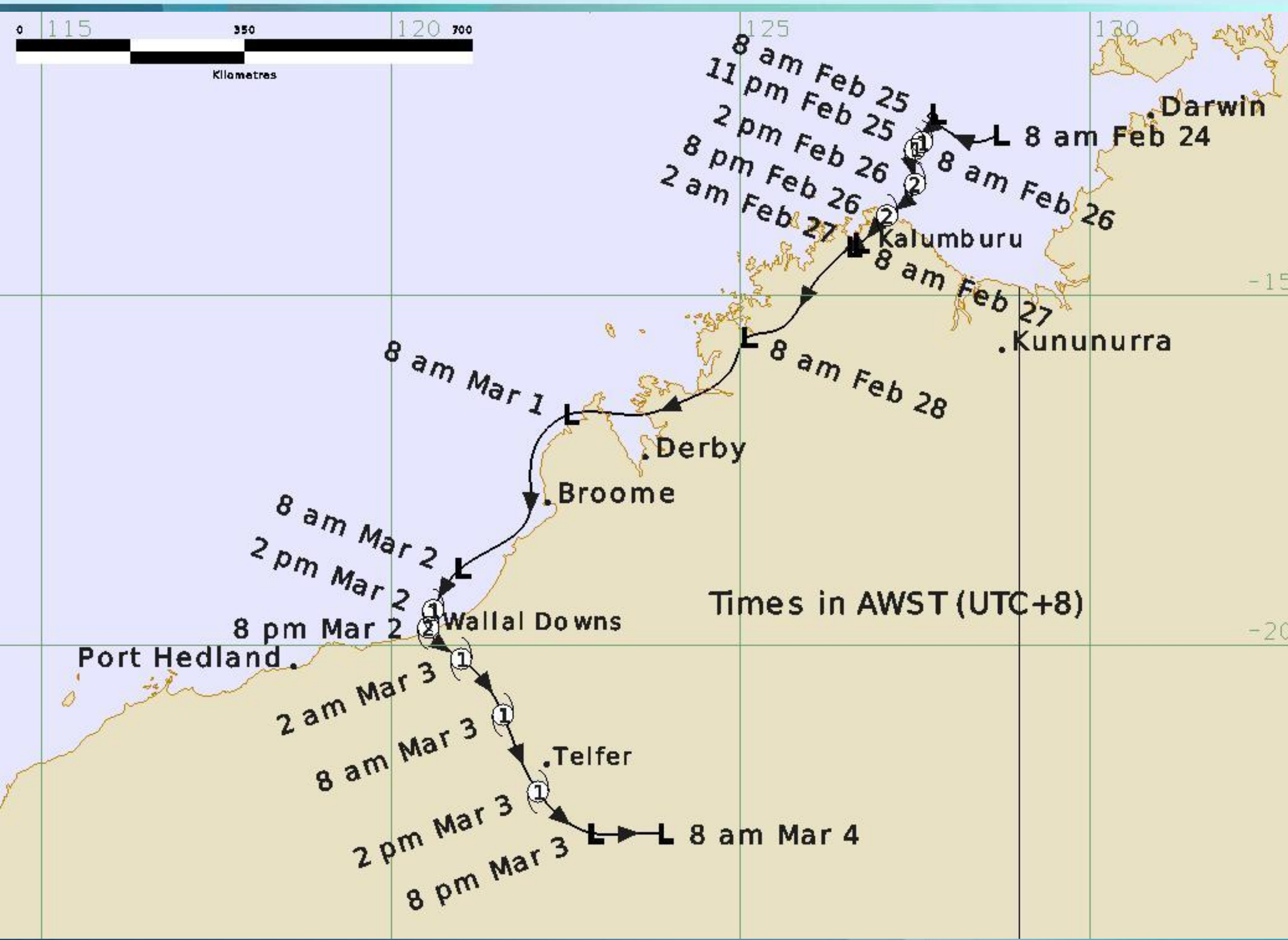
Tropical Cyclone Anika

24 February 2022 – 04 March 2022

Adam Conroy, Severe Weather Environmental Prediction Services
3 June 2022



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1 Summary

A slow moving tropical low formed in the Timor Sea on Thursday 24 February. The low initially moved south on Friday 25 February and intensified, being named Tropical Cyclone Anika later that evening. As Tropical Cyclone Anika continued south, it reached category 2 intensity (50 knots (kn)) shortly before crossing the Kimberley coast east of Kalumburu on the night of Saturday 26 February. After crossing the coast, Tropical Cyclone Anika weakened into a tropical low and tracked southwest just inland from the northwest Kimberley coast between Kalumburu and Cape Leveque.

During Tuesday 1 March ex-tropical cyclone Anika then moved back over water to the north of Broome and tracked south just off the west Kimberley coast. It initially struggled to redevelop, then on Wednesday 2 March, it re-intensified into a tropical cyclone. Tropical Cyclone Anika rapidly strengthened into a category 2 system, again reaching an intensity of 50 knots shortly before crossing the WA coast again along 80 Mile Beach, near Wallal Downs, at 1200 Universal Time Coordinated (UTC) (UTC=Australian Western Standard Time (AWST) - 8 hours) Wednesday 2 March.

Very heavy rain and damaging wind gusts extended over the eastern Pilbara during Thursday 3 March as Tropical Cyclone Anika tracked further inland towards the southeast. It maintained tropical cyclone intensity as it passed to the west of Telfer, then weakened into a tropical low by 1200 UTC 3 March.

A wind gust of 44 kn (81 kilometres per hour (km/h)) was recorded at Truscott at 2013 UTC Saturday 26 February. Rainfall of 333 millimetres (mm) and 250 mm was reported in the 24 hours to 0100 UTC Sunday 27 February at Truscott and Kalumburu respectively.

A wind gust of 50 kn (93 km/h) was reported at Mandora at 1410 UTC on Wednesday 2 March, just after Tropical Cyclone Anika crossed the coast for the second time, and Telfer reported a wind gust of 58 kn (107 km/h) at 0339 UTC on Thursday 3 March. Daily rainfall totals in excess of 100 mm were recorded at various sites in the west Kimberley and east Pilbara.

FIGURE 1 a. Best track of Tropical Cyclone Anika, 24 February 2022 – 4 March 2022 (times in AWST, UTC+8).

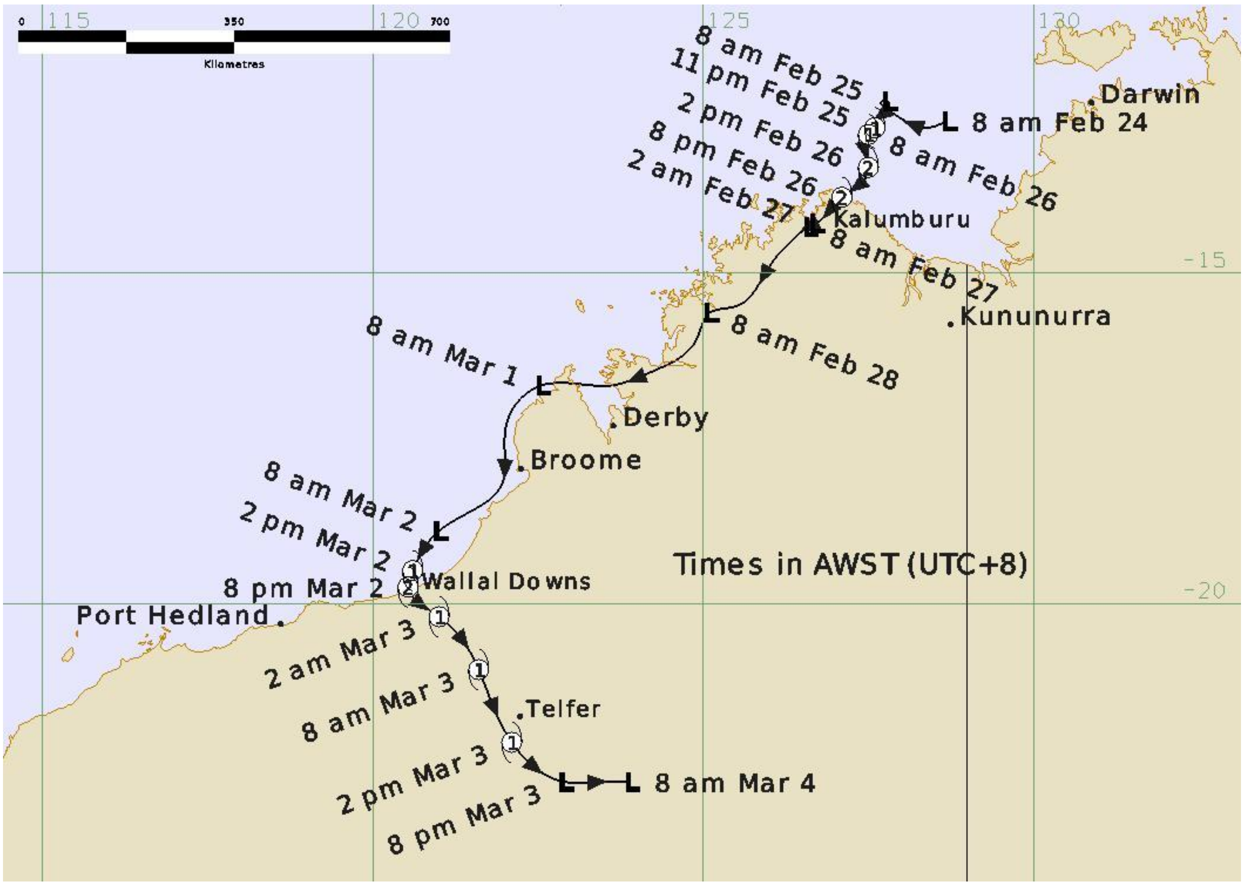


FIGURE 1 b. Best track of Tropical Cyclone Anika over the Timor Sea and North Kimberley, 24 February 2022 – 28 February 2022 (times in AWST, UTC+8).

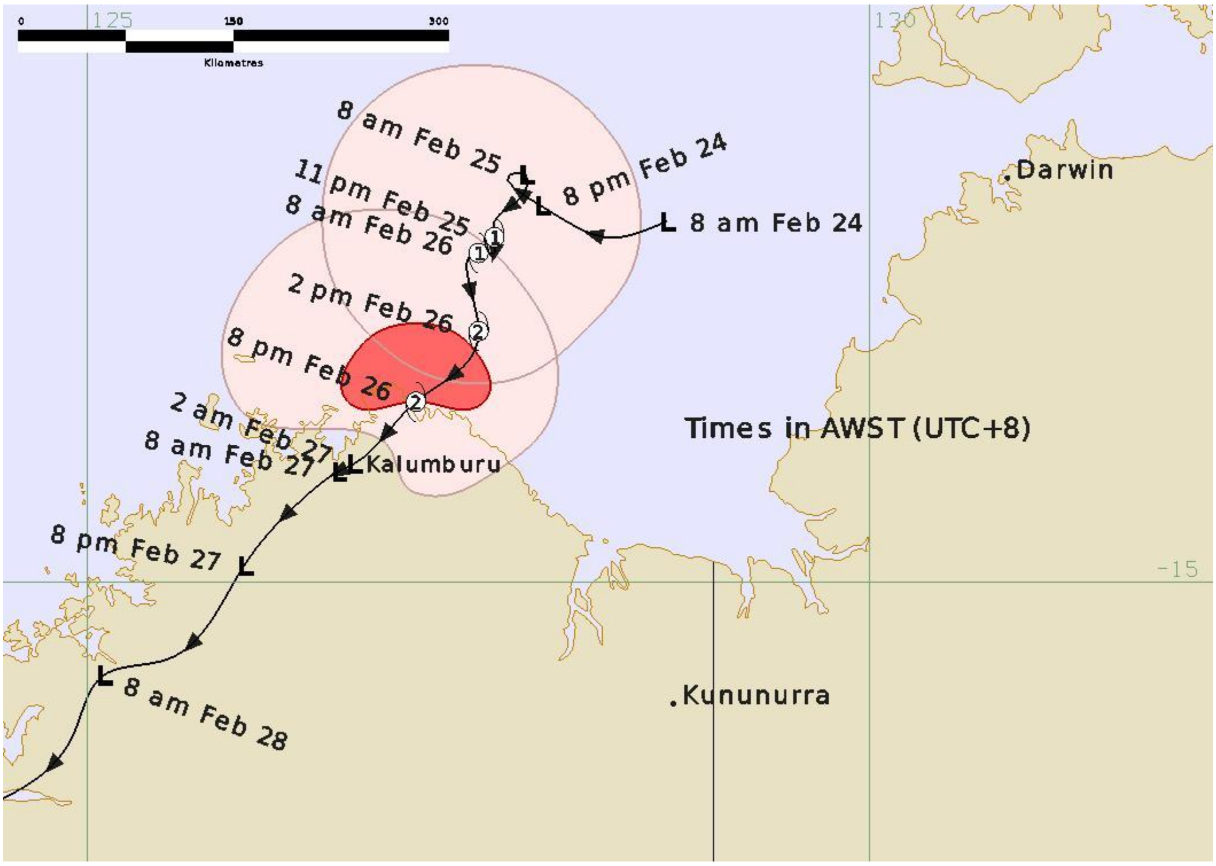
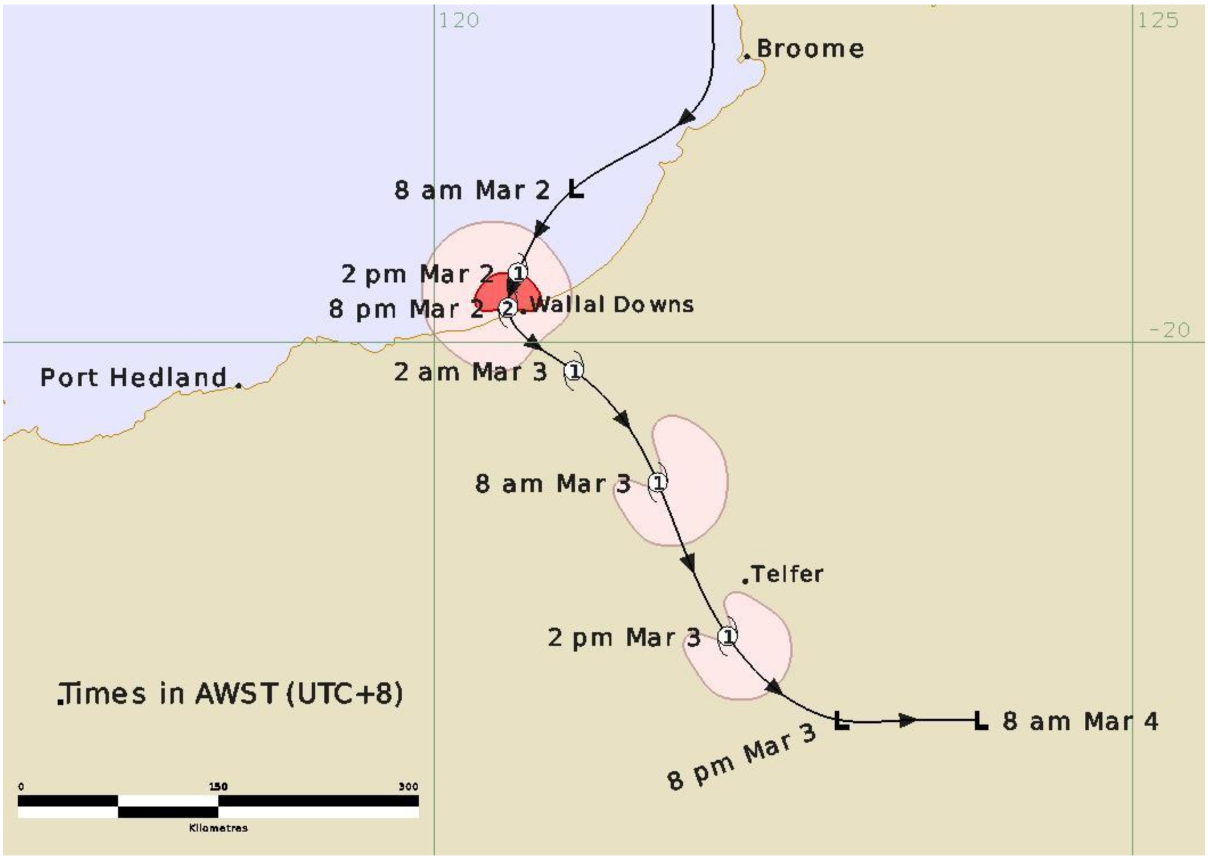


FIGURE 1 c. Best track of Tropical Cyclone Anika second coastal crossing and moving over the inland Pilbara, 1 March 2022 – 4 March 2022 (times in AWST, UTC+8).



2 Meteorological Description

2.1 Intensity analysis

A monsoon trough strengthened through the Timor Sea during 23 February. An area of enhanced convection developed along the trough associated with favourable conditions in the upper levels of the atmosphere. By the morning of 24 February, a low formed in the trough in this area. An initial Dvorak T=1.5 was assigned to the low (given that the convection was already well established once the low formed). The low then proceeded to develop at a faster-than-average rate on account of the favourable environmental conditions. By 1200 UTC 25 February, gales were estimated to have developed in the northwest quadrant of the system, and in the next few hours gales extended into remaining quadrants. At 1500 UTC, the system was name Tropical Cyclone Anika (Figure 2).

Conditions remained conducive to development, and Tropical Cyclone Anika continued to intensify. Advanced Scatterometer (ASCAT) passes (ASCAT-B at 0024 UTC (Figure 3) and ASCAT-C at 0117 UTC 26 February) showed a reasonably symmetric circulation with winds up to 45 knots and gales to a radius of approximately 60 nautical miles (nm). Storm force winds were estimated to have developed in the northern semicircle by 0600 UTC 26 February, and the system reached peak intensity of 50 kt (ten-minute mean) prior to making landfall. An ASCAT-B pass at 1256 UTC (Figure 5) confirmed this, with a small area of 50 kt winds (one-minute mean) to the north of the system centre.

Prior to making landfall at 1200 UTC 26 February, winds on the southern side of Tropical Cyclone Anika started to weaken under the influence of land, and this weakening continued as the system moved slowly inland. By 1800 UTC, land observations and radar structure indicated that gales were unlikely to still be occurring in the southern semicircle, and the system was no longer classified as a tropical cyclone. However, the system was still at 45 knot intensity based on the estimated wind field over waters to the north.

As now ex-tropical cyclone Anika tracked southwest inland from the Kimberley coast, gales continued in at least the northwest quadrant up until 0000 UTC 28 February (confirmed by an ASCAT-B pass at 0036 UTC 28 February). After this time, the low-level circulation weakened, and the mid-level circulation drifted further to the south.

The low-level circulation moved back over water at 0000 UTC 1 March, about 75 nm (140km) to the north of Broome, however it struggled to redevelop initially due to the mid-level circulation being displaced significantly to the south. The structure gradually improved overnight and into the morning of 2 March, and by 0000 UTC gales had redeveloped on the southern side. Conditions in the upper atmosphere were very conducive to development at this stage, with a sharp upper-level trough to the south providing strong upper divergence and outflow. The system responded to this environment by redeveloping into a tropical cyclone at 0600 UTC 2 March. By the time Tropical Cyclone Anika crossed the coast at 1200 UTC 2 March, structure had improved significantly on the Port Hedland radar (Figure 6), and intensity was estimated at 50 knots (Category 2 intensity), matching the peak intensity that was reached on 26 February prior to the first coastal crossing. This was confirmed by an ASCAT-B pass at 1313 UTC 2 March (Figure 7) which showed a small area of 50 knot winds (one-minute mean) near the coast, and the observed minimum mean sea level pressure (MSLP) at Mandora (about 17 nm (30 km) to the east of the crossing point) was 980.0 hPa.

Tropical Cyclone Anika maintained its intensity while moving inland, due to the continuing support in the upper levels of the atmosphere, combined with its passage over flat land with a high heat content (which can act as an energy source for the system similar to the warm tropical ocean). Sustained gales were observed on the eastern side of the system as it passed by Telfer during the middle of the day on 3 March. It is estimated from microwave imagery that gales where also still occurring in the southwest quadrant at 0600 UTC 3 March (Figure 8), thus maintaining the system as a tropical cyclone. Vertical wind shear then increased over the system, and it weakened below tropical cyclone intensity by 1200 UTC 3 March. The remnant low level circulation then dissipated after 0000 UTC 4 March.

Figure 9 shows a comparison of objective and subjective intensity estimates for Tropical Cyclone Anika. Unfortunately. the archived data for SATCON was only available for the period when tropical cyclone Anika redeveloped off the west Kimberley coast. The Advanced Dvorak Technique (ADT) dramatically increased its intensity estimates during 26 February using a Uniform Central Dense Overcast (CDO) scene with cold cloud-top temperatures, however scatterometry indicated that this intensification did not occur.

2.2 Structure

Prior to formation, the monsoon trough had 15 to 20 kt (30 to 40 km/h) west to northwesterly winds on the northern side, with lighter winds on the southern side. A persistent area of convection formed prior to the development of the surface circulation, and it appears likely that a mid-level circulation became established which then allowed the surface circulation to develop. An ASCAT-C pass at 0016UTC 24 February showed the surface circulation had become symmetric in structure, with 20 to 25 knot winds in all quadrants. Presentation on radar, microwave and scatterometry indicated that this circulation remained generally symmetric through tropical cyclone formation and right up until landfall (Figure 4). The radius to gales was mostly in the range of 60 to 80 nm during the tropical cyclone phase, with a radius to maximum winds estimated at 20 to 25 nm.

Once the system moved over land, it lost structure on the southern side (over land) while remaining stronger on the northern side (over water). The system maintained a deep vertical structure until 0000 UTC 28 February, after which the mid-level circulation became displaced to the south of the surface circulation. At 0000 UTC 1 March, the mid-level circulation was located around 70 nm (130 km) south of the surface circulation.

The system regained vertical structure by the morning of 2 March, with gales on the southern side then wrapping around the system during the day. Tropical Cyclone Anika was a smaller system during this second development phase, with the radius to gales mostly under 40nm and the radius to maximum winds estimated at only 12 to 15 nm. By 1200 UTC 2 March, a well-structured eye was visible on the Port Hedland radar (Figure 6), although most of the deep convection still remained over and to the southeast of the centre under the influence of northwesterly shear. These asymmetries remained as Tropical Cyclone Anika moved inland, however the core circulation was still well defined up until the afternoon of 3 March. After this time, the deep convection separated to the south of the low-level circulation under increased northwesterly shear, with the system ultimately dissipating during the morning of 4 March.

2.3 Motion

In the initial stages, the steering flow was balanced between a deep monsoonal northwesterly flow to the north and a ridge to the south. As a result, initial motion was slow, and there was uncertainty in forecast motion due to these competing flows. The ridge moved to the southeast of the system on 25 February, resulting in southwesterly motion over the coming days. There were subtle variations in model guidance during this time, which created uncertainty over if and when the system would move off the west Kimberley coast, but ultimately this did not occur until the morning of 1 March. At this stage, a mid-level trough approached from the southwest, which eroded the ridge and resulted in a more southerly motion until landfall. The trough then steered the system towards the southeast right up until it dissipated on the morning of 4 March.

FIGURE 2. Infrared image at 1500 UTC 25 February, at the time tropical cyclone intensity is estimated.

Image courtesy NRL: https://www.nrlmry.navy.mil/TC.html

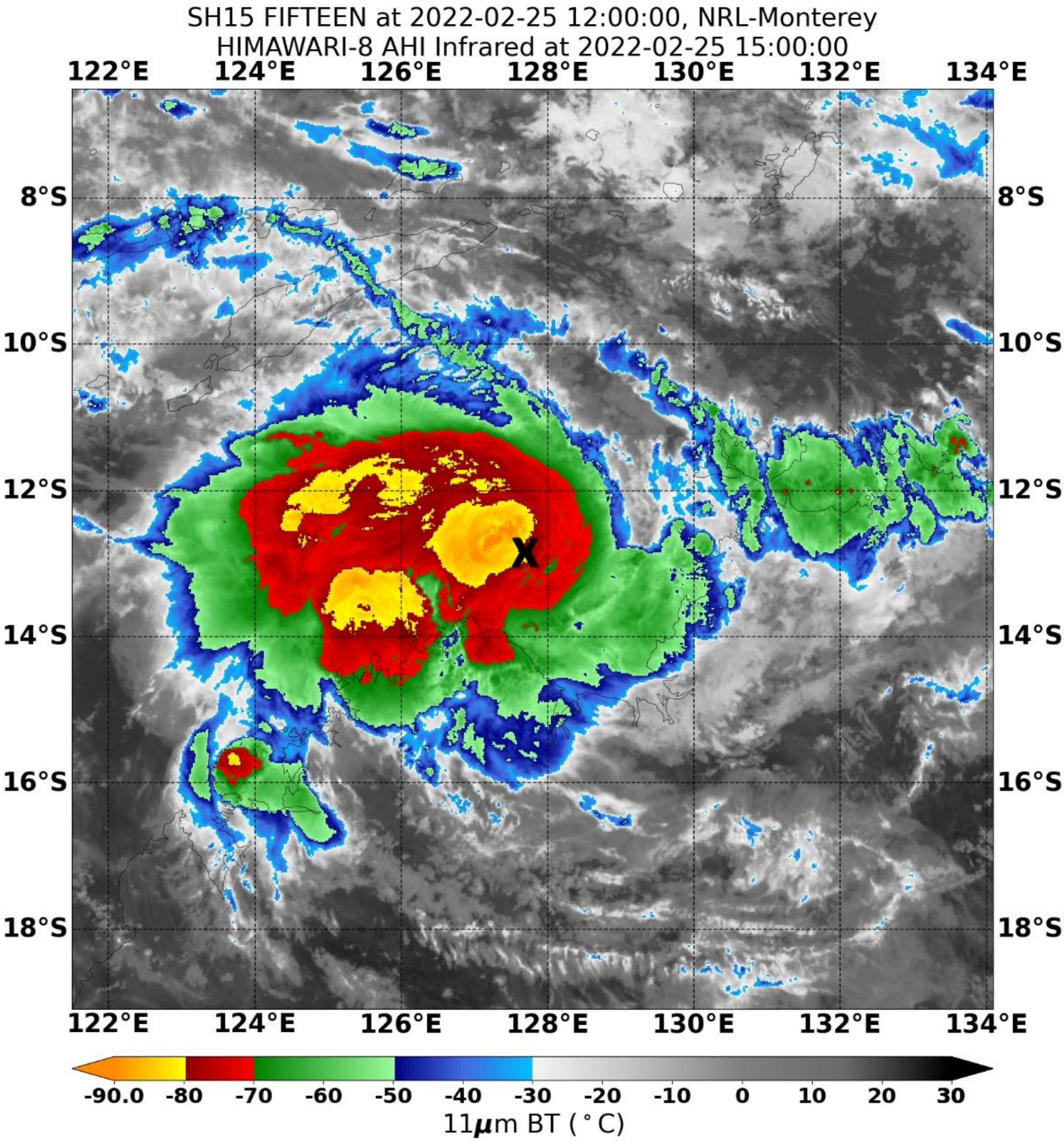


FIGURE 3. ASCAT-B at 0024 UTC 26 February, showing winds up to 45 knots (one-minute mean).

Image courtesy NRL: https://www.nrlmry.navy.mil/TC.html

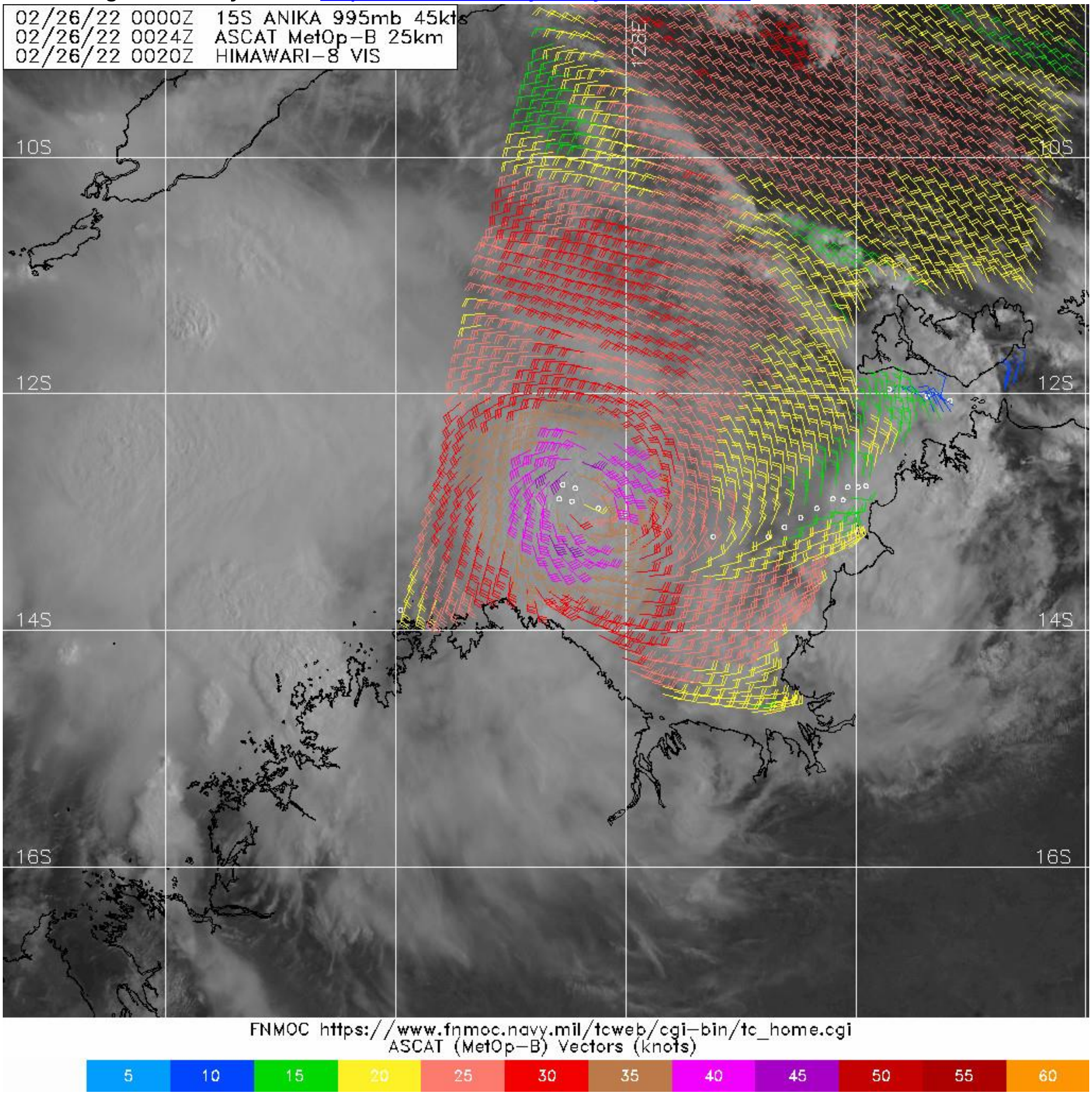


FIGURE 4. SSMIS F17 91GHz microwave pass at 0950 UTC 26 February, showing the structure of Tropical Cyclone Anika close to landfall.

Image courtesy NRL: https://www.nrlmry.navy.mil/TC.html

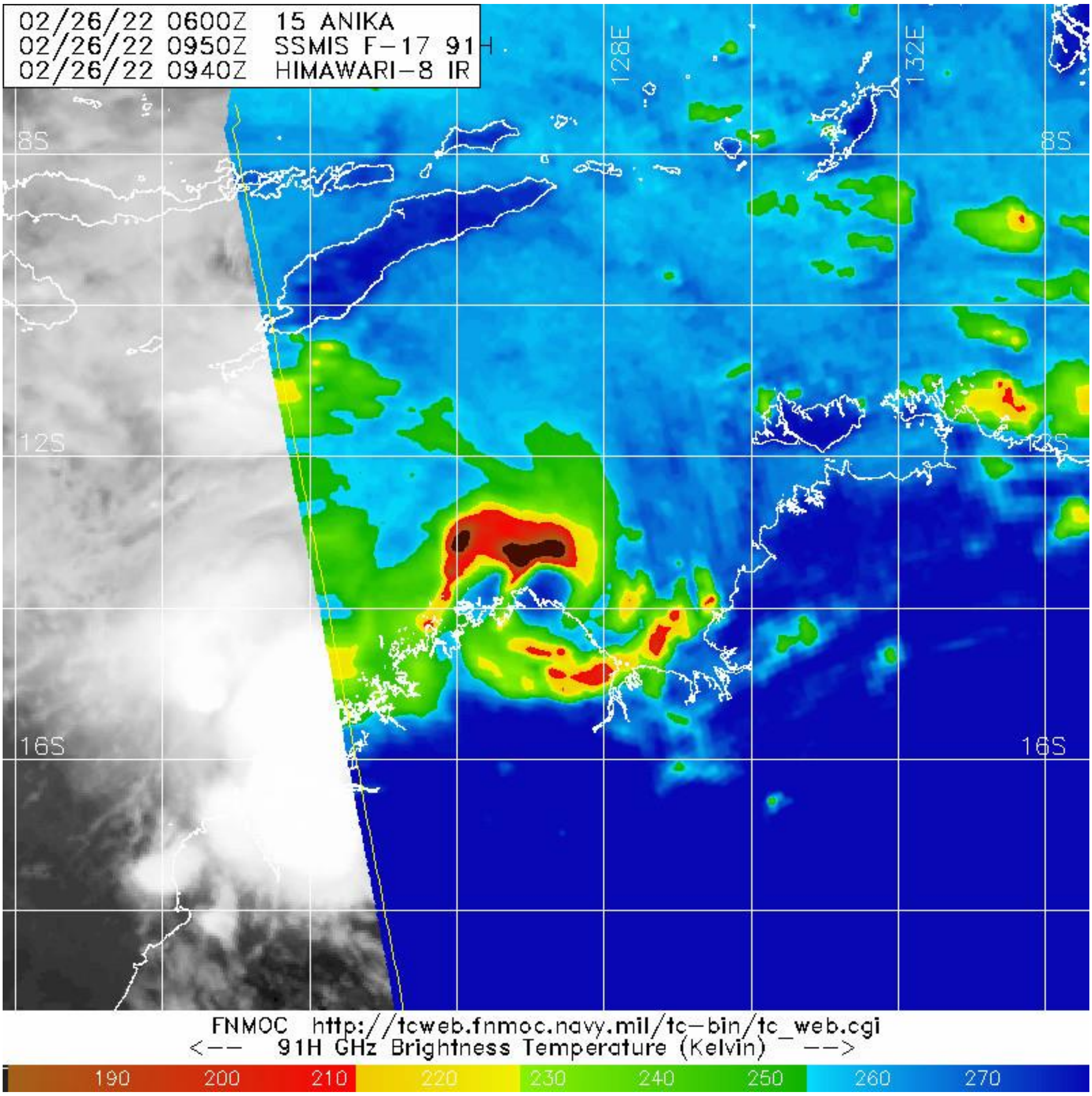


FIGURE 5. ASCAT-B at 1258 UTC 26 February, showing winds up to 50 knots (one-minute mean).

Image courtesy NRL: https://www.nrlmry.navy.mil/TC.html

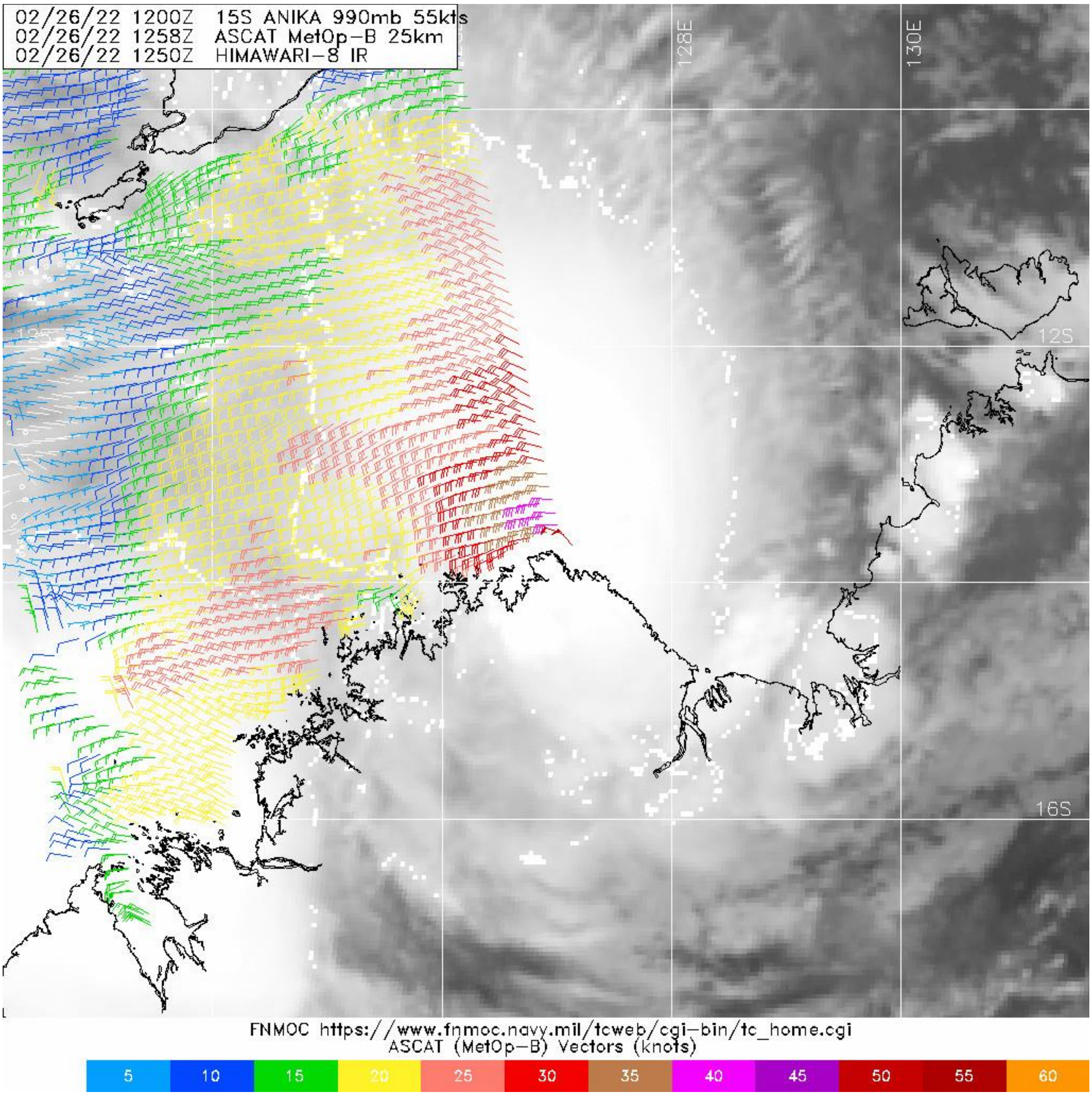


FIGURE 6. Port Hedland radar at second coastal crossing, 1200UTC 2 March, showing a well-defined eye.

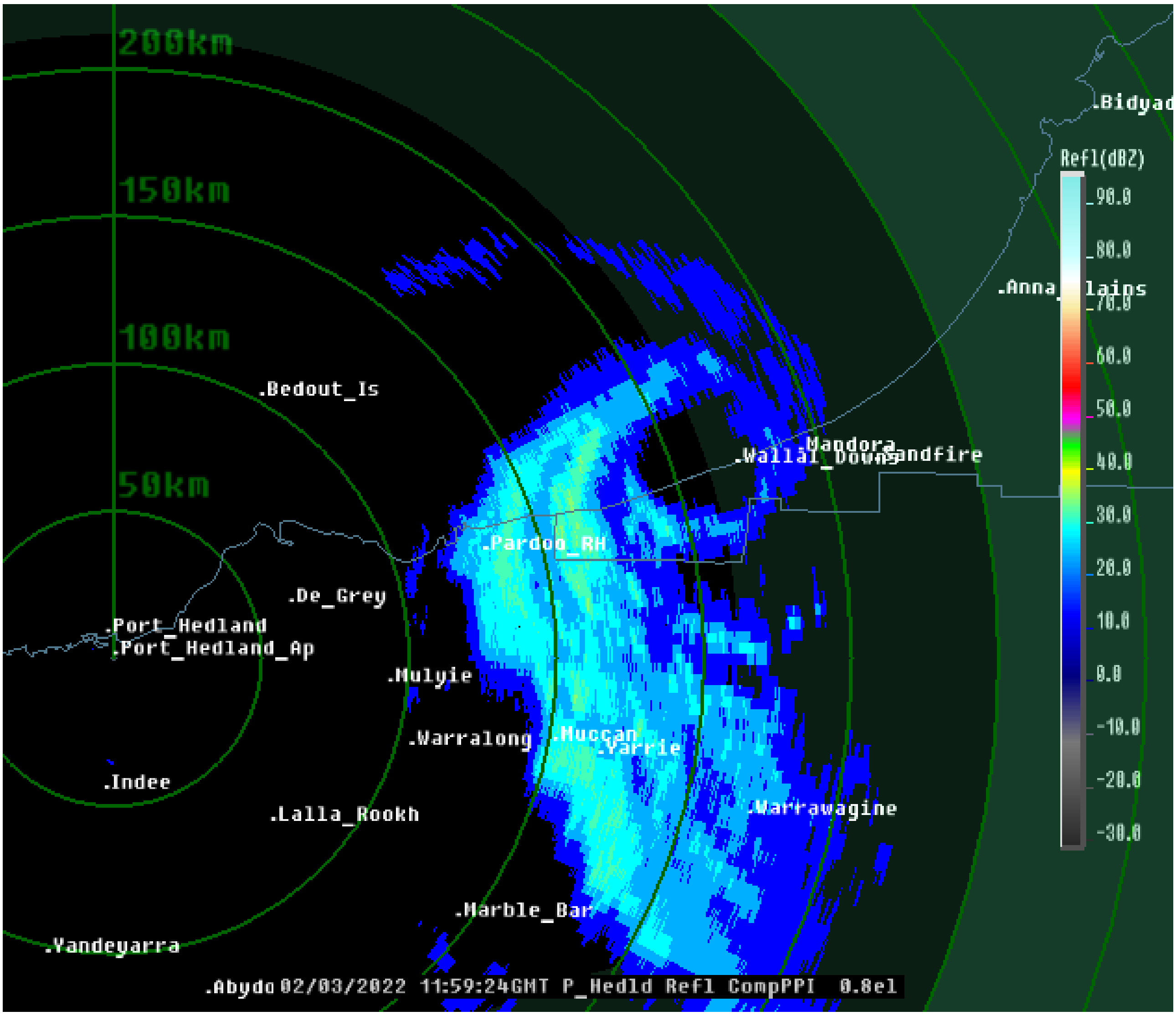


FIGURE 7. ASCAT-B at 1313 UTC 2 March, showing winds up to 50 knots (one-minute mean).

Image courtesy NRL: https://www.nrlmry.navy.mil/TC.html

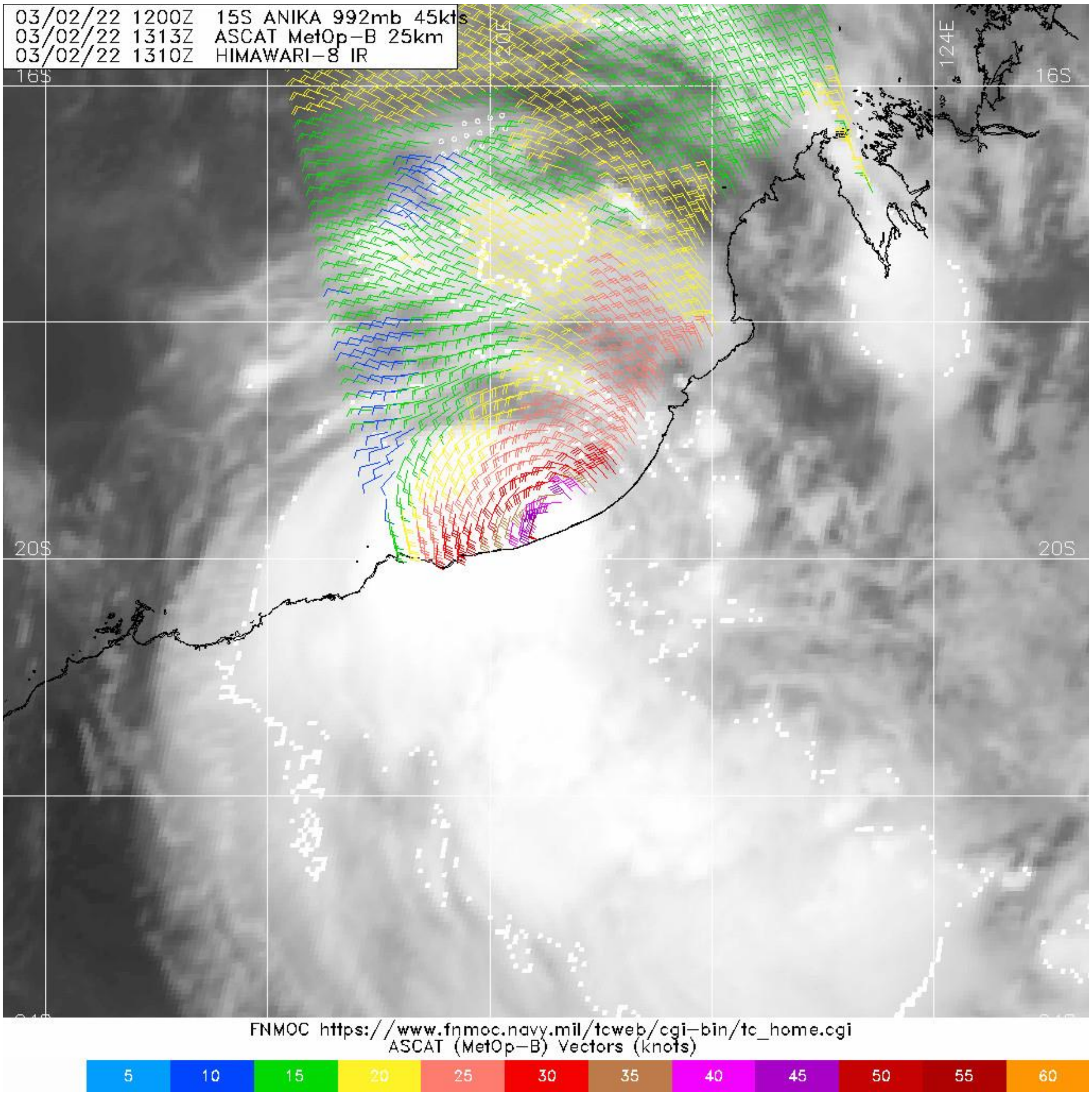


FIGURE 8. GMI 89GHz microwave pass at 0615 UTC 3 March, showing the structure of Tropical Cyclone Anika well inland.

Image courtesy NRL: https://www.nrlmry.navy.mil/TC.html

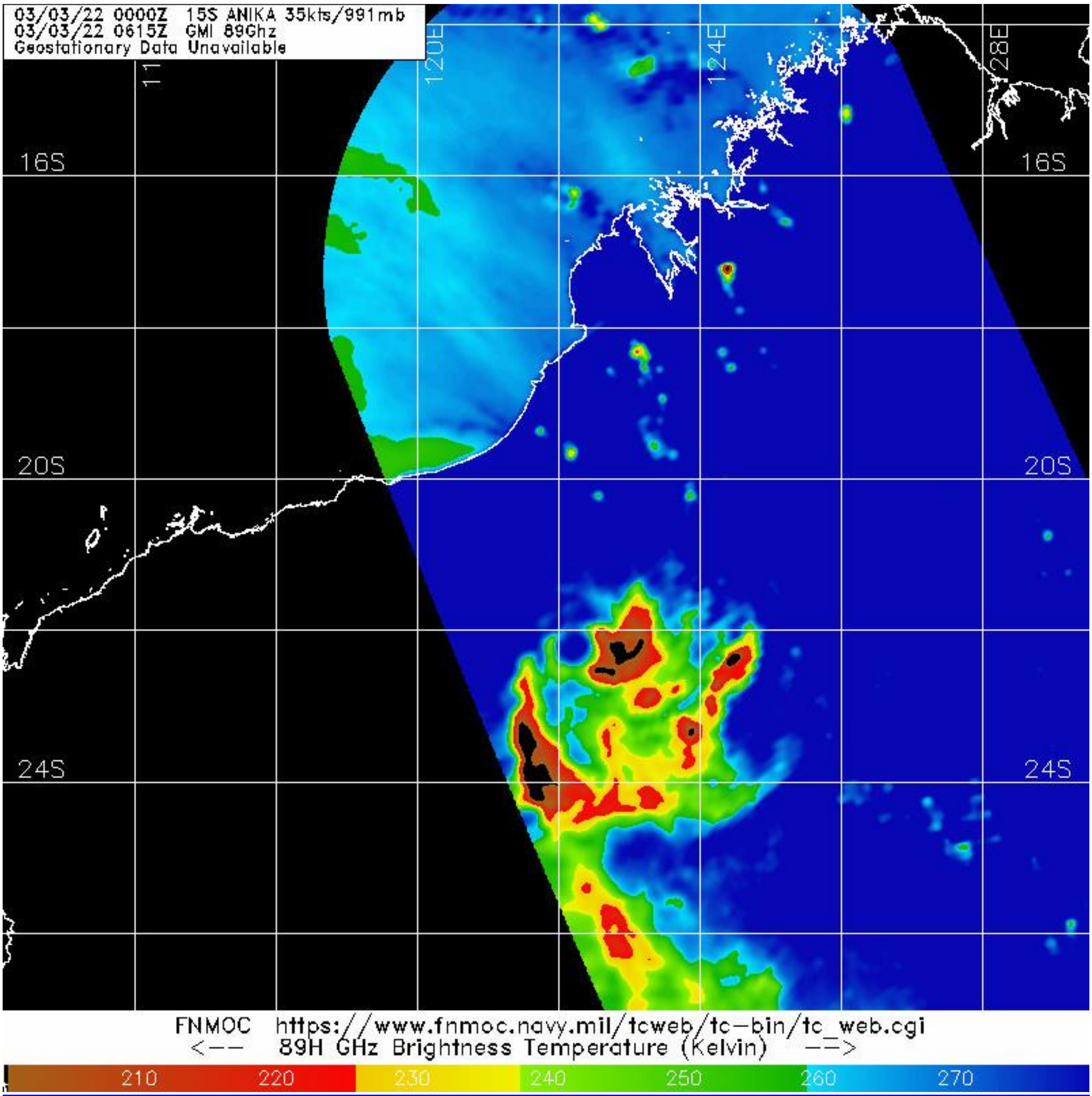
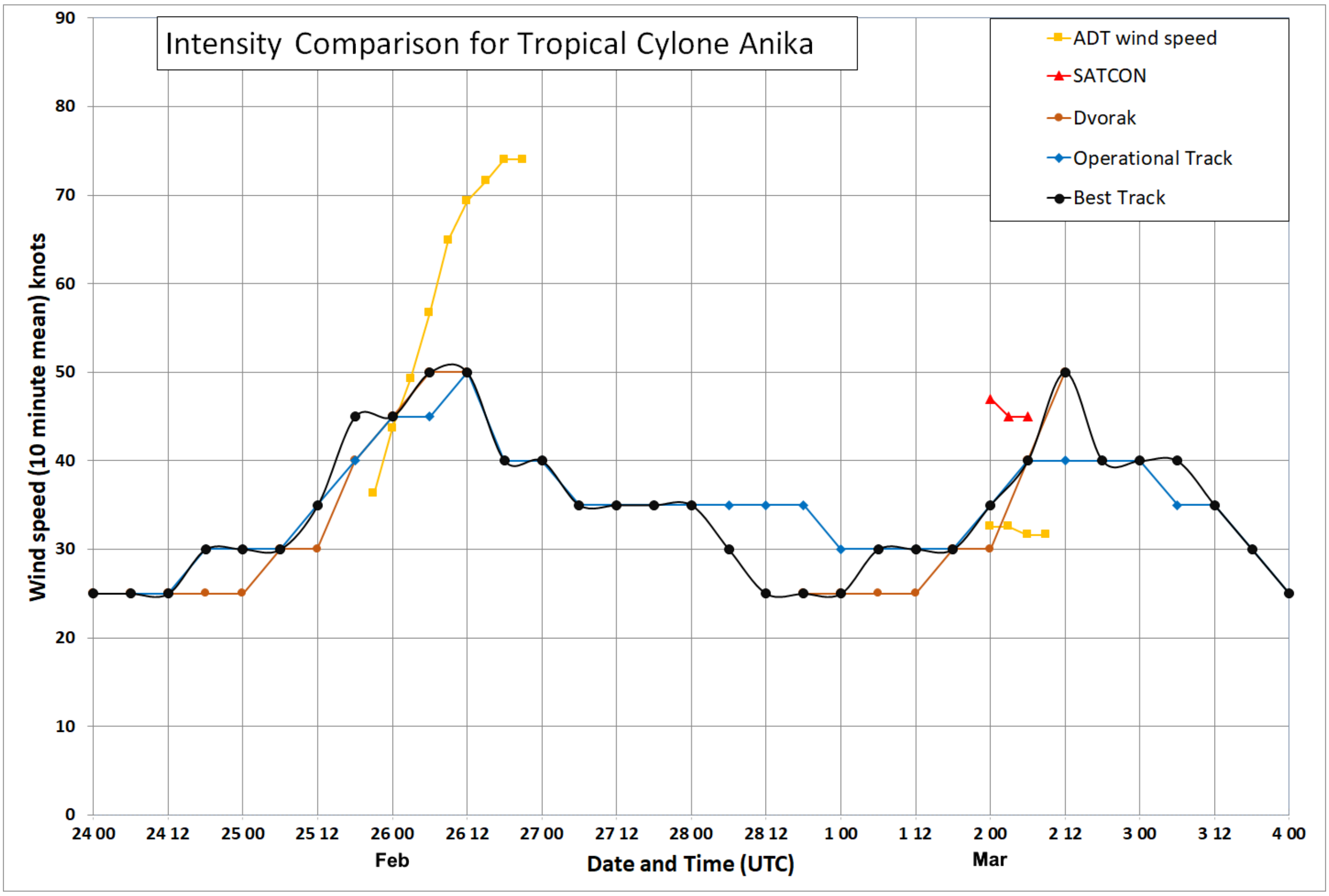


FIGURE 9. Plot of objective and subjective intensity estimates for Tropical Cyclone Anika.



3 Impact

Tropical Cyclone Anika impacted Western Australia while the State was already suffering from significant supply chain issues following flood damage to the Trans-Australian Railway in late January, along with growing COVID-19 cases and associated worker shortages. This meant that communities were potentially more vulnerable to being isolated by floodwaters than would usually be expected. Additionally, the community of Bidyadanga was placed into lockdown prior to the impact of this system due to a suspected COVID-19 outbreak, but luckily this was discovered to be a false alarm and ultimately did not impact the community's preparations for the forecast impact.

3.1 Rainfall.

Heavy rainfall over the northern Kimberley resulted in road closures and the isolation of Kalumburu, however evacuations were not required, and no significant property damage was reported.

Heavy rainfall further south also resulted in the closure of the Great Northern Highway for a period. Heavy rain extended inland to Telfer and Parnngurr, but with no significant damage reported.

3.2 Wind.

There was some vegetation damage in the Kalumburu area, but no structural damage was reported.

There were no reports of wind damage near the second coastal crossing point at either Wallal Downs or Mandora stations.

Newcrest Mining Community Relations Officer John McGuire, said at Telfer mine site there was "a lot of branches from trees strewn across the road and through the camp." However, there was no mention of any structural damage.

4 Observations

4.1 Wind

Telfer refer Figure 10d.

Gales* for periods between 0242 UTC 3 March and 0448 UTC 3 March.

Maximum 10-minute mean wind 40 kn (74 km/h) at 0337 UTC 3 March.

Maximum 3-second wind gust 58 kn (107 km/h) at 0340 UTC 3 March.

Mandora refer Figure 10c.

Gales* for a short period from 1407 UTC to 1421 UTC 2 March.

Maximum 10-minute wind 39 kn (72 km/h) at 1413 UTC 2 March.

Maximum 3-second wind gust: 50 kn (93 km/h) at 1410 UTC 2 March.

Truscott refer Figure 10b.

Maximum 10-minute wind 31 kn (57 km/h) at 1901 UTC 26 February.

Maximum 3-second wind gust: 44 kn (81 km/h) at 2013 UTC 26 February.

Kalumburu refer Figure 10a.

Maximum 10-minute wind 25 kn (46 km/h) at 1709 UTC 26 February.

Maximum 3-second wind gust: 39 kn (72 km/h) at 1702 UTC 26 February.

*Note: gales: 10-minute mean winds of 34-47 kn (63-88 km/h)

4.2 Lowest Mean Seal Level (MSL) Pressure

Mandora: 980.0 hPa at 1350 UTC 2 March

Telfer: 985.7 hPa at 0400 UTC 3 March

Kalumburu: 988.2 hPa at 1306 UTC 26 February

Truscott: 990.8 hPa at 1940 UTC 26 February

4.3 Rainfall

Heavy rainfall was observed with the passage of Tropical Cyclone Anika across parts of the Kimberley and Pilbara. Notable daily falls to 0100 UTC (9 am AWST) included:

- 27 February: Truscott 333 mm, Kalumburu 250 mm, Theda 103mm
- 28 February: Doongan 114mm, Drysdale River 80mm
- 1 March: Kilto Station 172mm
- 2 March: Bidyadanga 116mm, Kilto Station 111mm
- 3 March: Warrawagine 162 mm, Mandora 150 mm, Ripon Hills Road 131 mm, Nita Downs 108 mm, Yarrie 95 mm, Telfer 80 mm, Pardoo 68 mm;
- 4 March: Telfer 61 mm;

FIGURE 10a. Wind and pressure observations at Kalumburu, 26-27 February. Times in AWST (UTC+8h).

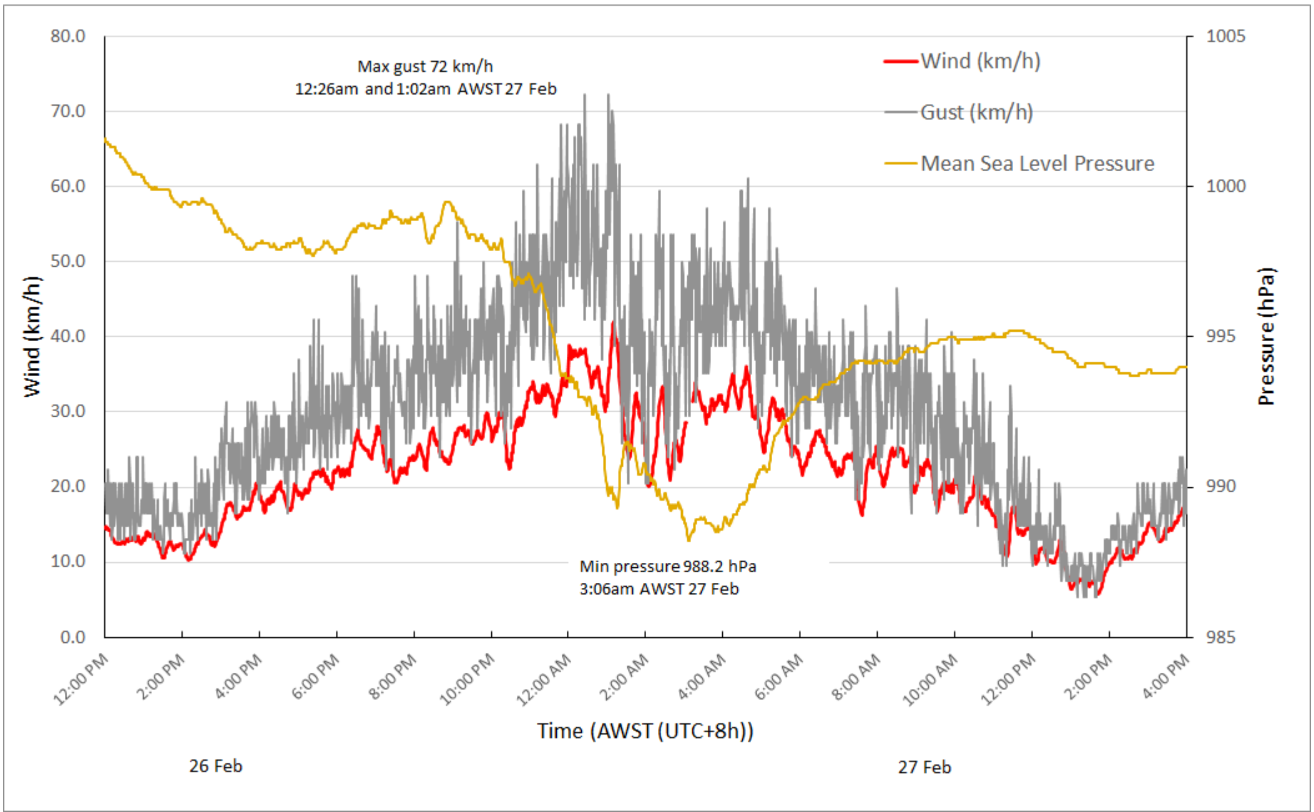


FIGURE 10b. Wind and pressure observations at Truscott, 26-27 February. Times in AWST (UTC+8h).

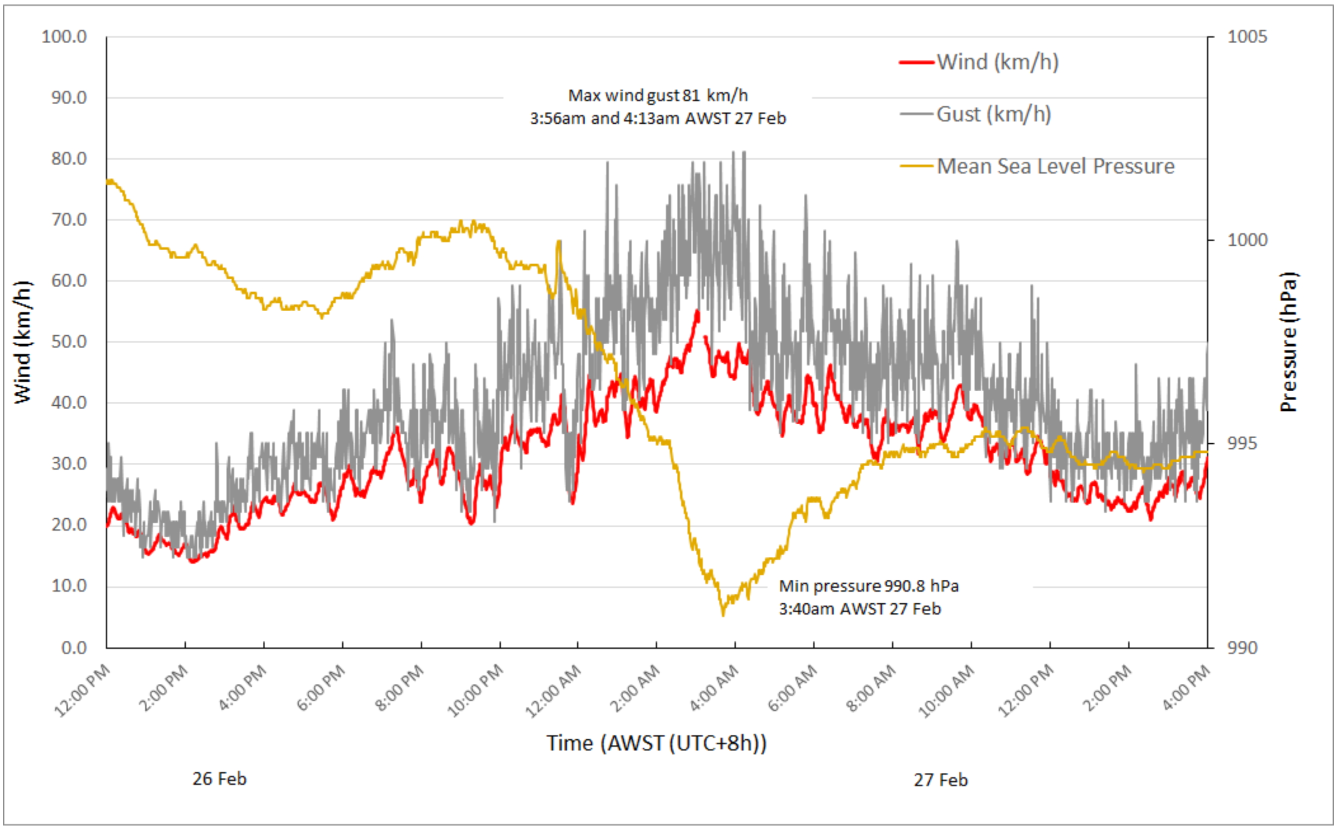


FIGURE 10c. Wind and pressure observations at Mandora, 2-3 March. Times in AWST (UTC+8h).

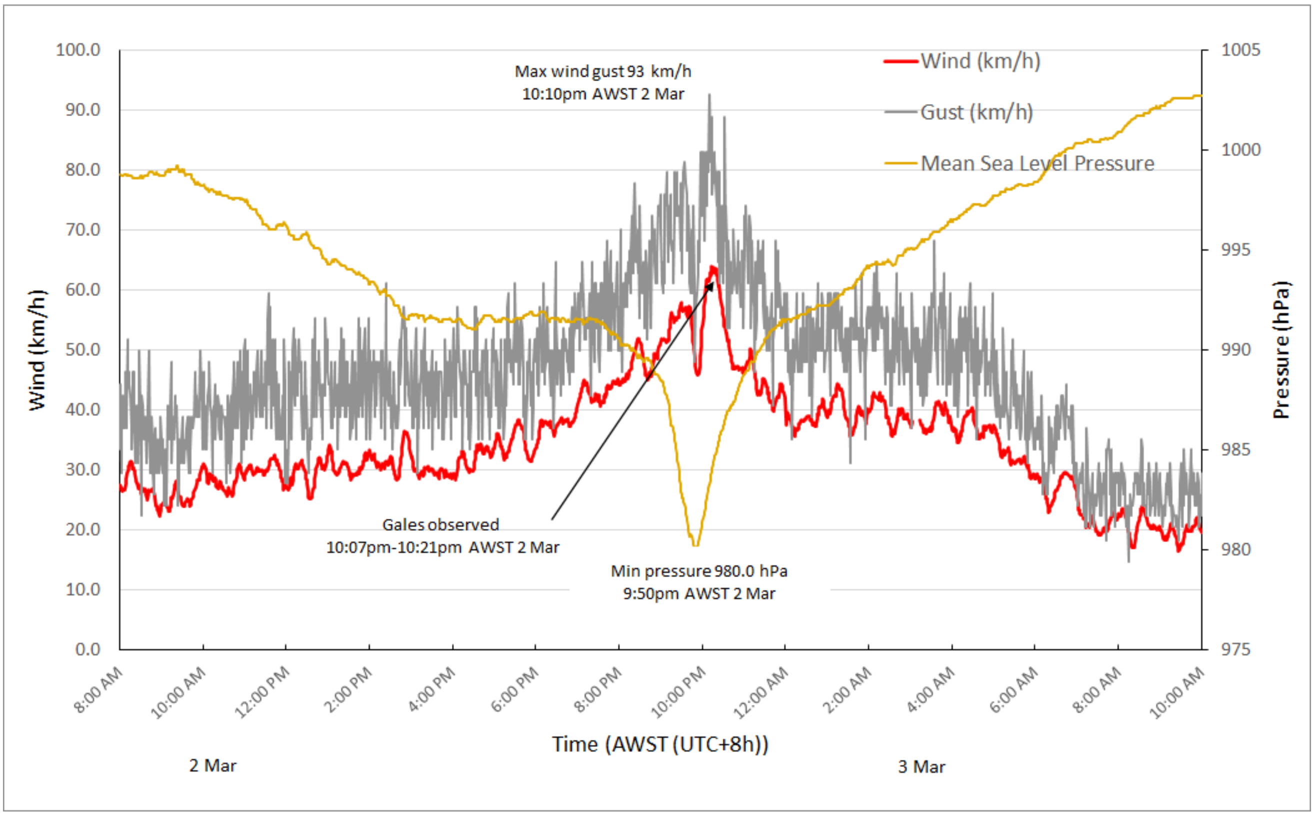


FIGURE 10d. Wind and pressure observations at Telfer, 3 March. Times in AWST (UTC+8h).

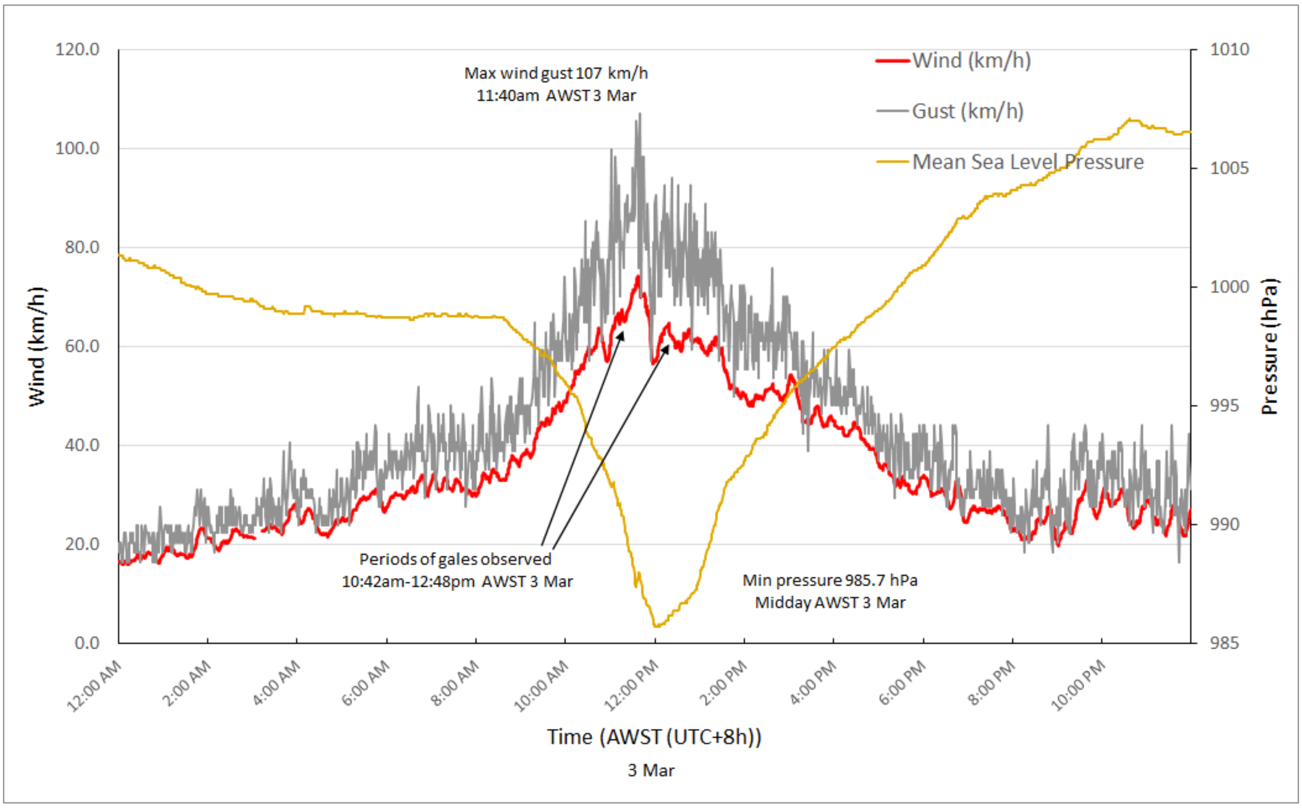


FIGURE 11. Distribution of rainfall totals for the week ending 0100 UTC 4 March.

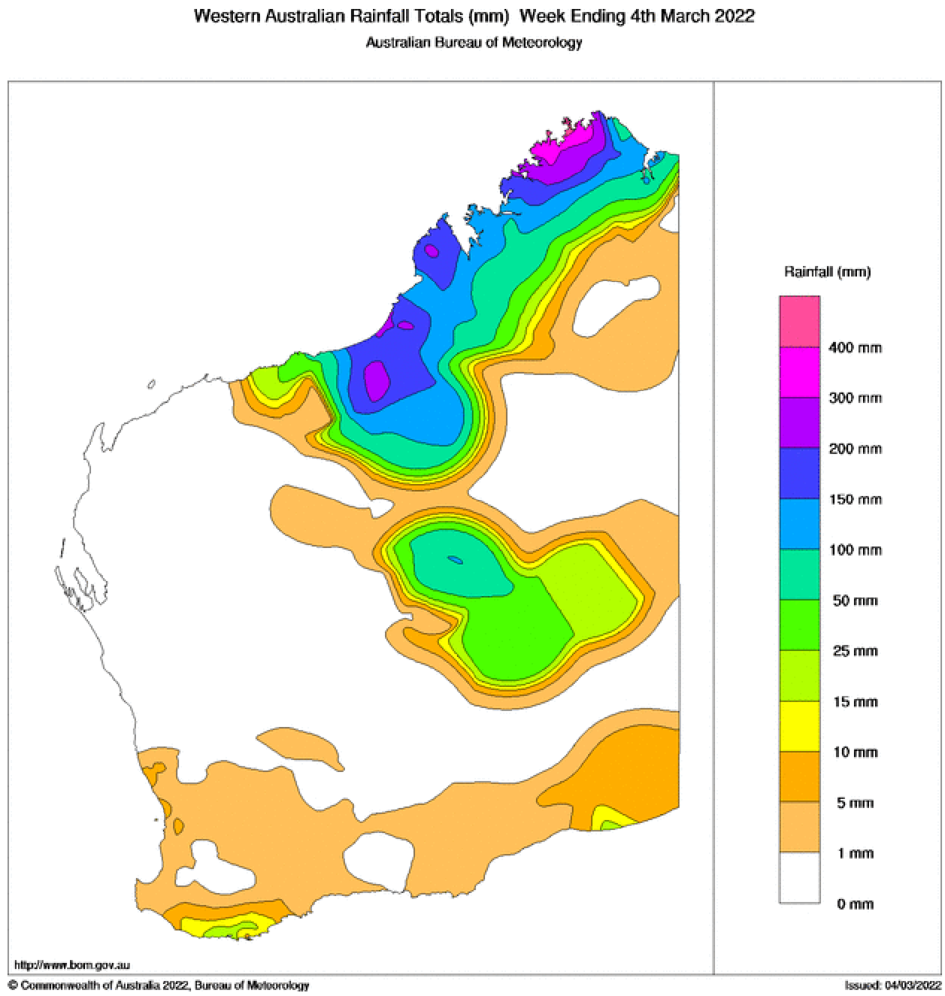


TABLE 1. Best track summary for Tropical Cyclone Anika 24 February to 4 March 2022.

Refer to the Australian Tropical Cyclone database for complete listing of parameters. Note: UTC is AWST - 8 hours.
*not at tropical cyclone intensity.

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 n mi
2022	2	24	0000	-12.7	128.7	20	25	45	1004	0/0/0/0	0/0/0/0	-
2022	2	24	0600	-12.8	128.4	20	25	45	1002	0/0/0/0	0/0/0/0	-
2022	2	24	1200	-12.6	127.9	20	25	45	1001	0/0/0/0	0/0/0/0	-
2022	2	24	1800	-12.4	127.7	20	30	45	998	0/0/0/0	0/0/0/0	-
2022	2	25	0000	-12.4	127.8	30	30	45	998	0/0/0/0	0/0/0/0	-
2022	2	25	0600	-12.5	127.8	20	30	45	997	0/0/0/0	0/0/0/0	-
2022	2	25	1200	-12.7	127.6	20	35*	50	995	0/0/0/60	0/0/0/0	-
2022	2	25	1500	-12.8	127.6	15	35	50	995	60/50/60/70	0/0/0/0	25
2022	2	25	1800	-12.9	127.6	15	45	65	990	60/50/60/70	0/0/0/0	20
2022	2	26	0000	-12.9	127.5	15	45	65	988	60/50/60/60	0/0/0/0	20
2022	2	26	0600	-13.4	127.5	15	50	70	986	60/60/70/80	40/30/0/0	25
2022	2	26	1200	-13.8	127.1	10	50	70	986	60/40/20/80	30/30/0/0	20
2022	2	26	1800	-14.2	126.7	15	40*	55	988	50/0/0/70	0/0/0/0	-
2022	2	27	0000	-14.3	126.6	15	40*	55	993	50/0/0/80	0/0/0/0	-
2022	2	27	0600	-14.4	126.4	25	35*	50	992	0/0/0/60	0/0/0/0	-

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 n mi
2022	2	27	1200	-14.9	126	30	35*	45	994	0/0/0/60	0/0/0/0	-
2022	2	27	1800	-15.5	125.5	30	35*	45	996	0/0/0/60	0/0/0/0	-
2022	2	28	0000	-15.6	125.1	30	35*	45	997	0/0/0/60	0/0/0/0	-
2022	2	28	0600	-16	124.9	30	30	45	996	0/0/0/0	0/0/0/0	-
2022	2	28	1200	-16.5	124.2	20	25	45	998	0/0/0/0	0/0/0/0	-
2022	2	28	1800	-16.7	123.6	30	25	45	998	0/0/0/0	0/0/0/0	-
2022	3	1	0000	-16.7	122.5	30	25	45	997	0/0/0/0	0/0/0/0	-
2022	3	1	0600	-17	122.1	30	30	45	996	0/0/0/0	0/0/0/0	-
2022	3	1	1200	-17.4	122	20	30	45	995	0/0/0/0	0/0/0/0	-
2022	3	1	1800	-18.2	121.9	20	30	45	992	0/0/0/0	0/0/0/0	-
2022	3	2	0000	-18.9	121	20	35*	50	993	0/30/50/0	0/0/0/0	-
2022	3	2	0600	-19.5	120.6	30	40	55	986	0/20/30/30	0/0/0/0	15
2022	3	2	1200	-19.7	120.5	15	50	70	978	30/20/30/40	15/15/0/0	12
2022	3	2	1800	-20.2	121	15	40	55	982	30/30/30/25	0/0/0/0	12
2022	3	3	0000	-21	121.6	20	40	55	982	30/30/20/0	0/0/0/0	15
2022	3	3	0600	-22.1	122.1	30	40	55	986	20/30/20/0	0/0/0/0	15
2022	3	3	1200	-22.7	122.9	45	35*	50	988	0/40/40/0	0/0/0/0	-
2022	3	3	1800	-22.7	123.4	60	30	45	999	0/0/0/0	0/0/0/0	-
2022	3	4	0000	-22.7	123.9	20	25	45	1001	0/0/0/0	0/0/0/0	-

5 Forecast Performance

Official tropical cyclone forecasts were issued from 24 February to 2 March. A tropical cyclone watch was first issued at 0410 UTC 24 February from Point Stuart in Northern Territory west to Kalumburu in Western Australia, including Darwin. A tropical cyclone warning was first issued at 0100 UTC 25 February from the WA/NT Border to Mitchell Plateau, with the watch extending further southwest to Cockatoo Island. The watch for parts of the Northern Territory north of Dundee Beach, including Darwin, was cancelled at 0345 UTC 26 February.

As Tropical Cyclone Anika approached and crossed the north Kimberley coast, watches and warnings were gradually extended further southwest through the Kimberley. Due to the forecast movement back off the coast, warnings remained current through the entire inland traversal of the Kimberley. The first tropical cyclone watch for Broome was issued at 0700 UTC on 27 February, and ultimately the watch was extended as far west as De Grey in the Pilbara (just to the east of Port Hedland).

Watches and warnings were extended through inland areas of the eastern Pilbara, though not as far inland as Telfer. The warning for Broome was cancelled at 1900 UTC 1 March as the system moved far enough south.

The last tropical cyclone forecast was issued at 1545 UTC on 2 March, as the operational track saw Anika downgraded to below tropical cyclone intensity. Severe Weather Warnings continued to be issued for damaging winds and heavy rainfall as the system tracked further inland through the eastern Pilbara and into the Interior.

The accuracy figures for Tropical Cyclone Anika below and in Figure 12 show that the forecast position error was close to the five-year average up until 36 hours ahead, but then larger than the five-year average at longer lead times. This was mostly due to early forecast uncertainty, where initially the system was forecast to traverse east across the Top End of the Northern Territory. Ultimately the system ended up tracking towards the southwest, resulting in large forecast position errors. The intensity forecasts had similar errors to the five-year average for across all time periods. These were based on official forecast tracks issued from 0000 UTC 24 February to 1200 UTC 2 March 2022.

Forecast hour	00	06	12	18	24	36	48	72	96	120
Position Absolute error (km)	11	22	30	37	44	60	84	141	205	279
Intensity Absolute error (kn)	1.7	3.2	4.4	5.9	7.0	8.0	8.4	14.9	14.4	12.3
Sample Size	27	27	27	27	27	27	25	21	17	13

FIGURE 12 a. Position accuracy figures for Tropical Cyclone Anika.

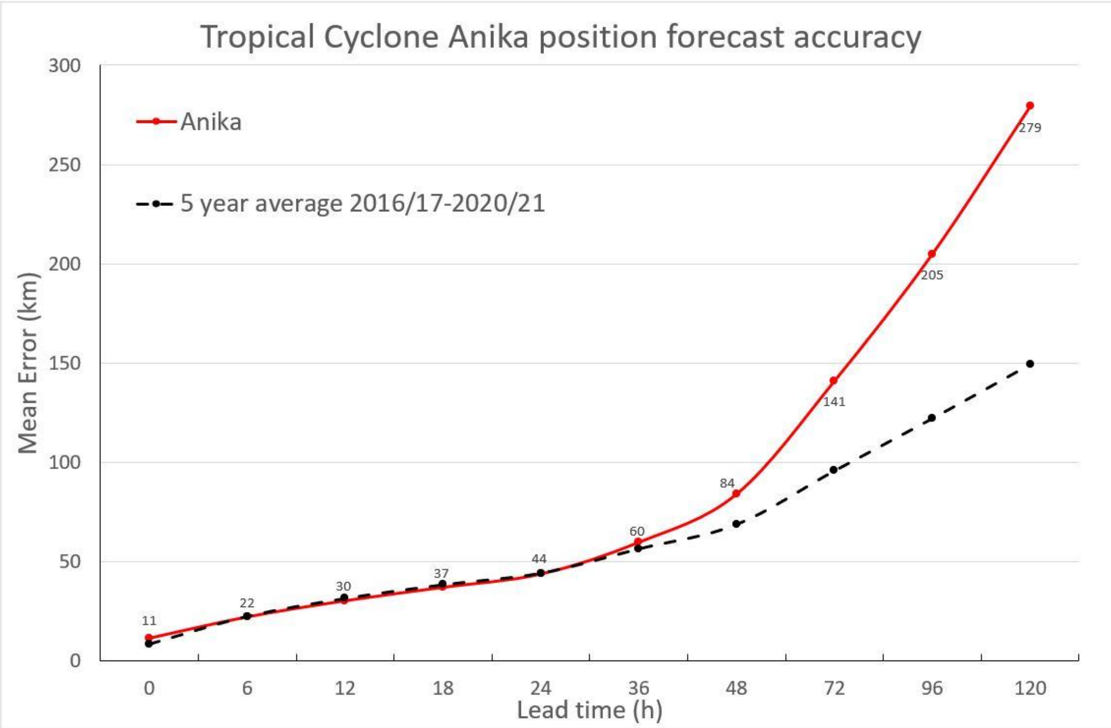


FIGURE 12 b. Intensity accuracy figures for Tropical Cyclone Anika.