NATIONAL HURRICANE CENTER
CENTRAL PACIFIC HURRICANE CENTER
TROPICAL CYCLONE REPORT

HURRICANE DOUGLAS

(EP082020)

20–29 July 2020

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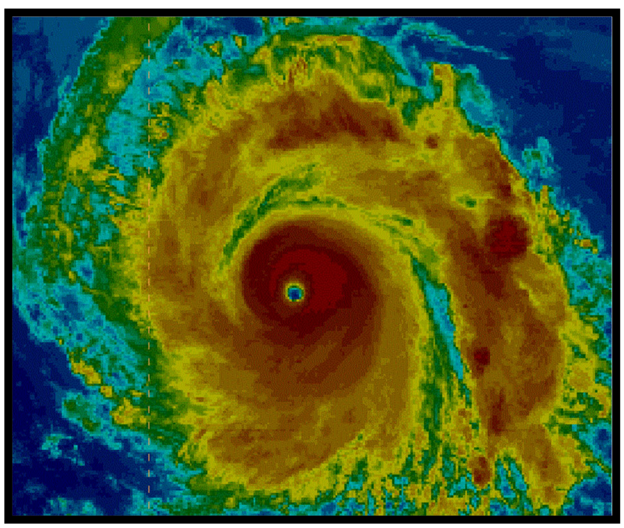

GOES-17 10.3-μM INFRARED SATELLITE IMAGE OF HURRICANE DOUGLAS NEAR ITS PEAK INTENSITY AT 0000 UTC 24 JULY 2020.

Douglas formed in the central portion of the eastern Pacific basin and become a category four hurricane (on the Saffir-Simpson Hurricane Wind Scale) before it crossed into the central Pacific. The hurricane eventually passed just north of the main Hawaiian Islands before crossing over a portion of the Northwestern Hawaiian Islands.

[1] Original report released 20 November 2020. Updated 25 May 2021 to include best track analysis, map, summary, and verification from the Central Pacific Hurricane Center.

Hurricane Douglas

20–29 JULY 2020

SYNOPTIC HISTORY

Douglas' origins can be traced to a tropical wave that emerged off the coast of Africa on 8 July. The deep convection quickly dissipated as the wave began to traverse the tropical Atlantic. The wave crossed northern South America from 12–14 July and then central America on 15 July before entering the eastern Pacific basin. There were intermittent bursts of deep convection associated with the wave as it passed south and southwest of the southern coast of Mexico from 16–18 July, but there were no signs of organization during that time. Early on 19 July, the shower and thunderstorm activity became more concentrated over the northern portion of the wave, and a little later that day it became apparent in satellite images and scatterometer wind data (not shown) that an area of low pressure was developing. By 0000 UTC 20 July, the satellite presentation continued to improve, and the system had developed sufficient organization to be considered a tropical depression while located about 700 n mi southwest of the southern tip of the Baja California peninsula. 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[2].

The depression continued to become better organized on 20 July, and it is estimated that it strengthened into a tropical storm by 1800 UTC that day, while located about 800 n mi south of the southern tip of the Baja California peninsula. The cyclone initially moved southwestward on 20 July, then west-southwestward through early 22 July as it was steered by a mid-level ridge located to its northwest. The environment during that time was generally conducive for strengthening, with low vertical wind shear and warm waters. Although Douglas battled some dry air intrusions on 21 July, the cyclone strengthened to a hurricane by 1800 UTC 22 July while located about midway between the coast of southwestern Mexico and the Island of Hawai'i. Around this same time the hurricane turned westward and then west-northwestward as Douglas began to move around the southern and southwestern portion of the mid-level ridge. This ridge would build westward with time and steer the hurricane in a generally west-northwestward direction until the cyclone dissipated, which would be several days after it passed into the central Pacific basin. When Douglas became a hurricane, a period of rapid intensification was already underway and the cyclone became a 100-kt category three hurricane on the Saffir-Simpson Hurricane Wind Scale by 0600 UTC 23 July, just 12 h after reaching hurricane strength. Douglas continued to intensify, and it became a 115-kt category four hurricane by 0000 UTC July 24 (cover photo). The hurricane maintained this intensity when it crossed into the central Pacific basin just

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[2] 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.

after 0600 UTC that day. Douglas was the strongest hurricane to cross from the eastern Pacific to central Pacific basin since Lane in 2018, and the second tropical cyclone since Boris earlier in the 2020 season.

At basin crossing, a robust satellite presentation indicated Douglas was a healthy system in its prime, with a well-defined eye and symmetrical outflow. Synthetic aperture radar imagery showed Douglas maintained good structure for at least 30 hours after crossing into the central North Pacific basin (Figs. 4 and 5). However, a collection of subjective Dvorak satellite intensity estimates indicated that Douglas was already beginning to weaken. Wind shear across Douglas was light, but with marginal sea surface temperatures to draw upon, Douglas began a slow weakening trend that would continue through the rest of its life. Douglas moved toward the west northwest rather rapidly and the center passed just northeast of and roughly parallel to the main Hawaiian Island chain, coming within 60 n mi of Oahu as an 80-knot hurricane shortly before 0600 UTC 27 July. Shortly after 1200 UTC 27 July, Douglas passed west of 160°W and approached the Papahaanaumokuaakea Marine National Monument northwest of the main Hawaiian islands. Douglas wavered in intensity between 75 kt and 80 kt immediately before and during closest approach to the main islands. However, once Douglas reached 160°W it began its final decline in the face of increasing wind shear and dry air aloft. The cyclone weakened to a tropical storm at 0000 UTC 28 July, then became a 30 kt post-tropical remnant low at 1200 UTC 29 July as satellite imagery showed that the associated deep convection had ceased. By 0600 UTC 30 July, the remnant low opened up into a trough just west of the International Date Line.

METEOROLOGICAL STATISTICS

Observations in Douglas (Figs. 2 and 3) include subjective satellite-based Dvorak and intensity estimates from the Tropical Analysis and Forecast Branch (TAFB), the Satellite Analysis Branch (SAB), the Central Pacific Hurricane Center (PHFO), and the Joint Typhoon Warning Center (JTWC), and objective Advanced Dvorak Technique (ADT) estimates and Satellite Consensus (SATCON) 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 5 flights (19 center fixes) by the 53rd Weather Reconnaissance Squadron of the U.S. Air Force Reserve during the period 25–27 July. Additionally, there were nine WSR-88D center fixes recorded by the PHMO radar site on the island of Molokai between 2000 UTC 26 July and 1000 UTC 27 July. 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 Douglas.

The peak intensity of Douglas at 0000 UTC 24 July was based on the Dvorak intensity estimates from TAFB and SAB of T6.0, which corresponds to a 115-kt intensity. The University of Wisconsin CIMSS ADT also provided a similar intensity estimate that that time. The estimated minimum central pressure of 954 mb was derived using the Knaff-Zehr-Courtney pressure-wind relationship.

Selected surface observations from land stations and data buoys are given in Table 2. Data from reconnaissance aircraft and radar showed that the wind field around Douglas became increasingly asymmetrical as this system neared its point of closest approach to the main Hawaiian island chain. Wind radii were significantly smaller to the south. By passing north of the islands along a west-northwest track, the islands remained on Douglas' weaker side. No tropical storm force winds were observed on land as Douglas passed within 60 n mi of Oahu. However, sustained winds in excess of 34 kt were observed at NDBC buoys 51001 and 51101 located northwest of Kauai after Douglas departed the main Hawaiian Islands.

There were no ship reports of winds of tropical storm force associated with Douglas in the eastern Pacific basin.

CASUALTY AND DAMAGE STATISTICS

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

FORECAST AND WARNING CRITIQUE

The genesis of Douglas was not well anticipated. The system that became Douglas was initially mentioned in the tropical weather outlook (TWO) only 18 h prior to genesis, introducing a low (<40%) chance of formation within both the 2-day and 5-day time periods (Table 3). The probabilities were raised to a medium (40–60%) chance for development within the next 5 days 12 h prior to formation. The 2-day and 5-day probabilities were then raised to the medium and high categories (>60%), respectively, 6 h before genesis occurred. The 2-day probabilities for formation never reached the high category prior to the system developing into a tropical cyclone. One reason that the genesis forecasts fell behind on this system was the lack of model support. Only two days prior to formation, the global models that did indicate that genesis would occur did not show it occurring until days 5–7. Only two global models indicated genesis within 5 days from the 0000 UTC run cycle 24 h prior to formation. One possible explanation for the models not recognizing genesis for Douglas was that they were resolving a larger scale gyre that also spawned Tropical Depression Seven-E. So, while the specific disturbance that resulted in the genesis of Douglas was not well forecast, the large-scale feature was accurately depicted by the models as a region of enhanced probability of tropical cyclone development.

A verification of NHC official track forecasts for Douglas is given in Table 4a. Official track forecast errors were lower than the mean official errors for the previous 5-yr period for the 12 h forecast time, near the mean official errors for the 24, 36, and 48 h forecast times, and above the long-term mean official errors for 60–120 h. The climatology and persistence errors (OCD5) were much higher than their 5-yr means at 24–120 h, indicating that Douglas' track was likely more difficult to predict than average at those time frames, despite the relatively straight track. A homogeneous comparison of the official NHC track errors with selected guidance models is given in Table 4b. Overall, the consensus track guidance performed slightly better than the official NHC forecasts. However, the NHC forecast performed better than the HWFI, GFSI, and CMCI at all time periods. The best-performing global model was the UKMET (EGRI), which beat the official NHC forecasts at all verifying times.

A verification of NHC official intensity forecasts for Douglas is given in Table 5a. Official intensity forecast errors were below the mean official errors for the previous 5-yr period for the verifying 24, 36, and 48 h forecast times and above the long-term mean official errors for 60–120 h. The OCD5 errors were well above their 5-yr means through 72 h, indicating that Douglas' intensity was difficult to predict for those forecast times. A homogeneous comparison of the official NHC intensity errors with selected guidance models is given in Table 5b. The NHC forecast performed better than the majority of the models at all forecast times. The only model that performed better than the NHC forecast for intensity at most forecast times was the FSU Superensemble (FSSE).

A verification of CPHC official track forecasts for Douglas is given in Table 6a. CPHC track errors for this system were smaller than the floating five-year average at all forecast times. CPHC performed better than OCD5 at all forecast times. A homogeneous comparison of the official track errors with selected guidance models is given in Table 6b. In general, CPHC performed better than most global and regional dynamic models like CMCI, NVGI and lastly GFEX, which is a blend of GFS and EMXI. However, EMXI itself outperformed CPHC. CPHC also performed better than trajectory models like TABD. Ensemble and consensus models like HCCA and TVCE performed well against CPHC, with FSSE and EMXI performing best.

A verification of CPHC official intensity forecasts for Douglas is given in Table 7a. CPHC intensity errors for this system were smaller than the floating five-year average at all forecast times. CPHC performed better than OCD5 at all forecast times. A homogeneous comparison of the official track errors with selected guidance models is given in Table 7b. CPHC performed better than CMCI, LGEM and DSHP while performing poorly against IVDR, IVCN and ICON. FSSE outperformed CPHC through 48 h, with CPHC performing better afterwards.

No coastal watches or warnings were issued in association with Douglas in the eastern Pacific basin. A summary of tropical cyclone watches and warnings issued for Douglas in the central Pacific basin is given in Table 8.

Table 1. Best track for Hurricane Douglas, 20–29 July 2020.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
20 / 0000	14.7	118.8	1008	30	tropical depression
20 / 0600	14.3	119.1	1008	30	"
20 / 1200	13.9	119.4	1008	30	"
20 / 1800	13.5	120.0	1006	35	tropical storm
21 / 0000	13.3	121.0	1004	40	"
21 / 0600	13.0	122.3	1001	50	"
21 / 1200	12.6	123.6	998	55	"
21 / 1800	12.2	124.8	998	55	"
22 / 0000	12.1	126.1	998	55	"
22 / 0600	11.8	127.5	998	55	"
22 / 1200	11.6	128.9	996	60	"
22 / 1800	11.9	130.3	989	70	hurricane
23 / 0000	12.3	131.8	981	80	"
23 / 0600	12.8	133.3	967	100	"
23 / 1200	13.3	134.9	964	105	"
23 / 1800	13.8	136.5	959	110	"
24 / 0000	14.6	138.0	954	115	"
24 / 0600	15.3	139.5	954	115	"
24 / 1200	16.1	141.1	962	105	"
24 / 1800	16.7	142.7	967	100	"
25 / 0000	17.5	144.3	967	100	"
25 / 0600	18.2	145.9	972	95	"
25 / 1200	18.7	147.6	975	90	"
25 / 1800	19.1	149.2	982	85	"
26 / 0000	19.7	150.7	982	80	"
26 / 0600	20.1	152.1	983	80	"
26 / 1200	20.5	153.6	983	80	"
26 / 1800	21.0	155.1	987	75	"
27 / 0000	21.7	156.6	989	75	"
27 / 0600	22.3	158.1	987	80	"

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
27 / 1200	22.7	159.7	987	80	"
27 / 1800	22.8	161.4	992	70	"
28 / 0000	22.9	162.8	996	60	tropical storm
28 / 0600	23.2	164.2	999	50	"
28 / 1200	23.8	165.7	1003	45	"
28 / 1800	24.2	167.7	1006	40	"
29 / 0000	24.4	169.9	1006	40	"
29 / 0600	24.6	172.1	1010	35	"
29 / 1200	24.6	174.4	1012	30	low
29 / 1800	24.8	176.4	1013	30	"
30 / 0000	25.0	178.1	1013	30	"
30 / 0600					dissipated
24 / 0000	14.6	138.0	954	115	maximum wind and minimum pressure

Table 2. Selected surface observations for Hurricane Douglas, 20–29 July 2020.

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Hawaii									
International Civil Aviation Organization (ICAO) Sites									
Lanai City Airport (PHNY) (20.79N 156.95W)	27/2156	1010.8	26/1705	31	39				
Kahului Airport (PHOG) (20.89N 156.44W)	27/0254	1010.8	26/1505	25	33				
Hilo International Airport (PHTO) (19.72N 155.06W)	26/1453	1009.8	26/1355	19	28				
Keahole Airport Kona (PHKO) (19.74N 156.05W)	26/1353	1011.2	26/1525	20	23				
Honolulu International Airport (PHNL) (21.33N 157.94W)	27/0253	1010.5	27/0053	18	25				
Lihue Airport (PHLI) (21.98N 159.34W)	27/0953	1009.8	26/2115	25	29				
Molokai Airport Kaunakakai (PHMK) (21.15N 157.10W)	26/2354	1011.1	26/2123	23	34				
Kalaeloa Airport (PHJR) (21.31N 158.07W)	27/0140	1011.5	27/0450	17	22				
Kaneohe Marine Corps Air Station (PHNG) (21.45N 157.77W)	27/0257	1008.4	26/2024	24	31				
Barking Sands Kekaha (PHBK) (22.04N 159.79W)	27/1056	1011.5	27/0210	27	33				
Wheeler Air Force Base (PHHI) (21.48N 158.03W)	27/0234	1009.4	27/0150	16	23				
Hydrology-Surface Observing Instrumentation System (H-SOIS) Site									
Hana Airport (HNAH1) (20.79N 156.02W)	26/2045	1009.1	26/1730	11	23				
Maalaea Harbor (P36) (20.79N 156.51W)	26/2100	1010.8	26/0000	25	37				
Hydrometeorological Automated Data System (HADS) Sites (NWS)									
AH6GR Maui (AR427) (20.87N 156.52W)			26/2016	17	31				

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Kahului (KLIH1) (20.90N 156.48W)			26/2012	24	30				
Kapaa (F0098) (22.07N 159.36W)			27/0853	10	25				
Kealia Pond NWR (KPDH1) (20.79N 156.47W)			26/0320	23	34				
Kaneloa (KAOH1) (20.52N 156.57W)			26/1935	25	42				
Kaupulehu (KPLH1) (19.80N 155.92W)			26/2236	19	30				
Lanai 1 (LNIH1) (20.87N 157.01W)			26/0337	23	35				
Makapulapai (MKPH1) (21.20N 156.97W)			26/0315	17	29				
Mana (MNRH1) (22.03N 159.76W)			27/0234	17	26				
Molokai 1 (MLKH1) (21.12N 156.95W)			26/0815	17	29				2.84
Mokuoloe (MOKH1) (21.43N 157.79W)			26/0124	23	27				
Kuaokala (KKRH1) (21.57N 158.26W)			26/1936	29	48				
Kahuku Training Area (KTAH1) (21.68N 157.99W)			27/0559	10	23				1.46
PTA East (PTAH1) (19.68N 155.55W)			25/2159	21	29				
Kii (KFWH1) (21.69N 157.95W)			26/1945	17	28				
Honokaa (HNKH1) (20.07N 156.46W)									2.34
Kahua Ranch (KASH1) (20.12N 155.79W)									2.93
Kahuku (KAAH1) (21.70N 157.98W)									2.18
Kamuela Upper (KUUH1) (20.01N 155.63W)									2.45
Kapahi (KPIH1) (22.10N 159.39W)									3.52
Kawainui Stream (KWSH1) (20.10N 155.70W)									3.39
Kilohana (KLOH1) (22.15N 159.59W)									4.21

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Makaha Stream (MKHH1) (21.59N 158.18W)									1.75
Mohihi Crossing (MCRH1) (22.12N 159.32W)									3.14
Mount Waialeale (WLLH1) (22.10N 159.5W)									6.35
Pukalani (PUKH1) (20.84N 156.33W)									2.01
Punaluu Pump (PUNH1) (21.58N 157.89W)									1.53
Puu Alii (PAFH1) (21.14N 156.90W)									2.10
Puu Mali (PMLH1) (19.93N 155.44W)									2.67
Waialae (WLGH1) (22.09N 159.57W)									2.98
Waianae Valley (WVNH1) (21.48N 158.16W)									1.25
US Geological Survey (USGS)									
Puu Kukui (PKKH1) (20.89N 156.59W)									5.20
Waiakoali (WKRH1) (22.12N 159.32W)									3.40
West Wailuaiki (WWKH1) (20.82N 156.14W)									2.24
National Ocean Service (NOS)									
Hilo (1617760) (19.73N 155.06W)	26/1430	1008.3	26/1340	20	26				
Honolulu (1612340) (21.31N 157.87W)	27/0230	1010.4	27/0012	13	19				
Kahului Harbor (1615680) (20.90N 156.47W)	27/0124	1009.8	25/2012	25	30				
Kawaihae (1617433) (20.04N 155.82W)	26/1948	1010.9	26/2042	17	20				
Mokuoloe (1612480) (21.43N 157.79W)	27/0236	1009.4	27/0206	23	27				
Nawiliwili (1611400) (21.96N 159.36W)	27/1006	1010.8	27/1036	23	38				
Offshore									
NOAA Buoys									

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Northwest Hawaii - One (51001) (24.45N 162.00W)	28/0220	1015.1	27/2210	37	43				
Northwest Hawaii – Two (51101) (24.36N 162.08W)	28/0310	1014.2	27/2200	37	41				
North Hawaii (51000) (23.54N 153.81W)	26/1310	1015.8	26/2220	29	33				
Southeast Hawaii (51004) (17.60N 152.40W)	26/0200	1010.6	25/2010	19	21				

[a] Date/time is for sustained wind when both sustained and gust are listed.
[b] Except as noted, sustained wind averaging periods for land-based reports are 2 min; buoy averaging periods are 10 min.

Table 3. 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.

	Hours Before Genesis	
	48-Hour Outlook	**120-Hour Outlook**
Low (<40%)	18	18
Medium (40%-60%)	6	12
High (>60%)	-	6

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Hurricane Douglas, 20–29 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	**20.8**	35.3	47.8	58.8	73.2	90.2	138.9	190.3
OCD5	34.4	84.3	142.9	200.4	260.9	320.3	433.6	555.7
Forecasts	16	16	16	16	16	16	16	16
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 4b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Hurricane Douglas in the eastern North Pacific basin. 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	20.9	35.3	52.0	65.9	77.1	91.1	139.9	184.0
OCD5	25.7	68.3	119.7	172.8	228.4	282.0	385.9	483.1
TABS	21.5	45.7	70.6	86.6	95.4	101.0	158.1	221.5
TABM	**17.0**	**32.5**	**51.3**	68.8	85.3	100.3	153.5	196.2
TABD	**19.1**	44.6	74.1	106.3	143.2	181.5	281.8	361.6
TVDG	**18.7**	**33.1**	**47.8**	**59.2**	**67.5**	**79.4**	**124.9**	**170.7**
TVCE	**18.4**	**33.4**	**50.0**	**64.8**	**74.4**	**87.5**	**137.7**	187.2
GFEX	20.9	37.2	53.4	**64.8**	**74.7**	**86.1**	**128.7**	**165.0**
TVCX	**19.6**	**34.3**	**48.6**	**61.8**	**71.0**	**83.2**	**128.6**	**174.1**
FSSE	**19.2**	36.3	**50.9**	**61.3**	**71.9**	**83.2**	**129.8**	**176.2**
HCCA	**19.8**	**33.4**	**48.0**	**58.9**	**68.5**	**83.4**	140.1	195.7
AEMI	**20.7**	40.4	60.9	80.8	99.5	121.0	176.1	217.3
NVGI	24.7	43.4	52.7	**47.6**	**42.4**	**53.6**	**117.4**	221.3
CMCI	30.0	53.5	74.8	91.8	109.1	125.6	177.7	249.6
EMXI	23.4	43.7	60.1	72.1	79.6	**85.9**	**107.1**	**122.1**
EGRI	**17.5**	**28.1**	**39.6**	**46.3**	**50.3**	**56.3**	**87.4**	**149.0**
HWFI	23.0	48.6	79.3	106.4	128.6	154.7	245.6	334.0
HMNI	**13.7**	**32.4**	56.7	76.1	88.6	103.7	166.0	226.0
GFSI	23.1	40.0	57.3	78.8	94.9	113.6	175.6	232.5
Forecasts	11	11	11	11	11	11	11	10

Table 5a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Hurricane Douglas, 20–29 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	7.5	**8.4**	**8.1**	**12.2**	18.8	23.1	21.2	18.8
OCD5	9.8	15.9	19.0	24.3	27.5	28.2	22.4	13.3
Forecasts	16	16	16	16	16	16	16	16
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 5b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Hurricane Douglas in the eastern North Pacific basin. 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 5a due to the homogeneity requirement.

Model ID	Forecast Period (h)							
	12	24	36	48	60	72	96	120
OFCL	6.4	8.2	9.1	14.1	18.2	20.9	20.5	18.0
OCD5	8.5	16.5	21.3	26.5	25.6	22.0	**18.8**	**11.8**
IVDR	8.0	12.7	14.2	18.9	21.1	21.7	23.2	19.8
IVCN	8.0	12.8	14.3	18.5	20.7	22.3	23.9	20.3
ICON	8.2	13.3	14.5	18.8	20.9	22.3	22.7	20.2
LGEM	8.0	16.2	20.3	24.9	26.7	27.7	29.0	24.6
DSHP	6.8	10.3	10.2	15.3	**17.6**	20.9	24.9	21.8
FSSE	8.1	11.4	10.2	**12.5**	**14.5**	**14.1**	**13.5**	**12.9**
HCCA	7.9	11.5	12.3	14.9	18.4	**20.4**	21.4	19.6
CMCI	9.5	15.5	19.9	27.5	28.6	26.9	23.0	26.6
EMXI	7.2	11.8	17.5	23.9	23.5	**20.8**	22.5	**17.7**
EGRI	9.3	14.5	19.6	25.5	24.5	21.2	**15.0**	21.7
HWFI	9.5	14.7	15.5	20.0	22.4	21.6	**16.8**	21.1
HMNI	9.5	14.7	14.7	16.5	18.6	**19.8**	22.0	**14.1**
GFSI	8.2	14.1	20.2	24.9	25.0	23.6	23.5	24.2
Forecasts	11	11	11	11	11	11	11	10

Table 6a. CPHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Hurricane Douglas, 20–29 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	**21.1**	**31.1**	**29.8**	**33.3**	45.3	**59.6**	**70.1**	-
OCD5	33.5	55.4	84.4	128.2	173.9	230.0	353.5	-
Forecasts	18	16	14	12	10	8	4	-
OFCL (2015-19)	26.6	40.2	53.8	63.6	NA	101.1	135.2	-
OCD5 (2015-19)	42.4	90.4	144.3	211.8	NA	353.2	487.8	-

Table 6b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Hurricane Douglas in the central North Pacific basin. Errors smaller than the CPHC official forecast are shown in boldface type.

Model ID	Forecast Period (h)							
	12	24	36	48	60	72	96	120
OFCL	21.1	31.1	29.8	33.3	45.3	59.6	70.1	-
OCD5	33.5	55.4	84.4	128.2	173.9	230.0	353.5	-
TABS	31.6	53.4	76.2	105.9	146.0	178.6	220.1	-
TABM	29.2	41.3	47.9	63.3	87.2	119.9	181.1	-
TABD	40.5	85.9	139.2	191.0	248.0	315.9	445.6	-
TVDG	**18.0**	**26.7**	32.9	38.9	48.8	63.4	88.4	-
TVCE	**18.2**	**28.7**	33.2	41.6	55.0	70.3	99.1	-
GFEX	**16.9**	**24.3**	31.3	39.0	53.1	74.2	104.4	-
TVCX	**17.9**	**26.3**	31.6	37.5	49.3	65.3	94.3	-
FSSE	**17.3**	**25.8**	30.7	**32.6**	**33.6**	**46.4**	78.9	-
HCCA	**17.8**	**26.2**	29.9	34.0	**35.1**	**48.9**	81.4	-
AEMI	23.8	42.7	56.9	77.8	106.0	120.6	138.4	-
NVGI	28.2	37.1	53.3	76.4	96.0	125.6	246.6	-
CMCI	30.5	52.8	71.8	98.4	126.9	148.0	168.7	-
EMXI	**17.0**	**23.1**	30.3	**29.2**	**29.1**	**45.4**	**61.6**	-
EGRI	**20.8**	**25.5**	34.3	39.9	**44.4**	**49.2**	**51.8**	-
HWFI	24.4	37.9	43.4	65.3	93.9	120.8	167.4	-
HMNI	**20.3**	31.9	42.6	65.2	90.5	104.3	132.7	-
GFSI	**18.8**	32.3	41.5	63.9	92.8	118.4	176.6	-
Forecasts	18	16	14	12	10	8	4	-

Table 7a. CPHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Hurricane Douglas, 20–29 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	**4.2**	**6.9**	**9.3**	**10.0**	10.5	**10.0**	**8.8**	-
OCD5	7.0	10.4	14.5	16.3	25.7	24.1	13.5	-
Forecasts	18	16	14	12	10	8	4	-
OFCL (2015-19)	5.8	9.0	11.3	12.6	NA	14.5	16.5	-
OCD5 (2015-19)	7.6	12.0	16.3	18.1	NA	27.8	28.3	-

Table 7b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Hurricane Douglas in the central North Pacific basin. Errors smaller than the CPHC official forecast are shown in boldface type.

Model ID	Forecast Period (h)							
	12	24	36	48	60	72	96	120
OFCL	4.2	6.9	9.3	10.0	10.5	10.0	8.8	-
OCD5	7.0	10.4	14.5	16.3	25.7	24.1	13.5	-
IVDR	**3.9**	**5.7**	**5.4**	**4.8**	**6.4**	**5.4**	**4.8**	-
IVCN	**4.2**	**6.1**	**7.2**	**6.5**	**7.9**	**6.4**	**3.8**	-
ICON	**4.2**	**6.1**	**7.0**	**6.4**	**7.8**	**6.8**	**6.5**	-
LGEM	6.4	10.9	14.8	15.0	14.8	12.1	**6.5**	-
DSHP	5.4	10.5	13.8	14.8	14.6	11.6	**7.3**	-
FSSE	**3.9**	**5.6**	**6.1**	**6.8**	11.4	13.5	12.0	-
HCCA	4.5	7.5	**8.0**	**5.2**	**6.5**	**6.5**	10.8	-
CMCI	6.5	9.9	12.3	14.4	18.1	25.3	42.0	-
EMXI	**4.1**	**6.5**	**6.8**	**8.3**	**10.1**	10.3	**5.3**	-
EGRI	4.9	**6.5**	**8.6**	**8.1**	**7.8**	11.6	22.8	-
HWFI	5.0	**5.6**	**5.1**	**5.9**	**7.0**	**8.3**	10.0	-
HMNI	4.0	**5.6**	**5.6**	**7.5**	**6.8**	**4.4**	**4.5**	-
GFSI	4.7	7.0	**6.1**	**5.8**	**7.3**	**8.1**	17.8	-
Forecasts	18	16	14	12	10	8	4	-

Table 8. Wind watch and warning summary for Hurricane Douglas, 20–29 July 2020.

Date/Time (UTC)	Action	Location
24 / 2100	Hurricane Watch issued	Islands of Hawaii, Maui, Molokai, Lanai and Kahoolawe
25 / 0300	Hurricane Watch issued	Island of Oahu
25 / 0900	Tropical Storm Warning issued	Islands of Hawaii, Maui, Molokai, Lanai and Kahoolawe
25 / 1500	Tropical Storm Watch issued	Islands of Kauai and Niihau
25 / 2100	Hurricane Watch changed to Hurricane Warning	Island of Oahu
26 / 0300	Tropical Storm Watch changed to Tropical Storm Warning	Islands of Kauai and Niihau
26 / 0300	Tropical Storm Watch issued	Papahanaumokuakea Marine National Monument from Nihoa to French Frigate Shoals
26 / 0900	Tropical Storm Warning changed to Hurricane Warning	Islands of Kauai and Niihau
26 / 1500	Hurricane Watch changed to Hurricane Warning	Islands of Maui, Molokai, Lanai and Kahoolawe
26 / 1500	Hurricane Watch discontinued	Island of Hawaii
26 / 1500	Tropical Storm Watch issued	Papahanaumokuakea Marine National Monument from French Frigate Shoals to Maro Reef
26 / 2100	Tropical Storm Warning issued	Papahanaumokuakea Marine National Monument from Nihoa to French Frigate Shoals
27 / 0300	Hurricane Warning discontinued	Islands of Maui, Molokai, Lanai and Kahoolawe
27 / 0900	Hurricane Warning discontinued	Island of Oahu
27 / 0900	Tropical Storm Watch changed to Tropical Storm Warning	Papahanaumokuakea Marine National Monument from French Frigate Shoals to Maro Reef
27 / 1500	Tropical Storm Warning changed to Hurricane Warning	Papahanaumokuakea Marine National Monument from Nihoa to French Frigate Shoals
27 / 1500	Hurricane Watch issued	Papahanaumokuakea Marine National Monument from French Frigate Shoals to Maro Reef

Date/Time (UTC)	Action	Location
27 / 1500	Tropical Storm Watch issued	Papahanaumokuakea Marine National Monument from Maro Reef to Lisianski
28 / 0300	Hurricane Warning changed to Tropical Storm Warning	Papahanaumokuakea Marine National Monument from Nihoa to French Frigate Shoals
28 / 0300	Hurricane Watch discontinued	Papahanaumokuakea Marine National Monument from French Frigate Shoals to Maro Reef
28 / 1500	Tropical Storm Watch changed to Tropical Storm Warning	Papahanaumokuakea Marine National Monument from Maro Reef to Lisianski
28 / 1500	Tropical Storm Watch issued	Papahanaumokuakea Marine National Monument from Lisianski to Pearl and Hermes Atoll
28 / 1500	Tropical Storm Warning discontinued	Papahanaumokuakea Marine National Monument from Nihoa to French Frigate Shoals
29 / 0300	Tropical Storm Watch discontinued	Papahanaumokuakea Marine National Monument from Lisianski to Pearl and Hermes Atoll
29 / 0600	Tropical Storm Warning discontinued	Papahanaumokuakea Marine National Monument from French Frigate Shoals to Maro Reef
29 / 1500	Tropical Storm Warning discontinued	Papahanaumokuakea Marine National Monument from Maro Reef to Lisianski

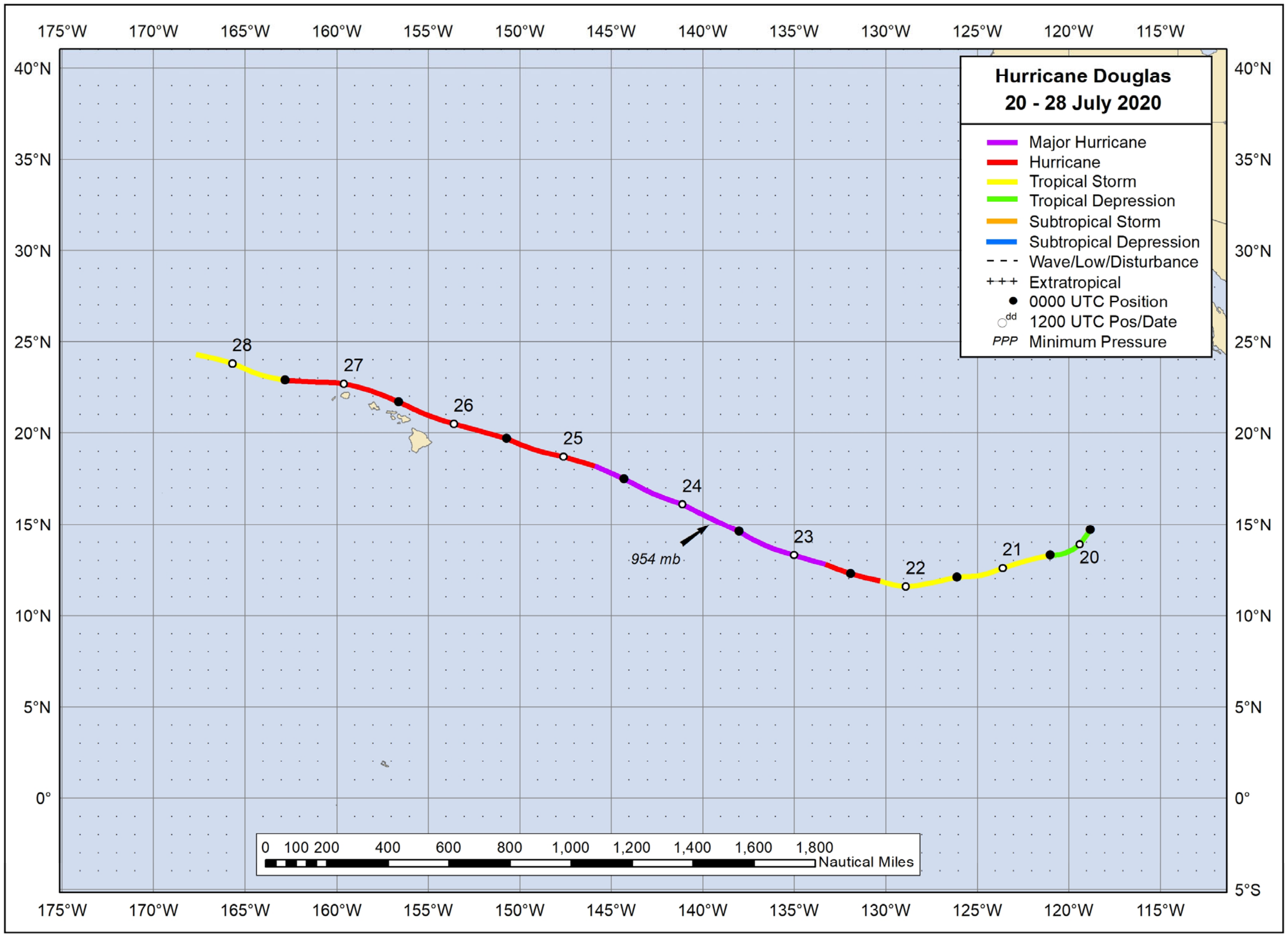

Figure 1. Best track positions for Hurricane Douglas, 20–29 July 2020.

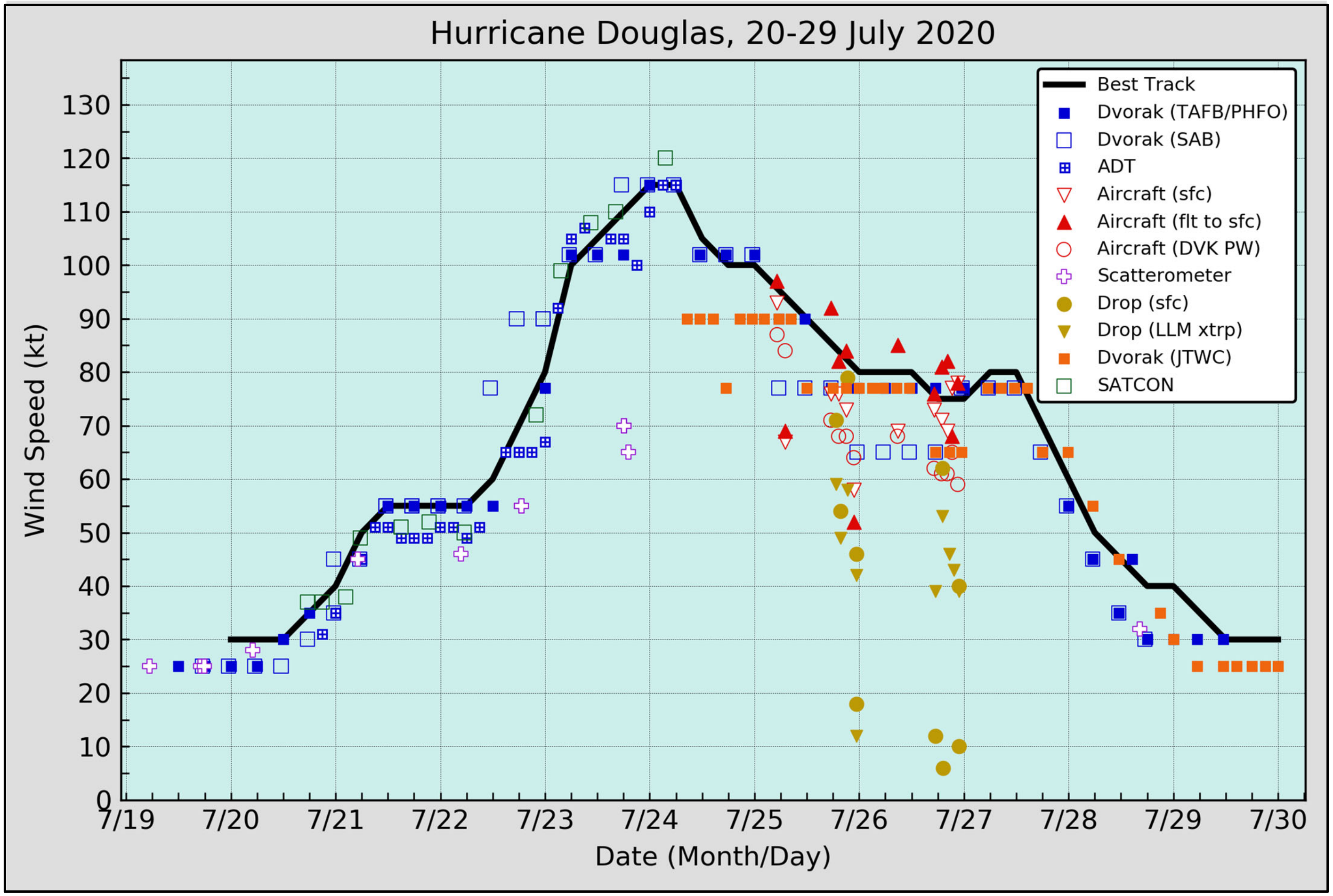

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Douglas, 20–29 July 2020. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies. 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. Dashed vertical lines correspond to 0000 UTC.

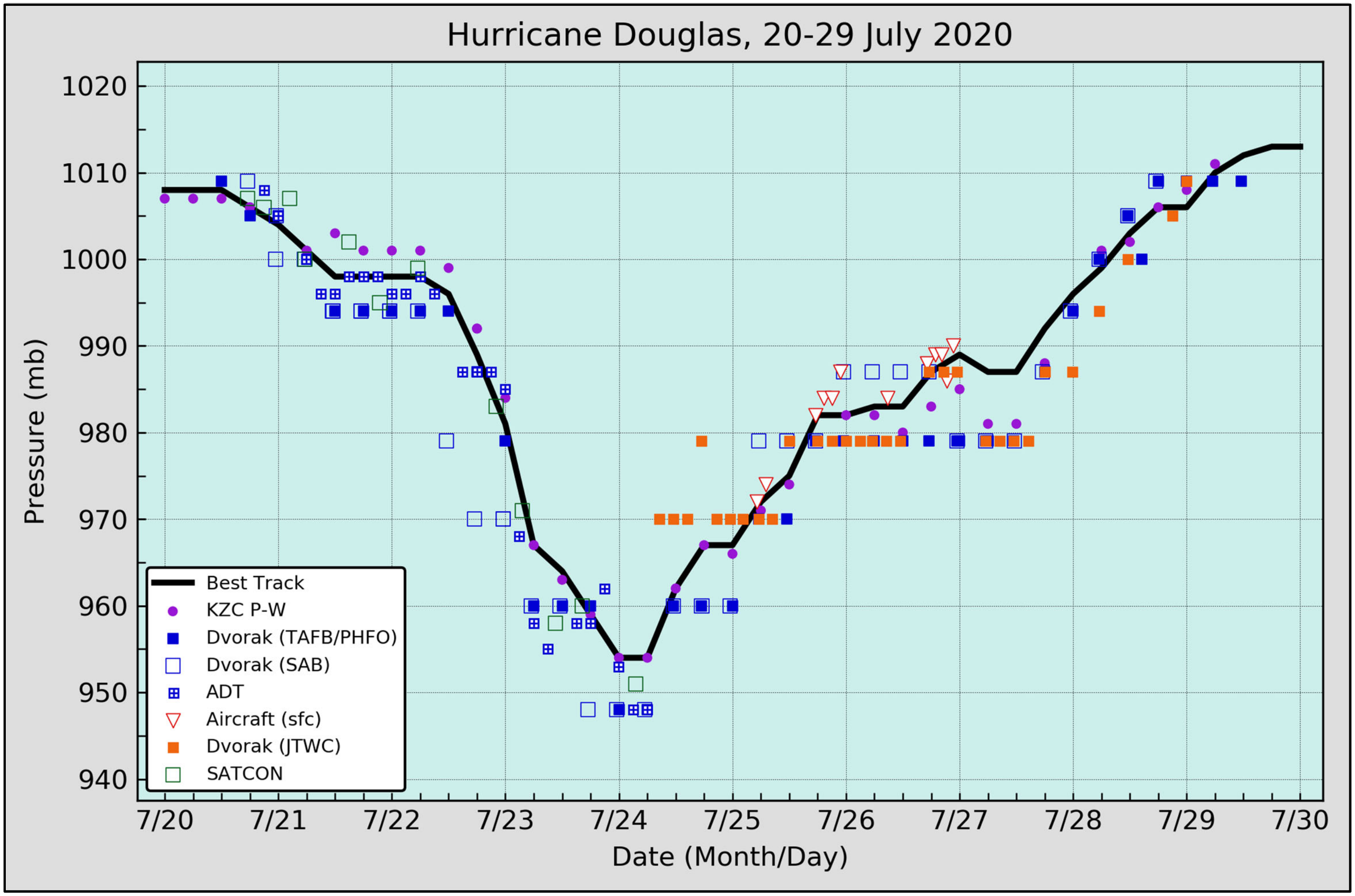

Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Douglas, 20–29 July 2020. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological 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.

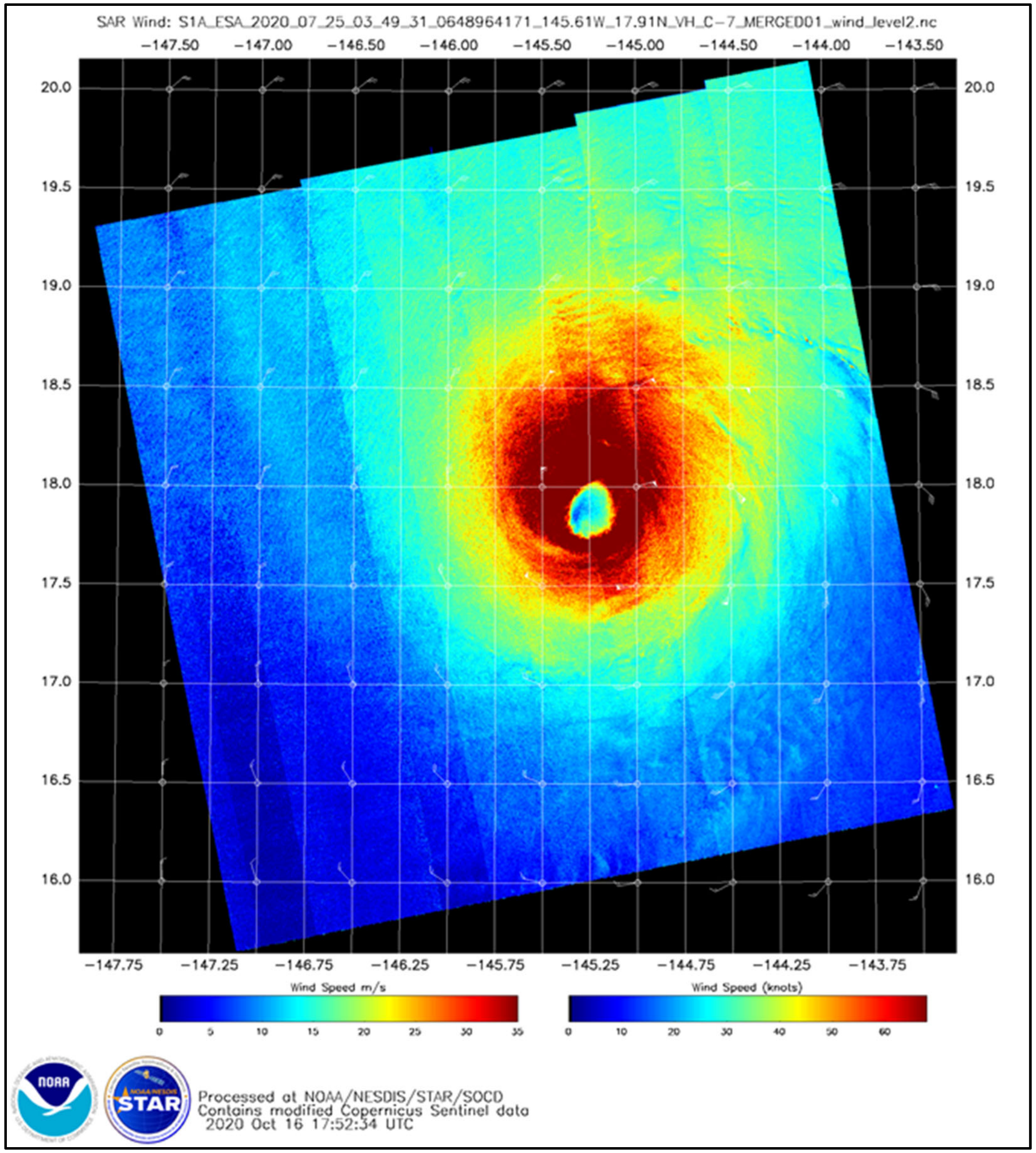

Figure 4. Synthetic Aperture Radar (SAR) image of Hurricane Douglas at 0349 UTC 25 July 2020.

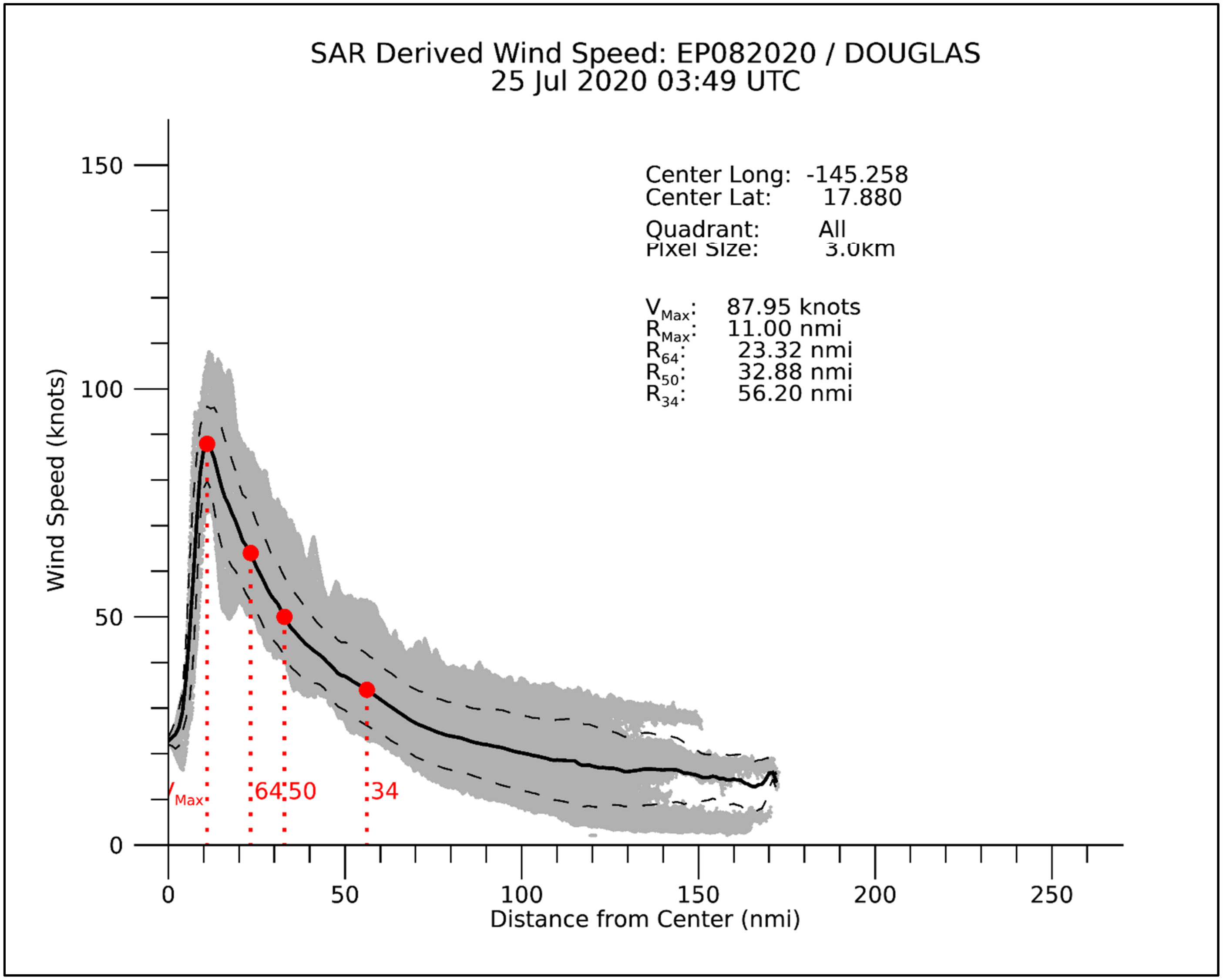

Figure 5. Synthetic Aperture Radar (SAR) derived wind speeds of Hurricane Douglas at 0349 UTC 25 July 2020.