

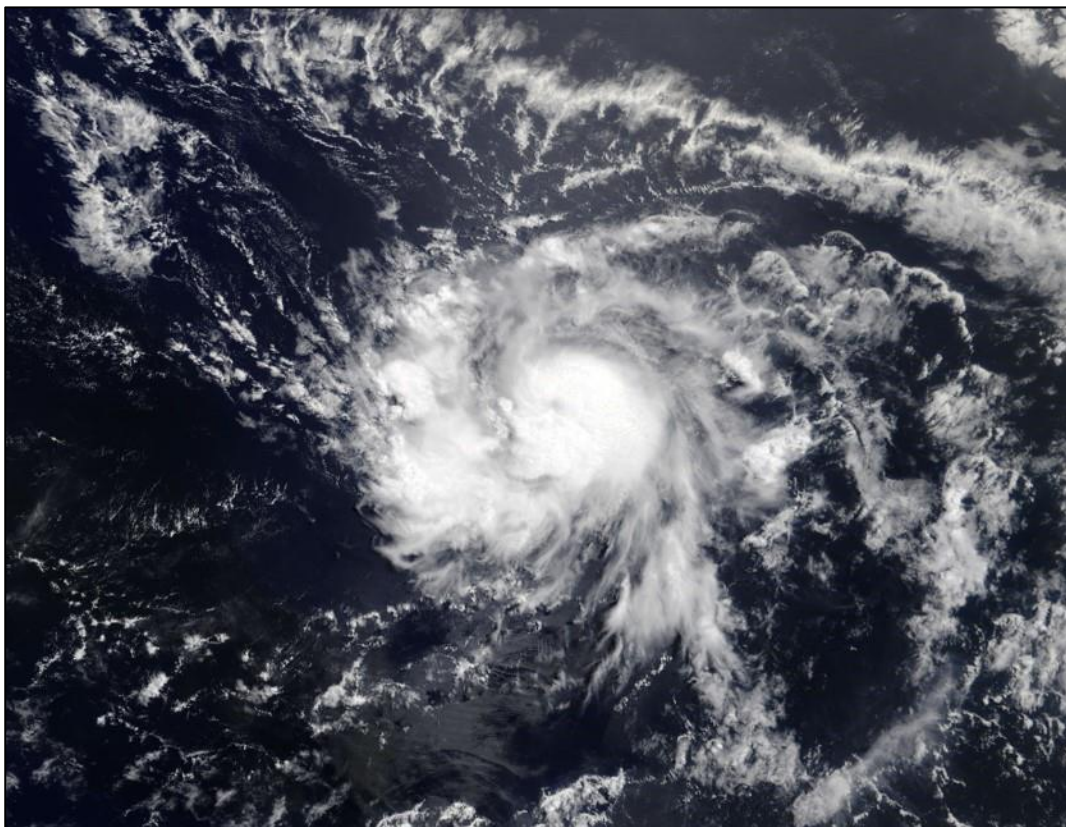


# NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

## TROPICAL STORM GONZALO (AL072020)

21–25 July 2020

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National Hurricane Center  
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GOES-16 TRUE COLOR VISIBLE IMAGE OF GONZALO AT 1335 UTC 22 JULY WHEN THE TROPICAL STORM WAS AT ITS PEAK INTENSITY OF 55 KT AND LOCATED ABOUT 800 N MI EAST OF TRINIDAD. IMAGE COURTESY NOAA/NESDIS.

Gonzalo was a moderate tropical storm that formed and remained at very low latitudes over the central tropical Atlantic Ocean. The small cyclone weakened to a tropical depression before it passed over the southern Windward Islands, where it produced tropical-storm-force wind gusts and minor damage.

# Tropical Storm Gonzalo

21–25 JULY 2020

## SYNOPTIC HISTORY

The disturbance that spawned Gonzalo appears to have been a dry, thermal low-pressure system that moved west-southwestward and then southwestward out of the Sahara Desert on 13–14 July that merged with a weak, low-latitude tropical wave just off the west coast of Africa on 15 July. The broad low pressure system then moved slowly westward within the Intertropical Convergence Zone (ITCZ) for the next couple of days, passing just south of the Cabo Verde Islands on 16 July. The disturbance produced limited shower activity and rainfall across the archipelago due to the relatively dry nature of the system. The low opened up into a trough early on 17 July while continuing its slow westward motion within the ITCZ for the next few days. On 20 July, the previously inert system began to develop spotty convection along and west of the wave axis when it was located over the deep tropical Atlantic more than 1300 n mi east of the southern Windward Islands. By early 21 July, ASCAT scatterometer surface wind data indicated that a small, well-defined low-pressure system had reformed within the ITCZ. Deep convection began to steadily increase and became better organized over the next 18 h, and it is estimated that a tropical depression formed around 1800 UTC that day when the small cyclone was located about 1250 n mi east of the southern Windward Islands. Under the influence of light easterly vertical wind shear and warm sea-surface temperatures (SST) greater than 28°C, the depression gradually strengthened, becoming a tropical storm 12 h later. The “best track” chart of Gonzalo’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<sup>1</sup>.

After acquiring tropical storm status, compact Gonzalo turned westward and doubled its forward speed from 5 kt to 10 kt, while remaining south of 10°N latitude. Thereafter, the low-latitude cyclone maintained its westward motion for the next several days due to a sprawling, deep-layer Bermuda-Azores ridge situated to the north of the cyclone that extended westward into the southeastern United States, the Gulf of Mexico, and the northern Caribbean Sea. Although the deep-layer vertical wind shear (Fig. 4) was generally favorable for significant strengthening to occur – even reaching near-zero values by 0000 UTC 24 July – the small cyclone was moving through a fairly dry environment characterized by mid-level humidity values around 55%, which likely inhibited convective development and organization. Despite the presence of dry air, Gonzalo gradually strengthened, reaching its peak intensity of 55 kt early on 23 July when the cyclone was located about 600 n mi east of the southern Windward Islands. The magnitude of the wind shear continued to decrease, but by the time Gonzalo reached the lowest shear

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<sup>1</sup> 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.

conditions, the vertical shear direction had shifted abruptly from a favorable easterly to northeasterly component to an unfavorable northwesterly component (SHRDIR/10, Fig. 4).

The sharp change in the direction of the wind shear was due to westerly flow along the base of a large upper-level trough that had dropped southward out of the mid-latitudes into the deep tropics a few days earlier. Although the resultant increase in the magnitude of the shear was only modest (<13 kt), the northwesterly shear direction, in conjunction with the entrainment of dry mid-level air, and Gonzalo's small size, gradually eroded the tropical storm's convective structure and induced slow but steady weakening. Gonzalo weakened to a tropical depression just before it made landfall along the northeastern coast of Trinidad near Manzanilla Beach at approximately 1530 UTC 25 July. Land interaction with Trinidad likely hastened the weakening process, causing Gonzalo to degenerate into an open trough by 0000 UTC 26 July when the disorganized system was located over the extreme southeastern Caribbean Sea.

## METEOROLOGICAL STATISTICS

Observations in Gonzalo (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 and stepped frequency microwave radiometer (SFMR) data from two missions conducted by the 53<sup>rd</sup> Weather Reconnaissance Squadron of the U.S. Air Force Reserve Command. 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 Gonzalo.

There were no ship or buoy reports of tropical-storm-force winds associated with Gonzalo. The highest wind reports from land stations were observed on 25 July, where 10-min average wind speeds of 24 kt at 1000 UTC and 1200 UTC were measured at Grantley Adams International Airport (**TBPB**) on Barbados. A gust to 35 kt occurred at 1400 UTC that day at St. Georges/Point Salines International Airport (**TGPY**) on Grenada along with a 10-min average wind speed of 23 kt at 2200 UTC.

### *Winds and Pressure*

The estimated peak intensity of 55 kt at 0600 UTC and 1200 UTC 23 July is based on a blend of Dvorak subjective satellite estimates of T3.5/55 kt from TAFB and SAB and objective intensity estimates of 55 kt from UW-CIMSS ADT and 54 kt from UW-CIMSS SATCON. This peak intensity estimate is coincident with the appearance of a 10-nmi-wide mid-level eye feature present in various passive microwave satellite images (data not shown) and a small, cloud-filled eye feature seen in visible satellite imagery (cover photo). It is worth noting that other than at the beginning and the end of Gonzalo's lifetime, ASCAT scatterometer surface wind speeds were

generally well below the subjective and objective satellite intensity estimates. This is likely due to the small inner-core wind field that Gonzalo possessed, which resulted in significant undersampling of the peak winds by ASCAT's relatively large measurement footprint. Even at Gonzalo's peak intensity, however, the 34-kt (tropical-storm-force) wind radii only extended outward up to 30 n mi, an indication of the compact-size of the cyclone's wind field.

Gonzalo's estimated minimum pressure of 997 mb is based on a blend of TAFB and SAB Dvorak satellite pressure-wind relationships and UW-CIMSS ADT and SATCON satellite pressure-wind relationships.

### **Rainfall and Flooding**

Since Gonzalo was weakening and rapidly becoming disorganized as it moved across the Windward Islands, rainfall amounts were less than 2 inches (50 mm), which resulted in no reports of freshwater flooding.

## **CASUALTY AND DAMAGE STATISTICS**

There were no reports of casualties associated with Gonzalo. The only damage reports received were on Tobago where a few downed trees damaged the roof of a medical facility in the town of Les Coteaux and also damaged a bus stop roof in Argyle.

## **FORECAST AND WARNING CRITIQUE**

The genesis of Tropical Storm Gonzalo was poorly anticipated. The disturbance from which Gonzalo developed was first introduced in the Tropical Weather Outlook in the low (<40%) and medium (40%–60%) categories only 36 h and 12 h prior to genesis in both the 48- and 120-h periods, respectively (Table 2), with formation probabilities never reaching the high category (>60%). The poor genesis forecasts were primarily due to the NHC's most reliable genesis models – the GFS, UKMET, and ECMWF – not explicitly depicting tropical cyclone development until the same day that genesis actually occurred. Some of the other global models such as the Navy NAVGEM (NVGI) and Canadian (CMCI) did show genesis a couple of days before Gonzalo formed, and even showed the system lasting for several days thereafter. However, those models backed off on their cyclogenesis forecasts within 12 h of Gonzalo becoming a tropical depression. The cyclone's compact size likely played a role in the global models' poor forecasts of the system's formation.

A verification of NHC official track forecasts for Gonzalo is given in Table 3a. Official forecast track (OFCL) errors were slightly greater than the mean official errors for the previous 5-yr period from 12-48 h, and were slightly better than the mean errors at 60 h and 72 h. There was only one forecast at 96 h, thus no meaningful assessment can be made at that forecast time. However, climatology-persistence model (OCD5) errors were lower than the previous 5-yr period

at all forecast times, ranging from more than 20% lower at 12 h to around 30% lower at 24-72 h, indicating that Gonzalo should have been easier than average to forecast. NHC's track forecasts had a pronounced right-of-track or poleward bias from the outset, especially beyond 48 h (Fig. 5). This bias occurred because Gonzalo was forecast to become a modest hurricane with a deeper vertical circulation that would be steered west-northwestward by the deep-layer flow instead of westward by the shallower trade wind flow. A homogeneous comparison of the official track errors with selected guidance models is given in Table 3b. The ECMWF (EMXI) and UKMET (EGRI) global models, the NOAA corrected-consensus model HCCA, and even the simple shallow- (TABS) and medium-depth (TABM) Beta-advection models, outperformed the OFCL track forecasts at almost all forecast times.

A verification of NHC official intensity forecasts for Gonzalo is given in Table 4a. Similar to the official track forecast errors, OFCL intensity forecast errors were greater than the mean official errors for the previous 5-yr period. These errors were due to forecasts that showed Gonzalo intensifying into a 65-75-kt hurricane (Fig. 6), even after the cyclone had begun to weaken. In contrast, the OCD5 errors were lower than the previous 5-yr period at almost all forecast times, indicating that Gonzalo's intensity was easier than average to forecast. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 4b. NHC official intensity forecasts were outperformed by every available model at nearly all forecast times, including the simple OCD5, thus the OFCL forecasts were not skillful. ECMWF global model intensity forecasts (EMXI) were the best, outperforming OFCL by about 50% at all forecast times.

Watches and warnings associated with Gonzalo are given in Table 5. The Hurricane Watch for Barbados, St. Vincent, and the Grenadines did not verify, and neither did the Tropical Storm Watches and Warnings since no sustained tropical-storm-force winds were observed on any of the Windward Islands.



Table 1. Best track for Tropical Storm Gonzalo, 21–25 July 2020.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
20 / 1200	8.9	36.8	1010	20	low
20 / 1800	8.6	37.5	1009	25	"
21 / 0000	8.6	38.2	1009	25	"
21 / 0600	8.8	38.8	1009	25	"
21 / 1200	9.2	39.3	1009	25	"
21 / 1800	9.7	40.0	1008	30	tropical depression
22 / 0000	9.8	40.9	1008	30	"
22 / 0600	9.8	41.9	1006	35	tropical storm
22 / 1200	9.9	43.0	1003	40	"
22 / 1800	9.9	44.2	1000	45	"
23 / 0000	9.9	45.4	998	50	"
23 / 0600	9.7	46.6	997	55	"
23 / 1200	9.7	47.6	997	55	"
23 / 1800	9.7	48.8	1000	50	"
24 / 0000	9.8	50.2	1000	50	"
24 / 0600	9.9	51.6	1001	50	"
24 / 1200	9.9	53.3	1003	45	"
24 / 1800	9.9	54.8	1008	35	"
25 / 0000	10.0	56.3	1008	35	"
25 / 0600	10.1	57.9	1008	35	"
25 / 1200	10.3	59.8	1008	35	"
25 / 1530	10.5	61.0	1009	30	tropical depression
25 / 1800	10.8	62.1	1009	30	"
26 / 0000					dissipated
25 / 1530	10.5	61.0	1009	30	landfall 4 n mi north of Manzanilla Beach, Trinidad
23 / 0600	9.7	46.6	997	55	minimum pressure & maximum wind



Table 2. Number of hours in advance of formation of Gonzalo 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%)	36	36
Medium (40%-60%)	12	12
High (>60%)	--	--

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Tropical Storm Gonzalo, 21–25 July 2020. 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	26.9	49.2	64.1	70.0	<b>79.6</b>	<b>85.4</b>	<b>96.8</b>	
OCD5	36.7	68.3	109.9	138.9	179.3	233.1	422.8	
Forecasts	15	13	11	9	7	5	1	
OFCL (2015-19)	24.1	36.9	49.6	65.1	80.7	96.3	133.2	171.6
OCD5 (2015-19)	44.7	96.1	156.3	217.4	273.9	330.3	431.5	511.9



Table 3b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Gonzalo. 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 3a due to the homogeneity requirement.

Model ID	Forecast Period (h)							
	12	24	36	48	60	72	96	120
OFCL	31.0	66.7	98.1	109.8	144.5			
OCD5	31.2	<b>60.1</b>	112.1	115.1	151.1			
GFSI	42.6	91.3	136.4	165.4	215.4			
EMXI	31.2	<b>52.3</b>	<b>74.4</b>	<b>74.7</b>	<b>16.8</b>			
EGRI	<b>23.7</b>	<b>43.9</b>	<b>60.2</b>	<b>49.8</b>	<b>58.2</b>			
NVGI	45.7	114.5	163.0	169.5	218.5			
CMCI	<b>22.9</b>	<b>45.7</b>	<b>84.7</b>	116.6	155.8			
HWFI	56.2	103.0	139.0	179.3	213.9			
HMNI	33.5	<b>61.3</b>	<b>89.8</b>	110.5	148.1			
CTCI	42.8	84.7	113.2	128.2	168.0			
TVCA	36.0	72.6	102.2	111.0	<b>136.3</b>			
HCCA	32.0	<b>62.6</b>	<b>85.7</b>	<b>86.6</b>	<b>67.6</b>			
FSSE	33.2	<b>65.5</b>	100.0	<b>104.9</b>	<b>124.8</b>			
AEMI	39.9	78.3	105.3	122.7	179.6			
TABS	<b>24.6</b>	<b>27.6</b>	<b>48.9</b>	<b>52.0</b>	<b>71.6</b>			
TABM	<b>27.0</b>	<b>47.7</b>	<b>78.5</b>	<b>95.9</b>	<b>121.8</b>			
TABD	34.3	80.6	134.2	171.7	219.1			
Forecasts	8	7	5	3	1			



Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Tropical Storm Gonzalo, 21–25 July 2020. 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	7.0	15.8	22.7	24.4	24.3	23.0	20.0	
OCD5	6.7	12.8	20.1	22.9	22.6	17.8	14.0	
Forecasts	15	13	11	9	7	5	1	
OFCL (2015-19)	5.2	7.7	9.4	10.7	11.9	13.0	14.4	15.5
OCD5 (2015-19)	6.8	10.8	14.1	17.0	18.8	20.6	22.5	24.6

Table 4b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Gonzalo. 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	9.4	20.7	34.0	36.7	40.0			
OCD5	<b>7.4</b>	<b>14.1</b>	<b>26.2</b>	<b>32.0</b>	42.0			
HWFI	15.8	26.9	37.4	45.7	57.0			
HMNI	12.3	<b>18.6</b>	<b>26.0</b>	<b>28.0</b>	<b>25.0</b>			
DSHP	<b>9.1</b>	<b>19.7</b>	35.2	40.7	55.0			
LGEM	<b>8.4</b>	<b>17.3</b>	<b>33.0</b>	41.3	58.0			
ICON	10.6	<b>20.4</b>	<b>33.2</b>	39.3	49.0			
IVCN	9.7	<b>19.4</b>	<b>31.4</b>	<b>36.3</b>	45.0			
CTCI	<b>8.6</b>	<b>14.3</b>	<b>24.0</b>	<b>24.7</b>	<b>27.0</b>			
GFSI	<b>8.7</b>	<b>12.7</b>	<b>21.0</b>	<b>23.3</b>	<b>32.0</b>			
EMXI	<b>5.0</b>	<b>9.4</b>	<b>12.8</b>	<b>9.7</b>	<b>7.0</b>			
HCCA	10.6	21.7	35.0	41.7	50.0			
FSSE	11.4	23.4	36.0	42.7	51.0			
Forecasts	9	7	5	3	1			

Table 5. Watch and warning summary for Tropical Storm Gonzalo, 21–25 July 2020.

Date/Time (UTC)	Action	Location
23 / 0300	Hurricane Watch issued	Barbados
23 / 1200	Hurricane Watch issued	St. Vincent / Grenadines
23 / 2100	Tropical Storm Watch issued	Tobago / Grenada & Its dependencies
24 / 0900	Tropical Storm Warning issued	Barbados
24 / 0900	Tropical Storm Warning issued	St. Vincent / Grenadines
24 / 0900	Tropical Storm Warning issued	St. Lucia
24 / 1800	Hurricane Watch changed to Tropical Storm Warning	Barbados
24 / 1800	Hurricane Watch changed to Tropical Storm Warning	St. Vincent / Grenadines
24 / 2100	Tropical Storm Watch changed to Tropical Storm Warning	Tobago / Grenada & Its dependencies
24 / 2100	Tropical Storm Warning discontinued	St. Lucia
25 / 0000	Tropical Storm Warning discontinued	Barbados
25 / 1200	Tropical Storm Warning discontinued	St. Vincent / Grenadines
25 / 1800	Tropical Storm Warning discontinued	All

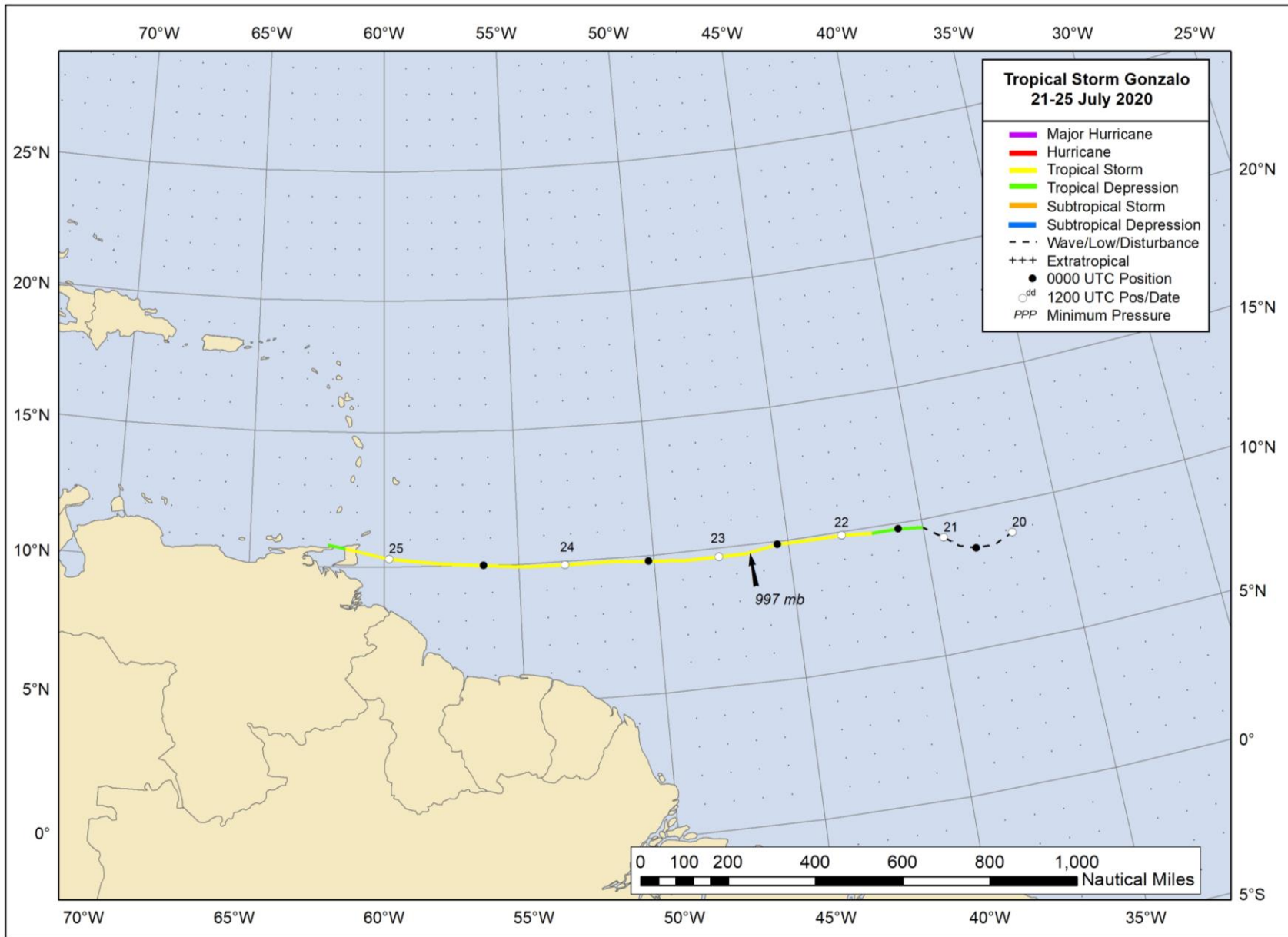


Figure 1. Best track positions for Tropical Storm Gonzalo, 21–25 July 2020.

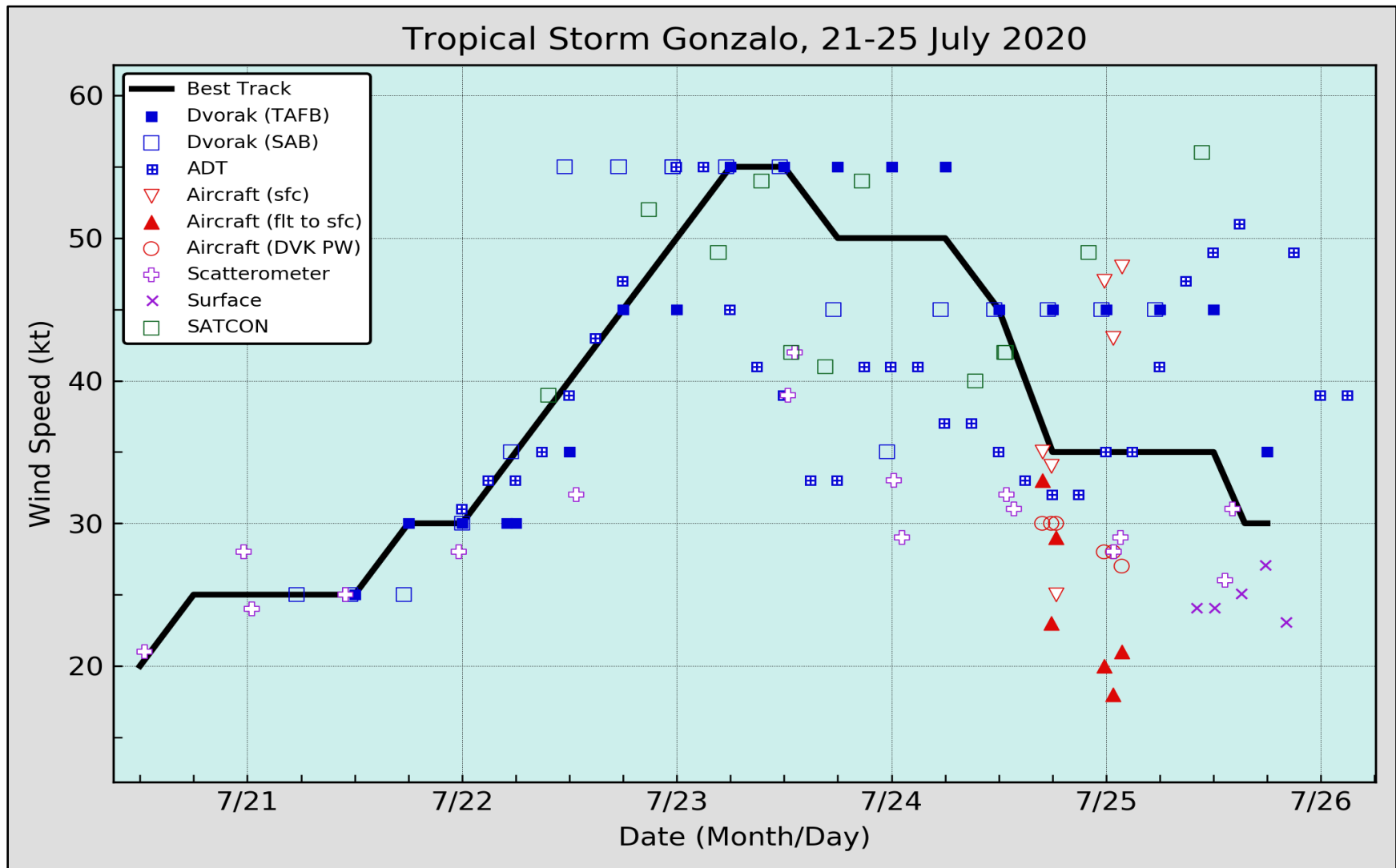


Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Gonzalo, 21–25 July 2020. Aircraft observations have been adjusted for elevation using 75% and 80% adjustment factors for observations from 925 mb and 850 mb, respectively. Advanced Dvorak 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 the solid vertical line corresponds to landfall.

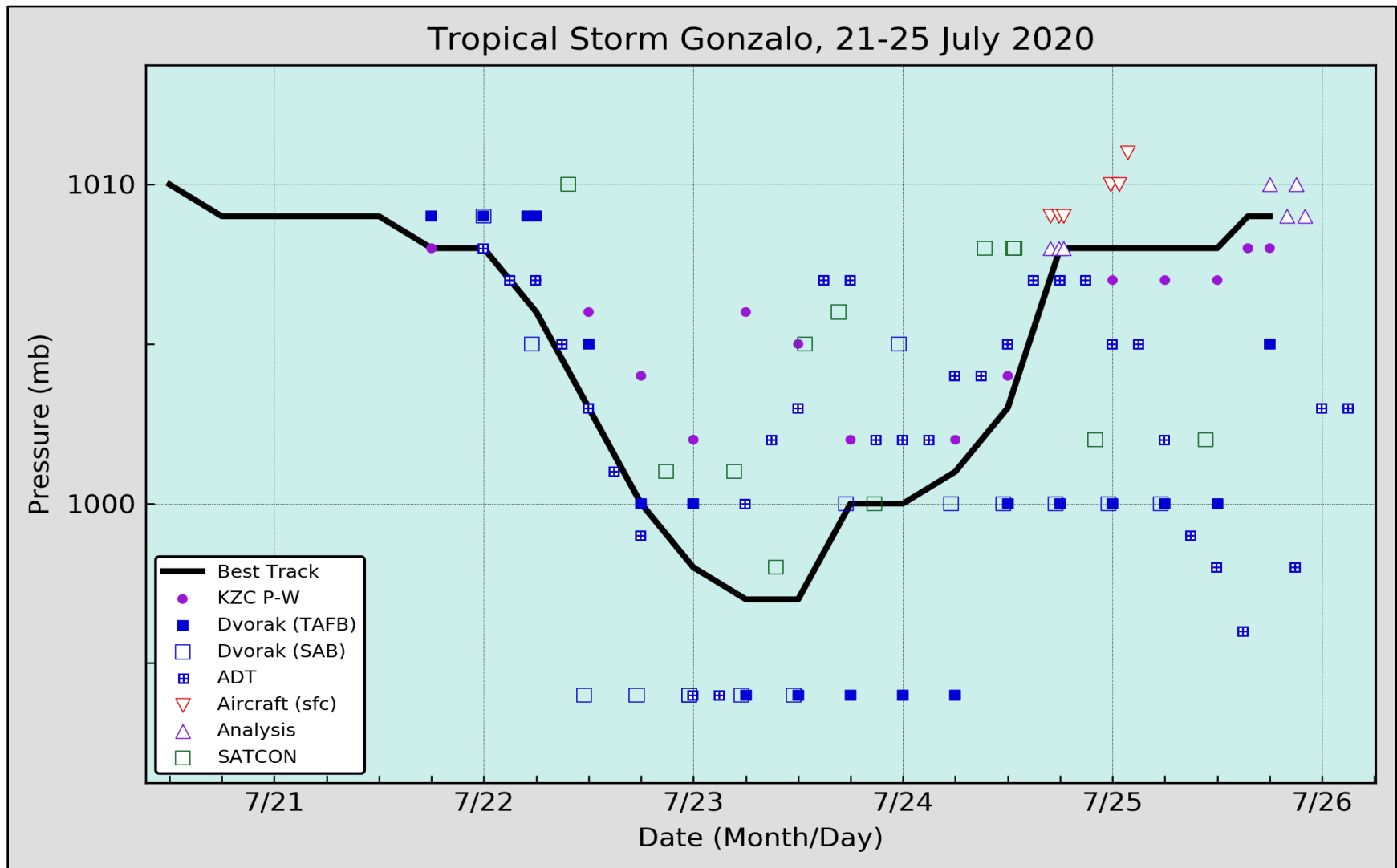


Figure 3. Selected pressure observations and best track minimum central pressure curve for Tropical Storm Gonzalo, 21–25 July 2020. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological 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 the solid vertical line corresponds to landfall.

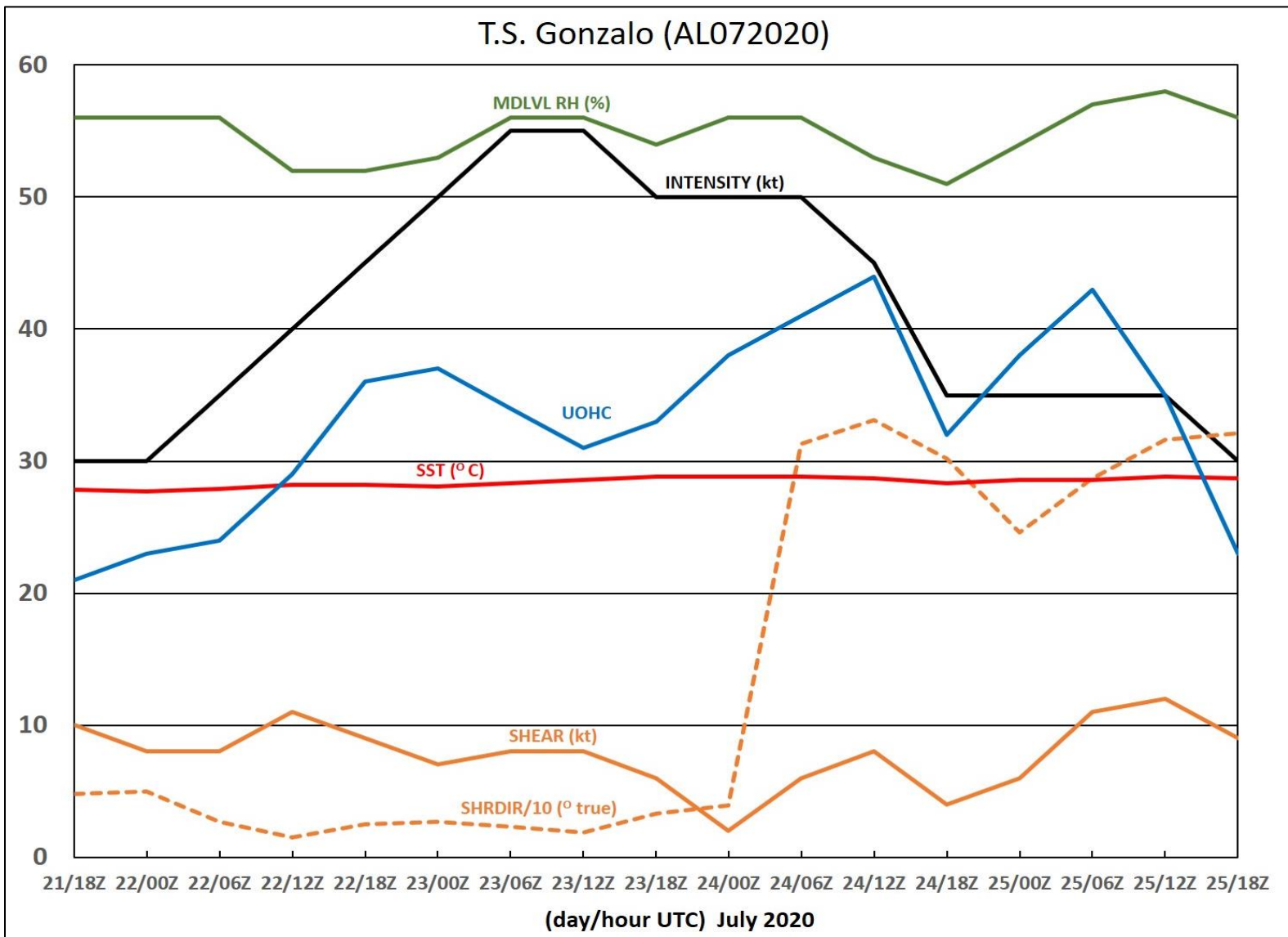


Figure 4. Graph of intensity (kt) versus GFS-based SHIPS model parameters for Tropical Storm Gonzalo, 21–25 July 2020. **SHEAR** is 850–200–mb vertical wind shear (kt); **SHRDIR/10** is shear direction divided by 10 (dashed line; degrees true); **SST** is sea-surface temperature (°C); **UOHC** is upper ocean heat content (KJ cm<sup>-2</sup>); **MDLVL RH** is 700–500 mb avg. relative humidity (%).



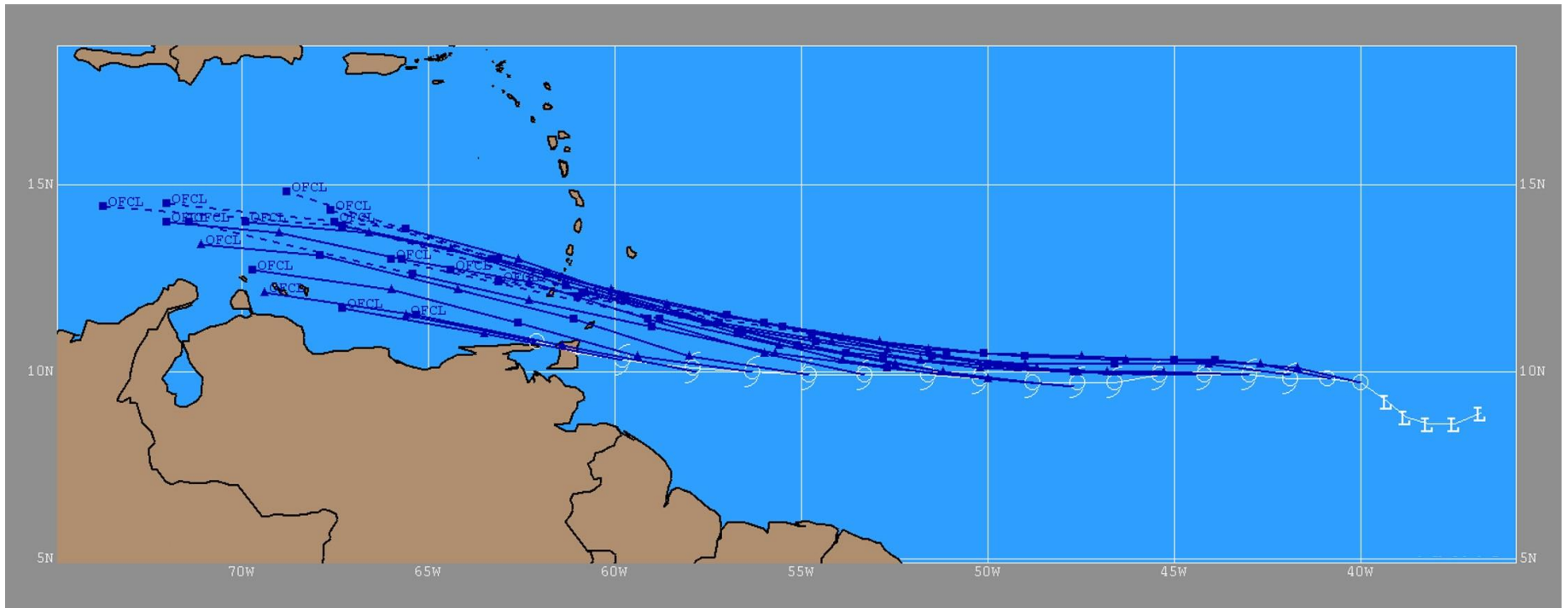


Figure 5. Selected NHC official track forecasts (OFCL – solid blue lines at 0, 12, 24, 36, 48, 60, 72 h intervals, and dashed blue lines at 96 and 120 h forecast intervals) for Tropical Storm Gonzalo, 21–25 July 2020. The best track is given by the thick solid line with positions given at 6-h intervals.

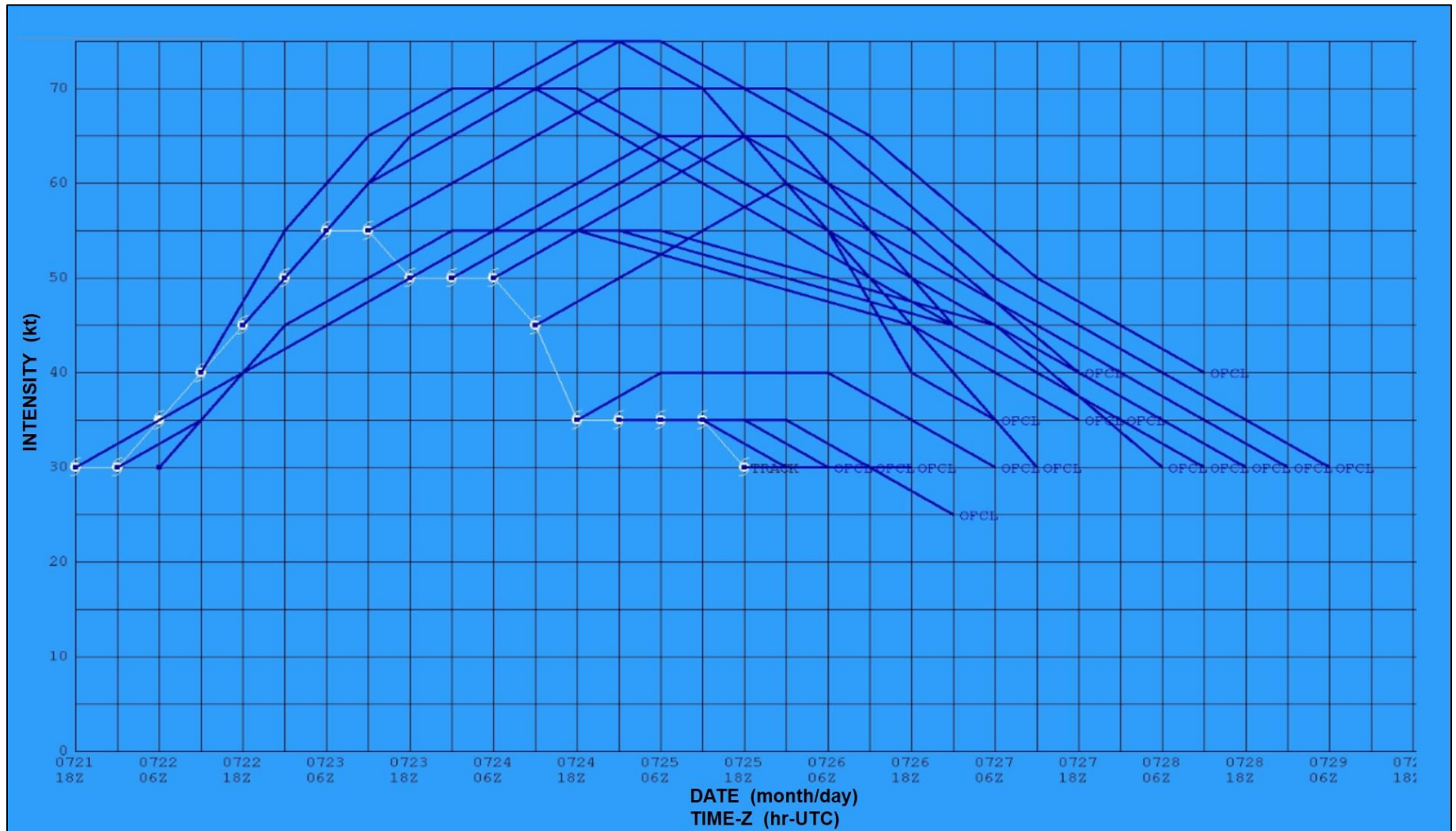


Figure 6. Selected NHC official intensity forecasts (kt, OFCL – solid blue lines at 0, 12, 24, 36, 48, 60, 72, 96, and 120 h forecast intervals) for Tropical Storm Gonzalo, 21–25 July 2020. The best track intensity (kt) is given by the thick solid line with positions given at 6-h intervals.