NATIONAL HURRICANE CENTER
TROPICAL CYCLONE REPORT

TROPICAL STORM CRISTINA

(EP052020)

6–12 July 2020

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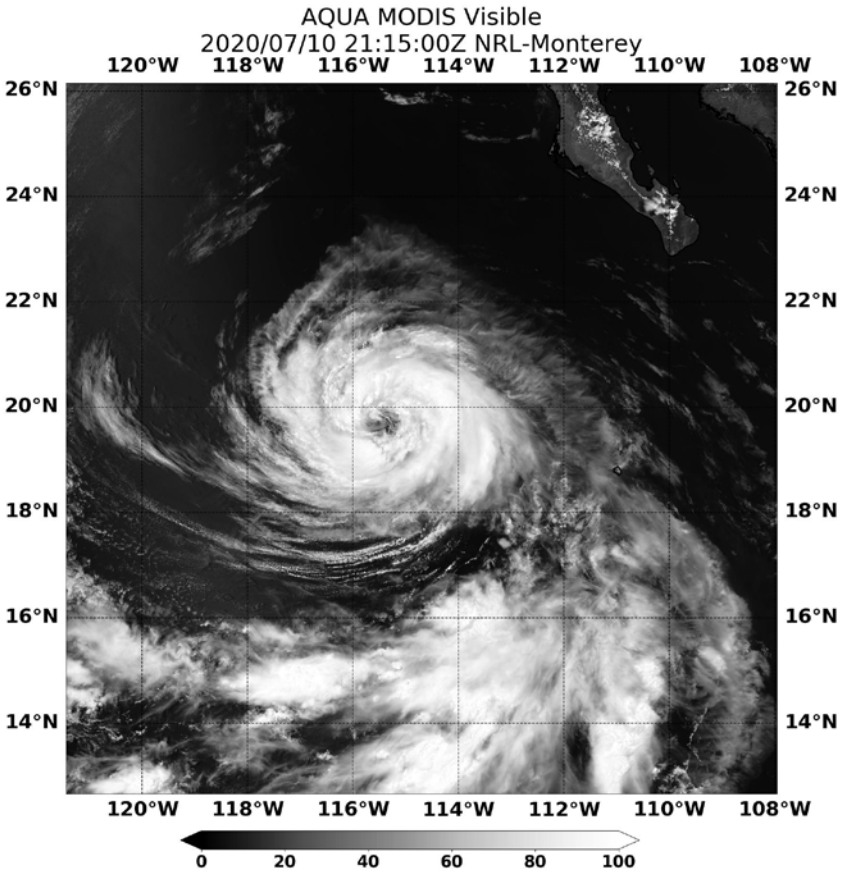
13 November 2020



AQUA MODIS VISIBLE SATELLITE IMAGE OF TROPICAL STORM CRISTINA NEAR ITS PEAK INTENSITY AT 2115 UTC 10 JULY 2020 (COURTESY OF THE NAVAL RESEARCH LABORATORY)

Cristina developed into a tropical storm a couple hundred miles south of southwestern Mexico and remained over the open Pacific Ocean without impacting land.

Tropical Storm Cristina

6–12 JULY 2020

SYNOPTIC HISTORY

Cristina's origins can be traced to a tropical wave that emerged off the coast of Africa on 20 June. The weak wave interacted with an extensive Saharan Air Layer and therefore did not produce any deep convection as it crossed the tropical North Atlantic and the Caribbean Sea over the next several days. When the system reached the eastern North Pacific on 3 July, deep convection developed near the wave in connection with the pre-existing monsoon trough south of Central America. Deep convection became increasingly extensive and organized over the next couple of days, and around 1800 UTC on 6 July a well-defined center formed and the system developed into a tropical depression while located around 380 n mi south of Acapulco, Mexico. The "best track" chart of the tropical cyclone'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].

During the next several days, the system was steered west-northwestward to northwestward along the south side of a large mid-level ridge located over the south-central United States. After genesis, the tropical cyclone gradually strengthened, becoming a tropical storm around 0600 UTC 7 July. Under the influence of warm 28-29°C sea surface temperatures (SSTs), moist mid-level air with 70–80% relative humidity, and moderate 10–15 kt tropospheric vertical wind shear, Cristina slowly intensified. The tropical storm reached its peak intensity of 55 kt by 1800 UTC 8 July, while located around 300 n mi south-southwest of the southern tip of the Baja California peninsula. Cristina maintained this intensity during the next two days while the vertical shear decreased somewhat, offsetting cooling SSTs underneath the cyclone. By late on 11 July, the cool waters and drier air that Cristina encountered led to gradual weakening. Around 1800 UTC 12 July, the associated deep convection dissipated and the system became a gale-force post-tropical cyclone, while centered around 860 n mi west of the southern tip of the Baja California peninsula. At that time, Cristina became increasingly steered toward the west at around 10 kt by the lower tropospheric flow south of the subtropical ridge over the eastern North Pacific. Over the next couple of days, the remnant low of Cristina continued moving toward the west to west-northwest at a slightly faster forward speed while gradually weakening. The system opened up into a trough after 1800 UTC 15 July when it was located about halfway between the Baja California peninsula and Hawaii.

[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 Cristina (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) as well as 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 Cristina.

The 60-kt peak intensity of Cristina from 1800 UTC 10 July and 0000 UTC 11 July was based upon a blend of the subjective Dvorak classifications from SAB and TAFB, objective ADT, and ASCAT measurements and was closest to the SATCON estimates. It is of note that the peak intensity of Cristina had more than the usual uncertainty with the subjective Dvorak estimates suggesting an intensity as high as 77 kt, while the objective ADT and ASCAT measurements were as low as 47 kt. The estimated minimum central pressure of 993 mb was derived using the Knaff-Zehr-Courtney pressure-wind relationship.

There were no ship reports of winds of tropical storm force associated with Cristina.

CASUALTY AND DAMAGE STATISTICS

There were no reports of damage or casualties associated with Tropical Storm Cristina.

FORECAST AND WARNING CRITIQUE

The genesis of Cristina was fairly well anticipated. The first Tropical Weather Outlook (TWO) for the system was issued 102 h prior to genesis with a low (<40%) chance for formation within the 5-day time period (Table 2). The 5-day probabilities were raised to a medium (40–60%) and high (>60%) chance for development 78 h and 42 h prior to formation, respectively. The 2-day probabilities were introduced as a low chance for development 30 h before genesis. These were raised to the medium category 24 h before genesis, but did not reach the high category prior to the system developing into a tropical cyclone because the global models suggested that genesis would occur around a day later than it actually did.

A verification of NHC official track forecasts for Cristina is given in Table 3a. Official track forecast errors (OFCL) were near the mean official errors for the previous 5-yr period for the 12 h forecast time, and smaller than the mean official errors for the 24 to 120 h forecast times. The climatology and persistence errors (OCD5) were also smaller than their 5-yr means at all forecast times from 24 to 120 h, indicating that Cristina's track was slightly easier to predict than average at those times. A homogeneous comparison of the official track errors with selected guidance models is given in Table 3b. Overall, OFCL consistently performed better than any individual model or consensus approach, with the exception of the Global Forecast System ensemble mean – AEMI – which had smaller errors from 12 through 96 h.

A verification of NHC OFCL intensity forecasts for Cristina is given in Table 4a. OFCL intensity errors were near the mean official errors for the previous 5-yr period for the verifying 12–36-h forecast times. However, the OFCL intensity errors for 48 through 120 h were much larger than NHC official errors during the last five years. Moreover, the OCD5 errors were much smaller than their 5-yr means at all forecast times, indicating that Cristina's intensity should have been easier to predict than usual. A homogeneous comparison of the OFCL intensity errors with selected guidance models is given in Table 4b. Unlike track forecasts, the NHC intensity forecasts had larger errors than nearly all of the standard guidance, including OCD5. All of the individual model guidance – except the ECMWF global model (EMXI) – had a substantial high bias, contributing toward a similar bias in the consensus techniques (ICON, IVCN, FSSE, and HCCA) used by NHC. As seen in Figure 4, the statistical-dynamical model LGEM, HWRF dynamical model (HWFI), corrected consensus approach (HCCA), and OFCL all displayed a high bias for Cristina's intensity, especially during its intensification and peak intensity stage. One possible reason for the high bias of these forecasts was that the anticipated vertical shear was incorrect. The shear was originally anticipated to be near zero from 8 through 10 July; instead it was around 10 kt from the north-northeast. In contrast, EMXI did not display a high bias, though this model did not show any intensification for the first couple days of Cristina's existence.

No coastal watches or warnings were issued in association with Cristina.

Table 1. Best track for Tropical Storm Cristina, 6–12 July 2020.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
6 / 1800	10.4	99.5	1007	30	tropical depression
7 / 0000	10.8	100.5	1007	30	"
7 / 0600	11.4	101.5	1005	35	tropical storm
7 / 1200	12.0	102.4	1005	35	"
7 / 1800	12.7	103.3	1003	40	"
8 / 0000	13.3	104.5	1003	40	"
8 / 0600	13.8	105.7	1003	40	"
8 / 1200	14.4	106.7	1001	45	"
8 / 1800	15.1	107.7	1001	45	"
9 / 0000	15.8	108.4	999	50	"
9 / 0600	16.5	109.1	999	50	"
9 / 1200	17.1	109.8	999	50	"
9 / 1800	17.5	110.5	996	55	"
10 / 0000	18.1	111.4	996	55	"
10 / 0600	18.5	112.4	996	55	"
10 / 1200	19.0	113.6	996	55	"
10 / 1800	19.4	114.8	993	60	"
11 / 0000	19.9	116.1	993	60	"
11 / 0600	20.2	117.6	996	55	"
11 / 1200	20.3	119.0	999	50	"
11 / 1800	20.3	120.3	1002	45	"
12 / 0000	20.4	121.6	1002	45	"
12 / 0600	20.5	122.7	1004	40	"
12 / 1200	20.6	123.7	1006	35	"
12 / 1800	20.6	124.8	1006	35	low
13 / 0000	20.7	126.0	1008	30	"
13 / 0600	20.9	127.1	1008	30	"
13 / 1200	21.0	128.2	1010	25	"
13 / 1800	21.2	129.4	1010	25	"
14 / 0000	21.5	130.6	1010	25	"
14 / 0600	21.8	132.0	1010	25	"
14 / 1200	22.1	133.5	1010	25	"
14 / 1800	22.4	135.0	1010	25	"
15 / 0000	22.7	136.5	1010	25	"
15 / 0600	23.0	137.8	1010	25	"
15 / 1200	23.4	139.0	1010	25	"
15 / 1800	23.8	140.0	1010	25	"

16 / 0000					dissipated
10 / 1800	19.4	114.8	993	60	Maximum intensity and minimum central pressure

Table 2. Number of hours in advance of formation of Cristina 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%)	30	102
Medium (40%-60%)	24	78
High (>60%)	0	42

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Tropical Storm Cristina, 6–12 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	21.8	**29.5**	**37.7**	**50.0**	**62.0**	**64.4**	**74.5**	**48.8**
OCD5	35.3	69.0	105.4	144.7	176.6	193.5	211.3	284.2
Forecasts	22	20	18	16	14	12	8	4
OFCL (2015-19)	21.8	34.0	44.9	55.3	66.2	77.1	99.1	123.2
OCD5 (2015-19)	34.3	69.9	108.7	146.8	181.4	216.0	268.7	328.0

Table 3b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Tropical Storm Cristina, 6–12 July 2020. 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	20.6	27.8	38.2	48.5	58.6	58.9	63.9	18.9
OCD5	30.4	63.2	101.0	144.2	174.9	186.8	172.2	227.9
GFSI	20.6	28.9	39.6	**45.7**	**48.8**	**52.4**	**49.0**	113.0
EMXI	23.3	33.3	44.0	60.3	75.1	79.7	121.3	71.4
NVGI	33.1	43.6	43.8	**48.2**	62.6	87.8	132.3	142.1
CMCI	21.6	34.0	39.3	**38.9**	**49.5**	61.5	**52.5**	52.2
AEMI	**20.3**	**25.3**	**30.0**	**35.1**	**38.5**	**39.8**	**62.7**	100.5
HWFI	25.0	40.6	56.2	71.6	78.5	79.5	95.1	105.8
HMNI	**19.0**	**25.9**	41.0	58.6	72.7	88.4	110.4	113.8
TVCE	**19.6**	**26.9**	38.9	51.5	61.0	64.0	69.5	**12.2**
GFEX	21.3	28.4	**37.3**	48.9	**57.9**	62.0	71.2	31.4
TVCX	21.1	28.0	39.0	52.2	63.5	66.5	74.7	**12.2**
FSSE	24.7	33.2	52.2	**48.2**	59.4	65.3	79.5	22.2
HCCA	**18.9**	**24.8**	**33.8**	48.5	58.8	60.6	67.2	26.8
TABS	35.8	66.4	94.9	117.4	125.6	124.1	102.1	49.2
TABM	32.8	52.4	66.4	85.3	97.9	106.9	87.6	65.4
TABD	28.4	42.7	55.4	68.0	74.6	92.2	86.7	86.3
Forecasts	17	15	14	13	11	9	5	2

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Tropical Storm Cristina, 6–12 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	**5.9**	**8.0**	**11.1**	15.3	18.2	19.6	20.6	23.8
OCD5	4.7	6.2	7.9	9.3	7.7	8.0	10.0	16.8
Forecasts	22	20	18	16	14	12	8	4
OFCL (2015-19)	6.0	9.9	12.1	13.5	14.5	15.4	15.6	16.4
OCD5 (2015-19)	7.8	13.0	16.6	18.9	20.2	21.4	22.6	22.4

Table 4b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Tropical Storm Cristina, 6–12 July 2020. 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	6.6	8.2	11.2	15.0	17.7	18.6	20.0	23.3
OCD5	**4.9**	**5.7**	**7.0**	**7.9**	**6.8**	**7.3**	**10.3**	**16.3**
HWFI	**4.5**	**4.7**	**6.9**	**8.6**	**9.8**	**10.8**	**13.3**	**21.3**
LGEM	**5.4**	**6.2**	**7.5**	**7.3**	**10.7**	**11.5**	**15.0**	**21.0**
SHIP	**6.3**	10.2	14.6	17.7	20.7	22.7	28.0	35.0
HMNI	**5.2**	**6.0**	**7.0**	**7.9**	**10.1**	**13.0**	**6.9**	**12.3**
GFSI	**6.3**	**7.8**	**8.9**	**9.5**	**11.4**	**13.8**	**16.1**	**16.3**
EMXI	**4.9**	**5.9**	**6.7**	**8.7**	**9.6**	**11.0**	**9.4**	**2.7**
ICON	**5.1**	**6.2**	**8.6**	**9.8**	**12.2**	**14.1**	**15.9**	**22.7**
IVCN	**5.5**	**6.6**	**9.0**	**10.3**	**13.2**	**15.1**	**16.6**	25.3
FSSE	7.7	10.6	13.6	15.6	18.2	19.5	21.7	27.3
HCCA	7.6	11.8	14.4	15.7	**16.5**	**16.1**	**15.6**	**21.7**
Forecasts	19	17	16	15	13	11	7	3

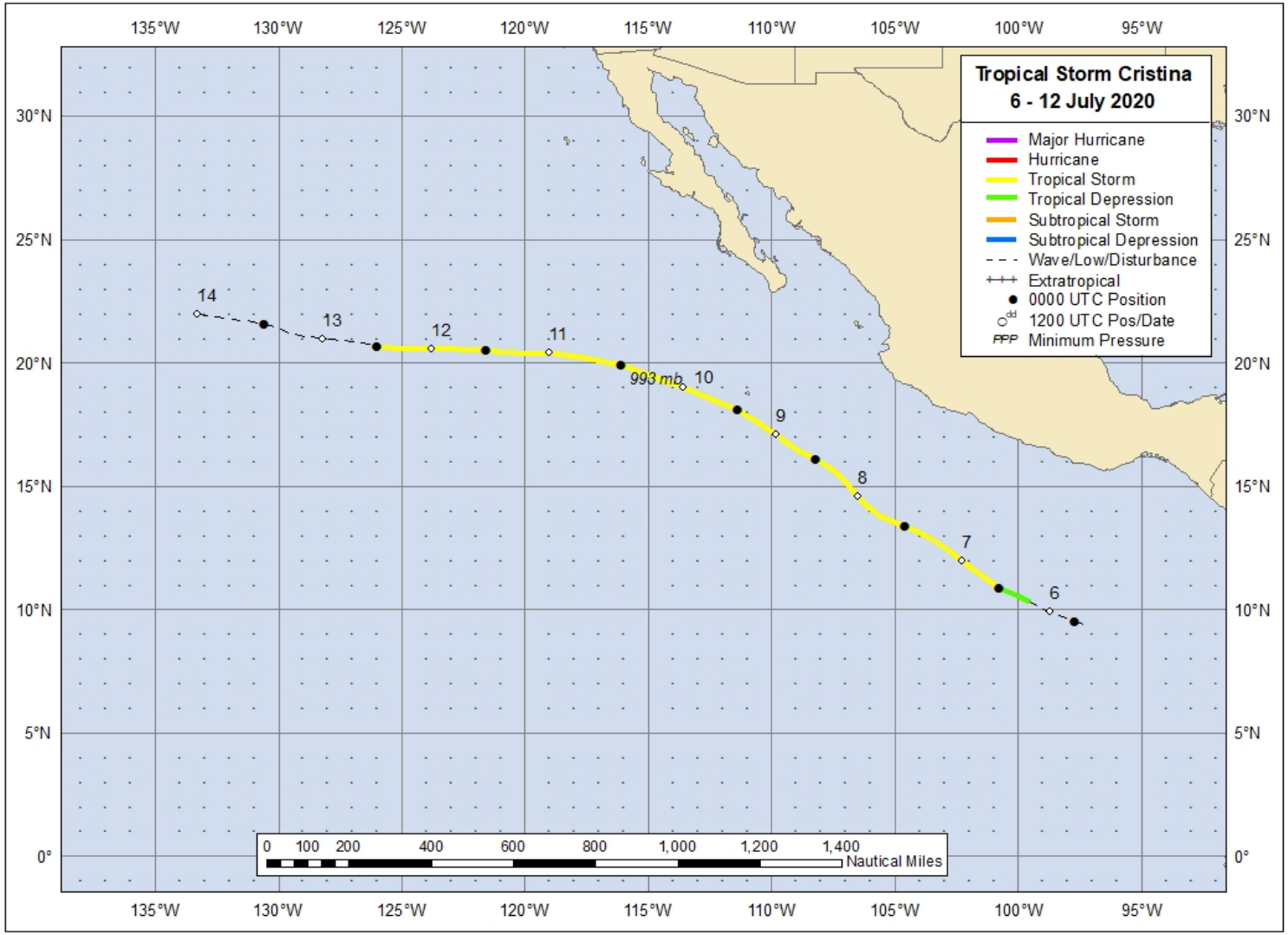


Figure 1. Best track positions for Tropical Storm Cristina, 6–12 July 2020. Post-tropical cyclone positions are based partly on analyses from TAFB.

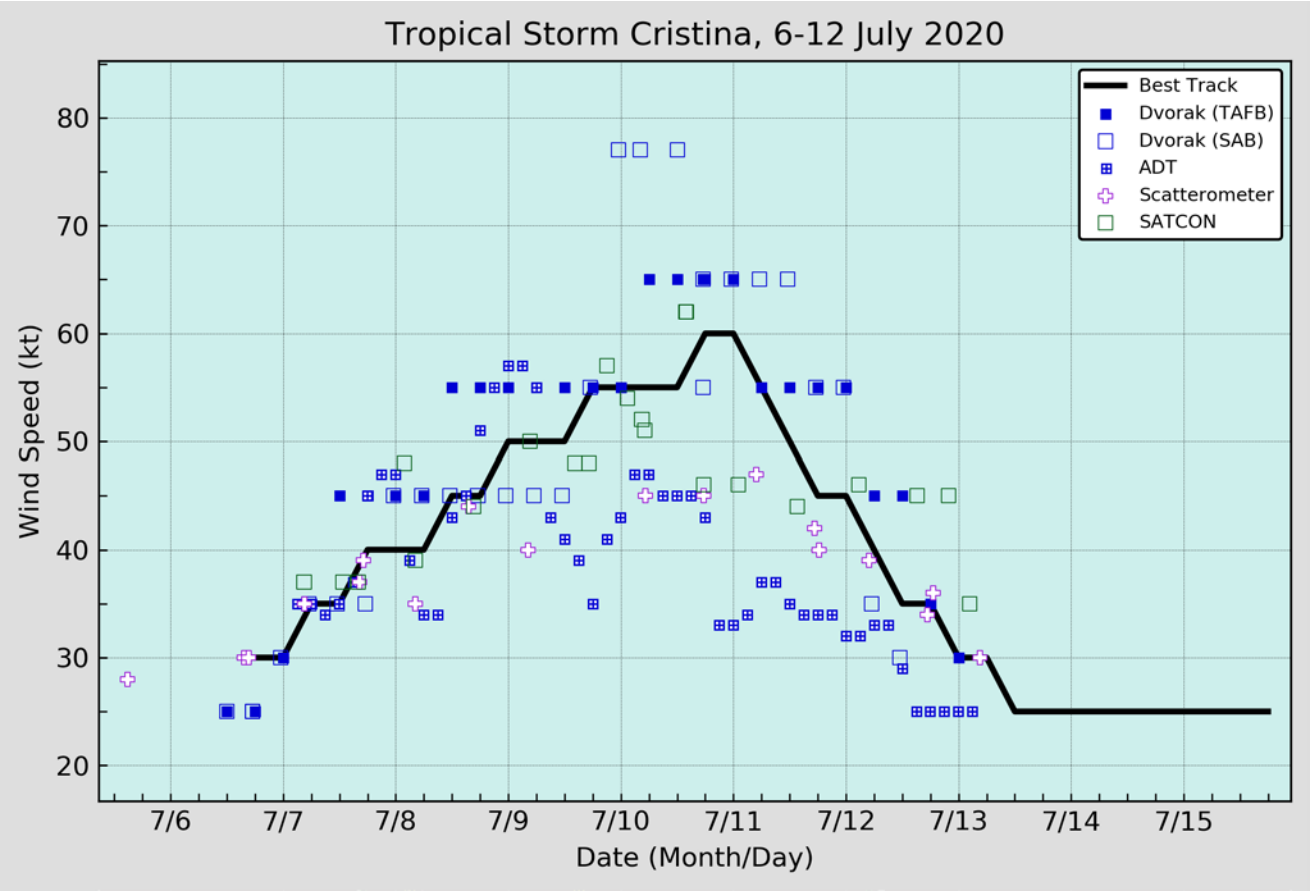


Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Cristina, 6–12 July 2020. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies. Dashed vertical lines correspond to 0000 UTC.

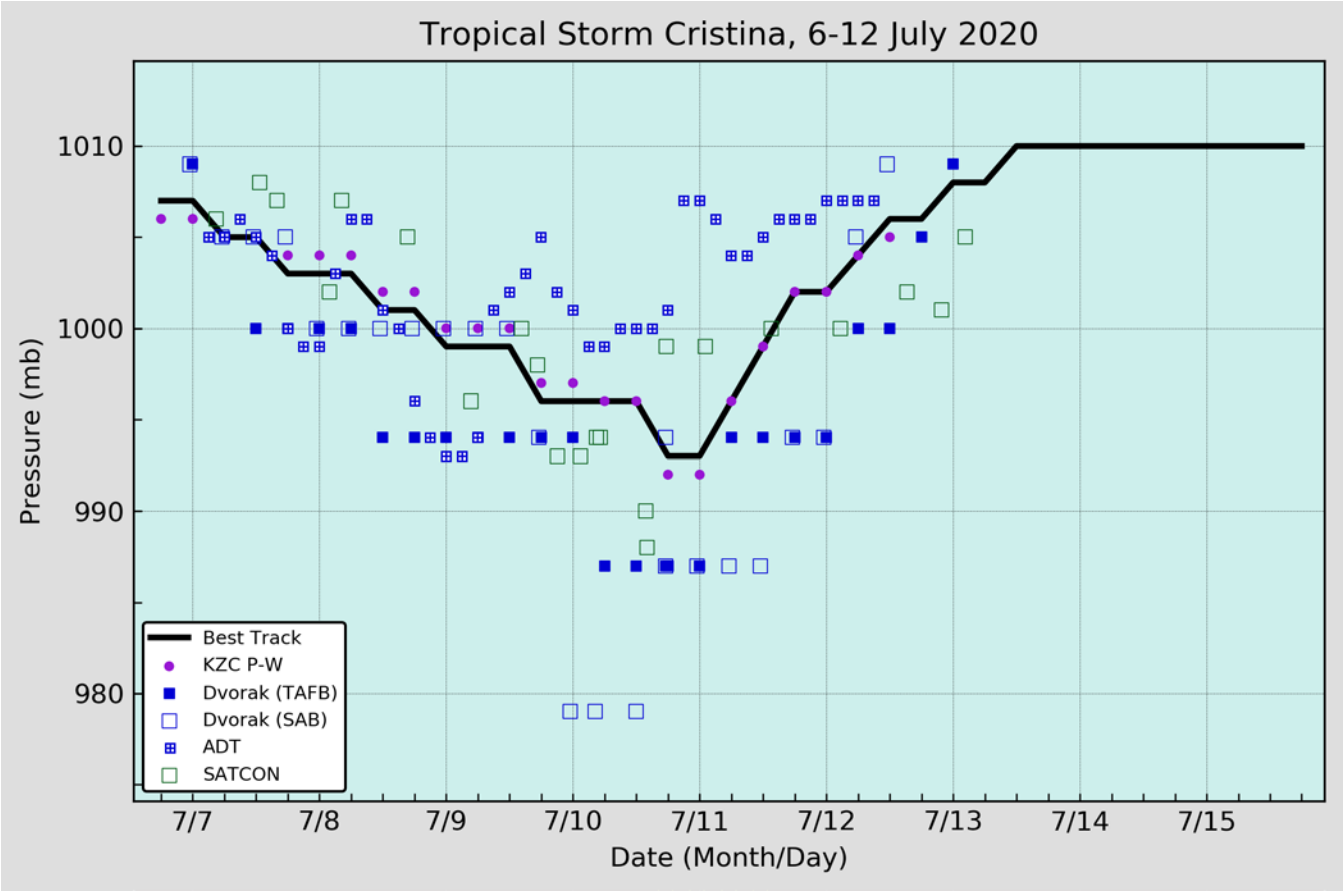


Figure 3. Selected pressure observations and best track minimum central pressure curve for Tropical Storm Cristina, 6–12 July 2020. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological 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.

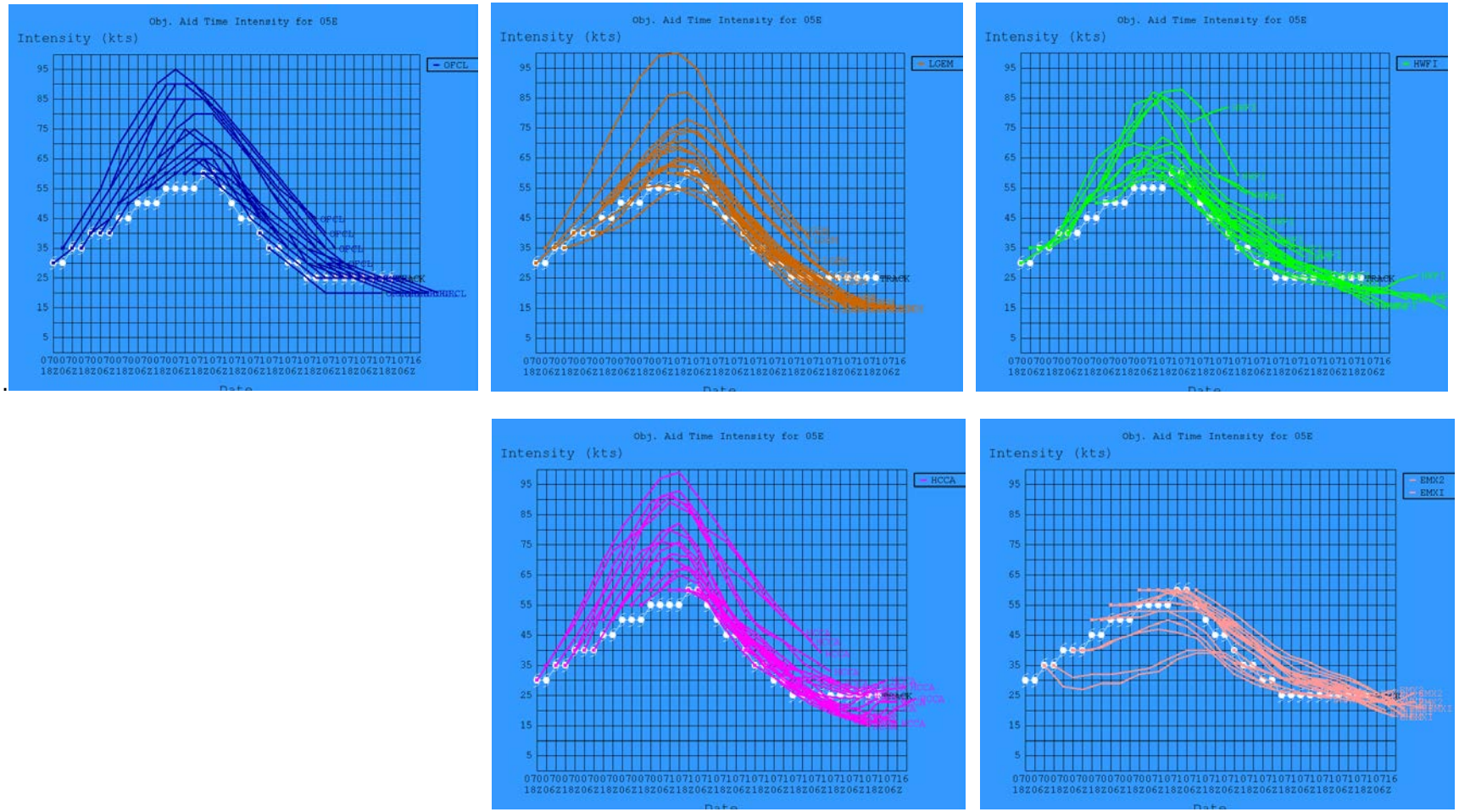


Figure 4. Intensity forecast guidance (kt) for Tropical Storm Cristina, 6–12 July 2020 including (going clockwise beginning upper left) OFCL, LGEM, HWRF, EMXI, and HCCA. The best track intensity (kt) is shown in the white symbols.