

# WG2 Short-term proposal to alert for tsunamis generated by the ongoing Hunga Tonga / Hunga Ha'apai volcanic event

Bill Fry and Charles McCreery, WG2



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

### Current status:

Most operational tsunami forecasting tools are predicated on an earthquake source

### Long-Term Goal:

Provide actionable forecast information for non-earthquake generated tsunamis

### Immediate Goal:

Provide most timely advice to underpin response to possible continued tsunamigenic activity from Hunga Tonga-Hunga Ha'apai to countries at local and regional travel times

Distribution of confirmed tsunamis by generation mechanism

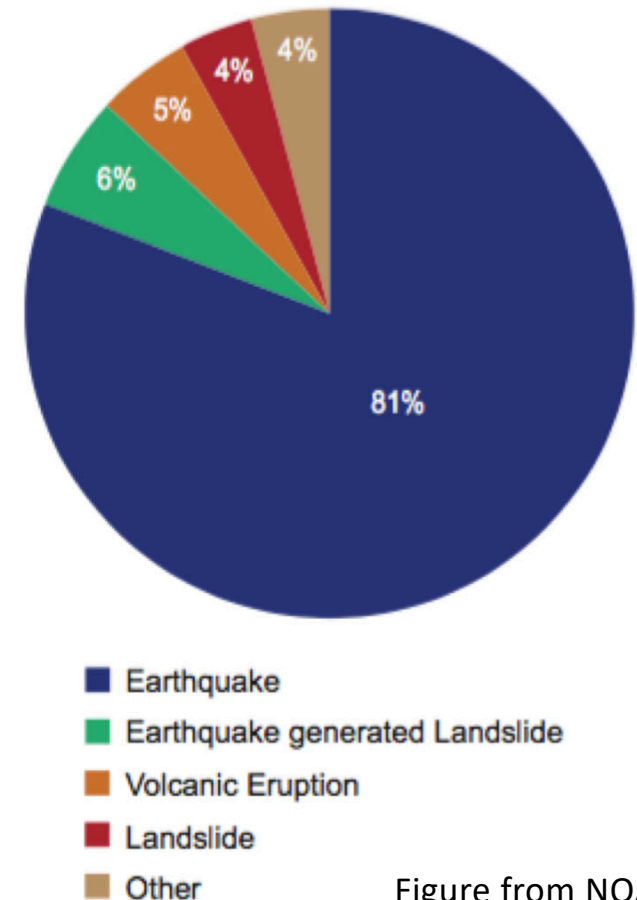
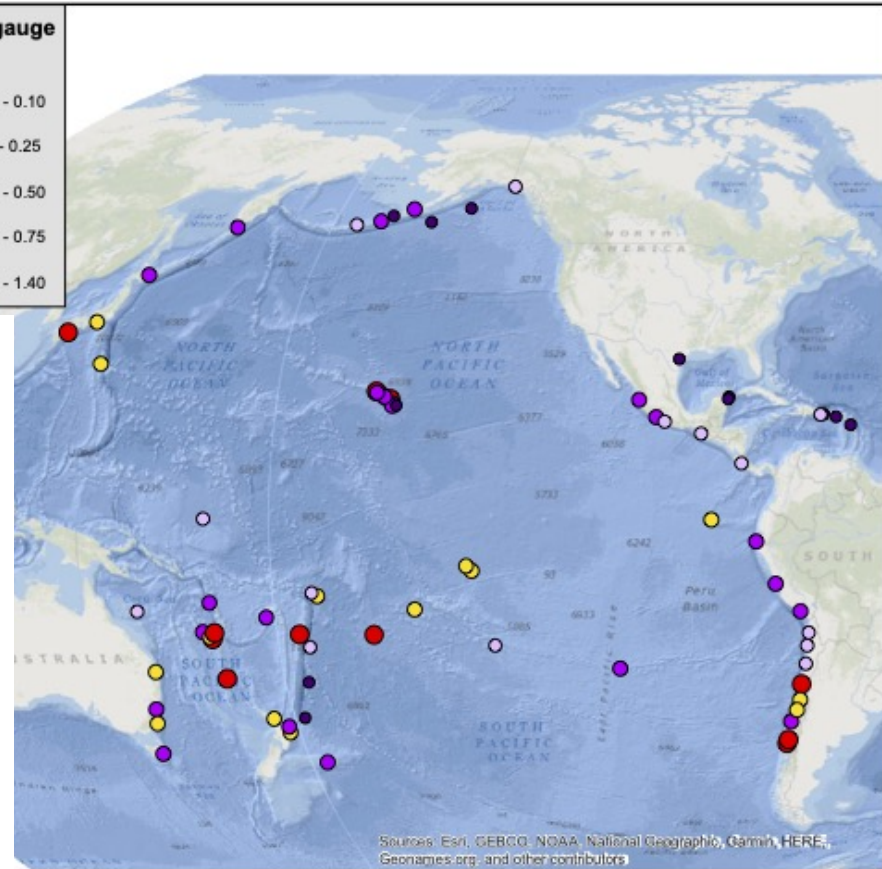
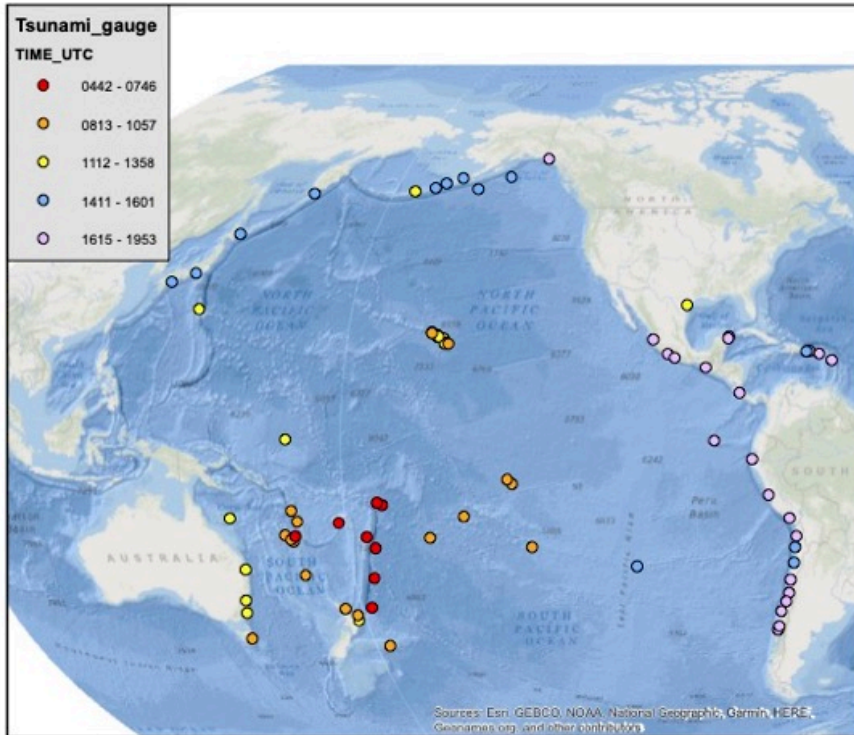
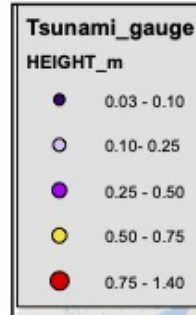


Figure from NOAA

# Challenges with forecasting non-earthquake tsunamis

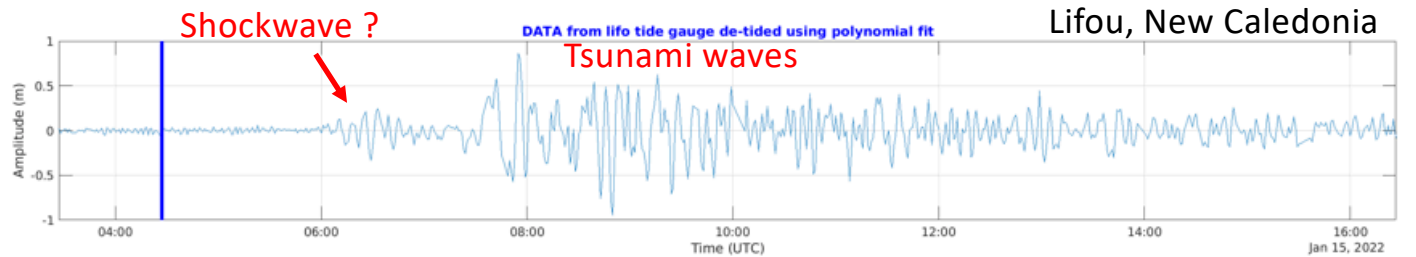
- Non-earthquake sources are difficult to describe due to limited data
- Volcanic sources are especially difficult to describe due to significant unknowns about both the complex eruption processes and the way these generate tsunamis
- Significant impacts of non-earthquake sourced tsunamis occur at local and regional travel times → **we need to be quick.**
- Natural warning may or may not be obvious
- Significant reduction of uncertainty (allowing for useful forecasts) can be made if source location is known. Given the ongoing hazard posed by Hunga Tonga Hunga Ha'apai, we will use the assumption of the volcano as a source for immediate analysis of local ocean observations.

# 15 Jan observations reported by PTWC



# Example coastal gauge records observed from 15 Jan tsunami

(downloaded from IOC website)



Lifou, New Caledonia

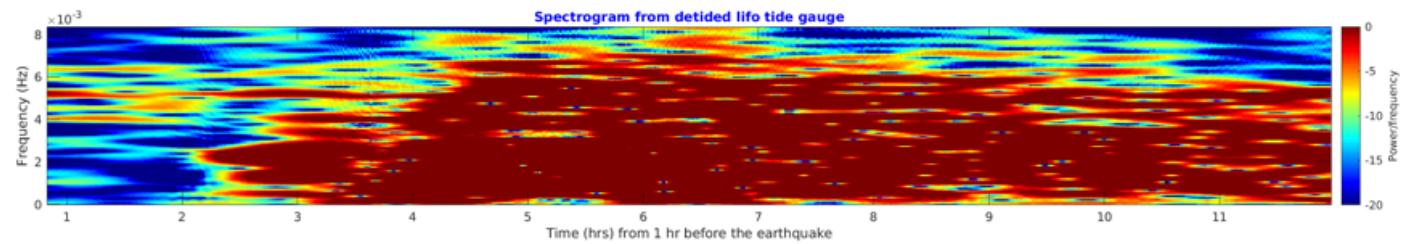
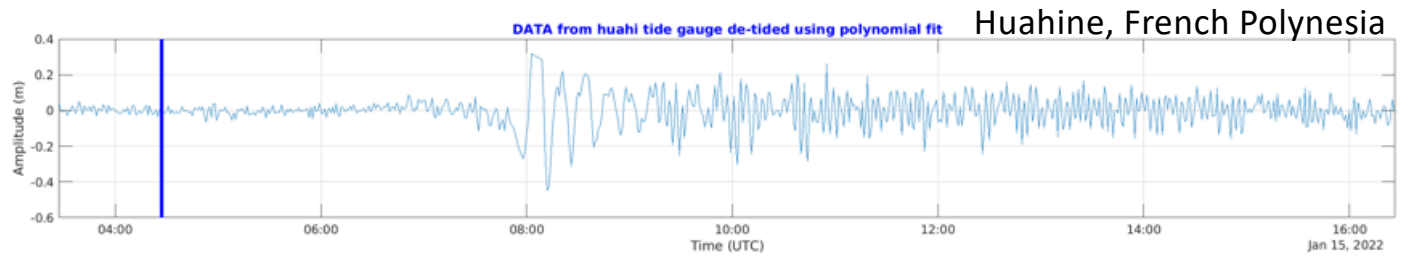


Figure prepared with TSUTIDA v1.2 - J. Roger, GNS Science



Huahine, French Polynesia

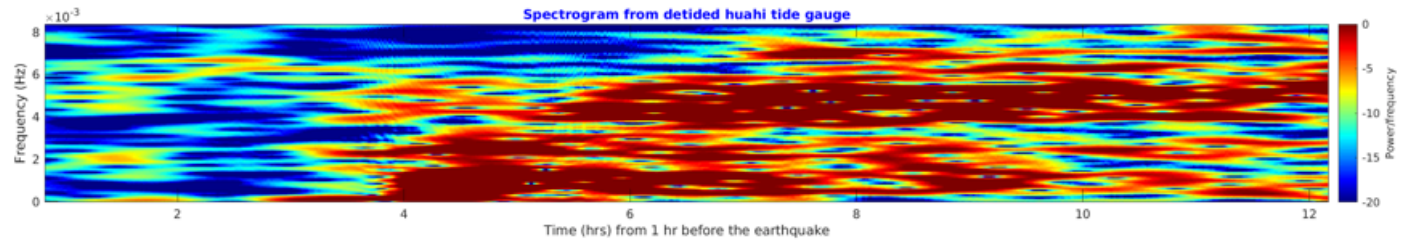


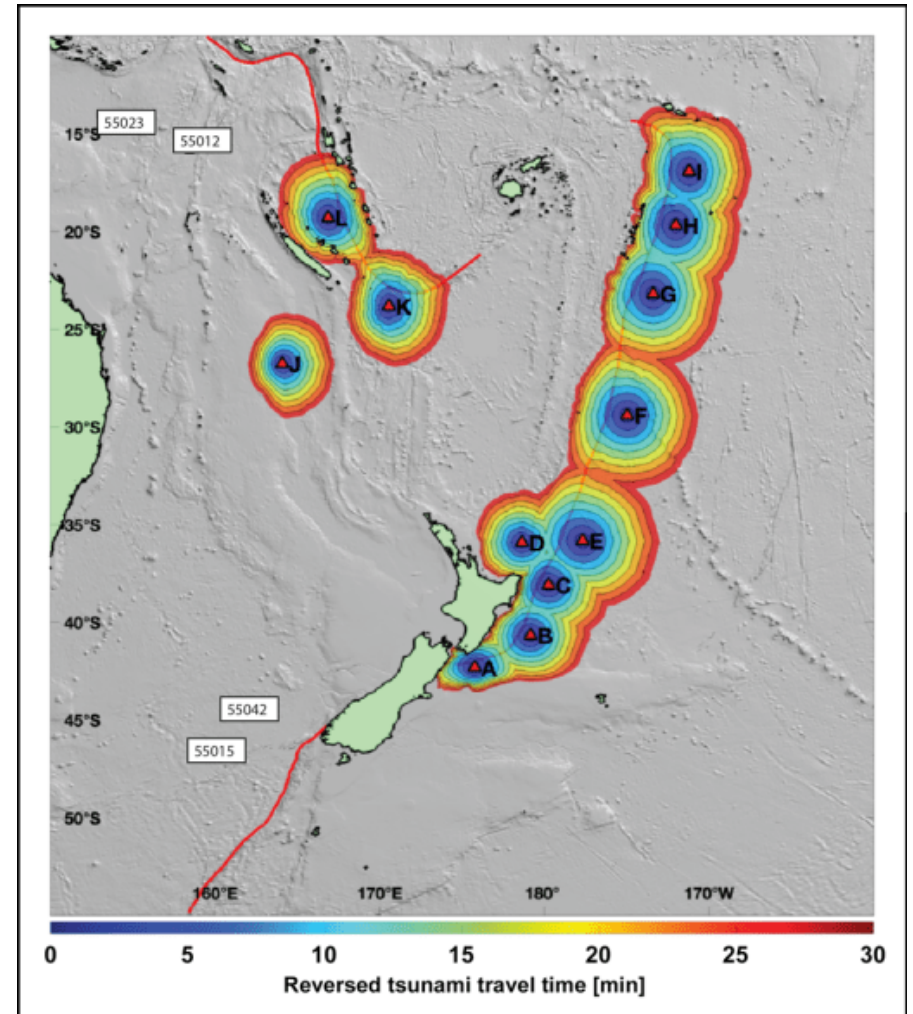
Figure prepared with TSUTIDA v1.2 - J. Roger, GNS Science

Provide by J. Roger, Te Pū Ao



# NZ DART Network

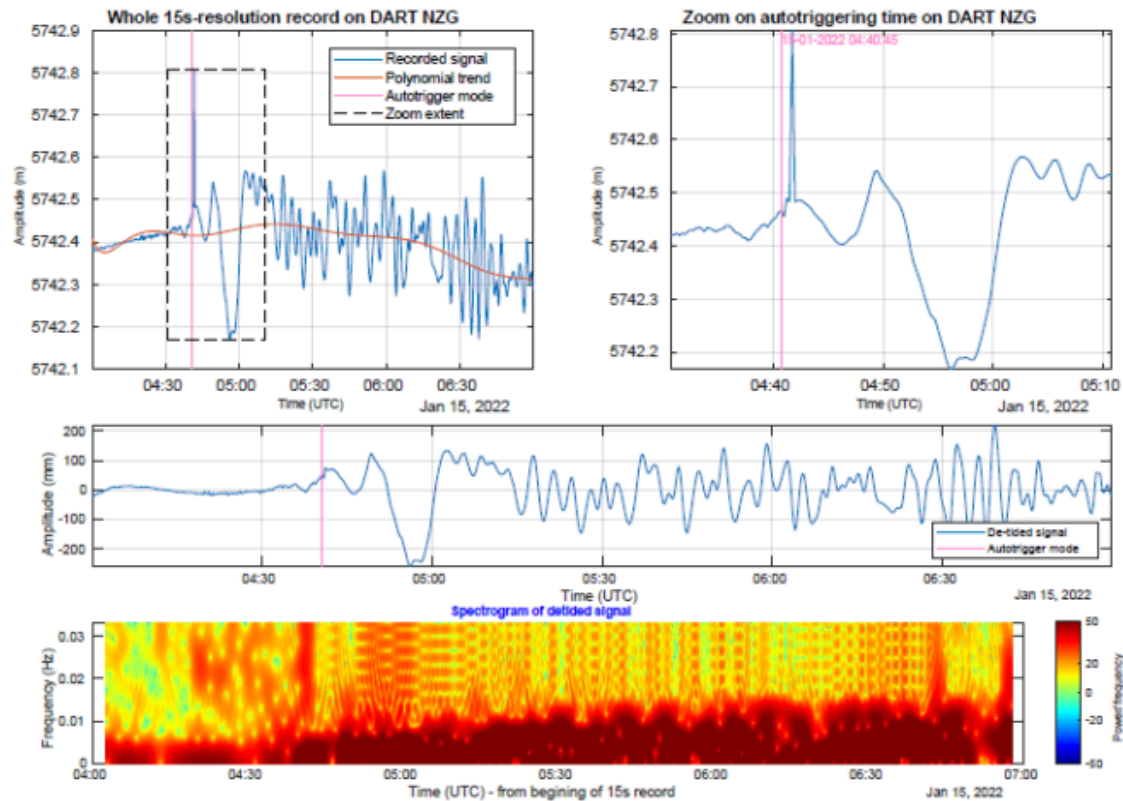
- The NZ DART Network (comprised of 12 stations) has 4 sites located within 1 hour travel time from Hunga Tonga Hunga Ha'apai
- Reverse tsunami travel times are shown as rainbow contours in the figure.
- Sources from Hunga Tonga Hunga Ha'apai arrive at NZG within approximately 20 minutes



Fry et al., 2020

# Tsunami recorded at nearest operational DART station - NZG

CATEGORY M - DATA from NZGP\_N3\_2022\_015\_01.csv



Provide by A. Gusman, J  
Roger, D. Burbidge Te Pū Ao

# Approximate travel times and impact at DART network

- Arrival at nearest station (NZG) is about 30 minutes

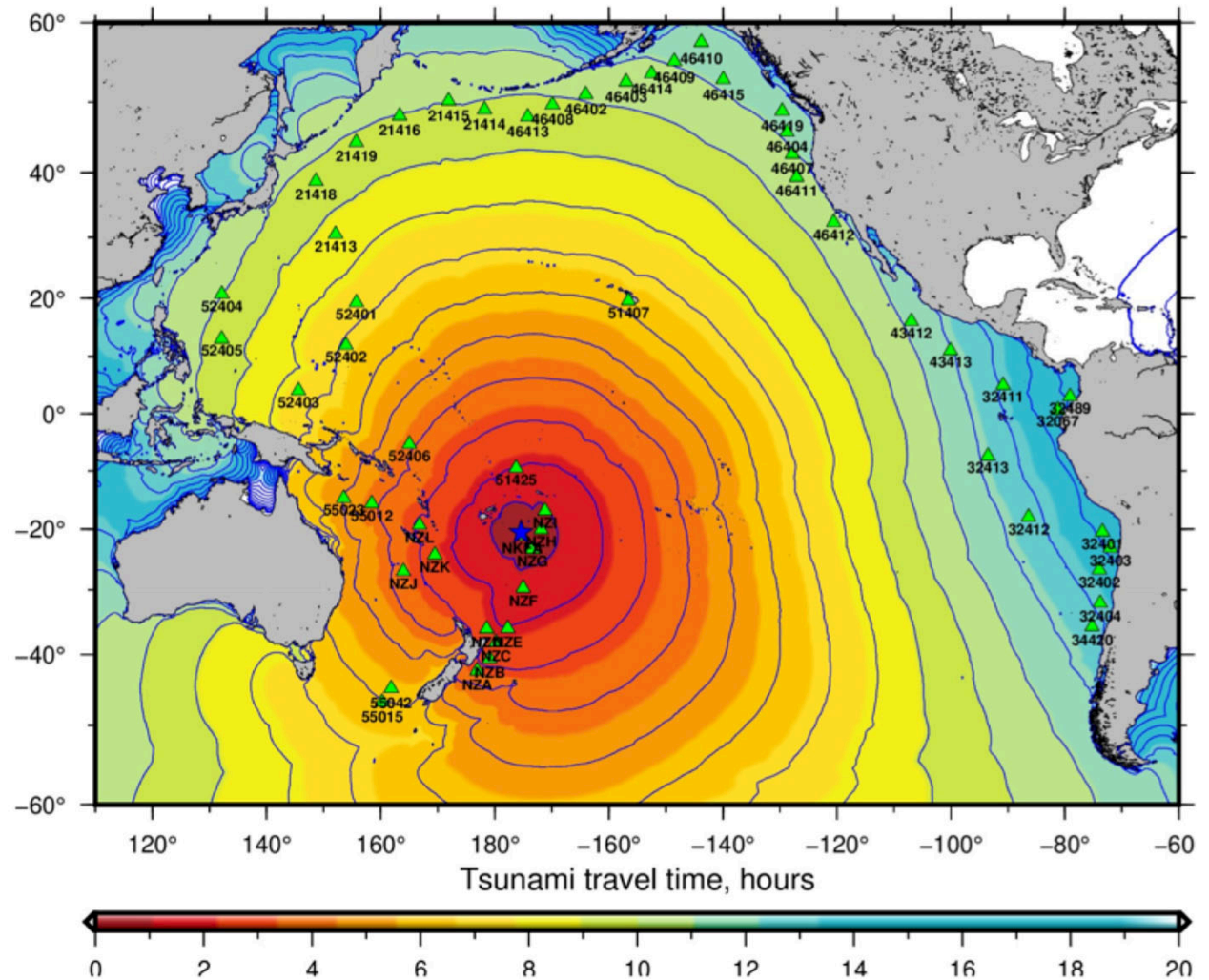


Figure courtesy of Aditya Gusman, Te Pū Ao



## 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 distance, **we propose to use first available single station (DART) amplitudes as an early indication of potential tsunami severity**
- Must assume the source is at or close to the source of 15 Jan
- We propose best endeavours to deliver notification (successively) when each of the following thresholds are reached on the nearest DART observation:
  - 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 Approach Short-Term – Alerting for subsequent Hunga Tonga-Hunga Ha’apai tsunami sources (continued)

- Indicative approximation of maximum wave height estimated from scaling 15 Jan recordings.
- Indicative arrival times of first waves from synthetic calculations (note, 15 Jan largest waves were not first arrivals in most regional recordings)
- Text based messages, at this point no graphical products are planned in the immediate future (outside of normal PTWC SOP)

## 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
- Indicative arrival times of first waves from synthetic calculations (note, 15 Jan largest waves were not first arrivals in most regional recordings)
- We have yet to record the complete tsunami and 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
OUIINNE_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



# Proposed Long-Term Approach (intersessional period)

- Creation of task team for developing volcano tsunami SOP guidelines
- Creation of task team for developing recommendations for using ocean wave observation to underpin and/or complement existing forecasting procedures

# Recommendations

It is recommended that the the PTWS ICG:

- **Considers** immediate implementation of the alerting procedure for future HTHH in the near term. It is expected that this implementation will be altered as necessary when additional capability and understanding arises.
- **Considers** establishing a task team to develop volcano tsunami SOP guidelines
- **Considers** establishing a task team to develop recommendations for utilizing ocean height observations into TEW procedures