Tropical Cyclone Report
Hurricane Eugene
(EP052011)
31 July - 6 August 2011

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Eugene was a powerful category 4 hurricane that stayed offshore of southwestern Mexico.

a. Synoptic History

The tropical wave that eventually spawned Eugene left the coast of west Africa on 16 July. The wave had a relatively high amplitude and showed some signs of organization over the central Atlantic Ocean, but no significant development occurred there. As the system entered the Greater Antilles, a large flare-up of thunderstorms was noted near Hispaniola and the northern end of the wave eventually caused the formation of Tropical Storm Don in the northwestern Caribbean Sea. The southern portion of the wave continued westward, likely causing convection to significantly increase near and south of the Gulf of Panama on 25 July. Another burst of convection two days later resulted in the formation of a low- to middle-level circulation a few hundred miles south of Guatemala. Northeasterly vertical wind shear, however, was too strong for any immediate development and the middle-level circulation decayed, leaving behind only a broad surface low. Areas of scattered thunderstorms waxed and waned for the next few days near the weak system until a strong burst of convection on 30 July helped to amplify the surface low. This burst could have been enhanced by an atmospheric Kelvin wave which was moving through the eastern Pacific during that time. Convection then became more persistent and banding features developed early the next day. It is estimated that this system became a tropical depression about 380 n mi south of Acapulco, Mexico near 0600 UTC 31 July and strengthened into a tropical storm six hours later. 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].

Initially Eugene was moving to the west-northwest at less than 10 kt with moderate northeasterly shear causing all of the thunderstorms to be located on the western side of the center. However, this shear was not strong enough to prevent steady development of the cyclone. The core of Eugene became better organized early on 1 August with the development of a small eye feature apparent on infrared and microwave images. Eugene became a hurricane around 1800 UTC 1 August, moving a bit faster to the west-northwest due to a large ridge building westward over Mexico and the eastern Pacific. The small eye was replaced by a larger

[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.

eye on 2 August, and the cyclone started to intensify more rapidly. Although the eye was ragged at first, it became better defined on 3 August, with Dvorak estimates indicating that Eugene became a major hurricane about 500 n mi south-southwest of the southern tip of Baja California. Figure 4 shows Eugene near its peak intensity of 120 kt at 2100 UTC 3 August with a large and well-defined eye. The cyclone briefly had some features of an annular hurricane; however the eye rapidly lost definition due to the cyclone's passage over waters below 24°C by late on 4 August. Eugene rapidly weakened to tropical storm intensity on 5 August, though its winds dropped more slowly afterwards. All deep convection disappeared the next day, and Eugene became a non-convective post-tropical low at 1200 UTC 6 August, located about 980 n mi west of the southern tip of Baja California. The low lost gale-force winds on 7 August and turned westward and southwestward with the low-level trade winds, eventually decaying into a trough early on 10 August about 850 n mi east of Hilo, Hawaii.

b. Meteorological Statistics

Observations in Eugene (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 the Advanced Dvorak Technique from the University of Wisconsin-Madison/Cooperative Institute for Meteorological Satellite Studies (UW-CIMSS). 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), Defense Meteorological Satellite Program (DMSP) satellites, among others, were also useful in constructing the best track of Eugene.

The 120 kt analyzed peak intensity of Eugene is based on a blend of 115 kt Dvorak estimates from TAFB and SAB and 125 kt from the UW-CIMSS ADT.

There were no ship reports of tropical-storm-force winds in association with Eugene.

c. Forecast and Warning Critique

The genesis of Eugene was not particularly well forecast. The precursor wave was introduced into the Tropical Weather Outlook with a low (20%) chance of genesis three days prior to its formation. However, this probability decreased with time as the system did not develop and eventually reached near 0% chance 48 h before genesis. The genesis probability was raised to a medium chance (40%) only 12 h before the formation of the system.

A verification of NHC official track forecasts for Eugene is given in Table 2a. Official forecast track errors were lower than the mean official errors for the previous 5-yr period through 48 h, but grew to nearly two times the long-term errors by 120 h. The OCD5 (CLIPER) errors for this system had a similar pattern, suggesting the forecasts were easier than average early on and more difficult than normal late in the forecast period. An inspection of the OFCL errors reveals that the early track forecasts for Eugene were too slow and biased to the north, causing large errors at 72 h and beyond. A homogeneous comparison of the official track errors with selected guidance models is given in Table 2b. The HWRF and GFDL models had extremely poor scores for Eugene with severe northeastward biases, and consequently negatively affected the consensus models. The HWRF errors were due to a bug in the coding of the model, and an emergency fix was made to the model in late August. While the official forecast bested the consensus models, enough weight was given to the consensus model solutions to cause rather large errors at 96 and 120 h. The GFS and its ensemble mean (AEMI) were top performers for Eugene, along with the BAMS suite, the LBAR model, and the ECMWF.

A verification of NHC official intensity forecasts for Eugene is given in Table 3a. Official forecast intensity errors were lower than the mean official errors for the previous five-year period, except at 48 and 72 h. This appears to be due to a low bias in the official forecast during the first couple of days, which did not anticipate as much strengthening as what occurred with Eugene, perhaps because the initial track forecasts were too far to the north (and over cooler waters). Later forecasts were better for both the peak intensity and rapid rate of decay of the cyclone. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 3b. The official forecast was superior to much of the model guidance, except for the Decay-Ships model (DSHP), throughout the period. The HWRF had a very difficult time with Eugene, with especially large errors at days 2 and 3.

There were no watches and warnings associated with Eugene, and no reports of casualties or damage.

Table 1. Best track for Hurricane Eugene, 31 July – 6 August 2011.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
30 / 1200	10.3	96.5	1007	25	low
30 / 1800	10.4	97.5	1007	25	"
31 / 0000	10.4	98.5	1006	30	"
31 / 0600	10.5	99.4	1006	30	tropical depression
31 / 1200	10.6	100.2	1004	35	tropical storm
31 / 1800	10.8	101.0	1002	40	"
01 / 0000	11.2	101.8	1000	45	"
01 / 0600	11.7	102.7	998	50	"
01 / 1200	12.2	103.8	996	55	"
01 / 1800	12.6	105.0	990	65	hurricane
02 / 0000	13.0	106.3	988	70	"
02 / 0600	13.4	107.6	985	75	"
02 / 1200	13.7	108.9	977	80	"
02 / 1800	14.0	110.1	970	90	"
03 / 0000	14.5	111.2	965	95	"
03 / 0600	15.0	112.4	961	100	"
03 / 1200	15.4	113.5	954	105	"
03 / 1800	15.7	114.7	947	115	"
03 / 2100	15.9	115.3	942	120	"
04 / 0000	16.1	115.9	946	115	"
04 / 0600	16.5	117.1	957	105	"
04 / 1200	16.8	118.3	962	100	"
04 / 1800	17.0	119.5	970	90	"
05 / 0000	17.2	120.6	977	80	"
05 / 0600	17.5	121.8	984	70	"
05 / 1200	17.8	123.0	990	60	tropical storm
05 / 1800	18.1	124.2	997	50	"
06 / 0000	18.4	125.4	1000	45	"
06 / 0600	18.7	126.5	1002	45	"
06 / 1200	19.0	127.7	1005	40	low
06 / 1800	19.3	128.8	1005	40	"
07 / 0000	19.6	129.8	1005	40	"
07 / 0600	19.8	130.8	1006	35	"
07 / 1200	20.0	131.8	1008	35	"
07 / 1800	20.1	132.7	1009	30	"
08 / 0000	20.2	133.5	1009	30	"
08 / 0600	20.3	134.3	1009	30	"
08 / 1200	20.3	135.1	1010	25	"
08 / 1800	20.2	135.9	1010	25	"
09 / 0000	20.0	136.7	1010	25	"
09 / 0600	19.6	137.6	1010	25	"
09 / 1200	19.0	138.5	1010	25	"
09 / 1800	18.3	139.4	1010	25	"
10 / 0000	17.5	140.5	1010	25	"
10 / 0600	-	-	-	-	dissipated
03 / 2100	15.9	115.3	942	120	minimum pressure and maximum winds

Table 2a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Hurricane Eugene. Mean errors for the five-year period 2006-10 are shown for comparison. Official errors that are smaller than the five-year means are shown in boldface type.

	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL (Eugene)	**17.8**	**30.3**	**49.6**	**75.3**	151.4	278.9	387.6
OCD5 (Eugene)	24.8	43.8	65.6	91.1	168.5	279.3	373.8
Forecasts	23	21	19	17	13	9	5
OFCL (2006-10)	29.7	49.9	69.0	86.6	119.0	155.8	197.7
OCD5 (2006-10)	38.4	74.8	115.3	155.9	226.3	273.7	310.4

Table 2b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Hurricane Eugene. 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	19.0	32.6	52.2	78.3	166.4	281.3	382.8
OCD5	23.3	44.8	70.3	103.6	204.3	303.1	444.3
GFSI	20.7	34.2	54.2	**73.4**	**123.5**	**195.8**	**270.4**
GHMI	23.8	47.1	75.7	120.1	264.9	475.7	831.9
HWFI	35.1	67.6	102.5	152.9	333.6	616.0	1144.1
NGPI	30.0	57.1	81.6	110.6	201.4	284.7	**365.9**
EMXI	22.5	39.5	64.3	93.1	**160.3**	**241.7**	**382.0**
AEMI	22.5	34.4	**48.2**	**59.5**	**80.2**	**111.2**	**183.2**
FSSE	22.9	40.2	60.1	83.5	**166.2**	295.7	485.1
TVCA	21.0	37.5	56.9	85.6	186.8	346.1	605.4
TVCE	21.3	39.3	58.4	85.5	186.1	334.9	565.6
TVCC	20.0	34.9	55.2	86.1	167.3	311.2	565.5
LBAR	22.1	49.4	79.3	113.5	**146.6**	**143.0**	**170.5**
BAMD	**18.1**	**29.5**	**46.8**	**69.6**	**142.6**	**218.3**	**303.0**
BAMM	19.5	36.0	57.1	81.9	**130.9**	**177.0**	**213.4**
BAMS	35.3	66.7	98.1	125.4	**156.0**	**166.7**	**197.6**
Forecasts	18	17	15	13	9	7	3

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Hurricane Eugene. Mean errors for the five-year period 2006-10 are shown for comparison. Official errors that are smaller than the five-year means are shown in boldface type.

	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL (Eugene)	**3.9**	**8.6**	**13.4**	16.8	21.9	**13.9**	**6.0**
OCD5 (Eugene)	7.0	11.0	15.3	17.5	23.1	18.9	12.8
Forecasts	23	21	19	17	13	9	5
OFCL (2006-10)	6.3	10.5	13.7	15.1	17.1	18.6	18.0
OCD5 (2006-10)	7.3	11.9	15.3	17.6	19.0	20.3	21.1

Table 3b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Hurricane Eugene. 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	4.0	8.7	12.9	16.3	19.1	7.1	3.3
OCD5	7.7	11.9	17.0	19.6	22.3	15.6	18.7
GHMI	6.8	13.3	18.0	19.5	**18.4**	17.9	13.7
HWFI	7.9	15.5	22.9	30.3	34.4	24.4	16.3
FSSE	4.5	9.4	13.8	18.3	20.2	14.1	9.0
DSHP	5.2	8.9	**11.9**	**15.2**	**15.1**	9.4	10.7
LGEM	6.1	11.2	15.9	18.9	20.5	10.3	5.0
ICON	5.9	11.5	16.0	19.9	20.5	14.0	**3.0**
IVCN	5.7	11.3	15.1	19.2	19.9	12.1	**2.7**
Forecasts	21	19	17	15	11	7	3

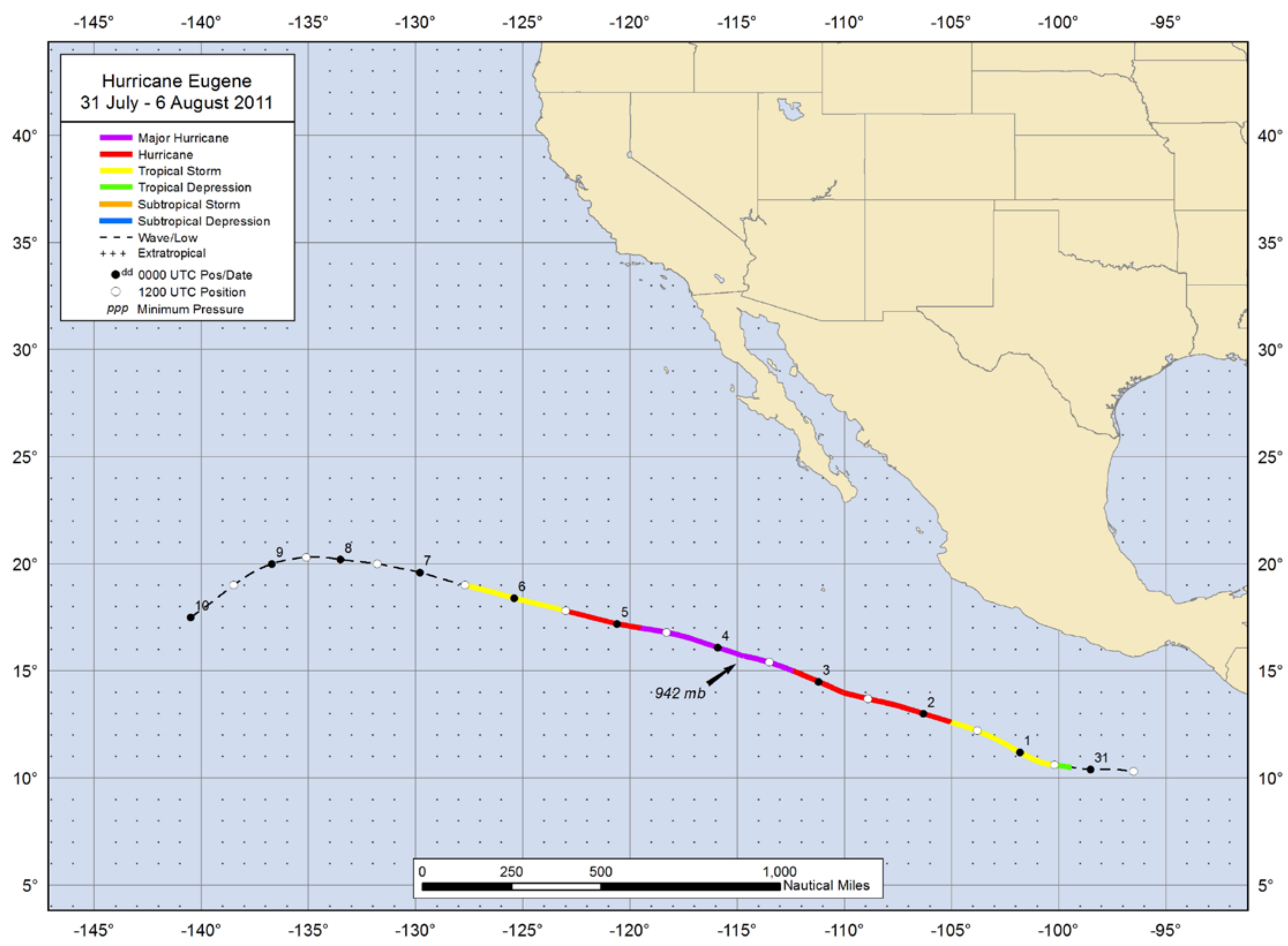

Figure 1. Best track positions for Hurricane Eugene, 31 July – 6 August 2011.

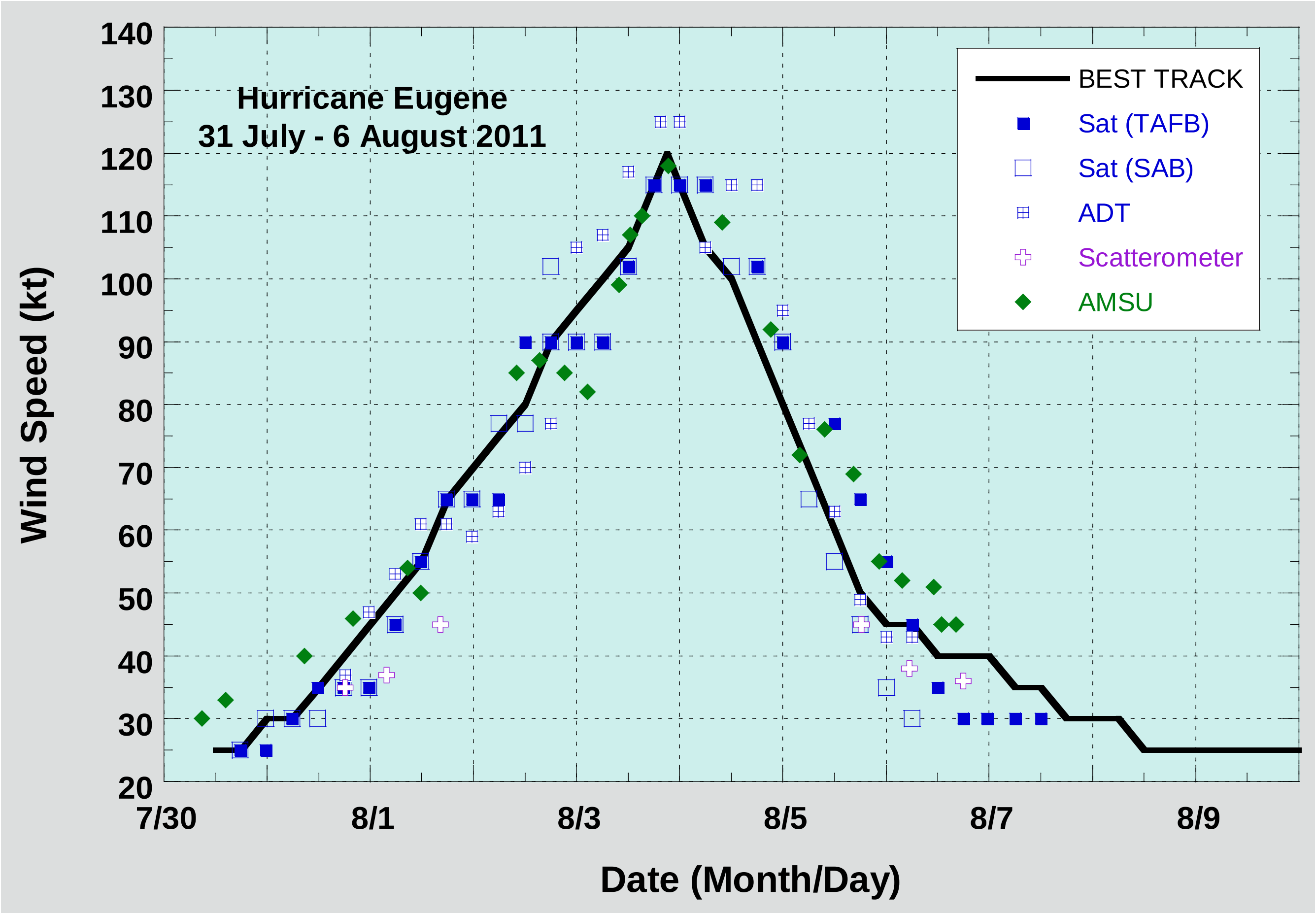

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Eugene, 31 July – 6 August 2011. Advanced Dvorak Technique (ADT) estimates courtesy of UW-CIMSS. AMSU estimates are derived from the UW-CIMSS technique. Dashed vertical lines correspond to 0000 UTC.

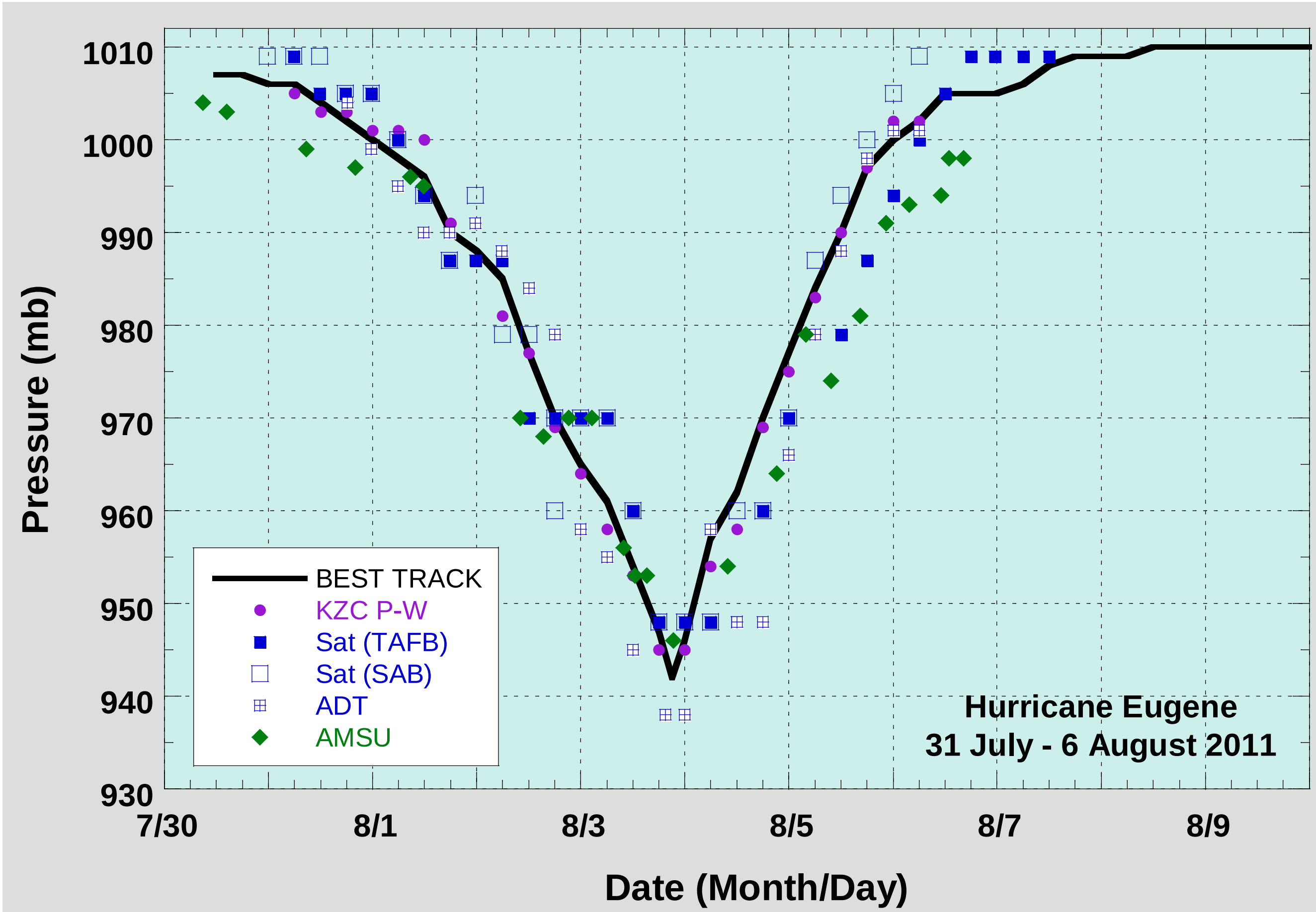

Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Eugene. Advanced Dvorak Technique (ADT) estimates courtesy of UW-CIMSS. Dashed vertical lines correspond to 0000 UTC. KZC P-W refers to pressure estimates derived by applying the Knaff-Zehr-Courtney pressure-wind relationship to the best track wind speeds. AMSU estimates are derived from the UW-CIMSS technique.

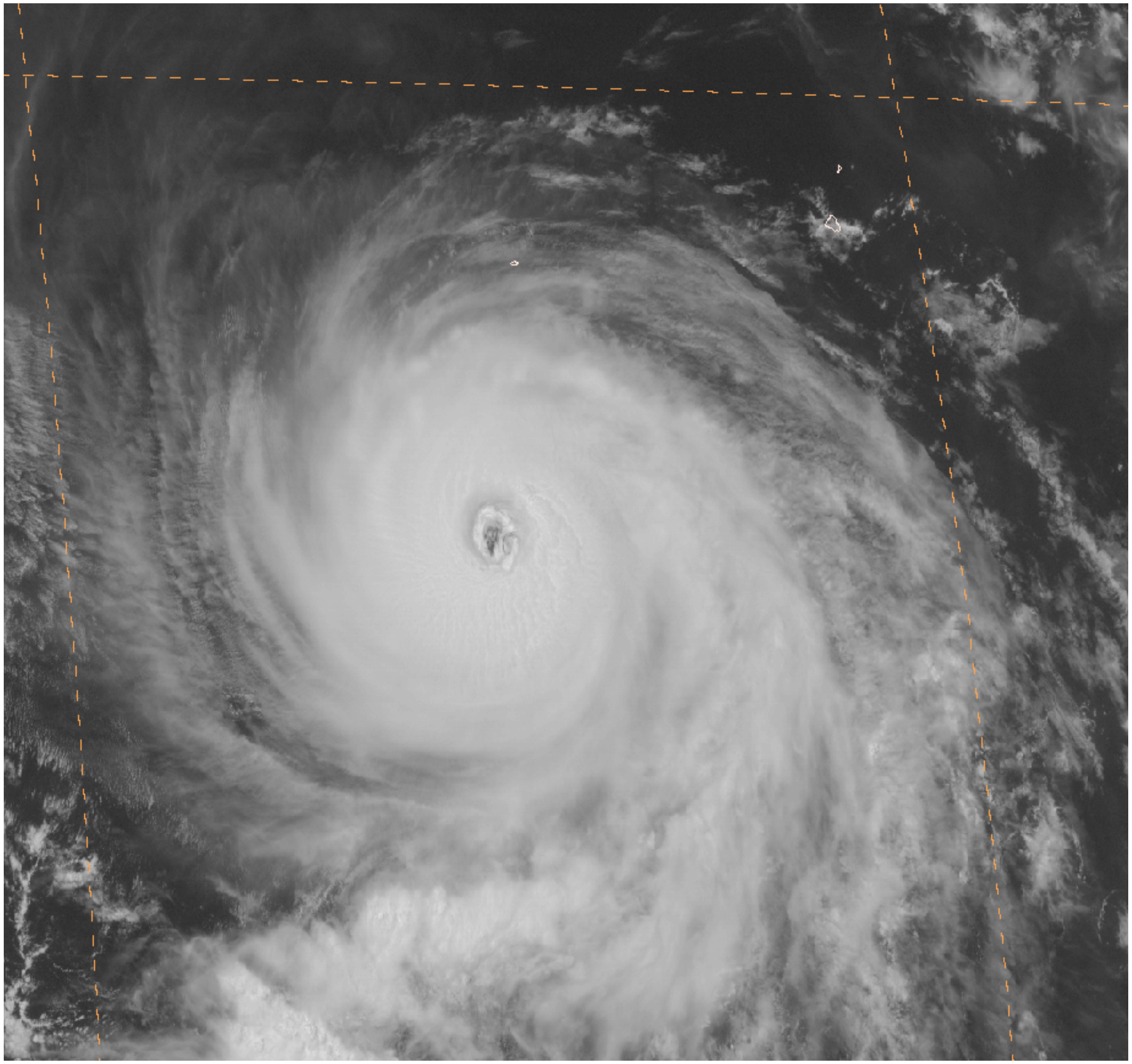

Figure 4. GOES-11 visible satellite picture of Eugene near peak intensity at 2100 UTC 3 August 2011.