

Tropical Cyclone Hilda

26 - 29 December 2017

February 2018



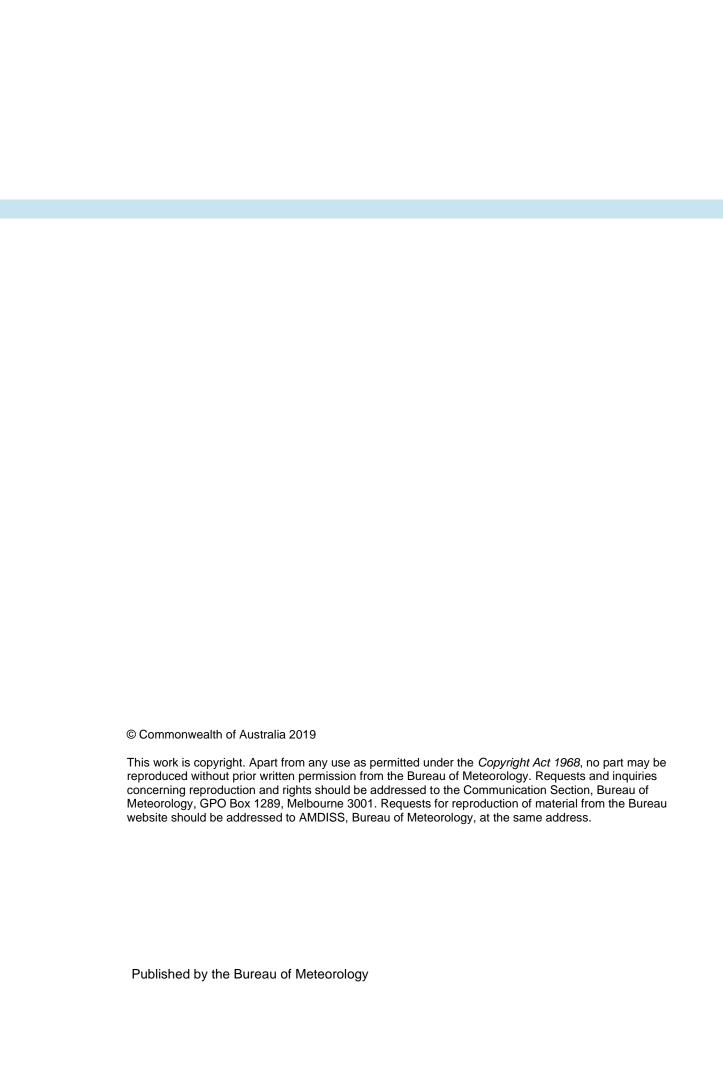


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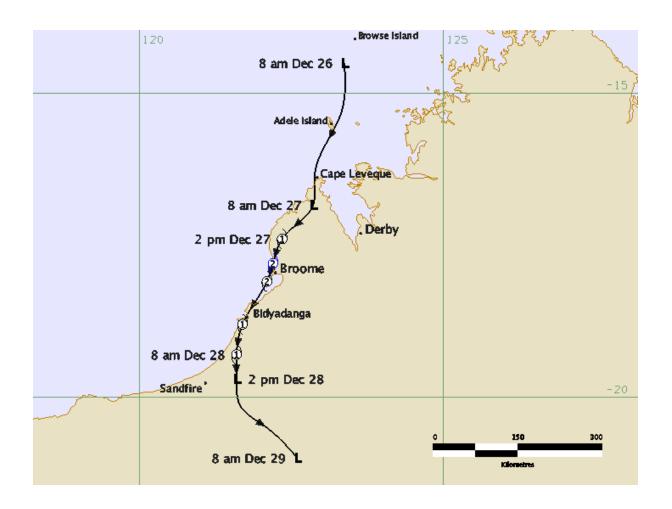
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Summary

Tropical Cyclone *Hilda* was a very small tropical cyclone that, unusually, reached tropical cyclone strength over land. A low was first identified between Browse and Adele Islands,) to the north of the Dampier Peninsular, off the northwest Kimberley coast, at 0000 Universal Time Co-ordinated (UTC) 26 December (0800 Australian Western Standard Time (AWST) = UTC+8 hours. The low moved south and crossed the Western Australian coastline near Cape Leveque at 1800 UTC 26 December. The low reached tropical cyclone strength at 0600 UTC 26 December, while over land, and passed very close to the town of Broome at 0900 UTC 26 December. Surface observations indicated a peak 10-minute mean wind of 55 knots (kn) (102 kilometres per hour (km/h)) was reached around this time. *Hilda* moved offshore for about 9 hours (h) before crossing the coast just north of the community of Bidyadanga at around 1500 UTC 26 December. The tropical cyclone quickly weakened and dissipated inland.

A maximum 3-second wind gust of 71 kn (131 km/h) at 0957 UTC 27 December was recorded at the Broome National Tidal Centre (NTC) Comparison Automatic Weather Station (AWS). Some structural and vegetation damage was reported at both Bidyadanga and at the Eco Beach resort as the system passed nearby. Minor vegetation damage and felled trees were reported at Broome. More significant was the rainfall that fell during this event. Heavy rainfall occurred along mainly coastal locations of the northwest Kimberley coast with 24 hour totals of 292 millimetres (mm) at Cygnet Bay (to 0900 AWST on 27 December) and 201 mm at Kilto Station (to 0900 AWST 28 December) recorded. Localised flooding was reported in Broome and road closures due to water occurred throughout the western Kimberley, eastern Pilbara and the North and South Interior districts.

FIGURE 1. Best track of *Hilda* 26 – 29 December 2017 (times in AWST, UTC+8).



Meteorological Description

2.1 Intensity analysis

A weak monsoon trough developed in mid-December between Australia and Indonesia which increased convection through this area. By 26 December a weak low was identified by surface observations about 225 kilometres (km) to the north northeast of Cape Levegue. This low formed out of phase with the Madden-Julien Oscillation (MJO) which was located in the central Indian Ocean. Satellite and microwave imagery showed little curvature in the cloud structures at this time, refer Figure 2. The low moved in a south south-west direction across Adele Island and then Cape Leveque. Wind speeds were around 15-20 kn (28-37 km/h) during the day at Adele Island. Wind speeds were similar when the low went past Cape Leveque (observations from nearby Lombadina Airstrip) but the mean sea level pressure (MSLP) fell rapidly, indicating the low was developing despite being located over land. During 26 December, Cooperative Institute for Meteorological Satellite Studies (CIMSS) vertical wind shear analyses indicate the low was located in an area of moderate to strong wind shear. On 27 December, as the low moved south it moved into an area of low wind shear. Upper wind analyses also show good outflow to the north and south of the developing low indicating conditions were favourable for development.

The Advanced Microwave Scanning Radiometer 2 (AMSR2) image at 0448 UTC 27 December showed a tightly wrapped system with bands of deep convection located over the western side of the tropical cyclone, over the ocean. A partial eye was also evident in the low level cloud banding, refer Figure 3. Despite the centre of the tropical low being located over land *Hilda* reached tropical cyclone strength between 0000 and 0600 UTC 27 March, around 60 km to the northeast of Broome. Observations from the Broome NTC AWS located at the Broome Port reached gale force at around this time. The Broome NTC anemometer is at a height of 19 metres (m), which is higher than the Bureau of Meteorology standard of 10 m. All observations from the Broome NTC AWS have been adjusted to be equivalent to 10 m above ground level. The Broome NTC Comparison site, also located at the Broome Port, but at a standard height of 10 m showed similar gale and storm force winds through the relevant time period. The Broome Port is located on the northern side of Roebuck Bay and south of the Broome Airport location.

Convection began to increase on the western side of the tropical cyclone which was located over the warm ocean, and *Hilda* continued to intensify as it moved southwest, past the town of Broome. The Broome NTC observations show the wind speed increased rapidly over the next few hours as the tropical cyclone approached. Wind speeds reached a 10-minute mean peak of 56 kn (104 km/h) at 1035 and 1036 UTC 27 December and a peak 3-second wind gust of 68 kn (126 km/h) was recorded at 0959 UTC 27 December. The Broome NTC Comparison site measured a peak 3-second gust of 71 kn (131 km/h) at 0957 UTC 27 December. *Hilda* reached a peak 10-minute mean wind intensity of 55 kn (102 km/h) at 0900 UTC 27 December.

Hilda continued to move on a southwest track across open water until it crossed the coast just north of Bidyadanga around 1500 UTC 27 December. The radar signature showed the tropical cyclone weakening and intensity was downgraded from 1200 UTC 27 December. Hilda continued along an inland path and weakened below tropical cyclone strength by 0000 UC 28 December.

No objective intensity guidance was available during *Hilda*. Subjective Dvorak was also not applicable due to land interaction.

2.2 Structure

Hilda was a very small tropical cyclone. The radius to gales was 35 nautical miles (nm) (65 km) in the southwest quadrant decreasing down to 20 nm (37 km) in the northern quadrants. The storm radii ranged from 10 nm (18 km) in the northern quadrants to 15 nm (28 km) in the southern quadrants. The radius to maximum wind (RMW) ranged from 35 nm (65 km/h) in initial stages to 10 nm (18 km) at its most intense.

2.3 Motion

Hilda was steered in a generally southerly direction by the mid-level ridge to the east. By the 28 December a mid-level trough located over the southern half of Western Australia steered the remnants to the southeast.

3 Impact

Hilda did have an impact on the west Kimberley communities during its lifetime. The town of Broome reported minor vegetation damage and felled trees. There was also significant localised flooding in Broome due to heavy rainfall. Some structural damage was reported from the Eco Beach Resort which is located along the southeast side of Roebuck Bay, about 80 km north of Bidyadanga. The force of the winds forced pool fencing through the restaurant windows. The community of Bidyadanga also reported some structural damage but mostly tree damage and downed power lines.

Heavy rainfall occurred along mainly coastal locations of the northwest Kimberley coast with 24 hour totals of 292 mm at Cygnet Bay (to 9am on 27 December) and 201 mm at Kilto Station (to 9am 28 December) being recorded. Significant disruptions occurred due to inundation of roads throughout the western Kimberley, eastern Pilbara and the North and South Interior districts.

Observations

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4.1 Wind

Broome NTC AWS height adjusted data recorded gale force winds between 0447 0448, 0451 -0454, 0506, 0547 – 1326 UTC 27 December. Storm force winds were recorded between 0848 – 0849, 0907 – 0909, 0912 – 0929, 0950 – 1043, 1133 – 1135 UTC 27 December. The maximum 10-minute mean wind recorded was 56 kn (104 km/h) at 1035 – 1036 UTC 27 December and the maximum 3-second wind gust recorded was 68 kn (126 km/h) at 0959 UTC 27 December.

Broome NTC Comparison AWS recorded gale force winds between 0441 – 0519 and 0541 – 1317 UTC 27 December. Storm force winds were recorded between 0841 – 0928 and 0946 – 1006 UTC 27 December. The maximum 10-minute mean wind recorded was 55 kn (102 km/h) at 0957 UTC 27 December and the maximum 3-second wind gust recorded was 71 kn (131 km/h) at 0957 UTC 27 December.

Broome Airport AWS recorded gale force winds between 0738 – 0743, 0753 - 0913 and 0946 - 1019 UTC 27 December. The maximum 10-minute mean wind recorded was 37 kn (68 km/h) at 1013 - 1014 UTC 27 December and the maximum 3-second wind gust recorded was 54 kn (100 km/h) at 1009 UTC 27 December.

West Roebuck AWS recorded no gales but did record a maximum 3-second wind gust of 49 kn (91 km/h) at 1024 UTC 27 December.

4.2 Pressure

Adele Island AWS recorded a minimum MSL pressure of 1000.8 Hectopascals (hPa) at 0809 UTC 26 December.

<u>Lombadina Airstrip AWS</u> recorded a minimum MSL pressure of 985.5 hPa at 1945 UTC 26 December.

<u>Broome NTC AWS</u> recorded a minimum MSL pressure of 982.9 hPa at 1035 UTC 27 December.

<u>Broome NTC Comparison AWS</u> recorded a minimum MSL pressure of 983.3 hPa at 1050 and 1054 UTC 27 December.

Broome Airport AWS recorded a minimum MSL pressure of 985.3 hPa at 1011 - 1013 UTC 27 December.

4.3 Rainfall

Cygnet Bay recorded 292 mm to 9am on 27 December.

Kilto Station recorded 201mm to 9am 28 December.

Forecast Performance

The accuracy figures for *Hilda* were either very similar to or better than the 2010 – 2015 five year average with the exception of the 72 and 96 hour (hr) figures.

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

	00	06	12	18	24	36	48	72	96	120	144	168
Absolute error (km)	20	36	50	93	102	105	148	292	393	340	291	334
RMS Error (km)	27	40	54	121	130	140	162	298	407	386	314	334
Sample Size	9	9	9	10	9	7	5	3	3	3	2	1

Figure 4 is a plot of the accuracy figures for *Hilda* compared to the five year mean.

Initially model guidance varied in location and intensity, refer Figure 5. Subsequent runs of the global models came into closer agreement that a small system would develop near Broome. The Global Forecast System (GFS) was the first model to indicate a small and intense system developing over land near Broome at the initialisation time of 1200 UTC 25 December, a lead time of 42 hours (refer Figure 5 b). The European Centre for Medium Range Weather Forecasting (ECMWF) model showed a similar tropical low but located offshore to the west of Broome. The next model run at 0000 UTC 26 December showed a similar scenario however the GFS model was correctly indicating the tight wind gradient that developed on the southern side of the developing tropical cyclone, refer Figure 5c. Overall the GFS model performed the best at modelling the development of a small tropical cyclone while still over land.

TABLE 1. Best track summary for Tropical Cyclone Hilda

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	12	26	00	14.5	123.4	20	25	45	1003			
2017	12	26	06	15.3	123.3	20	25	45	1001			
2017	12	26	12	16.1	123.0	20	25	45	998			
2017	12	26	18	16.4	122.9	15	30	45	994			
2017	12	27	00	16.8	122.9	10	30	45	984			
2017	12	27	06	17.4	122.3	10	40	55	982	20/30/35/ 20		35
2017	12	27	09	17.8	122.2	10	55	75	980	20/35/30/ 20	10/15/15/ 10	15
2017	12	27	12	18.1	122.1	10	50	70	980	20/35/30/ 20	0/10/10/0	10
2017	12	27	18	18.8	121.7	10	40	55	984	20/20/20/ 30		10
2017	12	28	00	19.3	121.6	10	35	50	990	20/20/20/ 30		20
2017	12	28	06	19.7	121.6	20	30	45	994			
2017	12	28	12	20.1	121.7	30	25	45	996			
2017	12	28	18	20.5	122.1	30	20	45	998			
2017	12	29	00	21.0	122.6	30	20	45	1000			

FIGURE 2. Tropical Cyclone Special Sensor Microwave Imager/Sounder (TCSSMIS) pass at 0805 UTC 26 December 2017 during the early stages of *Hilda's* development.

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

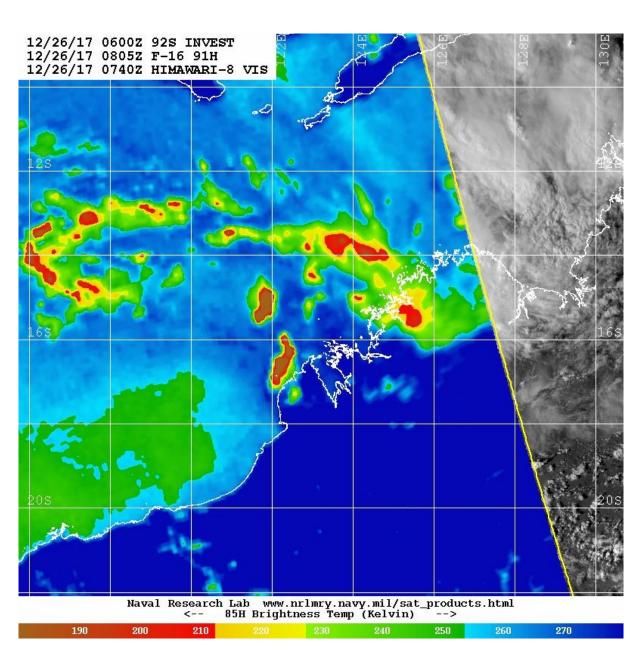


FIGURE 3. AMSR2 image at 0448 UTC 27 December which shows significant development of the tropical cyclone had occurred over a 24 hour period.

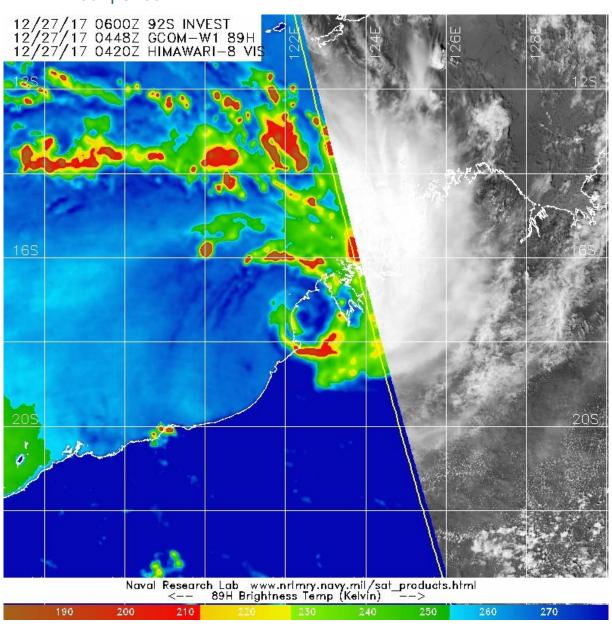


FIGURE 4 A plot of the accuracy figure for *Hilda* compared to the five year mean.

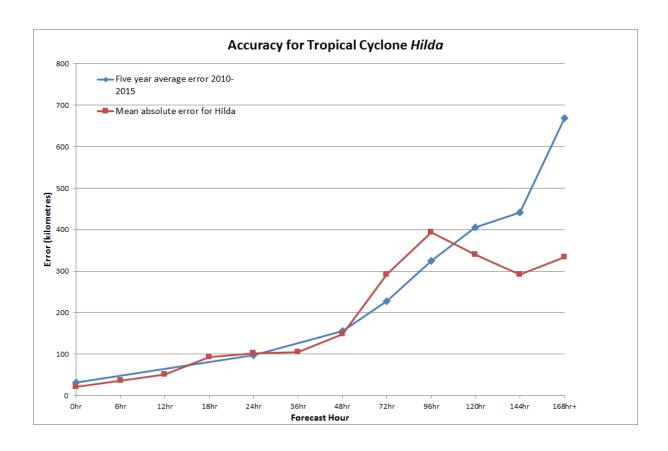


FIGURE 5 Model guidance for Hilda, top left panel is ECMF, top right panel is GFS, bottom left is Australian Community Climate and Earth-System Simulator Regional (ACCESS R), bottom right is Japan Meteorology Agency (JMA). The validity time for all panels is 0600 UTC 27 December.

Figure 5 a) Initialisation time is 0000 UTC 25 December, the forecast lead time is 54 hours.

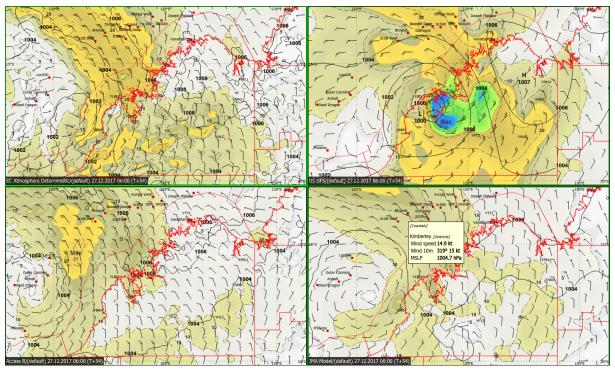


Figure 5 b) Initialisation time is 1200 UTC 25 December, the forecast lead time is 42 hours.

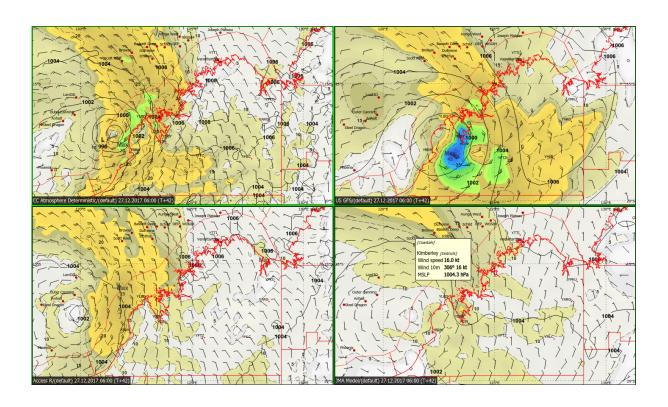


Figure 5 c) Initialisation time is 0000 UTC 26 December, the forecast lead time is 30 hours.

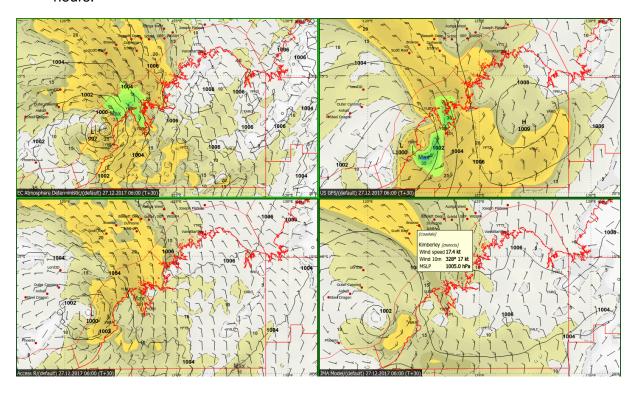


Figure 5 d) Initialisation time is 1200 UTC 26 December, the forecast lead time is 18 hours.

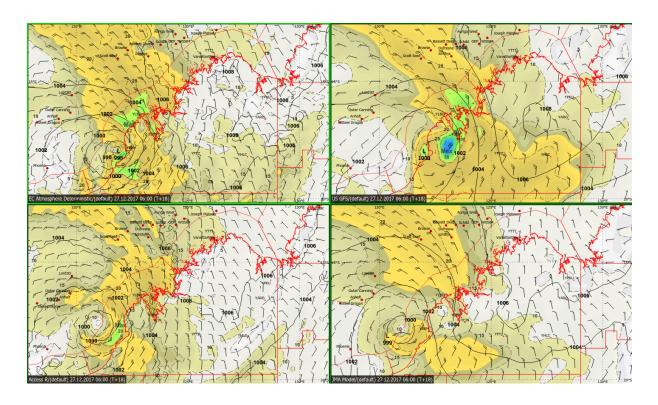


Figure 5 e) Initialisation time is 0000 UTC 27 December, the forecast lead time is 6 hours.

