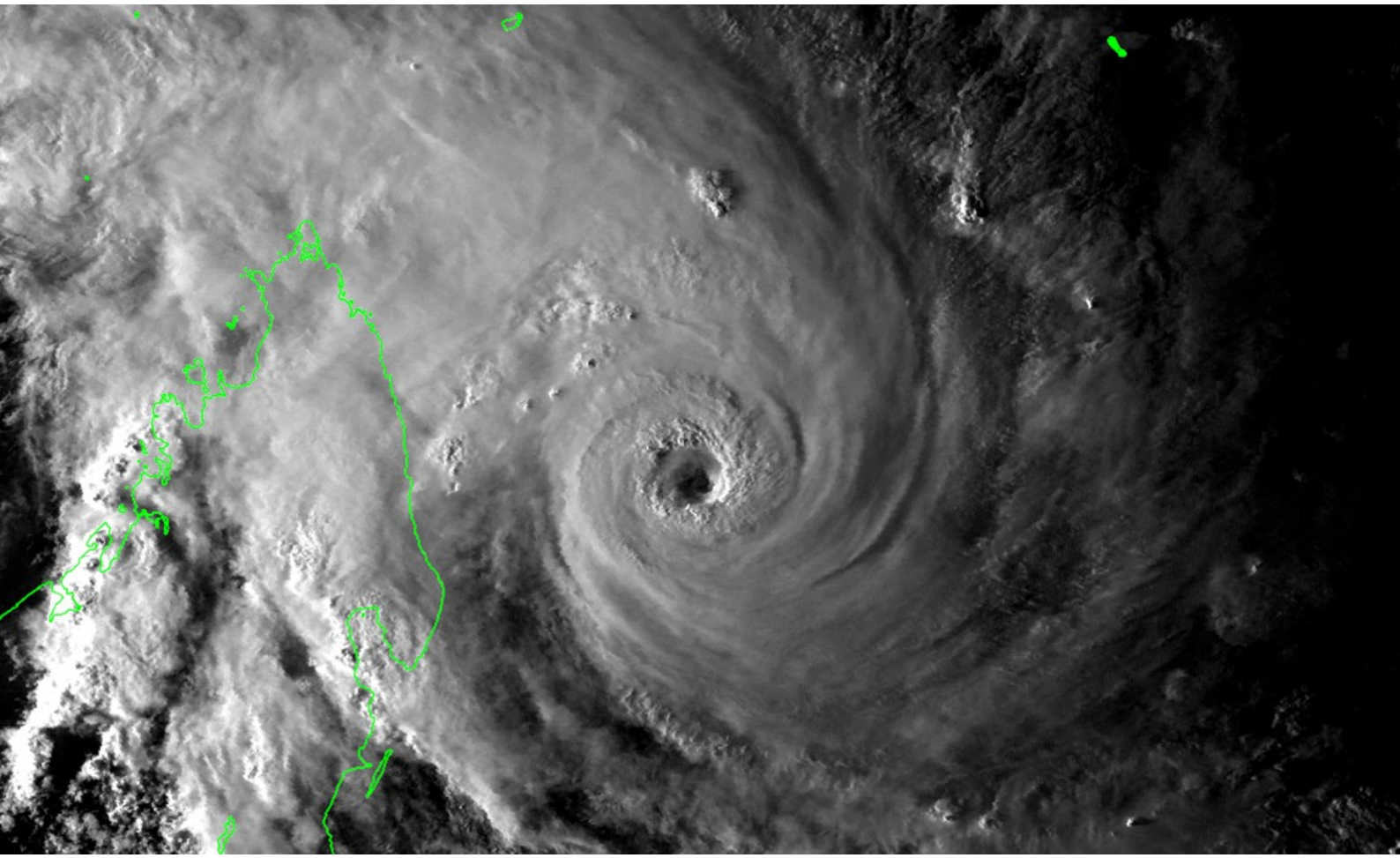
2017

Force Thirteen Cyclone Reports

Cyclone Enawo (201707)



Cyclone Enawo was the strongest storm to make landfall in Madagascar since Cyclone Gafilo of 2004. Enawo was the 25th most intense and 20th strongest storm in the basin.

Compiled by Nathan Foy at Force Thirteen, March 15, 2017
Amended on March 16, 2017
Direct contact: force-13@hotmail.co.uk

Cover photo: INSAT-3D image of Cyclone Enawo near peak intensity late on March 6th.

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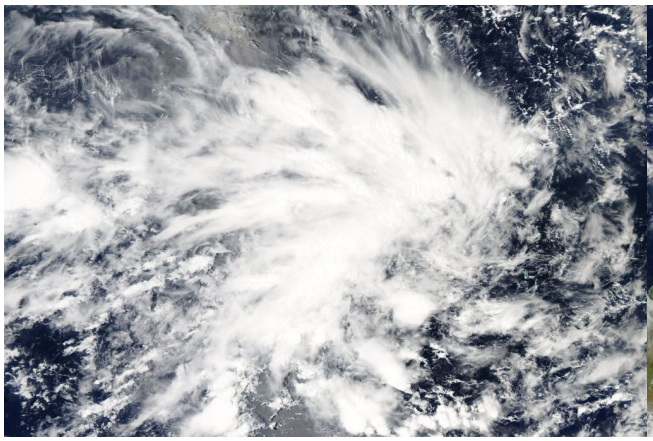
1.1. Synoptic History

On February 27th, a disorganised area of tropical thunderstorms were located near Diego Garcia in the Southern Indian Ocean, and progressed generally southwestwards over the following days. As rotation increased the next day, convection waned. The system fought with wind shear over the next few days and began displaying elevated cloud tops by March 2nd and began to show a comma type appearance, with outflow gradually increasing until March 3rd when the leading edge of the storm's influence reached the Mascarene islands. Despite this, the system still hadn't reached tropical storm status until later that day.

For the next day, Enawo displayed very high cloud tops and intense periods of convective activity, though not always above the center of the storm. By early on March 5th the system consolidated and an eye feature began to develop, reaching hurricane status later that day. They eye remained poor and ragged for nearly 24 hours before establishing a complete eyewall, allowing the eye to become more pronounced and deeper, reaching its epitome late on March 6th when Enawo had an eye temperature of around 20 degrees Celsius with cloud tops in the eyewall of between -72 and -83 degrees Celsius, conditions which would normally denote a Category 5 storm. However, since Enawo did not sustain this appearance for a long time, Force Thirteen's post-analysis keeps Enawo at Category 4 intensity.

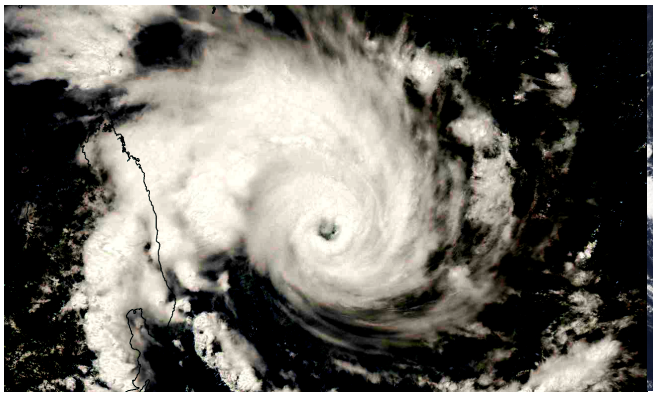
Enawo had complications with its western eyewall either due to land interaction, dry air intrusion or wind shear as it neared Madagascar, and thus missed out on further intensification. The storm took approximately 10 hours to traverse the final 100 miles before landfall, and was already in the process of rapidly weakening by the time landfall occurred. In the first hours after landfall, Enawo executed a clockwise loop in its track, briefly emerging once more off the coast. The center of the storm remained well defined as it moved inland during the day, not straying too far from the coastline.

Enawo briefly regained tropical storm intensity after moving off the southern coast of Madagascar, and attained 60mph winds before turning extratropical and merging with another storm on March 12th.

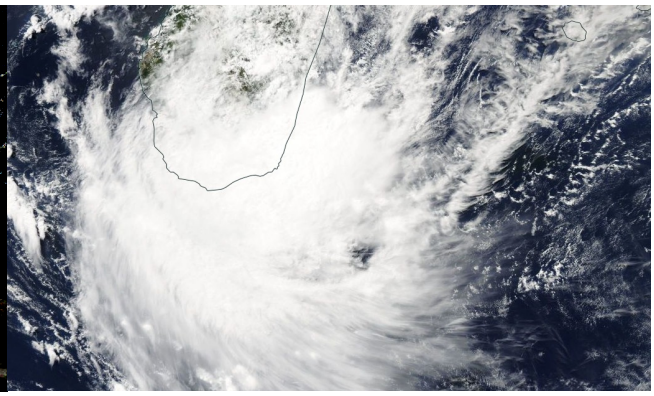


February 28th

March 5th



March 6th



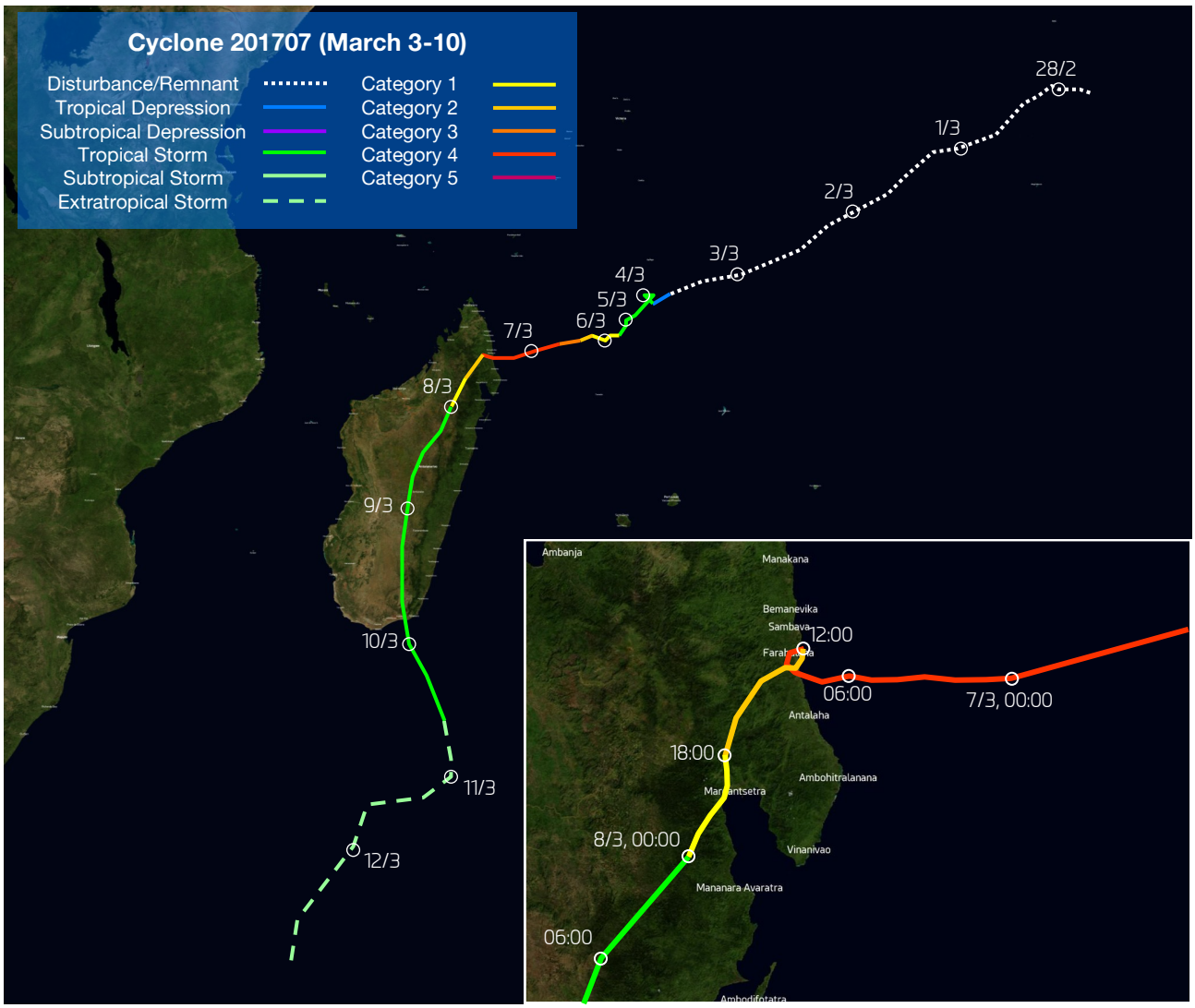
March 9th

1.2. Best Track

Below is the best track analysis from Force Thirteen, using Force Thirteen's SATOPS—a tool which uses infrared satellite imagery and cloud temperatures to estimate a storm's wind speed and air pressure. SATOPS does not take precedence over surface observations.

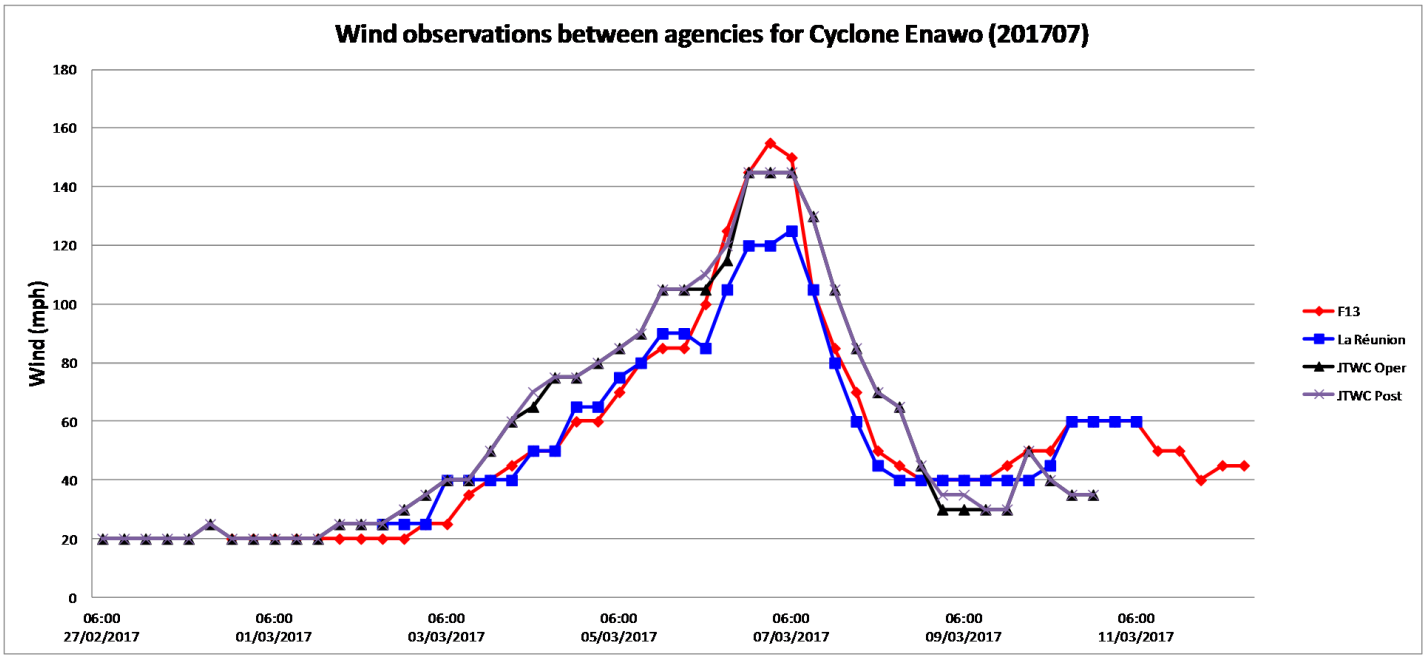
Date (dd/mm/yyyy)	Time	Latitude	Longitude	Wind	Pressure	Stage
27/02/2017	06:00	-6	73			Tropical Disturbance
27/02/2017	12:00	-5.5	72.5			Tropical Disturbance
27/02/2017	18:00	-5.6	72.4			Tropical Disturbance
28/02/2017	00:00	-5.6	72.2			Tropical Disturbance
28/02/2017	06:00	-5.2	71.8			Tropical Disturbance
28/02/2017	12:00	-5.8	71.5			Tropical Disturbance
28/02/2017	18:00	-6.8	69.9	20	1010	Tropical Disturbance
01/03/2017	00:00	-7.9	69	20	1010	Tropical Disturbance
01/03/2017	06:00	-8	68.2	20	1010	Tropical Disturbance
01/03/2017	12:00	-8.3	67.8	20	1010	Tropical Disturbance
01/03/2017	18:00	-9.1	67.1	20	1010	Tropical Disturbance
02/03/2017	00:00	-9.7	66.8	20	1009	Tropical Disturbance
02/03/2017	06:00	-10.8	63	20	1008	Tropical Disturbance
02/03/2017	12:00	-11.7	62	20	1008	Tropical Disturbance
02/03/2017	18:00	-12.1	58.3	20	1009	Tropical Disturbance
03/03/2017	00:00	-12.4	57.4	25	1007	Tropical Disturbance
03/03/2017	06:00	-12.7	56.8	25	1003	Tropical Disturbance
03/03/2017	12:00	-13.2	56.6	35	999	Tropical Depression
03/03/2017	18:00	-12.8	56.2	40	997	Tropical Storm
04/03/2017	00:00	-12.8	56.4	45	994	Tropical Storm
04/03/2017	06:00	-13.1	56.2	50	993	Tropical Storm
04/03/2017	12:00	-13.2	55.9	50	991	Tropical Storm
04/03/2017	18:00	-13.4	55.7	60	990	Tropical Storm
05/03/2017	00:00	-13.5	55.6	60	986	Tropical Storm
05/03/2017	06:00	-13.6	55.6	70	978	Tropical Storm
05/03/2017	12:00	-13.9	55.4	80	972	Category 1
05/03/2017	18:00	-13.9	55	85	965	Category 1
06/03/2017	00:00	-14.1	54.2	85	966	Category 1
06/03/2017	06:00	-14	53.9	100	963	Category 2
06/03/2017	12:00	-14.2	53.1	125	954	Category 3
06/03/2017	18:00	-14.4	52.4	145	945	Category 4
07/03/2017	00:00	-14.6	51.5	155	925	Category 4
07/03/2017	06:00	-14.6	50.6	150	929	Category 4
07/03/2017	12:00	-14.5	50.2	105	950	Category 2
07/03/2017	18:00	-15.4	49.6	85	965	Category 1
08/03/2017	00:00	-16	49.2	70	975	Tropical Storm
08/03/2017	06:00	-16.6	48.6	50	986	Tropical Storm
08/03/2017	12:00	-17.5	47.5	45	993	Tropical Storm
08/03/2017	18:00	-18	46.8	40	995	Tropical Storm
09/03/2017	00:00	-19.8	46.3	40	996	Tropical Storm
09/03/2017	06:00	-21.4	45.9	40	997	Tropical Storm
09/03/2017	12:00	-23.2	45.9	40	998	Tropical Storm
09/03/2017	18:00	-25.2	46.4	45	996	Tropical Storm
10/03/2017	00:00	-26.1	46.8	50	994	Tropical Storm
10/03/2017	06:00	-27.1	48.1	50	992	Tropical Storm
10/03/2017	12:00	-29.5	49.2	60	990	Extratropical
10/03/2017	18:00	-31.6	49.7	60	988	Extratropical
11/03/2017	00:00	-31.8	49.7	60	987	Extratropical
11/03/2017	06:00	-32.2	48.3	60	986	Extratropical
11/03/2017	12:00	-32.4	46.7	50	989	Extratropical
11/03/2017	18:00	-32.5	45.7	50	991	Extratropical
12/03/2017	00:00	-34.5	45.5	40	994	Extratropical
12/03/2017	06:00	-38.3	42.8	45	997	Extratropical
12/03/2017	12:00	-39.5	42.4	45	996	Extratropical

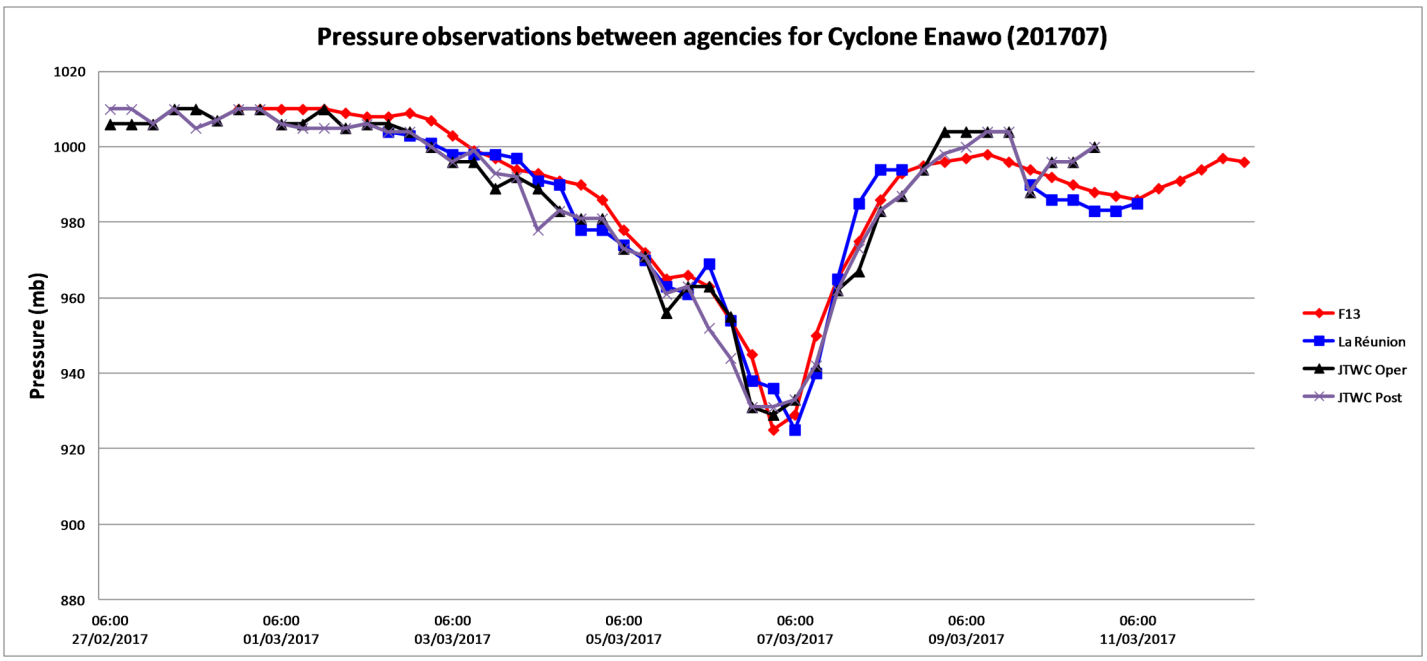
1.3. Track Chart



1.4. Comparison with other agencies

Enawo was monitored by the Regional Specialized Meteorological Centre at La Réunion, and by the U.S. Joint Typhoon Warning Center (JTWC). Below shows comparisons between all three agencies, along with the JTWC's operational vs post-analysed intensities.





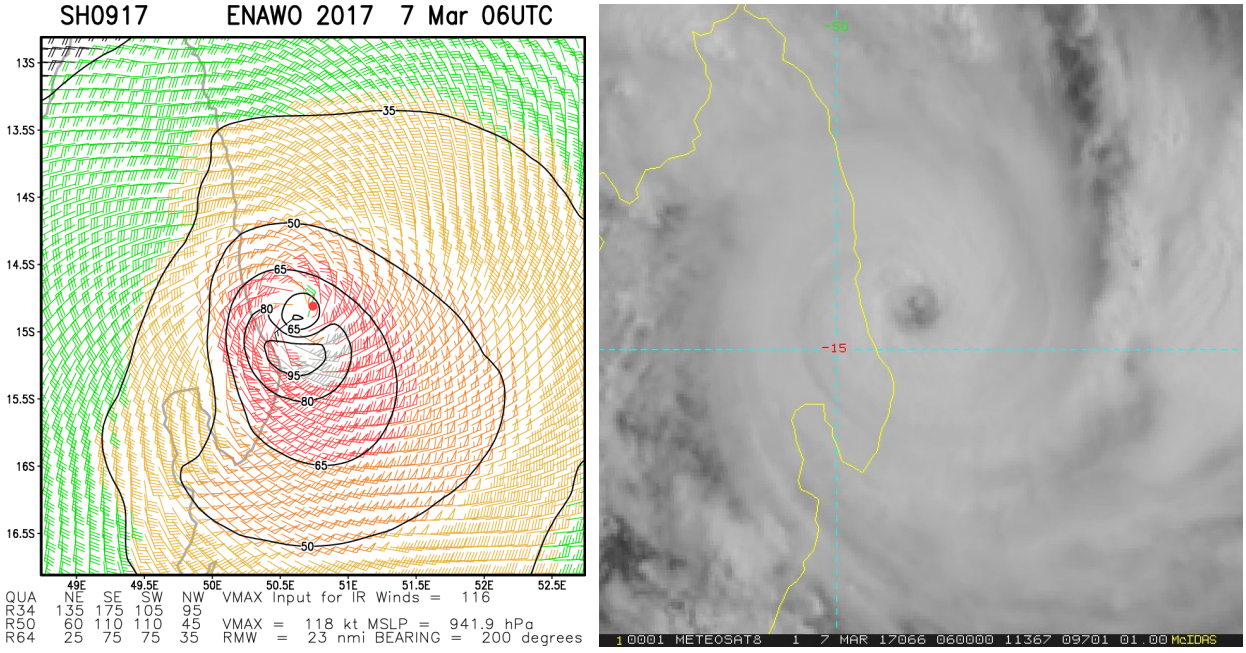
2. Effects on Land

Apart from Madagascar, Cyclone Enawo never affected any other land areas as a tropical cyclone, though it initially formed near Diego Garcia. Wind and pressure reports on land are not yet available, and so only rainfall reports are listed below. As of March 16, Enawo has caused 51 fatalities, with 21 still missing, and 238 injuries. The storm has affected over 250,000 people, with 110,000 evacuated at the height of the storm's aftermath.
Some inland locations of Madagascar reached rainfall totals of up to 250mm (10 inches). Most locations along the east coast received over 75mm (3 inches).

Satellite-derived rainfall observations:

Madagascar

Mahanoro	180mm		
Fenoarivo Atsinanana	150mm	Bemanevika	100mm
Manantenina	150mm	Ambohitralanana	90mm
Ambilobe	140mm	Antsirana	90mm
Brickaville	140mm	Manakara	90mm
Farafangana	140mm	Mananara Avaratra	90mm
Mananjary	140mm	Ambaritsatrana	80mm
Ambanja	130mm	Ambodifotatra	80mm
Antananarivo	130mm	Antalaha	80mm
Antsohihy	130mm	Boriziny	80mm
Fanambana	130mm	Farahalana	80mm
Vohemar	130mm	Vangaindrano	80mm
Toamasina	120mm	Manakana	70mm
Tolanaro	120mm	Maroantsetra	70mm
Analalava	110mm	Vinanivao	60mm



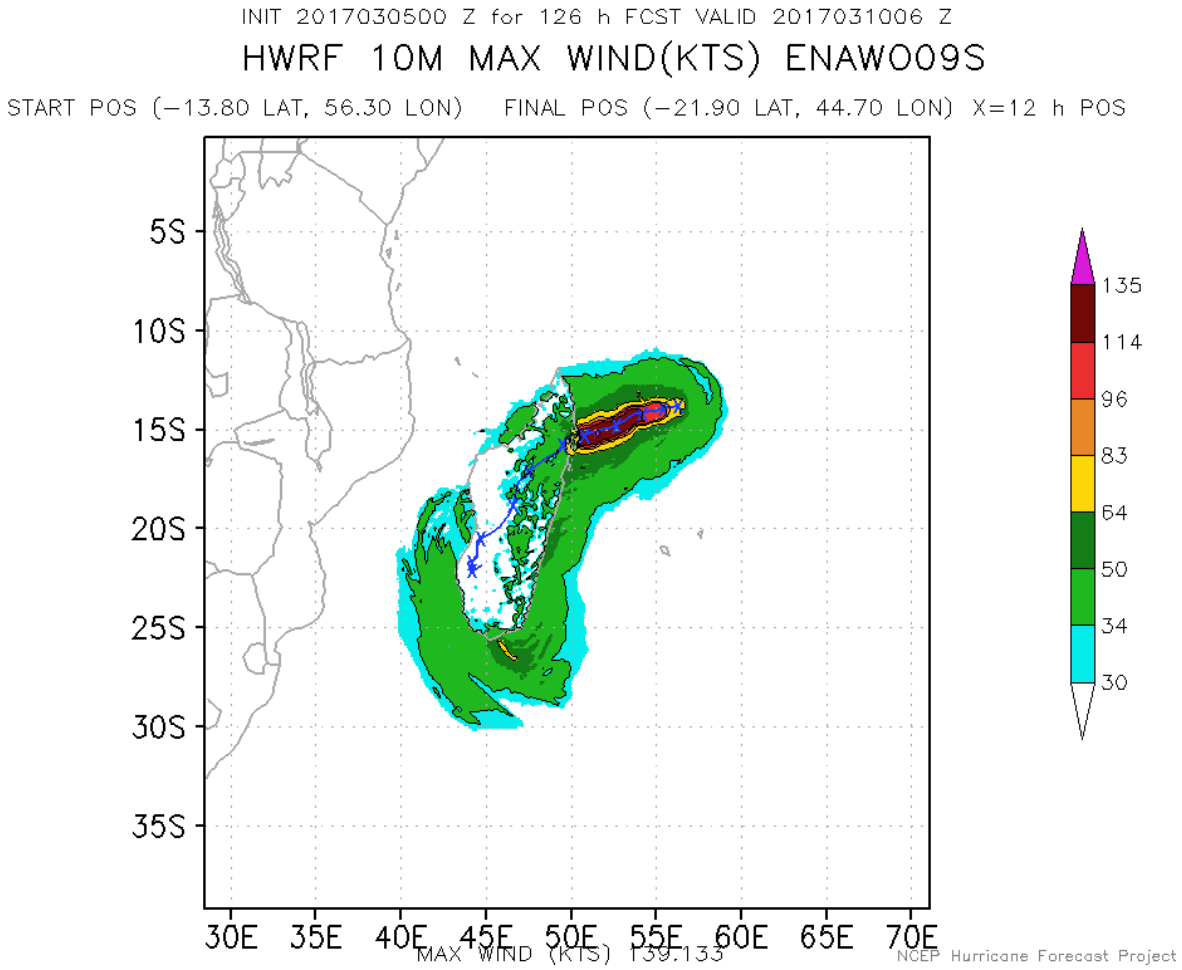
Satellite estimated winds and visible satellite image of Cyclone Enawo near peak intensity.

3. Forecasting Critique

Initially, computer models predicted that the storm would move much further east than it did, affecting the Mascarene islands as a significant storm. Models trended west in the days before Enawo was named. Notable model runs came from the GFS, which at one point predicted that Enawo would reach a pressure of 871mb. The GFDL was again an early leader in the model runs, predicting a Madagascar landfall as early as March 2nd, a day before other models picked up on the possibility.

By the time Enawo was named and forecasts were issued by the various organisations, models were in fair agreement over the approximate location of the storm's landfall, though not with its intensity. Early intensity forecasts were too conservative with the storm, predicting a Category 2 or 3 landfall. Force Thirteen's forecasts finally predicted a Category 4 landfall, twelve hours before verification. RSMC La Réunion never regarded Enawo as a Category 4 storm, and thus did not predict it.

The best performing computer model for intensity was probably the HWRF, which also produced the best track forecasts from 48 hours prior to landfall onwards.

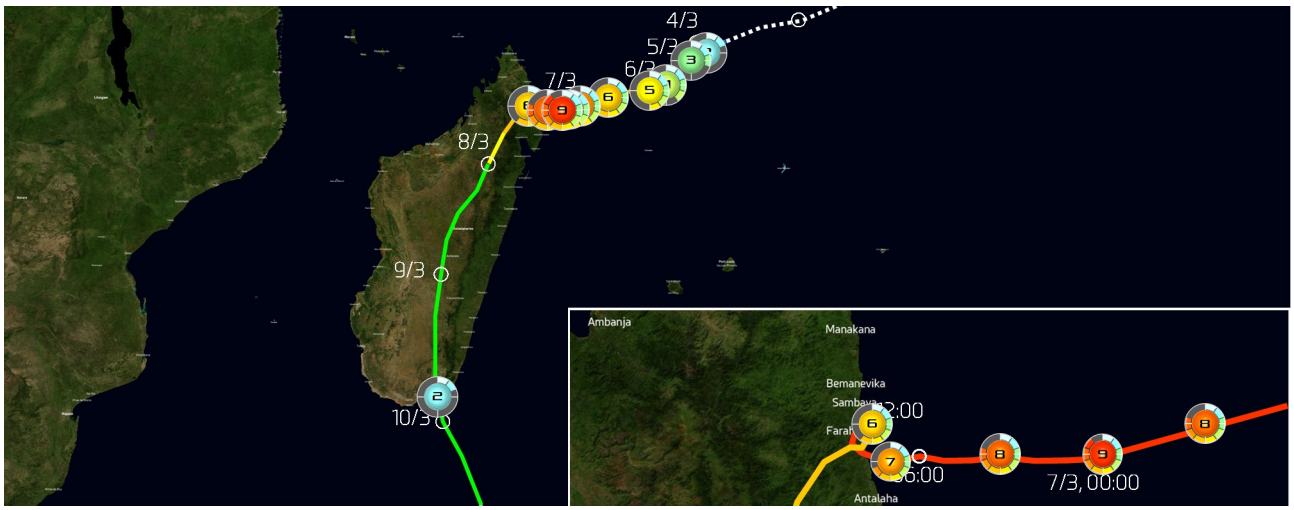


HWRF model run forecast 54 hours before the storm made landfall in Madagascar.

4. Cyclone Destruction Potential Scale

The Cyclone Destruction Potential Scale (CDPS) is a new way of measuring cyclone impacts in a more meaningful way. For the past 45 years, storms worldwide have been measured using the Saffir-Simpson Hurricane Wind Scale, split into five categories. However, this scale measures wind alone, and does not correlate well with actual impacts on land, measured by monetary damage.
The CDPS measures other factors, such as storm size and forward speed as well as intensity to create a ten tiered scale that encompasses tropical storms as well as hurricanes.

Stage 1—Small or weak storms that are unlikely to cause a significant impact.
Stage 2—Generally disorganised storms that can cause significant damage.
Stage 3—Further organised systems that are likely to cause significant damage.
Stage 4—Somewhat powerful storms that are likely to cause extensive damage.
Stage 5—Powerful storms that are likely to cause devastating damages.
Stage 6—Very powerful storms that are likely to cause catastrophic damage.
Stage 7—Extremely powerful storms that are likely to cause catastrophic damage.
Stage 8—Super storms that are likely to cause incredible damage.
Stage 9—Super storms that may cause total damage.
Stage 10—Super storms that are likely to cause total damage.



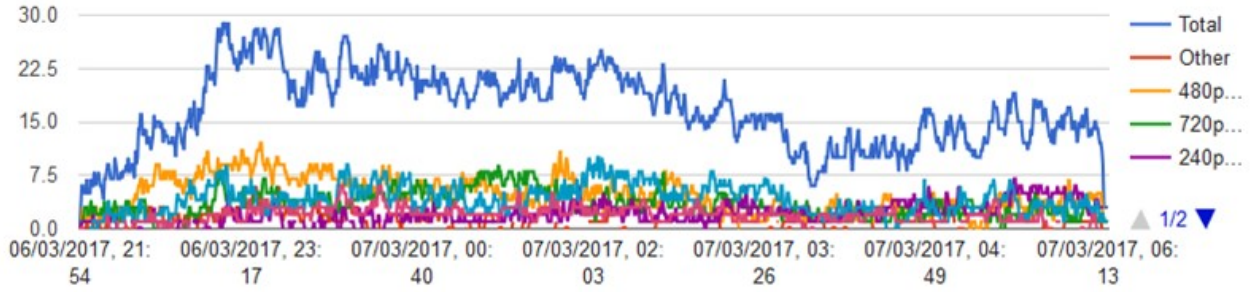
Cyclone Enawo was the seventh storm to be observed by Force Thirteen using the CDPS—a method which was adopted in January 2017.

Enawo was the first storm to reach Stage 9 on the CDPS scale since the system was launched. The previous strongest storm was Cyclone Dineo, which reached Stage 3.

The Cyclone Destruction Potential Scale was created by Devon Williams in 2016. More information can be found at: https://drive.google.com/file/d/0B7pEWk6yHKggSE1STHg2UFJmbHM/view

5. Force Thirteen's Coverage on Enawo

Force Thirteen issued six updates and a further seven hours of live coverage on Cyclone Enawo. The videos received a 96% approval rating during the storm. Top viewing countries during the storm were the United States (15,724), Mauritius (10,994), South Africa (7,806), Madagascar (4,563), and the Philippines (2,674).



The graphic shows viewing trends during the seven hours of live streaming on Force Thirteen Live when Cyclone Enawo was making landfall. Many were also viewing from the United States due to an ongoing tornado outbreak.

Comments, suggestions and inquiries should be directed to force-13@hotmail.co.uk, or any of Force Thirteen's online platforms.