

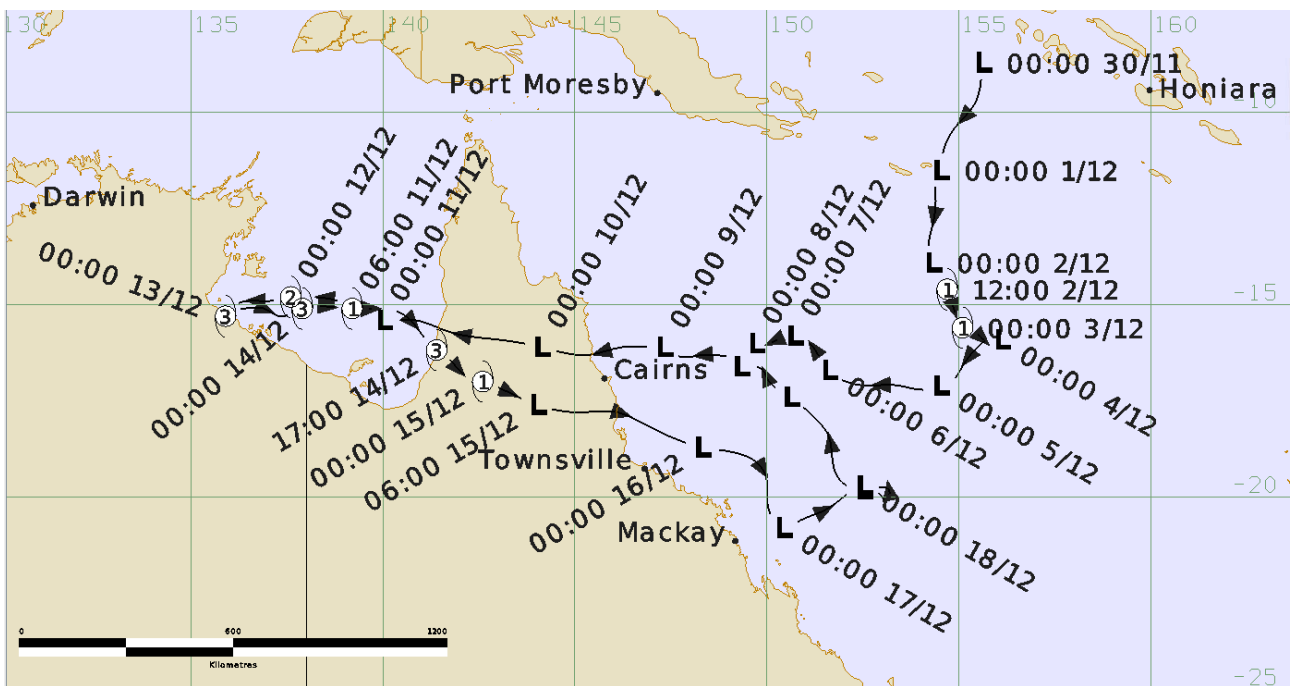
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Severe Tropical Cyclone Owen

30 November – 21 December 2018

Joe Courtney and Vikash Prasad, Tropical Cyclone Environmental Prediction Services,
22 January 2024



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Cover image: Track of Severe Tropical Cyclone Owen (Times in UTC)

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1. Summary

Severe Tropical Cyclone Owen was a long-lived, early season system that moved from the Coral Sea into the Gulf of Carpentaria and back again (Figure 1). Owen reached tropical cyclone intensity on two occasions during its lifetime, although it produced most of its impacts as a tropical low.

The precursor tropical low was identified and tracked in the Solomon Sea from 30 November. The system moved south into the Coral Sea and reached tropical cyclone intensity on 2 December. Tropical Cyclone Owen moved to the southeast as a category 1 cyclone but weakened below cyclone intensity some 30 hours later.

The tropical low then turned west and crossed the north Queensland coast early on 10 December near Port Douglas. Cairns and Innisfail recorded wind gusts to 47 kn (87 km/h). Strong winds brought trees down at Yarrabah, east of Cairns. Heavy rains also accompanied the system's landfall causing some flooding of local rivers and creeks.

The low crossed Cape York Peninsula and emerged into the Gulf of Carpentaria overnight from 10 to 11 December. Later, on 11 December Owen redeveloped into a tropical cyclone and intensified as it tracked westwards. Owen reached peak intensity as a category 3 system just as it made landfall on an uninhabited stretch of the southwestern Gulf coast, northeast of Port McArthur in the Northern Territory, on the morning of 13 December.

Owen then turned back towards the east, virtually retracing its steps across the Gulf of Carpentaria. It maintained category 3 but weakened slightly before making landfall again on the southwestern Cape York Peninsula coast, north of the Gilbert River Mouth, early on 15 December.

During this phase, Owen was notable for its tiny eye – not clearly visible on satellite imagery, but less than 20 km across on radar. As a result of this, the peak winds associated with Owen were very localised and the Centre Island Automatic Weather Station (AWS) on the periphery of the cyclone recorded just 3 hours of gale force winds with a peak gust of 49 kn (91 km/h). There were no significant impacts to populated areas apart from several remote roads cut by floodwaters. The residents of King Ash Bay and Bing Bong near Port McArthur were evacuated to Borroloola during the event.

Owen weakened to a tropical low for the final time as it crossed the base of Cape York Peninsula during 15 December before moving off the north tropical Queensland coast between Innisfail and Cardwell. Its passage was accompanied by torrential rain, particularly at Halifax (east of Ingham) where an Australian record for December of 681 mm fell in the 24 hours to 9am AEST on the 16th. The Bruce Highway was cut north of Ingham. Two rescues occurred, including a mother and daughter rescued from their vehicle in crocodile-infested floodwaters. Sugarcane crops were impacted, and hundreds of chickens were lost to flooding. Lucinda also recorded a 54 kn (100 km/h) wind gust as ex-Owen moved offshore.

After moving back into the Coral Sea, the remains of Owen persisted as a tropical low for several days but did not re-form into a tropical cyclone.

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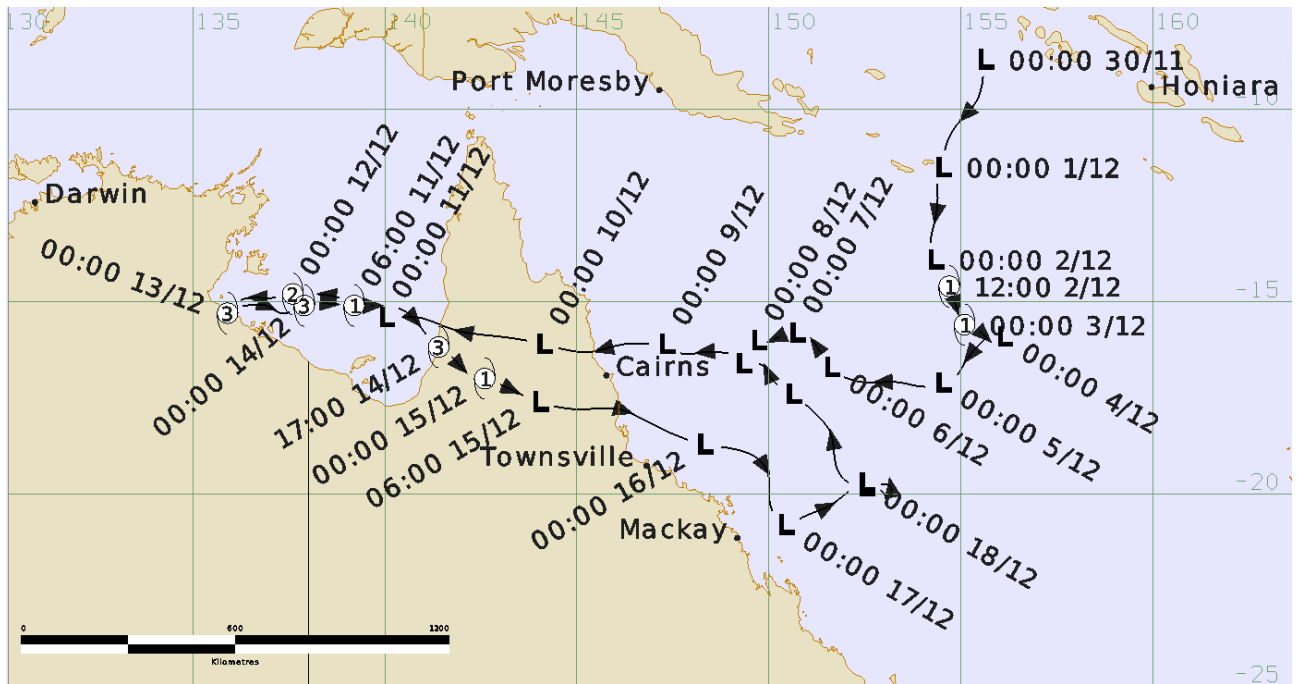


Figure 1. Best Track of Severe Tropical Cyclone Owen (times in UTC, AEST+10).

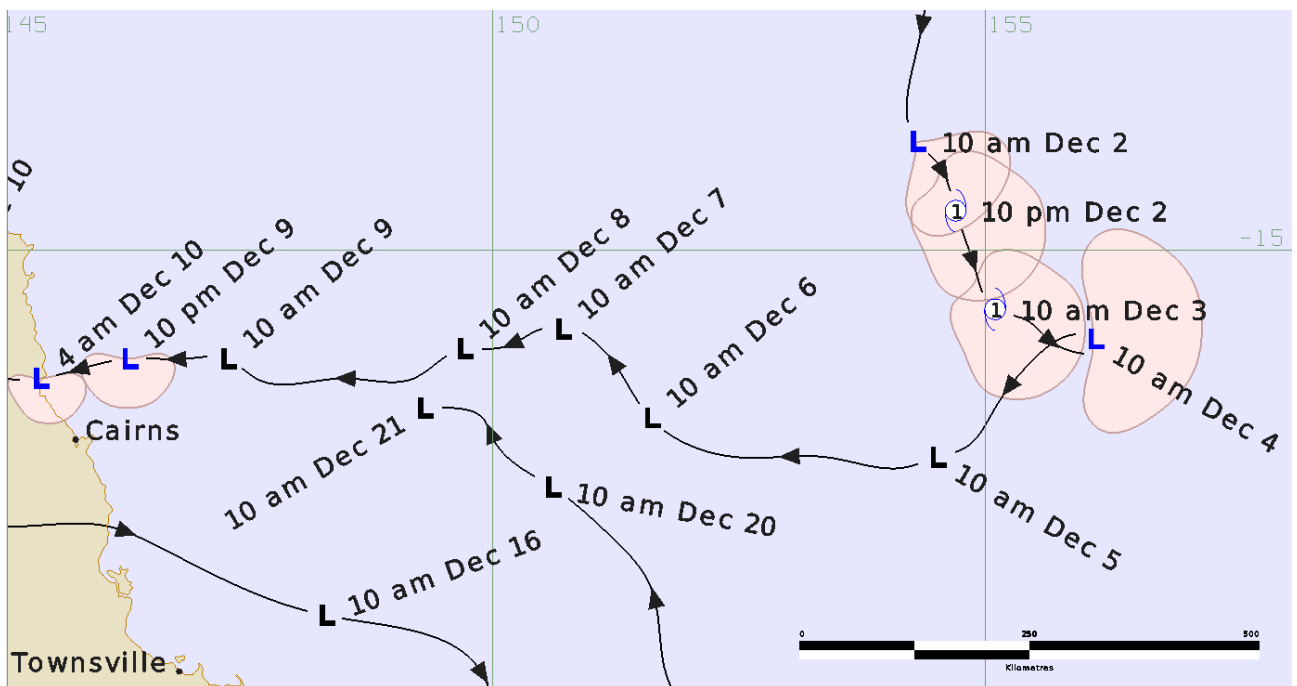


Figure 2 Detailed best track of Severe Tropical Cyclone Owen in the Coral Sea showing gale wind radii (times in AEST, UTC +10).

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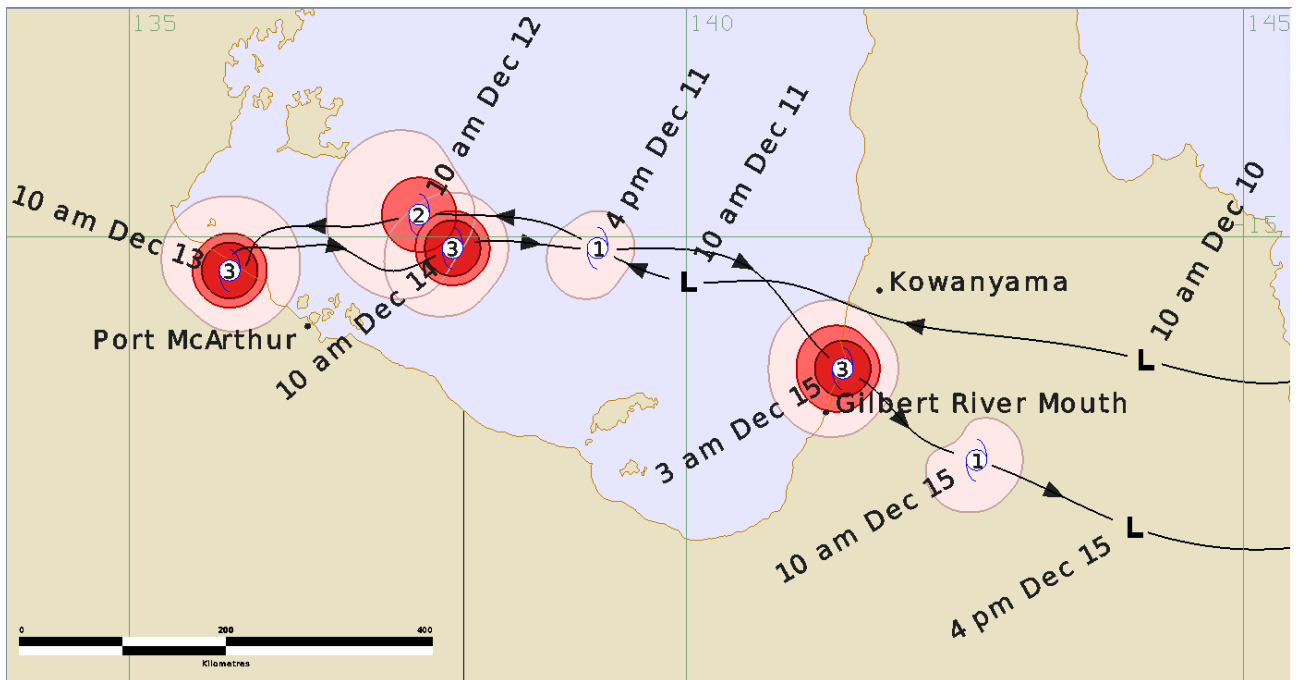


Figure 3 Detailed best track of Severe Tropical Cyclone Owen in the Gulf of Carpentaria for 11-15 December 2018 showing wind radii (gale - pink, storm - red and hurricane force – dark red) (times in ACST, UTC +9.5).

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Table 1. Best track summary for Severe Tropical Cyclone Owen, 30 November – 21 December 2018. UTC=ACST-9.5h and AEST - 10h.

Year	Month	Day	Hour UTC	Pos. Lat. S	Pos. Long. E	Pos. Acc. nm	Max Wind 10min kn	Max gust kn	Cent. Press. hPa	Rad. of gales (NE/SE/SW/NW)	Rad. of storm (NE/SE/SW/NW)	RMW nm
2018	11	30	0000	8.7	155.6	30	15	35	1008	0/0/0/0	0/0/0/0	-
2018	11	30	0600	9.8	155.4	40	15	40	1004	0/0/0/0	0/0/0/0	-
2018	11	30	1200	10.4	154.9	40	15	40	1005	0/0/0/0	0/0/0/0	-
2018	11	30	1800	11.0	154.6	50	15	40	1004	0/0/0/0	0/0/0/0	-
2018	12	1	0000	11.5	154.5	40	15	45	1004	0/0/0/0	0/0/0/0	-
2018	12	1	0600	11.9	154.4	40	15	45	1002	0/0/0/0	0/0/0/0	-
2018	12	1	1200	12.3	154.4	30	15	45	1002	0/0/0/0	0/0/0/0	-
2018	12	1	1800	13.0	154.3	40	25	45	1000	0/0/0/0	0/0/0/0	-
2018	12	2	0000	13.9	154.3	20	35*	45	1000	0/60/0/0	0/0/0/0	-
2018	12	2	0600	14.1	154.5	20	35	50	997	30/60/30/20	0/0/0/0	20
2018	12	2	1200	14.6	154.7	30	40	55	997	40/60/30/20	0/0/0/0	20
2018	12	2	1800	15.2	154.9	30	45	65	994	40/60/30/20	0/0/0/0	20
2018	12	3	0000	15.6	155.1	20	45	65	996	40/60/30/20	0/0/0/0	20
2018	12	3	0600	15.7	155.4	30	40	55	995	40/60/30/0	0/0/0/0	20
2018	12	3	1200	16.0	155.8	25	40*	55	995	40/60/0/0	0/0/0/0	20
2018	12	3	1800	16.0	156.2	30	40*	55	995	50/60/0/0	0/0/0/0	-
2018	12	4	0000	15.9	156.1	40	35*	45	996	70/60/0/0	0/0/0/0	-
2018	12	4	0600	16.2	155.4	30	30	40	998	0/0/0/0	0/0/0/0	-
2018	12	4	1200	16.6	155.1	25	30	40	1000	0/0/0/0	0/0/0/0	-
2018	12	4	1800	17.0	154.8	25	25	40	1000	0/0/0/0	0/0/0/0	-
2018	12	5	0000	17.1	154.5	20	25	40	1002	0/0/0/0	0/0/0/0	-
2018	12	5	0600	17.2	154.2	20	25	40	1000	0/0/0/0	0/0/0/0	-
2018	12	5	1200	17.1	153.4	20	25	40	1002	0/0/0/0	0/0/0/0	-
2018	12	5	1800	17.1	152.5	20	25	40	1002	0/0/0/0	0/0/0/0	-
2018	12	6	0000	16.7	151.6	15	25	40	1002	0/0/0/0	0/0/0/0	-
2018	12	6	0600	16.1	151.2	15	25	40	1000	0/0/0/0	0/0/0/0	-
2018	12	6	1200	15.9	151.0	20	25	40	1000	0/0/0/0	0/0/0/0	-
2018	12	6	1800	15.8	150.8	20	25	40	1000	0/0/0/0	0/0/0/0	-
2018	12	7	0000	15.8	150.7	20	30	40	1000	0/0/0/0	0/0/0/0	-
2018	12	7	0600	15.8	150.5	25	30	40	1000	0/0/0/0	0/0/0/0	-
2018	12	7	1200	15.9	150.3	30	30	40	1000	0/0/0/0	0/0/0/0	-
2018	12	7	1800	16.0	150.0	30	30	40	1000	0/0/0/0	0/0/0/0	-
2018	12	8	0000	16.0	149.7	30	30	40	1002	0/0/0/0	0/0/0/0	-
2018	12	8	0600	16.3	149.2	20	30	40	1000	0/0/0/0	0/0/0/0	-
2018	12	8	1200	16.3	148.5	50	30	45	1000	0/0/0/0	0/0/0/0	-
2018	12	8	1800	16.3	147.6	50	30	45	998	0/0/0/0	0/0/0/0	-
2018	12	9	0000	16.1	147.3	20	30	45	999	0/0/0/0	0/0/0/0	-
2018	12	9	0600	16.1	146.9	20	30	45	996	0/0/0/0	0/0/0/0	-
2018	12	9	1200	16.1	146.3	20	35*	45	995	0/30/30/0	0/0/0/0	-
2018	12	9	1800	16.3	145.4	20	35*	45	993	0/30/20/0	0/0/0/0	-
2018	12	10	0000	16.1	144.1	20	20	45	995	0/0/0/0	0/0/0/0	-
2018	12	10	0600	15.9	142.9	25	20	45	996	0/0/0/0	0/0/0/0	-
2018	12	10	1200	15.7	141.7	30	20	45	998	0/0/0/0	0/0/0/0	-



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2018	12	10	1800	15.4	140.8	30	25	45	998	0/0/0/0	0/0/0/0	-
2018	12	11	0000	15.4	140.0	20	30	45	998	0/0/0/0	0/0/0/0	-
2018	12	11	0600	15.1	139.2	15	35	50	997	20/20/30/20	0/0/0/0	10
2018	12	11	1200	14.9	138.8	10	40	55	993	30/30/50/30	0/0/0/0	12
2018	12	11	1800	14.8	137.9	15	40	55	994	30/30/50/30	0/0/0/0	15
2018	12	12	0000	14.8	137.6	15	50	70	986	30/30/50/50	20/20/20/20	12
2018	12	12	0600	14.9	137.1	15	55	75	980	40/40/40/40	20/20/20/20	10
2018	12	12	1200	14.9	136.6	15	60	85	978	40/40/40/40	20/20/20/20	8
2018	12	12	1800	15.1	136.1	15	70	100	970	40/30/30/40	20/15/15/20	8
2018	12	12	2100	15.3	136.0	15	85	120	957	40/30/30/40	20/20/20/20	7
2018	12	13	0000	15.3	135.9	15	85	120	956	40/35/30/40	20/20/20/20	7
2018	12	13	0300	15.2	135.9	10	80	110	958	40/35/30/40	20/20/20/0	7
2018	12	13	0600	15.1	136.3	15	80	110	959	35/35/30/30	20/20/20/20	7
2018	12	13	1200	15.1	136.9	15	80	110	962	30/30/40/30	20/20/20/20	8
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2018	12	14	0000	15.1	137.9	10	75	105	966	30/30/40/30	20/20/20/20	7
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2018	12	14	1200	15.3	140.6	15	65	90	975	40/30/40/30	20/20/20/20	10
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2018	12	14	1800	16.3	141.6	15	55	75	984	25/25/40/40	15/15/25/25	10
2018	12	14	2100	16.8	142.1	20	50	70	987	25/25/35/20	15/15/15/0	15
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2018	12	15	0600	17.6	144.0	20	30	45	994	0/0/0/0	0/0/0/0	-
2018	12	15	1200	17.8	145.2	20	30	45	996	0/0/0/0	0/0/0/0	-
2018	12	15	1600	17.8	146.1	20	30	45	996	0/0/0/0	0/0/0/0	-
2018	12	15	1800	18.0	146.6	20	30	45	996	0/0/0/0	0/0/0/0	-
2018	12	16	0000	18.7	148.3	20	30	45	998	0/0/0/0	0/0/0/0	-
2018	12	16	0600	19.3	149.9	20	25	40	996	0/0/0/0	0/0/0/0	-
2018	12	16	1200	19.6	150.0	20	25	40	998	0/0/0/0	0/0/0/0	-
2018	12	16	1800	20.0	150.0	20	25	40	998	0/0/0/0	0/0/0/0	-
2018	12	17	0000	20.8	150.4	20	25	40	1000	0/0/0/0	0/0/0/0	-
2018	12	17	0600	20.6	150.9	20	25	40	998	0/0/0/0	0/0/0/0	-
2018	12	17	1200	20.4	151.4	20	25	40	1000	0/0/0/0	0/0/0/0	-
2018	12	17	1800	20.0	152.0	20	25	40	1000	0/0/0/0	0/0/0/0	-
2018	12	18	0000	19.7	152.5	15	25	40	1002	0/0/0/0	0/0/0/0	-
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2018	12	18	1200	20.1	153.1	20	20	40	1002	0/0/0/0	0/0/0/0	-
2018	12	18	1800	19.9	153.2	20	20	40	1002	0/0/0/0	0/0/0/0	-
2018	12	19	0000	19.8	152.5	15	20	40	1004	0/0/0/0	0/0/0/0	-
2018	12	19	0600	19.4	151.8	20	20	40	1002	0/0/0/0	0/0/0/0	-
2018	12	19	1200	18.4	151.6	15	20	40	1004	0/0/0/0	0/0/0/0	-
2018	12	19	1800	17.9	151.2	20	20	40	1004	0/0/0/0	0/0/0/0	-
2018	12	20	0000	17.4	150.6	15	20	40	1004	0/0/0/0	0/0/0/0	-
2018	12	20	0600	16.9	150.0	20	20	40	1002	0/0/0/0	0/0/0/0	-
2018	12	20	1200	16.7	149.9	20	15	35	1004	0/0/0/0	0/0/0/0	-
2018	12	20	1800	16.6	149.6	20	15	35	1004	0/0/0/0	0/0/0/0	-
2018	12	21	0000	16.6	149.3	15	15	35	1004	0/0/0/0	0/0/0/0	-



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2. Meteorological description

2.1 Intensity analysis

A comparison of the intensity estimates is shown in Figure 4.

A weak low formed in the Solomon Sea on 30 November and moved southwards into the northeastern Coral Sea on 1 December. The circulation was initially hampered by easterly vertical wind shear but this eased overnight from 1 to 2 December coincident with an increase in deep convection near the centre. An ASCAT wind pass at 2232 UTC 1 December showed gales southeast of the centre. Tropical Cyclone intensity is estimated at 06 UTC 2 December. Microwave imagery (SSMIS 91 GHz H) at 0613 UTC 2 December shown in Figure 5 showed strong curvature in the deep convection and Dvorak estimates based on visible imagery reached 3.0. Subsequent ASCAT imagery (ASCAT-B at 2315 UTC 2 December) confirmed the extension of gales near the centre, albeit not continuous around the centre as shown in Figure 6. Deep convection and the strongest winds were evident southeast of the centre, assisted by strong upper-level divergent flow in that region associated with an upper-level mid-latitude low in the Tasman Sea.

As Tropical Cyclone Owen moved further to the south on 3 December it encountered higher upper-level westerly winds which combined with drier air in the mid-levels to weaken the circulation. An ASCAT-A pass at 1043 UTC 3 December showed gales restricted to eastern quadrants indicating the system was below tropical cyclone intensity.

Deep convection rapidly weakened near the centre on 4 December. Over the following days the low tracked westwards towards the Queensland coast as a weak circulation. Deep convection increased about the centre on 9 December but landfall north of Cairns early on 10 December prevented further intensification. The low then tracked overland, emerging into the southeast Gulf of Carpentaria on 11 December.

Environmental conditions in the Gulf of Carpentaria were favourable for the low to re-intensify with high SSTs ~30-31 °C; high moisture in the low to mid-levels; low to moderate wind shear and strong upper-level outflow south of the circulation. Once the low was located over water, deep convection developed quite quickly. Visible imagery indicated a small and tight circulation, although Dvorak DT numbers were limited to 2.5 at 0600 UTC 11 December. The Mornington Island radar depicted a well-developed circulation with heavy rainbands wrapping more than halfway around the centre (Figure 7). The low was renamed Tropical Cyclone Owen at 0600 UTC 11 December.

Owen continued to move westwards with deep convection persisting near its centre. It reached category 2 intensity at 0000 UTC 12 December over southwest Gulf of Carpentaria. Rapid intensification continued during 12 December and an eye emerged first on microwave imagery at 0725 UTC and then on IR imagery between 15-20 UTC 12 December.

Peak intensity was estimated at 80 kn (148 km/h) as Owen made landfall at 21 UTC 12 December. The SSMIS microwave image at 1836 UTC 12 December in Figure 8 and EIR at 2010 UTC in Figure 9 both showed well defined eye features. Hourly Dvorak DT estimates fluctuated and reached as high as 6.0 but time averaged FT estimates were constrained to 5.0. This is consistent with objective estimates: SATCON estimate at 1940 UTC was 93 kn (172 km/h), CIMSS ADT 90 kn (167 km/h) and AMSU at 1841 UTC was 96 kn (178 km/h) - all 1-minute estimates.

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Owen temporarily made landfall over southwest Gulf of Carpentaria coast, about 90 km northwest of Port McArthur at 2100 UTC 12 December. Owen maintained its peak intensity for another 12 hours as it moved northwards, back over open waters and began tracking towards the east, across the southern Gulf of Carpentaria. Owen maintained deep convection with cold cloud tops near its centre for its entire journey across the Gulf of Carpentaria. The AMSR2 89 GHz microwave image at 0417 UTC 14 December showed Owen as a well-defined but very small circulation. This was supported by the ASCAT-B wind distribution at 0029 UTC 14 December and the Monington Island radar imagery, as shown in the example at 0420 UTC in Figure 7.

The SSMI 85 GHz microwave image at 1722 UTC 14 December (refer Figure 12) shows a weakening of the northern eye wall as Owen made landfall over the west coast of Cape York Peninsula, 50 km north of Gilbert River Mouth in Queensland. The estimated intensity at the time of landfall was a category 3 cyclone with a 10-minute mean maximum wind of 65 kn (120 km/h).

Once over land, Owen weakened rapidly to a category 1 cyclone at 0000 UTC 15 December and below tropical cyclone strength soon after.

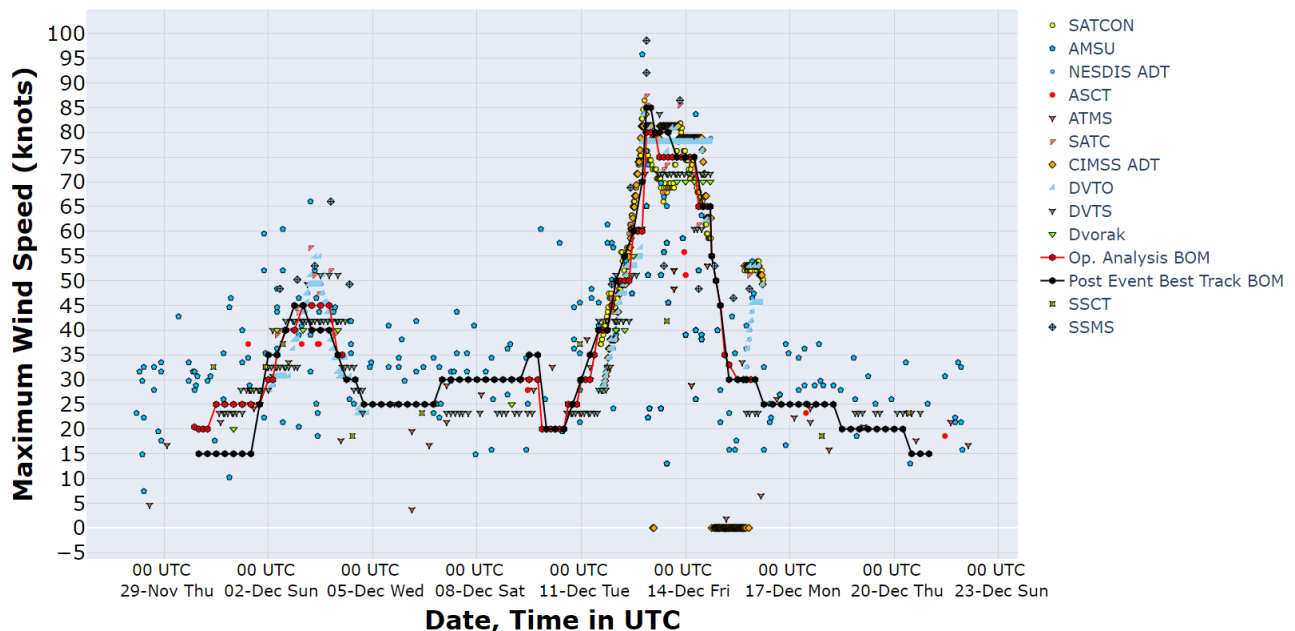


Figure 4 Intensity comparison plot showing the best track intensity (black) against the operational analysis (red) and subjective Dvorak and various objective estimates including SATCON and CIMSS ADT.



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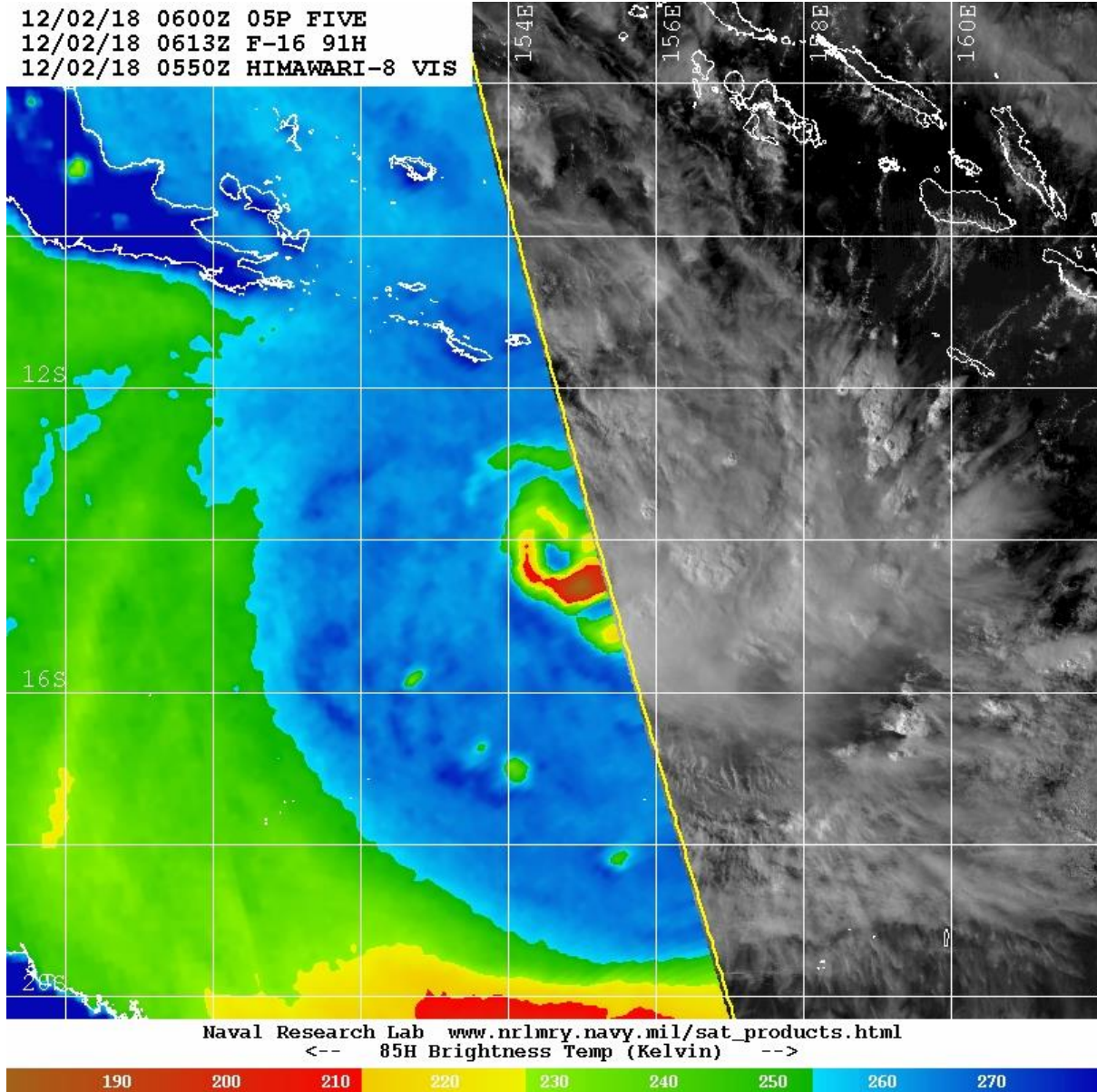


Figure 5 Special Sensor Microwave Image/Sounder (SSMIS) 91 GHz image at 0613 UTC 2 December, showing strong curvature in deep convection suggesting tropical cyclone intensity had been attained. Image courtesy NRL:
<https://www.nrlmry.navy.mil/TC.html>

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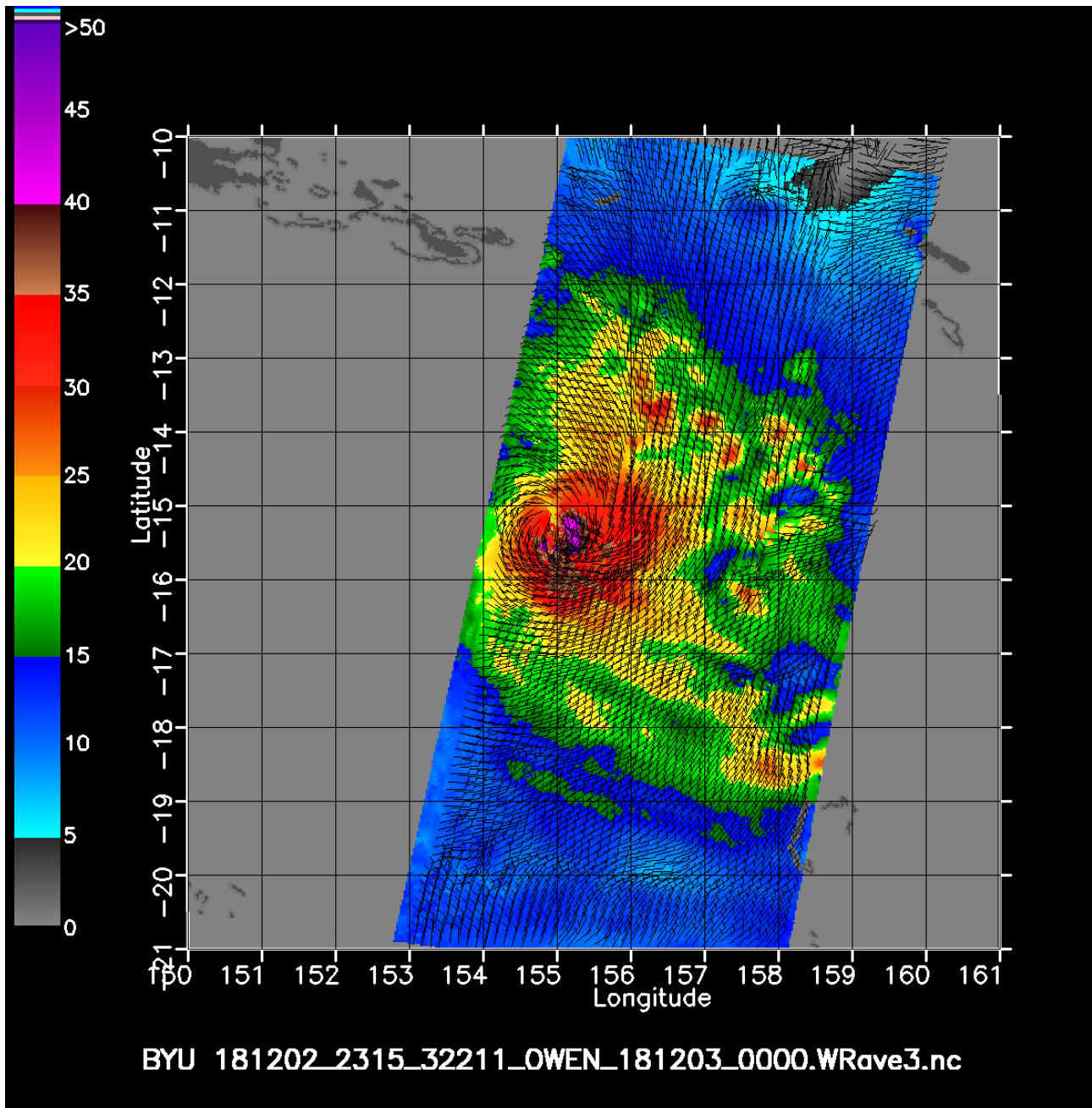


Figure 6 Advanced Scatterometer (ASCAT-B) wind distribution at 2315 UTC 2 December indicating gales around the centre. Image courtesy NRL: <https://www.nrlmry.navy.mil/TC.html>

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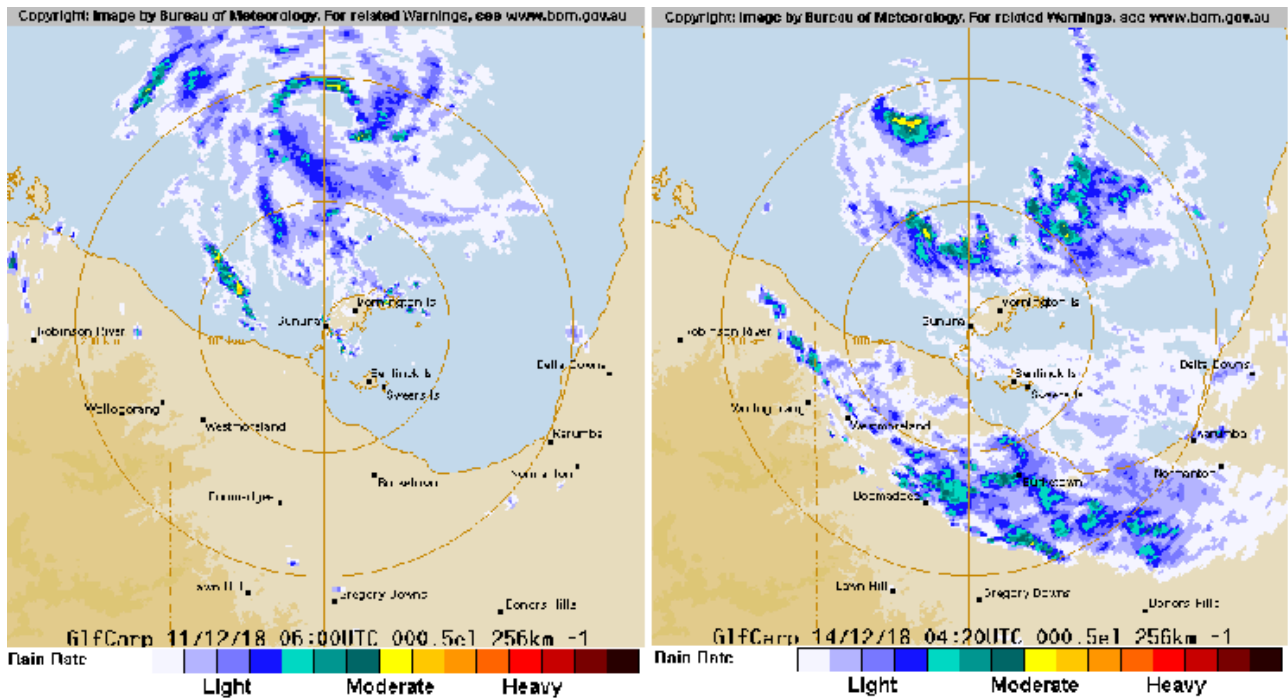


Figure 7 Morrongton Island radar image at a. 0600 UTC 11 December 2018 when category 1 Owen estimated was moving to the west; and b. 0420 UTC 14 December showing a small well-defined eye when category 3 Owen was tracking to the east.

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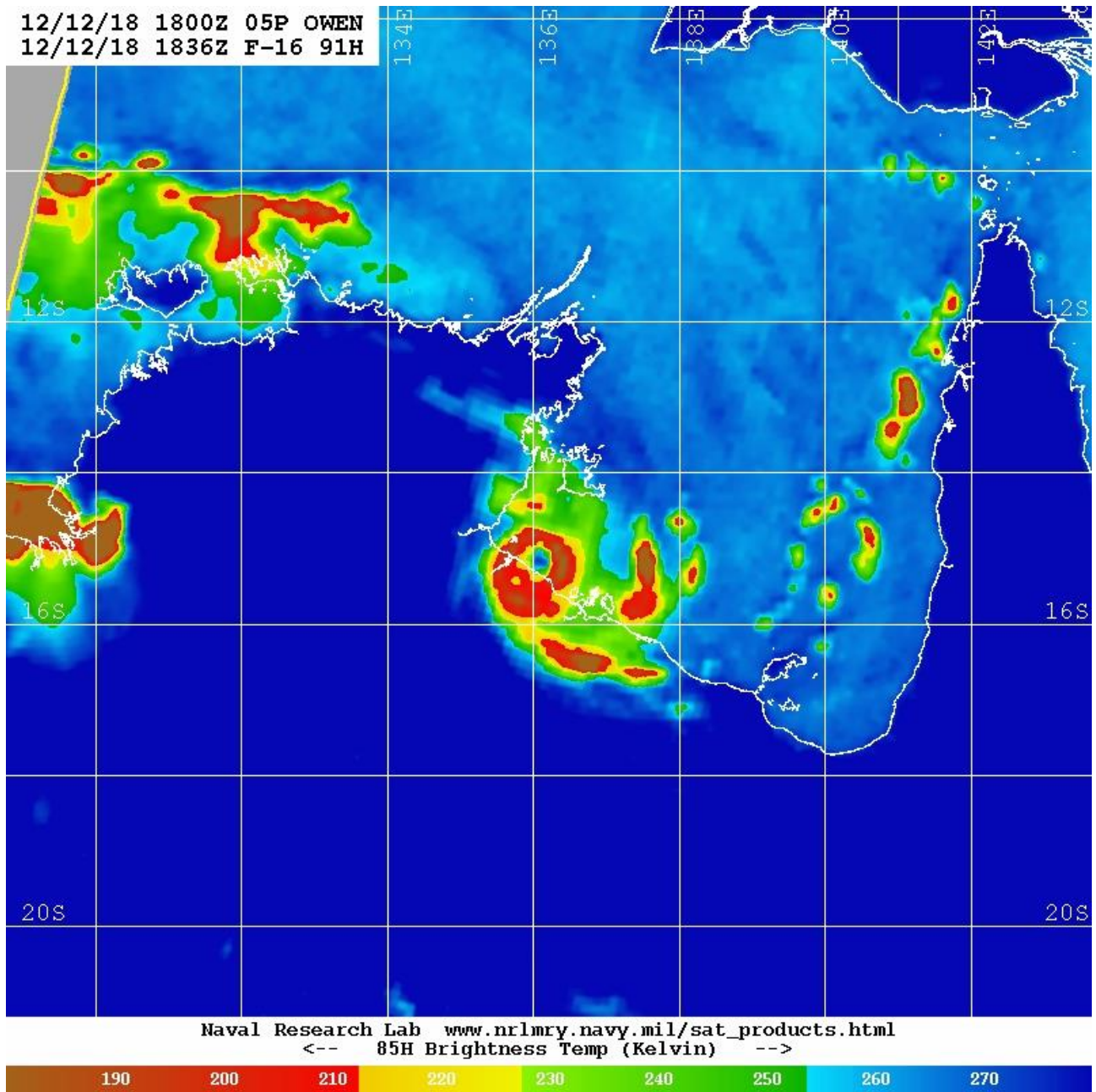


Figure 8 Special Sensor Microwave Image/Sounder (SSMIS) 91 GHz image at 1836 UTC 12 December near peak intensity, showing a small well-defined eye. Image courtesy NRL: <https://www.nrlmry.navy.mil/TC.html>

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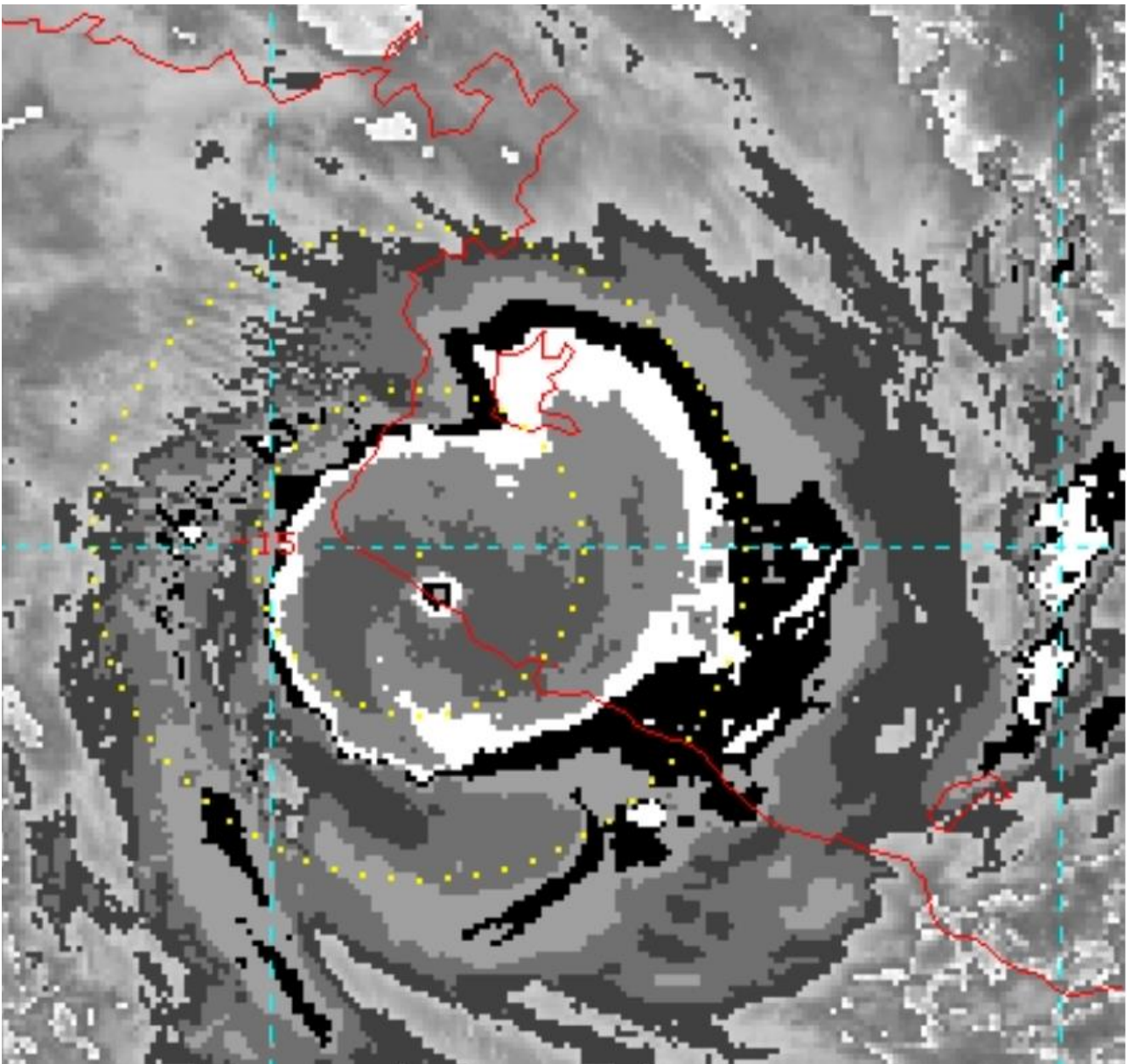


Figure 9 Enhanced Infra-Red image (using Dvorak enhancement) at 2010UTC 12 December near peak intensity, showing a small well-defined eye. Image courtesy CIRA http://rammb-data.cira.colostate.edu/tc_realtime/storm_satellite.asp?storm_identifier=sh052019

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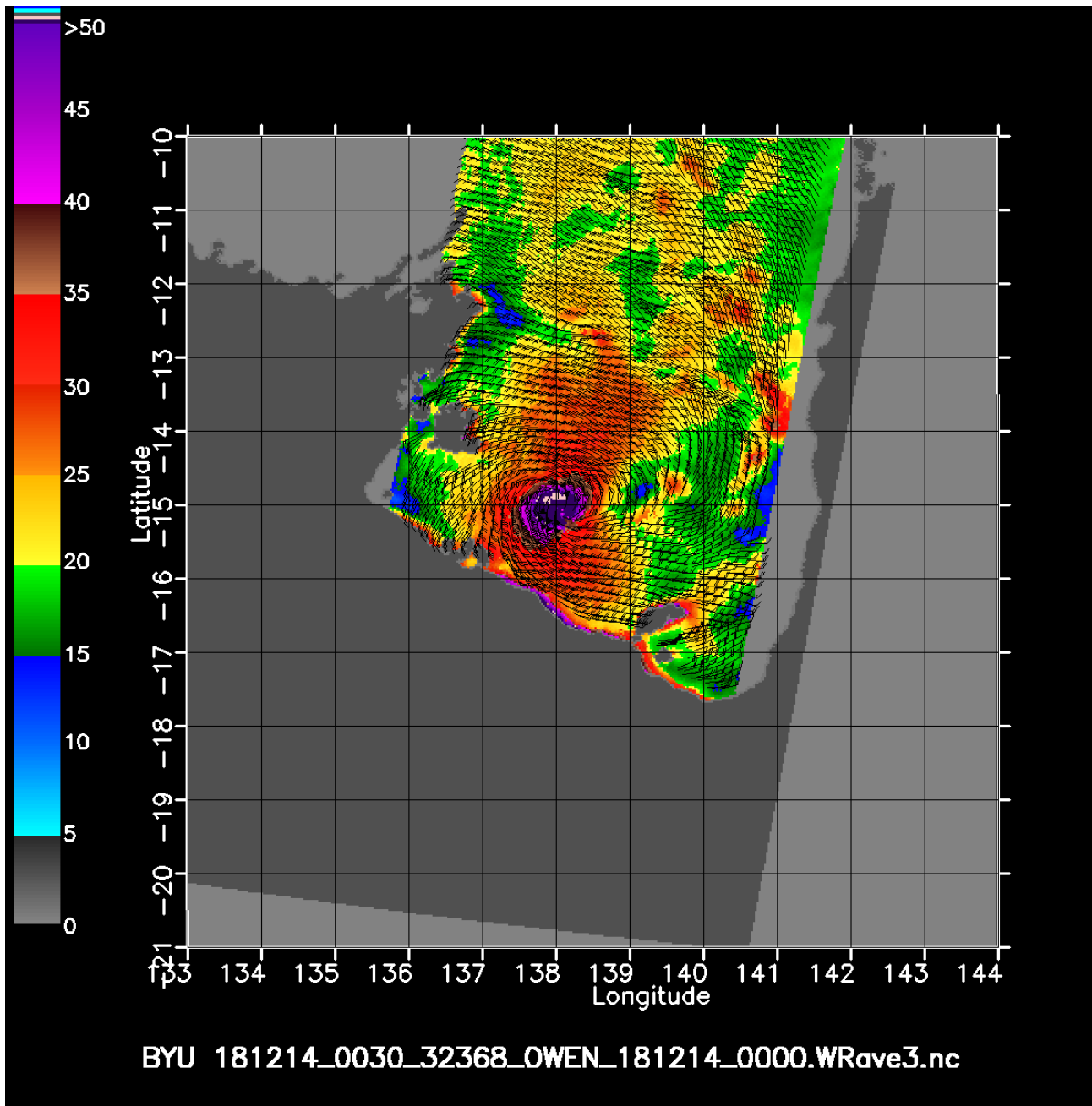


Figure 10 Advanced Scatterometer (ASCAT-B) wind distribution at 0029 UTC 14 December indicating the small extent of gales around the centre (30-40 nm). Image courtesy NRL: <https://www.nrlmry.navy.mil/TC.html>

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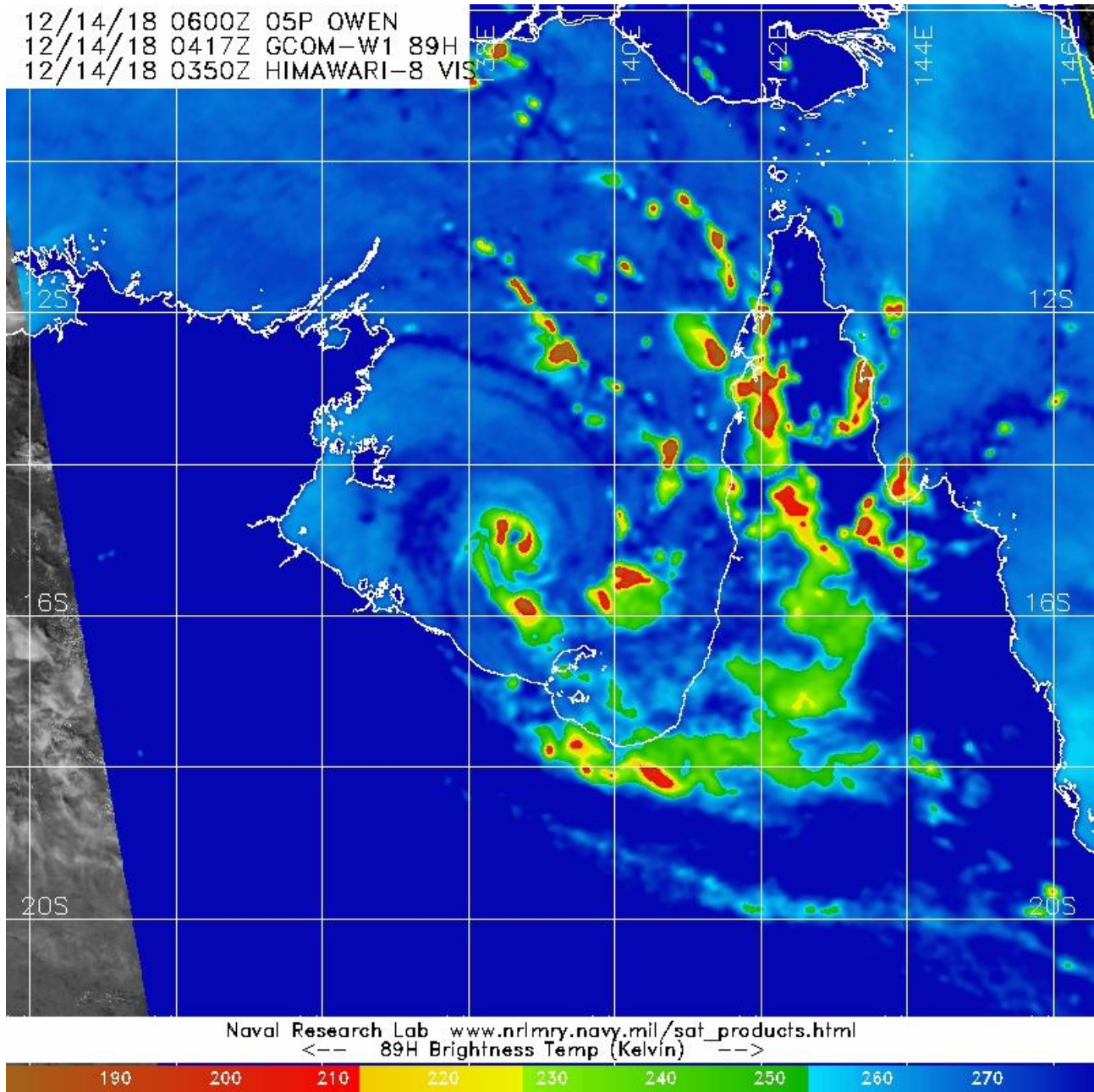


Figure 11 Advanced Microwave Scanning Radiometer (AMSR2) 89 GHz image at 0417 UTC 14 December showing Owen as a well-defined but very small circulation. Image courtesy NRL: <https://www.nrlmry.navy.mil/TC.html>.

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12/14/18 1200Z 05P OWEN
12/14/18 1722Z F-15 85H
12/14/18 1700Z HIMAWARI-8 IR

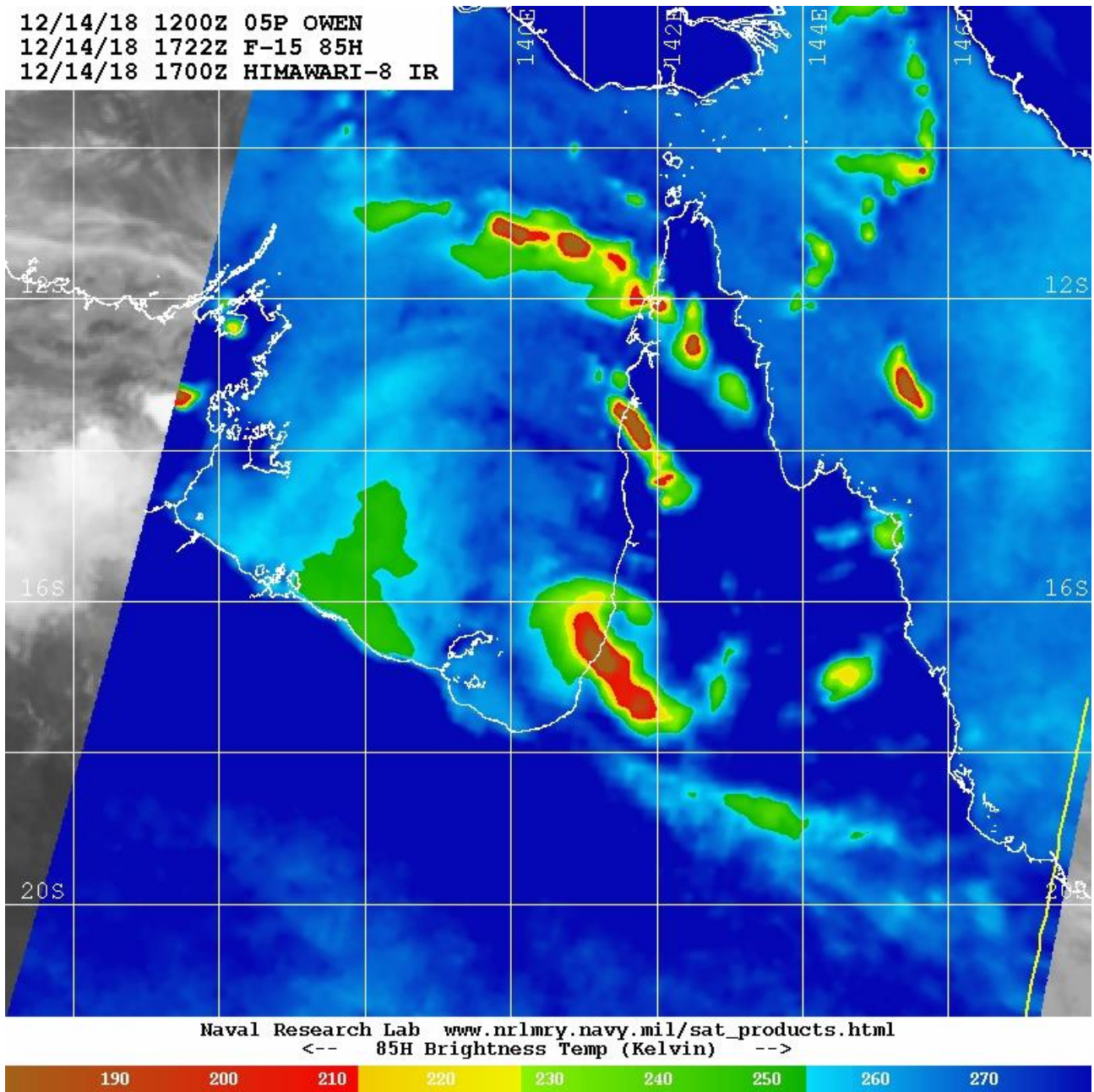


Figure 12 Special Sensor Microwave Imager (SSM/I) 85 GHz image at 1722 UTC 14 December showing Owen making landfall on the Queensland Gulf of Carpentaria coast. Image courtesy NRL: <https://www.nrlmry.navy.mil/TC.html>

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2.2 Structure

Owen was a small tropical cyclone during both its first and second periods at tropical cyclone intensity. During its Coral Sea phase on 2-3 December the radius to gales varied from about 30 to 50 nm (55 to 93 km) north of the centre to up to 60-70 nm (110-130 km) south of the centre as reflected in a series of ASCAT passes such as the ASCAT-B at 2315 UTC 2 December in Figure 6. This reflected the influence of the prevailing east southeasterly flow extending from the sub-tropical ridge to the south.

Owen maintained a very small footprint during its Gulf of Carpentaria phase from 11-14 December even as it reached peak intensity. The extent of gales was only 30-40 nm, as demonstrated on the ASCAT-B wind distribution at 0029 UTC 14 December in Figure 10. The radius to maximum winds (RMW) was small at just 7 nm (14 km) at peak intensity.

2.3 Motion

During the early stages of development, the system was steered to the south by the prevailing mid-level ridge to the northeast. As Owen weakened on 3-4 December and the circulation became shallower, the lower-level ridge to the south became the more dominant steering influence. Hence, the low moved in a general westerly direction at about 10-15 km/h crossing the north Queensland coast north of Cairns early on 10 December.

Under the influence of the low to mid-level ridge over central Australia, the system then moved west northwest at 15-20 km/h emerging into the Gulf of Carpentaria on 11 December. TC Owen slowed as it re-intensified later on 11 and during 12 December as a result of the ridge to the south weakening. The ridge eroded as an amplifying mid-level trough and cut-off low swept over southern Australia. This caused Owen to initially slow down just as it reached the Northern Territory coastline, then turn back to the east on 13 December over the Gulf of Carpentaria.

Owen accelerated to the southeast at 20-30 km/h crossing the Queensland coast early on 15 December south of Kowanyama. The low tracked overland then emerged into the Coral Sea on 16 December south of Cairns. The weakening low then drifted for several days, first to the southeast and east and then to the northwest as it finally dissipated on 21 December.

3. Impact

As the tropical low crossed the Queensland coast on 10 December, strong winds brought trees down at Yarrabah, east of Cairns. Heavy rains also accompanied the system's landfall causing flooding on some rivers systems.

As Owen was very small in size and crossed the coast in a remotely populated area there were no significant impacts apart from several remote roads cut by floodwaters. The residents of King Ash Bay and Bing Bong near Port McArthur were evacuated to Borroloola during the event.

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Centre Island AWS on the periphery of the cyclone recorded just 3 hours of gale force winds with a peak gust of 48 (91 km/h).

Although Owen weakened to a tropical low as it crossed the base of Cape York Peninsula during 15 December it produced a period of torrential rain. Halifax (east of Ingham) registered 681 mm in the 24 hours to 9am AEST 16 December, an Australian daily rainfall record for December. The Bruce Highway was cut by floodwaters north of Ingham. Two rescues occurred, including a mother and daughter rescued from their vehicle in crocodile-infested floodwaters. Sugarcane crops were impacted and hundreds of chickens were lost to flooding. Lucinda also recorded a 54 kn (100 km/h) wind gust as ex-Owen moved offshore.

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4. Observations

4.1 Winds

Low Isles (offshore from Cairns) recorded periods of gale-force winds between 14 – 18 UTC 9 December and a peak wind gust of 54 kn (100 km/h) at 1539 and 1551 UTC 9 Dec (0139 and 0151 AEST 10 Dec.).

Other sites reporting significant gusts included Arlington Reef: 50 kn (93 km/h); Cairns Airport: 47 kn (87 km/h); and Innisfail Airport: 47 kn (87 km/h).

Centre Island AWS (NT) on the periphery of the cyclone recorded gale force winds for periods between 12 – 19 UTC 13 December with a peak gust of 49 kn (91 km/h) at 0030 ACST 14 December (1500 UTC 13 December).

4.2 Rainfall

Figure 13 shows the weekly rainfall map over Queensland for the week ending 16 December showing widespread falls over 100 mm over tropical north Queensland.

Rainfall totals to 24 hours to 9am EST 10 December:

- Kirrama Range Alert (west of Cardwell): 349 mm;
- Flaggy Creek Alert (between Cairns and Port Douglas): 286 mm (including 200 mm in 6 h);
- Cardwell Tide Alert: 278 mm.

Rainfall totals to 24 hours to 9am EST 16 December:

- Halifax (east of Ingham): 681 mm.

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Queensland Rainfall Totals (mm) Week Ending 16th December 2018
Australian Bureau of Meteorology

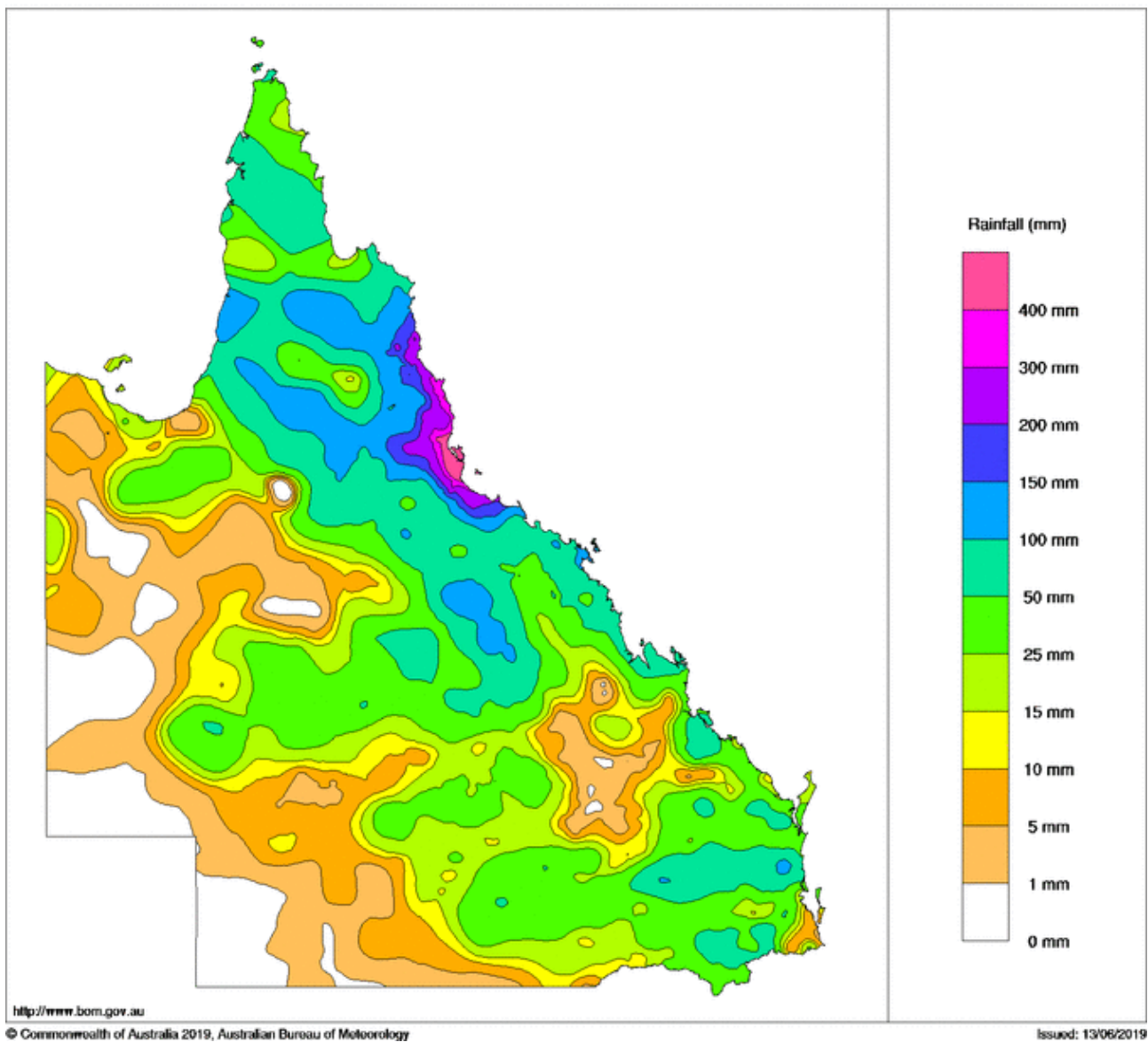


Figure 13 Weekly rainfall map for Queensland 9-16 December 2018 showing widespread falls over 100 mm over tropical north Queensland. Source: <http://www.bom.gov.au/climate/maps/>



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5. Forecast Performance

Tropical Cyclone products were issued from 18 UTC 1 December to 00 UTC 4 December and then from 06 UTC 10 December until 06 UTC 15 December.

Official Tropical Cyclone Advices (hereafter Advices) for the Gulf of Carpentaria region between Cape Shield (NT) to Burketown (Qld) were issued from 04 UTC 10 December. Early Advices included mention of development possibly reaching category three intensity, as shown in the forecast track map in Figure 14. Advices for the Queensland Gulf coast between Burketown and Pormpuraaw commenced around 02 UTC 12 December as shown on the forecast track map in Figure 15. This shows the sharp turn to the east that occurred on 13 December for a severe impact south of Kowanyama. These track maps compare favourably with the actual track and intensity shown in Figure 1. During 13-14 December as Owen approached the southeastern Gulf of Carpentaria, forecasts indicated intensification from category 3 to category 4 intensity by landfall whereas this failed to occur.

The overall accuracy figures for Severe Tropical Cyclone Owen are below and also shown in Figure 16 and Figure 17. These show that the forecast position was similar to the five-year average to 72 hours then better at 96 and 120 hours. The intensity forecasts had similar errors to the five-year average for the first 18 hours, but then significantly better from 24 to 120 hours. These performance figures are even more impressive given the fluctuations in intensity and a track that includes three landfalls and sharp turns in direction.

Table 2. Verification statistics for Severe Tropical Cyclone Owen.

	0	6	12	18	24	36	48	72	96	120
Position										
Absolute error (km)	11	41	63	83	106	147	180	229	256	323
Intensity										
Absolute error (kn)	1.9	6.6	8.7	9.0	8.1	7.4	7.6	8.2	8.3	7.7
Sample Size	31	31	31	31	31	31	31	31	26	26

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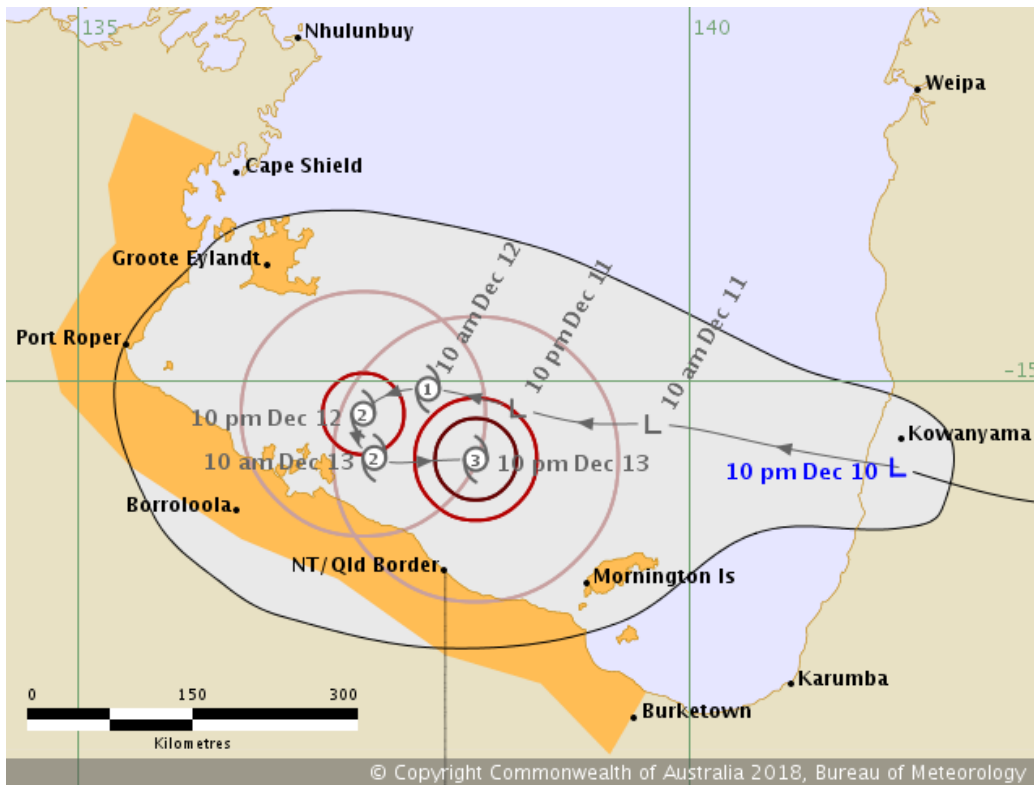


Figure 14 Forecast track map valid from 10pm CST 10 December when ex-TC Owen was over Cape York Peninsula.

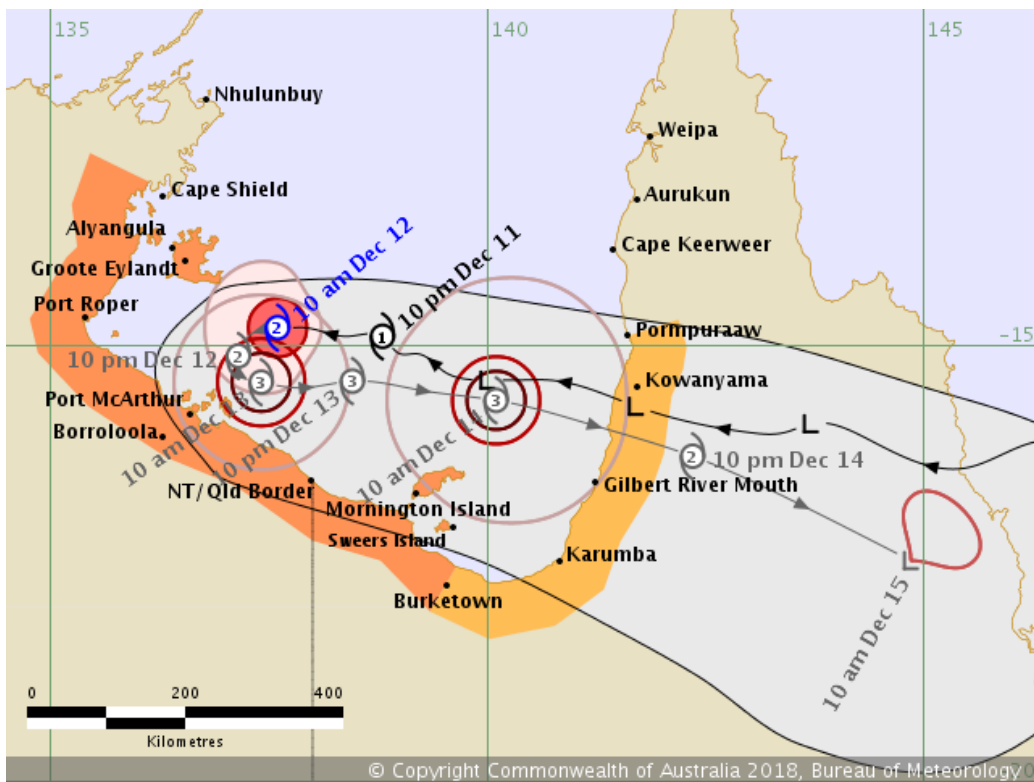


Figure 15 Forecast track map valid from 10am CST 12 December when TC Owen was a Category 2 system approaching the NT coastline.

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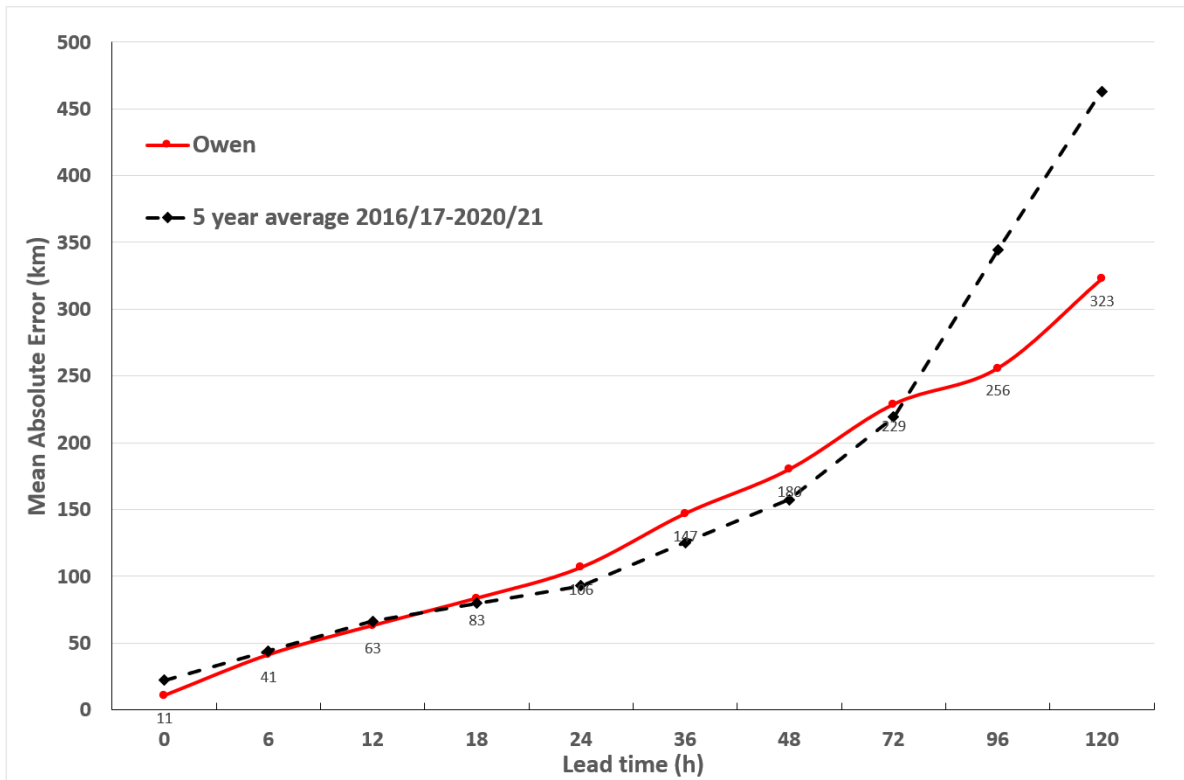


Figure 16 Position accuracy figures for Severe Tropical Cyclone Owen.

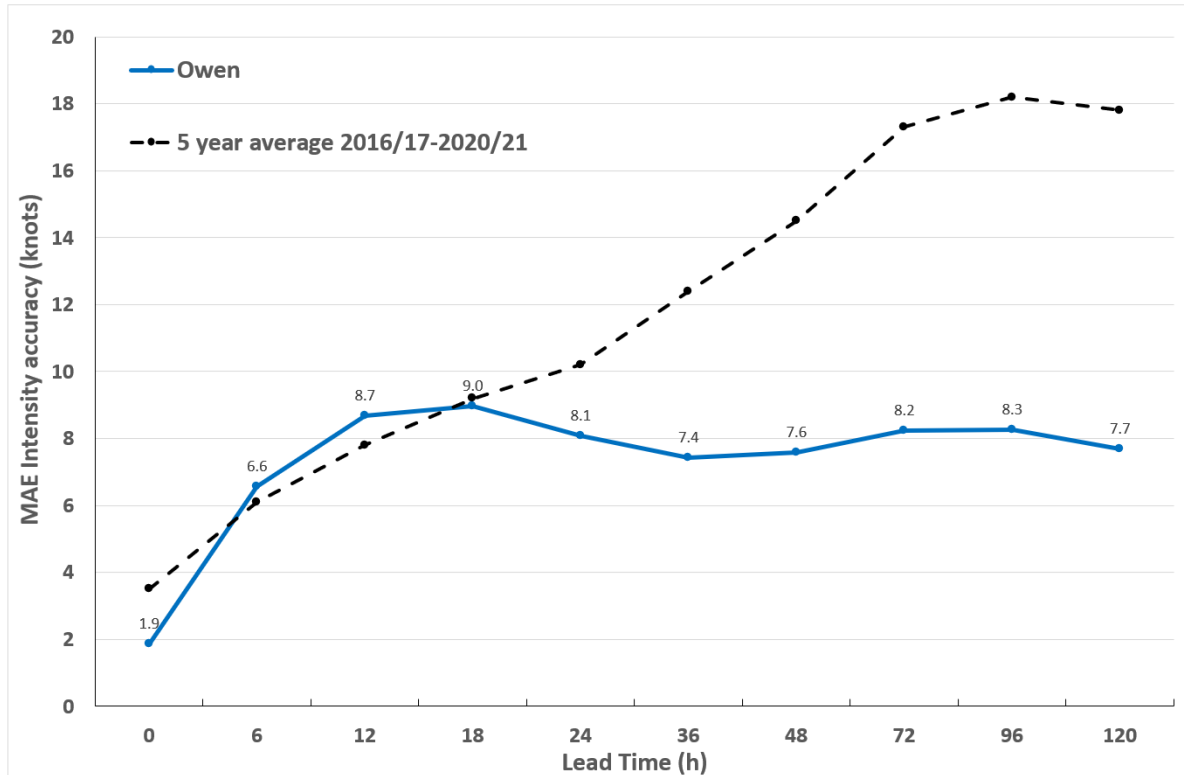


Figure 17 Intensity accuracy figures for Severe Tropical Cyclone Owen.

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6. Appendix: List of abbreviations

Abbreviation	Term
ADT	Advanced Dvorak Technique
ACST	Australian Central Standard Time
AEST	Australian Eastern Standard Time
AMSR2	Advanced Microwave Scanning Radiometer
ASCAT	Advanced Scatterometer
ATMS	Advanced Technology Microwave Sounder
AWS	Automatic Weather Station
AWST	Australian Western Standard Time
°C	Celsius
CI	Current intensity
CIMSS	Cooperative Institute for Meteorological Satellite Studies (USA)
CIRA	Cooperative Institute for Research in the Atmosphere (USA)
EIR	Enhanced InfraRed
ERC	eyewall replacement cycle
FNMOCC	Fleet Numerical Meteorology and Oceanography Centre (USA)
FT	Final T-number
GCOM	Global Change Observation Mission
GHz	Gigahertz
GMI	Global Precipitation Measurement Microwave Imager
h	hour
hPa	hectopascal
HSCAT	Hai Yang 2 Scatterometer (HY-2B, HY-2C)
km	kilometres
km/h	kilometres per hour
kn	knot
LLCC	LLCC



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MET	Model Expected T-number
METOP	Meteorological Operational Satellite
MJO	Madden-Julian Oscillation
mm	millimetres
MSLP	mean sea level pressure
nm	nautical mile
NOAA	National Oceanic and Atmospheric Administration
NRL	Navy Research Lab (USA)
PAT	Pattern T-number
RH	relative humidity
RMW	radius of maximum winds
RSMC	Regional Specialised Meteorological Centre
SAR	Synthetic Aperture Radar
SATCON	satellite Consensus
SMAP	Soil Moisture Active Passive
SMOS	Soil Moisture and Ocean Salinity
SSMIS	Special Sensor Microwave Imager/Sounder
TC	Tropical Cyclone
TCWC	Tropical Cyclone Warning Centre
UTC	Universal Time Co-ordinated