

## EXERCISE PACIFIC WAVE 16

# Manual on Experimental NWPTAC Enhanced Products for PacWave16

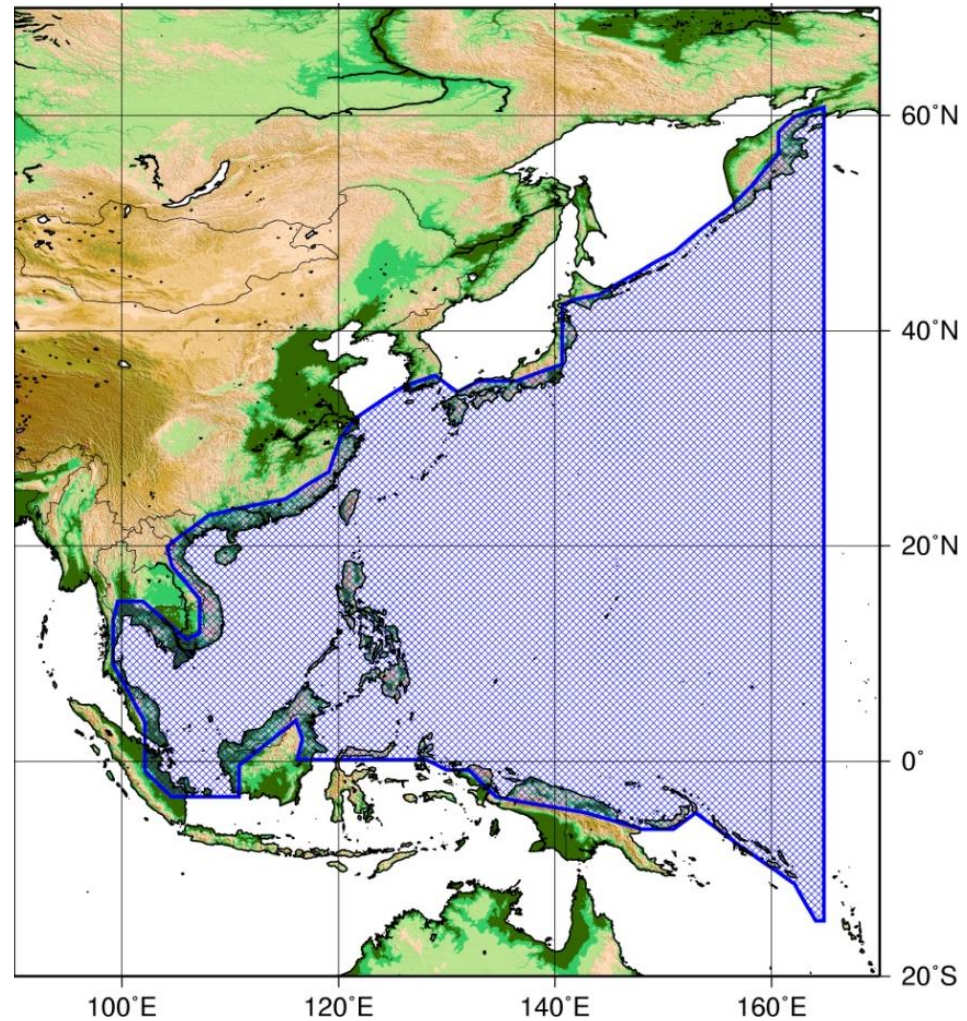
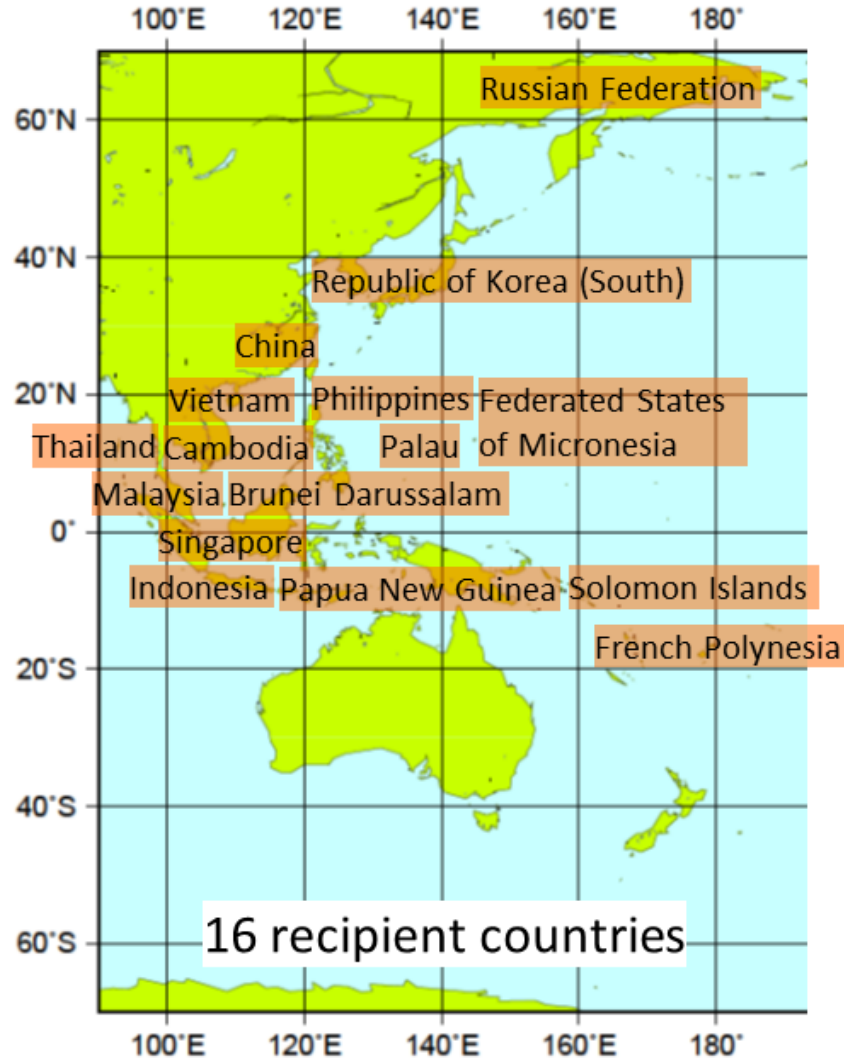
**A Draft Users Guide for the NWPTAC Enhanced Products  
for the Pacific Tsunami Warning System**



# Introduction

- During the 23rd session of the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS) in February 2009, the group formulated Recommendation that established a Task Team on Enhanced Products under Working Group on Detection, Warning and Dissemination (WG2) to review current capabilities, obtain customer feedback, consider best practices, and develop recommendations to improve existing or create new products, and improve dissemination for more effective, functional, and timely delivery.
- After years of discussions by the Task Team and dedicated efforts by the Pacific Tsunami Warning Center (PTWC), the Intergovernmental Oceanographic Commission (IOC) Secretariat announced the start of issuance of PTWC Enhanced Products for the Pacific Tsunami Warning and Mitigation System on 1st October 2014.
- In the pursuit of improving the PTWS tsunami warning products, Japan announced at the IOC Executive Council in July 2014, that the Northwest Pacific Tsunami Advisory Centre (NWPTAC) would also be preparing new products based on the requirements of the recipient countries. Following this announcement, the PTWS Steering Committee (SC) met in July 2014 and agreed about the timeline to introduce Enhanced NWPTAC Products targeting 2018 for its complete transition, and recommended the Japan Meteorological Agency (JMA) to continue the process of developing NWPTAC Enhanced Products for PTWS.
- At the 26th session the ICG/PTWS held in Honolulu, United States of America, from 22 to 24 April 2015 (ICG/PTWS-XXVI), the group agreed that the NWPTAC should proceed with its development of enhanced products for the Northwest Pacific. At the session, the group also approved to conduct Exercise Pacific Wave 2016 (PacWave16) during the first quarter of 2016 as a regional exercise involving the sixteen countries that receive products of NWPTAC.

# Recipient Countries and Area of Coverage of NWPTA



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.

# Background

- The successful launch of PTWC Enhanced Products demonstrated a mature capacity of Member States to utilize the advanced graphical products. This encouraged JMA to consider providing NWPTAC Enhanced Products including similar graphical information to meet the user requirements. Considering the issuance of graphical products will require elaborate tsunami forecast, JMA plans to add real-time simulation technique to the existing database driven forecast.
- On the other hand, taking into account the concise and easy-to-understand nature of conventional text messages which include forecasted amplitudes at selected but individual Forecast Points (FPs), JMA recognizes it is still indispensable to provide them to the recipient countries. Therefore, JMA plans to issue both existing texts and graphics.
- It should also be noted that the NWPTAC products are issued only in support of ICG/PTWS and meant for national authorities in each country in NWPTAC's Area of Service, which are responsible for the determination of domestic alert level. In this regard, graphical products should be exclusive for the national authorities to avoid unexpected confusion of the public.
- Moreover, JMA will add/modify FPs, for which forecast and observed data are reported in NWPTAC products, in line with those for PTWC products and recipient countries' requirements.
- JMA expects the NWPTAC Enhanced Products will contribute to tsunami disaster mitigation within the Northwest Pacific region.

# Implementation Timeline (1/2)

The following timeline is proposed for the coordinated implementation of NWPTAC Enhanced Products:

## **February 2016: PacWave16– the beginning of Experimental Products Phase**

- NWPTAC to issue experimental NWPTAC Enhanced Products
- Feedback from PacWave16 to be used to evaluate enhanced products and identify necessary modification.

## **PacWave16 to the Meeting of the Task Team on Enhanced Products**

- Recipient countries to comment and evaluate the experimental products through PacWave16 evaluation questionnaire.
- September 2016 (TBD): the Task Team Meeting
- Task Team to analyse the Evaluation Questionnaire responses from recipient countries.
- NWPTAC to provide a report on its implementation issues and feedback for new products.
- Task Team to recommend modification of the experimental products where necessary based on the evaluation.
- Task Team to plan another PacWave exercise using NWPTAC experimental products before official changeover. This exercise will aim at finalizing the new NWPTAC products and procedures.

## **The Task Team Meeting to the PacWave17**

- NWPTAC to accordingly modify experimental products for operations.

# Implementation Timeline (2/2)

The following timeline is proposed for the coordinated implementation of NWPTAC Enhanced Products:

## **February 2017 (TBD): PacWave17**

- NWPTAC to issue modified experimental products
- Feedback from PacWave17 to be used to finalize enhanced products.

## **PacWave17 to ICG/PTWS-XXVII**

- Recipient countries to comment and evaluate the experimental products through PacWave17 evaluation questionnaire.
- NWPTAC to draft the User's Guide for the NWPTAC Enhanced Products for the PTWS for approval by ICG/PTWS.

## **September/October 2017 (TBD): ICG/PTWS-XXVII – the end of Experimental Products Phase**

- Task Team to report the analysis of the Evaluation Questionnaire responses from Recipient Countries.
- NWPTAC to report the final proposal on enhanced products and the User's Guide.
- ICG/PTWS to endorse the finalized NWPTAC Enhanced Products, implementation date and User's Guide.

## **ICG/PTWS-XXVII to the final changeover**

- NWPTAC to implement parallel issuance of existing and enhanced products.

## **October 2018 (TBD): The final changeover**

- NWPTAC to cease to provide existing products.

# Task Team Recommendations

Considering the foregoing discussion, the Task Team on Enhanced Products makes six recommendations on the NWPTAC improvements:

1. *NWPTAC will, in accordance with the course of action agreed by the PTWS SC, begin issuing enhanced products that consist of an initial text message based on pre-established tsunami database, and the following text messages accompanied by graphics based on real-time simulation technique.*
2. *NWPTAC basically will not change contents of the text messages in order to keep them compact and avoid overloading of recipient countries.*
3. *NWPTAC will disseminate graphical products exclusively for national authorities of recipient countries.*
4. *NWPTAC will harmonize Forecast Points for the NWPTAC Enhanced Products with those for the PTWC Enhanced Products.*
5. *NWPTAC will set an experimental products phase before the final changeover, with a view to sufficient feedback opportunity and training on the new products.*
6. *The Task Team on Enhanced Products will provide NWPTAC with guidance during the inter-sessional period regarding details on the development, implementation, and evaluation of the products.*

# Experimental NWPTAC Enhanced Products

## First Message :

Database output based on an assumed fault

- Text which contains hypocentral parameters (origin time, location, magnitude), tsunami-genic potential, estimated tsunami arrival times and amplitudes, and observed tsunami arrival times and amplitudes, if any.  
... basically same with the present version

## Second Message :

Database output or real-time simulation based on a result of Centroid Moment Tensor(CMT) analysis

- Text (in the same format as First Message)
- Graphics
  - Tsunami travel time map
  - Deep-Ocean maximum tsunami amplitude forecast map
  - Coastal maximum tsunami amplitude forecast map

## Third or later Message:

Update text and graphics if necessary

\* In the case the result of automatic CMT analysis has large error and it takes time to obtain an appropriate result, the updated text may be issued earlier than the graphical products



# Dissemination of Products

## Text Products

- GTS
- Email
- FAX

... basically same with the present version

## Graphical Products

- Email

... sent to designated IOC Tsunami Focal Points of recipient countries

# Forecast Model Description

## Numerical Simulation

- JMA uses a tsunami forecast system with a numerical simulation technique based on the nonlinear long wave theory including effects of Coriolis force  
(In the procedure for tsunami travel time map, the nonlinear effects are neglected)
- For the Northwest Pacific, grid resolution of 5 arc-min is used

## Deep-ocean Maximum Tsunami amplitude

- The system produces a time series of the sea level fluctuations caused by the passing tsunami waves at each model grid point in the ocean
- Shown on the deep-ocean maximum tsunami amplitude forecast map is the maximum amplitude (zero to peak wave amplitude) of those fluctuations

## Coastal Maximum Tsunami amplitude

- For each model grid point near the coast, the tsunami amplitude at the coast can be estimated based on Green's Law as follows:

$$A_{coast} = A_{offshore} (D_{offshore} / D_{coast})^{1/4},$$

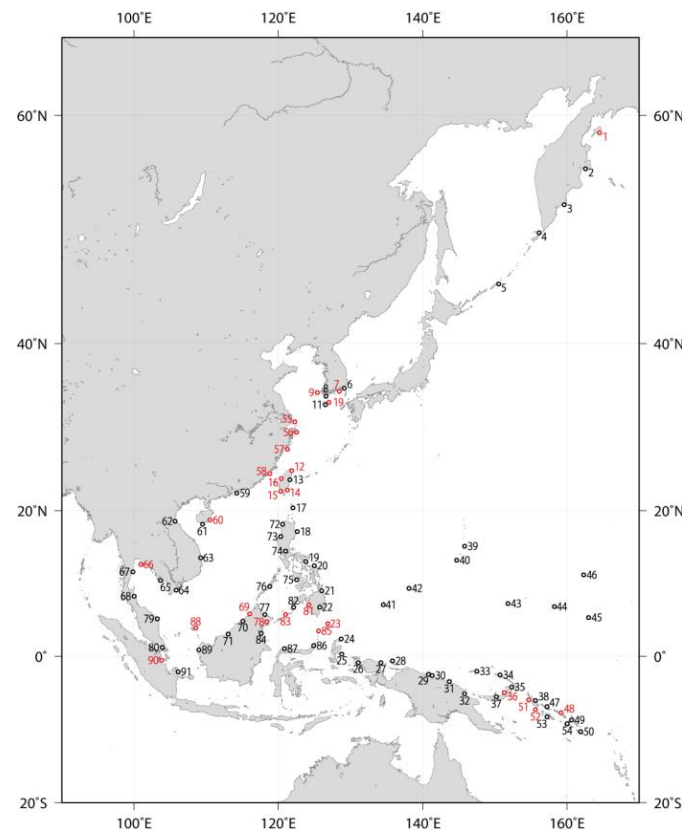
where  $A_{coast}$  is the tsunami amplitude at the coast,  
 $A_{offshore}$  is the tsunami amplitude at the offshore grid point,  
 $D_{offshore}$  is the depth of the ocean at the offshore grid point, and  
 $D_{coast}$  is the depth of the ocean at the coast

- The coastal ocean depth is set to be 1 m

# Description of Experimental Products

## Text Products

- Basically it is same with the present version
  - ... details are shown in “OPERATIONAL USERS GUIDE FOR THE PACIFIC TSUNAMI WARNING AND MITIGATION SYSTEM (PTWS) Second edition” p81-p96)
- Regarding the forecast points, for which estimated tsunami arrival times and estimated tsunami amplitudes are listed in the text product, updated ones which reflect the results of coordination among recipient countries are used
- Categories of tsunami amplitude classification are modified to “0.2 – 1m”, “1 – 5m”, “5 – 10m” and “OVER 10m”. When Tsunami amplitude of less than 0.2m is estimated for all forecast points, “ESTIMATION AT FORECAST POINTS – NO TSUNAMI WAVES WITH AN AMPLITUDE OF 0.2METERS OR MORE ARE EXPECTED AT ANY FORECAST POINT” is described.
- There are some minor changes in wording in the text products.



Forecast points(FP) of the experimental NWPTAC Enhanced Products for PacWave16. Changed points from current ones are indicated as red symbols. (FP names are listed in P12)

# Description of Experimental Products

## Forecast points and coastal blocks of NWPTAC Enhanced Products for PacWave16

Coastal Block	Forecast Point	Latitude	Longitude	FP Number
EAST COASTS OF KAMCHATKA PENINSULA	OSTROV_KARAGINSKIY	58.8N	164.5E	1
	UST_KAMCHATSK	56.1N	162.6E	2
	PETROPAVLOVSK_K	53.2N	159.6E	3
KURIL ISLANDS	SEVERO_KURILSK	50.8N	156.1E	4
	URUP_IS.	46.1N	150.5E	5
SOUTH COASTS OF KOREAN PENINSULA	BUSAN	35.1N	129.1E	6
	TONGYEONG	34.7N	128.4E	7
	NOHWA	34.2N	126.6E	8
	HEUKSANDO	34.6N	125.4E	9
	CHEJU_ISLAND	33.5N	127.0E	10
	SEOGWIPO	33.2N	126.5E	11
TAIWAN	CHILUNG	25.2N	121.8E	12
	HUALIEN	24.0N	121.6E	13
	TAITUNG	22.7N	121.2E	14
	KAOHSIUNG	22.5N	120.3E	15
	HOMEL	24.2N	120.4E	16
EAST COASTS OF PHILIPPINES	BASCO	20.4N	122.0E	17
	PALANAN	17.2N	122.6E	18
	LEGASPI	13.2N	123.8E	19
	LAOANG	12.6N	125.0E	20
	MADRID	09.2N	126.0E	21
	DAVAO	06.9N	125.7E	22
NORTH COASTS OF IRIAN JAYA	GEME	04.6N	126.8E	23
	BEREBERE	02.5N	128.7E	24
	PATANI	00.4N	128.8E	25
	SORONG	00.8S	131.1E	26
	MANOKWARI	00.8S	134.2E	27
	WARSA	00.6S	135.8E	28
NORTH COASTS OF PAPUA NEW GUINEA	JAYAPURA	02.4S	140.8E	29
	VANIMO	02.6S	141.3E	30
	WEWAK	03.5S	143.7E	31
	MADANG	05.2S	145.8E	32
	MANUS_IS.	02.0S	147.5E	33
	KAVIENG	02.5S	150.7E	34
	RABAU	04.2S	152.3E	35
	ULAMONA	05.0S	151.3E	36
	KIMBE	05.6S	150.2E	37
MARIANA ISLANDS	SAIPAN	15.3N	145.8E	39
	GUAM	13.4N	144.7E	40
PALAU	MALAKAL	07.3N	134.5E	41
MICRONESIA	YAP_IS.	09.5N	138.1E	42
	CHUUK_IS.	07.4N	151.8E	43
	POHNPEI_IS.	07.0N	158.2E	44
	KOSRAE_IS.	05.5N	163.0E	45
MARSHALL ISLANDS	ENIWETOK	11.4N	162.3E	46

Coastal Block	Forecast Point	Latitude	Longitude	FP Number
NORTH COASTS OF SOLOMON ISLANDS	PANGGOE	06.9S	157.2E	47
	GHATERE	07.8S	159.2E	48
	AUKI	08.8S	160.6E	49
SOLOMON SEA	KIRAKIRA	10.4S	161.9E	50
	AMUN	06.0S	154.7E	51
	FALAMAE	07.4S	155.6E	52
	MUNDA	08.4S	157.2E	53
COASTS OF EAST CHINA SEA	HONIARA	09.3S	160.0E	54
	SHANGHAI	31.2N	122.3E	55
	ZHOUSHAN	29.9N	122.5E	56
COASTS OF SOUTH CHINA SEA	WENZHO	27.8N	121.2E	57
	QUANZHOU	24.8N	118.8E	58
	HONG_KONG	22.3N	114.2E	59
	HAINAN_ISLAND	18.8N	110.5E	60
COASTS OF GULF OF TONKIN	SANYA	18.2N	109.5E	61
EAST COASTS OF INDO CHINA PENINSULA	VINH	18.6N	105.7E	62
	QUI_NHON	13.7N	109.2E	63
GULF OF THAILAND	BAC_LIEU	09.3N	105.8E	64
	SIHANOUKVILLE	10.6N	103.6E	65
	PATTAYA	12.8N	100.9E	66
	PRACHUAP_KHIRI_KHAN	11.8N	099.8E	67
NORTHWEST COASTS OF KALIMANTAN	NAKHON_SI_THAMMARAT	08.4N	100.0E	68
	KOTA_KINABALU	6.0N	116.0E	69
	MUARA	05.0N	115.1E	70
WEST COASTS OF PHILIPPINES	BINTULU	03.2N	113.0E	71
	LAOAG	18.2N	120.6E	72
SULU SEA	SAN_FERNANDO	16.6N	120.3E	73
	MANILA	14.6N	121.0E	74
	ILOILO	10.7N	122.5E	75
	PUERTO_PRINCESA	09.8N	118.8E	76
EAST COASTS OF MALAY PENINSULA	SANDAKAN	05.9N	118.1E	77
	LAHAD_DATU	04.9N	118.4E	78
	KUALA_TERENGGANU	05.3N	103.2E	79
CELEBES SEA	SINGAPORE	01.3N	103.9E	80
	COTABUTO_CITY	07.3N	124.2E	81
	ZAMBOANGA	06.9N	122.1E	82
	MAIMBUNG	05.9N	121.0E	83
	TARAKAN	03.3N	117.6E	84
	TABUKAN_TENGAH	03.6N	125.6E	85
	MANADO	01.6N	124.9E	86
NATUNA SEA	TOLITOLI	01.1N	120.8E	87
	KEPULAUAN_RIAU	04.0N	108.5E	88
	SINGKAWANG	01.0N	109.0E	89
	KUALA_INDRAGIRI	00.5S	103.8E	90
	PANGKALPINANG	02.1S	106.1E	91

# Description of Experimental Products

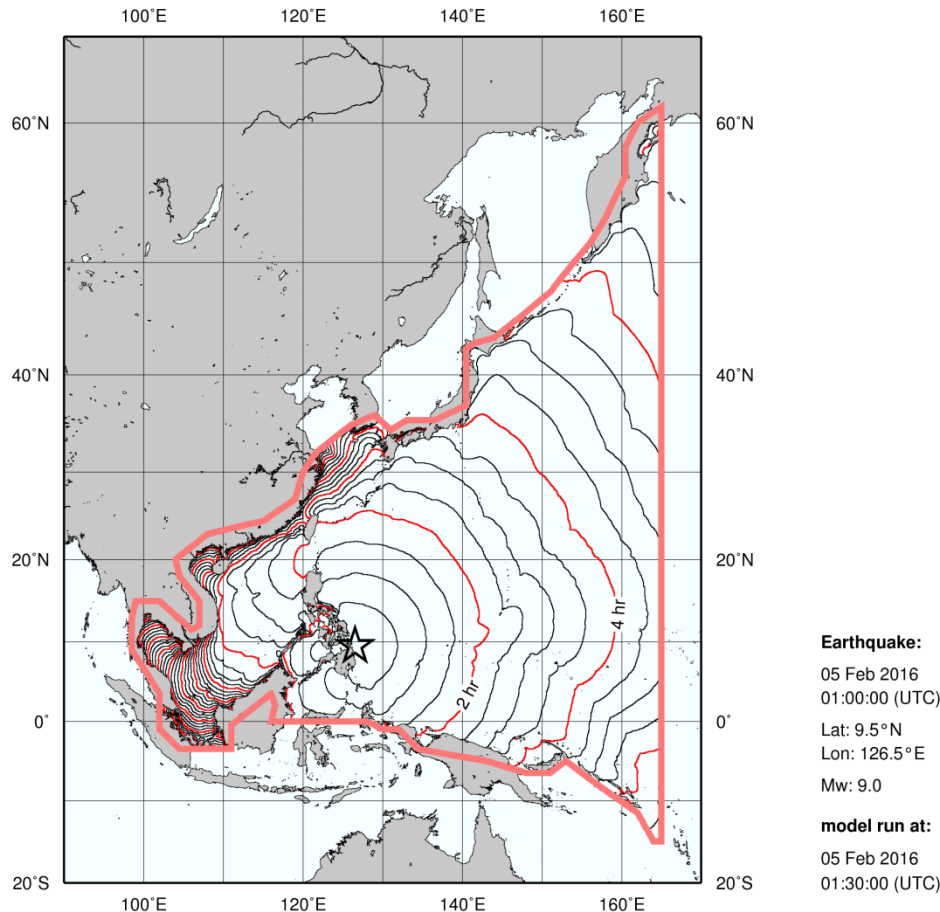
## Tsunami travel time map

**FOR EXERCISE USE ONLY**

### NWPTAC Tsunami Travel Time Forecast

Actual arrival times at the coast may vary from forecast arrival times and the initial wave may not be the largest.

Information bulletins provided by the Northwest Pacific Tsunami Advisory Center (NWPTAC) should not be construed as official warnings or evacuation notices for the areas concerned. The issuance of actual evacuation notices is the responsibility of individual local authorities.



- 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

# Description of Experimental Products

## Coastal tsunami amplitude forecast map

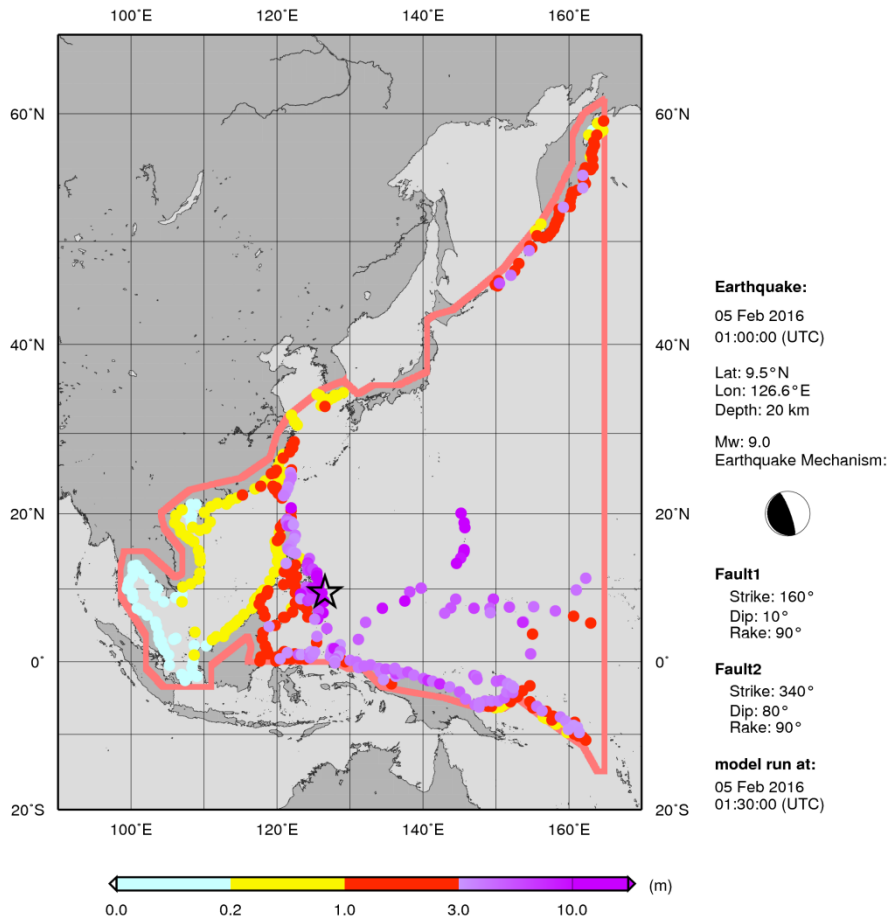
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### NWPTAC Coastal Tsunami Amplitude Forecast

This map shows the larger maximum coastal amplitudes of two different forecasts based on a conjugate fault set obtained by CMT analysis. The amplitudes are shown in meters from the undisturbed sea level to the crest.

Actual coastal amplitudes at the coast may vary from forecast coastal amplitudes due to uncertainties in the forecast and local features.

Information bulletins provided by the Northwest Pacific Tsunami Advisory Center (NWPTAC) should not be construed as official warnings or evacuation notices for the areas concerned. The issuance of actual evacuation notices is the responsibility of individual local authorities.



- 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.

# Description of Experimental Products

## Deep-ocean tsunami amplitude forecast map

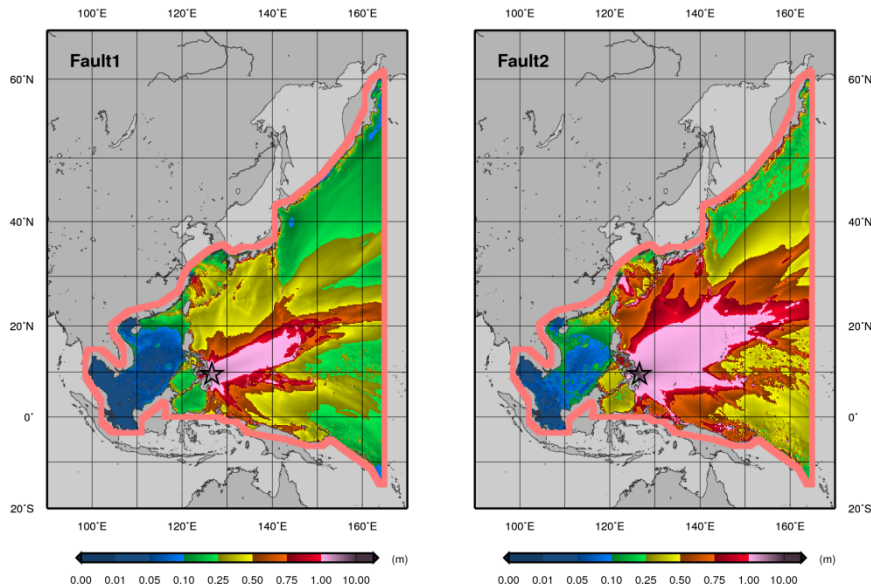
**FOR EXERCISE USE ONLY**


### NWPTAC Deep–Ocean Tsunami Amplitude Forecast

The amplitudes shown in these maps are the maximum amplitudes in meters from the undisturbed sea level to the crest.

These maps should not be used to estimate coastal tsunami amplitudes or impacts. Deep–ocean tsunami amplitudes are usually much smaller than coastal amplitudes.

Information bulletins provided by the Northwest Pacific Tsunami Advisory Center (NWPTAC) should not be construed as official warnings or evacuation notices for the areas concerned. The issuance of actual evacuation notices is the responsibility of individual local authorities.



**Earthquake:** 05 Feb 2016 01:00:00 (UTC)  
Lat: 9.5°N, Lon: 126.6°E, Depth: 20 km  
Mw: 9.0  
Earthquake Mechanism:   
**Fault1** Strike: 160°, Dip: 10°, Rake: 90°  
**Fault2** Strike: 340°, Dip: 80°, Rake: 90°  
**model run at:** 05 Feb 2016 01:30:00 (UTC)

- 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.