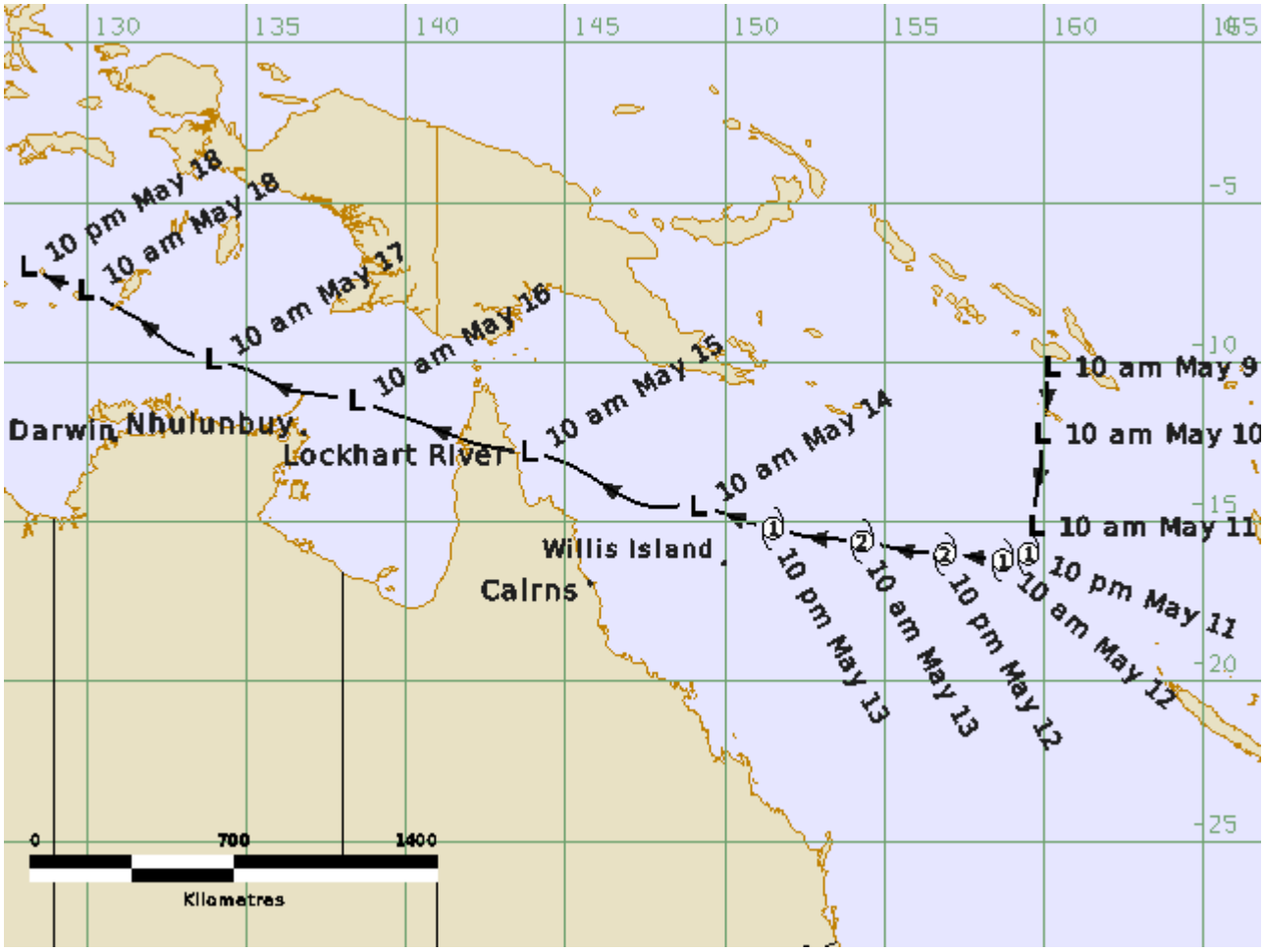
The Bureau of Meteorology

# Tropical Cyclone Ann

## 8 – 18 May 2019

Joe Courtney, Tropical Cyclone Environmental Prediction Services




Times in AEST (UTC+10h)

### Revision history

| Date | Version | Author | Description |
|---|---|---|---|
| 13/03/2023 | 1.0 | Joe Courtney | Final draft ready |

### Review status

| Date | Version | Reviewer | Description |
|---|---|---|---|
| 14/03/2023 | 1.0 | Linda Paterson | Completed |

### Release history

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|---|---|---|---|
| 3/04/2023 | 1.0 | Approved for release | Andrew Burton |

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Cover image: Track of Tropical Cyclone Ann

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# 1. Summary

Tropical Cyclone Ann was a small, late season cyclone event in the Coral Sea that weakened before crossing the far north Queensland coast.

A tropical low formed in the eastern Coral Sea assisted by strong south-easterly winds to the south. It reached cyclone intensity late on 11 May and peaked at category 2 intensity on 13 May. Although tropical cyclone advices were issued for the far north Queensland coast to the north of Cairns, Ann weakened below cyclone intensity on 14 May before crossing the coast on 15 May. The low continued on an unusual northwest track passing to the north of the Top End, eventually dissipating over islands of Indonesia's eastern district northeast of Timor Leste.

Ex-Tropical Cyclone Ann brought a period of heavy rain to Cape York Peninsula but there were no known impacts.

Refer to the track in Figure 1, and Table 1 for tabulated parameter estimates for the period 9-18 May.

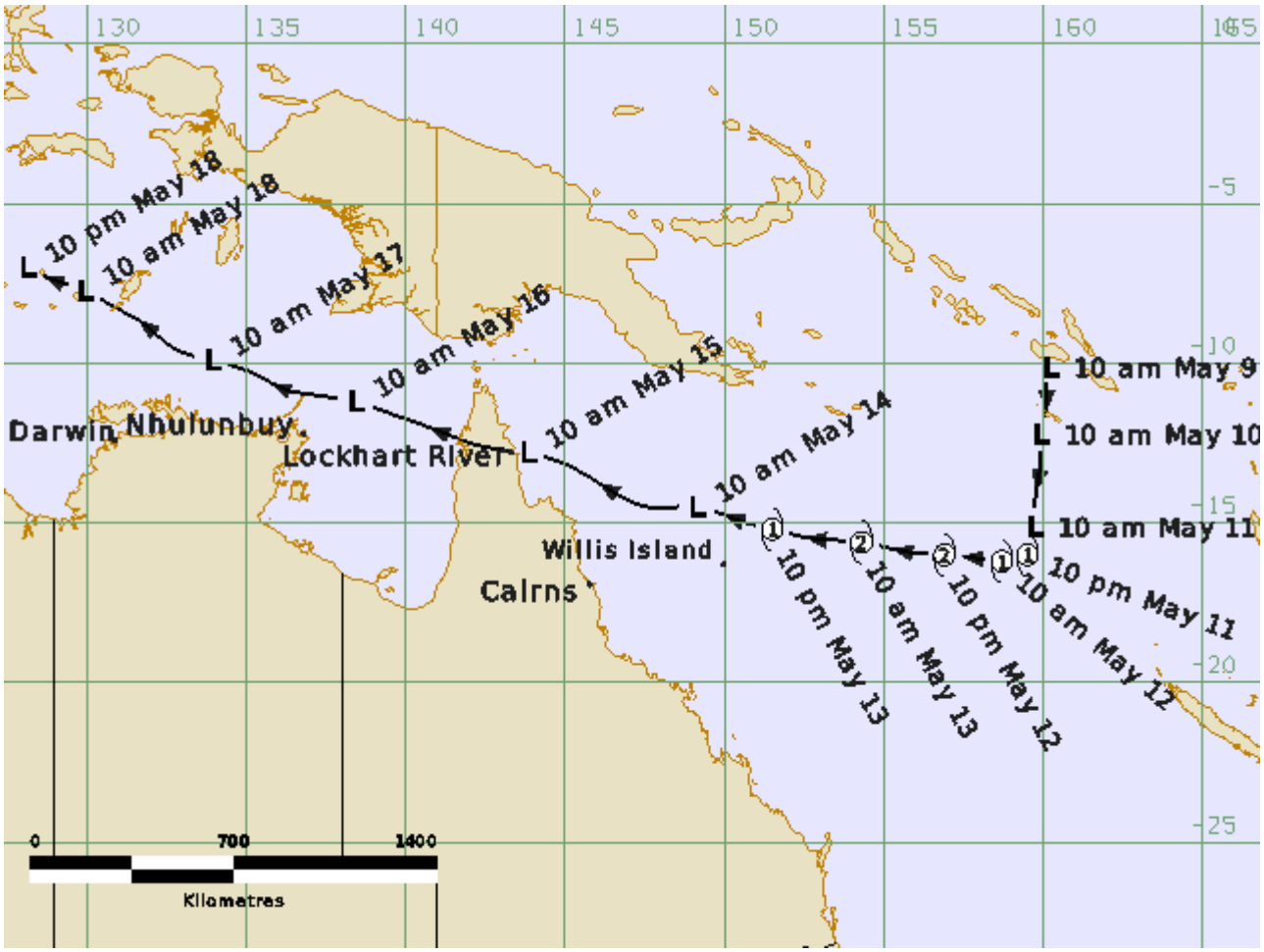


Figure 1. Best Track of Tropical Cyclone Ann (times in AEST, UTC +10).

Table 1. Best track summary for Tropical Cyclone Ann, 9-18 May 2019.

UTC=AEST-10h. * 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 nm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2019 | 5 | 9 | 0000 | 10.1 | 160.2 | 40 | 15 | 35 | 1007 | 0/0/0/0 | 0/0/0/0 | - |
| 2019 | 5 | 9 | 0600 | 10.8 | 160.1 | 30 | 15 | 35 | 1006 | 0/0/0/0 | 0/0/0/0 | - |
| 2019 | 5 | 9 | 1200 | 11.3 | 160.1 | 30 | 15 | 35 | 1007 | 0/0/0/0 | 0/0/0/0 | - |
| 2019 | 5 | 9 | 1800 | 11.8 | 160.0 | 25 | 15 | 35 | 1006 | 0/0/0/0 | 0/0/0/0 | - |
| 2019 | 5 | 10 | 0000 | 12.2 | 159.9 | 25 | 15 | 35 | 1007 | 0/0/0/0 | 0/0/0/0 | - |
| 2019 | 5 | 10 | 0600 | 13.0 | 159.9 | 25 | 20 | 35 | 1004 | 0/0/0/0 | 0/0/0/0 | - |
| 2019 | 5 | 10 | 1200 | 13.9 | 159.8 | 25 | 20 | 38 | 1004 | 0/0/0/0 | 0/0/0/0 | - |
| 2019 | 5 | 10 | 1800 | 14.6 | 159.7 | 20 | 25 | 40 | 1002 | 0/0/0/0 | 0/0/0/0 | - |
| 2019 | 5 | 11 | 0000 | 15.1 | 159.7 | 20 | 30 | 40 | 1000 | 0/0/0/0 | 0/0/0/0 | - |
| 2019 | 5 | 11 | 0600 | 15.7 | 159.7 | 20 | 35* | 50 | 998 | 0/0/40/0 | 0/0/0/0 | - |
| 2019 | 5 | 11 | 1200 | 16.0 | 159.5 | 20 | 40 | 45 | 996 | 30/40/50/0 | 0/0/0/0 | 20 |
| 2019 | 5 | 11 | 1800 | 16.2 | 159.1 | 20 | 40 | 50 | 997 | 30/40/80/30 | 0/0/0/0 | 20 |
| 2019 | 5 | 12 | 0000 | 16.2 | 158.7 | 20 | 45 | 65 | 996 | 20/40/80/30 | 0/0/0/0 | 20 |
| 2019 | 5 | 12 | 0600 | 16.1 | 157.9 | 20 | 45 | 65 | 994 | 20/40/80/30 | 0/0/0/0 | 20 |
| 2019 | 5 | 12 | 1200 | 16.0 | 156.9 | 20 | 50 | 70 | 992 | 20/60/80/30 | 0/25/25/0 | 20 |
| 2019 | 5 | 12 | 1800 | 15.9 | 155.7 | 20 | 55 | 75 | 990 | 20/80/80/40 | 0/20/25/0 | 15 |
| 2019 | 5 | 13 | 0000 | 15.6 | 154.3 | 15 | 50 | 70 | 994 | 20/80/80/40 | 0/0/25/0 | 15 |
| 2019 | 5 | 13 | 0600 | 15.5 | 152.9 | 20 | 45 | 65 | 996 | 0/70/70/20 | 0/0/0/0 | 15 |
| 2019 | 5 | 13 | 1200 | 15.2 | 151.5 | 15 | 45 | 65 | 998 | 0/60/70/20 | 0/0/0/0 | 15 |
| 2019 | 5 | 13 | 1800 | 14.9 | 150.4 | 15 | 40 | 55 | 1000 | 0/60/80/20 | 0/0/0/0 | 15 |
| 2019 | 5 | 14 | 0000 | 14.5 | 149.1 | 15 | 35* | 50 | 1002 | 0/40/60/0 | 0/0/0/0 | - |
| 2019 | 5 | 14 | 0600 | 14.5 | 147.6 | 15 | 35* | 50 | 1000 | 0/0/40/0 | 0/0/0/0 | - |
| 2019 | 5 | 14 | 1200 | 13.9 | 146.3 | 20 | 30 | 45 | 1002 | 0/0/0/0 | 0/0/0/0 | - |
| 2019 | 5 | 14 | 1800 | 13.2 | 145.1 | 20 | 30 | 45 | 1002 | 0/0/0/0 | 0/0/0/0 | - |
| 2019 | 5 | 15 | 0000 | 12.8 | 143.8 | 15 | 25 | 45 | 1005 | 0/0/0/0 | 0/0/0/0 | - |
| 2019 | 5 | 15 | 0600 | 12.6 | 142.4 | 20 | 25 | 45 | 1006 | 0/0/0/0 | 0/0/0/0 | - |
| 2019 | 5 | 15 | 1200 | 12.1 | 141.0 | 20 | 25 | 45 | 1007 | 0/0/0/0 | 0/0/0/0 | - |
| 2019 | 5 | 15 | 1800 | 11.6 | 139.6 | 15 | 25 | 45 | 1007 | 0/0/0/0 | 0/0/0/0 | - |
| 2019 | 5 | 16 | 0000 | 11.2 | 138.4 | 15 | 25 | 45 | 1008 | 0/0/0/0 | 0/0/0/0 | - |
| 2019 | 5 | 16 | 0600 | 11.0 | 137.2 | 15 | 25 | 45 | 1006 | 0/0/0/0 | 0/0/0/0 | - |
| 2019 | 5 | 16 | 1200 | 10.8 | 136.2 | 15 | 25 | 45 | 1007 | 0/0/0/0 | 0/0/0/0 | - |
| 2019 | 5 | 16 | 1800 | 10.3 | 135.2 | 20 | 25 | 45 | 1007 | 0/0/0/0 | 0/0/0/0 | - |
| 2019 | 5 | 17 | 0000 | 9.9 | 133.9 | 15 | 25 | 45 | 1008 | 0/0/0/0 | 0/0/0/0 | - |
| 2019 | 5 | 17 | 0600 | 9.5 | 132.7 | 15 | 25 | 45 | 1006 | 0/0/0/0 | 0/0/0/0 | - |
| 2019 | 5 | 17 | 1200 | 8.7 | 131.7 | 15 | 25 | 45 | 1008 | 0/0/0/0 | 0/0/0/0 | - |
| 2019 | 5 | 17 | 1800 | 8.2 | 130.8 | 20 | 20 | 45 | 1008 | 0/0/0/0 | 0/0/0/0 | - |
| 2019 | 5 | 18 | 0000 | 7.7 | 129.9 | 15 | 20 | 45 | 1010 | 0/0/0/0 | 0/0/0/0 | - |
| 2019 | 5 | 18 | 0600 | 7.4 | 129.0 | 15 | 20 | 45 | 1009 | 0/0/0/0 | 0/0/0/0 | - |
| 2019 | 5 | 18 | 1200 | 7.0 | 128.1 | 20 | 20 | 45 | 1010 | 0/0/0/0 | 0/0/0/0 | - |

# 2. Meteorological description

## 2.1 Intensity analysis

The Madden-Julian Oscillation moved through the Australian region enhancing the monsoonal flow as a result. This combined with strong south-easterly flow in the Coral Sea helped to develop a low-level circulation near the Solomon Islands around 9 May. A Scatterometer Satellite (SCATSAT) image at 2131 UTC 9 May showed a broad circulation with light winds near the centre and stronger winds well to the south. Deep convection remained well displaced to the south of the centre.

Late on 10 May deep convection increased near the centre heralding a period of intensification. Yet an SCATSAT at 2221 UTC 10 May only showed light winds to the south and 25 kn winds southwest of the centre. Gales are estimated to have commenced southwest of the centre at 06UTC where deep convection persisted.

Tropical cyclone intensity is estimated at 1200 UTC 11 May as deep convection became more organised about the centre. Microwave imagery such as Advanced Microwave Scanning Radiometer (AMSR2) 89 GHz at 1449 UTC (shown in Figure 2) and then Special Sensor Microwave Imager/Sounder (SSMIS) at 1948 UTC showed strong curvature in the deep convection.

Scatterometry, such as SCATSAT at 2059 UTC, Advanced Scatterometer (ASCAT)-A at 2154 UTC and ASCAT-B at 2308 UTC in Figure 3 showed a small region of gales about the centre which extended further southwest of the centre into the unidirectional south-easterly wind regime.

Deep convection peaked during the overnight period from 12-13 May. An ASCAT-B image at 1129 UTC 12 May in Figure 4 confirmed storm force winds were present south of the centre. There was strong curvature in the microwave imagery as shown in the SSMIS 91GHz image at 1851 UTC in Figure 5 and enhanced IR showed very cold clouds tops. Ann reached peak intensity of 55 kn (category 2) at 18 UTC 12 May based on Dvorak CI of 4.0 consistent with peak objective estimates: SATCON (61 kn 1-minute mean) and ADT (CI=3.9 and 63 kn 1-minute mean).

Despite being in a low shear environment, deep convection weakened rapidly during 13 May due to dry air wrapping into the circulation. It is estimated that Ann weakened below tropical cyclone intensity at 00UTC 14 May, although gales are estimated to have continued southwest of the centre until 12 UTC 14 May. Deep convection pulsed about the centre from 14 May for several days thereafter including as the centre passed over the northern part of Cape York Peninsula on 15 May as shown in the visible image at 0400 UTC 15 May image in Figure 5. The circulation was tracked in subsequent days as it moved to the northwest, north of Australia, until late on 18 May as it entered the Banda Sea, northeast of Timor Leste.

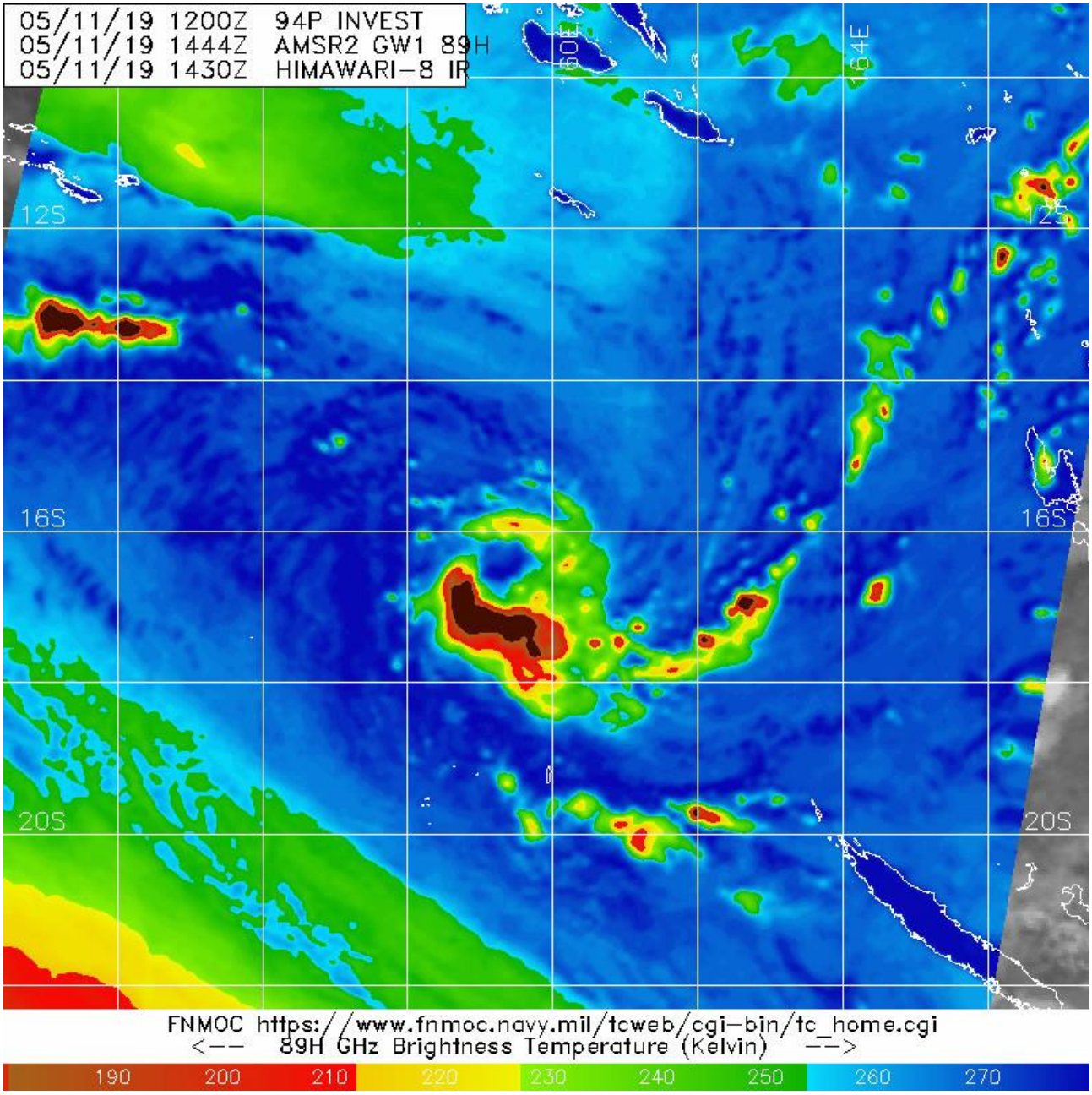


Figure 2. Advanced Microwave Scanning Radiometer (AMSR2) 89 GHz microwave image at 1447 UTC 11 May, showing strong curvature in deep convection suggesting tropical cyclone intensity had been attained. Image courtesy NRL: https://www.nrlmry.navy.mil/TC.html

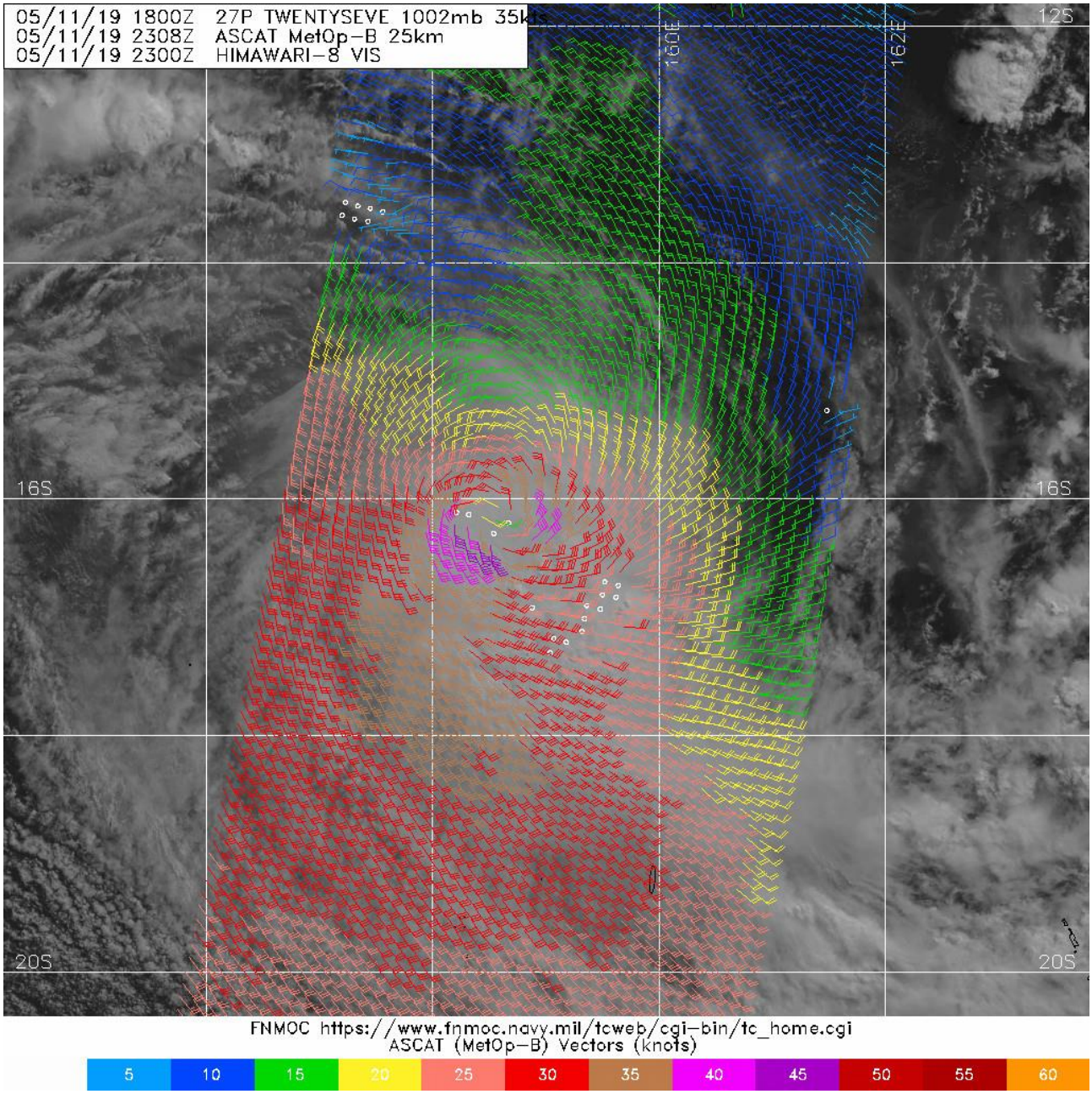


Figure 3. ASCAT-B scatterometer pass at 2308 UTC 11 May showing gales around the centre and extending into the synoptic south-easterly flow in the southwest quadrant. Image courtesy NRL: https://www.nrlmry.navy.mil/TC.html

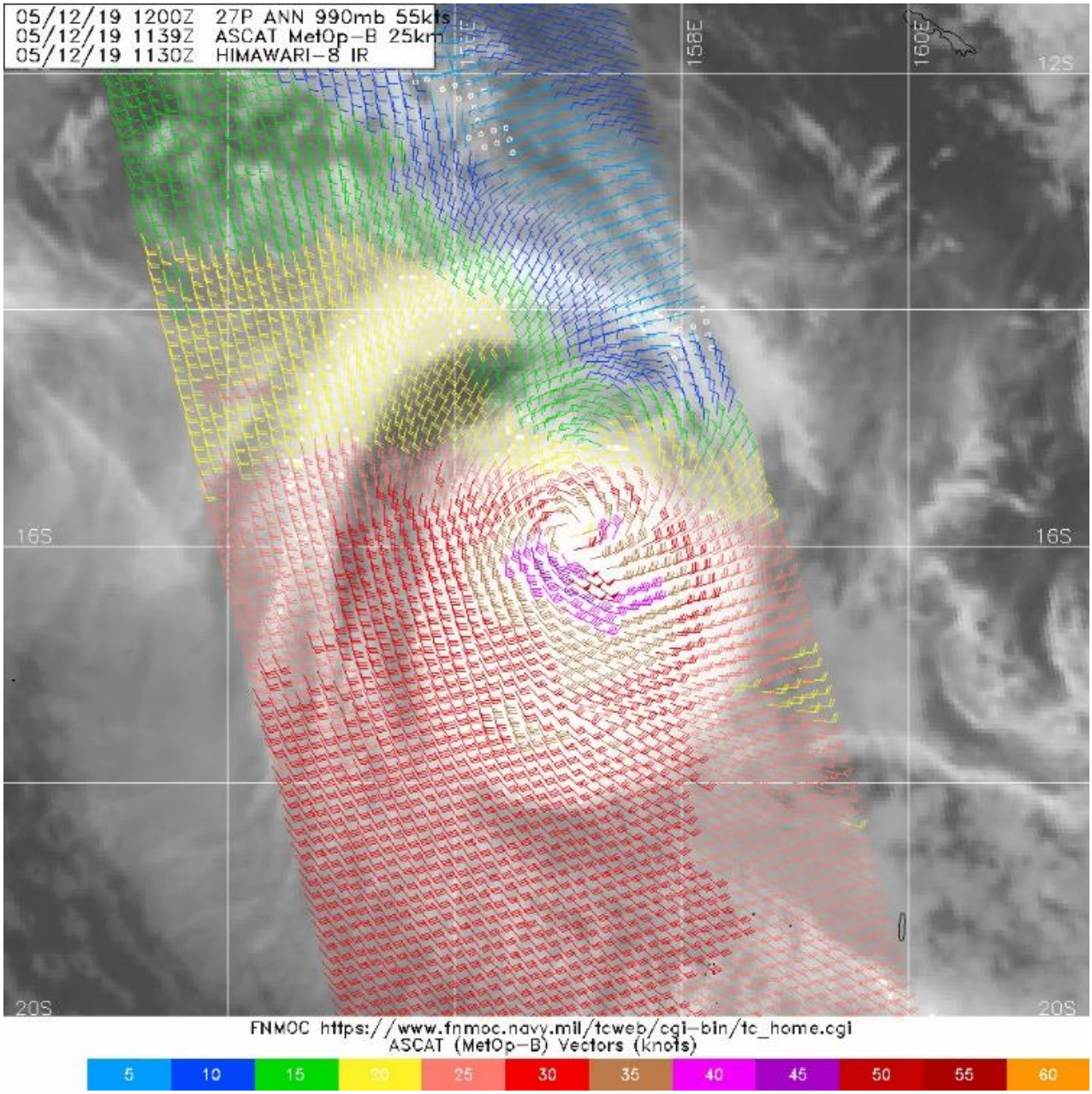


Figure 4. Advanced Scatterometer (ASCAT-B) at 1139 UTC 12 May, maximum winds of 50 kn south of the centre. Image courtesy NRL: https://www.nrlmry.navy.mil/TC.html

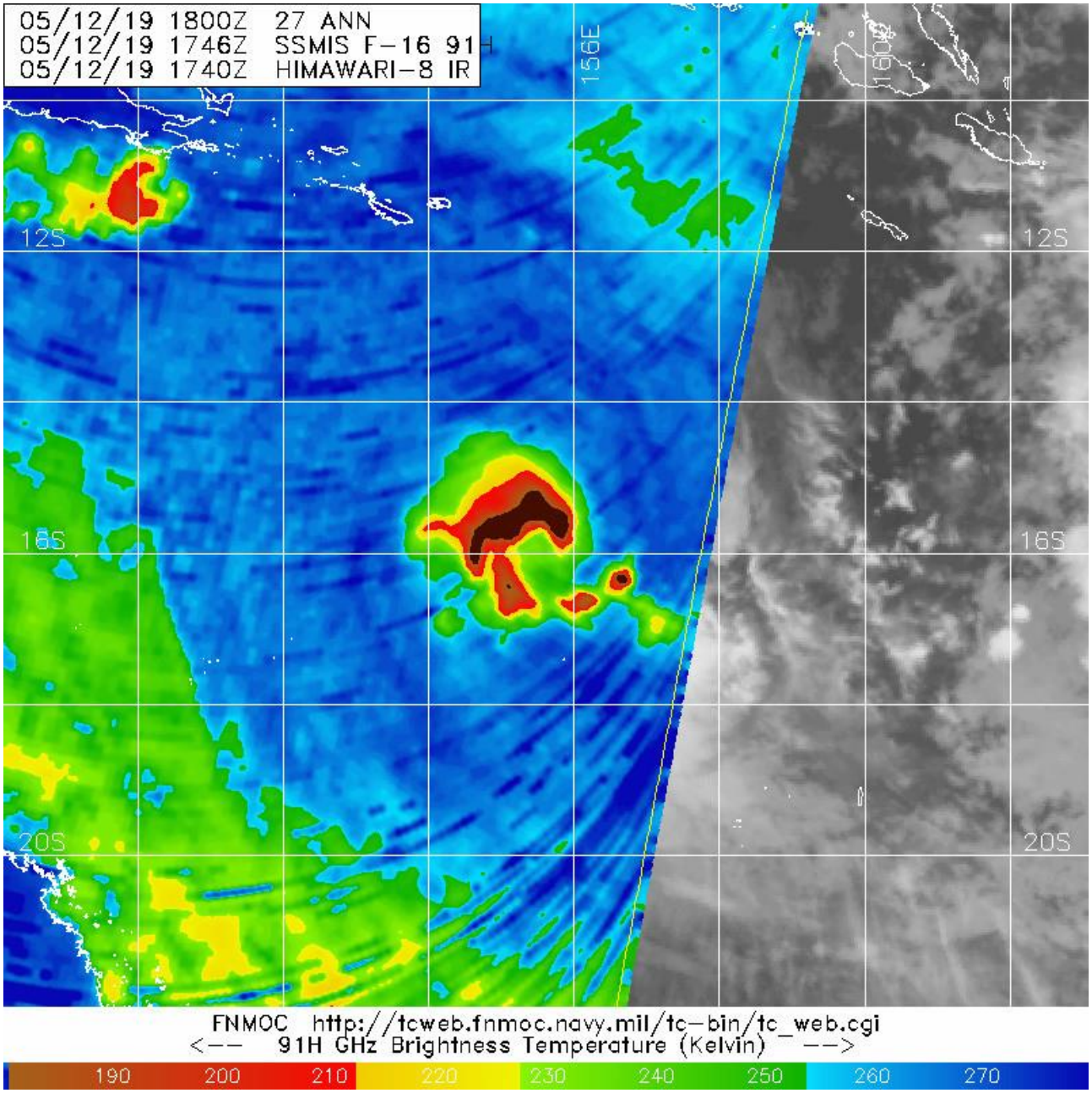


Figure 5. SSMIS 91 GHz microwave image at 1851 UTC 12 May, near peak intensity showing strong curvature in deep convection. Image courtesy NRL: https://www.nrlmry.navy.mil/TC.html

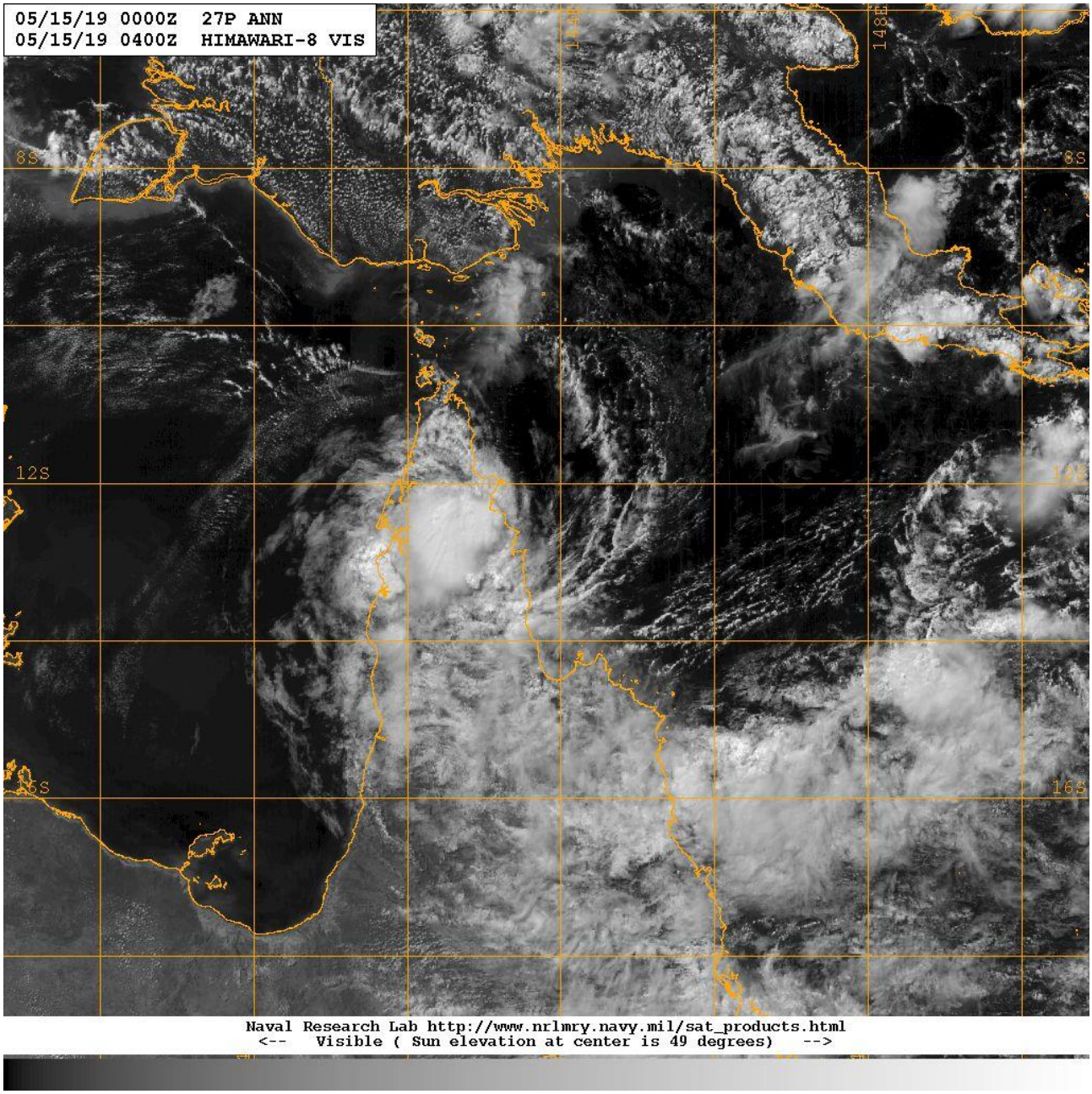


Figure 6. Visible image at 0400 UTC 15 May 2023 following landfall near Lockhart River. Image courtesy NRL: https://www.nrlmry.navy.mil/TC.html

## 2.2 Structure

Tropical Cyclone Ann was a reasonably compact system with the strongest winds south of the centre. The radius to gales varied from just 20 to 40 nautical miles (nm) (37 to 74 km) north of the centre to up to 80 nm (148 km) south of the centre. This reflected the influence of the strong east south-easterly flow extending from the sub-tropical ridge to the south.

Peak winds occurred to the south and south-west of the centre as shown in the ASCAT images in Figures 3 and 4. The radius to maximum winds (RMW) was 15 - 20 nm (28-37 km) throughout the time Ann was at tropical cyclone intensity.

## 2.3 Motion

The developing low initially tracked to the south south-west under the influence of a ridge to the east. Later on 11 May, as Ann reached tropical cyclone intensity the steering changed to the west then west north-west as the ridge strengthened to the south. This continued for the remainder of the lifetime of the circulation.

# 3. Impact

There were no known impacts from this system.

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# 4. Observations

## 4.1 Winds

Gale force winds were recorded at Willis Island for periods between 1549 and 2114 UTC 13 May as Ann passed within 200 km to the north. The peak 10-minute mean wind recorded was 41kn (76 km/h) at 1714 UTC 13 May. The peak 3-second wind gust recorded was 46 kn (85 km/h) at 1714 UTC 13 May.

## 4.2 Rainfall

Moderate rainfall to 50 mm was recorded over far north Queensland as ex-Tropical Cyclone Ann crossed on 15 May.

# 5. Forecast performance

Tropical cyclone products were initiated as Tropical Cyclone Ann was named in the early morning of 12 May (19UTC 11 May).

Official tropical cyclone advices for the far north Queensland coast north of Port Douglas and were issued from 07 UTC 13 May but were cancelled when Ann weakened below tropical cyclone intensity at 03UTC 14 May.

The accuracy figures for Tropical Cyclone Ann below and in Figure 7 show that the forecast position was similar to the five-year average at all time steps to 72 hours. The intensity forecasts had higher errors than the five-year average for the first 24 hours, but were better from 36-72 hours. There were insufficient data points for 96 and 120 hours. These were based on official forecast tracks issued from 1800 UTC 11 May to 0000 UTC 14 May.

Table 2. Verification statistics for Tropical Cyclone Ann.

| | 0 | 6 | 12 | 18 | 24 | 36 | 48 | 72 | 96 | 120 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Position Absolute error (km)** | 16 | 40 | 52 | 62 | 77 | 102 | 132 | 182 | 363 | 426 |
| **Intensity Absolute error (kn)** | 3.2 | 4.2 | 5.2 | 7.1 | 8.2 | 6.2 | 1.8 | 3.3 | 4.1 | 5.0 |
| **Sample Size** | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 7 | 3 | 1 |

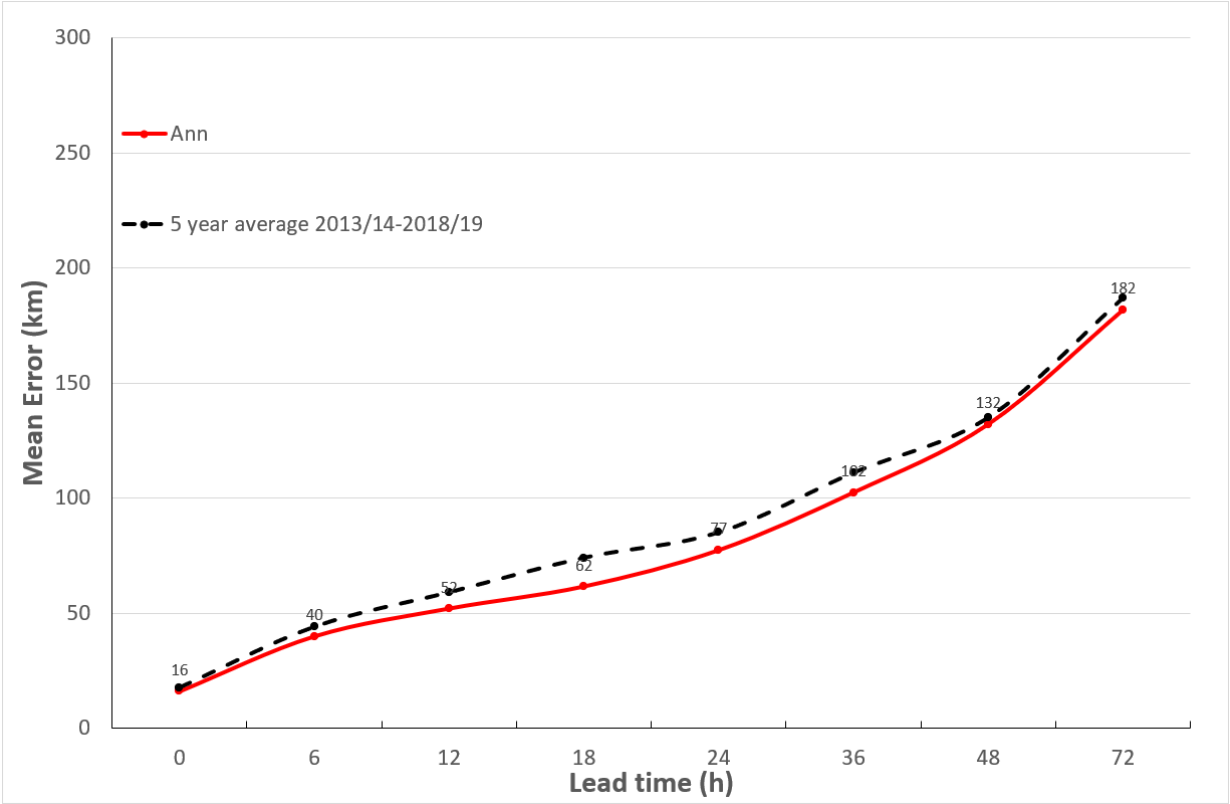


Figure 7 a. Position accuracy figures for Tropical Cyclone Ann.

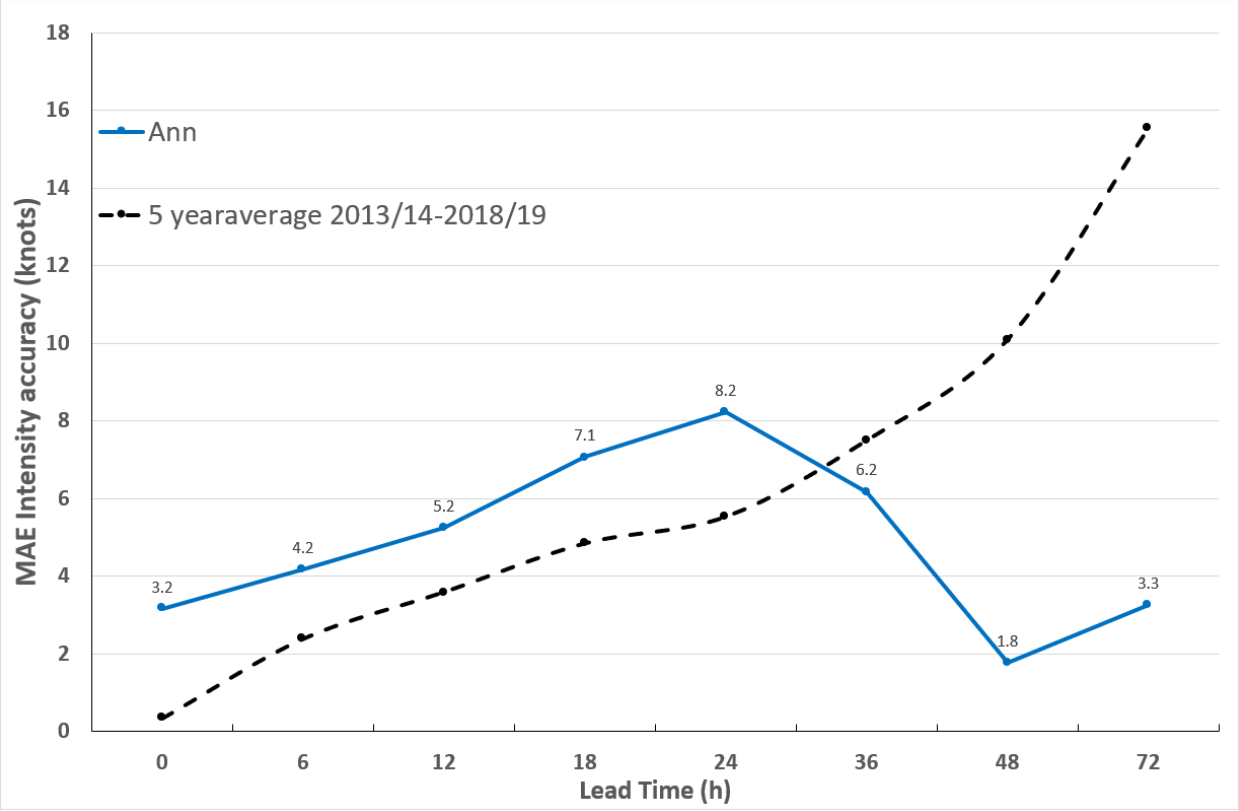


Figure 7 b. Intensity accuracy (Mean Absolute Error (MAE)) figures for Tropical Cyclone Ann.

# 6. Appendix: List of abbreviations

| Abbreviation | Term |
|---|---|
| ADT | Advanced Dvorak Technique |
| ACST | Australian Central Standard Time |
| AEST | Australian Eastern Standard Time |
| AMSR2 | Advanced Microwave Scanning Radiometer |
| ASCAT | Advanced Scatterometer |
| ATMS | Advanced Technology Microwave Sounder |
| AWS | automatic weather station |
| AWST | Australian Western Standard Time |
| C | Celsius |
| CI | Current intensity |
| CIMSS | Cooperative Institute for Meteorological Satellite Studies (USA) |
| CIRA | Cooperative Institute for Research in the Atmosphere (USA) |
| EIR | Enhanced InfraRed |
| ERC | eyewall replacement cycle |
| FNMOC | Fleet Numerical Meteorology and Oceanography Centre (USA) |
| FT | Final T-number |
| GCOM | Global Change Observation Mission |
| GHz | Gigahertz |
| GMI | Global Precipitation Measurement Microwave Imager |
| h | hour |
| hPa | hectopascal |
| HSCAT | Hai Yang 2 Scatterometer (HY-2B, HY-2C) |
| km | kilometres |
| km/h | kilometres per hour |
| kn | knot |
| LLCC | LLCC |
| MET | Model Expected T-number |

| | |
|---|---|
| METOP | Meteorological Operational Satellite |
| MJO | Madden-Julian Oscillation |
| mm | millimetres |
| MSLP | mean sea level pressure |
| nm | nautical mile |
| NOAA | National Oceanic and Atmospheric Administration |
| NRL | Navy Research Lab (USA) |
| PAT | Pattern T-number |
| RH | relative humidity |
| RMW | radius of maximum winds |
| RSMC | Regional Specialised Meteorological Centre |
| SAR | Synthetic Aperture Radar |
| SATCON | satellite Consensus |
| SMAP | Soil Moisture Active Passive |
| SMOS | Soil Moisture and Ocean Salinity |
| SSMIS | Special Sensor Microwave Imager/Sounder |
| TC | Tropical Cyclone |
| TCWC | Tropical Cyclone Warning Centre |
| UTC | Universal Time Co-ordinated |