# NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

# TROPICAL STORM BRET (AL032023)

19–24 June 2023

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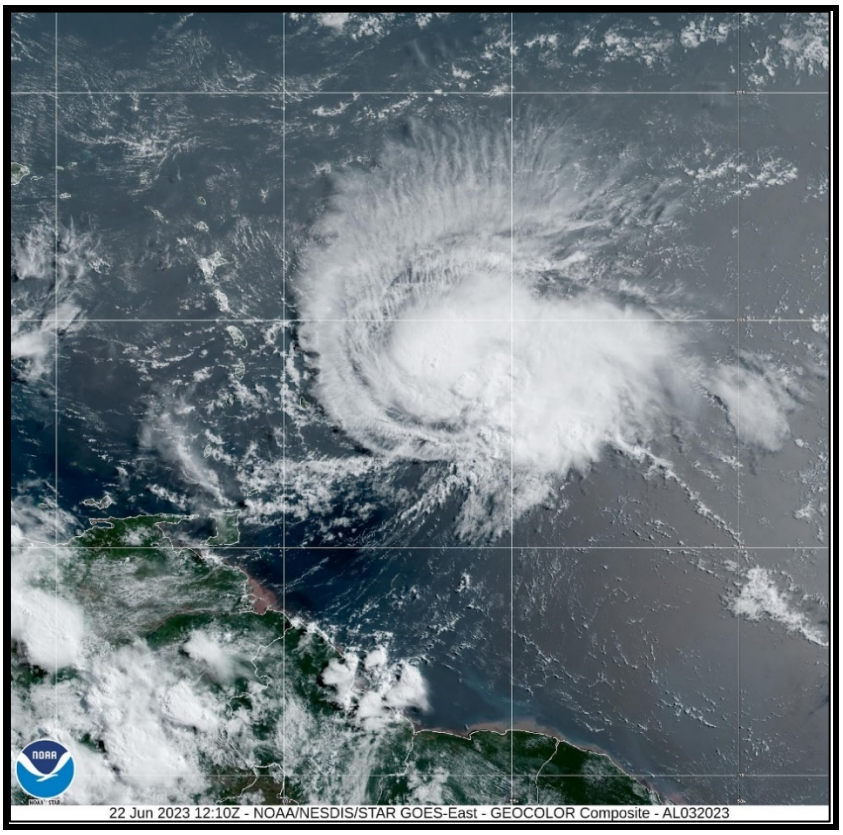


**GOES-16 GEOCOLOR IMAGE OF TROPICAL STORM BRET AT 1210 UTC 22 JUNE 2023. IMAGE COURTESY OF NOAA/NESDIS/STAR.**

Bret was a tropical storm that formed over the tropical Atlantic unusually early in the hurricane season. The cyclone brought tropical-storm-force winds and locally heavy rainfall to portions of the Lesser Antilles before it dissipated over the south-central Caribbean Sea.

# Tropical Storm Bret

**19–24 JUNE 2023**

## SYNOPTIC HISTORY

Bret formed from a tropical wave that moved off the west coast of Africa on 15 June. The wave was accompanied by a large area of disorganized shower and thunderstorm activity while it moved westward over the eastern tropical Atlantic to the south of a mid-level ridge during the next couple of days. The shower and thunderstorm activity began to show signs of organization on 17 June when the system was located about 500 n mi southwest of the Cabo Verde Islands. The next day a broad area of low pressure formed in association with the wave, and the convective activity continued to gradually become better organized. By 0600 UTC 19 June, the low-level center became better defined and the deep convection became sufficiently organized, resulting in the formation of a tropical depression about 1300 n mi east of Barbados in the Lesser Antilles. The cyclone's convective structure continued to improve, and subjective Dvorak satellite intensity estimates indicated that the depression strengthened into Tropical Storm Bret by 1800 UTC 19 June when it was located about 1100 n mi east of Barbados. The "best track" chart of Bret's path is given in Fig. 1, with the wind and pressure histories shown in Figs. 2 and 3, respectively. The best track positions and intensities are listed in Table 1[1].

Bret moved quickly westward after formation to the south of a deep-layered ridge anchored over the central Atlantic. Within generally favorable oceanic and atmospheric conditions, convection increased near the center of the cyclone, and Bret strengthened into a 50-kt tropical storm by 0600 UTC 21 June. After a brief plateau in intensity likely caused by an increase in mid-level westerly vertical wind shear, Bret resumed strengthening and reached its estimated peak intensity of 60 kt by 0600 UTC 22 June when it was located about 215 n mi east of Barbados. An additional increase in the westerly shear caused Bret to begin weakening later that day, and the center of the tropical storm passed near the northern tip of Barbados just after 2100 UTC. Bret continued westward, making landfall on the island of St. Vincent in the Lesser Antilles around 0315 UTC 23 June within an estimated intensity of 50 kt. The strongest winds associated with the tropical storm were located to the north of the center when it passed through the Lesser Antilles.

After the center of Bret moved into the far eastern Caribbean Sea, southwesterly vertical wind shear increased and Bret began to lose organization. The combination of increasing vertical wind shear and the fast translational speed of Bret caused the low-level center to become exposed, and Bret gradually weakened while passing about 75 n mi north of Bonaire, Curacao, and Aruba. Shortly after 1200 UTC 24 June, satellite wind data and data from an Air Force

[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.

Reserve reconnaissance aircraft indicate that the system degenerated into a trough of low pressure over the central Caribbean Sea. At that time, the system was still producing disorganized showers and thunderstorms with winds of 35 to 40 kt. The remnants of Bret continued moving westward for another day or so across the central and southwestern Caribbean Sea and continued to produce winds to gale force.

# METEOROLOGICAL STATISTICS

Observations in Bret (Figs. 2 and 3) 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 flight-level, stepped frequency microwave radiometer (SFMR), and dropwindsonde observations from seven flights of the 53rd Weather Reconnaissance Squadron of the U.S. Air Force Reserve Command (Fig. 4). These flights provided a total of 20 center "fixes" during Bret's lifecycle. 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 Bret.

There were no ship reports of winds of tropical storm force in association with Bret. Selected surface observations from land stations and data buoys are given in Table 2.

## *Winds and Pressure*

Bret's formation (10.7°N 37.3°W) in the central portion of tropical Atlantic was quite unusual for June. In the satellite era (beginning in 1966), Bret's development is the farthest south and east that a tropical cyclone has formed in the basin so early in the hurricane season. Less than three days later, Tropical Storm Cindy became a tropical cyclone in the tropical Atlantic at 39.9°W longitude, marking the first time that two named storms formed in the tropical Atlantic (south of 20°N and east of 60°W) in the month of June and the first simultaneous occurrence of two storms in that part of the basin in June. The formation of these two tropical storms was aided by record-warm sea surface temperatures across the tropical Atlantic for that time of year (Fig. 5).

The 60-kt peak intensity of Bret from 0600 UTC to 1200 UTC 22 June is based on a blend of subjective Dvorak intensity estimates from TAFB and SAB and data from a reconnaissance aircraft. The aircraft reported a peak SFMR surface wind of 69 kt and 700-mb flight-level winds of 55 kt (which supports an intensity of 50 kt) around 0503 UTC 22 June. Around this time, a mid-level eye-like feature was noted in microwave imagery, but this feature was displaced about 30 n mi east of the low-level center due to the westerly shear (Fig. 6). A dropsonde released by the aircraft around this time measured a minimum pressure of 996 mb with 31-kt winds. It appears that the higher SFMR winds may have been associated with transient convection associated with the mid-level eye. Therefore, a blend of the SFMR data and lower flight-level-reduced wind

estimate (Fig. 2) is used as the basis for the 60-kt peak intensity estimate. At that time, the subjective Dvorak estimates ranged from T3.5 (55 kt) from SAB to T4.0 (65 kt) from TAFB. A blend of those subjective estimates also supports a 60-kt peak intensity.

The estimated minimum central pressure at 0600 UTC 22 June is set at 996 mb, which is based on the above-mentioned dropsonde data. Typically, the pressure reported by that dropsonde would be reduced by a few millibars since the dropsonde reported 31-kt surface winds. However, because it appears that the lowest pressure reading was likely associated with the transient convective feature, the pressure from that drop was not reduced further. During the next mission into the storm about 6 h later, dropsonde data did not support minimum pressures lower than about 1002 mb. Therefore, the minimum pressure estimates in the best track from 0600 UTC 22 June through 0000 UTC 23 June are a blend of those derived from the Knaff-Zehr-Courtney pressure-wind relationship and the data collected by the Air Force Reserve Hurricane Hunter aircraft.

Bret brought tropical-storm-force winds, especially in gusts, to portions of the Lesser Antilles early on 23 June. Although the reporting station at Hewanorra Airport (TLPL) on St. Lucia stopped transmitting data early on 23 June, the St. Lucia Meteorological Service provided a post-storm report that showed that sustained winds of 54 kt and a gust to 90 kt were measured at that observing site around 0240 UTC 23 June. Those winds are the basis for the 55-kt intensity of Bret at 0000 UTC 23 June. Bret made landfall a few hours later at 0315 UTC on the island of St. Vincent, and the 55-kt landfall intensity is also based on that observation. The strongest winds associated with Bret were located north of the center, and radar data from Barbados (not shown) indicated that a band of strong thunderstorms moved across St. Lucia around the time of those peak winds. The estimated minimum pressure of 1001 mb at the time of Bret's landfall on St. Vincent is based on dropsonde data from an Air Force Reserve Hurricane Hunter aircraft.

Farther north in the Lesser Antilles, wind gusts of 45 to 55 kt were reported at elevations near sea level in Martinique (Table 2, Fig. 7). The highest wind gusts at near sea-level sites were 56 kt at Vauclin and 51 kt at the Lamentin Airport. The highest wind gust report on that island was 76 kt at a highly elevated station (493 m) at Fond-Denis-Cadet.

## *Rainfall and Flooding*

Bret's fast motion across the Windward Islands limited the amount of rainfall that fell across that area. Most of the area received 2 to 3 inches (25 to 50 mm) of rainfall with isolated amounts of 5 to 6 inches (125 to 150 mm). The highest storm total amount recorded during the event was 5.98 in (151.8 mm) at Jennings Station on St. Vincent. A couple of other weather stations on that island reported 2.70 in (68.7 mm) and 2.56 in (65.0 mm) at South Rivers and Perseverance, respectively. On Barbados, a storm total of 2.60 in (66 mm) was reported at the Grantly Adams International Airport. A storm total amount of 2.78 in (70.6 mm) was measured at Hewanorra Airport on St. Lucia. On the island of Martinique, rainfall amounts of less than 2 inches (51 mm) occurred (Fig. 7).

# CASUALTY AND DAMAGE STATISTICS

There have been no reports of deaths or serious injuries in association with Bret. Media reports indicate that downed trees, power outages, and limited damage to homes occurred in Barbados, St. Lucia, and St. Vincent and the Grenadines. Reports from the Caribbean Disaster Emergency Management Agency indicate that roofs of 35 structures and 17 homes were damaged. In St. Vincent and the Grenadines, some damage to the agricultural sector was reported. About 50-60 percent of customers lost power on St. Lucia and in St. Vincent and the Grenadines. In Bridgetown, Barbados, a tree fell onto a home, but the homeowner escaped serious injuries. There have been no monetary damage estimates received.

# FORECAST AND WARNING CRITIQUE

The genesis of Bret was adequately predicted, especially since it was the earliest formation on record so far east in the tropical Atlantic during June. The tropical wave from which Bret developed was introduced in the Tropical Weather Outlook 90 h prior to genesis (Table 3). The 7-day probabilities were raised to the medium (40-60%) and high (>60%) categories 72 and 54 h before genesis, respectively. A 2-day chance of formation was introduced into the 66 h before formation, and the 2-day probabilities were raised to the medium and high categories 48 and 24 h before development, respectively. Bret's location of formation was well anticipated as every NHC genesis area drawn correctly encapsulated the formation location over the central portion of the tropical Atlantic (Fig. 8). These forecasts were aided by consistent global model forecasts that indicated the potential for tropical cyclone formation in that area for several days, as well as awareness of the unusually warm sea surface temperatures across the tropical Atlantic (Fig. 5).

A verification of NHC official track forecasts for Bret is given in Table 4a. Official track forecast errors through 72 h were slightly lower than the mean official errors for the previous 5-year period. The mean 96- and 120-h track forecast errors were significantly higher than the 5-year means, albeit for a relatively small sample size at those lead times. A homogeneous comparison of the official track errors with selected guidance models is given in Table 4b and illustrated in Figure 9. The best performing individual track model was the ECMWF (EMXI) which had mean errors lower than the official forecast through 96 h. Nearly all the other global and regional hurricane models predicted that Bret would strengthen more than what occurred. This error resulted in a stronger, deeper cyclone moving more poleward, especially in the early forecasts for this system (Fig. 10). Of the consensus aids, the HFIP Corrected Consensus (HCCA) and the GFEX (ensemble of the GFS and ECMWF) had the lowest mean errors. The HCCA model had the lowest mean errors of any of the track guidance at 60 through 96 h (Table 4b).

A verification of NHC official intensity forecasts for Tropical Storm Bret is given in Table 5a. Official intensity forecast errors were lower than the mean official errors for the previous

5-year period through 72 h, but larger than the long-term means at 96 and 120 h. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 5b and illustrated in Figure 11. Despite early forecasts that called for Bret to reach hurricane strength, the NHC forecasts were more skillful than nearly all the intensity guidance at each verifying lead time (Fig. 11). At 96 h, the HMNI, CTCI, LGEM, and GFSI had lower mean errors (Table 5b), but the official forecast had lower mean errors than all the various consensus aids at the remaining lead times. By the fourth NHC advisory package (issued at 1500 UTC 20 June), the NHC forecast accurately predicted Bret's dissipation over the eastern Caribbean Sea.

Coastal watches and warnings associated with Tropical Storm Bret are given in Table 6.

Table 1. Best track for Tropical Storm Bret, 19–24 June 2023.

| Date/Time (UTC) | Latitude (°N) | Longitude (°W) | Pressure (mb) | Wind Speed (kt) | Stage |
|---|---|---|---|---|---|
| 19 / 0600 | 10.7 | 37.3 | 1009 | 30 | tropical depression |
| 19 / 1200 | 10.9 | 39.1 | 1009 | 30 | " |
| 19 / 1800 | 11.1 | 40.9 | 1008 | 35 | tropical storm |
| 20 / 0000 | 11.3 | 42.7 | 1008 | 35 | " |
| 20 / 0600 | 11.5 | 44.5 | 1008 | 35 | " |
| 20 / 1200 | 11.7 | 46.3 | 1008 | 35 | " |
| 20 / 1800 | 12.0 | 48.0 | 1006 | 40 | " |
| 21 / 0000 | 12.4 | 49.4 | 1004 | 45 | " |
| 21 / 0600 | 12.7 | 50.7 | 1001 | 50 | " |
| 21 / 1200 | 13.0 | 52.0 | 1001 | 50 | " |
| 21 / 1800 | 13.3 | 53.3 | 1000 | 55 | " |
| 22 / 0000 | 13.4 | 54.6 | 999 | 55 | " |
| 22 / 0600 | 13.5 | 55.9 | 996 | 60 | " |
| 22 / 1200 | 13.5 | 57.3 | 998 | 60 | " |
| 22 / 1800 | 13.4 | 58.8 | 1000 | 55 | " |
| 23 / 0000 | 13.3 | 60.3 | 1001 | 55 | " |
| 23 / 0315 | 13.3 | 61.2 | 1001 | 55 | " |
| 23 / 0600 | 13.3 | 62.0 | 1001 | 50 | " |
| 23 / 1200 | 13.2 | 63.8 | 1002 | 50 | " |
| 23 / 1800 | 13.1 | 65.6 | 1003 | 45 | " |
| 24 / 0000 | 13.0 | 67.4 | 1004 | 45 | " |
| 24 / 0600 | 13.0 | 69.2 | 1005 | 40 | " |
| 24 / 1200 | 13.0 | 70.9 | 1007 | 40 | " |
| 24 / 1800 | | | | | dissipated |
| 22 / 0600 | 13.5 | 55.9 | 996 | 60 | maximum wind and minimum pressure |
| 23/ 0315 | 13.3 | 61.2 | 1001 | 55 | landfall on St. Vincent |

Table 2. Selected surface observations for Tropical Storm Bret, 19–24 June 2023.

| Location | Minimum Sea Level Pressure | | Maximum Surface Wind Speed | | | Storm surge (ft) | Storm tide (ft) | Estimated Inundation (ft) | Total rain (in) |
|---|---|---|---|---|---|---|---|---|---|
| | Date/ time (UTC) | Press. (mb) | Date/ time (UTC)[a] | Sustained (kt)[b] | Gust (kt) | | | | |
| **Offshore** | | | | | | | | | |
| **Buoys** | | | | | | | | | |
| 470 NM East of Martinique (41040) (14.54ºN 53.14ºW) | 21/1820 | 1010.2 | 21/1908 | 37 (3.8 m, 1 min) | 43 | | | | |
| **Barbados** | | | | | | | | | |
| Grantley Adams International Airport (TBPB) (78954) (13.08ºN 59.49ºW) | 22/2000 | 1004.8 | 22/0429 | 38 | 48 | | | | 2.60 |
| **Saint Vincent and the Grenadines** | | | | | | | | | |
| Jennings | | | | | | | | | 5.98 |
| South Rivers | | | | | | | | | 2.70 |
| Perseverance | | | | | | | | | 2.56 |
| **Saint Lucia** | | | | | | | | | |
| Hewanorra Airport (TLPL) (13.74ºN 60.95ºW) | 23/0100 | 1010.6 | 23/0240 | 54 | 90 | | | | 2.78 |
| GFL Charles Airport (TLPC) (14.02ºN 60.99ºW) | 23/0450 | 1010.7 | 23/0400 | 25 | 43 | | | | 0.96 |
| **Martinique** | | | | | | | | | |
| Fond-Denis-Cadet (14.735ºN 61.145ºW) | | | | | 76 (493 m) | | | | |
| Fort-de-France-Desaix (14.618ºN 61.064ºW) | | | | | 47 (143 m) | | | | |
| Fort-de-France-Pte Negres (14.599ºN 61.090ºW) | | | | | 47 (12 m) | | | | |
| Francois Chopot (14.627ºN 61.919ºW) | | | | | 41 (53 m) | | | | |
| Lamentin Aeroport (14.595ºN 60.996ºW) | | | | | 51 (3 m) | | | | |

| Location | Minimum Sea Level Pressure | | Maximum Surface Wind Speed | | | Storm surge (ft) | Storm tide (ft) | Estimated Inundation (ft) | Total rain (in) |
|---|---|---|---|---|---|---|---|---|---|
| | Date/ time (UTC) | Press. (mb) | Date/ time (UTC)[a] | Sustained (kt)[b] | Gust (kt) | | | | |
| Lorrain Vallon (14.829ºN 61.049ºW) | | | | | 44 (83 m) | | | | |
| Robert Pte Fort (14.679ºN 60.925ºW) | | | | | 48 (16 m) | | | | |
| St-Joseph Lezard (14.658ºN 60.998ºW) | | | | | 48 (65 m) | | | | |
| Trinite Caravelle (14.774ºN 60.875ºW) | | | | | 53 (26 m) | | | | |
| Vauclin (14.551ºN 60.837ºW) | | | | | 56 (12 m) | | | | |

[a] Date/time is for sustained wind when both sustained and gust are listed.
[b] Except as noted, sustained wind averaging periods for C-MAN and land-based reports are 2 min; buoy averaging periods are 8 min.

Table 3. Number of hours in advance of formation 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** | **168-Hour Outlook** |
| Low (<40%) | 66 | 90 |
| Medium (40%-60%) | 48 | 72 |
| High (>60%) | 24 | 54 |

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Tropical Storm Bret. 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 | **21.8** | **33.9** | **43.9** | **57.1** | **65.8** | **84.4** | 176.2 | 330.6 |
| OCD5 | 26.8 | 62.9 | 104.0 | 168.7 | 203.7 | 235.1 | 288.9 | 412.0 |
| Forecasts | 19 | 17 | 15 | 13 | 11 | 9 | 5 | 1 |
| OFCL (2018-22) | 23.8 | 35.7 | 47.8 | 61.4 | 76.1 | 90.5 | 125.7 | 172.1 |
| OCD5 (2018-22) | 46.4 | 99.2 | 157.4 | 215.0 | 254.9 | 321.2 | 405.1 | 486.6 |

Table 4b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Tropical Storm Bret. Errors smaller than the NHC official forecast are shown in boldface type. The number of official forecasts shown here will generally be smaller than that shown in Table 4a due to the homogeneity requirement.

| Model ID | Forecast Period (h) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 12 | 24 | 36 | 48 | 60 | 72 | 96 | 120 |
| OFCL | 22.3 | 34.5 | 43.6 | 57.8 | 68.2 | 87.4 | 207.9 | |
| OCD5 | 28.2 | 65.4 | 110.1 | 176.4 | 211.8 | 243.1 | 299.7 | |
| GFSI | 28.6 | 53.5 | 74.6 | 96.9 | 116.4 | 140.8 | 285.9 | |
| EMXI | **22.0** | **32.5** | **38.1** | **46.7** | **58.1** | **85.6** | **125.2** | |
| CMCI | **22.0** | 41.2 | 67.3 | 105.6 | 132.7 | 175.2 | **185.1** | |
| HMNI | 28.5 | 48.6 | 71.3 | 103.0 | 132.4 | 175.3 | 453.9 | |
| HWFI | 43.3 | 84.0 | 114.7 | 151.6 | 178.0 | 224.7 | 342.9 | |
| HFAI | 32.5 | 53.7 | 70.8 | 94.7 | 112.4 | 143.8 | 317.9 | |
| HFBI | 27.8 | 43.7 | 55.2 | 73.1 | 84.1 | 103.5 | 252.5 | |
| CTCI | 35.1 | 67.6 | 86.2 | 101.7 | 114.8 | 125.6 | 276.5 | |
| AEMI | 22.9 | 39.0 | 54.1 | 72.8 | 87.3 | 99.8 | **163.6** | |
| HCCA | 23.9 | 38.6 | **42.6** | **49.9** | **54.0** | **63.5** | **80.7** | |
| FSSE | 22.6 | 40.1 | 44.6 | **54.5** | **66.2** | 90.3 | **184.8** | |
| TVCX | 24.2 | 42.0 | 50.7 | 63.8 | 72.6 | **86.2** | **157.8** | |
| GFEX | **22.2** | 35.4 | 44.4 | **57.4** | **63.6** | **76.8** | **114.1** | |
| TVCA | 25.0 | 43.5 | 53.7 | 68.4 | 80.8 | 97.9 | **200.3** | |
| TVDG | 23.8 | 40.8 | 50.1 | 65.5 | 77.3 | 95.3 | **180.4** | |
| TABD | 42.6 | 103.0 | 167.2 | 240.4 | 310.5 | 393.1 | 620.0 | |
| TABM | 28.8 | 55.0 | 86.1 | 125.3 | 163.4 | 212.2 | 413.7 | |
| TABS | 37.1 | 76.7 | 124.2 | 161.1 | 179.9 | 178.7 | **133.8** | |
| Forecasts | 18 | 16 | 14 | 12 | 10 | 8 | 3 | |

Table 5a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Tropical Storm Bret. 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 | **2.9** | **3.8** | **4.0** | **4.2** | **4.1** | **5.0** | 14.0 | 25.0 |
| OCD5 | 4.0 | 7.1 | 11.1 | 14.2 | 13.1 | 10.9 | 11.2 | 17.0 |
| Forecasts | 19 | 17 | 15 | 13 | 11 | 9 | 5 | 1 |
| OFCL (2018-22) | 5.1 | 7.6 | 8.9 | 10.1 | 10.7 | 11.5 | 13.3 | 15.5 |
| OCD5 (2018-22) | 6.8 | 10.7 | 13.9 | 16.5 | 18.3 | 20.2 | 22.9 | 23.4 |

Table 5b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Tropical Storm Bret. Errors smaller than the NHC official forecast are shown in boldface type. The number of official forecasts shown here will generally be smaller than that shown in Table 5a due to the homogeneity requirement.

| Model ID | Forecast Period (h) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 12 | 24 | 36 | 48 | 60 | 72 | 96 | 120 |
| OFCL | 2.8 | 3.4 | 3.6 | 3.8 | 3.5 | 4.4 | 12.5 | |
| OCD5 | 4.1 | 7.6 | 11.4 | 14.5 | 13.3 | 10.8 | 13.2 | |
| HWFI | 5.4 | 7.9 | 7.6 | 12.0 | 21.2 | 35.8 | 56.8 | |
| HMNI | 5.0 | 7.8 | 9.1 | 8.3 | 7.7 | 7.1 | **2.5** | |
| HFAI | 4.5 | 5.1 | 4.5 | 6.5 | 9.8 | 16.2 | 29.0 | |
| HFBI | 4.4 | 5.1 | 5.2 | 6.1 | 4.8 | 6.9 | 13.5 | |
| CTCI | 4.7 | 6.4 | 8.1 | 9.2 | 8.2 | 8.4 | **5.0** | |
| DSHP | 3.3 | 5.2 | 6.1 | 6.8 | 4.5 | 7.5 | 19.8 | |
| LGEM | 3.6 | 5.2 | 6.4 | 6.8 | 4.9 | 5.5 | **9.5** | |
| ICON | 3.9 | 5.1 | 5.4 | 5.0 | 4.5 | 9.1 | 20.5 | |
| IVCN | 4.1 | 5.2 | 5.6 | 5.6 | 4.5 | 7.6 | 17.2 | |
| IVDR | 4.0 | 5.3 | 5.6 | 5.4 | 4.0 | 7.1 | 15.5 | |
| HCCA | 3.3 | 4.6 | 5.2 | 5.2 | 6.8 | 11.6 | 17.8 | |
| FSSE | 3.1 | 4.6 | 5.6 | 5.2 | 5.3 | 7.6 | 18.2 | |
| GFSI | 4.4 | 6.0 | 8.4 | 10.1 | 12.4 | 12.0 | **7.8** | |
| EMXI | **2.7** | 5.6 | 8.6 | 10.6 | 10.7 | 12.5 | 16.2 | |
| Forecasts | 18 | 16 | 14 | 12 | 10 | 8 | 4 | |

Table 6. Watch and warning summary for Tropical Storm Bret, 19–24 June 2023.

| Date/Time (UTC) | Action | Location |
|---|---|---|
| **20 / 2100** | Tropical Storm Watch issued | Barbados |
| **20 / 2100** | Tropical Storm Watch issued | Dominica |
| **21 / 0000** | Tropical Storm Watch issued | St. Lucia |
| **21 / 0000** | Tropical Storm Watch issued | Martinique |
| **21 / 1500** | Tropical Storm Watch changed to Tropical Storm Warning | St. Lucia |
| **21 / 2100** | Tropical Storm Watch changed to Tropical Storm Warning | Martinique |
| **21 / 2100** | Tropical Storm Watch issued | Saint Vincent and the Grenadines |
| **22 / 0300** | Tropical Storm Watch changed to Tropical Storm Warning | Dominica |
| **22 / 0600** | Hurricane Watch issued | St. Lucia |
| **22 / 1800** | Tropical Storm Watch changed to Tropical Storm Warning | Barbados |
| **22 / 1800** | Tropical Storm Watch changed to Tropical Storm Warning | Saint Vincent and the Grenadines |
| **23 / 0300** | Hurricane Watch discontinued | St. Lucia |
| **23 / 0900** | Tropical Storm Warning discontinued | Dominica |
| **23 / 0900** | Tropical Storm Warning discontinued | Barbados |
| **23 / 1200** | Tropical Storm Warning discontinued | St. Lucia |
| **23 / 1200** | Tropical Storm Warning discontinued | Martinique |
| **23 / 1500** | Tropical Storm Warning discontinued | All |

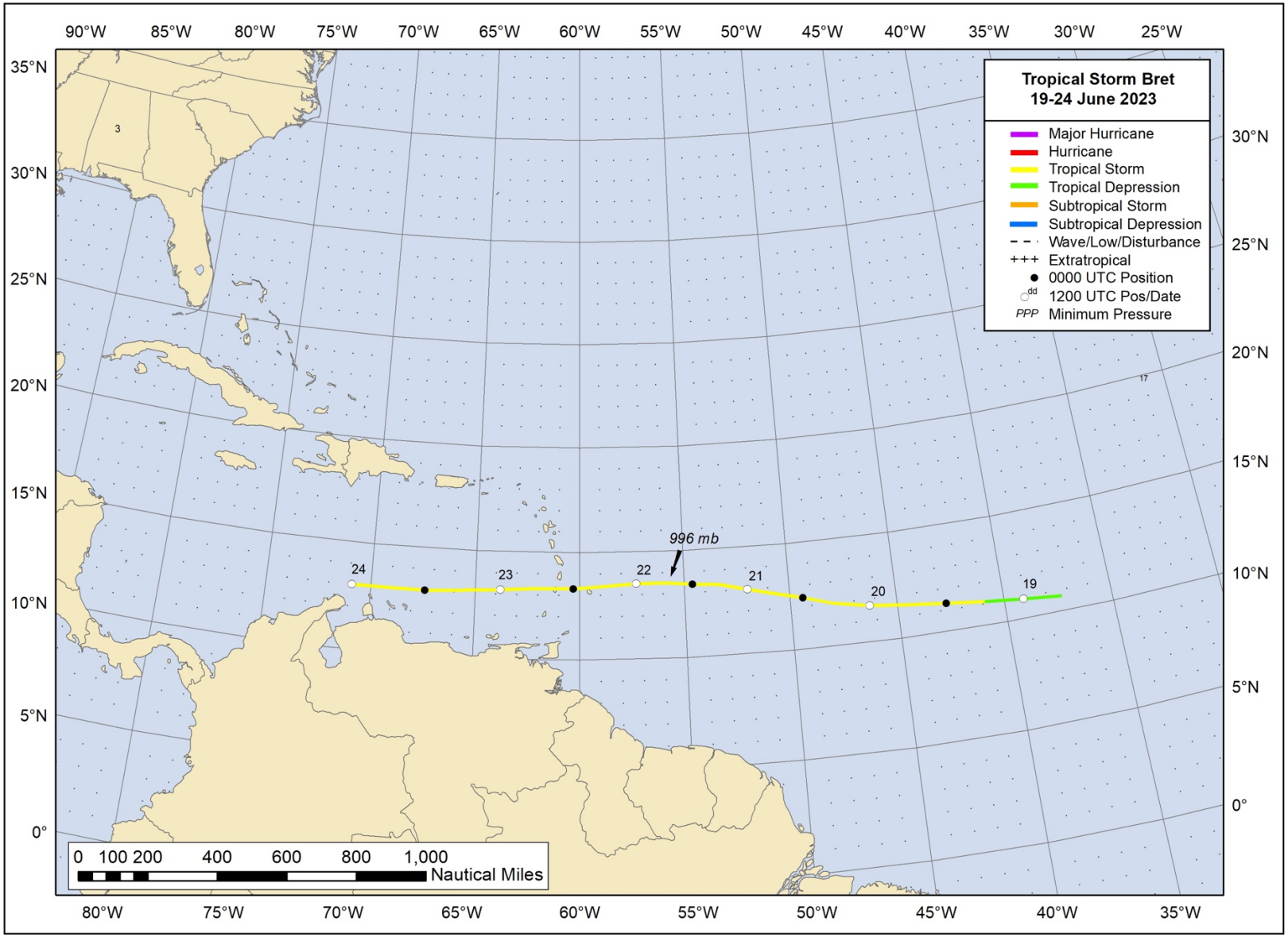


Figure 1. Best track positions for Tropical Storm Bret, 19–24 June 2023.

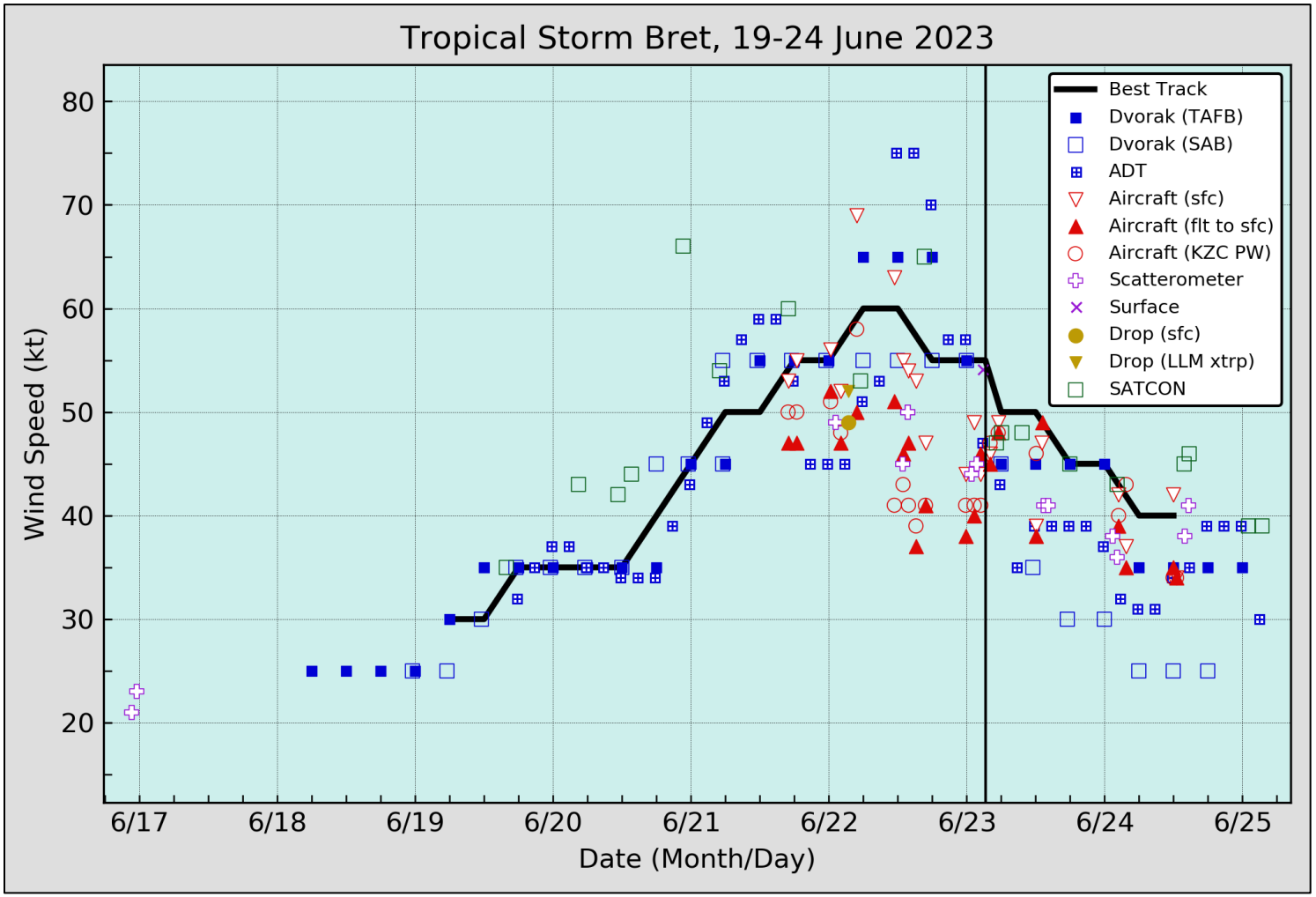


Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Bret, 19–24 June 2023. Aircraft observations have been adjusted for elevation using 90%, 80%, and 80% adjustment factors for observations from 700 mb, 850 mb, and 1500 ft, respectively. Dropwindsonde observations include actual 10 m winds (sfc), as well as surface estimates derived from the mean wind over the lowest 150 m of the wind sounding (LLM). 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, and solid vertical lines correspond to landfalls.

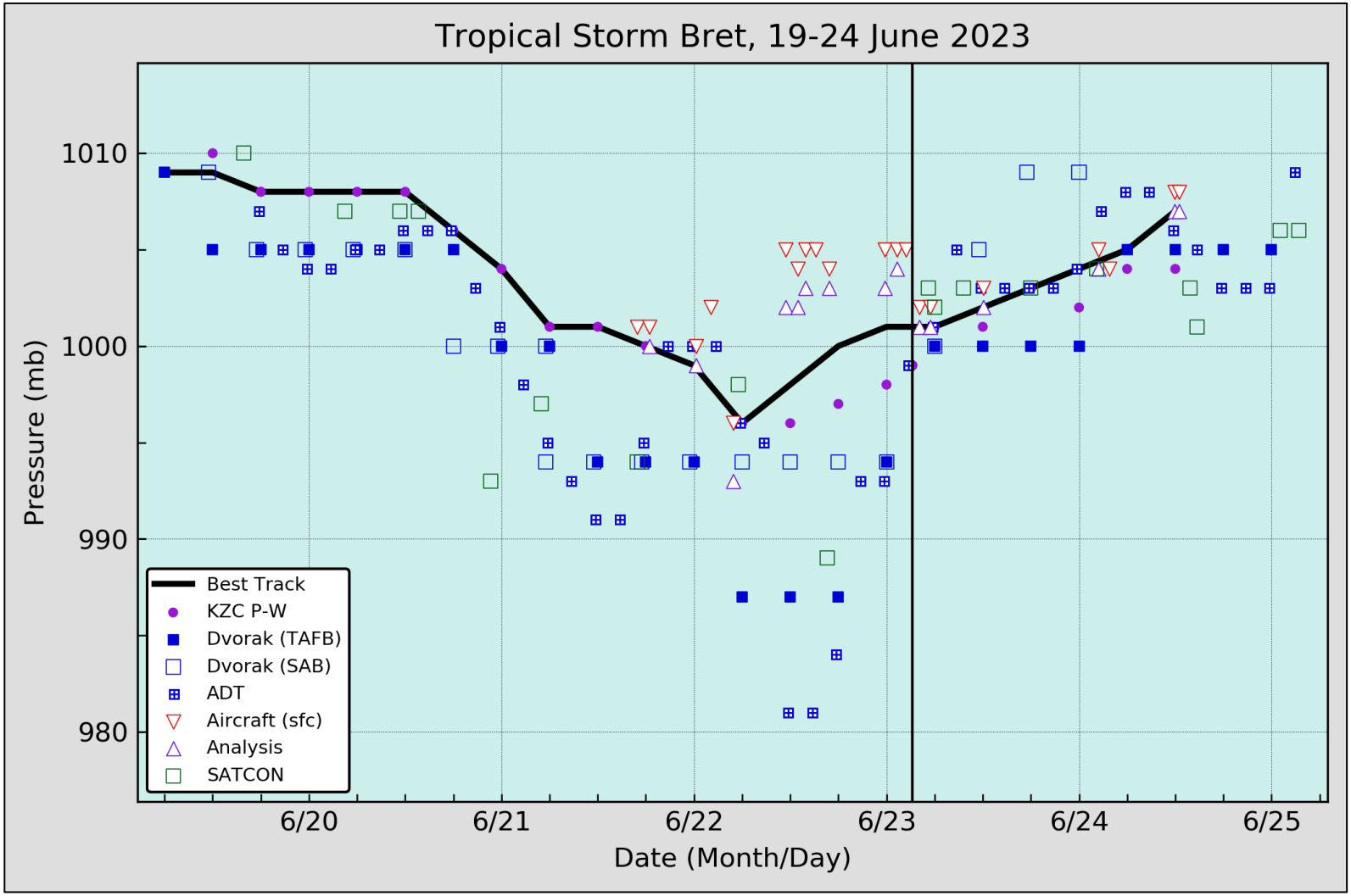


Figure 3. Selected pressure observations and best track minimum central pressure curve for Tropical Storm Bret, 19–24 June 2023. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological 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, and solid vertical lines correspond to landfalls.

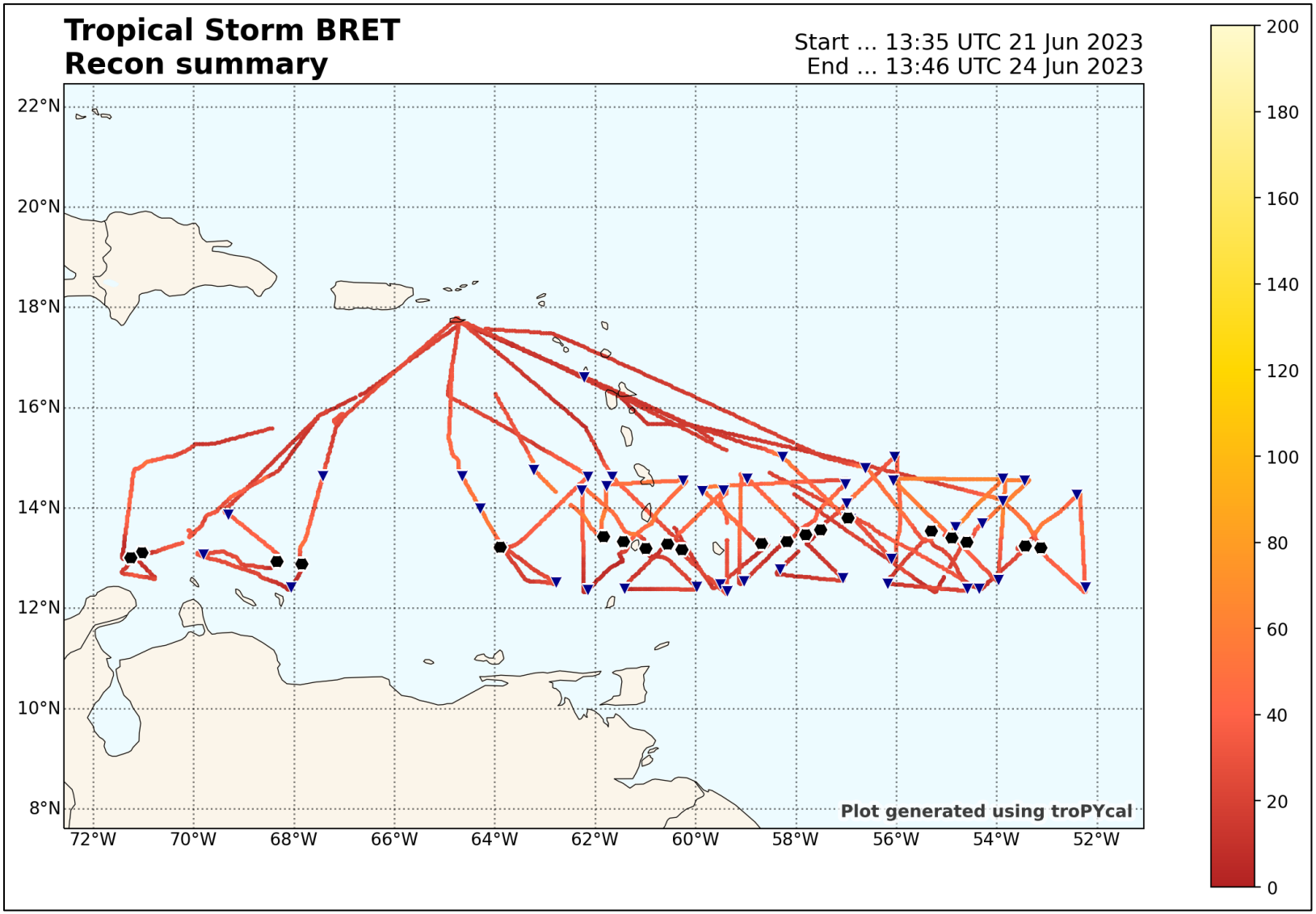


Figure 4. Air Force Reserve Hurricane Hunter aircraft flight tracks (red) from reconnaissance missions into Bret on 21–24 June 2023. The black markers denote center fixes, and the blue triangles indicate dropsonde locations. The color coding of the flight tracks is based on the observed flight-level wind speed with the color legend to the right of the map representing the color associated with the various wind speeds in knots.

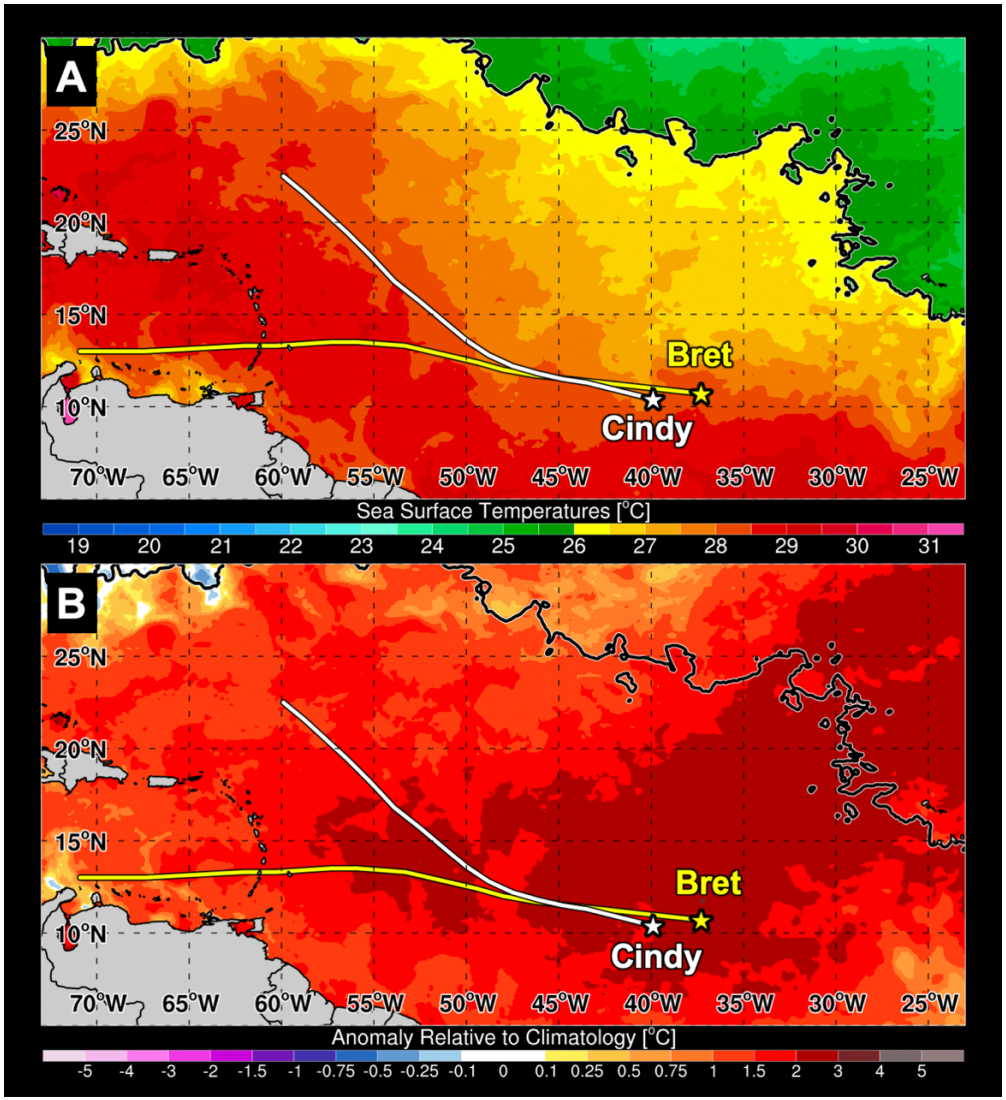


Figure 5. Sea surface temperatures (°C, panel a) and sea surface temperature anomalies relative to a daily climatology (°C, panel b) on 19 June 2023, just prior to the formation and passage of Tropical Storms Bret and Cindy. The 26°C sea surface temperature isotherm is highlighted as a black contour, while the track (line) and location of genesis (star) of both tropical storms are shown for Bret (yellow) and Cindy (white), respectively. Data obtained from NOAA's Coral Reef Watch, accessible at https://coralreefwatch.noaa.gov/.

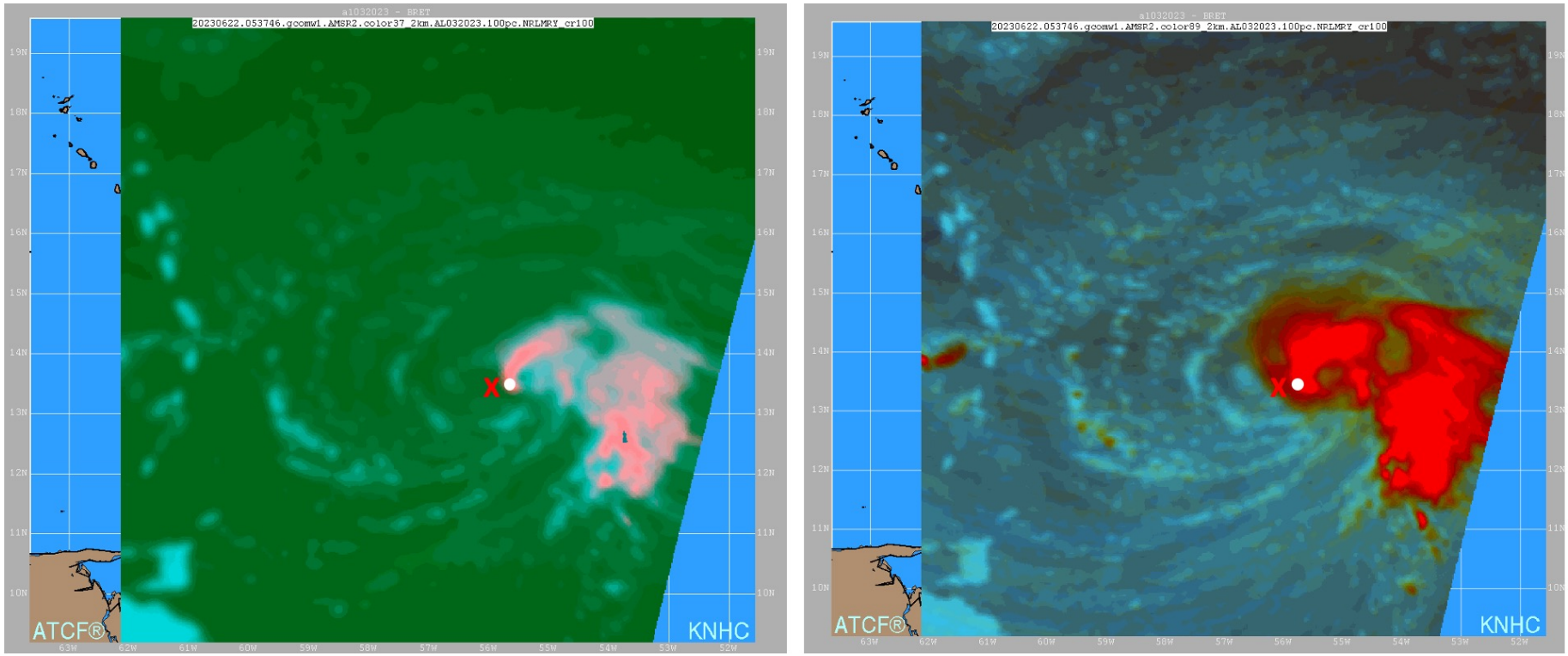


Figure 6. AMSR2 37-GHz (left) and 89-GHz (right) Color Composite images of Tropical Storm Bret at 0537 UTC 22 June 2023. Note the mid-level eye feature seen in the 89-GHz image and the displacement of that feature to the east of the low-level center marked with the red “X” in both images. The white dot is the approximate location of the 69-kt SFMR wind observation from the Air Force Reserve reconnaissance aircraft at 0503 UTC that day.

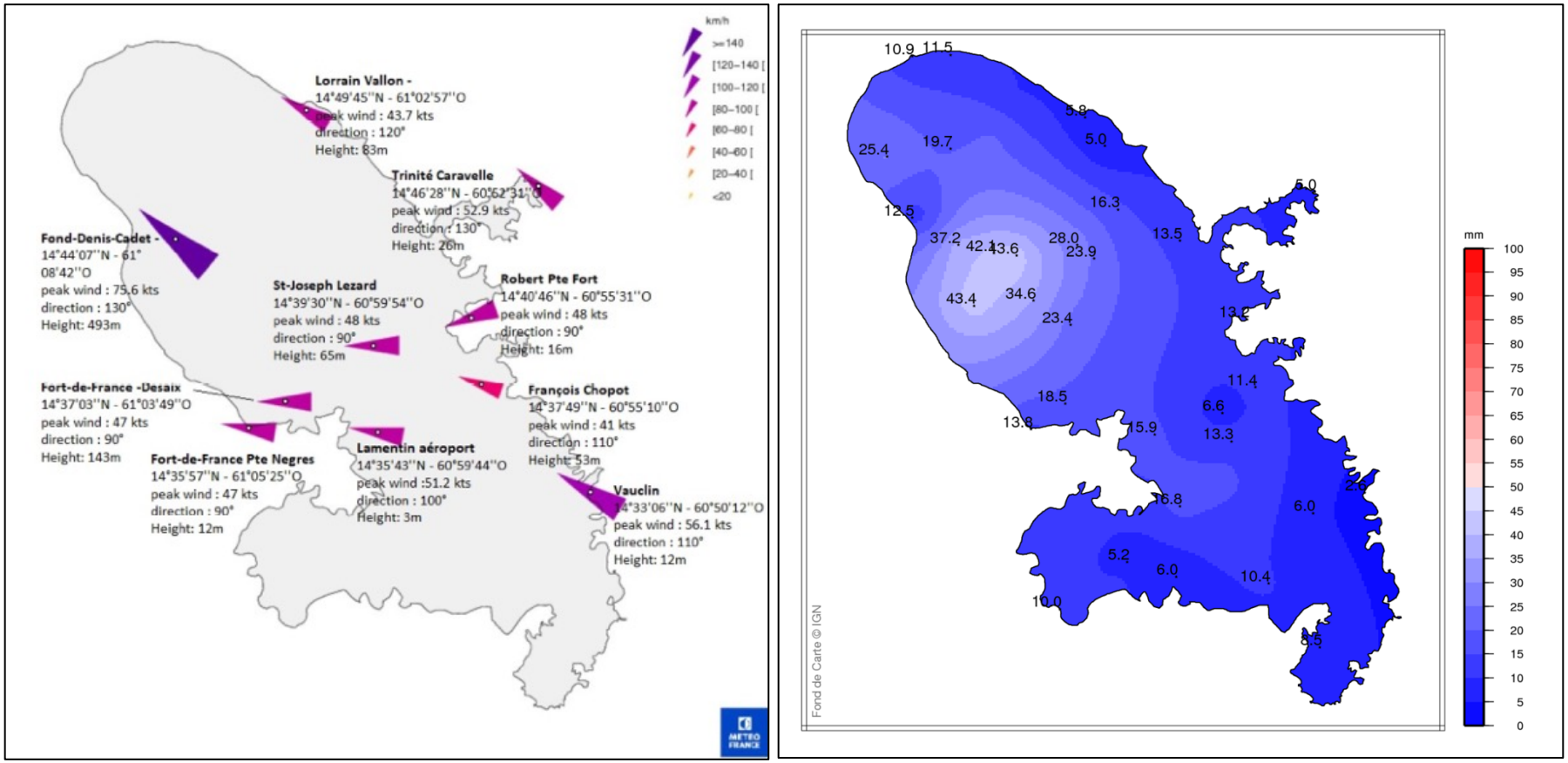


Figure 7. Selected peak wind gust measurements (left, in kt) and storm total rainfall observations (right, in mm) from Martinique during the passage of Tropical Storm Bret on 22-23 June. Images courtesy of MeteoFrance. The peak gust data covers the period from 0600 UTC 22 June to 0500 UTC 23 June. The rainfall data is from the 48-h period ending at 2000 UTC 23 June.

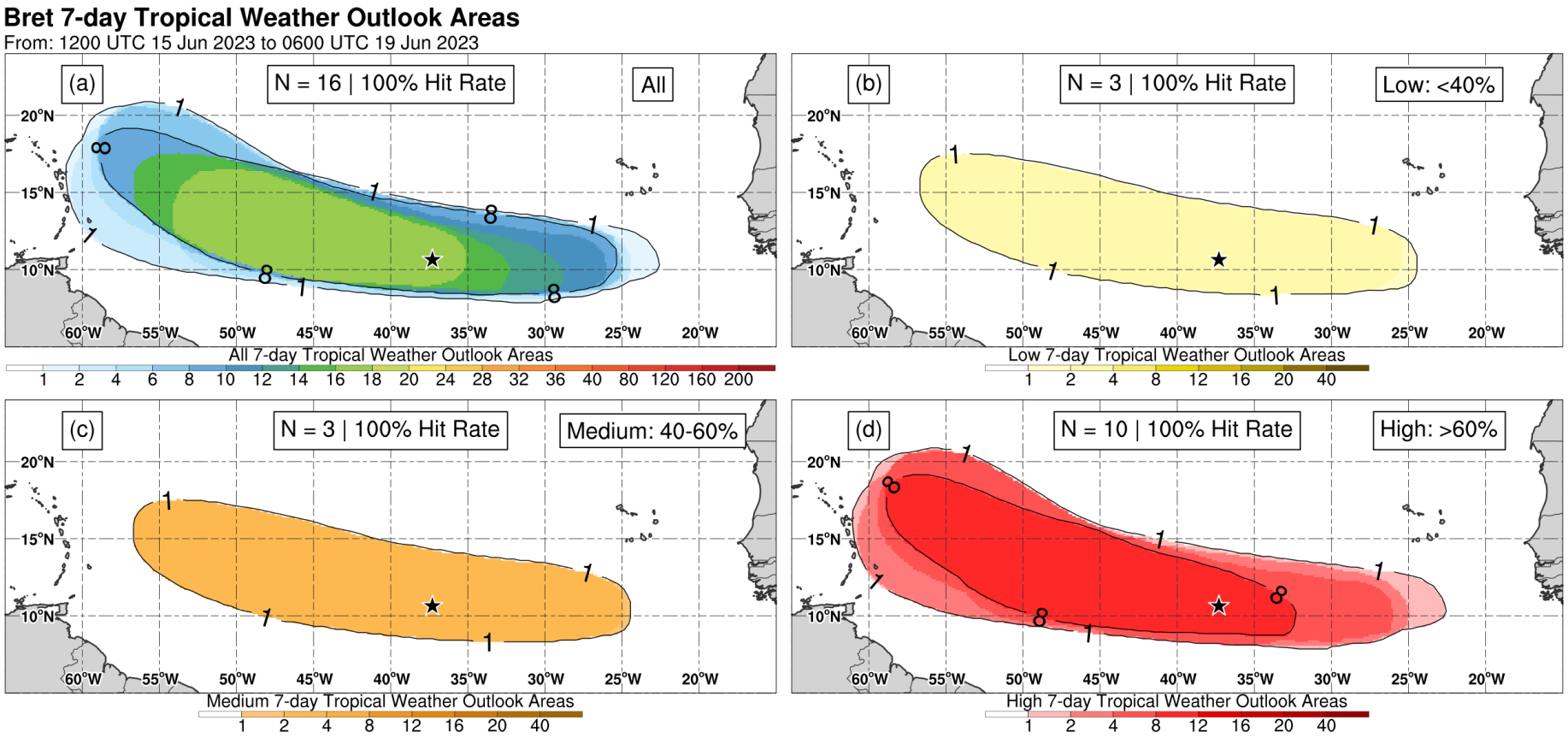


Figure 8. Composites of 7-day tropical cyclone genesis areas depicted in NHC's Tropical Weather Outlooks prior to the formation of Tropical Storm Bret for (a) all probabilistic genesis categories, (b) the low (<40%) category, (c) medium (40–60%) category, and (d) high (>60%) category. Bret's location of genesis is indicated by the black star.

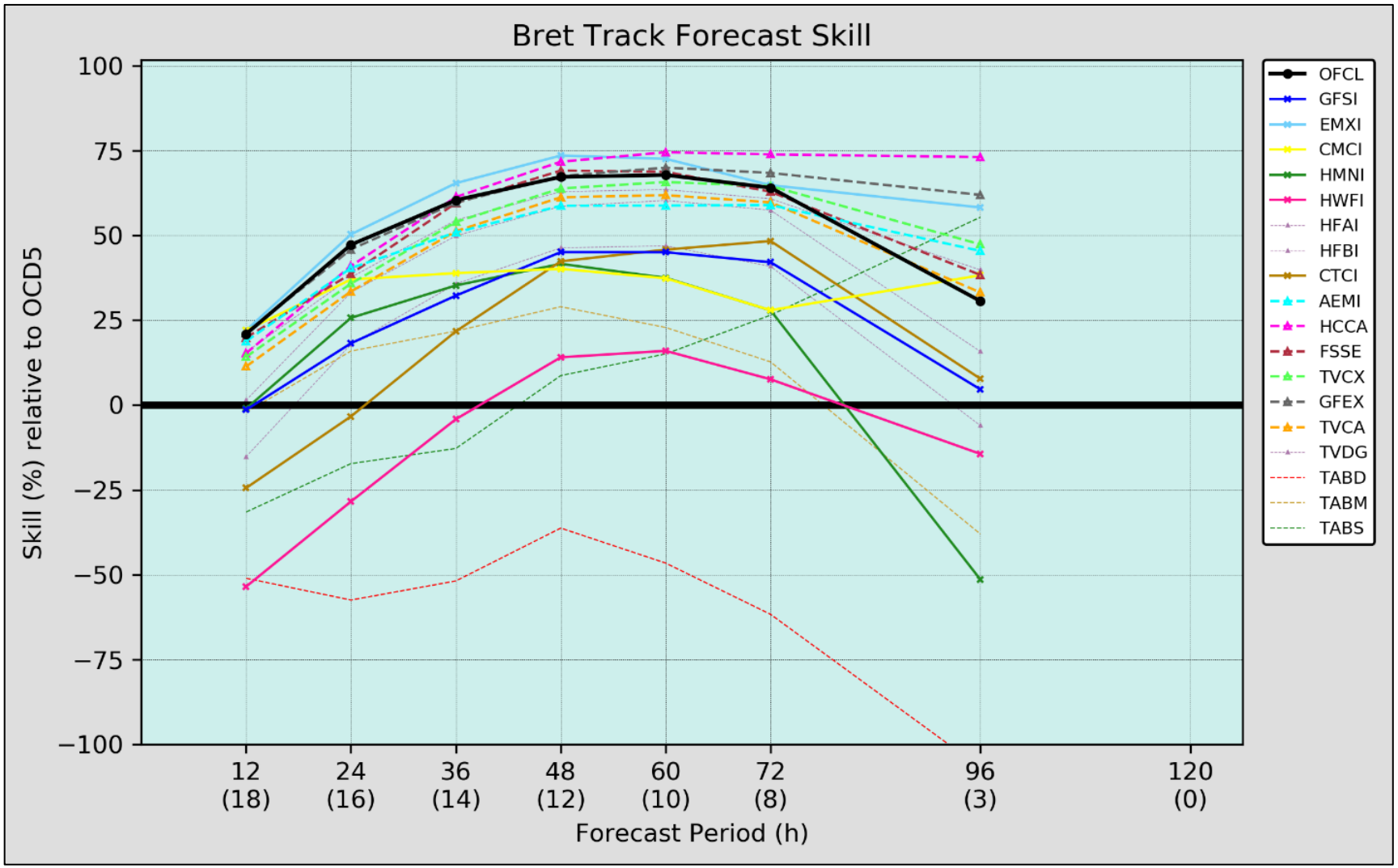


Figure 9. Official forecast and selected model forecast track skill for Tropical Storm Bret, 19–24 June 2023.

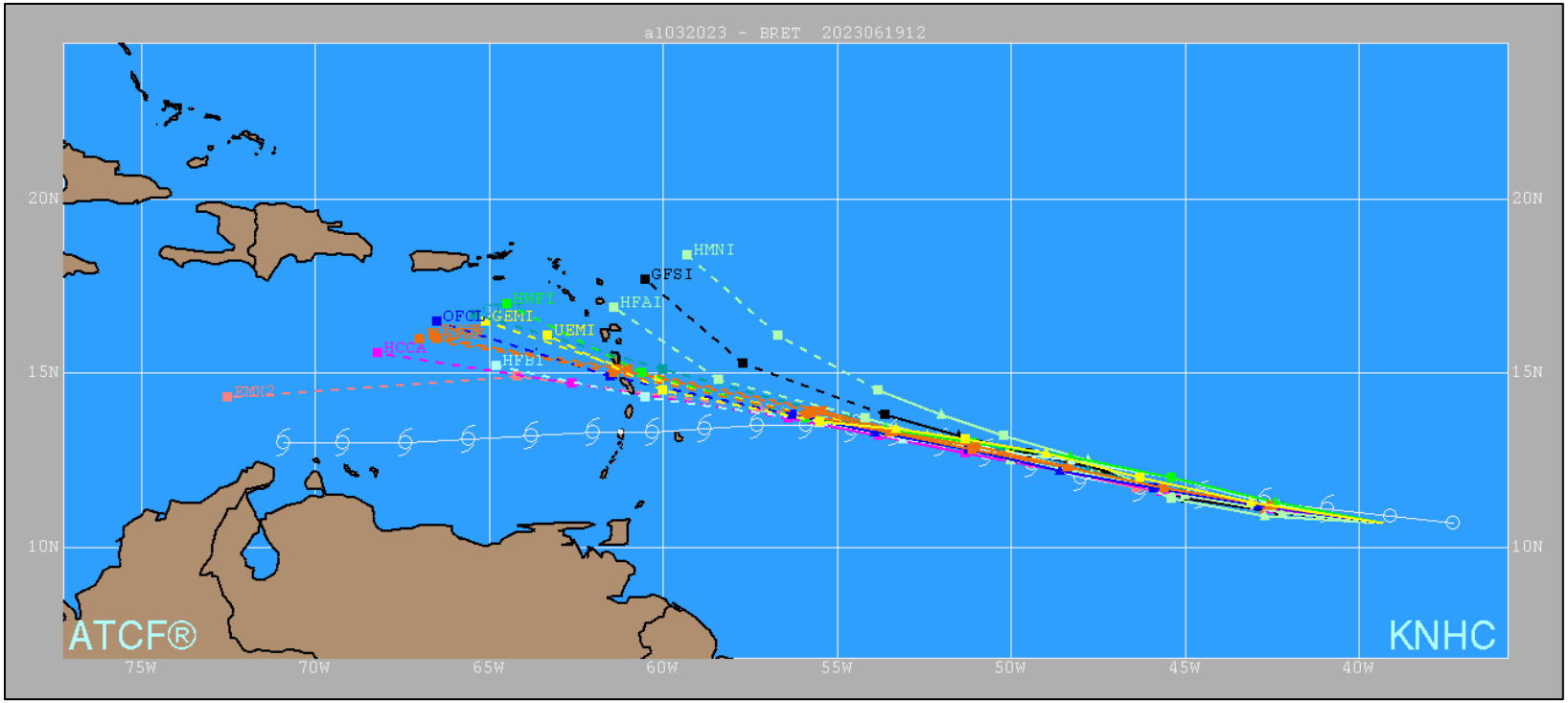


Figure 10. Selected track model guidance and the official forecast (OFCL – in blue) for the initial advisory issuance on Tropical Depression Three (which later became Bret) at 1500 UTC 19 June 2023. The best track is given by the solid white line with positions given at 6-h intervals. Note the poleward bias in much of the guidace. The ECMWF (EMX2) was along the southern edge of the guidance envelope, especially at days 4 and 5.

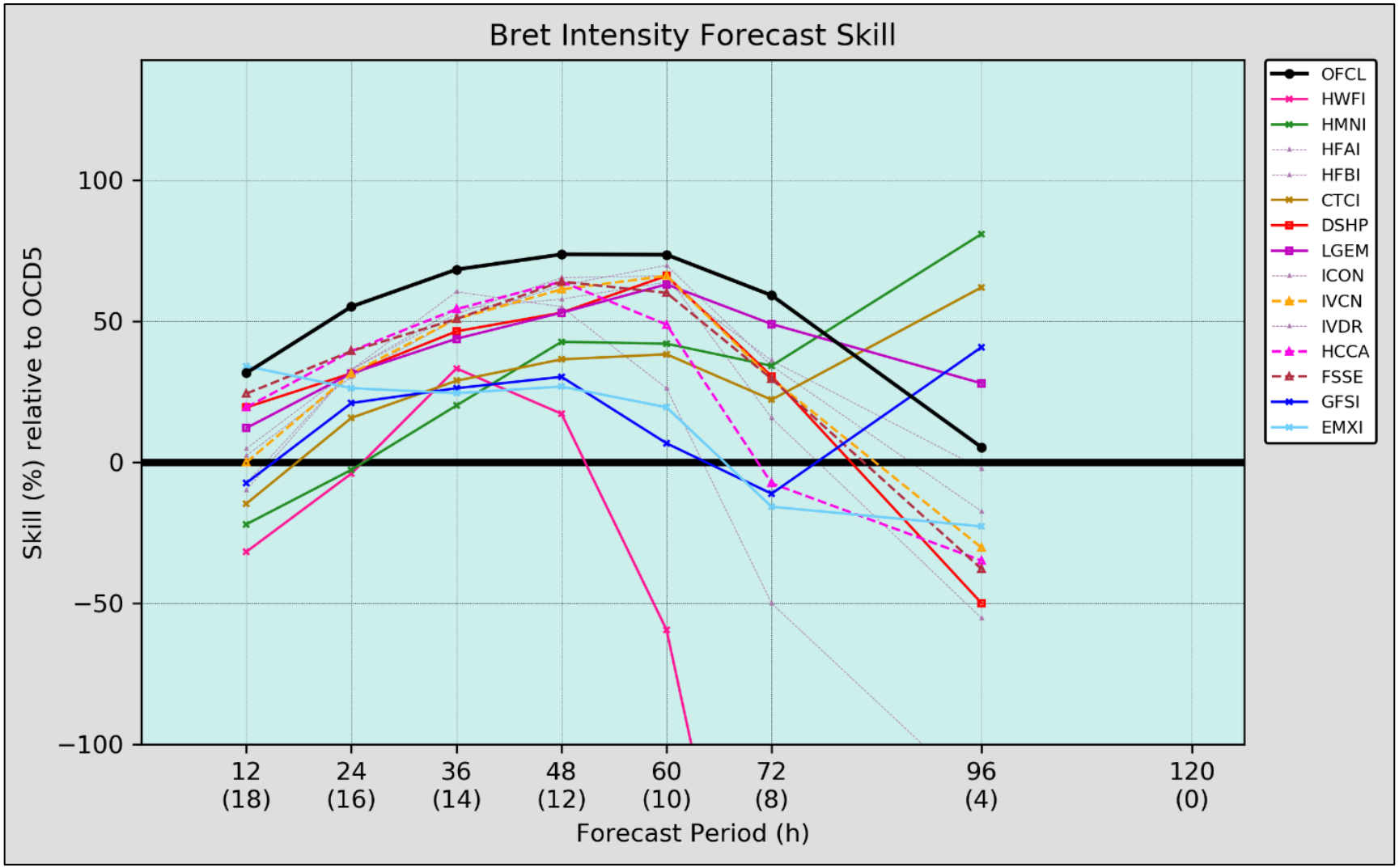


Figure 11. Official forecast and selected model forecast intensity skill for Tropical Storm Bret, 19–24 June 2023.