Australian Government
Bureau of Meteorology

Severe Tropical Cyclone *Ernie*

4 -11 April 2017

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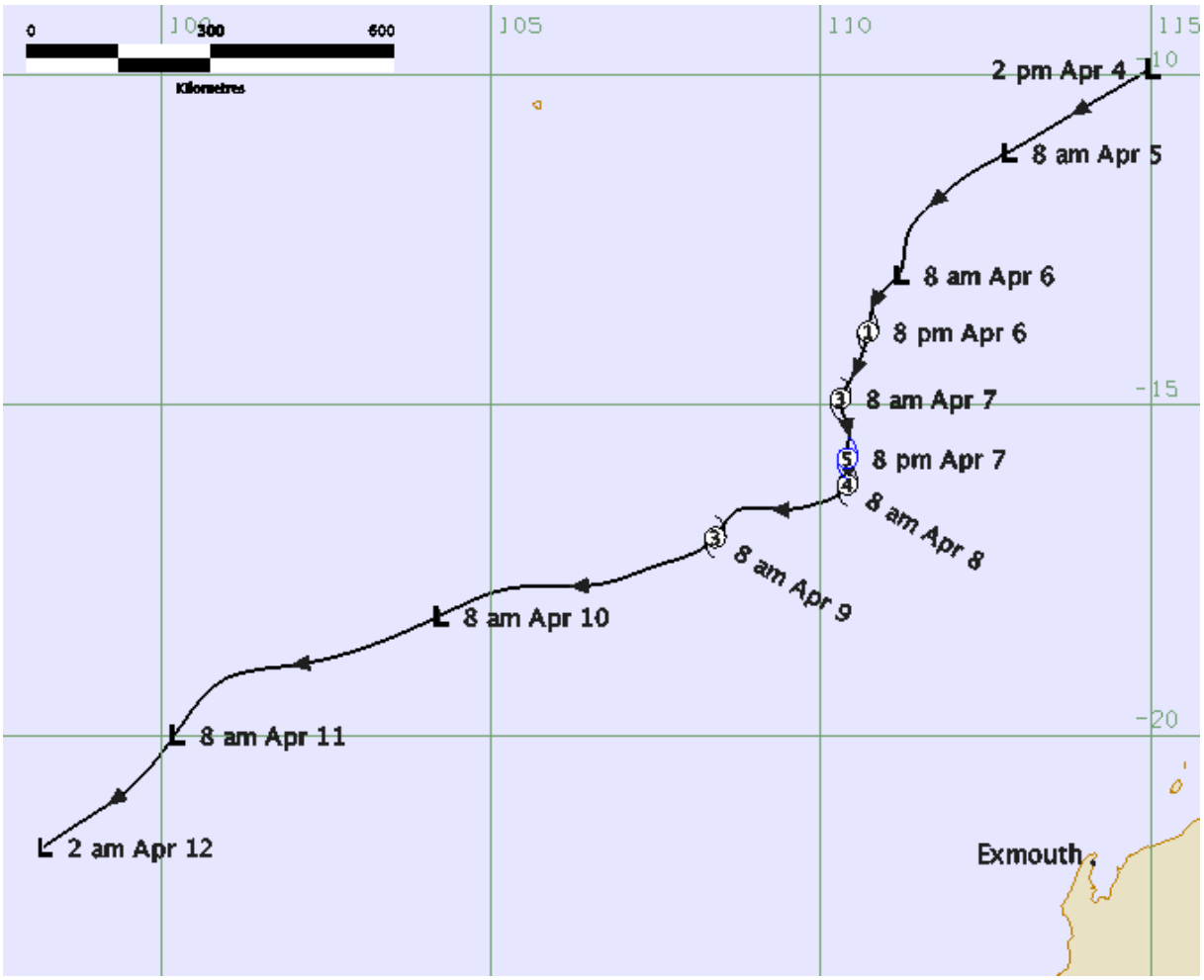
1 Summary

Severe Tropical Cyclone *Ernie* was a very small and intense tropical cyclone that underwent one of the most rapid intensification cycles documented in the Australian Area of Responsibility (AoR).

A low formed near the Indonesian Islands on 4 April and tracked southwest. Initially the development of the tropical low appeared to be hindered by moderate to strong vertical wind shear, this decreased during 6 April and *Ernie* underwent a period of rapid intensification. The tropical cyclone reached a 10-minute mean wind peak intensity of 120 knots (kn) (220 kilometres per hour (km/h)) at 1200 Universal Time Coordinated (UTC) 7 April (0200 Australian Western Standard Time (AWST) 8 April), only twenty four hours after reaching tropical cyclone strength and breaking Dvorak constraints on development. Early on 8 April *Ernie* was steered to the west southwest as a combination of drier mid-level air and increased wind shear caused *Ernie* to begin to weaken. The low decreased below cyclone strength by 0600 UTC 10 April. *Ernie*'s very small size played a part in the tropical cyclone undergoing an unusually rapid intensification and then subsequent rapid weakening.

Ernie had no impact on mainland Australia or Island territories.

FIGURE 1. Best track of *Ernie* 4 – 12 April (times in AWST, UTC+8).



2 Meteorological Description

2.1 Intensity analysis

A tropical low became evident on satellite imagery around 0600 UTC 4 April which was then steered to the southwest. An initial Dvorak T-number (DT) of 1.0 was assigned at 0600 5 April. *Ernie* developed quickly and a DT of 3.0 was reached at 0000 UTC 6 April, Final T (FT) and Current Intensity (CI) were constrained to 2.5 at this point. An 0225 UTC 6 April Advanced Scatterometer (ASCAT) pass (refer Figure 2) showed a circulation with 35 to 40 kn (65 – 74 km/h) winds in the southwest and northwest quadrant. Visible (VIS) and Infrared (IR) imagery indicated *Ernie* was affected by moderate northeast vertical wind shear during the day. By 1200 UTC 6 April Enhanced IR (EIR) imagery showed the centre located well under the cold cloud canopy and Cooperative Institute for Meteorological Satellite Studies (CIMSS) analyses indicated vertical wind shear had decreased from 20 kn (37 km/h) earlier in the day to 12 kn (22km/h). *Ernie* reached tropical cyclone strength by 1200 UTC 6 April when subjective Dvorak FT/CI reached 3.0 and gales were likely to have been present in more than two quadrants. Objective techniques such as Satellite Consensus (SATCON), and CIMSS and National Environmental Satellite, Data, and Information Service (NESDIS) advanced Dvorak Techniques (ADT) indicated intensity was around 40 - 45 kn (75 - 85 km/h) (refer Figure 3). By 1800 UTC EIR imagery showed a more symmetric cloud pattern with a spiral curved band pattern giving a DT of 3.5 with an additional 0.5 added for a white band giving a DT=4.0. The Pattern Adjusted Model Expected T number (MET) was also 4.0 using a developing plus trend. Objective techniques were at 50 – 55 kn (95 - 100 km/h).

By 0000 UTC 7 April satellite imagery showed *Ernie* was beginning to develop an eye in VIS and EIR imagery and microwave imagery showed a fully enclosed ring of deep cold convection about the centre of the system (refer Figure 4). The three-hour averaged DT was 4.5 and intensity was set at 70 kn (130 km/h). At this time the objective ADT methods were lagging behind due to fluctuations in the scene type used. By 0600 UTC 7 April both methods were consistently using an eye scene type and DT numbers climbed rapidly to be more consistent with subjective Dvorak and SATCON estimates. By 0600 UTC 7 April DT numbers averaged 6.5 but FT/CI was constrained to 5.5. The eye pattern continued to produce increasing DT values and by 1300 UTC the three-hour average DT was 7.5 which equates to a 10-minute mean wind of 130 kn (240 km/h). The 1200 UTC SATCON intensity estimates reached a peak of 125 kn (230 km/h) and the best track intensity was set at 120 kn (220 km/h). From this point intensity began to decrease though EIR and microwave imagery still showed a well formed eye (refer Figure 5). SATCON estimates decreased to around 100 kn (185 km/h) at 1800 UTC but it is possible the technique may have been influenced by a suspect AMSU intensity estimate which typically does not cope well with a very small system. At this time the radius to gales was around 55 nautical miles (nm) (102 kilometres (km)) which was the largest Ernie achieved and the eye diameter was 10 nm (18 km).

An eye persisted through until around 0400 UTC 8 April but DT numbers decreased as the eye temperature cooled and the surrounding convective ring warmed. Initial weakening began due to the intrusion of dry air into the tropical cyclone. Objective techniques also showed a rapid decrease in intensity and by 0600 UTC 9 April the intensity was set at 60 kn (110 km/h) (refer Figure 6). By 1800 UTC 9 April vertical wind shear had increased to greater than 20 kn (35 km/h) and this combined with the intrusion of dry air continued the rapid weakening trend. *Ernie* weakened below tropical cyclone strength by 0600 UTC 10 April when the low level cloud centre was completely exposed with only a small amount of cold convection remaining in the southeast quadrant.

In just over forty eight hours *Ernie* increased from a DT of 1.0 to a DT of 7.5, an extraordinary development cycle. The system then decreased in intensity with nearly equal rapidity from a DT of 7.5 to a DT of 3.0 in the following forty eight hours.

2.2 Structure

Ernie initially appeared to be adversely affected by vertical wind shear with the low level centre exposed and intense convection confined to the southwest quadrant. As vertical wind shear decreased the tropical cyclone became symmetric though very small. Initially the radius to gales was 60 nm (110 km) in the southwest quadrant and 30 nm (55 km) in the southeast quadrant. As *Ernie* became a cyclone, the largest gale radii was 60 nm (110 km) in the southwest quadrant reducing to 25 nm (45 km) in the eastern quadrants. The storm radius was estimated to be around 20 nm (35 km) and the hurricane radius 15 nm (30 km).

Ernie was an extremely small tropical cyclone and the eye diameter ranged from 10 nm (20 km) at its largest down to 5 nm (10km) at its smallest. The radius to maximum wind (RMW) ranged from 20 nm (35 km/h) in initial stages to 10 nm (20 km) at its most intense.

2.3 Motion

Ernie was steered southwest by the mid-level ridge before a mid-level trough turned the steering more northerly during 6 April and the cyclone moved south. The trough moved to the east and from 8 April *Ernie* was again steered to the west by the mid-level ridge until the cyclone weakened.

3 Impact

Ernie had no impact on mainland Australia or any Island communities.

4 Observations

No observations of note were recorded during *Ernie*.

5 Forecast Performance

The accuracy figures for *Ernie* were either very similar to or better than the 2010 – 2015 five year average.

The accuracy statistics obtained by comparing the forecast positions against the best track positions for *Ernie* are

	0	**06**	**12**	**18**	**24**	**36**	**48**	**72**	**96**	**120**
Absolute error (km)	22	43	61	75	77	91	104	129	183	220
RMS Error (km)	30	48	66	86	91	111	116	133	187	222
Sample Size	17	17	17	17	17	17	16	12	8	4

Figure 7 is a plot of the accuracy figures for *Ernie* compared to the five year mean.

TABLE 1. Best track summary for Tropical Cyclone *Ernie*

Refer to the Australian Tropical Cyclone database for complete listing of parameters. WST is UTC + 8 hours.

Year	Month	Day	Hour UTC	Pos. Lat S	Pos. Long. E	Pos. Acc. nm	Max Wind 10 min kn	Max gust kn	Cent. Press. hPa	Rad. of gales (NE/SE/ SW/NW)	Rad. of storm (NE/SE/ SW/NW)	RMW n mi
2017	04	04	0600	9.9	115.0	45	20	45	1008			
2017	04	04	1200	10.3	114.3	45	20	45	1008			
2017	04	04	1800	10.7	113.5	45	20	45	1008			
2017	04	05	0000	11.2	112.8	45	20	45	1008			
2017	04	05	0600	11.6	112.1	30	20	45	1006			
2017	04	05	1200	11.8	111.9	25	25	45	1003			
2017	04	05	1800	12.5	111.3	20	30	45	1001			
2017	04	06	0000	13.0	111.2	20	35	50	998	0/0/60/30		20
2017	04	06	0600	13.3	110.9	20	40	55	995	0/0/60/30		20
2017	04	06	1200	13.9	110.7	15	45	65	992	25/25/60/ 30		20
2017	04	06	1800	14.7	110.4	15	55	75	987	25/25/60/ 30	20	15
2017	04	07	0000	14.9	110.3	10	70	100	973	25/25/55/ 25	20	10
2017	04	07	0600	15.3	110.4	10	95	135	951	35/25/55/ 25	20	10
2017	04	07	1200	15.8	110.4	10	120	170	924	35/35/55/ 25	20	10

Year	Month	Day	Hour UTC	Pos. Lat S	Pos. Long. E	Pos. Acc. nm	Max Wind 10 min kn	Max gust kn	Cent. Press. hPa	Rad. of gales (NE/SE/ SW/NW)	Rad. of storm (NE/SE/ SW/NW)	RMW n mi
2017	04	07	1800	15.9	110.4	10	115	160	927	25/45/55/ 25	20	10
2017	04	08	0000	16.2	110.4	15	105	145	940	25/55/55/ 25	20	10
2017	04	08	0600	16.5	109.9	15	95	135	946	25/55/55/ 25	20	10
2017	04	08	1200	16.6	109.5	15	85	120	955	25/55/55/ 25	20	10
2017	04	08	1800	16.6	108.7	10	75	105	971	25/55/55/ 25	20	10
2017	04	09	0000	17.0	108.4	15	70	100	974	25/55/55/ 25	20	10
2017	04	09	0600	17.4	107.5	15	60	85	977	25/55/40/ 25	20	10
2017	04	09	1200	17.7	106.7	10	55	75	980	20/55/30/ 20	20	10
2017	04	09	1800	17.8	105.3	10	50	70	985	20/55/30/ 20	20	15
2017	04	10	0000	18.2	104.2	15	40	55	996	0/55/30/0		20
2017	04	10	0600	18.7	103.0	15	30	45	1000			
2017	04	10	1200	18.9	101.9	15	25	45	1005			
2017	04	10	1800	19.2	100.9	15	25	45	1005			
2017	04	11	0000	20.0	100.2	10	25	45	1005			
2017	04	11	0600	20.9	99.4	10	25	45	1005			

Year	Month	Day	Hour UTC	Pos. Lat S	Pos. Long. E	Pos. Acc. nm	Max Wind 10 min kn	Max gust kn	Cent. Press. hPa	Rad. of gales (NE/SE/ SW/NW)	Rad. of storm (NE/SE/ SW/NW)	RMW n mi
2017	04	11	1200	21.3	98.8	10	25	45	1006			
2017	04	11	1800	21.7	98.2	10	25	45	1006			

FIGURE 2. METOP-A ASCAT pass at 0225 6 April 2017 during the early stages of *Ernie's* development.

Image courtesy of https://manati.star.nesdis.noaa.gov/datasets/ASCATData.php

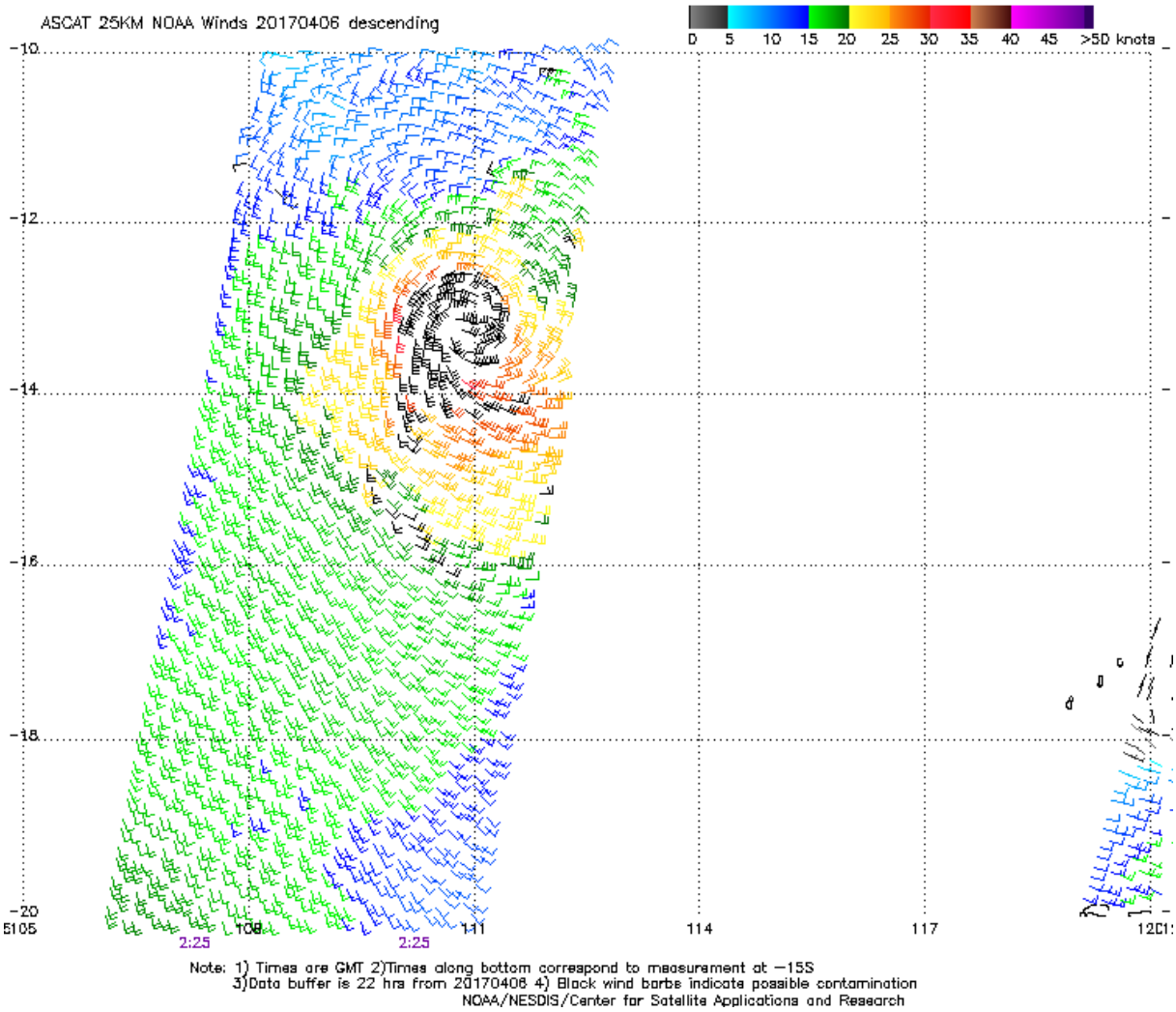


FIGURE 3. Comparison of objective and subjective intensity analysis techniques.

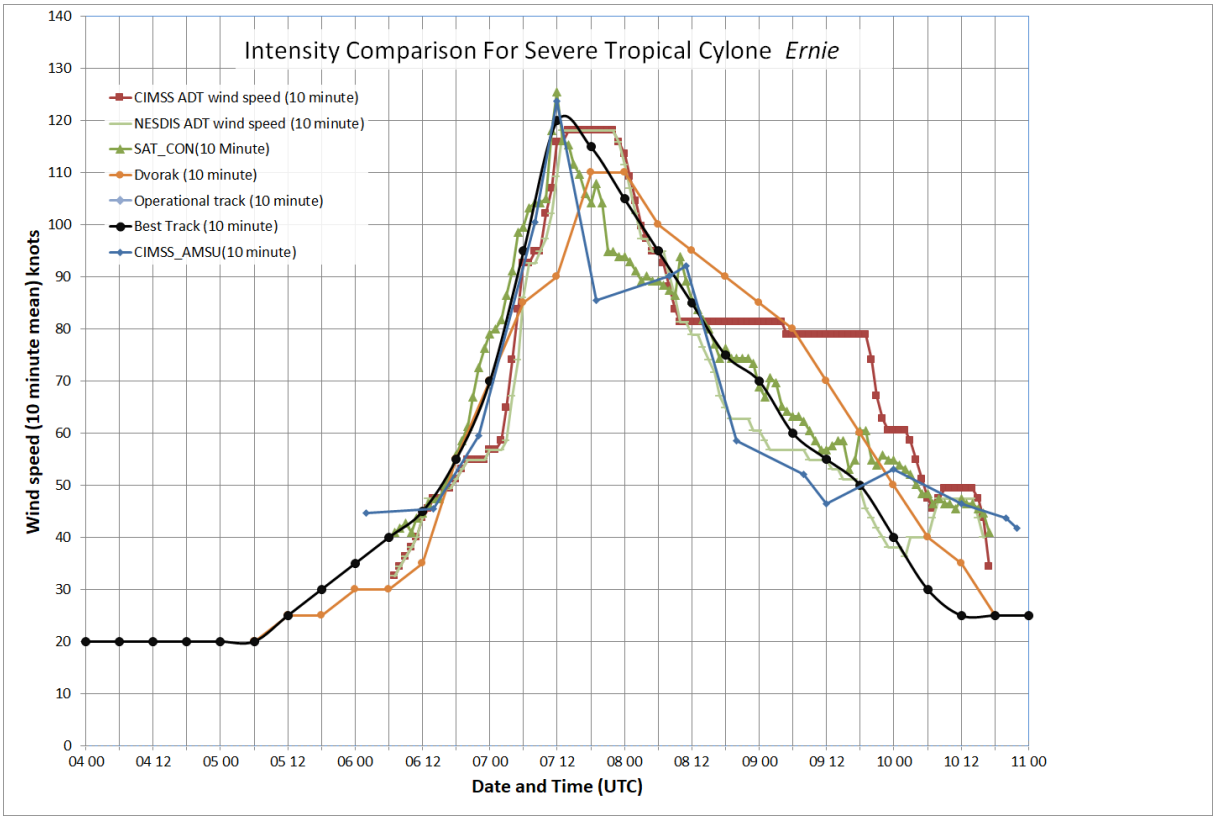


FIGURE 4. 91 GHz microwave imagery at 2303 UTC 6 April when *Ernie* was beginning to develop an eye pattern.

Image courtesy of https://www.fnmoc.navy.mil/tcweb/cgi-bin/tc_home.cgi

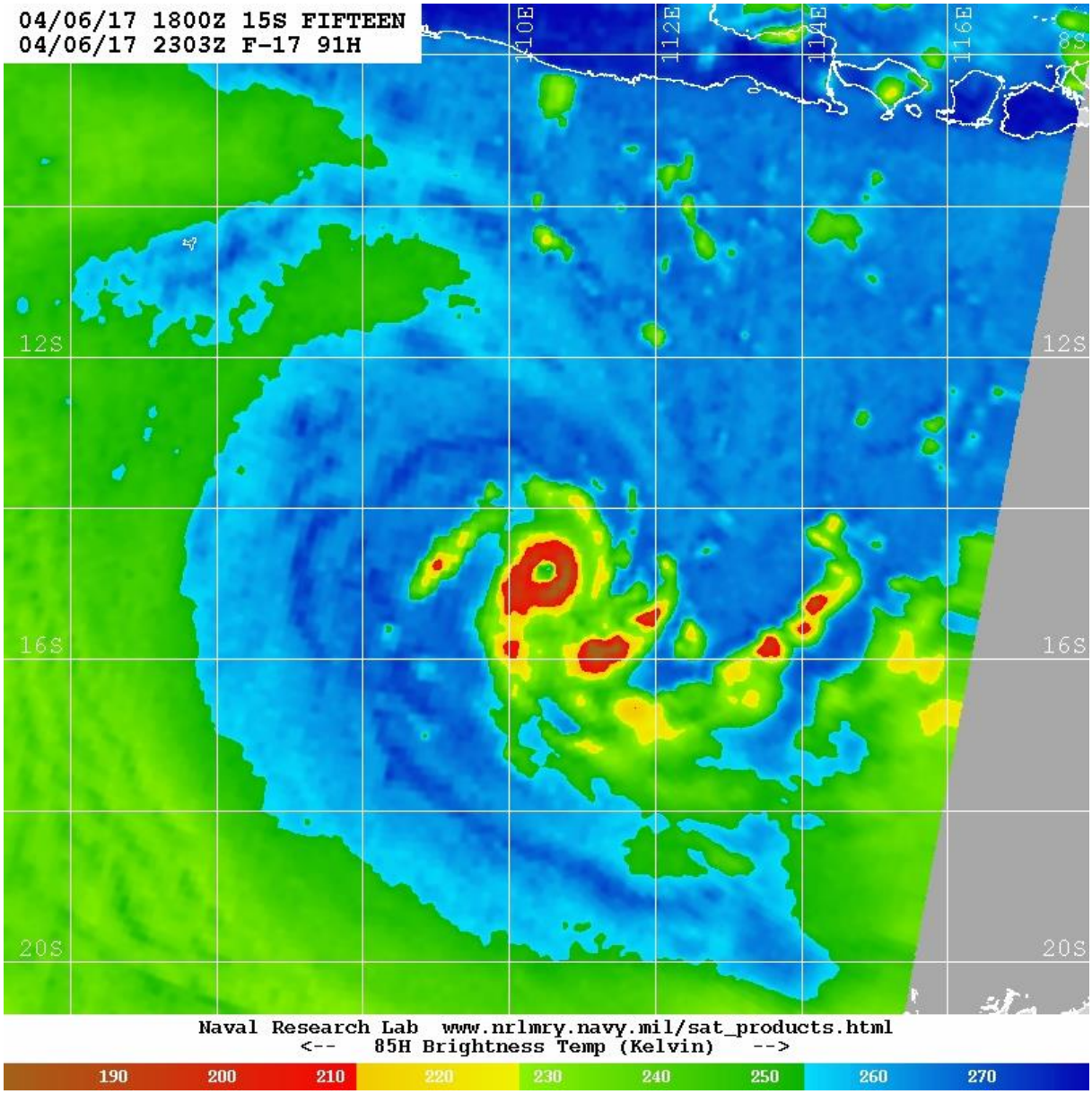


FIGURE 5. 89 GHz microwave image of *Ernie* at 1706 UTC 7 April 2017 near peak intensity.

Image courtesy of https://www.fnmoc.navy.mil/tcweb/cgi-bin/tc_home.cgi

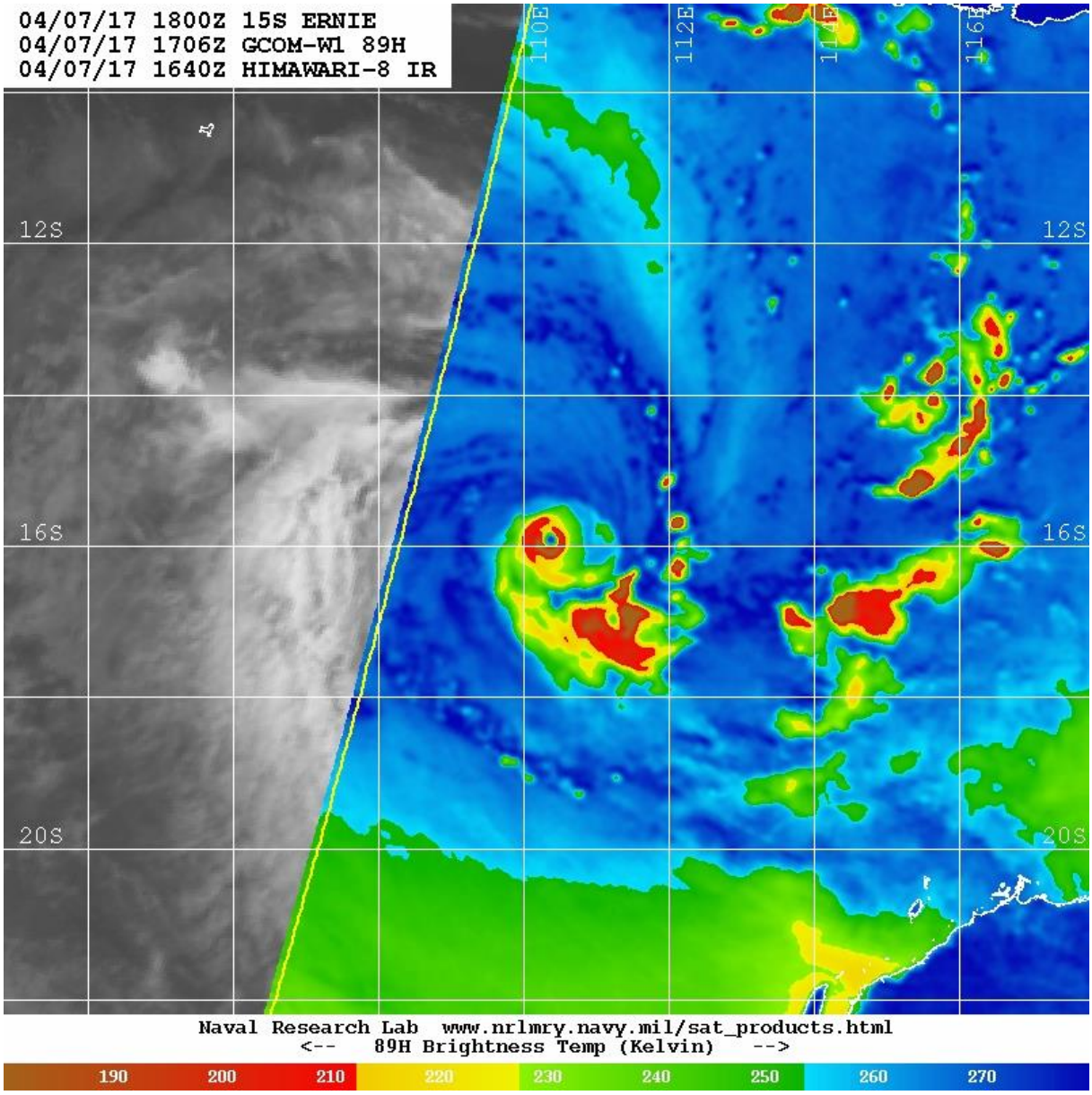


FIGURE6. 89 GHz microwave image of *Ernie* at 0524 UTC 9 April 2017 showing significant weakening.

Image courtesy of https://www.fnmoc.navy.mil/tcweb/cgi-bin/tc_home.cgi

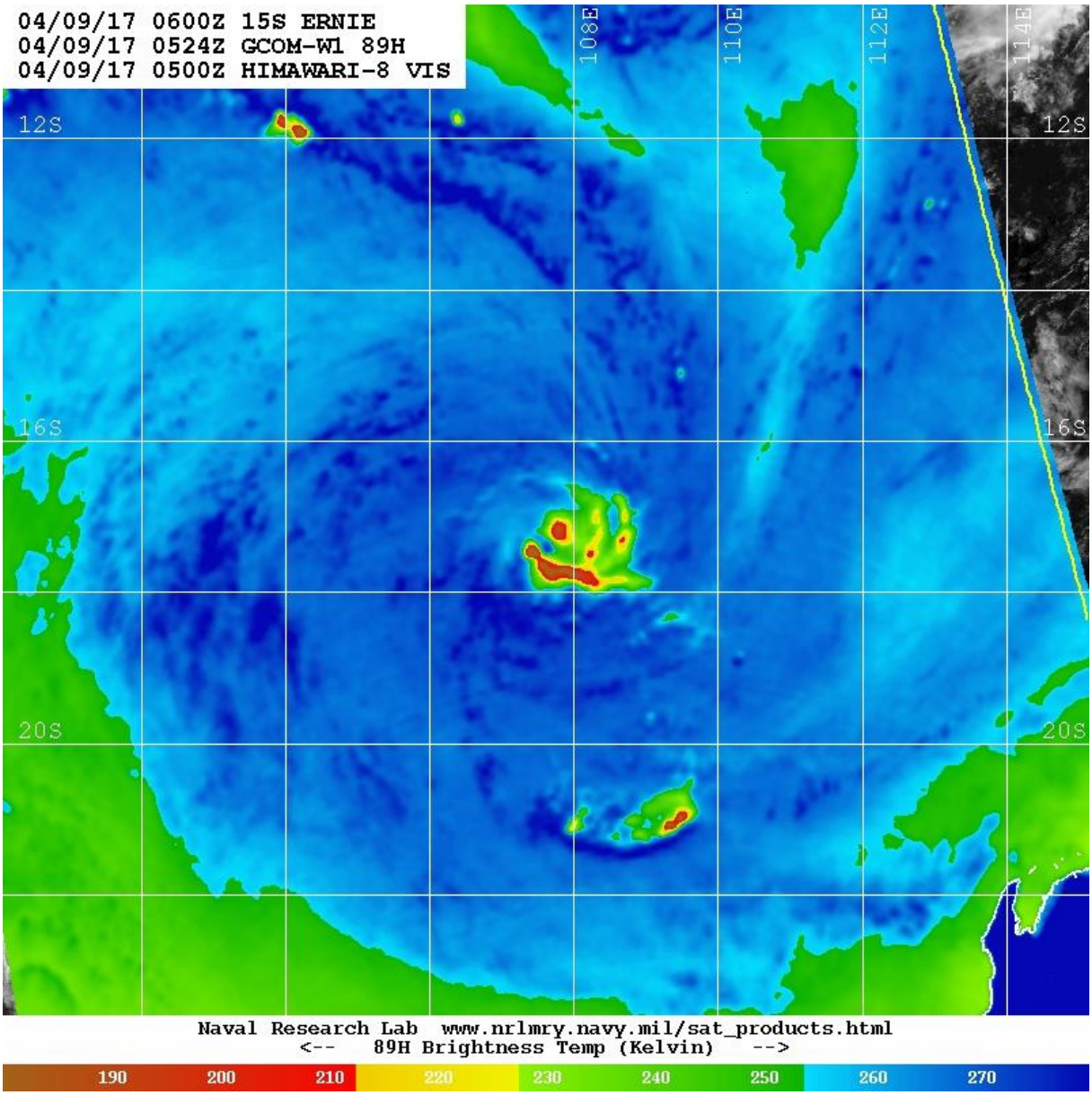


FIGURE 7 A plot of the accuracy figure for *Ernie* compared to the five year mean.