



Severe Tropical Cyclone *Rusty* 21 February – 1 March 2013

Perth Tropical Cyclone Warning Centre
Bureau of Meteorology

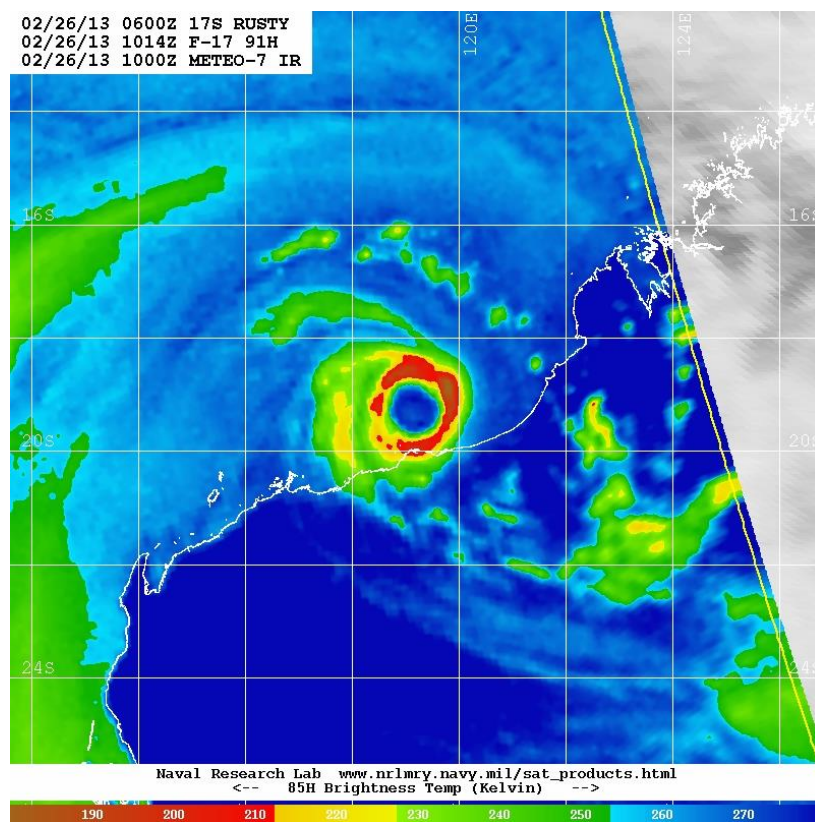


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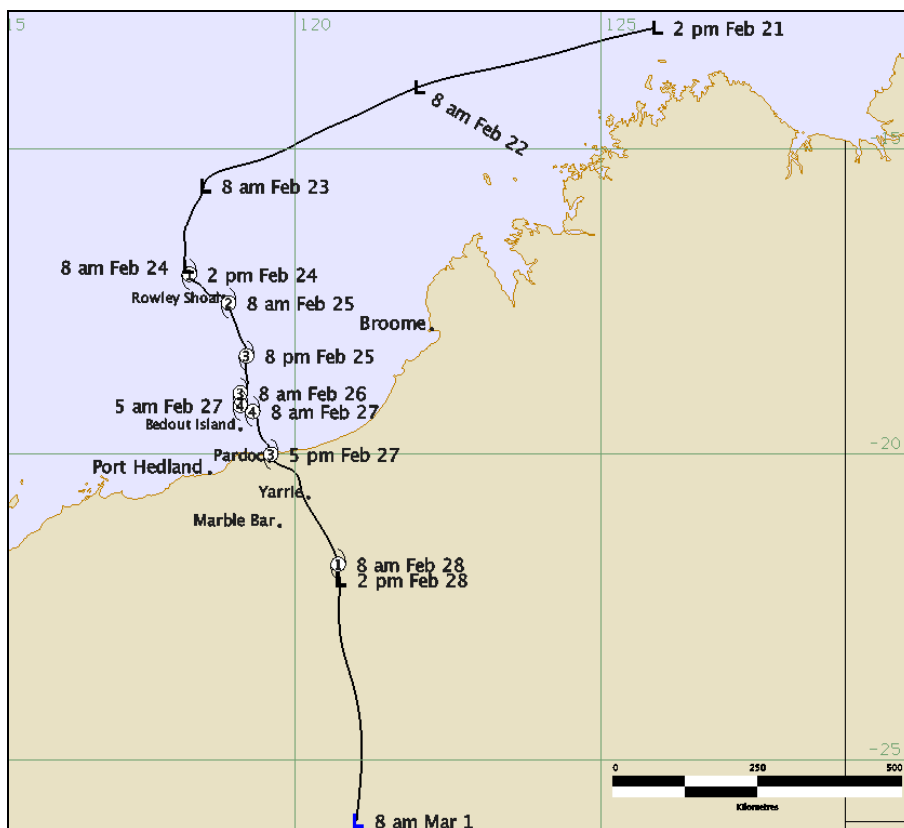
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Summary

Severe Tropical Cyclone (STC) *Rusty* formed when an active phase of the Madden-Julian Oscillation (MJO) combined with a monsoon trough. A weak tropical low became evident north of the Kimberley coast during 21 February and initially tracked southwest before turning south on 23 February. The low reached cyclone intensity during 24 February and began to move in a south-southeast direction towards the Pilbara coastline. *Rusty* became stationary during 26 February with an unusually large radius of gale-force winds surrounding the centre which contracted as the cyclone gradually intensified. *Rusty* briefly reached Category 4 intensity on 27 February before it began to weaken and crossed the coast to the east of Pardoo Station as a Category 3 intensity around 0900 UTC (Coordinated Universal Time) 27 February. *Rusty* was downgraded to a tropical low by 0600 UTC 28 February before it dissipated over land.

Water and structural damage to buildings were reported from both Pardoo Station and Pardoo Roadhouse, with many trees down and significant flooding. Pardoo Station also reported cattle loss as a result of hypothermia. Only minor damage was reported in Port Hedland. Due to the very slow movement of the cyclone there was significant disruption to shipping and offshore industries, with Port Hedland Port closed for eighty-six hours, as well as onshore mining operations near the path of *Rusty*. Port Hedland Airport recorded sustained gales for forty-five hours from 1430 UTC 25 February which is unprecedented in the wind record that goes back to 1942. Major flooding occurred in the De Grey River catchment as a result of the prolonged heavy rainfall.

Figure 1. Best track of Severe TC *Rusty* 21 February – 1 March 2013 (times in WST, UTC+8).



Meteorological Description

Intensity analysis

An active phase of the MJO combined with an active monsoon trough to produce a weak tropical low to the north of the Kimberley coastline during 21 February. The low developed slowly during the period 22 to 24 February. At times there were little, or no curvature associated with the convection and at other times the curved bands were well removed from the centre of rotation. Shear analyses show light to moderate shear over the tropical low indicating it wasn't shear that slowed the initial development. By 24 February, a 0319 UTC Oceansat-2 SCATterometer (OSCAT) (Refer Fig. 2) pass showed a well-developed circulation north of the Pilbara coast with stronger winds well removed from the centre. The image also shows a large swathe of 25 to 30 knot northwest winds to the north of the low associated with a strong burst of the monsoon.

The low reached cyclone intensity at 0600 UTC 24 February and despite having an unusually large radius to maximum wind (RMW) it continued to steadily intensify at a Dvorak rate of 0.5 to 1.0 T-number a day over the next 48 hours. Infrared (IR) satellite imagery showed that a weak eye developed initially around 1000 UTC 25 February. The 1022 UTC 25 February microwave image (refer Figure. 3) showed an unusual large eye, with what appeared to be two separate circulations within it, one to the northwest and one to the south east. From around 0600 UTC 25 February through until 0000 UTC 26 February the rate of intensification slowed a little with a slight plateau evident in the intensity plot (refer Figure. 5) between 1200 UTC and 1800 UTC 25 February at around 65 knots. During this period the gale radius decreased from at its largest 200 nm, to a more average size of 120 nautical miles (nm) and the RMW contracted from 60 nm to 25 nm by 0000 UTC 26 February.

Between 0000 UTC and 1200 UTC 26 February, the intensity again showed a plateau at around 75 knots while the RMW continued to contract. Satellite images showed a clear though elongated eye during the day. During the overnight period the eye became circular and raw DT numbers increased steadily to a peak of 6.0 several times between 1630 UTC and 2130 UTC 26 February. At this time the peak intensity was reached with a maximum 10-minute mean wind of around 90 knots using an average of the objective and subjective intensity estimates available (refer Figure. 5). In addition, microwave and radar imagery showed a marked contraction of the eye wall and RMW.

While this contraction persisted from 0000 UTC 27 February as *Rusty* neared landfall, *Rusty* had began to show signs of weakening. The temperatures surrounding the eye were warming and the eye temperature cooled leading to a rapid decrease in raw Dvorak Date T-numbers (DT). *Rusty* was located 45 nm (around 85 kilometres) north of the Pilbara coast for a prolonged period. It is likely that the close proximity to land and possible entrainment of mid-level dry air may have had an effect on the intensity as shear analyses at this time continued to show low values. *Rusty* crossed the Pilbara coast at around 0900 UTC 27 February as a Category 3 system and weakened quickly below cyclone strength by 0600 UTC 28 February.

Figure 5 shows the comparison of objective and subjective intensity estimates for *Rusty*. Most techniques are in good agreement. CIRA AMSU (Cooperative Institute for Research in the Atmosphere Advanced Microwave Sounding Unit) estimates were about 10 to 15 knots higher than other techniques late on 25 February and estimates ceased altogether by 0000 UTC 26 February. Late on 26 February Cooperative Institute for Meteorological Satellite Studies Advanced Dvorak Technique (CIMSS ADT) (8.1.3) raw DT numbers were too low as the method failed to use an eye pattern when an eye was clearly evident on satellite imagery.

Motion

STC *Rusty*'s motion over its lifetime was significantly slower than the average speed of movement of around 8 knots for the Western Australian region. Initially *Rusty* was steered to the west southwest at an average speed of around 8 knots by a mid level ridge located to the south. During 23 February a mid-level trough amplified over southern Western

Australia which caused the 500 hPa high to weaken. This allowed the system to move to the south and then south southeast. *Rusty's* average speed of movement slowed significantly as a mid-level high pressure centre to its west balanced the northwest flow produced by a significant mid-level low over eastern Australia. Through 24 and 25 February *Rusty* moved at an average speed of around 2 to 3 knots. This slowed further on 26 February to 1 knot when it was located around 55 nm (95 kilometres) north of the Pilbara coast. During 27 February, as *Rusty* crossed the Pilbara coast, the average speed of movement to the southeast increased as the mid-level trough moved eastwards increasing the northwesterly steering flow.

Structure

During the initial stages of *Rusty's* development (22 – 24 February) the system exhibited monsoonal low type characteristics in its structure. The system had a much larger than average radius to gales of 200 nm in the northern quadrants and 140 nm in the southern quadrants. Satellite imagery indicated that curved convective bands were at times located a long way away from the system centre which supports a larger than average RMW of around 60 nm initially.

During 25 February the cyclone appeared to have two eyes with one centre located to the northwest and one to the southeast in the convective banding. At 1000 UTC 25 February the cyclone had an eye diameter on radar of around 85 nm and a RMW of around 40 nm. This is supported by microwave imagery at the time. As the cyclone intensified during 26 February the gale radius contracted to between 90 and 120 nm and the RMW contracted to around 15 nm on radar with a symmetric system demonstrated on all methods of detection.

The cyclone passed almost directly over Rowley Shoals around 0000 UTC 25 February. Despite the low reaching cyclone strength as it approached the island from the northwest, the observations showed only near gale force winds when the cyclone was approximately 40 nm to the northwest of the island. The wind speed decreased as the cyclone passed close by and then increased again as it moved further south of the island. Observations showed a long period of gale force winds commenced at 0600 UTC 26 February, when the cyclone was located about 30 nm to the south southeast of the island.

Despite satellite imagery showing that cloud top temperatures had warmed, and Dvorak raw DT numbers had decreased indicating *Rusty* had begun to weaken the RMW continued to contract. As the cyclone approached the Pilbara coast, radar indicated that the RMW had contracted to as small as 10 nm.

Impact

Rusty crossed the Pilbara coast near Pardoo around 0900 UTC 27 February as a severe Category 3 cyclone with wind gusts estimated at 105 knots (195 km/h). Water and structural damage to buildings were reported from both Pardoo Station and Pardoo Roadhouse, with many trees down and significant flooding. Pardoo Station also reported cattle loss as a result of hypothermia.

Due to the slow movement of the cyclone and its prolonged proximity to the Pilbara coast, there was significant disruption to shipping and offshore industries, with Port Hedland Port closed for eighty-six hours. Onshore mining operations near the path of *Rusty* were also affected. Port Hedland Airport recorded sustained gales for 45 hours from the afternoon of 25 February, which is unprecedented in the wind record that goes back to 1942. Despite this only minor damage was reported in Port Hedland.

Prolonged heavy rainfall associated with *Rusty* caused major flooding in the De Grey River catchment. Rainfall totals recorded in the Pilbara for the period 22 February to 28 February included 552.5 millimetres (mm) at Pardoo Station, 415 mm at Yarrie, 400.8 mm at Yarrie BHP, 282.6mm at Mandora and 274.6mm at Telfer Aerodrome. Moderate to heavy rainfall was reported through the Southern Interior and the Goldfield Districts on 1 March as the remains of *Rusty* moved over southern Western Australia (refer Figure 6).

Observations

Wind

Rowley Shoals Automatic Weather Station (AWS) recorded a brief period of gales between 1410 and 1449 UTC 24 February and then again between 0549 UTC and 0730 UTC 25 February when the equipment stopped recording. Data recommenced at 1540 UTC 25 February with gales recorded until 2019 UTC 26 February.

Bedout Island AWS equipment failed after a short period. Between 0225 UTC and 1055 UTC 25 February, storm force winds were recorded with a maximum gust of 67 knots (124 km/h).

Port Hedland AWS recorded gale force winds from 1430 UTC 25 February until 1130 UTC 27 February, a period of 45 hours. Storm force winds were recorded briefly from 1954 UTC to 2030 UTC 25 February.

Marble Bar recorded gale force winds from 0830 UTC until 1700 UTC 27 February, a period of 8 and a half hours.

Pressure

Rowley Shoals recorded a lowest pressure of 970.7 hPa at 0410, 017 and 0610 25 February.

The lowest recorded pressure was 959hPa at Pardoo Station, approximately 2 hours before the centre crossed the coast

Rainfall

Pilbara rainfall totals for the period 22 - 28 February included 552.5mm at Pardoo Station, 415 mm at Yarrie, 400.8 mm at Yarrie BHP, 282.6mm at Mandora and 274.6mm at Telfer Aerodrome.

Lorna Glen in the Southern Interior recorded 107.5 mm in the 24 hours to 0900 WST 1 March.

Record February daily rainfall totals were recorded at Pardoo Station 26 February (200 mm) and Telfer Aerodrome on 28 February (177 mm).

Forecast Performance

Good model performance during *Rusty* meant that long lead time warning of the risk of a severe coastal impact and significant flooding were possible and that overall the warning service provided accurate information. The **European Centre for Medium-Range Weather Forecasts (ECMWF)** deterministic model runs indicated a Pilbara impact as early as the 0000 UTC run on 22 February. Most subsequent ECMWF model runs continued to indicate this.

The first Tropical Cyclone Advice was issued at 0100 UTC 23 February when a TC Watch was declared for coastal areas between Cape Leveque to Dampier. The advice contained a statement indicating there was a significant risk of a severe impact on the Pilbara coast in 3 to 4 days time. At 0100 UTC 24 February the Advice was upgraded to a Warning for coastal areas between Wallal and Whim Creek with a Watch extending east to Broome and west to Mardie. Advice messages also included messages of significant flooding risk to the Pilbara and Kimberley due to the slow movement of the system.

During 25 and 26 February, the Watch/Warning boundaries were changed slightly to reflect uncertainty in the coastal crossing location. The warning boundaries and were extended inland as appropriate. Advices reflecting the possibility of a very dangerous storm tide near the crossing location were also included. The final Tropical Cyclone Advice was issued at 0600 UTC 28 February, indicating *Rusty* had weakened below tropical cyclone strength and that further heavy rainfall associated with the remains of the cyclone was likely.

Table 1. Best track summary for Severe Tropical Cyclone *Rusty*

Refer to the Australian Tropical Cyclone database for complete listing of parameters.

Year	Month	Day	Hour UTC	Pos. Lat. S	Pos. Long. E	Position Accuracy nm	Max wind 10min knots	Max gust knots	Central Pressure hPa	Rad. of Gales nm (NE/SE/SW/NW)	Rad. of storm force winds (NE/SE/SW/NW)	Radius Max. Wind (RMW)
2013	2	21	06	13.0	125.9	60	20	45	1005			
2013	2	21	12	13.3	124.6	60	20	45	1003			
2013	2	21	18	13.7	123.3	60	20	45	1003			
2013	2	22	00	14.0	122.0	60	25	45	1002			
2013	2	22	06	14.4	121.1	60	25	45	1002			
2013	2	22	12	14.8	120.2	60	25	45	1000			
2013	2	22	18	15.2	119.4	60	25	45	1000			
2013	2	23	00	15.6	118.5	30	25	45	1000			
2013	2	23	06	15.9	118.4	30	25	45	997			
2013	2	23	12	16.3	118.2	30	25	45	995			
2013	2	23	18	16.6	118.2	25	25	45	995			
2013	2	24	00	16.9	118.2	20	30	45	990			
2013	2	24	06	17.1	118.3	20	35	50	985	200/130/ 140/200		60
2013	2	24	12	17.2	118.4	30	40	55	981	200/130/ 140/200		60
2013	2	24	18	17.3	118.5	30	45	65	978	200/130/ 140/200		60
2013	2	25	00	17.5	118.9	30	50	70	970	200/130/ 140/200	120	60
2013	2	25	06	18.0	119.1	30	55	75	965	170/130/ 140/180	110	60
2013	2	25	12	18.4	119.2	20	65	90	962	140/120/ 170/120	100	40

2013	2	25	18	18.7	119.2	20	65	90	960	140/120/ 140/120	90	35
2013	2	26	00	19.0	119.1	20	75	105	957	120/110/ 120/120	80	25
2013	2	26	06	19.2	119.1	15	75	105	955	120/90/9 0/120	70	20
2013	2	26	12	19.2	119.1	15	75	105	950	100	60	20
2013	2	26	18	19.2	119.1	10	85	120	948	100	60	15
2013	2	27	00	19.3	119.3	10	90	125	944	90/90/12 0/90	50	15
2013	2	27	06	19.8	119.5	10	75	105	950	90	40	12
2013	2	27	09*	20.0	119.6	10	75	105	955	90	40	10
2013	2	27	12	20.2	119.8	10	65	90	967	90	30	10
2013	2	27	18	20.6	120.1	30	45	65	982	60/60/30/ 60		20
2013	2	28	00	21.2	120.5	60	35	50	990	40/40/20/ 40		20
2013	2	28	06	22.0	120.7	60	30	45	992	40/40/20/ 40		20
2013	2	28	12	23.0	120.7	60	25	45	990			
2013	2	28	18	24.0	121.0	60	25	45	990			
2013	3	1	00	26.0	121.0	90	25	45	996			

*Position added for time of coastal crossing.

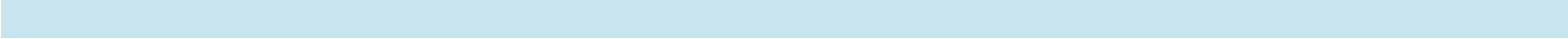


Figure 2. OSCAT pass 0319 UTC 24 February 2013.

(image courtesy of NOAA US NOAA <http://manati.orbit.nesdis.noaa.gov/datasets/OSCATData.php/>)

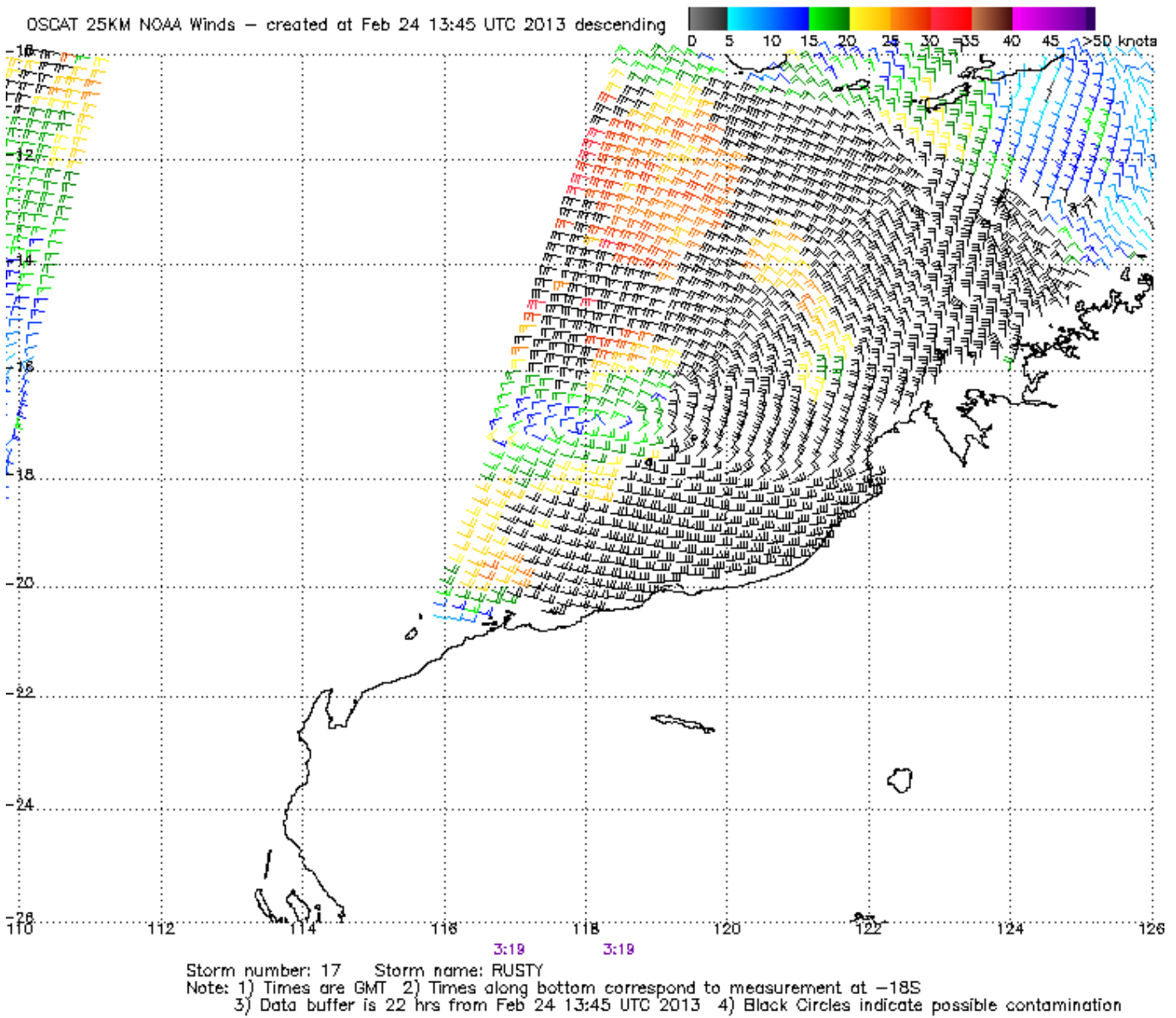
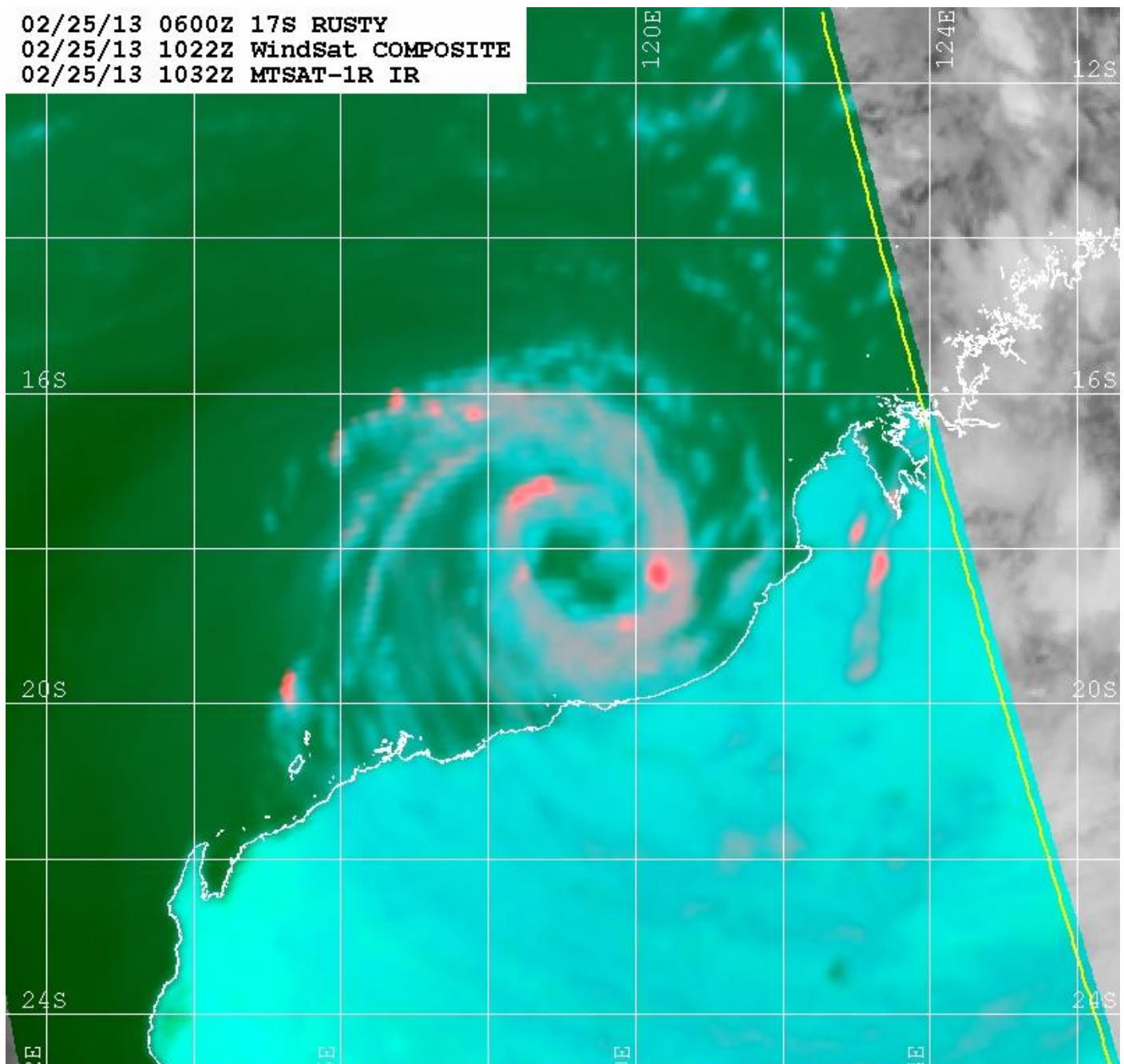


Figure 3. 37 GHz Windsat image 1022 UTC 25 February 2013.

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

02/25/13 0600Z 17S RUSTY
02/25/13 1022Z WindSat COMPOSITE
02/25/13 1032Z MTSAT-1R IR



Naval Research Lab www.nrlmry.navy.mil/sat_products.html
Red=37PCT Green=37V Blue=37H

Figure 4. 91 GHz TC_SSMIS microwave image 2128 UTC 26 February of *Rusty* near peak intensity.

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

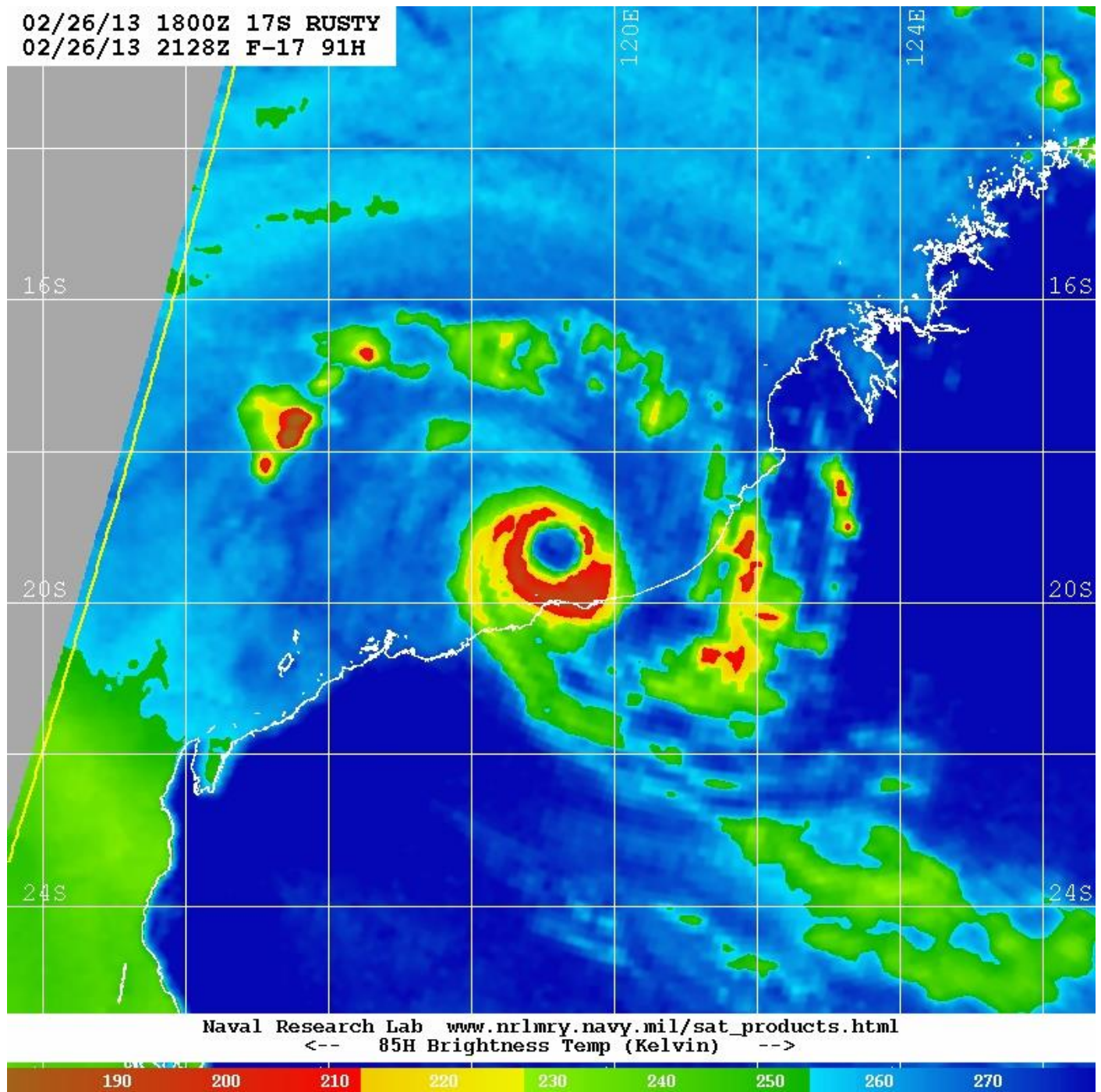


Figure 5. Comparison of objective and subjective intensity analysis techniques.

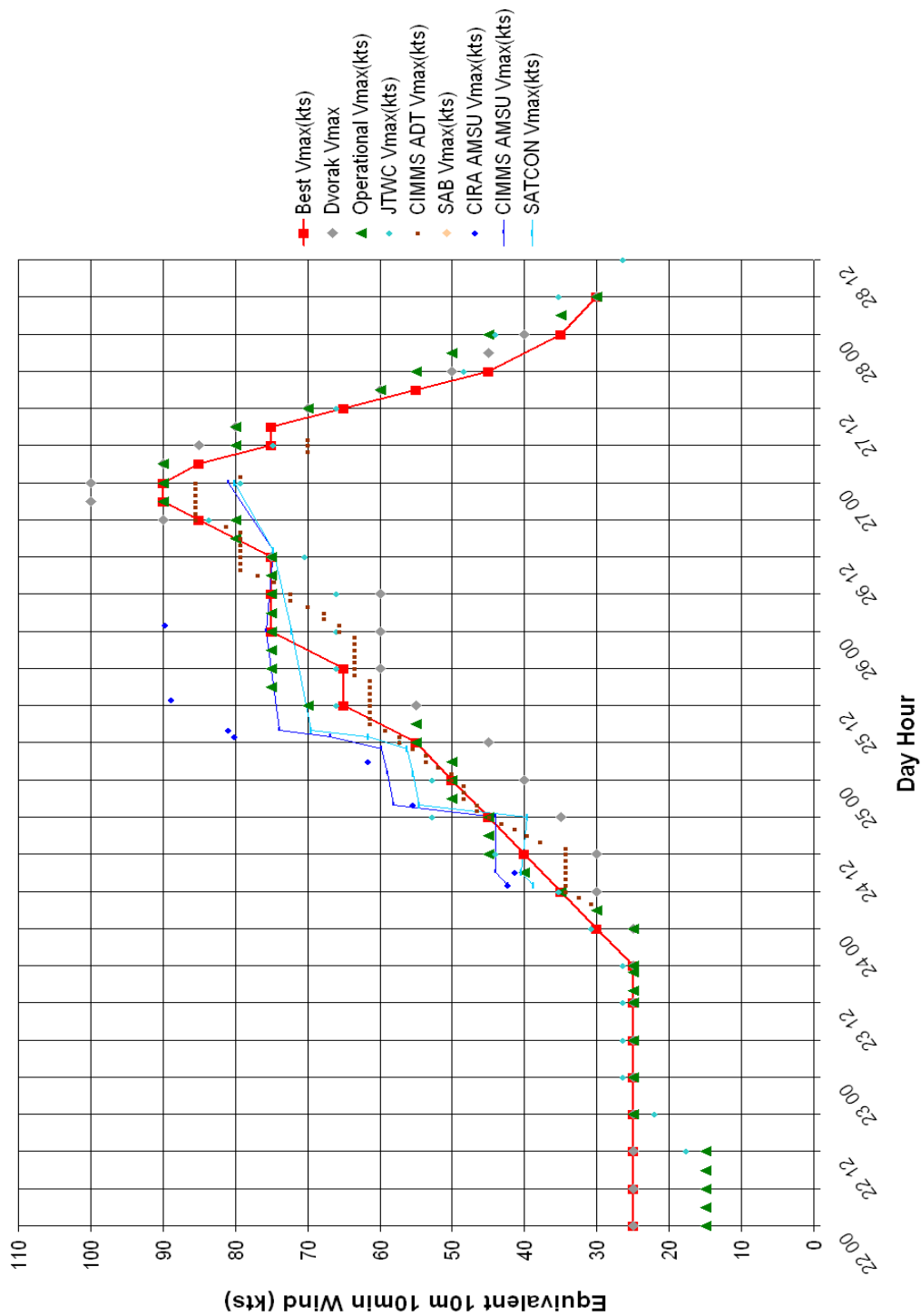


Figure 6. Western Australian rainfall totals in mm for the week ending 2 March.

Western Australian Rainfall Totals (mm) Week Ending 2nd March 2013
Product of the National Climate Centre

