

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



DCA23FM036

METEOROLOGY

Specialist's Factual Report

May 14, 2024

TABLE OF CONTENTS

A. ACCIDENT.....	3
B. METEOROLOGY SPECIALIST	3
C. DETAILS OF THE INVESTIGATION	3
D. FACTUAL INFORMATION	4
1.0 SYNOPTIC SITUATION	4
1.1 Surface Analysis Charts	4
2.0 SURFACE OBSERVATIONS	7
3.0 SATELLITE DATA.....	7
4.0 NATIONAL WEATHER SERVICE TEXT MARINE WEATHER PRODUCTS	8
5.0 NATIONAL WEATHER SERVICE GRAPHICAL INFORMATION.....	11
6.0 SIGNIFICANT WAVE HEIGHT	12
7.0 CURRENT INFORMATION.....	13
8.0 WATER TEMPERATURE.....	15
9.0 ADDITIONAL TEMPERATURE DATA	15
10.0 ASTRONOMICAL DATA	16
11.0 ADDITIONAL NOAA AND NWS DATA	17
E. LIST OF ATTACHMENTS	17

A. ACCIDENT

Location: Around 900 miles east of Cape Cod, Massachusetts
Date: June 18, 2023
Time: 1047 Newfoundland daylight time
1317 coordinated universal time (UTC)
Vessel: *Titan*

B. METEOROLOGY SPECIALIST

Paul Suffern
Senior Meteorologist
National Transportation Safety Board
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C. DETAILS OF THE INVESTIGATION

The NTSB's Senior Meteorologist was not on scene for this investigation and conducted the meteorology phase of the investigation remotely, collecting data from official National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) sources including the Weather Prediction Center (WPC), the Ocean Prediction Center (OPC), and the National Center for Environmental Information (NCEI). This Specialist's Factual Report contains the meteorological factors pertinent to the weather surrounding the accident time. All times are Newfoundland daylight time (NDT) and are based upon the 24-hour clock, where local time is -2.5 hours from UTC. Directions are referenced to true north and distances are in nautical miles. Heights are above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles. NWS station identifiers use the standard International Civil Aviation Organization 4-letter station identifiers versus the International Air Transport Association 3-letter identifiers, which deletes the initial country code designator "K" for U.S. airports.

The accident site was located at an approximate latitude 41.733° N, longitude 49.9983°.

D. 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 and the WPC located in College Park, Maryland. These are the base products used in describing synoptic weather features and in the creation of forecasts and warnings for the NWS. Reference to these charts can be found in the Federal Aviation Administration (FAA) "Aviation Weather Handbook", FAA-H-8083-28.¹

1.1 Surface Analysis Charts

The WPC Surface Analysis Chart centered over the northern Atlantic Ocean for 0930 NDT is provided as figure 1 with the location of the accident site within the black circle. The chart depicted a low-pressure system northeast of Newfoundland, Canada with a pressure of 1010-hectopascals (hPa) and another low-pressure system southwester of Nova Scotia, Canada, with a pressure of 1000-hPa. A warm front stretched eastward from the 1000-hPa low-pressure center into the Atlantic Ocean and a cold front stretched southward from the 1000-hPa low-pressure center into the western Atlantic Ocean. The accident site was located south of the warm front and east of the cold front in the warm air sector.

The closest weather observation to the accident site in the warm air sector was a ship observation near 41.0°N and 56.5°W and it depicted a southwesterly wind at 20 knots, an air temperature of 69°F, and a dew point temperature of 67°F. The WPC Surface Analysis Charts from June 16 to June 18 can be found in attachment 1.

The OPC Atlantic Surface Analysis Chart for 0930 NDT is provided as figure 2 with the 1010-hPa low-pressure system east of Newfoundland in the northern Atlantic Ocean north of the accident site. A 1026-hPa high-pressure system was located south of the accident site in the northern Atlantic Ocean. A 1000-hPa low-pressure system was located southwest of Nova Scotia in the Gulf of Maine. Frontal boundaries stretched from the 1000-hPa low-pressure center eastward into the northern Atlantic with a warm front above the accident site at 0930 NDT (figure 2).

¹ [FAA-H-8083-28](#)

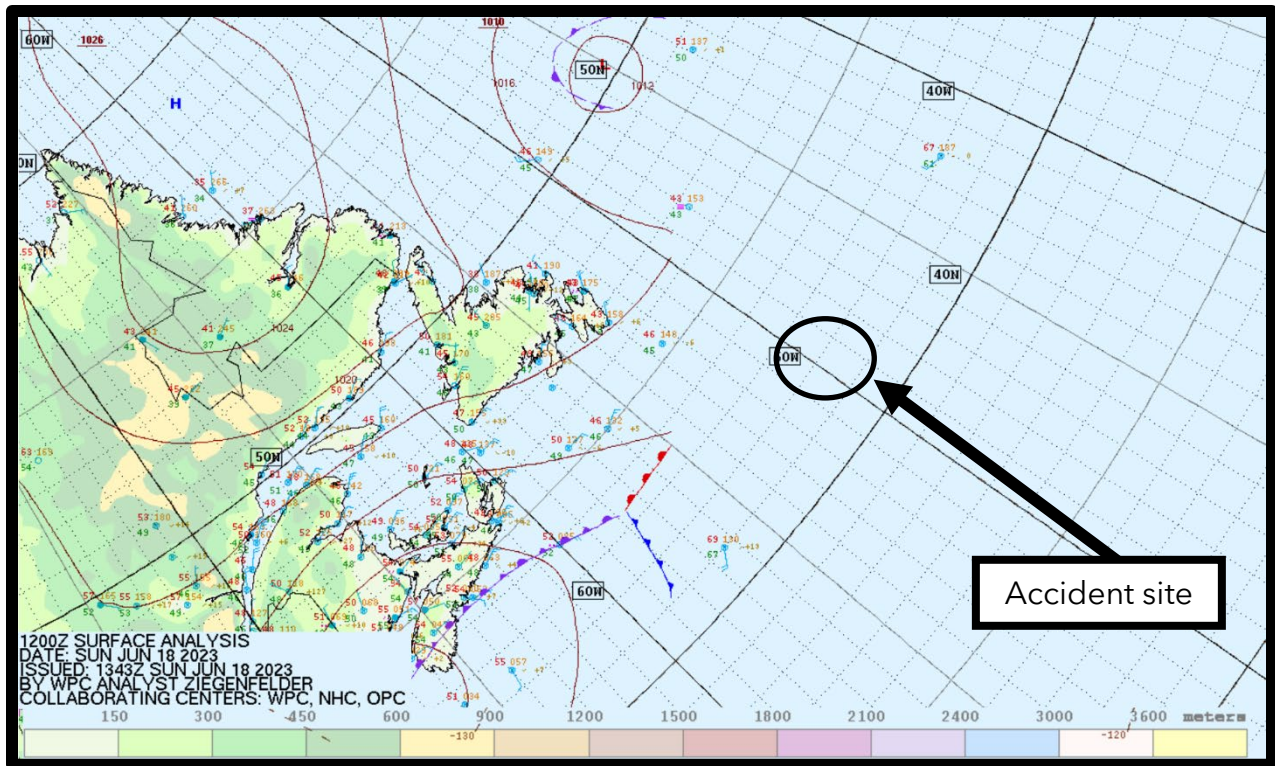


Figure 1. WPC Surface Analysis Chart for 0930 NDT.

ATLANTIC SURFACE ANALYSIS
ISSUED: 16:03 UTC 18 JUN 2023
VALID: 12:00 UTC 18 JUN 2023
FCSTR: FUTTERMAN
SOURCES: OPC NHC WPC

FORECAST TRACKS ARE FOR VALID TIME + 24 HOURS.
WARNING LABELS ARE FOR HIGHEST CONDITIONS FROM
VALID TIME THROUGH 24 HOURS.

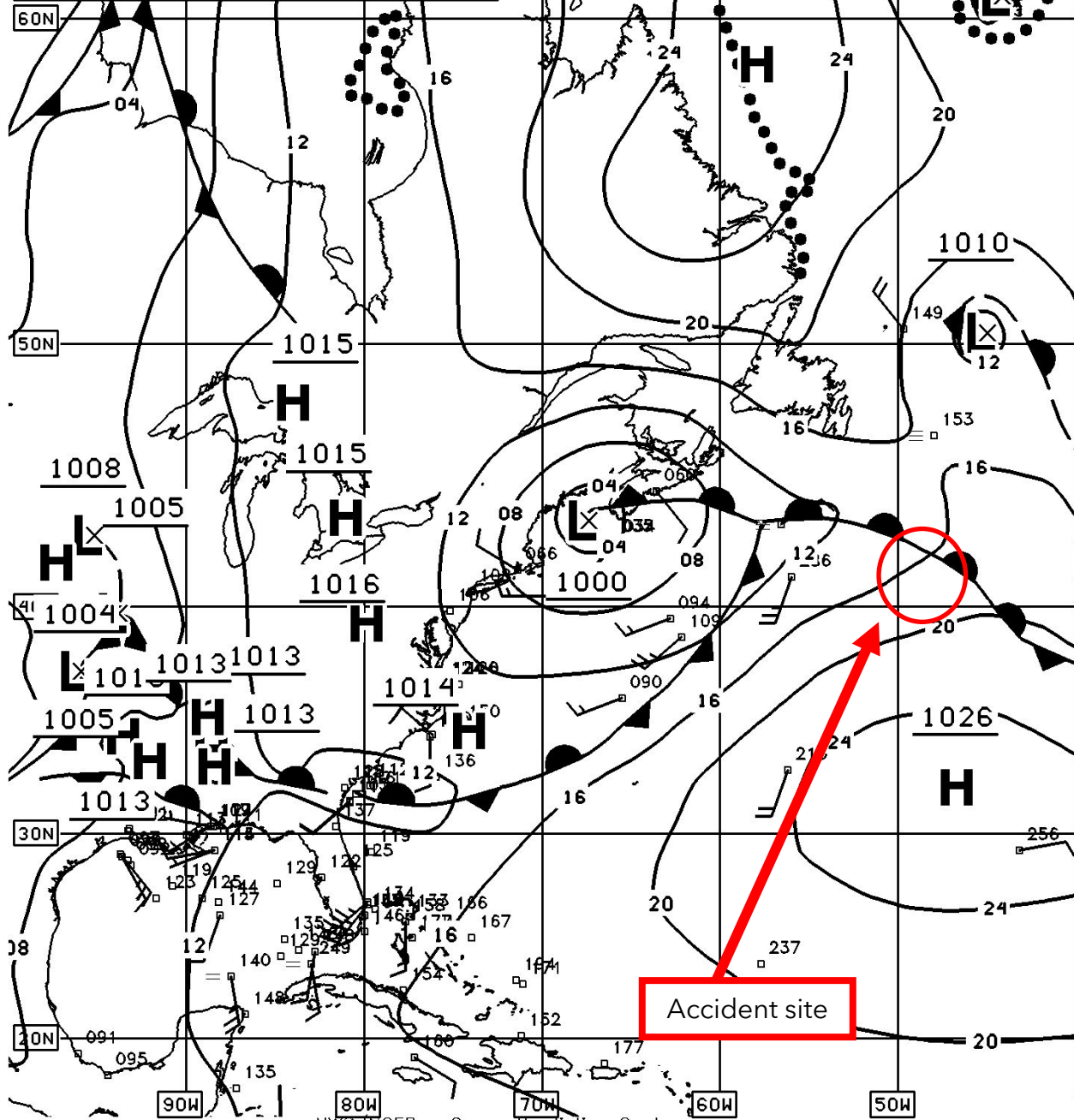


Figure 2. OPC Surface Analysis Chart for 0930 NDT.

2.0 Surface Observations

There were no surface or marine observation stations within 300 miles of the accident site at the accident time. However, the vessel *Polar Prince* did record weather observations once an hour from June 16 through June 18 and those observations can be found in attachment 2. Around the accident time the *Polar Prince* reported the wind from the southwest at Beaufort Scale² 4 with the sea state at Beaufort Scale level 3, 5 miles visibility, an air pressure of 1014-hPa, and air temperature of 25°C. For more information please see attachment 2.

3.0 Satellite Data

Geostationary Operational Environmental Satellite number 16 (GOES-16) visible data were obtained from an archive at the Space Science Engineering Center at the University of Wisconsin-Madison in Madison, Wisconsin, and processed using the Man-computer Interactive Data Access System software. Visible imagery (GOES-16 band 2) at a wavelength of 0.64 microns (μm) was retrieved for the period from 0800 NDT through 1500 NDT and reviewed, and the closest images to the time of the accident were documented.

Figure 3 presents the GOES-16 visible imagery from 1050 NDT at -3X magnification with the accident site highlighted with a red square. Cloud cover was observed above the accident site. It should be noted that this figure has not been corrected for any parallax error.

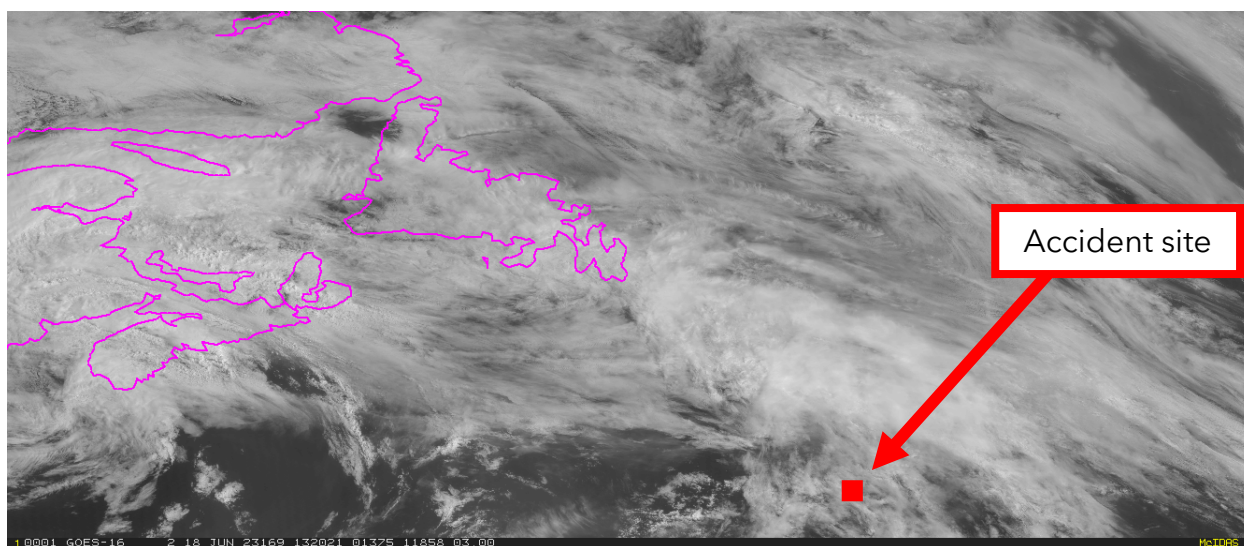


Figure 3. GOES-16 visible image at 1050 NDT.

² [Beaufort Scale \(weather.gov\)](http://www.weather.gov)

4.0 National Weather Service Text Marine Weather Products

The accident site was located more than 200 miles from shore and therefore fell into the "High Seas" marine forecast area, which were issued by the Ocean Prediction Center (OPC, see figure 4). The accident site was located in forecast area HSFAT1. Below figure 4 is the forecast valid at the accident time with text forecast information. Text forecast information valid back to June 16 can be found in attachment 3.³

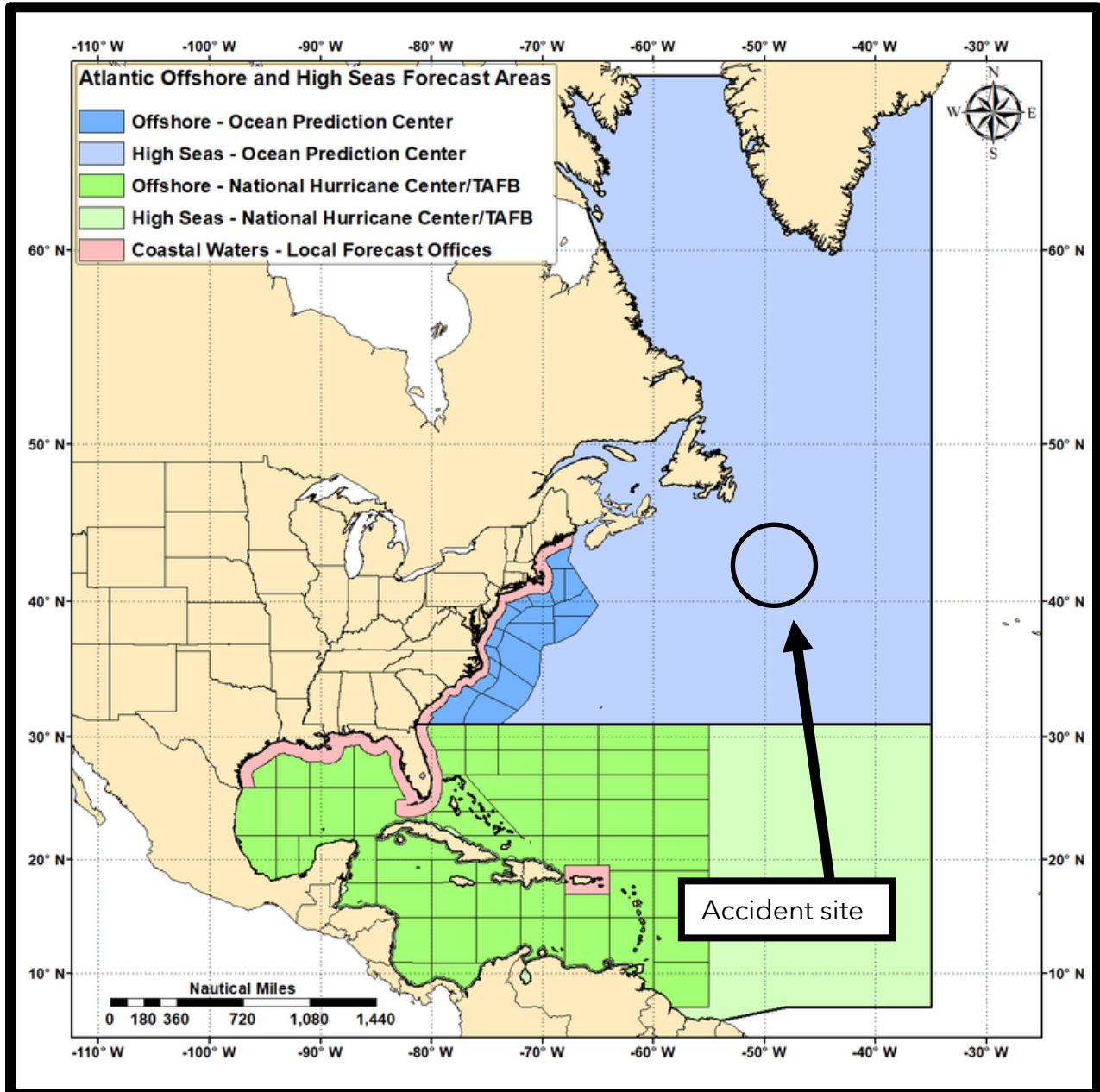


Figure 4. NOAA marine forecast areas and responsible issuing center.

³ Seas = significant wave height

791
FZNT01 KWBC 181000
HSFAT1

HIGH SEAS FORECAST FOR METAREA IV
NWS OCEAN PREDICTION CENTER WASHINGTON DC
1030 UTC SUN JUN 18 2023

CCODE/1:31:04:01:00/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.

ONLY YOU KNOW THE WEATHER AT YOUR POSITION. REPORT IT TO THE
NATIONAL WEATHER SERVICE. EMAIL US AT
VOSOPS@NOAA.GOV(LOWERCASE).

FOR INFORMATION ON ATLANTIC ICEBERGS SEE INFORMATION FROM NORTH
ATLANTIC ICE SERVICE AT [HTTPS://OCEAN.WEATHER.GOV/ATL_TAB.PHP](https://ocean.weather.gov/atl_tab.php)
(ALL LOWERCASE).

SECURITE

NORTH ATLANTIC NORTH OF 31N TO 67N AND WEST OF 35W

ALL FORECASTS VALID OVER ICE FREE FORECAST WATERS

SYNOPSIS VALID 0600 UTC JUN 18.
24 HOUR FORECAST VALID 0600 UTC JUN 19.
48 HOUR FORECAST VALID 0600 UTC JUN 20.

.WARNINGS.

.NONE.

.SYNOPSIS AND FORECAST.

.LOW 43N67W 996 MB MOVING NE 10 KT. WITHIN 600 NM N AND NE...780
NM SE...420 NM S...AND 120 NM W QUADRANTS WINDS 20 TO 30 KT. SEAS
TO 10 FT.

.24 HOUR FORECAST LOW 45N62W 1009 MB. WITHIN 420 NM N AND
NE...420 NM S...AND 360 NM W QUADRANTS WINDS 20 TO 30 KT. SEAS TO
9 FT.

.48 HOUR FORECAST LOW 47N50W 1011 MB. WITHIN 360 NM S...AND 660
NM W AND SW QUADRANTS WINDS TO 25 KT. SEAS LESS THAN 8 FT.

.COMPLEX LOW WITH FIRST CENTER 50N45W 1011 MB MOVING E 05 KT AND
SECOND LOW 44N36W 1011 MB MOVING SE 10 KT. WITHIN 600 NM NW
QUADRANT OF FIRST CENTER AND 540 NM S AND 300 NM SW QUADRANTS OF
SECOND CENTER WINDS TO 25 KT. SEAS LESS THAN 8 FT.

.24 HOUR FORECAST COMPLEX LOW WITH FIRST CENTER 50N43W 1013 MB AND SECOND LOW E OF THE AREA. WITHIN 480 NM NW AND 240 NM NE QUADRANTS OF FIRST CENTER AND FROM 31N TO 43N E OF 37W WINDS TO 25 KT. SEAS LESS THAN 8 FT.

.48 HOUR FORECAST LOW 50N41W 1011 MB. WITHIN 480 NM NW...360 NM E AND NE AND 240 NM S QUADRANTS WINDS TO 25 KT. SEAS LESS THAN 8 FT.

.WITHIN 180 NM W OF THE GREENLAND COAST S OF 64N AREA OF NW WINDS TO 25 KT. SEAS TO 8 FT.

.24 HOUR FORECAST WITHIN 180 NM W AND SW OF THE GREENLAND COAST S OF 64N AREA OF NW WINDS TO 25 KT. SEAS LESS THAN 8 FT.

.48 HOUR FORECAST CONDITIONS DIMINISHED.

.24 HOUR FORECAST NEW LOW 42N40W 1014 MB. WITHIN 480 NM S AND SW QUADRANTS AND 360 NM SE OF A LINE FROM 43N50W TO 34N68W TO 31N73W WINDS TO 25 KT. SEAS TO 8 FT.

.48 HOUR FORECAST LOW E OF AREA NEAR 38N30W 1014 MB. WITHIN 540 NM SW SEMICIRCLE WINDS TO 25 KT. SEAS LESS THAN 8 FT.

.48 HOUR FORECAST NEW LOW 41N50W 1010 MB. WITHIN 360 NM SE SEMICIRCLE WINDS 20 TO 30 KT. SEAS TO 9 FT. ELSEWHERE WITHIN 480 NM SE SEMICIRCLE AND 660 NM W QUADRANT WINDS TO 25 KT. SEAS LESS THAN 8 FT.

.48 HOUR FORECAST FROM 31N TO 38N W OF 67W WINDS TO 25 KT. SEAS LESS THAN 8 FT.

.48 HOUR FORECAST N OF 64N W OF GREENLAND WINDS TO 25 KT. SEAS LESS THAN 8 FT.

.DENSE FOG. VSBY OCCASIONALLY LESS THAN 1 NM FROM 47N TO 57N BETWEEN 37W AND 50W AND FROM 41N TO 46N BETWEEN 52W AND 66W.

.24 HOUR FORECAST DENSE FOG FROM 41N TO 53N BETWEEN 42W AND 62W.

.48 HOUR FORECAST DENSE FOG FROM 42N TO 52N BETWEEN 42W AND 58W.

.FORECASTER ACHORN. OCEAN PREDICTION CENTER.

NWS NATIONAL HURRICANE CENTER MIAMI FL

ATLANTIC FROM 07N TO 31N W OF 35W INCLUDING CARIBBEAN SEA AND GULF OF MEXICO

SYNOPSIS VALID 0600 UTC SUN JUN 18.

24 HOUR FORECAST VALID 0600 UTC MON JUN 19.

48 HOUR FORECAST VALID 0600 UTC TUE JUN 20.

.WARNINGS.

...ATLC GALE WARNING...

.ATLC 18 HOUR FORECAST LOW PRES...POSSIBLE TROPICAL CYCLONE...

NEAR 10.5N35.5W 1008 MB. WITHIN 14N35W TO 14N36W TO 14N37W TO 12N37W TO 11N36W TO 11N35W TO 14N35W WINDS 20 TO 30 KT. SEAS 8

TO 10 FT.

.24 HOUR FORECAST LOW PRES...POSSIBLE TROPICAL CYCLONE...NEAR 10.5N37W 1007 MB. WITHIN 14N35W TO 15N38W TO 13N39W TO 11N38W TO 10N36W TO 12N35W TO 14N35W 20 TO 30 KT. SEAS 8 TO 11 FT.

.48 HOUR FORECAST LOW PRES...POSSIBLE TROPICAL CYCLONE...NEAR 11N43.5W 1006 MB. WITHIN 12N42W TO 12N44W TO 11N44W TO 10N44W TO 10N42W TO 12N42W WINDS 30 TO 35 KT. SEAS 8 TO 13 FT. ELSEWHERE WITHIN 14N40W TO 17N43W TO 16N46W TO 13N46W TO 11N41W TO 14N40W NE TO E WINDS 20 TO 30 KT. SEAS 8 TO 10 FT.

.SYNOPSIS AND FORECAST.

.CARIBBEAN WITHIN 16N75W TO 16N81W TO 14N82W TO 12N79W TO 12N70W TO 16N75W E WINDS 20 TO 25 KT. SEAS 8 TO 10 FT.

.24 HOUR FORECAST WITHIN 16N70W TO 16N75W TO 13N76W TO 11N75W TO 13N69W TO 16N70W...INCLUDING THE GULF OF VENEZUELA...E WINDS 20 TO 25 KT. SEAS 8 TO 9 FT.

.48 HOUR FORECAST LITTLE CHANGE.

.CARIBBEAN WITHIN 18N86W TO 18N88W TO 17N88W TO 16N88W TO 16N86W TO 18N86W...INCLUDING THE GULF OF HONDURAS...E WINDS 20 TO 25 KT. SEAS LESS THAN 8 FT.

.24 HOUR FORECAST LITTLE CHANGE.

.30 HOUR FORECAST CONDITIONS IMPROVE. WINDS 20 KT OR LESS. SEAS LESS THAN 8 FT.

.REMAINDER OF AREA WINDS 20 KT OR LESS. SEAS LESS THAN 8 FT.

.FORECASTER LEWITSKY. NATIONAL HURRICANE CENTER.

\$\$

5.0 National Weather Service Graphical information

The OPC Wind and Wave Analysis valid at 0930 NDT is found in figure 5 with significant wave heights between 4 and 6 ft identified for the accident site. Additional marine graphical forecast information can be found in attachment 4.

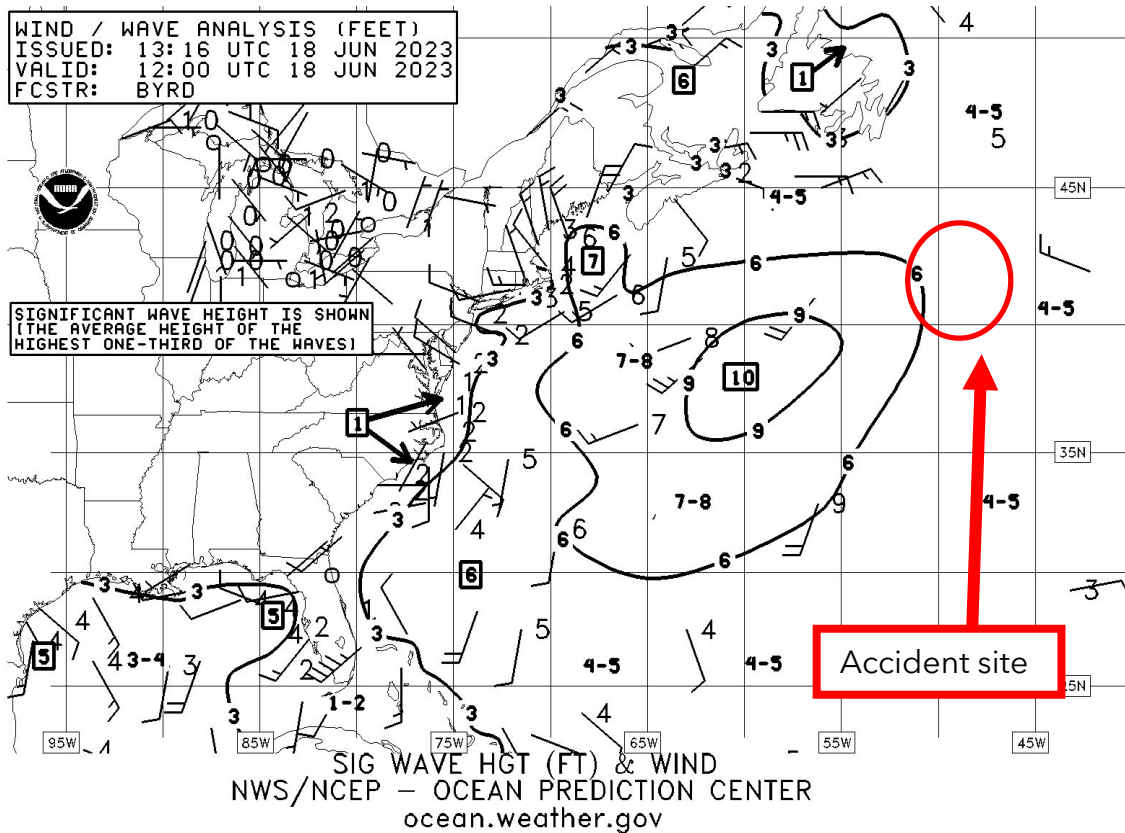


Figure 5. OPC marine wind and wave analysis valid at 0930 NDT.

6.0 Significant Wave Height

The standard ocean wave forecast set forth by the World Meteorological Organization (WMO) states that the countries responsible for the weather forecasts for the world's oceans should use significant wave height for their ocean wave height forecasts. The OPC and the National Hurricane Center's Tropical Analysis and Forecast Branch are responsible for the NOAA forecasts for the northern Atlantic and northern Pacific Oceans. NWS Weather Forecast Offices (WFO) are responsible for NOAA forecasts for coastal regions. As mentioned above, the OPC was responsible for the NOAA forecasts for the accident site.

The wavy water surface in the ocean is 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 6 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, given a significant wave height observed of 20 ft, the mean wave height encountered by a vessel for that wave

spectrum would be 12.8 ft with the most probable wave height encountered of 12 ft. However, the highest 10 percent of waves within that wave spectrum would be 25.4 ft and the highest one percent of waves would be around 33.4 ft high. The highest wave a vessel could encounter with a significant wave height of 20 ft would be 40 ft.

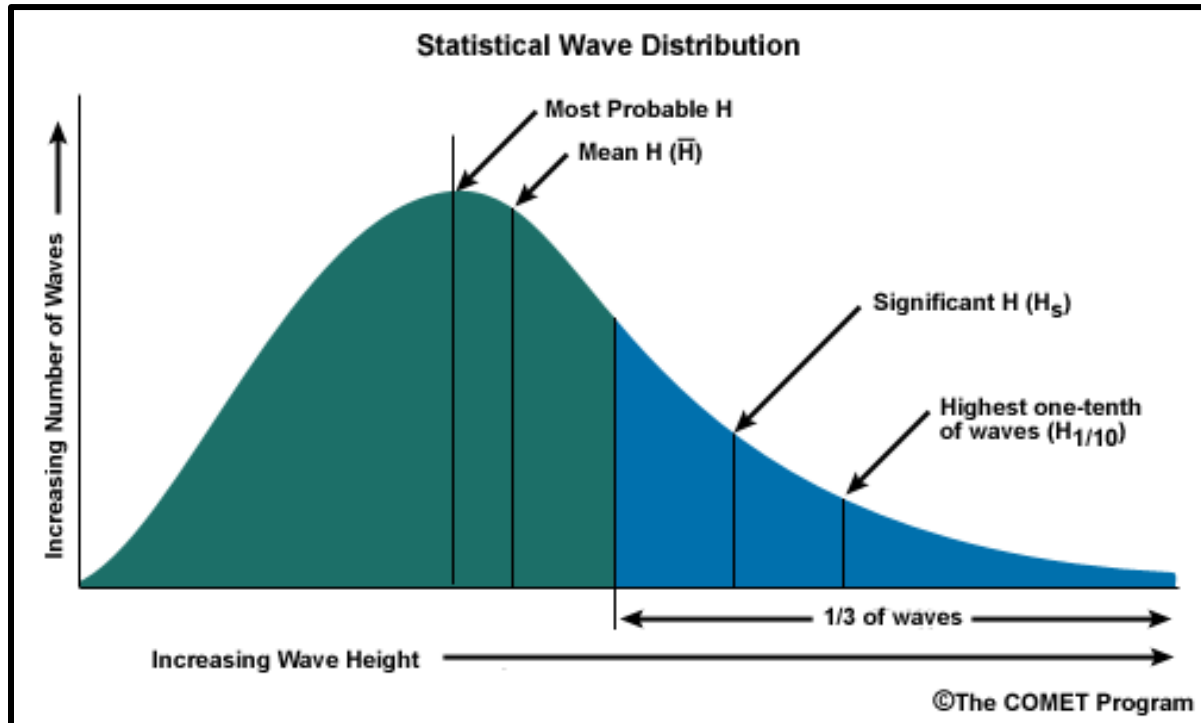


Figure 6. Typical statistical wave distribution.

7.0 Current Information

The Global Hybrid Coordinate Ocean Model (HYCOM)⁴ current data was obtained from the Navy from 1430 NDT on June 18, 2023, and the data is plotted on figure 7. The data indicated that the sea surface current was from the west-northwest around 0.80 meters per second (m/s) in speed. The Global HYCOM current data from the Navy was retrieved for 1630 NDT on June 16 through 1430 NDT on June 18 and these data for the accident site are plotted in figures 8 and 9 with the same y-axis on both figures.

⁴ [HYCOM + NCODA Gulf of Mexico 1/25° Analysis \(GOMu0.04/expt_90.1m000\) NetCDF Subset Service for Grids \(hycom.org\)](https://www.hycom.org/)



Figure 7. Global HYCOM Navy sea surface current data from 1430 NDT.

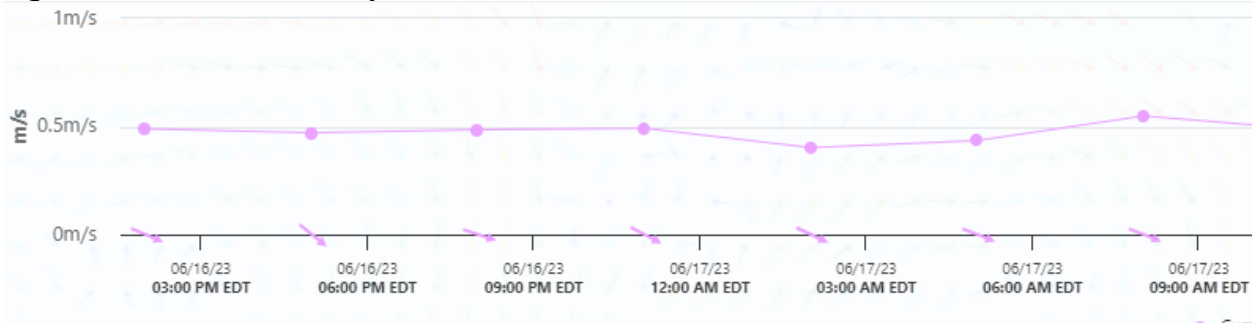


Figure 8. Global HYCOM Navy sea surface current data from June 16 and 17.

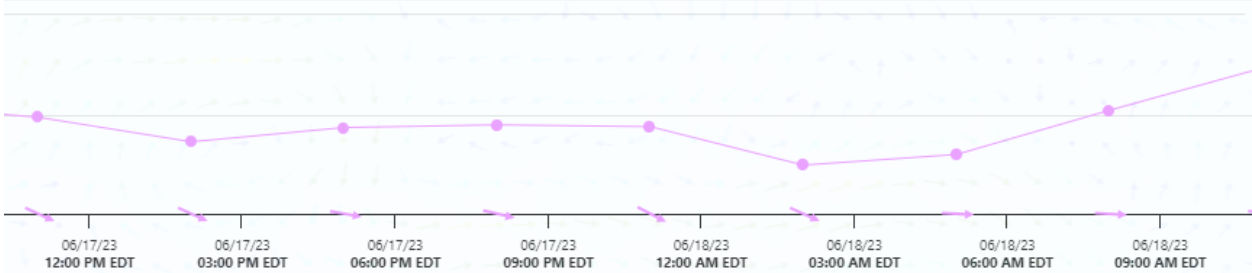


Figure 9. Global HYCOM Navy sea surface current data from June 17 and 18. Figure 9 uses the same y-axis as figure 8.

8.0 Water Temperature

The sea surface temperature was analyzed from the Global HYCOM Navy data from 1030 NDT on June 18, with the data plotted in figure 10. The sea surface temperature around the accident site was 15.2°C.

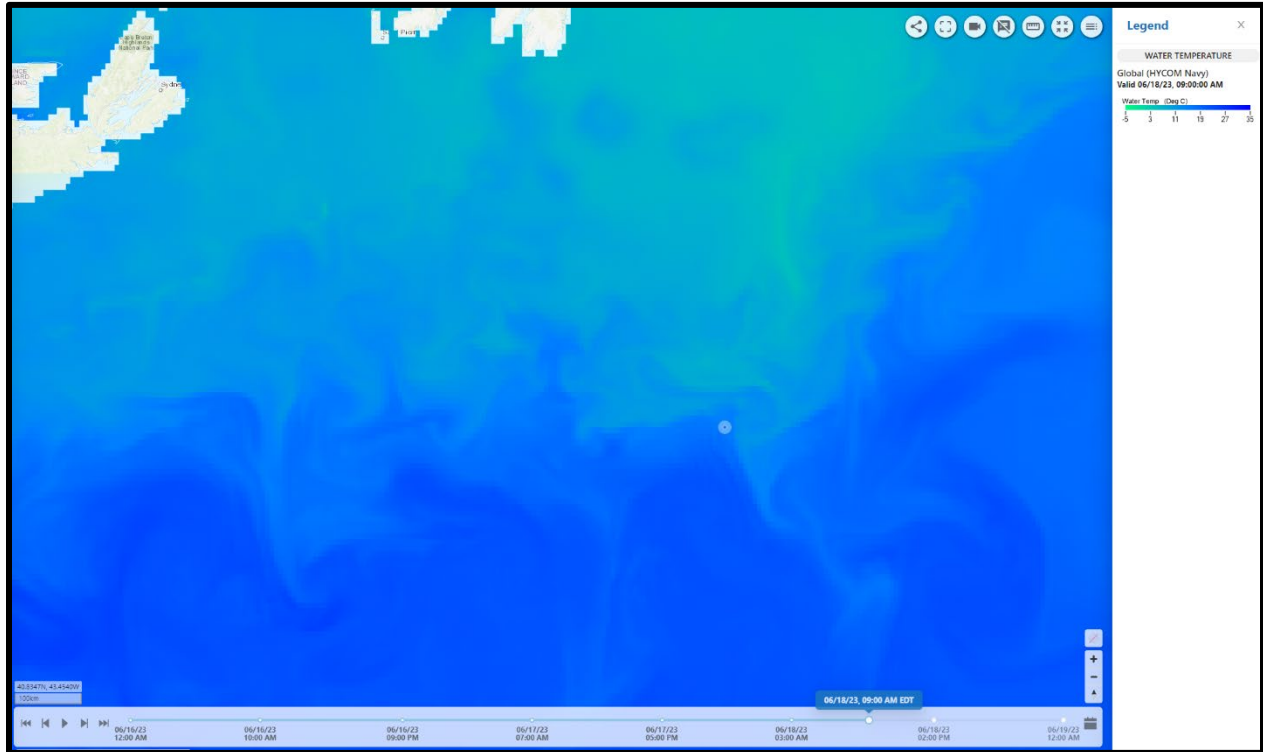


Figure 10. Sea surface temperature plot from 1030 NDT.

9.0 Additional Temperature Data

Weather information was retrieved from St. John's International Airport (CYYT) and that information from August 2022 through May 2023 can be found in attachment 5. The air temperature from August 2022 through May 2023 in °F can be found in figure 11 with data points every hour on the x-axis.

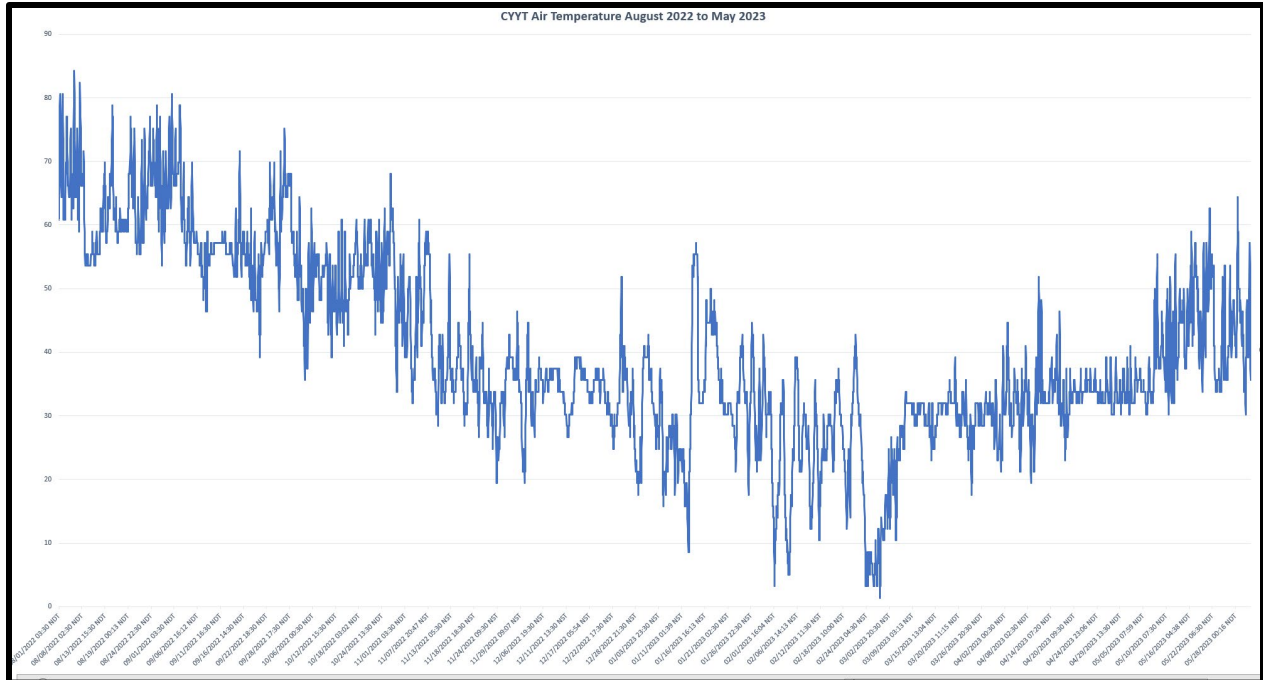


Figure 11. Air temperature plot from August 2022 through May 2023 for CYTT.

10.0 Astronomical Data

The astronomical data obtained for the accident site on June 18, 2023, indicated the following:

SUN

Begin civil twilight	0411 NDT
Sunrise	0443 NDT
Accident time	1047 NDT⁵
Sun transit	1221 NDT
Sunset	1958 NDT
End civil twilight	2032 NDT

At the time of the accident the Sun was located at an altitude of 63.18° and azimuth of 125.74°.

⁵ Inserted accident time for reference and context.

11.0 Additional NOAA and NWS Data

Additional Weather information was received from NOAA and the NWS regarding additional accident vessel missions taken between May 20, 2023, and June 18, 2023. That additional weather information and charts can be found in attachments 6 and 7.

E. LIST OF ATTACHMENTS

Attachment 1 - WPC Surface Analysis Charts from June 16 to 18

Attachment 2 - *Polar Prince* weather observations from June 16 to 18

Attachment 3 - OPC High Seas weather forecast from June 16 to 18

Attachment 4 - Additional NWS marine graphical information

Attachment 5 - CYYT weather information from August 2022 through May 2023

Attachment 6 - Additional NOAA and NWS weather information for the additional vessel missions in May and June 2023

Attachment 7 - Description of the additional NOAA and NWS information

Submitted by:

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