

# Tsunami Warnings – the GeoNet Component

**William Power**  
Geophysicist, Natural Hazards, GNS Science



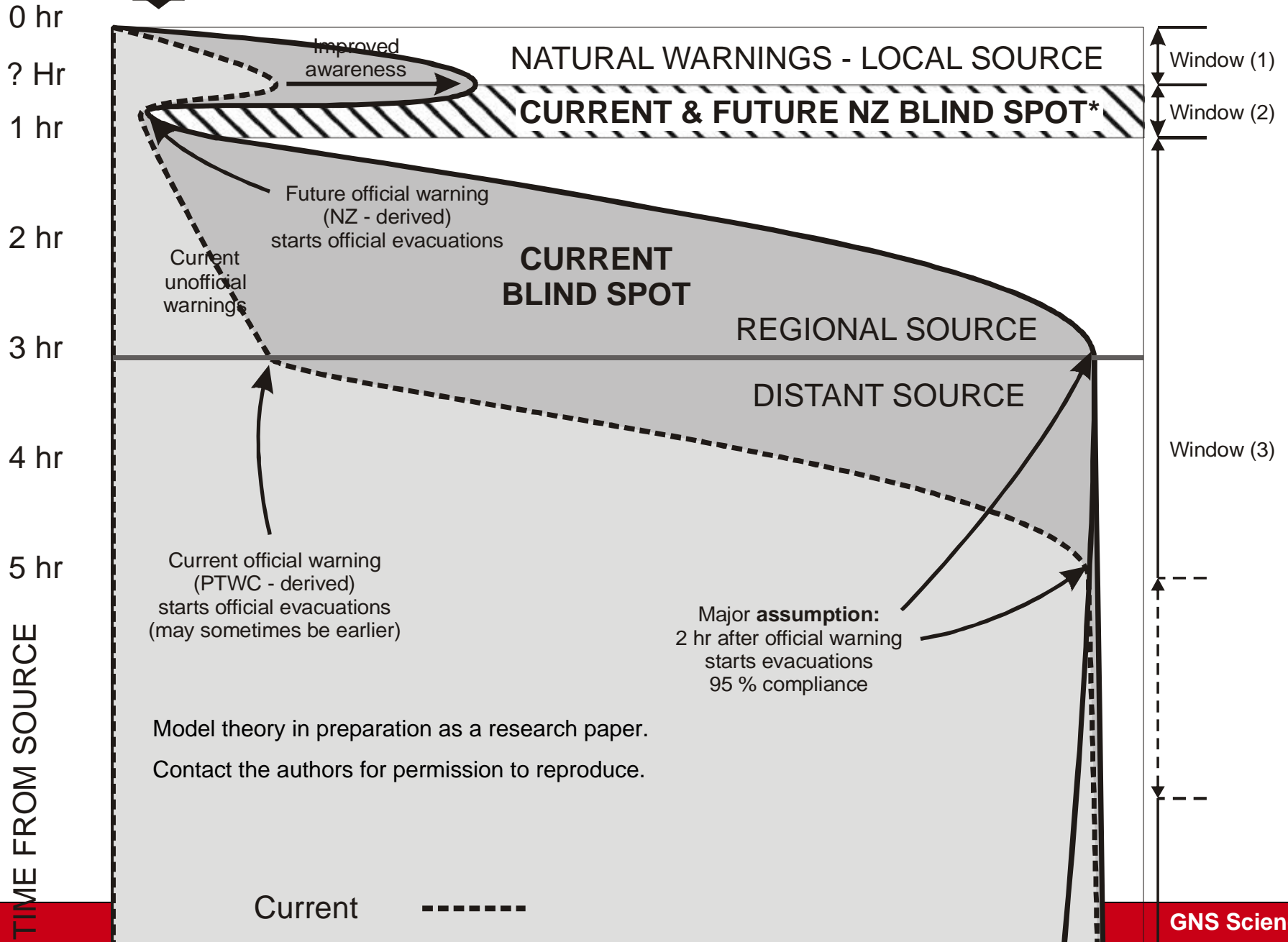
# Tsunami Source Categorisation

- **Distant Source – travel time > 3 hours**  
**National Warning System**
- **Regional Source – travel time 1–3 hours**  
**National Warning System + Informal Evacuation**
- **Local Source – travel time less than 1 hour**  
**Self Evacuation (Natural Signs)**

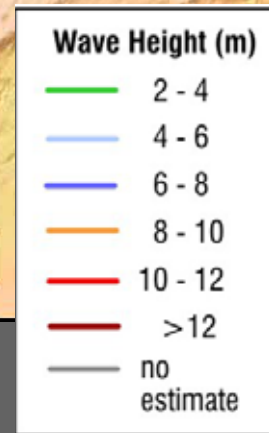
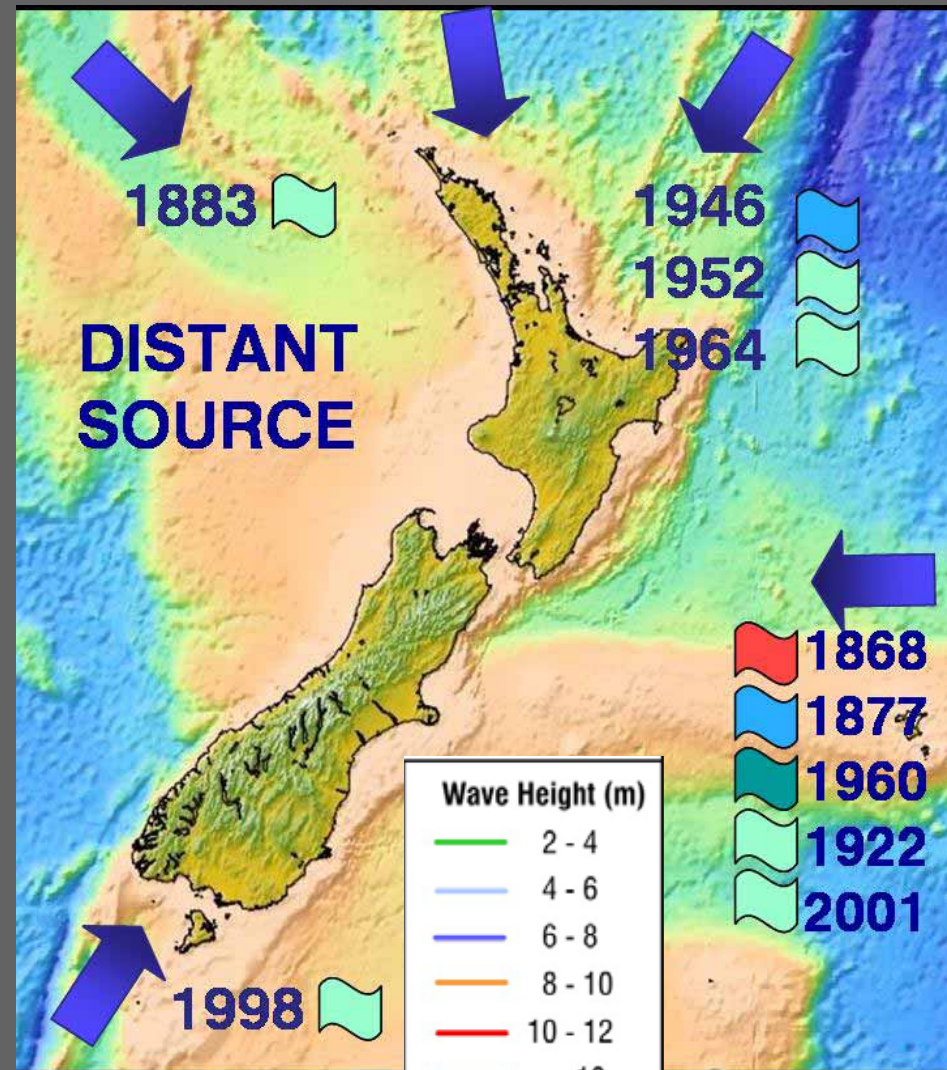
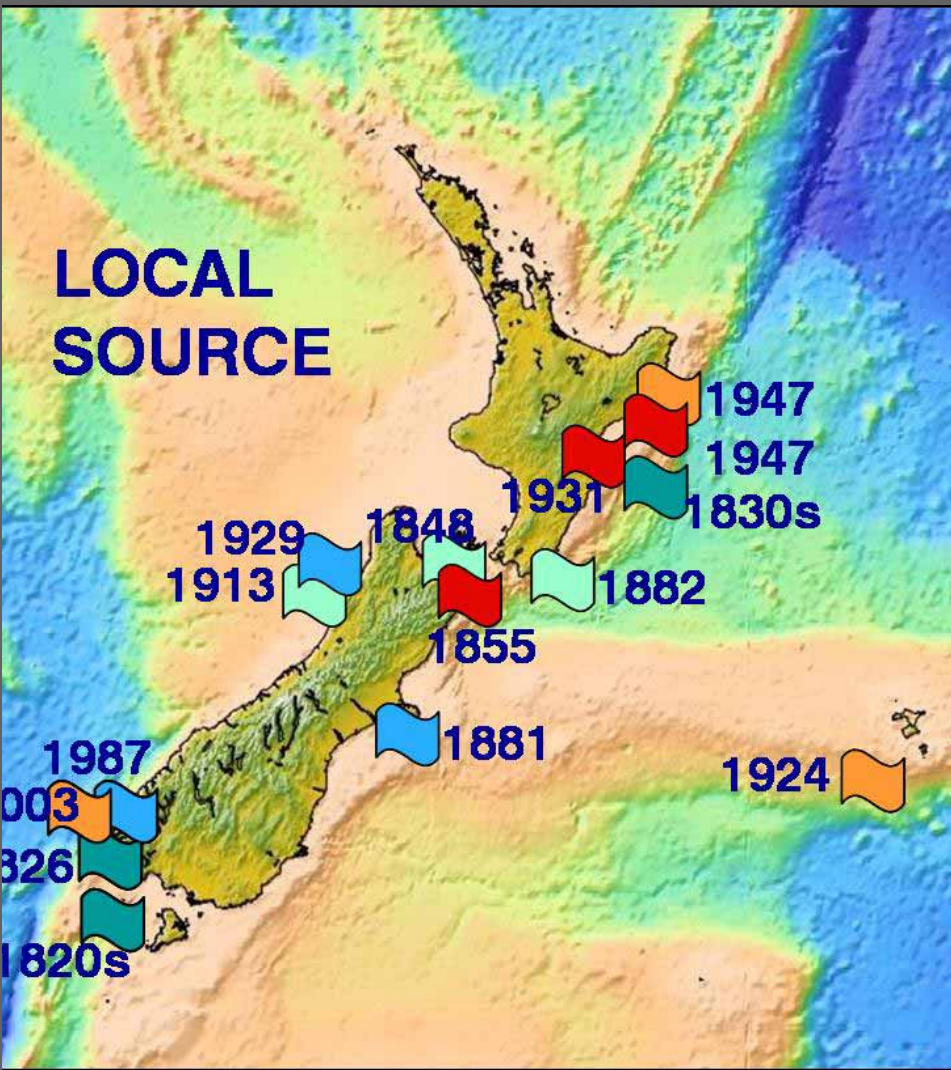
**Today: Distant-Source Warnings**



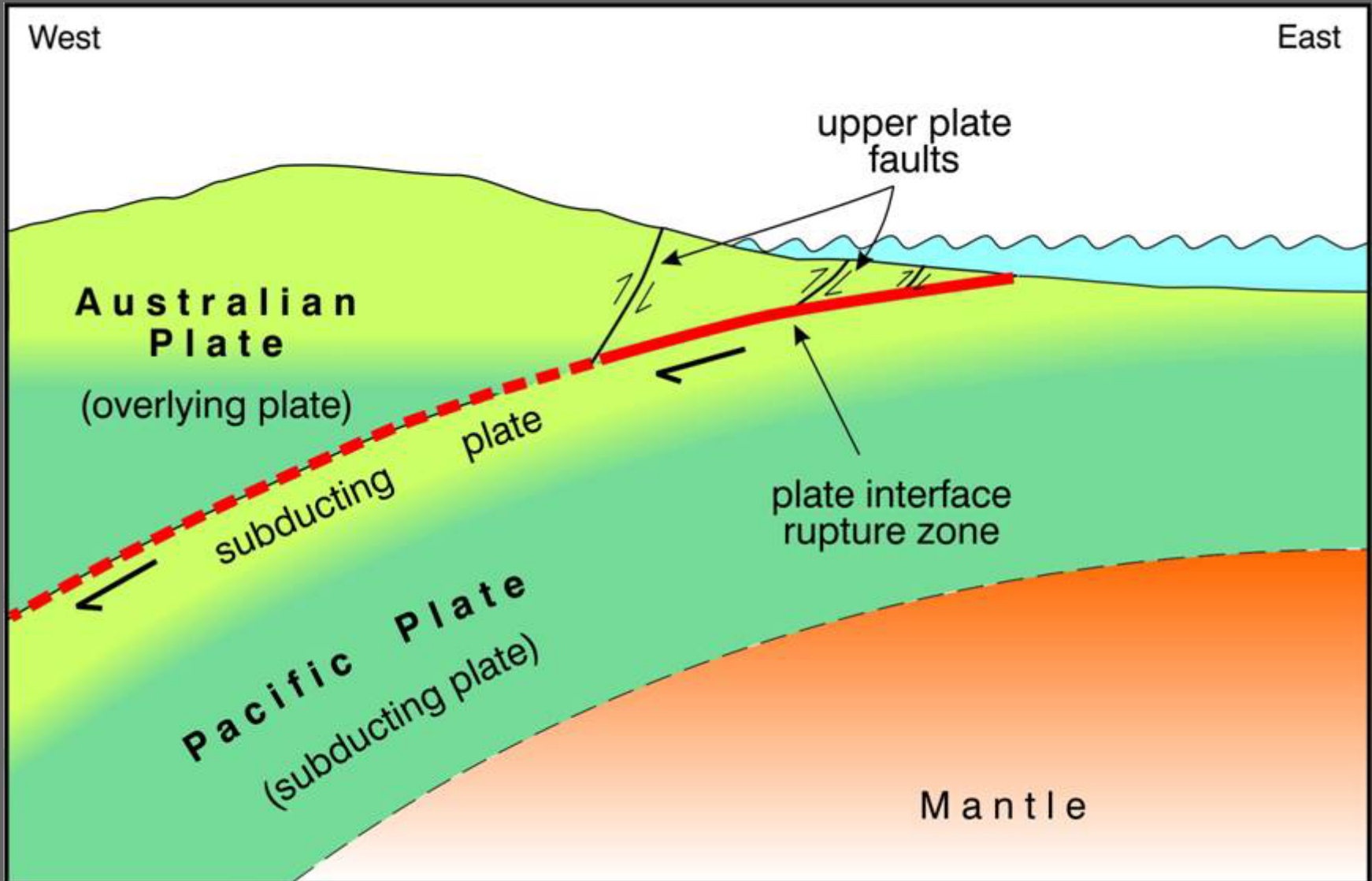
# DAYTIME EVACUATION COMPLIANCE RATES MODEL



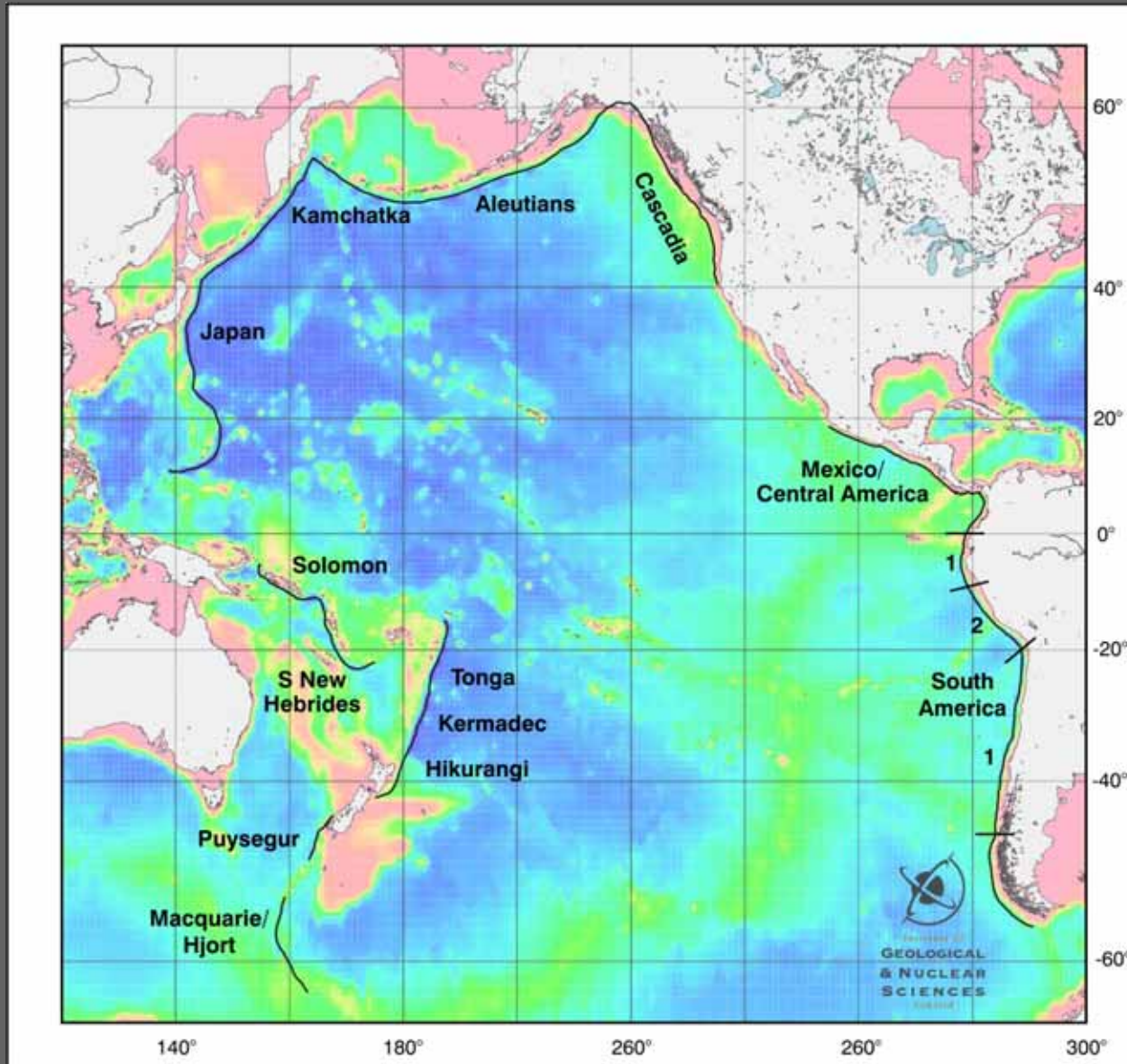
# Historical Tsunami in New Zealand



# Cross-Section Through the Hikurangi Subduction Zone



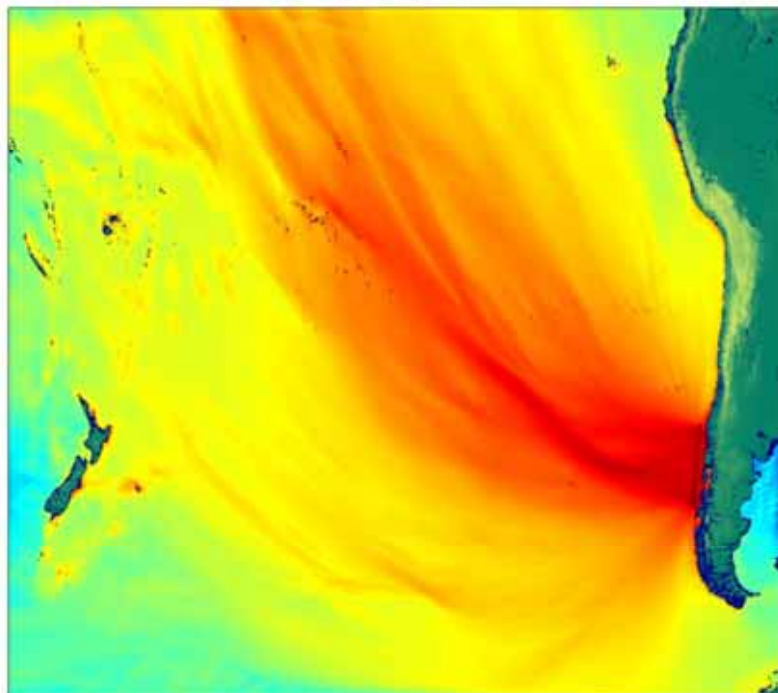
# Circum-Pacific Tsunami Sources



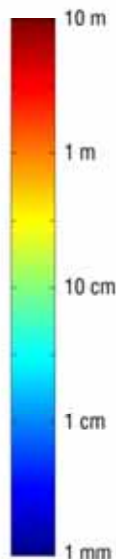
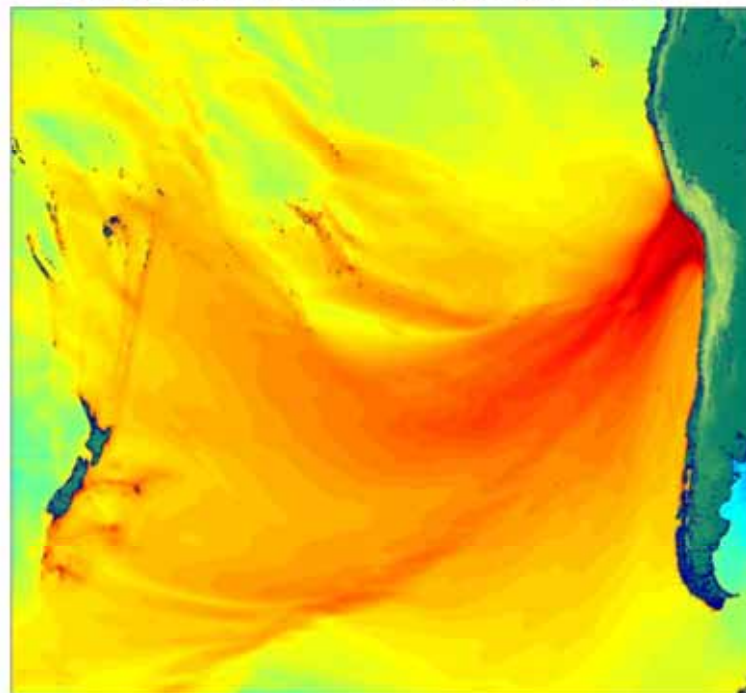
# Tsunami modelling - scenarios

## Maximum wave height

Chile 1960 M9.5



Equivalent Scenario  
M9.5 Southern Peru / Northern Chile



The models shown estimate wave heights offshore (>25 m deep). Wave heights may increase by several times close to the coast. To estimate wave heights at the shore higher resolution 'nested grid' models can be used.

Modelling by William Power (Institute of Geological & Nuclear Sciences)  
in collaboration with and using Vasily Titov's (NOAA PMEL) MOST programs.

# The GeoNet Project



- **GeoNet is a project to monitor, in real time, earthquake, volcano, landslide and tsunami hazards in New Zealand**
- **Funded by EQC; built and operated by GNS Science**
- **National network of modern instruments with data centres in Wellington and Wairakei**
- **Collection of data for research**
- **Data freely available over the internet**



# GNS Science Role in Tsunami Warning

- **GNS Science (via GeoNet) receives and integrates the tsunami gauge data with the earthquake data to provide tsunami advice for New Zealand via MCDEM**
- **The GeoNet Duty team will be trained as the first point of contact for tsunami advice**

# Tsunami Response (1)

1. Receipt of tsunami bulletin from PTWC
2. Ensure receipt by MCDEM
3. Preliminary advice on likely threat based on location, magnitude, historical data and travel times
4. Convene Tsunami Experts Panel (NIWA, University of Waikato, GNS Science) if above threshold
5. Detailed advice to MCDEM within one hour

## Tsunami Response (2)

6. **Send Liaison Officer to NCMC (Beehive basement) if requested by MCDEM**
7. **Provide ongoing input to the Expert Panel and Liaison Officer on seismic and sea level data, and via any modelling tools available**
8. **Updates to MCDEM at least once per hour and after each new message from PTWC**

# Tsunami Response Tools

## In hand:

- Earthquake information (size, location, depth, mechanism)
- Historical tsunami information for similar events
- Tsunami travel time models to locations in New Zealand

## Underway:

- Sea level data from stations between New Zealand and the earthquake location
- Tsunami wave height models for key locations

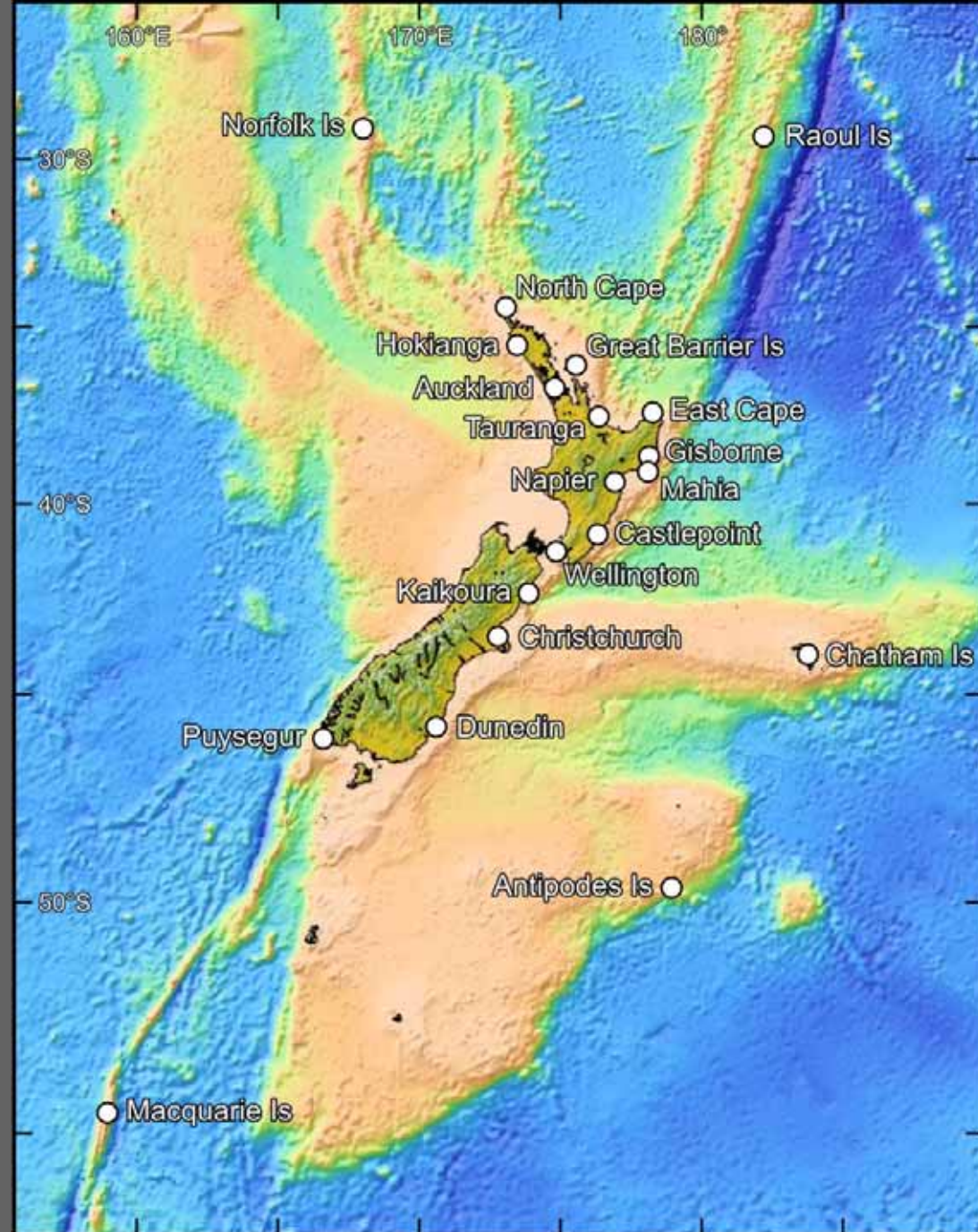
## Future developments:

- Regional source modelling
- Real-time inversion and forward modelling for wave height at coast
- Data display tools (web based)

# Proposed Tsunami Gauge Network

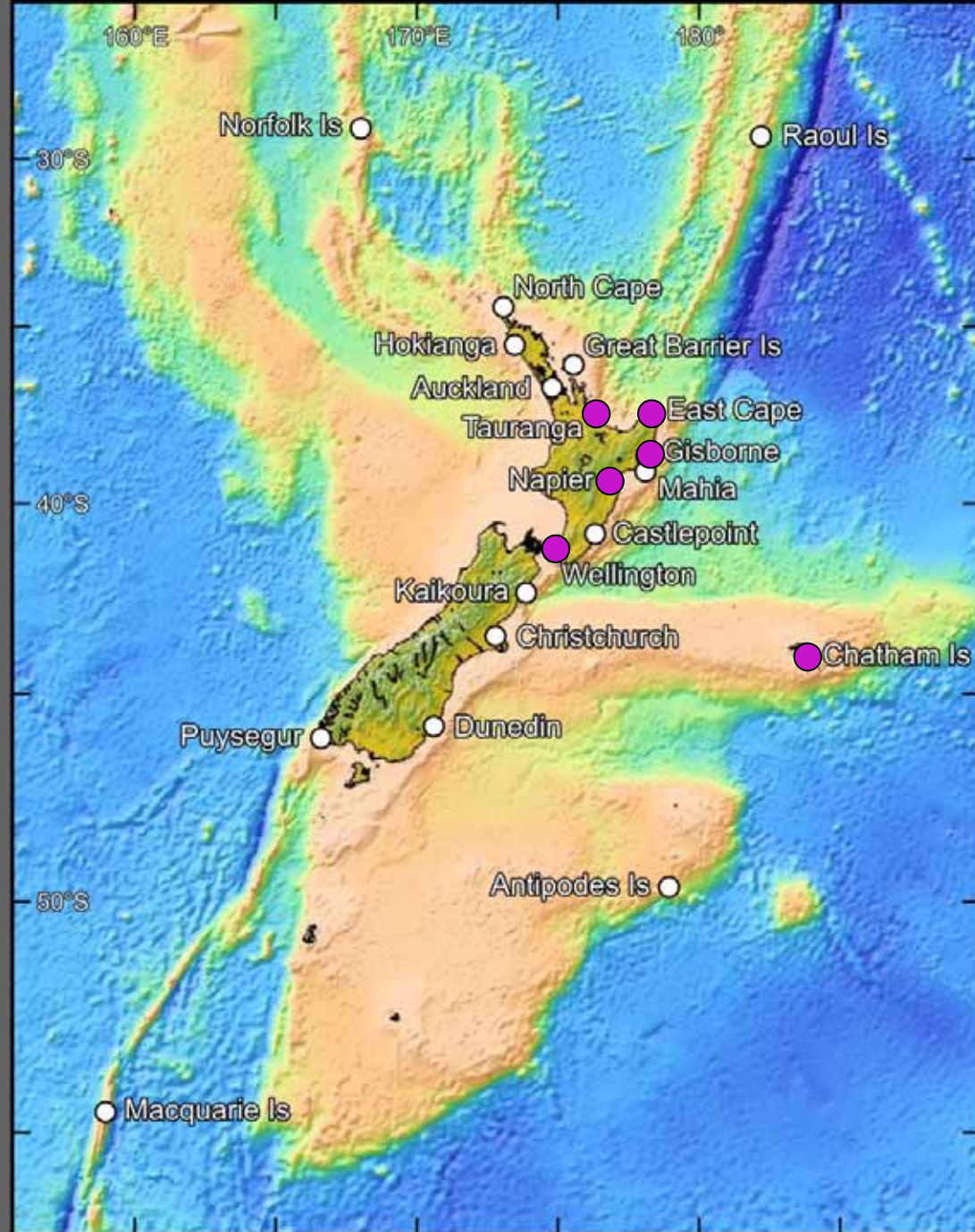
GNS Science and LINZ partnership

- 20 tsunami gauge stations (2 to be installed by Australia)
- 2 New Zealand offshore islands
- 2 Australian offshore islands
- 8 open coastal sites
- 7 at centres of population
- Network to operate in real-time

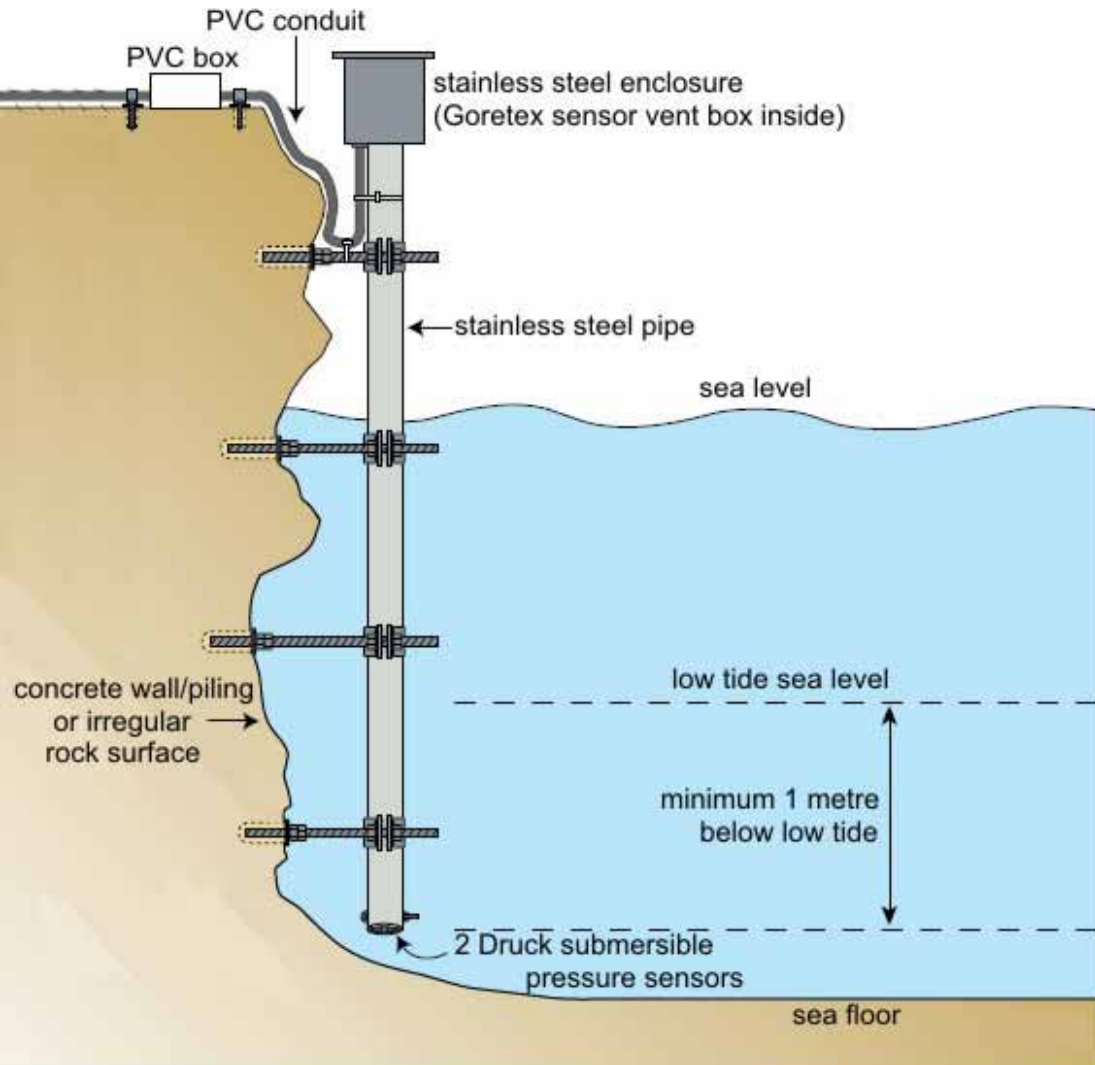


# Progress

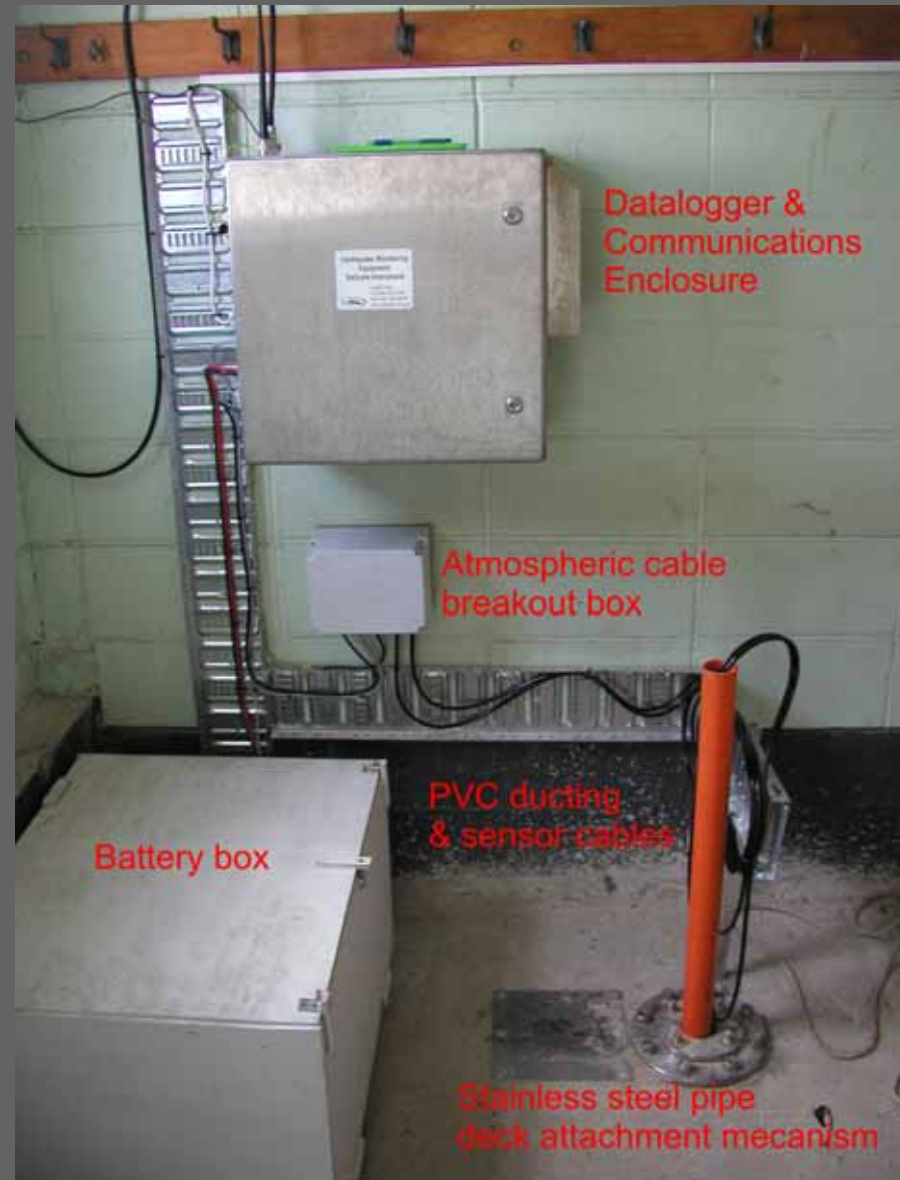
- Completed:
  - Wellington Harbour Pilot Site
  - Chatham Island
  - Port of Napier
  - Gisborne
  - Tauranga
- Soon:
  - East Cape (installed)
  - Up to 4 others depending on resource consents
- Scheduled completion June 2010



# Vertical Attachment Method



# Queens Wharf, Wellington Harbour



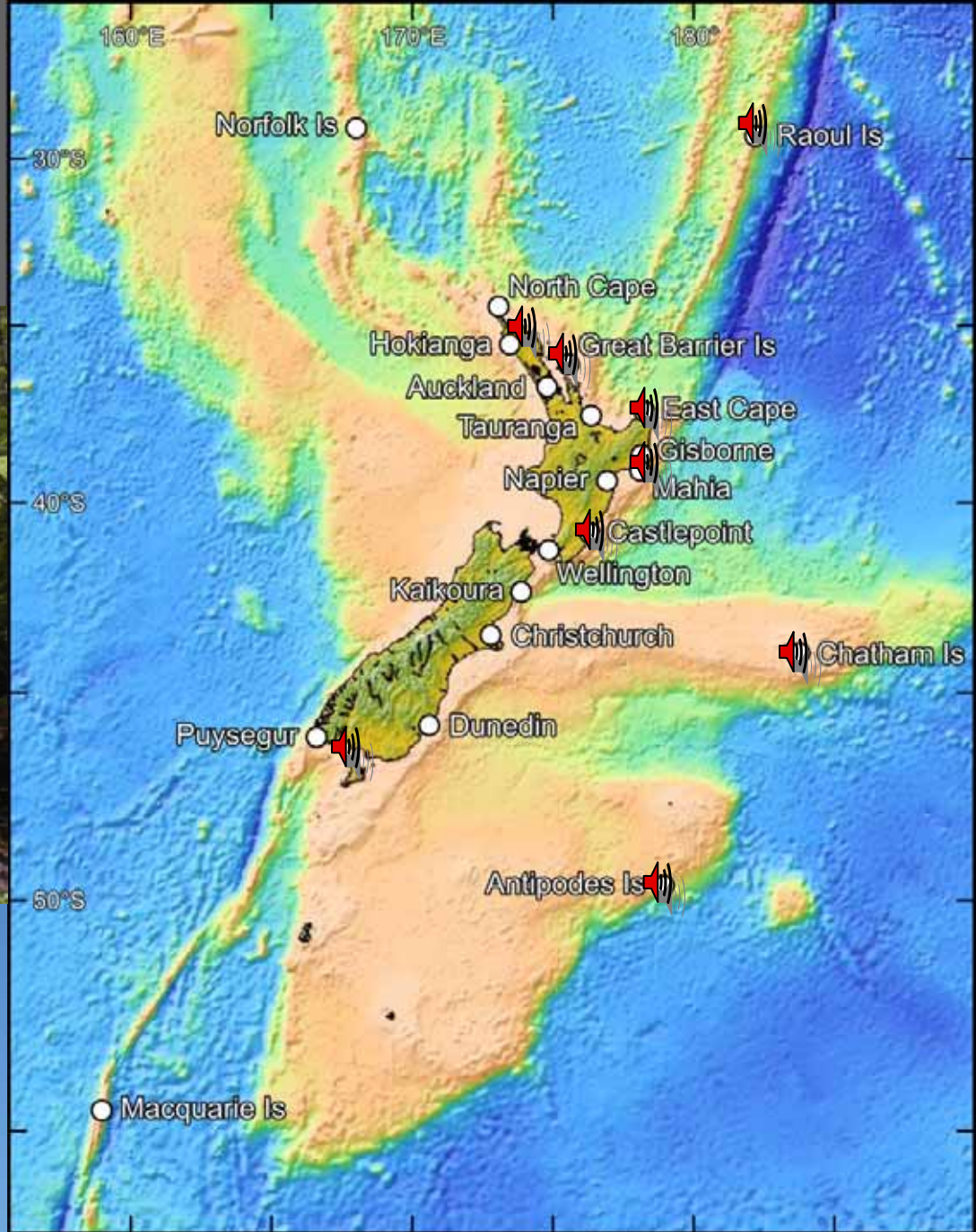


# Chatham Island

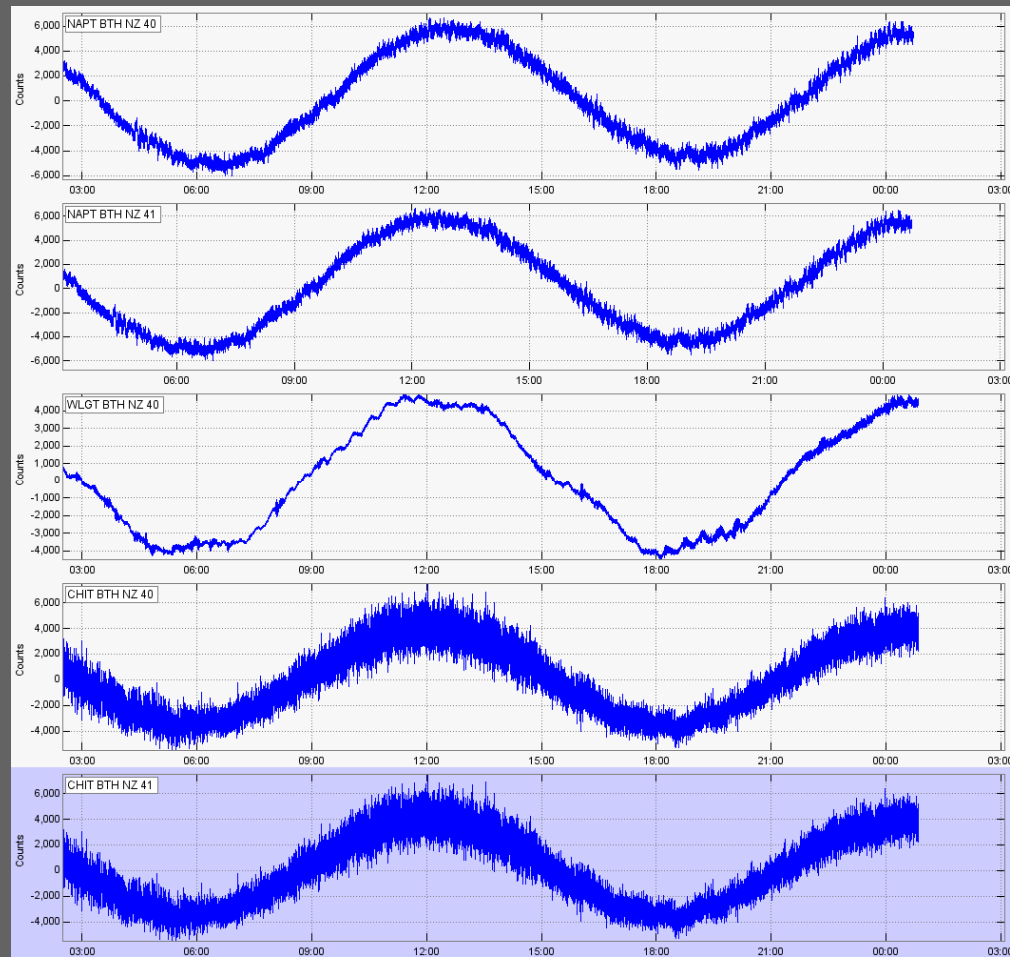


# Communications

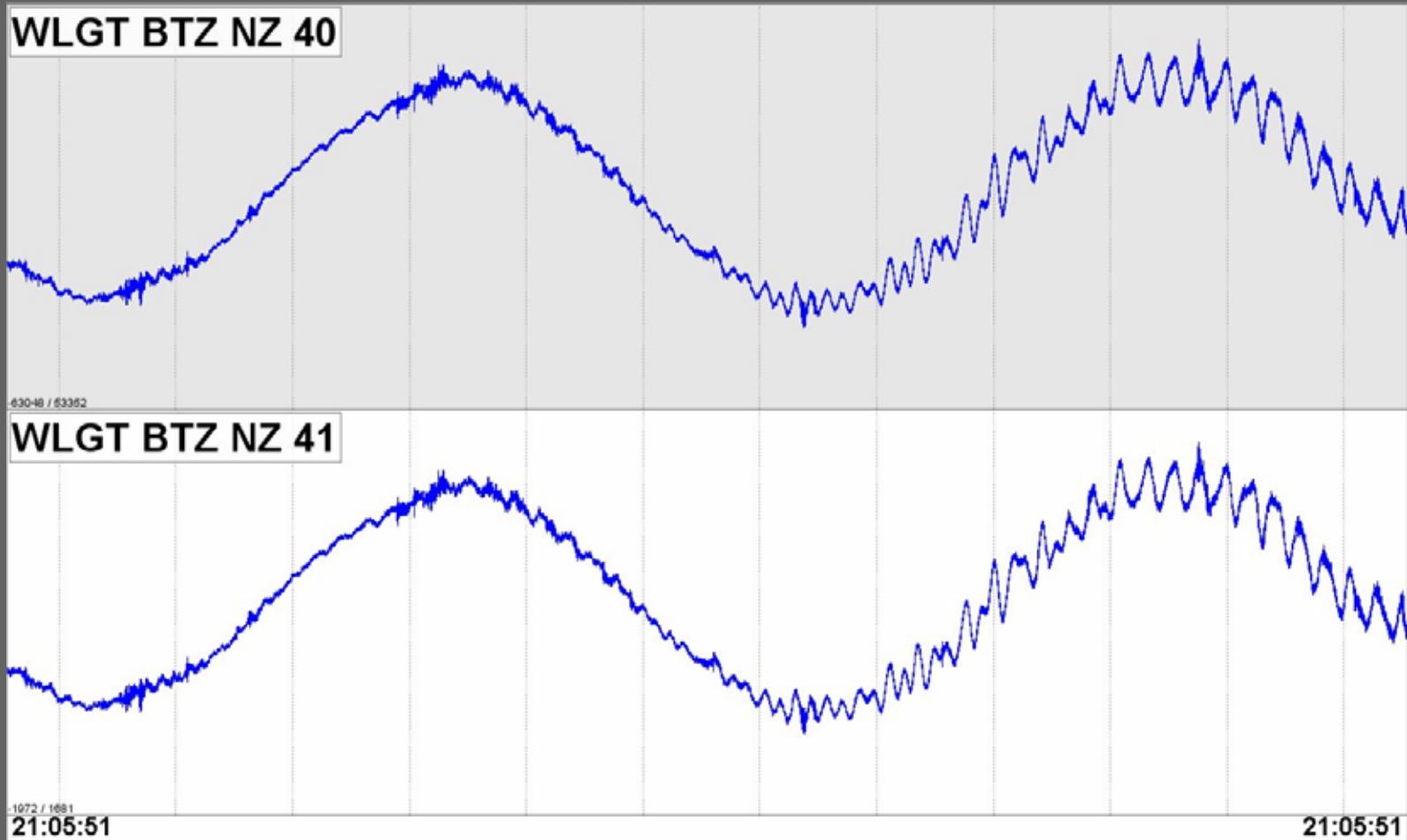
- Satellite or radio communications
- Redundancy for high priority sites



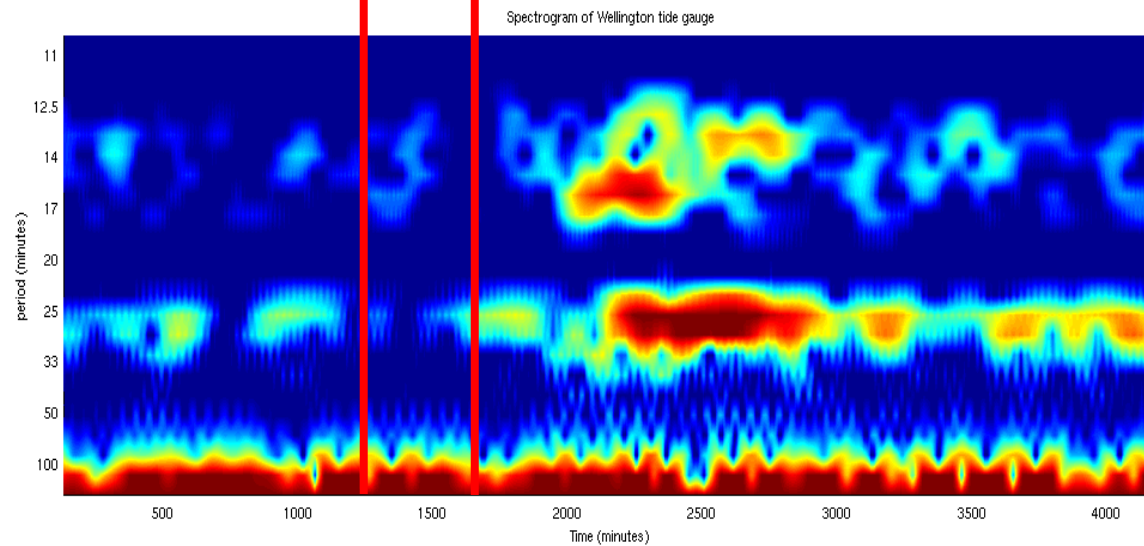
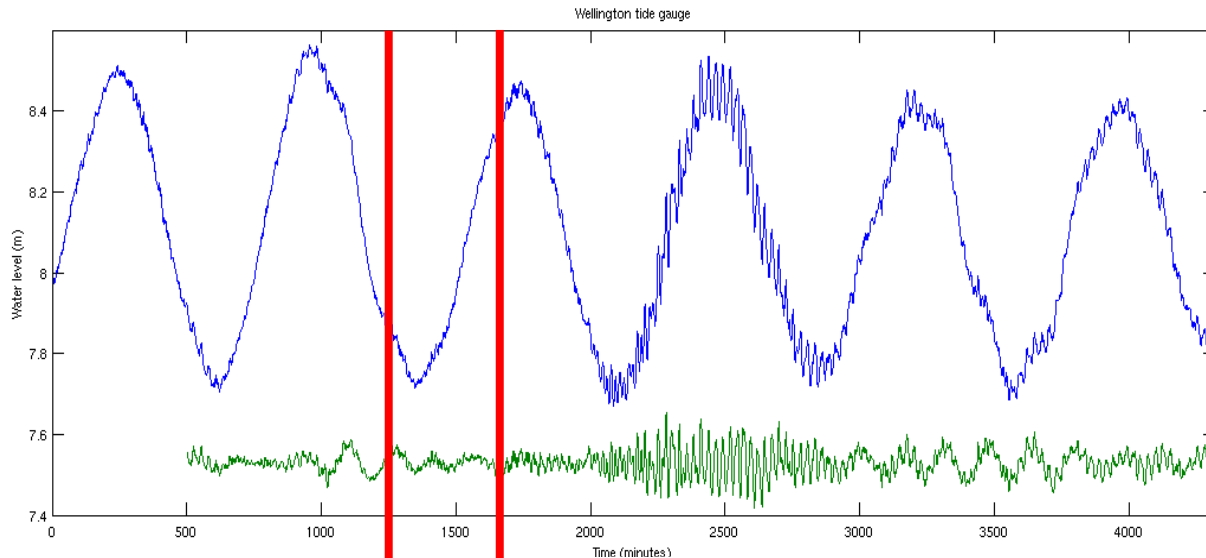
# Tsunami Gauge Data: [www.geonet.org.nz](http://www.geonet.org.nz)



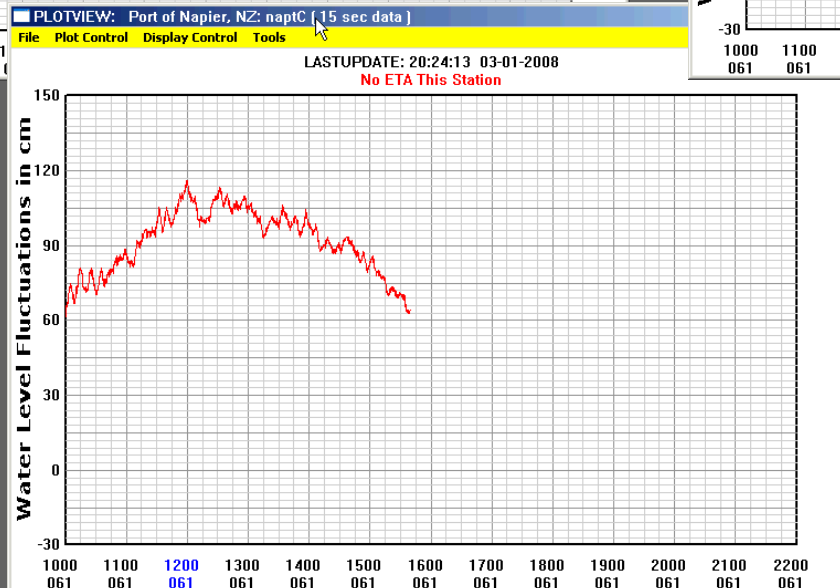
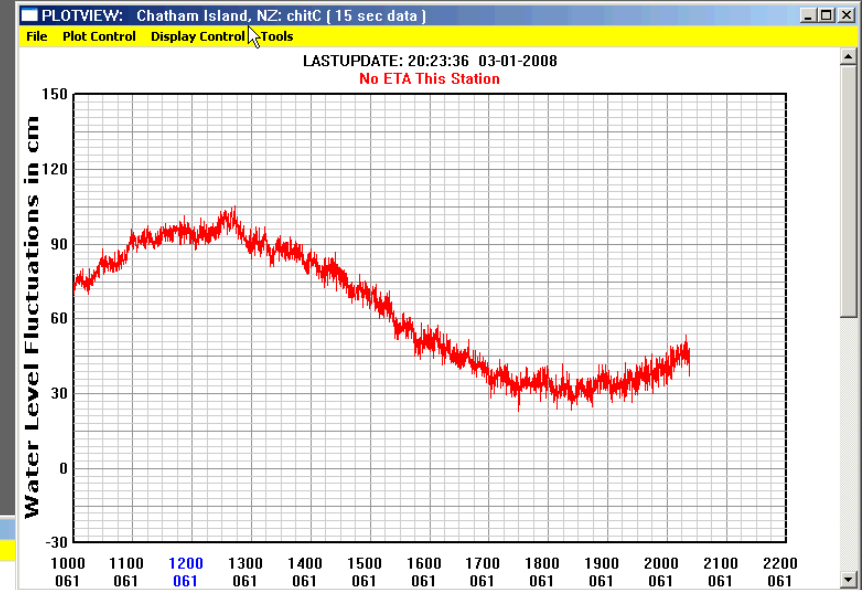
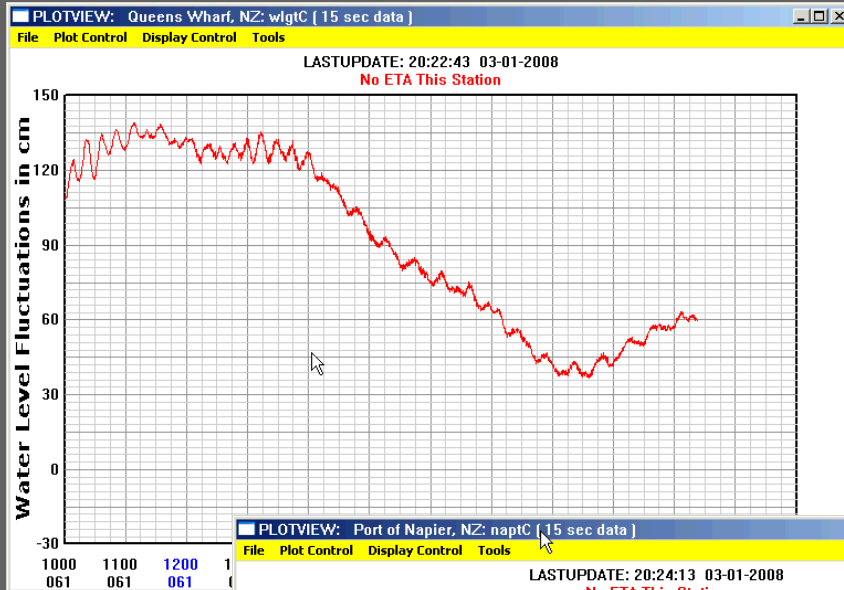
# Solomon Island Tsunami – 2 April 2007



# Solomon Island Tsunami – 2 April 2007



# New Zealand Sea Level Data at WCATWC



Other people's data has more value than your own

# Tsunami Response Tools

## In hand:

- Earthquake information (size, location, depth, mechanism)
- Historical tsunami information for similar events
- Tsunami travel time models to locations in New Zealand

## Underway:

- Sea level data from stations between New Zealand and the earthquake location
- Tsunami wave height models for key locations

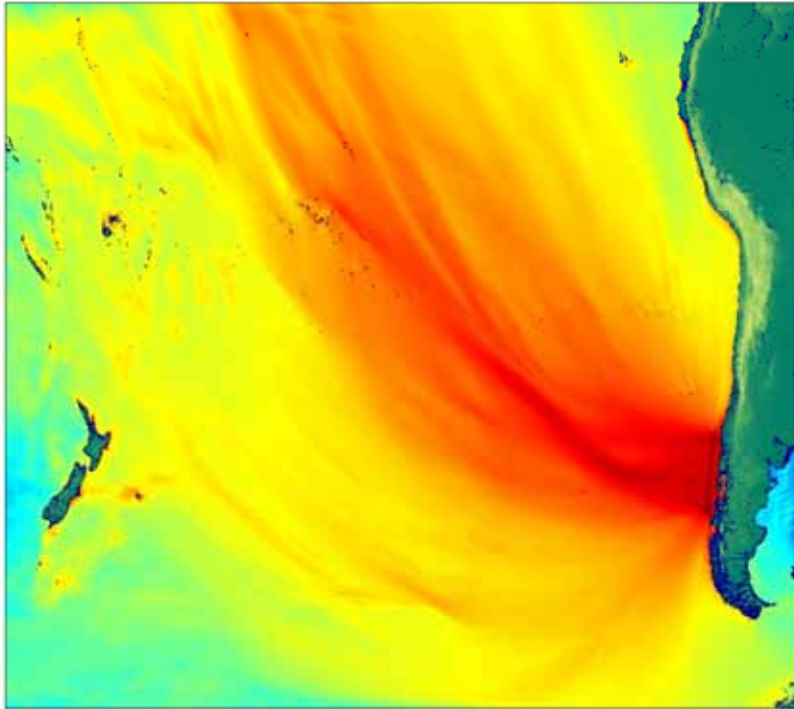
## Future developments:

- Regional source modelling
- Real-time inversion and forward modelling for wave height at coast
- Data display tools (web based)

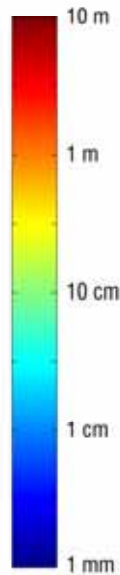
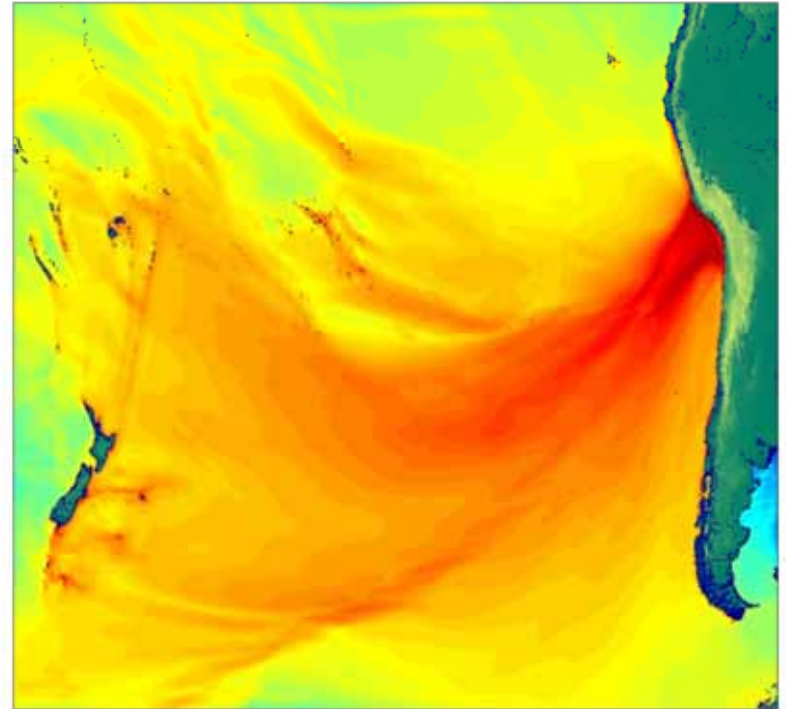
# Tsunami modelling - scenarios

## Maximum wave height

Chile 1960 M9.5



Equivalent Scenario  
M9.5 Southern Peru / Northern Chile



The models shown estimate wave heights offshore (>25 m deep). Wave heights may increase by several times close to the coast. To estimate wave heights at the shore higher resolution 'nested grid' models can be used.

Modelling by William Power (Institute of Geological & Nuclear Sciences)  
in collaboration with and using Vasily Titov's (NOAA PMEL) MOST programs.



# Threat Levels for Mw 9.1 S. American Earthquake (e.g. 1868)

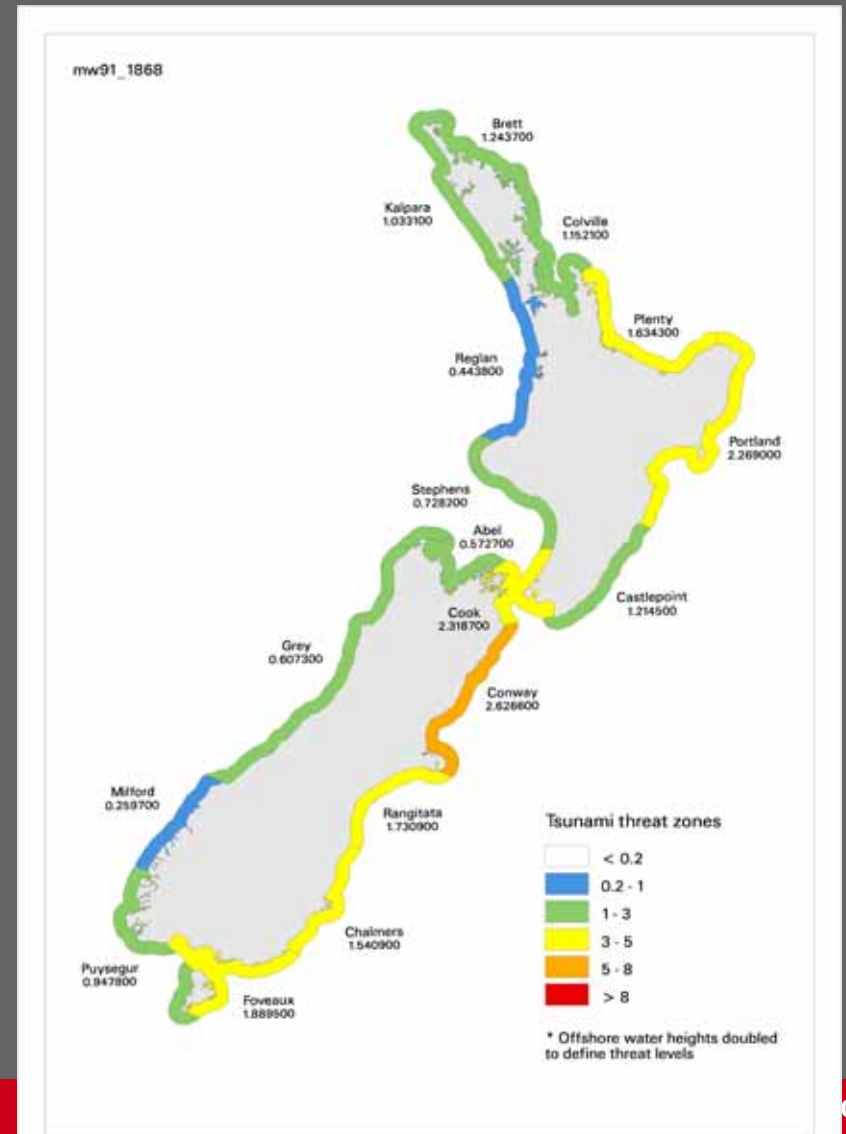
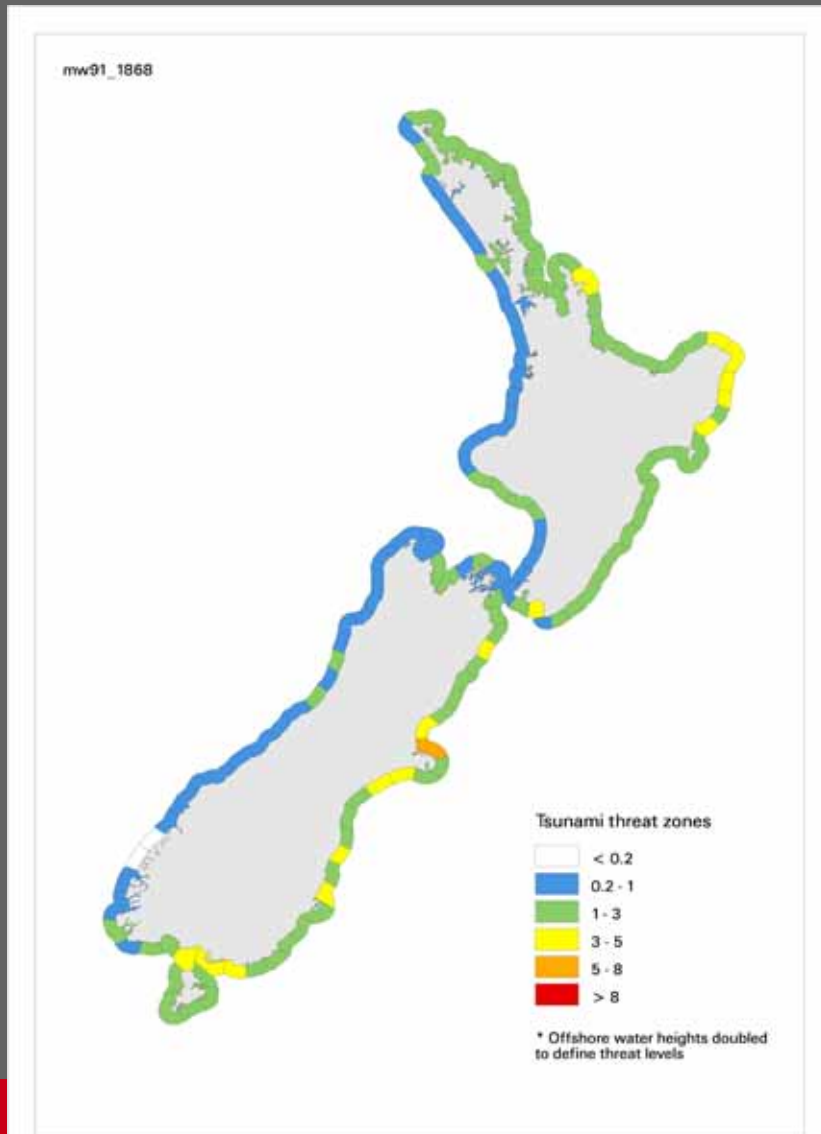


- Example shows Marine Forecast zones – zonation suited to CDEM requirements yet to be agreed.
- Choice of threat levels may also change, but is to be consistent nationally.
- In the near future historical data will be incorporated to validate computed threat levels.

# Threat Levels for Mw 9.1 S. American Earthquake

50 km intervals

Marine Forecast Zones



# Issues Around Threat Levels

- **Should we allow for tides?**
- **What detail and what boundaries for coastal domains?**
- **What threat level thresholds?**

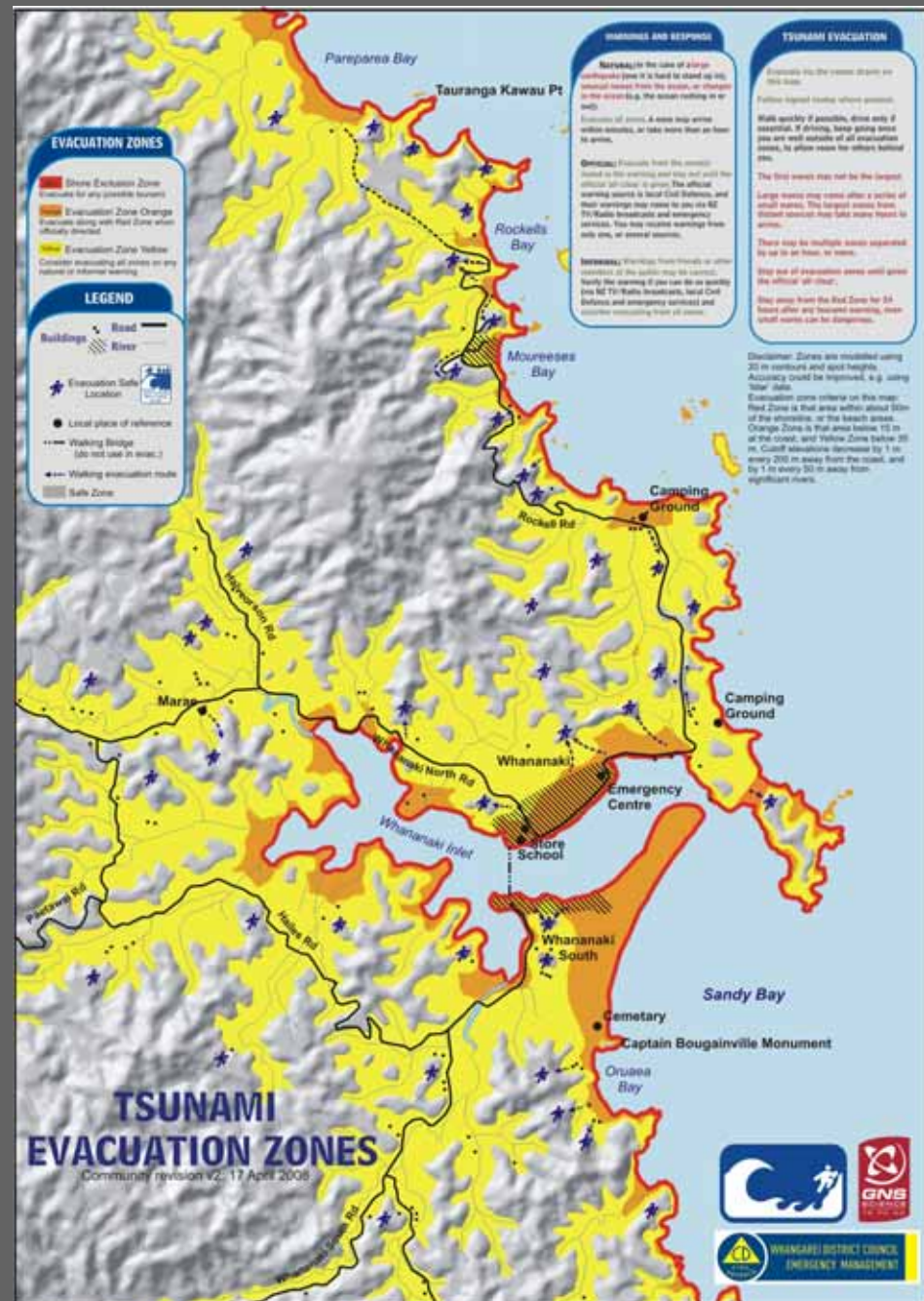
## Possible threat levels:

- 20cm - 1m Threat to beach and small boats
- 1m - 3m Some land threat
- 3m - 5m Moderate land threat
- 5m – 8m High land threat
- 8m+ Severe land threat (local & regional sources)

**NB: Wave run-up is up to twice as high** (on steep slopes near the coast)

Note the community-revised local legend

Official directed evacuation is intended for **orange** zone only. **Yellow** zone is a much less frequent self-evacuation zone only.



# The End is Here



Contact: Dr Terry Webb  
General Manager, Natural Hazards  
GNS Science  
T.Webb@gns.cri.nz  
P +64-4-570-4869  
F +64-4-570-1440  
[www.gns.cri.nz](http://www.gns.cri.nz)