Australian Government
Bureau of Meteorology

Tropical Cyclone *Joyce*

7 – 15 January 2018

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1 Summary

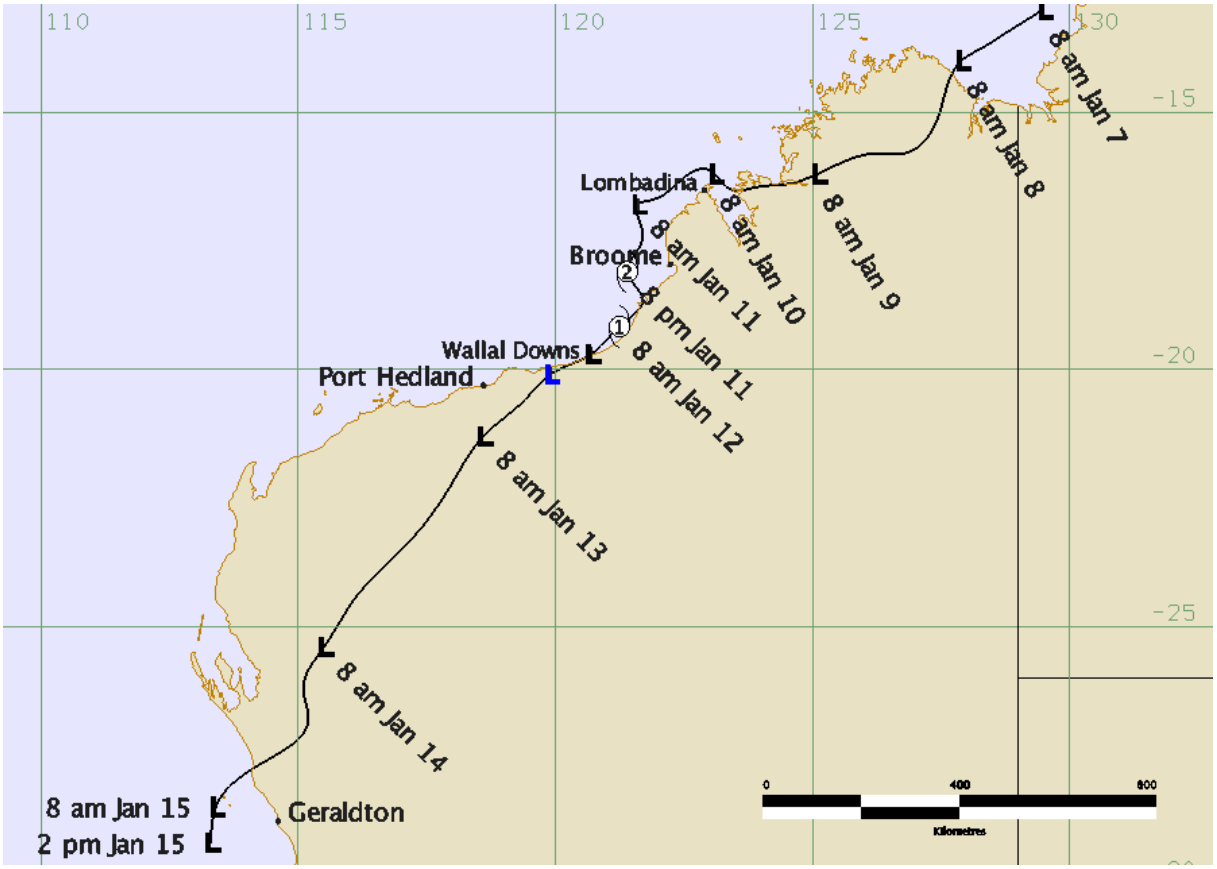
A low formed in the Joseph Bonaparte Gulf on 7 January 2018, during an active phase of the monsoon trough. The low initially tracked west southwest which took it inland across the far north of Western Australia during 8 and 9 January. On 10 January the low moved offshore north of the Dampier Peninsular and began to develop.

Joyce took a southerly track and reached tropical cyclone strength at 1200 Universal Time Coordinated (UTC) (2000 Australian Western Standard Time (AWST)) 11 January (AWST = UTC + 8 hours). The tropical cyclone reached a 10-minute mean wind peak intensity of 50 knots (kn) (93 kilometres per hour (km/h)) at 1200 UTC 11 January just prior to touching the coast near Bidyadanga. *Joyce* then turned west- southwest and moved parallel to the Pilbara coastline. The tropical cyclone moved inland around 10 kilometres (km) west of Wallal Downs at 0700 UTC 12 January as a category 1 system and then weakened quickly. The remnants of *Joyce* continued to move through western parts of Western Australia before moving offshore again north of Geraldton on 15 January.

The most notable impact of *Joyce* was rainfall, there were numerous 24-hour rainfall totals in excess of 75 millimetres (mm) with some falls exceeding 150 mm. Heavy rainfall continued over western parts of Western Australian between 13 and 16 January with widespread falls of 40 to 80 mm and some totals in excess of 100 mm. Many sites recorded their wettest January day or wettest day on record. In the 24 hours to 9 am AWST 12 January Mandora recorded 150 mm which was a January daily record and the highest total for this for event.

Multiple Flood Watches and Warnings were issued for the De Grey, Gascoyne, Greenough, Moore Hill, Ord River catchments and the Sandy Desert and West Kimberley river districts with some minor flooding recorded in the De Grey and Gascoyne River catchments.

FIGURE 1. Best track of Tropical Cyclone *Joyce* 7-15 January 2018 (times in AWST, UTC+8).



2 Meteorological Description

2.1 Intensity analysis

A low formed in the Joseph Bonaparte Gulf during 7 January and moved west-southwest. The low moved inland and then across northern Western Australia during 8 and 9 January. On 10 January the low moved offshore north of Lombadina and began to slowly develop. Once over open water a Dvorak Data T (DT) number of 1.5 was assigned. As the day progressed a curved band was evident on imagery and the DT number climbed steadily to reach 2.5 by 1800 UTC 10 January. Between 1800 UTC and 0000 UTC 11 January Adele Island reported two short periods of gale force winds but these were associated with a band of deep convection well removed from the circulation.

By 0000 UTC 11 January a curved band pattern in the Enhanced Infrared Imagery (EIR) gave a DT of 3.0, however Final T (FT) number was constrained to 2.5. Two Advanced Scatterometer (ASCAT) passes at 0049 and 0145 UTC 11 January captured *Joyce* and showed only one report of gales in the southwest quadrant, refer Figure 2. Both objective Advanced Dvorak Technique (ADT) estimates were between 30-35 kn (56-65 km/h) with the Satellite Consensus (SATCON) method at around 40 kn (74 km/h). The estimate from SATCON may have been a slight overestimate due to the small size of *Joyce* at this time. Refer to Figure 3 for a plot of both subjective and objective intensity estimates for *Joyce*.

During 11 January *Joyce* moved in a southerly direction, parallel to the Dampier Peninsular and intensified. Subjective Dvorak DT estimates were at 3.0 and objective estimates climbed to reach a peak in excess of 50 kn (93 km/h) by 1200 UTC 11 January. An evening ASCAT pass showed gales extending out to around 80 nautical miles (nm) in the southwest quadrant. Final peak intensity was set at 50 kn (93 km/h) 10-minute mean wind at 1200 UTC 11 January, refer Figure 4. *Joyce* was very close to the coast at Bidyadanga and proximity to land affected *Joyce*'s development. The tropical cyclone's intensity weakened slightly as it moved parallel to the Pilbara coast and Mandora, to the east of Joyce's track, recorded no sustained gale force winds. As a result gales were reduced to two quadrants (western) in the best track at this time and Joyce no longer met the definition of a tropical cyclone.

Joyce crossed the Pilbara coast at around 0700 UTC (3pm AWST) 12 January about 10 km west of Wallal Downs. Surface observations from the Department of Primary Industries and Regional Development (DPIRD) Pardoo site (located very close to the track on the northwest side) reported a 10-minute peak wind of 43 kn (80 km/h) at 1038 UTC 12 January so an intensity of 45 kn was maintained from 1800 UTC 11 January until 1200 UTC 12 January. Pardoo also reported a minimum Mean Sea Level (MSL) pressure of 977.43 hPa at 1133 UTC 12 January. Port Hedland radar showed a clear circulation until the next morning but *Joyce* continued to weaken as it moved further inland.

The low remained intact and travelled in a southwest direction across Western Australia, eventually moving back offshore to the north of Geraldton in the mid-latitudes. The remnants produced heavy rainfall across the southwest of the state of Western Australia.

2.2 Structure

Joyce initially had gales in the southwest quadrant, as it developed this extended to the southeast quadrant. By 1200 UTC 11 January gales were present in all quadrants with a gale radii of 40 nm in the southeast and northwest quadrants extending out to 80 nm in the southwest quadrant. These estimates were obtained using radar images and ASCAT passes. Between 0000 UTC and 0600 UTC 12 January the gale radii decreased to two quadrants and *Joyce* was no longer classified as a tropical cyclone, however 45 kn winds persisted in the western quadrants through until 1200 UTC.

Radius to maximum wind (RMW) ranged from 20 nm down to 10 nm at peak intensity.

2.3 Motion

Joyce was initially steered to the west southwest by the middle level ridge to the south of the low. A mid-level trough amplified over the southern part of Western Australia which helped to produce a northerly steering flow which moved *Joyce* to the south. This northerly steering pattern persisted until 1200 UTC 11 January. As the mid-level trough relaxed to the south of *Joyce* the mid-level ridge reformed south of the tropical cyclone and *Joyce* was steered to the west southwest by a generally easterly steering pattern. The mid-level ridge remained the dominant steering pattern until the low dissipated on 15 January over the Indian Ocean.

3 Impact

The main impact of *Joyce* to Western Australia was rainfall and associated flooding. *Joyce* produced widespread 24 hour rainfall totals in excess of 75 mm across the Kimberley and Pilbara with some falls exceeding 150 mm. This rainfall occurred on an already wet catchment from the passage of Tropical Cyclone Hilda during late December 2017 and caused some disruptions with the town of Broome due to localised flooding. Road closures occurred between Broome and Cape Leveque and the Great Northern Highway between Roebuck Roadhouse and Marble Bar Road Intersection.

As the remains of *Joyce* moved across western parts of the state heavy rainfall continued. Some notable falls in the 24 hours to 9 am AWST 16 January were:

- Marradong recorded 162.2 mm (January daily record and highest for event);
- Bickley 139.2 mm (annual daily record),
- and Saddleback Road Bridge 149.2 mm (annual daily record).

Refer to Figure 5 for a map of rainfall across Western Australia for the week ending 17 January 2018.

4 Observations

4.1 Wind

Broome NTC Comparison Automatic Weather Station (AWS) recorded gale force winds between 0954 - 1011 UTC 11 January. The maximum 10-minute mean wind recorded was 35 kn (65 km/h) at 0024 - 0041, 0156, 0248 - 0256 UTC 11 January and the maximum 3-second wind gust recorded was 46 kn (85 km/h) at 0153 UTC 11 January.

Mandora AWS did not record gale force winds but did record a maximum 3-second wind gust recorded of 50 kn (93 km/h) at 0707 UTC 12 January.

Bedout Island AWS recorded gale force winds between 0421, 0507 - 0510, 0709 - 0748, 0805 - 2206 UTC 12 January. The maximum 10-minute mean wind recorded was 42.2 kn (78 km/h) at 1902 UTC 12 January and the maximum 3-second wind gust recorded was 53 kn (98 km/h) at 1056 UTC 12 January.

Pardoo DPIRD AWS recorded gales between 1029 – 1118 UTC 12 January. The maximum 10-minute mean wind recorded was 43 kn (80 km/h) at 1038 UTC 12 January.

4.2 Pressure

Adele Island AWS recorded a minimum mean sea level (MSL) pressure of 997.9 Hectopascals (hPa) at 1859 - 1906 UTC 10 January.

Broome NTC Comparison AWS recorded a minimum MSL pressure of 991.4 hPa at 1700 UTC 11 January.

Mandora AWS recorded a minimum MSL pressure of 980.4 hPa at 0730 UTC 12 January.

Pardoo DPIRD AWS recorded a minimum MSL pressure of 977.4 hPa at 1133 UTC 12 January.

Bedout Island AWS recorded a minimum MSL pressure of 994.3 Pa at 1550 UTC 12 January.

4.3 Rainfall

There were many highest January daily rainfall records broken during *Joyce*, some notable falls being:

Site	Rainfall mm	24 hours to 9 am AWST
Mandora	150.0	12 January
Araluen	145.6	15 Janaury

Murgoo	106.0	15 January
Dalgetty Downs	75.2	15 January
Karagullen	147.6	16 January
Bickley	139.2	16 January

5 Forecast Performance

The position accuracy figures for Tropical Cyclone *Joyce* show that the forecast performed initially at least as well as and then better than the five-year average.

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

	00	**06**	**12**	**18**	**24**	**36**	**48**	**72**	**96**	**120**
Absolute error (km)	31	48	59	71	81	96	106	147	193	166
RMS Error (km)	40	56	67	81	91	105	117	157	202	178
Sample Size	25	25	25	25	25	26	27	24	20	15

Figure 6 is a plot of the position accuracy figures for *Joyce* compared to the five-year mean.

TABLE 1. Best track summary for Tropical Cyclone *Joyce*.

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
2018		07	00	13.0	129.5	45	15	45	1008			
2018		07	06	13.2	129.1	45	15	45	1006			
2018		07	12	13.5	128.7	45	15	45	1006			
2018		07	18	13.7	128.3	45	15	45	1006			
2018		08	00	14.0	127.9	45	20	45	1005			
2018		08	06	15.4	127.3	45	20	45	1005			
2018		08	12	15.8	126.8	45	20	45	1005			
2018		08	18	15.8	126.3	45	20	45	1005			
2018		09	00	16.2	125.1	45	20	45	1004			
2018		09	06	16.4	124.5	45	20	45	1000			
2018		09	12	16.4	123.9	60	20	45	1000			
2018		09	18	16.5	123.4	60	20	45	1000			
2018		10	00	16.2	213.1	45	25	45	997			
2018		10	06	16.1	122.9	30	25	45	996			
2018		10	12	16.2	122.6	15	30	45	994			
2018		10	18	16.7	121.9	10	30	45	995			
2018		11	00	16.8	121.6	10	35	50	993	0/0/25/0		20

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
2018		11	06	17.4	121.7	10	45	65	986	0/40/40/0		15
2018		11	12	18.1	121.4	15	50	70	982	50/40/80/ 40	20	10
2018		11	18	18.6	121.7	15	45	65	980	20/20/80/ 40		15
2018		12	00	19.2	121.2	20	45	65	978	20/20/90/ 120		20
2018		12	06	19.7	120.7	10	45	65	978	0/0/40/70		15
2018		12	12	20.1	119.9	10	45	65	975	0/0/30/60		15
2018		12	18	20.6	119.4	5	30	45	990			
2018		13	00	21.3	118.6	5	25	45	995			
2018		13	06	22.2	118.0	15	25	45	998			
2018		13	12	23.3	117.2	15	20	45	1001			
2018		13	18	24.5	116.1	15	20	45	1001			
2018		14	00	25.4	115.5	20	20	45	1001			
2018		14	06	26.2	115.1	20	20	45	1001			
2018		14	12	26.8	115.2	20	20	45	1002			
2018		14	18	27.6	114.3	15	20	45	1002			
2018		15	00	28.5	113.4	10	20	45	1002			
2018		15	06	29.2	113.3	10	20	45	1002			

FIGURE 2. ASCAT pass at 0145 UTC 11 January as *Joyce* moved offshore from the town of Broome.

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

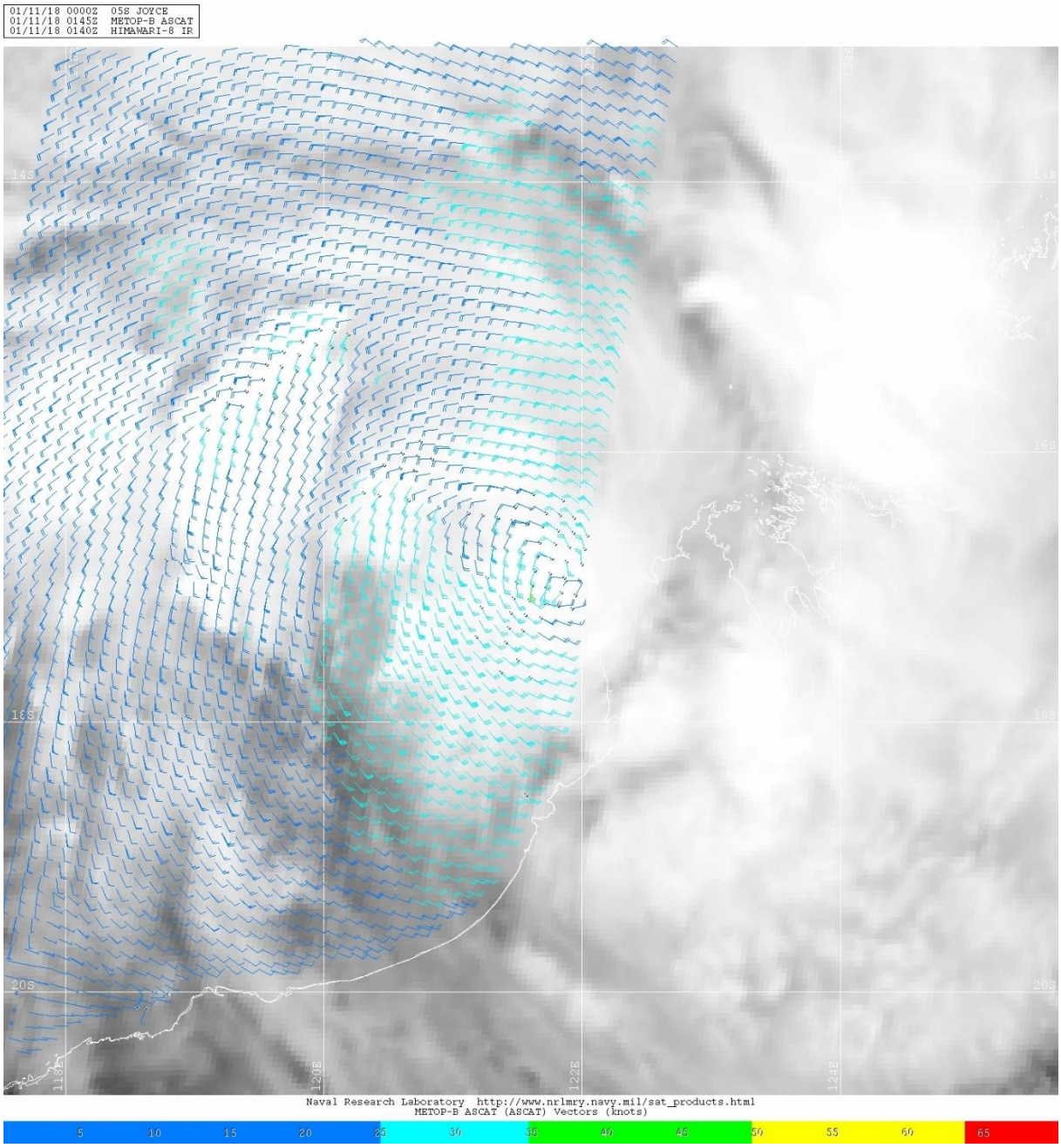


FIGURE 3. Plot of objective and subjective intensity estimates for *Joyce*.

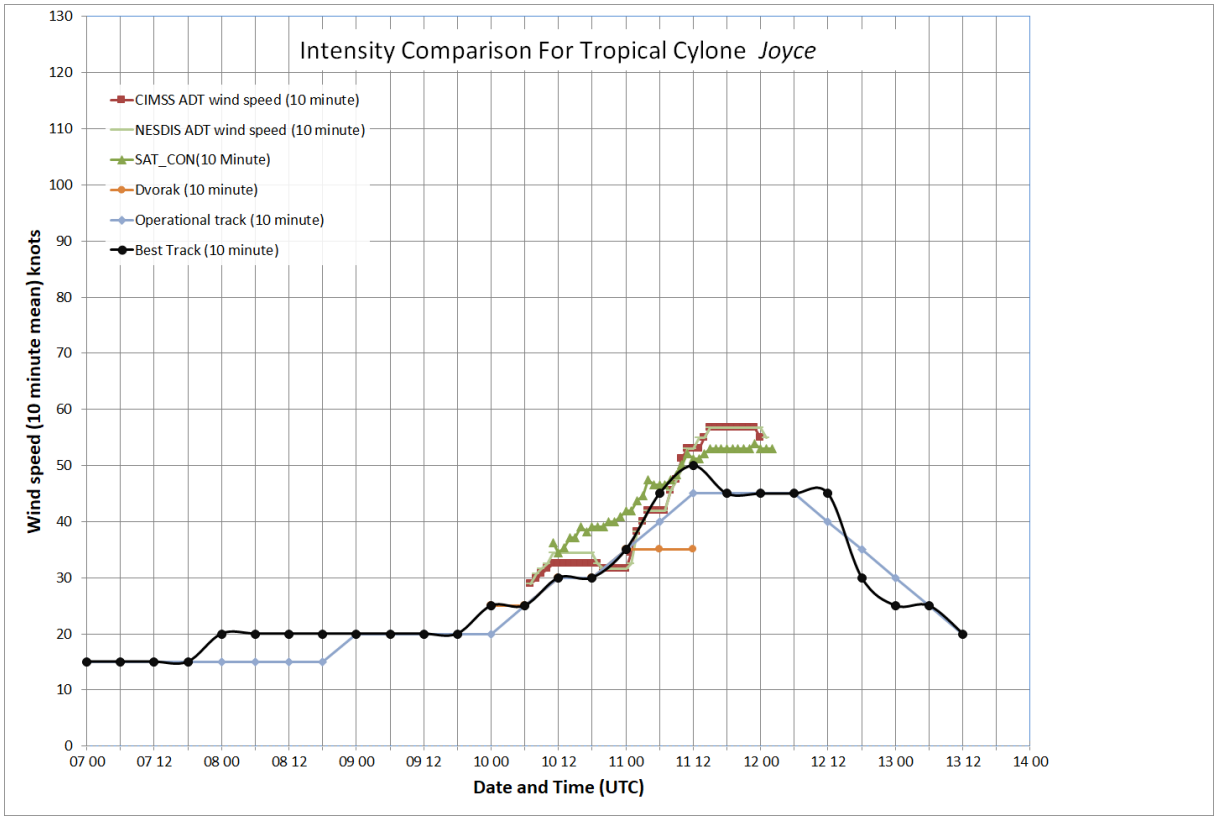


FIGURE 4. TCSSMIS image at 1021 UTC 11 January as *Joyce* approached peak intensity.

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

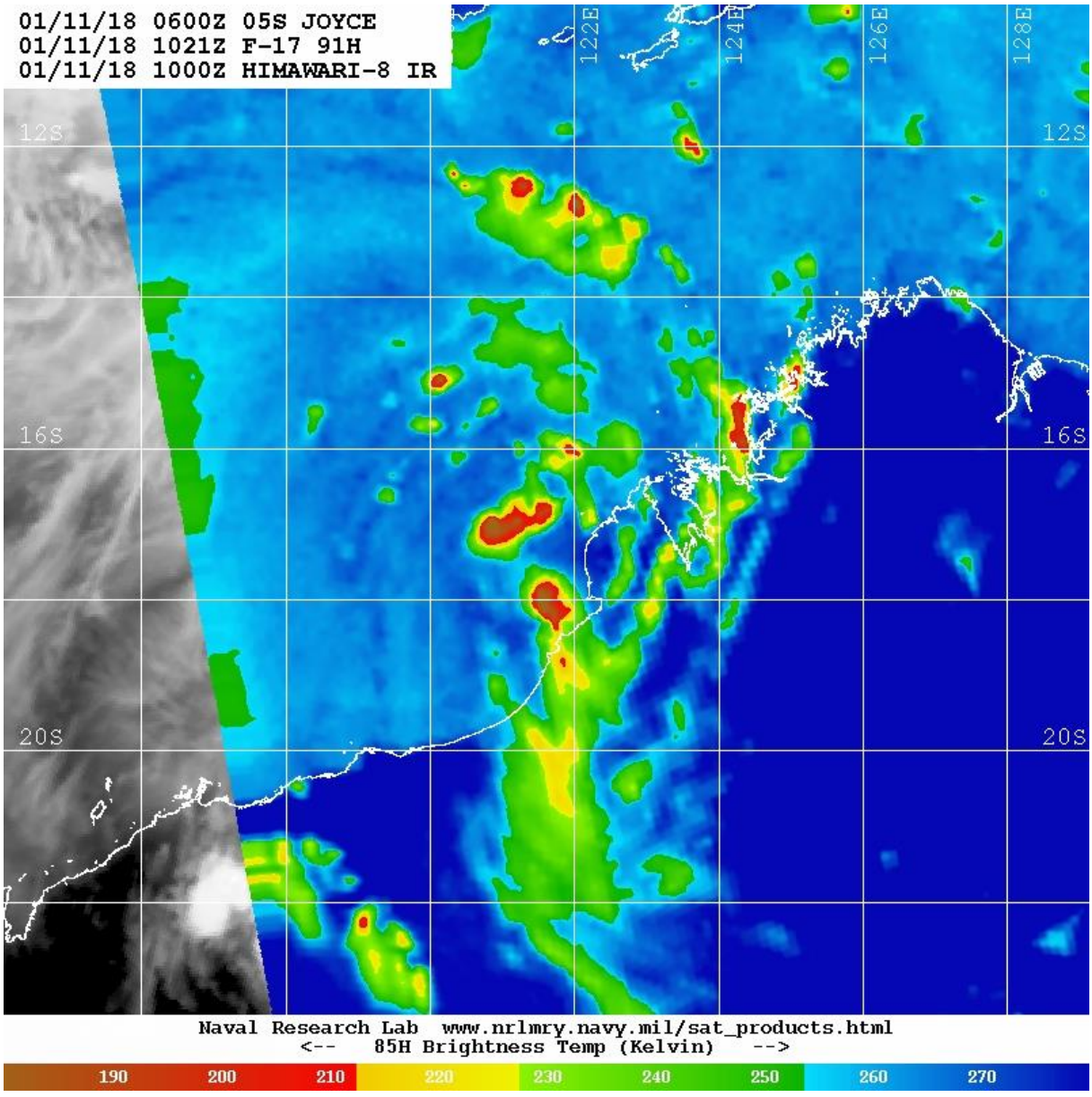


FIGURE 5. Rainfall totals for the week ending 17 January 2018.

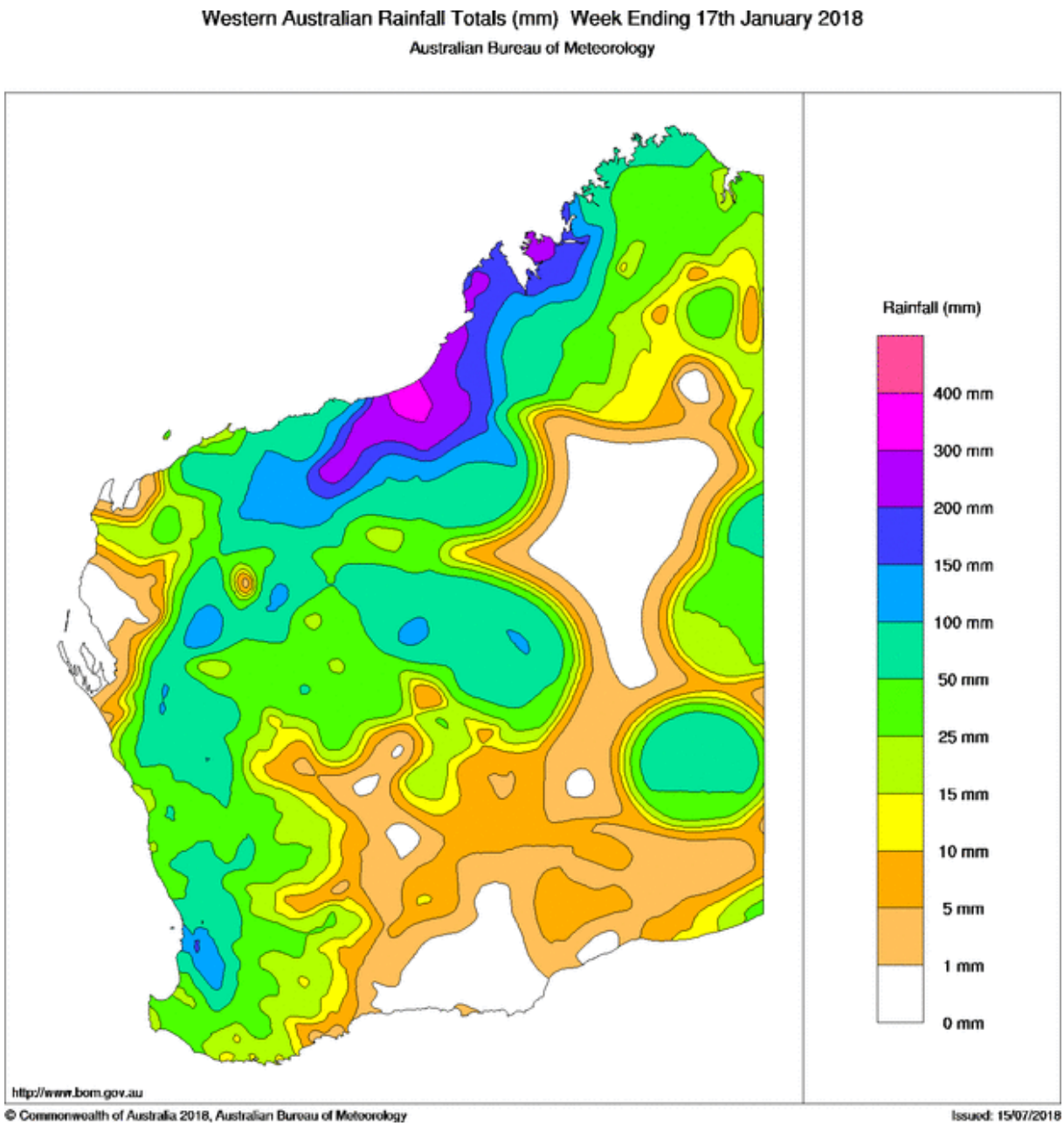


Figure 6. Position accuracy plot for Tropical Cyclone *Joyce.*