# Tsunami Coastal Assessment Tool
# TsuCAT

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*TsuCAT v4.5, September 2025*

# GLOBAL TSUNAMI WARNING AND MITIGATION SYSTEMS

Intergovernmental Oceanographic Commission of UNESCO
www.ioc-tsunami.org

**2024**

**NEAMTWS**
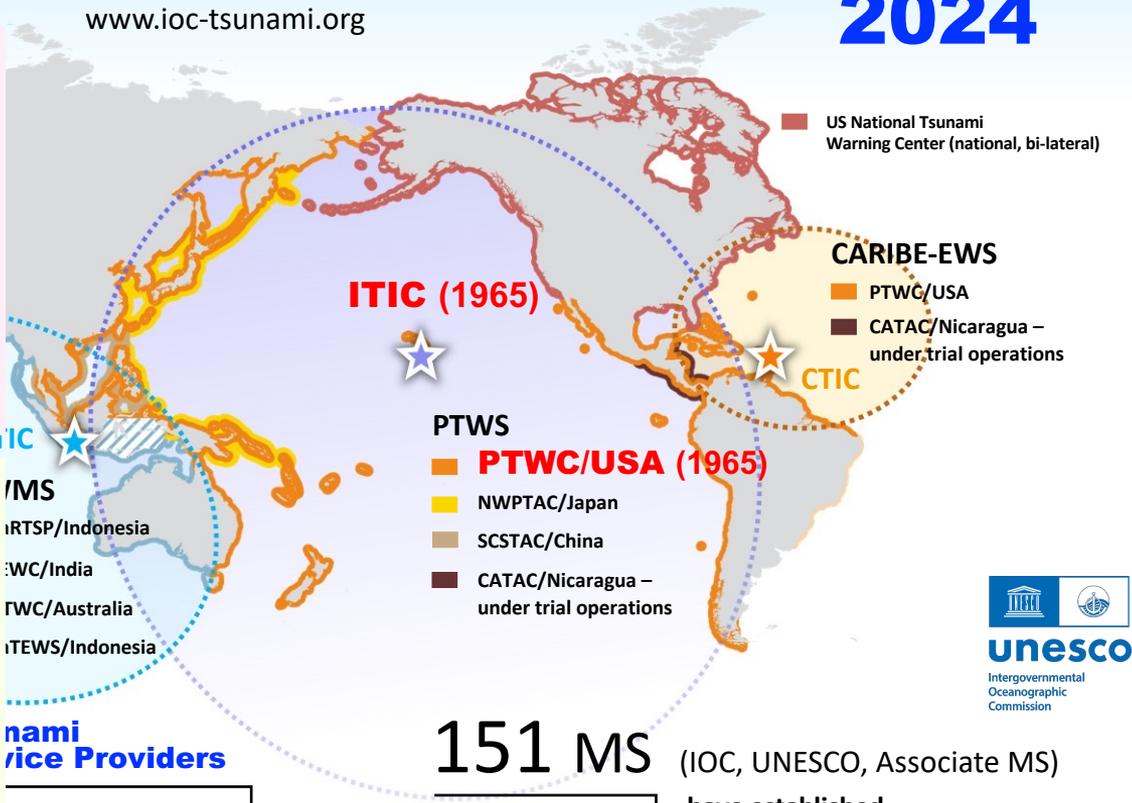
- CENALT/France
- IPMA/Portugal
- INGV/Italy
- KOERI/Turkiye
- NOA/Greece

**PTWC is Tsunami Service Provider**

for the **PTWS** and **CARIBE-EWS**

*(Pacific (46 countries) and Caribbean (49)*

**ITIC (1965)**

**4 Regional Systems**

- NEAMTWS
- IOTWMS
- PTWS
- CARIBE EWS

**ITIC is Tsunami Information Center**

for the **PTWS** and supports **CARIBE-EWS**

**4 Regional Information**

- NEAMTIC
- IOTIC
- ITIC
- CTIC

Supporting the Regional System

IOTIC

...WMS

RTSP/Indonesia
EWC/India
TWC/Australia
TEWS/Indonesia

**Tsunami Service Providers**

- 5 – NE Atlantic, Mediterranean
- 3 – Indian Ocean
- 4 – Pacific Ocean
- 2 – Caribbean

US National Tsunami Warning Center (national, bi-lateral)

**CARIBE-EWS**

- PTWC/USA
- CATAC/Nicaragua – under trial operations

CTIC

**PTWS**

- **PTWC/USA (1965)**
- NWPTAC/Japan
- SCSTAC/China
- CATAC/Nicaragua – under trial operations

**151 MS** (IOC, UNESCO, Associate MS)

36 – SIDS
12 – African

**have established National Tsunami Warning Focal Points/ National Tsunami Warning Centres**

unesco
Intergovernmental Oceanographic Commission

*After Frolov, 2023, IOC update 2024*

# Tsunami Warning Decision Support Tools
## ITIC-distributed, supported

- **Tsunami Bull Board Listserv** (ITIC, 1995) **468** science/tsu/govt (2025)
  ADDR FOR POSTING: **tsunami_bb@list.woc.noaa.gov**

- **Real time EQ Display** (CISN, USGS / NTHMP, 2005), 346+ **v3.13.227** (Aug 2024)
  **NO PTWC EQ Observatory message.  NO registration code required so cannot track nbr users**

- **Real-time Sea Level monitoring**
  - **Tide Tool – TWC operations monitoring** (PTWC, 2005) **v10.71**
  - **IOC Sea Level Monitoring web site** (IOC, 2008)

- **Tsunami Travel Time Software** (ITIC, NGDC, 2007) – **SDK4.0.1, with GUI for PC**

- **Tsunami Historical Database** Online (WDS-NCEI), Offline (TsuDig, NCEI, ITIC, 2009)

- **Tsunami Hazard Assessment Tools** (2017) – PMEL, ITIC
  - **ComMIT/MOST inundation modeling** **=> OTGA hybrid late 2026**
  - **Tsu Coastal Assessment Tool** (TsuCAT v4.5, Sep 2025) **=> PTWC messages from multiple countries, with community exercise injects, near-real time USGS earthquake ingest**
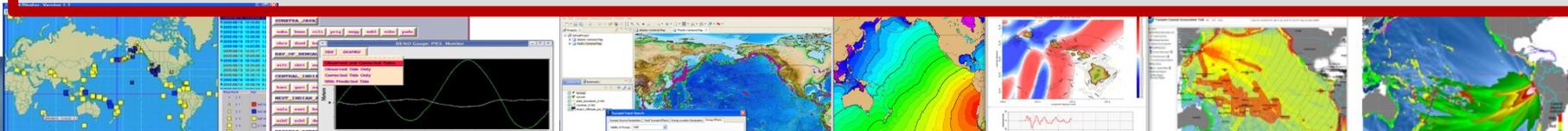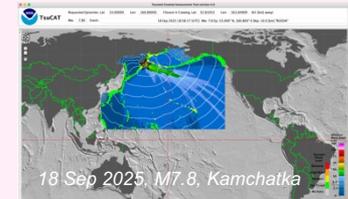
# TsuCAT: Tsunami Coastal Assessment Tool

- **Why / What:** Request by Pacific Islands for warning DSS
  Gives country capacity to assess tsunami hazard.
  Support better understanding, use of PTWC Forecast Products

- **Who:** Country agencies with Tsunami Hazard Assessment, Warning and Emergency Response responsibilities

- **Tool use:**
  - Planning tool - assess threat before – 'energy beams'
  - Decision system support tool – Customize country sub-regions (polygons), Quick, early assessment through DB lookup
  - Exercise tool – develop scenarios to use (from v4.0, 2019)
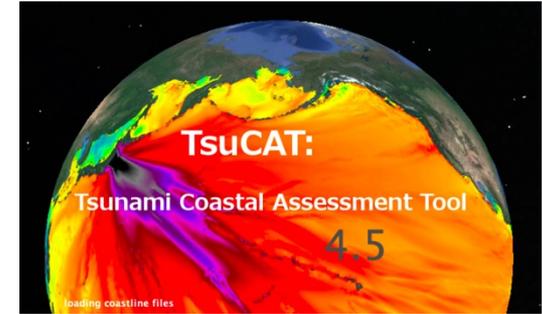
- **Features:**
  - Database (NOAA Propagation DB – fault catalog based on Slab 2, extended by E. Giest USGS): ~5400 earthquake scenarios from along active subduction zones, Pacific, Caribbean, Indian Ocean (M6.5-9.5)
  - Scenarios from Expert Meetings (Caribbean, Pacific)
  - Results from NOAA models (MOST/SIFT (M8+), RIFT (M6.5-7.9)
    - Offshore max amplitude / coastal wave amplitude (Green's Law)
    - PTWC or User custom forecast polygons
  - Exercise Messages and Injects
  - Near real-time threat w/USGS EQ alerts


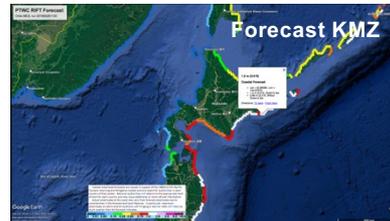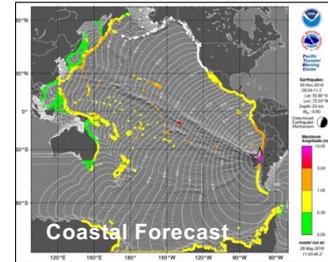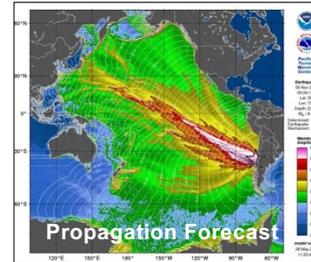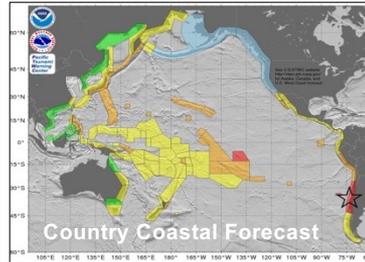TsuCAT: Tsunami Coastal Assessment Tool 4.5 — loading coastline files


18 Sep 2025, M7.8, Kamchatka

# PTWC Text and Graphical Tsunami Products

☐ **Issued when there is a potential tsunami threat (~M7.1+)**

☐ **Help Countries determine tsunami alert levels for their coasts**

**Public Text Product (tsunami.gov)**



**Graphical Products (only sent by email to Country TWC)**


Country Coastal Forecast


Propagation Forecast


Coastal Forecast


Forecast KMZ

**Forecast Statistics**

# Propagation and Coastal Forecasts
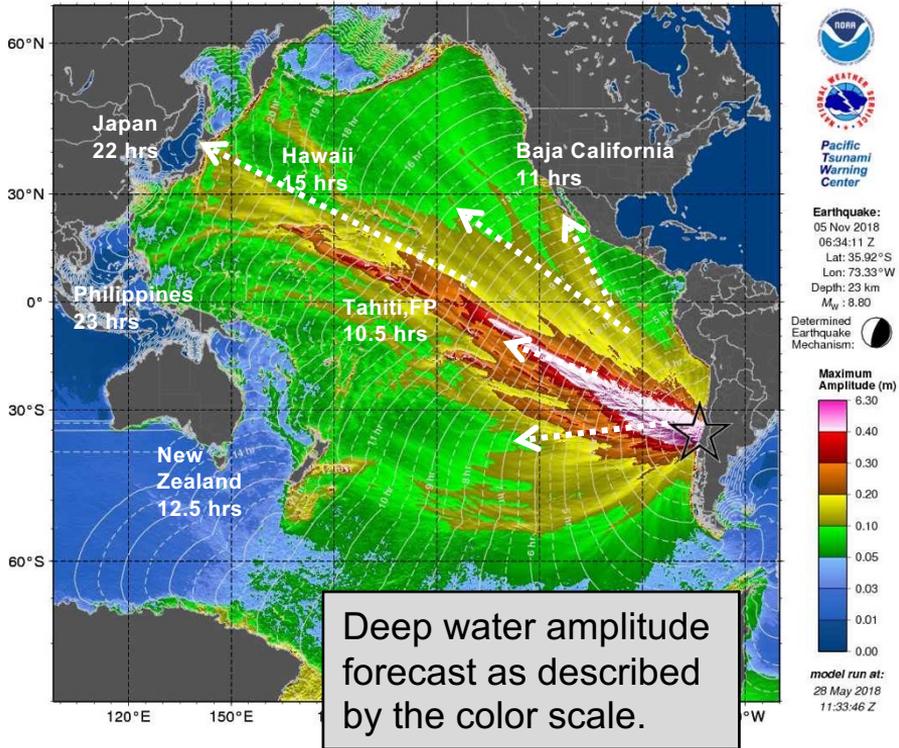


Deep water amplitude forecast as described by the color scale.

Coastal Hazard Guidance (CHG)
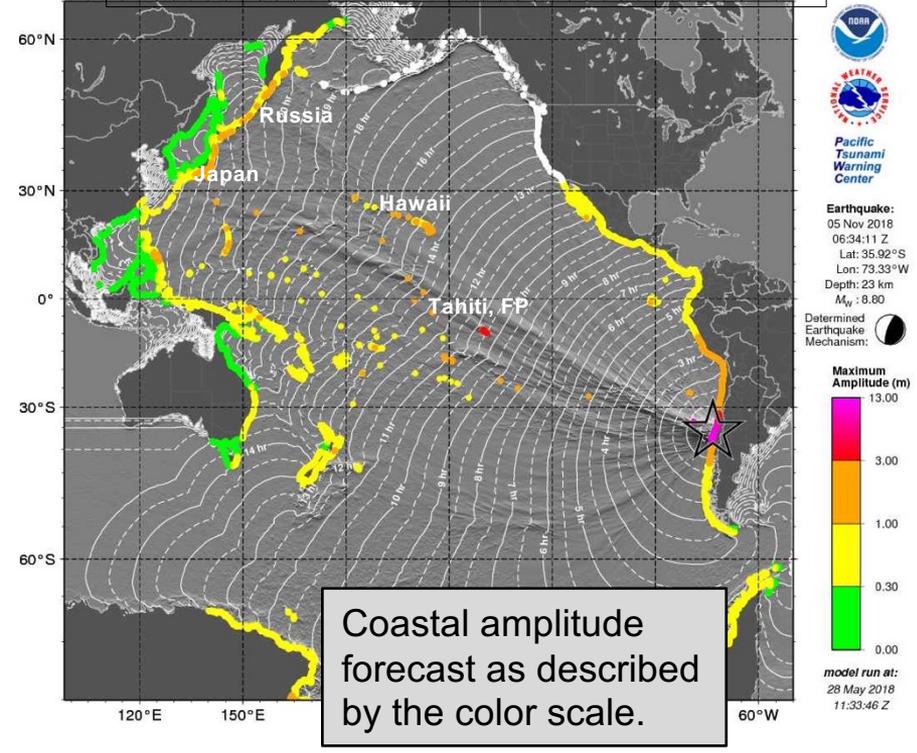
Coastal amplitude forecast as described by the color scale.

# Coastal Hazard Guidance – Green's Law

☐ **PTWC RIFT Model uses Green's Law to quickly estimate coastal ampl**
  - ■ Modeling on fine-scale coastal grids takes too long, even on supercomputers
  - ■ PTWC does not have access to fine-scale bathymetry for all coasts

**Green's Law:**

$$\eta_s \cong \eta_d \left( \frac{H_d}{H_s} \right)^{1/4}$$

$\eta_s$   *wave amplitude at shoreline point*

$\eta_d$   *wave amplitude at nearest deep ocean grid point*

$H_d$   *water depth at nearest deep ocean grid point*

$H_s$   *water depth at shoreline point*

| Offshore Tsunami Amplitude (10 cm) | Shoreline Amplitude from Green's Law (1 m water depth) | |
|---|---|---|
| **Water Depth** | **Amplitude** | **Amplification** |
| **1000 m** | **56 cm** | **5.6** |
| 500 m | 47 cm | 4.7 |
| 100 m | 32 cm | 3.2 |
| 50 m | 27 cm | 2.7 |

**Green's Law Example**

Offshore: nearest deep ocean grid point

$\eta_d$ = 10 cm

$\eta_s$ = 56 cm

*Mean Sea Level*

$H_s$ = 1 m

$H_d$ = 1000 m

seafloor

At Coastline: nearest shoreline grid point
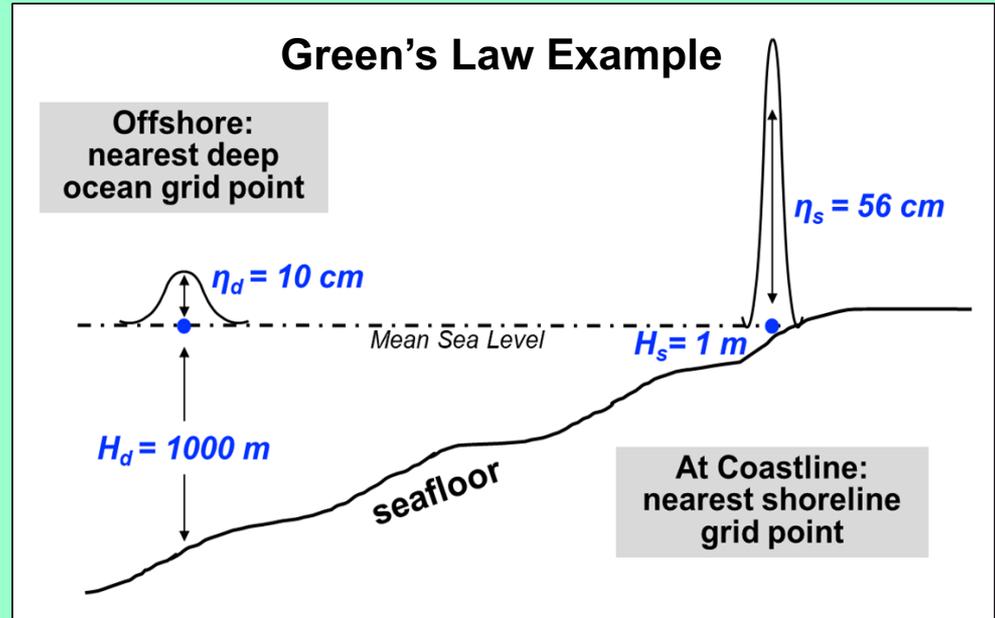
# Coastal Hazard Guidance - improvement

## Wave shoaling: Green's Law,
## plus Modified Amplification Factor



Offshore Wave Ampl (cm)

| | |
|---|---|
| | 400 |
| | 300 |
| | 200 |
| | 100 |
| | 90 |
| | 80 |
| Coastal Hazard Guidance | 70 |
| | 60 |
| | 50 |
| | 40 |
| Extreme | 30 |
| | 20 |
| High | 10 |
| | 8 |
| Med | 6 |
| | 4 |
| | 2 |
| Low | 1 |
| | 0.10 |
| No Data | 0 |
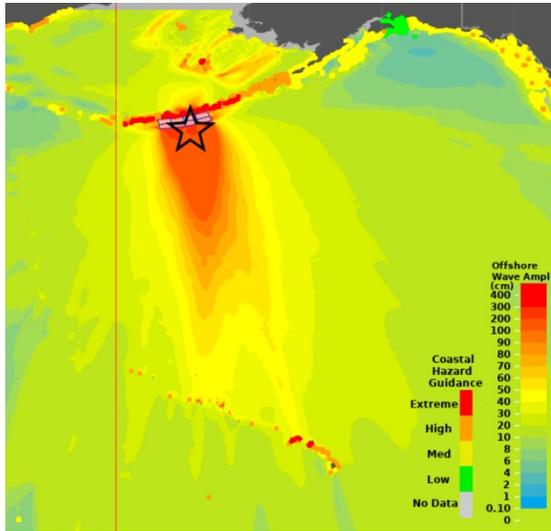
- Modifications to plane-wave ampl: $a \propto h^{1/4}$

- Model runs on 4 arcmin grids: deeper reference depth (to account for poorly resolved shelf waves)

- Steep slopes (atoll, > 1:10): $a = 1.25$ (approximately profile #1, Løvholt 2012)
  e.g., much reduced AF1.25 compared to 50-meter AF 2.69

# TsuCAT - Background

- **Requirements:**
  - Offline (no internet required) - portable
    Online (internet, adds geographic map tiles (OpenStreet, ESRI)
  - Platform:  Windows, Linux, Macintosh; Java v1.8
  - Storage: 28 GB; No installation - run from flash drive
  - Bathymetric grid resolution:  MOST (compute 4 arc-min),
    RIFT (compute 4 arc-min decr to 30 arc-sec)
- **Layers**
  - Offshore Wave Amplitude, Coastal Hazard Guidance, Travel Time
  - PTWC coastal polygons, or user-customized
  - Results export – model, regional report
  - Reference information:  Historical Seismicity(USGS, NOAA NCEI Significant), Tsunami Obs (NOAA NCEI), USGS Plates, Place names
  - User-supplied maps (polygon shape files), Quick guide tutorial
  - PTWC Enhanced Products Exercise messages

# Scenarios - NOAA Propagation DB, Historical Tsunamis
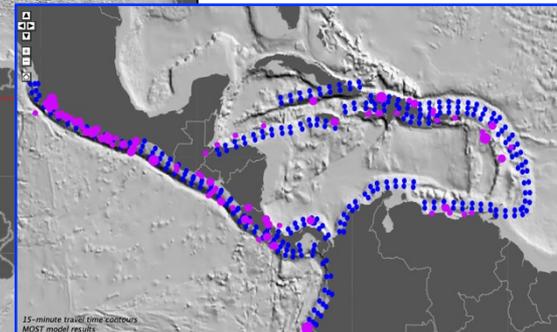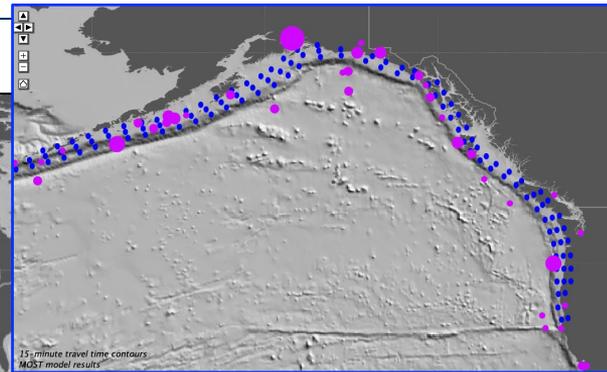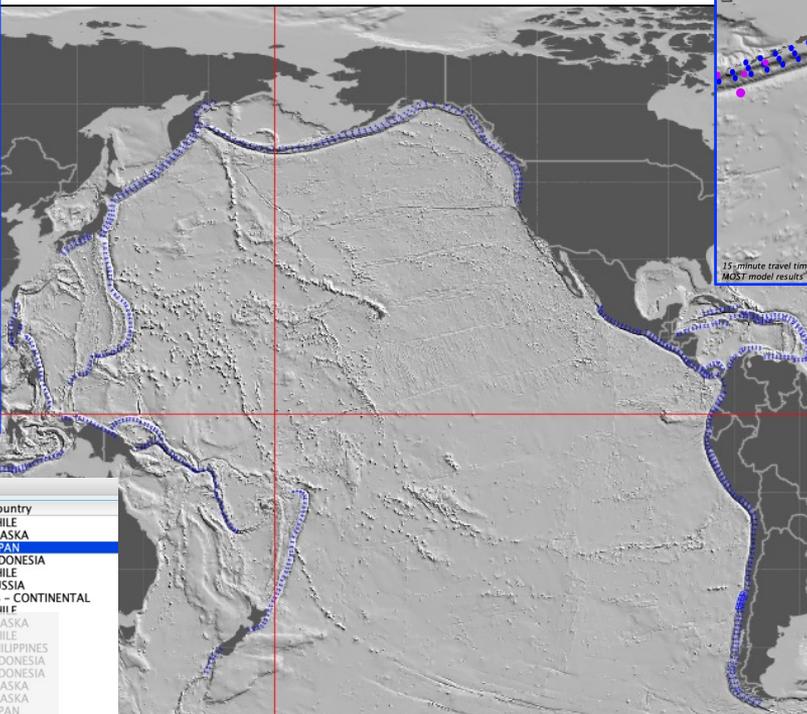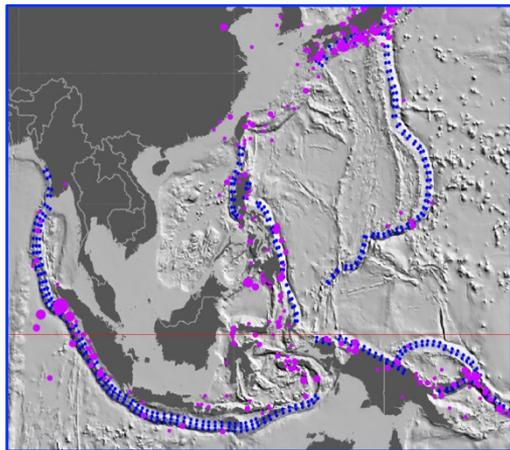
**Tsunamigenic Earthquakes, 1700-present**

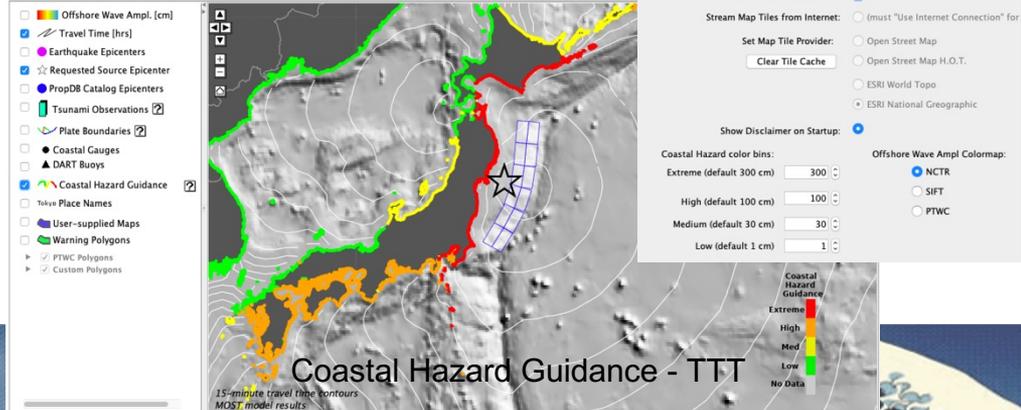| Date | Mw | Latitude | Longitude | Country |
|------|-----|----------|-----------|---------|
| 1960-05-22 19:11 | 9.5 | 38.143° S | 73.407° W | CHILE |
| 1964-03-28 03:36 | 9.2 | 61.017° N | 147.648° W | ALASKA |
| 2011-03-11 05:46 | 9.1 | 38.297° N | 142.372° E | JAPAN |
| 2004-12-26 00:58 | 9.1 | 3.316° N | 95.854° E | INDONESIA |
| 1730-07-08 08:45 | 9.1 | 32.500° S | 71.500° W | CHILE |
| 1952-11-04 16:58 | 9.0 | 52.755° N | 160.057° E | RUSSIA |
| 1700-01-27 05:00 | 9.0 | 45.000° N | 125.000° W | US – CONTINENTAL |
| 2010-02-27 06:34 | 8.8 | 36.122° S | 72.898° W | CHILE |
| 1965-02-04 05:01 | 8.7 | 51.290° N | 178.550° E | ALASKA |
| 1922-11-11 04:32 | 8.7 | 28.553° S | 70.755° W | CHILE |
| 1897-09-21 05:11 | 8.7 | | 122.000° E | PHILIPPINES |
| 2012-04-11 08:38 | 8.6 | | 93.063° E | INDONESIA |
| 2005-03-28 16:09 | 8.6 | 2.085° N | 97.108° E | INDONESIA |
| 1957-03-09 14:22 | 8.6 | | | ALASKA |
| 1946-04-01 12:29 | 8.6 | | 135.300° E | ALASKA |
| 0887-08-26 00:00 | 8.6 | | | JAPAN |
| 0869-07-13 00:07 | | | | |
| 1963-10-13 05:17 | 8.5 | | | |
| 1938-02-01 19:04 | 8.5 | | | |
| 1906-01-31 15:36 | 8.5 | 0.988° N | 79.347° W | ECUADOR |

**Select from:**
- **Tsunamigenic Eqs,**
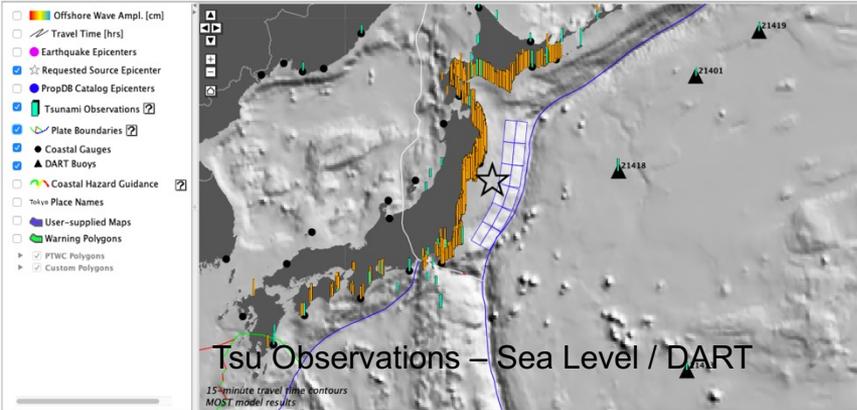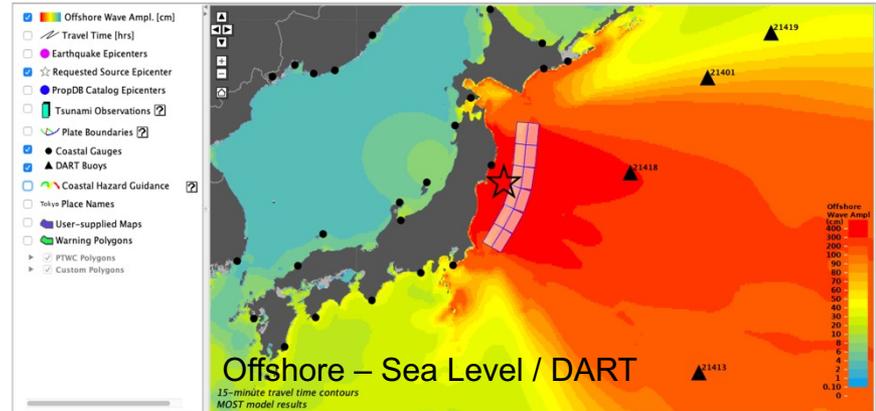- **UNESCO Expert mtgs**
- **User-chosen**

- WR-255_Earthquake_tsunami_sources_NorthernHaiti__2013.pdf
- WR-275_Scientific_meeting_of_experts_for_coordinated_scenario...hemes_for_the_South_C
- WR-276_Sources_tsunamis_Dominican_Republic_2016.pdf
- WR-278_Tsunami_Hazard_in_Central_America_Historical_Events_and_Potential_Sources_C
- WR-289_Experts_Meeting_on_Tsunami_Sources_Tonga-Kermadec.pdf
- WR-291_Expers_Meeting_on_Sources_of_Tsunamis_in_the_Lesser_Antilles_2020.pdf

15-minute travel time contours
MOST model results

International Tsunami Information

# 2011 Great East Japan, M9.1 – Data / Result Layers

| Requested Epicenter, Lat: | 38.29700 | Lon: | 142.37200 | Closest in Catalog, Lat: | 38.18725 | Lon: | 142.73354 | (34 [km] away) |
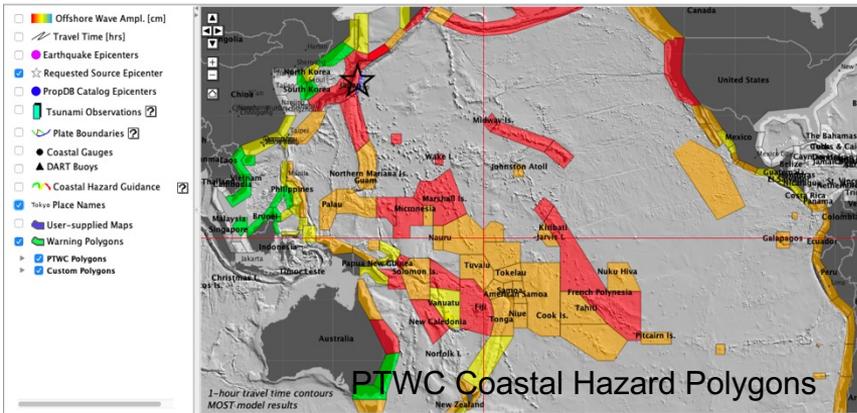
Mw: 9.10  Event: 11 Mar 2011 05:46:24 (UTC)  Mw: 9.1 Ep: 38.297° N, 142.372° E Dep: 30.0 [km] "JAPAN"



PTWC Coastal Hazard Polygons

Offshore – Sea Level / DART

Tsu Observations – Sea Level / DART

Coastal Hazard Guidance - TTT
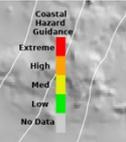
# TsuCAT – Tool Applications

- ☐ **Hazard Assessment -** conduct study to determine worst case, or likely impact, to a country's coast from different scenarios

- ☐ **Exercise development -** decide which scenario to use for a tsunami exercise, generate PTWC exercise messages

- ☐ **Response Planning –** use scenarios to develop tsunami response plans, protocol and procedures (SOPs)

- ☐ **Warning decision making –** estimate tsunami impact using the nearest similar scenario during a real event (early assessment prior to receiving PTWC forecast products

# Uses: Threat Assessment

**What location is most dangerous to Fiji for a M8.7?**
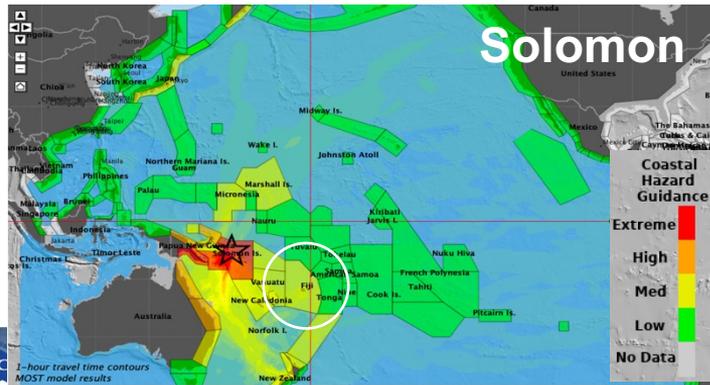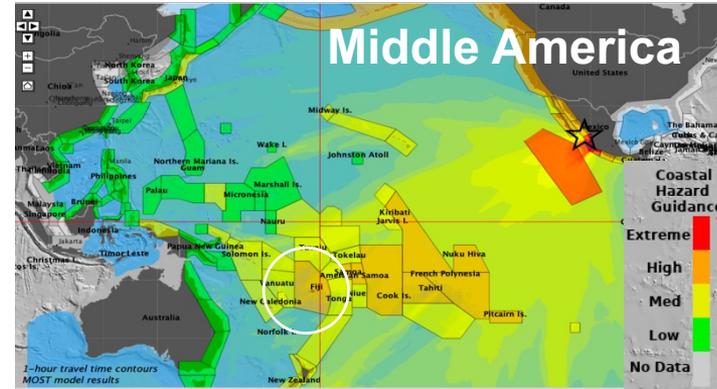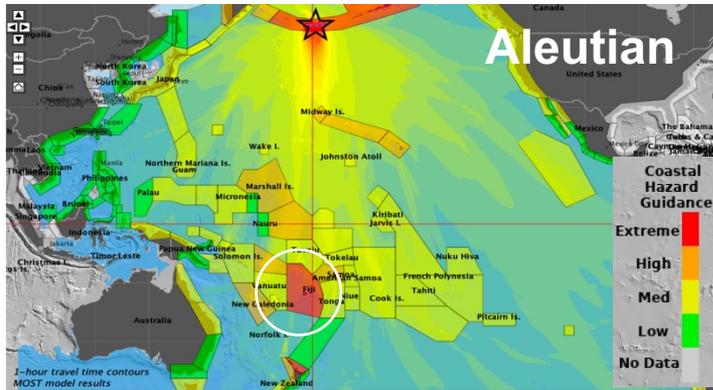
# Uses : Threat Assessment

**What size earthquake is most dangerous?**
**Aleutian Trench source:  M8.0, 8.5, 9.0**
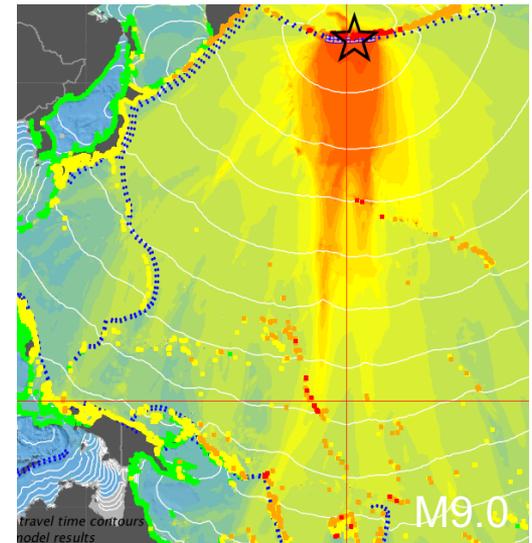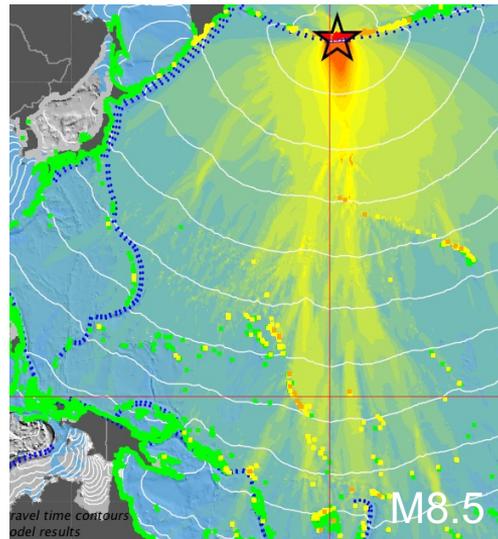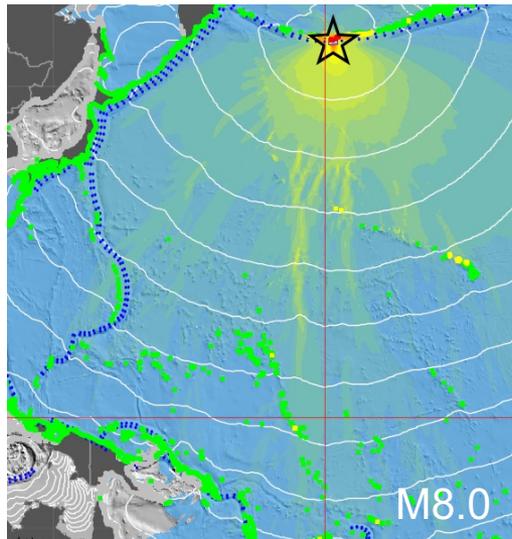
# Uses :  Overlay of additional data layers
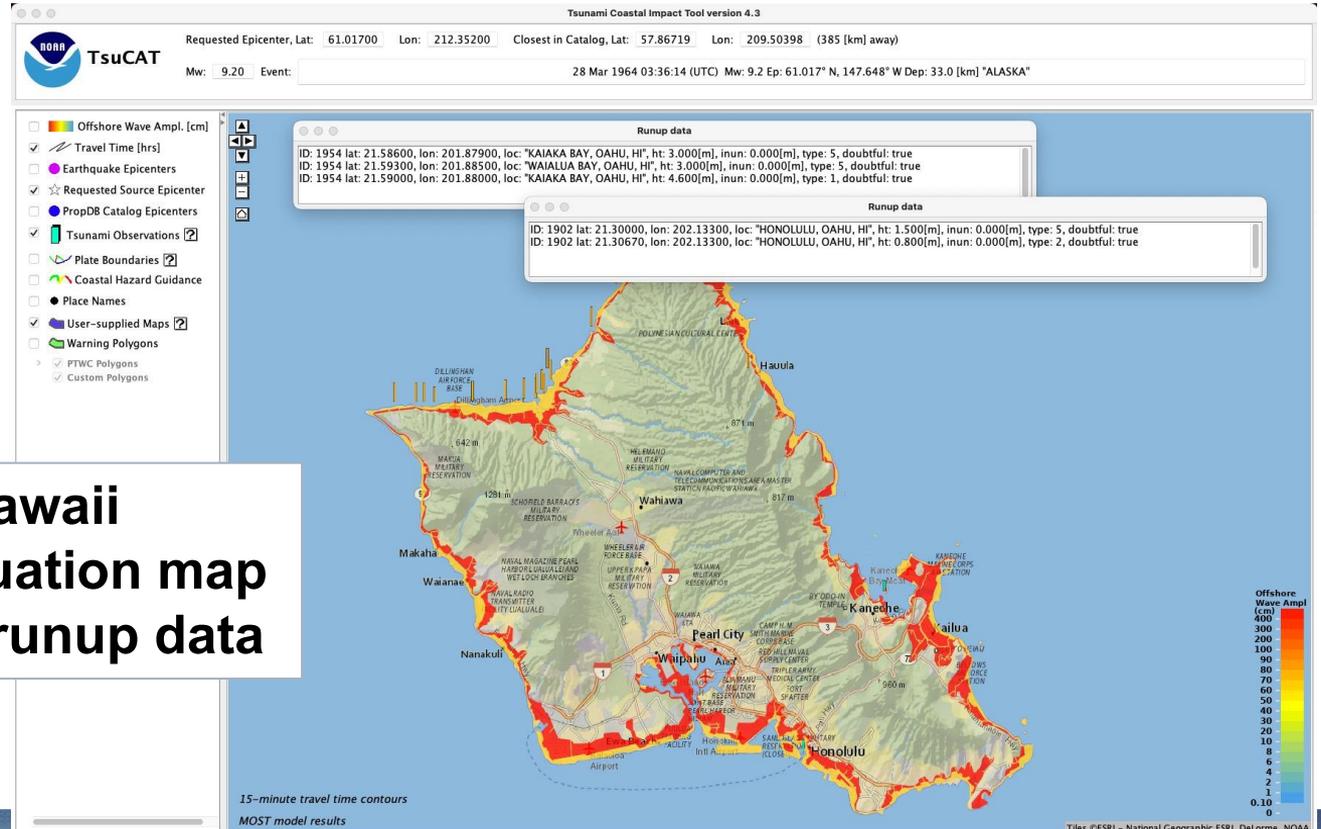


**Oahu, Hawaii**
- **Evacuation map**
- **NCEI runup data**

# Uses:  Generate Exercise messages with Injects

- **PTWC Public Text and Enhanced Products for multiple countries for events in pre-computed Pacific and Caribbean database**

- **Situational Injects for responding to based on selected scenario**

- **Password protected – to minimize 'hoaxes'**

- **Set Event (historical database or by mouse, origin time, magnitude)**

- **Select Menu - "Generate Exercise Messages"**
  - "Include Exercise Injects" (optional, customize)
  - "Generate" (PTWC Text Messages, Enhanced Products (graphical, polygon table, kmz file)
  - Output folder, e.g., message/2019-04-02_0000_M9.0_Russia_PTWCproducts

- **Varying issue time and magnitude update**

# GUI – Export PTWC Exercise Messages

## 2010 Chile M8.8 (nearest scenario 28 km away)

# Exercise Situational Injects

- **Injects enable customization**

- **Injects: unexpected scenario, questions, inquiries related to PTWC messages**

- **Excel format** (can adjust, add)



Exercise Injects

Set Country: CHILE
Name/Acronym of Tsunami Warning Center: SNAM
Head of Tsunami Warning Center: Director SHOA
Name of Earthquake Monitoring Agency: CSN
Name/Acronym of Emergency Management Agency: SENAPRED
Government lead (eg, President, Senator, Prime Minister): President
Member of the Public: School Principal
Media (TV, Radio) station: ón Nacional de Chile (TVN)

Add

Exercise Injects filename (Excel): ExerciseInjects.xls

**Earthquake - Origin: 09/25/2025 15:46 UTC**
**Coordinates: 36.0S 73.2W Depth: 23km Magnitude: 8.8**

| Inject # | Time (UTC) | Time Since Event [hhmm] | Exercise Time Local | Product/Inject | To | From |
|---|---|---|---|---|---|---|
| 1 | 1546 | 0 | 0546 | Earthquake Occurs! | All | Controller |
| 2 | 1548 | 2 | 0548 | Earthquake alarms trigger from P wave amplitudes off-scale at regional seismic network station | All | Controller |
| 3 | 1549 | 3 | 0549 | CSN calculates Preliminary Earthquake Parameters: 36.0° S, 73.2° W, 8.1, depth unknown. | All | Controller |
| 4 | 1551 | 5 | 0551 | CISN Display shows PTWC Earthquake Information, M8.7 | All | Controller |
| 5 | 1552 | 6 | 0552 | PTWC Message 1: PTWC Tsunami Threat Message Initial M8.7 | SNAM | PTWC |
| 6 | 1553 | 7 | 0553 | The shaking woke me up and my house was shaking for more than 60 seconds. Some power lines fell down are down. What has just happened? Where was the earthquake? Is there a tsunami? When will it hit? | SENAPRED, SNAM | Coastal Resident |
| 7 | 1600 | 14 | 0600 | PTWC Message 2: PTWC Tsunami Threat Message Magnitude Update M8.8 | SNAM | PTWC |
| 8 | 1608 | 22 | 0608 | Many coastal provinces and local governments hear media reports that PTWC is forecasting waves more than 2.3-meters. A school principal calls: What should she do? Her school is on the beach! | SENAPRED /SNAM | Local Government |
| 9 | 1610 | 24 | 0610 | PTWC Message 3: PTWC Tsunami Threat Message Regional M8.8 | SNAM | PTWC |
| 10 | 1611 | 25 | 0611 | Televisión Nacional de Chile (TVN) News broadcasts live video of start of surf contest at North Coast beach It looks like a great day and waves look to be 3 m high. Surf's up. There are surfers heading into the water, and crowds are gathering | SENAPRED, SNAM | Media |
| 11 | 1615 | 29 | 0615 | TWC confirms tsunami at gauge: TALCAHUANO by Tide Tool, measured 13.4 m at 1614 UTC, Wave Period 36 min | TWC | Controller |
| 12 | 1620 | 34 | 0620 | PTWC Message 4: PTWC Tsunami Threat Message Pacific M8.8 | SNAM | PTWC |
| 13 | 1620 | 34 | 0620 | CHILE President calls and wants an update immediately as to what going on and what actions are being undertaken. What is expected for our country and when? Do we need to call a Tsunami Warning? | SNAM | President |
| 14 | 1630 | 44 | 0630 | TWC confirms tsunami at gauge: VALPARAISO by Tide Tool, measured 2.0 m at 1630 UTC, Wave Period 37 min | TWC | Controller |

CHILE   +

UNESCO/IOC-NOAA
International Tsunami I...

# How to use - simple

- **Run from flash drive (or can copy to hard disk, 28 GB)**
- **Requirement – Java 1.8x installed** **https://java.com/en/download/**
- **Click on application (Window, Mac, Linux)**
  - On 1st time opening, use start password (Inund8ed)
  - Then set 'personal' password (unique to user)
  - Default is 'No Internet'
  - With Internet, on starting, will
    - Update EQ &Tsunami database files, e.g., ingests latest USGS earthquake hypocenters, and shows threat assessment
    - Use addtl online map databases (more detailed but req bandwidth)
  - For exercise messages/injects tool, enter password (genr8mess)

# Thank You

**TsuCAT:  https://tsunami.ioc.unesco.org/en/tsucat**
**https://tsunami.ioc.unesco.org/en/**

Tools & Products:  https://tsunami.ioc.unesco.org/en/tools-products

**Email:  ITIC:**  itic.tsunami@noaa.gov, laura.kong@noaa.gov

**NCTR:**  Christopher.Moore@noaa.gov