

# Tsunami Response and the Enhance PTWC Alerts



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***GNS Science***



# Overview



1. GNS Science Procedures
2. Why Enhanced PTWC Products?
3. Event timeline for the Enhanced Products
4. Examples of the Enhanced Products
5. Example: Japan 2011

# Tsunami Response (1)

1. The response is initiated by either a message from the Pacific Tsunami Warning Centre (PTWC) or the location of an earthquake by GeoNet.
2. Preliminary advice to MCDEM on the likely threat to New Zealand is based only on PTWC and/or GeoNet information (supplemented by United States Geological Survey (USGS) National Earthquake Information Center (NEIC) information) **Predefined thresholds levels for magnitude, depth and location are used.**
3. GNS Science management are advised, and extra resources requested if required.

## Tsunami Response (2)

4. A Liaison Officer (Scientist) is made available to the National Crisis Management Centre if activated. For a local or regional event there may not be time for this to occur.
5. The Tsunami Experts Panel (TEP) is activated if the event will allow time for detailed discussions. For a local or regional event there may not be time for this to occur.
4. MCDEM are advised of threats to regions of New Zealand based on the **Tsunami Scenario Models**, and expected arrival times at key localities on the New Zealand coast, by utilising **Tsunami Travel Time software**.

## Tsunami Response (3)

7. The first detailed advice to MCDEM on the likely impact to New Zealand is provided within one hour based on:
  - a. Current earthquake parameters and sea-level data;
  - b. Available tsunami forecast models (Tsunami Scenario Models, WebSIFT);
  - c. Historical tsunami information.
8. Hourly updates are provided to MCDEM even if there is no new information and after each new message from PTWC.
9. Advice is provided on 'all clear' based on tsunami propagation models and observed sea level data. **Large surges and strong currents are possible many hours after the first arrival.**

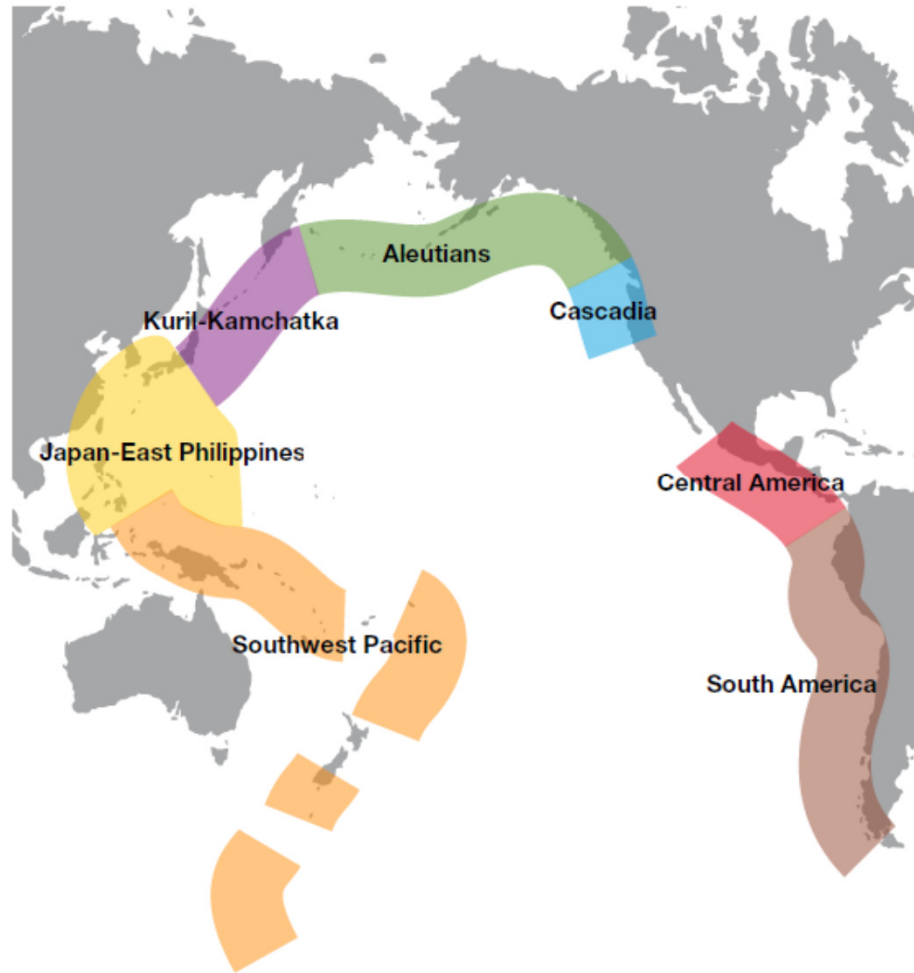
# Tsunami Experts Panel

- The role of the Tsunami Experts Panel (TEP) is to support the GeoNet Duty Team in its provision of authoritative scientific advice to MCDEM on the likely impacts of tsunami.
- The TEP is comprised of 14 New Zealand resident scientists
  - Expertise in seismology, plate tectonics, historical tsunami impacts, water modelling, or inundation.
  - Temperament to allow working collegially and under pressure



# TSUNAMI SCENARIO DATABASE

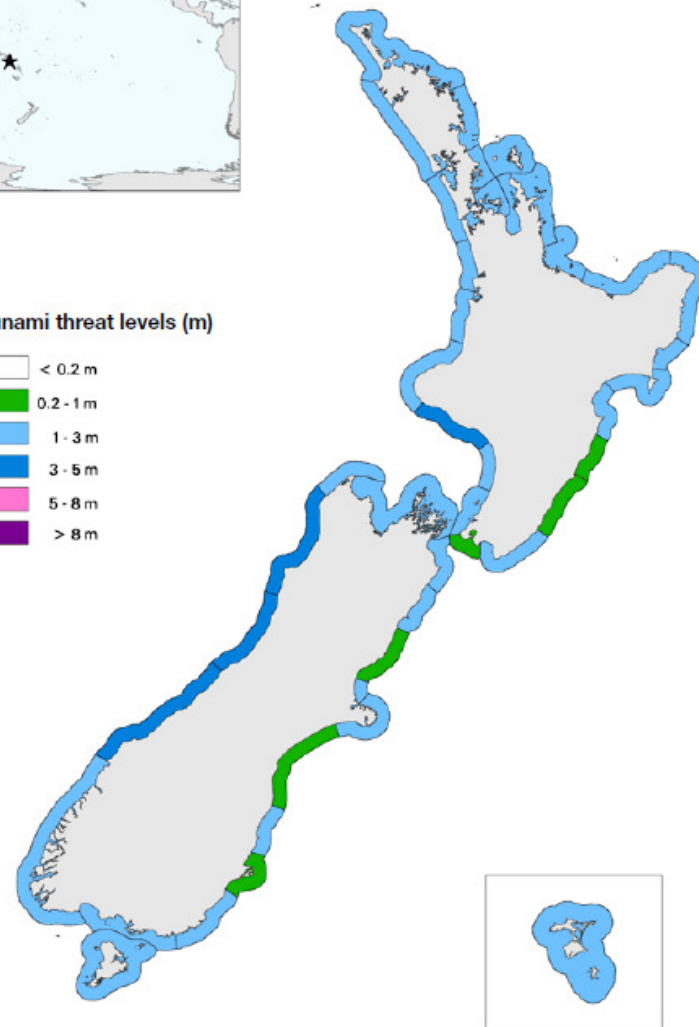
[Main Index Map](#) >> [Southwest Pacific](#) >> [New Britain-Solomons-Vanuatu](#) >> [Magnitude 9.0](#)



NH\_mw90\_5 Mw 9 Loc: 162.4E 11S



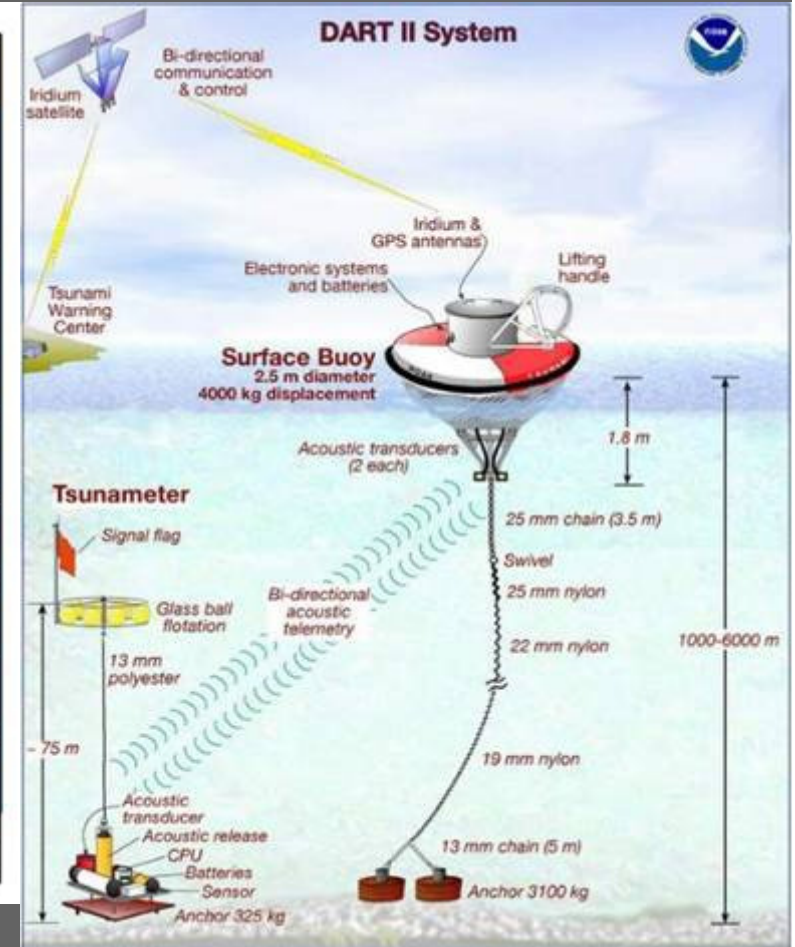
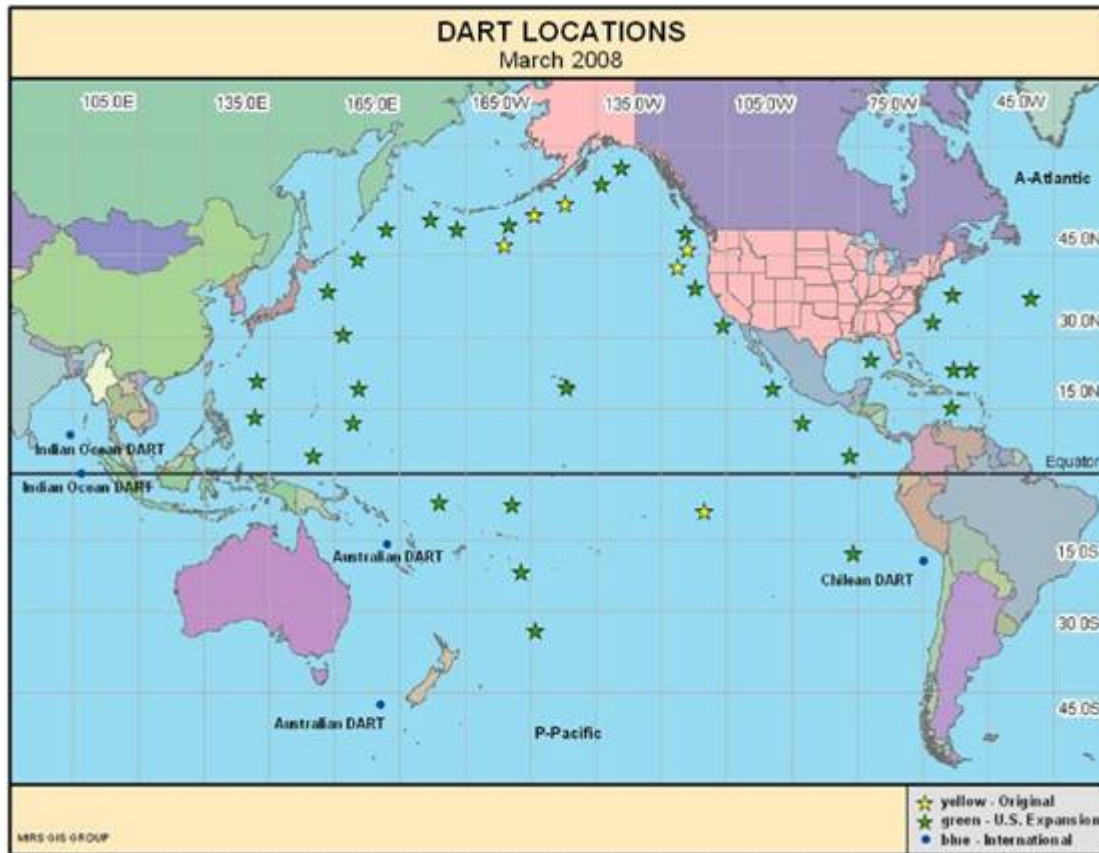
Tsunami threat levels (m)



Version 2.02 September 2013

This document is due to be replaced by 1 September 2015.  
It is not recommended to use this document after this date.

# Tsunami Monitoring – DART Buoys

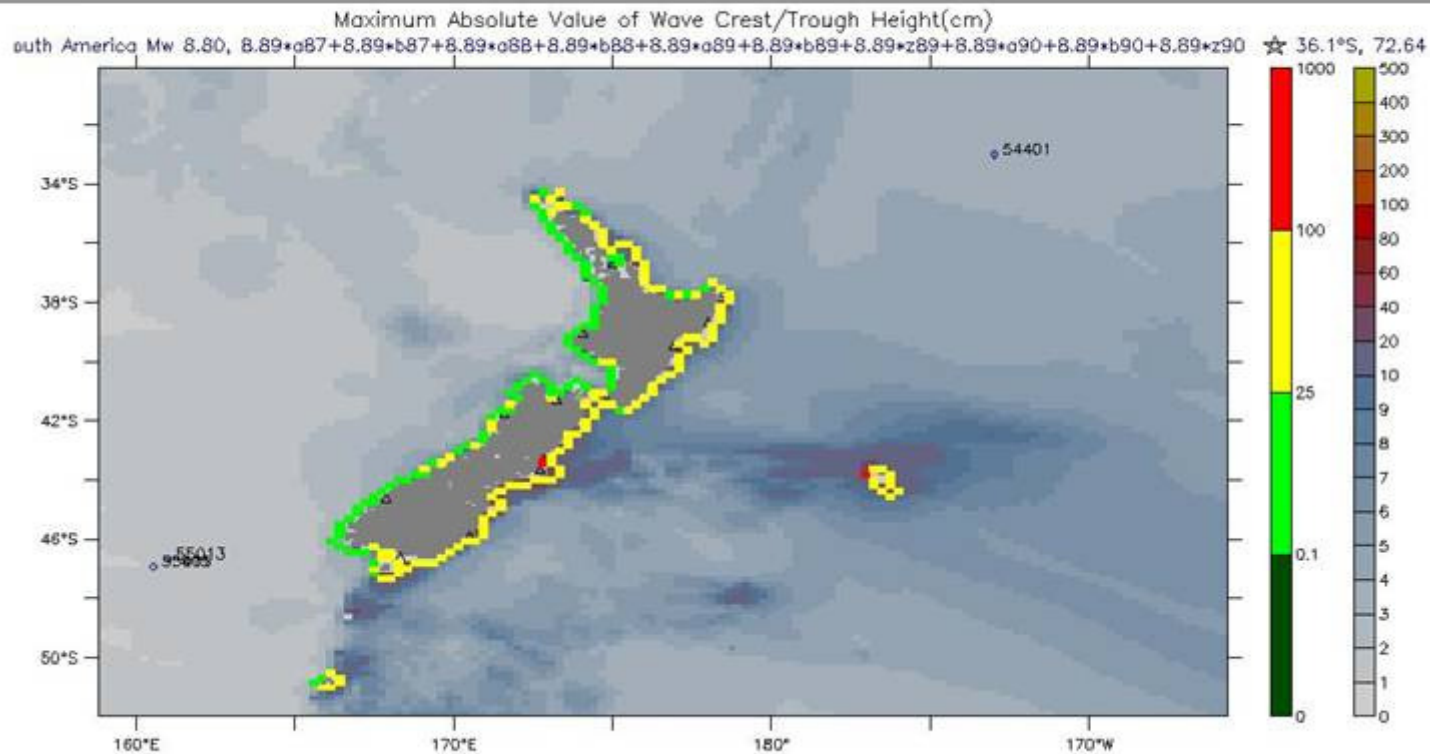




# WebSIFT

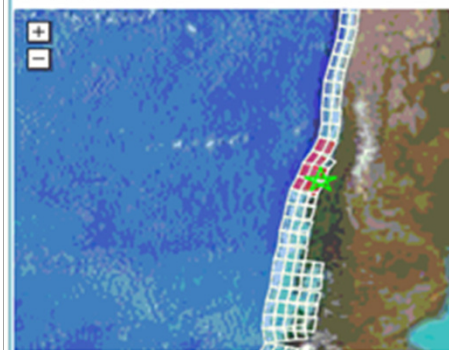
Maximum Wave Forecast Coastal Forecast DART Inversion Export

Update



27 Feb 2010 06:34:16 (UTC) Mw: 8.5 Ep: 36.100°

Unit Source Editor



Maximum Wave Forecast Coastal Forecast DART

Get DART timeseries

Do Inversion



## Tsunami Forecast modelling

Applet gov.noaa.tsunami.websift.SiftApplet started

# Overview



1. **GNS Science Procedures**
2. **Why Enhanced PTWC Products?**
3. **Event timeline for the Enhanced Products**
4. **Examples of the Enhanced Products**
5. **Example: Japan 2011**

# Why Enhanced PTWC Products?

## Introduction

- ❑ Current PTWC “Products” effectively put the whole Pacific Ocean into warning following a large earthquake, despite the fact that the tsunami will be minor in most locations
- ❑ Over the last decade very good forecast models have been developed and tested which can indicate the possible size of a tsunami at a given location
- ❑ During recent years the Pacific Tsunami Warning & Mitigation System (PTWS) has been developing new protocols and messaging to alert countries of tsunami threats
- ❑ Tsunami modelling tools can be used to provide countries with a more realistic estimate of the level of threat they can expect from earthquake induced tsunami
- ❑ Starting in May this year (2013) the Pacific Tsunami Warning Center in Hawaii began issuing Enhanced Products on an experimental basis (in parallel with current official messaging). These will replace the current messages in October 2014.

# Why Enhanced PTWC Products?

## The New:

- ❑ Based primarily on numerical tsunami forecasts
- ❑ Initial forecast based on preliminary earthquake parameters (location, depth and magnitude)
- ❑ Initial products issued in less than 10 min
- ❑ Later forecasts constrained by earthquake mechanism and sea level readings. Text (public) as well as graphical information for NWC
- ❑ No alert levels, watches or warnings – this is left to national authorities
- ❑ Only 3 general threat levels (a part from “no threat”):
  - 0.3-1m
  - 1-3m
  - >3m

# Tsunami Threat Levels (New Zealand)

Maximum water level along coastal sections

- Threat Levels:
  - 20cm - 1m Marine and beach threat
  - 1m - 3m Marine and land threat
  - 3m - 5m
  - 5m – 8m
  - 8m+

**Wave run-up is potentially up to twice as high** (on steep slopes and v-shaped valleys near the coast)

- **Tidal states are not included in the threat levels**

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## Sample Timeline (1)

00h00m	A large earthquake occurs in the Pacific region
00h02m	Vibrations from the earthquake reach seismic stations near the earthquake epicenter, triggering event alarms at PTWC. PTWC duty analysts respond and begin to analyze the event.
00h08m	Using a combination of automatic and interactive analyses, duty analysts complete their preliminary determination of the earthquake epicenter, depth, and magnitude. These parameters are used to initiate runs of numerical tsunami forecast models for a limited region near the epicenter.
00h10m	A. If there is no tsunami threat because the earthquake is too small or too deep inside the earth or inland, then the initial product will just be an Information Statement.

## Sample Timeline (2)

**Initial Product. The type of product issued will depend on the estimate threat:**

**00h10m**

B. If there is a potential tsunami threat, then the initial product may either be

1. The entire suite of products with the initial forecast amplitudes or
2. A text product only containing the earthquake parameters and a statement to the effect that earthquakes of this size and location typically pose a tsunami threat but that it has not yet been quantified and the forecast will follow later.

(Option B.2 may be necessary to indicate a potential threat as quickly as possible but avoid issuing a misleading forecast if it is too poorly constrained with the initial seismic data)

**00h20m**

If the earthquake parameters change significantly from what was in the initial bulletin then the forecasts are re-run. If there is a significant change in the forecasts then appropriate supplemental products, similar to those described above, are issued.



## Sample Timeline (3)

**The seismic analyses continue as data from additional seismic stations arrive and are processed**

**00h25m**

For earthquakes above about magnitude 7.0, a preliminary mechanism for the earthquake is available about this time. The mechanism helps constrain the estimate of seafloor changes that causes tsunami, and is used in re-runs of the forecast models that covers the entire Pacific.

**00h35m**

For events with a tsunami threat, additional messages are issued based upon the earthquake mechanism and includes maps, table, and other products that cover the entire Pacific region and marginal seas of the PTWS.

**Up to  
02h00m**

Within the first 2 hours, and depending upon where the earthquake occurs, the tsunami will arrive and be measured on the nearest one or two coastal gauges and one or two deep-ocean gauges.

## Sample Timeline (4)

### Sea level data is used to refine the modeling and messages

<b>01h00m to 03h00m</b>	<p>As observations of tsunami waves become available, they will be used to compare with existing forecasts and to adjust those forecasts when necessary. Updates will be provided at least once per hour.</p> <p>Typically, the forecast will become stable after a few readings from deep-ocean gauges and not require further adjustment. Products will be issued at least once an hour with any updated forecasts.</p>
<b>Beyond 3h</b>	<p>The tsunami is monitored on coastal and deep-ocean sea-level gauges as it advances. Reports from Member States and the media may also be received.</p> <p>When it is clear there is no longer a significant tsunami threat or the tsunami has crossed the entire Pacific then a final product is issued. This is not an “all clear” but will just state it is the last message for this event – it is up to countries to provide the “all clear” for their citizens</p>

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# Sample Text Product

ZCZC

WEPA40 PHEB 150008

TSUPAC

EXPERIMENTAL TSUNAMI MESSAGE NUMBER 1

NOT FOR DISTRIBUTION

NWS PACIFIC TSUNAMI WARNING CENTER EWA BEACH HI

0008 UCT THU AUG 15 2013

...TSUNAMI THREAT MESSAGE...

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

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.

**NATIONAL AUTHORITIES WILL DETERMINE THE TSUNAMI THREAT AND  
APPROPRIATE LEVEL OF ALERT FOR EACH COUNTRY.**

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

# Sample Text Product

## PRELIMINARY EARTHQUAKE PARAMETERS

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\* MAGNITUDE            8.6  
\* ORIGIN TIME        0000 UTC AUG 15 2013  
\* COORDINATES        14.3 SOUTH 166.2 EAST  
\* DEPTH                20 KM / 12 MILES  
\* LOCATION            VANUATU

## EVALUATION

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- \* AN EARTHQUAKE WITH A PRELIMINARY MAGNITUDE OF 8.6 OCCURRED IN THE VANUATU ISLANDS AT 0000 UTC ON THURSDAY AUGUST 15 2013.
- \* BASED ON THE PRELIMINARY EARTHQUAKE PARAMETERS... HAZARDOUS TSUNAMI WAVES ARE FORECAST FOR SOME COASTS.
- \* ACTUAL AMPLITUDES AT THE COAST MAY VARY FROM FORECAST AMPLITUDES DUE TO UNCERTAINTIES IN THE FORECAST AND LOCAL FEATURES. IN PARTICULAR, MAXIMUM TSUNAMI AMPLITUDES ON ATOLLS WILL LIKELY BE MUCH SMALLER THAN THE FORECAST INDICATES

# Sample Text Product

TSUNAMI THREAT FORECAST...UPDATED

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- \* TSUNAMI WAVES REACHING MORE THAN 3 METERS ABOVE THE TIDE LEVEL ARE POSSIBLE ALONG SOME COASTS OF

VANUATU... SOLOMON ISLANDS... AND PAPUA NEW GUINEA.

- \* TSUNAMI WAVES REACHING 1 TO 3 METERS ABOVE THE TIDE LEVEL ARE POSSIBLE ALONG SOME COASTS OF

AUSTRALIA... NEW CALEDONIA... MARSHALL ISLANDS... FIJI... SAMOA... KIRIBATI... AND WALLIS AND FUTUNA.

- \* TSUNAMI WAVES REACHING 0.3 TO 1 METERS ABOVE THE TIDE LEVEL ARE POSSIBLE FOR SOME COASTS OF

NEW ZEALAND... AMERICAN SAMOA... TOKELAU... NAURU... HOWLAND AND BAKER... TONGA... TUVALU... AND NIUE.

- \* FOR OTHER AREAS COVERED BY THIS PRODUCT A FORECAST HAS NOT YET BEEN COMPUTED. THE FORECAST WILL BE EXPANDED AS NECESSARY IN SUBSEQUENT PRODUCTS.

# Sample Text Product

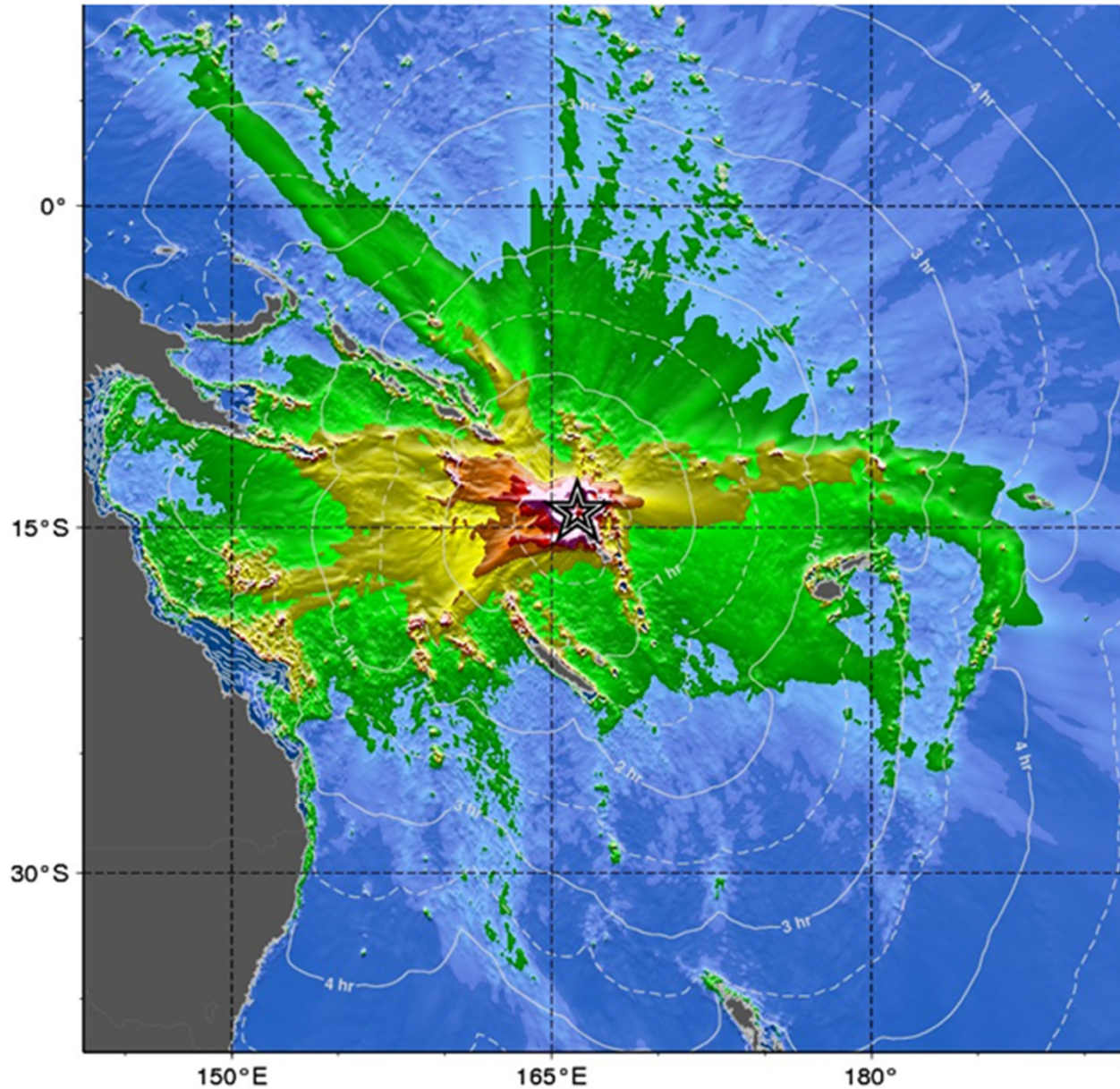
## RECOMMENDED ACTIONS

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- \* 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.
- \* PERSONS LOCATED IN THREATENED COASTAL AREAS SHOULD FOLLOW INSTRUCTIONS FROM NATIONAL AND LOCAL AUTHORITIES.

## PTWC Deep-Ocean Tsunami Amplitude Forecast

(Actual amplitudes at the coast may vary from forecast amplitudes due to uncertainties in the forecast and local features. In particular, maximum tsunami amplitudes on atolls will likely be much smaller than the forecast indicates.)



### Model Run 1



Pacific  
Tsunami  
Warning  
Center

#### Earthquake:

15 Aug 2013

00:00:00 Z

Lat: 14.30°S

Lon: 166.20°E

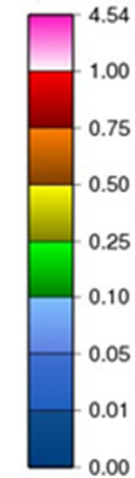
Depth: 20 km

$M_w$ : 8.60



Assumed  
Earthquake  
Mechanism

#### Maximum Amplitude (m)



model run at:

09 Aug 2013

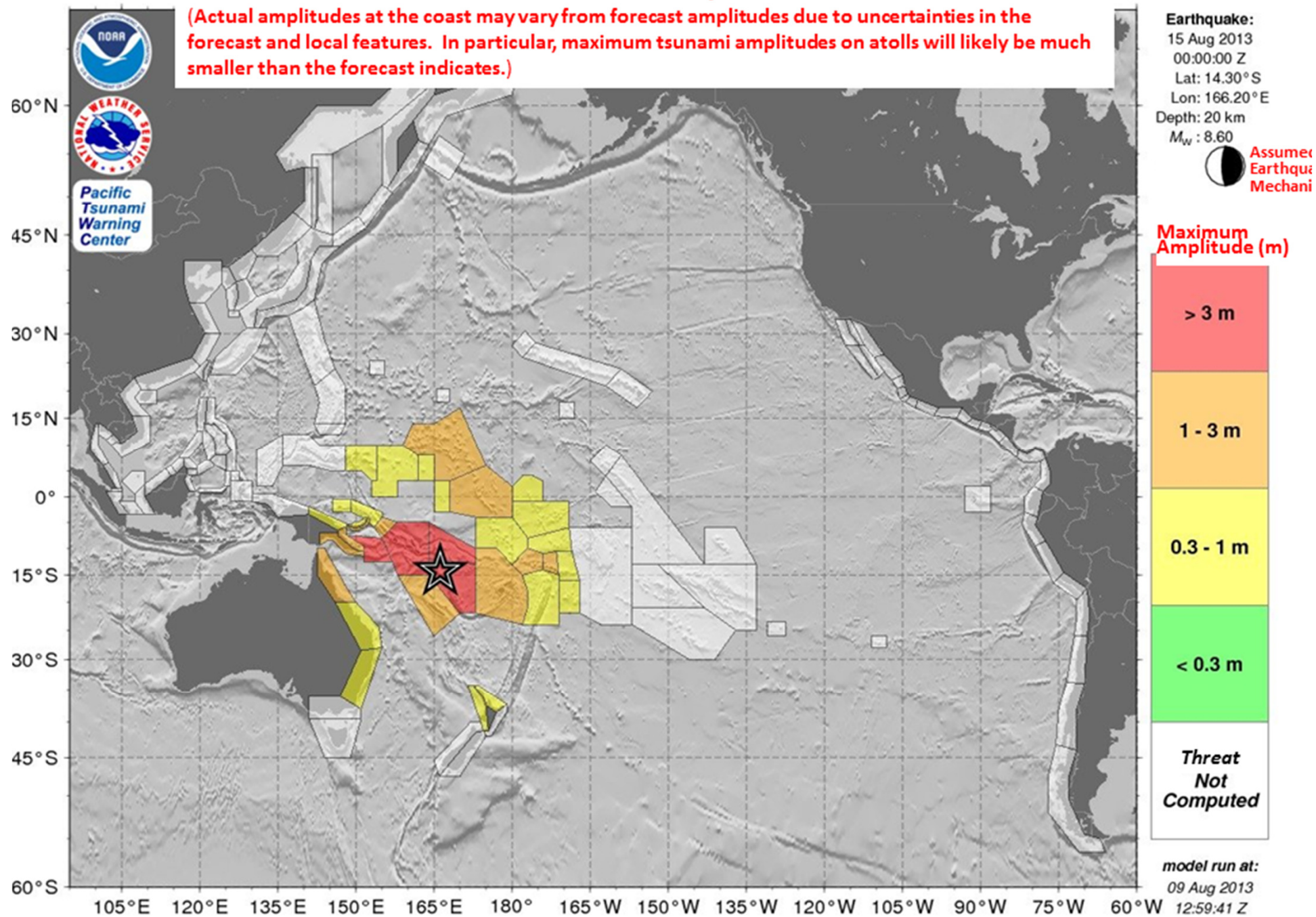
12:59:41 Z



## PTWC Coastal Tsunami Amplitude Forecast

(Actual amplitudes at the coast may vary from forecast amplitudes due to uncertainties in the forecast and local features. In particular, maximum tsunami amplitudes on atolls will likely be much smaller than the forecast indicates.)

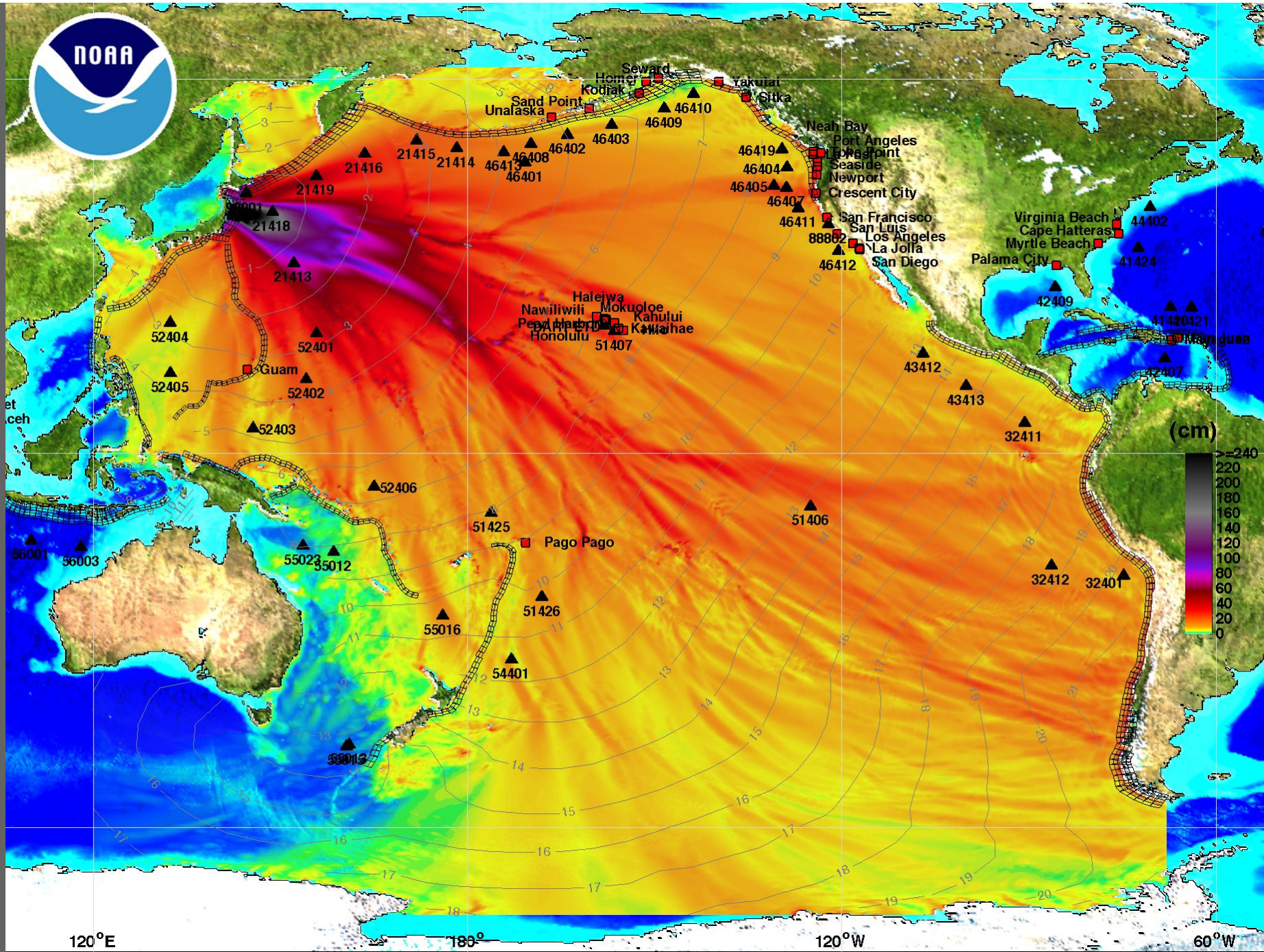
### Model Run 1



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# Tsunami Threat Level Map

## Quick Statistics

### Earthquake size and source:

M8.9, near east coast of Honshu Japan

### Time of earthquake:

1846 NZDT 11/03/2011

### First estimated tsunami arrival time in NZ:

0623 NZDT 12/03/2011  
(North Cape)



### NOTE:

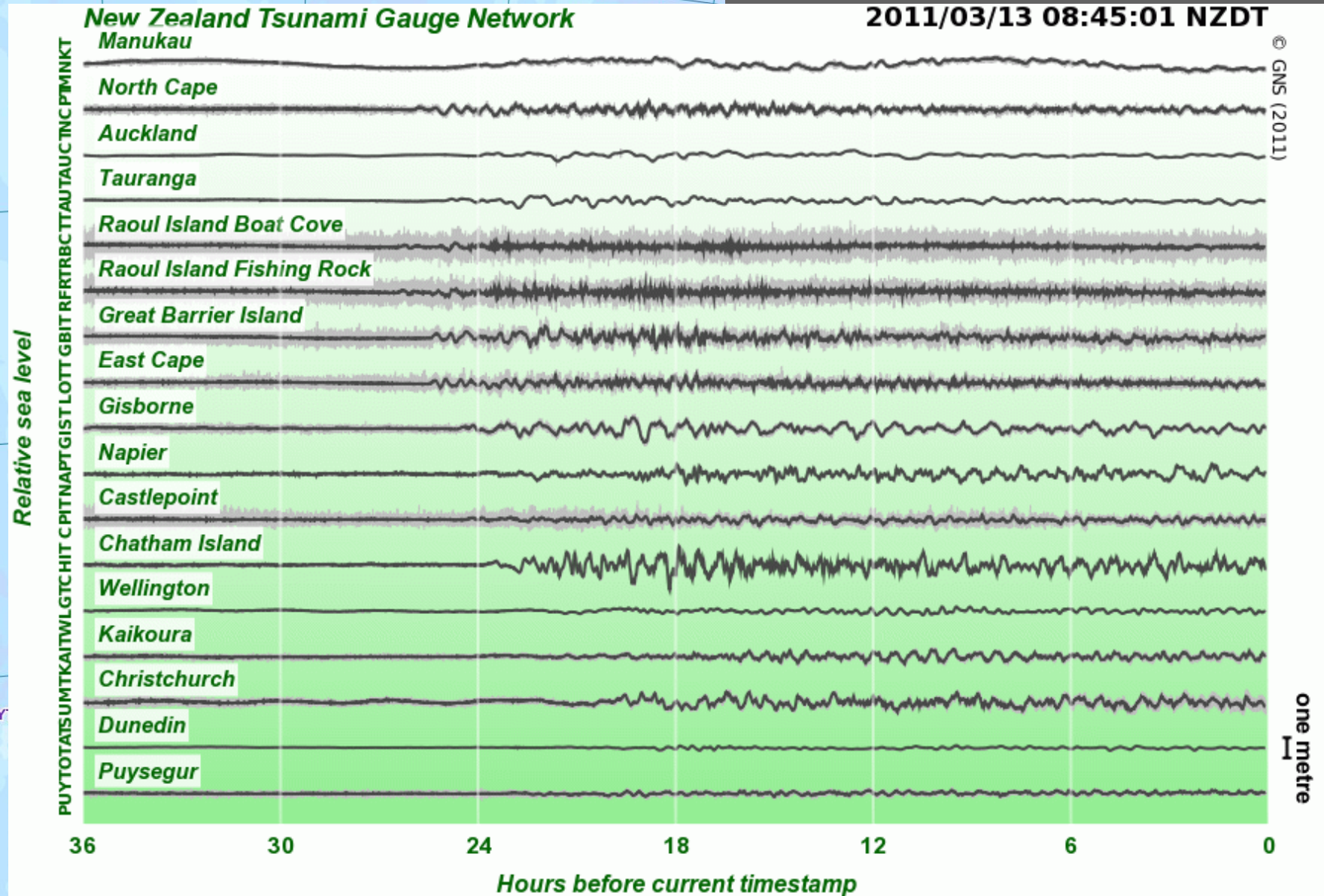
1. The stated threat levels may apply to any one of the series of waves generated by the event and not necessarily to the first wave. The first wave is not always the largest or highest and waves are likely to continue for many hours.
2. The threat levels suggest the largest wave at any coastal point inside the zone. Wave heights will vary within a zone.
3. The amplitudes do not include the tidal state (sea level) at the time the wave reaches the shore.
4. The estimate is for the maximum expected wave amplitude at shore. Run-up can be up to twice as high on steep slopes onshore near the coast, i.e. a wave measuring 5m at shore can run up as high as 10m on-land near the shore.
5. The colours used to illustrate threat levels do not relate to the colours used for evacuation zones (red, orange, yellow – see *Tsunami Evacuation Zones DGL08/08*, MCDDEM).
6. The expected wave amplitudes (crest to sea level) at the shore are likely to be different to measurements given in PTWC bulletins. PTWC measurements are taken at sea level gauges in the open ocean or at coastal points off-shore from New Zealand. MCDDEM information represents the official threat estimates.

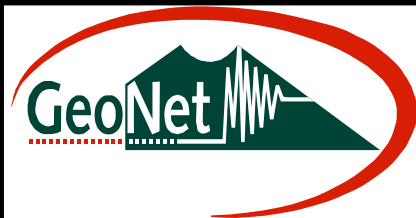
Maximum expected amplitude at shore	Threat definition
<20cm	No threat
20cm-1m	Threat to beach, harbours, estuaries & small boats
1m-3m	Minor land threat
3m-5m	Moderate land threat
5m-8m	High land threat
8m+	Severe land threat

Last updated: 0020 NZDT 12/03/2011

# New Zealand Tsunami Gauge Network

# Tsunami Gauge Network





[www.geonet.org.nz](http://www.geonet.org.nz)

