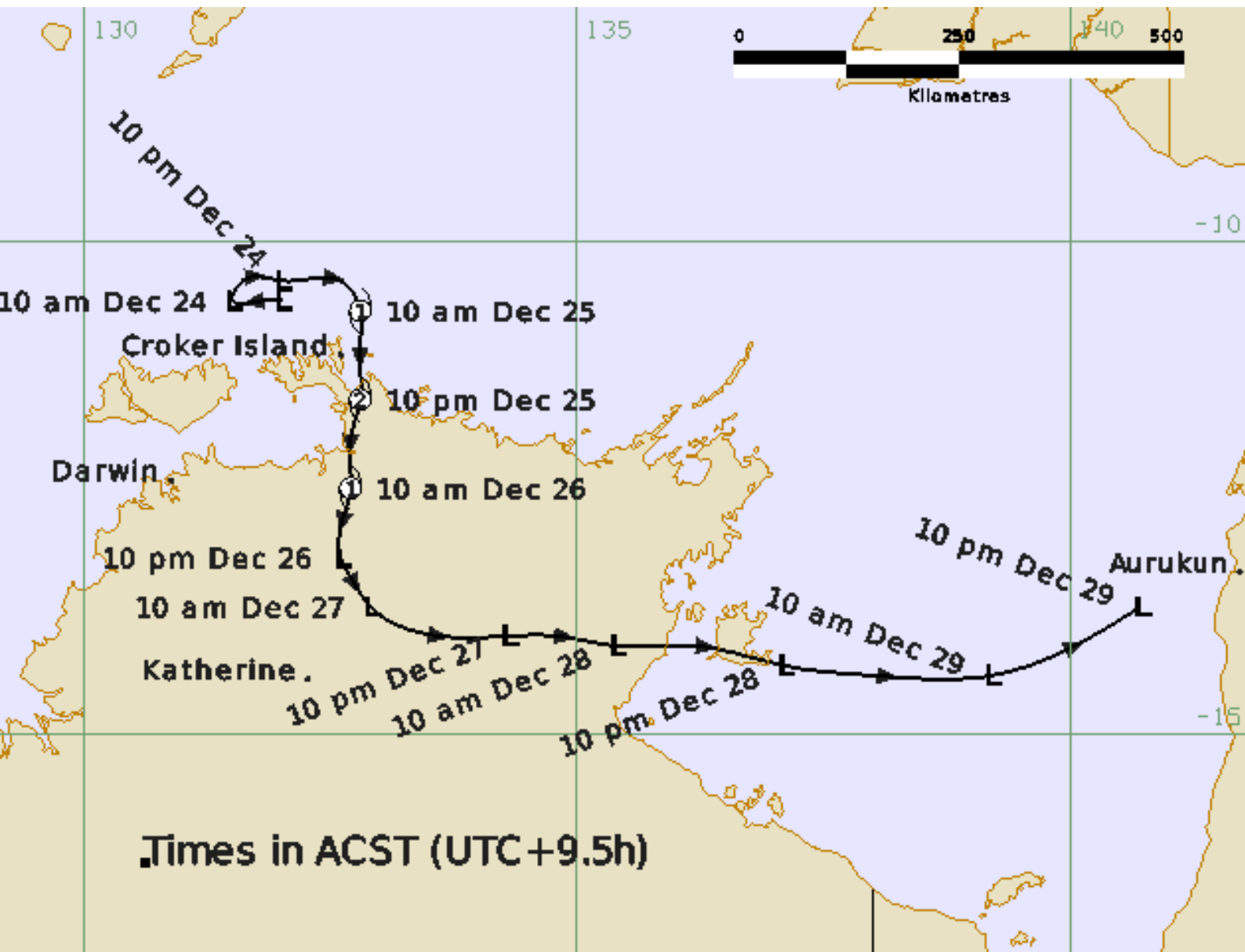




Tropical Cyclone *Grant*

23 – 29 December 2011

Joe Courtney, Severe Weather Environmental Prediction Services
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Contact details:

Tropical Cyclone Team Lead
Severe Weather Environmental Prediction Services
Bureau of Meteorology
PO Box 1370, West Perth WA 6872
Email: tcwc@bom.gov.au

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1 Summary

Tropical Cyclone (TC) *Grant* crossed the Northern Territory coast as a category 2 system and caused heavy rain across the top end.

A tropical low formed within an active monsoon trough just north of the Northern Territory coast during 23 December. Overnight on 24 December, the low rapidly intensified and reached tropical cyclone intensity on Christmas morning, 25 December. The cyclone reached category 2 intensity as it tracked to the south passing to the east of Croker Island and peaking at 60 knots (kn) (111 kilometres per hour (km/h)) as it made landfall on the Cobourg Peninsula coast in the evening.

During the early morning of 26 December, TC *Grant* continued moving to the south on 26 December weakening below cyclone intensity in the afternoon near Jabiru.

TC *Grant* caused torrential rainfall over parts of the Cobourg Peninsula and the adjacent north coast of the Arnhem District. Many trees were brought down in the community of Minjilang on Croker Island and the surrounding outstations and power supply was interrupted. Coastal erosion and minor flooding of low-lying coastal areas was reported between the Cobourg Peninsula and Nhulunbuy due to a combination of spring tides, larger than usual swell and strong onshore monsoonal winds. The Automatic Weather Station at McCluer Island reported a maximum wind gust of 68 kn (126 km/h) at 0907 Universal Time Coordinated (UTC) (6:37 pm Australian Central Standard Time (ACST) (ACST=UTC+9.5 hours)) on 25 December as TC *Grant* passed to the west.

Overnight on the 26 December and during the early morning of the 27 December heavy rainfall occurred over the Edith, Cullen and Fergusson River Catchments, including 385 millimetres (mm) at Edith River Falls in the 24 hours to 9 am ACST 27 December. A rapid river rise damaged a railway bridge and caused a train to derail while crossing over it. Significant damage was also made to the Stuart Highway rendering it impassable for two to three days.

Ex-TC *Grant* moved steadily to the east over the Top End of the Northern Territory during 27 December and moved into the Gulf of Carpentaria on 28 December, weakening near the Queensland side of the gulf on 29 December. Tides were abnormally high in the Gulf of Carpentaria during this time.

FIGURE 1a. Best track of Tropical Cyclone *Grant* 23-29 December 2011 (times in ACST, UTC+9.5h).

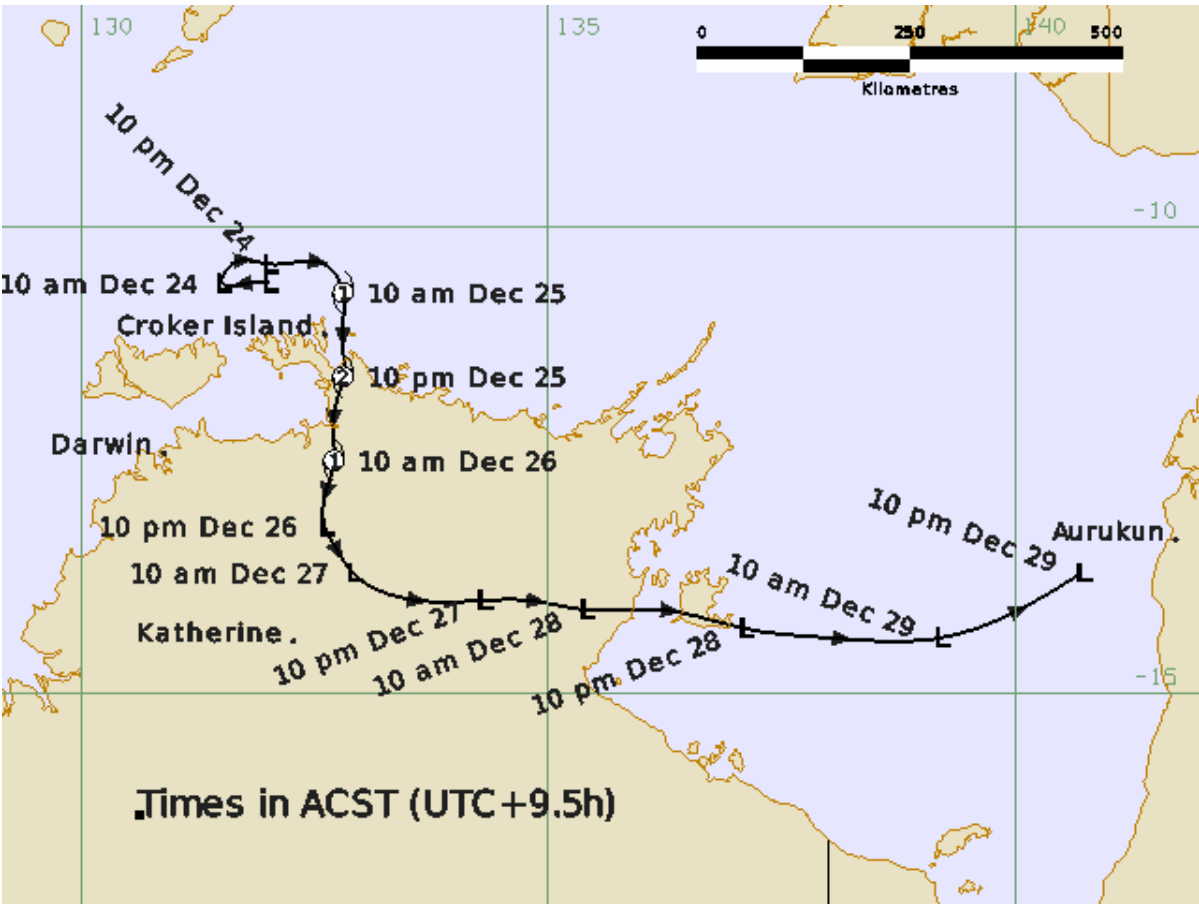
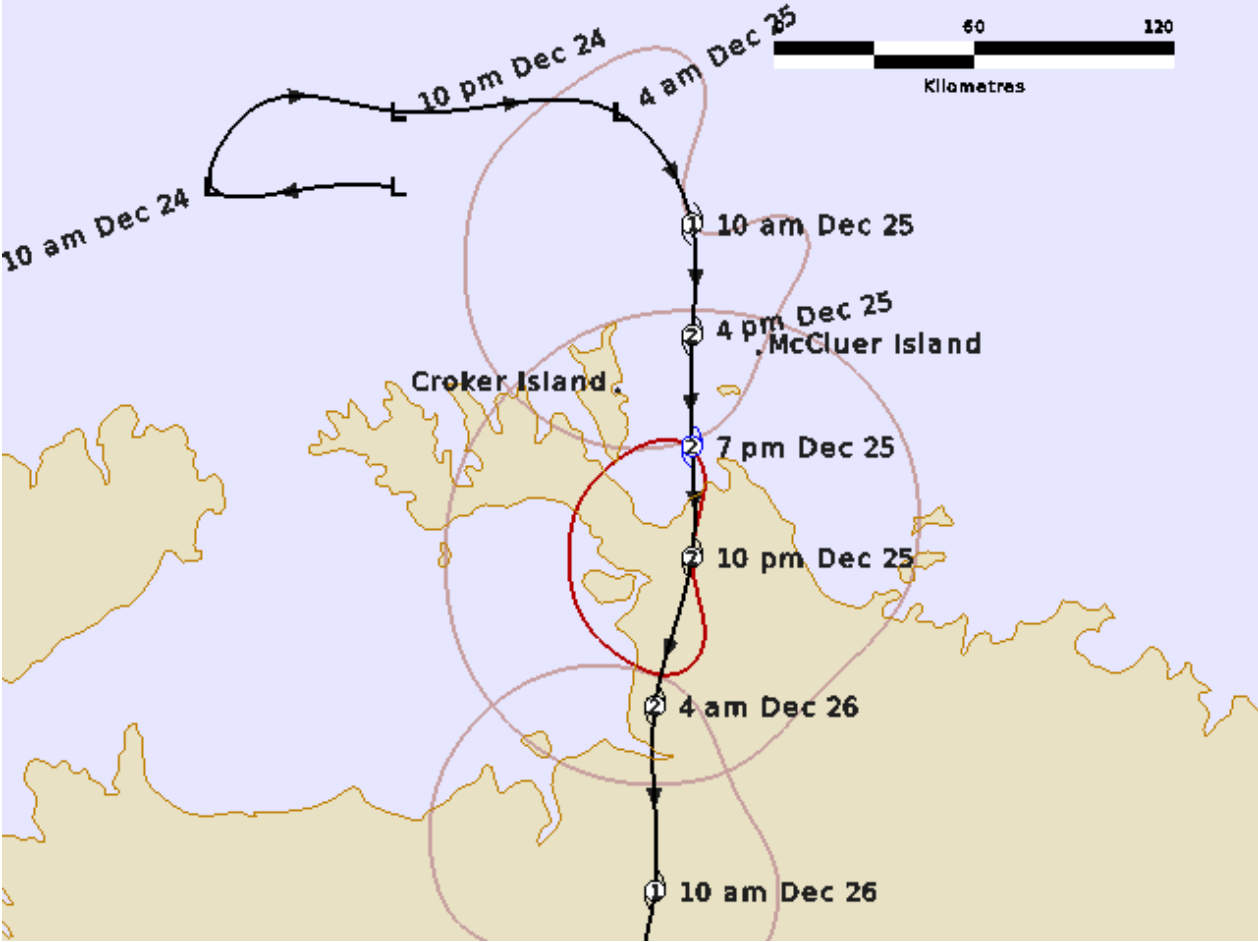


FIGURE 1b. Best track of Tropical Cyclone *Grant* 23-26 December 2011 with selected gale and storm radii shown (times in ACST).



2 Meteorological Description

2.1 Intensity analysis

A low formed in the monsoon trough off the Northern Territory coast, north of the Tiwi Islands/Cobourg Peninsula region on 23 December. The low developed only slightly during 24 December but lacked ongoing deep convection near the centre. However, the system rapidly developed vigorous deep convection near the centre overnight. On Christmas Day, 25 December, microwave imagery showed improved curvature in the deep convection to the west of the centre and then an Advanced Scatterometer (ASCAT) pass at 0053 UTC (10:23 am ACST) showed gales in western and southeastern sectors to indicate that tropical cyclone intensity had been attained, as shown in Figure 2.

In addition, winds at McCluer Island to the southeast of the centre reached gale-force (34 kn or 63 km/h) intensity at 0021 UTC (9:51 am ACST) 25 December increasing to storm-force intensity (48 kn (89 km/h) at 0225 UTC (11:55 am ACST) and peaking at 52.4 kn at 0240 UTC (12:10 pm ACST). McCluer Island recorded a minimum pressure of 980.9 hectoPascals (hPa) at 0536 UTC (3:06 pm ACST) at a distance of about 12 nautical miles (nm) (20 kilometres (km)) from the centre of *Grant* and while it was located inside the radius of maximum winds (RMW). The central pressure was estimated at 979 hPa at 06 UTC consistent with 10-minute maximum winds of 55 kn using the Courtney-Knaff wind pressure relationship.

TC *Grant* continued to intensify to landfall, best shown by the Special Sensor Microwave Imager/ Sounder (SSMIS) microwave image at 0916 UTC in Figure 4. This showed *Grant* had developed a microwave eye. The landfall 10-minute wind intensity is estimated at 60 kn. While it is possible that *Grant* reached severe intensity of at least 65 kn, the land influences of Cobourg Peninsula and Croker Islands is likely to have reduced winds west of the centre where the strongest winds were earlier located.

Subjective wind gust estimates of over 110 km/h were also received from Minjaling on the eastern side of Croker Island during the afternoon of 25 December. Dvorak and objective techniques underestimated the intensity (Figure 5), which is to be expected given the small scale of the circulation and lack of curvature in convective bands.

TC *Grant* was estimated to have remained at category 2 intensity during the subsequent overnight period. Even though the centre tracked over land, the wind flow to the west remained over water. The satellite imagery showed the cloud signature rapidly weakened on 26 December and *Grant* weakened below cyclone intensity in the afternoon while located near Jabiru.

The low then tracked overland to the east and then moved over the Gulf of Carpentaria but deep convection failed to reorganise.

2.2 Structure

TC *Grant* was a small tropical cyclone with a maximum gale radius of 40 nautical miles (nm) (75 km) from the centre. Gales initially formed in the western side where the deep convection was most vigorous as indicated by ASCAT pass at 0053 UTC 25 December. Observations at McCluer Island, to the east of the track provided supporting evidence for wind radii estimates.

The radius to maximum winds (RMW) was estimated using ASCAT, microwave and McCluer Island observations to be 15 nm (28 km) initially, contracting slightly to 12 nm (22 km) at landfall.

2.3 Motion

Initially the movement of the tropical low was erratic due to the competing influence of strengthening monsoonal northwesterly winds to the north of the low and southeasterly winds to the south. As the system developed on 25 December it tracked towards the south crossing the coast on the evening of 25 December. By 27 December the now weakened low tracked to the east, entering the Gulf of Carpentaria on 28 December and weakening near Cape York.

FIGURE 2. ASCAT scatterometer pass at 0053 UTC 25 December.

Image courtesy NOAA: <https://manati.star.nesdis.noaa.gov/datasets/ASCATData.php>

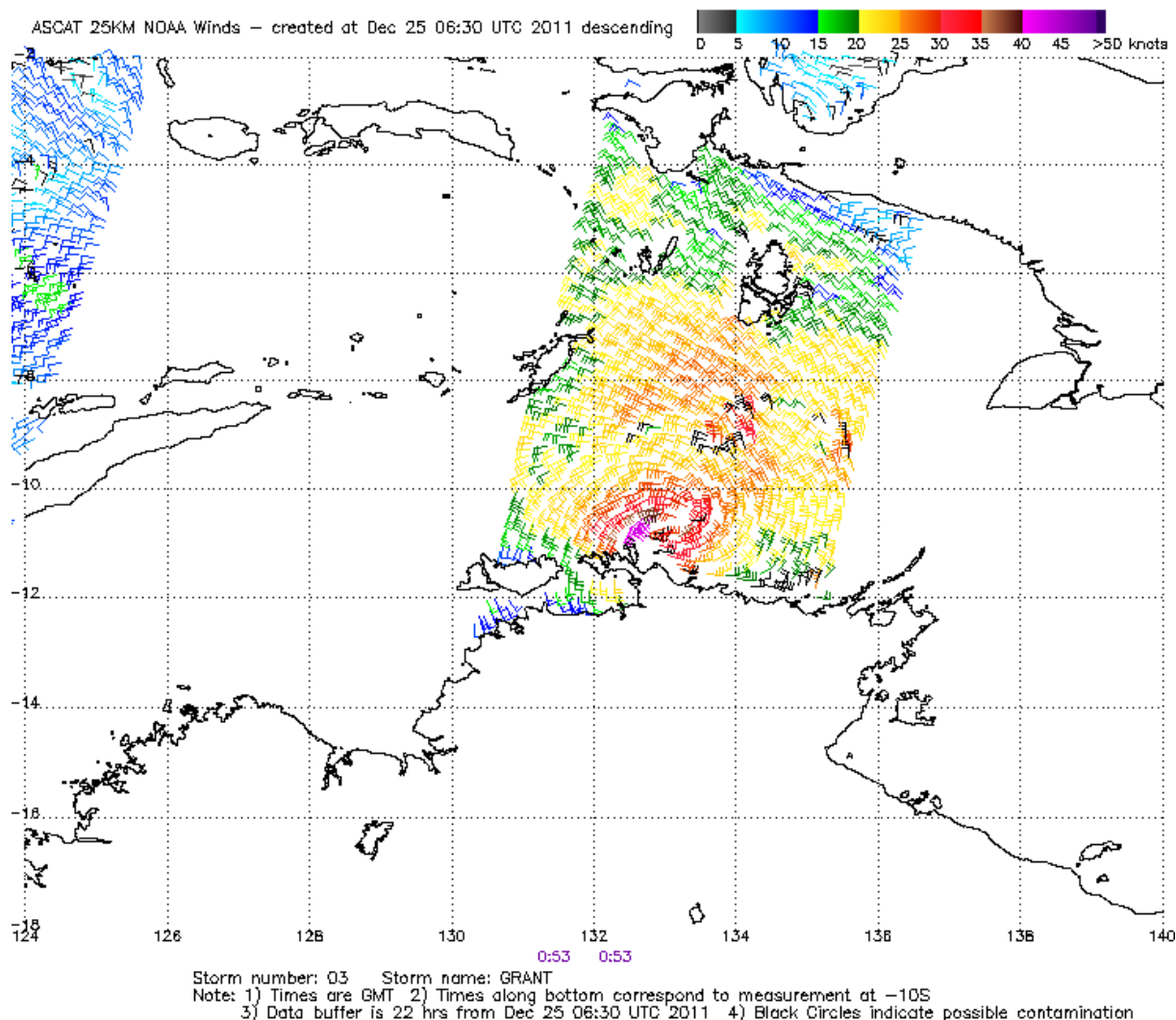


FIGURE 3. SSMIS 91GHz microwave pass at 0916 UTC 25 December near peak intensity at landfall.

Images courtesy NRL: <https://www.nrlmry.navy.mil/TC.html>

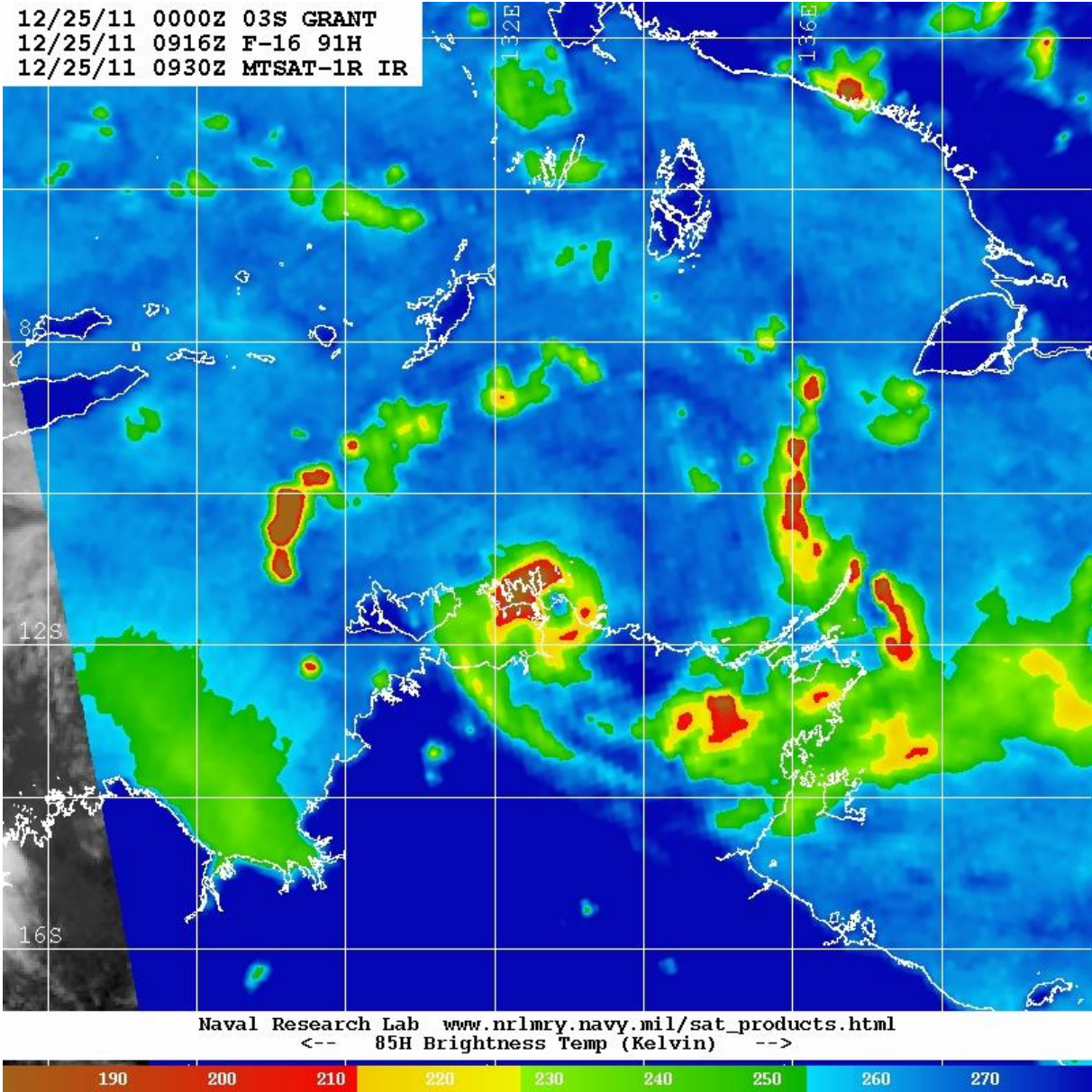


FIGURE 4. SSMIS 91GHz microwave pass at 0911 UTC 26 December when heavy rainfall was falling near Katherine.
Images courtesy NRL: <https://www.nrlmry.navy.mil/TC.html>

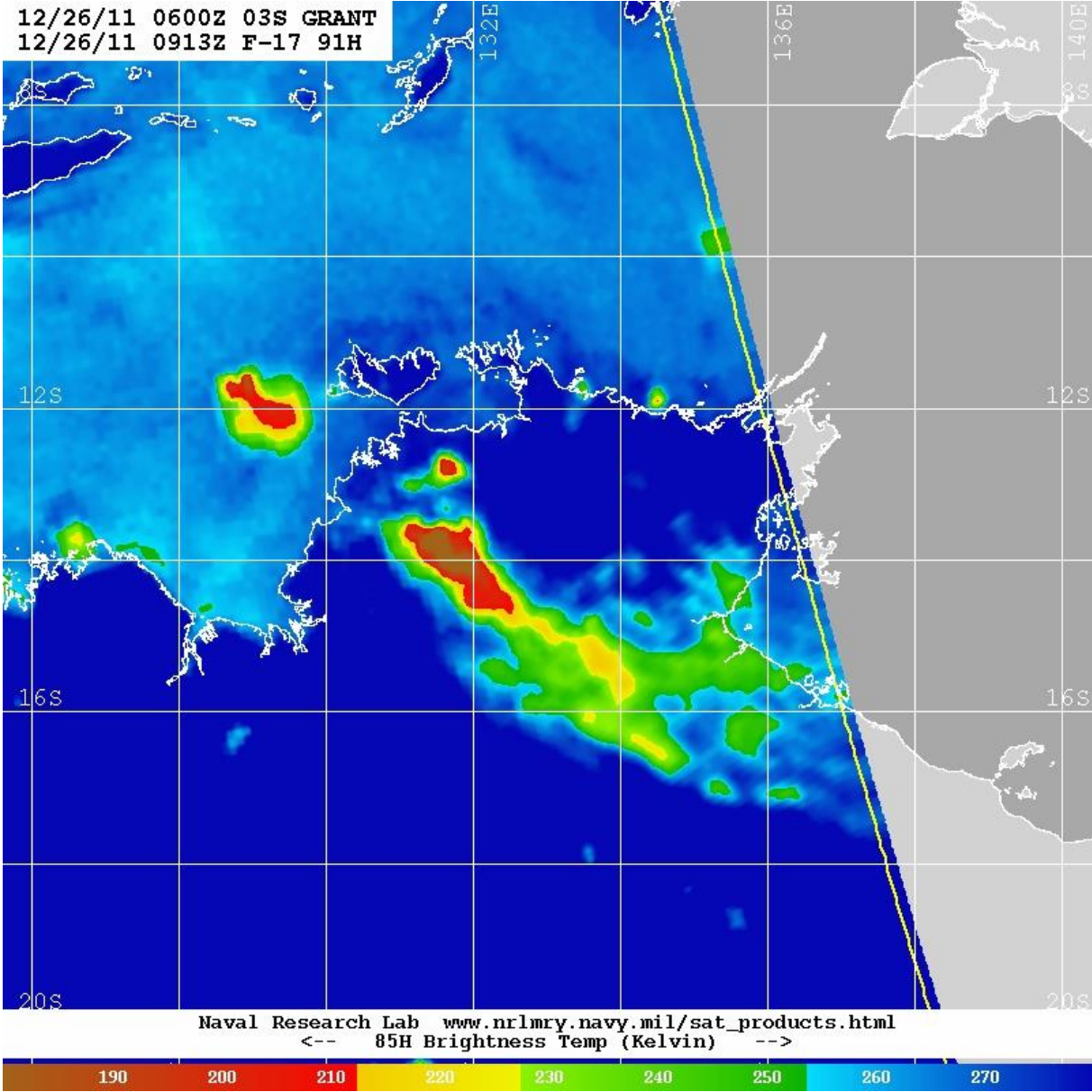
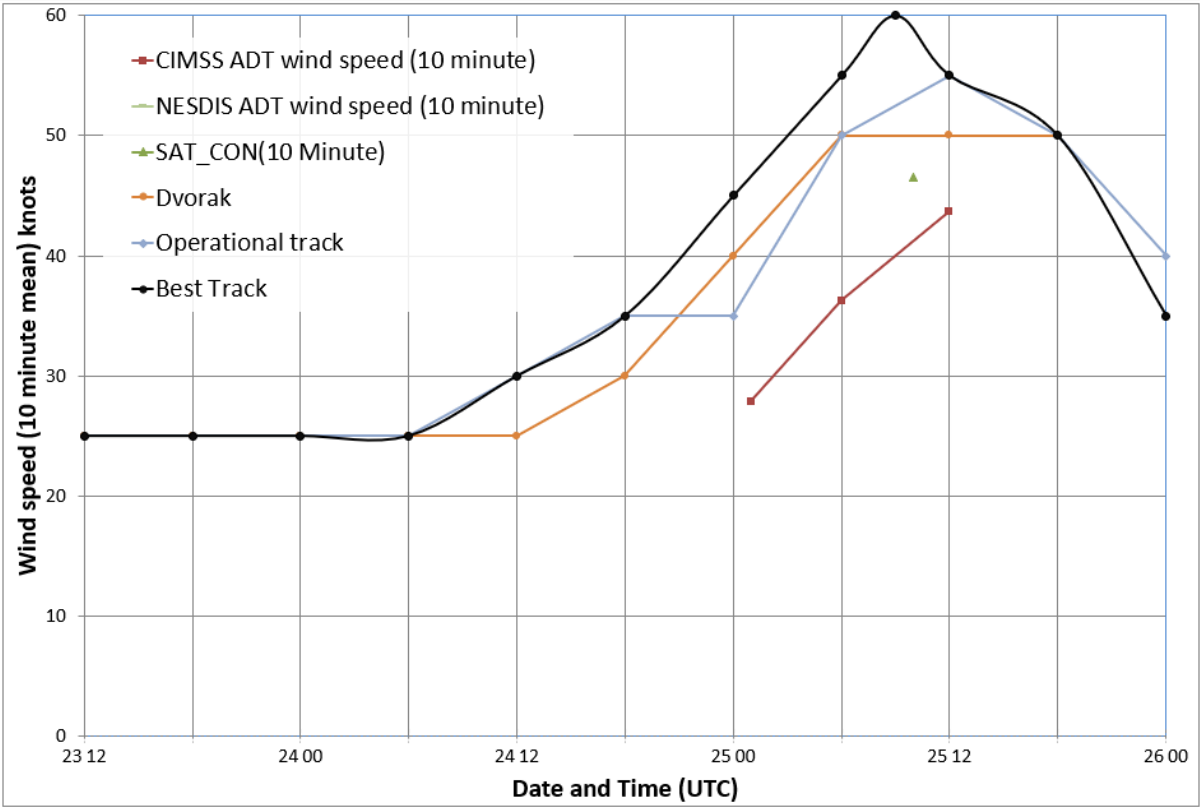


FIGURE 5. Plot of objective and subjective intensity estimates of Tropical Cyclone Grant.



3 Impact

TC *Grant* caused torrential rainfall over parts of the Cobourg Peninsula and the adjacent north coast of the Arnhem district. Many trees were brought down in the community of Minjilang on Croker Island and the surrounding outstations, and power supply was interrupted. Coastal erosion and minor flooding of low-lying coastal areas was reported between the Cobourg Peninsula and Nhulunbuy due to spring tides, larger than usual swell and strong onshore monsoonal winds.

After crossing the coast, ex-TC *Grant* continued moving south then southeast over the Top End during 26 December. Overnight on 26 December and during the early morning of 27 December heavy rainfall occurred over the Edith, Cullen and Fergusson River Catchments, including 385 mm at Edith River Falls in the 24 hours to 9am on 27 December. A rapid river rise damaged a railway bridge and caused a train to derail while crossing over it. Significant damage was also made to the Stuart Highway rendering it impassable for two to three days.

Ex-TC *Grant* moved steadily to the east over the Top End of the Northern Territory during the 27 December and moved over the Gulf of Carpentaria during the evening of the 28 December. Tides were abnormally high in the Gulf of Carpentaria during this time.

4 Observations

4.1 Wind

The Automatic Weather Station at McCluer Island, location shown in Figure 1b, 40 km east of Croker Island, reported gales between 09:51 am ACST 25 December and 01:41 am ACST 26 December (0021-1611 UTC); and storm force winds for periods 11:55 am to 1217 pm ACST (0225-0247 UTC) and 5:44 to 6:23 pm ACST (0814-0853 UTC) 25 December. The maximum 10-minute average wind was 52 kn (97 km/h) at 12:10 pm ACST (0240 UTC) and the maximum wind gust was 68 kn (126 km/h) at 6:37 pm ACST (0907 UTC) on 25 December. A graph of winds and pressure at McCluer Island is shown in Figure 6.

Wind gusts at Minjilang community on the eastern side of Croker Island were estimated at over 110 km/h during the afternoon of 25 December.

4.2 Rainfall

On the evening of 26 January heavy falls occurred in the Edith, Cullen and Fergusson River catchments as the rain band from the remnants of TC *Grant* stalled over these catchments. The rainfall totals across most of these catchments were massive resulting in a flash flood and extremely fast rising river levels in the Edith, Cullen and Fergusson Rivers.

Rainfall totals in the area in the 24 hours to 9 am ACST 27 December 2011:

Bureau of Meteorology Gauges

Edith Falls Ridge 385 mm; Upper 17 Mile Creek 311 mm; Edith Farms 247 mm; Mary River Rangers 193 mm; Foelsche Headland 191 mm; Nitmiluk Rangers 185 mm; Nitmiluk Ridge 157 mm; The Pines 148 mm; Tindal RAAF AWS 135 mm;

Natural Resources, Environment, The Arts and Sport (NRETAS) Gauges - NT Government

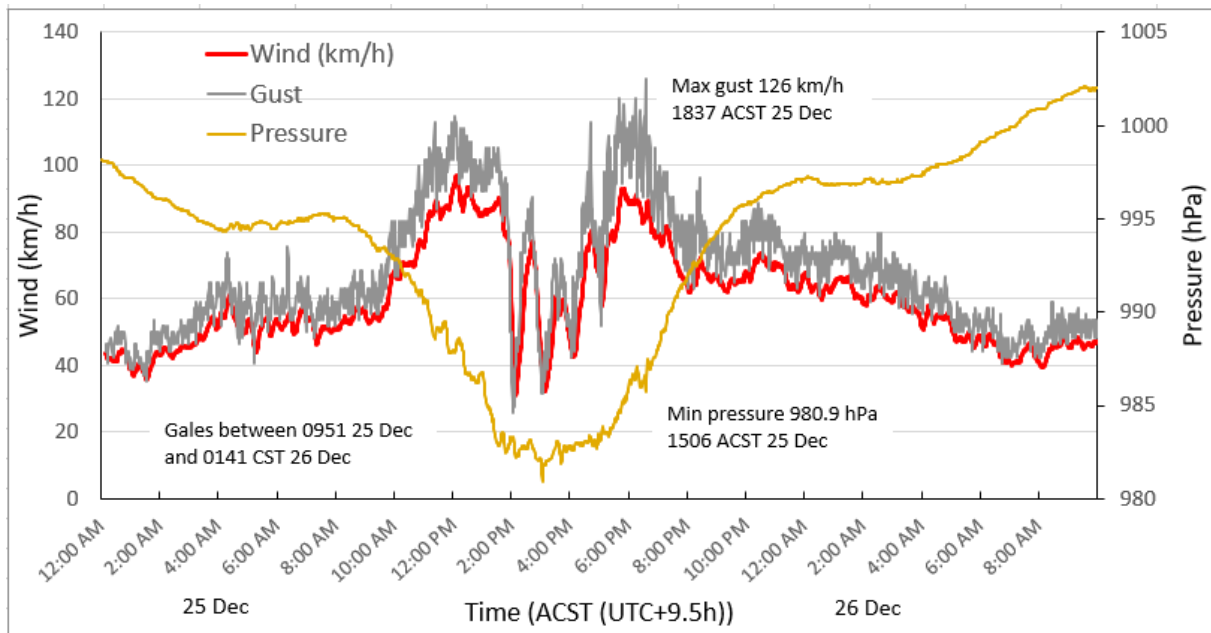
Cullen River 342 mm; 17 Mile Creek 185 mm; Fergusson River 144 mm; Ironwood Station 142 mm; Katherine Bridge 125 mm.

The rainfall rates recorded at Edith Falls Ridge, Cullen River and Upper Seventeen Mile Creek indicated that the six to 24 hour rainfall totals were less than the one per cent annual exceedance probability (higher than a '1 in 100 year' event).

4.3 Pressure

McCluer Island recorded a minimum pressure of 980.9 hPa at 3:06 pm ACST (0536 UTC) 25 December when the centre passed 20 km to the west (refer Fig. 6).

FIGURE 6. Surface observations of winds and pressure at McCluer Island, 25-26 December 2011.



5 Forecast Performance

Official tropical cyclone forecasts were issued from 5 pm ACST 21 December to 2 pm ACST 26 December for the Northern Territory coast, and then from 2 pm ACST 27 December to 9 am ACST 29 December for when the system threatened parts of the Gulf of Carpentaria coast.

The accuracy figures for TC *Grant* in Figure 7 a and b were calculated using official forecast tracks issued from 0600 UTC 21 December to 0600 UTC 26 December and 0600 UTC 27 December to 0000 UTC 29 December. These show that the forecast position was similar to the five-year average for the first 36 hours then better at longer lead times. Initial forecasts on 21-22 December indicated a track further to the west including the potential for a significant impact at Darwin on Christmas Day which attracted significant media and community interest. The track forecast improved significantly on 23 December when the centre became better defined and model guidance improved.

The intensity accuracy was better than the five-year average noting the system was generally not expected to intensify significantly and the peak intensity was 60 kn. Forecasts from 27-29 December indicated the potential for re-intensification in the Gulf of Carpentaria which failed to occur.

	00	06	12	18	24	36	48	72	96	120	144
Absolute position error (km)	24	47	70	96	114	109	105	147	212	269	205
Absolute mean wind error (kn)	1	3	5	6	7	10	12	14	17	29	-
Sample Size	20	21	22	22	22	22	22	21	18	14	4

FIGURE 7 a. Position accuracy graph for Tropical Cyclone *Grant*.

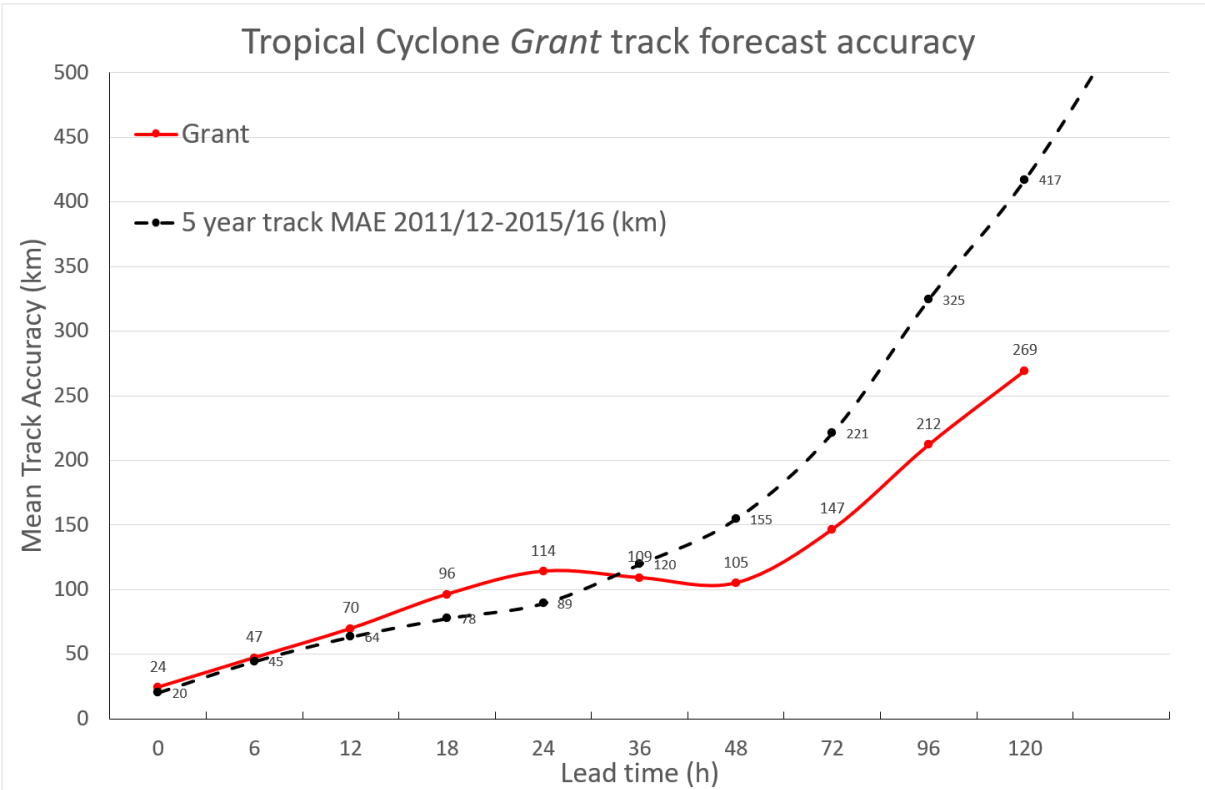
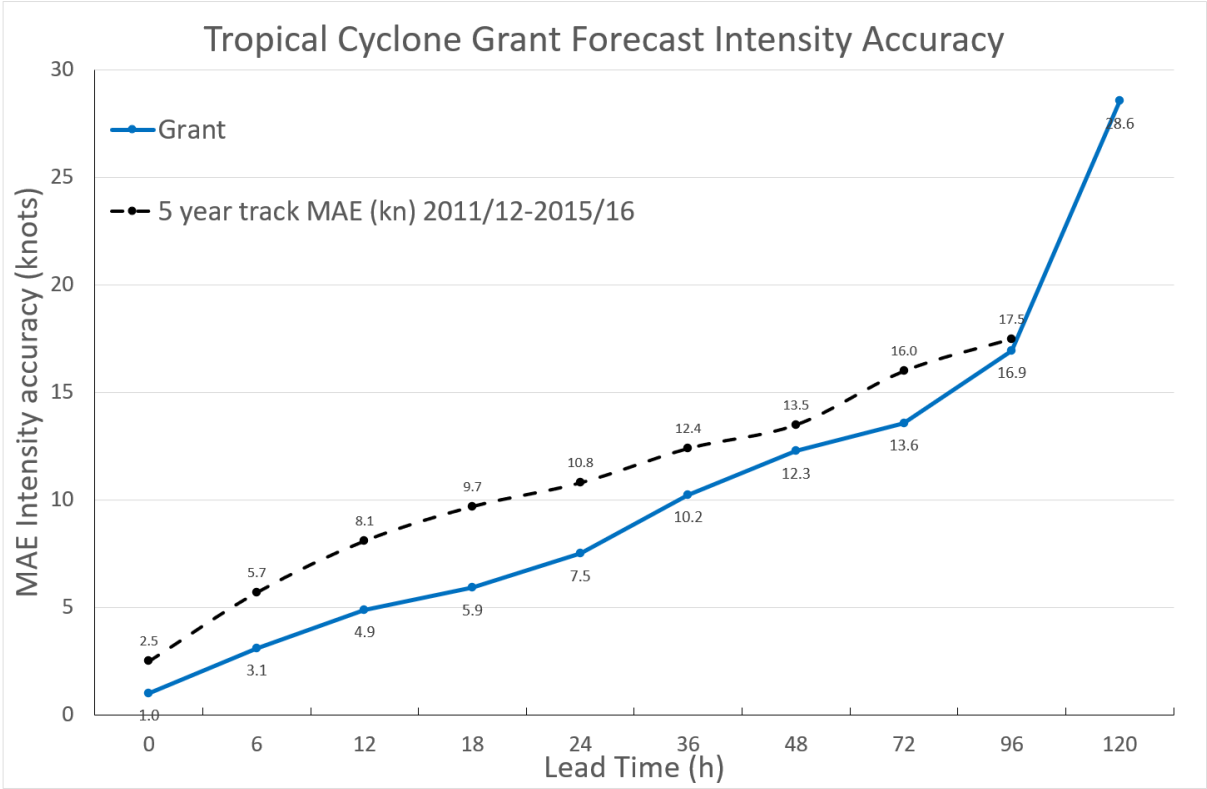


FIGURE 7 b. Intensity accuracy figures for Tropical Cyclone *Grant*.



**TABLE 1. Best track summary for Tropical Cyclone *Grant* 23-29
December 2011.**

Refer to the Australian Tropical Cyclone database for complete listing of parameters and track. Note:
UTC is ACST – 9.5 hours.

*not at tropical cyclone intensity.

** Non-standard time of 09UTC included being the time near landfall.

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) nm	Rad. of storm nm	RMW nm
2011	12	23	12	10.6	132.0	60	25	45	999	-	-	-
2011	12	23	18	10.6	131.7	60	25	45	998	-	-	-
2011	12	24	00	10.6	131.5	60	25	45	998	-	-	-
2011	12	24	06	10.4	131.6	40	25	45	997	-	-	-
2011	12	24	12	10.4	132.0	40	30	45	996	-	-	-
2011	12	24	18*	10.4	132.6	40	35	50	993	-/-/30/30	-	-
2011	12	25	00	10.7	132.8	30	45	65	985	-/20/40/30	-	15
2011	12	25	06	11.0	132.8	20	55	75	979	40/40/40/40	10-20	15
2011	12	25	09**	11.3	132.8	20	60	85	976	40/30/40/40	15-25	12
2011	12	25	12	11.6	132.8	20	55	75	979	40/30/40/40	0-20	12
2011	12	25	18	12.0	132.7	20	50	70	984	30/20/30/40	0-15	12
2011	12	26	00	12.5	132.7	25	35	50	990	20/20/20/40	-	12
2011	12	26	06	12.9	132.6	30	30	45	996	-	-	-
2011	12	26	12	13.2	132.6	40	20	45	996	-	-	-
2011	12	26	18	13.4	132.7	30	20	45	997	-	-	-