United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

IOC of UNESCO
Intergovernmental Coordination Group for the
PacificTsunami Warning and Mitigation System (PTWS)
December 2016

Exercise Pacific Wave 2017
PacWave17 Overview

Laura Kong
International Tsunami Information Center
Jo Guard
New Zealand Ministry of Civil Defence & Emergency Management
Tomoaki Ozaki
Japan Meteorological Agency

Exercise Pacific Wave (PacWave)

- IOC-coordinated international tsunami exercises
- Started 2006 to test readiness of Pacific countries – 2006, 2008, 2011, 2013, 2015, 2016, 2017
- PacWave11, 13, 15 – introduce and test PTWC new enhanced products prior to changeover (1 October 2014), and after
- PacWave 16, 17 - introduce and test JAM NWPTAC new enhanced products prior to changeover (2018)

PacWave 16 and 17 – Overall Goals

Test NWPTAC new products prior to implementation through 2 PacWave exercises

PacWave16

- Small-scale exercise with 16 countries that receive NWPTAC products
- Table-top exercise recommended

PacWave17

- Full-scale exercise with all Member States
- Encourage additional activities over and above table top exercise.

PacWave Planning, Conduct, Evaluation

PacWave Exercises Task Team:

- **Three co-chairs**
  - Laura Kong - ITIC
  - Jo Guard - New Zealand
  - Tomoaki Ozaki - Japan

Members - same for PacWave16 and 17

- Viviana Dionicio – Colombia
- Jun-Hee Lee – Korea
- Yuelong Miao – Australia
- Jerome Aucau – New Caledonia
- Dominique Reymond – French Polynesia
- Viacheslav Gusiakov and Tatiana Ivelskaya – Russia
- Chip McCreery – PTWC

PacWave17 – Date and Purpose

- **Exercise Web Site:** http://www.pacwave.info
- **Announcement:**
  IOC CL 2636 issued 16 August 2016

  15-17 February 2017:
  PTWS Exercise Pacific Wave “PacWave17”
- **Exercise Purpose:**
  The aim of PacWave17 is to test the NWPTAC enhanced products and PTWC enhanced products. Proposed new SCSTAC products tested in parallel with PacWave17

PacWave17 – Objectives

1. Test communications from the PTWS PTWC and NWPTAC Tsunami Service Providers to Member States.

2. Test whether the PTWS PTWC and NWPTAC Tsunami Service Provider products are interpreted by Member States accurately and in a timely manner.

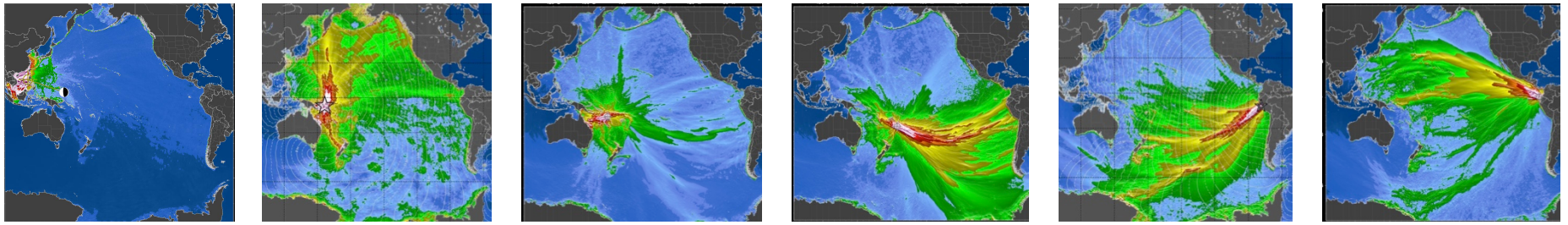
3. Test national and regional communication.

4. Test national and regional cooperation.

PacWave17 – 7 Scenarios

All scenarios: Magnitude: M9.0
Depth 20 km (except Manila)

- **Manila Trench (Depth 35 km)**
- **New Britain-San Cristobal Trench (PacWave16)**
- **New Hebrides Trench (PacWave11)**
- **Tonga Trench (PacWave11, 15)**
- **Peru-Chile Trench (PacWave11)**
- **Colombia-Ecuador Trench (PacWave11)**

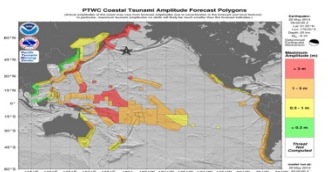


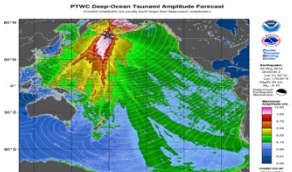
PacWave17 – Conduct

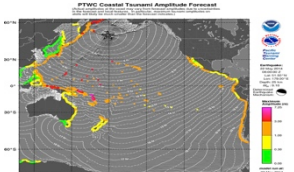
- **Exercise Date:**
  - Event start live, but may conduct on diff date / time
  - 15 Feb: Colombia-Ecu, Peru-Chile, Tonga
  - 16 Feb: New Hebrides, San Cristobal, Manila
- **Exercise Type and Participants – Recommend:**
  - Tabletop Exercise
  - Minimum participation: NTWC, NDMO
  - Each Country - exercise 1 Tsunami Scenario
- **TSP Messages (on web site)**
  - PTWC, JMA NWPTAC
  - Live ‘Dummy Text’ messages to start

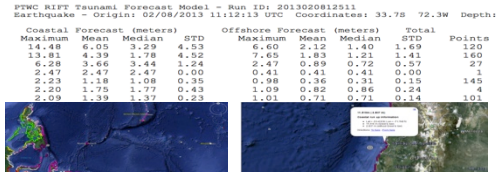
PTWC New Enhanced Products

- **Base threat on wave forecast models, not on pre-determined magnitude threshold**
- **Forecasts constrained by EQ mechanism (W-CMT) and sea level readings**
- **Public Text Msg continues** – Summary Information
- **Graphical forecasts and Statistics table only to Country Tsunami Warning Focal Points (TWFP):**
  - Coastal Tsunami Amplitude Forecast Polygon Map - Overview
  - Deep-Ocean Tsunami Amplitude Forecast Map – Pacific-wide
  - Coastal Tsunami Amplitude Forecast Map – Pacific-wide and Regional, with Tsunami Travel Times
  - Coastal Tsunami Amplitude Forecast KMZ– input to Google Earth
  - Table of Forecast Statistics for Regional Polygons









PTWC RIFT Tsunami Forecast Model - Run ID: 2013020812511
Earthquake - Origin: 02/08/2013 11:12:13 UTC Coordinates: 33.7S 72.3W Depth: 020km Magnitude: 8.9

Coastal Forecast (meters)				Offshore Forecast (meters)				Total	
Maximum	Mean	Median	STD	Maximum	Mean	Median	STD	Points	Region Name
14.48	6.05	3.29	4.53	6.60	2.12	1.40	1.69	120	North Central Chile
13.81	4.39	1.78	4.52	7.65	1.83	1.21	1.41	160	South Central Chile
6.28	3.66	3.44	1.24	2.47	0.89	0.72	0.57	27	Marquesas Islands
2.47	2.47	2.47	0.00	0.41	0.41	0.41	0.00	1	Palmyra Island
2.23	1.18	1.08	0.35	0.98	0.36	0.31	0.15	145	Hawaii
2.20	1.75	1.77	0.43	1.09	0.82	0.86	0.24	4	Tuamotu Archipelago
2.09	1.39	1.37	0.23	1.01	0.71	0.71	0.14	101	Central Peru
									Southern Peru
									Line Islands
									Easter Island
									Northern Chile
									Society Islands
									Cook Islands
									Pacific Coast of Kamchatka
									East Coast of Japanese Main Islands

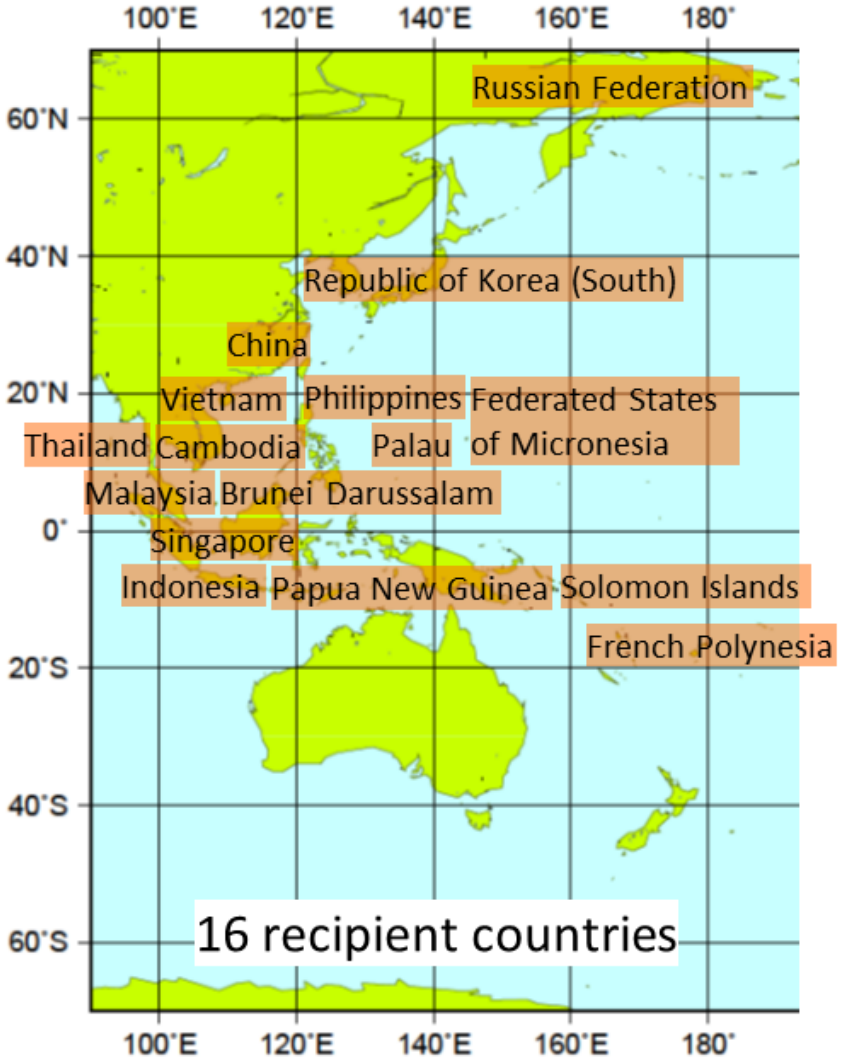
PTWC New Enhanced Products

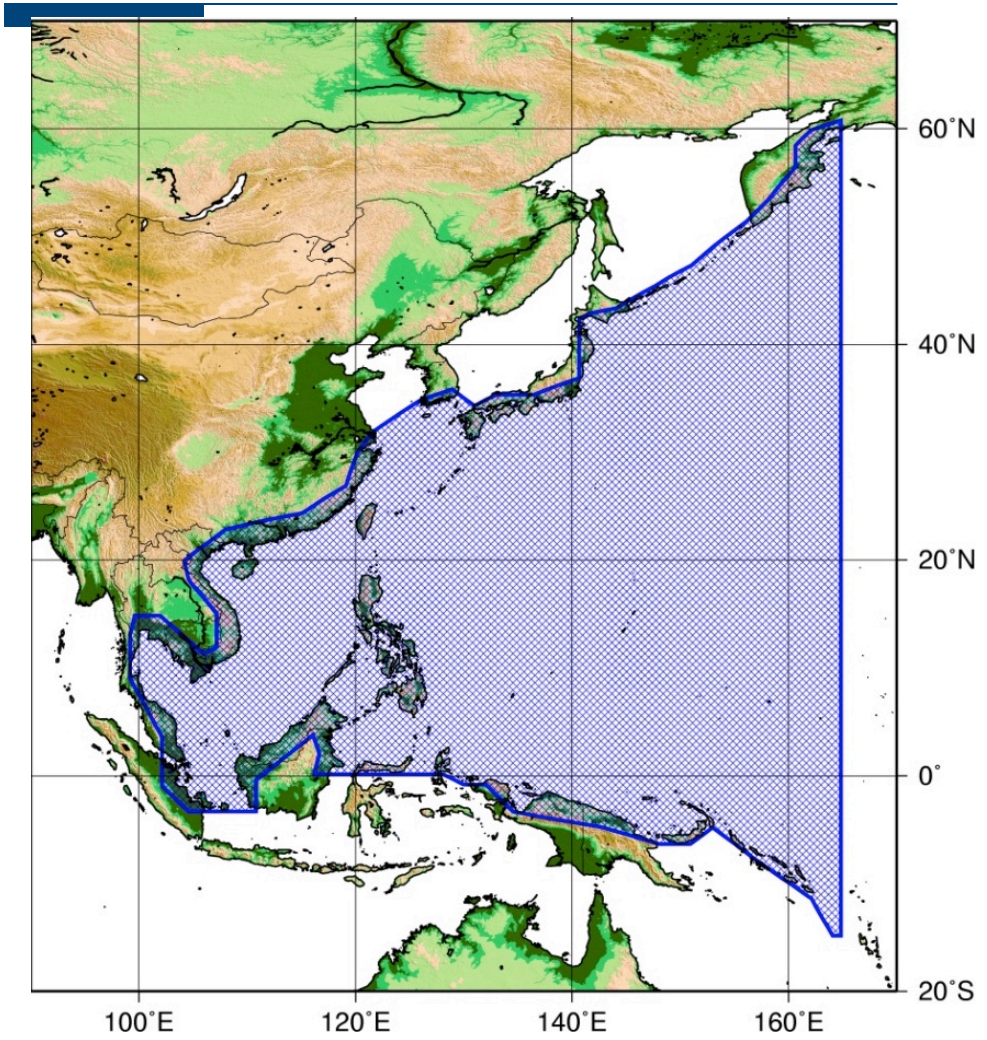
- **No Warning / Watch Alert Levels**
- **Instead, issue Threat Levels:**
  4 categories based forecast maximum coastal tsunami wave amplitudes
  - < 0.3m (no Threat)
  - 0.3 to < 1m
  - 1 to 3m
  - > 3m
  - Other: Forecast not yet computed

Northwest Pacific Tsunami Advisory Centre

- **Developed and tested – PacWave16, 17 Implement 2018 with ICG/PTWS approval**
- **NWPTA Forecast Points:** revised to align with PTWC products, and meet Member States requests
- **Text Products – continue as before**
- **Graphical Products – sent by email**
  - Travel Time Map
  - Coastal Tsunami Amplitude Forecast Map
  - Deep-ocean Tsunami Amplitude Forecast Map

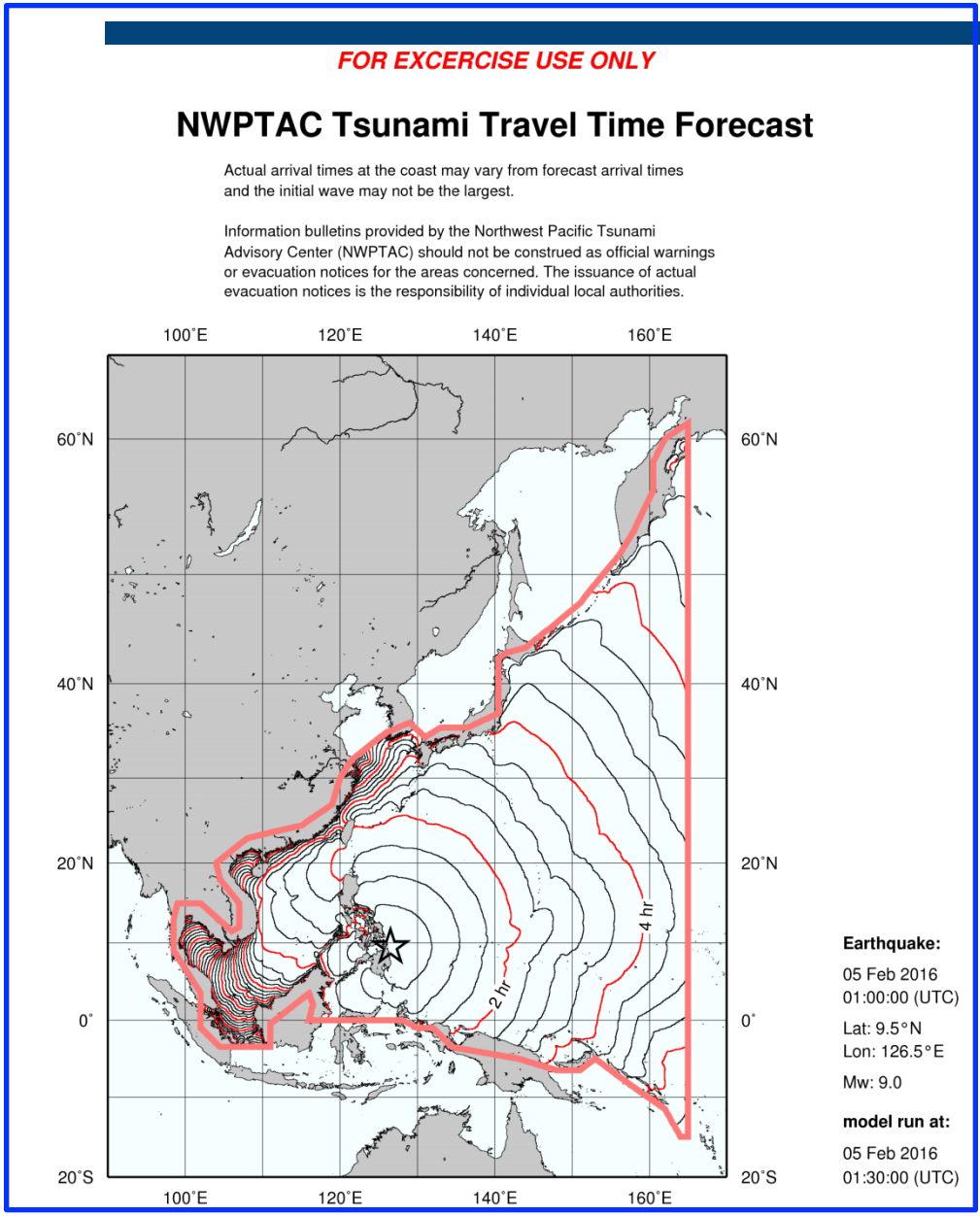
NWPTA Recipient Countres, Area Coverage





NWPTA will be issued to 16 recipient countries when the NWPTAC detects occurrence of an earthquake of magnitude 6.5 or greater in the blue-shaded area.

NWPTAC Products: Tsunami Travel Time



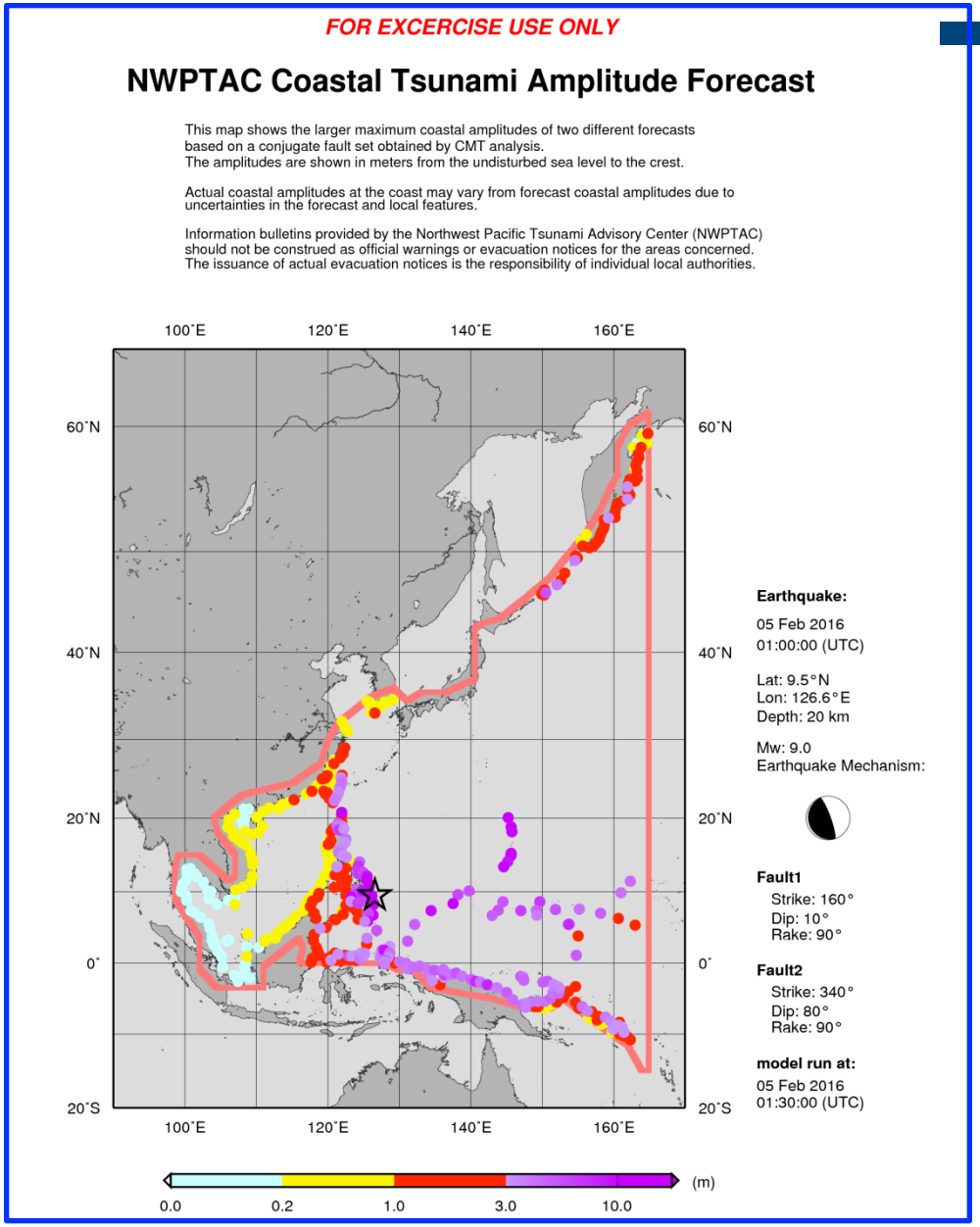
- This map shows the estimated travel time based on determined earthquake location (hypocenter or centroid) and magnitude.

Limitations

Actual arrival time at the coast may vary from forecast arrival time due to many reasons including:

- Uncertainties in tsunami source (the area of seafloor deformation is assumed from earthquake location and magnitude)
- Uncertainties in bathymetry especially in the vicinity of the observation point
- Nonlinear effects on tsunami propagation which is not taken into account in estimating travel time (the nonlinear effects may be important especially in shallow water)
- Difficulty in measuring the first wave arrival from observed sea level data

Coastal Tsunami Amplitude Forecast



- This map shows the individual coastal points colored according to the forecast tsunami amplitude at each point
- The larger of two different forecast amplitudes based on a conjugate fault set obtained by CMT analysis is used as a forecast tsunami amplitude at each point

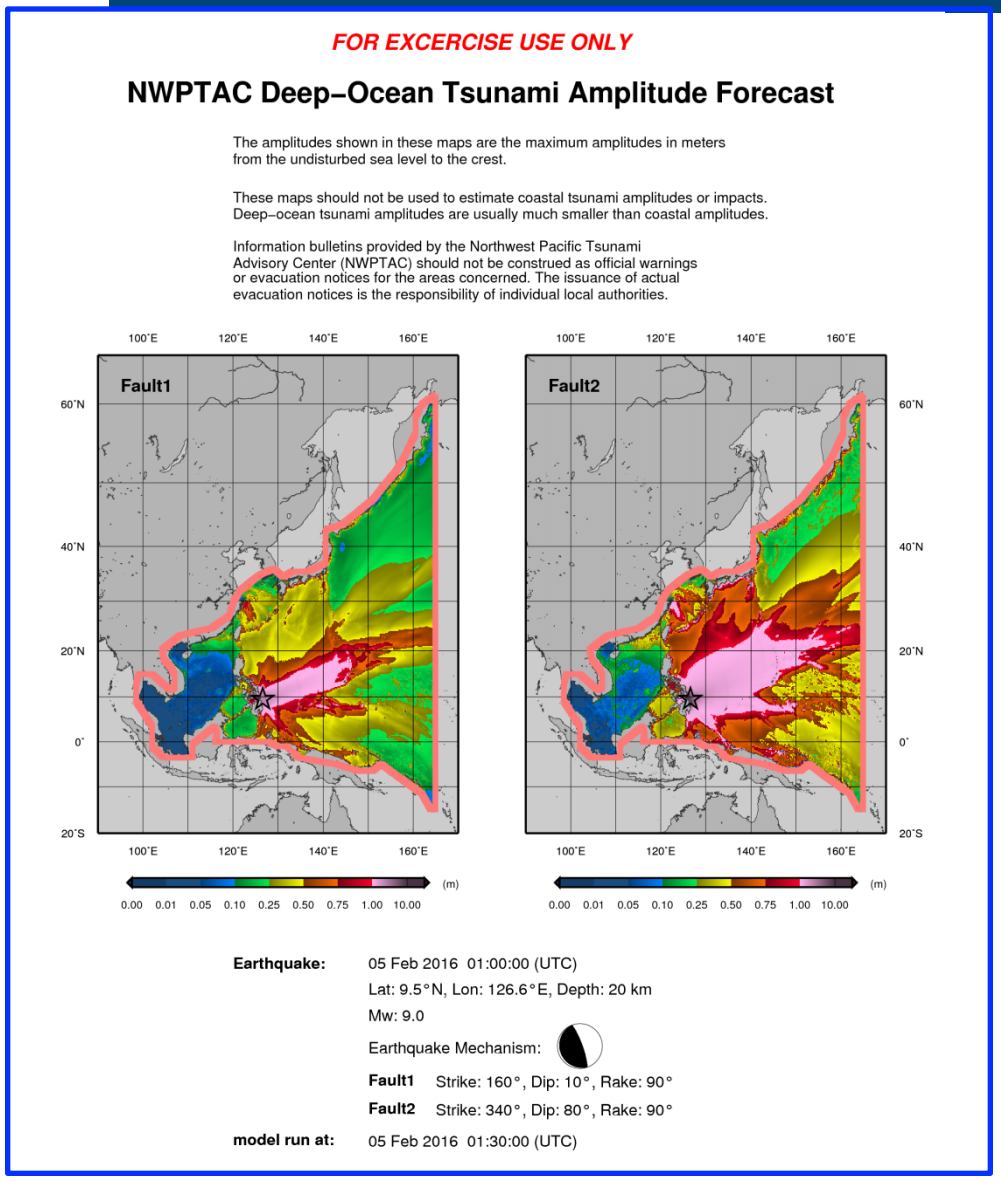
Limitations

Actual tsunami amplitudes at the coast may vary from forecast amplitudes due to many reasons including:

- Uncertainties in tsunami source (two rectangular faults are assumed based on the result of CMT analysis)
- Uncertainties in the way that the tsunami interact with the coast (a general approximation, Green's Law, is used)

The results can vary easily by a factor of two because of the uncertainties written above.

Deep-ocean Tsunami Amplitude Forecast



- This map shows the maximum tsunami amplitude at each place in the deep ocean.
- It shows how the tsunami is directed away from the tsunami source, how it is focused and defocused by the shape of the seafloor, and how it diminishes by spreading
- Two different maps based on a conjugate fault set obtained by CMT analysis will be provided

Limitations

Actual deep-ocean tsunami amplitude may vary from forecast amplitudes mainly due to uncertainties in tsunami source (two rectangular faults are assumed based on the result of CMT analysis).

This map should not be used to estimate coastal tsunami amplitudes or impacts.

PacWave17 - Documents

PacWave17 web site: www.pacwave.info

- Exercise Messages (PTWC, JMA/NWPTA)
- PacWave Exercise Manual (IOC TS 131, 2016)
- User's Guide to PTWC Enhanced Products for the PTWS (IOC TS 105, revised, 2014)
- PacWave17 Summary (this ppt)
- How to Plan, Conduct, and Evaluate IOC Tsunami Wave Exercises (IOC M&G 58 2013)
- PacWave17 Announcement (IOC CL 2636, 16 Aug 2016)

PacWave17 - Evaluation

- **Post-Exercise Evaluation**
  - **Due 10 March 2017**
  - **Preliminary Results available for ICG/PTWS-XXVII, 28-31 March 2017**
  - **Online:**
    https://www.surveymonkey.com/s/pacwave17_eval

PacWave17 Timetable

4 Nov 2016	Nominate PacWave17 National Contact
1 Dec 2016	Exercise manual (incl scenarios) on www.pacwave.info
31 Jan 2017	Exercise messages posted
15-17 Feb 2017	PacWave17
18 Feb -10 Mar 2017	Countries complete and submit evaluation survey online
28 - 31 Mar 2017	Draft Preliminary Results discussed at ICG/ PTWS-XXVII
21 Apr 2017	Draft PacWave17 Preliminary Report available to Member States
30 Jun 2017	Final PacWave17 Summary Report on www.pacwave.info

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Exercise Pacific Wave, 2006-2016:
A decade of reflection

PacWave6: 16-17 May 2006

Exercise Purpose:
To test, exercise, evaluate and review the operational lines of communication within the Pacific Tsunami Warning and Mitigation System's area of responsibility

Participants: 44 countries

Scenarios: 1

PacWave6: Objectives

1. Validate the Tsunami Warning Centres' dissemination process of issuing tsunami watch and warning bulletins to Pacific basin countries;
2. Validate the process for countries to receive and confirm tsunami bulletins;
3. Validate dissemination of warning messages to relevant agencies within a country, provinces and local jurisdictions;
4. Validate the organisational decision making process about public warnings and evacuations;
5. Identify the modes that would be employed to notify and instruct the public; and
6. Assess the elapsed time until the public would be notified and instructed.

PacWave8: 28-30 October 2008

Exercise Purpose:
The purpose of the exercise was to evaluate and improve the effectiveness of the PTWS, its operational Tsunami Warning Centers, and its Member States in responding to a destructive tsunami.

Participants: 40 countries

Scenarios: 1

PacWave8: Objectives

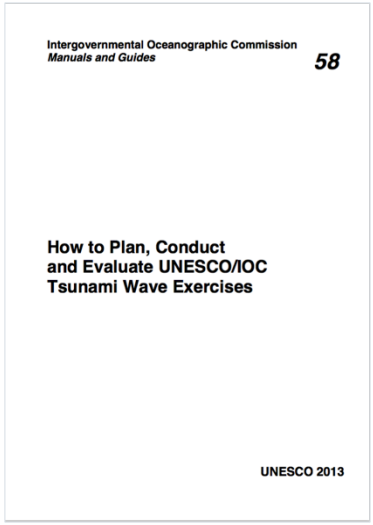
1. Validate the international Tsunami Warning [or Advisory] Centers' dissemination process of issuing Tsunami Watch and Warning Bulletins to Pacific countries;
2. Validate the process of countries receiving and confirming Tsunami Bulletins through their designated focal point;
3. Validate dissemination of warning messages to relevant agencies within a country;
4. Validate the organizational decision making process about public warnings and evacuations;
5. Identify the methods that would be used to notify and instruct the public;
6. Assess the elapsed time until the public would be notified and instructed.

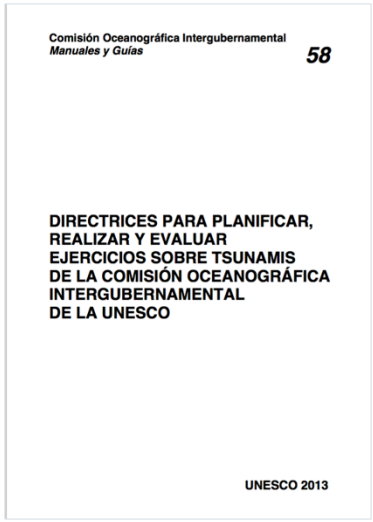
Real Tsunami events: 2009-2011

- **M8.0 Samoa - 29 September 2009**
  - Samoa – 149 deaths, -20% GDP impact
  - American Samoa – 34 deaths, $90 million damage
  - Niuatoputapu Island, Tonga – 9 deaths, airport inoperable (debris), so at 1st only ship access
- **M8.8 Chile – 27 February 2010**
  - 156 deaths, $600 million damage
  - Civil court cases (ONEMI, SHOA liable)
- **M9.0 Japan – 11 March 2011**
  - ~18,000 dead or missing, $6 billion damage
  - Civil court cases (Ishinomaki, school liable, 74 school-children died)

Improving Exercise Conduct

- **How to Plan, Conduct and Evaluate UNESCO/IOC Tsunami Wave Exercises** (IOC, Manual & Guides 58, 2013, English, Spanish)
- NZ Ministry of Civil Defence and Emergency Management, ITIC collaboration
- Draft used PacWave11





PacWave11: 9-10 November 2011

Exercise Purpose:
To improve local and regional source tsunami warning and response capability in the Pacific.

Participants: 35 countries

Scenarios: 10

PacWave11: Objectives

1. **To exercise and evaluate operations of the current PTWS, including:**
   - Validate the issuance of tsunami advice from PTWC, JMA/NWPTAC and WCATWC
   - Validate receipt of this tsunami advice by Pacific Country TWFP
2. **To begin a process of exposure to an initial test version of PTWC experimental products that were being developed to provide a more rapid and quantitative forecast of tsunami impacts:**
   - Review and evaluate PTWC experimental products that will be available in parallel with existing PTWC products for each scenario exercised.
   - Provide feedback on the staging, format, and content of the experimental products.
3. **To validate the readiness of Member States to respond to a local/regional source tsunami:**
   - Validate the operational readiness of the National Tsunami Warning Centre (NTWC), or similar in-country function, and/or the National Disaster Management Office (NDMO).
   - Improve operational readiness. Before the exercise, ensure
   - appropriate tools and response plan(s) have been developed,
   - including public education materials.
   - Validate dissemination of warnings and information/advice by
   - NTWC to relevant in-country agencies and the public is accurate and timely.
   - Validate the organisational decision-making process about public warnings and evacuations.
   - Validate the methods used to notify and instruct the public are accurate and timely.

PacWave13: 1-14 May 2013

Exercise Purpose:

The aim of PacWave13 is to validate the understanding and use of the PTWC Enhanced Products.

1. **Evaluate the format and content of the PTWC Enhanced Products for each scenario exercised**
2. **Provide feedback that a country is prepared to officially receive and implement and utilize the PTWC Enhanced Products**
3. **Provide feedback that a country's stakeholder agencies will be informed on the PTWC Enhanced Products so as to make appropriate future changes to their Standard Operating Procedures.**

Participants: 34 countries

Scenarios: 3

PacWave15: 2-6 February 2015

Exercise Purpose:
To test the new PTWC Enhanced Products

1. **Test communications from the PTWS Tsunami Service Providers to Countries.**
2. **Test whether the PTWS PTWC Tsunami Service Provider products are interpreted by countries accurately and in a timely manner.**
3. **Test national and regional cooperation.**

Participants: 41 countries

Scenarios: 6

PacWave15 - Evaluation Summary

- Majority received messages in timely manner without issues.
- Majority ranked the text message as most useful product
- KMZ file least useful product
- Format and content of products clear and easy to interpret
- Respondents understand the contents of the enhanced products
- Information provided assists with decision making

PacWave15 - Evaluation Summary

- Countries open to receiving higher resolution products
- NTWC/NDMOs have activation and response processes
- Respondents used national tsunami experts to help assess threat messages
- 40% of respondents have tsunami related curriculum programmes in all levels of education
- Stakeholder agencies have a better understanding of their goals, responsibilities and roles in tsunami emergencies.

PacWave15 - Recommendations

Tsunami Warning Focal Point contact data

Issue: TWFP contact information needs to be 100% accurate 100% of the time

Recommendation: **Countries to routinely review contact information, inform IOC (who will then forward to Tsunami Service Providers)**

PacWave15 - Recommendations

Exercise Planning

Issue: Insufficient time provided to fully prepare for the exercise

Recommendation:

- **IOC to announce future PacWave activities at least 6 months prior**
- **Exercise manual to be published 3 months prior**
- **Tsunami Service Providers to provide products at least 1 month prior.**

PacWave15 - Recommendations

Community Preparedness

Issue: 35% of countries do not have evacuation maps, signs, routes, assembly areas etc. This hampers a community to plan for tsunami response.

Recommendation:

- **IOC and Member States should support preparedness efforts as highest priority.**
- **All communities should have tsunami evacuation maps**

PacWave15 - Recommendations

Routine exercising

Issue: 35% of countries do not conduct annual, routine tsunami exercises.

Recommendation: **Countries are encouraged to conduct annual tsunami exercises (starting with small, controllable coastal school drills).**

PacWave15 - Recommendations

Conduct of future exercises

Issue: Past PacWave exercises have been conducted in controlled, moderately-paced timelines, in a table-top format. Many countries are now ready to move towards more realistic exercise response timeline.

Recommendation: **Future PacWave exercises should be conducted in real time, initially during the daytime working hours with full staffing. Later, consideration should be given to real time exercises simulating minimal staff during night time or weekend hours.**

PacWave16: 1-5 February 2016

Exercise Purpose:

The aim of PacWave16 is to evaluate experimental NWPTAC Enhanced Products and identify necessary modifications.

1. **Evaluate the format and content of experimental NWPTAC Enhanced Products.**
2. **Determine whether countries are prepared to officially receive and utilize the NWPTAC Enhanced Products.**

Participants: 12 countries

Scenarios: 6

Thank You

Dr. Laura Kong, ITIC
laura.kong@noaa.gov

Jo Guard, MCDEM
jo.guard@dpmc.govt.nz

Tomoaki Ozaki, JMA
tozaki@met.kishou.go.jp