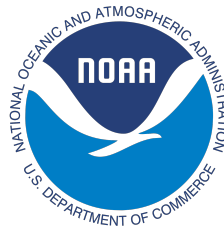


# Interim SOP

Charles McCreery and Bill Fry, WG2



*Te Whakaahuatanga Tere o ngā*  
**R-CET**  
*Rū Whenua me ngā Parawhenua*

# Approach based on first ocean observations

- Tsunamis from volcanoes are not adequately forecast with traditional earthquake magnitude/mechanism and resulting seafloor deformation based approaches
- Tsunami waves from Hunga Tonga Hunga Ha'apai arrive at Nukualofa prior to arrival at any deep ocean (DART) observation sites
- Nearest operational DART is within approximately 20-30 minutes tsunami travel time from Hunga Tonga Hunga Ha'apai

# Approximate travel times

- Tsunamis from volcanoes are not adequately forecast with traditional earthquake magnitude based approaches
- Tsunami waves from Hunga Tonga Hunga Ha'apai arrive at Nukualofa prior to arrival at any deep ocean observation sites (DART)
- Nearest operational DART within approximately 20-30 minutes

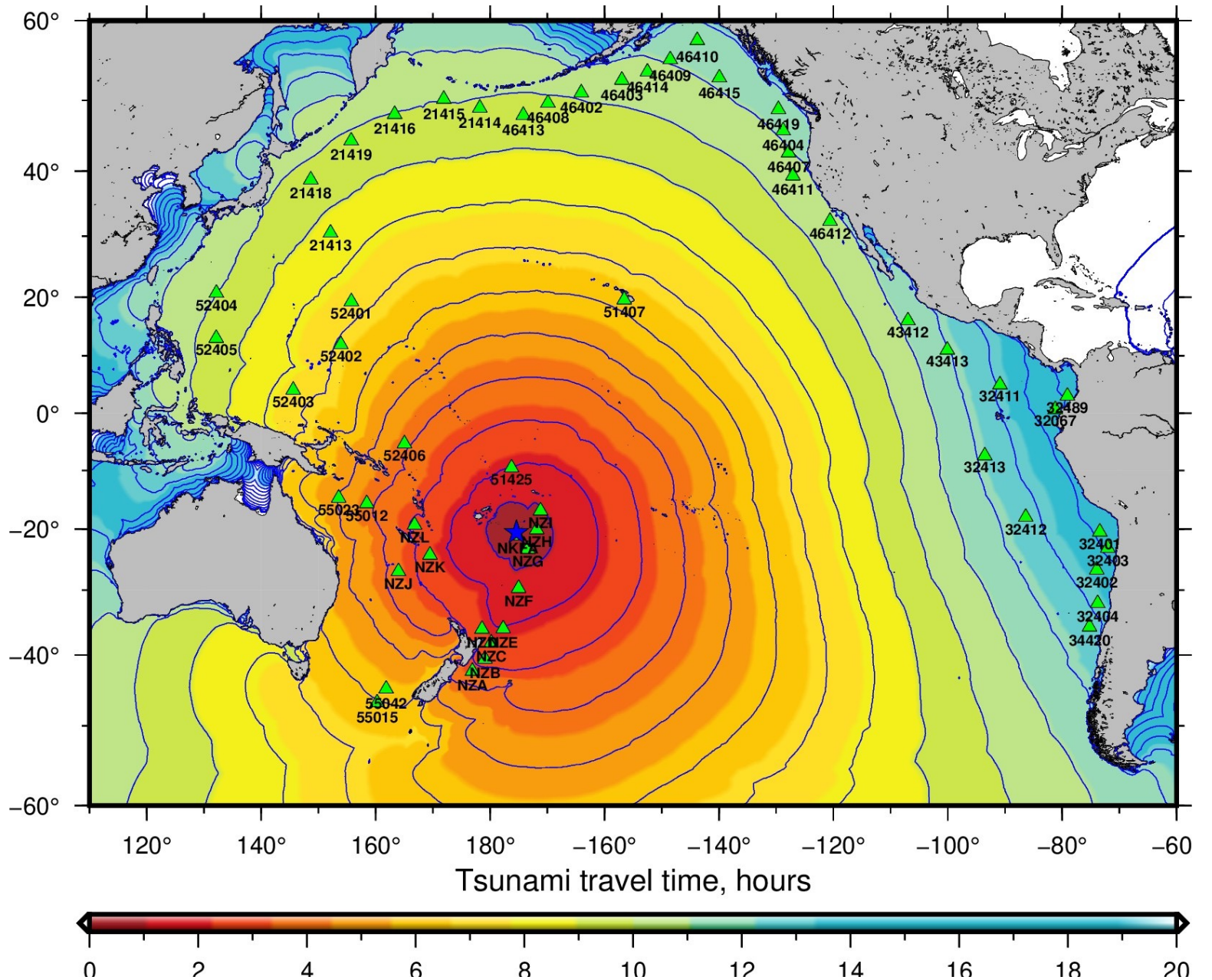


Figure courtesy of Aditya Gusman, Te Pū Ao

# Proposed Approach Short-Term – Alerting for subsequent Hunga Tonga-Hunga Ha’apai tsunami sources

- Because we do not have the ability to measure and adequately describe the tsunami generation process sufficiently quickly to deliver physics-based pre-impact forecasting at local and regional distances, **PTWC will use first available single station (Nuku`alofa tide gauge or DART NZG) amplitudes as an early indication of potential tsunami severity**
- Must be reasonably likely that tsunami source is at or close to the source of 15 Jan
- Notification will be delivered (successively) when each of the following thresholds are reached on the nearest DART observation:
  - Significant waves are recorded at Nukualofa tide gauge
  - or
  - 5cm (~25% of 15 Jan wave impacts), 10cm (~50% of 15 Jan impacts), 20cm (similar impacts to 15 Jan) and maximum (information for wider, distant sourced coastlines)

# Proposed key message content:

- Text based messages, at this point no graphical products are planned in the immediate future (outside of normal PTWC SOP)
- Indicative approximation of maximum wave height estimated from scaling 15 Jan recordings
- Expected arrival times of first waves from synthetic calculations (note, 15 Jan largest waves were not first arrivals in most regional recordings)
- Tsunami amplitudes observed on coastal or deep-ocean sea level gauges
- We have yet to record the complete tsunami so estimations of wave amplitude can rise.

# Forecast by Scaling to January 15 Observations

SEA LEVEL GUAGE	LAT	LON	TIME	METERS	SCALE							
					1.50	1.25	1.00	0.75	0.50	0.25	0.10	
<b>DART_01003</b>	<b>23.4S</b>	<b>173.4W</b>	<b>442</b>	<b>0.12</b>	0.18	0.15	0.12	0.09	0.06	0.03	0.01	
<b>NUKUALOFA_TO</b>	<b>21.1S</b>	<b>175.2W</b>	<b>516</b>	<b>0.82</b>	1.23	1.03	0.82	0.62	0.41	0.21	0.08	
PAGO_PAGO_AS	14.3S	170.7W	531	0.62	0.93	0.78	0.62	0.47	0.31	0.16	0.06	
DART_01002	29.7S	175.0W	542	0.10	0.15	0.13	0.10	0.08	0.05	0.03	0.01	
APIA_UPOLU_WS	13.8S	171.8W	551	0.17	0.26	0.21	0.17	0.13	0.09	0.04	0.02	
DART_01001	36.0S	177.7W	612	0.07	0.11	0.09	0.07	0.05	0.04	0.02	0.01	
SUVA_VITI_LEVU_FJ	18.1S	178.4E	633	0.26	0.39	0.33	0.26	0.20	0.13	0.07	0.03	
FONGAFALE_TV	8.5S	179.2E	735	0.12	0.18	0.15	0.12	0.09	0.06	0.03	0.01	
LIFOU_NEW_CALEDONIA	20.9S	167.3E	746	0.89	1.34	1.11	0.89	0.67	0.45	0.22	0.09	
TUBUAI_PF	23.3S	149.5W	800	0.33	0.50	0.41	0.33	0.25	0.17	0.08	0.03	
PAPEETE_TAHITI	17.5S	149.6W	811	0.27	0.41	0.34	0.27	0.20	0.14	0.07	0.03	
VAIRAO_FP_FR	17.8S	149.3W	813	0.43	0.65	0.54	0.43	0.32	0.22	0.11	0.04	
HUAHINE_PF	16.7S	151.0W	813	0.53	0.80	0.66	0.53	0.40	0.27	0.13	0.05	
THIO_NEW_CALEDONIA	21.6S	166.2E	819	0.57	0.86	0.71	0.57	0.43	0.29	0.14	0.06	
OUVEA_NEW_CALEDONIA	20.5S	166.6E	823	0.39	0.59	0.49	0.39	0.29	0.20	0.10	0.04	
LUGANVILLE_VU	15.5S	167.2E	826	0.37	0.56	0.46	0.37	0.28	0.19	0.09	0.04	
QUINNE_NEW_CALEDONI	22.0S	166.7E	826	1.13	1.70	1.41	1.13	0.85	0.57	0.28	0.11	
DART_01004	36.1S	178.6E	829	0.11	0.17	0.14	0.11	0.08	0.06	0.03	0.01	
EAST_CAPE_NZ	37.6S	178.2E	834	0.26	0.39	0.33	0.26	0.20	0.13	0.07	0.03	

# Timing of alerting

- **Best endeavours** will be undertaken to release alerts as quickly as possible
- Waves take ~30 minutes to reach nearest DART
- Additional time to record waves over trigger thresholds will be event dependent. In the 15 Jan event, 5cm amplitude was recorded within the first 5 minutes.
- Accounting for message processing and distribution, we hope for alert messaging to be disseminated within about 40 minutes following the event, but as the evolution of future events is uncertain, timing is necessarily best endeavours

- The measurements will be used to estimate the generation time of the tsunami at Hunga Tonga and from that to estimate tsunami first-arrival times at shorelines where the first-arrival time is within the next 3 hours.
- The measurements will be used to estimate possible tsunami maximum wave amplitudes at gauge locations by scaling to the maximum measurements recorded at those gauges on 15 January.
- The PTWC will only issue a text product. It will include the preliminary time of the tsunamigenic event at Hunga Tonga, potentially threatened coastlines with estimated arrival times and estimated wave amplitudes, and current gauge measurements of tsunami heights.



## IMPORTANT, Please Note:

- The forecast will be released as soon as waves over specific thresholds have been measured. This means the forecast may change during the initial few hours of the response. This is a consequence of using limited data to provide forecasts as quickly as possible. Clear version (threat message # and time stamp) will accompany the message.

## Note:

- It is expected that NDMO will use knowledge of 15 January impacts to scale response measures accordingly.
- These forecasts are based on very limited data and will be highly uncertain.
- With current network density, Nuku'alofa will not receive PTWC warning prior to first arriving waves.

-----  
TEST...TSUNAMI MESSAGE NUMBER 1...TEST  
NWS PACIFIC TSUNAMI WARNING CENTER HONOLULU HI  
2159 UTC WED JAN 26 2022

...THIS MESSAGE IS FOR TEST PURPOSES ONLY...  
...TEST PTWC TSUNAMI THREAT MESSAGE TEST...

\*\*\*\* NOTICE \*\*\*\* NOTICE \*\*\*\* NOTICE \*\*\*\* NOTICE \*\*\*\* NOTICE \*\*\*\*

THIS IS A TEST MESSAGE. THIS MESSAGE IS ISSUED FOR INFORMATION ONLY IN SUPPORT OF THE UNESCO/IOC PACIFIC TSUNAMI WARNING AND MITIGATION SYSTEM AND IS MEANT FOR NATIONAL AUTHORITIES IN EACH COUNTRY OF THAT SYSTEM.

THIS IS A TEST MESSAGE. NATIONAL AUTHORITIES WILL DETERMINE THE APPROPRIATE LEVEL OF ALERT FOR EACH COUNTRY AND MAY ISSUE ADDITIONAL OR MORE REFINED INFORMATION.

\*\*\*\* NOTICE \*\*\*\* NOTICE \*\*\*\* NOTICE \*\*\*\* NOTICE \*\*\*\* NOTICE \*\*\*\*

-----  
TEST... A VOLCANO HAS ERUPTED GENERATING TSUNAMI WAVES ...TEST  
-----

TEST... PRELIMINARY ERUPTION PARAMETERS ...TEST  
-----

\* ERUPTION TIME 2146 UTC JAN 26 2022  
\* COORDINATES 20.5 SOUTH 175.4 WEST  
\* LOCATION TONGA

TEST... EVALUATION ...TEST  
-----

\* THIS IS A TEST MESSAGE. AN VOLCANIC ERUPTION OCCURRED IN THE TONGA ISLANDS AT 2146 UTC ON WEDNESDAY JANUARY 26 2022.

TEST... TSUNAMI THREAT FORECAST ...TEST  
-----

\* THIS IS A TEST MESSAGE. HAZARDOUS TSUNAMI WAVES FROM THIS ERUPTION ARE POSSIBLE WITHIN THE NEXT THREE HOURS ALONG SOME COASTS OF

TONGA... NIUE... AMERICAN SAMOA... WALLIS AND FUTUNA...  
SAMOA... KERMADEC ISLANDS... FIJI... TOKELAU... COOK  
ISLANDS... VANUATU... TUVALU... NEW ZEALAND AND KIRIBATI

\* THIS IS A TEST MESSAGE. BASED UPON THE INITIAL OBSERVATIONS... THIS TSUNAMI IS FORECAST TO BE ABOUT 0.5 TIMES THE SIZE OF THE JANUARY 15 2022 TSUNAMI FROM HUNGA TONGA VOLCANO.

\* THIS IS A TEST MESSAGE. THE FOLLOWING ARE FORECAST MAXIMUM TSUNAMI HEIGHTS RELATIVE TO NORMAL SEA LEVEL AT COASTAL GAUGES WHERE THE TSUNAMI IS EXPECTED TO ARRIVE WITHIN THE NEXT THREE HOURS. TSUNAMI WAVES ALONG OTHER COASTS NEAR EACH GAUGE CAN BE LARGER.

GAUGE LOCATION	COORDINATES		FIRST WAVE ETA (UTC)	FORECAST MAX TSUNAMI HEIGHT
	LAT	LON		
NUKUALOFA TO	21.1S	175.2W	01/26 2204	0.41M/ 1.34FT
DART 5401003	23.4S	173.4W	01/26 2228	0.10M/ 0.34FT
DART 5401002	29.7S	175.0W	01/26 2311	0.05M/ 0.16FT

OUVEA NEW CALEDONIA 20.5S 166.6E 01/27 0052 0.19M/ 0.64FT TEST... POTENTIAL IMPACTS ...TEST  
 VANUATU 17.8S 168.3E 01/27 0058 0.70M/ 2.31FT -----  
 OUIVNE NEW CALEDONIA 22.0S 166.7E 01/27 0058 0.56M/ 1.85FT

\* THIS IS A TEST MESSAGE. A TSUNAMI IS A SERIES OF WAVES. THE TIME BETWEEN WAVE CRESTS CAN VARY FROM 5 MINUTES TO AN HOUR. THE HAZARD MAY PERSIST FOR MANY HOURS OR LONGER AFTER THE INITIAL WAVE.

\* THIS IS A TEST MESSAGE. IMPACTS CAN VARY SIGNIFICANTLY FROM ONE SECTION OF COAST TO THE NEXT DUE TO LOCAL BATHYMETRY AND THE SHAPE AND ELEVATION OF THE SHORELINE.

\* THIS IS A TEST MESSAGE. IMPACTS CAN ALSO VARY DEPENDING UPON THE STATE OF THE TIDE AT THE TIME OF THE MAXIMUM TSUNAMI WAVES.

\* THIS IS A TEST MESSAGE. PERSONS CAUGHT IN THE WATER OF A TSUNAMI MAY DROWN... BE CRUSHED BY DEBRIS IN THE WATER... OR BE SWEEPED OUT TO SEA.

TEST... RECOMMENDED ACTIONS ...TEST  
 -----

\* THIS IS A TEST MESSAGE. GOVERNMENT AGENCIES RESPONSIBLE FOR THREATENED COASTAL AREAS SHOULD TAKE ACTION TO INFORM AND INSTRUCT ANY COASTAL POPULATIONS AT RISK IN ACCORDANCE WITH THEIR OWN EVALUATION... PROCEDURES AND THE LEVEL OF THREAT.

\* THIS IS A TEST MESSAGE. PERSONS LOCATED IN THREATENED COASTAL AREAS SHOULD STAY ALERT FOR INFORMATION AND FOLLOW INSTRUCTIONS FROM NATIONAL AND LOCAL AUTHORITIES.

TEST... ESTIMATED TIMES OF ARRIVAL ...TEST  
 -----

\* THIS IS A TEST MESSAGE. ESTIMATED TIMES OF ARRIVAL -ETA- OF THE INITIAL TSUNAMI WAVE FOR PLACES WHERE THE INITIAL WAVE IS EXPECTED WITHIN THE NEXT 6 HOURS. ACTUAL ARRIVAL TIMES MAY DIFFER AND THE INITIAL WAVE MAY NOT BE THE LARGEST. A TSUNAMI IS A SERIES OF WAVES AND THE TIME BETWEEN WAVES CAN BE FIVE MINUTES TO ONE HOUR.

LOCATION	REGION	COORDINATES	ETA(UTC)
NUKUALOFA	TONGA	21.0S 175.2W	2156 01/26
HOLEVA	TONGA	18.6S 173.9W	2222 01/26
NIUE ISLAND	NIUE	19.0S 170.0W	2246 01/26
NIUATOPUTAPU	TONGA	15.9S 173.8W	2251 01/26

TEST... TSUNAMI OBSERVATIONS ...TEST  
 -----

\* THIS IS A TEST MESSAGE. THE FOLLOWING ARE TSUNAMI WAVE OBSERVATIONS FROM COASTAL AND/OR DEEP-OCEAN SEA LEVEL GAUGES AT THE INDICATED LOCATIONS. THE MAXIMUM TSUNAMI HEIGHT IS MEASURED WITH RESPECT TO THE NORMAL TIDE LEVEL.

GAUGE LOCATION	GAUGE COORDINATES		TIME OF MEASURE (UTC)	MAXIMUM TSUNAMI HEIGHT	WAVE PERIOD (MIN)
	LAT	LON			
NUKUALOFA TO	21.1S	175.2W	2150	0.40M/ 1.3FT	04

GAUGE LOCATION	COORDINATES		MEASURE (UTC)	TSUNAMI HEIGHT	PERIOD (MIN)
	LAT	LON			
NUKUALOFA TO	21.1S	175.2W	2150	0.40M/ 1.3FT	04

TEST... NEXT UPDATE AND ADDITIONAL INFORMATION ...TEST

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\* THIS IS A TEST MESSAGE. THE NEXT MESSAGE WILL BE ISSUED IN ONE HOUR... OR SOONER IF THE SITUATION WARRANTS.

\* THIS IS A TEST MESSAGE. FURTHER INFORMATION ABOUT THIS EVENT MAY BE FOUND AT [WWW.TSUNAMI.GOV](http://WWW.TSUNAMI.GOV).

\* THIS IS A TEST MESSAGE. COASTAL REGIONS OF HAWAII... AMERICAN SAMOA... GUAM... AND CNMI SHOULD REFER TO PACIFIC TSUNAMI WARNING CENTER MESSAGES SPECIFICALLY FOR THOSE PLACES THAT CAN BE FOUND AT [WWW.TSUNAMI.GOV](http://WWW.TSUNAMI.GOV).

\* THIS IS A TEST MESSAGE. COASTAL REGIONS OF CALIFORNIA... OREGON... WASHINGTON... BRITISH COLUMBIA AND ALASKA SHOULD ONLY REFER TO U.S. NATIONAL TSUNAMI WARNING CENTER MESSAGES THAT CAN BE FOUND AT [WWW.TSUNAMI.GOV](http://WWW.TSUNAMI.GOV).

THIS IS A TEST MESSAGE. DO NOT TAKE ACTION BASED ON THIS TEST MESSAGE.

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