NATIONAL HURRICANE CENTER
TROPICAL CYCLONE REPORT

HURRICANE CRISTINA

(EP032014)

9 – 15 June 2014

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National Hurricane Center
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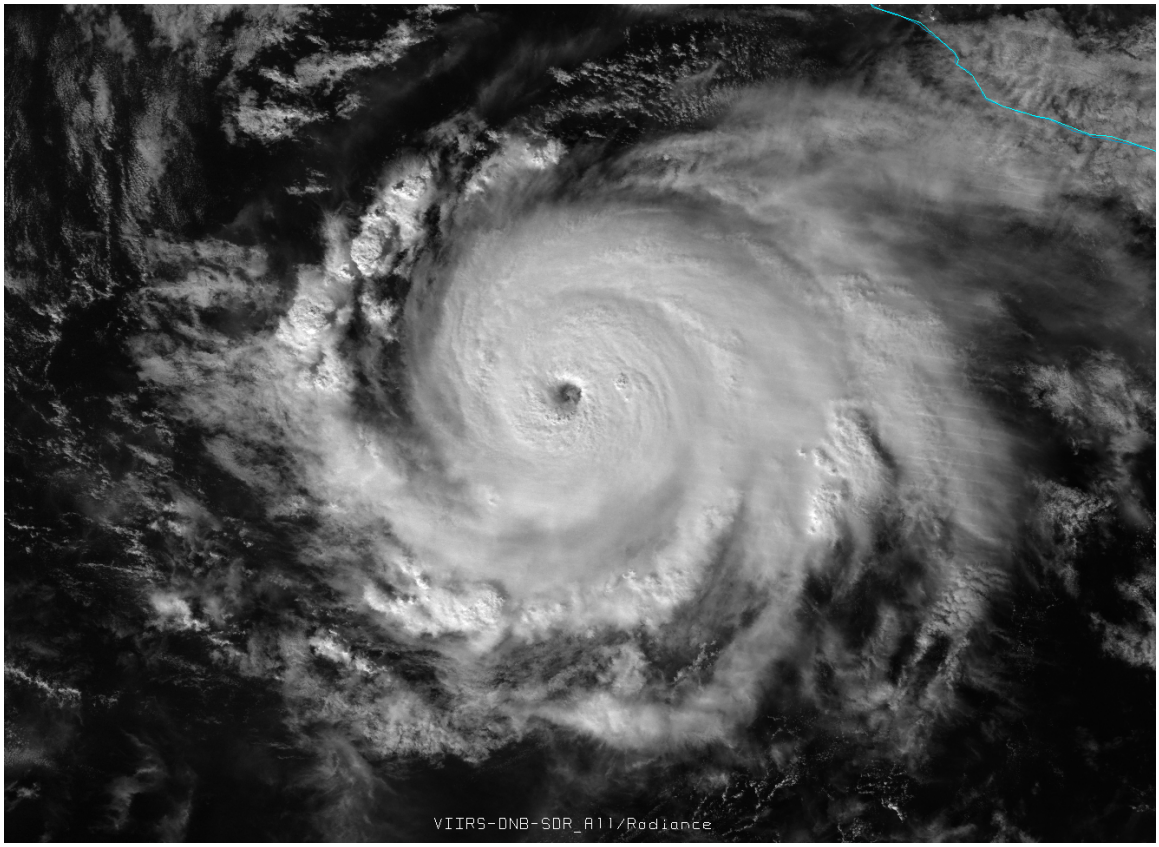

CRISTINA NEAR PEAK INTENSITY FROM VIIRS (12 JUN 0827 UTC) – NOAA

Cristina was a category 4 hurricane on the Saffir-Simpson Hurricane Wind Scale that brought hurricane-force wind gusts to Socorro Island. It was the earliest second major hurricane of a season on record for the eastern North Pacific basin.

Hurricane Cristina

9 – 15 JUNE 2014

SYNOPTIC HISTORY

Cristina formed from the combination of an intertropical convergence zone (ITCZ) disturbance, a tropical wave, and a convectively coupled Kelvin wave (CCKW). The low-latitude tropical wave left the coast of western Africa on 26 May, travelled quickly westward and moved into the eastern Pacific on 5 June. Meanwhile, a broad area of low pressure was noted within the ITCZ several hundred miles south of Acapulco, Mexico on 3 June, perhaps initiated by an earlier weak tropical wave. The low drifted northwestward over the next few days, with the tropical wave from the east catching up with the low on 7 June, causing a temporary increase in convection. On 8 June, thunderstorm activity increased again, likely due to the CCKW passing through the area early that day, which resulted in the formation of a well-defined low pressure area early on 9 June. After a decrease in overnight convection, organized convective bands formed near and east of the center by 1200 UTC 9 June, marking the formation of a tropical depression about 135 n mi southwest of Acapulco. The "best track" chart of Cristina'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].

Initially, the low- and mid-level circulations of the depression were not vertically aligned, perhaps due to northerly shear. The depression intensified only slowly with this structure, becoming a tropical storm 18 h after genesis, and the cyclone turned westward. However by midday on 10 June, a decrease in shear was noted in SHIPS-model analyses, and microwave images showed that the circulation of Cristina had become more vertically aligned. Scatterometer data also indicated that the radius of maximum winds had decreased, and by late on 10 June Cristina started to rapidly intensify with a faint eye noted in visible satellite images. The storm became a hurricane early on 11 June, and turned west-northwestward around a ridge centered over Mexico. Cristina strengthened into a major hurricane early the next day, with an increase in wind speed of about 45 kt from 0000-1200 UTC 12 June. The cyclone reached a peak intensity of 130 kt around 1200 UTC 12 June about 210 n mi southwest of Manzanillo, Mexico, with a well-defined eye and symmetric presentation (cover image). The hurricane did not stay very intense for long, however, due to an eyewall replacement cycle that began later that day. In addition, Cristina was moving into a more stable and drier environment, which also contributed to the weakening process.

Almost as fast as it had intensified, Cristina rapidly weakened during the next three days. The weakening rate levelled off somewhat on 13 June when the eyewall cycle was completed, but by that point the cyclone was moving over cooler waters and was deeper into the more

[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.

stable eastern Pacific environment, and the weakening continued. The hurricane moved to the northwest for about a day, with the center of the cyclone passing about 20 n mi north of Socorro Island. Cristina weakened into a tropical storm on 14 June, and turned toward the west-northwest later that day. The storm lost all of its deep convection early on 15 June, and Cristina became a non-convective low around 0600 UTC when it was located about 230 n mi southwest of Cabo San Lucas, Mexico. The remnant low generally moved to the west-northwest or northwest for the next couple of days and gradually weakened. Late on 17 June, the weak circulation turned eastward then southeastward within the low-level flow and dissipated just after 0000 UTC 19 June about 275 n mi west of Cabo San Lucas.

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), and objective Advanced Dvorak Technique (ADT) 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 Tropical Rainfall Measuring Mission (TRMM), 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 estimated peak intensity of 130 kt is based on a blend of subjective Dvorak satellite intensity estimates of 115 kt and an objective ADT estimate of 139 kt.

A Mexican Navy surface station on Socorro Island (site elevation 35 m), reported a 10-min sustained wind of 295°/60 kt at 0330 UTC 14 June, with a peak gust of 76 kt measured 45 minutes prior.

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

Cristina was the earliest second major hurricane of a season recorded in the basin, reaching that intensity early on 12 June. The previous record was Darby of 2010, which became a major hurricane on 25 June.

CASUALTY AND DAMAGE STATISTICS

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

FORECAST AND WARNING CRITIQUE

Table 2 indicates how far in advance of formation the NHC official genesis forecasts first reached the indicated likelihood categories. The genesis of Cristina was poorly forecast, especially in the long range, with no lead time beyond 48 h. Although the system spent 36 h in the medium (30-50%) chance of genesis category, the system was not considered to have a high chance of genesis until the time of formation in the final best-track.

A verification of NHC official track forecasts is given in Table 3a. Official forecast track errors were extraordinarily lower than the mean official errors for the previous 5-yr period, although the CLIPER errors were also smaller than average. A homogeneous comparison of the official track errors with selected guidance models is given in Table 3b. The TVCE consensus model provided the best overall forecasts for Cristina, with extremely low errors, and the best single deterministic model was the HWRF. Otherwise, the official forecast (OFCL) was generally superior to the rest of the guidance. The ECMWF model (EMXI) did not perform well for this storm.

A verification of NHC official intensity forecasts is given in Table 4a. Official forecast intensity errors were much higher than the mean official errors for the previous 5-yr period at most time intervals, which matched the higher-than-average CLIPER errors. This is not a surprising result given the longstanding issues with rapid intensification and rapid weakening. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 4b. Although all of the guidance had large errors, the Florida State Superensemble (FSSE) had the best performance for this storm. Interestingly, the FSSE had significantly lower errors than the intensity consensus IVCN, which suggest the corrections used by the FSSE model were somewhat effective for this cyclone. Most of the guidance demonstrated a notable low bias at first, and a high bias after Cristina started to weaken (Figs 4, 5). The global models GFSI and EMXI did not provide much useful guidance, with extremely high errors noted.

Table 1. Best track for Hurricane Cristina, 9-15 June 2014.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
09 / 0000	14.8	101.3	1007	25	low
09 / 0600	15.0	101.4	1007	25	"
09 / 1200	15.2	101.5	1006	30	tropical depression
09 / 1800	15.4	101.6	1006	30	"
10 / 0000	15.6	101.8	1006	30	"
10 / 0600	15.5	102.2	1005	35	tropical storm
10 / 1200	15.4	102.6	1003	40	"
10 / 1800	15.3	103.0	1001	45	"
11 / 0000	15.3	103.4	996	55	"
11 / 0600	15.3	103.9	990	65	hurricane
11 / 1200	15.4	104.4	987	70	"
11 / 1800	15.6	104.9	983	75	"
12 / 0000	15.8	105.4	975	85	"
12 / 0600	16.1	106.1	959	105	"
12 / 1200	16.4	106.8	935	130	"
12 / 1800	16.7	107.5	940	125	"
13 / 0000	17.0	108.1	955	110	"
13 / 0600	17.4	108.8	967	95	"
13 / 1200	17.8	109.5	973	85	"
13 / 1800	18.3	110.1	978	80	"
14 / 0000	18.7	110.5	979	80	"
14 / 0600	19.0	110.8	984	70	"
14 / 1200	19.3	111.2	990	60	tropical storm
14 / 1800	19.5	111.6	997	50	"
15 / 0000	19.7	112.0	1002	40	"
15 / 0600	19.9	112.5	1003	35	low
15 / 1200	20.1	113.0	1004	30	"
15 / 1800	20.4	113.5	1005	30	"
16 / 0000	20.7	114.1	1005	30	"
16 / 0600	21.1	114.8	1005	30	"

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
16 / 1200	21.6	115.6	1005	25	"
16 / 1800	22.1	116.4	1005	25	"
17 / 0000	22.5	116.9	1006	20	"
17 / 0600	22.7	117.2	1006	20	"
17 / 1200	22.8	117.6	1007	15	"
17 / 1800	23.0	117.8	1007	15	"
18 / 0000	23.1	117.5	1008	15	"
18 / 0600	23.0	117.2	1009	15	"
18 / 1200	22.8	117.0	1010	15	"
18 / 1800	22.5	116.8	1010	15	"
19 / 0000	22.2	116.6	1010	15	"
19 / 0600					dissipated
12 / 1200	16.4	106.8	935	130	min pressure & max winds

Table 2. 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.

Category	Hours Before Genesis	
	48-Hour Outlook	120-Hour Outlook
Low (<30%)	48	48
Medium (30%-50%)	36	48
High (>50%)	0	42

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Cristina. 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	72	96	120
OFCL	**18.0**	**25.1**	**34.5**	**45.4**	**57.6**	**89.8**	**127.6**
OCD5	21.2	40.4	59.3	75.7	89.9	81.5	77.2
Forecasts	20	18	16	14	10	6	2
OFCL (2009-13)	25.7	41.4	55.0	68.6	97.8	134.2	167.1
OCD5 (2009-13)	37.2	74.8	118.0	162.5	249.4	332.6	413.3

Table 3b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Cristina. Errors smaller than the NHC official forecast are shown in boldface type.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	17.1	23.7	31.9	41.2	53.7	83.4	94.7
OCD5	20.9	38.6	56.5	72.6	86.2	**76.9**	96.7
GFSI	21.1	29.3	36.1	43.8	59.3	**78.0**	**30.7**
AEMI	19.7	31.8	41.2	50.4	66.0	98.2	**61.8**
GHMI	19.5	31.3	46.9	61.1	104.6	117.6	226.9
HWFI	18.9	26.5	**31.8**	**36.0**	**40.6**	**58.1**	**36.4**
EMXI	21.4	39.6	59.4	74.3	103.4	166.8	266.1
CMCI	29.4	58.0	81.6	97.8	129.3	231.6	240.4
NVGI	27.7	52.5	77.1	95.8	144.6	201.3	178.2
GFNI	22.4	38.5	53.4	56.3	114.9	202.6	329.5
FSSE	**16.3**	24.7	36.6	48.5	62.7	122.3	164.8
TVCE	**13.9**	**22.5**	**31.4**	**38.4**	**42.2**	**40.3**	**24.7**
LBAR	20.8	45.1	75.8	110.3	181.3	234.6	310.4
BAMD	26.0	40.9	56.3	64.9	96.2	130.6	142.7
BAMM	32.3	55.2	76.8	103.9	171.1	234.5	306.4
BAMS	35.5	63.2	94.7	124.9	209.1	281.6	386.5
Forecasts	19	17	15	13	9	5	1

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Cristina. 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	72	96	120
OFCL	10.8	17.2	20.0	23.6	19.0	**15.0**	**7.5**
OCD5	14.7	22.9	27.4	34.9	32.6	22.3	5.5
Forecasts	20	18	16	14	10	6	2
OFCL (2009-13)	6.1	10.4	13.4	14.5	15.0	16.4	16.1
OCD5 (2009-13)	7.7	12.7	16.4	18.8	20.5	20.3	20.8

Table 4b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Cristina. Errors smaller than the NHC official forecast are shown in boldface type.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	11.1	17.9	21.0	25.0	15.0	14.0	5.0
OCD5	15.4	23.9	27.7	35.1	27.0	18.8	**3.0**
DSHP	13.3	20.3	23.5	26.1	15.6	**11.6**	18.0
LGEM	13.3	19.7	23.0	26.8	18.6	**12.2**	9.0
HWFI	11.1	**17.1**	**20.9**	27.3	18.0	15.2	23.0
GHMI	13.2	19.8	**20.6**	**20.4**	**13.6**	**6.0**	32.0
IVCN	12.2	18.5	21.5	**24.7**	15.9	**7.4**	21.0
FSSE	11.2	**14.9**	**13.7**	**16.5**	**11.8**	**10.4**	8.0
GFSI	14.1	24.2	31.7	37.5	20.4	**10.6**	6.0
EMXI	18.5	30.2	36.9	42.6	28.4	16.6	**2.0**
Forecasts	19	17	15	13	9	5	1

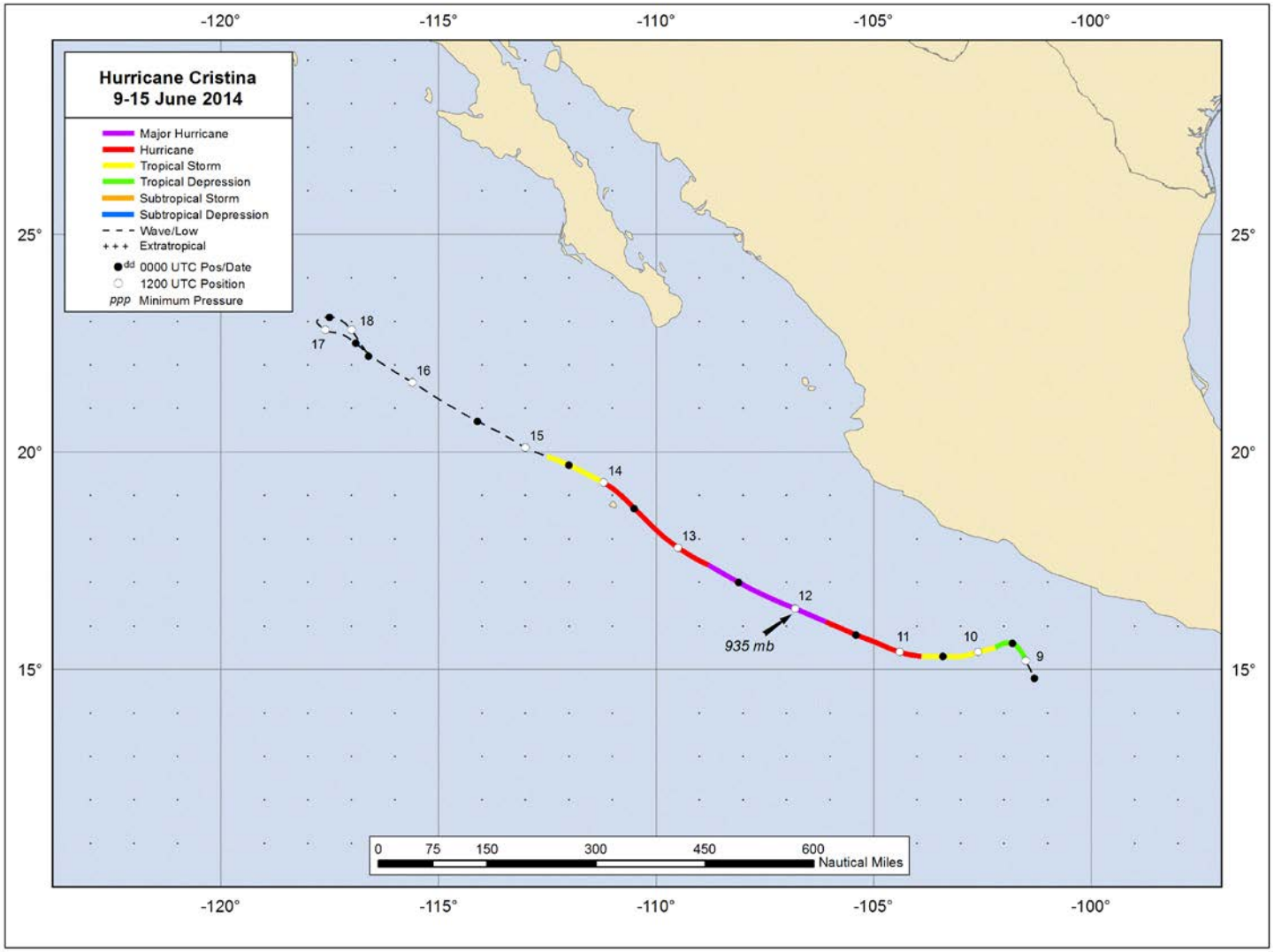

Figure 1. Best track positions for Hurricane Cristina, 9-15 June 2014.

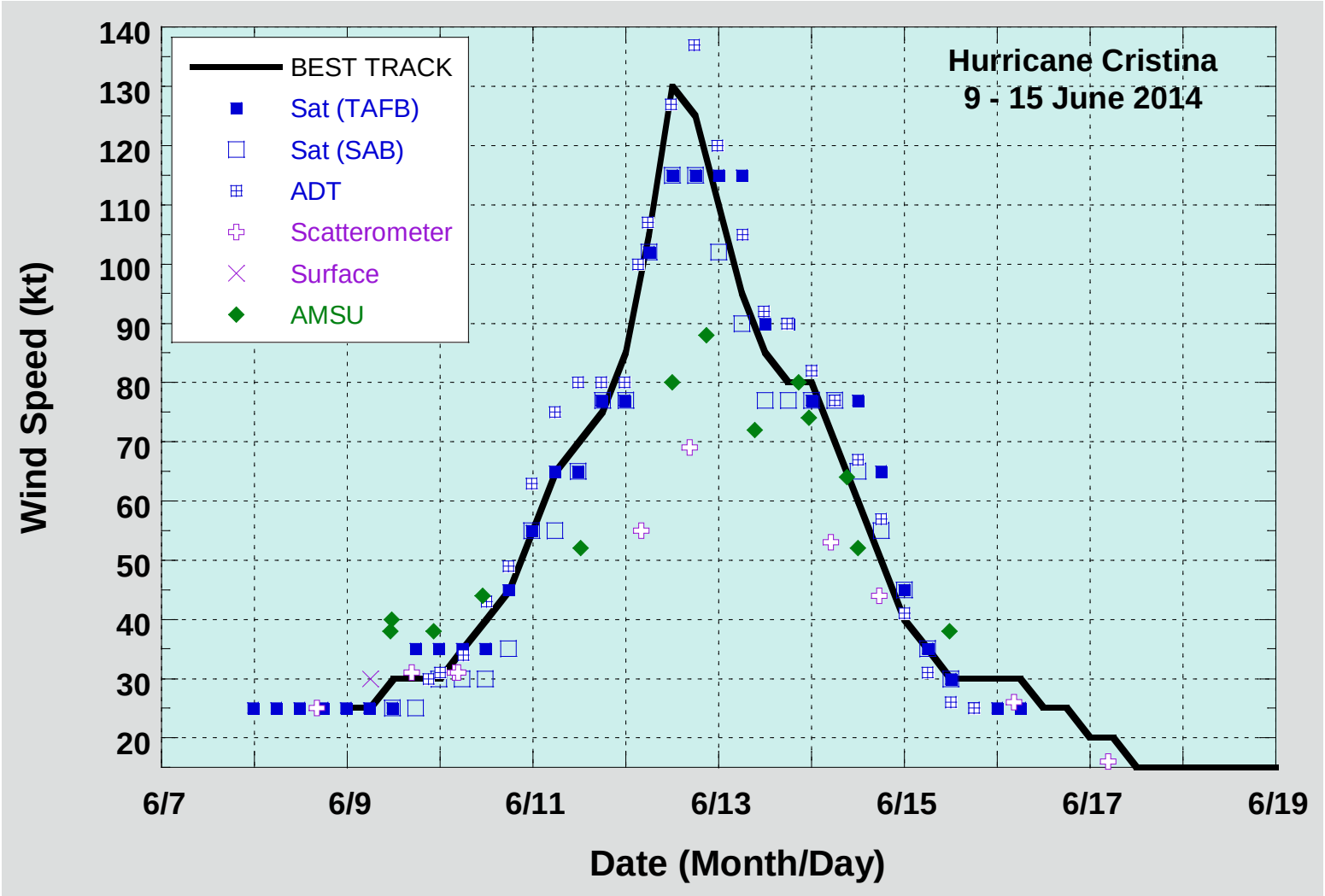

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Cristina. Advanced Dvorak Technique estimates represent the current intensity at the nominal observation time. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. Dashed vertical lines correspond to 0000 UTC.

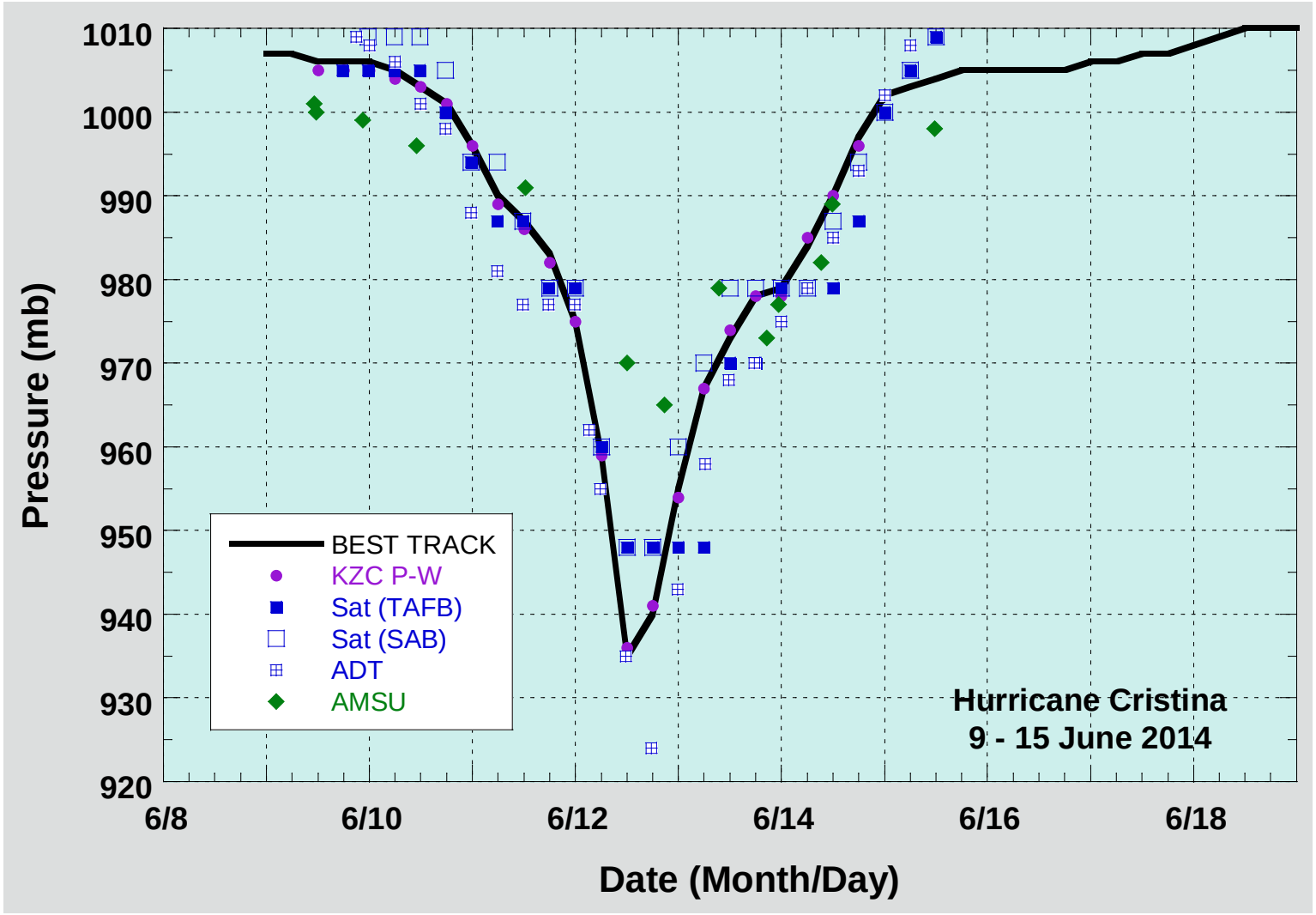

Figure 3. Selected pressure observations and best track minimum central pressure curve for Cristina. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. KZC P-W refers to pressure estimates derived using the Knaff-Zehr-Courtney pressure-wind relationship. Dashed vertical lines correspond to 0000 UTC.

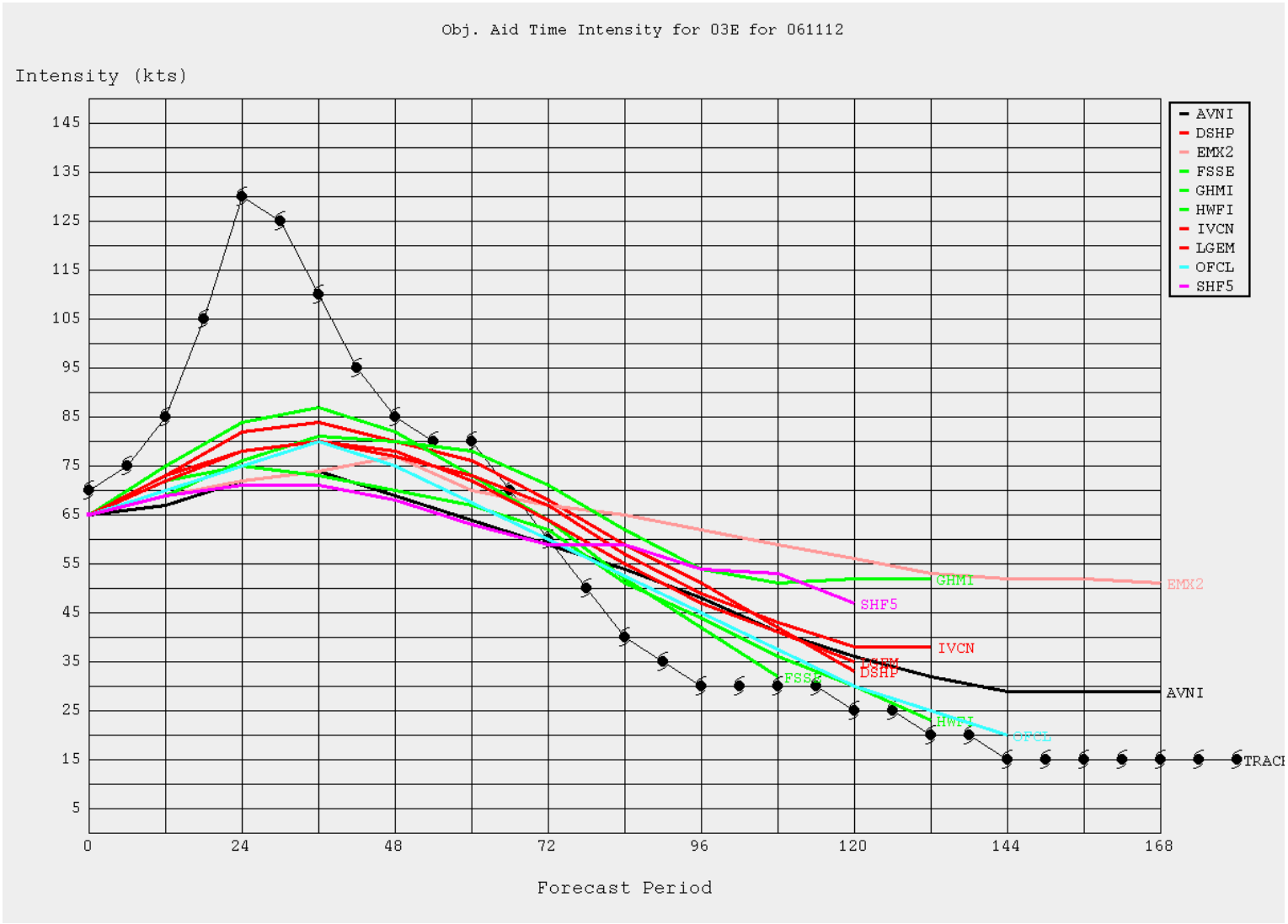

Figure 4. Plot of selected intensity model guidance for Cristina valid 1200 UTC 11 June 2014, about 24 h before the time of maximum intensity. All of the guidance models had a substantial low bias for about 36h, and were too high beyond 72h.

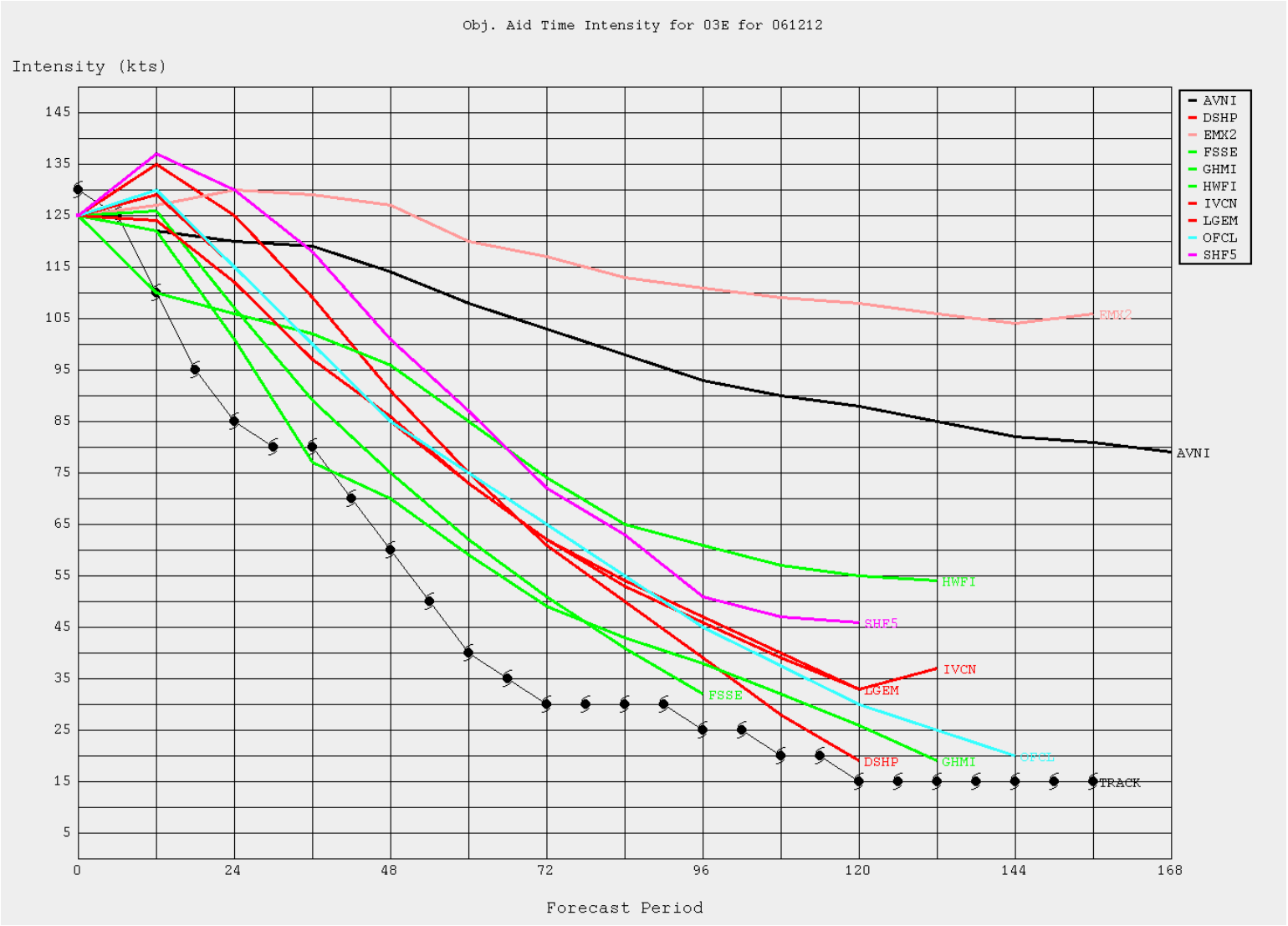

Figure 5. Plot of selected intensity model guidance for Cristina valid 1200 UTC 12 June 2014, near the time of maximum intensity. All of the guidance models had a substantial high bias after this point.