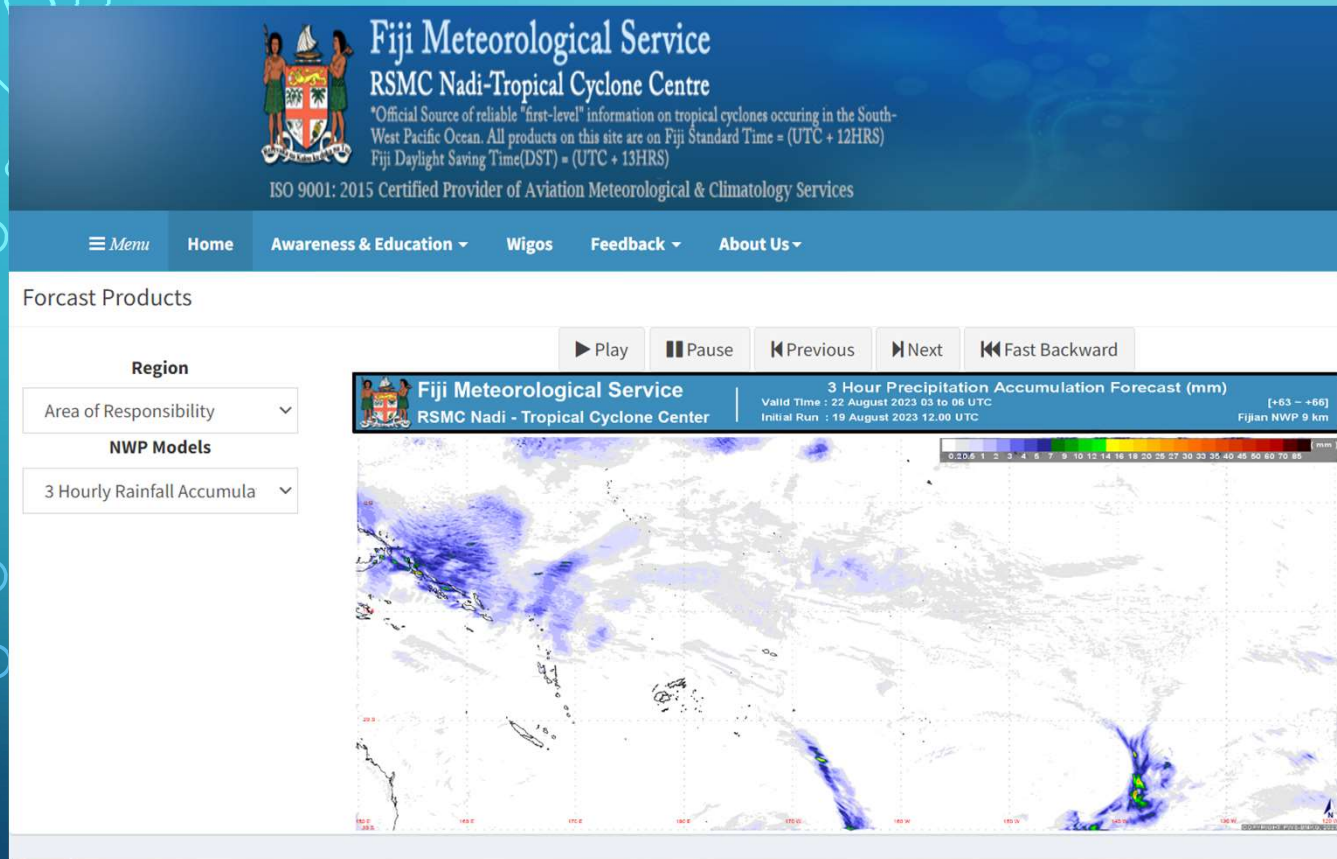# 13TH ASIA OCEANIA METEOROLOGICAL SATELLITE USERS CONFERENCE

PRESENTER: SOWNAL CHAND

FIJI METEOROLOGICAL SERVICES

TITLE: REGIONAL NWP MODEL FOR PREDICTION OF ADVERSE WEATHER CONDITIONS AND NOWCASTING

- Atmospheric Modelling, Artificial intelligence and the advancement in technology has made meteorologist work more easier and a wide variety of guidance for forecasting and daily weather updates.

BACKGROUND – NWP INITIAL SETUP PLANS AND PHASES

- This project is being carried out in collaboration with BMKG Indonesia NWP experts and Fiji Metservice with the support from WMO.

- Initial phases were on NWP modelling for administrators and forecasters

- Phase I and II was on knowledge and expertise required in installation and running of WRF Model.

- Phase III and IV – Model running and verification of model data

WMO-BMKG-FMS COLLABORATION ON NWP MODELLING AND HWRF SETUP AT FMS HEADQUARTERS IN NADI, FIJI ISLANDS

- High Processing Computing System was installed at the FMS headquarters for running the High Resolution Weather Research and Forecasting Model.

- Lenovo HPC/BMKG experts were able to install and provide expert knowledge on HPC and its administration process.

- WRF Model installed and running at the FMS Headquarters

WRF/HWRF SETUP

- Weather Research and Forecasting (WRF) model from National Center for Atmospheric Research (NCAR), the National Oceanic and Atmospheric Administration (represented by the National Centers for Environmental Prediction (NCEP) and the Earth System Research Laboratory), the U.S. Air Force, the Naval Research Laboratory, the University of Oklahoma, and the Federal Aviation Administration (FAA) was used to create basic model for the Tropical Southwest Pacific Region

- High Resolution Weather Research and Forecasting Model – in collaboration with WMO-BMKG

- Basic two dynamical setup is implemented and currently running at FMS HQ in Nadi.

- Phase I Feasibility Study 2021, Phase II Planning & Training of Adminisrators 2021-2022 of the NWP modelling has completed thanks to WMO, BMKG trainers, Phase III Regional Model implementation,

- Currently underway, Phase IV Model verification

- Next Phase V Data Assimilation and Bias correction to suite the regional models data accuracy and validity.
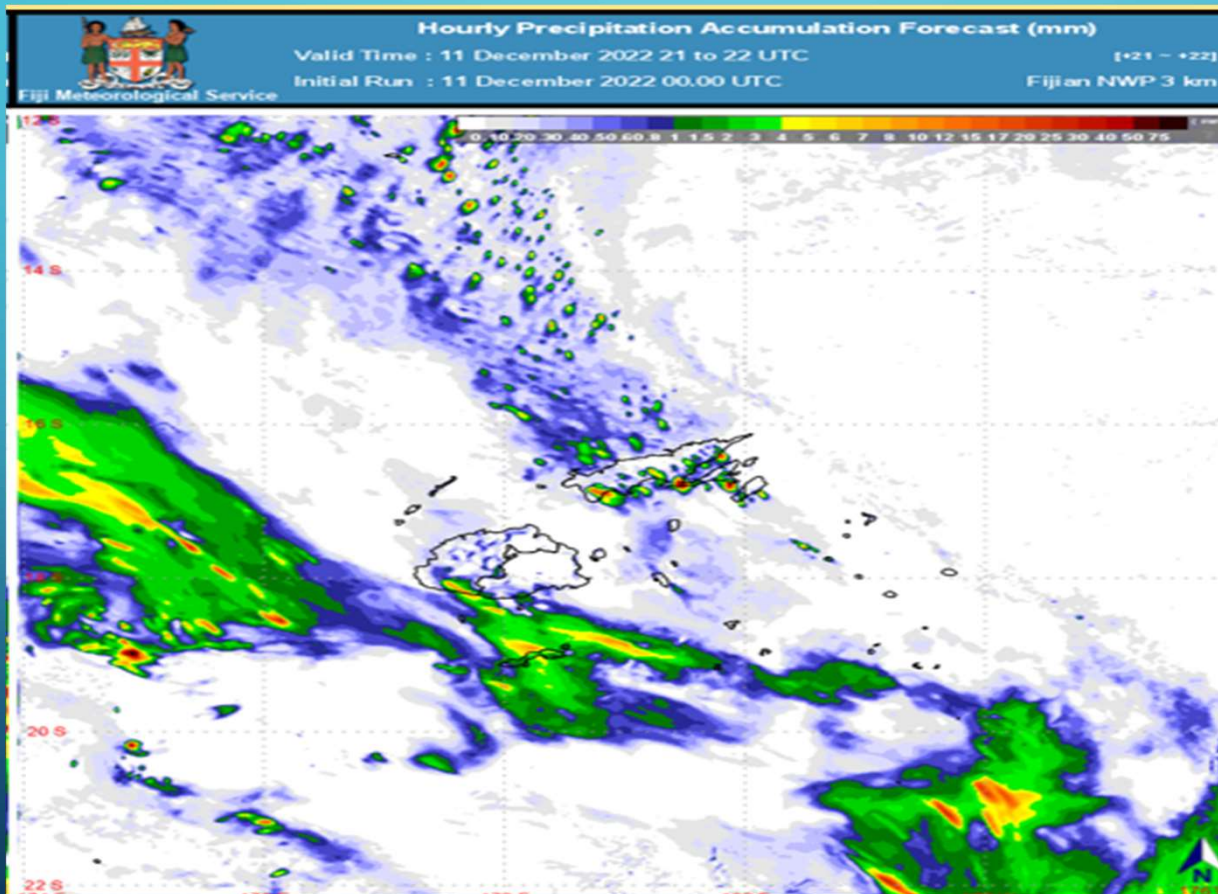
DOMAINS

- Regional Domain - 9km High Resolution [150E to 125W, 05N to 35S

- Input data GFS to capture global atmospheric signatures
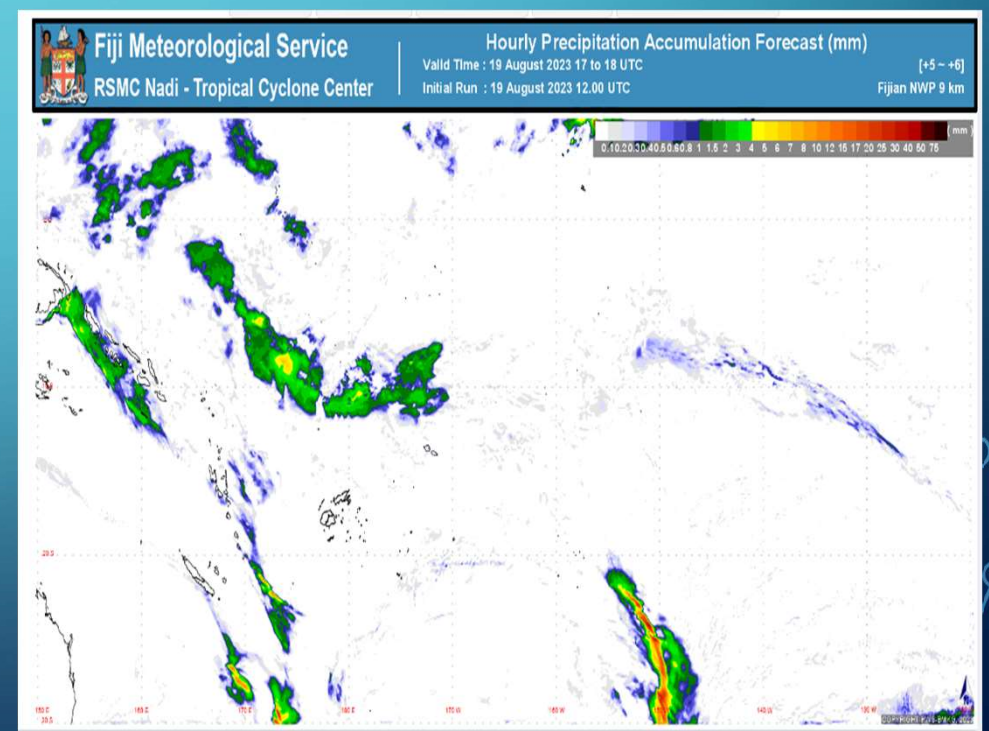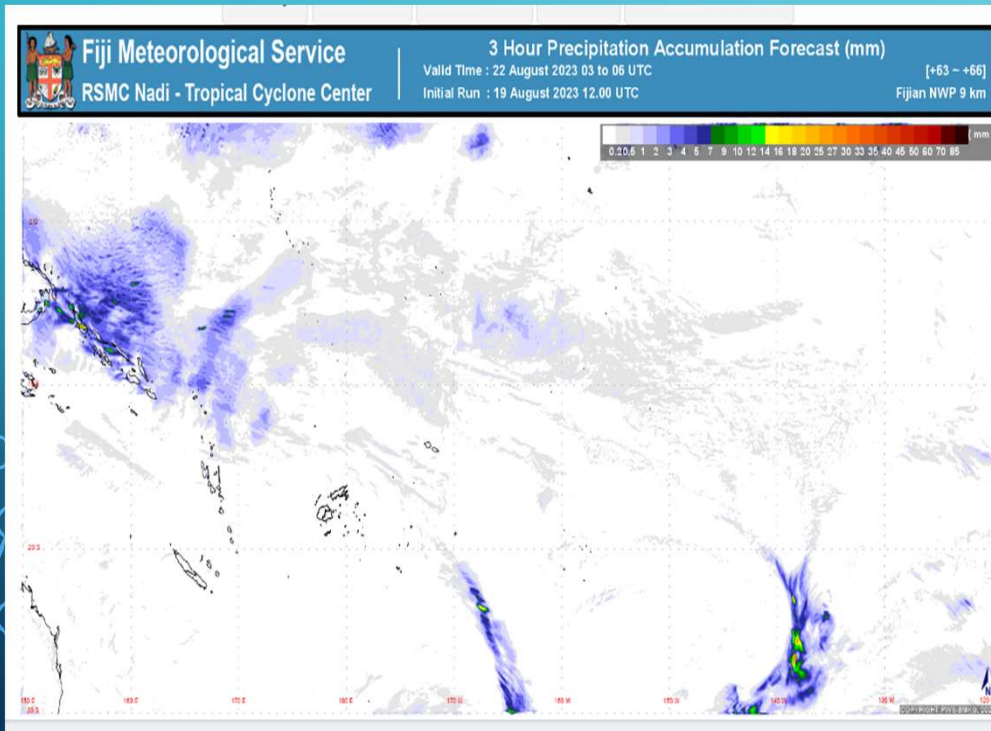
NESTED DOMAIN - FIJI AND ROTUMA

- Fiji Domain – 3km High Resolution, Nested Domain for Fiji and Rotuma region

PROBLEM STATEMENT – DETECTION OF ADVERSE WEATHER CONDITIONS IN FIJI ISLANDS

- Fiji Metservice provides alerts and warnings to the regional countries which are smaller than the actual size of a grid .

- Intensity of events (Heavy Rain, Strom surges, Inundation) has impacted these countries causing damage to infrastructure and lives of people.

- People have lost life, livestock, vegetables and crops. Loss to economic development and economic growth.

- Regional Models will assist in prediction of the events more accurately and will also assist them to take action well in advance in terms of disaster preparedness.

PROPOSAL PLAN

- Proposed plan was to develop regional weather analysis and nowcasting model which can predict these adverse weather well in advance and provide alerts and warnings at least a week in advance for the Disaster Managers to act accordingly.

- Regional model with the assistance of actual observation/data assimilation will improve nowcasting for such event.

- Realtime and early detection of adverse weather conditions can assist a lot of the sectors in the islands and improve the overall productivity and economic growth of the nation.

CASES STUDIES OF ADVERSE WEATHER CONDITIONS CAPTURED BY THE FIJIAN HWRF MODEL

- Background – Case study 1 (19th Dec,22 till 06 Jan 23)

- Data was obtained from National Weather Forecasting Center's Climate Division QDC and used to generate observed interpolated precipitation maps to compare with JAXA GSMap (time averaged precipitation maps) and NWP Forecasted Maps for similarity, accuracy and verification of NWP Model Precipitation Product for better understanding the Fijian NWP HWRF model.
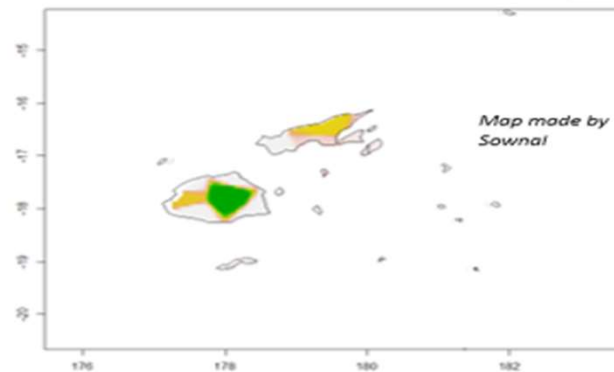
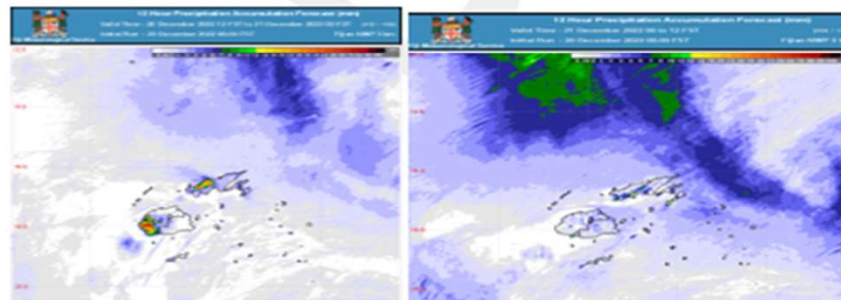# RESULTS

19TH DEC 2022

GSMap on the 19th of Dec, 2022
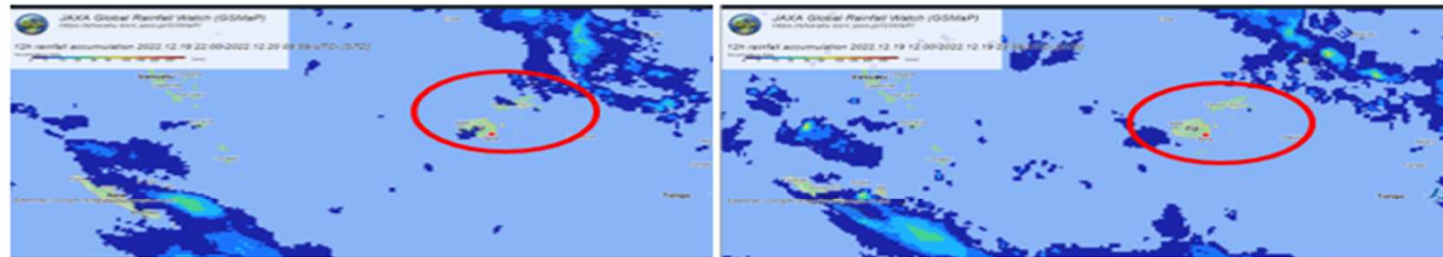
Station Rainfall on the 19th of Dec, 2022

Map made by Sownal

Station	Latitude	Longitude	Rainfall
Labasa	-16.43	179.36	3.7
Laucala	-18.15	178.45	0
Lautoka	-17.6	177.45	0
Levuka	-17.68	178.83	0
Matei	-16.69	180	0.2
Matuku	-19.15	179.76	0
Nabouwalu	-16.98	178.7	0
Nacocolevu	-18.1	177.55	0
Nadi	-17.75	177.45	3.4
Nausori	-18.03	178.56	0
Ono-I-Lau	-20.65	178.7	5.9
Penang	-17.37	178.15	0
Savusavu	-16.78	179.34	0.6
UduPoint	-16.11	181	0
Viwa	-17.14	176.93	0
Yasawa	-16.78	181.3	0
Monasavu	-17.75	178.05	8.2

NWP Model Forecast Map on the 19th of Dec, 2022

GSMap, NWP indicated the trough approaching the group from the northeast.
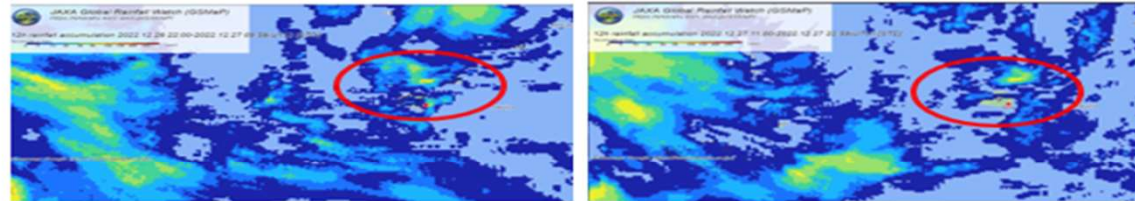
Precipitation maps shows few rainfall ranging from 0 till 9mm.

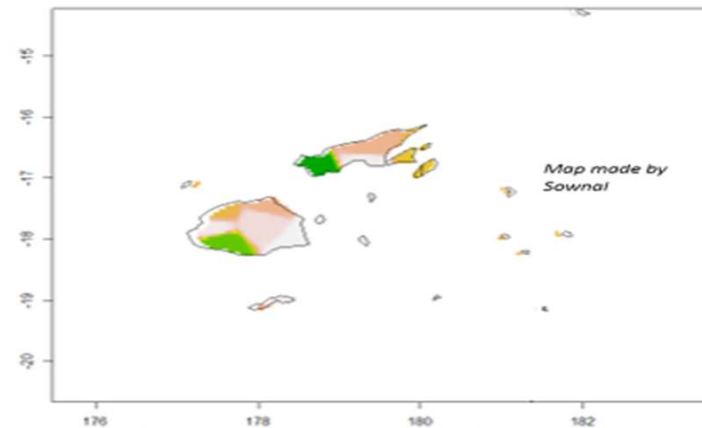Similar rainfall range is also picked up by the NWP Map on the 19th of December.

Also noting the afternoon convection shown on the IDW.

# 27TH DEC 2022

Jaxa GSMap for 27th Dec, 2022

Station Rainfall on the 27th of Dec,2022

Map made by Sownal

station	Latitude	Longitude	Rainfall
Labasa	-16.43	179.36	2
Laucala	-18.15	178.45	0
Lautoka	-17.6	177.45	3.5
Levuka	-17.68	178.83	0
Matei	-16.69	180	4
Matuku	-19.15	179.76	0
Nabouwalu	-16.98	178.7	10
Nacocolevu	-18.1	177.55	7.5
Nadi	-17.75	177.45	0.2
Nausori	-18.03	178.56	0
Ono-I-Lau	-20.65	178.7	0
Penang	-17.37	178.15	2
Savusavu	-16.78	179.34	0.1
UduPoint	-16.11	181	0
Viwa	-17.14	176.93	1.1
Yasawa	-16.78	181.3	3.5
Monasavu	-17.75	178.05	0.5

NWP Forecasted Map on the 27th of Dec, 2022
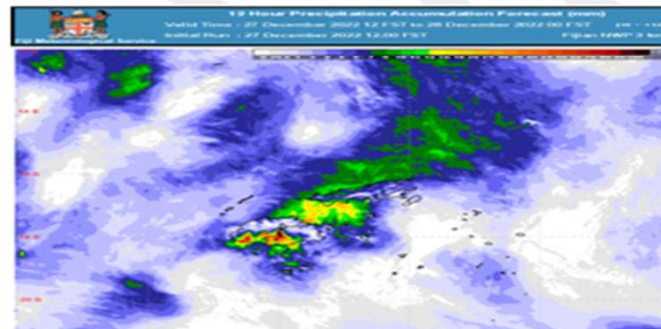
The model output and the GSMap shows exactly the same amount of precipitation and the condition are also exactly the same.

The Range of the precipitation is also seen to be the in the range of 2mm till 12mm.

One importance thing to not is the meteorological stations not reporting any significant data in these areas, it need to be look at closely as why this is happening.
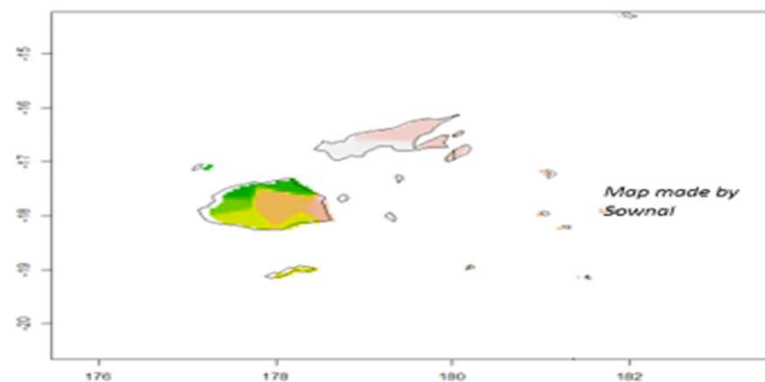
The IDW map also depletes the rainfall as corresponding to the NWP model and the GSMap data.

30TH DEC 2022

Jaxa GSMap for 30th Dec, 2022
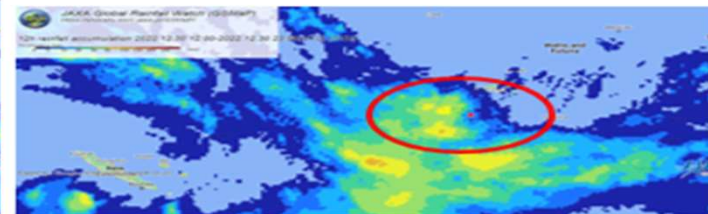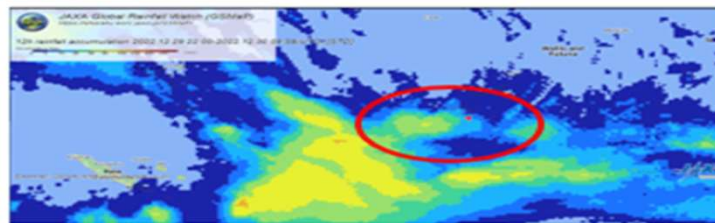
Station Rainfall on the 30th of Dec,2022

Map made by Sownal

station	Latitude	Longitude	Rainfall
Labasa	-16.43	179.36	9.1
Laucala	-18.15	178.45	60.2
Lautoka	-17.6	177.45	110.5
Levuka	-17.68	178.83	0.5
Matei	-16.69	180	9.9
Matuku	-19.15	179.76	12.8
Nabouwalu	-16.98	178.7	0
Nacocolevu	-18.1	177.55	59.5
Nadi	-17.75	177.45	79.7
Nausori	-18.03	178.56	20.6
Ono-I-Lau	-20.65	178.7	33.1
Penang	-17.37	178.15	101.5
Savusavu	-16.78	179.34	0.6
UduPoint	-16.11	181	1.2
Viwa	-17.14	176.93	12.3
Yasawa	-16.78	181.3	22
Monasavu	-17.75	178.05	36

NWP Forecasted product on the 30th of Dec, 2022
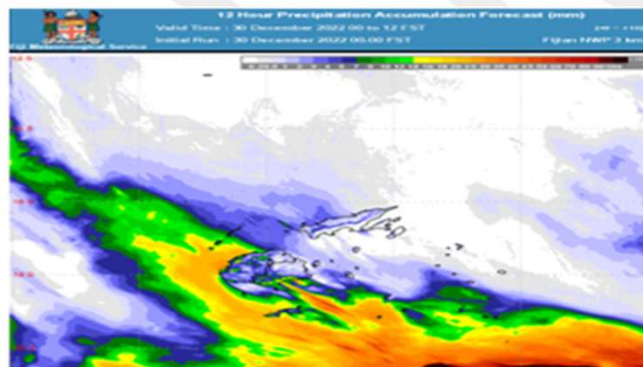
GSMap shows precipitation in the range of 100mm and also the NWP model output. The recorded rainfall in some stations has this as indicated in the table. Lautoka, Nadi, Penang stations recorded this events.
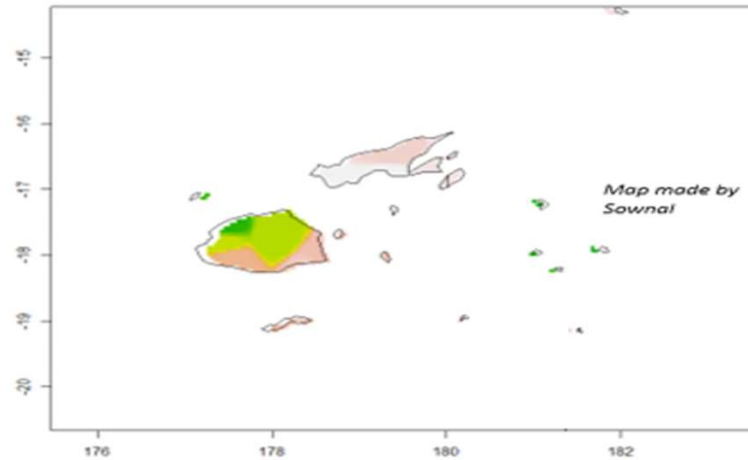
IDW maps also picks up the rainfall amounting to be in this range. It really good to see the data and the Forecasted maps giving accurate data.

# 3RD JAN 2023

Jaxa GSMap for 3rd Jan, 2023

Station Rainfall on the 3rd Jan,2023

Map made by Sownal

| station	Latitude	Longitude	Rainfall
Labasa	-16.43	179.36	10.5
Laucala	-18.15	178.45	13.8
Lautoka	-17.6	177.45	118.1
Levuka	-17.68	178.83	14
Matei	-16.69	180	3.8
Matuku	-19.15	179.76	10.4
Nabouwalu	-16.98	178.7	0
Nacocolevu	-18.1	177.55	27.2
Nadi	-17.75	177.45	74.2
Nausori	-18.03	178.56	18.1
Ono-I-Lau	-20.65	178.7	2.1
Penang	-17.37	178.15	78.5
Savusavu	-16.78	179.34	0
UduPoint	-16.11	181	0
Viwa	-17.14	176.93	14.9
Yasawa	-16.78	181.3	133
Monasavu	-17.75	178.05	78

NWP Forecasted Map on the 3rd Jan, 2023
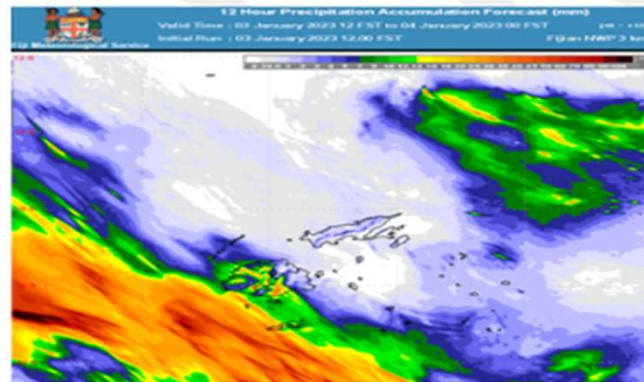
Central, western and eastern division received significant rainfall and has been clearly seen in the NWP model, GSMap and also the IDW interpolated data.

This is a good example of the data that we receive should be accurate so that when Data Assimilation phase of NWP modelling is done it will provide very accurate guidance to bench forecaster and can progress to now-casting in future.

CASE STUDY II – HEAVY RAIN CONDITION
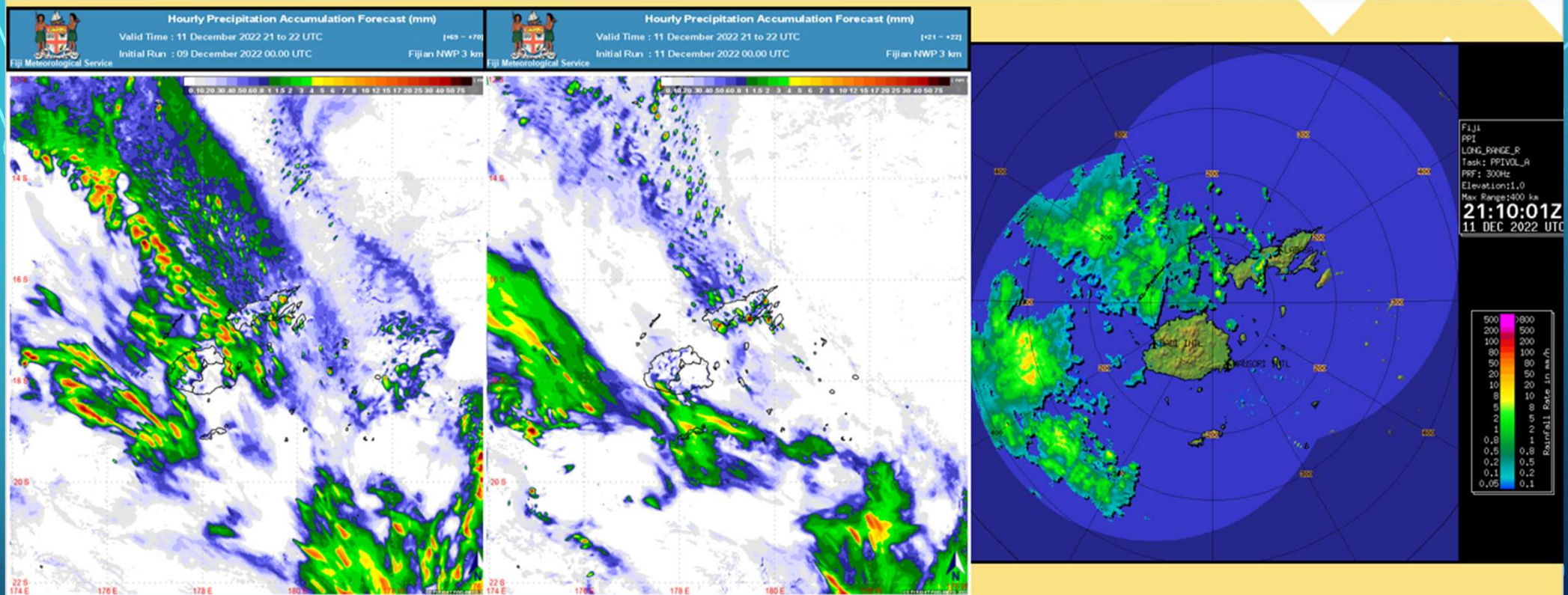
Significant rainband to west of Viti Levu well forecast. Rain area over Vanua Levu slightly offset to the west. This is likely due to the NWP position of the surface trough being located west of the actual. An overestimation trend is again evident in this time step. However, this may be a better indicator for potential heavy rainfall.
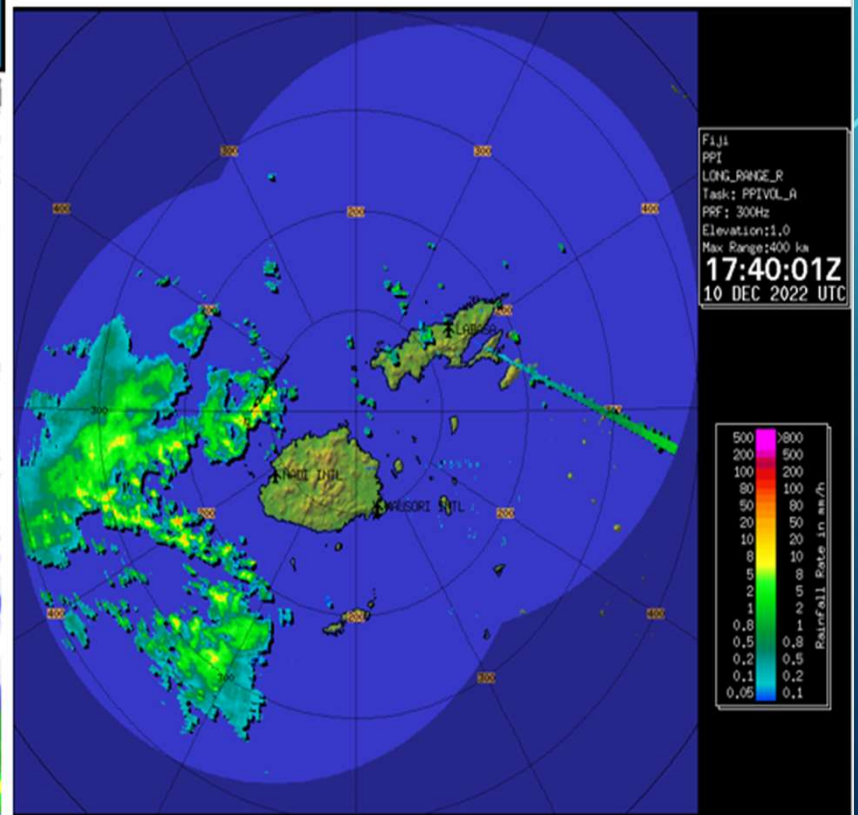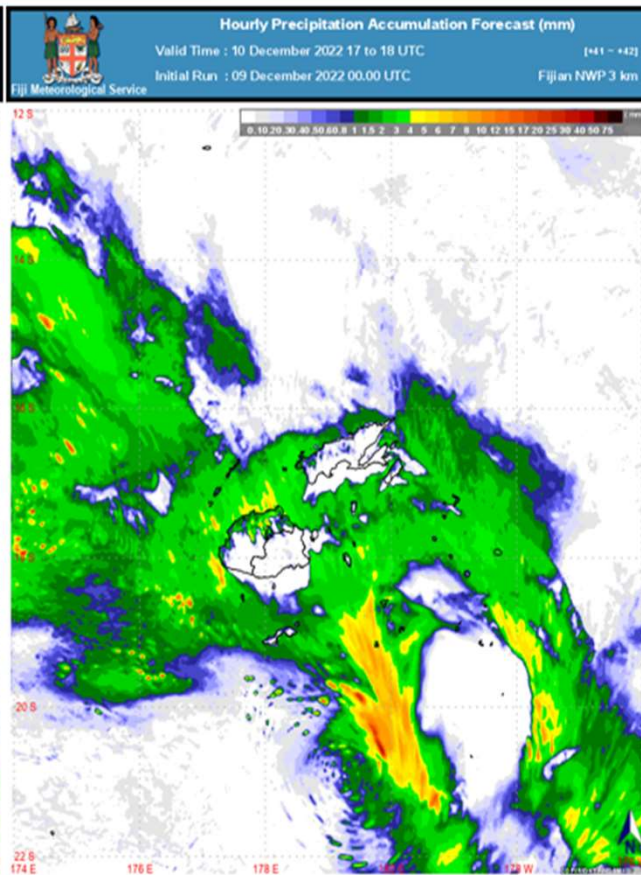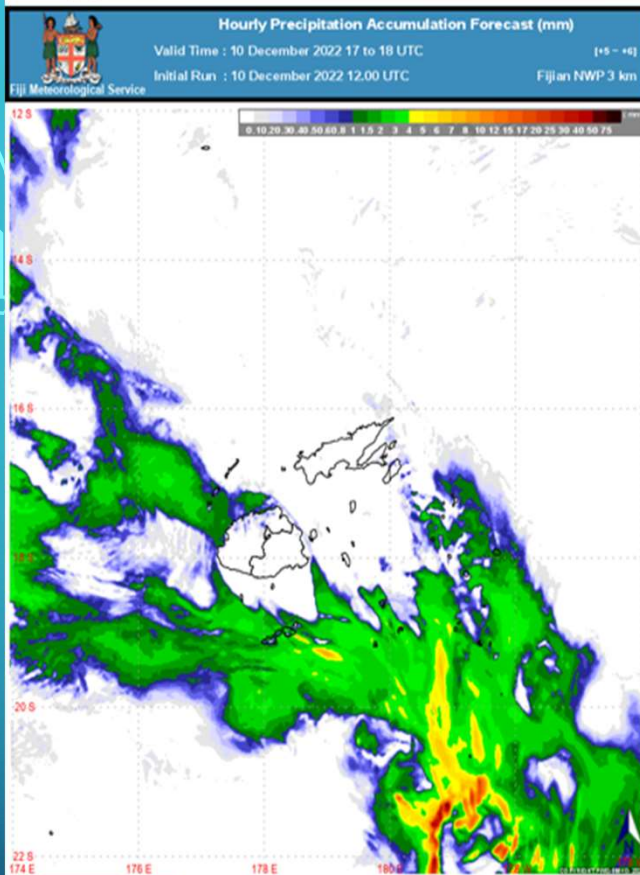
Well identified areas of rainfall, rain band west and south of Viti Levu. Rain coverage distinguished in the Yasawa group (Whole Yasawa group not affected in this timestep. Older model run has overestimated rainfall patterns. Note: Band on southeast of group not covered by radar.
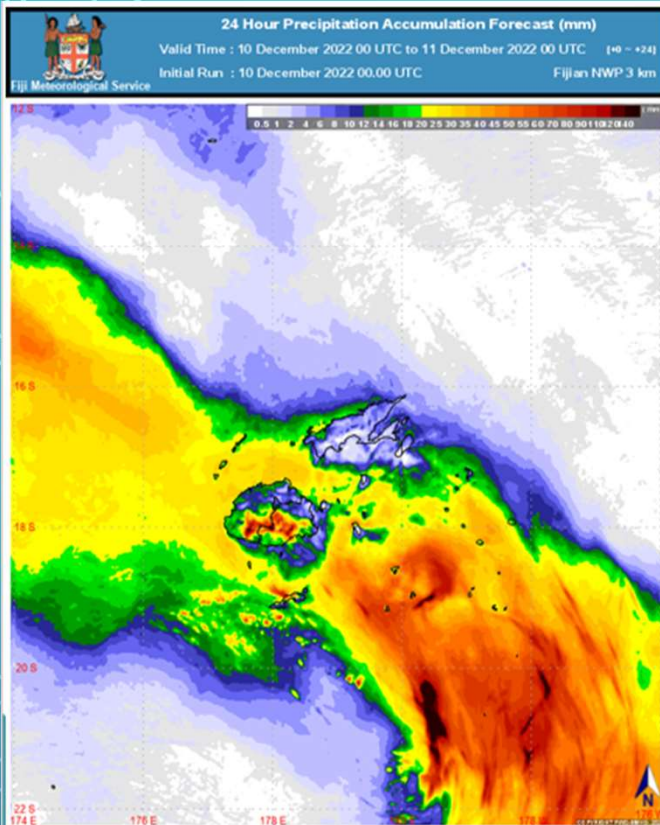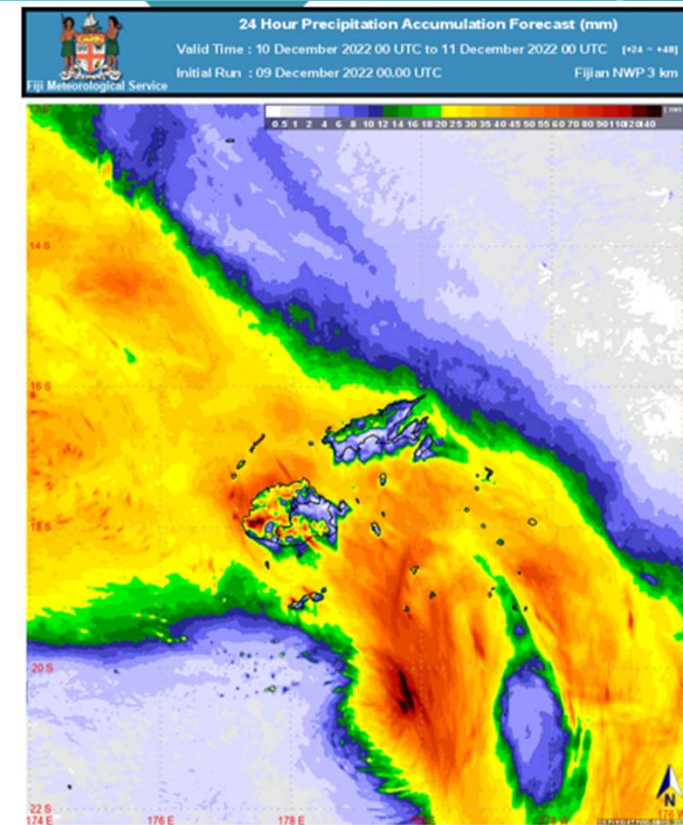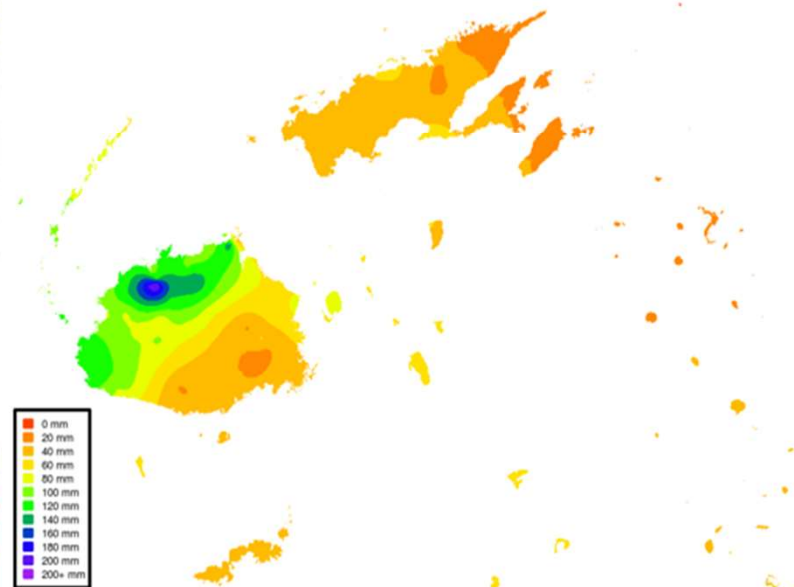
Interpolated rainfall data only available over land from surface observations. HWRF model identifies very less rainfall over Vanua Levu which agrees will with observations. However, Rainfall over Central division and interior of Viti Levu has been overestimated.

Note: Rainfall observation station density is not same for the entire country, and this may lead to some extreme figures.
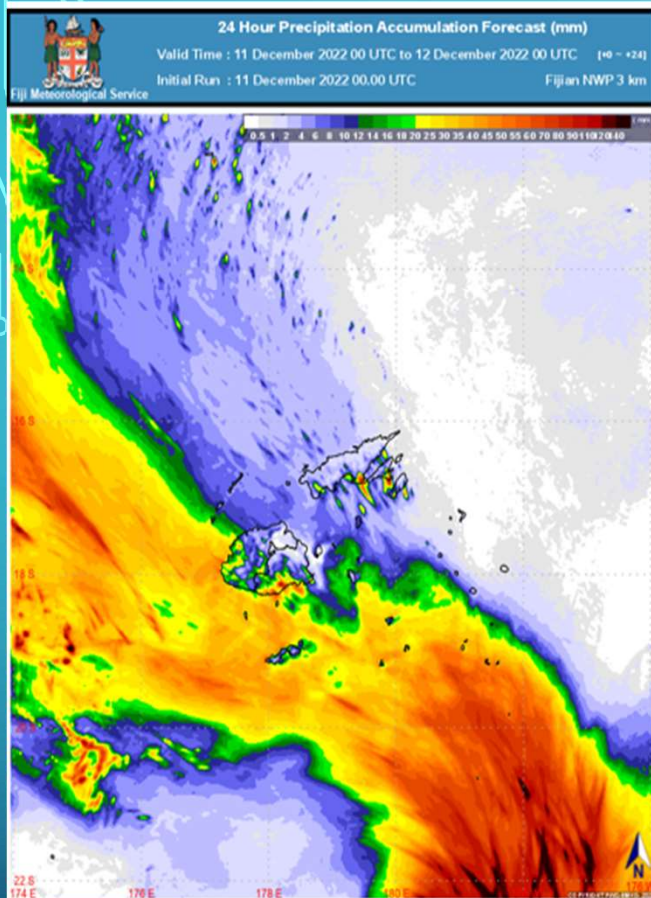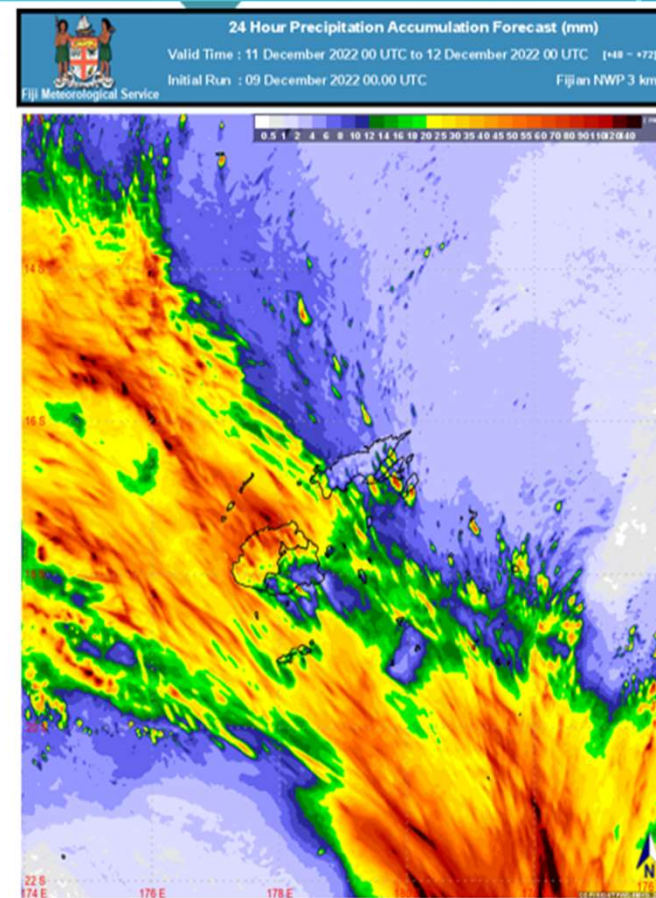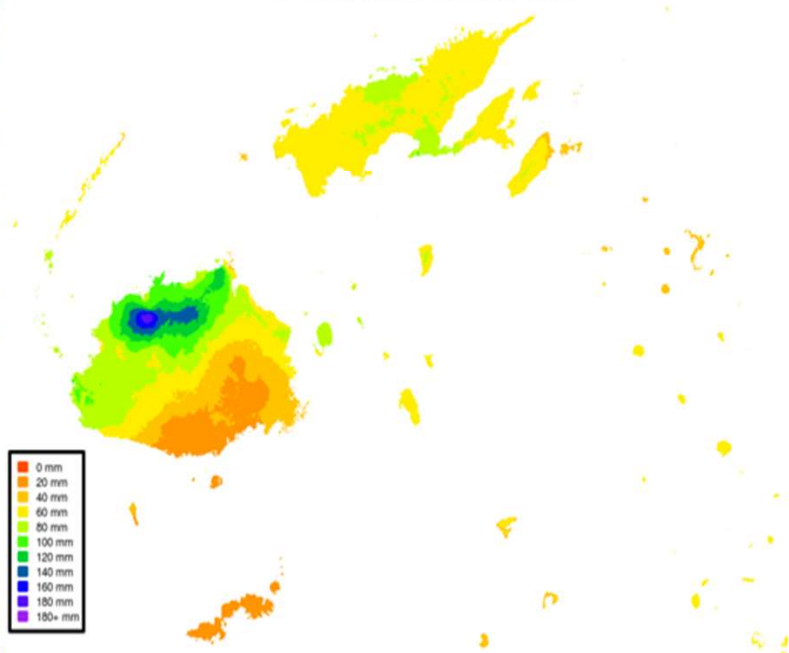
HWRF model identifies highest 24 hour rainfall in the central Division but observational data indicates maxima near Nadarivatu, Ba, Tavua area. Overall the total 24 hour rainfall was underestimated over land for this timestep.

Note: Rainfall observation station density is not same for the entire country, and this may lead to some extreme figures.

DAMAGE AND ASSESSMENT ON GROUND

FUTURE WORK

- HWRF for Tropical cyclone forecasting and analysis

- Data assimilation and Satellite data ingestion in the HWRF system

- Research on changing climate and weather for future seasonal prediction

CHALLENGES

- HPC Infrastructure and ICT requirements for better computing and upgrade of the systems

- Storages Capabilities

- Research funding and collaboration from Government Agnecies, Meteorological Institutions for better development of projects for the pacific island region.

- Collaborations from other NHMC for tailor made products and services

- Staffing/ NWP team building for future

QUESTIONS AND COMMENTS

- Thank you