

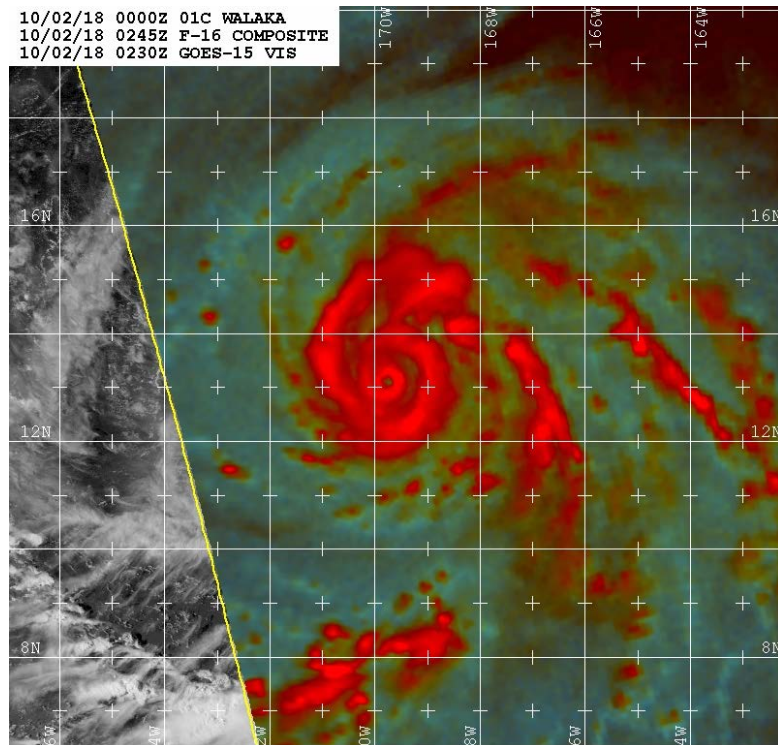


CENTRAL PACIFIC HURRICANE CENTER TROPICAL CYCLONE REPORT

HURRICANE WALAKA (CP012018)

29 September–6 October 2018

Sam Houston and Thomas Birchard
Central Pacific Hurricane Center
9 June 2020



SSMIS IMAGERY AT 0245 UTC 2 OCTOBER 2018.
IMAGE COURTESY OF THE NAVAL RESEARCH LABORATORY

Walaka was a category 5 hurricane (on the Saffir-Simpson Hurricane Wind Scale) which developed in the central North Pacific. The tropical cyclone crossed portions of the Papahānaumokuākea Marine National Monument as a category 3 hurricane.

Hurricane Walaka

29 SEPTEMBER–6 OCTOBER 2018

SYNOPTIC HISTORY

The system which later developed into Hurricane Walaka originated within a surface trough that formed just east of the Central Pacific Hurricane Center's (CPHC's) area of responsibility in late September 2018. Based on satellite imagery and scatterometer data, the disturbance remained poorly organized east of longitude 140°W. However, a small swirl of low clouds with embedded towering cumulus clouds became evident in satellite imagery just west of 140°W early on 26 September. This poorly defined feature tracked westward at 10 to 15 kt during the next 24 h south of a deep subtropical ridge located to the north of the main Hawaiian Islands. By 1200 UTC 27 September, a weak surface low was evident about 700 n mi southeast of Hilo, Hawaii. This poorly defined feature continued moving westward with little significant change during the next 36 h. Early on 29 September, a series of SSMI and SSMIS images between 1348 and 1716 UTC indicated the structure of this system was improving, and provided the location of the low-level circulation center (LLCC). Conventional infrared satellite imagery also showed this system had developed persistent deep convection near the LLCC, in addition to a well-defined banding feature within the eastern and southern quadrants when it was about 600 n mi south of Honolulu, Hawaii. Therefore, the first advisory was issued by the CPHC for this system, which was named Tropical Storm Walaka at 2100 UTC 29 September (note that this was the last name in the rotating list of tropical cyclone names for the central North Pacific, which was first used starting in 1982). In retrospect, this system had likely already acquired tropical characteristics at least 6 h earlier, so it has been reclassified as a tropical depression as of 1200 UTC 29 September in the final "best track". The "best track" chart of the tropical cyclone's path is given in Fig. 1, while the best track positions and intensities are listed in Table 1¹.

Once Walaka developed, the environment around the tropical cyclone was characterized by low vertical wind shear and deep tropical moisture, as well as sea surface temperatures (SSTs) of 29–30°C. As a result, Walaka was able to rapidly intensify during the next 24 h, and it became a hurricane by 1800 UTC 30 September (note that based on reanalysis, this is 6 h earlier than the real-time advisories indicated). This rapid intensification continued during the next 24 to 30 h, so the eye and eyewall structure was very well-defined by 2200 UTC 1 October (see Fig. 2). By 0000 UTC 2 October, Walaka's sustained winds were estimated to be around 140 kt, making Walaka the fourth major hurricane of the 2018 central North Pacific hurricane season, and remarkably, the third category 5 hurricane of the season. There was evidence that concentric eyewalls had developed around this time according to microwave imagery (as seen in the 0245 UTC 2 October SSMIS image on the cover page of this report). There were only minor fluctuations in intensity during the next 18 h, which was likely related to the inner core structure remaining in near steady state. In addition, a deep upper-level trough was digging southward over the North Pacific, which was beginning to erode the western end of the subtropical ridge. This

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

change in the steering flow caused Walaka to track toward the northwest, and then later toward the north. By 0000 UTC 3 October, the eye had become less distinct in conventional satellite imagery, and the tropical cyclone had weakened to around 115 kt. This was likely due to the completion of the eyewall replacement cycle, as well as the outflow aloft becoming somewhat restricted in the western semicircle due to increasing vertical wind shear. Starting around 1200 UTC 3 October, a large and well-defined eye was evident for 6 - 12 h, with Walaka re-intensifying to around 125 kt. After that, the hurricane began to accelerate toward the north-northeast, with increasing vertical wind shear and cooler SSTs causing a steady weakening.

By 0600 UTC 5 October, Walaka was downgraded to a tropical storm moving over the cooler waters of the central North Pacific Ocean. The system was undergoing extratropical transition about 24 h later, and was classified as a post-tropical extratropical low at 1200 UTC 6 October. This extratropical low continued moving over the open ocean with wind speeds of 35 to 45 kt until dissipation around 1800 UTC 7 October.

METEOROLOGICAL STATISTICS

Observations in Walaka include subjective satellite-based Dvorak technique intensity estimates from the Satellite Analysis Branch (SAB), CPHC, and the Joint Typhoon Warning Center (JTWC). They also include objective Advanced Dvorak Technique (ADT) estimates from the Cooperative Institute for Meteorological Satellite Studies/University of Wisconsin-Madison (CIMSS). Data and imagery from NOAA polar-orbiting satellites including the Advanced Microwave Sounding Unit (AMSU), 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 Walaka. Surface analyses and high seas forecasts issued by the Ocean Prediction Center in College Park, Maryland were useful for the portion of the final best track for Walaka after it became an extratropical low over the central North Pacific.

The peak estimated intensity of 140 kt for Walaka is based on several inputs, including subjective Dvorak satellite classifications from CPHC, SAB, and JTWC, as well as ADT estimates from CIMSS.

There were no ship reports of tropical-storm-force winds associated with Walaka while it was a tropical cyclone.

CASUALTY AND DAMAGE STATISTICS

There were no reports of casualties associated with Walaka. However, the hurricane moved rapidly toward the north-northeast across portions of the Papahānaumokuākea Marine National Monument. Its intensity was estimated to be about 110 kt (category 3) around 0620 UTC 4 October according to Table 1 ("landfall" is defined here as the approximate time the eye moved across the island chain near Brooks Banks, which is a submerged volcanic cone). About 1 h before "landfall", the eye was beginning to become elongated, but the eyewall structure remained

intact in all quadrants according to microwave imagery presented in Figure 3. Walaka's eastern eyewall moved across French Frigate Shoals in the Papahānaumokuākea Marine National Monument, which is an atoll that includes a large, crescent-shaped reef surrounding numerous small, sandy islets. While the land area is a little more than 1/8 square mile, the total coral reef area is over 460 square miles according to the web site for the Monument [<https://www.papahanaumokuakea.gov/>]. The combined effects of Walaka's storm surge and the extremely large waves caused significant sediment loss on East Island and Tern Island. In fact, East Island, which was an important nesting site for threatened green sea turtles, almost completely disappeared (see Fig. 4). While some unhatched turtle nests were likely impacted on both of these islands by the storm, scientists believed that it was unlikely adult turtles were utilizing these small land areas at the time of "landfall". The atoll is also host to endangered Hawaiian monk seals, and serves as an important "pupping site". Additional impacts from Walaka may have occurred to the west of the storm track. However, the areal extent of these impacts would likely have been much closer to the center along the path of the western eyewall.

During the summer of 2019, researchers visiting the Monument found that many of the coral reefs near French Frigate Shoals, Lisianski Island, and Pearl and Hermes Atoll showed significant amounts of damage due to the hurricane. In addition, many of the native fish populating these reefs also seemed to have "disappeared" based on observations from these scientists. More recently, some of the sediment that was displaced from Tern Island and East Island appears to be gradually returning. However, the areal coverage and depth of the sand is so low on these islands now, there is great concern about the limited number of green turtles that can currently construct viable nests.

FORECAST AND WARNING CRITIQUE

The genesis of Walaka (Table 2) was very well anticipated. The Tropical Weather Outlook (TWO) issued by CPHC indicated that the incipient disturbance had a low chance of formation (<40%) 102 h before the actual formation (i.e., the time when Walaka became a tropical depression in the final best track). The 48-h genesis probabilities were increased to the medium category (40%-60%) 54 h before genesis, and were then increased to the high category (>60%) 36 h before formation occurred.

A verification of CPHC official track forecasts for Walaka is given in Table 3a. Official track forecast errors were lower than the mean official errors for the previous 5-yr period for all forecast times. A homogeneous comparison of the official track errors with selected guidance models is given in Table 3b. The corrected consensus models, TVCE and TVCN, had lower errors compared with the official track forecasts during the 12 to 72 h forecast times. The GFS and ECMWF models, as well as the TVCX and GFEX consensus models, had lower errors during the 12 to 48 forecast times. Additional models which did well for a few forecast times, include the UKMET (i.e., the EGRI) model and the GFS ensemble mean during 24 to 48 h forecast times, the HMON during the 48 to 72 h forecast times, and the FSSE during the 48 and 96 h forecast times.



A verification of CPHC official intensity forecasts for Walaka is shown in Table 4a. Official intensity forecast errors were lower than the mean official errors for the previous 5-yr period for the 72 to 120 h forecast times. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 4b. The HWRF model had lower errors compared with the official intensity forecasts during the 12 to 96 h forecast times, while the FSSE had lower errors during the 24 to 96 h forecast times. The corrected consensus models, ICON and IVCN, had lower intensity errors during the 36 to 120 h forecast times.

At 1500 UTC September 30, a Hurricane Watch was issued for Johnston Atoll (see Table 5). The Hurricane Watch was upgraded to a Hurricane Warning at 0600 UTC 1 October. A crew of four scientists located on the atoll were evacuated by the U.S. Coast Guard in advance of the tropical cyclone's arrival. The Hurricane Warning for Johnston Atoll was discontinued at 1500 UTC 3 October after the outer circulation of Walaka passed by the area.

A Hurricane Watch was issued at 0300 UTC 2 October for portions of the Papahānaumokuākea Marine National Monument from Nihoa to French Frigate Shoals to Maro Reef (see Table 5). A Hurricane Warning was issued 18 h later from French Frigate Shoals to Maro Reef. In addition, a Tropical Storm Warning was issued from Nihoa to French Frigate Shoals. That same day, seven researchers studying Hawaiian monk seals and green sea turtles on French Frigate Shoals were evacuated to Honolulu, Hawaii. Once Walaka's core had moved north of the Papahānaumokuākea Marine National Monument, the Hurricane Warning was changed to a Tropical Storm Warning at 0300 UTC 4 October from French Frigate Shoals to Maro Reef. All tropical cyclone warnings were discontinued at 2100 UTC 4 October once Walaka moved away from the region, and conditions began to improve. Based on the 34-kt wind radii in the northern semicircle of Walaka, it appears that the onset of tropical-storm-force winds was approximately 2100 UTC 3 October near French Frigate Shoals. Therefore, the Hurricane Watch was issued about 42 h before the onset of 34 kt winds, while the Hurricane Warning was issued about 24 h in advance of the arrival of these winds.



Table 1. Best track for Hurricane Walaka in the central North Pacific, 29 September–6 October 2018.

| Date/Time (UTC) | Latitude (°N) | Longitude (°W) | Pressure (mb) | Wind Speed (kt) | Stage |
|-----------------|---------------|----------------|---------------|-----------------|---------------------|
| 29/1200 | 11.7 | 157.1 | 1006 | 30 | tropical depression |
| 29/1800 | 11.6 | 158.6 | 1005 | 35 | tropical storm |
| 30/0000 | 11.6 | 160.0 | 1003 | 40 | “ |
| 30/0600 | 11.6 | 161.5 | 1000 | 50 | “ |
| 30/1200 | 11.6 | 163.0 | 998 | 60 | “ |
| 30/1800 | 11.6 | 164.5 | 995 | 65 | hurricane |
| 01/0000 | 11.7 | 166.0 | 985 | 75 | “ |
| 01/0600 | 11.8 | 167.1 | 970 | 90 | “ |
| 01/1200 | 12.0 | 168.0 | 955 | 110 | “ |
| 01/1800 | 12.5 | 168.8 | 935 | 130 | “ |
| 02/0000 | 12.9 | 169.6 | 921 | 140 | “ |
| 02/0600 | 13.5 | 169.9 | 921 | 140 | “ |
| 02/1200 | 14.2 | 170.0 | 927 | 135 | “ |
| 02/1800 | 15.1 | 170.2 | 935 | 130 | “ |
| 03/0000 | 16.1 | 170.3 | 946 | 115 | “ |
| 03/0600 | 17.4 | 170.1 | 946 | 115 | “ |
| 03/1200 | 18.8 | 169.7 | 938 | 125 | “ |
| 03/1800 | 20.5 | 169.0 | 942 | 120 | “ |
| 04/0000 | 22.2 | 168.1 | 946 | 115 | “ |
| 04/0600 | 24.0 | 166.9 | 950 | 110 | “ |
| 04/1200 | 25.9 | 166.2 | 954 | 100 | “ |
| 04/1800 | 28.0 | 166.3 | 969 | 85 | “ |
| 05/0000 | 29.7 | 167.5 | 981 | 65 | “ |
| 05/0600 | 30.5 | 168.3 | 985 | 60 | tropical storm |
| 05/1200 | 30.9 | 168.3 | 987 | 55 | “ |
| 05/1800 | 31.8 | 168.1 | 989 | 50 | “ |
| 06/0000 | 32.6 | 167.1 | 992 | 45 | “ |



| | | | | | |
|---------|------|-------|------|-----|---|
| 06/0600 | 33.5 | 165.9 | 992 | 45 | “ |
| 06/1200 | 35.1 | 164.5 | 994 | 45 | extratropical |
| 06/1800 | 36.9 | 163.0 | 998 | 45 | “ |
| 07/0000 | 39.7 | 160.6 | 1004 | 45 | “ |
| 07/0600 | 44.4 | 158.3 | 1004 | 45 | “ |
| 07/1200 | 47.8 | 155.1 | 1008 | 35 | “ |
| 07/1800 | | | | | dissipated |
| 02/0000 | 12.9 | 169.6 | 921 | 140 | maximum wind |
| 04/0620 | 24.1 | 166.8 | 950 | 110 | “Landfall” about 31 n mi WNW of French Frigate Shoals |

Table 2. Number of hours in advance of tropical cyclone formation associated with the first CPHC 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, and these values are based on when Walaka initially became a tropical depression in the final best track.

| | Hours Before Genesis | |
|------------------|----------------------|------------------|
| | 48-Hour Outlook | 120-Hour Outlook |
| Low (<40%) | 102 | 108 |
| Medium (40%-60%) | 54 | 102 |
| High (>60%) | 36 | 60 |



Table 3a. CPHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Hurricane Walaka. 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 | 25.5 | 37.9 | 50.1 | 60.8 | 64.7 | 83.8 | 66.4 |
| OCD5 | 58.8 | 146.9 | 254.7 | 349.7 | 677.9 | 919.4 | 1023.8 |
| Forecasts | 25 | 23 | 21 | 19 | 15 | 11 | 7 |
| OFCL (2013-17) | 28.2 | 43.2 | 58.0 | 75.6 | 121.0 | 163.2 | 208.4 |

Table 3b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Hurricane Walaka. Errors smaller than the CPHC 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 | 25.5 | 37.9 | 50.1 | 60.8 | 64.7 | 83.8 | 66.4 |
| OCD5 | 58.8 | 146.9 | 254.7 | 349.7 | 677.9 | 919.4 | 1023.8 |
| GFSI | 23.6 | 29.1 | 40.5 | 52.4 | 78.7 | 132.2 | 138.7 |
| EMXI | 24.3 | 33.0 | 44.8 | 57.5 | 98.9 | 169.8 | 173.5 |
| EGRI | 27.0 | 32.5 | 38.1 | 43.9 | 89.5 | 168.8 | 208.1 |
| CMCI | 33.6 | 48.9 | 52.9 | 47.1 | 105.8 | 152.8 | 245.6 |
| HWFI | 29.6 | 51.8 | 71.0 | 76.1 | 75.6 | 101.2 | 235.7 |
| HMNI | 27.4 | 45.3 | 51.7 | 44.2 | 55.6 | 90.0 | 145.1 |
| TVCN | 21.8 | 31.3 | 41.0 | 44.8 | 64.3 | 115.6 | 126.4 |
| TVCE | 22.6 | 33.1 | 41.4 | 44.0 | 59.7 | 98.0 | 105.5 |
| TVCX | 20.7 | 30.0 | 39.9 | 44.8 | 65.2 | 111.3 | 119.6 |
| GFEX | 21.8 | 27.0 | 35.7 | 46.9 | 68.3 | 100.4 | 97.0 |
| FSSE | 26.0 | 53.5 | 73.1 | 57.3 | 66.6 | 81.5 | 86.4 |
| AEMI | 25.7 | 32.6 | 46.9 | 58.4 | 65.5 | 103.4 | 129.6 |
| TABS | 53.1 | 100.1 | 131.0 | 122.1 | 167.1 | 225.1 | 340.9 |
| TABM | 33.8 | 83.8 | 143.6 | 127.6 | 97.7 | 155.8 | 176.0 |
| TABD | 24.2 | 87.3 | 173.6 | 191.2 | 156.7 | 222.0 | 224.4 |
| Forecasts | 25 | 23 | 21 | 19 | 15 | 11 | 7 |

Table 4a. CPHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (in kt) for Hurricane Walaka. 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 | 9.2 | 12.6 | 14.5 | 14.2 | 12.0 | 16.4 | 11.4 |
| OCD5 | 14.6 | 21.6 | 27.0 | 27.3 | 40.3 | 37.5 | 10.1 |
| Forecasts | 25 | 23 | 21 | 19 | 15 | 11 | 7 |
| OFCL (2013-17) | 5.6 | 9.0 | 11.3 | 12.9 | 15.7 | 17.4 | 18.9 |

Table 4b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Hurricane Walaka. Errors smaller than the CPHC 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 | 72 | 96 | 120 |
| OFCL | 9.2 | 12.6 | 14.5 | 14.2 | 12.0 | 16.4 | 11.4 |
| OCD5 | 14.6 | 21.6 | 27.0 | 27.3 | 40.3 | 37.5 | 10.1 |
| DSHP | 10.7 | 13.8 | 12.6 | 12.1 | 12.8 | 19.6 | 10.9 |
| LGEM | 10.0 | 14.0 | 14.1 | 15.0 | 8.0 | 7.3 | 7.1 |
| HWFI | 8.4 | 10.1 | 10.3 | 10.7 | 7.0 | 9.8 | 15.1 |
| HMNI | 11.8 | 16.8 | 17.9 | 19.4 | 15.7 | 18.2 | 9.4 |
| ICON | 9.5 | 12.8 | 12.1 | 11.8 | 7.3 | 12.0 | 7.7 |
| IVCN | 9.5 | 12.3 | 12.2 | 11.2 | 5.4 | 11.2 | 7.4 |
| FSSE | 9.8 | 10.9 | 10.4 | 10.0 | 6.8 | 6.5 | 13.0 |
| GFSI | 11.2 | 17.6 | 23.0 | 24.5 | 20.8 | 20.2 | 11.1 |
| EMXI | 14.3 | 22.3 | 27.7 | 31.9 | 27.5 | 20.1 | 4.7 |
| Forecasts | 25 | 23 | 21 | 19 | 15 | 11 | 7 |



Table 5. Wind watch and warning summary for Hurricane Walaka.

| Date/Time (UTC) | Action | Location |
|------------------------|-------------------------------------|---|
| 30 / 1500 | Hurricane Watch issued | Johnston Atoll |
| 01 / 0600 | Hurricane Warning issued | Johnston Atoll |
| 02 / 0300 | Hurricane Watch issued | Nihoa to French Frigate Shoals to Maro Reef |
| 02 / 2100 | Hurricane Warning issued | French Frigate Shoals to Maro Reef |
| 02 / 2100 | Tropical Storm Warning issued | Nihoa to French Frigate Shoals |
| 03 / 1500 | Hurricane Warning discontinued | Johnston Atoll |
| 04 / 0300 | Hurricane Warning discontinued | French Frigate Shoals to Maro Reef |
| 04 / 0300 | Tropical Storm Warning issued | French Frigate Shoals to Maro Reef |
| 04 / 2100 | Tropical Storm Warning discontinued | Nihoa to French Frigate Shoals to Maro Reef |

Figure 1. Best track positions for Hurricane Walaka, 29 September–6 October 2018.

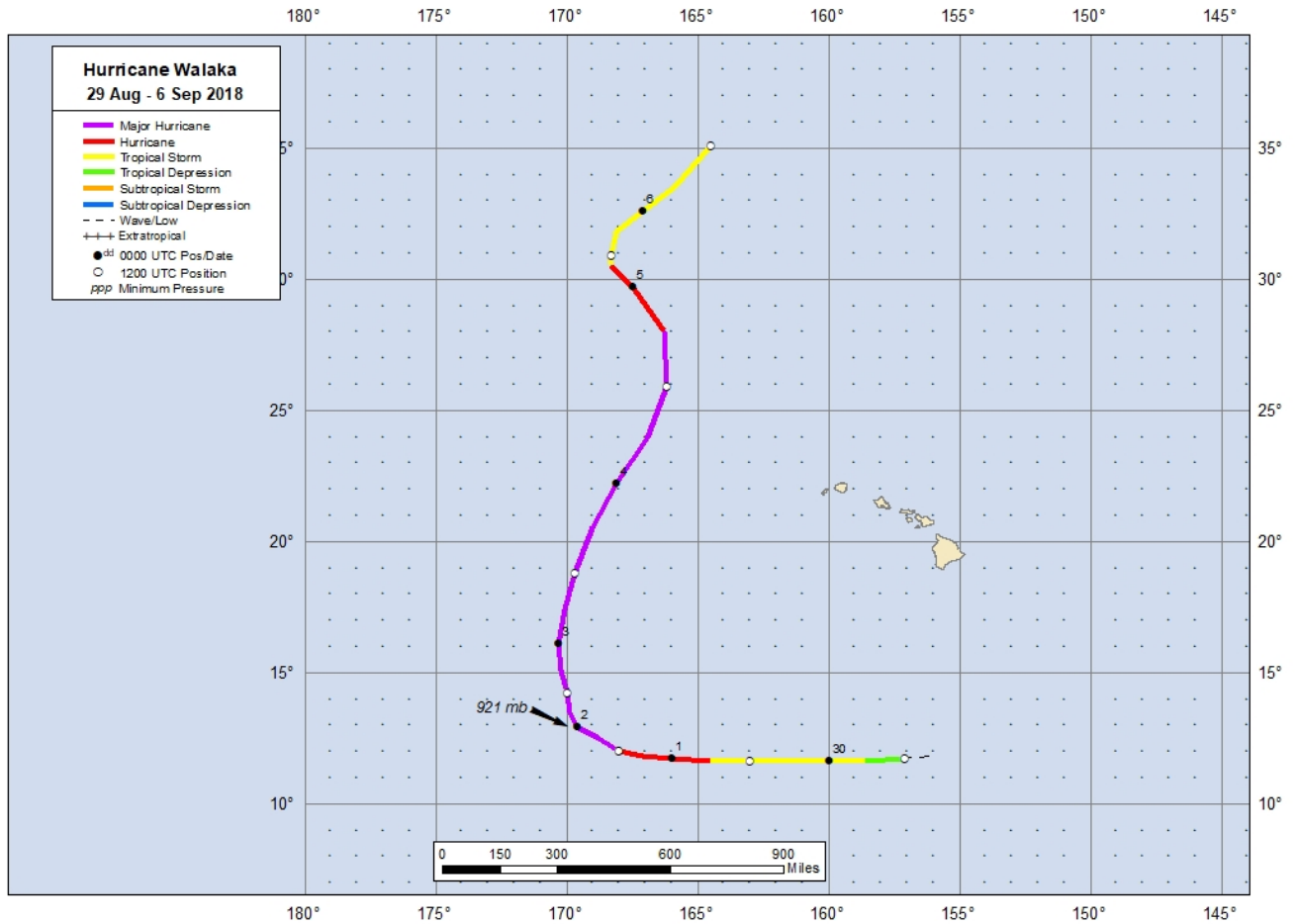


Figure 2. GOES-15 infrared satellite image of Hurricane Walaka at 2200 UTC 1 October 2018. The image shows Walaka in relation to French Frigate Shoals (also, note the main Hawaiian Islands located to the northeast of the hurricane). [Image generated by N. Hui and S. Houston, CPHC/NWS/NOAA].

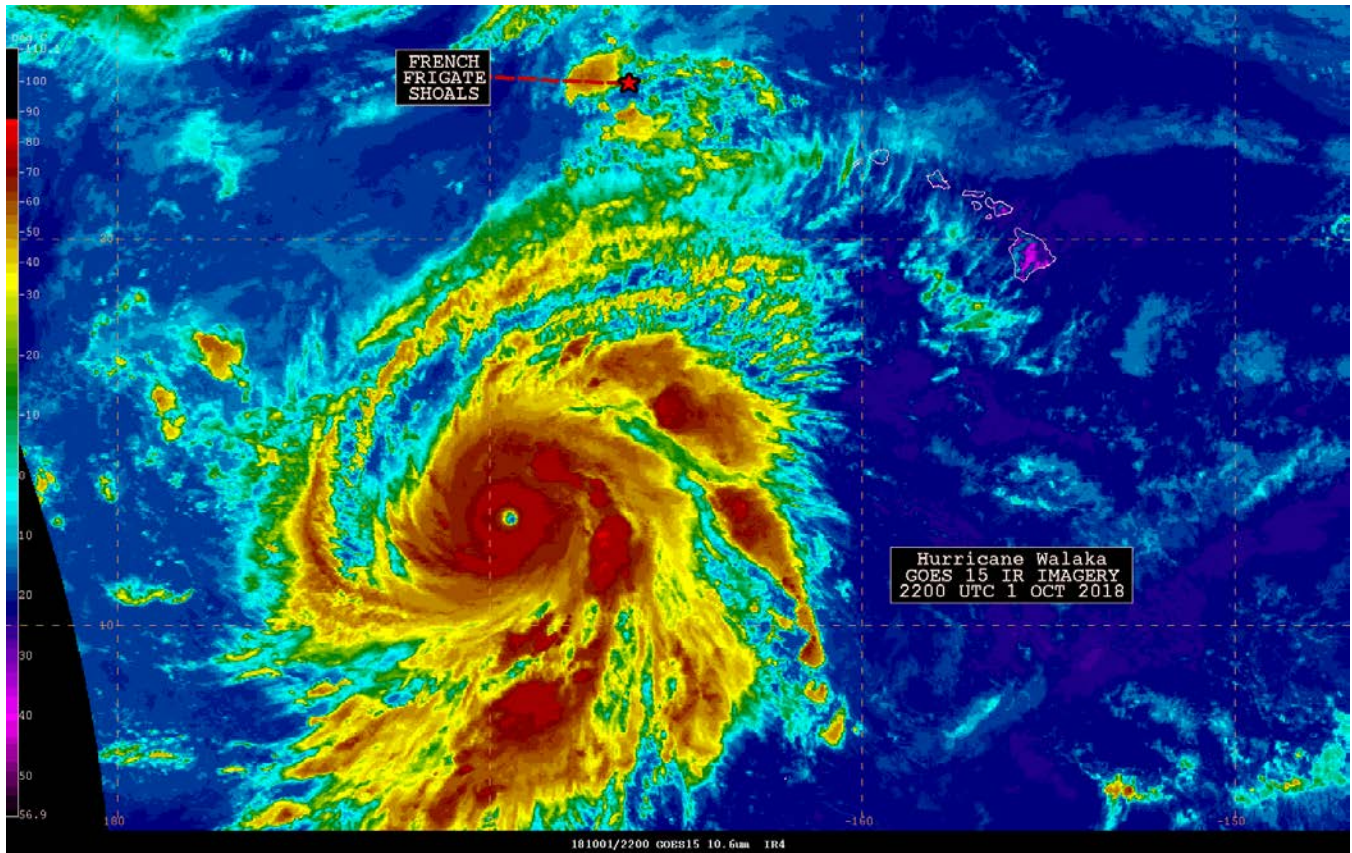


Figure 3. SSMIS color microwave image of Hurricane Walaka at 0517 UTC 4 October 2018 just before the time of landfall west of French Frigate Shoals. Note: the islands of Kauai and Niihau are shown along the right hand side of the image. [Image courtesy of the Naval Research Laboratory, Monterey, CA].

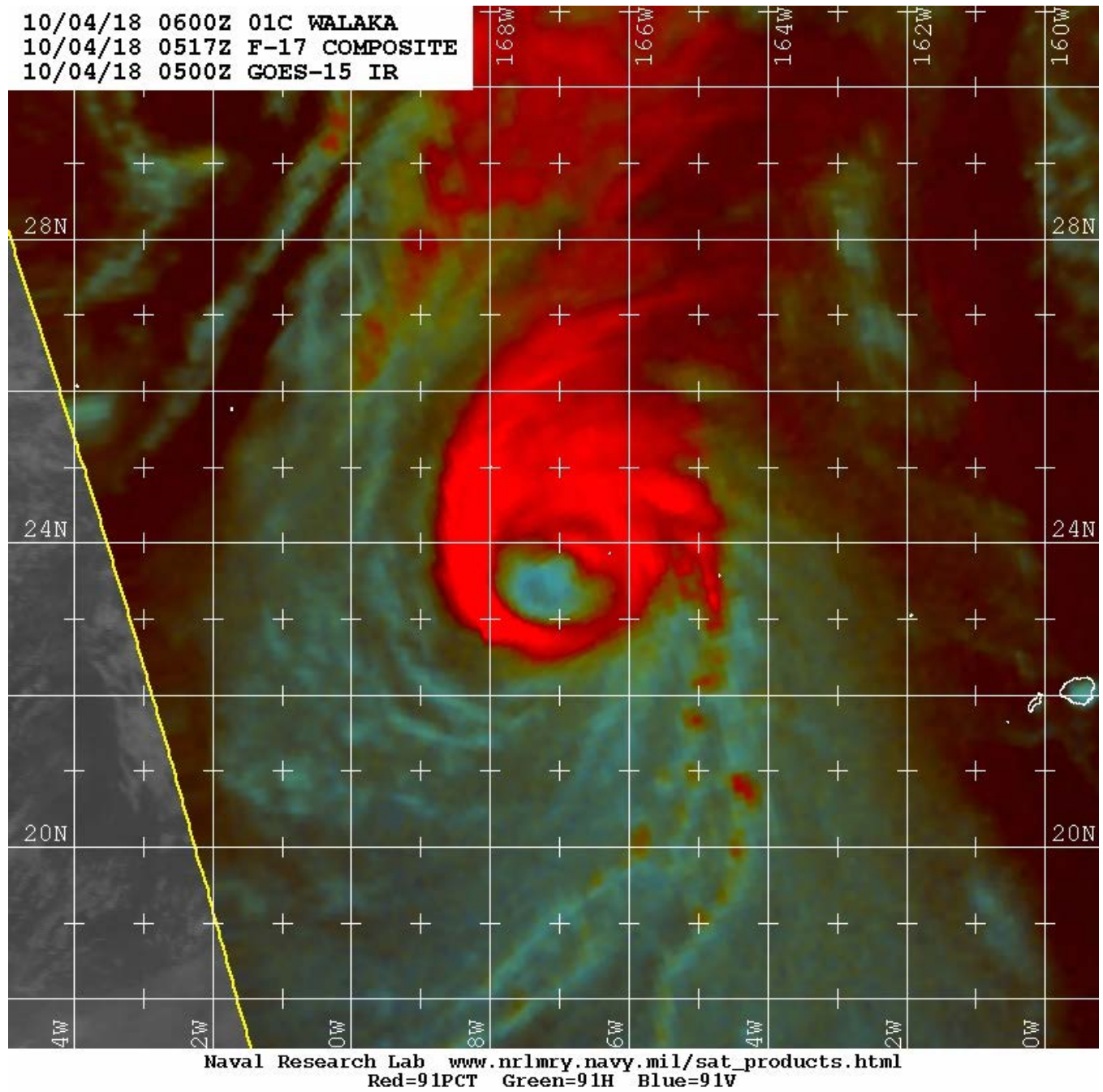


Figure 4. Photos showing the sediment on East Island during the late spring of 2018 compared with the almost complete lack of sediment after Walaka's eastern eyewall crossed the area in October 2018 [Image courtesy of the U.S. Fish and Wildlife Service].

