



Australian Government
Bureau of Meteorology

Severe Tropical Cyclone *Monty*

27 February – 3 March 2004

Perth Tropical Cyclone Warning Centre
Bureau of Meteorology

A. Summary

TC *Monty* was a small and intense cyclone that developed rapidly off the Pilbara coast and affected offshore oil and gas infrastructure before making landfall near Mardie station and causing flooding in the inland Pilbara.

A low moved off the Kimberley coast near Broome on 26 February and rapidly formed into a tropical cyclone just twenty-four hours later. *Monty* moved roughly parallel with the Pilbara coast and developed to category 4 intensity before moving towards the west Pilbara coast on 1 March. After causing hurricane-force winds at offshore reporting sites, *Monty* crossed the coast as a lower end category 3 system near Mardie station between Onslow and Dampier about 2100 WST on Monday 1 March. Miraculously only minor property damage occurred although two vessels in Mermaid Sound broke their moorings and ran aground causing significant damage.

Although rapidly weakening later on 1 March, *Monty* produced widespread rainfall over the Pilbara causing significant flooding. Two people were rescued from the roof of the Yarraloola homestead on the Robe River and the town of Pannawonica was cut-off. The bridge over the Maitland River on the Northwest coastal highway was destroyed. The floods on the Maitland, Robe and Fortescue Rivers were the highest on record.

On a positive note the rainfall brought an end to the long drought over the west Pilbara.

B. Meteorological Description

A low tracked steadily westwards over the Kimberley for several days being steered by easterlies in depth. Although the low was well defined it lacked sustained deep convection. The low moved offshore on the evening of the 26 February and rapidly developed over water where the sea surface temperature was 29-30°C. The visible image at 0325 UTC 27 February in figure 2 (a) showed developing curvature in the deep convection. Cyclone intensity was estimated at 0900 UTC 27 February just 24 hours after moving offshore.

Despite the rapid development, easterly wind shear was on the order of 20 knots, if anything having increased from the previous day.

Rapid development continued on 28 February assisted by decreasing wind shear to less than 10 knots which persisted until landfall late on 1 March. A ragged eye appeared on visible imagery as shown in Fig. 2 (b). This image also suggested upper level outflow to the north and south. Subsequent microwave imagery showed a well-defined symmetrical eye.

At about this time *Monty* was moving to the west northwest and then passed within 10 nm of a privately operated buoy where mean winds of 80 knots were recorded (at ~4 m above MSL) before the instrument failed. This suggested that *Monty* reached category three intensity within 24 hours of being a cyclone. It took much longer for an eye to appear on IR imagery.

Monty passed to the north of North Rankin platform coming within 30 km at about 03-05 UTC 29 February as shown on the Dampier radar image in figure 4a. North Rankin was in the southern and southeastern parts of the eye wall for about nine hours experiencing hurricane force winds that peaked at 81 knots at 0450 UTC (see wind analysis in figure 2.7. North Rankin did not experience a decrease in winds whereas at a nearby facility winds did drop below 30 knots and the pressure fell to 950.9 hPa.

Peak Intensity

A well-developed eye became more evident on 29 February as seen on the visible images in figures 2 (c) and (d) and the TRMM 85GHz microwave image at 0702 UTC. The peak intensity appeared to occur at about 0900 UTC when a data T number was estimated at 6.0. However only a few images suggested at 6.0 T number and subsequent images showed a weakening signal and by 0000 UTC 1 March the DT number was down to 4.5. Without further information *Monty* would have been given a maximum intensity of 95 knots (between 5.5-6.0). This would at first appear consistent with North Rankin observation of maximum 10 minimum wind of 81 knots earlier at 0450UTC as the southern eye-wall passed over.

However, the maximum intensity was estimated slightly higher at 100 knots for several reasons:

- The privately operated buoy was in the northern eye-wall when mean winds of 80 knots were recorded before instrument failure. However *Monty* was still developing at that stage and did not peak until another 18 hours later. It is even possible that winds were higher at that time as the instrument failed after that observation and the height of the anemometer is only at 4 m. The Dvorak analysis at the time was just 4.5 corresponding to winds of 70 knots suggesting an underestimation of intensity via conventional satellite means.
- Although North Rankin was in the eye wall for nine hours, radar and satellite imagery indicate that the heaviest rainfall and, by inference, wind speeds, were generally in the northern quadrants. This was an interesting feature of *Monty* for much of its lifetime as shown on radar imagery in Fig.

4 all suggested the strongest winds on the northern side. This is also indicated on satellite imagery. Winds at Varanus and Barrow Islands were about twenty per cent stronger in the northern part of the eye-wall passed over despite the fact that *Monty* was in a weakening phase.

- Peak intensity occurred later than when the strongest winds were observed at North Rankin.

A study of data from the sites that *Monty* passed close to, showed that the radius of maximum winds corresponds to about 15 nm from the centre. Interestingly the eye diameter did not appear to change and there was no evidence of secondary eye wall or eye wall replacement occurring.

The strongest pressure gradient recorded was 34 hPa over 17 nm in the northern eye wall.

Pressure-wind relationships

Using the Atkinson and Holliday (A-H) pressure wind relationship that was used operationally in the Perth TCWC a CI of 6.0 corresponds to a delta P of 83 hPa. Based on an environmental pressure of 1004 hPa this would result in a central pressure of 921 hPa. Given that *Monty* was a marginal 6.0 it is plausible to use a delta P of 75 hPa (midway between 5.5 and 6.0) that would result in a central pressure of 930 hPa. Several studies have revised the P-W relationships for smaller sized storms. The Northern region P-W relationship adopted from a study by Love and Murphy (1985) would suggest a central pressure of 942 hPa (delta P of 62 hPa for CI=6.0), although their findings were questioned by Harper (2002). Harper (2002) recommended that the Dvorak Atlantic relationship be used for small and intense storms. This would suggest a central pressure of about 940 hPa.

Weakening Phase

Monty commenced weakening over water despite the wind shear remaining quite low. At that stage *Monty* was still over SST of 28.5°C but this decreased below 27°C just prior to landfall and so this may have contributed to some weakening at that stage. Upon landfall *Monty* continued to weaken especially as it began to accelerate inland. The Mardie winds show a significant wind decrease from the southern eye-wall to the northern eye-wall. This is in contrast to other observations such as Varanus Is and radar imagery that indicated winds were stronger on the northern side. This seems to suggest that *Monty* weakened faster than satellite imagery indicated and so the estimated intensity was lowered from that based on the Dvorak CI equivalent.

As discussed in Harper (2002) the short inertial response of small storms results in rapid development and decay. It seems likely that *Monty* weakened faster than the standard lag by conventional Dvorak rules and as such the intensity was lowered faster than satellite interpretation would suggest. Also studies by Brown and Franklin (2002) showed that Dvorak CI constraints tends to be too limiting during the weakening phase and that a six hour rather than 12 hour lag criterion should be adopted.

Motion

Throughout its lifetime *Monty* remained close enough to the coast to be tracked on radar (Broome, Port Hedland, Dampier and Learmonth) allowing a high confidence in position especially once an eye had formed.

For the first few days *Monty* moved slowly at about 5 knots on a general westerly track under the influence of mid-level easterly winds. During 29 February the ridge to the south weakened in response to an approaching mid-latitude trough to the southwest and *Monty* tracked slowly to the south southeast then southeast until making landfall at Mardie late on 1 March. *Monty* continued its southeast track inland and accelerated to over 10 knots before weakening.

C. Impact

Monty caused considerable disruption to oil and gas facilities off the Pilbara coast. Over land only minor property damage occurred although two vessels in Mermaid Sound broke their moorings and ran aground causing significant damage.

Despite weakening as it approached landfall, *Monty* produced widespread rainfall over the Pilbara causing significant flooding. Two people were rescued from the roof of the Yarraloola homestead on the Robe River and the town of Pannawonica was cut-off. The approaches to the bridge over the Maitland River on the Northwest coastal highway was washed away. The floods on the Maitland, Robe and Fortescue Rivers were described as being the highest on record.

On a positive note the rainfall brought an end to the long drought over the west Pilbara.

D. Observations

Maximum Wind gust:

209 km/h (113 knots) at North Rankin Platform 1400 WST 29 February.

169 km/h (91 knots) at Barrow Island 1740 WST 1 March.

154 km/h (83 knots) at Mardie Station 1910 WST 1 March.

Lowest Pressure:

963.7 hPa at Barrow Island 1530 WST 1 March.

964.1 hPa at Mardie Station 0020 WST 2 March.

Rainfall:

393 mm at Mardie* The gauge overflowed so this value is an under-estimate.

382 mm at Yalleen

323 mm at Roebourne (highest two-day rainfall total since 1945)

References

- Atkinson, G.D., and Holliday, C.R. 1977. Tropical cyclone minimum sea level pressure/maximum sustained wind relationship for the Western North Pacific. *Mon. Wea. Rev.*, 105, 421-427.
- Brown, D. B., and Franklin, J. L. 2002. Accuracy of pressure-wind relationships and Dvorak satellite intensity estimates for tropical cyclones determined from recent reconnaissance-based “best track” data. 25th *Conf. On Hurricanes and Tropical Meteorology*. San Diego, CA, Amer. Meteor. Soc., 458-459.
- Harper, B.A., 2002. Tropical cyclone parameter estimation in the Australian region - wind-pressure relationships and related issues for engineering planning and design - a discussion paper. Systems Engineering Australia Pty Ltd (SEA) for Woodside Energy Ltd, SEA Rep. No. J0106-PR003E, Nov, 83 pp. [Available from Systems Engineering Australia Pty Ltd, 7 Mercury Ct, Bridgeman Downs, QLD 4035, Australia and on-line at <http://uqconnect.net/seng/download/Wind-Pressure%20Discussion%20Paper%20Rev%20E.pdf>]
- Love, G., and Murphy, K. 1985. The operational analysis of tropical cyclone wind fields in the Australian northern region. Northern Territory Region Research Papers 1984–85, Bureau of Meteorology, 44–51. [Available from National Meteorological Library, GPO Box 1289, Melbourne, VIC 3001, Australia.]

Table 1. Best track summary for *Monty*, 25 February – 3 March 2004

Note: Add 8 hours to convert to WST. Refer to best track database for complete track details.

Year	Month	Day	Hour UTC	Position Latitude S	Position Long. E	Central Pressure hPa	Max Wind 10-min knots	Max Gust Winds knots	Rad. Gale s nm	Rad. Storm Winds nm	Rad. Hurr. Winds nm	RMW nm
2004	2	25	6	17.8	124.5	1002	15	30				
2004	2	26	0	17.7	123.2	1003	15	35				
2004	2	26	6	18.0	122.6	1002	15	35				
2004	2	26	12	18.3	121.9	1002	15	35				
2004	2	26	18	18.6	121.2	1000	20	35				
2004	2	27	0	18.8	120.4	999	25	40				
2004	2	27	3	18.9	120.1	997	25	40				
2004	2	27	6	19.1	119.9	995	30	45				
2004	2	27	9	19.2	119.8	992	35	50	35			
2004	2	27	12	19.2	119.6	990	35	50	35			
2004	2	27	15	19.2	119.4	988	40	55	40			
2004	2	27	18	19.2	119.2	985	40	55	40			
2004	2	27	21	19.2	118.9	982	45	65	50			
2004	2	28	0	19.2	118.5	980	50	70	50	25		
2004	2	28	3	19.2	118.2	975	55	75	50	30		
2004	2	28	6	19.2	117.8	970	60	80	55	30		15
2004	2	28	9	19.1	117.6	965	70	90	55	35	20	15
2004	2	28	12	19.0	117.3	965	75	95	60	40	20	15
2004	2	28	15	18.9	117.1	960	80	105	65	40	20	15
2004	2	28	18	19.0	116.8	955	80	105	70	40	20	15
2004	2	28	21	19.1	116.6	950	85	110	70	40	20	15
2004	2	29	0	19.2	116.3	950	85	115	75	40	20	15
2004	2	29	3	19.3	116.0	945	90	120	75	40	20	15
2004	2	29	6	19.5	115.8	940	95	125	80	40	20	15
2004	2	29	9	19.7	115.7	935	100	135	80	45	25	15
2004	2	29	12	19.9	115.5	935	100	135	80	45	25	15
2004	2	29	15	20.0	115.3	935	100	135	85	45	25	15
2004	2	29	18	20.1	115.2	935	95	130	90	45	25	15
2004	2	29	21	20.1	115.2	940	90	125	90	40	25	15
2004	3	1	0	20.2	115.3	945	90	120	90	40	25	15
2004	3	1	3	20.4	115.3	950	85	115	90	40	25	15
2004	3	1	6	20.6	115.5	955	80	110	90	40	25	15
2004	3	1	9	20.9	115.6	955	75	105	85	40	25	15
2004	3	1	12	21.0	115.8	955	75	105	80	40	25	15
2004	3	1	15	21.1	115.9	960	70	95	80	40	20	15
2004	3	1	18	21.2	116.0	965	65	90	70	30	20	15
2004	3	1	21	21.4	116.1	970	65	85	65	20	15	15
2004	3	2	0	21.6	116.3	975	60	80	60	20		15
2004	3	2	3	22.0	116.5	975	55	75	50	20		15
2004	3	2	6	22.4	116.7	980	55	75	50	15		10
2004	3	2	9	22.9	116.9	985	50	70	40	15		10
2004	3	2	12	23.2	117.1	988	45	65	30			10
2004	3	2	15	23.6	117.3	992	40	60	30			10
2004	3	2	18	24.1	117.6	995	35	50	20			10
2004	3	2	21	24.7	117.8	998	30	45				
2004	3	3	0	25.4	118.1	1000	25	40				

Figure 1. Track of Tropical Cyclone *Monty* 25 February – 3 March 2004
All times in WST.

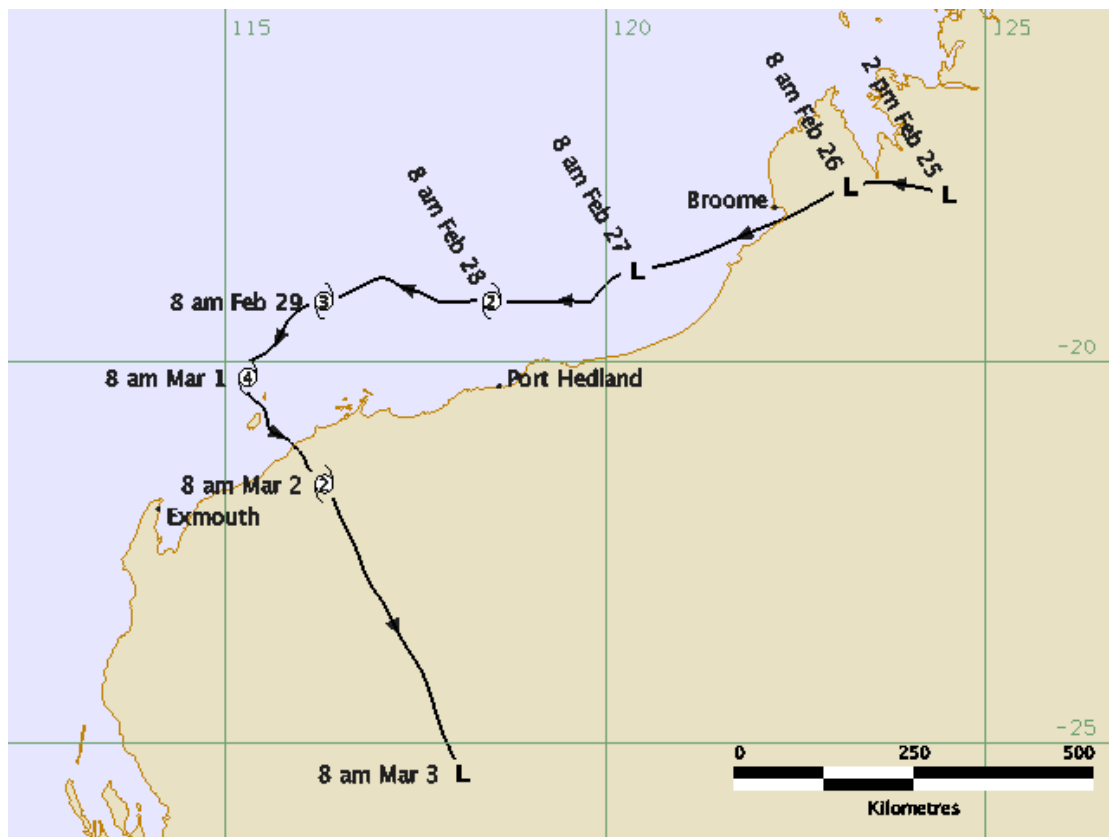
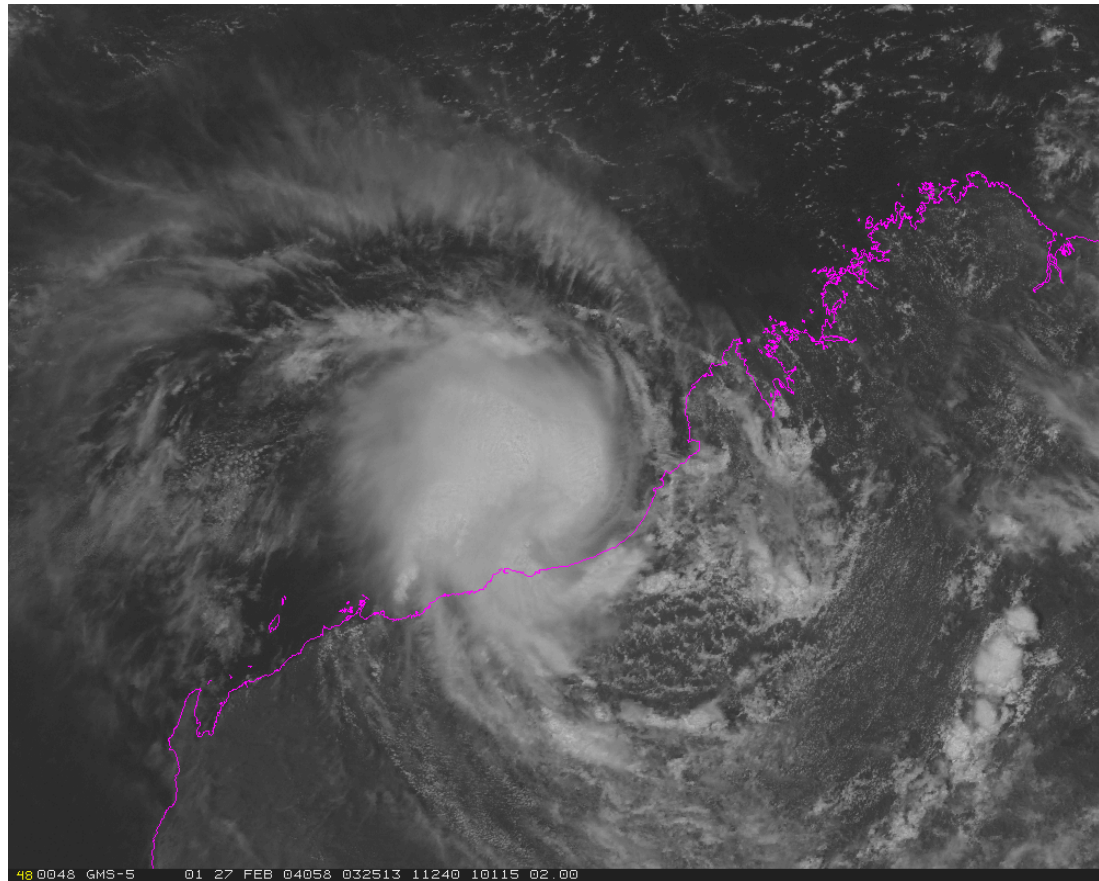
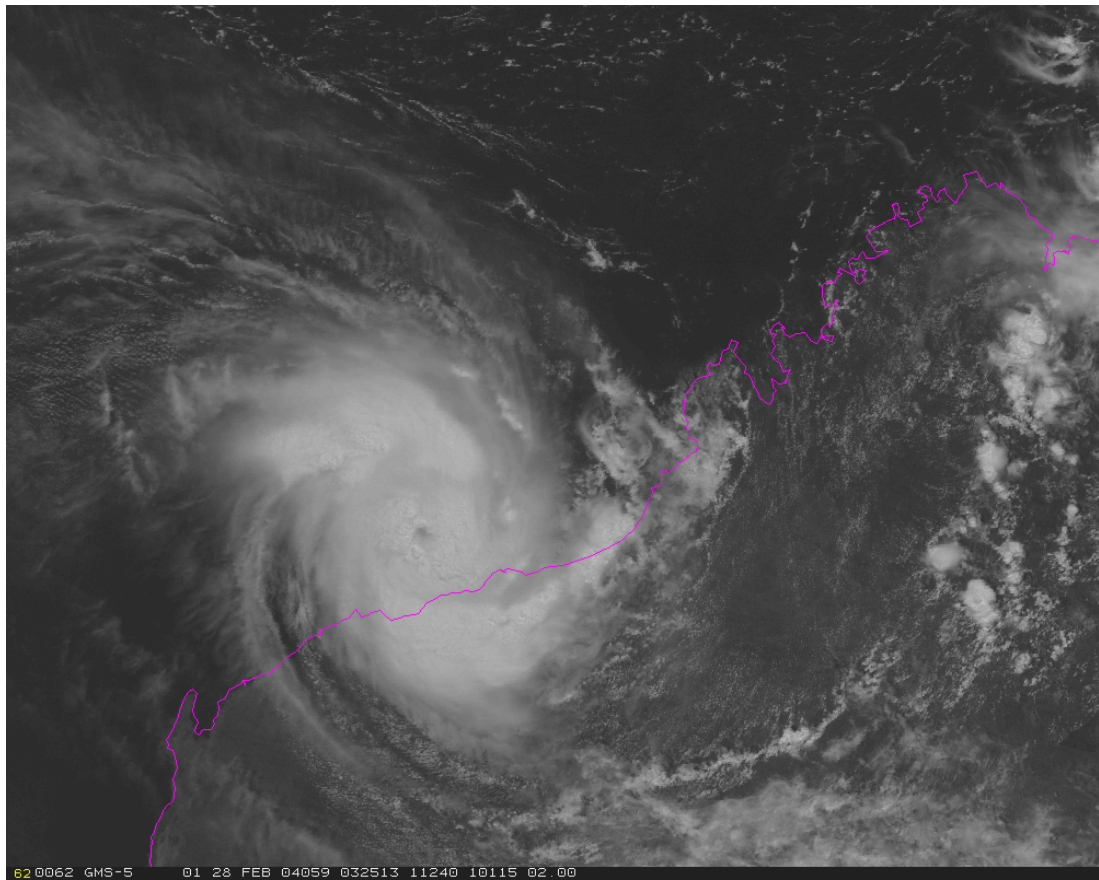


Figure 2. Visible images at (a) 0325 UTC 27 February, (b) 0325 UTC 28 February, (c) 0325 UTC 29 February, and (d) 0725 UTC 29 February (enhanced).

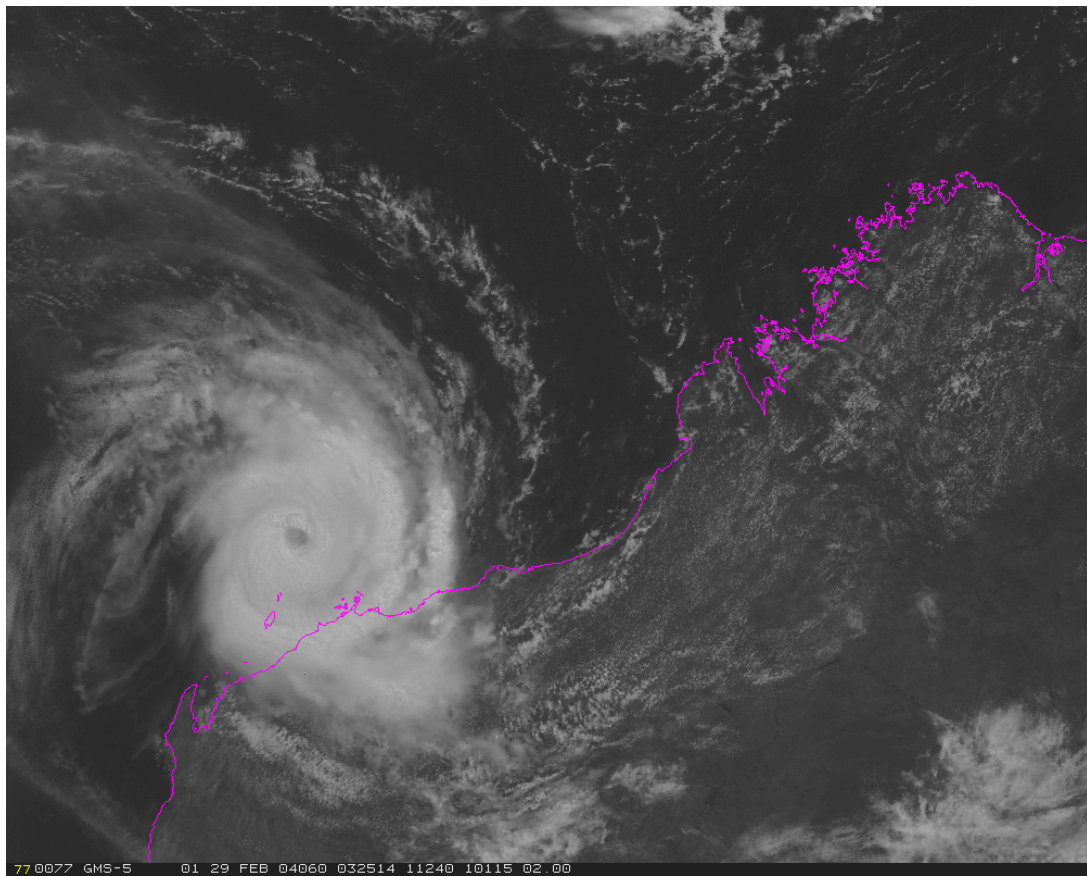
(a)



(b)



(c)



(d)

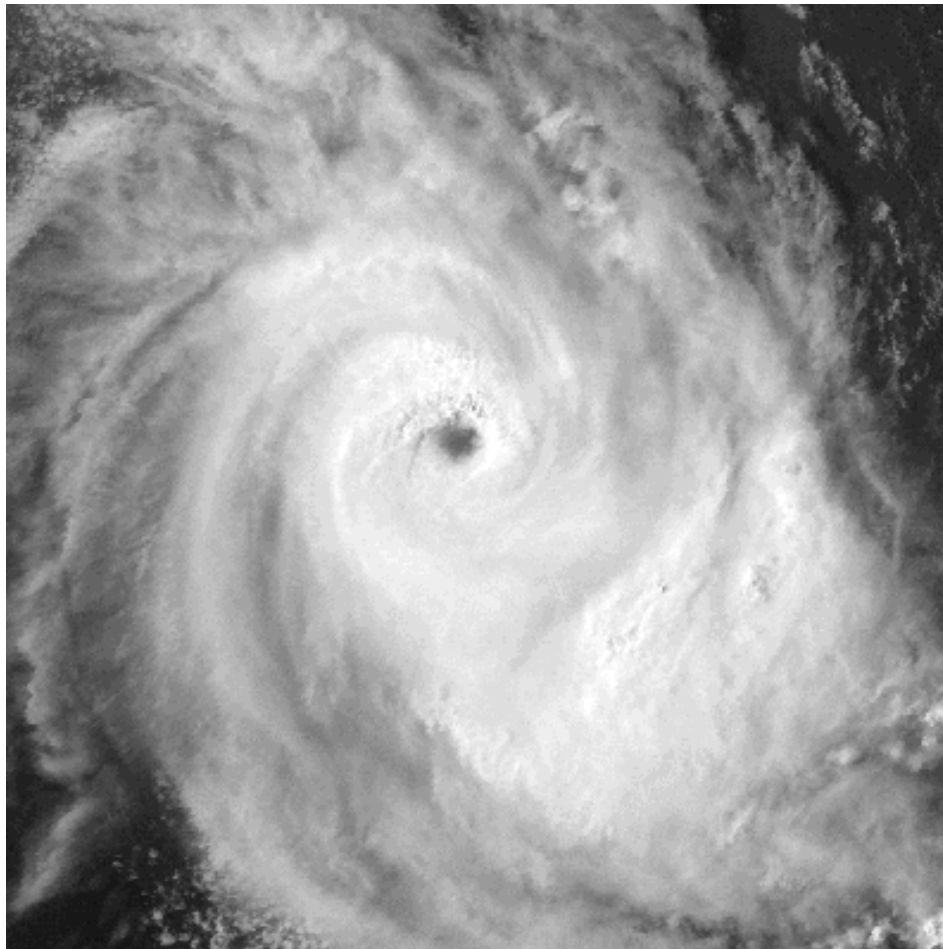


Figure 3. TRMM 85GHz Microwave image of Tropical Cyclone *Monty* close to maximum intensity, 0702 UTC 29 February.

(image courtesy of US NRL: <http://www.nrlmry.navy.mil/>)

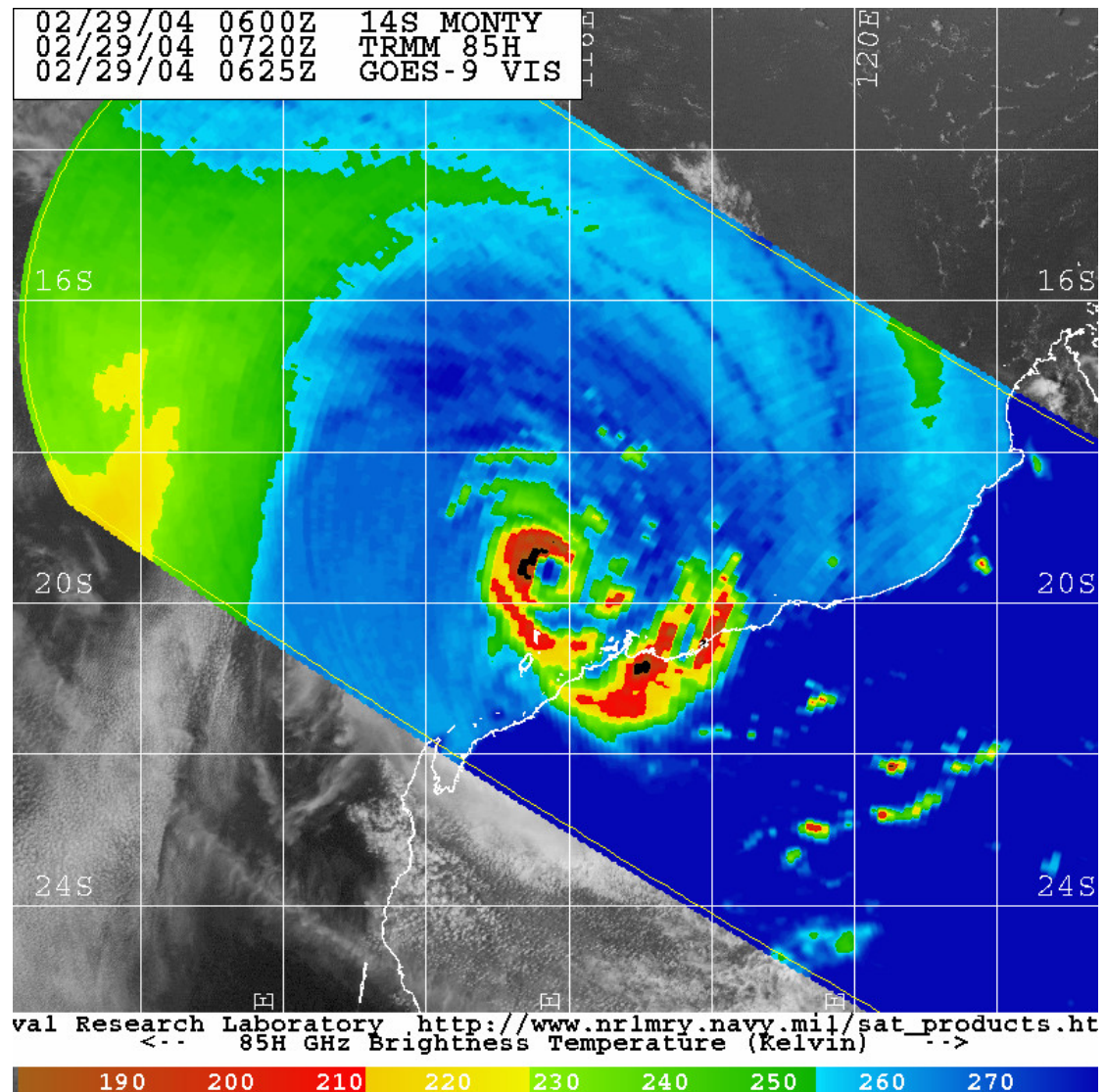
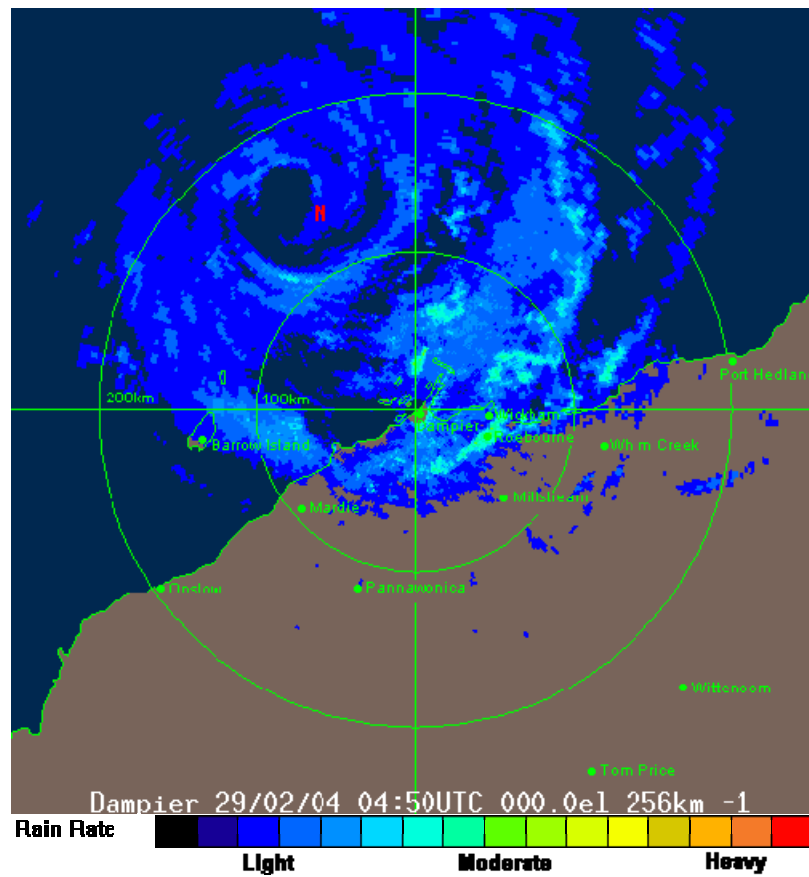
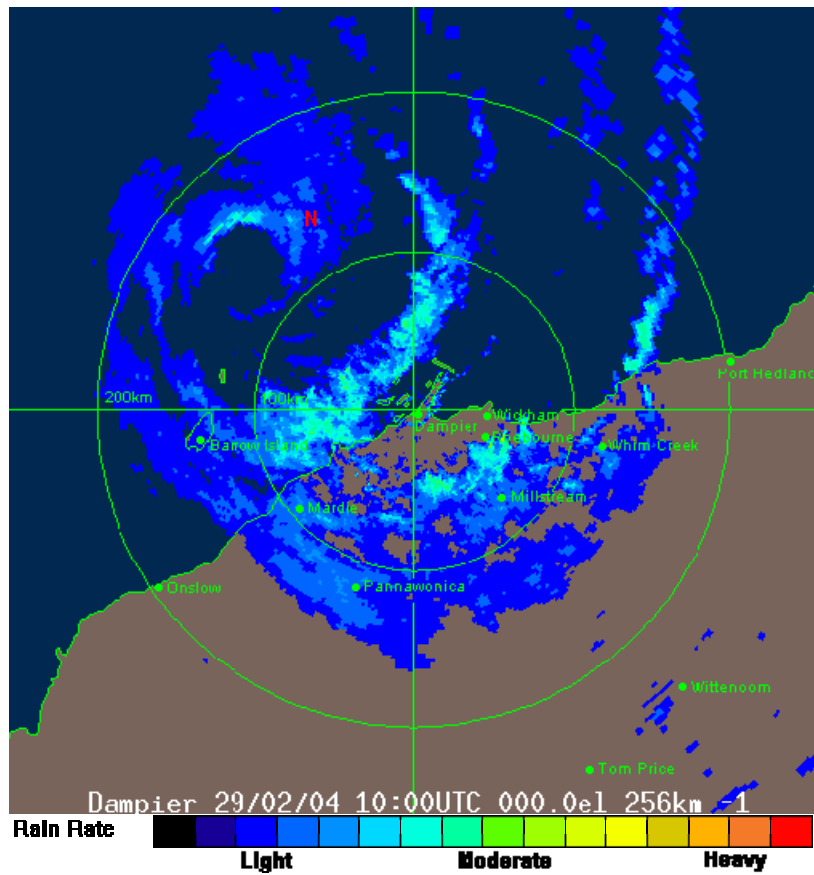


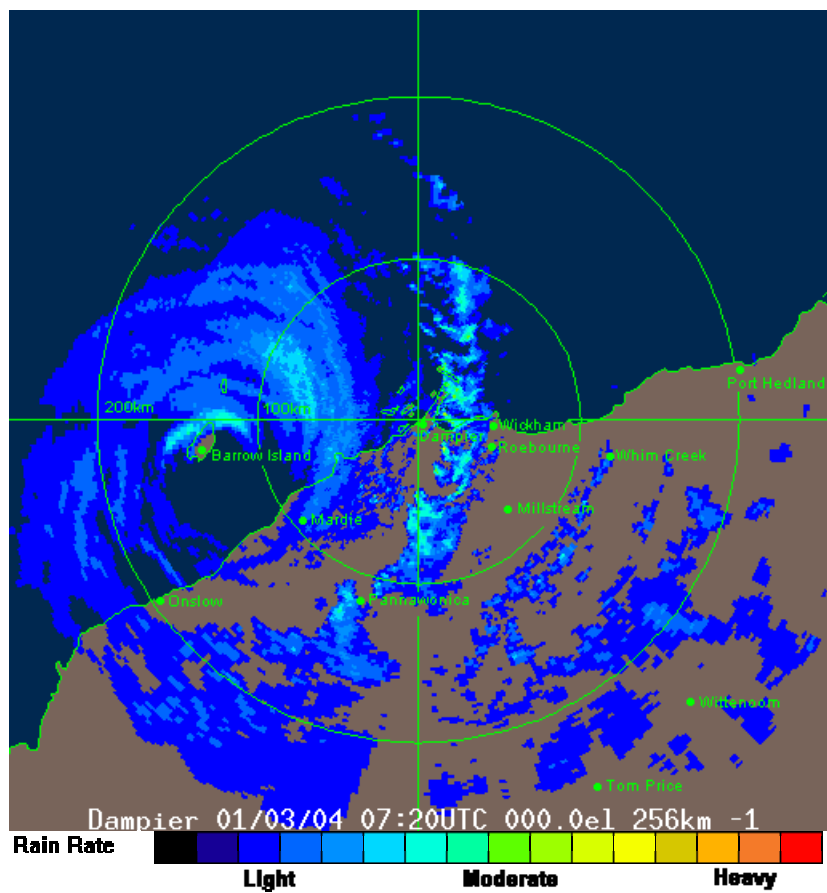
Figure 4. Radar images from Dampier at (a) 0450 UTC 29 February showing North Rankin in the eye wall, (b) 1000 UTC 29 February near peak intensity, (c) 0720 UTC 1 March showing Varanus Island in the eye wall and (d) 1430 UTC 1 March near the time of coastal crossing.



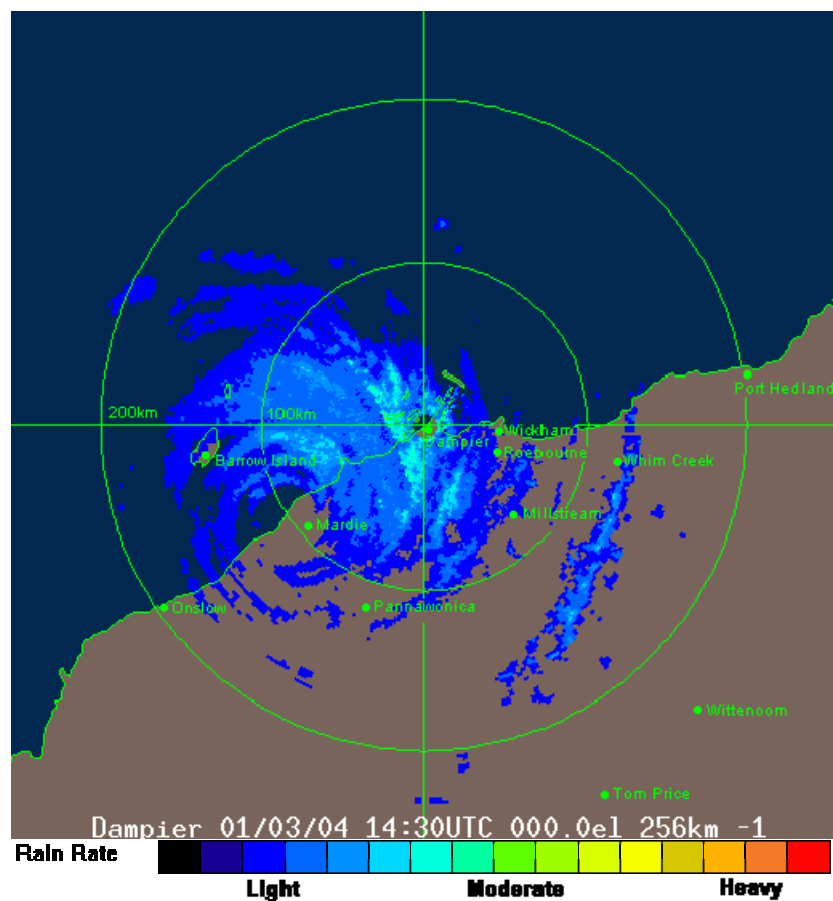
(a)



(b)



(c)



(d)

Figure 5. Sea Surface Temperature analysis on (a) 27 February and (b) 1 March. Images courtesy of RSS (www.rss.com).

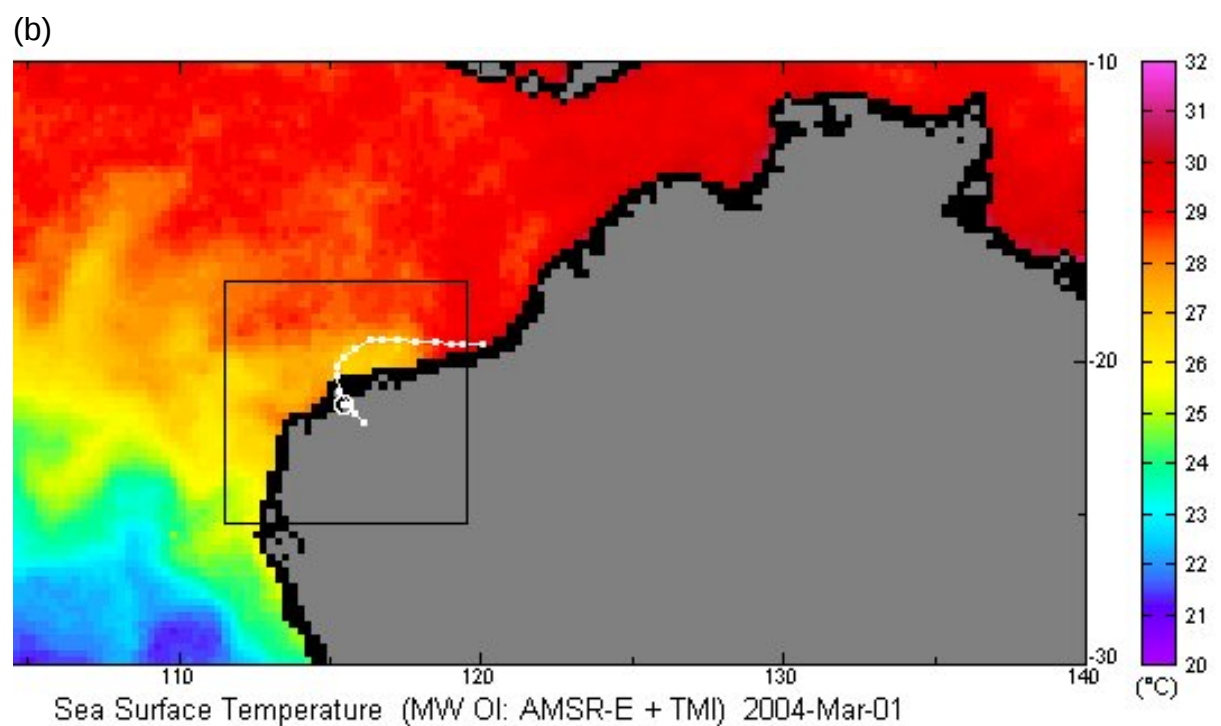
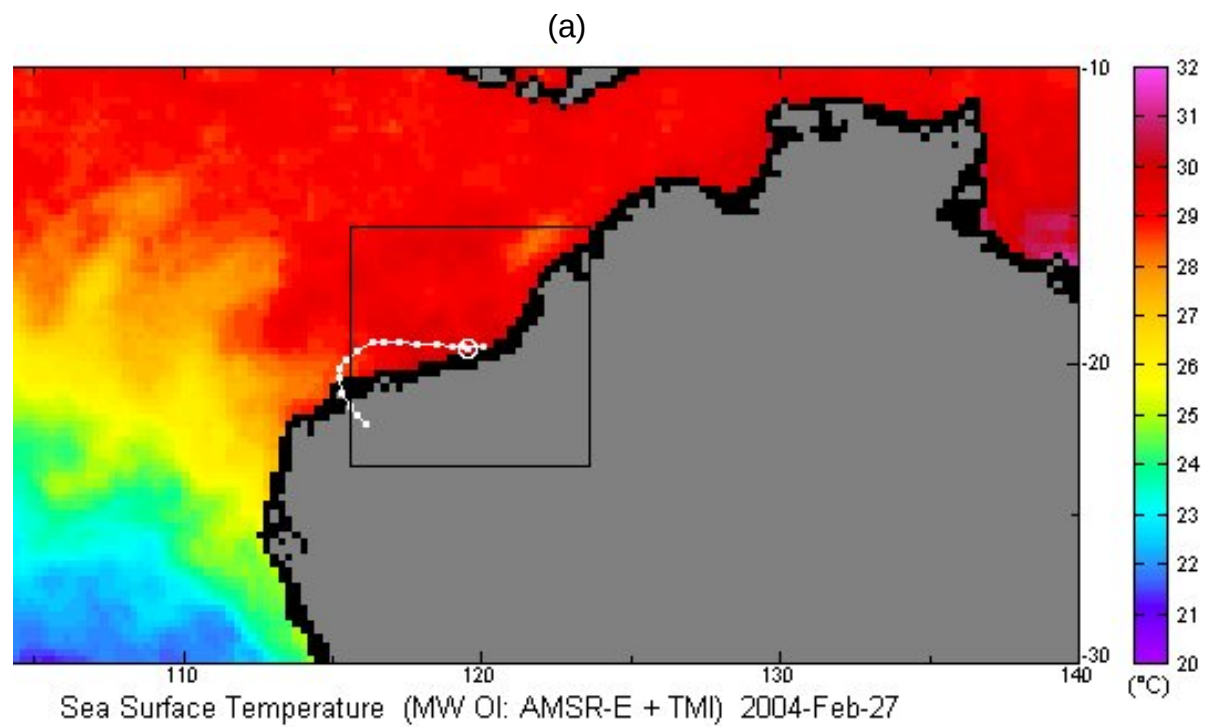


Figure 6a. Wind and pressure time series from North Rankin.

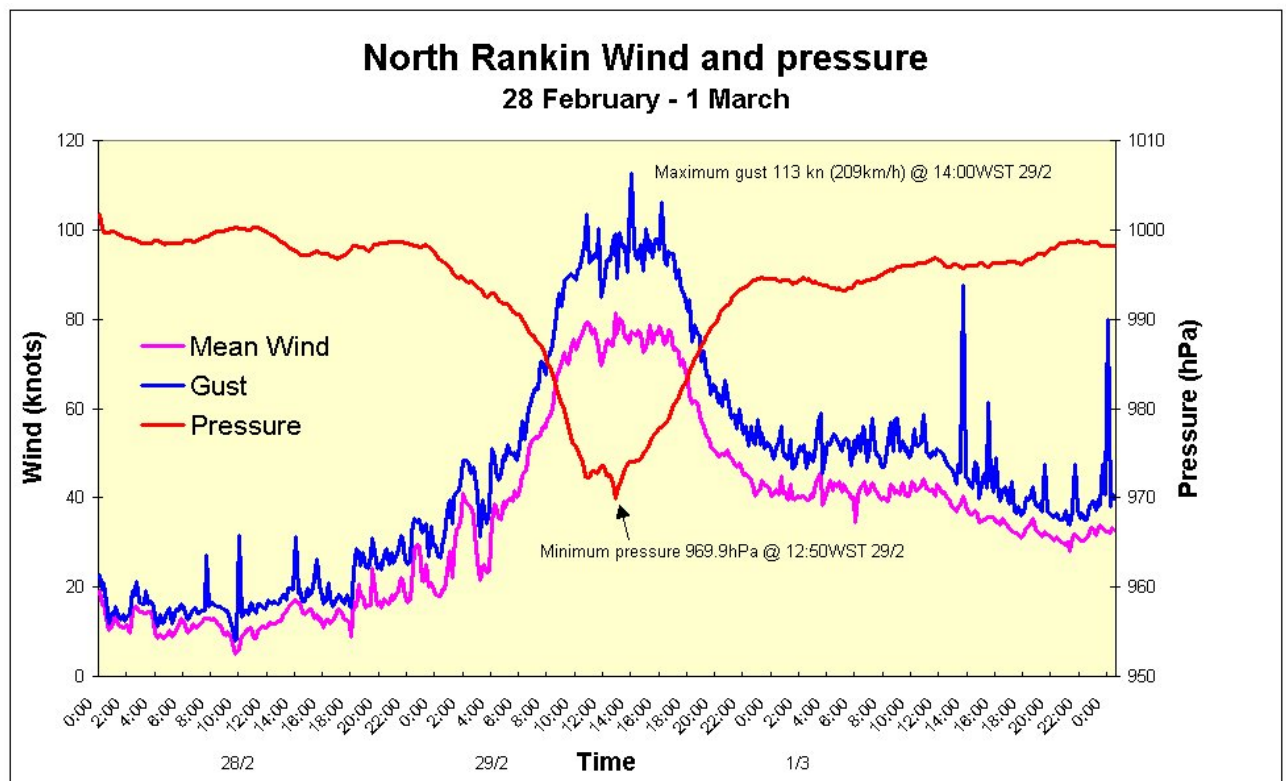


Figure 6b. Wind and pressure time series from Barrow Island.

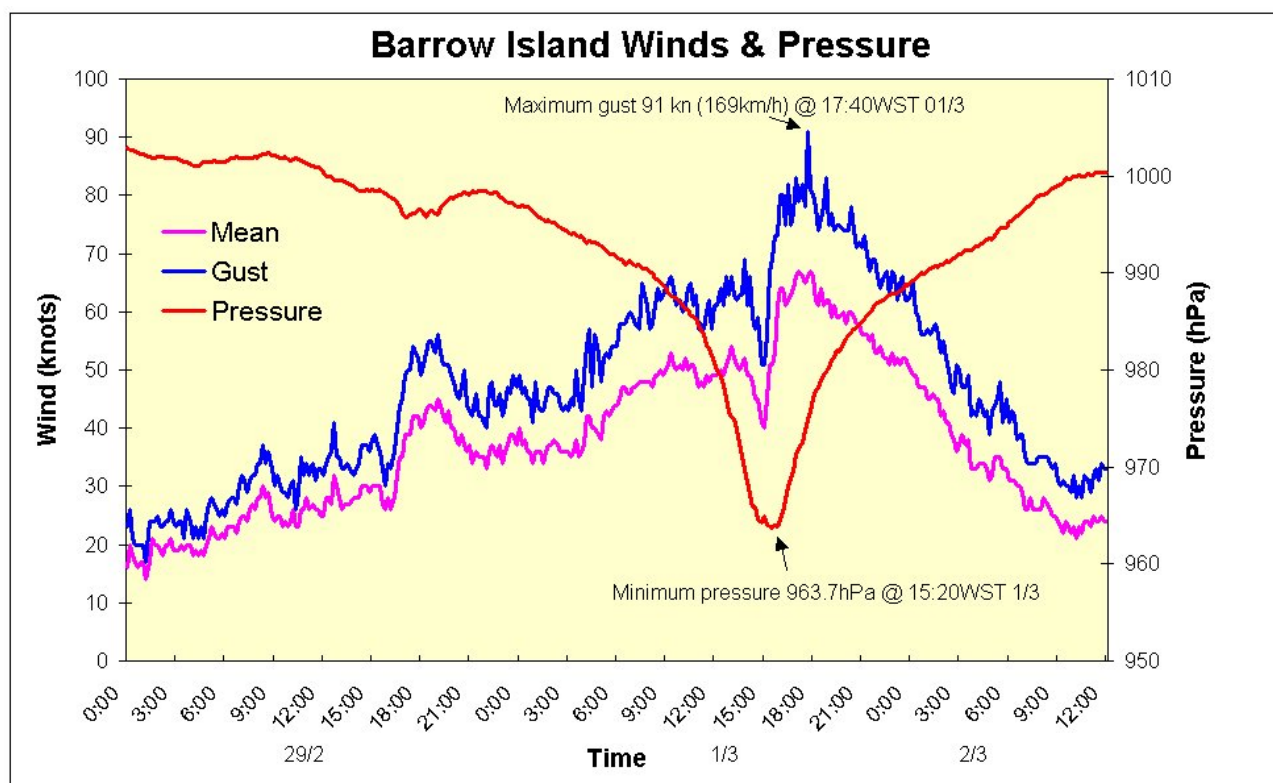


Figure 6c. Wind and pressure time series from Mardie.

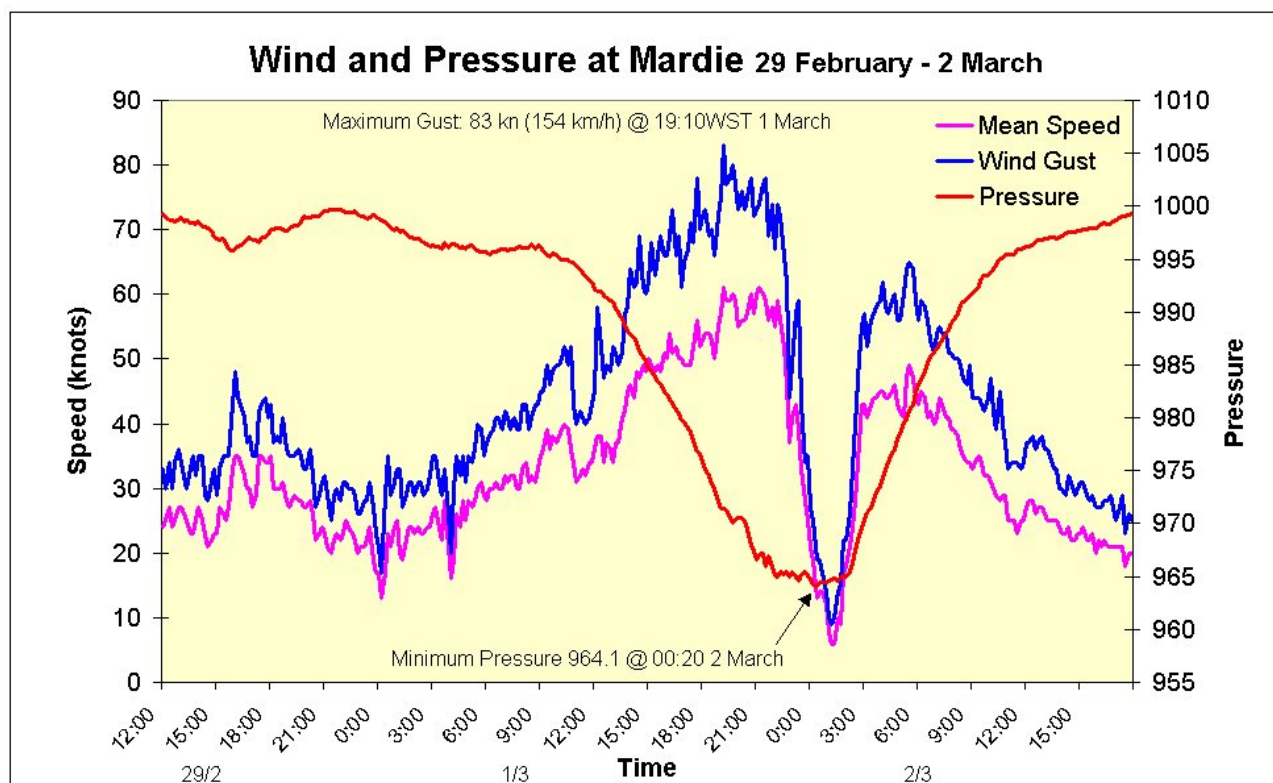


Figure 6d. Wind and pressure time series from Karratha.

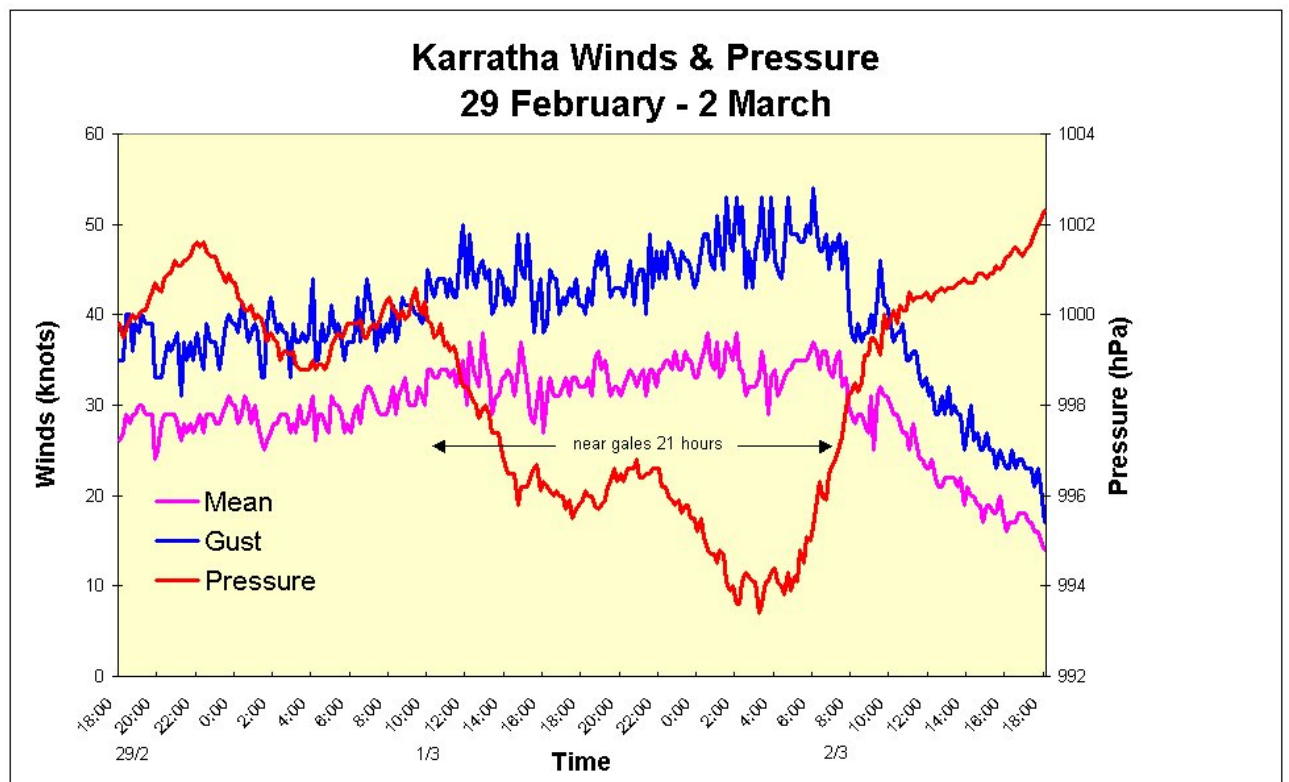


Figure 7. Total rainfall for week ending 3 March 2004.

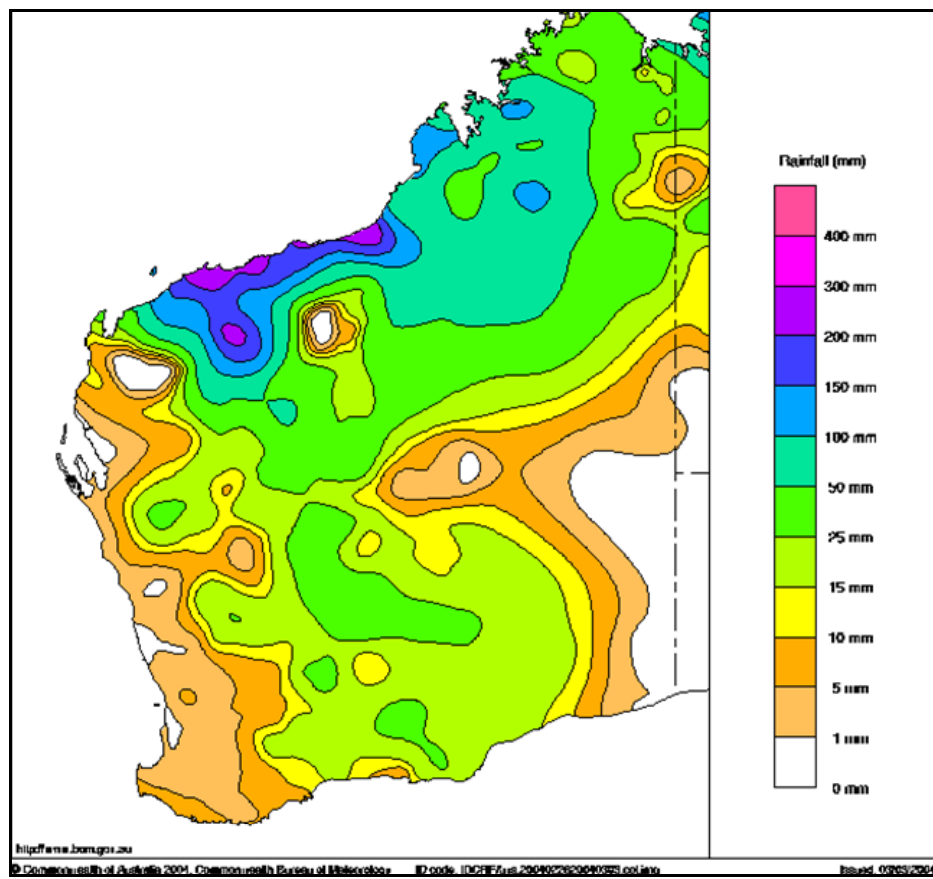


Figure 8. Photos near Harding River Dam, south of Roebourne; (a) the spillway and (b) the old Cooya Pooya Homestead. Photos provided by the Water Corporation.

(a)



(b)



Figure 9. Photos of (a) Fortescue River looking north along the bridge and (b) road damage. Photos provided by Main Roads Department.

(a)



(b)



Figure 10. Photos along the Robe River; (a) looking north along Great Northern Highway and (b) Yarraloola Station. Photos provided by FESA, State Emergency Service.

(a)



(b)



Figure 11. Photos of (a) the Maitland River Bridge and (b) the Ashburton River. Photos provided by FESA State Emergency Service.

(a)



(b)

