Fiji Meteorological Service
RSMC Nadi-Tropical Cyclone Centre

Tropical Cyclone Irene

18th - 20th January 2023

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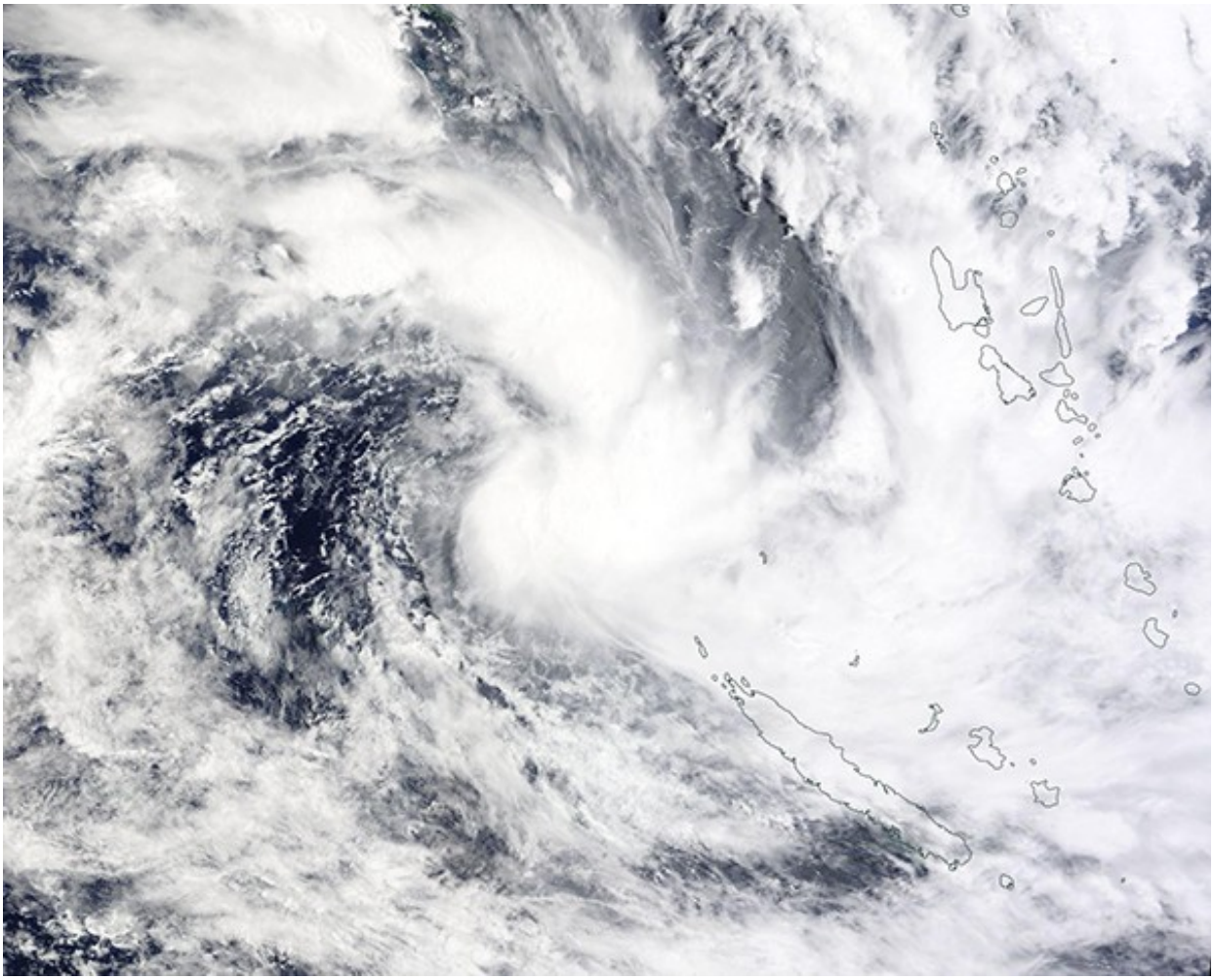
Fiji Meteorological Service
August 2023.



On January 18, 2023, the Moderate Resolution Imaging Spectroradiometer (MODIS) acquired a true-color image of newly-formed Tropical Cyclone Irene as it spun up over the South Pacific basin to the northeast of New Caledonia.

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1.0 SUMMARY

A tropical low developed over northern Vanuatu waters on the 13th January 2023. This low pressure system intensified into Tropical Disturbance 05F (TD05F) 24 hours later in open waters between Solomon Islands and Vanuatu whilst slowly moving west. The system moved west of 160° East longitude and out of Regional Specialized Meteorological Center (RSMC) Nadi's area of responsibility (AOR) on Sunday night, the 15th of January and continued to move west into the Coral Sea.

The system made a turn and moved southeast on the 17th of January whilst in the Coral Sea and re-entered RSMC Nadi's area of responsibility in the early morning at 1800UTC of Monday, 17th January as it continued to track east-southeast as Tropical Depression, TD05F. TD05F intensified into a category 1 Tropical Cyclone 12 hours later on Wednesday afternoon, at 0600UTC on 18th January and named Tropical Cyclone Irene. This was northeast of Grand Terre, New Caledonia as Irene continued to move east-southeast towards Vanuatu.

Irene further intensified into a Category 2 system about 120 kilometers west-northwest of Tanna, Vaunatu as the tropical cyclone continued to move east-southeast towards southern Vanuatu. The system remained a category 2 system till midday on 19th January as it was passing between Tanna and Aneityum islands, in southern Vanuatu.

The cyclone caused damages to the the southern islands of Vanuatu especially over the Tafea and Shefa province with damages mostly to trees, gardens, few temporary buildings, roofing iron blown away, power cuts, widespread flooding, road closures and landslides.

Irene weakened to a category 1 system at 0600UTC on 19th January as it moved south of 20° South latitude due to strong northwesterly wind shear. Irene continued to move southeast and remained a category 1 system before moving south of 25° latitude exiting RSMC Nadi's AOR.
TC Irene was the second tropical cyclone in RSMC Nadi's area of responsibility for the 2022/23 season.

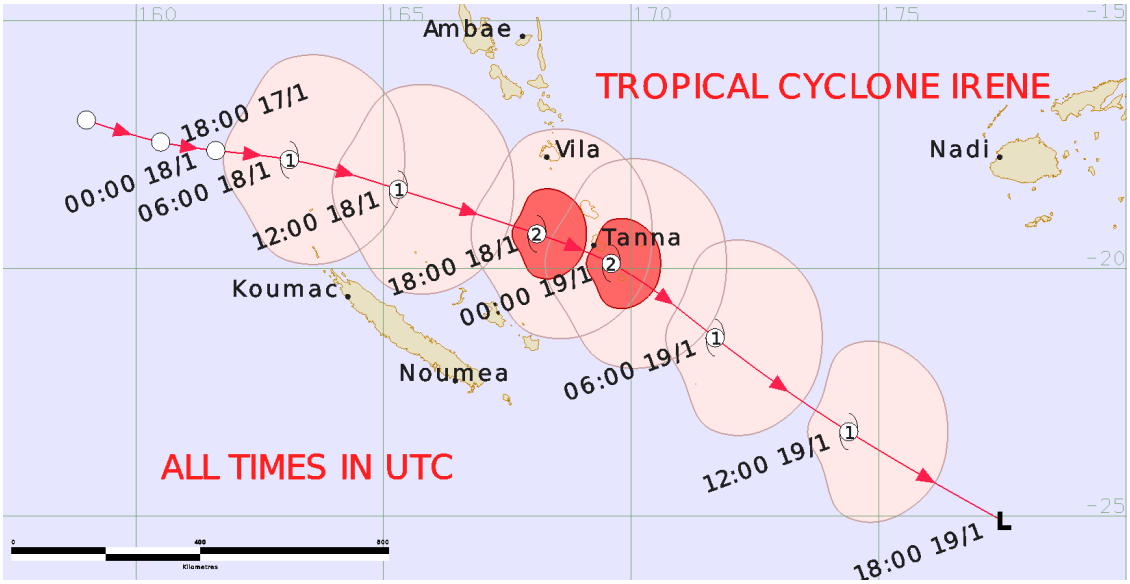


Fig 1: Post Event Best track of Tropical Cyclone Irene.

2.0 METEOROLOGICAL DESCRIPTION

Tropical Disturbance 05F re-entered RSMC Nadi's area of responsibility during the early morning of Tuesday, 18th January as it continued to track east-southeast as TD05F. This was about 530km northwest of Koumac on the Grande Terre, the main island of New Caledonia. The system showed deep persistent convection with primary bands wrapping onto the low level circulating center with a 0.35 wrap cloud pattern in terms of Dvorak analysis with a Final T number of 2.0 and Current intensity of 2.0. Winds close to the center were estimated to be 25 knots or 45km/hr.

TD05F continued to move east southeast at about 15 knots (or 28km/hr) towards southern Vanuatu under the influence of the near-equatorial ridge(NER) located to the northeast of the system (Figure 2 below). The system was moving into a favorable environment for tropical cyclone intensification and developed into Tropical Cyclone Irene at 180600UTC (Figure 3 below). Irene developed in an area of low shear (Fig 4) with good upper divergence to the southeast of the low level circulating center (Fig 5).

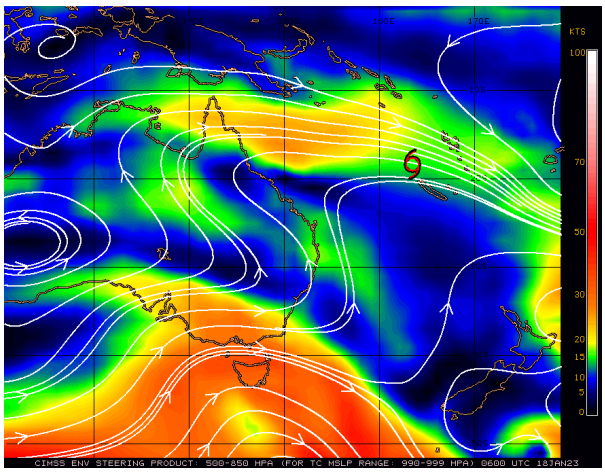


Fig 2: Deep Layer mean steering (850-500hpa).

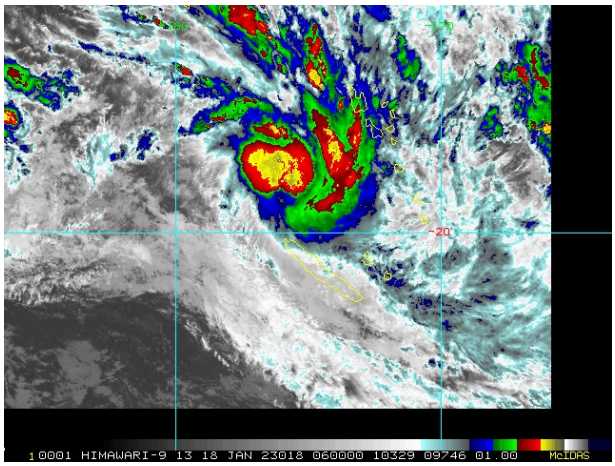


Fig 3: TD05F intensifying into Tropical Cyclone Irene.

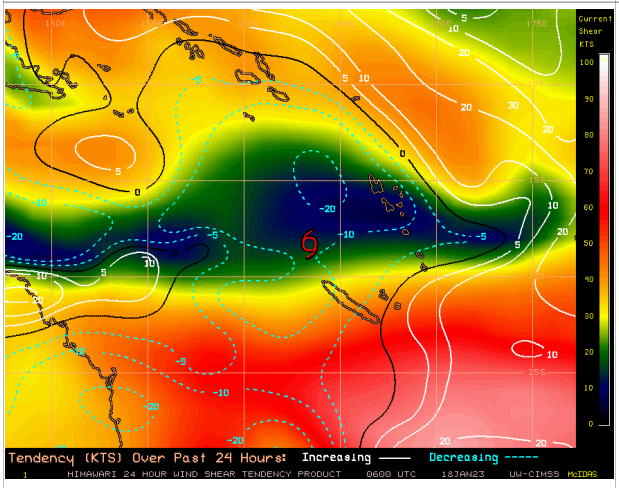


Fig 4: TC Irene developed in an environment of decreasing shear.

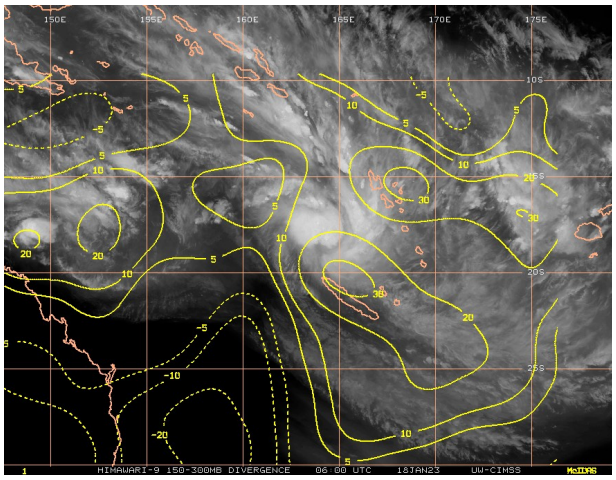


Fig 5: TC Irene developed in an environment of good upper divergence and good outflow.

TC Irene had a 0.6 cloud pattern wrap in the Dvorak analysis giving a Final T-number and Current intensity of 3.0 which qualified the system to be a Category 1 Tropical system with the estimated winds near the center to be 35 knots(65km/hr).

The cyclone continued to track east-southeast into favourable environmental conditions and further intensified into a Category 2 system at 181800UTC (Fig 6) as it was approaching southern Vanuatu. This was about 120 kilometers (or 67 nautical miles) west-northwest of Tanna island or about 170km (or 94 nm) south of Vila.

Deep convection continued to be persistent with primary bands wrapping onto the low level circulating centre with moderate shear (Fig 7), strong upper divergence and good outflow to the southeast of the system (Fig 8 & 9). TC Irene continues to be steered to east-southeast by the near-equatorial ridge to the northeast of the system with sea-surface temperature of 28 degrees celsius.

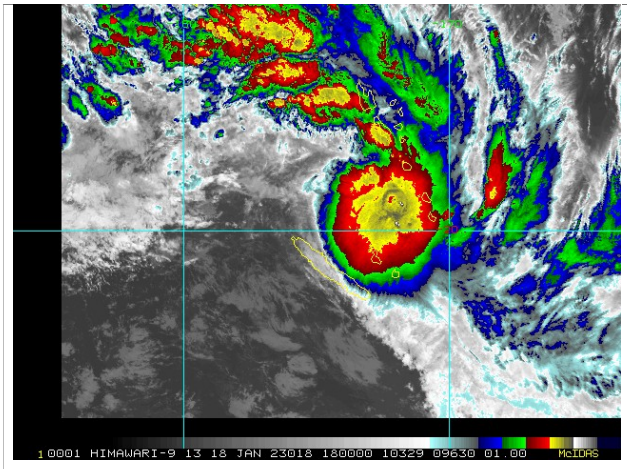


Fig 6: Himawari satellite image at 181800UTC with 0.75 cloud pattern wrap yielding FT & CI of 3.5 resulting in a category 2 system with estimated winds of 50 knots(95km/hr) near the center.

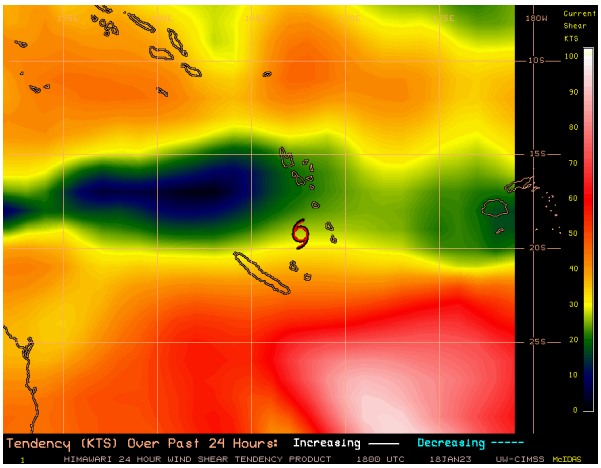


Fig 7: TC Irene, Category 2 system moving east-southeast in a moderate sheared environment.

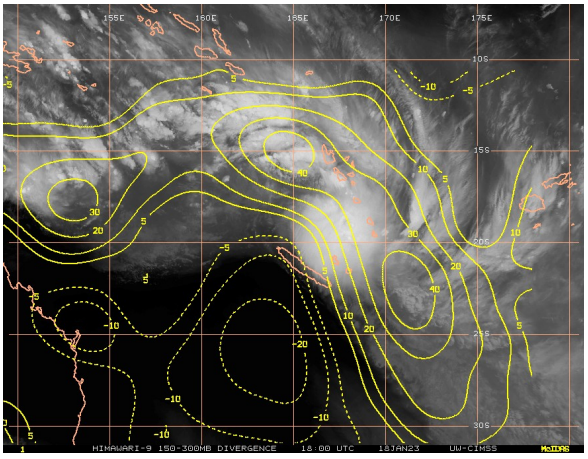


Fig 8: Strong upper divergence to the southeast of TC Irene.

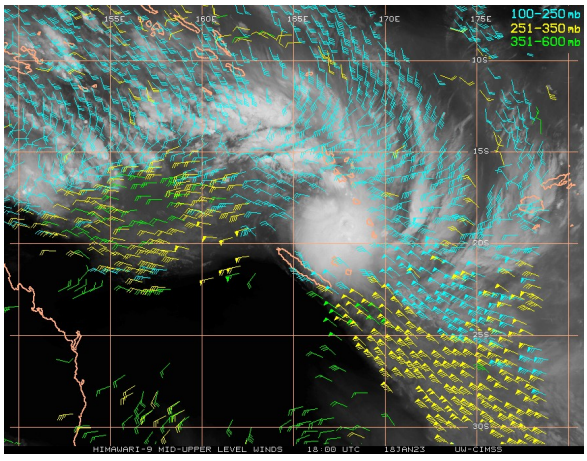


Fig 9: Good outflow to the southeast of TC Irene.

The gale radius for Irene ranged between 220 to 260km (or 120-140nm) in the eastern semicircle and 90 to 145km (or 50-80nm) in the western semicircle. The storm force wind radius ranged between 55 to 110km (30-60nm) during Irene's Category 2 lifetime(Fig 10).

Irene was a category 2 system as it passed southern Vanuatu till 190000UTC. The steering changed from the influence of the near-equitorial ridge to the influence of the subtropical ridge located to the east of the system (Figure 11) which continued to move Irene southeast.

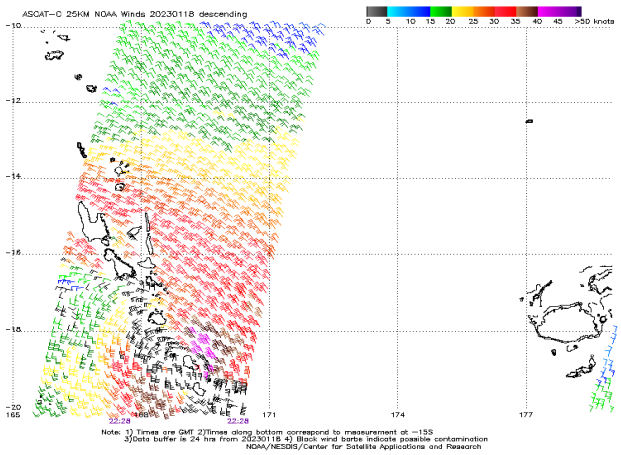


Fig 10: above shows the wind structure of TC Irene whlist being a Category 2 system at 182238UTC.

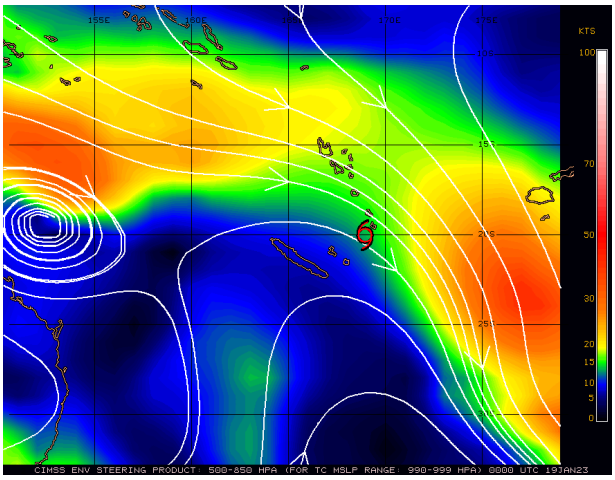


Fig 11: Movement of TC Irene changed to southeast due to deep mean steering of western periphery of subtropical ridge.

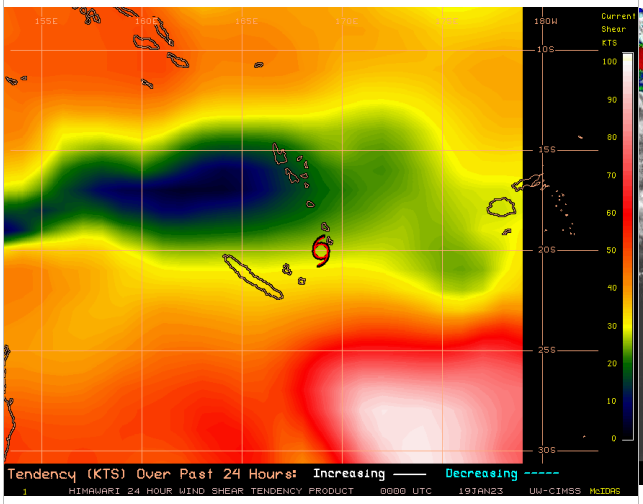


Fig 12: TC Irene moving southeast into an area of increasing shear which weakened the system.

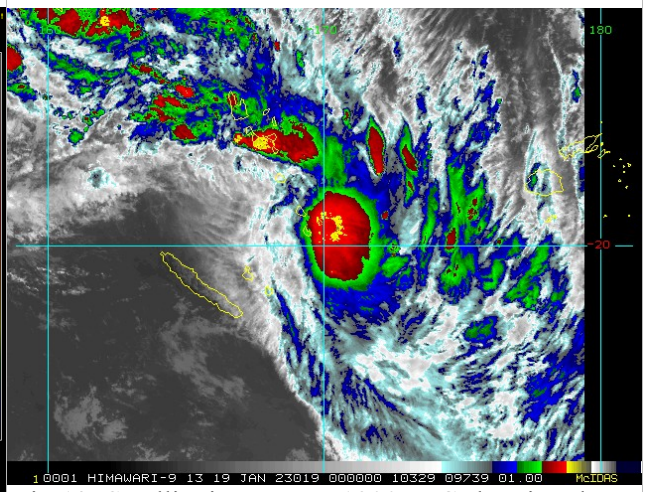


Fig 13: Satellite imagery at 1900UTC showing deep convection mostly to the east of low level circulating center with partially exposed LLCC.

As Irene moved south of 20 degree latitude, the system weakened to a category 1 cyclone due to moderate to high shear affecting the system with a strong northwesterly shear (Figure 15), the low level circulating center was partially exposed (Figure 14 and 17) with the strong upper divergence displaced to the southeast of LLCC (Figure 16).

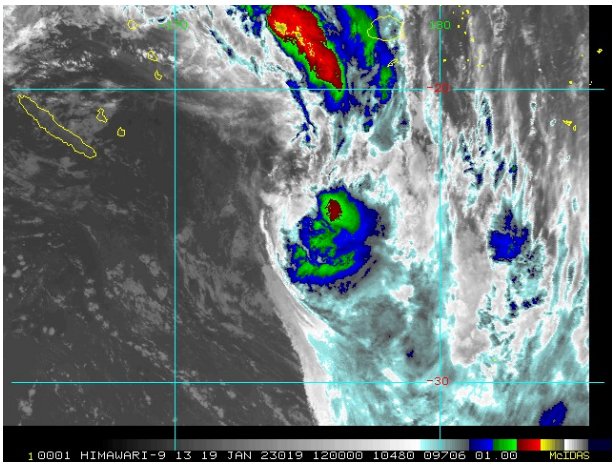


Fig 14: Himawari satellite imagery at 191200UTC with partially low level circulating center near 23.3S 174.4E.

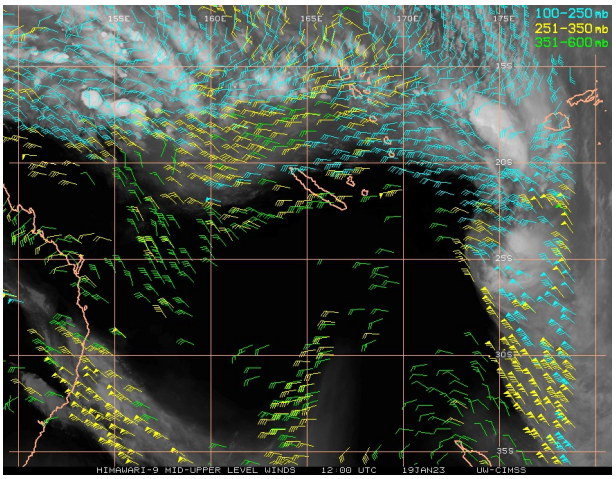


Fig 15: Strong northwesterly winds with approaching upper trough weakening the system at 191200UTC.

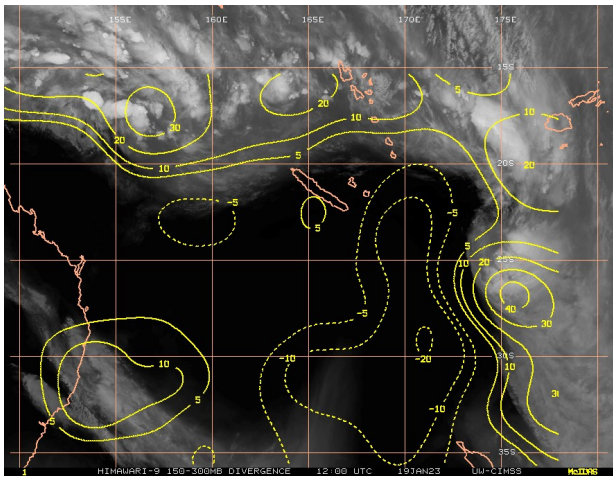


Fig 16: Strong upper divergence to the southeast of low level center at 191200UTC.

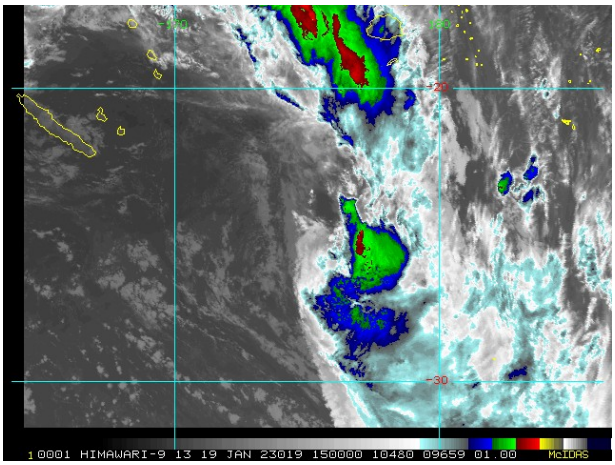


Fig 17: Himawari satellite imagery at 191500UTC with exposed low level circulating center moving southeast before crossing 25S.

Irene remained a category 1 Tropical Cyclone whilst moving into area of high shear before exiting RSMC Nadi's area of responsibility by 191800UTC. The Dvorak restrictions for weakening systems kept Irene as a Category 1 although it was rapidly weakening due to high shear.

3.0 IMPACTS

Irene caused damages to the the southern islands of Vanuatu especially over the Tafea and Shefa province (Figures 18 & 19 below). According to media sources, continuous torrential rain caused widespread flooding (flash flooding), road closures, landslides on Thursday, January 19. Forecasted winds of 100 kilometers per hour(km/hr) or 55 knots close to the center with gusts of up to 140km/hr or 75 knots affected the southern islands of Vanautu causing damages mostly to trees, gardens, few temporary buildings, roofing iron blown away and power cuts. The category 2 system also caused all international and domestic flights to be cancelled for safety reasons.

Fig 18: Fallen trees and damaged gardens in the Tafea and Shefa Province.

Fig 19: Widespread flooding in Port Vila during TC Irene.

4.0 OBSERVATIONS

Station	Lowest Pressure & Time (UTC)	Maximum Winds	24 Hours Rainfall received
Baufield	994hpa @ 181800UTC	32023G52kt	81.3mm
White Grass Airport	996hpa @ 182000UTC	04015G25kt	149.6mm
Aneityum	998hpa @ 181600UTC	09015kt	108.9mm

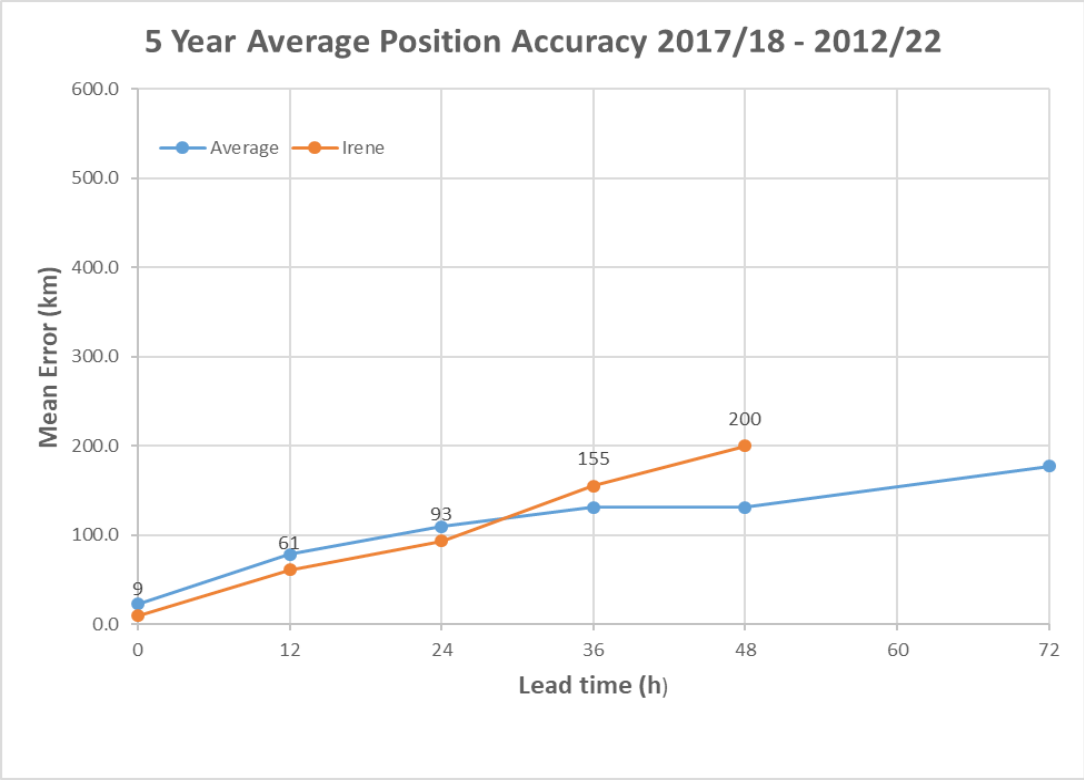
Tabulated above are significant weather observations received courtsey of Vanuatu Meteorology, from weather stations especially over southern Vanuatu close to TC Irene's track on the 19th of January 2023.

The large 24-hour rainfall amount received from the 3 stations resulted in the reported flooding over these regions.

The anticipated category 2 wind intensity of winds strength between 48 to 63 knots was not observed as shown in the table above as winds of only 20kt, 15kt and 08kt intensity was recorded. Something is amiss especially for White Grass and Aneityum observations as the 2 stations were very close to the track of TC Irene center and wind intensity observed were nowhere close to the forecasted Category 2 system wind intensity as shown below. Enquiries sent to Vanuatu Meteorology in regards to these observations remain unanswered to date.

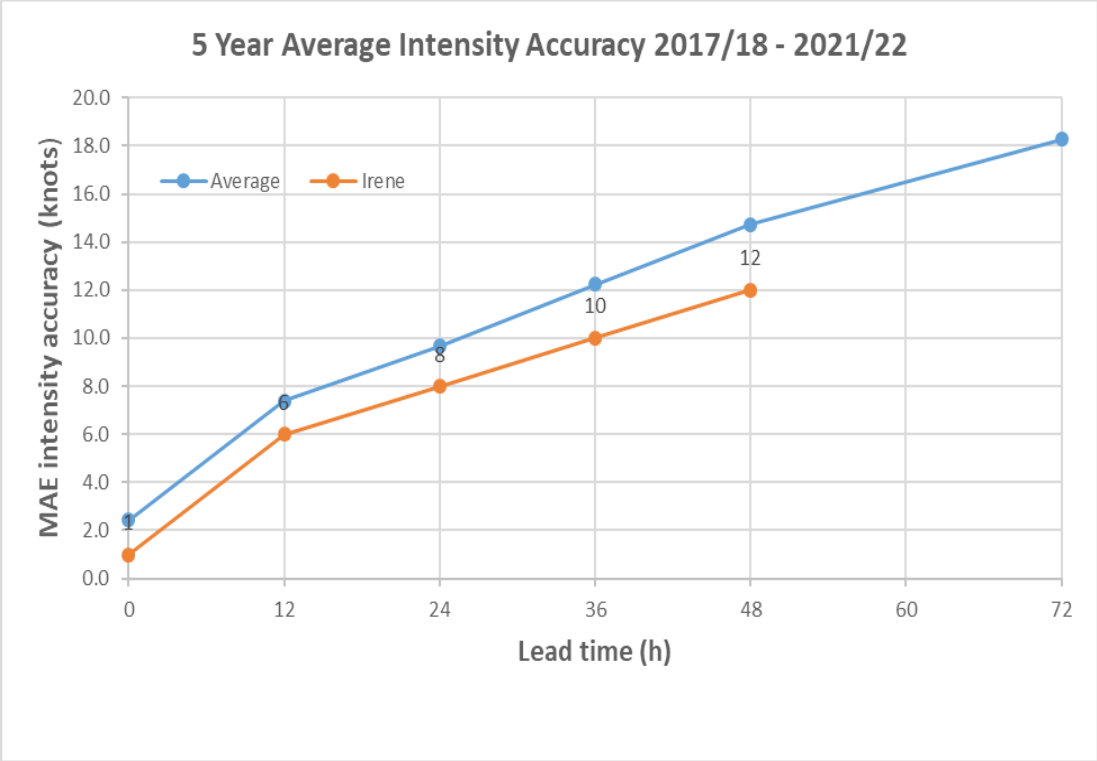
5.0 FORECAST PERFORMANCE

5.1 Mean Position Error



The figure above shows the mean error position forecast for TC Irene (in orange) and the 5-year average position (in blue). Irene's mean position average was better in the first 30hrs forecast position than the 5-year average position accuracy from the 2017/18 to 2021/22 TC Season. This is a good indication of proper analysis and accuracy up to the 36-hour forecast. The track position error for Irene was slightly more than the 5 years average in the 36 hours forecast position and increased significantly up to the 48 hours mean error position. The large positional errors beyond the 36 to 48 hours forecast period is due to the change in the steering influences as earlier explained in the Meteorological descriptions due to the streering influences on TC Irene, i.e. the shift from the near-equatorial ridge(NER) to the subtropical ridge(STR) and the effect of the northwesterly flow ahead of the upper trough.

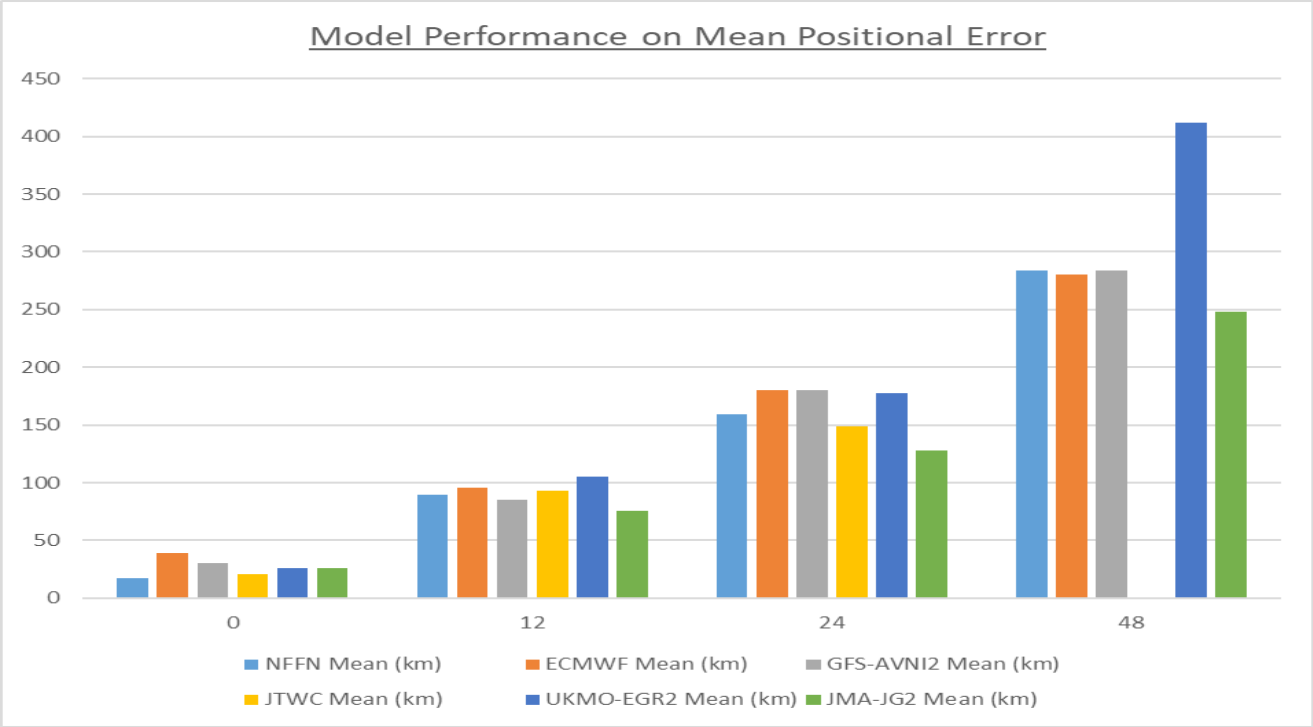
5.2 Mean Intensity Error



The figure above shows the forecast intensity errors for TC Irene (orange) was also better than 5-year mean intensity accuracy (blue) from 2017/18 to 2021/22 TC Season. This is also a good indication of proper and thorough Dvorak analysis being done during analysis time and also to forecast intensity for Irene considering the evolving environmental conditions the tropical cyclone was subjected to.

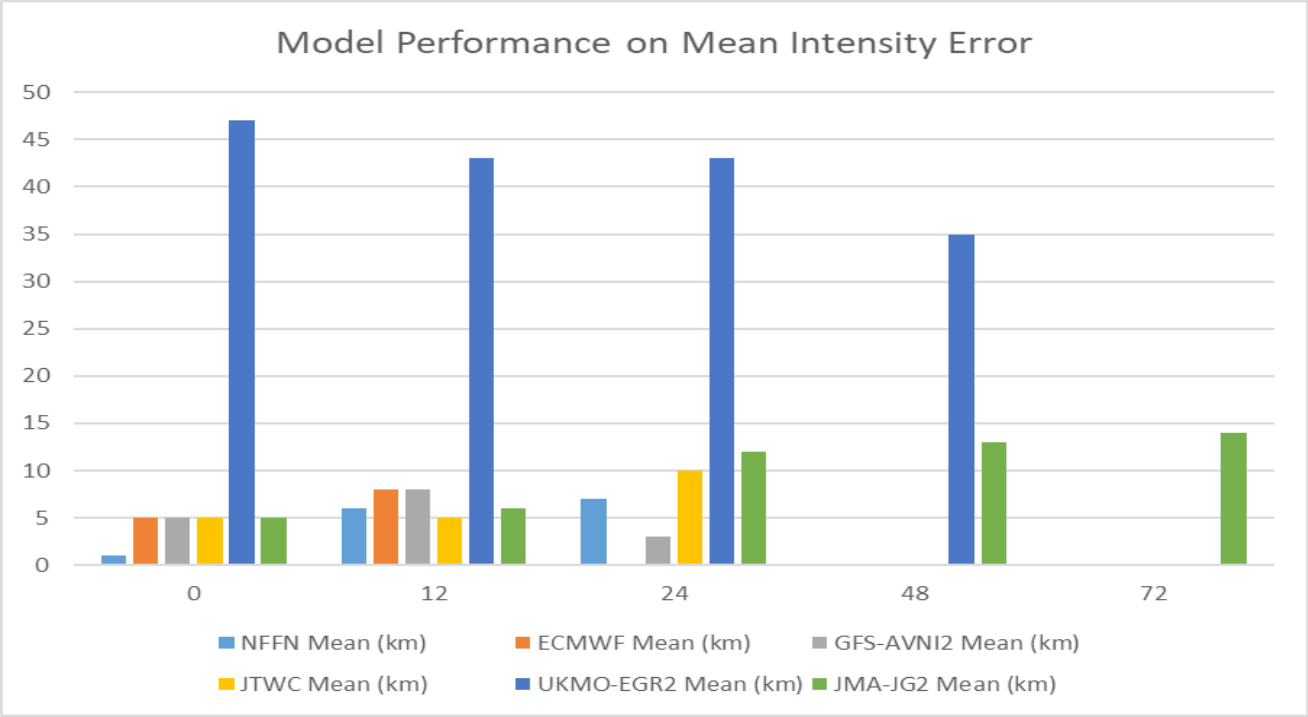
6.0 MODEL PERFORMANCE

6.1 Mean Position Error



The plot above shows the comparision of the Official forecast track (NFFN) together with the global models on the mean positional error verification. It can be noted that NFFN performed well against the European (ECWMF), American (GFS-AVNI2) & JTWC, English(UKMO-EGR2) and Japanese(JMA-JG2) at 0 hours with the least minimum error (17km) and averagely well (90km) at the 12hour period compared to the other models. The Japanese(JMA-JG2) model proved to be the best with minimum positional error between the 12 and 24-hour period positional forecast with about 75km and 128km respectively compared to NFFN and other global models. JTWC was on the dot on the 48-hour period with nil positional error. NFFN performed well within the the ranges of the 0hr, 12hr, 24hr and 48hr mean positional error forecasts in comaprision to the other global models.

6.2 Mean Intensity Error



The plot above shows the mean intensity error of Global models compared with the NFFN Official forecast intensity. NFFN performed very well at the 0-hour mark and averagely well at the 12-hours forecast period. At the 24-hour period, ECWMF was excellent with nil mean intensity error. Beyond the 24-hour mark, NFFN, ECWMF, GFS-AVNI2 and JTWC all did well in terms of intensity with nil mean intensity error. Throughout the plot, the English(UKMO-EGR2) performed poorly with the over-forecasting of wind intensity during the 0hr, 12hr, 24hr and 48hr.

7.0 CONCLUSION

- The NFFN mean error position forecast was better than the 5-year mean position average up to the 30-hour forecast position. The mean error position forecast got slightly more than the 5-year average in the 36-hour mark and increased significantly beyond 36 to 48 hours which indicates a Poor mean error position beyond the 36 hours forecast.
- The NFFN forecast intensity error for Irene was better than the 5-years average.
- The intensity forecasts for Irene performed well in relation to other Global models which is a good indication of thorough analysis considering the environmental conditions with the model data.
- From the model performances, JMA did well in terms of the mean positional error and all models performed well in terms of mean intensity error except for UKMO which performed poorly all throughout the 72-hours period.
- Wind observations received from Vanuatu Meteorology in regards to White Grass and Aneityum weather stations was a suspect as both stations were very close to the track of TC Irene with the recorded winds not even close to the anticipated mean wind intensity of a Category 2 system.
- The use of satellite data with the available surface observations were major components in performing Dvorak analysis, locating the center positions and movement of TC Irene. The majority of the tropical cyclone warnings, advisories and track maps were prepared in TC Module which allowed considerable time saving and minimal constraints.
- The tracking and forecasting of Tropical Cyclone Irene was handled very well by RSMC Nadi in the first 30 hour forecasts of position and 48 hours of intensity forecasts, i.e. considering the 5-year mean position and intensity average.

8.0 INTERNATIONAL BEST TRACK FORMAT

Name	YYYY	MM	DD	HHHH	LAT	LON	PRES	W(KT)	CAT
DEPRESSION	2023	01	18	0000	-17.6	161.6	997	30	0
DEPRESSION	2023	01	18	0300	-17.7	162.0	996	30	0
IRENE	2023	01	18	0600	-17.8	163.1	995	35	1
IRENE	2023	01	18	0900	-18.0	164.1	990	40	1
IRENE	2023	01	18	1200	-18.4	165.3	987	45	1
IRENE	2023	01	18	1500	-18.8	166.7	985	50	2
IRENE	2023	01	18	1800	-19.3	168.1	980	55	2
IRENE	2023	01	18	2100	-19.6	168.9	980	55	2
IRENE	2023	01	19	0000	-19.9	169.6	985	50	2
IRENE	2023	01	19	0300	-20.7	170.8	987	45	1
IRENE	2023	01	19	0600	-21.4	171.7	987	45	1
IRENE	2023	01	19	0900	-22.5	173.2	990	40	1
IRENE	2023	01	19	1200	-23.3	174.4	993	35	1
IRENE	2023	01	19	1500	-24.3	176.1	995	35	1
DEPRESSION	2023	01	19	1800	-25.1	177.5	997	30	0