainfall, and any other pertinent weather observations. The advisories are issued every 6 hours with intermediate advisories every 3 hours when coastal watches or warnings are in effect.

14.2 Tropical Cyclone Forecast/Advisory (TCM)

The Tropical Cyclone Forecast/Advisory contains a list of watches and warnings on a tropical or subtropical cyclone, the current coordinates of the storm, and motion. The advisory contains forecasts of the cyclones position, intensity, and wind fields (KT) for 12, 24, 36, 48, and 72 hours from the current synoptic period. The advisories are issued every 6 hours beginning at 0300Z.

14.3 Tropical Cyclone Discussion (TCD)

The Tropical Cyclone Discussion explains the reasoning for the analysis and forecast of a tropical or subtropical cyclone. It includes a table of the forecast track and intensity, and are issued every 6 hours beginning at 0100Z.

14.4 Tropical Cyclone Surface Wind Speed Probabilities (PWS)

The Tropical Cyclone Surface Wind Speed Probabilities text product provides probabilities in percent, of sustained wind speeds equal to or greater than 34, 50, and 64 knots wind speeds thresholds, which meet the definitions of gale, tropical storm, and hurricane force conditions. The product is issued every 6 hours beginning at 0300Z.

14.5 Tropical Cyclone Update (TCU)

The Tropical Cyclone Update message is a brief text message to inform users of significant changes in a tropical storm in between regular schedules public advisories. The advisories may provide information on the expected time and location of landfall, or a change in intensity of the storm. The position of the storms center is often provided by reference from land based weather radar data, which can detect the center as it approaches land.

14.6 Tropical Weather Outlook (TWO)

The Tropical Weather Outlook is a discussion of significant areas of disturbed weather and their potential for development out to 48 hours. It provides an explanation of the meteorology behind the outlook, and the chance of development of the system. This often the first bulletin issued on a developing tropical cyclone. A graphic product is also often created with the issuance of the outlook based on the latest satellite image and provides a percentage likelihood of development. During the Atlantic hurricane season from June through November, the outlooks are issued four times a day.

14.7 Tropical Cyclone Valid Time Event Code (TCV)

The Tropical Cyclone Watch/Warning text product (TCM) is based upon the Valid Time Event Code (VTEC). It summaries all new, continued, and canceled watches and warnings issued by the NHC. The product is typically used within the NWS and broadcast media.

14.8 Tropical Cyclone ICAO Advisory (TCA)

This product is the aviation advisory and is issued to provide short term tropical cyclone forecast guidance for international aviation safety and routing purposes. It provides the current tropical cyclone position, motion, and intensity, and includes a 6, 12, 18, and 24 hour forecast positions and intensity.

Donald Eick
NTSB Senior Meteorologist