# NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

# TROPICAL STORM HERMINE

(AL102022)

23–24 September 2022

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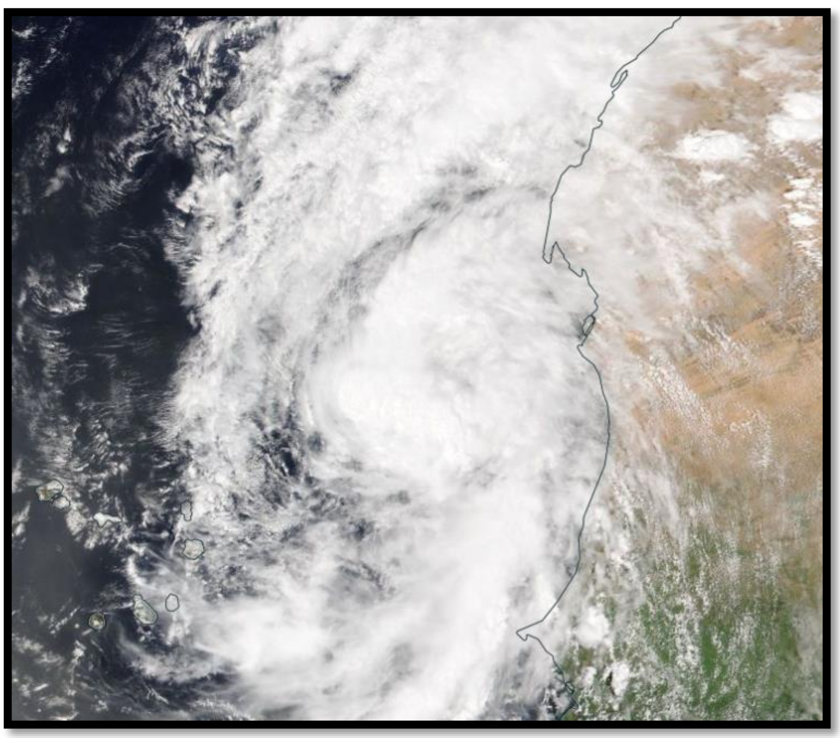

NOAA-20 VISIBLE INFRARED IMAGING RADIOMETER SUITE (VIIRS) IMAGERY AT 1457 UTC 23 SEPTEMBER 2022, SHORTLY BEFORE THE DEPRESSION STRENGTHENED INTO TROPICAL STORM HERMINE.
IMAGE COURTESY OF NASA EOSDIS WORLDVIEW.

Hermine was a short-lived, sheared tropical storm that formed over the far eastern Atlantic Ocean. The interaction of an upper-level trough with moisture from Hermine and its remnants resulted in record rainfall totals and flooding on the Canary Islands.

# Tropical Storm Hermine

**23–24 SEPTEMBER 2022**

## SYNOPTIC HISTORY

Hermine originated from a vigorous tropical wave that emerged from the west coast of Africa on 22 September (Fig. 1). Scatterometer data showed a broad low-level circulation later that day between the Cabo Verde Islands and the west coast of Africa, but the circulation lacked a well-defined surface center. Although the leading edge of the wave was accompanied by dust associated with a Saharan Air Layer (SAL) (Fig. 2), there was enough moisture and instability along the northern portion of the wave axis for a large burst of deep convection to develop early on 23 September. A well-defined surface low pressure system formed by 0600 UTC that day, about 265 n mi east of the Cabo Verde Islands. Some curved bands of convection developed around the circulation that morning and attained enough organization to support the formation of a tropical depression by 1200 UTC that day, when it was located about 250 n mi east-northeast of the Cabo Verde Islands. The depression strengthened into Tropical Storm Hermine 6 h later (cover photo). The "best track" chart of Hermine's path is given in Fig. 3, with the wind and pressure histories shown in Figs. 4 and 5, respectively. The best track positions and intensities are listed in Table 1[1].

The cyclone moved north-northwestward on 23 September due to a weakness in the eastern Atlantic subtropical ridge induced by an upper-level trough located just west of the Canary Islands. This trough was also responsible for deep-layer southwesterly shear over Hermine, which displaced the associated convection to the northeast of the center. Hermine failed to strengthen further, despite passing over relatively warm 26–27°C sea-surface temperatures that day. Satellite imagery indicated dusty air wrapped around the western and southern portions of Hermine, and the shear may have imported some drier and more stable air associated with the SAL into the circulation. Hermine turned northward early on 24 September, and a further increase in southwesterly shear stripped away most of its organized convection. The low-level center became exposed in visible satellite imagery, and Hermine weakened to a tropical depression by 1200 UTC that day, about 310 n mi northeast of the Cabo Verde Islands. The depression continued moving northward over cooler waters, while only producing limited bursts of sheared convection well northeast of its center. The remaining convection collapsed later that day, and Hermine degenerated to a post-tropical remnant low by 0000 UTC 25 September, when it was located about 410 n mi south-southwest of the Canary Islands. The remnant low turned northeastward and gradually weakened as it moved around the northwestern periphery of a low-level ridge. Scatterometer data early on 26 September showed that the low opened into a surface trough about 250 n mi southwest of the Canary Islands.

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[1] A digital record of the complete best track, including wind radii, can be found on line at ftp://ftp.nhc.noaa.gov/atcf. Data for the current year's storms are located in the *btk* directory, while previous years' data are located in the *archive* directory.

# METEOROLOGICAL STATISTICS

Observations in Hermine (Figs. 4 and 5) include subjective satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB) and the Satellite Analysis Branch (SAB), objective Advanced Dvorak Technique (ADT) estimates and Satellite Consensus (SATCON) estimates from the Cooperative Institute for Meteorological Satellite Studies/University of Wisconsin-Madison. Observations also include dropwindsonde observations from one flight of the NASA DC-8 aircraft as part of NASA's Convective Processes Experiment – Cabo Verde (CPEX-CV) field campaign. Data and imagery from NOAA polar-orbiting satellites including the Advanced Microwave Sounding Unit (AMSU), the NASA Global Precipitation Mission (GPM), the European Space Agency's Advanced Scatterometer (ASCAT), and Defense Meteorological Satellite Program (DMSP) satellites, among others, were also useful in constructing the best track of Hermine.

There were no reports of tropical-storm-force winds associated with Hermine from land stations, ships, or buoys. The interaction of Hermine with an upper-level trough resulted in several days of persistent rainfall over the Canary Islands, and selected rainfall observations are given in Table 2.

## *Winds and Pressure*

Hermine's peak intensity of 35 kt is supported by T2.5/35 kt Dvorak current intensity estimates from TAFB early on 24 September. This is consistent with objective SATCON estimates between 30–35 kt during this period.

The estimated minimum pressure of 1003 mb is partially based on dropsonde data from a research flight of the NASA DC-8 aircraft. A 1052 UTC 23 September dropsonde measured a 1006-mb surface pressure with 18-kt surface winds, which would support an estimated central pressure of 1004 mb. It is assumed that the minimum pressure was attained several hours later once Hermine strengthened into a tropical storm.

## *Rainfall and Flooding*

Although the center of Hermine remained well southwest of the Canary Islands, widespread moisture associated with the cyclone and its remnants interacted with the diffluent region of an upper-level trough to the west for several days (Fig. 6). This resulted in a historic rainfall event for the Canary Islands. Elevated locations on the islands of El Hierro, Gran Canaria, La Palma, and Tenerife received 8–12 inches (203–305 mm) of rainfall from 23–28 September, which included rainfall related to Hermine and its remnants. A peak storm-total rainfall of 20.87 inches (530.0 mm) was measured at San José in the Breña Baja municipality on La Palma.

According to the State Meteorological Agency (AEMET) of Spain, several locations set all-time daily precipitation records on 25 September. The Gran Canaria Airport (GCLP) received 4.96 inches (126 mm) of rainfall from 23–27 September, which is 83% of its average annual rainfall (5.94 inches, 151 mm). The Tenerife South Airport (GCTS) recorded 4.09 inches

(104 mm) of rainfall during the event, which is 79% of its average annual rainfall (5.20 inches, 132 mm). Media reports indicate that the excessive rainfall resulted in flooding and landslides.

# CASUALTY AND DAMAGE STATISTICS

There were no reports of casualties[2] associated with Hermine in the Canary Islands. According to media reports, flooding caused some damage particularly on the islands of Gran Canaria and La Palma. Floodwaters washed out some roadways and damaged infrastructure, and debris from landslides forced some road closures. Numerous schools suffered damage from flooding and water leaks, and power disruptions due to damaged power lines affected several thousand people. Hundreds of flights were cancelled across the islands, primarily due to visibility restrictions caused by the rainfall.

# FORECAST AND WARNING CRITIQUE

The genesis of Hermine over the far eastern Atlantic was anticipated, although the cyclone formed sooner than forecast (Table 3). The wave from which Hermine developed was introduced in the Tropical Weather Outlook with a low (<40%) chance of formation 66 h prior to genesis, while the wave was still well inland over western Africa. The 5-day formation chance was increased to medium (40–60%) 60 h before Hermine formed. For the 2-day outlook, a low and medium formation chance was added into the TWO 54 h and 36 h before formation, respectively. The disturbance reached the high (>60%) category in the 2- and 5-day outlook only 6 h before genesis. Despite the broad structure of the initial disturbance and only marginal environmental conditions, Hermine was able to develop into a short-lived tropical cyclone. The location of genesis was well forecast, with all of the NHC Graphical TWO areas capturing the area where Hermine formed (Fig. 7). This is notable since Hermine's genesis occurred in an uncommon location for late September, north of 15°N over the far eastern Atlantic between the Cabo Verde Islands and the west coast of Africa (Fig. 8).

A verification of NHC official track and intensity forecasts for Hermine is given in Tables 4 and 5, respectively. Official track forecast errors were comparable to the mean official errors for the previous 5-yr period, albeit for a small sample size of only four verifying 12-h forecasts and two 24-h forecasts. Official intensity forecast errors were lower than the mean official errors for the previous 5-yr period. No meaningful comparisons can be made with the models due to Hermine's brief existence as a tropical cyclone.

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[2] Deaths occurring as a direct result of the forces of the tropical cyclone are referred to as "direct" deaths. These would include those persons who drowned in storm surge, rough seas, rip currents, and freshwater floods. Direct deaths also include casualties resulting from lightning and wind-related events (e.g., collapsing structures). Deaths occurring from such factors as heart attacks, house fires, electrocutions from downed power lines, vehicle accidents on wet roads, etc., are considered "indirect" deaths.

There were no coastal watches and warnings associated with Hermine.

## ACKNOWLEDGEMENTS

Thanks to the NASA CPEX-CV program managers and science team for collecting and sharing data that was useful in the operational assessment and post-analysis of Hermine. Dropsonde data from the CPEX-CV field campaign are courtesy of Lee Thornhill and Claire Robinson (NASA Langley Research Center). Rainfall data from the Canary Islands (Table 2) was provided by Tomás Gutiérrez Cobo of AEMET (Spain). Philippe Papin created the composite TWO verification graphic (Fig. 7).

Table 1. Best track for Tropical Storm Hermine, 23–24 September 2022.

| Date/Time (UTC) | Latitude (°N) | Longitude (°W) | Pressure (mb) | Wind Speed (kt) | Stage |
|---|---|---|---|---|---|
| 23 / 0600 | 16.6 | 19.4 | 1005 | 30 | low |
| 23 / 1200 | 17.4 | 19.9 | 1004 | 30 | tropical depression |
| 23 / 1800 | 18.1 | 20.3 | 1003 | 35 | tropical storm |
| 24 / 0000 | 18.7 | 20.7 | 1003 | 35 | " |
| 24 / 0600 | 19.4 | 20.9 | 1004 | 35 | " |
| 24 / 1200 | 20.3 | 20.9 | 1005 | 30 | tropical depression |
| 24 / 1800 | 21.4 | 20.7 | 1006 | 30 | " |
| 25 / 0000 | 22.4 | 20.5 | 1006 | 30 | low |
| 25 / 0600 | 23.1 | 20.3 | 1007 | 25 | " |
| 25 / 1200 | 23.7 | 20.1 | 1007 | 25 | " |
| 25 / 1800 | 24.1 | 19.8 | 1008 | 25 | " |
| 26 / 0000 | 24.6 | 19.4 | 1008 | 25 | " |
| 26 / 0600 | | | | | dissipated |
| 23 / 1800 | 18.1 | 20.3 | 1003 | 35 | maximum wind and minimum pressure |

Table 2. Storm-total rainfall from 23–28 September 2022, including the period when moisture from Hermine and its remnants contributed to persistent rainfall over the Canary Islands. Data provided by the State Meteorological Agency of the Government of Spain.

| Location | Total rainfall (in) | Location | Total rainfall (in) |
|---|---|---|---|
| **Canary Islands** | | | |
| **La Palma** | | | |
| Breña Baja – San José (28.64N 17.84W) | 20.87 | San Andrés y Sauces – Balsa Adeyahame (28.81N 17.93W) | 13.30 |
| Mazo – Rosas (28.62N 17.80W) | 20.28 | Mazo – Tigalate (28.55N 17.83W) | 12.71 |
| Breña Alta – Ledas (28.64N 17.80W) | 15.41 | San Andrés y Sauces – Verada Lomadas (28.79N 17.87W) | 11.08 |
| Breña Alta – Botazo (28.67N 17.87W) | 15.27 | Barlovento – Gallegos (28.82N 17.91W) | 9.24 |
| Santa Cruz de la Palma – Velhoco (28.69N 17.81W) | 13.51 | La Palma Airport (GCLA) (28.63N 17.76W) | 6.93 [a] |
| **El Hierro** | | | |
| Pinar – Deposito (27.72N 18.08W) | 12.47 | San Andrés – Depósito Cabildo (27.77N 18.05W) | 10.15 |
| Valverde (27.81N 17.95W) | 10.54 | | |
| **Tenerife** | | | |
| Araya (28.37N 16.53W) | 12.06 | Toponegro (28.33N 16.46W) | 10.28 |
| Güímar – Plaza Fatima (28.32N 16.53W) | 11.80 | Mena (28.27N 16.45W) | 10.12 |
| Candelaria – Depósito Cuevecitas (28.36N 16.41W) | 11.18 | Tenerife North Airport (GCXO) (28.48N 16.34W) | 5.39 [a] |
| Arafo (28.34N 16.43W) | 10.63 | Izaña (60010) (28.31N 16.50W) | 4.45 [a] |
| Güímar (28.32N 16.52W) | 10.39 | Tenerife South Airport (GCTS) (28.05N 16.57W) | 4.09 [a] |
| **Gran Canaria** | | | |
| Santa Brígida – Campo de Golf Bandama (28.03N 15.58W) | 8.57 | Santa Brígida – Monte Coello (28.05N 15.55W) | 8.01 |
| Valleseco – La Retamilla (28.03N 15.65W) | 8.37 | Gran Canaria Airport (GCLP) (27.93N 15.39W) | 4.96 [a] |
| Valsequillo – Granja las Rosas (27.99N 15.60W) | 8.07 | | |

[a] Storm-total rainfall from 0500 UTC 23 September to 0500 UTC 27 September 2022.

Table 3. Number of hours in advance of formation of Hermine associated with the first NHC Tropical Weather Outlook forecast in the indicated likelihood category. Note that the timings for the "Low" category do not include forecasts of a 0% chance of genesis.

| | **Hours Before Genesis** | |
|---|---|---|
| | **48-Hour Outlook** | **120-Hour Outlook** |
| Low (<40%) | 54 | 66 |
| Medium (40%-60%) | 36 | 60 |
| High (>60%) | 6 | 6 |

Table 4. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Tropical Storm Hermine, 23–24 September 2022. Mean errors for the previous 5-yr period are shown for comparison. Official errors that are smaller than the 5-yr means are shown in boldface type.

| | Forecast Period (h) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 12 | 24 | 36 | 48 | 60 | 72 | 96 | 120 |
| OFCL | **22.4** | 36.4 | | | | | | |
| OCD5 | 40.7 | 95.7 | | | | | | |
| Forecasts | 4 | 2 | | | | | | |
| OFCL (2017-21) | 23.6 | 35.5 | 47.6 | 61.4 | 78.2 | 91.3 | 125.6 | 172.1 |
| OCD5 (2017-21) | 45.5 | 98.3 | 156.7 | 213.7 | 252.4 | 316.9 | 403.6 | 484.6 |

Table 5. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Tropical Storm Hermine, 23–24 September 2022. Mean errors for the previous 5-yr period are shown for comparison. Official errors that are smaller than the 5-yr means are shown in boldface type.

| | Forecast Period (h) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 12 | 24 | 36 | 48 | 60 | 72 | 96 | 120 |
| OFCL | **5.0** | **5.0** | | | | | | |
| OCD5 | 5.0 | 11.0 | | | | | | |
| Forecasts | 4 | 2 | | | | | | |
| OFCL (2017-21) | 5.4 | 8.0 | 9.5 | 10.9 | 11.0 | 12.1 | 13.1 | 14.7 |
| OCD5 (2017-21) | 7.0 | 11.1 | 14.5 | 17.1 | 18.0 | 20.2 | 21.9 | 22.1 |

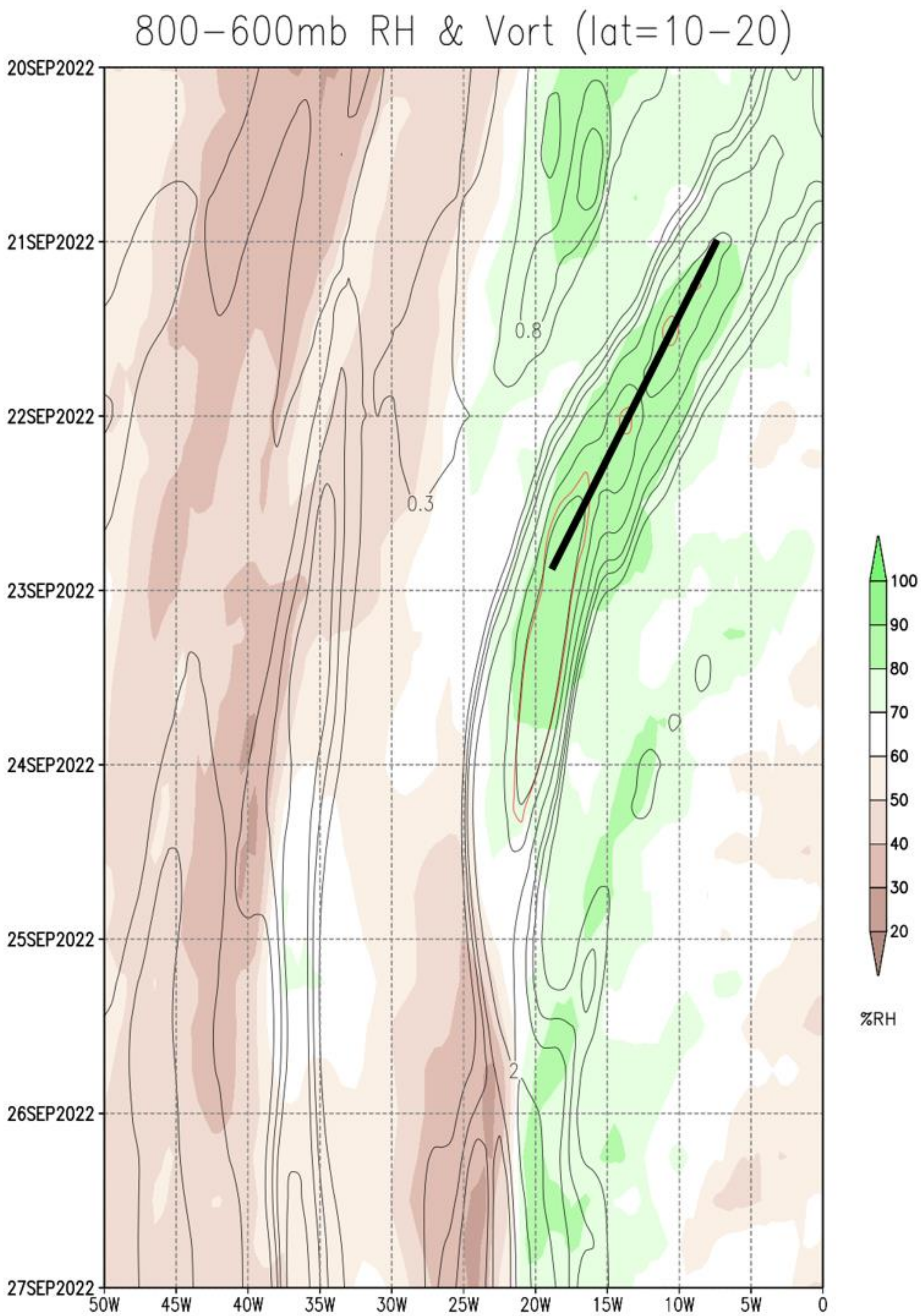


Figure 1. Hovmöller diagram of the GFS model analyses of 800–600 mb relative humidity (color shaded) and 800–600 mb relative vorticity (contours) between 10°N–20°N from 20–27 September. The solid black line highlights the tropical wave that led to the development of Hermine.

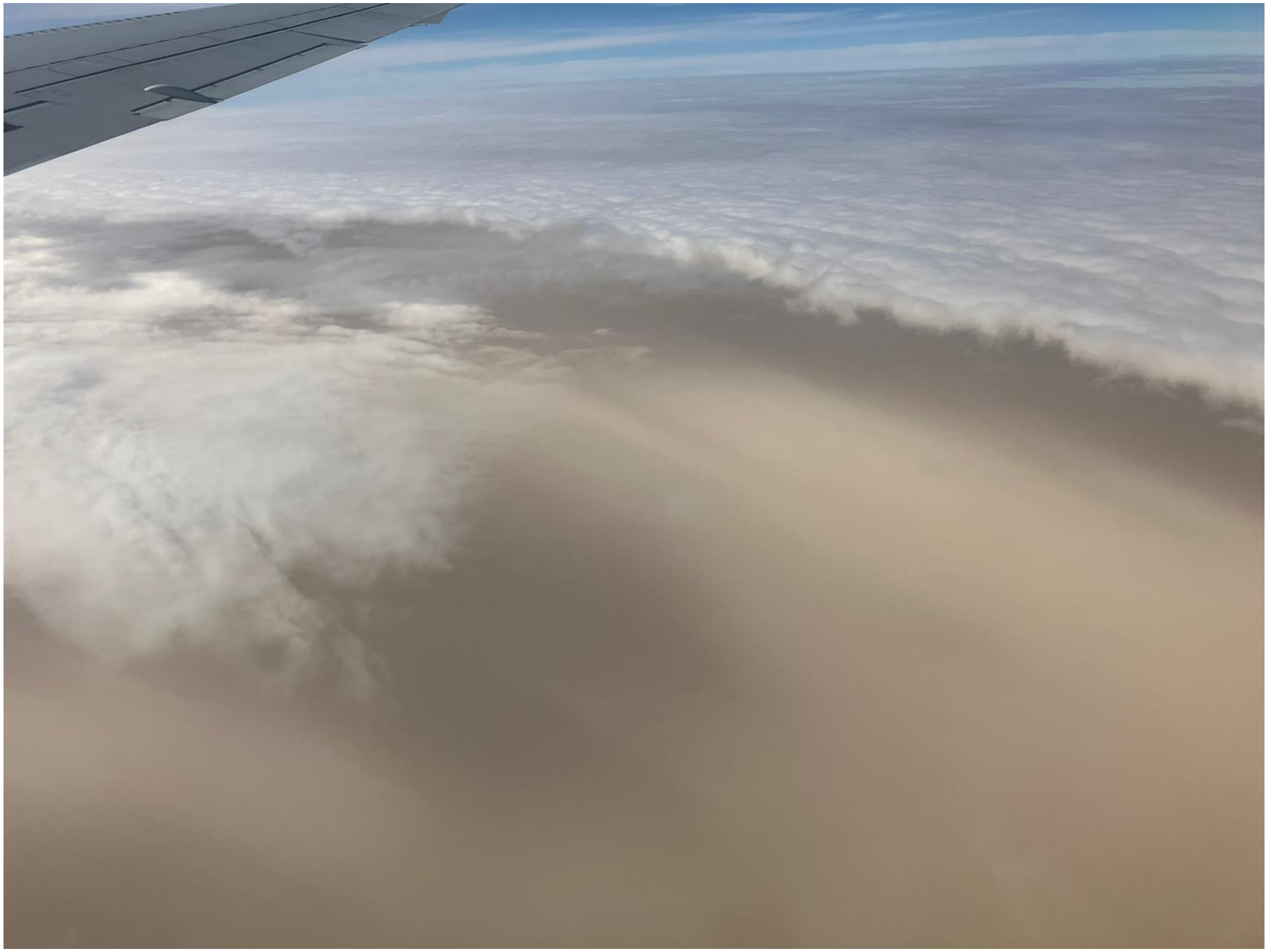

Figure 2. Photo from the NASA DC-8 aircraft during a 22 September CPEX-CV science flight into the tropical wave from which Hermine originated. The tan, milky appearance of the air below the aircraft indicates the presence of Saharan dust. Photo credit Kris Bedka, NASA Langley Research Center.

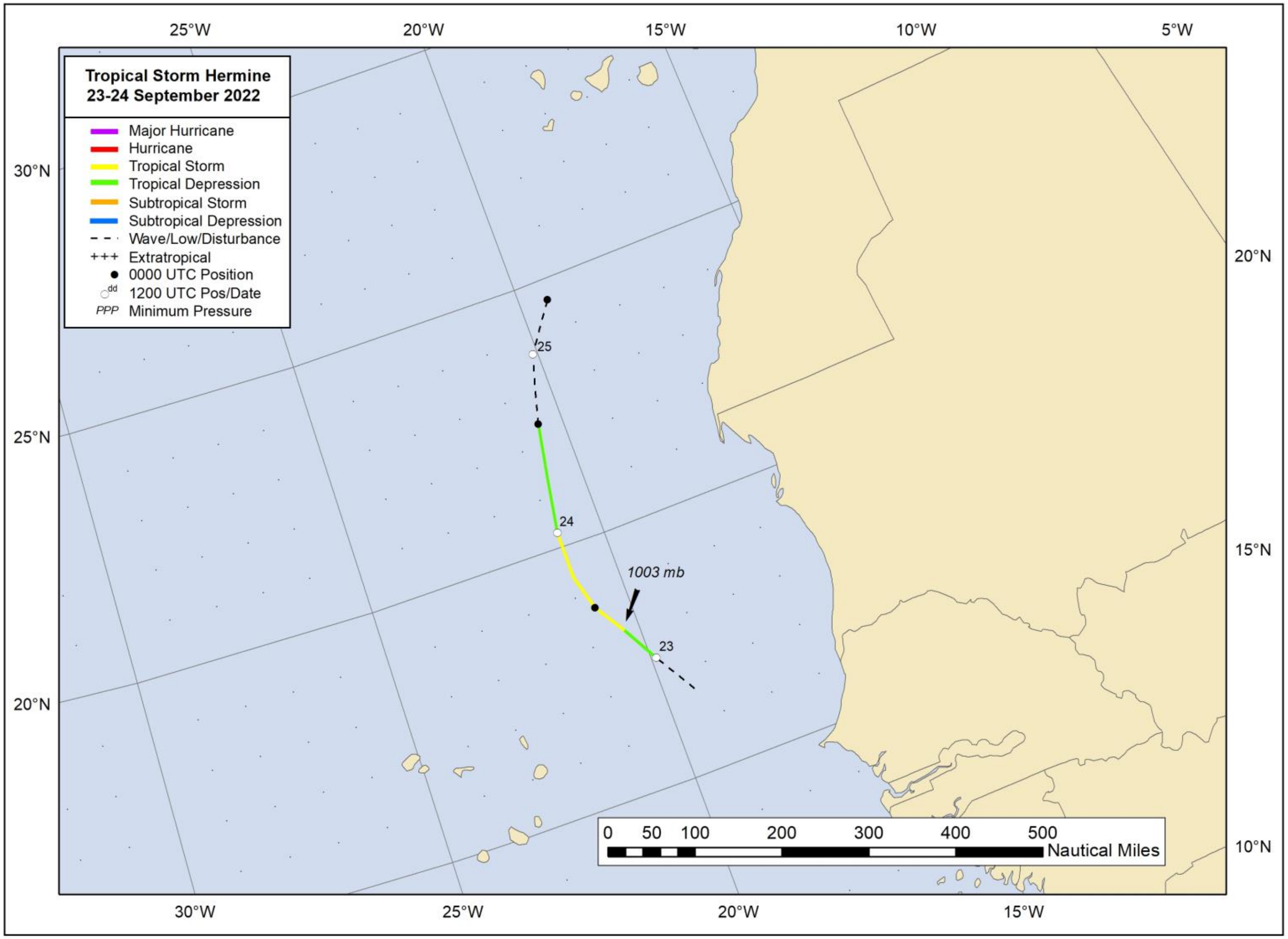


Figure 3. Best track positions for Tropical Storm Hermine, 23–24 September 2022.

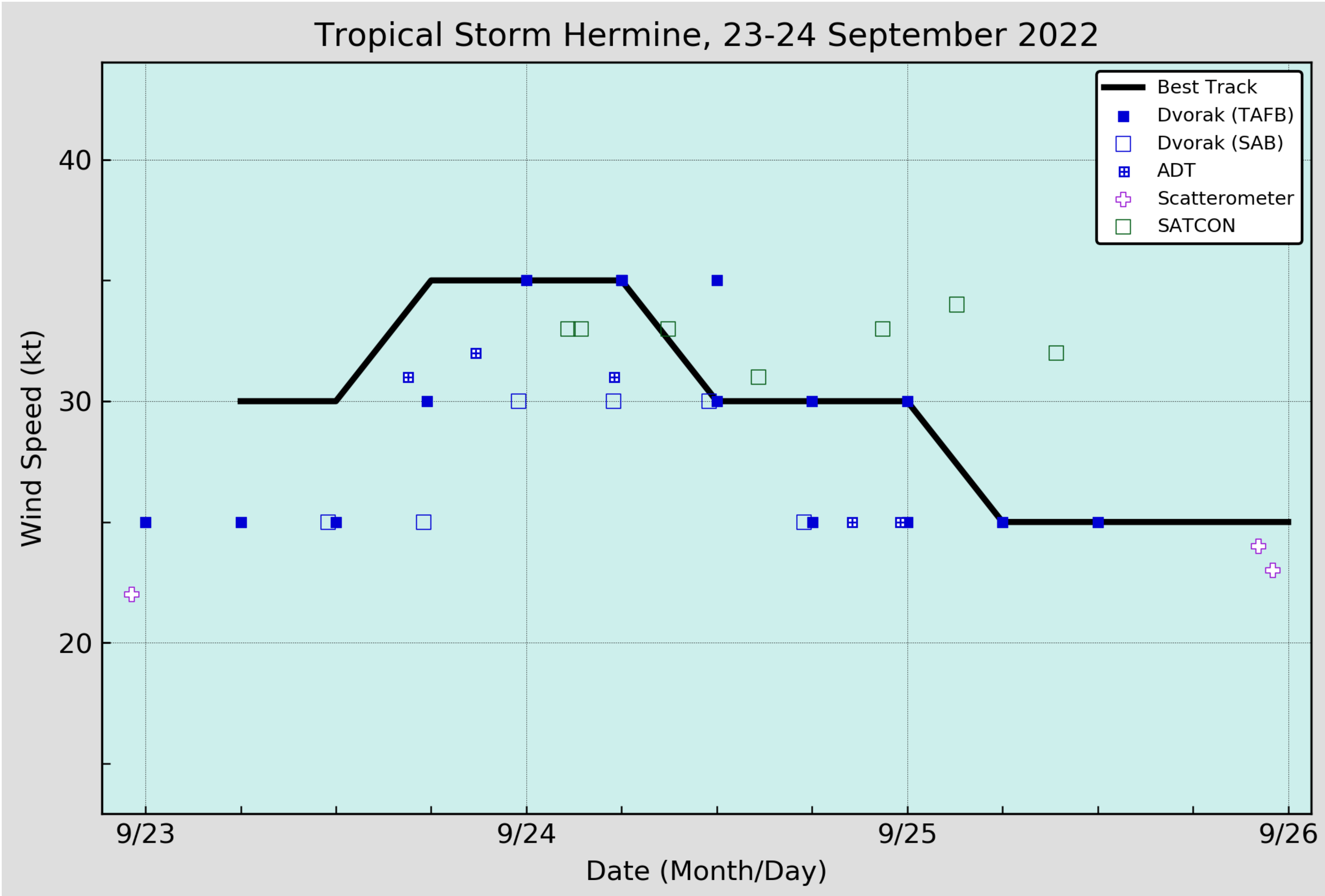


Figure 4. Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Hermine, 23–24 September 2022. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies. Dashed vertical lines correspond to 0000 UTC.

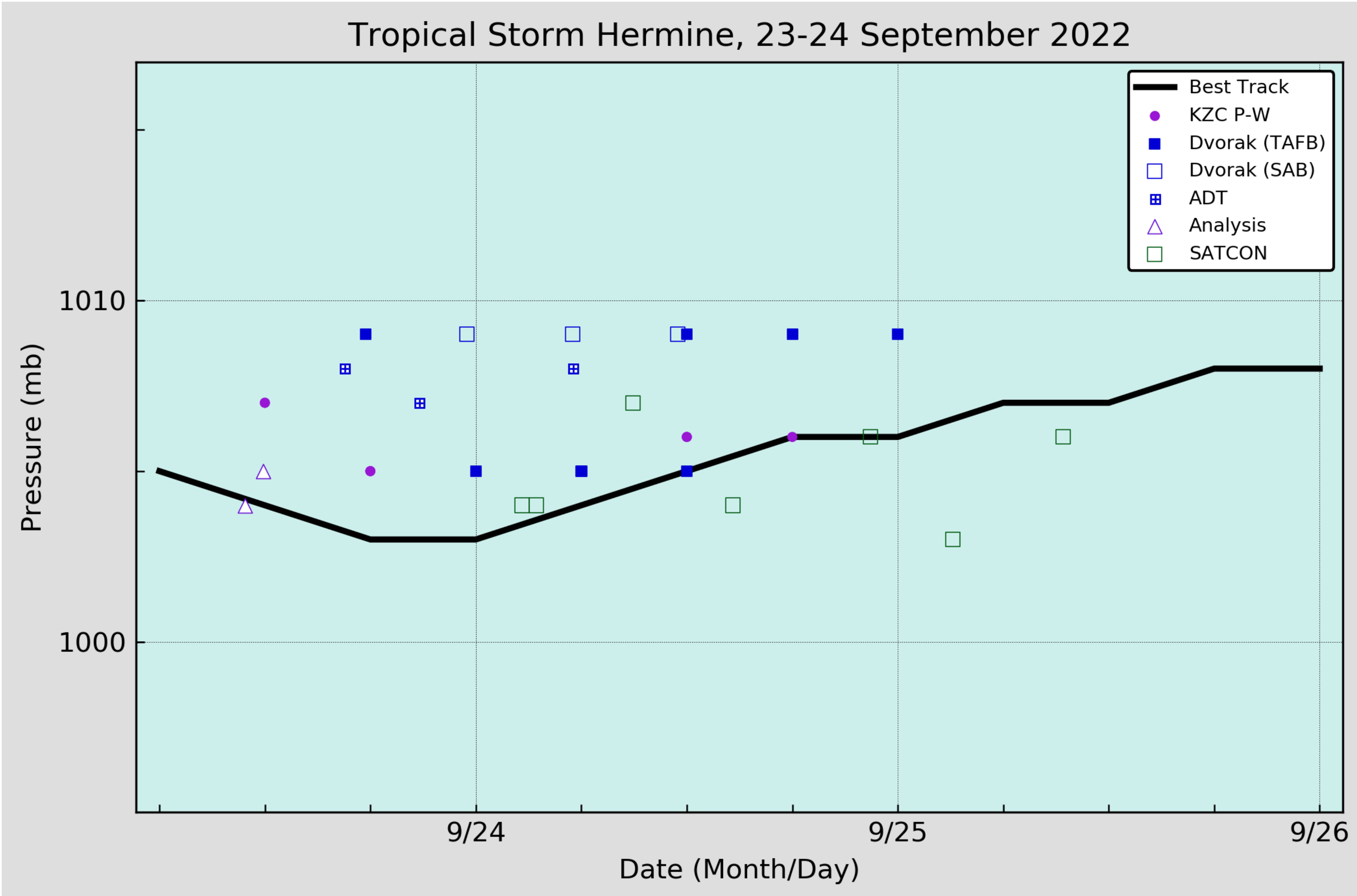


Figure 5. Selected pressure observations and best track minimum central pressure curve for Tropical Storm Hermine, 23–24 September 2022. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies. KZC P-W refers to pressure estimates derived using the Knaff-Zehr-Courtney pressure-wind relationship. Dashed vertical lines correspond to 0000 UTC.

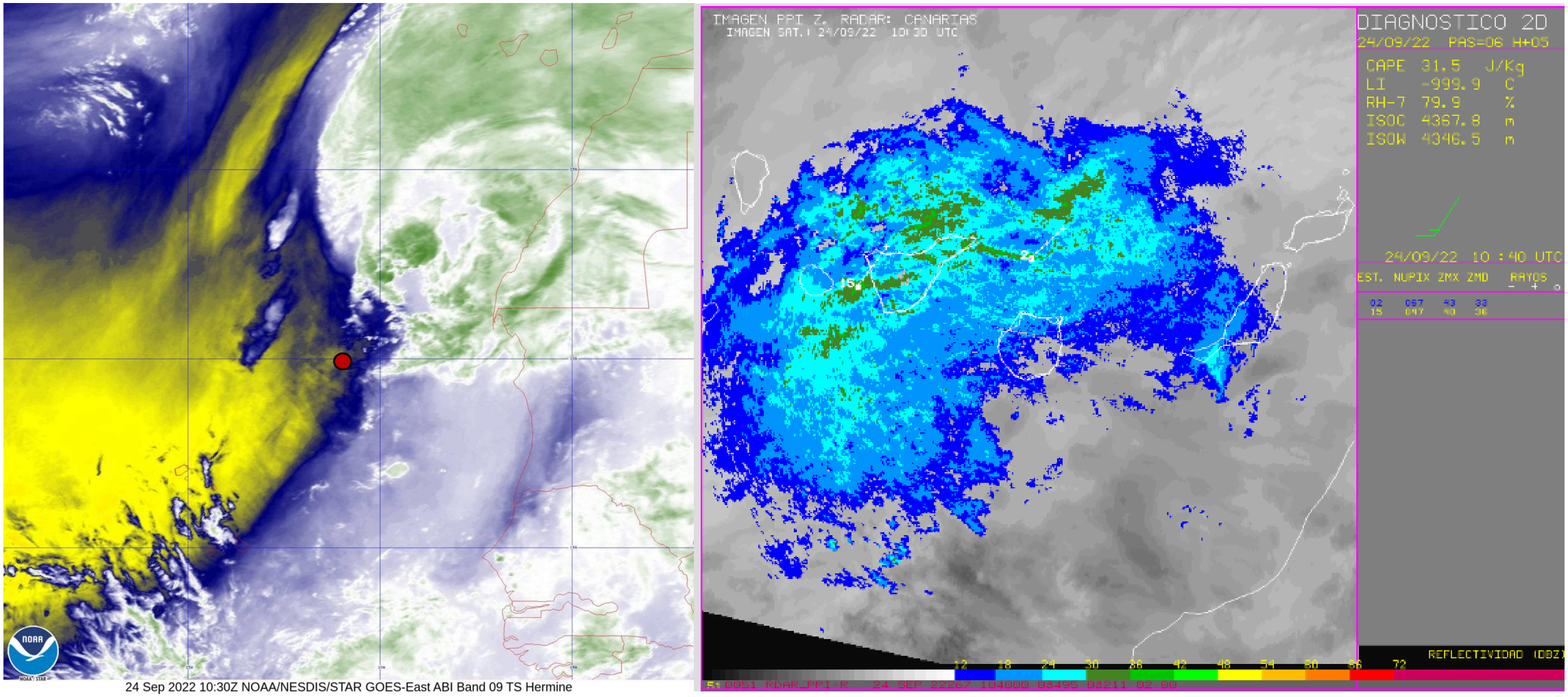


Figure 6. (left) GOES-East 6.9 µm mid-level water vapor image of Tropical Storm Hermine at 1030 UTC 24 September. The estimated center position of Hermine is denoted by the red circle. (right) Canary Islands radar reflectivity image at 1030 UTC 24 September, as rainfall associated with Hermine spread northward over the islands. Image courtesy of AEMET via Twitter (@AEMET_Canarias).

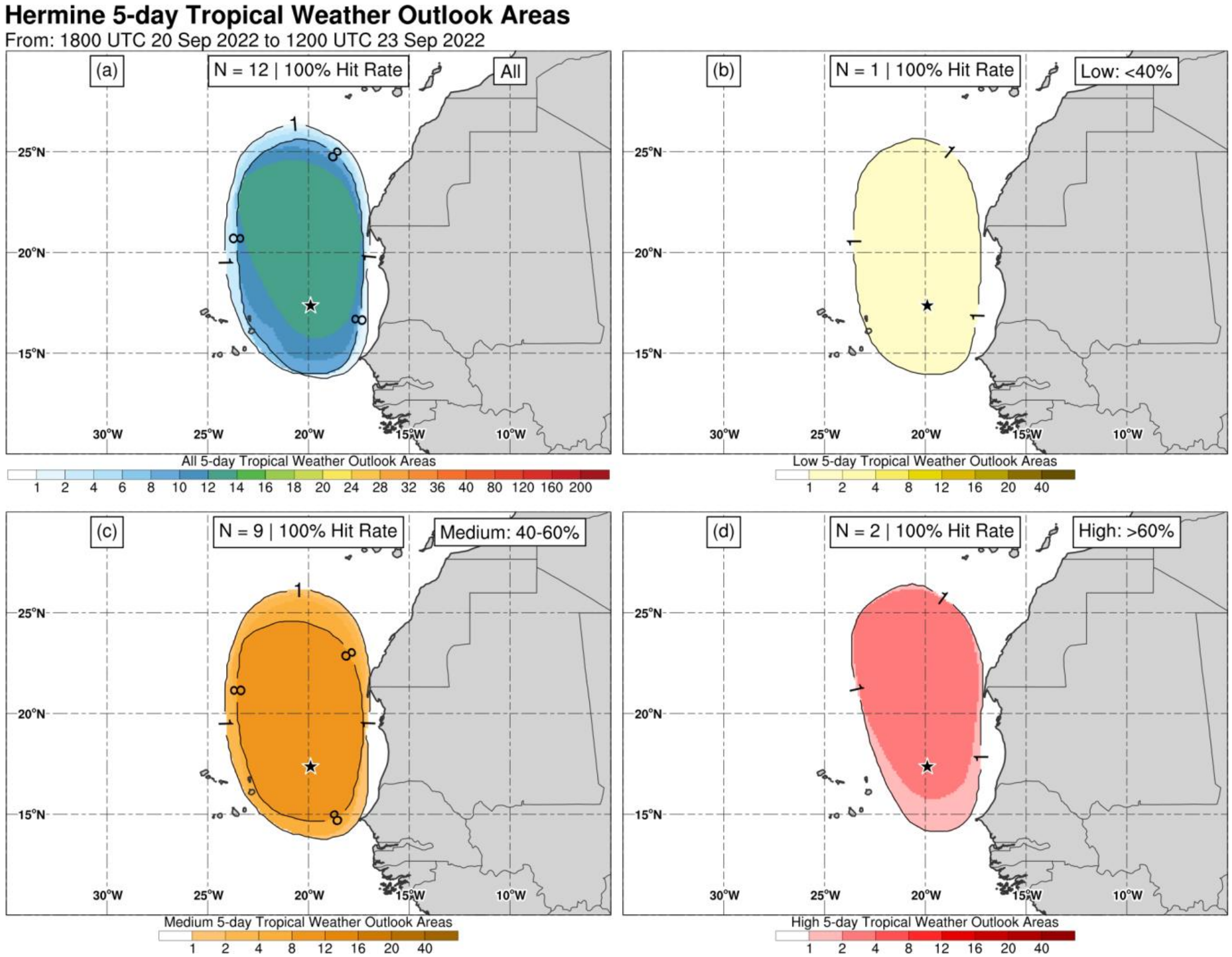


Figure 7. Composites of 5-day tropical cyclone genesis areas depicted in NHC's Tropical Weather Outlooks prior to the formation of Hermine for (a) all probabilistic genesis categories, (b) the low (<40%) category, (c) medium (40–60%) category, and (d) high (>60%) category. The black star in each panel indicates the genesis location of Hermine. The hit rate in each plot indicates the percentage of outlook areas that capture the location of genesis.

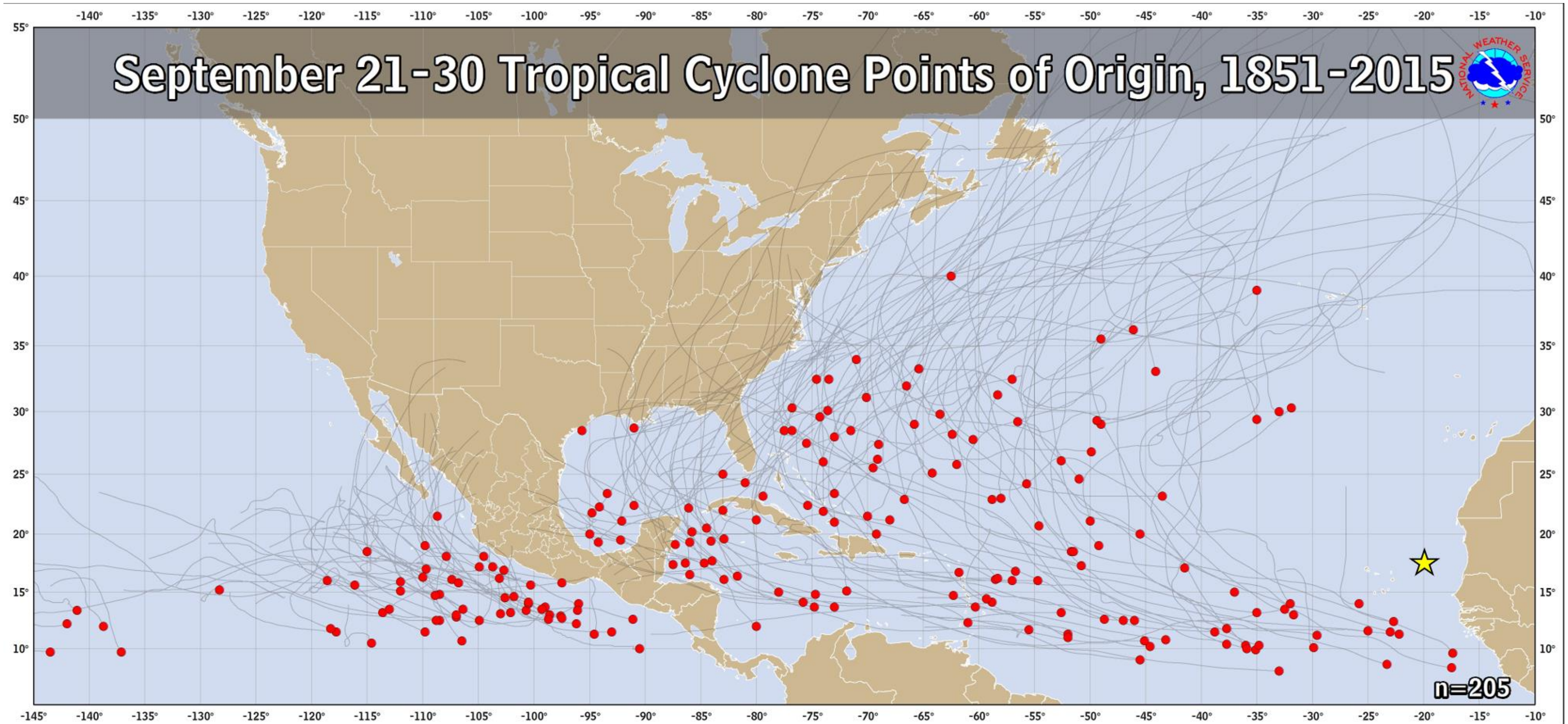


Figure 8. Historical locations of tropical cyclone genesis (red circles) from 21–30 September across the Atlantic (1851–2015) and Eastern Pacific (1949-2015) basins. The location of Hermine's genesis on 23 September 2022 is denoted by the yellow star.