

Tropical Cyclone Report  
Hurricane Dora  
(EP042011)  
18- 24 July 2011

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Dora was a category 4 hurricane (on the Saffir-Simpson Hurricane Wind Scale) that moved parallel to the southern coast of Mexico.

a. Synoptic History

Dora formed from a westward-moving tropical wave that interacted with anomalously strong southwesterly low-level flow over the far eastern Pacific Ocean. The wave moved off the west coast of Africa on 7 July and reached the southwestern Caribbean Sea about one week later. As the wave traversed the southwestern Caribbean Sea and neared Central America, it reached the eastern extent of an area of enhanced southwesterly flow over the eastern Pacific and Central America that was possibly associated with an eastward-moving Kelvin wave. The interaction of the wave and the strong southwesterly winds resulted in the formation of a broad area of low pressure over the extreme southwestern Caribbean Sea on 15 July. The system moved slowly westward across Central America during the next day or so and entered the eastern Pacific basin early on 17 July. During the next 24 h, the low continued westward and gradually became better defined. Early on 18 July, the associated thunderstorm activity quickly became organized, resulting in the formation of a tropical depression at 0600 UTC about 200 n mi south-southwest of San Salvador, El Salvador. The depression became a tropical storm 6 h later. The “best track” chart of Dora’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>.

In a favorable atmospheric environment and over warm sea surface temperatures, Dora steadily strengthened as it moved west-northwestward to the south of a strong deep-layer ridge over the central United States and Mexico. Dora became a hurricane by 1800 UTC 19 July when it was centered about 215 n mi south-southwest of Puerto Escondido, Mexico. Around that time, Dora began a period of rapid intensification while the inner-core structure became more coherent. An eye, which was first detected in microwave imagery, became better defined on 20 July and shortly after 1200 UTC that day it became apparent in visible and infrared satellite imagery. Dora attained major hurricane strength by 1800 UTC 20 July and reached an estimated peak intensity of 135 kt at 1200 UTC the next day, while centered about 175 n mi southwest of Manzanillo, Mexico.

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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 *bt* directory, while previous years’ data are located in the *archive* directory.

After reaching its peak intensity, Dora turned northwestward as it moved around the southwestern periphery of the strong ridge over the central United States. Shortly thereafter northeasterly vertical shear increased markedly and Dora began moving over slightly cooler waters, which resulted in an episode of rapid weakening. During the 24-h period ending at 1800 UTC 22 July, Dora weakened from a 130-kt category 4 hurricane to a 60-kt tropical storm (Fig. 4). Soon thereafter, Dora crossed a sharp sea surface temperature gradient and into waters colder than 26°C. Deep convection gradually decreased in coverage and became less organized, and the tropical storm weakened further. Dora became a tropical depression at 1200 UTC 24 July, about 220 n mi west of the southern tip the Baja California peninsula and degenerated into a non-convective remnant low by 0000 UTC 25 July. The track of the remnant low turned north-northwestward and then northward before dissipating early on 26 July off of the west-central coast of the Baja peninsula, about 60 n mi south-southwest of Bahía Asunción.

#### b. Meteorological Statistics

Observations in Dora (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 Dvorak estimates from the Cooperative Institute for Meteorological Satellite Studies/University of Wisconsin-Madison. Observations also include flight-level, stepped frequency microwave radiometer (SFMR), and dropwindsonde observations from three flights of the NOAA WP-3D Hurricane Hunter Aircraft. Data and imagery from NOAA polar-orbiting satellites including the Advanced Microwave Sounding Unit (AMSU), the NASA Tropical Rainfall Measuring Mission (TRMM) and Aqua, 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 Dora.

Dora's analyzed peak intensity of 135 kt at 1200 UTC 21 July is based on a blend of subjective and objective Dvorak intensity estimates. Peak subjective estimates from SAB and TAFB were 140 kt and 127 kt, respectively, and objective T-numbers from the Advanced Dvorak Technique (ADT) reached T6.7 (132 kt).

The NOAA Hurricane Research Division conducted three WP-3D aircraft research missions into Dora as part of an eastern North Pacific tropical cyclone decay experiment. The missions were flown about 24 h apart as Dora moved over cooler waters and weakened from just below hurricane strength to a 25-kt remnant low. The aircraft data from the first flight (late on 22 July) confirmed that Dora had weakened below hurricane strength. The aircraft recorded a maximum 850-mb flight-level wind of 69 kt with a peak SFMR surface wind of 56 kt. The next day the aircraft measured an 850-mb flight-level wind of 53 kt and a peak SFMR surface wind of 42 kt. On the final day of the experiment, the aircraft flew into Dora as the remaining thunderstorm activity was dissipating and the highest 850-mb flight-level wind found was 33 kt. The SFMR did not measure any valid surface winds of tropical storm strength during this mission.

There was one believable ship observation of tropical-storm-force winds in association with Dora. The ship *Indiana Highway* (call sign JMVS) reported 47-kt winds about 75 n mi

northeast of the center at 0600 UTC 19 July. There were no observations of tropical-storm-force winds over land.

c. Casualty and Damage Statistics

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

d. Forecast and Warning Critique

The development of Dora was not particularly well anticipated, as the system became a tropical cyclone sooner than initially indicated. Dora's incipient disturbance was first mentioned in the Tropical Weather Outlook (TWO) at 1800 UTC 16 July, as it was emerging from the coast of Central America. The system was initially assessed to have a low chance (<30%) of development during the next 48 h, primarily due to its proximity to land; however, the first Outlook correctly noted that environmental conditions would be conducive for "more significant development" after 48 h. The probability of formation was raised to the medium category (30%-50%) in the TWO issued 24 h later, which was about 12 h before genesis.

A verification of NHC official track forecasts (OFCL) for Dora is given in Table 2a. Mean official track errors for Dora were 18, 27, 32, 32, 37, 64, and 71 n mi for the 12, 24, 36, 48, 72, 96, and 120 h forecasts, respectively. These errors were substantially lower than the long-term official track errors for the 5-yr period of 2006-10. A homogeneous comparison of the official track errors with selected guidance models is given in Table 2b. The GFS (GFSI) and ECMWF (EMXI) global models also accurately predicted the track of Dora, though the NHC forecasts generally outperformed them. The GFS ensemble mean (AEMI) had the lowest average track errors at 96 and 120 h. The only model that had lower errors than OFCL at most forecast times was the Florida State Super Ensemble (FSSE).

A verification of NHC official intensity forecasts (OFCL) for Dora is given in Table 3a. Mean official forecast intensity errors were larger than the mean official errors for the previous 5-yr period, except at 120 h where it was lower. The climatology-persistence (OCD5) errors were also larger than the long-term average, indicating that the intensity forecasts for Dora were more difficult than normal, due to both the rapid intensification of the system on 19-20 July and the rapid weakening of the hurricane a couple of days later. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 3b. The official forecasts had lower average errors than all of the guidance at all time periods except 96 h, where most of the guidance exhibited somewhat lower intensity errors.

Watches and warning associated with Dora are noted in Table 4. A tropical storm watch was issued for a portion of the coast of southwest Mexico at 0300 UTC 20 July and discontinued a little more than 24 h later when it was apparent that the tropical storm conditions would remain offshore. A tropical storm warning was issued for the extreme southern portion of Baja California; however, the tropical-storm-force winds remain offshore of this area as well.

Table 1. Best track for Hurricane Dora, 18-24 July 2011.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Intensity (kt)	Stage
18 / 0000	10.2	89.0	1008	25	low
18 / 0600	10.3	90.0	1006	30	tropical depression
18 / 1200	10.4	91.1	1005	35	tropical storm
18 / 1800	10.6	92.3	1002	45	"
19 / 0000	10.9	93.7	999	50	"
19 / 0600	11.3	95.1	996	55	"
19 / 1200	11.8	96.5	993	60	"
19 / 1800	12.4	97.9	989	65	hurricane
20 / 0000	13.1	99.4	987	70	"
20 / 0600	13.8	100.9	981	80	"
20 / 1200	14.5	102.3	970	90	"
20 / 1800	15.1	103.6	957	105	"
21 / 0000	15.7	104.7	948	115	"
21 / 0600	16.3	105.7	939	125	"
21 / 1200	16.9	106.5	929	135	"
21 / 1800	17.4	107.1	932	130	"
22 / 0000	18.0	107.8	948	115	"
22 / 0600	18.6	108.5	967	95	"
22 / 1200	19.1	109.1	981	75	"
22 / 1800	19.6	109.7	987	60	tropical storm
23 / 0000	20.1	110.3	990	55	"
23 / 0600	20.5	111.0	994	50	"
23 / 1200	20.9	111.7	998	45	"
23 / 1800	21.4	112.4	1000	45	"
24 / 0000	21.9	113.0	1002	40	"
24 / 0600	22.4	113.5	1004	35	"
24 / 1200	22.9	113.9	1006	30	tropical depression
24 / 1800	23.6	114.3	1009	25	"
25 / 0000	24.3	114.6	1010	25	low
25 / 0600	24.9	114.7	1010	20	"
25 / 1200	25.5	114.8	1010	20	"
25 / 1800	26.0	114.8	1010	20	"
26 / 0000	26.3	114.8	1010	20	"
26 / 0600					dissipated
21 / 1200	16.9	106.5	929	135	minimum pressure and maximum wind

Table 2a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Hurricane Dora, 18-24 July 2011. Mean errors for the 5-yr period 2006-10 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	<b>18.0</b>	<b>27.3</b>	<b>31.5</b>	<b>31.7</b>	<b>37.2</b>	<b>63.7</b>	<b>71.3</b>
OCD5	25.2	54.6	88.2	125.0	200.7	272.1	306.7
Forecasts	24	22	20	18	14	10	6
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 Dora, 18-24 July 2011. 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	16.9	24.3	29.3	29.2	38.2	62.4	61.6
OCD5	23.1	50.7	83.4	118.9	193.5	265.8	307.8
GHMI	23.8	47.3	63.3	74.5	83.5	131.3	131.1
HWFI	26.3	45.6	57.6	70.2	93.9	144.1	155.6
GFNI	25.8	39.9	51.5	68.9	115.0	162.9	201.6
GFSI	17.4	30.9	36.5	40.5	50.4	74.0	<b>48.8</b>
EMXI	<b>16.6</b>	24.3	31.4	36.8	58.5	97.7	82.3
NGPI	28.7	44.4	55.4	61.4	85.5	139.4	210.2
UKMI	<b>15.3</b>	<b>21.5</b>	<b>25.4</b>	33.1	67.8	111.1	131.7
CMCI	34.1	66.4	83.0	88.5	92.7	122.9	173.3
AEMI	21.1	33.5	36.7	41.5	<b>30.6</b>	<b>39.7</b>	<b>34.3</b>
FSSE	<b>15.8</b>	27.1	<b>28.0</b>	<b>28.6</b>	<b>27.7</b>	<b>60.1</b>	85.3
TVCA	<b>15.7</b>	25.6	29.9	30.0	41.3	80.3	69.6
TVCE	<b>15.3</b>	27.2	32.0	33.0	44.0	79.9	80.8
TVCC	<b>16.0</b>	30.3	34.6	30.1	<b>28.7</b>	133.2	193.6
LBAR	20.9	32.4	53.6	71.2	105.8	142.8	149.4
BAMD	25.8	44.5	63.2	77.4	100.1	146.1	144.4
BAMM	23.8	41.5	58.2	69.9	63.1	86.6	<b>53.3</b>
BAMS	25.6	49.0	72.9	91.7	91.5	109.5	98.3
Forecasts	21	18	16	14	11	8	4

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Hurricane Dora, 18-24 July 2011. Mean errors for the 5-yr period 2006-10 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	9.2	14.3	16.5	17.2	22.1	22.5	<b>15.0</b>
OCD5	12.4	18.2	23.8	24.9	29.8	25.9	27.5
Forecasts	24	22	20	18	14	10	6
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 Dora, 18-24 July 2011. 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	9.2	15.5	17.4	18.2	22.1	22.5	13.0
OCD5	12.4	19.6	24.5	26.0	29.8	25.9	28.8
GHMI	11.8	17.8	19.9	24.0	26.4	23.8	21.6
HWFI	12.4	19.5	25.7	30.8	29.4	<b>16.3</b>	<b>7.8</b>
DSHP	10.7	16.7	22.5	25.4	23.1	<b>20.1</b>	23.6
LGEM	11.5	18.5	23.8	28.4	26.5	<b>16.9</b>	14.4
ICON	11.3	17.2	22.1	26.2	26.0	<b>17.9</b>	15.4
IVCN	11.3	17.5	21.4	25.4	24.7	<b>17.5</b>	15.0
Forecasts	24	20	19	17	14	10	5

Table 4. Watch and warning summary for Hurricane Dora, 18-24 July 2011.

Date/Time (UTC)	Action	Location
20/0300	Tropical Storm Watch issued	Lázaro Cárdenas to Cabo Corrientes
21/0600	Tropical Storm Watch discontinued	All
21/2100	Tropical Storm Watch issued	Agua Blanca to Buenavista including Cabo San Lucas
22/0300	Tropical Storm Watch changed to Tropical Storm Warning	Agua Blanca to Buenavista including Cabo San Lucas
23/1200	Tropical Storm Warning discontinued	All



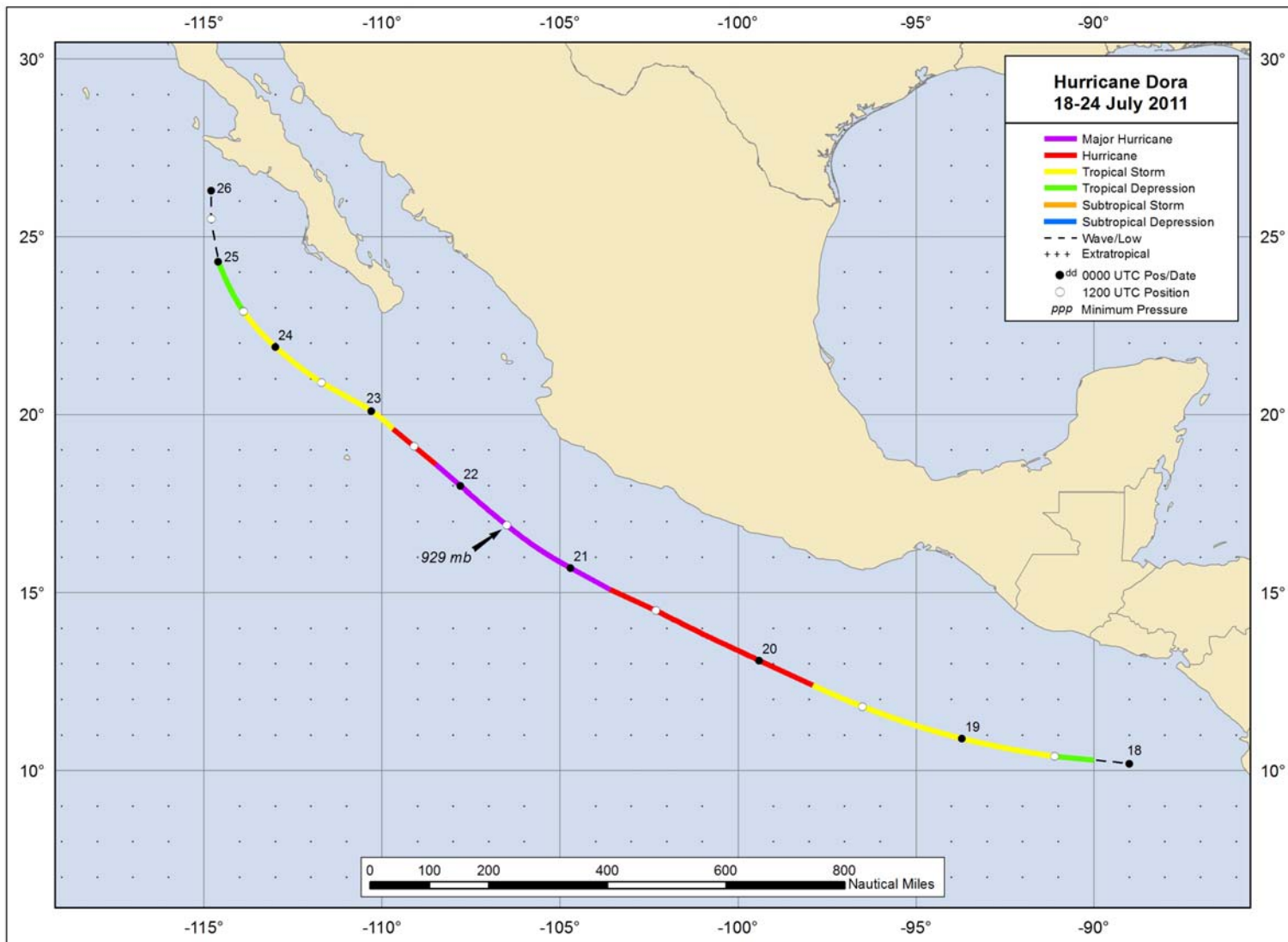


Figure 1. Best track positions for Hurricane Dora, 18-24 July 2011.

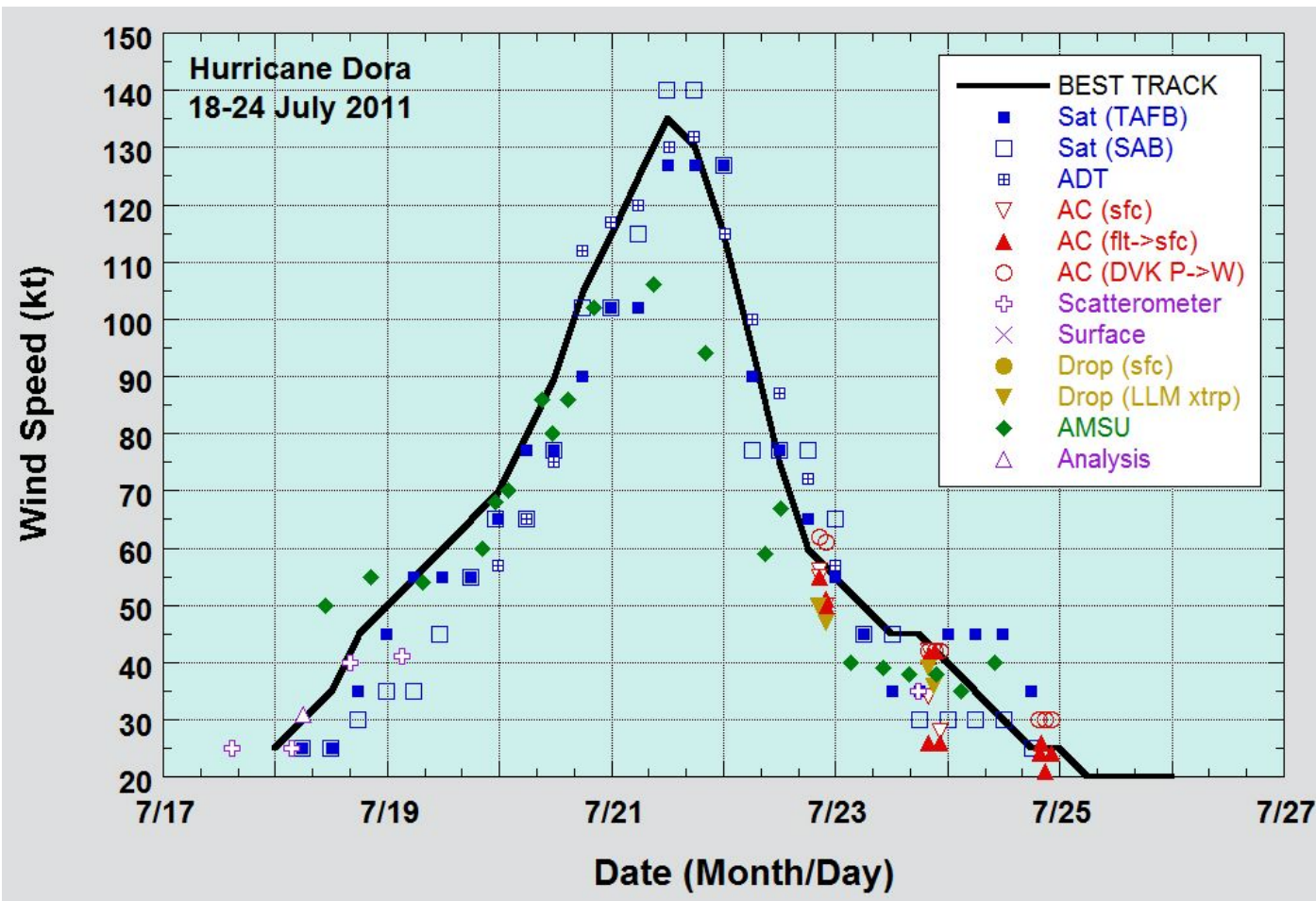


Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Dora, 18-24 July 2011. Aircraft observations have been adjusted for elevation using 90%, 80%, and 80% adjustment factors for observations from 700 mb, 850 mb, and 1500 ft, respectively. Dropwindsonde observations include actual 10 m winds (sfc), as well as surface estimates derived from the mean wind over the lowest 150 m of the wind sounding (LLM). Advanced Dvorak Technique estimates represent linear averages over a three-hour period centered on the nominal observation time. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. Dashed vertical lines correspond to 0000 UTC.

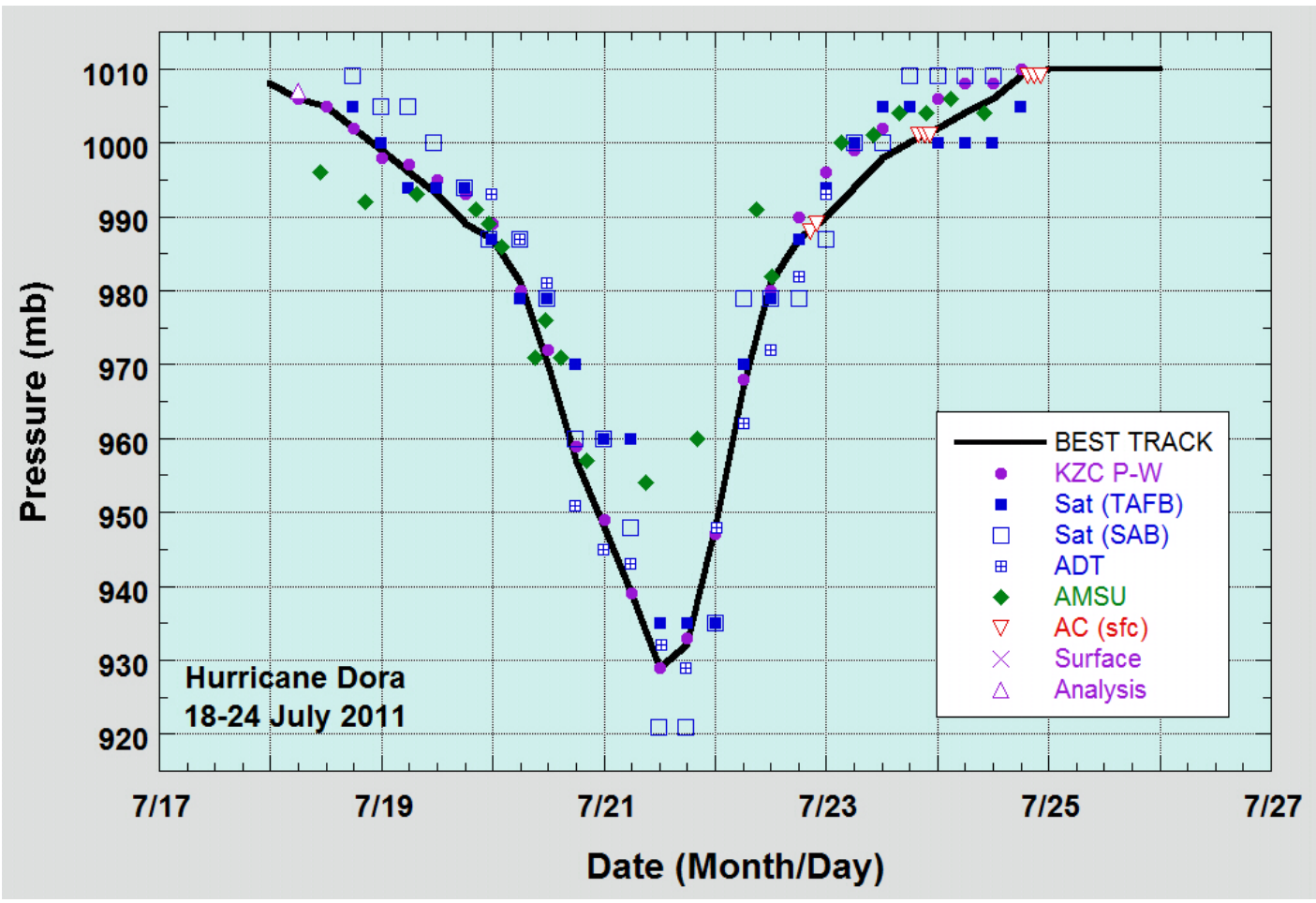


Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Dora, 18-24 July 2011. Advanced Dvorak Technique estimates represent linear averages over a three-hour period centered on the nominal observation time. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. KZC-PW represents the Knaff-Zahr-Courney pressure-wind relationship, where best-track winds have been utilized to obtain these central pressure estimates. Dashed vertical lines correspond to 0000 UTC.

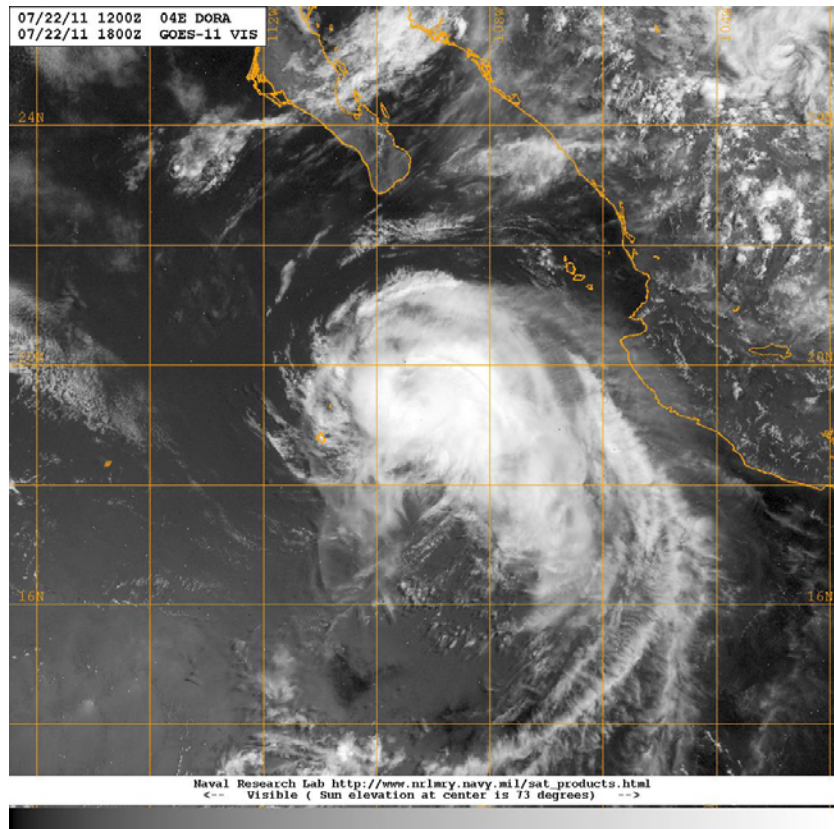
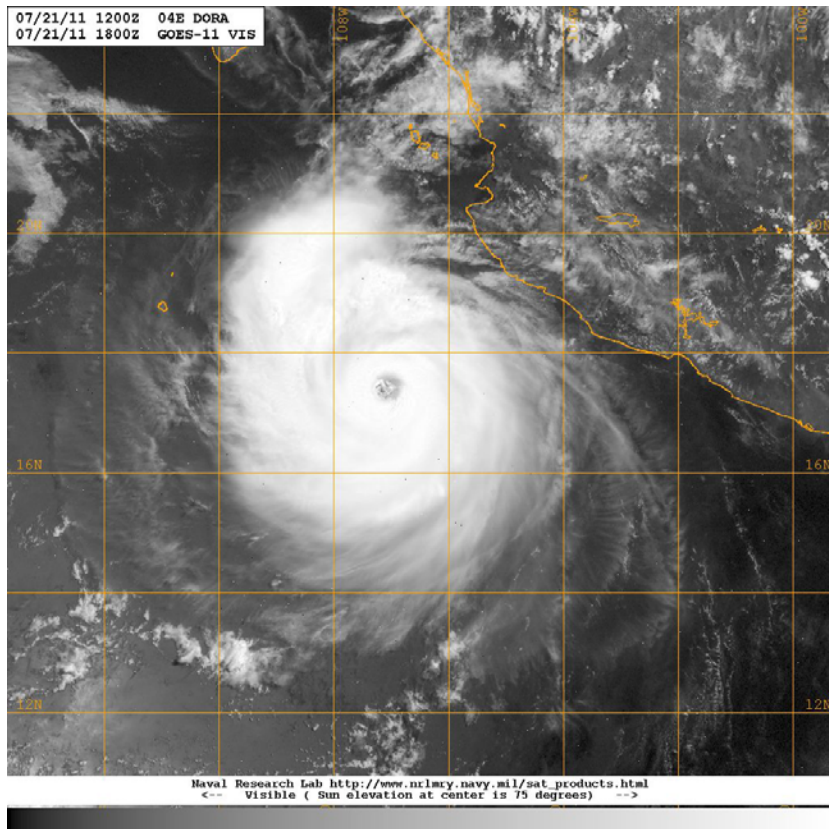


Figure 4. GOES-11 visible satellite imagery of Dora shortly after peak intensity at 1800 UTC 21 July (left) and 24 h later (right), after the tropical cyclone rapidly weakened to a tropical storm. Images courtesy of the Naval Research Laboratory.