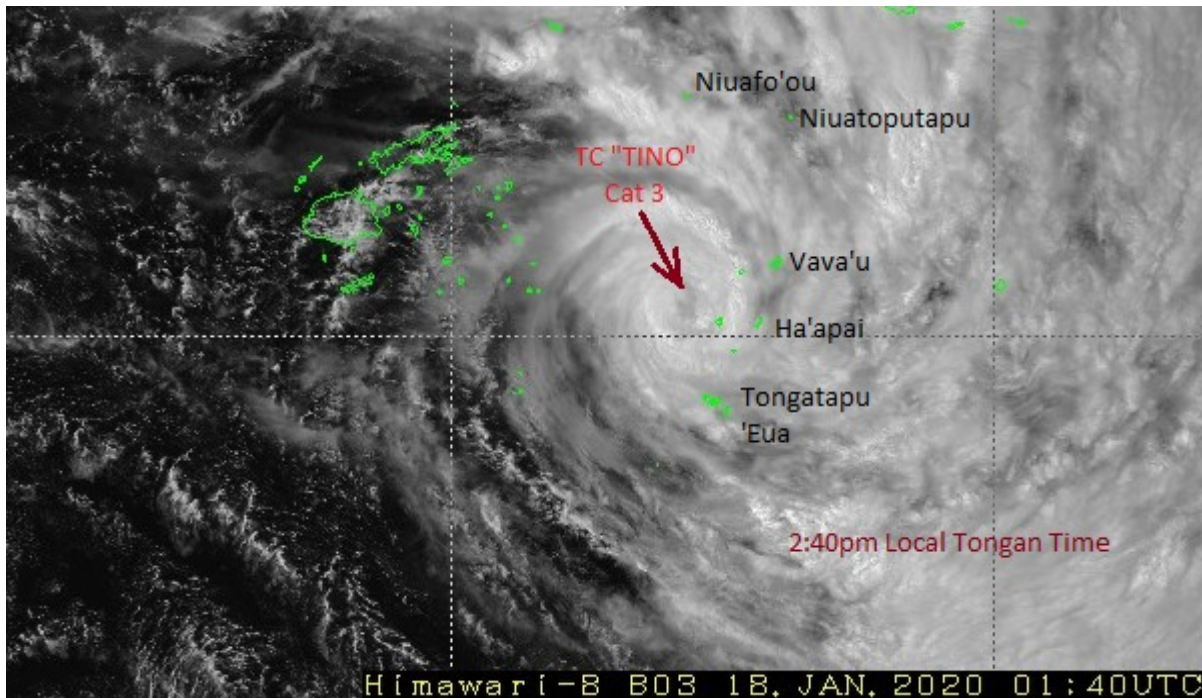


Meteorological report on
TROPICAL CYCLONE “TINO” (Category 3)
16th January 2020 – 19th January 2020



1. Introduction

Tropical Cyclone “TINO” (Category 3) was first developed into Tropical Disturbance 04F at 11:55am on 11th of January, 2020 and intensify into Tropical Cyclone Category 1 named “TINO” at 12am mid-night on the 17th of January. As the system move Southeasterly towards Ha’apai it was further intensify and upgrade to Category 2 at 1am on Saturday 18th of January, 2020 and Category 3 at 10am on the same day. Its forecast track maps stated that TC “TINO” was propagate East Southeastwards within the Northwestern peripherals of the Ha’apai Coastal Waters. TC “TINO” Category 3 was the third Tropical Cyclone to enter our Area of Responsibility (AOR) during Tropical Cyclone Season 2019/2020.

From its place of origin, it was noted that it was thriving in an area of favorable sea surface temperature ($>29^{\circ}\text{C}$) coupled with the moist Northwesterly wind burst converging with the Southeasterly trade winds into this favorable environment for growth of TD04F with the on-going support from the low Vertical Wind Shears (VWS).

TC “TINO” tracked in a more East to South-Easterly direction as it moved within the Fiji group for the 12-24hrs while it passed Rotuma and the Northern island of Vanua Levu group, then as it continued to move South it remained to the Eastern quadrants of Vanua Levu groups. It was noted that the system steered by the low to mid-level ridge at below 500hPa levels.

Once the system was located to the Southeast of Labasa, it was predicted that it would remain to take a more East Southeast direction and enter our AOR in the next 12-24 hours. At this point in time, Fua’amotu Tropical Cyclone Warning Center (FTCWC) was strategically activated at about 11:00am on 16th January 2020 as per our TC Standard Operating Procedures (SOP) of activating the FTCWC 48 hours prior to the radius of Gale force winds entering our AOR. Once FTCWC activated, the operational staff was rooster into two teams of 12 hours rotational shift and as such, we continued to provide Tropical Cyclone Advisories (TCAs). TC Alerts and Warnings issued for Tonga was at every six hours, three hours and advisories was updated more often prior to its movement closing into our AOR.

Majority of the warnings that were issued was of hurricane and storm, gale and strong winds, heavy rain and flash floods, heavy damaging swells and small craft advisory. These warnings was issued to respective island groups such as the Niuas, Vava’u, Ha’apai, Tongatapu, ‘Eua, Tele-ki-Tonga and Tele-ki-Tokelau land and coastal waters.

Tropical Cyclone Advisory for TC “TINO” was deactivated at 4pm on 19th January, 2020 as the radius of gale force winds was no longer evident in our AOR and the system itself (Ex-Tropical Cyclone “TINO”) continuing to move out from our AOR.

2. Dissemination of Advisories and Early Warning System

The Director for Meteorology (Mr. 'Ofa Fa'anunu) and the Director of NEMO (Mr. Mafua Maka), regularly updated the people on the latest TC information/updates of the system as well as providing advice in regards to their state of readiness and preparations before, during and after the event.

The meteorological briefings and interactions with the public based on the latest advisory was being broadcast live on air immediately after TCA was issued to the public. This is usual procedure of further advising the people to better understand and to take notice of the warnings for each of the Tropical Cyclone Alert and warnings being issued for public safety and preparation. These live broadcasts was carried out via AM Radio Tonga 1 & 2(A3Z/FM 90), FM87.5 and FM88.1, also the dissemination of advisories and warnings via our website, facebook page and the email distribution lists. In addition to this was the on-going direct question and answer session on the telephone line from the people of Tonga, basically from the Niuas, Vava'u, Ha'apai, Tongatapu and 'Eua. Communications between the FTCWC and the MET officers in the outer islands were updated on our VHF/HF radio frequencies, telephone and Facebook messenger. In additions, regular updates and communications was being carried out between the FTCWC and the NEMO office was primarily being done via the HF radio network.

The briefing of the National Emergency Committee (NEMC) was also amongst our priority responsibilities during our operations for TC "TINO". Director for Meteorology (Mr. 'Ofa Fa'anunu) carried out three (3) meteorological briefings to the NEMC during this event on the 16th, 17th, 18th and 19th January 2020. The core parts of these meteorological briefings were basically updating and explaining to the NEMC chair and members about the current situations and possible scenarios for Tonga with regards to the nature and movement of TC "TINO". Meteorological explanations for these scenarios and current situations of the system was briefed to the NEMC as a response to the question and answer sessions that followed each presentation.

3. Meteorological Analysis

Figure 3.1 Longwave analysis at 500hpa level (12am, 16th January 2020).

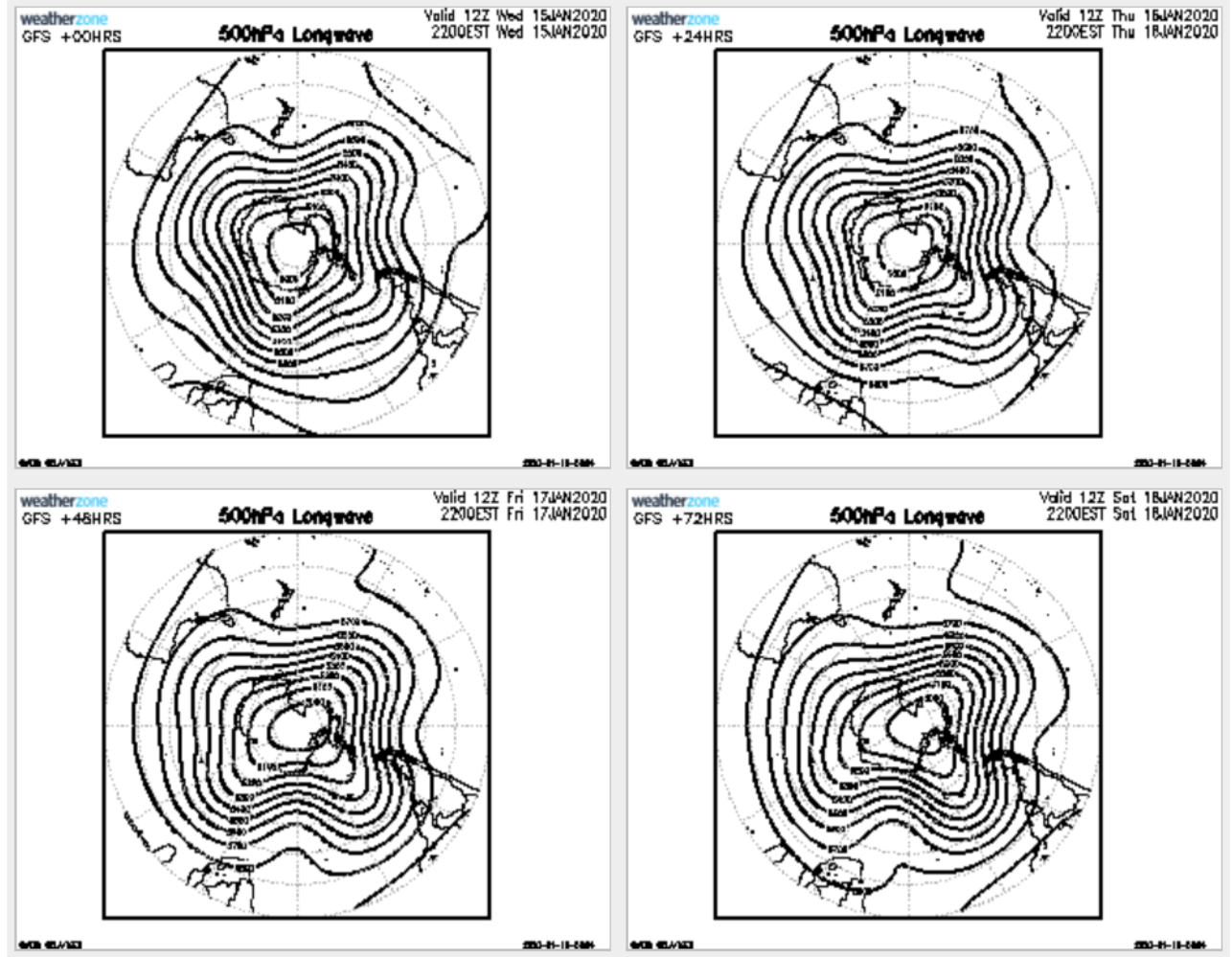


Figure 3.2 Steering flow analysis at low to mid-level ridge, NE of the system (7am, 17th January 2020).

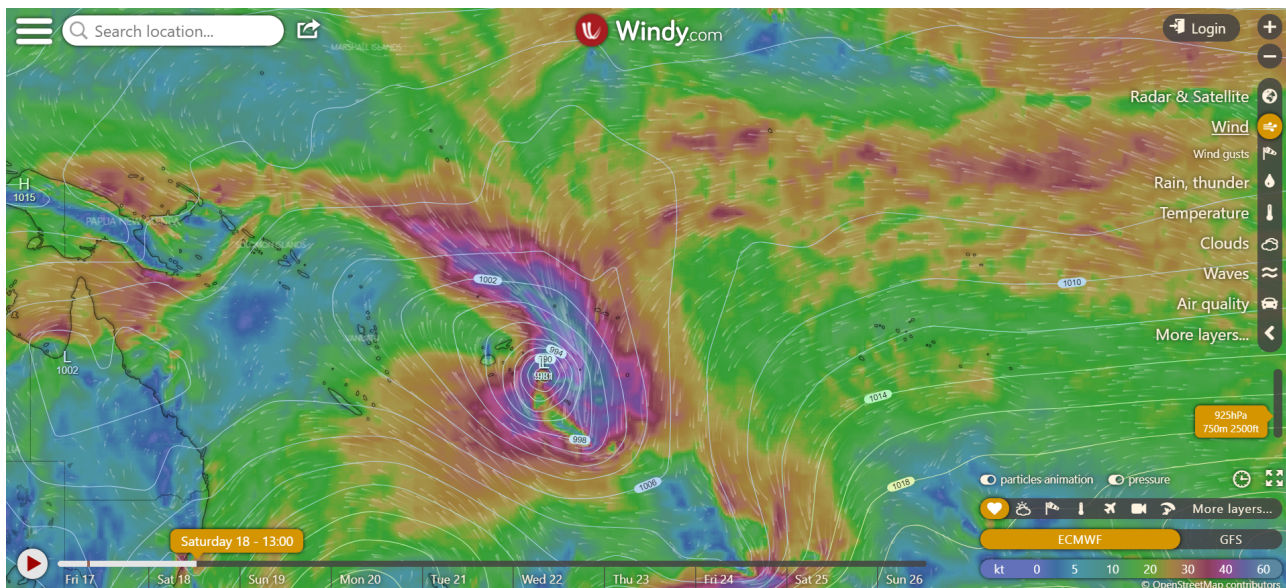
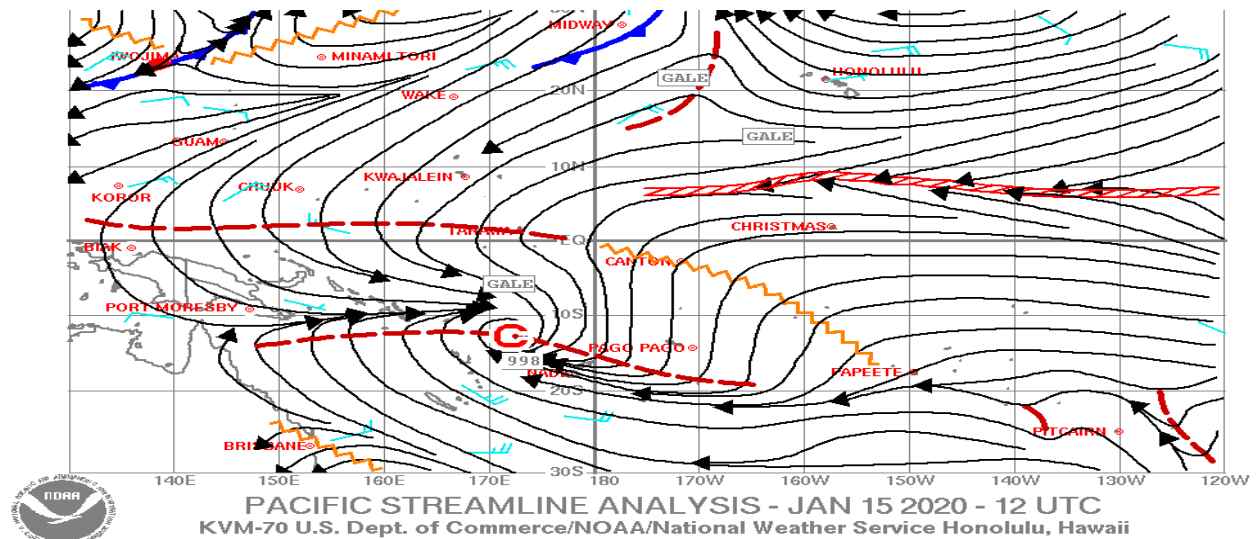
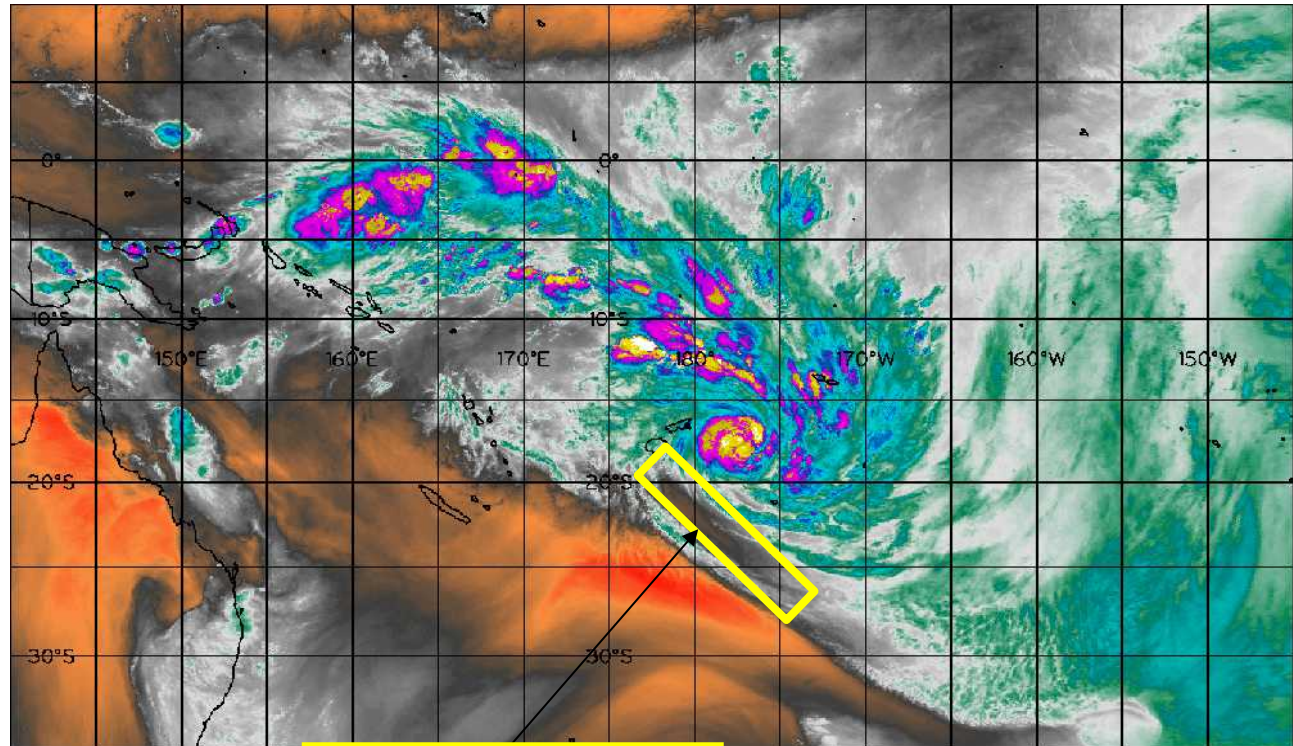


Figure 3.3 Pacific streamline analysis at the surface on 16th January 2020 at 1am local time



TC “TINO” was initially tracking eastwards before moving East-Southeast in our AOR. According to the steering mechanism of the system, Figure 3.1 explain the longwave at 500hpa level that extend over our area driven the system to propagate southeast. Figure 3.2 shows the low to mid-level ridge steering mechanism that further blocking the system from propagating eastward and the high pressure to the Southwest of the system, which is, evidenced by the streamline at the surface shown in Figure 3.3. In addition, TC “TINO” lies under moderate to strong upper divergent in a low sheared environment with moderate poleward outflow. It was intensified into Category 3 at 10am on 18th January 2020 driven by the moisture feeding from the North into the system and the Jet stream at 200hpa level further support the upper divergent aloft to withstand a strong vertical motion.

Figure 3.4: Sandwich satellites image of TC TINO within our Tongan AOR.



DRY AIR SLOTS

Figure 3.4 captured the dry air intrusion from the South into the system as it propagate southeast which indicate TC “TINO” will weaken gradually. This was exactly the case for TC “TINO” in our AOR as it rapidly intensify within 15hrs to Category 3 at 10am on 18th January, 2020 when it reach Nomuka and then gradually decayed and downgrade to Category 2 at 1am on 19th January, 2020 as it tracks over cooler sea surface temperature and begins extra-tropical transition.

Figure 3.5: Advance Scatterometer (ASCAT) pass at 9:50pm local time on 18th January, 2020)

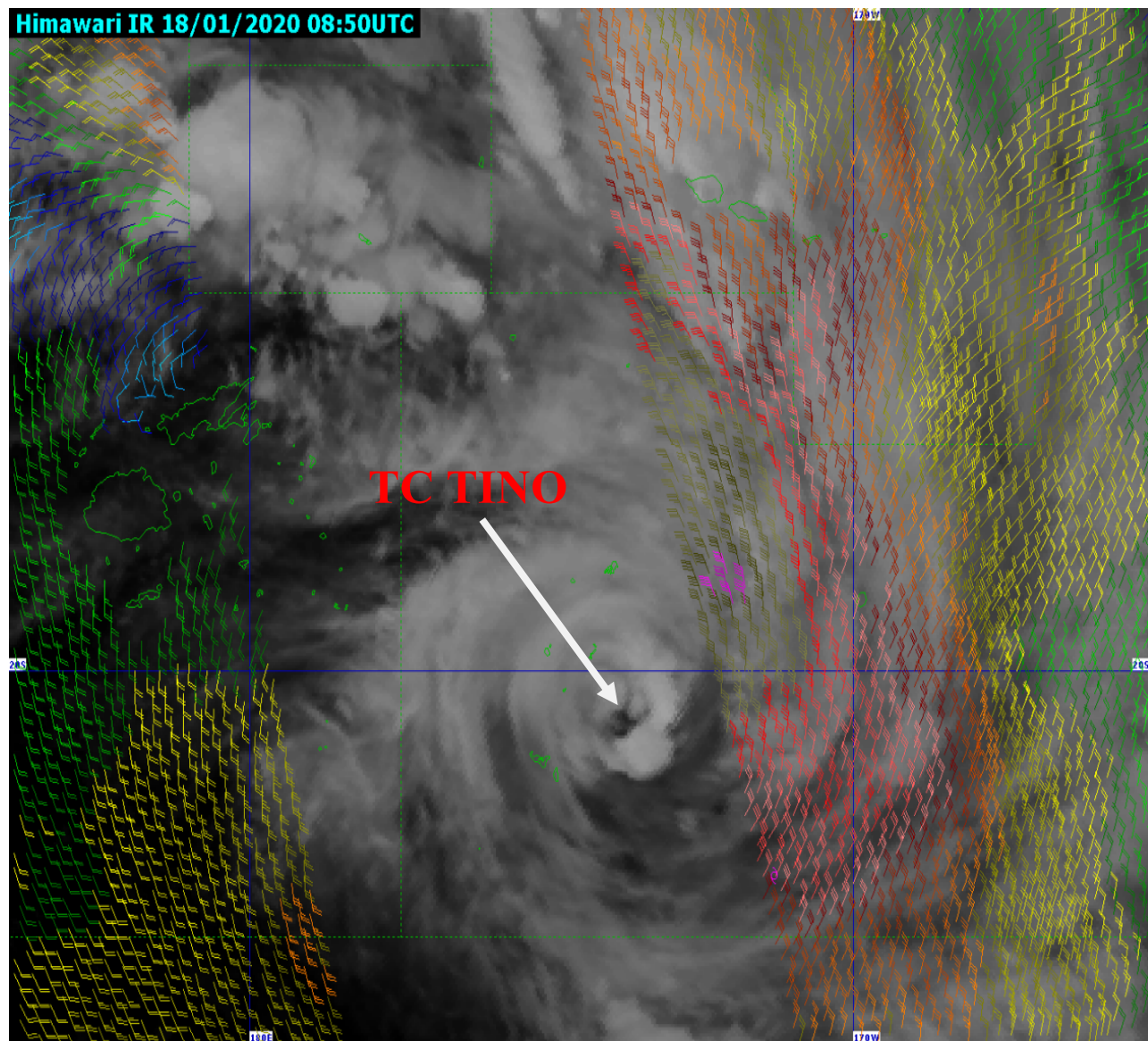


Figure 3.5 shows the strength of the winds near the center of the cyclone to be around 65-70 knots (130-140km/hr). This meteorological information provide our forecasting team to clearly identify the center of the cyclone, re-confirm its strength, approximately measure the radius of storm and gale force winds and also verified the current warnings that was in-force for Tonga.

4. Tropical Cyclone Products issued from the FTCWC on TC “TINO”.

Figure 4.1: All the product release to the public on TC “TINO”

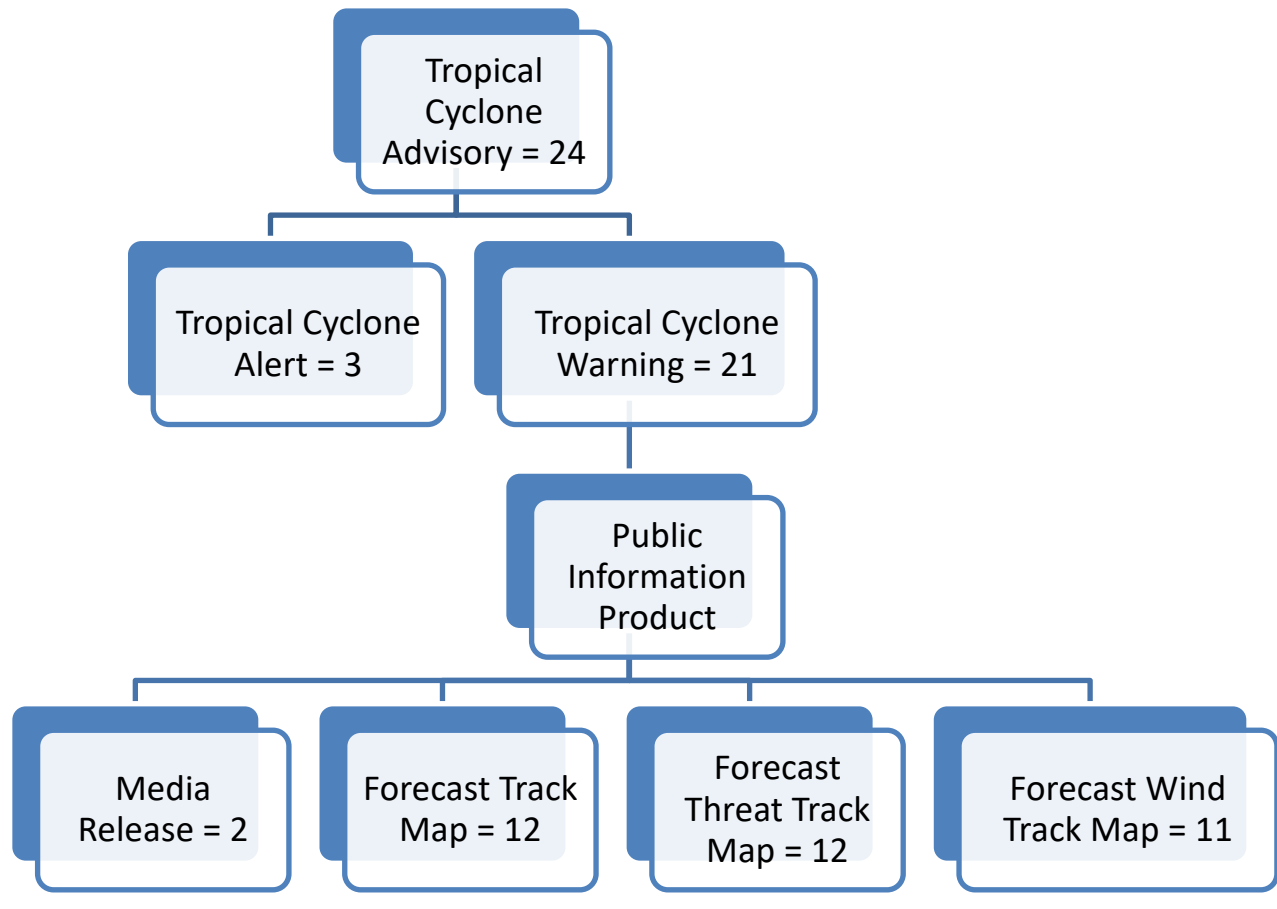


Figure 4.1 shows 24 tropical cyclone advisories were issued during the operations for TC “TINO”. Within the TC Advisory, there are 3 TC alerts and 21 TC warnings. In addition, FTCWC issued 4 main product to the public include 2 media release, 12 forecast track map, 12 forecast threat track map and 11 forecast wind track map that was disseminated to all our distribution list and media channel.

5. Official Forecast Track Maps and Warning product

FTCWC decided to produce two more product to make it easy for the public to understand the track, threat area and the winds area that need to be warned for early preparation. These forecast maps basically highlighted the boundaries of expected TC track and movement in the next 24, 48, 72, 120 hours, strength and radius of storm and gale force winds, areas of gale force winds and destructive storm force winds in our AOR. These forecast maps was created using the TC Module and photoshop software(s) as shown below and in the preceding sections.

Figure 5.1: Forecast track map

Tonga Meteorological Service
MEIDECC
TROPICAL CYCLONE WARNING CENTRE FUA'AMOTU



Tropical Depression 04F Track Map

Tropical Depression 04F (TD04F)

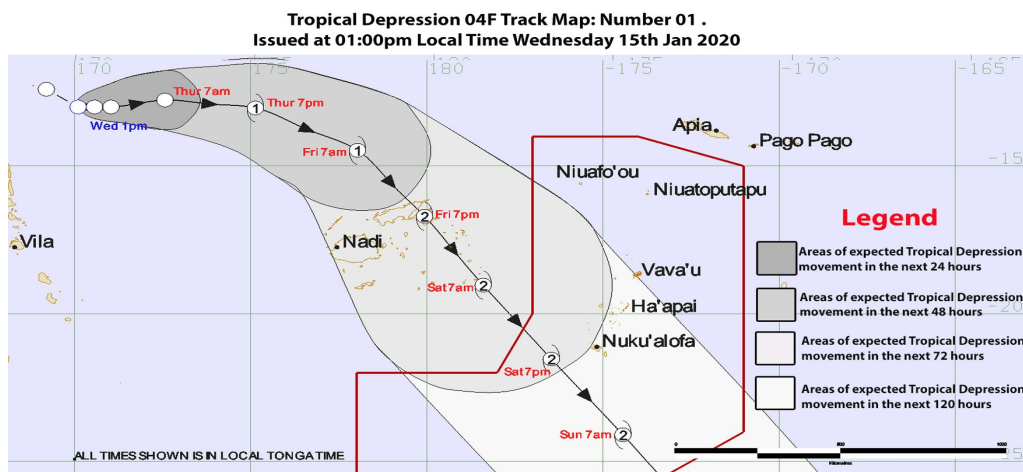


Figure 5.2: Forecast threat track map

Tonga Meteorological Service
MEIDECC
TROPICAL CYCLONE WARNING CENTRE FUA'AMOTU



Tropical Depression 04F Threat Map

Tropical Depression 04F (TD04F)

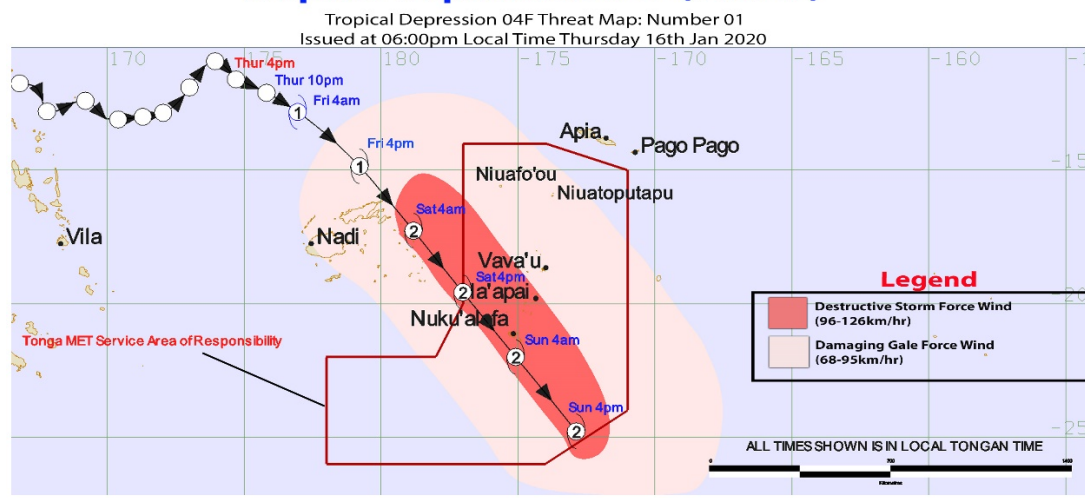


Figure 5.3: Forecast wind track map



Tropical Depression 04F Forecast Wind Track Map

Tropical Depression 04F (TD04F)

Tropical Depression 04F Wind Map: Number 01 .
Issued at 12:00am Local Time Friday 17th Jan 2020

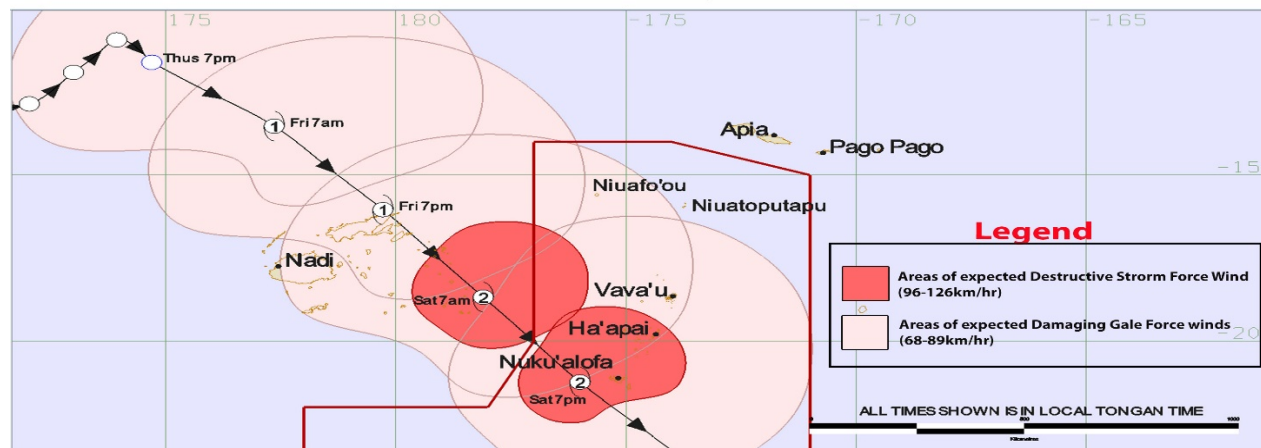


Figure 5.4: Warning details

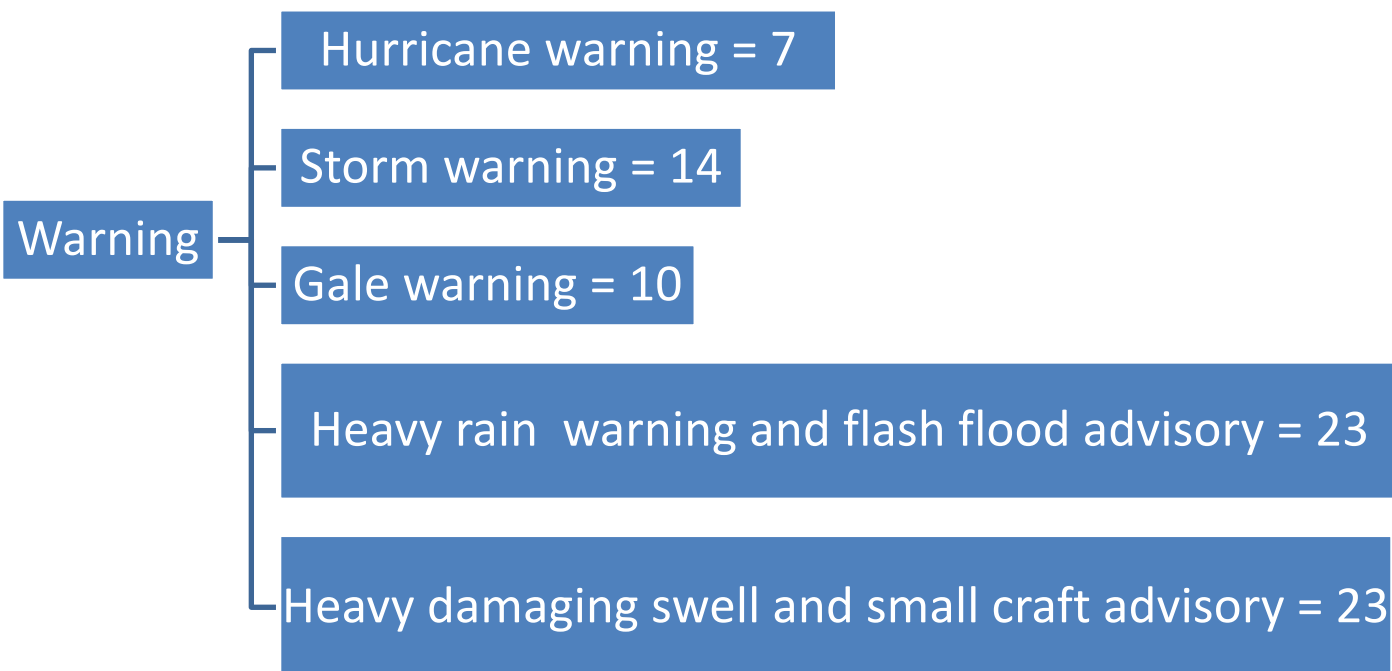


Figure 5.4 shows all the warning that was issued from FTCWC on TC “TINO” with a total of 77 warning for all of Tonga land and coastal waters.

6. METEOROLOGICAL OBSERVATION

Observation from our automatic weather stations (AWS) around the islands was one of the best method we used to track TC Tino as it approached along our area of responsibility. As shown in the figures below, Nomuka Island was the closest island to the center of TC TINO with the lowest pressure recorded of 966.8mb(see fig6.2.5) and also the drop of wind speed(see fig6.2.4) at the same time around 7:10pm 18th January, 2020. This observation clearly describes the nature of a tropical cyclone eye. Maximum wind gust(see fig6.2.3) was recorded at Pilolevu Airport, it was about 72.7knots at around 8:40pm. We continued to use the wind direction and the pressure readings from the stations to track TC TINO as it moved southeast away from our area of responsibility (AOR).

6.1 Metar and SpecI on 18th January, 2020

Figure 6.1.1: Niuatoputapu

Latest Niuatoputapu Aerodrome - NFTP METAR/SPECI for 18/01/2020

METAR	NFTP	171100Z	35018KT	9999	SCT007	SCT016	OVC100	27/25	Q0998=
METAR	NFTP	171200Z	35019KT	9999	SCT017CB	OVC100	27/24	Q0998=	
METAR	NFTP	171300Z	NIL=						
METAR	NFTP	171400Z	NIL=						
METAR	NFTP	171500Z	NIL=						
SPECI	NFTP	171800Z	35024KT	9999	-SHRA	BKN006	OVC100	27/26	Q0996=
SPECI	NFTP	171900Z	35025KT	1000	+RA	BKN006	OVC090	27/26	Q0997=
METAR	NFTP	172000Z	35025KT	9999	SCT007	OVC100	27/26	Q0997=	
METAR	NFTP	172100Z	35025KT	9999	-SHRA	SCT006	OVC090	27/26	Q0997=
METAR	NFTP	172200Z	35025KT	9999	-SHRA	SCT006	OVC100	27/26	Q0996=
METAR	NFTP	172300Z	35025KT	9999	-SHRA	SCT006	OVC100	27/26	Q0996=
SPECI	NFTP	180000Z	35025KT	9999	-SHRA	BKN007	OVC100	27/26	Q0996=
METAR	NFTP	180100Z	35025KT	9999	-RA	SCT006	OVC100	26/25	Q0996=
SPECI	NFTP	180300Z	34025G35KT	9999	BKN007	OVC100	28/26	Q0995=	
SPECI	NFTP	180400Z	34025G35KT	1000	+RA	SCT006	OVC090	27/26	Q0996=
SPECI	NFTP	180500Z	34025G35KT	1000	+RA	SCT006	OVC090	27/26	Q0996=
SPECI	NFTP	180600Z	34025G40KT	9999	-SHRA	BKN006	OVC090	27/26	Q0996=
SPECI	NFTP	180700Z	34025G35KT	9999	SCT007	OVC100	27/26	Q0998=	
METAR	NFTP	180800Z	34030KT	9999	-SHRA	SCT006	OVC100	27/26	Q0993=
METAR	NFTP	180900Z	34030KT	9999	SCT007	OVC100	2726	Q0986=	
METAR	NFTP	181000Z	34030KT	9999	-SHRA	SCT006	OVC090	27/26	Q0993=

Figure 6.1.2: Niuafu'ou

Latest Niuafu'ou Aerodrome - NFTO METAR/SPECI for 18/01/2020

METAR	NFTO	171100Z	33009KT	9999	SHRA	SCT007	BKN016	OVC100	25/24	Q0997=
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METAR	NFTO	171300Z	35013KT	9999	-SHRA	SCT006	BKN016	OVC100	27/26	Q0994=
METAR	NFTO	171400Z	35014KT	9999	SCT006	BKN016	OVC100	27/26	Q0994=	
METAR	NFTO	171500Z	31019KT	9999	SHRA	SCT006	BKN016	OVC100	27/27	Q0993=
METAR	NFTO	171600Z	31020KT	9999	SHRA	SCT006	BKN016	OVC100	28/27	Q0993=
METAR	NFTO	171700Z	32018KT	9999	SCT006	BKN017	OVC100	27/27	Q0993	RERA=
METAR	NFTO	171800Z	32018KT	9999	SCT007	BKN016	OVC090	25/25	Q0994=	
METAR	NFTO	171900Z	32018KT	9999	SCT007	BKN017	OVC100	26/25	Q0995=	
METAR	NFTO	172000Z	33019KT	9999	SCT007	SCT017	OVC100	26/25	Q0995=	
METAR	NFTO	172100Z	NIL=							
METAR	NFTO	180300Z	32018KT	9999	-SHRA	SCT007	BKN017	BKN100	27/26	Q0996=
METAR	NFTO	180400Z	33018KT	9999	-RA	SCT007	BKN016	OVC100	26/25	Q0995=
METAR	NFTO	180500Z	31019KT	9999	SCT008	BKN017	OVC100	26/25	Q0996=	
METAR	COR	NFTO	180600Z	31019KT	9999	SCT008	BKN017	OVC100	26/25	Q0996=
METAR	NFTO	180700Z	29018KT	9999	SCT007	BKN016	OVC100	27/27	Q0998=	
METAR	NFTO	180800Z	NIL=							
METAR	NFTO	180900Z	NIL=							
METAR	NFTO	181000Z	29021KT	9999	SHRA	SCT006	BKN016	OVC100	28/27	Q1000=

Figure 6.1.3 Lupepau'u Airport (Vava'u)

Latest Lupepau'u Aerodrome - NFTV METAR/SPECI for 18/01/2020.

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METAR NFTV 171100Z 35012KT 9999 FEW008 SCT017 OVC100 27/26 Q0999=
METAR NFTV 171200Z 36014KT 9999 FEW008 BKN017 OVC110 27/26 Q0999=
METAR NFTV 171300Z 35014KT 9999 SCT008 BKN017 OVC110 27/26 Q0998=
METAR NFTV 171400Z 35013KT 9999 -RA SCT007 BKN016 OVC110 27/26 Q0997=
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METAR NFTV 171600Z NIL=
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SPECI NFTV 172030Z 34018KT 9999 RA BKN006 OVC100 27/25 Q0995=
SPECI NFTV 172100Z 35019KT 9999 BKN007 OVC110 27/26 Q0994=
SPECI NFTV 172120Z 35020G35KT 9999 BKN007 OVC100 27/26 Q0994=
SPECI NFTV 172200Z 35020G35KT 9999 BKN007 OVC100 27/26 Q0994=
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SPECI NFTV 172300Z 36035G45KT 9999 BKN007 OVC100 27/26 Q0993=
SPECI NFTV 172330Z 35033G45KT 9999 BKN007 OVC100 27/26 Q0992=
SPECI NFTV 180000Z 36035G46KT 9999 BKN007 OVC110 26/26 Q0992=
SPECI NFTV 180100Z 36045G60KT 9999 -RA BKN007 OVC100 26/26 Q0991=
SPECI NFTV 180110Z 36045G60KT 9999 -RA BKN007 OVC100 26/26 Q0991=
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SPECI NFTV 180820Z 36030G45KT 9999 BKN007 OVC100 26/26 Q0991=

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Figure 6.1.4: Pilolevu Airport (Ha'apai)

Latest Pilolevu Aerodrome - NFTL METAR/SPECI for 18/01/2020.

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METAR NFTL 171100Z 01008KT 9999 FEW010 SCT017TCU OVC100 27/25 Q0999=
METAR NFTL 171200Z 35006KT 9999 -DZ SCT007 SCT016TCU OVC100 27/26 Q0998=
METAR NFTL 171300Z 36008KT 9999 FEW008 SCT016TCU OVC100 27/26 Q0997=
METAR NFTL 171400Z 36010KT 9999 FEW008 SCT016TCU OVC100 27/26 Q0996=
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METAR NFTL 171800Z 33014KT 9999 -RA FEW007 BKN016TCU OVC100 26/26 Q0996=
METAR NFTL 171900Z 34010KT 9999 -RA SCT007 BKN016TCU OVC090 26/26 Q0995=
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METAR NFTL 172100Z 35014KT 9999 -RA SCT006 BKN016 OVC100 27/26 Q0994=
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SPECI NFTL 180200Z 36020G35KT 9999 FEW008 BKN016 OVC100 27/26 Q0986=
SPECI NFTL 180300Z 35025G45KT 9999 -SHRA SCT008 BKN016 OVC100 27/26 Q0984=
SPECI NFTL 180400Z 36030G45KT 9999 -RA SCT008 BKN016 OVC100 27/26 Q0980=
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SPECI NFTL 180600Z 33030G60KT 3000 +RA SCT008 BKN015 OVC090 26/26 Q0975=
SPECI NFTL 180700Z 31040G70KT 1000 +RA BKN006 BKN012 OVC080 26/26 Q0974=
SPECI NFTL 180800Z NIL=
SPECI NFTL 180900Z 29030G50KT 7000 -RA BKN006 BKN015 OVC080 26/26 Q0983=
SPECI NFTL 181000Z 28030G45KT 9999 -RA SCT006 BKN015 OVC080 26/26 Q0984=

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Figure 6.1.5: Fua'amotu Airport (Tongatapu)

Latest Fua'amotu Aerodrome - NTF METAR/SPECI for 18/01/2020.

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SPECI NTF 171100Z 09008G15KT 9999 -RA SCT006 BKN015TCU OVC100 25/25 Q1000=
SPECI NTF 171200Z 06003KT 9999 -RA SCT006 BKN015TCU OVC100 25/25 Q0999=
SPECI NTF 171300Z 10005KT 9999 -RA BKN006 BKN014TCU OVC100 25/25 Q0998=
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SPECI NTF 180800Z 11013G29KT 9999 SCT008 SCT015 BKN100 26/26 Q0984=
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SPECI NTF 181100Z 20019G27KT 9999 SCT006 BKN016 OVC100 27/26 Q0988=
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6.2 Automatic Weather Station (AWS)

Figure 6.2.1: Niuafu'ou AWS wind gust

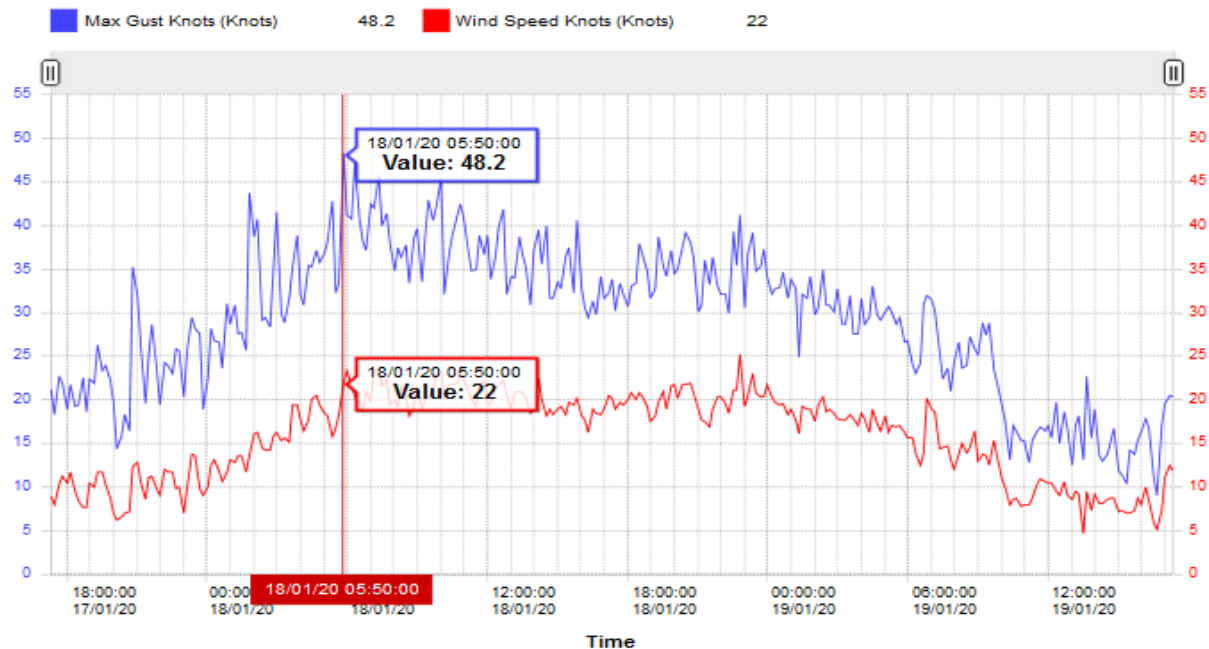


Figure 6.2.3: Lupepau'u Airport AWS, Vava'u

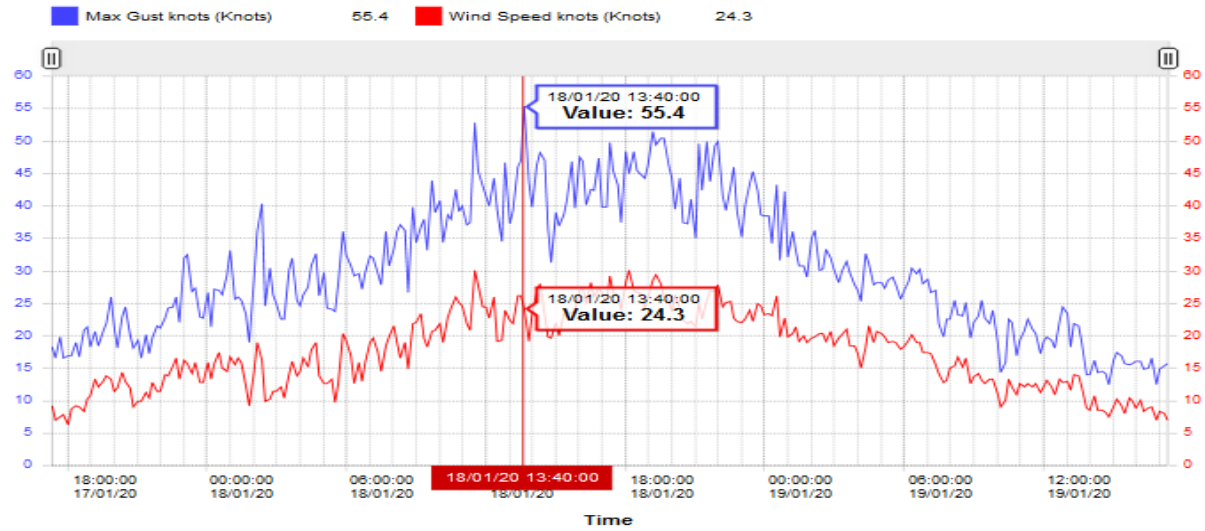


Figure 6.2.3: Pilolevu Airport wind gust(AWS), Ha'apai

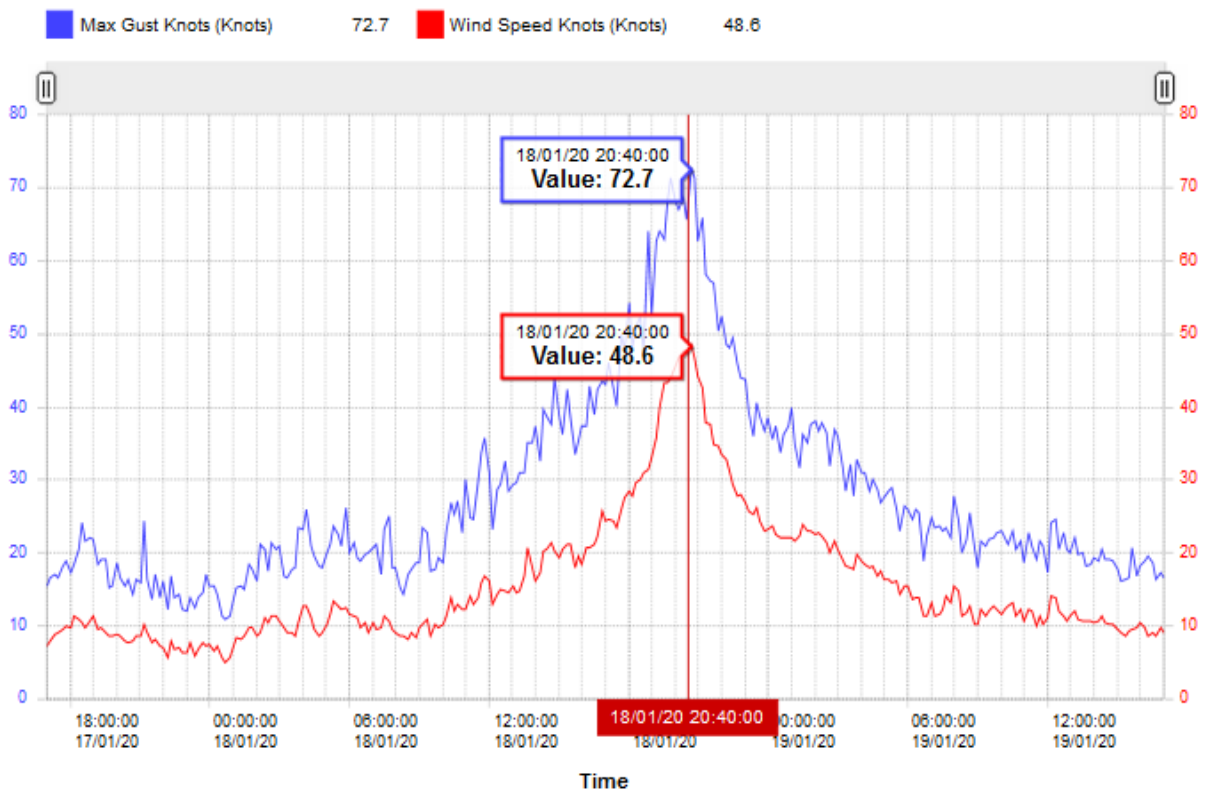


Figure 6.2.4: Nomuka (AWS) wind gust, Ha'apai

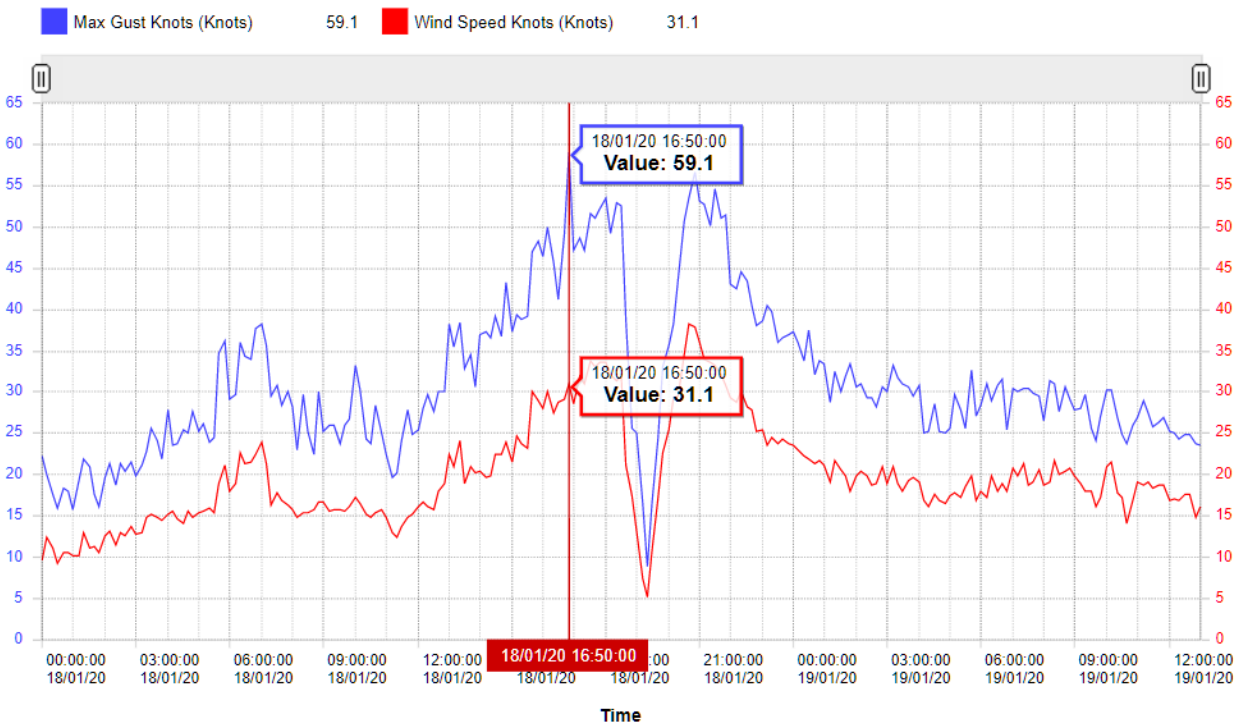


Figure 6.2.5: Nomuka (AWS) recorded pressure,

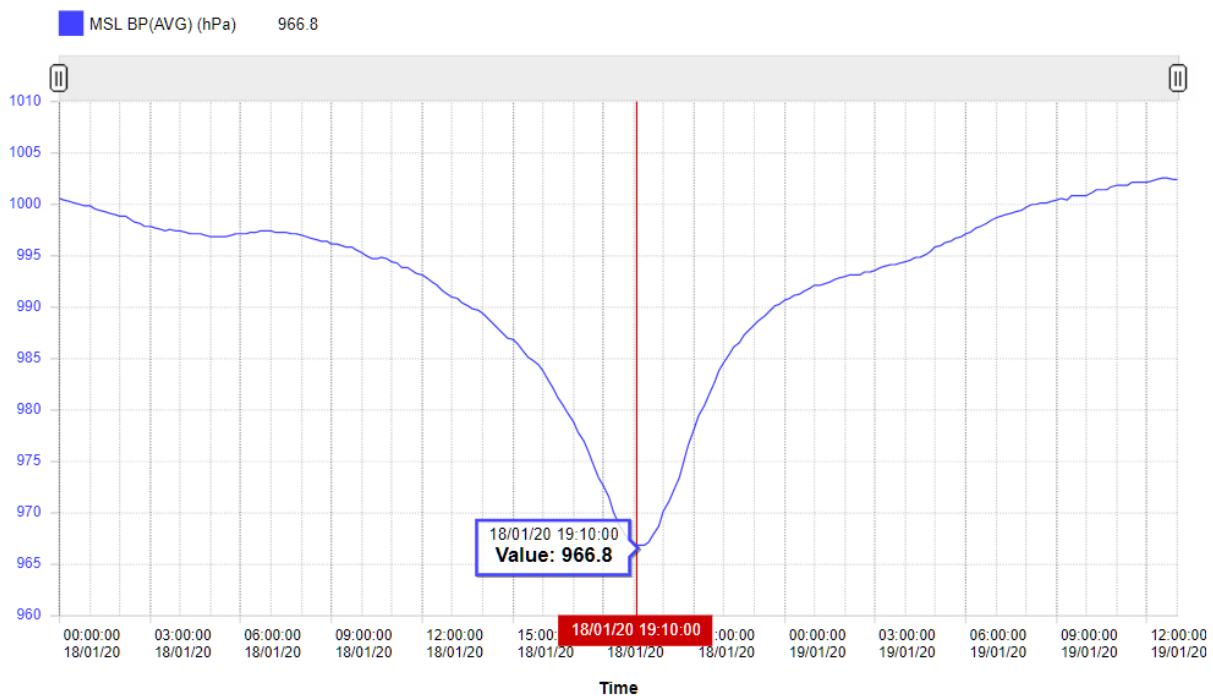


Figure 6.2.6: Kanokupolu AWS wind gust(Tongatapu)

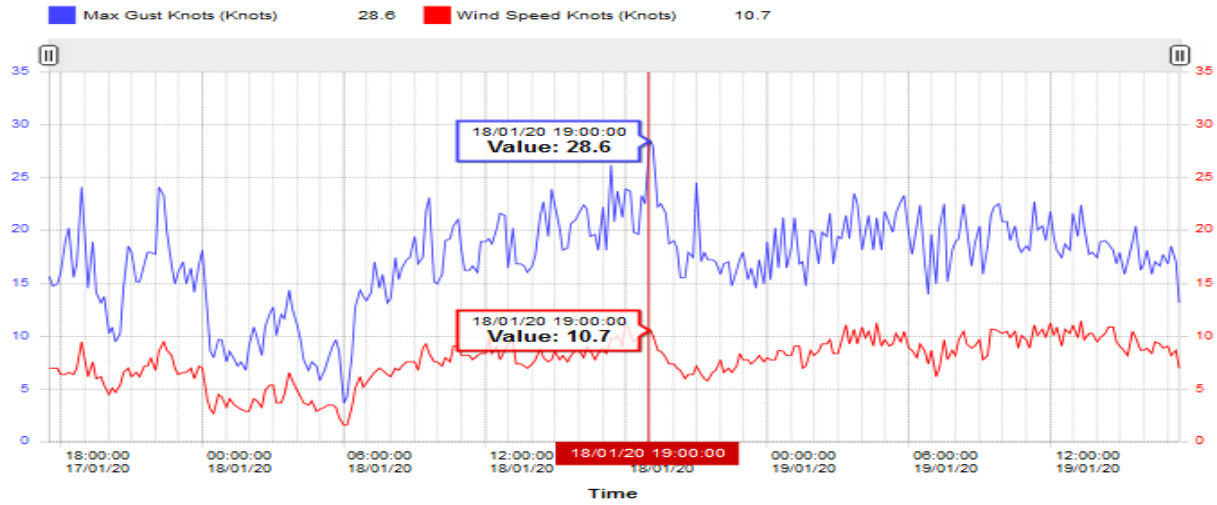
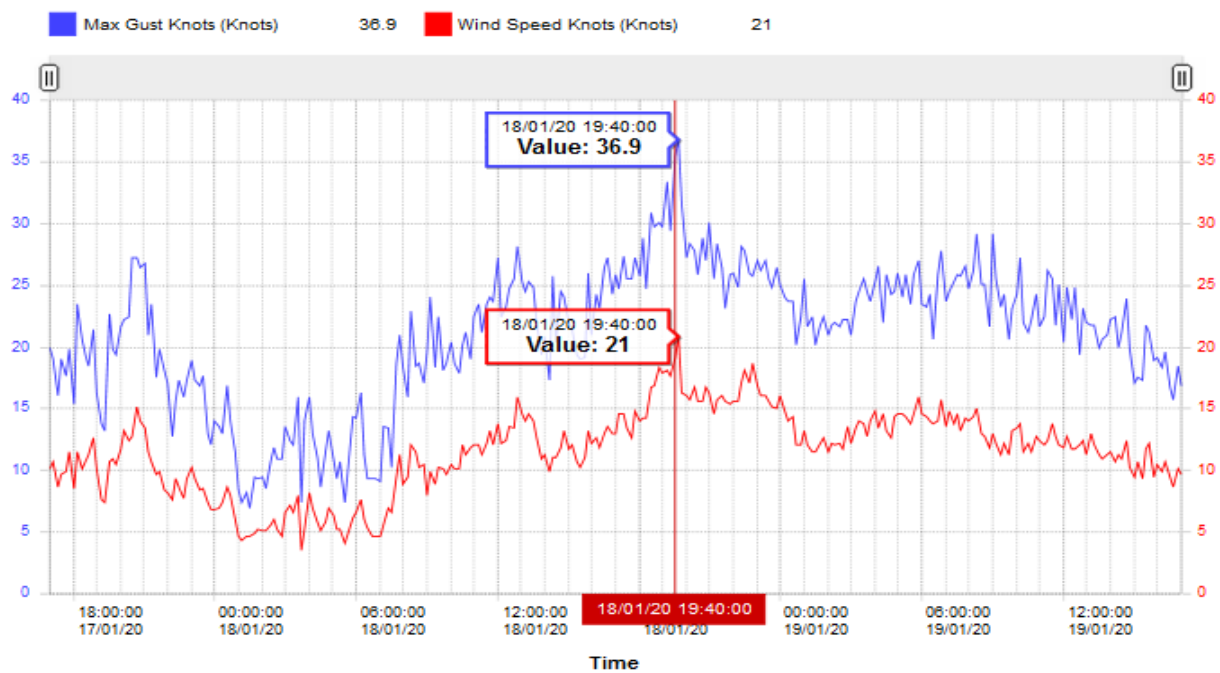


Figure 6.2.7: Kaufana AWS wind gust('Eua)



7. **Impact associated with TC TINO over Tonga**

Figure 7.1: Niuafo'ou agricultural damages



Figure 7.2: Ha'apai coastal damages



8. Meteorological Summary

TC “TINO” originated over the warmer waters between Solomon and Vanuatu before it had tracked East over to the Fijian waters, then moving Southeastwards once it pass the Northern part of Vanua Levu and heading towards our AOR. The assessment and analysis of the likelihood of whether TC “TINO” will

continue Southeast into our AOR was high confident. Frankly, TC “TINO” was completely clear on the steering mechanism that dominate the steering flow which is the low to mid-level ridge and the high pressure system to the Southwest of the system acting as a blocking features so that TC “TINO” remain Southeast as it approached AOR and cross Ha'apai group. In addition, majority of the model that used to predict the movement of the system were align together to Southeasterly propagation. The surface observations both in the Fiji and Tonga AOR is indeed an effective methodology to verify the behavior of the system in the past 24 hours for the benefits of determine the current location of the system.

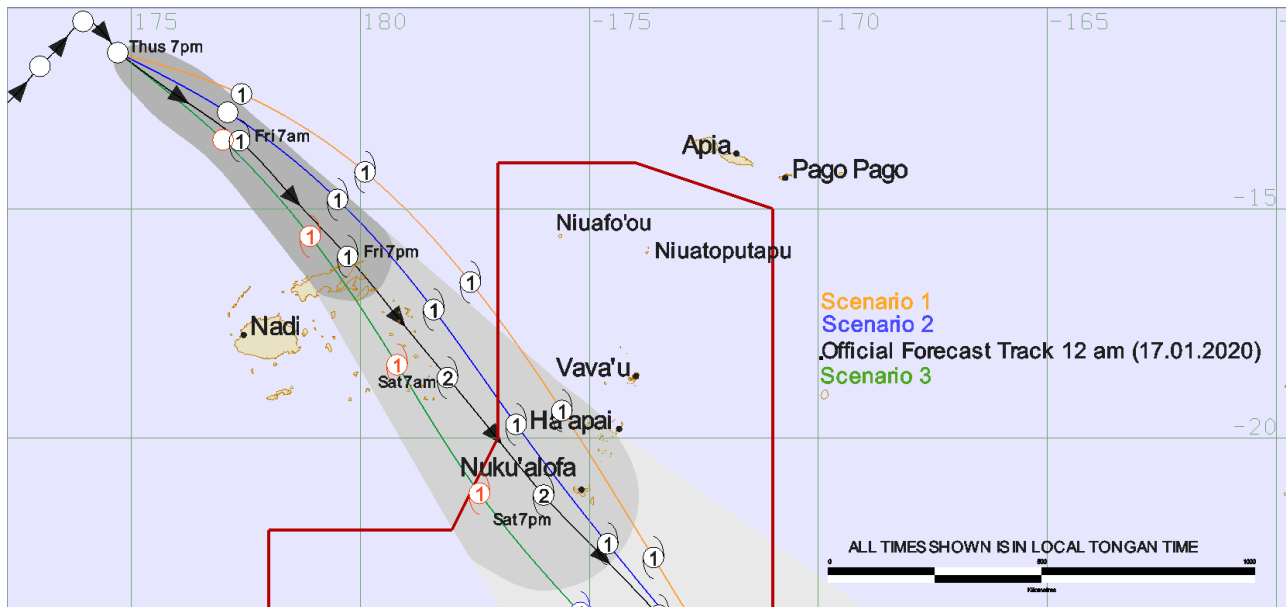


Figure 8.1: Possible scenarios that were analyzed by the FTCWC TC Forecaster to decide the likely behavior and movement of TC “SARAI” with a lead time of 24-48 hours prior to our AOR boundaries (red polygon).

In addition, FTCWC has experienced less phone call from the public regards the weather during cyclone “TINO” and we believed that the products was released to the public via radio, social media, email, etc is start to enlighten the public in term of understanding the weather phenomena and the impacts associated with the cyclone.

9. Recommendations:

Based on our experiences and encounters during the operations of TC“TINO”, this report puts forward the following recommendations to be considered and to be noted:

- IT technician standby at all times in the FTCWC in-case of any unforeseen IT related technical problems.
- A priority and the need to carry out TC trainings with experts from the Bureau of Meteorology on a yearly basis before the start of any TC Season.

- The need for our TC forecasters to familiarize with and to carry out Dvorak Analysis and more TC module hands on practical session.
- Competency assessments on TC forecasters to be implemented during TC operations.
- The need to review our current Tropical Cyclone SOPs.
- The need for a media training for those who recorded TV Weather and radio live broadcasting.

