

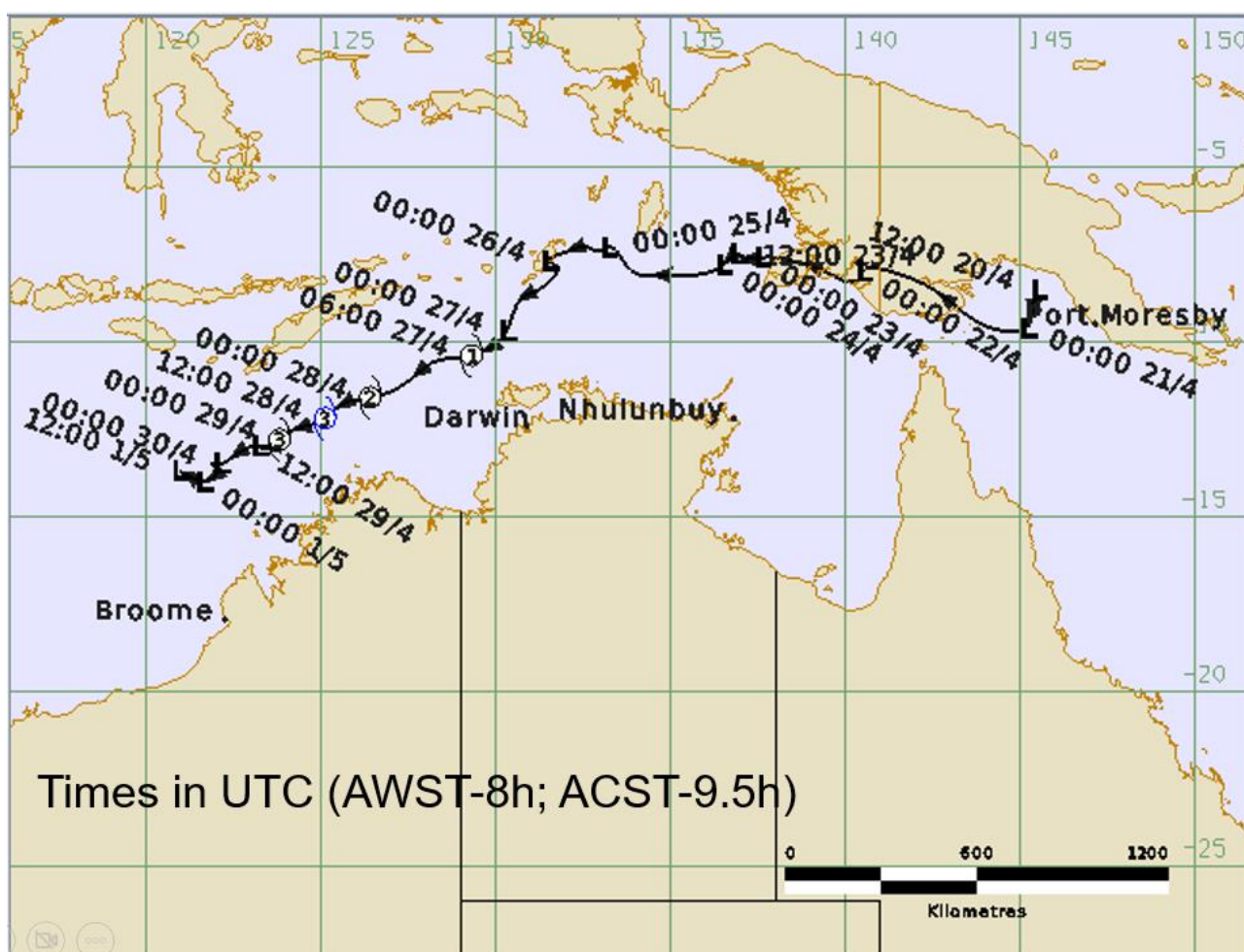
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Severe Tropical Cyclone Frances

20 April – 1 May 2017

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Review status

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Cover image: Track of Severe Tropical Cyclone Frances (Times in UTC)

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1. Summary

Severe Tropical Cyclone Frances was a late season small tropical cyclone that developed rapidly and weakened rapidly over the Timor Sea.

A tropical low in the Gulf of Papua on 20 April, about 200 km west of Port Moresby, Papua New Guinea, moved westwards across southern parts of Papua New Guinea during 22 April until it emerged over the northeast Arafura Sea on 23 April, about 500 km north of Nhulunbuy. The tropical low strengthened slowly as it continued to move westwards over warm waters of the Arafura Sea. The low passed south of the Aru Islands, Indonesia during 24 and 25 April until it stalled near Tanimbar Island, Indonesia on 26 April.

Overnight, the tropical low took a turn towards the southwest and experienced a period of rapid development. The tropical low continued to strengthen during 27 April and reached tropical cyclone intensity that afternoon, about 300 km northwest of Darwin. Frances moved west southwest across the central Timor Sea and continued to rapidly develop, reaching severe tropical cyclone intensity (category 3) by the afternoon of 28 April, just 24 hours after initially reaching tropical cyclone intensity. Severe Tropical Cyclone Frances maintained category 3 strength until the morning of 29 April. Due to increasingly unfavourable atmospheric conditions, the tropical cyclone weakened quickly over open water between the northwest Kimberley region of Australia and the island of Timor and was downgraded to a tropical low on the morning of 30 April.

Although Severe Tropical Cyclone Frances did not directly impact the surrounding coastlines of Australia, Indonesia and Timor Leste, the outer rainbands of the developing tropical cyclone produced heavy rainfall over the Tiwi Islands north of Darwin, Australia - Pirlangimpi recorded 192 mm in the 24-hour period to 9am Friday 28 April. An automatic weather station located in the Timor Sea reported a maximum wind gust of 120 km/h on the morning of 28 April as the tropical cyclone passed to the south. Refer to the tracks in Figure 1 and 1b, and Table 1 for tabulated parameter estimates.

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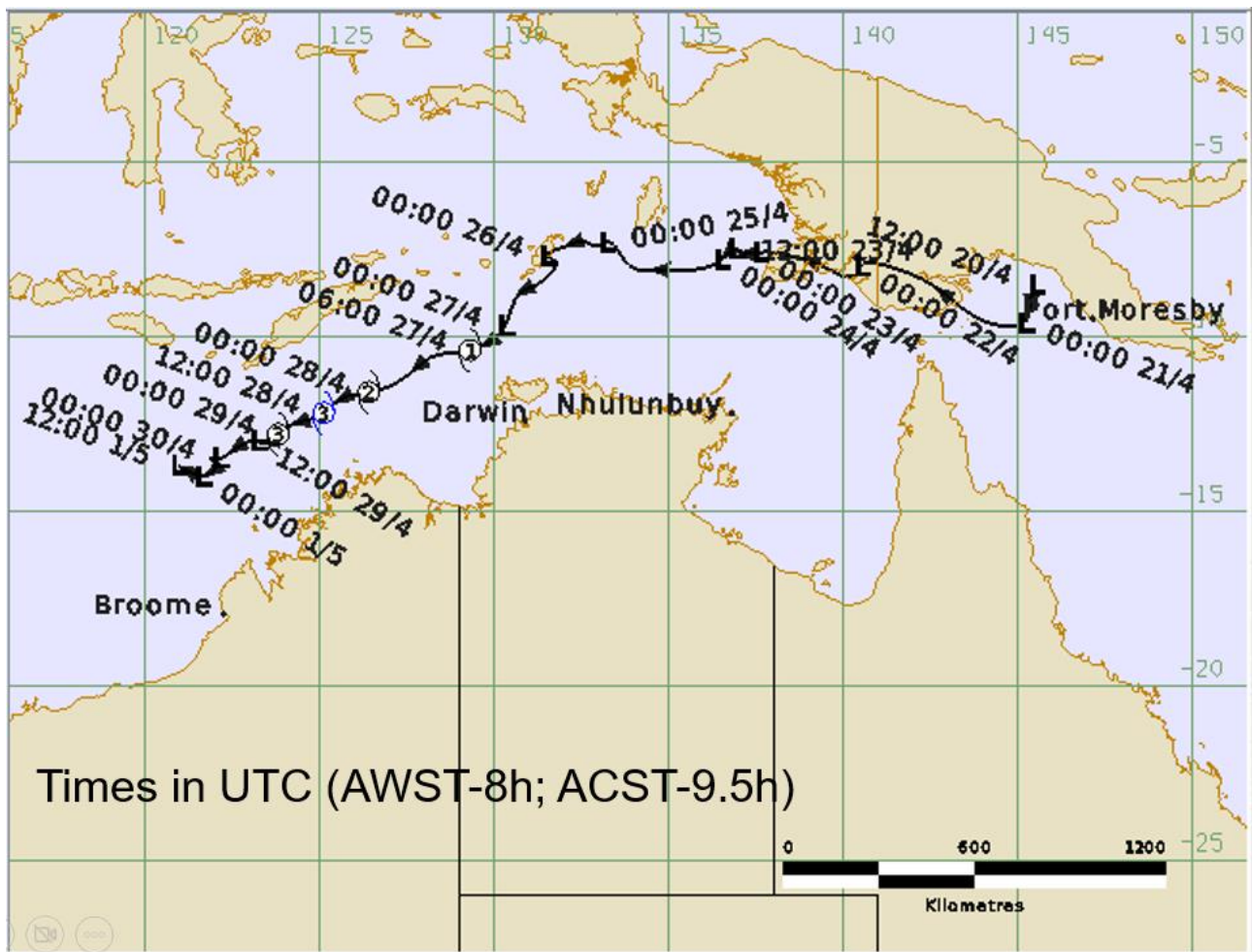


Figure 1a. Best track of Severe Tropical Cyclone Frances (times in UTC, AWST-8h).

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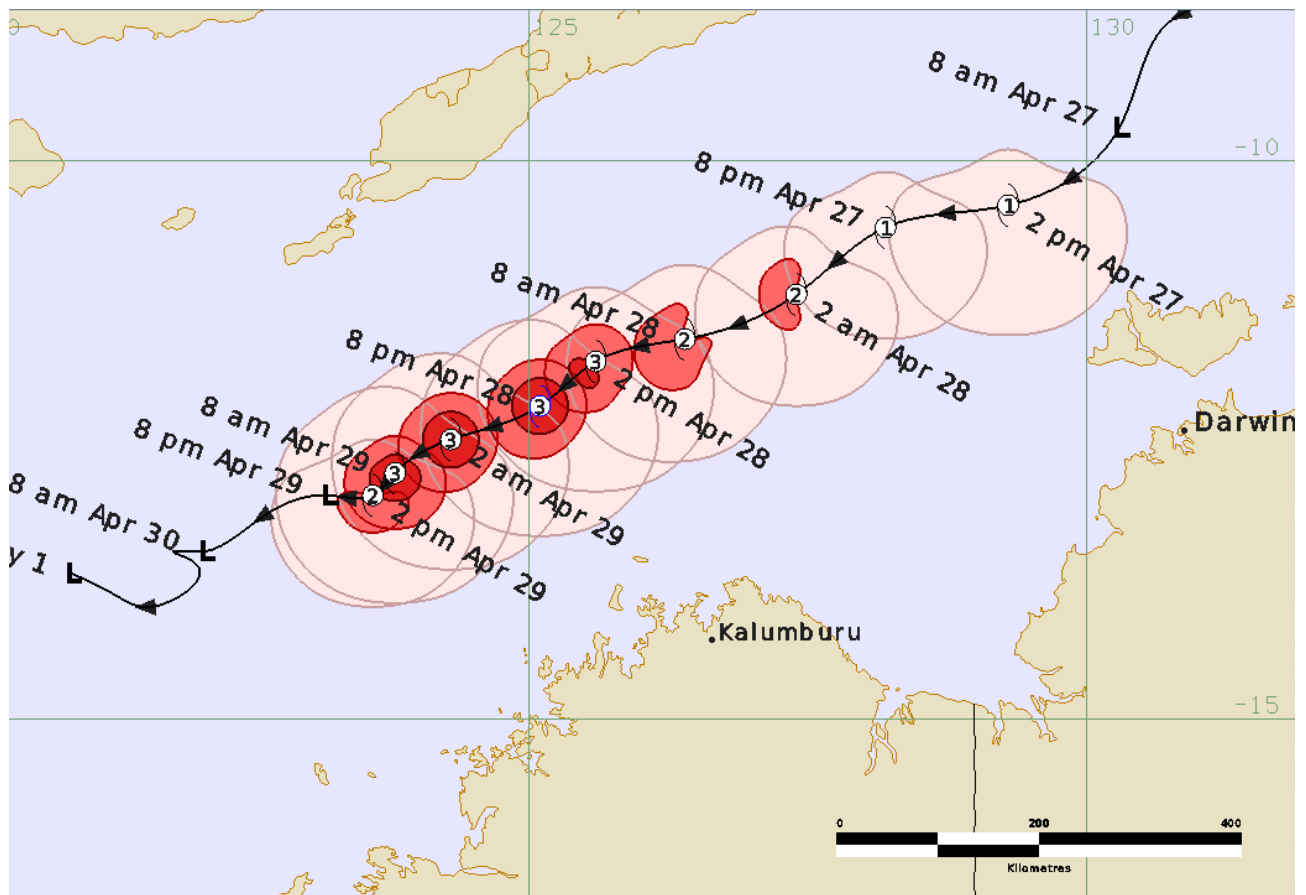


Figure 2b. Detailed best track of Severe Tropical Cyclone Frances showing wind radii (gale - pink, storm - red and hurricane force – dark red) (times in AWST, UTC +8).

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Table 1. Best track summary for Severe Tropical Cyclone Frances, 20 April -1 May 2017.

UTC=AWST-8h.

* Not at tropical cyclone intensity as gales less than halfway around centre.

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
2017	4	20	1200	8.5	145.5	50	15	45	1006	0/0/0/0	0/0/0/0	-
2017	4	20	1800	9.1	145.4	50	15	45	1007	0/0/0/0	0/0/0/0	-
2017	4	21	0000	9.6	145.2	40	15	45	1008	0/0/0/0	0/0/0/0	-
2017	4	21	0600	9.7	144.5	50	15	45	1006	0/0/0/0	0/0/0/0	-
2017	4	21	1200	8.5	142.5	50	10	45	1009	0/0/0/0	0/0/0/0	-
2017	4	21	1800	8.0	141.3	40	15	45	1007	0/0/0/0	0/0/0/0	-
2017	4	22	0000	8.0	140.5	40	15	45	1009	0/0/0/0	0/0/0/0	-
2017	4	22	0600	8.2	140.4	30	15	45	1006	0/0/0/0	0/0/0/0	-
2017	4	22	1200	8.0	139.4	50	15	45	1006	0/0/0/0	0/0/0/0	-
2017	4	22	1800	7.7	138.5	50	15	45	1007	0/0/0/0	0/0/0/0	-
2017	4	23	0000	7.6	137.6	40	15	45	1009	0/0/0/0	0/0/0/0	-
2017	4	23	0600	7.6	137.1	30	15	45	1006	0/0/0/0	0/0/0/0	-
2017	4	23	1200	7.5	136.9	40	15	45	1007	0/0/0/0	0/0/0/0	-
2017	4	23	1800	7.6	136.7	40	15	45	1007	0/0/0/0	0/0/0/0	-
2017	4	24	0000	7.8	136.5	30	15	45	1008	0/0/0/0	0/0/0/0	-
2017	4	24	0600	8.1	135.7	50	15	45	1006	0/0/0/0	0/0/0/0	-
2017	4	24	1200	8.1	134.5	50	15	45	1008	0/0/0/0	0/0/0/0	-
2017	4	24	1800	8.0	133.9	50	15	45	1008	0/0/0/0	0/0/0/0	-
2017	4	25	0000	7.3	133.2	50	15	45	1009	0/0/0/0	0/0/0/0	-
2017	4	25	0600	7.4	132.9	30	15	45	1006	0/0/0/0	0/0/0/0	-
2017	4	25	1200	7.3	132.6	40	20	45	1006	0/0/0/0	0/0/0/0	-
2017	4	25	1800	7.4	132.1	40	25	45	1004	0/0/0/0	0/0/0/0	-
2017	4	26	0000	7.7	131.5	30	25	45	1006	0/0/0/0	0/0/0/0	-
2017	4	26	0600	7.8	131.7	20	25	45	1002	0/0/0/0	0/0/0/0	-
2017	4	26	1200	8.4	131.4	30	25	45	1004	0/0/0/0	0/0/0/0	-
2017	4	26	1800	8.8	130.7	30	25	45	1002	0/0/0/0	0/0/0/0	-
2017	4	27	0000	9.7	130.3	20	35*	50	1002	0/70/70/0	0/0/0/0	-
2017	4	27	0600	10.4	129.3	20	40	55	998	30/70/70/30	0/0/0/0	10
2017	4	27	1200	10.6	128.2	30	45	65	996	30/60/60/30	0/0/0/0	10
2017	4	27	1800	11.2	127.4	30	55	75	990	30/60/60/40	0/0/20/20	10
2017	4	28	0000	11.6	126.4	20	60	85	987	40/60/70/40	0/15/30/20	20
2017	4	28	0600	11.8	125.6	15	65	90	981	40/70/70/40	20/20/30/20	10
2017	4	28	1200	12.2	125.1	20	70	100	979	40/70/70/50	25/25/30/25	8
2017	4	28	1800	12.5	124.3	20	70	100	978	40/70/70/50	25/25/30/25	8
2017	4	29	0000	12.8	123.8	20	65	90	980	40/70/70/50	20/30/30/20	8
2017	4	29	0600	13.0	123.6	30	55	75	988	30/60/60/30	0/20/20/0	10
2017	4	29	1200	13.0	123.2	20	35*	50	994	0/0/40/0	0/0/0/0	-
2017	4	29	1800	13.2	122.6	20	30	45	996	0/0/0/0	0/0/0/0	-
2017	4	30	0000	13.5	122.1	15	30	45	1000	0/0/0/0	0/0/0/0	-
2017	4	30	0600	13.5	121.9	15	25	45	1002	0/0/0/0	0/0/0/0	-
2017	4	30	1200	13.5	121.8	20	25	45	1004	0/0/0/0	0/0/0/0	-
2017	4	30	1800	13.6	122.0	20	25	45	1006	0/0/0/0	0/0/0/0	-
2017	5	1	0000	14.0	121.6	15	25	45	1008	0/0/0/0	0/0/0/0	-
2017	5	1	0600	13.9	121.3	15	25	45	1007	0/0/0/0	0/0/0/0	-
2017	5	1	1200	13.7	120.9	20	20	45	1009	0/0/0/0	0/0/0/0	-



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2. Meteorological description

2.1 Intensity analysis

A comparison of the intensity estimates is shown in Figure 2. A weak low formed in the Gulf of Papua on 20 April, about 200 km west of Port Moresby, Papua New Guinea. The low tracked to the west across southern parts of Papua New Guinea during 22 April, emerging over the northeast Arafura Sea on 23 April. The tropical low slowly developed during 24 and 25 April. Deep convection developed for a period south of the centre overnight from 25 to 26 April but then eased during the 26th.

The low-level centre developed further in the Timor Sea following another convective burst south of the centre overnight from 26 to 27 April that heralded rapid intensification. At this time the low had moved into an environment favourable for intensification: high moisture in low to mid-levels, low vertical wind shear and high sea surface temperatures (SST) exceeding 30 °C. Gales were evident south of the centre on the Advanced Scatterometer (ASCAT-B) at 0103 UTC (UTC=AWST-8 hours) 27 April. Tropical cyclone intensity was estimated at 0600 UTC 27 April as the system tracked west southwest over the Timor Sea. Deep convection had extended around to the north of the low-level centre as shown on the Special Sensor Microwave Imager (SSM/I) microwave composite image at 0619 UTC in Figure 3.

Tropical Cyclone Frances continued developing rapidly reaching severe tropical cyclone intensity (category 3) by 0600 UTC 28 April, just 24 hours after initially reaching tropical cyclone intensity. The visible image at 0500 UTC 28 April in Figure 4 shows an eye typical of a severe tropical cyclone. Figure 5 shows a more distinct eye on the enhanced infra-red (EIR) at 1020 UTC 28 April as Frances reached peak intensity with the estimated maximum winds of 70 knots (kn). This was based upon subjective Dvorak estimates of 4.5, consistent with SATCON estimates but higher than ADT which only peaked at 3.4 as shown in Figure 2. However, ADT failed to recognise an eye pattern so underestimated the intensity.

Frances weakened rapidly from about 21 UTC 28 April over open water between the northwest Kimberley region of Australia and the island of Timor. Dry air was entrained into the core of the circulation and combined with increasing wind shear to erode the deep convection. Frances was downgraded to a tropical low at 12 UTC 29 April. By this time deep convection was well removed from the core of the circulation. The ASCAT-A pass at 1341 UTC showed gales confined to the southwest quadrant. The weakening was stronger than subjective Dvorak weakening rates would allow. The intensity was also higher than SATCON and ADT objective estimates as shown in Figure 2.

The low then weakened further on 30 April and 1 May.

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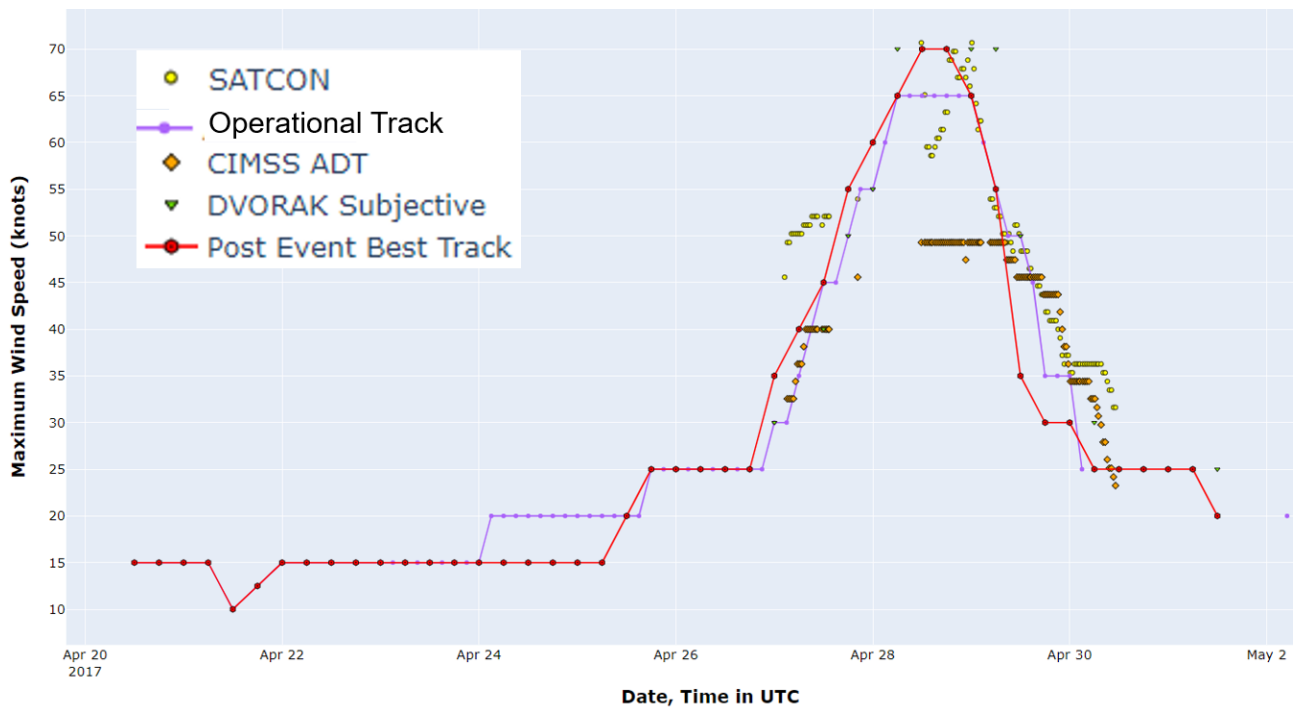


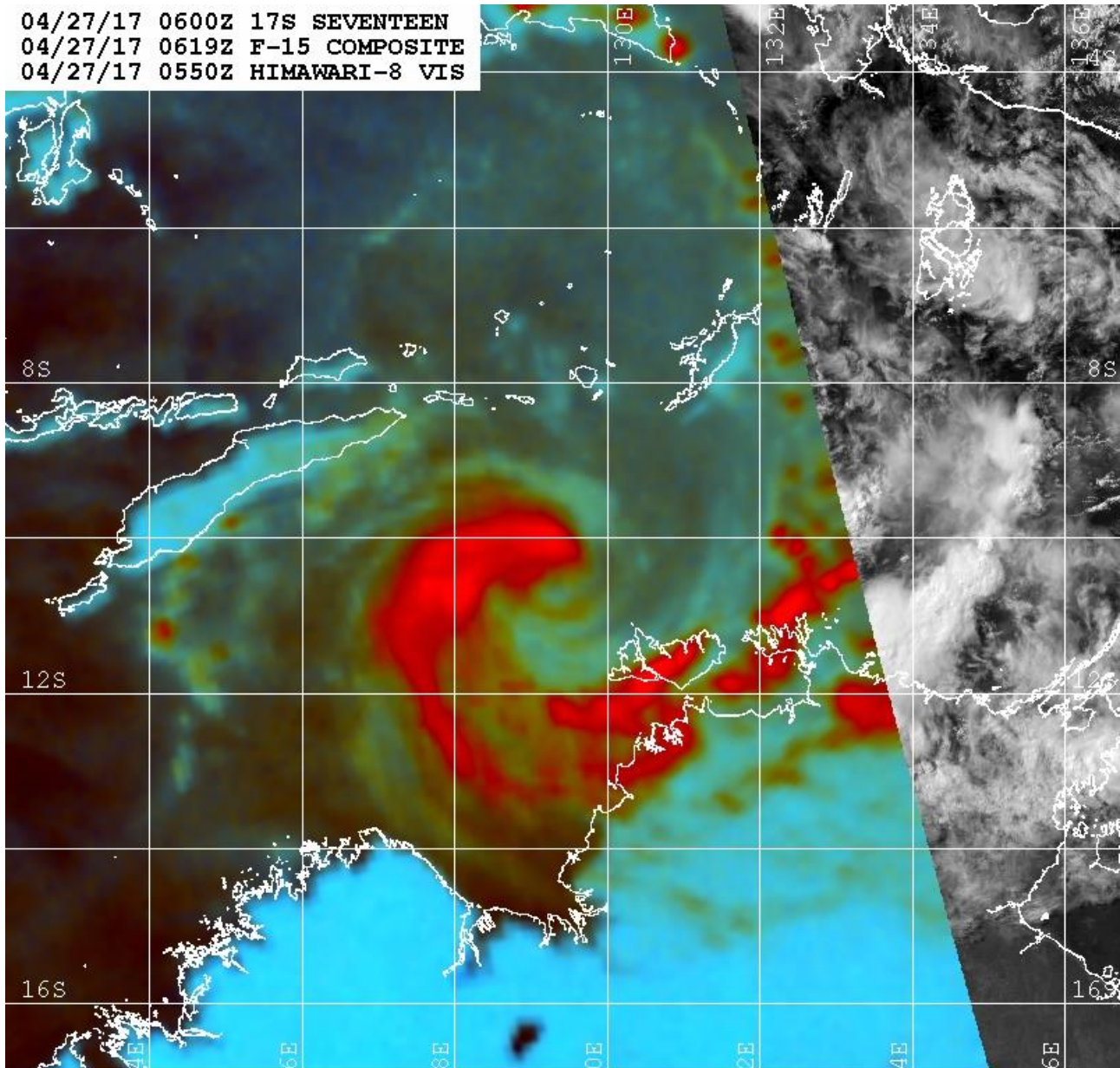
Figure 2. Intensity comparison plot showing the best track intensity (red) against the operational estimate, subjective Dvorak and objective estimates (SATCON and CIMSS ADT).

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04/27/17 0600Z 17S SEVENTEEN
04/27/17 0619Z F-15 COMPOSITE
04/27/17 0550Z HIMAWARI-8 VIS



Naval Research Lab www.nrlmry.navy.mil/sat_products.html
Red=85PCT Green=85H Blue=85V

Figure 3. Special Sensor Microwave Imager (SSM/I) microwave image at 0619 UTC 27 April, showing strong curvature in deep convection suggesting tropical cyclone intensity had been attained. Image courtesy NRL:
<https://www.nrlmry.navy.mil/TC.html>

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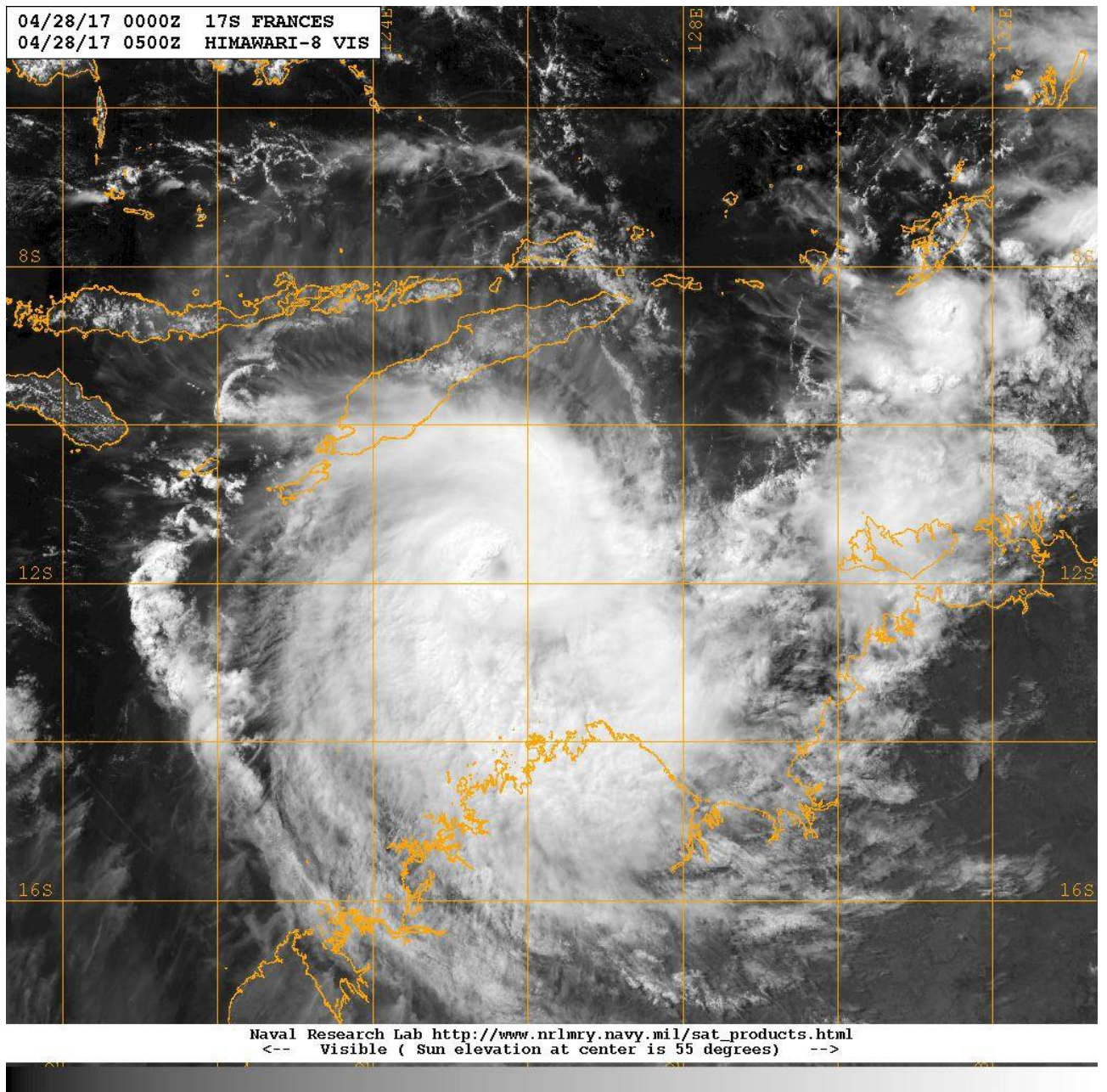


Figure 4. Visible image at 0500 UTC 28 April 2023 showing an eye indicative that Frances had reached severe tropical cyclone intensity. Image courtesy NRL: <https://www.nrlmry.navy.mil/TC.html>

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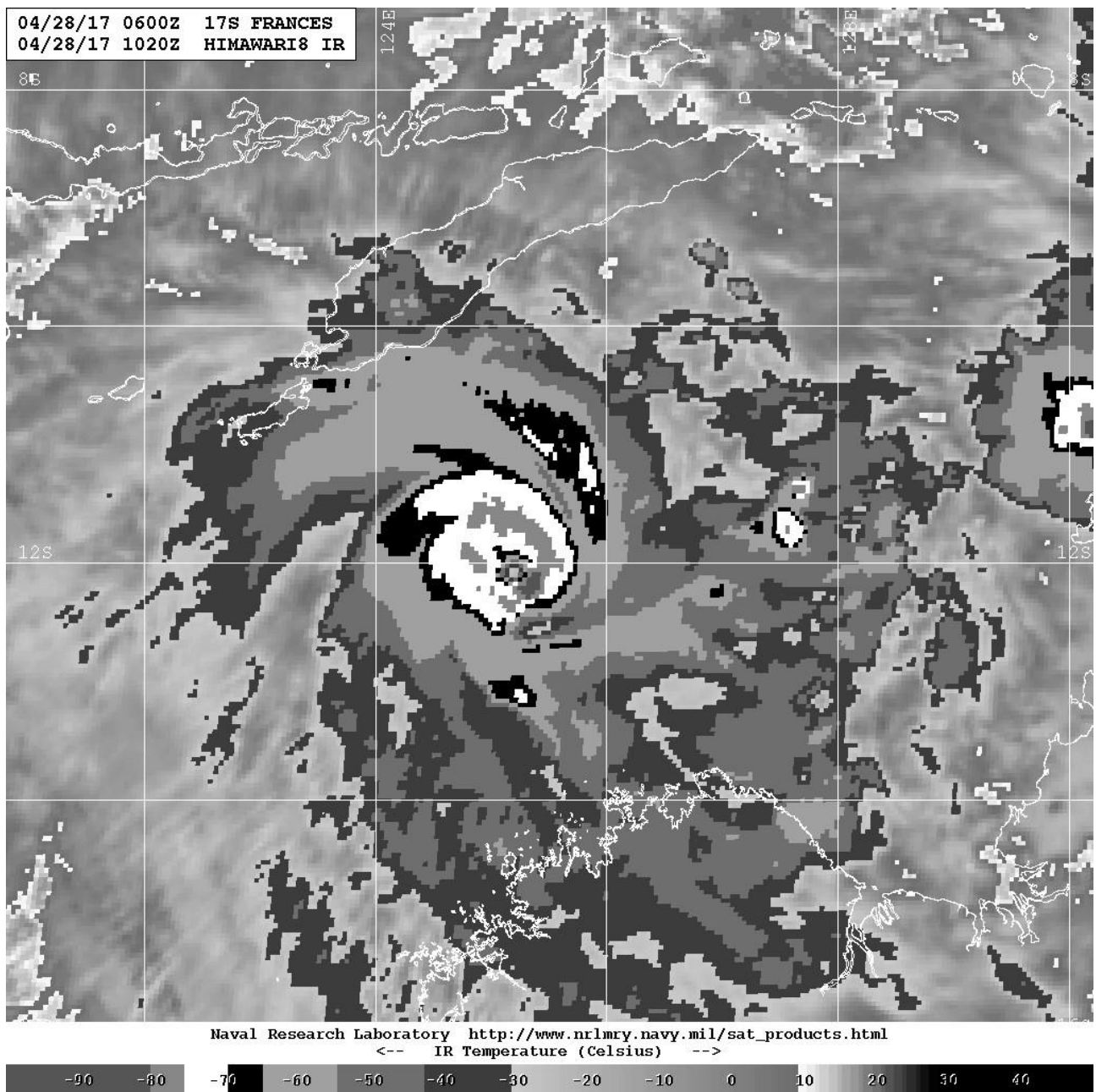


Figure 5. Enhanced (Dvorak) infra-red (EIR) image at 1020 UTC 28 April 2023 showing a small distinct eye as Frances reached peak intensity. Image courtesy NRL: <https://www.nrlmry.navy.mil/TC.html>

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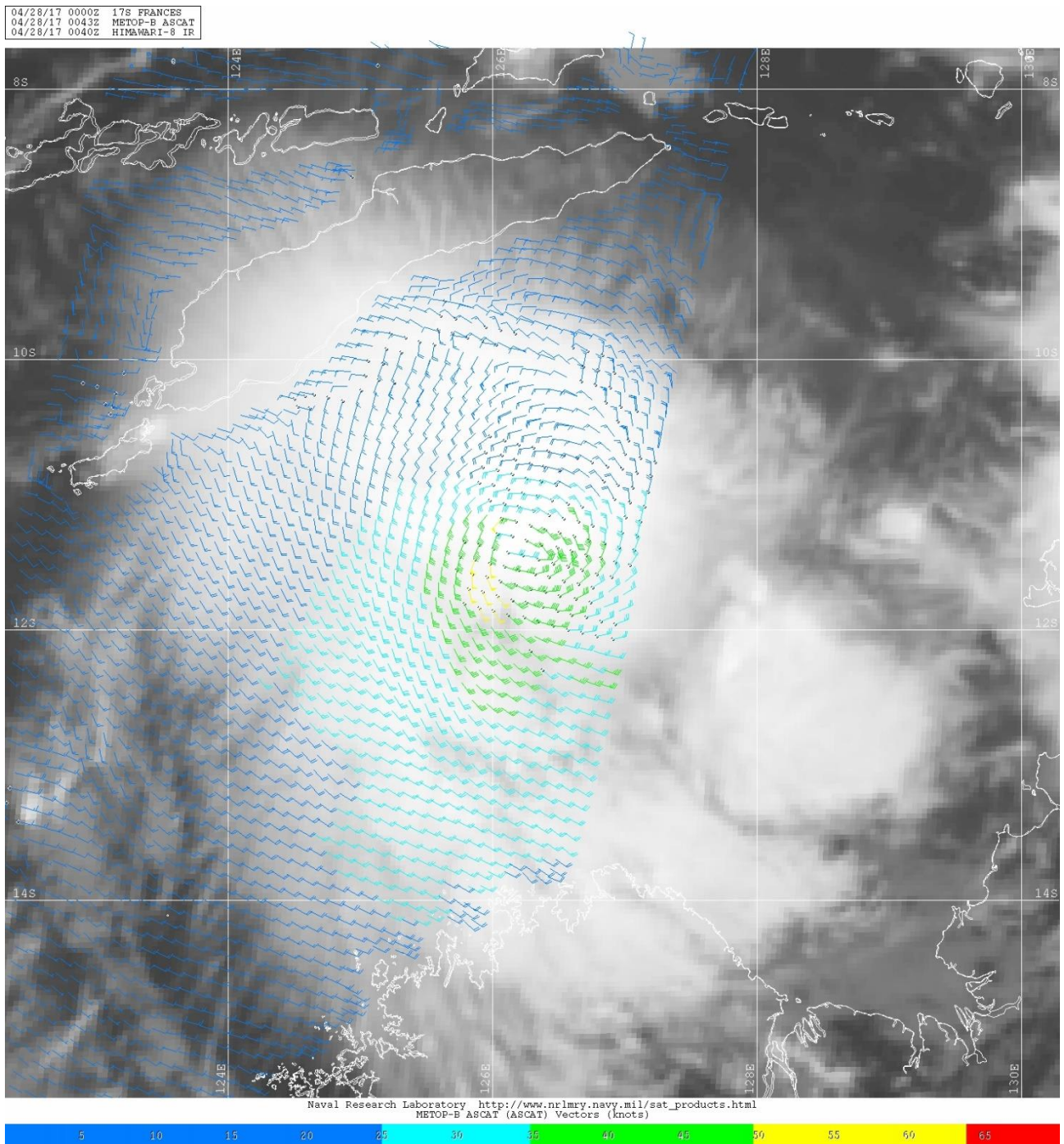


Figure 6. Advanced Scatterometer (ASCAT-B) wind distribution at 0043 UTC 28 April showing winds exceeding 50 kn in the southwest quadrant. Image courtesy NRL: <https://www.nrlmry.navy.mil/TC.html>

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2.2 Structure

Frances was a reasonably compact system having the strongest winds south of the centre. The radius to gales varied from about 30 to 50 nautical miles (nm) (55 to 93 km) north of the centre to up to 60-70 nm (110-130 km) south of the centre as reflected in a series of ASCAT passes such as the ASCAT-B at 0043 UTC 28 April in Figure 6. This reflected the influence of the prevailing east southeasterly flow extending from the sub-tropical ridge to the south.

Peak winds occurred to the south to southwest of the centre as shown in the ASCAT image in Figures 6. The radius to maximum winds (RMW) was small being just 8 nm (15 km) at peak intensity.

2.3 Motion

The system was steered by the prevailing ridge to the south.

Initially the weak low formed in the Gulf of Papua on 20 April and tracked to the west across southern parts of Papua New Guinea during 22 April, emerging over the northeast Arafura Sea on 23 April. The tropical low passing south of the Aru Islands, Indonesia during 24 and 25 April until it stalled near Tanimbar Island, Indonesia on 26 April.

From 26 April the system took a southwest track as the orientation of the ridge shifted further to the southeast. Frances developed as it moved to the southwest through the Timor Sea. This continued to 30 April when the weakening system turned to the west before dissipating.

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3. Impact

Although Severe Tropical Cyclone Frances did not directly impact the surrounding coastlines of Australia, Indonesia and Timor Leste, the outer rainbands of the developing tropical cyclone produced heavy rainfall over the Tiwi Islands north of Darwin.

Oil and gas facilities in the Timor Sea region were affected as the cyclone passed by.

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4. Observations

4.1 Winds

Bayu Undan, in the Timor Sea, registered a peak ten-minute mean wind of 59 kn (109 km/h) at 2110 UTC 27 April and a peak gust of 71 kn (131 km/h) at 2219 UTC 27 April. The site recorded gales from 17 UTC 27 April to 01 UTC 28 April and periods of storm-force winds from 2050 UTC to 2230 UTC 27 April.

4.2 Rainfall

Pirlangimpi, located on the Tiwi Islands northwest of Darwin, recorded 192 mm in the 24-hour period to 9am ACST 28 April.



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5. Forecast performance

Tropical Cyclone products were initiated from 01 UTC 27 April until 01 UTC 30 April.

Official tropical cyclone advices for the north Kimberley coast were issued from 07 UTC 27 April until 19 UTC 29 April. The cyclone remained sufficiently north of the coast for gales not to reach the Kimberley coast.

The accuracy figures for Severe Tropical Cyclone Frances are below and also shown in Figure 7. These show that the forecast position was slightly better than to the five-year average at time steps to 48 hours. The intensity forecasts had similar errors to the five-year average for the first 24 hours, but better at 48-72 hours. The forecasts issued during the developing stages correctly identified the intensification on 27 and 28 April and then the rapid weakening on 29 April. This is reflected in Figure 8 that shows the first five forecast intensity plots from the official forecast tracks (OFT) from 00UTC 27 April to 00UTC 28 April against the reanalysed intensity.

There were insufficient data points for 96 and 120 hours. These were based on official forecast tracks issued from 0000 UTC 27 April to 0000 UTC 30 April.

Table 2. Verification statistics for Severe Tropical Cyclone Frances.

	0	6	12	18	24	36	48	72	96	120
Position										
Absolute error (km)	21	33	50	71	90	109	142	242	213	0
Intensity										
Absolute error (kn)	4.2	6.2	9.2	10.0	10.8	11.5	6.8	2.9	5.0	0.0
Sample Size	13	13	13	13	13	13	11	7	3	0

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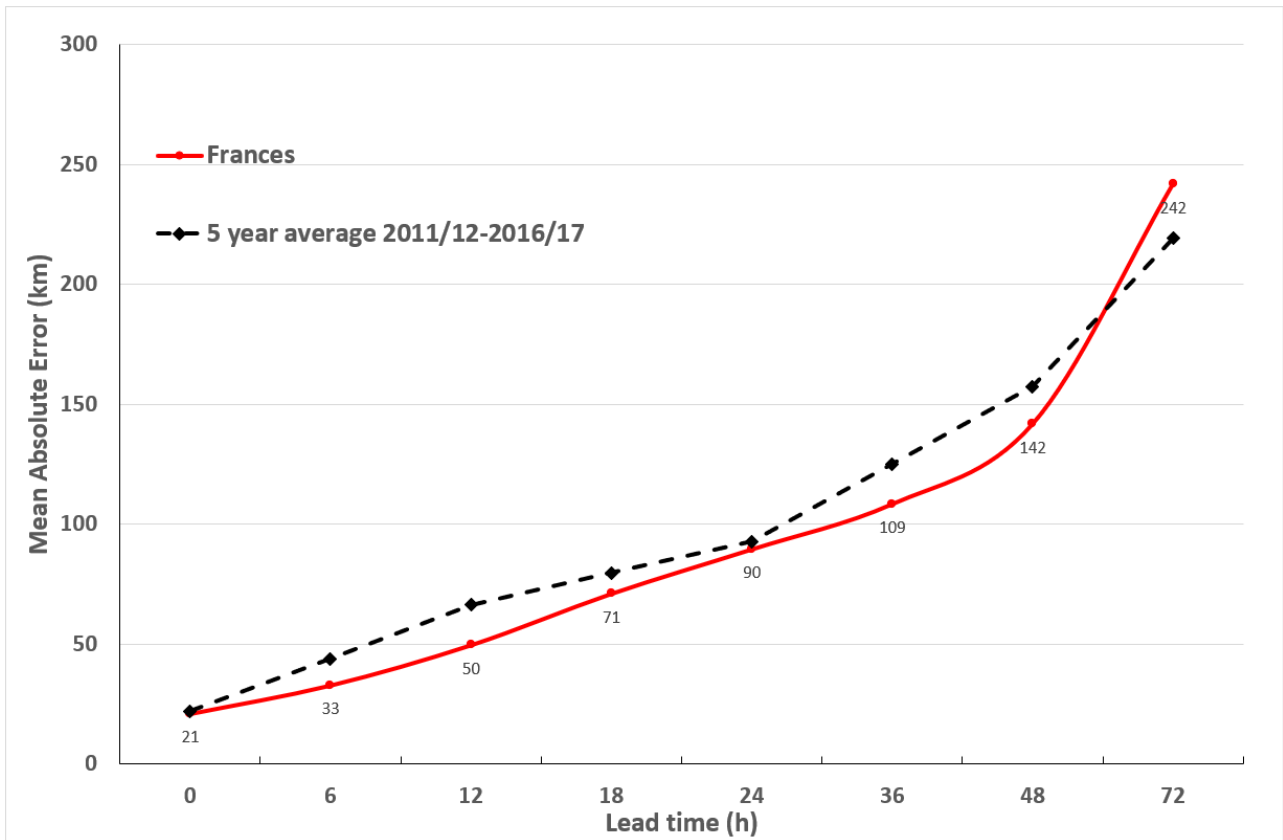


Figure 7 a. Position accuracy figures for Severe Tropical Cyclone Frances.

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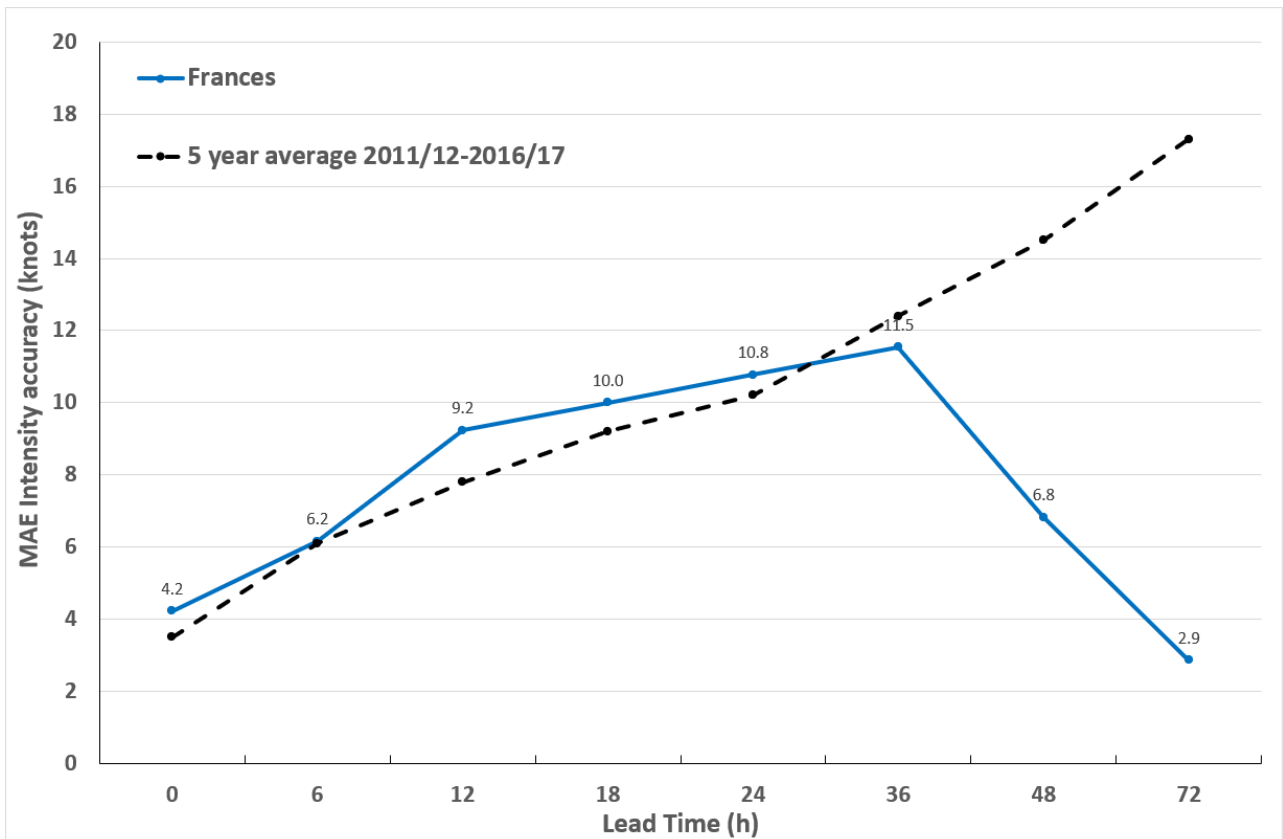
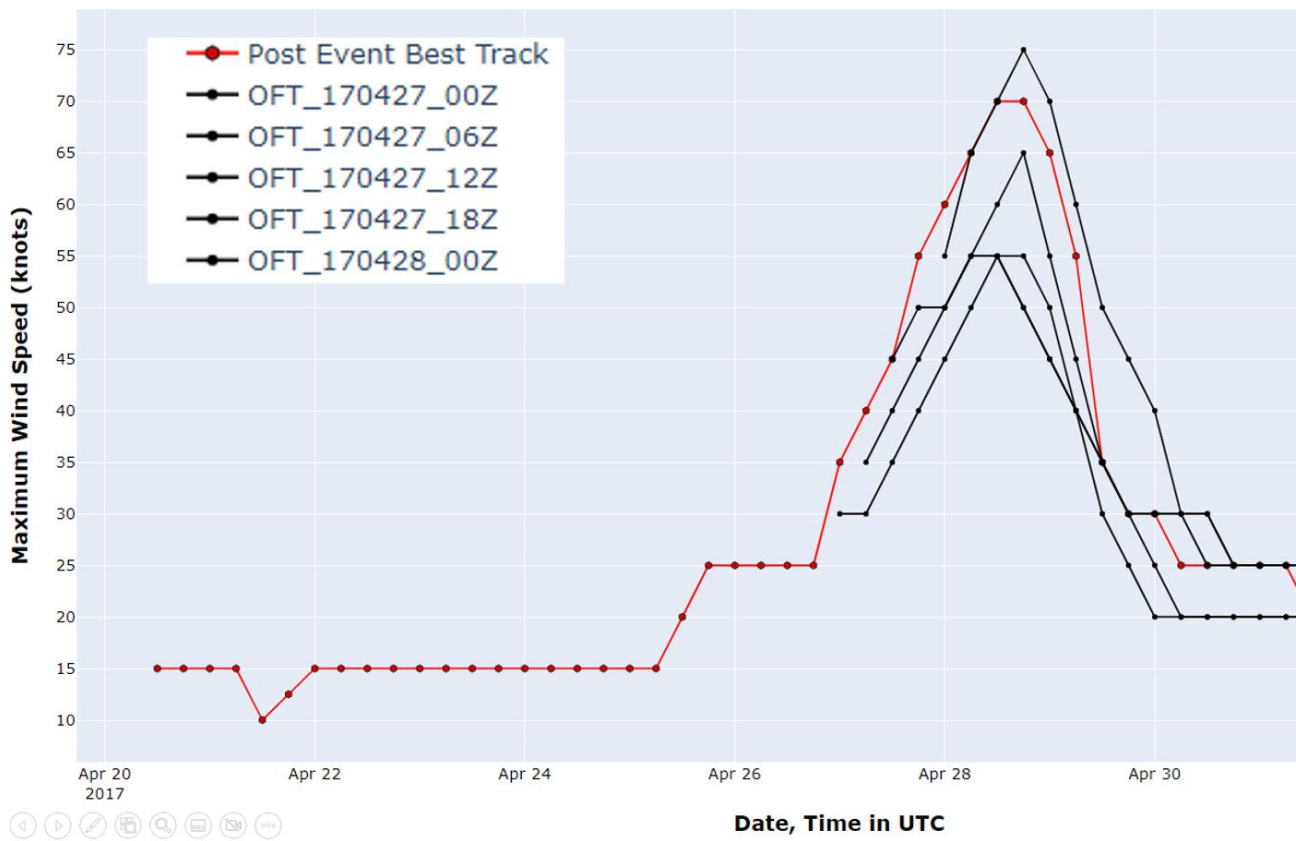


Figure 7 b. Intensity accuracy figures for Severe Tropical Cyclone Frances. MAE: mean absolute error.

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1. 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
FNMOCC	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



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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