



UNESCO – IOC – US NOAA ITIC
US NOAA Pacific Tsunami Warning Center
September 2014

PTWC New Enhanced Products for Pacific countries: Overview

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Outline of Presentation

- **PTWC Services Summary**
- **New PTWC Enhanced Products**



PTWC Activity: January 2013 – May 2014

- ❑ **2000+ Alarms** triggered by EQs worldwide
- ❑ **~500 Observatory Messages** issued (=> CISON)

FROM PACIFIC TSUNAMI WARNING CENTER

THIS IS PRELIMINARY DATA, NOT FOR PUBLIC DISSEMINATION.
COMPLETE INFORMATION CAN BE OBTAINED FROM THE USGS/NEIC
TELEPHONE (303) 273-8500.

H 08:24:47Z MAY 24 2014Z LAT 16.3N LONG 98.2W DEPTH 16.2km Mwp 5.7 (5 STATIONS)

NEAR THE COAST OF GUERRERO, MEXICO

PNIG	P	082452.2	PNIG	S	082456.7	UNM	P	082535.0	CUIG	P	082535.0
LVIG	P	082542.5	PCIG	P	082600.1	TGIG	P	082600.5	ZAIG	P	082638.8
LNIG	P	082650.0	TEIG	P	082713.5	TGUH	P	082722.7	HKT	P	082808.5

- ❑ **68 Tsunami Information Bulletins** issued for PTWS (no tsunami threat)
- ❑ **6 Tsunami Warnings** issued for PTWS

Warnings: January 2013 – May 2014

Time (UTC)	Lat	Lon	Dep (km)	Region	PTWC Mw	USGS Mw	1 st Msg (min)	Cancel (min)
02/06/13 0112	10.9S	165.1E	33	Santa Cruz Islands	8.0	8.0	6	155
04/01/14 2347	19.8S	70.8W	10	Northern Chile	8.0	8.2	8	296
04/03/14 0243	20.4S	70.1W	20	Northern Chile	7.8	7.7	8	76
04/12/14 2015	11.3S	162.3E	10	Solomon Islands	8.3	7.6	5	81
04/13/14 1236	11.5S	162.1E	20	Solomon Islands	7.7	7.4	10	126
04/19/14 1328	6.7S	155.0E	10	Solomon Islands	7.8	7.5	9	71

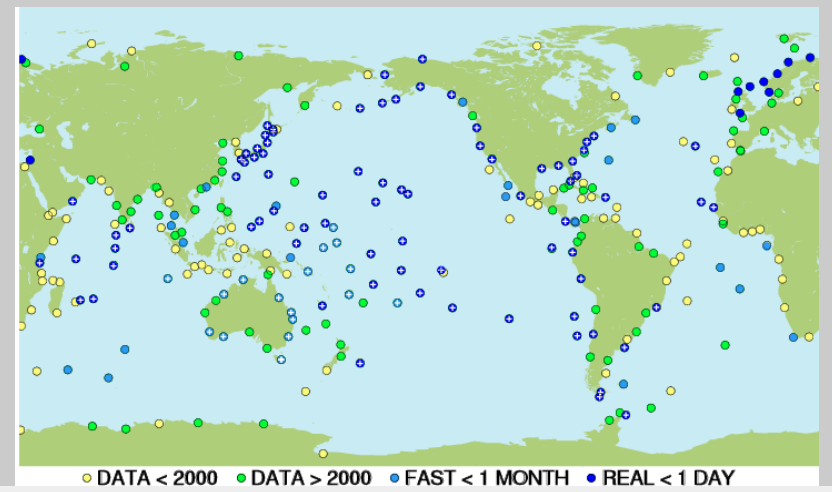
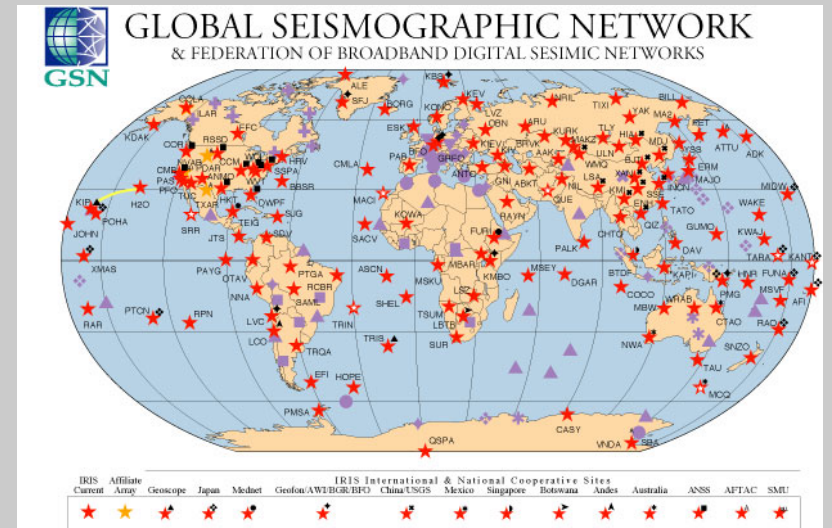


For Tsunami Warning - 3 Basic Needs

- **VERY RAPID** (sec-min)
EARTHQUAKE EVAL
- **VERY RAPID TSUNAMI**
(min-hr) **SEA LEVEL EVAL**
- **VERY RELIABLE**
COMMUNICATIONS

*e.g., Multi-national,
global data networks
with real-time transmission
and free/open data sharing*

➤ **ALL REQUIRED FOR
TIMELY WARNING**



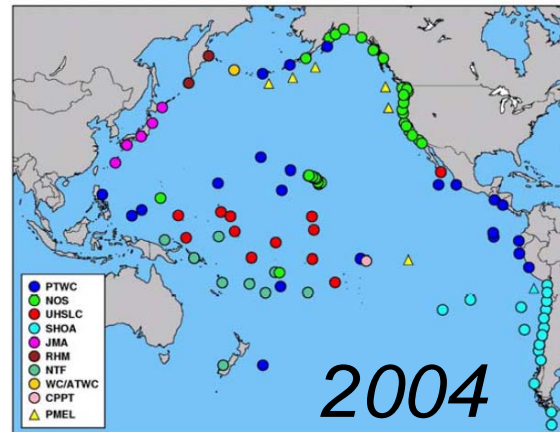
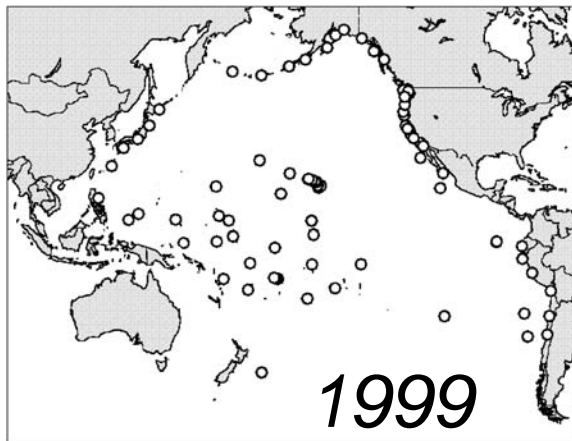
IOC GLOSS Network, incl real-time, non-real time, archive



**=> Earthquake
location & magnitude
in 10s sec - minutes**

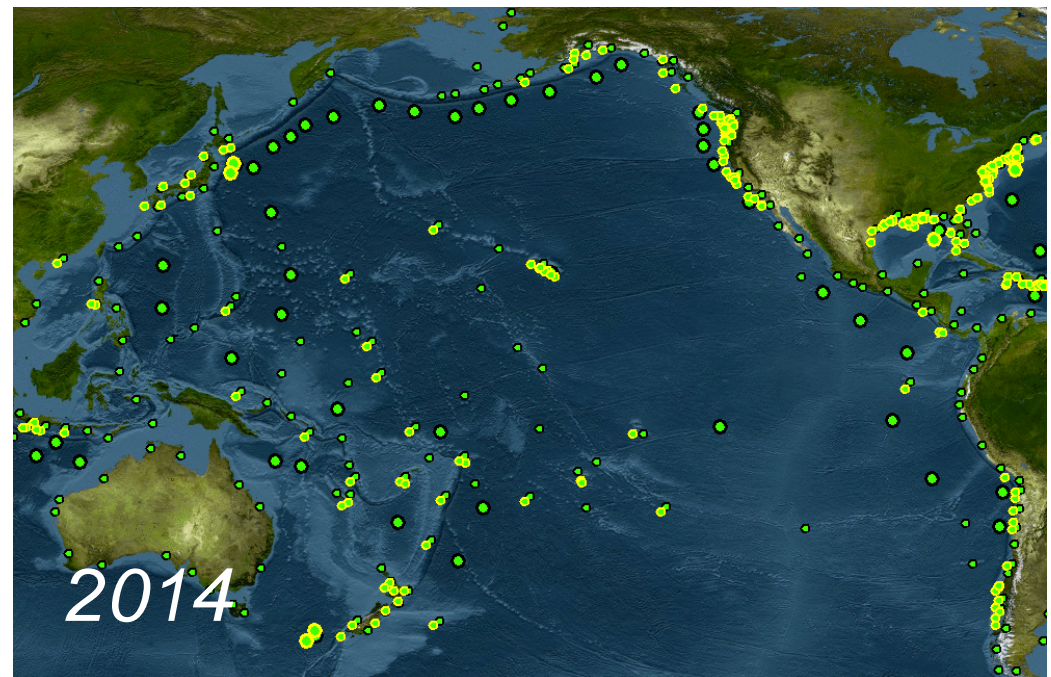


Core Sea Level Network - PTWC



*In 2014, PTWC
receiving data from
> 500 stations
(coastal, deep-ocean)
in real time*

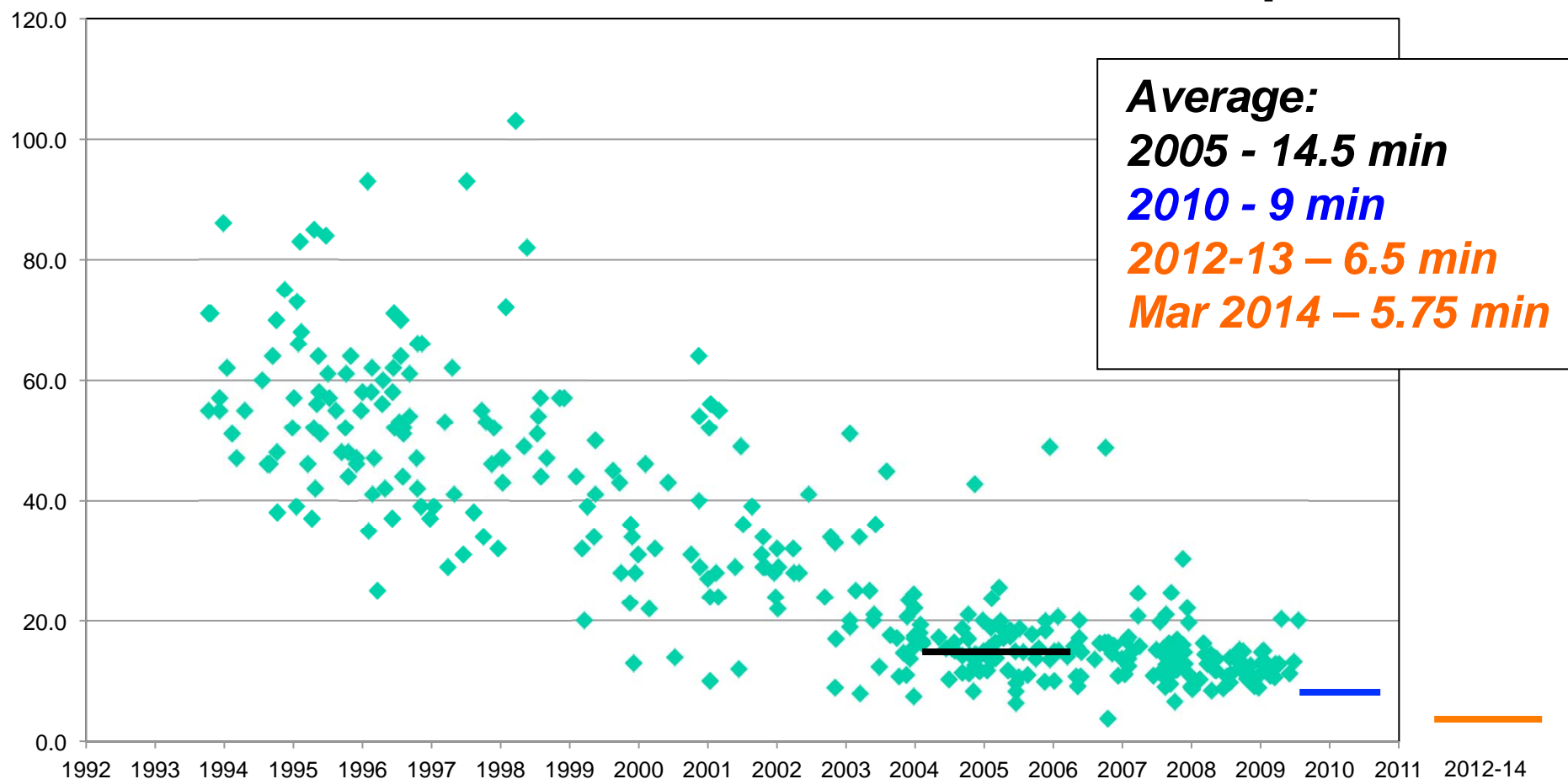
*=> Confirm tsunami
within 1 hr locally*



PTWC Elapsed Time to Initial Bulletin



**Earthquakes:
Denser Networks, Higher Quality Data, Better and
Faster Methods => Faster Detection & Response**



Current PTWC Products

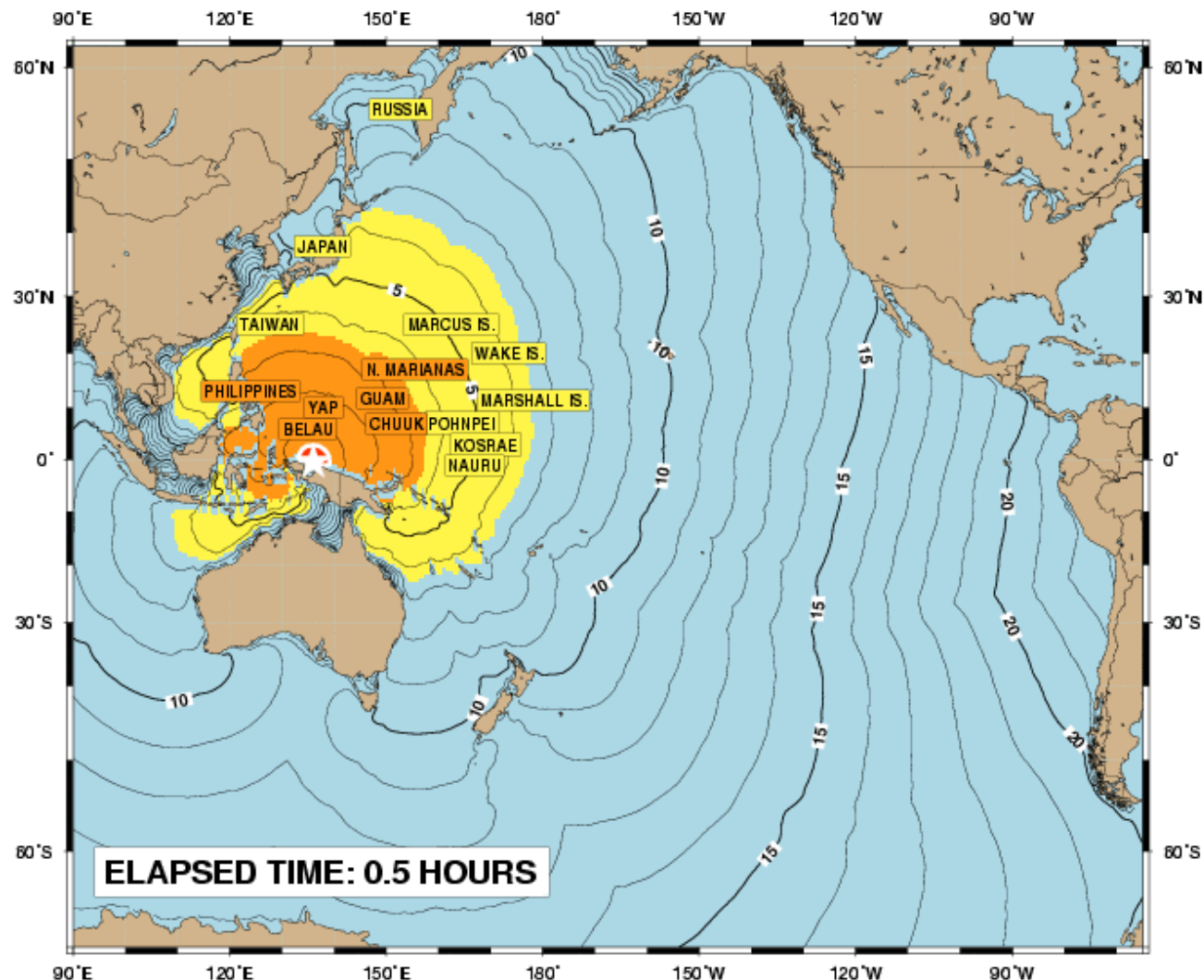
- ❑ **Public Text product only (disseminated by GTS, AFTN, fax, email, EMWIN, website, SMS)**
- ❑ **Product Content**
 - **Places assigned to be in a Warning or Watch (alert status)**
 - **Forecast of tsunami arrival times given at designated forecast points**
 - **Measurements of observed tsunami waves**
 - **General response guidance**
- ❑ **Issued hourly, or sooner if new information**



Current PTWC Products – Criteria Table

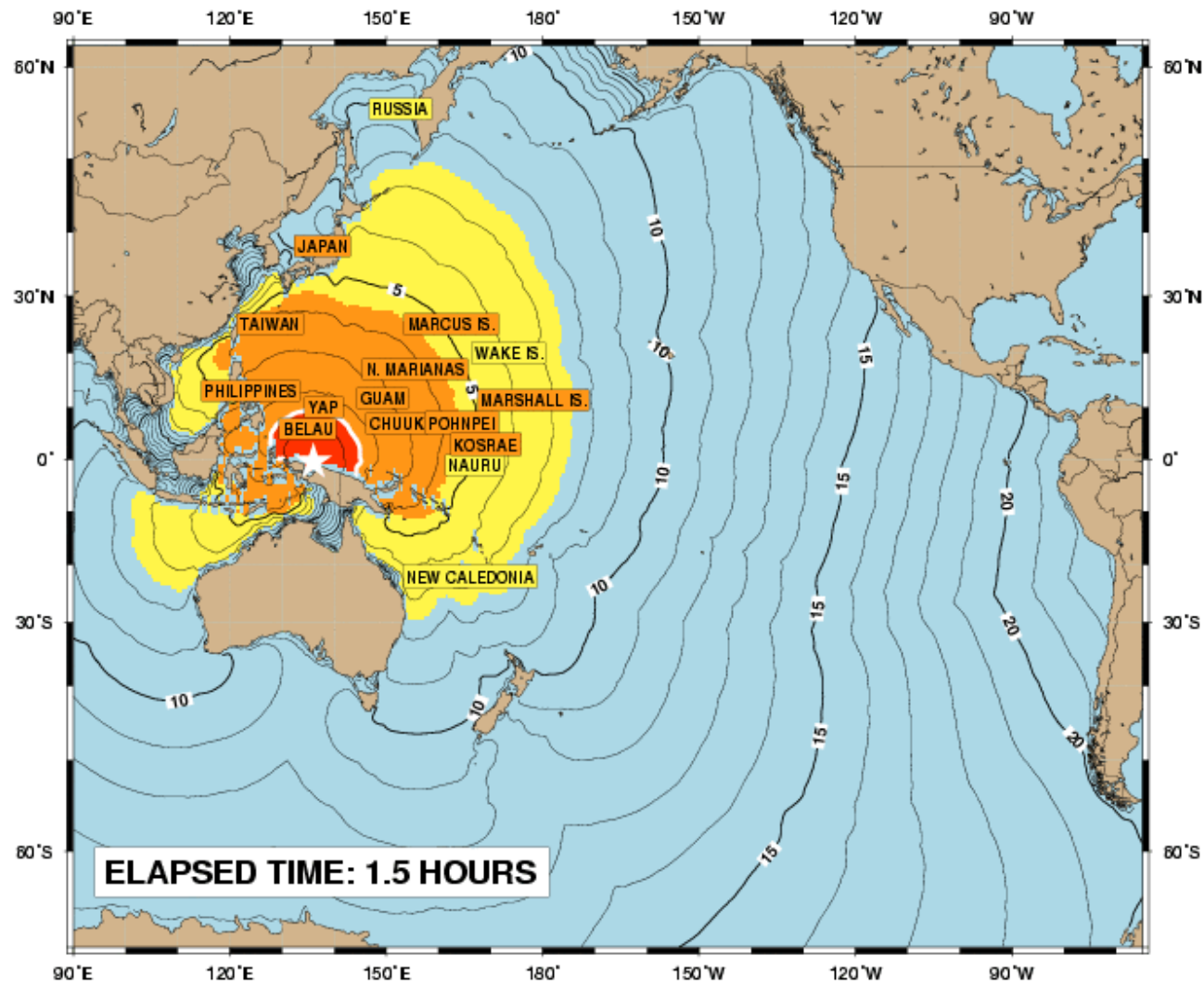
Earthquake	Product Type	Description
Magnitude 6.5-7.5 or >6.5 and >100km depth or far inland	Information Bulletin	No Tsunami Threat or only small Local Tsunami Threat
Magnitude 7.6-7.8 and <100 km depth and under sea or near sea	Regional Warning	Warning to 1000km from epicenter
Magnitude >7.8 and <100km depth and under sea or near sea	Expanding Warning	Warning if < 3 hours to impact, Watch if 3-6 hours to impact
Confirmed major tsunami	Pacific-wide Warning	Confirmed tsunami with widespread destructive threat

Current PTWC procedures - Status based on time until wave arrival



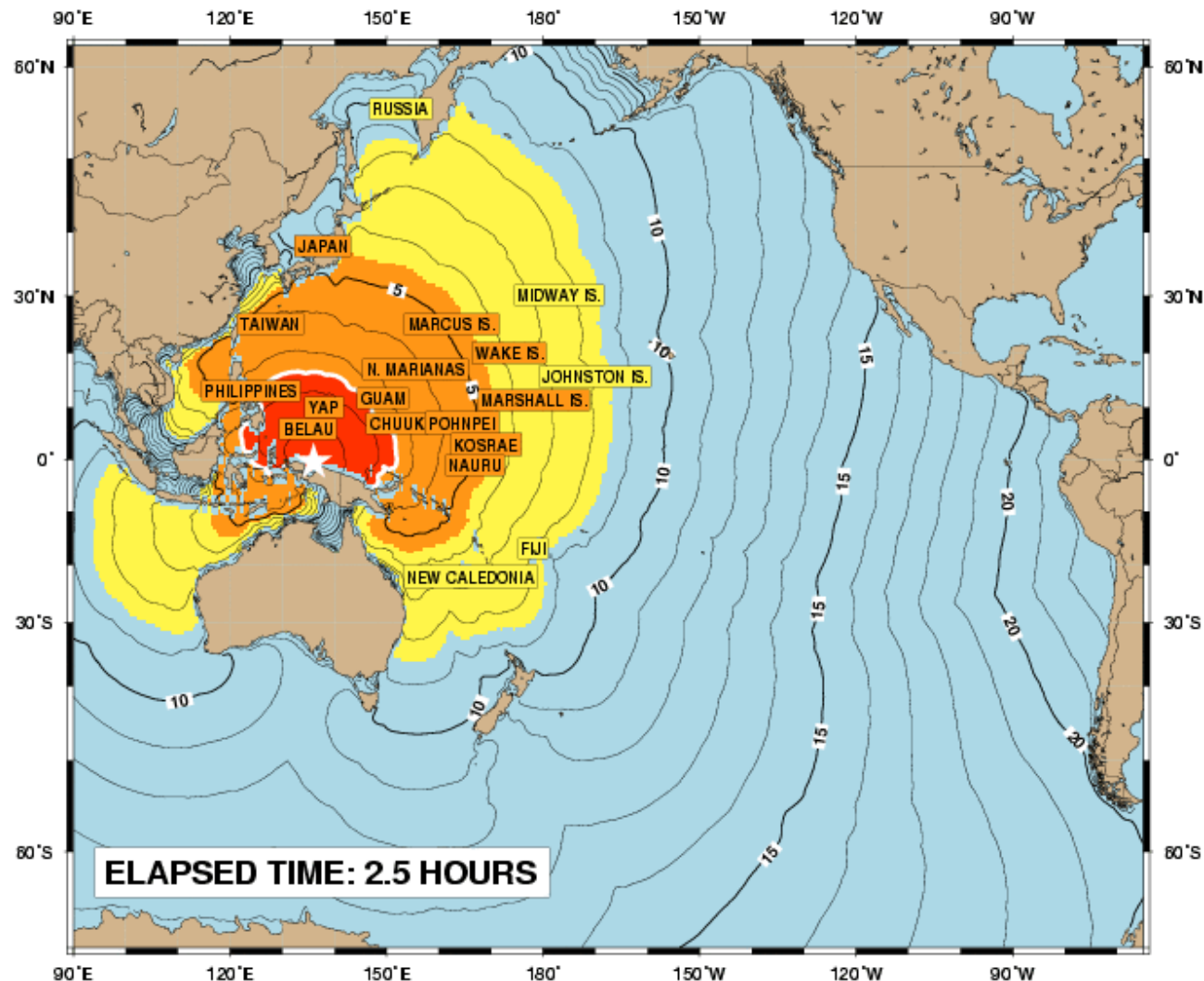
Tsunami Warning < 3 hrs, Watch 3 – 6 hrs from arrival

Current PTWC procedures - Status based on time until wave arrival



Tsunami Warning < 3 hrs, Watch 3 – 6 hrs from arrival

Current PTWC procedures - Status based on time until wave arrival



Tsunami Warning < 3 hrs, Watch 3 – 6 hrs from arrival

Limitations of Current Procedures

- **Last major revision in 2001 (change Ms to Mw)**
- **Very conservative for safety.** Based primarily on limited historical data. Resulted in significant over-warning
- **Initially puts areas in Warning or Watch based on:**
 - Earthquake magnitude
 - Estimated time left to tsunami impact or
 - Distance from earthquake epicenter
- **Timely Alert for regional and basin-wide tsunamis.**
Not timely for local tsunamis.
- **No information on forecast levels of wave impact (hgt)**
- **PTWC warning advice caused confusion with Country's authoritative warning**
- **Text product only**



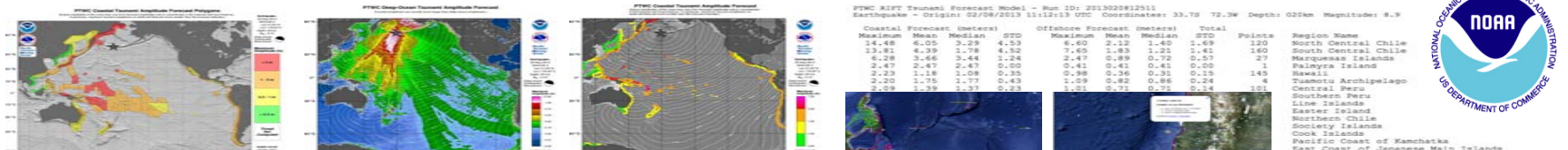
PTWC New Enhanced Products -Timeline

- **History** – in discussion and requested since 2007
 - ICG/PTWS-XXIII, 2011: approved for development
 - Exercise Pacific Wave 2011, 2013 – introduce, feedback
 - ICG/PTWS XXIV, 2013: approved for changeover
 - July 11, 2014: PTWS Steering Committee final review of progress requirements – approved changeover date
- **Changeover: October 1, 2014, 0000Z**
 - PTWC stops Alert Levels; Starts wave height forecasts
 - Countries decide and issue own Alert Levels
- **Exercise Pacific Wave 2015 – February 2-6, 2015**
- **PTWS 50th Commemoration, April 20-24, 2015**
 - International Symposium: April 20-21
 - ICG/PTWS-XXVI: April 22-24



Product Changes – Procedures, 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



Product Changes - Threat Levels

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



Benefits



- **Reduce conflict with Country NTWC Alert levels**
- **Still conservative, but greatly reduce over-warning**
- **Provides estimated level of impact**
- **Provide Country NTWC with additional decision-making information**
 - Graphical, as well as text products
 - “kmz” file of forecast points allows drilling-down to finer spatial resolution
 - Real-time model handles earthquake locations and mechanisms anywhere, not just shallow-thrust events in subduction zones (limitation of SIFT / ATFM models)
 - RIFT model provide Green’s Law coastal forecast for all coasts.

IOC Executive Council (June 2014)



- **Update / New Terms and Definitions**

- ❑ **National Tsunami Warning Centre (NTWC):**

- A centre officially designated by the government to monitor and issue tsunami warnings and other related statements within their country according to established National Standard Operation Procedures (SOPs)

- ❑ **Tsunami Warning Focal Point (TWFP):**

- A 24 x 7 point of contact (office, operational unit or position, not a person) officially designated by the NTWC or the government to receive and disseminate tsunami information from an ICG Tsunami Service Provider according to established National Standard Operation Procedures.
The TWFP may or not be the NTWC

- **Member States update TWFP data to IOC**

- (esp for PTWC New Products to start October 1, 2014)

PTWC New Products – Training

IOC / ITIC / PTWC working together to :

- **Provide SOP Guidance**
- **Conduct In-Region, Regional Training:**
 - South China Sea region, Dec 18-19, 2013
 - Pacific Island Countries, May 22-24, 2014
 - Latin America (Central America, Mexico, South America), Jun 2-4, 2014
- **Conduct ITP-Hawaii 2014 – New Products SOPs**
 - 2 weeks, Hawaii, August 18-29, 2014
 - 30 participants (80% NTWC), 16 countries
- **Assist specific Country , on request**
 - Micronesia (FSM), Palau, Marshall Islands
 - Others, on request





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US NOAA Pacific Tsunami Warning Center
September 2014

PTWC New Enhanced Products for Pacific countries: Public Text Product - Example

Public Text message

Information Statement

- No Threat
- No Action

A. Tsunami Information Statement (no tsunami threat)

a. Initial Product (text only)

i. Text Product

ZCZC
WEPA42 PHEB 010008
TIBPAC

TSUNAMI INFORMATION STATEMENT NUMBER 1
NWS PACIFIC TSUNAMI WARNING CENTER EWA BEACH HI
0008 UTC WED OCT 1 2014

...TSUNAMI INFORMATION STATEMENT...

**** NOTICE **** NOTICE **** NOTICE **** NOTICE **** NOTICE ****

THIS STATEMENT IS ISSUED FOR INFORMATION ONLY IN SUPPORT OF THE
UNESCO/IOC PACIFIC TSUNAMI WARNING AND MITIGATION SYSTEM AND IS
MEANT FOR NATIONAL AUTHORITIES IN EACH COUNTRY OF THAT SYSTEM.

NATIONAL AUTHORITIES WILL DETERMINE THE APPROPRIATE LEVEL OF
ALERT FOR EACH COUNTRY AND MAY ISSUE ADDITIONAL OR MORE REFINED
INFORMATION.

**** NOTICE **** NOTICE **** NOTICE **** NOTICE **** NOTICE ****

PRELIMINARY EARTHQUAKE PARAMETERS

* MAGNITUDE 6.7
* ORIGIN TIME 0000 UTC OCT 1 2014
* COORDINATES 20.0 SOUTH 173.4 WEST
* DEPTH 178 KM / 111 MILES
* LOCATION TONGA

EVALUATION

* AN EARTHQUAKE WITH A PRELIMINARY MAGNITUDE OF 6.7 OCCURRED
 IN THE TONGA ISLANDS AT 0000 UTC ON WEDNESDAY OCTOBER 1 2014.

* BASED ON ALL AVAILABLE DATA... THERE IS NO TSUNAMI THREAT
 FROM THIS EARTHQUAKE.

RECOMMENDED ACTIONS

* NO ACTION IS REQUIRED.

NEXT UPDATE AND ADDITIONAL INFORMATION

*PTWC guidance
information
to Country
TWFP/NTWC*

Public Text message – Threat Message

- Threat
- Take Action

PTWC
Quantitative
Forecast -
est wave height

ZCZC
WEPA40 PHEB 220830
TSUPAC

EXPERIMENTAL TSUNAMI MESSAGE NUMBER 2
NOT FOR DISTRIBUTION
NWS PACIFIC TSUNAMI WARNING CENTER EWA
0830 UTC THU MAY 22 2014

...TSUNAMI THREAT MESSAGE...

**** NOTICE **** NOTICE **** NOTICE **** NOTICE **** NOTICE ****

THIS MESSAGE IS ISSUED FOR INFORMATION ONLY IN SUPPORT OF THE
UNESCO/IOC PACIFIC TSUNAMI WARNING AND MITIGATION SYSTEM AND IS
MEANT FOR NATIONAL AUTHORITIES IN EACH COUNTRY OF THAT SYSTEM.

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

**** NOTICE **** NOTICE **** NOTICE **** NOTICE **** NOTICE ****

PRELIMINARY EARTHQUAKE PARAMETERS

* MAGNITUDE 8.8
* ORIGIN TIME 0800 UTC MAY 22 2014
* COORDINATES 13.0 NORTH 144.5 EAST
* DEPTH 25 KM / 16 MILES
* LOCATION MARIANA ISLANDS

EVALUATION

*PTWC guidance
information
to Country
TWFP/NTWC*

TSUNAMI THREAT FORECAST...UPDATED

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

JAPAN... PHILIPPINES... NORTHERN MARIANAS... GUAM... PAPUA
NEW GUINEA... AND INDONESIA.

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

TAIWAN... YAP... PALAU... MARSHALL ISLANDS... SOLOMON ISLANDS...
AND
RUSSIA.

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

CHINA... KIRIBATI... NAURU... WAKE ISLAND... AND TUVALU.

* TSUNAMI WAVES LESS THAN 0.3 METERS ABOVE THE TIDE LEVEL ARE
POSSIBLE FOR SOME COASTS OF

AUSTRALIA... REPUBLIC OF KOREA... MALAYSIA... AND BRUNEI.

* ACTUAL AMPLITUDES AT THE COAST MAY VARY FROM FORECAST
AMPLITUDES DUE TO UNCERTAINTIES IN THE FORECAST AND LOCAL
FEATURES. IN PARTICULAR MAXIMUM TSUNAMI AMPLITUDES ON ATOLLS
WILL LIKELY BE MUCH SMALLER THAN THE FORECAST INDICATES.

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



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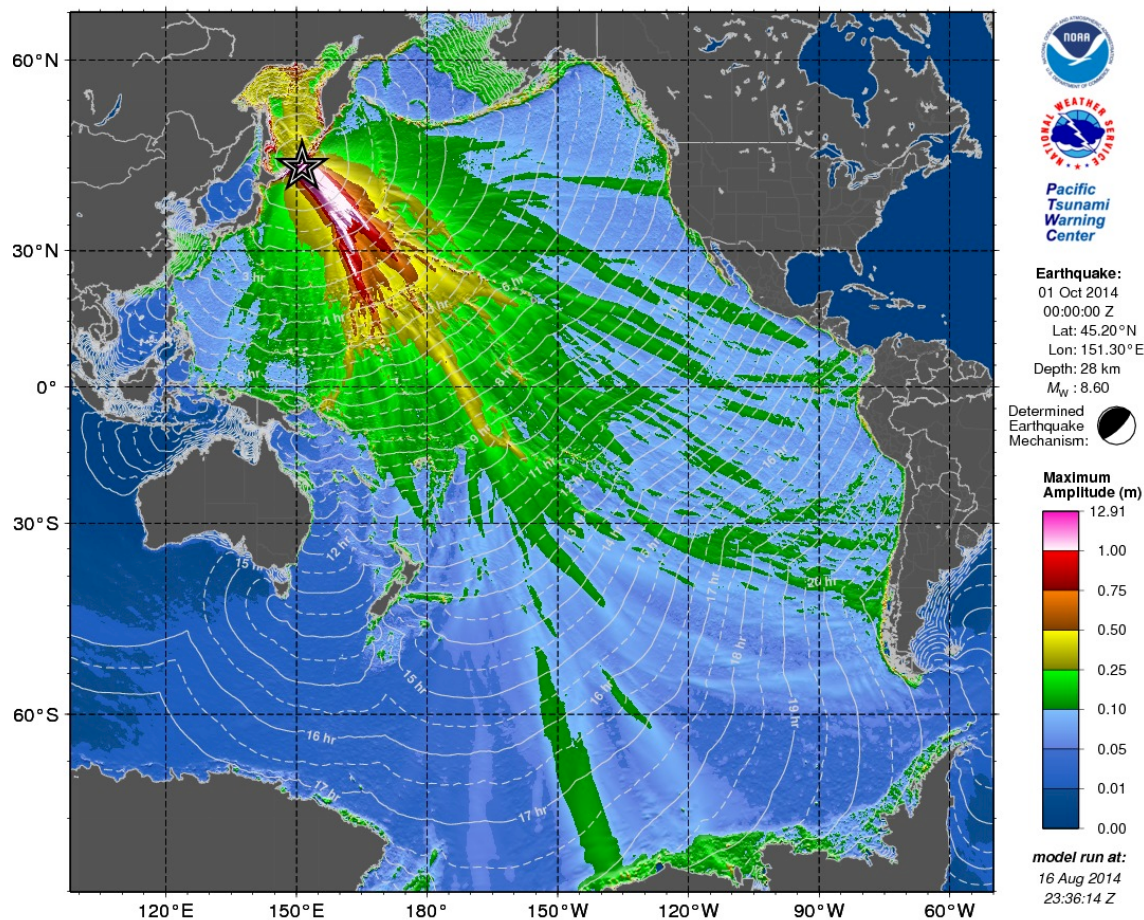
PTWC New Enhanced Products for Pacific countries: TWFP Products - Examples

Graphical Product: Deep-Ocean Forecast

PTWC Deep-Ocean Tsunami Amplitude Forecast

This map should not be used to estimate coastal tsunami amplitudes or impacts. Deep-ocean amplitudes are usually much smaller than coastal amplitudes.

This message is issued for information only in support of the UNESCO/IOC Pacific Tsunami Warning and Mitigation System and is meant for national authorities in each country of that system. National authorities will determine the appropriate level of alert for each country and may issue additional or more refined information.



- Tsunami Travel Time contours (assumes point source)
- Color range scaled so red / white show maxima
- Shaded textures show energy distribution

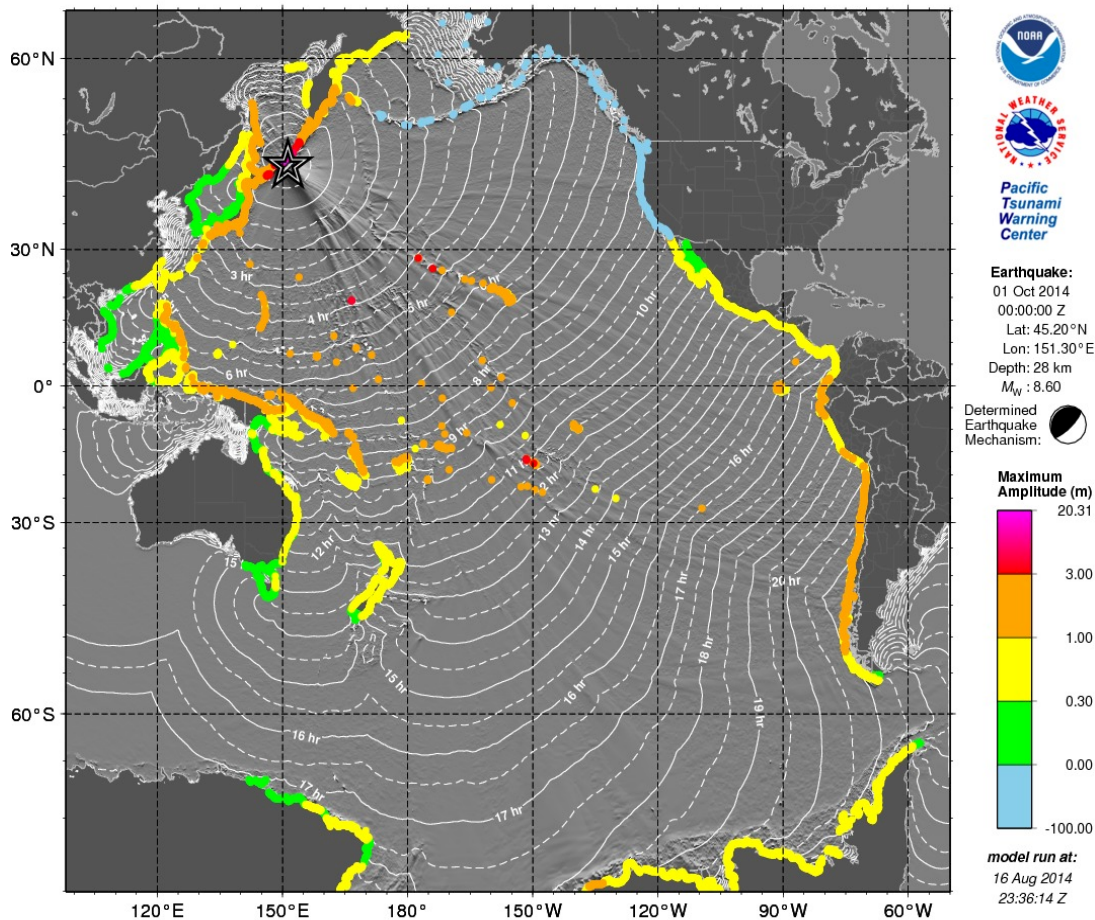


Graphical Product: Coastal Forecast

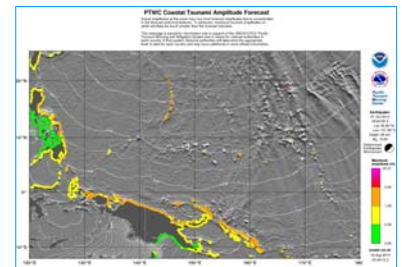
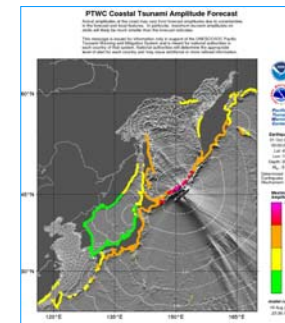
PTWC Coastal Tsunami Amplitude Forecast

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

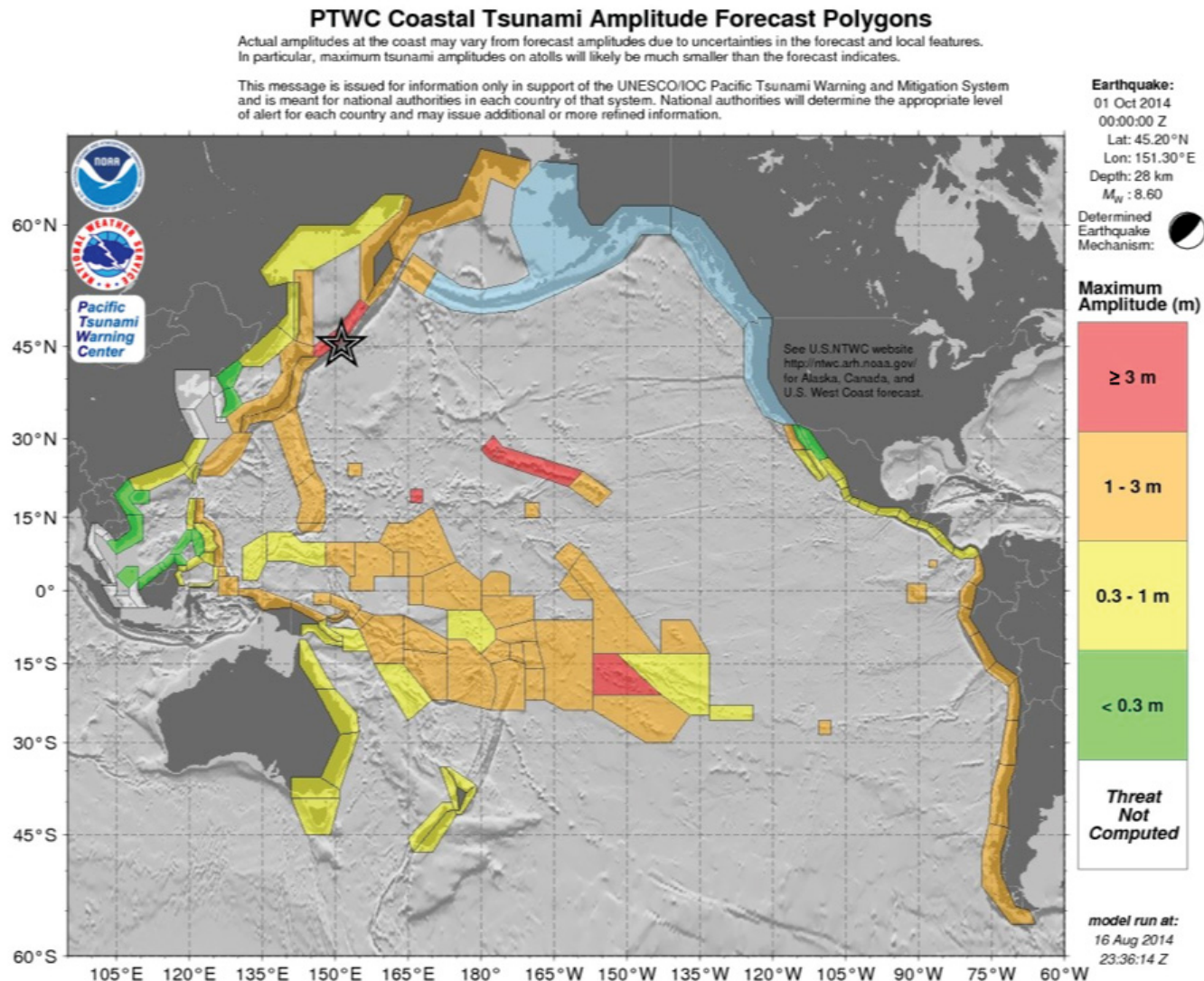
This message is issued for information only in support of the UNESCO/IOC Pacific Tsunami Warning and Mitigation System and is meant for national authorities in each country of that system. National authorities will determine the appropriate level of alert for each country and may issue additional or more refined information.



- Green's Law used to propagate off-shore, deep-ocean to coast
- Tsunami Travel Time contours (assumes point source)
- Tsunami Wave Amplitudes at designated coastal forecast points (Green's Law)
- Shaded textures show energy distribution
- Pacific-wide, sub-region plots

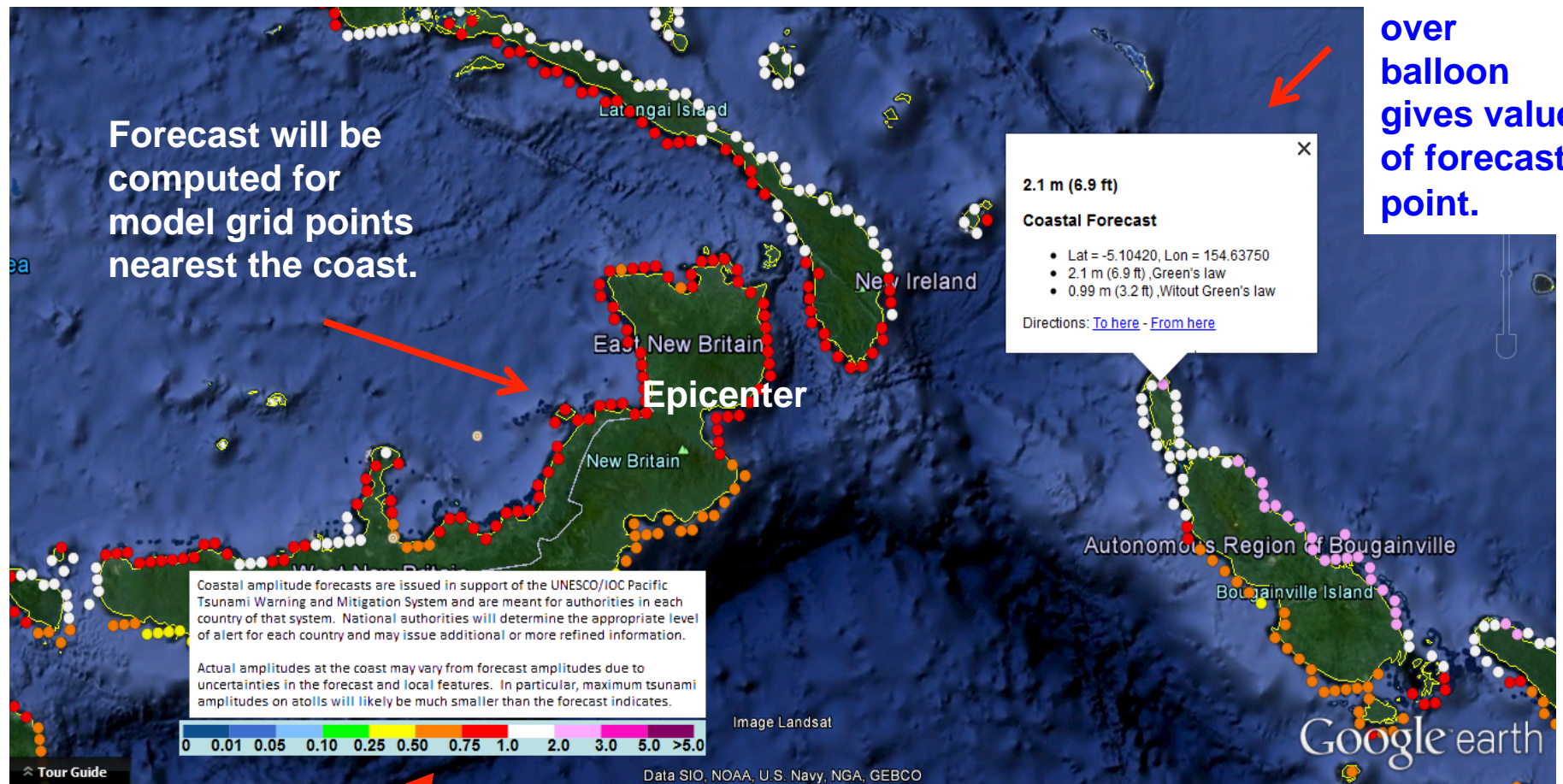


Graphical Product: Forecast Polygon



- Threat level for designated forecast zones (based on geographical, geopolitical)
- Grey-shaded textures shows energy distribution

Sample of kmz file in GoogleEarth



Color-scale indicates values of forecast points.

Earthquake: 45.2N 151.3E Depth: 028km Magnitude: 8.6

Zoom in to area of interest.

Text File: Forecast Polygon Table



- Coastal and Deep-Ocean Forecasts for polygons
- Includes statistics giving uncertainty / quality estimate.
- E.g., for each polygon (comprised of # forecast points), max / mean / median / standard deviation of coastal and offshore (deep-ocean) wave amplitude for that polygon
- Complements GoogleEarth .kmz tool - can show value variation from point-to-point.

PTWC TABLE OF FORECAST STATISTICS FOR REGIONAL POLYGONS - RUN ID 20140816233614
(for internal use only - not for distribution)

Earthquake - Origin: 10/01/2014 00:00:00 UTC Coordinates: 45.2N 151.3E Depth: 028km Magnitude: 8.6

This table is issued for information only in support the UNESCO/IOC Pacific Tsunami Warning and Mitigation System and is meant for national authorities in each country of that system. National authorities will determine the appropriate level of alert for each country and may issue additional or more refined information.

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

Region_Name	Coastal	Forecast (meters)				Offshore Forecast (meters)				Total Points
	Maximum	Mean	Median	STD		Maximum	Mean	Median	STD	
Urup_Etorofu_Kunashiri_Shikotan_and_Habomai_Islands	20.	5.46	3.25	4.55		13.	2.55	1.84	2.49	101
Kuril_Islands	13.	3.37	2.44	2.67		5.9	1.43	1.10	1.07	95
Wake_Island	5.8	5.77	5.84	0.09		0.97	0.93	0.90	0.03	3
Society_Islands	4.4	2.24	1.89	0.88		1.8	0.57	0.48	0.33	35
Midway_Island	3.3	2.32	1.82	0.72		1.9	1.33	1.04	0.41	3
Northwestern_Hawaiian_Islands	3.1	2.07	1.98	0.58		1.4	0.90	0.99	0.41	5
East Coast of Japanese Main Islands	3.0	1.37	1.21	0.39		3.0	0.86	0.70	0.48	407



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Thank You

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September 2014

Saving Lives: **End-to-End Tsunami Warning**

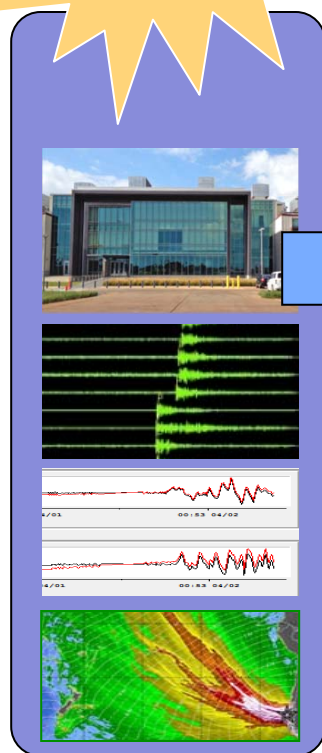
Additional Slides

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End-to-End Tsunami Warning

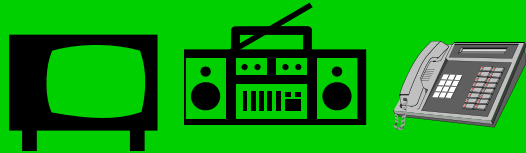
**EQ
Tsunami**



**TWC -
Science**

Intl / Natl

**Country
Alert System**



**Emergency Alert System
& Mass Media**

**DMO – Public Safety
Evacuate / All-Clear**

Natl / Local Govt



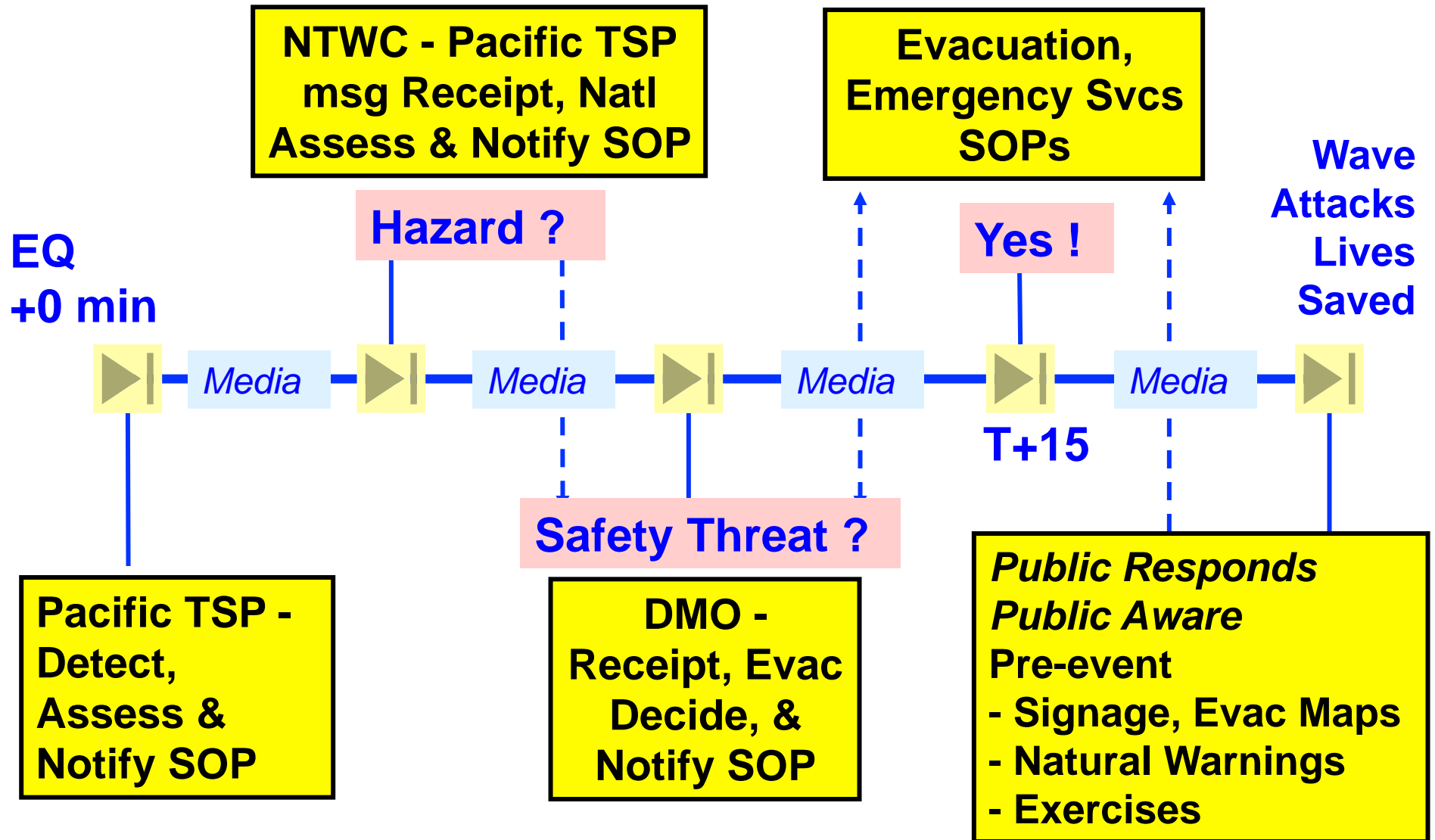
Public

ITIC, SeismicReady Consulting 2009 after Japan Cabinet Office 2005

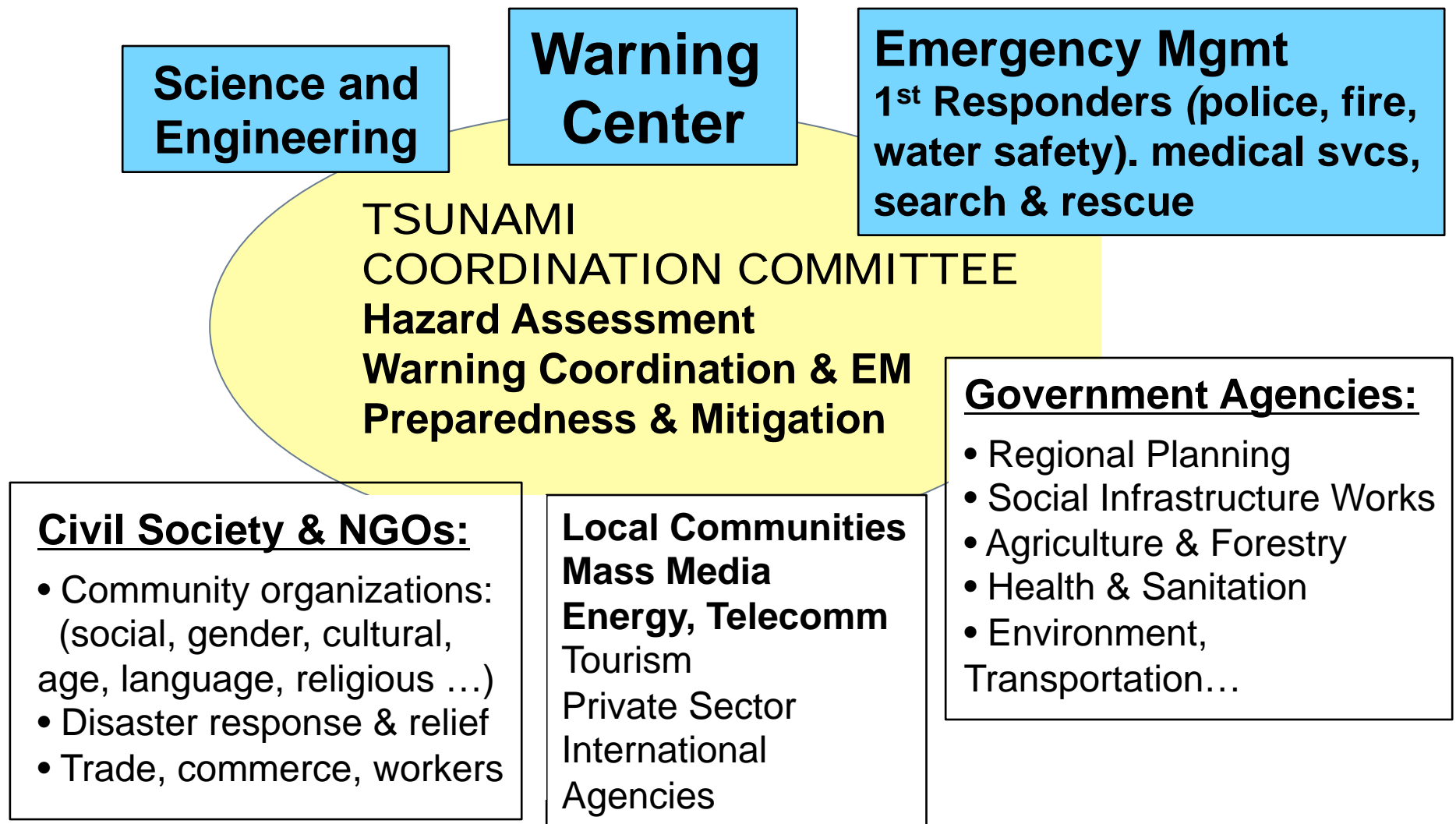


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International Tsunami Information Center

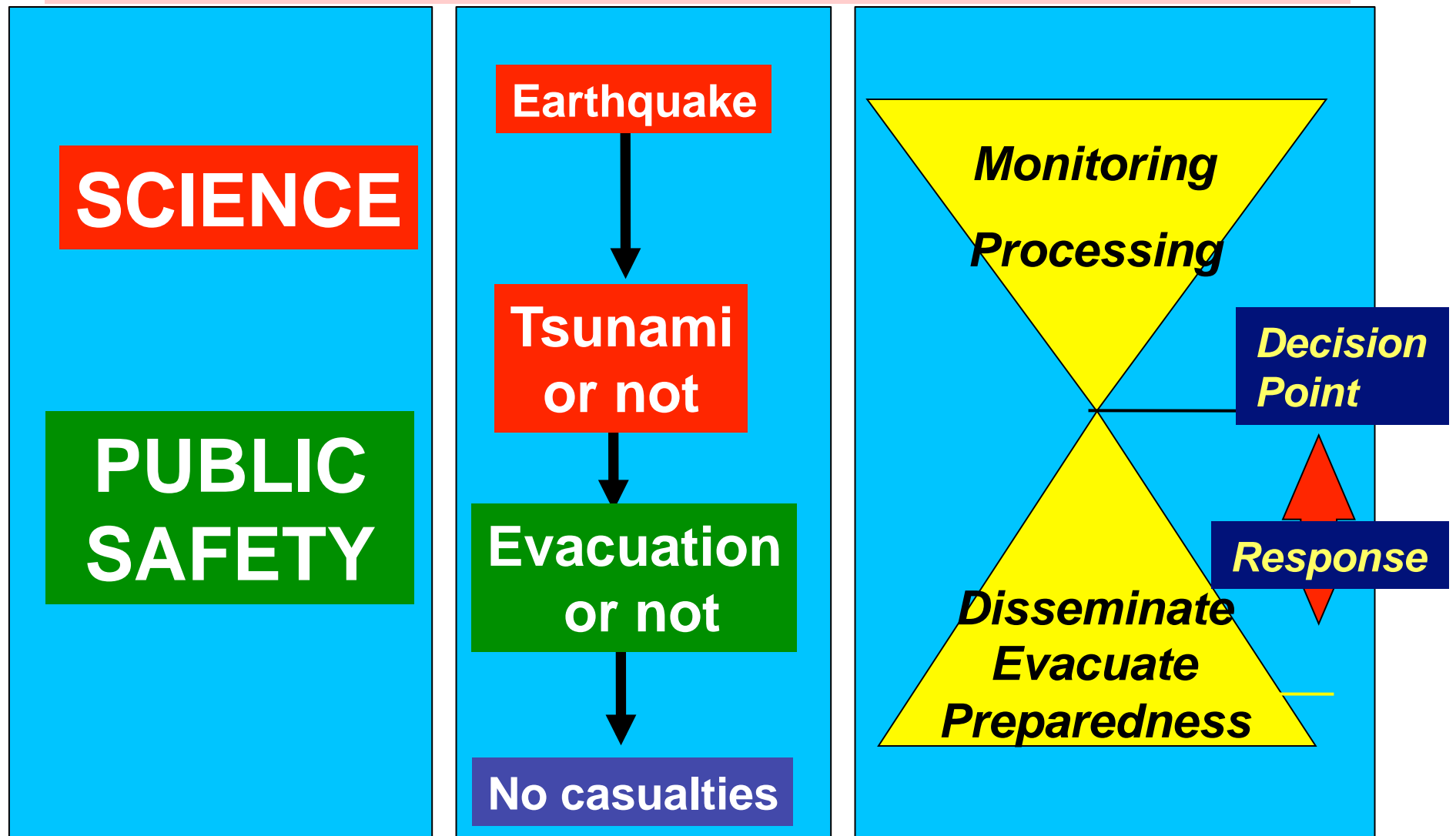
End-to-End Warning SOP – Activities



Stakeholder Coordination is Essential



Tsunami Early Warning: Science and Public Safety





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US NOAA Pacific Tsunami Warning Center
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Saving Lives: **End-to-End Tsunami Warning**

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