NATIONAL HURRICANE CENTER
TROPICAL CYCLONE REPORT

TROPICAL STORM ANA

(AL012021)

22–23 May 2021

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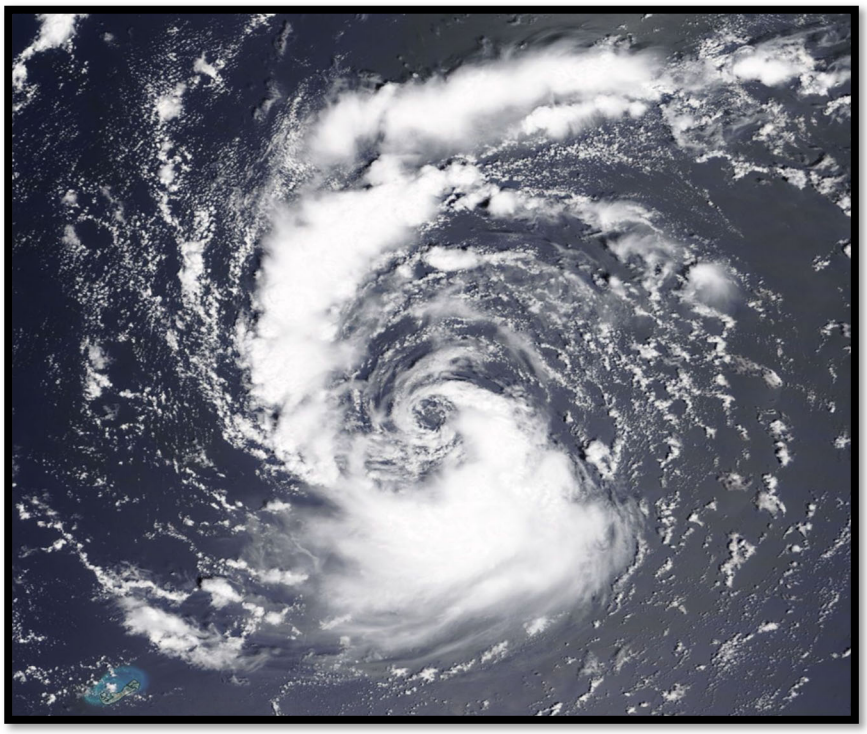

NASA/TERRA MODERATE RESOLUTION IMAGING SPECTRORADIOMETER (MODIS) IMAGERY OF SUBTROPICAL STORM ANA AT 1507 UTC 22 MAY 2021. IMAGE COURTESY OF NASA EOSDIS WORLDVIEW.

Ana originated from a large extratropical cyclone that developed east of Bermuda. It transitioned to a subtropical storm, and then became a tropical storm while moving northeastward out to sea. Ana briefly produced gale-force winds near and over portions of Bermuda when the system was near the end of its extratropical cyclone phase.

Tropical Storm Ana

22–23 MAY 2021

SYNOPTIC HISTORY

Ana developed from a large, extratropical cyclone that formed over the central Atlantic Ocean. On 19 May, a mid- to upper-level shortwave trough dug southeastward over the western North Atlantic and moved toward a nearly stationary baroclinic zone that was draped across the central Atlantic. The upper-level diffluence associated with the shortwave trough induced surface low pressure development along the stalled front roughly 500 n mi east-southeast of Bermuda, and the low became evident in scatterometer data shortly after 0000 UTC 20 May. The extratropical cyclone (Fig. 1a) quickly developed gale-force winds in its northern semicircle that morning, and storm-force winds early on 21 May as a surface ridge strengthened to the northeast of the now occluded low. The cyclone's asymmetric wind field expanded during this period, with gale-force winds reaching as far as 330 n mi from the center in the northeast quadrant. The cyclone initially moved northeastward on 20 May, but it became caught in the flow of a cutoff upper-level low soon thereafter, which caused the system to accelerate west-northwestward and then westward on 21 May. The cyclone slowed down as it moved underneath the upper-level low early on 22 May. This orientation reduced the vertical wind shear over the surface low, and also provided enhanced instability aloft that allowed some moderate convection to develop near the center, despite sea-surface temperatures (SSTs) of only 21° to 22°C. The convection began showing some signs of organization early on 22 May as the surface low finished shedding its frontal structure. Since the system was collocated with the upper-level low and had a large radius of maximum wind (60 n mi), it is estimated that Subtropical Storm Ana formed by 0600 UTC 22 May, when it was located about 175 n mi northeast of Bermuda. The "best track" chart of Ana's path is given in Fig. 2, with the wind and pressure histories shown in Figs. 3 and 4, respectively. The best track positions and intensities are listed in Table 1[1].

Ana completed a small, counter-clockwise loop on 22 May under the influence of only weak steering currents. Several scatterometer passes that morning indicated the tropical-storm-force wind radii had contracted from the previous day and the system had weakened, with maximum sustained winds of around 35 kt. The moderate convection associated with Ana was organized into a couple of bands displaced well away from the fully exposed low-level center (cover photo; Fig. 1b). Late on 22 May, Ana began producing a small, more persistent area of moderate convection near and over its center. Shortly thereafter, a 0054 UTC 23 May scatterometer pass revealed Ana had developed a more symmetric surface wind field, and the

[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.

radius of maximum wind had decreased to 15 n mi. Thus, it is estimated that Ana transitioned to a tropical storm by 0000 UTC 23 May, when it was located about 205 n mi northeast of Bermuda.

The compact tropical cyclone began accelerating northeastward on 23 May when it became embedded within deep-layer southwesterly flow between a ridge to its southeast and an amplifying trough over Atlantic Canada. A flare-up of moderate convection, combined with the increased forward speed of Ana, helped the cyclone reach an estimated peak intensity of 40 kt from 0000 UTC to 0600 UTC 23 May. Soon thereafter, Ana encountered an environment of cooler SSTs (< 21°C) and increasing wind shear, which led to a decrease in convection and slight weakening of the cyclone later that morning. By 1800 UTC that day, Ana lost all deep convection and became a 35-kt post-tropical cyclone. The system continued accelerating northeastward, and scatterometer data around 0100 UTC 24 May indicated that the cyclone had opened up into a trough while located about 525 n mi northeast of Bermuda. Later that day, the trough merged with a strong cold front that was racing eastward across the North Atlantic Ocean.

METEOROLOGICAL STATISTICS

Observations in Ana (Figs. 3 and 4) include subjective satellite-based Hebert-Poteat subtropical technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB), Dvorak technique intensity estimates from 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. 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 Ana.

Selected ship reports of winds of tropical storm force associated with Ana are given in Table 2, and selected surface observations from land and marine stations are given in Table 3.

Winds and Pressure

The extratropical cyclone from which Ana developed is estimated to have reached a peak intensity of 50 kt from 0000 UTC to 0600 UTC 21 May. A partial ASCAT-A pass at 2240 UTC 20 May revealed an area of 45-kt winds displaced well northeast of the circulation center. Model wind analyses (not shown) suggest higher wind speeds occurred shortly thereafter to the north of the bent-back occlusion associated with the extratropical cyclone.

The strongest winds reported on Bermuda occurred while the system was an extratropical cyclone. At Pearl Island, a sustained wind of 38 kt with a gust to 43 kt was measured at 2332 UTC 21 May, over six hours before the system transitioned to a subtropical storm. Several other

locations on the island measured tropical-storm-force gusts early on 22 May, shortly before Ana became a subtropical cyclone.

Ana's estimated peak intensity as a tropical storm is 40 kt from 0000 UTC to 0600 UTC 23 May. An ASCAT-B pass at 0051 UTC 23 May showed winds up to 36 kt in the southeastern quadrant of Ana. Shortly thereafter, a small area of convection became more concentrated near the center as the system was accelerating northeastward. Since the resolution of scatterometer data does not adequately sample the peak winds in small tropical cyclones like Ana, it is likely that the wind speed peaked around 40 kt early on 23 May. This is supported by a 0600 UTC 23 May Hebert-Poteat classification of 35–40 kt from TAFB.

The estimated minimum central pressure of 1004 mb at 0600 UTC 23 May is based on the Knaff-Zehr-Courtney pressure wind relationship.

CASUALTY AND DAMAGE STATISTICS

There were no reports of casualties or damage associated with Ana.

FORECAST AND WARNING CRITIQUE

Despite its extratropical origins, Ana's genesis was forecast well for an out-of-season tropical cyclone (Table 4). A noteworthy NHC product change in 2021 was the routine issuance of the Atlantic Tropical Weather Outlook (TWO) beginning on 15 May, in order to provide more consistent information on the potential for systems that could develop in late May, such as Ana. The disturbance from which Ana developed was introduced in the low (<40%) category of the 5-day TWO 72 h before it became a subtropical storm. The 5-day probabilities were raised to the medium (40–60%) and high (>60%) categories 60 h and 48 h before formation, respectively. For the 2-day probabilities, a low chance of genesis was introduced 60 h, a medium chance 48 h, and a high chance 42 h before formation, respectively.

A verification of NHC official track and intensity forecasts for Ana is given in Tables 5 and 6, respectively. Official forecast track errors were slightly greater than 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 forecast intensity errors were lower than the mean official errors for the previous 5-yr period. Due to Ana's brief existence as a subtropical and tropical storm, no meaningful comparisons can be made with the models.

The Bermuda Weather Service issued a Tropical Storm Watch for the island at 1500 UTC 20 May. The watch was never upgraded to a warning, and it was discontinued at 1500 UTC 22 May.

Table 1. Best track for Tropical Storm Ana, 22–23 May 2021.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
20 / 0000	30.3	55.5	1015	30	extratropical
20 / 0600	31.5	54.5	1013	35	"
20 / 1200	33.0	53.0	1012	40	"
20 / 1800	34.2	53.8	1010	45	"
21 / 0000	34.8	55.0	1008	50	"
21 / 0600	35.5	57.0	1006	50	"
21 / 1200	35.7	59.3	1005	45	"
21 / 1800	35.0	61.1	1005	45	"
22 / 0000	34.5	61.8	1006	40	"
22 / 0600	34.2	62.1	1006	35	subtropical storm
22 / 1200	34.3	62.7	1006	35	"
22 / 1800	34.2	62.4	1006	35	"
23 / 0000	34.7	61.8	1005	40	tropical storm
23 / 0600	35.4	61.1	1004	40	"
23 / 1200	36.1	60.3	1005	35	"
23 / 1800	36.8	58.7	1006	35	low
24 / 0000	37.6	56.7	1007	35	"
24 / 0600					dissipated
23 / 0600	35.4	61.1	1004	40	maximum wind and minimum pressure

Table 2. Selected ship reports with winds of at least 34 kt for Ana, including the extratropical phase before the system became Subtropical Storm Ana.

Date/Time (UTC)	Ship call sign	Latitude (°N)	Longitude (°W)	Wind dir/speed (kt)	Pressure (mb)
21 / 1200	ZDNC7	35.2	61.2	020 / 35	1017.4
22 / 0600	ZDNC7	36.9	66.2	040 / 42	1021.7

Table 3. Selected surface observations for Ana, including the extratropical phase before the system became Subtropical Storm Ana.

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)	Gust (kt)	
Bermuda						
Bermuda Weather Service Office (32.37N 64.68W)	22/0735	1016.2				0.21
Pearl Island *(nearshore)* (32.29N 64.84W)		1017.1	21/2332	38 (8 m, 1 min)	43	
Maritime Operations Centre (MAROPS) *elev. 290 ft* (32.38N 64.68W)			22/0223	33 (1 min)	37	
The Crescent *(offshore)* (32.41N 64.82W)			22/0104	33 (6 m, 10 min)	39	
L.F. Wade Intl. AP Heliport (32.36N 64.70W)			21/2158	28 (12 m, 1 min)	36	
Airport AviMet – 12 (32.37N 64.69W)			22/0146	24 (10 m, 2 min)	29	
L.F. Wade Intl. AP (TXKF) (32.36N 64.67W)	22/0711	1016.4	21/1555	22 (10 m, 10 min)	37	
Airport AviMet – 30 (32.36N 64.67W)			22/0125	20 (10 m, 2 min)	27	

[a] Date/time is for sustained wind when both sustained and gust are listed.

Table 4. Number of hours in advance of subtropical formation of Ana 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%)	60	72
Medium (40%-60%)	48	60
High (>60%)	42	48

Table 5. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Ana. 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	30.8	45.2						
OCD5	65.8	187.1						
Forecasts	4	2						
OFCL (2016-20)	23.9	36.3	49.1	63.9	79.0	94.1	128.1	169.7
OCD5 (2016-20)	45.1	97.2	157.2	216.7	257.6	325.4	414.4	490.0

Table 6. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Ana. 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	**3.8**	**2.5**						
OCD5	4.5	6.5						
Forecasts	4	2						
OFCL (2016-20)	5.4	8.0	9.6	10.9	11.5	12.1	13.3	14.5
OCD5 (2016-20)	7.0	11.0	14.3	16.8	18.5	19.7	21.7	23.0

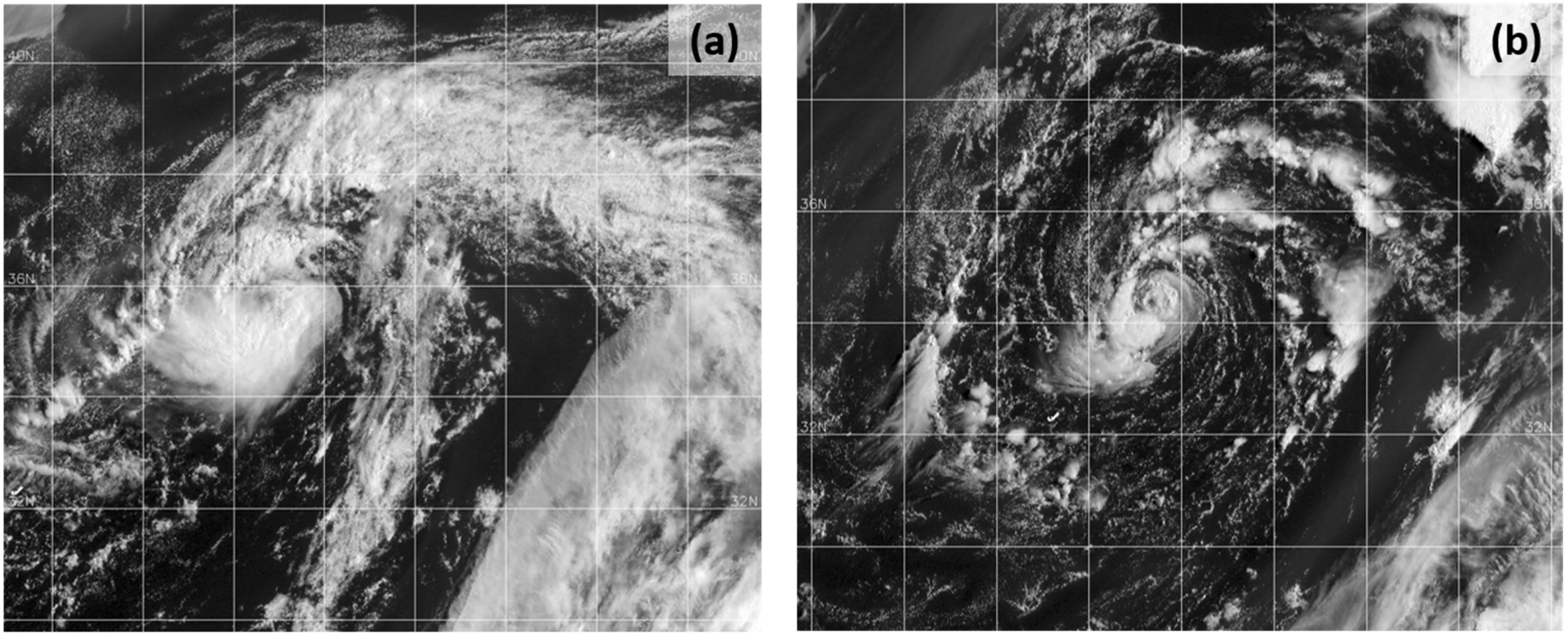

Figure 1. (a) 1200 UTC 21 May 2021 GOES-16 visible imagery of the large extratropical low from which Ana developed. (b) 1200 UTC 22 May 2021 GOES-16 visible imagery of Subtropical Storm Ana, after the cyclone lost its frontal structure and developed a small, curved band of moderate convection. Images courtesy of the Fleet Numerical Meteorology and Oceanography Center (FNMOC).

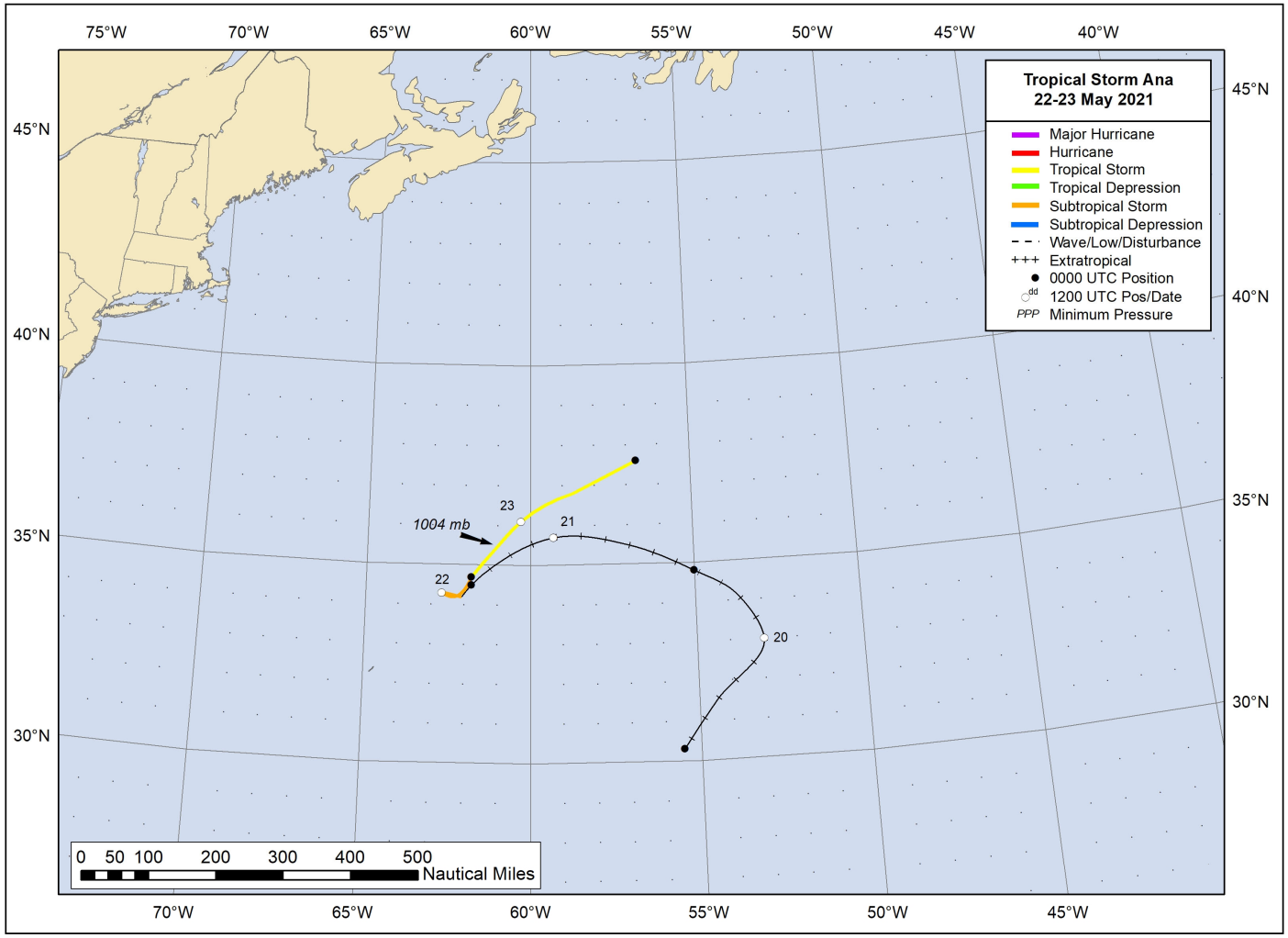

Figure 2. Best track positions for Tropical Storm Ana, 22–23 May 2021. Tracks during the extratropical stage are partially based on analyses from the NOAA Ocean Prediction Center.

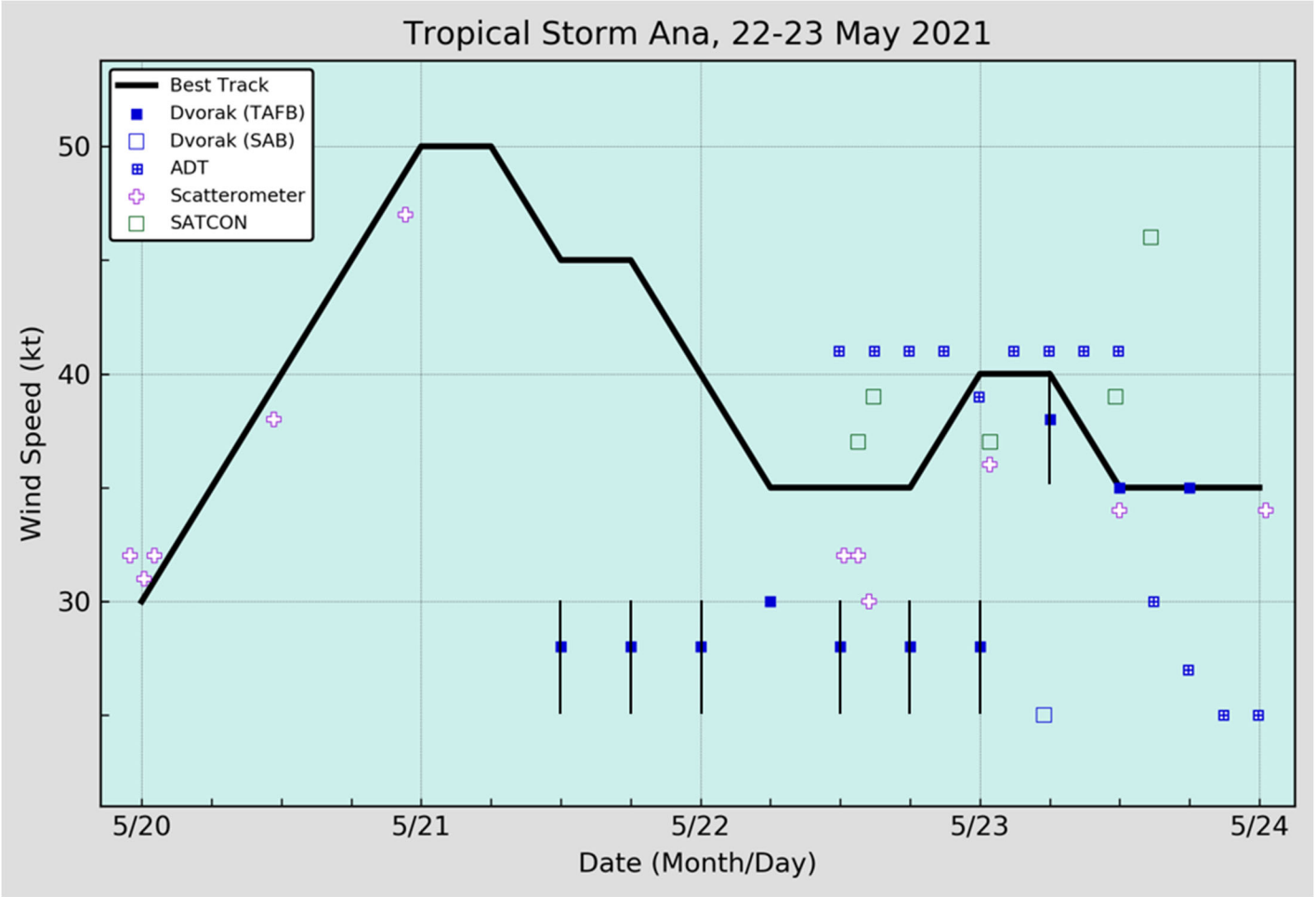

Figure 3. Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Ana, 22–23 May 2021. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies. Dashed vertical lines correspond to 0000 UTC. Solid vertical lines depict intensity ranges associated with Hebert-Poteat subtropical satellite classifications.

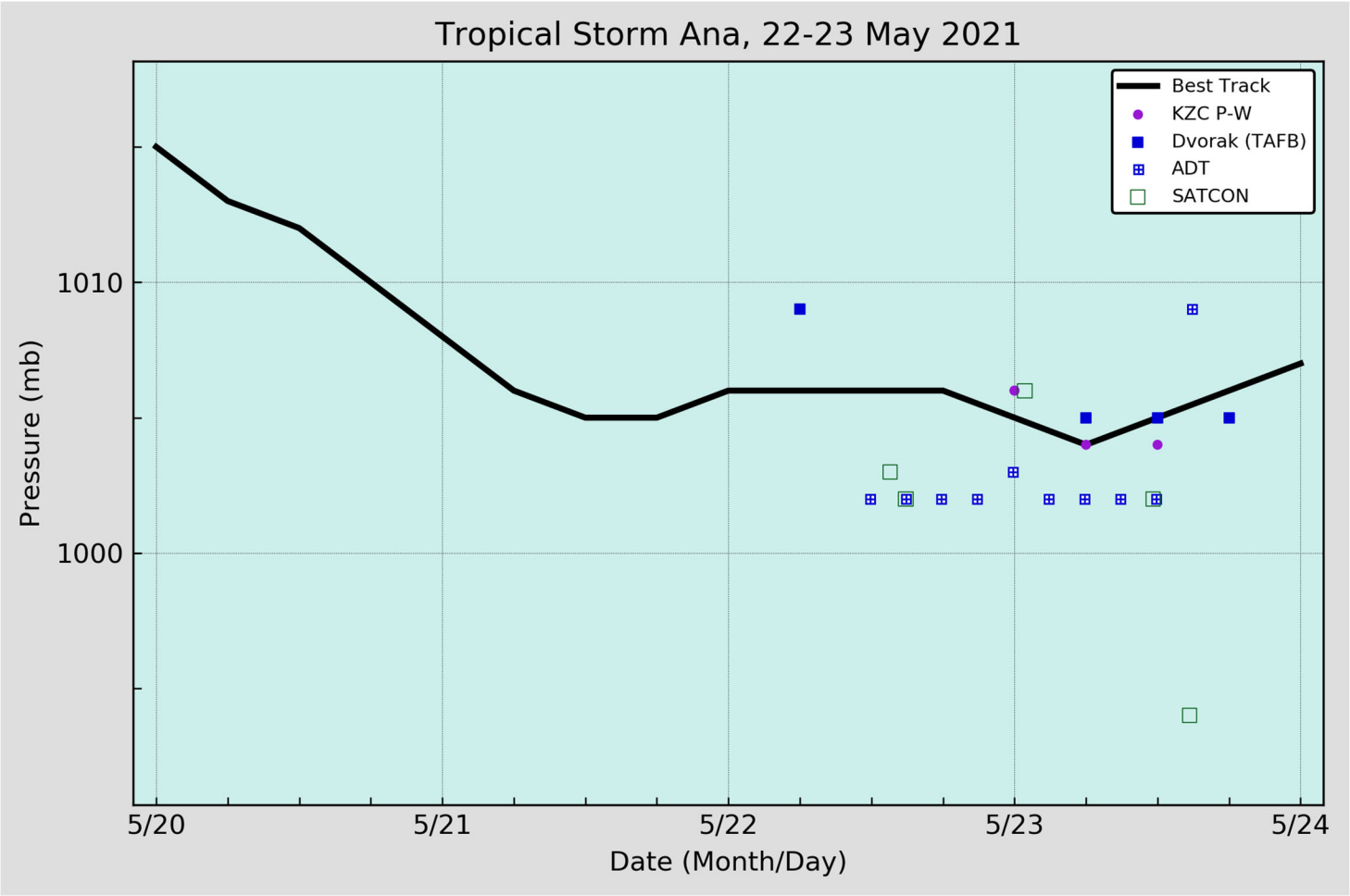

Figure 4. Selected pressure observations and best track minimum central pressure curve for Tropical Storm Ana, 22–23 May 2021. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological 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.