Tsunami Warnings in Australia

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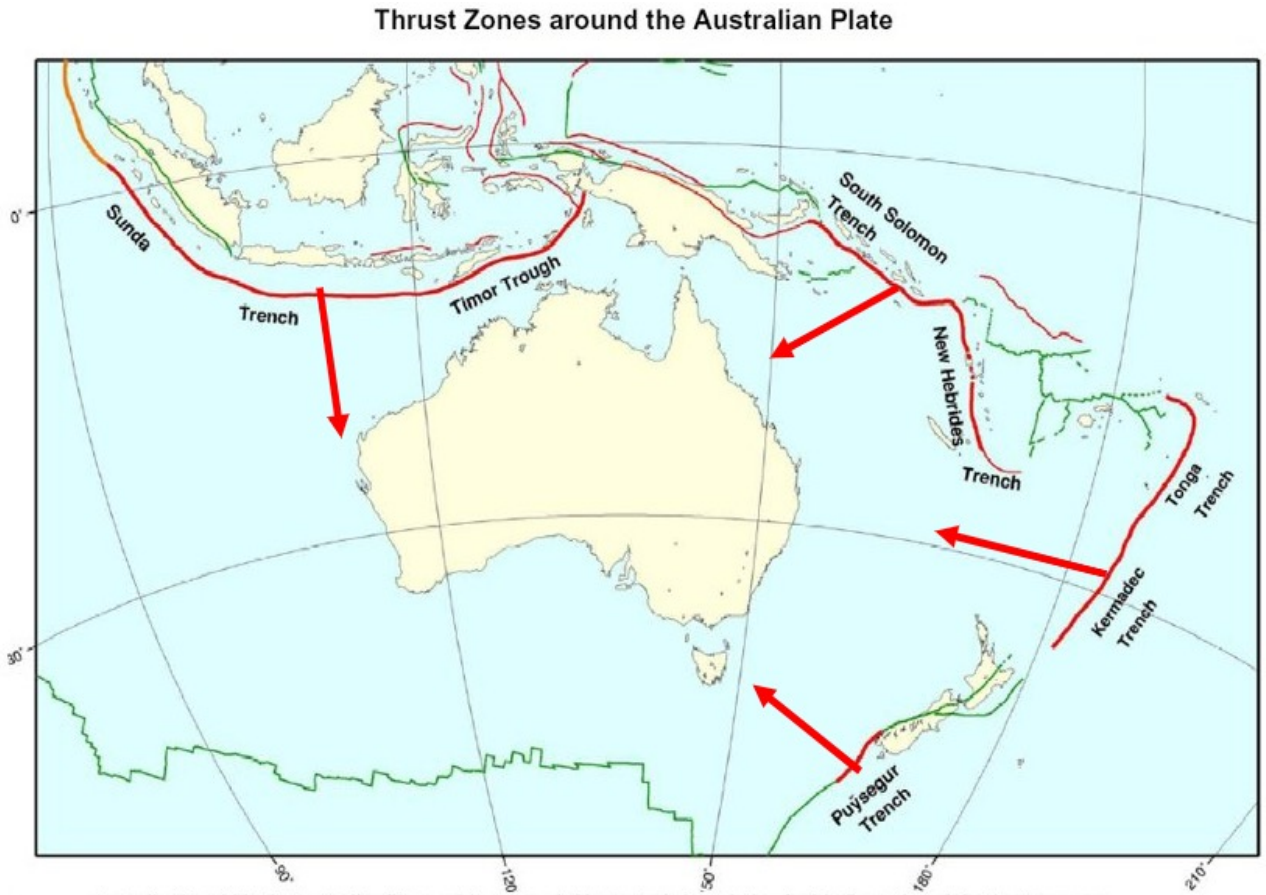
Bureau of Meteorology

Overview

- The Need for the Joint Australian Tsunami Warning Centre (JATWC)
- JATWC and the Australian Tsunami Warning System (ATWS)
- Tsunami Processes and Products
- Tsunami SOPs
- Training, Exercises, and Current and Future Work

The Need for the JATWC

Likely Tsunami Source Zones



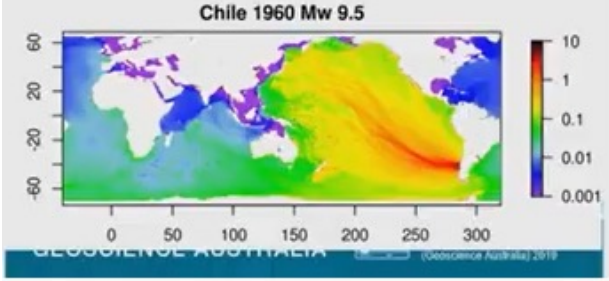
Australia sits within the Australian Plate and is surrounded by tectonic boundaries. In this figure the subduction zones are plotted in red and the other types of plate boundary in green, with the boundary ruptured by the 2004 Andaman-Sunda earthquake in orange. The thick red lines are those subduction zone plate boundaries with the potential to excite a large tsunami that could directly impact Australia.

Australia, in recent history, has experienced more than 50 tsunami events

Australia's Tsunami Vulnerability

Mw 9.5, Chile 1960

- **Widely observed in east Australia**
  - Mostly marine impacts
    - Limited inundation
- **Damages**
  - Boats damaged, sunk
  - Oyster industry



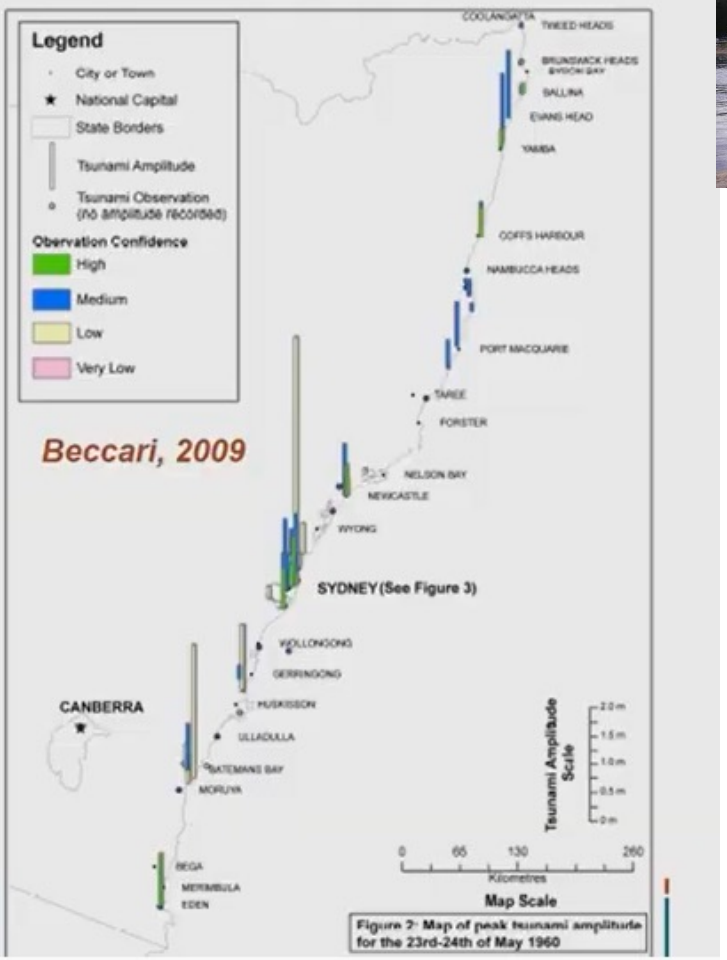


Figure 2: Map of peak tsunami amplitude for the 23rd-24th of May 1960

SYDNEY HARBOUR IN CHAOS FROM QUAKE WAVE

SYDNEY. — Tidal waves generated by the earthquakes in Chile smashed into the New South Wales coastline yesterday.

AIR PILOT SEES BEACH DISAPPEAR

MELBOURNE. — Salmon spotting pilot Dick Ritchie yesterday saw Three-Mile Beach

Swift Action from Australia after Indian Ocean Tsunami 2004

- Department of Foreign Affairs and Trade (DFAT) led a major proposal to develop a National Tsunami Warning System.

- This proposal was successful and announced in the joint media release of 10 May 2005 by the then Foreign Minister The Hon Alexander Downer and the Attorney-General Philip Ruddock.

The Hon. Alexander Downer, MP
FORMER MINISTER FOR FOREIGN AFFAIRS, AUSTRALIA

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Joint Media Release

The Minister for Foreign Affairs, Alexander Downer and The Attorney-General, Philip Ruddock

10 May2005

National Tsunami Warning System

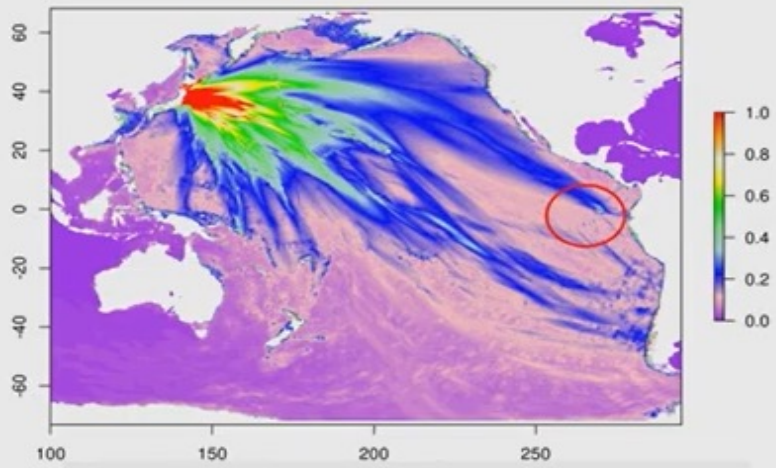
Following the tragic events of the Indian Ocean tsunami in December last year, the Australian Government has announced a major initiative t
National Tsunami Warning System.

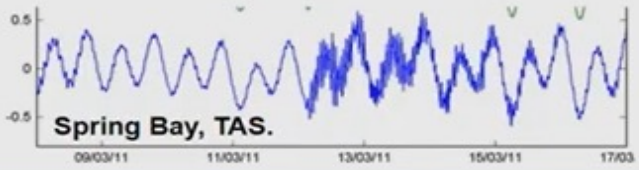
- $68.9million (AUD) over 4 years of 2005-2009 to
  - Develop a comprehensive Australian Tsunami Warning System (ATWS).
  - Support international efforts to establish an Indian Ocean tsunami warning system.
  - Contribute to the facilitation of tsunami warnings for the South West Pacific.
- A core deliverable was to establish the Joint Australian Tsunami Warning Centre (JATWC)
  - Through partnership between Geoscience Australia (GA) and Bureau of Meteorology (BoM)
  - Emergency Management Australia a key operational arm in the ATWS, supported by all State/Territory Emergency Services

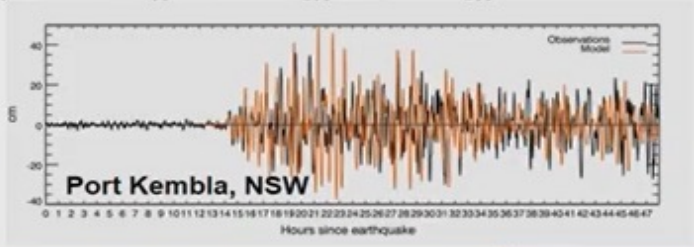
Australia's Tsunami Vulnerability

Mw 9.1, Offshore Japan, 2011

- SE Australia ~ 30 cm wave amplitudes
  - No significant inundation
- Swimmers @ Merimbula washed 500m into lagoon
- Galapagos Islands
  - 5 m runup

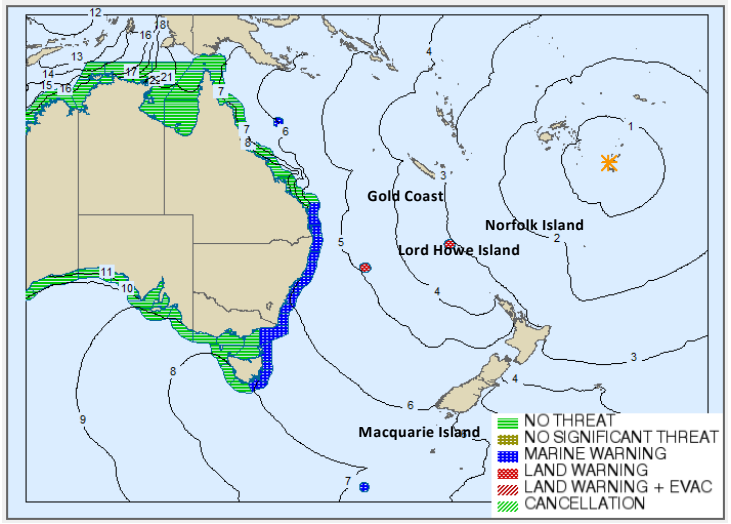


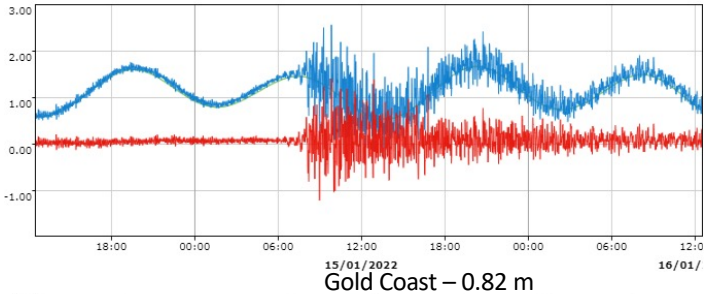




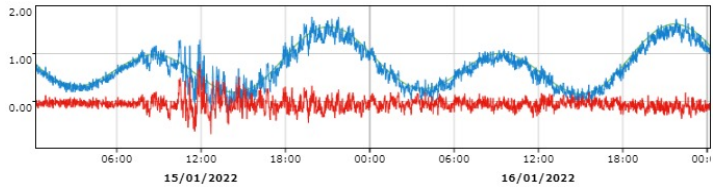
JATWC in the HUNGA TONGA-HUNGA HA'APAI (HTHH) Volcanic Tsunami

UTC	AEDT	Elapsed Time hh:mm	15-16 January 2022 JATWC key actions
04:10	15:10	00:00	Explosive volcanic eruption of the Hunga Tonga-Hunga Ha'apai volcano (Tonga)
04:30	15:30	00:20	1.2m tsunami waves observed at a Nuku Alofa tide gauge station (but JATWC was unaware of it till later)
05:48	16:58	01:48	No Threat Bulletin issued. Based on 3 hours travel time (TTT) with Norfolk just outside the 3hr isochrone, VEI assessed as 3 or 4
08:26	19:36	04:26	Marine Warning for Norfolk Island issued after 50 cm wave observed at the tide gauge. Reactively revised.
09:00	20:00	04:50	Marine Warning issued for Lord Howe Island (in 5hr TTT).
09:37	20:37	05:27	Significant observations in NSW and QLD: (40cm at Twofold Bay, NSW at 20:10 AEDT; 25 cm at Gold Coast, QLD at 19:40 AEDT) prompts the issuing of Marine Warnings to south QLD & entire NSW. Also revised VEI >=5, expanding areas covered by 6hr TTT
09:58	20:58	05:48	Norfolk Island Marine Warning upgraded to Land Threat Warning after wave observations exceed 1.0 m at the tide gauge.
10:00	21:00	05:50	Marine Warnings extended to Victoria, Tasmania and Macquarie Island covered by 7hr TTT.
10:18	21:18	06:08	Lord Howe Island Marine Warning upgraded to Land Threat Warning with evacuation order issued by NSWSES at 20:12 AEDT.
		06 – 18	Each warning updated on hourly basis during the 12 hr period
23:09	10:09 +1 day	18:59	Land Threat Warnings for Norfolk Island and Lord Howe Island downgraded to Marine Warnings.
23:30 – 00:50 +1 day	10:30-11:50 +1 day	19:20 to 20:40	Cancelled QLD, Macquarie Island, Victoria and Tasmanian Marine Warnings.
08:56 – 10:59 +1 day	19:56 - 21:59 +1 day	28:46 to 30:49	Cancelled Lord Howe Island, Norfolk Island and NSW Warnings.





Gold Coast – 0.82 m

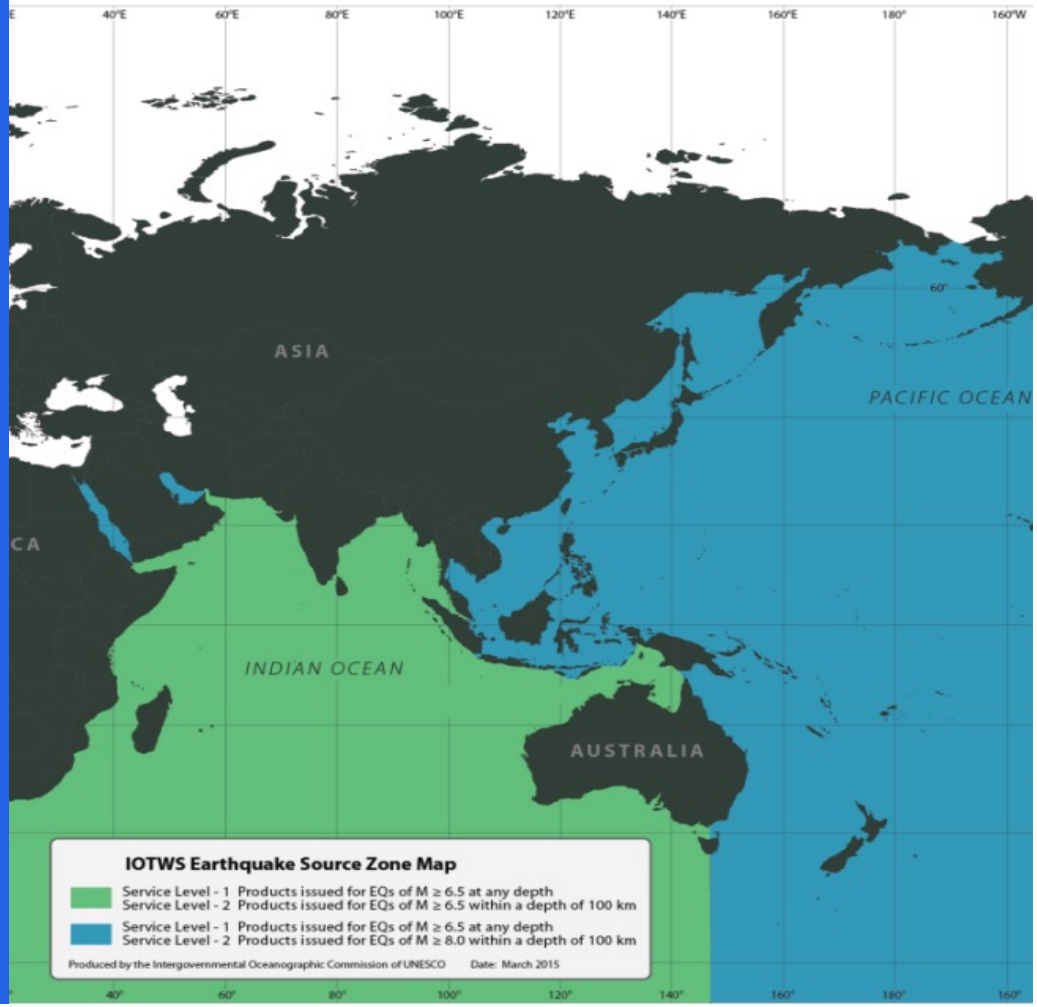


JATWC and ATWS

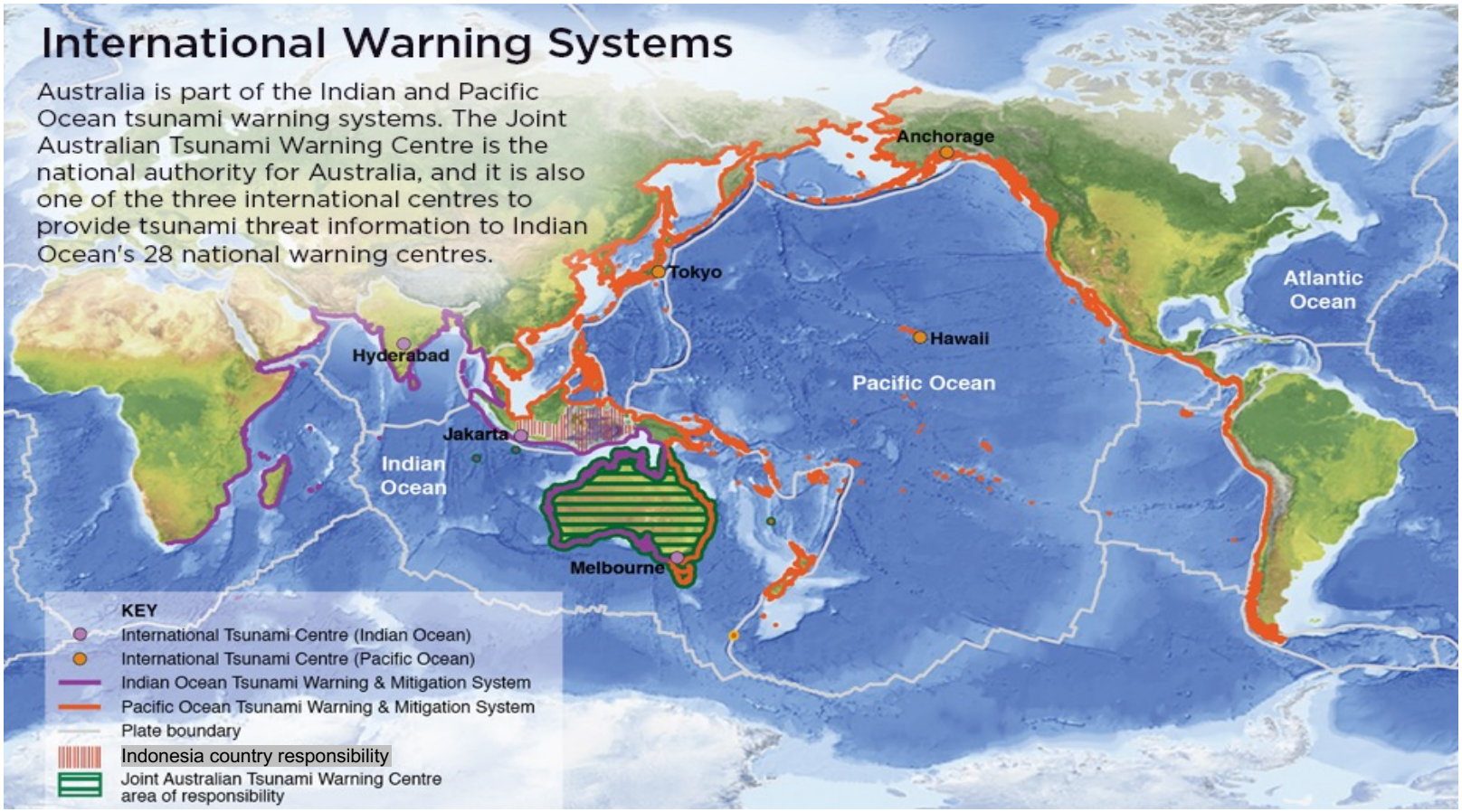
Joint Australian Tsunami Warning Centre (JATWC)

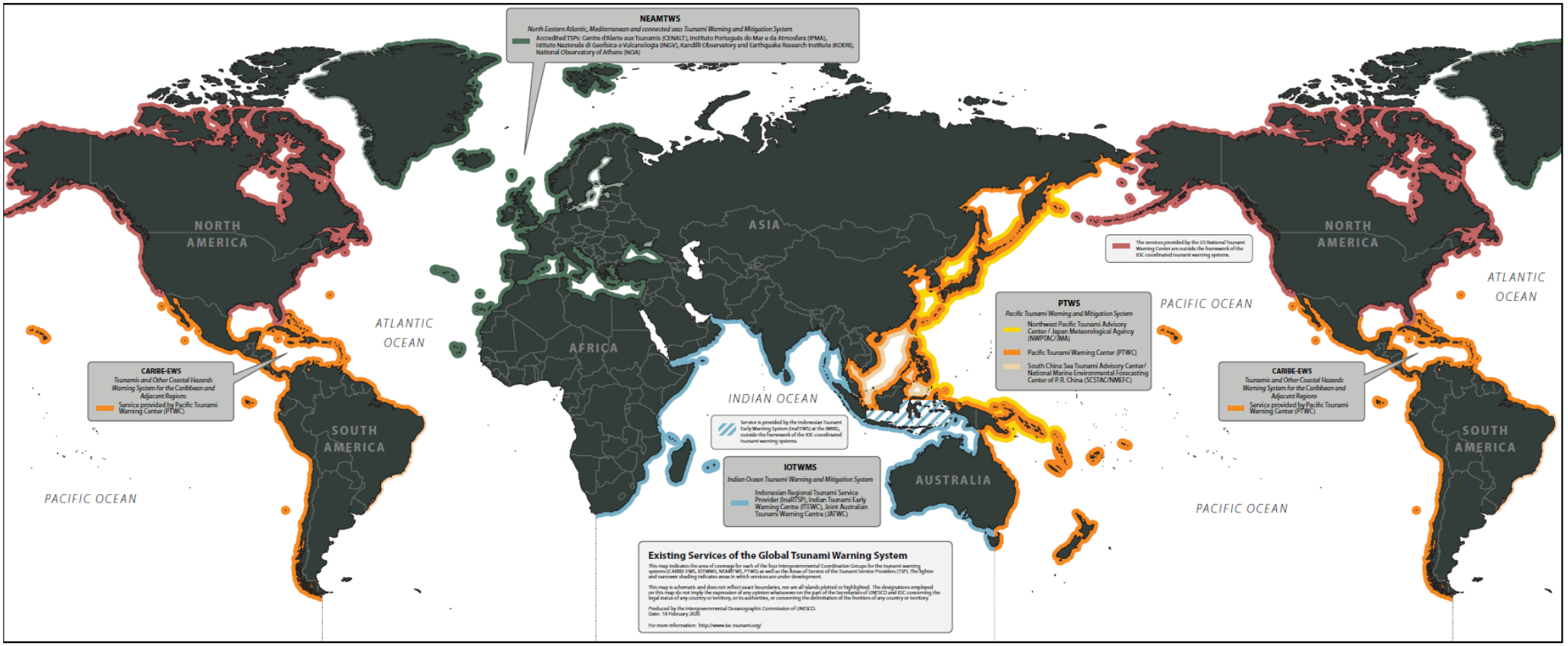
Australian Tsunami Warning System (ATWS)

Tsunami Service Provider (TSP) for the Indian Ocean Tsunami Warning and Mitigation Service (IOTWMS)

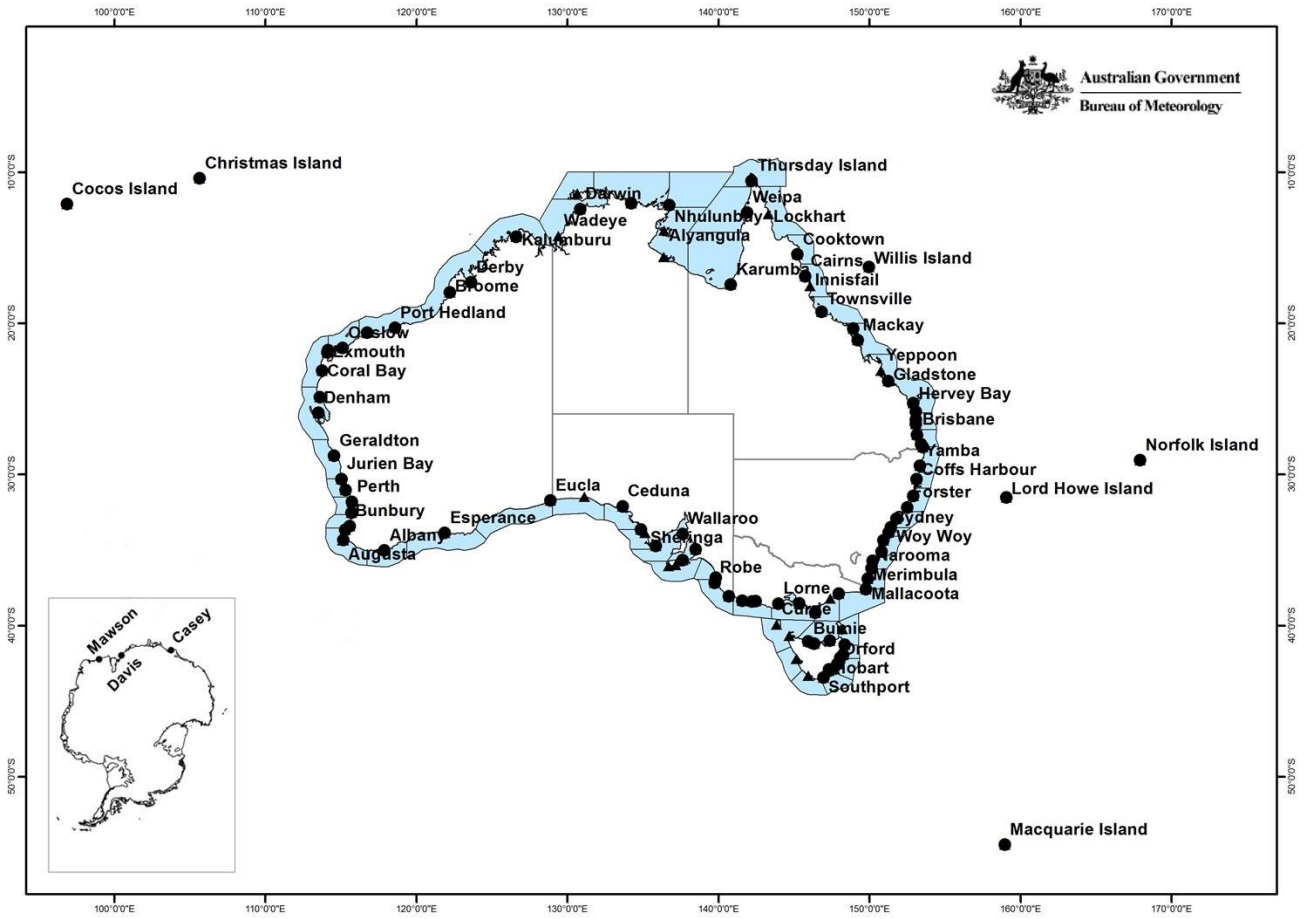


Australian Role in International Tsunami Warning Systems




NEAMTWS
North Eastern Atlantic, Mediterranean and connected seas Tsunami Warning and Mitigation System
Accredited TSPs: Centre d'Alerte aux Tsunamis (CENALT), Instituto Português do Mar e da Atmosfera (IPMA), Istituto Nazionale di Geofisica e Vulcanologia (INGV), Kandilli Observatory and Earthquake Research Institute (KOERI), National Observatory of Athens (NOA)
NORTH AMERICA
ASIA
AFRICA
ATLANTIC OCEAN
PACIFIC OCEAN
INDIAN OCEAN
SOUTH AMERICA
AUSTRALIA
CARIBE-EWS
Tsunamis and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions
Service provided by Pacific Tsunami Warning Center (PTWC)
PTWS
Pacific Tsunami Warning and Mitigation System
Northwest Pacific Tsunami Advisory Center / Japan Meteorological Agency (NWPTAC/JMA)
Pacific Tsunami Warning Center (PTWC)
South China Sea Tsunami Advisory Center/ National Marine Environmental Forecasting Center of P.R. China (SCSTAC/NMEFC)
The services provided by the US National Tsunami Warning Center are outside the framework of the IOC coordinated tsunami warning systems.
Service is provided by the Indonesian Tsunami Early Warning System (InaTEWS) at the BMKG, outside the framework of the IOC-coordinated tsunami warning systems.
IOTWMS
Indian Ocean Tsunami Warning and Mitigation System
Indonesian Regional Tsunami Service Provider (InaTEWS), Indian Tsunami Early Warning Centre (ITEWC), Joint Australian Tsunami Warning Centre (JATWC)
Existing Services of the Global Tsunami Warning System
This map indicates the area of coverage for each of the four Intergovernmental Coordination Groups for the tsunami warning systems (CARIBE-EWS, IOTWMS, NEAMTWS, PTWS) as well as the Areas of Service of the Tsunami Service Providers (TSP). The lighter and narrower shading indicates areas in which services are under development.
This map is schematic and does not reflect exact boundaries, nor are all islands plotted or highlighted. The designations employed on this map do not imply the expression of any opinion whatsoever on the part of the Secretariats of UNESCO and IOC concerning the legal status of any country or territory, or its authorities, or concerning the delimitation of the frontiers of any country or territory.
Produced by the Intergovernmental Oceanographic Commission of UNESCO.
Date: 18 February 2020
For more information: http://www.ioc-tsunami.org/

ATWS Area of Coverage



Joint Australian Tsunami Warning Centre - JATWC

Australian Government
Geoscience Australia

Detect and analyse seismic signals

Estimate earthquake parameters of location, magnitude, and depth etc.

Provide an earthquake solution to BoM within 15min of an earthquake, then provide updates as available

Australian Government
Bureau of Meteorology

Assess tsunami threat to Australia, usually via MOST model tsunami wave prediction

Issue tsunami advice (No Threat/Watch/Warning) to Australia **within 15min** after receiving GA solution (so within 30min of earthquake)

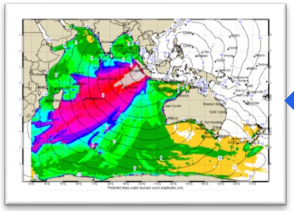
Liaise with emergency response partners, and TWC authorities in the Indian Ocean

Monitor tsunami with Australian and global sea level networks

Joint Australian Tsunami Warning Centre

JATWC

Indian Ocean Tsunami 2004



Tsunami Scenario Database using **MOST** model

ATWS Project (2005-2009)

Australian Deep Ocean and Coastal Sea Level Monitoring Network - **ASLOS**

IOTWMS
Indian Ocean Tsunami Warning & Mitigation System (IOTWMS)

Bureau of Meteorology

Geoscience Australia

ATWS
Australian Tsunami Warning System (ATWS)

JATWC (2008 – present)

Jointly operated by the **Bureau of Meteorology** and **Geoscience Australia**

As one of the three designated Tsunami Service Providers (TSPs) for IOTWMS

Issue earthquake and tsunami bulletins to NTWCs in the IOTWMS

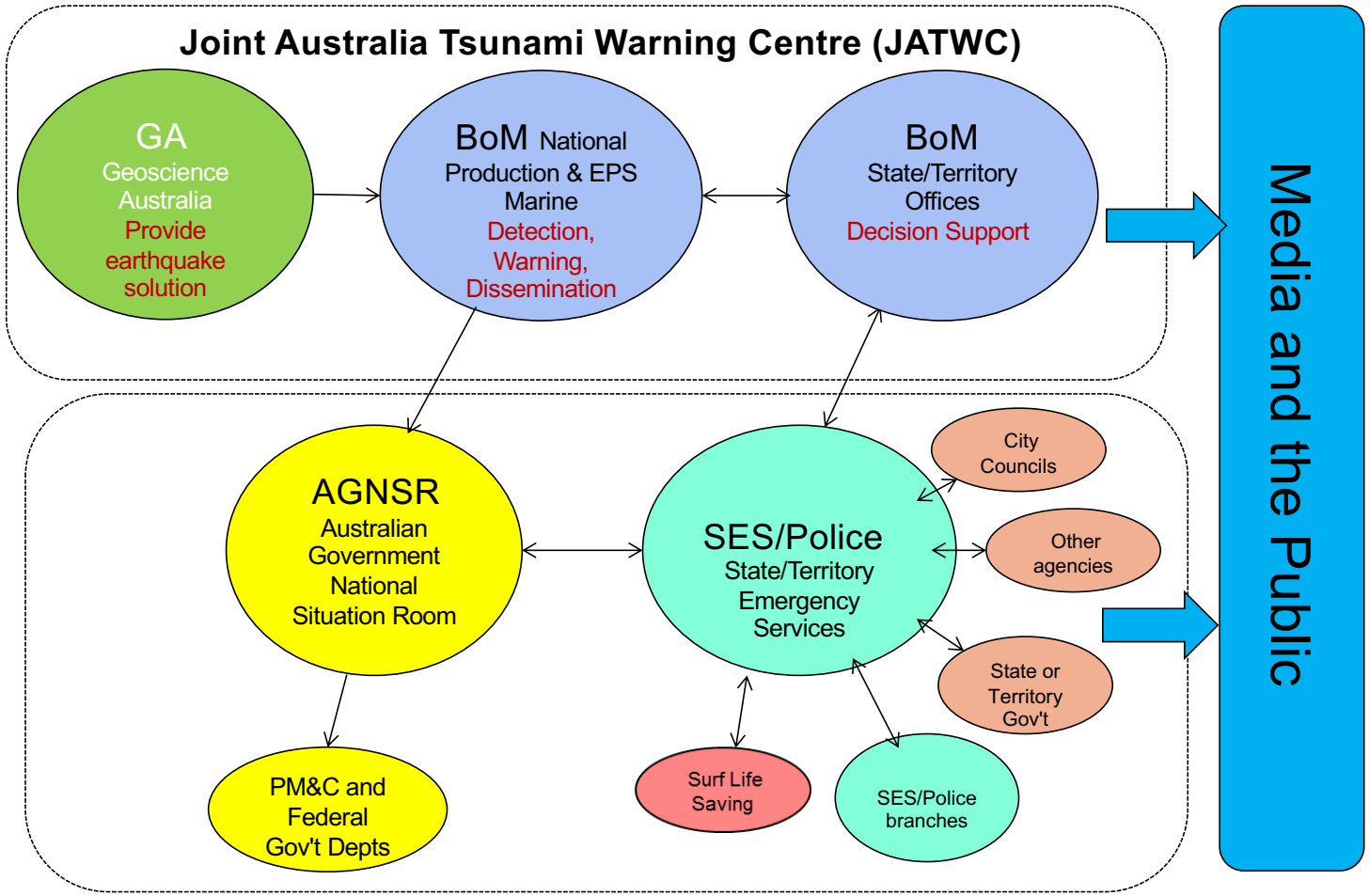
As national tsunami warning centre for Australia

Issue tsunami warnings for Australia including offshore islands and Antarctic stations

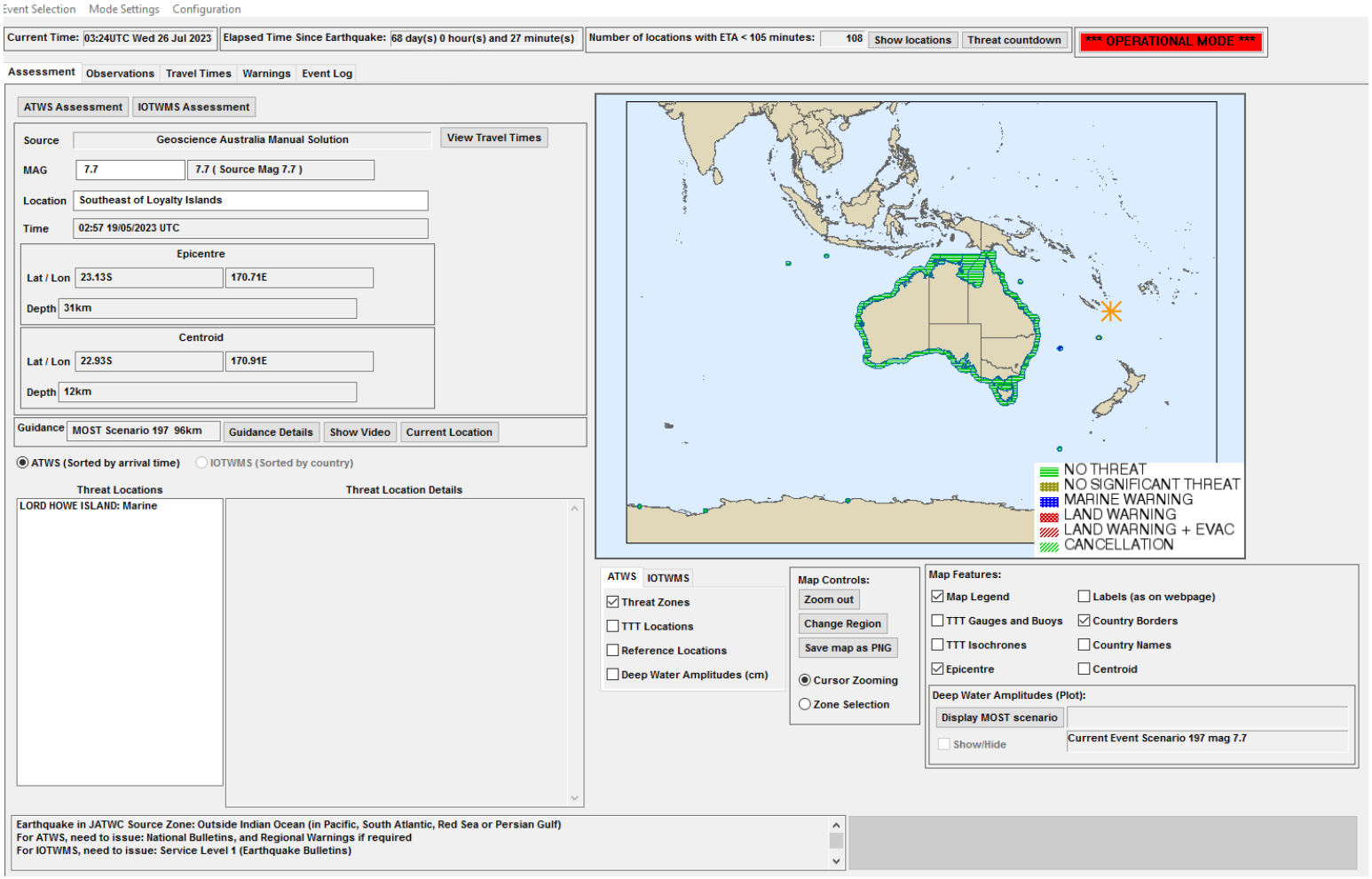
NTWCs = National Tsunami Warning Centres

Tsunami Processes and Products

Australian Tsunami Warning System (ATWS)



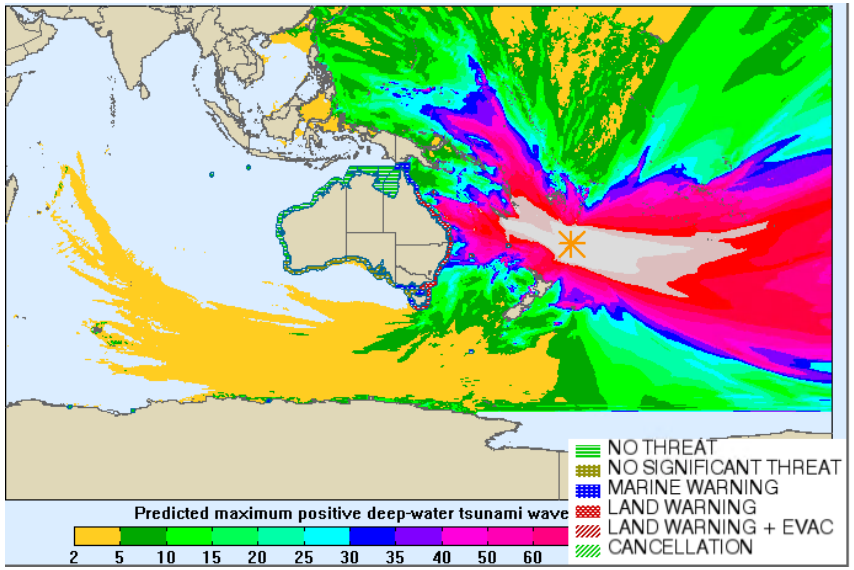
Decision Support Tool (DST)



DST set to be replaced by TOAST (bespoke version) in 2024

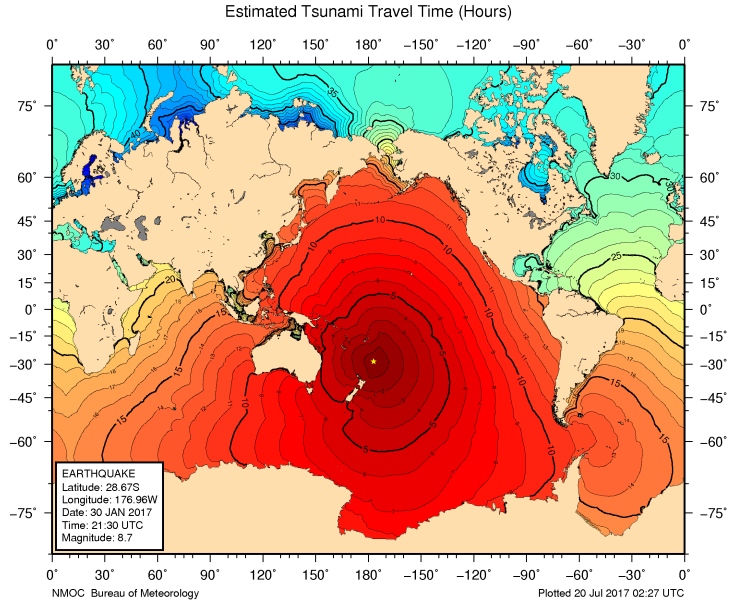
Tsunami Threat Assessment

Modeled Scenarios



Tsunami Threat Tier (Classification)	95th Percentile Deep Water Threshold Value
No Threat	<20cm (Australian continent, and Antarctica) <10cm (Offshore territories)
No Threat (low level effects)	10 – 20cm (Australian continent, and Antarctica) 5 – 10cm (Offshore territories)
Marine Threat	20 – 55cm (Australian continent, and Antarctica) 10 – 50cm (Offshore territories)
Land Inundation Threat	>55cm (Australian continent, and Antarctica) >50cm (Offshore territories)

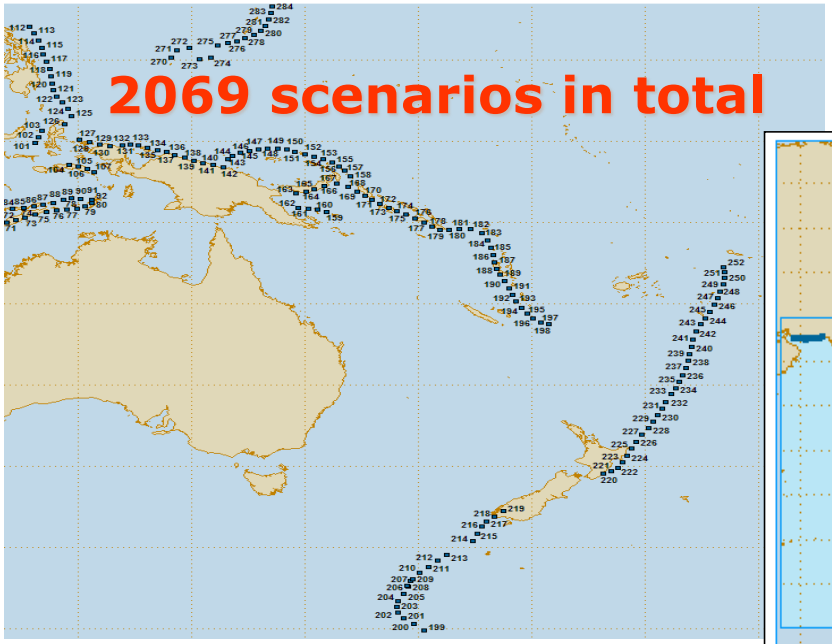
Tsunami Travel Times

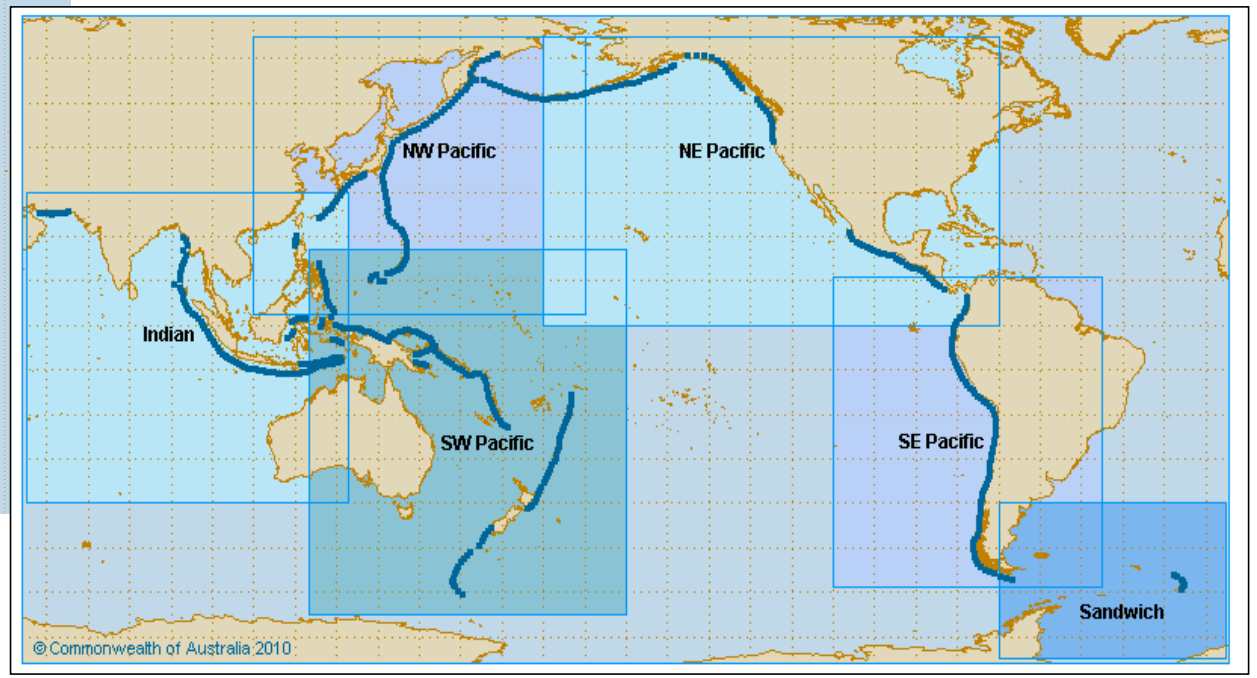


Mag	Action
6.5 to 7.5	The threat area is defined to be within the 1 hour travel time isochrone
7.6 to 7.8	The threat area is defined to be within the 3 hour travel time isochrone
7.9 and above	The threat area is defined to be within the 6 hour travel time isochrone

A scenario is pre-computed tsunami propagation modelling for a given earthquake magnitude, location and focal mechanism.

Australia currently uses the MOST Model to generate the scenario database

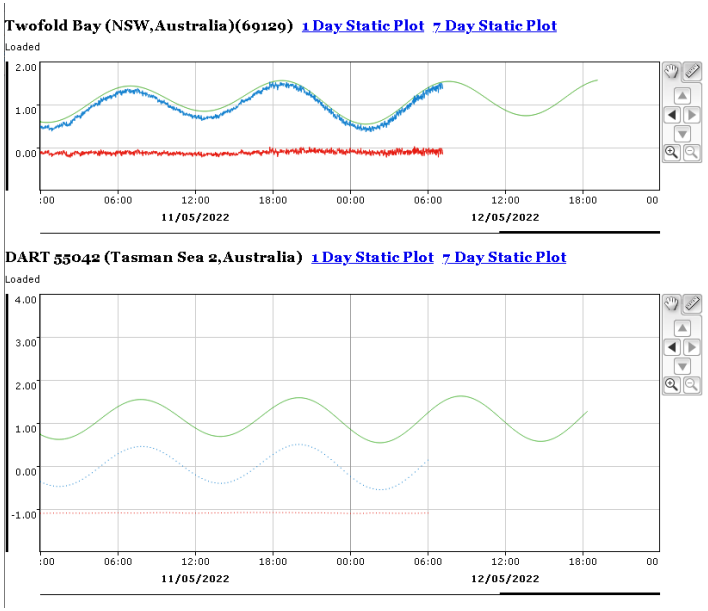




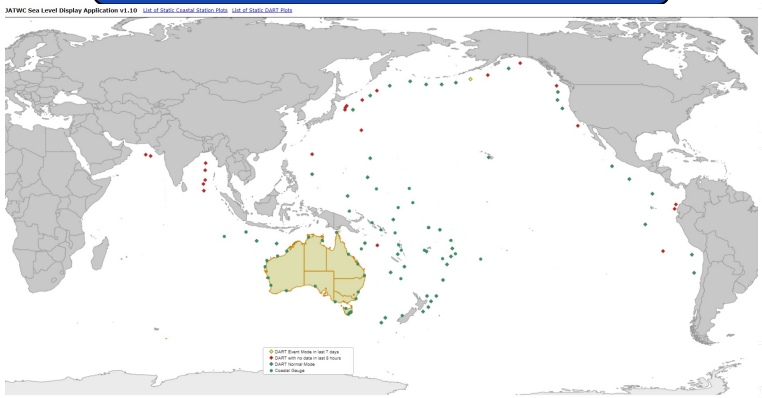
http://web.bom.gov.au/nmoc/srco/Tsunami/resources/MOST/MOST_scenario_locations.shtml (choose a scenario for maximum wave prediction map)

web.bom.gov.au/nmoc/srco/most_t2_threats/coastal_threats_t2_aust_v2.html (choose a scenario number and magnitude to assess threat to Australian coastal zones

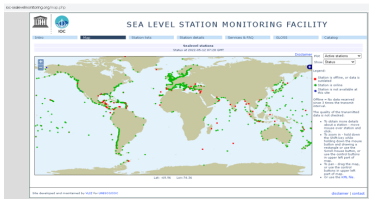
Sea Level Observations

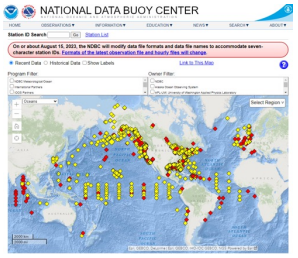


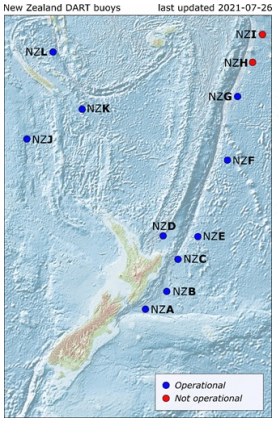
Internal Sea level viewer



Sea level monitoring

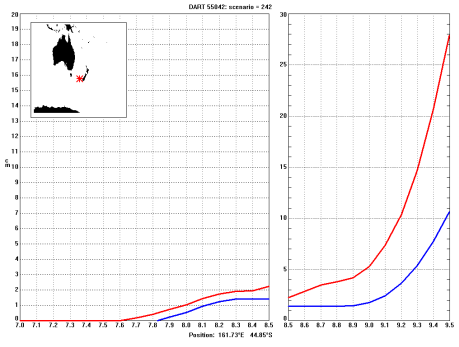






Wave observation to Threat Level

Tsunami Threat Tier (Classification)	At tide gauge depth (~5m)
No Threat	<40cm
Marine Threat	40cm – 100cm
Land Inundation Threat	>100cm



Warning Process

TSUNAMI WARNING
Marine Threat

Emphasise potential danger from:
- strong rips, ocean currents and dangerous waves for people swimming, surfing and boating in coastal waters

Advise that people should get out of the water, secure boats and move away from beaches, harbours, marinas, coastal estuaries and rock platforms even though major evacuations are NOT required

TSUNAMI WARNING
Land Threat

Emphasise potential danger from:
- major flooding for people in low lying coastal areas
- dangerous waves, strong rips, ocean currents for people swimming, surfing or boating in coastal waters

Advise people in identified regions to move to higher ground (10m above sea level or 1km inland)

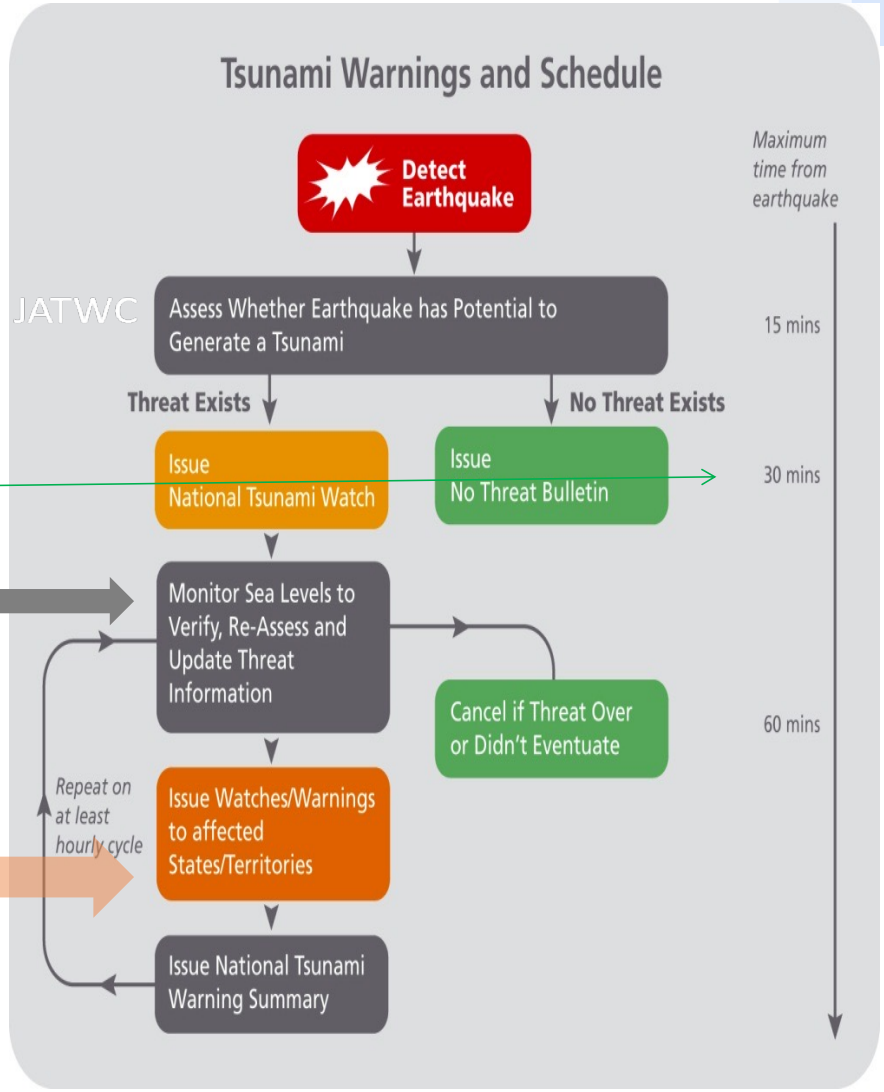
No Threat or Potential Threat advice – target <= 30mins

Use Australian and global sea level networks to monitor

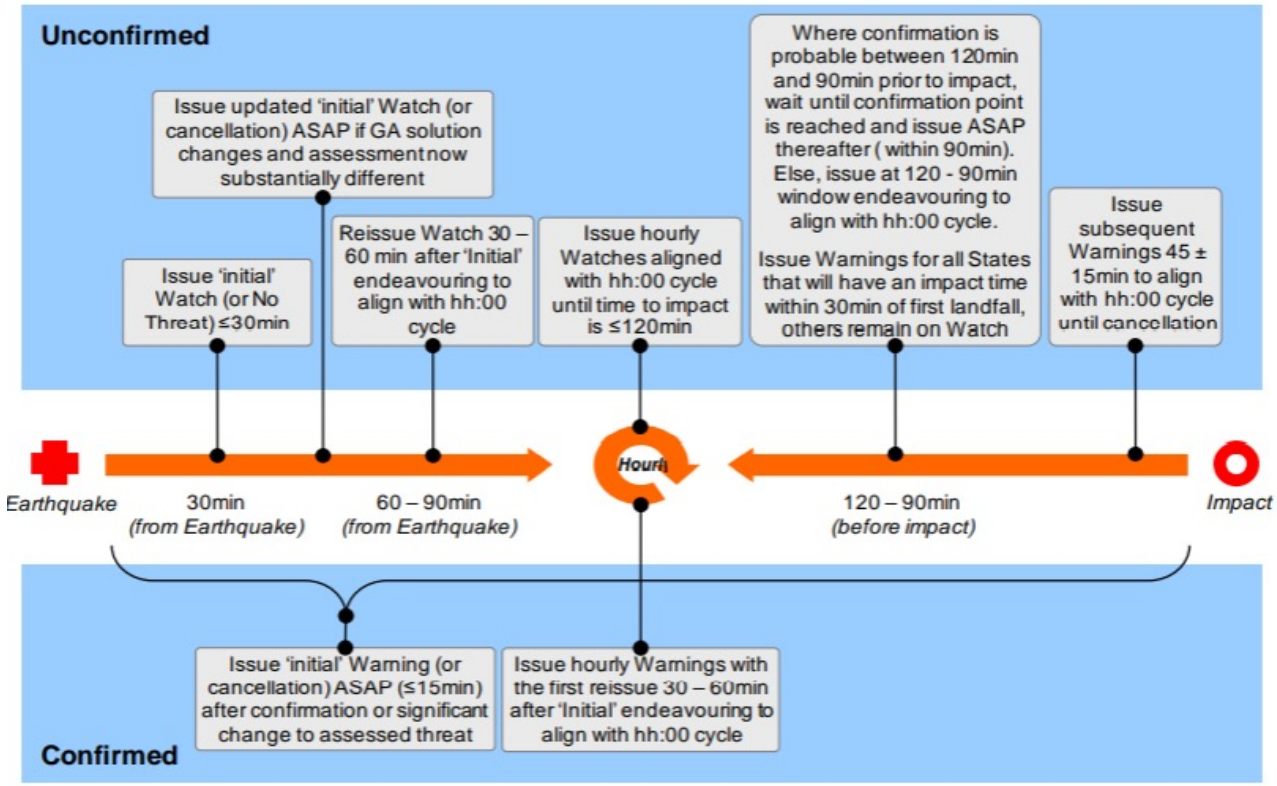
Warnings if tsunami is confirmed or threat less than 105min away

Provincial Emergency Services to review draft warnings which include action statements and whether evacuation order has been issued by SES/Police

Warnings then reissued every hour till cancelled



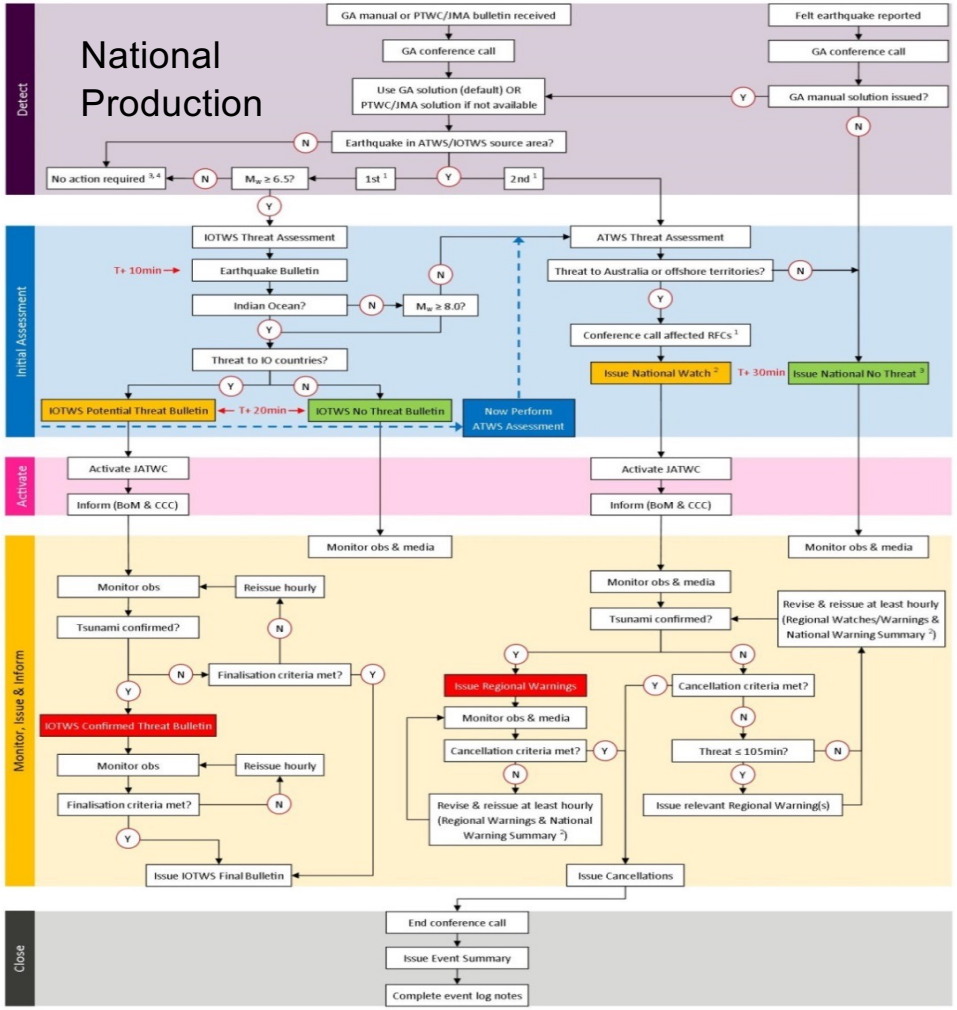
Product Issue Timeline

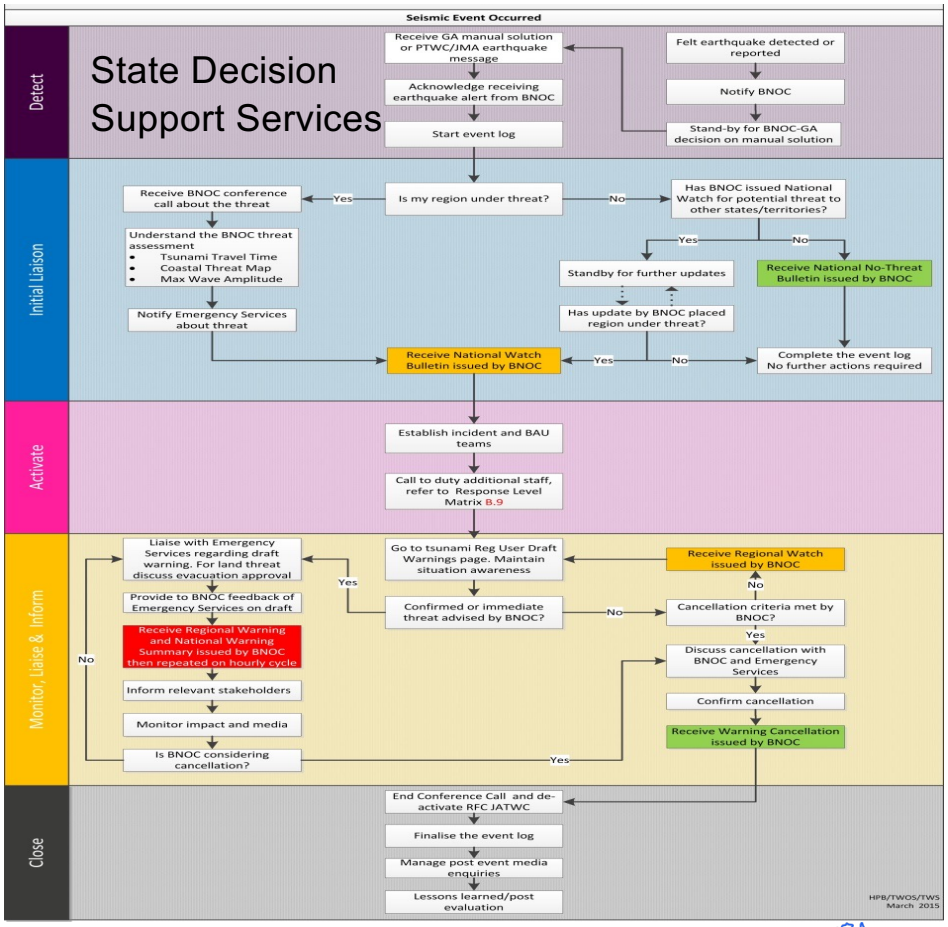


Preparation and distribution time:

1. Allow ~15min for preparation and dissemination. Hence to meet the 90min threshold warning development should commence at 105min before impact
2. To meet the hh:00 cycle, messages should be sent 10 minutes beforehand (i.e. hh:50). This allows media time to receive and embed the messages in bulletins / broadcasts

Decision Flowcharts





Product Examples

National Watch

IDY68005
Australian Government Bureau of Meteorology

MEDIA:
NO USE OF STANDARD EMERGENCY WARNING SIGNAL (SEWS)
TOP PRIORITY FOR IMMEDIATE AND FREQUENT BROADCAST
****
TSUNAMI WATCH NUMBER 1 FOR AUSTRALIA
Issued by the Joint Australian Tsunami Warning Centre (JATWC) at #issue_time_jatwc#
****

POTENTIAL TSUNAMI THREAT TO NEW SOUTH WALES, QUEENSLAND, TASMANIA, VICTORIA, MACQUARIE ISLAND, CASEY, LORD HOWE ISLAND, NORFOLK ISLAND

****
SUMMARY:
An undersea earthquake of magnitude 9.3 occurred at 8:30 AM AEDT on Tuesday 31 January 2017 near KERMADEC ISLANDS REGION.

AT THIS STAGE NO TSUNAMI WAVES HAVE BEEN OBSERVED THAT MAY THREATEN AUSTRALIA.

If a tsunami has been generated, it may start affecting the following States and Territories after these local times:

Norfolk Island after 11:00 am (UTC+11hrs) Tuesday
Lord Howe Island after 12:15 pm (UTC+10.5hrs) Tuesday
New South Wales after 1:30 pm (AEDT) Tuesday
Queensland after 12:45 pm (AEST) Tuesday
Victoria after 2:00 pm (AEDT) Tuesday
Macquarie Island after 03:00 UTC Tuesday
Tasmania after 2:15 pm (AEDT) Tuesday
Casey after 07:30 UTC Tuesday

The Joint Australian Tsunami Warning Centre is closely monitoring the situation and will advise immediately if there is cause for concern.

LISTEN FOR FURTHER UPDATES.

The NEXT UPDATE will be issued by #next_issue_jatwc#.

For latest and further information on tsunami warnings, please call 1300 TSUNAMI (1300 878 626) or visit www.bom.gov.au/tsunami

****
The JATWC is operated by the Australian Bureau of Meteorology and Geoscience

National No Threat

IDY68009
Australian Government Bureau of Meteorology

MEDIA:
NO USE OF STANDARD EMERGENCY WARNING SIGNAL (SEWS)
PLEASE BROADCAST THIS INFORMATION IF REFERRING TO THE EARTHQUAKE IN NEWS REPORTS.
****

NO TSUNAMI THREAT TO AUSTRALIA
Issued by the Joint Australian Tsunami Warning Centre (JATWC) at #issue_time_jatwc#

****
SUMMARY:
An undersea earthquake of magnitude 7.8 has occurred at 8:30 AM AEDT on Tuesday 31 January 2017 near KERMADEC ISLANDS REGION.

THERE IS NO TSUNAMI THREAT TO THE AUSTRALIAN MAINLAND, ISLANDS OR TERRITORIES.

For further information check the Bureau's website www.bom.gov.au/tsunami or call 1300 TSUNAMI (1300 878 6264).

No further updates will be issued unless the situation changes.
****
DETAILS:
An undersea earthquake of magnitude 7.8 has occurred at 8:30 AM AEDT on Tuesday 31 January 2017 near KERMADEC ISLANDS REGION (latitude 28.67S, longitude 176.96W). The JATWC has assessed that there is NO TSUNAMI THREAT TO THE AUSTRALIAN MAINLAND, ISLANDS OR TERRITORIES from this earthquake.

No further updates will be issued unless the situation changes.

For the latest and further information on tsunami warnings, please call 1300 TSUNAMI (1300 878 626) or visit www.bom.gov.au/tsunami.

****
The JATWC is operated by the Australian Bureau of Meteorology and Geoscience Australia
****

IDY68029
Australian Government Bureau of Meteorology
MEDIA:
PLEASE USE THE STANDARD EMERGENCY WARNING SIGNAL (SEWS)
TOP PRIORITY FOR IMMEDIATE AND FREQUENT BROADCAST

State Warning

****

TSUNAMI WARNING NUMBER 1 FOR VICTORIA Issued by the Joint Australian Tsunami Warning Centre (JATWC) at #issue_time_state#

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TSUNAMI THREAT TO LOW LYING COASTAL AREAS AND THE MARINE ENVIRONMENT

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SUMMARY:
Tsunami warning for VICTORIA.

LAND THREAT

For all low-lying coastal areas from Wilsons Promontory to 60nm east of Gabo Island including Central Gippsland Coast, Gippsland Lakes, East Gippsland Coast there is a threat of MAJOR LAND INUNDATION, FLOODING, DANGEROUS RIPS, WAVES AND STRONG OCEAN CURRENTS commencing after 2:00 pm (AEDT) Tuesday and persisting for several hours.

People in affected land threat areas are strongly advised by VICTORIA STATE EMERGENCY SERVICE to go to higher ground at least 10 metres above sea level or move to at least one kilometre inland.

MARINE THREAT

For the marine environment from SA-VIC Border to Wilsons Promontory including West Coast, Central Coast, Port Phillip, Western Port there is the possibility of DANGEROUS RIPS, WAVES AND STRONG OCEAN CURRENTS, AND SOME LOCALISED OVERFLOW ONTO THE IMMEDIATE FORESHORE commencing after 2:00 pm (AEDT) Tuesday and persisting for several hours.

While evacuations are not necessary for Marine Threat areas, people in these areas are advised to get out of the water and move away from the immediate water's edge.

The NEXT UPDATE will be issued by #next_issue_state#.

For latest and further information on tsunami warnings, please call 1300 TSUNAMI (1300 878 626) or visit www.bom.gov.au/tsunami

FOR URGENT EMERGENCY ASSISTANCE call 000
FOR EMERGENCY SERVICE ADVICE or GENERAL ASSISTANCE call:
VICTORIA STATE EMERGENCY SERVICE on 132 500

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DETAILS:
LAND THREAT - TSUNAMI THREAT TO LOW LYING COASTAL AREAS

A threat of MAJOR LAND INUNDATION, FLOODING, DANGEROUS RIPS, WAVES AND STRONG OCEAN CURRENTS exists from Wilsons Promontory to 60nm east of Gabo Island including Central Gippsland Coast, Gippsland Lakes, East Gippsland Coast commencing after 2:00 pm (AEDT) Tuesday and persisting for several hours.

MARINE THREAT - TSUNAMI THREAT TO THE MARINE ENVIRONMENT

A threat to the marine environment of DANGEROUS RIPS AND WAVES, STRONG OCEAN CURRENTS AND SOME LOCALISED OVERFLOW ONTO THE IMMEDIATE FORESHORE exists from SA-VIC Border to Wilsons Promontory including West Coast, Central Coast, Port Phillip, Western Port commencing after 2:00 pm (AEDT) Tuesday and persisting for several hours.

The tsunami threat will commence any time after the following local times and will persist for several hours:

Mallacoota after 2:00 pm (AEDT) Tuesday
Lakes Entrance after 2:45 pm (AEDT) Tuesday
Port Fairy after 4:00 pm (AEDT) Tuesday
Warrnambool after 4:15 pm (AEDT) Tuesday
Portland after 4:15 pm (AEDT) Tuesday
Wilsons Promontory after 4:45 pm (AEDT) Tuesday
Lorne after 5:00 pm (AEDT) Tuesday
Phillip Island after 6:15 pm (AEDT) Tuesday

COMMUNITY RESPONSE ADVICE FROM VICTORIA STATE EMERGENCY SERVICE FOR AREAS UNDER LAND THREAT:

People are strongly advised by VICTORIA STATE EMERGENCY SERVICE to go to higher ground, at least ten metres above sea level, or if possible move at least one kilometre away from all beaches and the water's edge of marinas, harbours and coastal estuaries.

Take only essential items that you can carry including important papers, family photographs and medical needs.

It will be in your own interests to walk to safety if possible to avoid traffic jams.

If you cannot leave the area take shelter in the upper storey of a sturdy brick or concrete multi-storey building.

Boats in harbours, estuaries or shallow coastal water should return to shore. Secure your boat and move away from the waterfront.

Vessels already at sea should stay offshore in water at least 25 metres deep until further advised.

Do not go to the coast to watch the tsunami.

Check that your neighbours have received this advice.

COMMUNITY RESPONSE ADVICE FROM VICTORIA STATE EMERGENCY SERVICE FOR AREAS UNDER MARINE THREAT:

People are strongly advised by VICTORIA STATE EMERGENCY SERVICE to get out of the water and move away from the immediate water's edge of beaches, marinas, harbours, coastal estuaries and rock platforms.

Boats in harbours, estuaries or shallow coastal water should return to shore. Secure your boat and move away from the waterfront.

Vessels already at sea should stay offshore in water at least 25 metres deep until further advised.

Do not go to the coast to watch the tsunami as there is the possibility of dangerous, localised flooding of the immediate foreshore.

Check that your neighbours have received this advice.

CAUTION:
Tsunami waves are more powerful than the same size beach waves. There will be many waves and the first wave may not be the largest. Take care in other coastal areas where low-level effects may be observed.

TSUNAMI SOURCE:
An undersea earthquake of magnitude 9.3 has occurred at 08:30 AM AEDT on Tuesday 31 January 2017 near KERMADEC ISLANDS REGION (28.67S, 176.96W).

The NEXT UPDATE will be issued by #next_issue_state#.

For latest and further information on tsunami warnings, please call 1300 TSUNAMI (1300 878 626) or visit www.bom.gov.au/tsunami

FOR URGENT EMERGENCY ASSISTANCE call 000
FOR EMERGENCY SERVICE ADVICE or GENERAL ASSISTANCE call:
VICTORIA STATE EMERGENCY SERVICE on 132 500

National Warning Summary

IDY68020
Australian Government Bureau of Meteorology

MEDIA:
NO USE OF STANDARD EMERGENCY WARNING SIGNAL (SEWS)
REFER TO INDIVIDUAL STATE AND TERRITORY TSUNAMI WARNINGS AND WATCHES FOR MORE DETAILED INFORMATION.
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NATIONAL TSUNAMI WARNING SUMMARY FOR AUSTRALIA NUMBER 2
Issued by the Joint Australian Tsunami Warning Centre (JATWC) at #issue_time_jatwc#

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TSUNAMI SOURCE:
An undersea earthquake of magnitude 8.7 has occurred at 8:30 AM AEDT on Tuesday 31 January 2017 near KERMADEC ISLANDS REGION (latitude 28.67S, longitude 176.96W).

Sea level observations have confirmed a tsunami has been generated.

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NATIONAL TSUNAMI WARNING STATUS:

NORFOLK ISLAND

Land Warning is current from 11:00 am (00:00 UTC) Tuesday

LORD HOWE ISLAND

Land Warning is current from 12:15 pm (01:45 UTC) Tuesday

NEW SOUTH WALES

Land Warning is current for all coastal areas from 1:30 pm (AEDT) Tuesday

VICTORIA

Land Warning is current for:

Wilsons Promontory to 60nm east of Gabo Island including Central Gippsland Coast, Gippsland Lakes, East Gippsland Coast from 2:00 pm (AEDT) Tuesday

Marine Warning is current for:

SA-VIC Border to Wilsons Promontory including West Coast, Central Coast, Port Phillip, Western Port from 2:00 pm (AEDT) Tuesday

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TSUNAMI DETAILS:
The following sea level gauges have observed a tsunami, heights refer to wave amplitudes (positive wave values):

Name	Country	Lat	Lon	Height (m)	Time (AEDT)
Raoul Island Fishing R	NEW ZEALAND	29.30S	177.90W	6.0	31 Jan 08:30 AM
Raoul Island Boat Cove	NEW ZEALAND	29.30S	177.89W	6.2	31 Jan 08:30 AM
Nuku'Alofa	TONGA	21.10S	175.20W	4.2	31 Jan 09:45 AM
DART 51426	TONGA	23.30S	168.29W	Detected	31 Jan 09:45 AM
East Cape	NEW ZEALAND	37.50S	178.17E	4.3	31 Jan 10:00 AM
Pago Pago	SAMOA	14.30S	170.69W	3.7	31 Jan 10:15 AM

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ADVICE
People in areas with threat of land inundation and flooding are strongly advised by emergency authorities to go to higher ground or at least 1 kilometre inland.
In areas with a threat to the marine environment only, emergency authorities advise people to get out of the water and move away from the immediate water's edge of harbours, coastal estuaries, rock platforms and beaches.

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FOR FURTHER INFORMATION:
Refer to individual State and Territory tsunami warnings and watches issued by the JATWC for more detailed information.
Listen for any further advice from your local emergency service through the media.
Check the Bureau's web site: www.bom.gov.au/tsunami
Call 1300 TSUNAMI (1300 878 6264)

FOR URGENT EMERGENCY ASSISTANCE call 000
For EMERGENCY SERVICE ADVICE OR GENERAL ASSISTANCE, call your local emergency service on 132 500 (in Tasmania call 131 444, on Norfolk Island call 977, on Cocos or Christmas Islands call (08) 9320 3444).

The NEXT UPDATE will be issued by #next_issue_state#.

AEST = AEDT - 1 hour
ACST = AEDT - 1.5 hours
ACDT = AEDT - 0.5 hour
AWST = AEDT - 3 hours
AEDT = Australian Eastern Daylight Time

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The JATWC is operated by the Australian Bureau of Meteorology and Geoscience Australia
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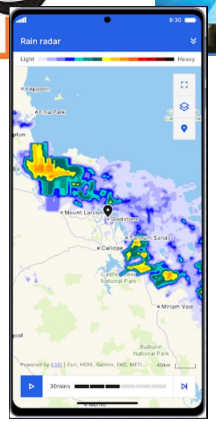
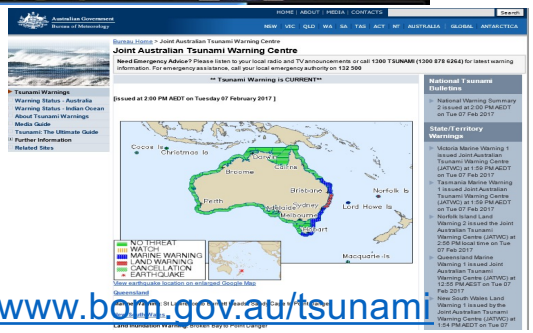
Ending with Cancellation

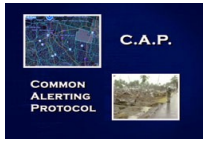
Disseminate Warnings via Multi-channels



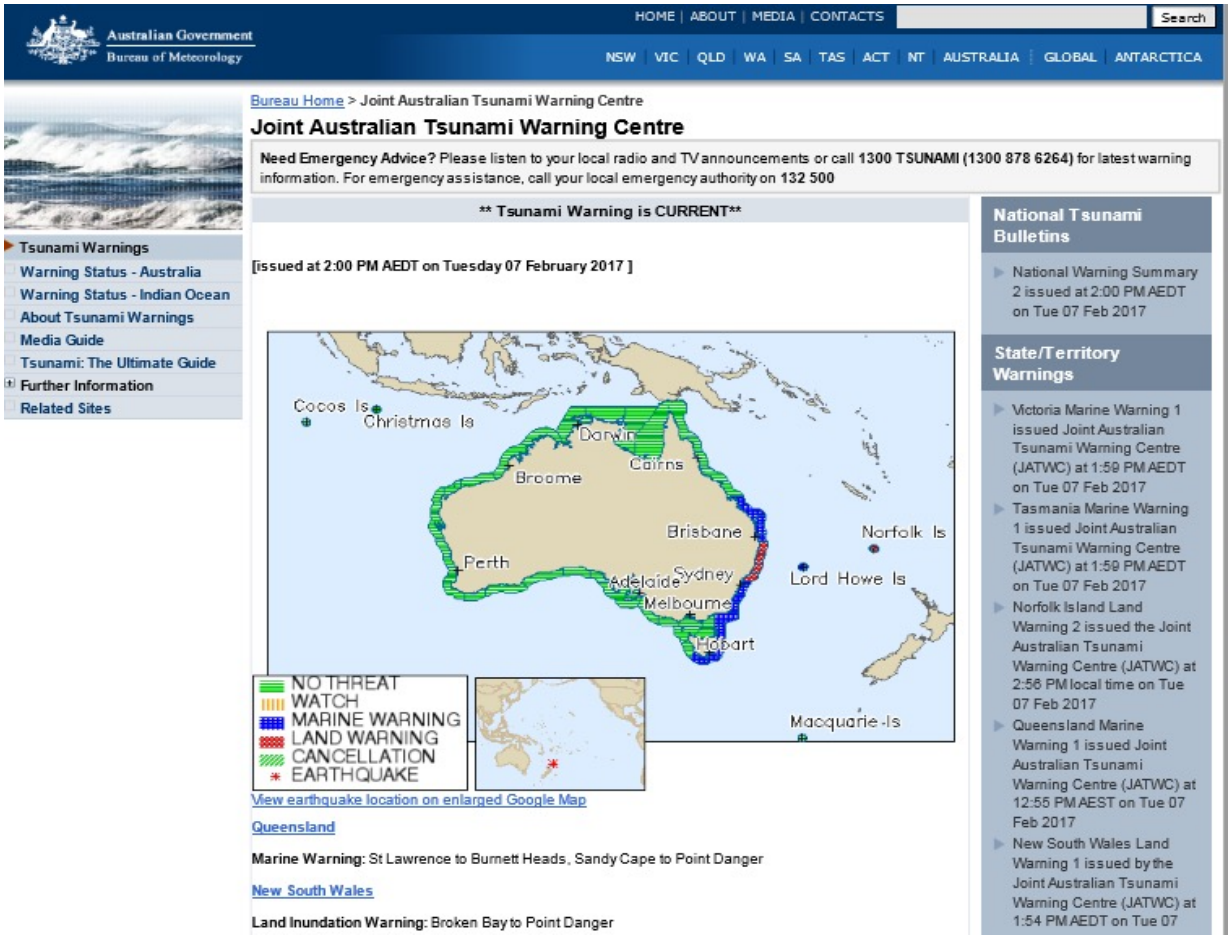


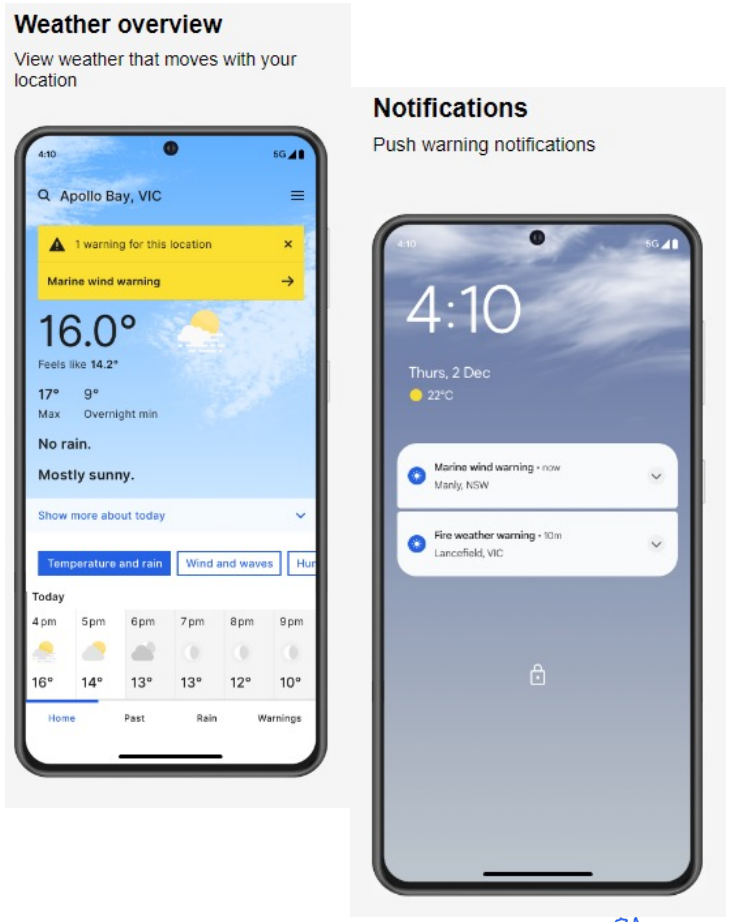
www.bom.gov.au/tsunami

www.bom.gov.au/tsunami/iotwms



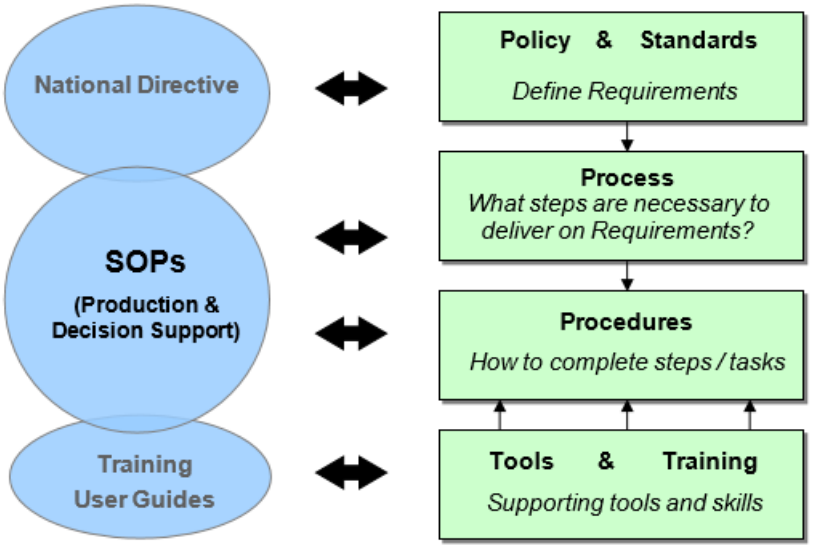
Public Webpage and the Bureau Weather App





Tsunami SOPs

Tsunami Operational Documents



SOPs - Bureau

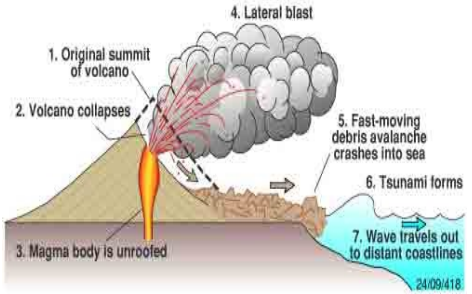
- TWS Production SOPs
- TWS Decision Support SOPs
- Media Tsunami SOPs
- ITCC Tsunami Checklist as Comms Officer

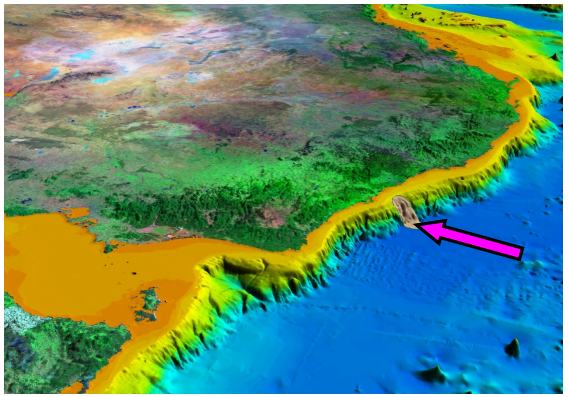
SOPs - GA and AGCCC

- GA Tsunami SOPs - Australian Polygon less than M3.5
- GA Tsunami SOPs - International M6 Plus
- GA Tsunami SOPs - IOTWMS M6.5
- GA Tsunami SOPs - SW Pacific Polygon M5
- GA Tsunami SOPs - Selector Table
- GA Tsunami SOPs - International less than M6
- GA Tsunami SOPs - Australian Polygon M3.5 Plus
- AGCCC Tsunami SOPs

Tsunami Types in SOPs

- Seismic with or without a corresponding MOST scenario
  - Also felt earthquake (no manual solution initially)
- Non-seismic
  - Volcanically generated (with assistance from the Volcanic Ash Advisory Centre)
  - Landslides
  - Celestial impact
- Oceanic – unknown sea level change





With a matching MOST scenario from pre-computed database

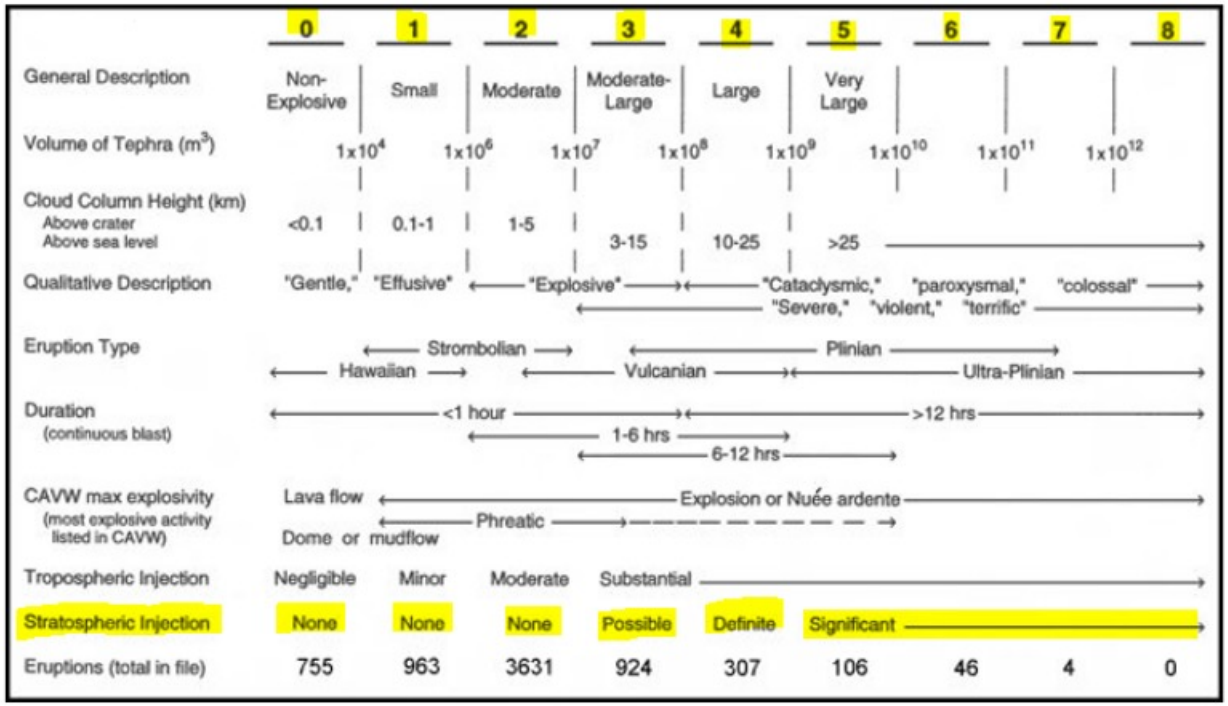
Tsunami Threat Classification	95th Percentile Deep Water Threshold Value	Indicative Threshold Value in shallow water (~ 5m depth)
No Threat	<20cm (Australian continent, and Antarctica) <10cm (Offshore Territories)	**<40cm**
Marine Threat	20 – 55cm (Australian continent, and Antarctica) 10 – 50cm (Offshore territories)	**40cm – 1m**
Land Inundation Threat	**>55cm (Australian continent, and Antarctica)** **>50cm (Offshore territories)**	**> 1m**

Without a matching scenario

Mag	Action
6.5 to 7.5	The threat area is defined to be within the 1 hour travel time isochrone
7.6 to 7.8	The threat area is defined to be within the 3 hour travel time isochrone
7.9 and above	The threat area is defined to be within the 6 hour travel time isochrone

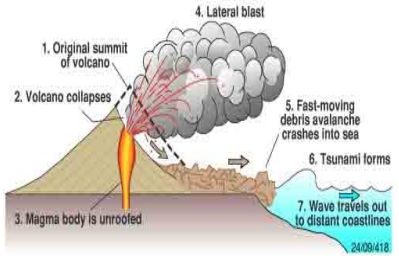
Define a severity level of 1, 3 or 6 corresponding to TTT hours

Severity	Action
Level 1	The threat area is defined to be within the 1 hour travel time isochrone
Level 3	The threat area is defined to be within the 3 hour travel time isochrone
Level 6	The expanding threat area is defined by the elapsed time since event + 6 hour travel time isochrone



	0	1	2	3	4	5	6	7	8
General Description	Non-Explosive	Small	Moderate	Moderate-Large	Large	Very Large			
Volume of Tephra (m^3)		$1x10^4$	$1x10^6$	$1x10^7$	$1x10^8$	$1x10^9$	$1x10^{10}$	$1x10^{11}$	$1x10^{12}$
Cloud Column Height (km) Above crater / Above sea level	<0.1	0.1-1	1-5	3-15	10-25	>25			
Qualitative Description	"Gentle,"	"Effusive"	← "Explosive" →		← "Cataclysmic," "Severe,"		"paroxysmal," "violent,"	"colossal" "terrific" →	
Eruption Type	← Hawaiian →	← Strombolian →	← Vulcanian →		← Plinian →		← Ultra-Plinian →		
Duration (continuous blast)	← <1 hour →	← 1-6 hrs →	← 6-12 hrs →		← >12 hrs →				
CAVW max explosivity (most explosive activity listed in CAVW)	Lava flow / Dome or mudflow	← Phreatic →			← Explosion or Nuée ardente →				
Tropospheric Injection	Negligible	Minor	Moderate	Substantial →					
Stratospheric Injection	None	None	None	Possible	Definite	Significant →			
Eruptions (total in file)	755	963	3631	924	307	106	46	4	0

Stratospheric injection	None	None	None	Possible	Definite	Significant
Tsunami NOT observed	Nil	Nil	Nil	1 hour	3 hour	6 hour
Tsunami Observed	1 hour	1 hour	1 hour	1 hour	3 hour	6 hour

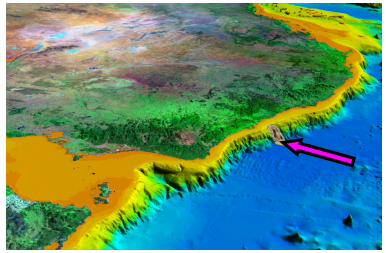


(1) *Issue no products and monitor for any potential tsunami*: This action should be taken if there is little to no stratospheric injection and there is no evidence a tsunami has been generated.

(2) *Create the event in the DST with a Severity of 1 hour*: This action should be taken if there is little to no stratospheric injection and there is evidence that a small tsunami has been generated and the impacts are consistent with a low-level Marine Threat.

(3) *Create the event in the DST with a Severity of 3 hours*: This action should be taken if there is obvious stratospheric injection consistent with a VEI of 4 and/or there are reliable observations or reports that indicate a tsunami has been generated and the impacts are consistent with a high-level Marine Threat or low-level Land Threat.

(4) *Create the event in the DST with a Severity of 6 hours*: This action should be taken if there is significant stratospheric injection consistent with a VEI of 5+ and/or there are reliable observations or reports that indicate a catastrophic tsunami has been generated.



The main area of risk for Australia is a landslide on the continental shelf

If a landslide is identified, then

(1) *Create the event in the DST with a Severity of 1 hour*: This action should be taken if there are reliable observations or reports that indicate a small tsunami has been generated.

(2) *Create the event in the DST with a Severity of 3 hours*: This action should be taken if there are reliable observations or reports that indicate a tsunami has been generated and the impacts are consistent with a low-level Marine Threat.

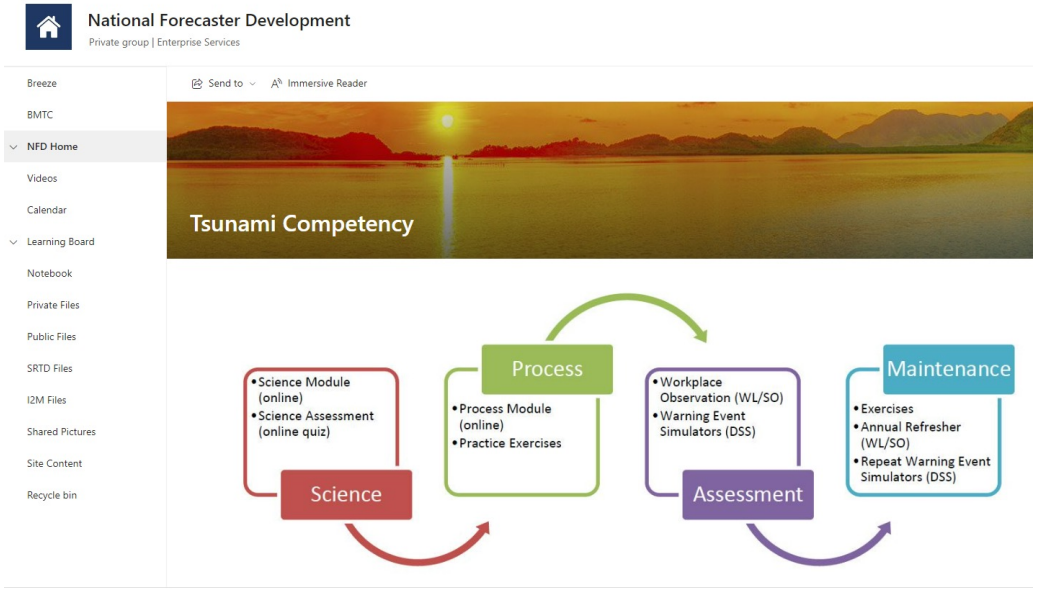
(3) *Create the event in the DST with a Severity of 6 hours*: This action should be taken if there are reliable observations or reports that indicate a catastrophic tsunami has been generated and the impacts are consistent with a high-level Marine Threat or low-level Land Threat.

Celestial Impact Tsunamis

Approximate impactor radius	Approximate equivalent earthquake magnitude	Severity level
10m	M6.5	3
20m	M7.0	3
30m	M7.5	3
60m	M8.0	3
110m	M8.5	6
200m	M9.0	6

Training, Exercises, and Current and Future Work

Tsunami Training and Competency Framework



Science: The science module is common to NP* and DSS forecasters. NP forecasters explore a few additional concepts with respect to modelling and seismology. Completion of a quiz (NP | DSS) satisfies the assessment requirements for this phase.

Process: The process training provides relevant information regarding the SOPs and supports learners through tsunami lessons. Separate online training courses have been created to suit NP and DSS forecasters. NP forecasters must also complete the Decision Support Tool module to use the software effectively for tsunami events. Participation in tsunami exercises may also support skill development during this phase.

Assessment: The assessment phase is conducted via workplace observation for NP forecasters every three years and online Warning Event Simulators for DSS staff every 5 years (manual enrolment required - request by emailing tsunami_training@bom.gov.au).

Maintenance: Skill maintenance will be achieved through participation in GA/Bureau joint tsunami exercises, self-guided practice (NP) and repeating Warning Event Simulators (DSS).

*For the future state of CSG, EPS specialists will offer surge support into NP and will require the same level of learning/development and competency as the NP science officers and tsunami warning leads.

Learning

Tsunami Training Package

Core modules (enrolment key: rootgH):

- Tsunami Science
- Tsunami Science Assessment (DSS)
- Tsunami Warning Process (DSS)
- Tsunami Process Assessment (DSS)
- Tsunami Decision Support Tool & 11.2 Upgrade course (NP/EPS)
- Tsunami Warning Process (NP/EPS)
- Tsunami Assessment (NP/EPS)

Other resources:

- COMET modules (search for tsunami)

Competency Descriptions

NP

- Science (TsuSciA: 50006169)
- Process - TWL (TsuProA: 50006171)
- Process - SO (TsuProB: 50006174)

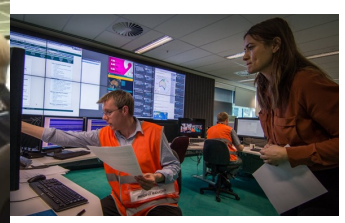
DSS

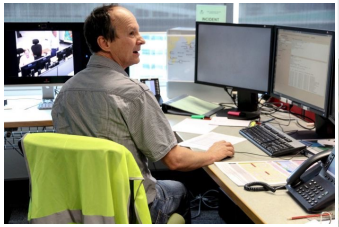
- Science (TsuSciB: 50006172)
- Process (TsuProD: 50006177)

Current Plans & Activities

NOC Training & Assessment Plan

Regular Exercises – Ausnami, IOWave, PacWave, BoM/GA, Comms Tests.





We're testing our tsunami warning processes today, as part of the UNESCO international Indian Ocean tsunami warning exercise #IOWave18

If a real tsunami ever threatens our shores, you'll find warnings and advice at http://www.bom.gov.au/tsunami

IOWave18

IOWave20

IOWave23

Current and Future Work

- The Bureau is undertaking a major tsunami decision support tool replacement project.
- The Bureau is developing a future warning framework and capacity to provide impact-based and location specific warnings, in partnership with emergency services and in alignment with the Australian Warning System (AWS). Tsunami is in scope.
  - Need real-time modelling, both in tsunami propagation and inundation, to improve accuracy of tsunami warnings.
- Need more public and emergency services education and engagement activities to raise the current low level of tsunami awareness in Australia.
  - Need to engage the Australian community routinely in tsunami mitigation and participatory planning activities guided by the IOC Tsunami Ready guideline.
- Need to form better partnerships with TV and radio stations (especially commercial).
- Research required to understand the interaction between sea ice and tsunami waves and therefore tsunami impacts on Antarctic stations.

The Bureau of Meteorology

Thank you

Glen Perrin

Bureau of Meteorology

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