UNESCO IOC – NOAA International Tsunami Information Center (ITIC)
NOAA Pacific Environmental Laboratory,
NOAA Center for Tsunami Research (PMEL/NCTR)
Pacific Tsunami Warning Center (PTWC)

Tsunami Coastal Assessment Tool

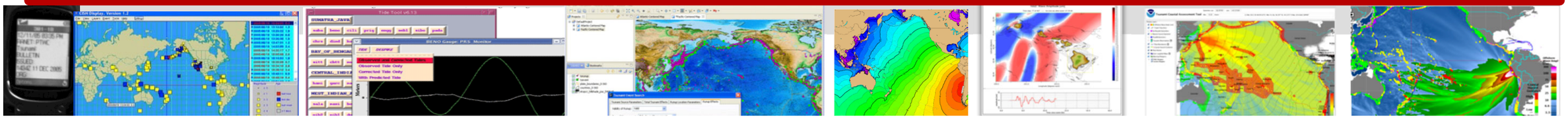
TsuCAT

Christopher Moore, NOAA Center for Tsunami Research (NCTR)
Dr. Laura Kong, ITIC
Dr. Charles McCreery, PTWC

TsuCAT v4.3, Feb 2023

Tsunami Warning Decision Support Tools
ITIC-distributed, supported

- **Tsunami Bull Board** (ITIC, 1995) ~469 science/tsu/govt
- **Real time EQ Display** (v3.7.039 (CISN, USGS / NTHMP, 2005), 350+
- **Real-time Sea Level monitoring**
  - Tide Tool v10.70 – TWC operations monitoring (PTWC, 2005)
  - IOC Sea Level Monitoring web site (IOC, 2008)
- **Tsunami Travel Time Software** v4.0.01 (ITIC, NCEI, 2007) – TTSDK4.0.1
- **Tsunami Historical Database** Online (WDS-NCEI), Offline (TsuDig, NCEI, ITIC, 2009)
- **Tsunami Hazard Assessment Tools – PMEL, ITIC**
  - ComMIT/MOST inundation modeling (2015 TEMPP; put under OTGA for Tsunami Ready)
  - Tsunami Coastal Assessment Tool (TsuCAT) v4.3 Feb 2023 – situational exercise injects

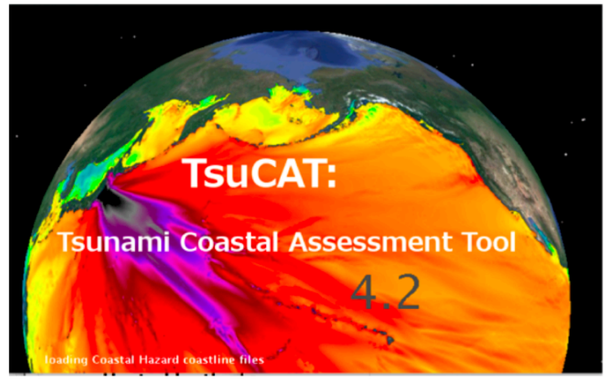


TsuCAT update: v4.3, February 2023

- Java security update in bundled Java Runtime Environment
- Proxy configuration for outbound firewall networking configuration
- **PTWS Messages now password protected.**
  Contact ITIC or PMEL for access to feature.
- **PTWC Messages feature includes Exercise Injects** option to generate Excel spreadsheet of injects to react to when testing SOPs.
- **Updates to NCEI Tsunami event database and runup database:**
  observations of real event runups through 2022.
- **Updates to Seismic Expert Sources**
  - Lesser Antilles (IOC Workshop Rpt 291, 2019) – included
  - Colombia-Ecuador (IOC Workshop Rpt 295, 2020) – later, download PMEL

TsuCAT: Tsunami Coastal Assessment Tool (NCTR, ITIC)

- **Why / What:** Request by Pacific Islands for warning DSS
  Gives country capacity to assess tsunami hazard
- **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)



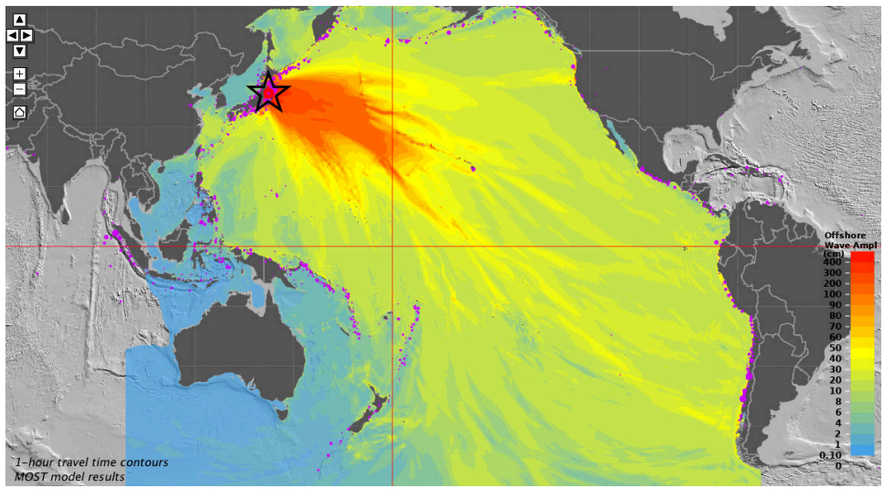
- **Features:**
  - Database: ~5400 earthquake scenarios from along active subduction zones, Pacific, Caribbean, Indian Ocean (M6.5-9.5)
  - Scenarios from Expert Meetings (Caribbean, Pacific)
  - Results from NOAA models (MOST/SIFT (M8+), RIFT (M6.5-7.9)
    - Offshore max amplitude / coastal wave amplitude (Green's Law)
    - PTWC or User custom forecast polygons
  - Exercise Messages and Injects

TsuCAT - Background

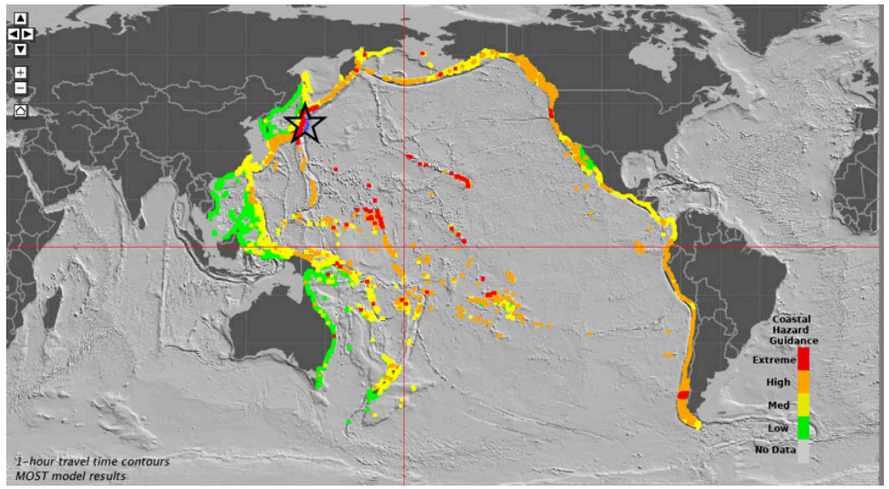
- **Requirements**:
  - Offline (no internet required) - portable
    Online (internet, adds geographic map tiles (OpenStreet, ESRI)
  - Platform: Windows, Linux, Macintosh; Java v1.8
  - Storage: 27 GB; No installation - run from flash drive
  - Bathymetric grid resolution: MOST (compute 4 arc-min),
    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 Observations (NOAA NCEI), USGS Plate boundaries, Place names
  - User-supplied maps (polygon shape files), Quick guide tutorial
  - PTWC Enhanced Products Exercise messages

TsuCAT: Coastal Impact DB Tool

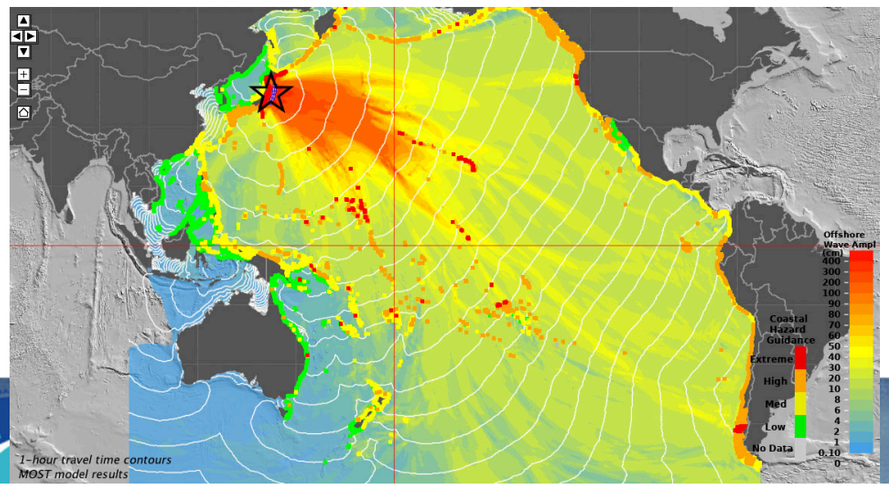
Deep-Ocean Offshore Max Ampl – Historical seismicity



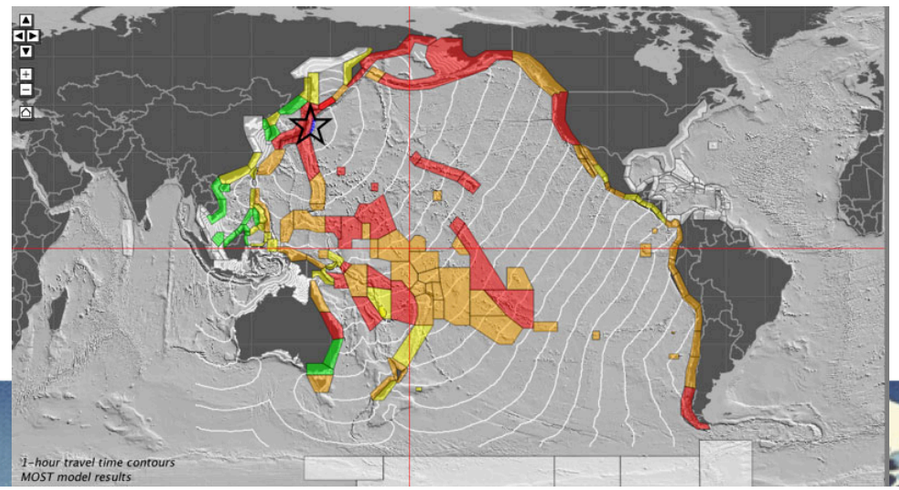
Coastal Hazard Guidance Ampl (CHG)



Offshore – CHG – Tsunami Travel Times (TTT)



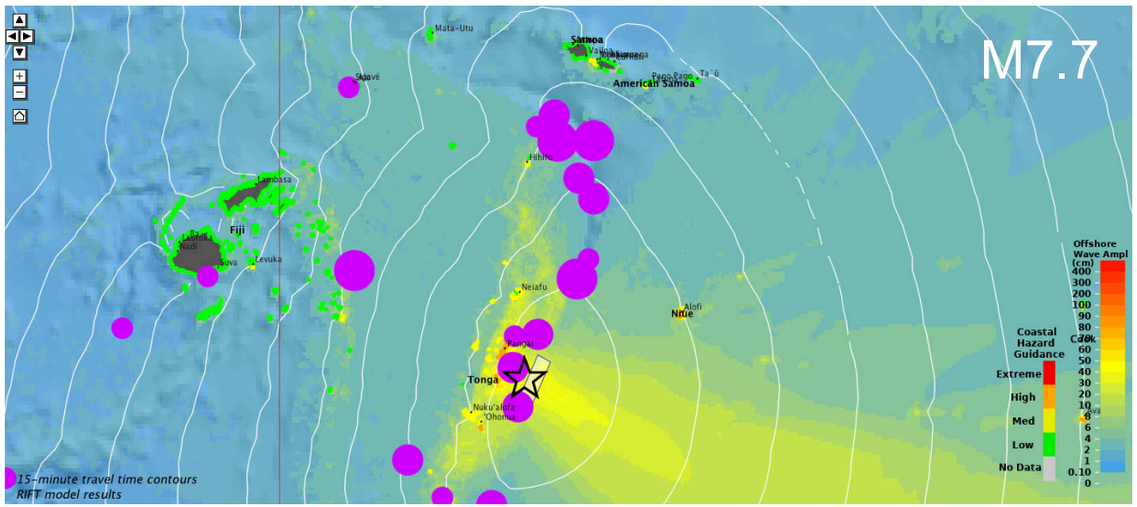
PTWC Coastal Polygons – TTT

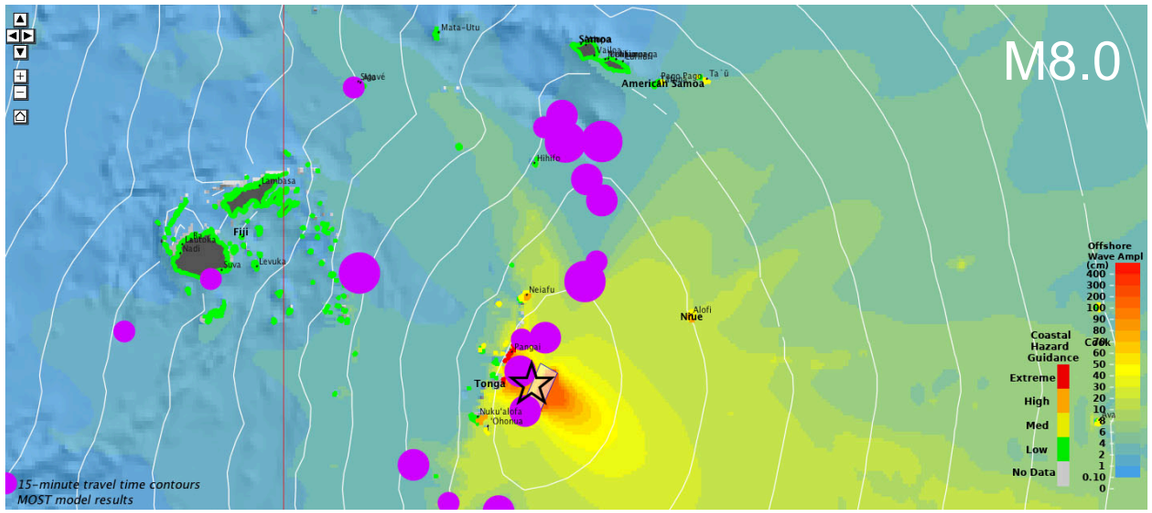


TsuCAT – Tool Applications

- **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

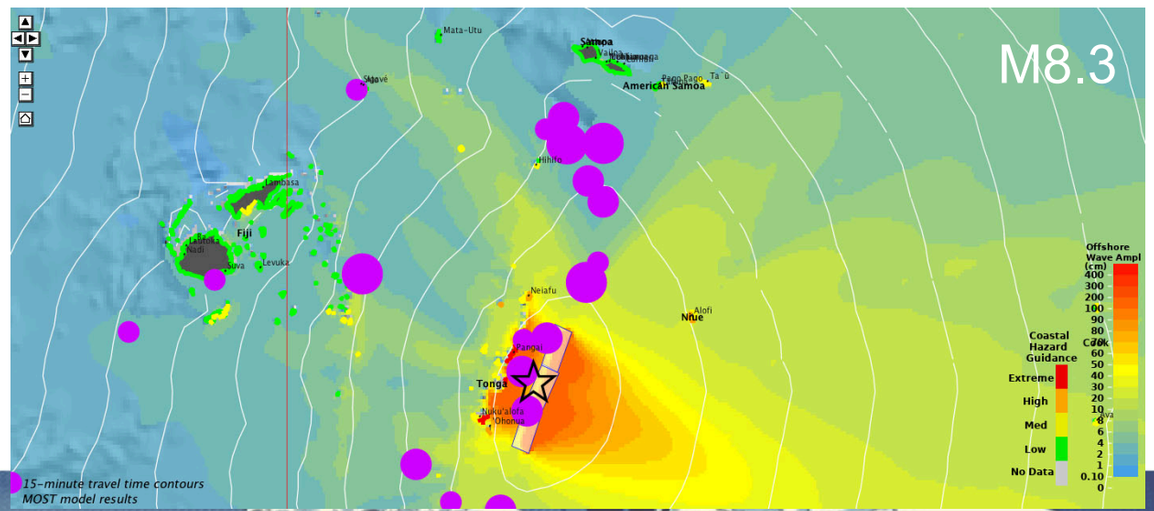
Uses: Threat Assessment





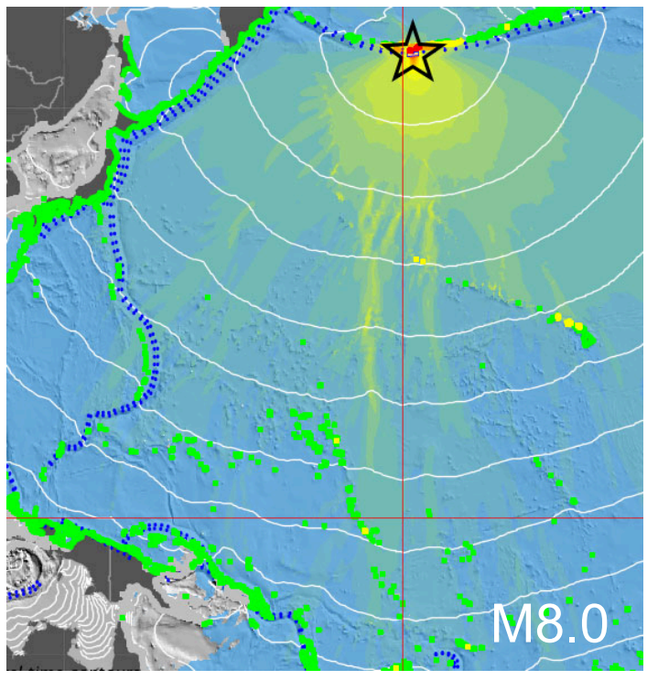
What size earthquake is most dangerous to Tonga?

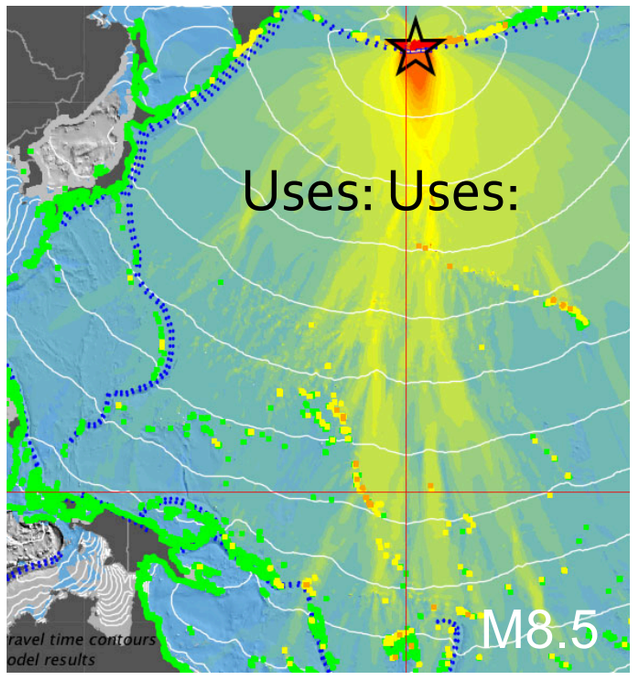
Central Tonga source
M7.7, 8.0, 8.3

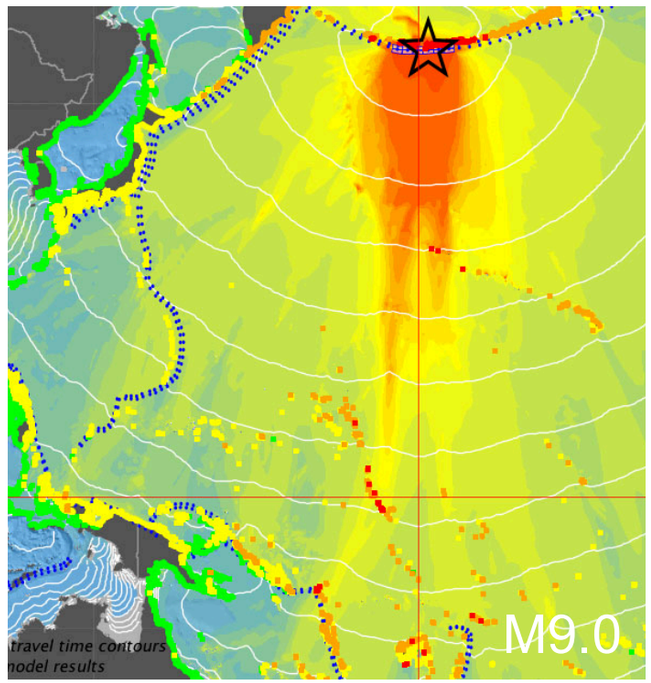


Uses : Threat Assessment

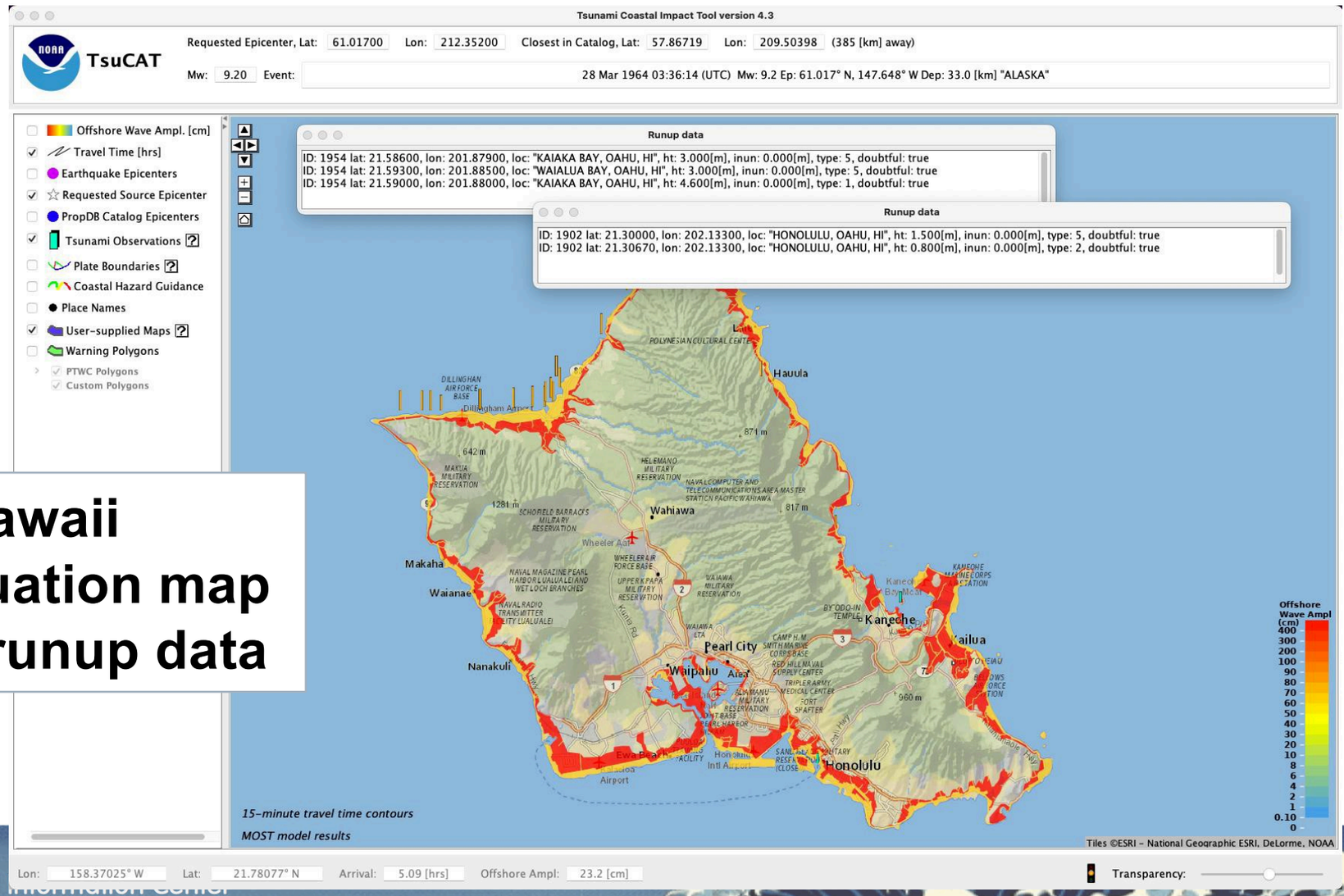
What size earthquake is most dangerous?
Aleutian Trench source: M8.0, 8.5, 9.0







Uses : Overlay of additional data layers



Oahu, Hawaii

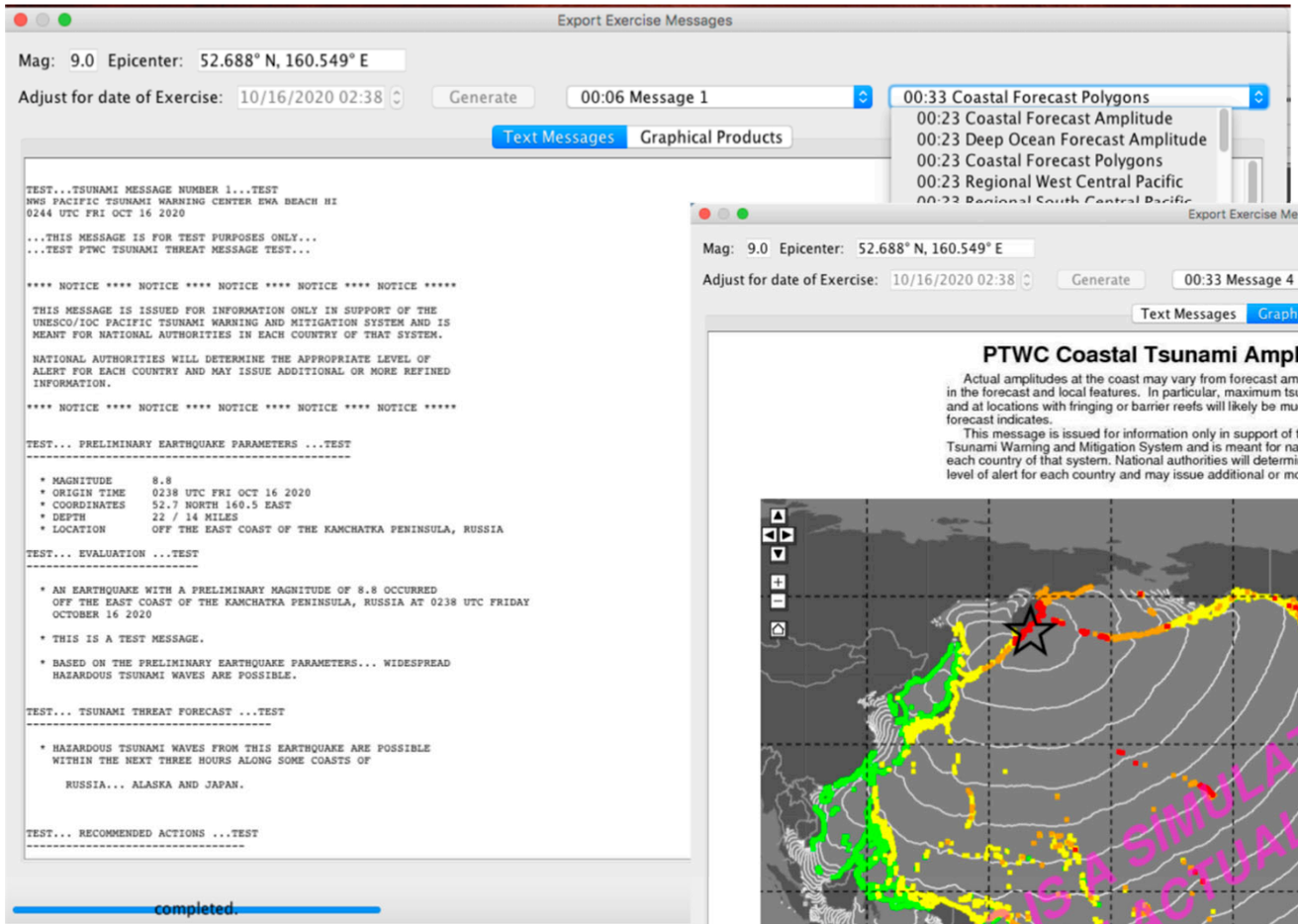
- **Evacuation map**
- **NCEI runup data**

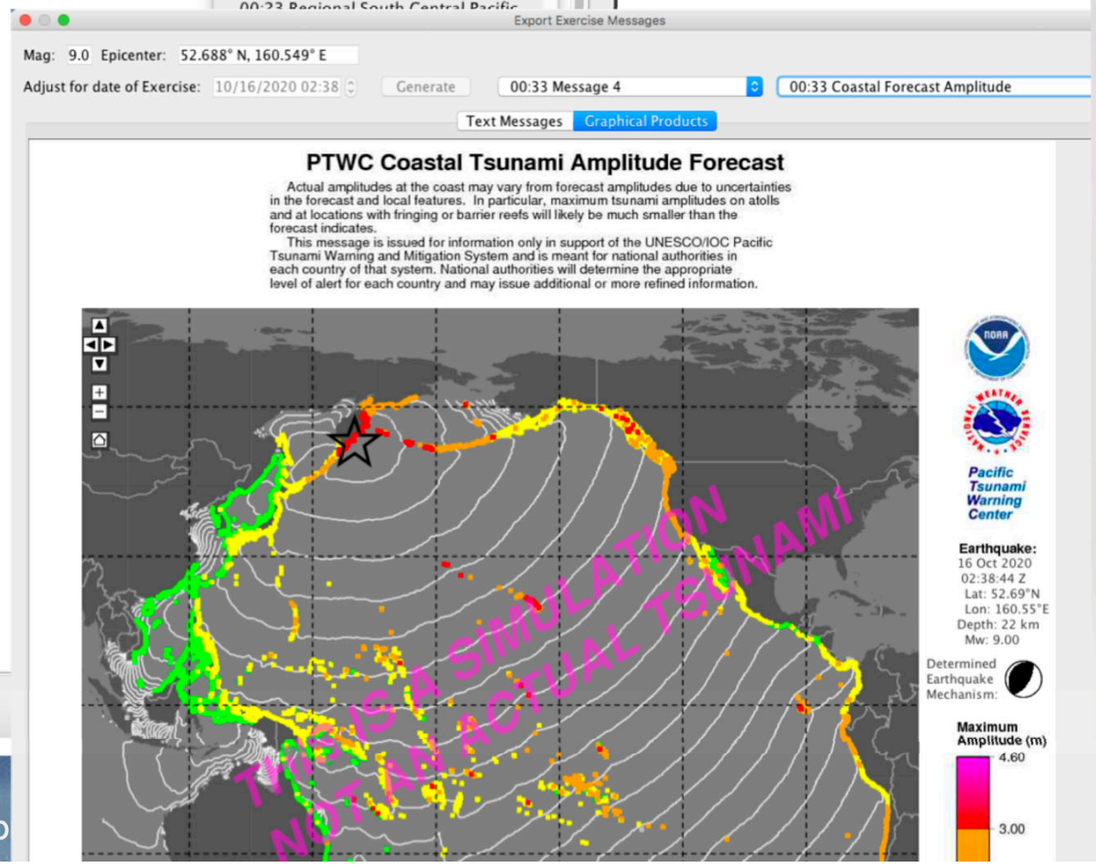
Uses: Generate Exercise messages with Injects

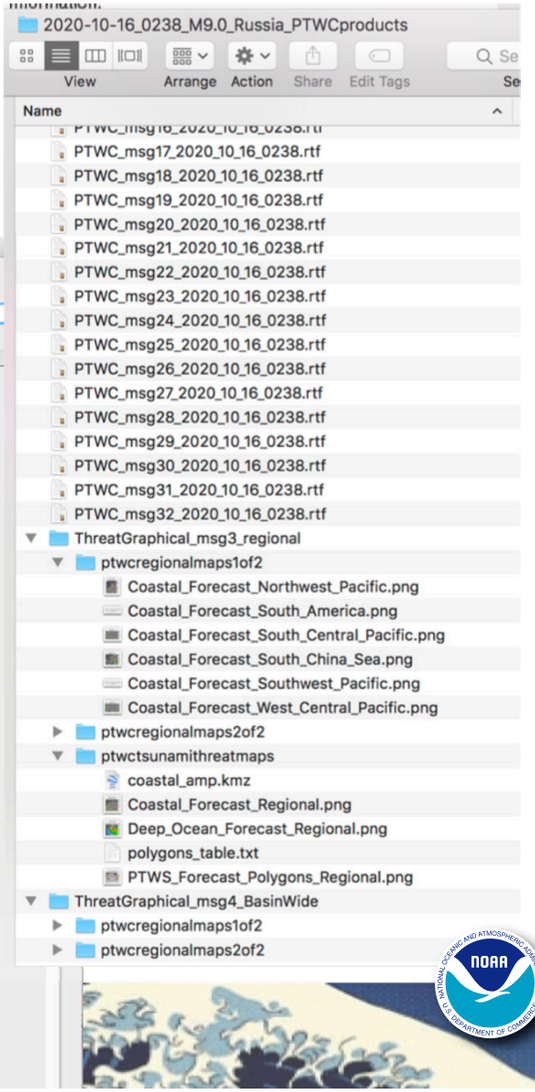
- **PTWC Public Text and Enhanced Products for events in TsuCAT pre-computed Pacific and Caribbean database**
- **Situational Injects for responding to based on selected scenario**
- **Password: genr8mess**
- **Select Menu - "Export Exercise Messages"**
  - Set Event (historical database or by mouse, origin time, magnitude)
  - Choose 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

1957 Kamchatka M9.0



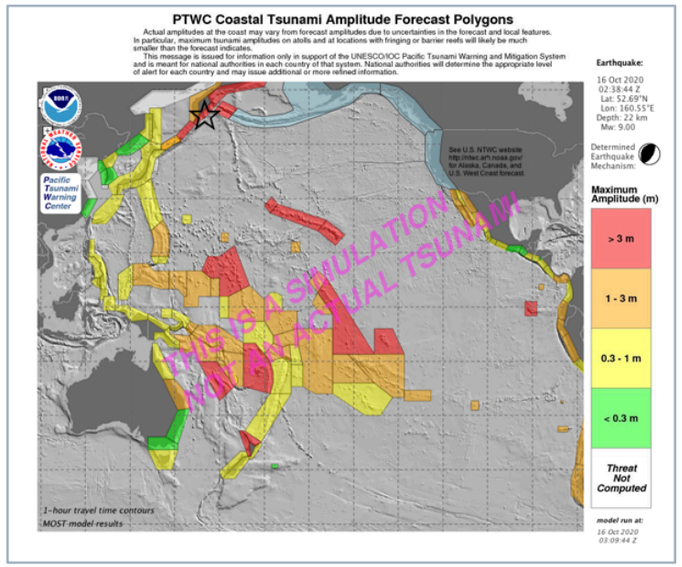


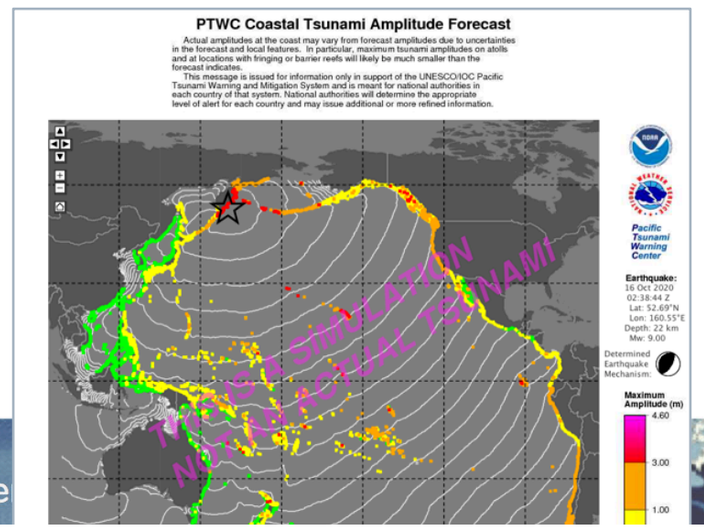


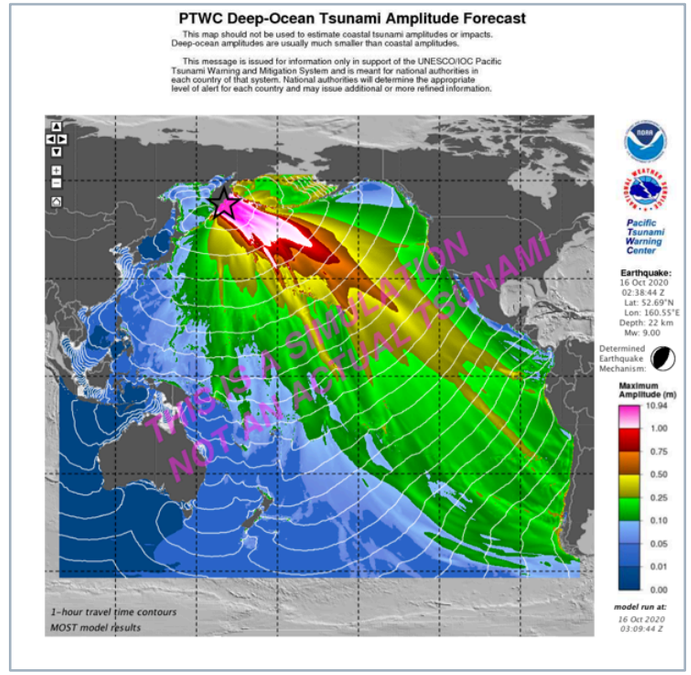
PTWC Messages – THIS IS A SIMULATION NOT AN ACTUAL TSUNAMI

1957 Kamchatka M9.0

```
TEST...TSUNAMI MESSAGE NUMBER 31...TEST
NWS PACIFIC TSUNAMI WARNING CENTER EWA BEACH HI
0500 UTC WED APR 3 2019

...THIS MESSAGE IS FOR TEST PURPOSES ONLY...
...TEST PTWC FINAL TSUNAMI THREAT MESSAGE TEST...


**** 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 APPROPRIATE LEVEL OF
 ALERT FOR EACH COUNTRY AND MAY ISSUE ADDITIONAL OR MORE REFINED
 INFORMATION.

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

THE TSUNAMI FORECAST IS UNCHANGED IN THIS MESSAGE.


TEST... PRELIMINARY EARTHQUAKE PARAMETERS ...TEST
-------------------------------------------------

  * MAGNITUDE      9.0
  * ORIGIN TIME    0000 UTC TUE APR 2 2019
  * COORDINATES    52.8 NORTH 160.1 EAST
  * DEPTH          22 / 14 MILES
  * LOCATION       OFF THE EAST COAST OF THE KAMCHATKA PENINSULA, RUSSIA

TEST... EVALUATION ...TEST
--------------------------

  * AN EARTHQUAKE WITH A PRELIMINARY MAGNITUDE OF 9.0 OCCURRED
    OFF THE EAST COAST OF THE KAMCHATKA PENINSULA, RUSSIA AT 0000 UTC TUESDAY
    APRIL 2 2019

  * THIS IS A TEST MESSAGE.

  * BASED ON ALL AVAILABLE DATA... THE TSUNAMI THREAT FROM
    THIS EARTHQUAKE HAS NOW PASSED.


TEST... TSUNAMI THREAT FORECAST...UPDATED ...TEST
-------------------------------------------------

  * THE TSUNAMI THREAT HAS NOW LARGELY PASSED.


TEST... RECOMMENDED ACTIONS ...TEST
-----------------------------------

  * THIS IS A TEST MESSAGE.

  * GOVERNMENT AGENCIES RESPONSIBLE FOR THREATENED COASTAL AREAS
    SHOULD TAKE ACTION TO INFORM AND INSTRUCT ANY COASTAL
```





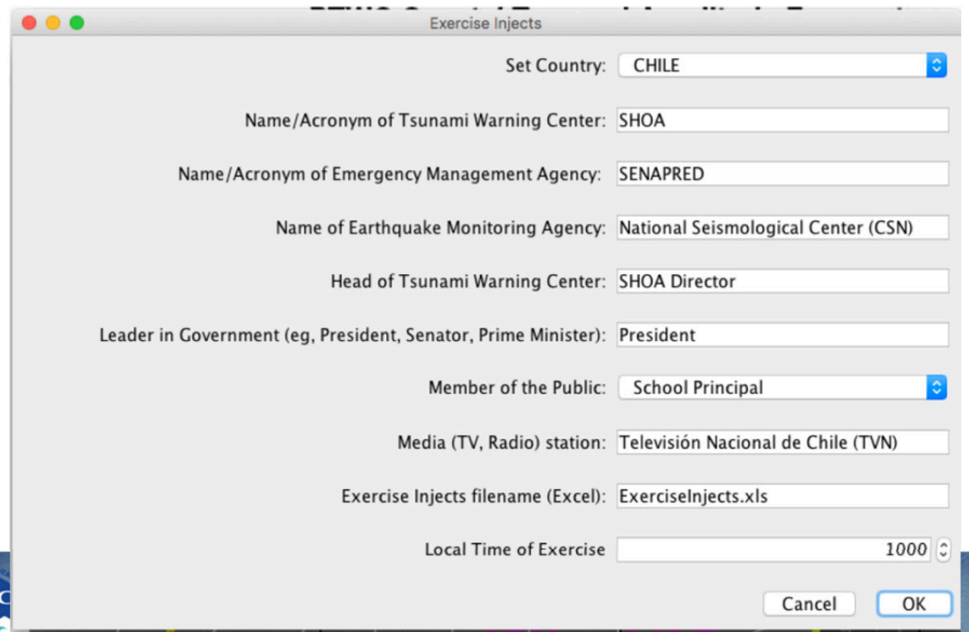



```
*** THIS IS A SIMULATION, NOT AN ACTUAL TSUNAMI ***
*** THIS IS A SIMULATION, NOT AN ACTUAL TSUNAMI ***

PTWC TABLE OF FORECAST STATISTICS FOR REGIONAL POLYGONS - RUN ID 20201016030944
(for internal use only - not for distribution)

Earthquake - Origin: 10/16/2020 02:38:44 UTC  Coordinates: 52.7N 160.5E  Depth: 022km  Magnitude: 9.0

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.
```

	Coastal Forecast (meters)				Offshore Forecast (meters)				Total
Region_Name	Maximum	Mean	Median	STD	Maximum	Mean	Median	STD	Points
Pacific_Coast_of_Kamchatka_Russia	28.03	17.03	21.31	7.55	4.68	2.93	3.58	1.29	157
Komandorsky_Islands_Russia	11.03	5.96	2.86	4.00	1.91	1.01	0.46	0.69	38
Bering_Sea_Coast_of_Eastern_Russia	8.92	2.37	2.41	1.03	1.44	0.40	0.41	0.17	264
Kuril_Islands_Russia	6.16	1.42	0.87	1.35	1.08	0.25	0.15	0.24	94
Hawaii	4.86	2.53	2.01	1.14	0.81	0.42	0.34	0.19	147
Line_Islands_Kiribati	4.51	2.18	1.13	1.65	0.74	0.35	0.16	0.28	3
Marquesas_Islands	4.38	1.74	1.66	0.63	0.53	0.27	0.26	0.07	24
Galapagos_Islands	4.32	1.97	1.77	0.71	0.76	0.33	0.30	0.12	94
Midway_Island	3.79	3.24	3.39	0.41	0.54	0.51	0.54	0.06	13
Northwestern_Hawaiian_Islands	3.60	2.52	2.36	0.81	0.61	0.41	0.36	0.13	5
Vanuatu	2.98	0.58	0.52	0.28	0.40	0.10	0.09	0.04	188
Vanuatu: Tafea	2.98	0.51	0.45	0.41	0.40	0.09	0.08	0.05	38
Society_Islands	2.81	0.85	0.82	0.38	0.33	0.13	0.13	0.04	35
South_Central_Chile	2.74	1.53	1.40	0.34	0.46	0.27	0.25	0.06	156
Southern_Chile	2.74	1.48	1.51	0.54	0.46	0.25	0.26	0.09	349
New_Caledonia	2.68	0.41	0.40	0.27	0.30	0.07	0.07	0.04	153
Palmyra_Island	2.63	2.63	2.63	0.00	0.42	0.42	0.42	0.00	1

Exercise Situational Injects

- Injects enable customization
- Injects are unexpected scenario questions, inquiries additional to PTWC messages
- Excel format



CHILE

Inject No	Event Time	Local Time	Event	To	From
1	0	1000	Earthquake Occurs!	All	Controller
2	2	1002	Earthquake alamrs trigger from P wave amplitudes off-scale at regional seismic network station	SHOA	Controller
3	2	1002	National Seismological Center (CSN) calculates Preliminary Earthquake Parameters:	SHOA	Controller
4	5	1005	CISN Display shows PTWC Earthquake Observatory Message, M8.5	SHOA	Controller
5	6	1006	PTWC Message 1: PTWC Tsunami Threat Message Initial M8.5	SHOA	PTWC
6	7	1007	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?	SHOA, SENAPRED	Coastal Resident
7	16	1016	Many coastal provinces and local governments hear media reports that PTWC is forecasting waves more than 2.3-meters. A school principal calls SENAPRED: What should she do? Her school is on the beach	SHOA, SENAPRED	Controller
8	17	1017	PTWC Message 2: PTWC Tsunami Threat Message Magnitude Update M8.8	SHOA	PTWC
9	22	1022	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	SHOA, SENAPRED	Media
10	27	1027	PTWC Message 3: PTWC Tsunami Threat Message Regional M8.8	SHOA	PTWC
11	29	1029	SHOA confirms tsunami at gauge: TALCAHUANO by Tide Tool, measured 13.4 m at 0055 UTC, Wave Period 40 min	SHOA	Controller
12	30	1030	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?	SHOA	President
13	37	1037	PTWC Message 4: PTWC Tsunami Threat Message Pacific M8.8	SHOA	PTWC
14	44	1044	SHOA confirms tsunami at gauge: VALPARAISO by Tide Tool, measured 2.0 m at 0111 UTC, Wave Period 38 min	SHOA	Controller

How to use

- **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, set password (unique to user)
  - Default is 'No Internet'
  - With Internet, will
    - Seek updates EQ &Tsunami database files (not needed often)
    - Use additional online map databases (more detailed but requires bandwidth
  - Enter 'start' password, Set 'personal' password. 'start' = Inund8ed
  - For exercise messages/injects tool, password = genr8mess

Summary Information

- **2018-23 improvements (v3 and v4):**
  - 2018 (v3.0) – security, global bathymetric DB (remove seam), higher-resolution SIFT/RIFT runs
  - 2019 (v4.0) - PTWC messages (text and enhanced graphical products) so countries able to conduct exercises on their own)
  - 2019 - 2023 (v4.x) – Include Scenarios from Expert Meetings (Caribbean, Pacific); input addtl data layers (such as ComMIT layer/inundation); Exercise situational Injects
- **Information, questions, feedback:**

  Web site http://itic.ioc-unesco.org/index.php?option=com_content&view=category&layout=blog&id=2239&Itemid=2763

  Email ITIC, NCTR:

  itic.tsunami@noaa.gov, laura.kong@noaa.gov
  Christopher.Moore@noaa.go

UNESCO IOC – NOAA International Tsunami Information Center (ITIC)
NOAA Pacific Environmental Laboratory,
NOAA Center for Tsunami Research (PMEL/NCTR)
Pacific Tsunami Warning Center (PTWC)

Thank You

Christopher Moore, NOAA Center for Tsunami Research (NCTR)
Dr. Laura Kong, ITIC
Dr. Charles McCreery, PTWC

TsuCAT hands-on activity

- **Open TsuCAT, set your password**
- **Explore TsuCAT features**
  1. Understand user preferences. Setting Coastal Hazard Guidance ranges.
  2. Selection and variation of source using menu and mouse
  3. PTWC polygons and Customized polygons
  4. Understand what is (and what is not) in regional reports
- **Hazard Assessment – Country response planning**
  1. Create a summary of what distant or regional source region is most hazardous to your country
- **Tsunami Warning – Country TWC Warning Criteria**

  Based on the database assessment and your country's warning criteria, what will you place your country in for the following:
  1. MX1 earthquake in Y1 trench (or off Z1 country)
  2. MX2 earthquake in Y2 trench (of off Z2 country)
- **Generate PTWC messages for exercise** - Choose scenario, create messages

How to obtain / update

- **If you have older version, request Flash Drive with entire software loaded (28 GB). Send request to** laura.kong@noaa.gov

  Recommended since it will be clean installation.

  You may run it from the flash drive or copy folder to hard drive

  You may not need administrator privileges to load

- **If you have v4.0 - 4.2, you can download v4.3 executable and other data files from PMEL server (or request Flash Drive).**
  More info, contact: laura.kong@noaa.gov, christopher.moore@noaa.gov

  URL: https://sift.pmel.noaa.gov/ComMIT/TsuCAT/software

  User: tsucat Password: Inund8ed

  Place in your existing TsuCAT folder

  On startup, will automatically download additional source files

  You may need administrator privileges to download/load