Tropical Cyclone Report
Hurricane Julia
(AL122010)
12 – 20 September 2010

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9 December 2010

Julia was a category 4 hurricane (on the Saffir-Simpson Hurricane Wind Scale) over the eastern Atlantic Ocean that threatened the Cape Verde Islands as a tropical storm.

a. Synoptic History

The system that spawned Julia was a vigorous tropical wave that emerged from the coast of West Africa on 11 September. The wave was of particular note on that date because of its very strong (50 kt) easterly wind maximum at 925 mb measured by the Dakar, Senegal rawindsonde. The system maintained deep convection after moving into the eastern Atlantic Ocean and quickly spawned a tropical depression at 0600 UTC 12 September about 250 n mi southeast of the southernmost Cape Verde Islands. Twelve hours later the cyclone became a tropical storm about 150 n mi southeast of the southernmost Cape Verde Islands. The “best track” chart of Julia’s path is given in Fig. 1, with the wind and pressure histories shown in Figs. 2 and 3, respectively. The cyclone’s best track positions and intensities are listed in Table 1[1].

Julia’s moved toward the west-northwest at around 10 kt from 12-14 September along the southwestern periphery of a deep-layer ridge. Julia slowly intensified and early on 14 September a ragged, banded eye became apparent in satellite imagery. During a subsequent period of rapid intensification, Julia became a hurricane around 1200 UTC that day and a major hurricane (Category 3 or higher on the Saffir-Simpson Hurricane Wind Scale) around 0600 UTC 15 September. The 36-h-long period of rapid intensification occurred while Julia was moving through an environment characterized by high sea surface temperatures (~28^{o} C), relatively low oceanic heat content, high ambient relative humidity, and light northwesterly tropospheric vertical shear.

On 15 September, Julia turned toward the northwest and accelerated around a mid to upper-level low to its southwest. The same upper low also caused moderate southerly vertical shear, which may have induced weakening of the cyclone. By early on 16 September, Julia’s eye was no longer visible in geostationary satellite imagery and it is estimated that Julia dropped below major hurricane intensity after 0600 UTC that day. Meanwhile the hurricane turned back toward the west-northwest steered primarily by a deep-layer ridge to its north and east. The eye of Julia was briefly visible again late on 16 September.

[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.

The next day, Julia, a relatively small system with tropical-storm-force wind radii of about 100 n mi, moved to within 780 n mi to the east of the much larger Hurricane Igor. Upper-level outflow from Igor began to impinge upon the circulation of Julia, increasing the vertical wind shear and causing Julia to weaken. Julia dropped below hurricane intensity late on 17 September, while located about 1350 n mi west-southwest of the Azores. Julia continued to recurve around the deep-layer ridge from 17-20 September as it progressively turned toward the northwest, north, northeast, and finally to the east.

By mid-day on 18 September, Julia's low-level center was exposed to the north of the deep convection. For a short time later that day and early the next, convection redeveloped over the center and scatterometer data indicate that a brief secondary peak in intensity to 55 kt occurred. Later on 19 September, strong vertical shear again caused Julia's low-level center to become exposed, and deep convection ceased after 1200 UTC 20 September. It is estimated that Julia degenerated to a post-tropical low by 1800 UTC 20 September, while located about 950 n mi west of the Azores. The cyclone slowly decayed and its peak winds dropped below gale force a day later. The remnant low turned back toward the west on 23-24 September when a surface ridge developed north of the system. Julia briefly redeveloped deep convection from around 0000-1200 UTC on 23 September. Eventually, the remnants of Julia dissipated into an open trough after 1800 UTC 24 September.

b. Meteorological Statistics

Observations in Hurricane Julia (Figs. 2 and 3) include satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB) and the Satellite Analysis Branch (SAB), as well as from the Advanced Dvorak Technique (ADT) from University of Wisconsin-CIMSS. Data and imagery from NOAA polar-orbiting satellites (including UW CIMSS AMSU-based intensity estimates), the NASA Tropical Rainfall Measuring Mission (TRMM), the European Space Agency's ASCAT, and Defense Meteorological Satellite Program (DMSP) satellites, among others, were also useful in constructing the best track of Julia.

The estimated peak intensity of Julia of 120 kt around 1200 UTC 15 September was determined from a blend of the TAFB and SAB subjective Dvorak satellite intensity estimates and the objective ADT. It should be noted that the peak subjective Dvorak estimates of 6.0 from both TAFB and SAB are only achievable by foregoing the final T-number constraints used in the past for intensifying systems. If the constraints were adhered to, this would have limited the peak intensity to a Dvorak number of 5.5, or about 102 kt. Figure 4 provides satellite imagery of Julia near its peak intensity.

Julia is the strongest hurricane in the Atlantic hurricane database (HURDAT) to be recorded east of 40^{o}W. However, it is highly unlikely that either this peak intensity as a Category 4 hurricane or its 1.25 day duration as a major hurricane would have been observed for a hurricane in this location before the advent of regular satellite imagery and the Dvorak intensity analysis system in the 1970s.

There were no reliable ship or coastal reports of tropical-storm-force or greater winds received in association with Julia. However, it is possible that that some tropical-storm-force winds did affect the southern Cape Verde islands.

c. Casualty and Damage Statistics

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

d. Forecast and Warning Critique

The genesis of Julia was not well anticipated. The disturbance that became Julia was introduced into the Tropical Weather Outlook (TWO) with a medium (30%) chance of formation only 18 h before the system became a tropical cyclone. This prediction was raised to a high (70%) chance 6 h before genesis occurred. The lateness in mentioning the disturbance that spawned Julia may have been due to the typical operational practice of not introducing an African wave disturbance into the TWO until it reaches the Atlantic Ocean. In this case, the disturbance developed into a tropical cyclone only about one day after leaving the West African coast. It is of note that many of the global model forecasts successfully called for the genesis of Julia up to several days in advance.

A verification of NHC official track forecasts (OFCL) for Julia is given in Table 2a. Official forecast track errors were comparable to the mean official errors for the previous 5-yr period at 12 to 36 h and substantially smaller at 48 h and beyond. As illustrated in Fig. 5, OFCL had a moderate northeastward bias (for example, at 72 h the NHC official forecasts had a 45 degree and 43 n mi bias). A homogeneous comparison of the official track errors with selected guidance models is given in Table 2b. The best performing individual track model was the ECMWF (EMXI), with lowest errors recorded at nearly all lead times and lower than OFCL except at 120 h. The consensus models TVCN and the Florida State Super Ensemble (FSSE) generally outperformed OFCL at all times but only bested EMXI at 96 and 120 h.

A verification of NHC official intensity forecasts for Julia is given in Table 3a. OFCL intensity errors were worse at the 24 to 48 h leads than the mean official errors for the previous 5-yr period, but were substantially better at the 96 to 120 h lead times. This behavior is explained by Fig. 6, which shows that none of the 4- and 5-day predictions encompassed the period of rapid intensification on 14-15 September and only a few of these predictions spanned the period of rapid weakening on 16-17 September. In general, OFCL substantially under-predicted the intensity during the rapid intensification and over-predicted the intensity during the rapid weakening. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 3b. The best performing individual intensity model was the Decay-SHIPS (DSHP) with errors smaller than OFCL at all times except at 120 h. The Geophysical Fluid Dynamics Laboratory (GHMI) and the Hurricane Weather and Research Forecasting (HWFI) dynamical models had substantially worse errors than the statistical methods. In addition, the intensity consensus techniques were generally not as skillful as DSHP or the OFCL.

Watches and warnings associated with Julia are listed in Table 4.

Table 1. Best track for Hurricane Julia, 12 – 20 September 2010.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
12 / 0600	12.9	20.5	1007	30	tropical depression
12 / 1200	13.0	21.3	1006	30	"
12 / 1800	13.1	22.1	1005	35	tropical storm
13 / 0000	13.5	23.1	1004	40	"
13 / 0600	14.0	24.2	1004	40	"
13 / 1200	14.5	25.4	1004	40	"
13 / 1800	15.0	26.5	1003	45	"
14 / 0000	15.3	27.5	1002	45	"
14 / 0600	15.6	28.4	994	60	"
14 / 1200	15.9	29.2	987	70	hurricane
14 / 1800	16.1	29.9	979	80	"
15 / 0000	16.4	30.6	973	90	"
15 / 0600	16.9	31.4	956	110	"
15 / 1200	17.7	32.2	948	120	"
15 / 1800	18.8	33.0	951	115	"
16 / 0000	19.9	34.1	958	105	"
16 / 0600	20.9	35.8	962	100	"
16 / 1200	21.8	37.7	970	90	"
16 / 1800	22.7	40.0	977	80	"
17 / 0000	23.1	42.0	981	75	"
17 / 0600	23.5	44.0	981	75	"
17 / 1200	23.9	45.8	983	70	"
17 / 1800	24.6	47.4	986	65	"
18 / 0000	25.6	48.7	988	60	tropical storm
18 / 0600	26.9	49.8	991	55	"
18 / 1200	28.3	50.7	994	50	"
18 / 1800	29.8	51.4	993	50	"
19 / 0000	31.4	51.8	989	55	"
19 / 0600	32.8	52.0	993	50	"
19 / 1200	33.9	51.4	995	45	"
19 / 1800	34.6	50.2	995	45	"
20 / 0000	34.9	49.2	995	45	"
20 / 0600	34.9	48.0	997	40	"
20 / 1200	34.7	46.9	999	40	"
20 / 1800	34.6	46.0	1002	40	low
21 / 0000	34.4	45.1	1003	40	"
21 / 0600	34.4	44.1	1004	35	"
21 / 1200	34.5	43.0	1005	35	"
21 / 1800	34.5	41.9	1006	30	"
22 / 0000	34.3	40.9	1007	30	"

22 / 0600	33.9	39.9	1007	30	"
22 / 1200	33.6	38.8	1007	30	"
22 / 1800	33.2	38.0	1008	30	"
23 / 0000	33.0	37.8	1008	30	"
23 / 0600	32.7	37.7	1009	30	"
23 / 1200	32.4	37.8	1009	30	"
23 / 1800	32.0	38.6	1010	30	"
24 / 0000	31.5	40.0	1010	30	"
24 / 0600	31.2	41.6	1011	30	"
24 / 1200	30.9	43.1	1011	30	"
24 / 1800	30.6	44.3	1012	30	"
25 / 0000					dissipated
15 / 1200	17.7	32.2	948	120	minimum pressure and maximum wind

Table 2a. NHC official (OFCL) and climatology-persistence skill baseline (CLIPER-OCD5) track forecast errors (n mi) for Hurricane Julia, 12 – 20 September 2010. Mean errors for the 5-yr period 2005-9 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	34.0	57.1	**71.7**	**79.1**	**92.6**	**116.4**	**128.1**
OCD5	61.9	129.5	190.8	245.2	325.5	390.1	396.1
Forecasts	31	29	27	25	21	17	13
OFCL (2005-9)	31.8	53.4	75.4	96.8	143.8	195.6	252.1
OCD5 (2005-9)	46.9	97.3	155.4	211.6	304.8	387.9	467.8

Table 2b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Hurricane Julia, 12 – 20 September 2010. 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 2a due to the homogeneity requirement.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	35.0	58.7	75.2	81.6	91.8	118.5	106.6
OCD5	64.1	132.1	193.5	245.8	322.7	418.0	426.0
GFSI	**33.8**	**56.6**	81.0	100.7	131.4	191.2	217.5
GHMI	**31.7**	**49.0**	**71.1**	91.4	106.5	123.6	134.0
HWFI	35.0	63.8	93.0	111.4	116.2	128.8	119.3
GFNI	42.5	73.2	102.9	106.0	125.1	138.1	160.9
NGPI	44.2	81.3	114.8	123.9	131.2	**116.9**	149.0
UKMI	50.7	91.7	120.7	133.1	137.2	**104.8**	160.1
EMXI	**29.4**	**49.6**	**54.9**	**56.7**	**67.9**	**96.0**	146.1
TVCN	**34.1**	**57.5**	**74.6**	**80.0**	**79.9**	**84.4**	**92.6**
TVCC	**32.3**	**52.1**	**67.5**	**73.3**	**82.2**	**101.9**	144.8
FSSE	**32.3**	**57.6**	78.5	85.1	**73.7**	**70.9**	**78.2**
AEMI	41.9	71.7	95.5	108.6	121.5	175.3	242.2
BAMS	57.9	117.7	186.5	237.3	268.8	239.2	289.1
BAMM	41.7	79.5	117.7	159.1	191.2	198.3	201.2
BAMD	53.0	102.9	144.1	192.3	296.5	352.8	393.5
LBAR	47.4	95.2	144.1	186.5	259.3	260.1	218.2
Forecasts	27	25	23	21	18	13	10

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (Decay SHIFOR - OCD5) intensity forecast errors (kt) for Hurricane Julia, 12 - 20 September 2010. Mean errors for the 5-yr period 2005-9 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	**6.9**	12.8	16.7	18.0	**17.6**	**10.3**	**5.8**
OCD5	9.0	15.3	22.1	27.8	35.4	27.8	23.2
Forecasts	31	29	27	25	21	17	13
OFCL (2005-9)	7.0	10.7	13.1	15.2	18.6	18.7	20.1
OCD5 (2005-9)	8.6	12.5	15.8	18.2	21.0	22.7	21.7

Table 3b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Hurricane Julia, 12 - 20 September 2010. 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	72	96	120
OFCL	7.0	13.1	16.9	18.4	13.1	8.2	6.0
OCD5	8.9	15.7	22.5	27.2	31.3	26.5	21.4
GHMI	8.9	15.5	21.3	24.3	20.8	14.6	10.1
HWFI	8.9	13.2	18.5	23.0	23.9	21.3	17.1
FSSE	7.1	**11.3**	**14.7**	**17.2**	14.9	11.4	7.5
DSHP	**6.9**	**11.6**	**14.0**	**15.9**	**8.3**	**3.9**	6.5
LGEM	7.0	**12.0**	**16.2**	19.4	16.5	10.9	8.1
ICON	7.6	**12.2**	**16.4**	19.5	16.5	10.9	7.8
IVCN	7.9	**13.0**	18.3	21.5	18.5	11.5	7.3
Forecasts	28	26	24	22	18	14	10

Table 4. Watch and warning summary for Hurricane Julia, 12 – 20 September 2010.

Date/Time (UTC)	Action	Location
12 / 1500	Tropical Storm Warning issued	Southern Cape Verde Islands including Maio, Sao Tiago, Fogo, and Brava
14 / 0000	All warnings discontinued	Southern Cape Verde Islands including Maio, Sao Tiago, Fogo, and Brava

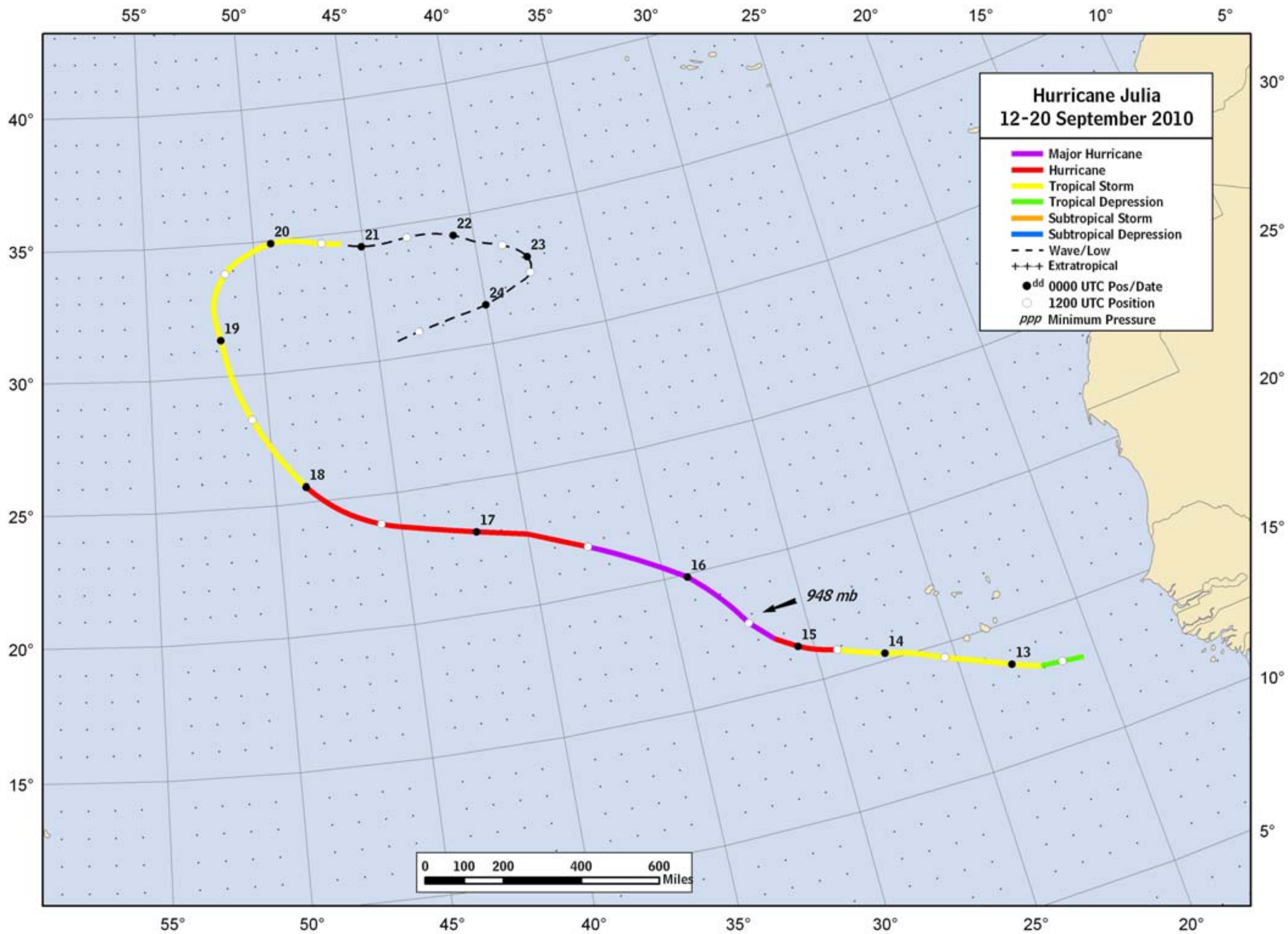

Figure 1. Best track positions for Hurricane Julia, 12 – 20 September 2010.

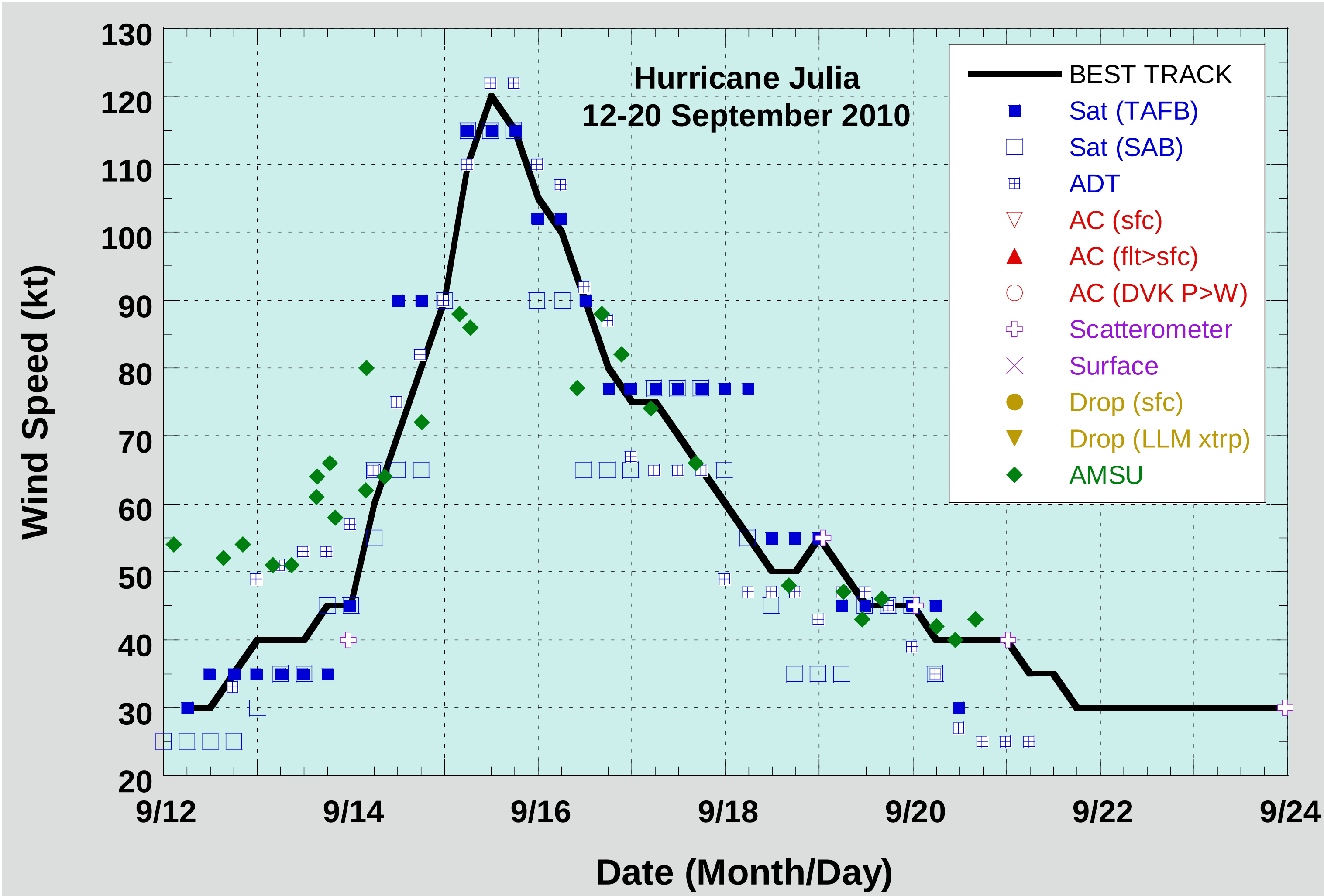

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Julia, 12 – 20 September 2010. Advanced Dvorak Technique estimates represent linear averages over a three-hour period centered on the nominal observation time. The AMSU observations refer to the University of Wisconsin-CIMSS AMSU intensity method. Dashed vertical lines correspond to 0000 UTC.

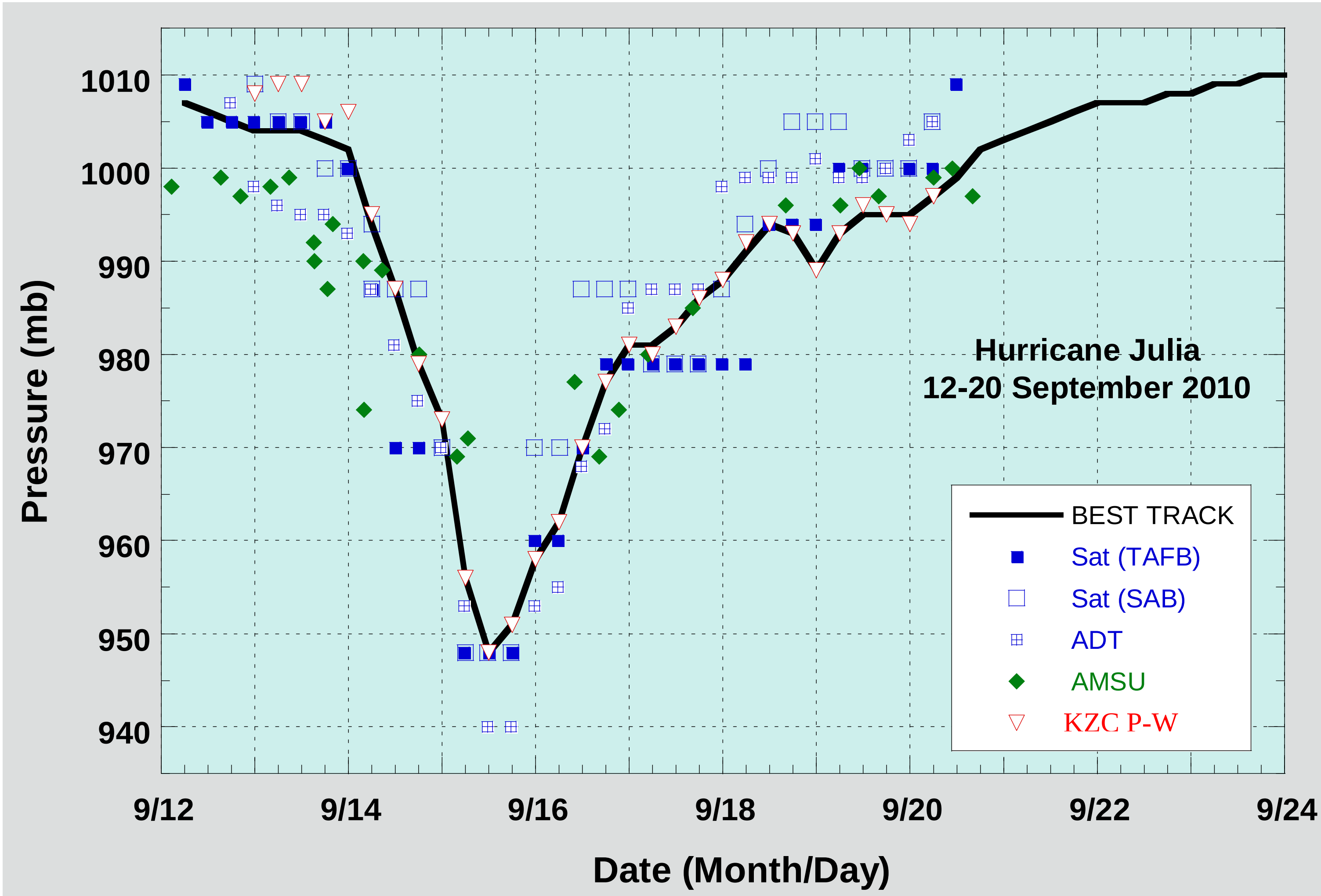

Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Julia, 12 – 20 September 2010. Advanced Dvorak Technique estimates represent linear averages over a three-hour period centered on the nominal observation time. The AMSU observations refer to the University of Wisconsin-CIMSS AMSU intensity method. KZC P-W refers to the Knaff-Zehr-Courtney pressure-wind relationship, with the best track winds converted to a pressure shown here. Dashed vertical lines correspond to 0000 UTC.

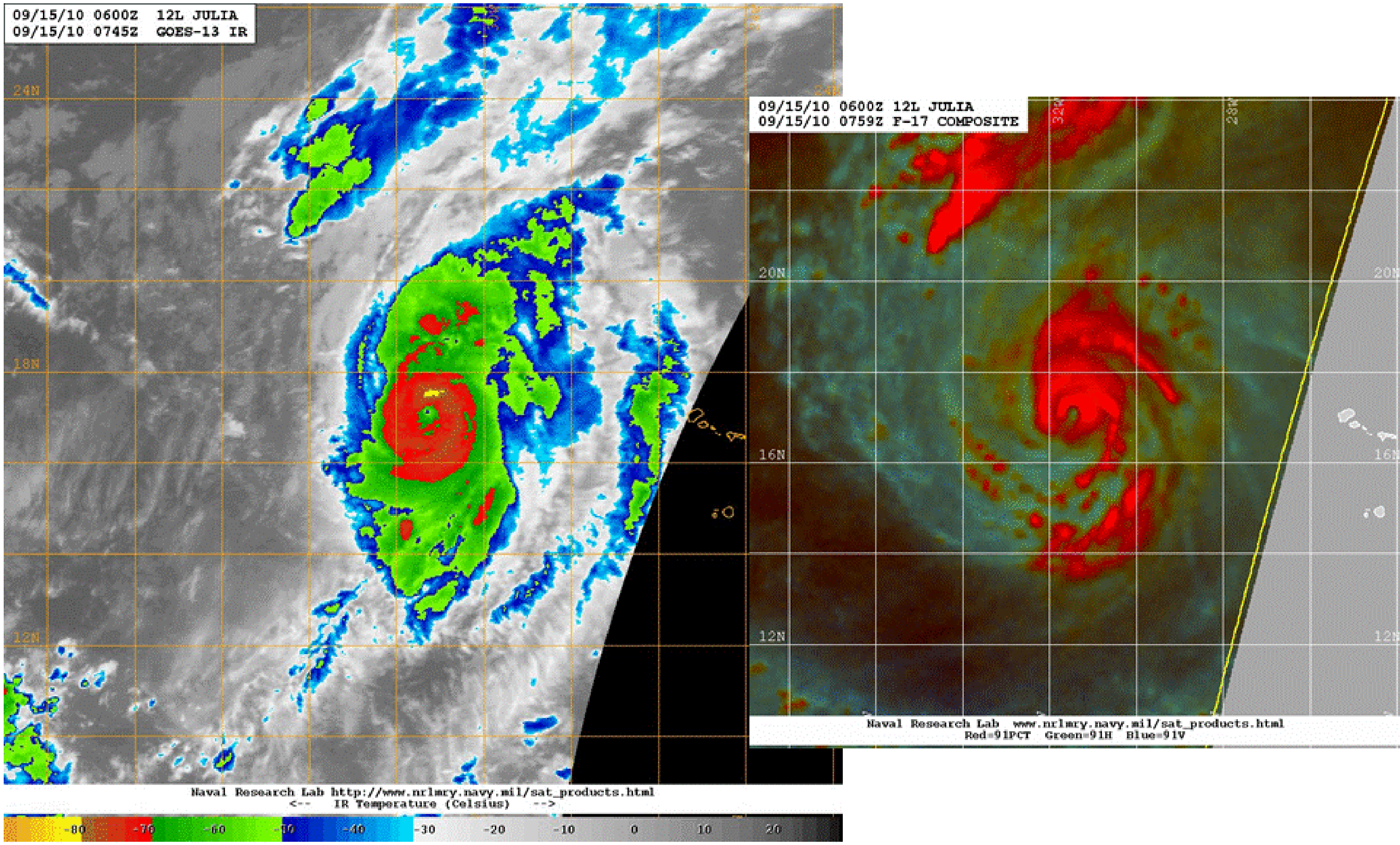

Figure 4. 0745 UTC 15 September enhanced infrared imagery from GOES-13 (left) and 0759 UTC 15 September 91 GHz microwave imagery from the SSMIS polar orbiting satellite near the time of the maximum intensity of Hurricane Julia. Imagery courtesy of the Naval Research Laboratory, Monterey, CA.

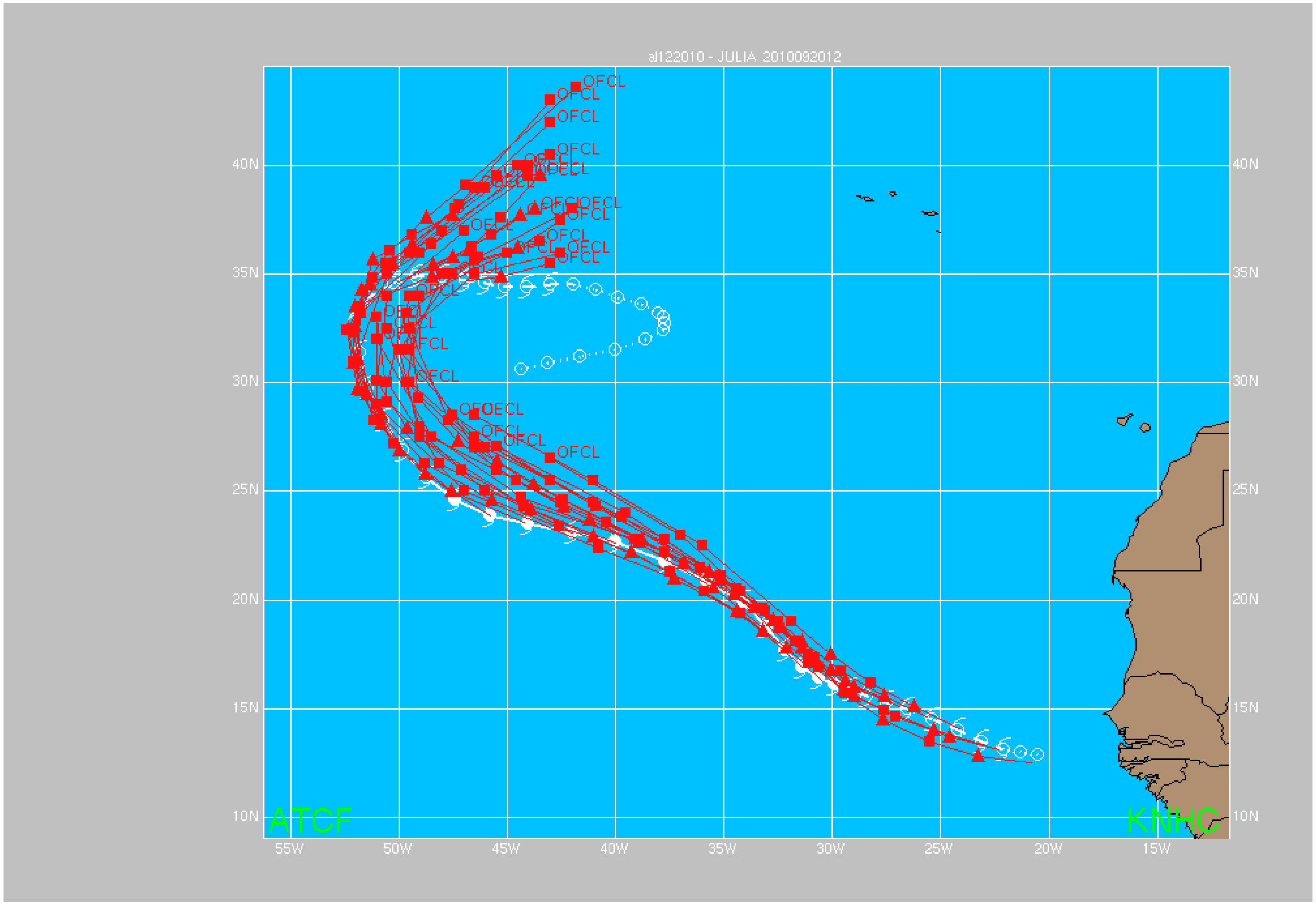

Figure 5. NHC official track forecasts (red lines, with 0, 12, 24, 36, 48, 72, 96 and 120 h positions indicated) for Hurricane Julia, 12 – 20 September 2010. The best track is given by the thick solid white line with positions given at 6 h intervals.

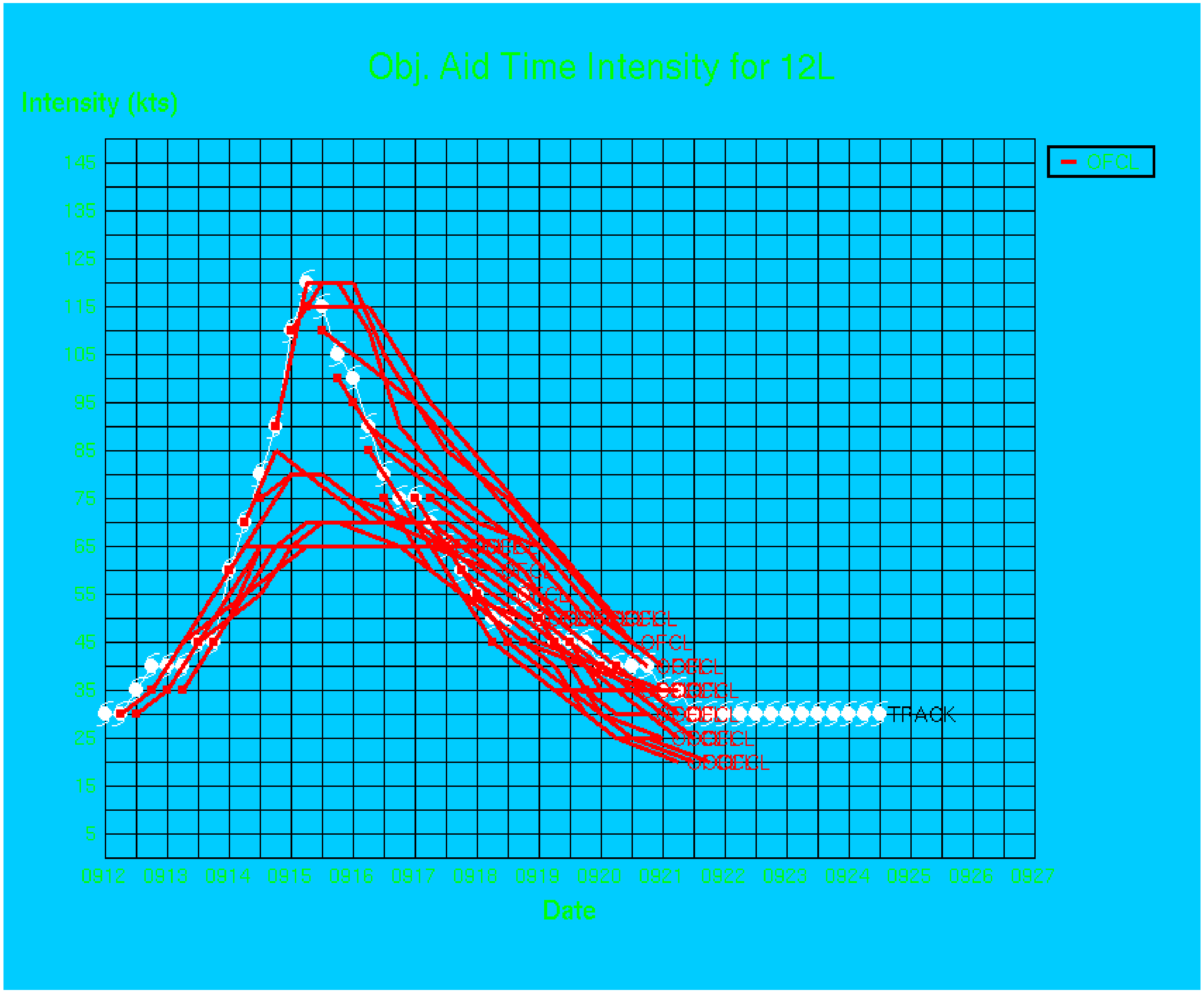

Figure 6. NHC official intensity forecasts (red lines) for Hurricane Julia, 12 -20 September 2010. The best track intensity is given by the while solid line.