Keeping Authorities Informed:
Available TW Decision Support Tools
Earthquakes, Sea Level, Historical Events, Travel Times, Hazard Assessment
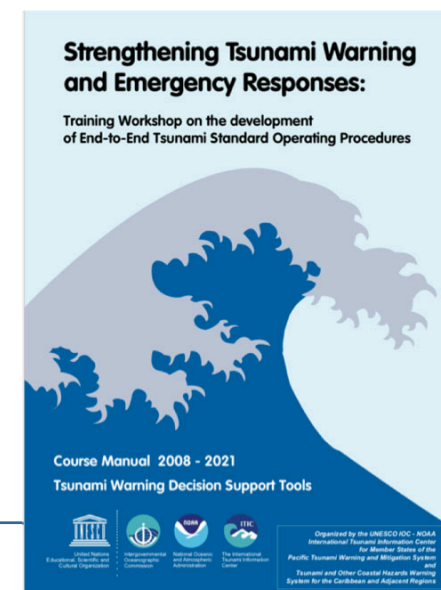
Strengthening Tsunami Warning and Emergency Responses:

Training Workshop on the development of End-to-End Tsunami Standard Operating Procedures

Course Manual 2008 - 2021
Tsunami Warning Decision Support Tools

Laura Kong

UNESCO/IOC – NOAA International Tsunami Information Center

ITIC, IOC, USGS, PTWC, NCEI, WDS-Geophysics, RANET, PMEL/NCTR

# Tsunami Warning Decision Support Tools
ITIC distributed, supported

- ~~**Heads-up SMS TW Alert Bull Board**~~ ~~(NOAA USAID RANET, ITIC, PTWC, 2005-2014)~~

- **Tsunami Bull Board** (ITIC, 1995) ~500 science/tsu/govt – email to itic.tsunami@noaa.gov

- **Real time EQ Display** (v1.72, EQ Observatory msg (CISN, USGSNTHMP, 2005), ~350

- **Real-time Sea Level monitoring**
  - Tide Tool v10.68 – TWC operations monitoring (PTWC, 2005)
  - IOC Sea Level Monitoring web site (IOC, 2008)

- **Tsunami Travel Time Software** SDK 4.0.1 (ITIC, NCEI, 2007)

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

- **Tsunami Hazard Assessment Tools (2017)**
  - ComMIT/MOST inundation modeling (PMEL, 2000, support evac maps 2015)
    - *OTGA TEMPP planned as hybrid 2022-2023*
  - Tsunami Coastal Assessment Tool v4.2 Oct 2020 (TsuCAT, PMEL, ITIC)
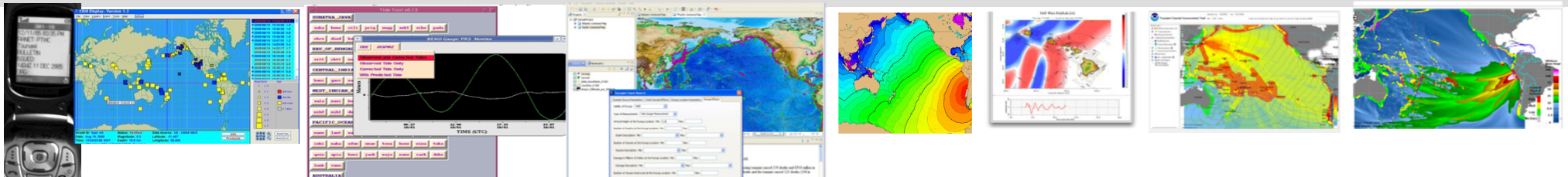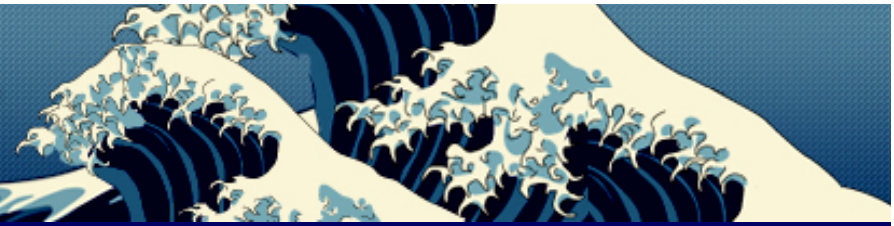
Tsunami Bulletin Board

Email List-serve, Currently, ~500 (March 2021)

Membership: Scientists, Tsunami prof, govt, NO MEDIA - NO PUBLIC

Features
1. Immediate delivery
2. No censureship
3. Forum for sharing science and early results - NOT peer-reviewed
4. PTWC, US NTWC tsunami messages

Contact: itic.tsunami@noaa.gov

Real-Time Earthquake Display and Alert System (CISN)

- **Internet**
- **Passive (automatic receive)**
- **Multi-platform**
- **EQ broadcast**
- **Alert system (SMS, email)**
- **GIS layers**
- **Tsunami Warning msgs**

Sign-up - Contact: itic.tsunami@noaa.gov

CISN Display, Version 1.64

File   View   Layers   Event   Tools   Help   Settings
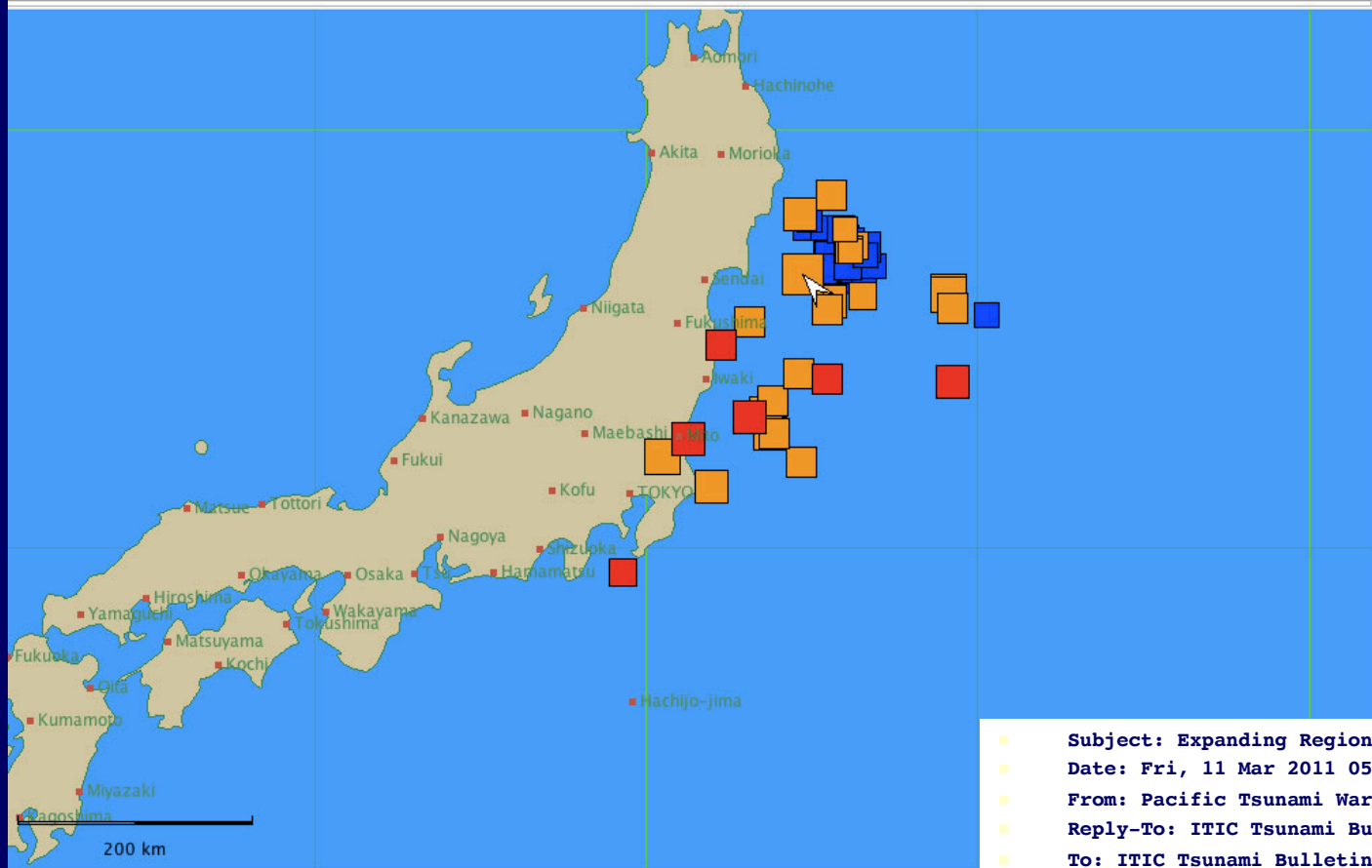
Date/Time ▲	M
T 2011/03/11 05:46:23	7.9
2011/03/11 05:46:23	8.9
2011/03/11 06:06:11	6.4
2011/03/11 06:07:21	6.4
2011/03/11 06:15:45	6.8
2011/03/11 06:25:50	7.1
2011/03/11 06:25:51	7.1
2011/03/11 06:48:47	6.3
2011/03/11 06:57:14	6.3
2011/03/11 07:10:59	5.8
2011/03/11 07:13:47	5.9
2011/03/11 07:14:59	6.3
2011/03/11 07:25:33	6.1
2011/03/11 07:28:12	6.1
2011/03/11 07:38:26	5.9
2011/03/11 07:42:55	5.8
2011/03/11 07:54:44	5.7
2011/03/11 07:56:15	5.6
2011/03/11 08:01:58	5.9
2011/03/11 08:10:47	5.4
2011/03/11 08:12:04	6.2
2011/03/11 08:15:40	6.2

Magnitude		Age	
▪	≥ 0		last hour
▪	≥ 1		≥ 1 hour
■	≥ 2		≥ 1 day
■	≥ 3		≥ 2 days

Event ID: c0001xgp vA   Status: Unverified   Data Source: US – USGS NEIC
Date: Mar 11, 2011   Magnitude: 8.9   Latitude: 38.322
Time: 05:46:23.70 GMT   Depth: 24.4 km   Longitude: 142.369
Note: 130 km E of Sendai, Honshu, Japan

Notice: Earthquake data may be preliminary ar

CISN: 11 March 2011

Subject: Expanding Regional Warning – Initial
Date: Fri, 11 Mar 2011 05:56:02 +0000 (GMT)
From: Pacific Tsunami Warning Center <ptwc@ptwc.noaa.gov>
Reply-To: ITIC Tsunami Bulletin Board <tsunami_bb@infolist.nws.noaa.gov>
To: ITIC Tsunami Bulletin Board <tsunami_bb@infolist.nws.noaa.gov>

ITIC Tsunami Bulletin Board
TSUNAMI BULLETIN NUMBER 001
PACIFIC TSUNAMI WARNING CENTER/NOAA/NWS
ISSUED AT 0555Z 11 MAR 2011

THIS BULLETIN APPLIES TO AREAS WITHIN AND BORDERING THE PACIFIC
OCEAN AND ADJACENT SEAS...EXCEPT ALASKA...BRITISH COLUMBIA...
WASHINGTON...OREGON AND CALIFORNIA.

... A TSUNAMI WARNING AND WATCH ARE IN EFFECT ...

A TSUNAMI WARNING IS IN EFFECT FOR

 JAPAN / RUSSIA / MARCUS IS. / N. MARIANAS

TideTool - Interactive Sea Level Monitoring
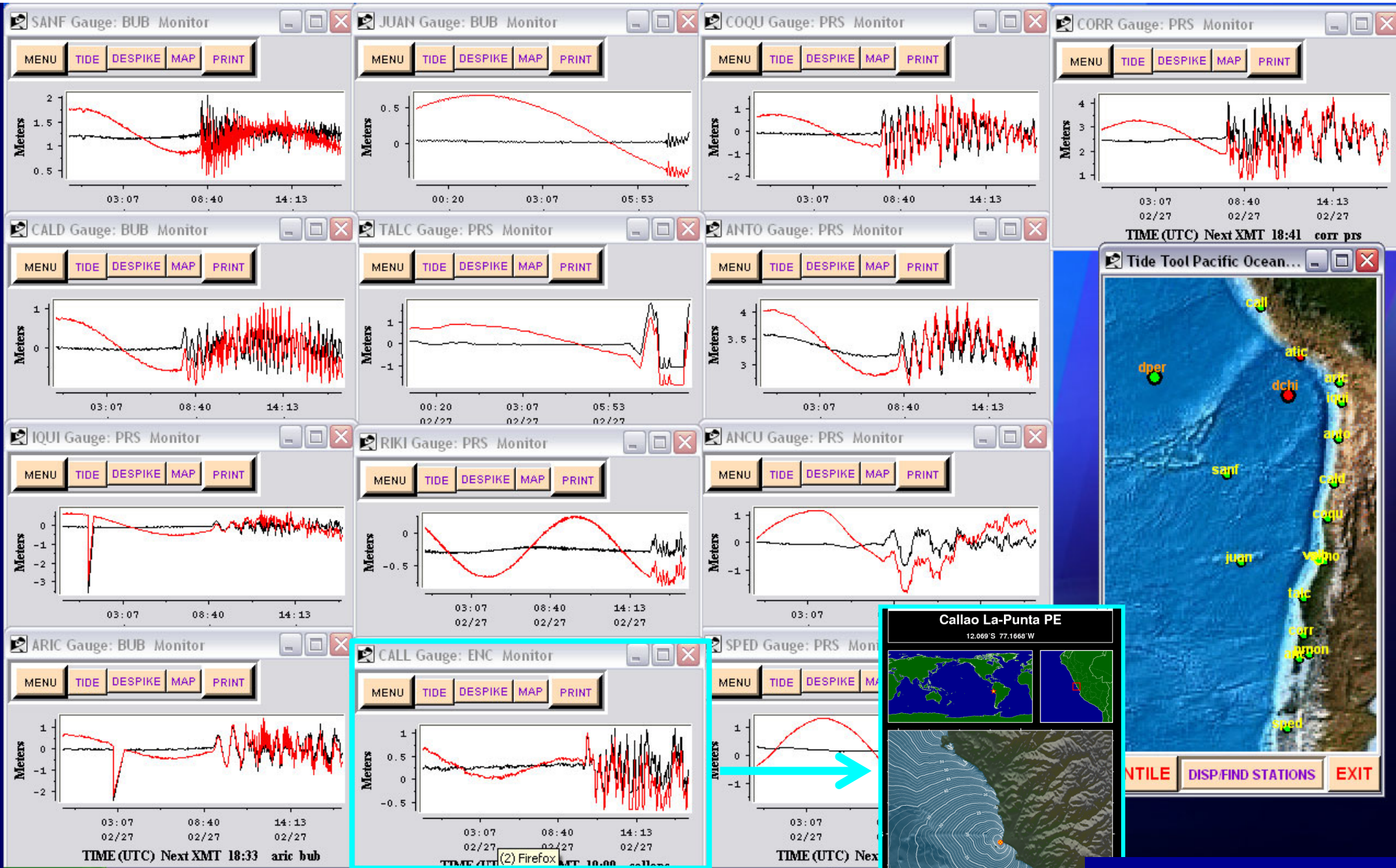## *(OPERATIONAL Tool for Tsunami Warning Centres)*

- **PTWC-received sea level stations** (GLOSS, non-GLOSS)

- **Decode, Display, Manipulate** (expand, measure period/amplitude) satellite-transmitted sea level data

- **Open-source** shell programming, graphics (Tcl/Tk, BLT extension), PC, Linux, Unix

- **Continuously decodes:** expand time series, remove tide, pick amplitude, metadata, msg Downloads data from GTS (Met Svc) Also by ftp from NOAA NWS gateway

- **Runs locally (data, software)**

- **Dynamic, interactive, customize**

Data transmission path
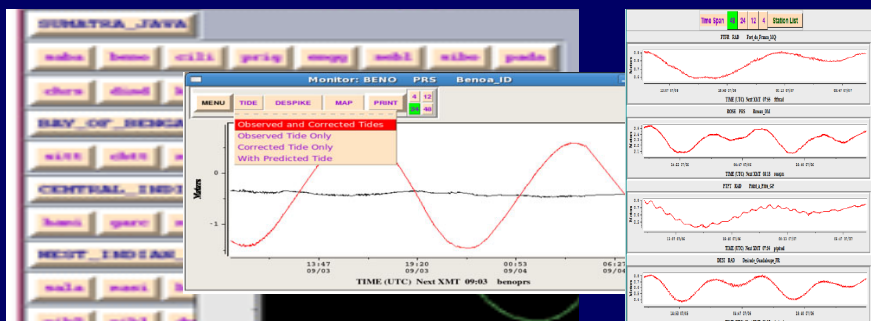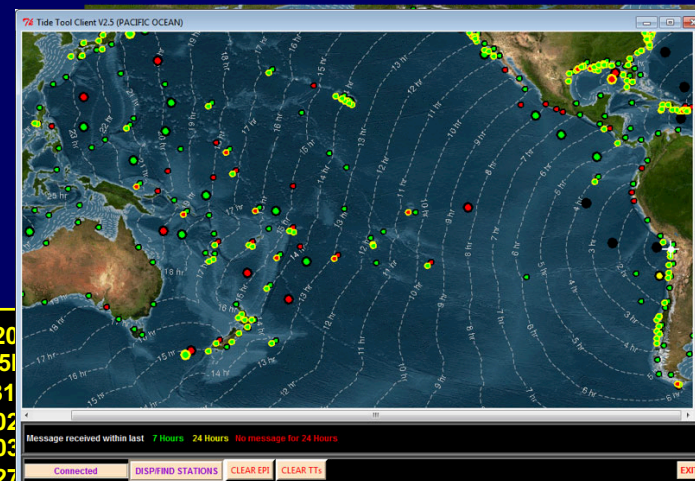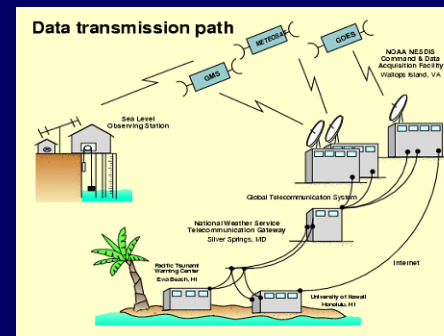
```
91642 46/// /1205 10296 40080 2220
555 77744 A0102 516`3 60029 6315
24520 2400A 13025 90036 00297 31
B2102 37103 100A2 50266 50330 02
8318B 33022 92026 00A37 02736 03
00299 319B4 50222 50230 0A490 27
20380 02983 19B57 02163 03200 BV289 134S1 41249 C0501 22080 00070 23677 44777=
```

Contact: stuart.weinstein@noaa.gov, laura.kong@noaa.gov

Pisagua, Chile
3.3 m Peak-to-Trough
~10 min period

Iquique, Chile
4.4 m Peak-to-Trough
~18 min period

TTT to Iquique, Chile

Tide Tool: 1 April 2014

Tide Tool: 27 February 2010

TTT to Callao, Peru

8

IOC Sea Level Monitoring Facility
http://www.ioc-sealevelmonitoring.org/map.php

- **Global Monitoring** of satellite-transmitted data (Station health)

- Easy-to-use Web tool (runs in Belgium, not locally) Uses Internet (could become clogged during real event)

- **Continuously downloads to site:** from GTS and other sites

- **Continuously decodes:** displays / expand time series, station metadata, messages

- **Data download** manually

9
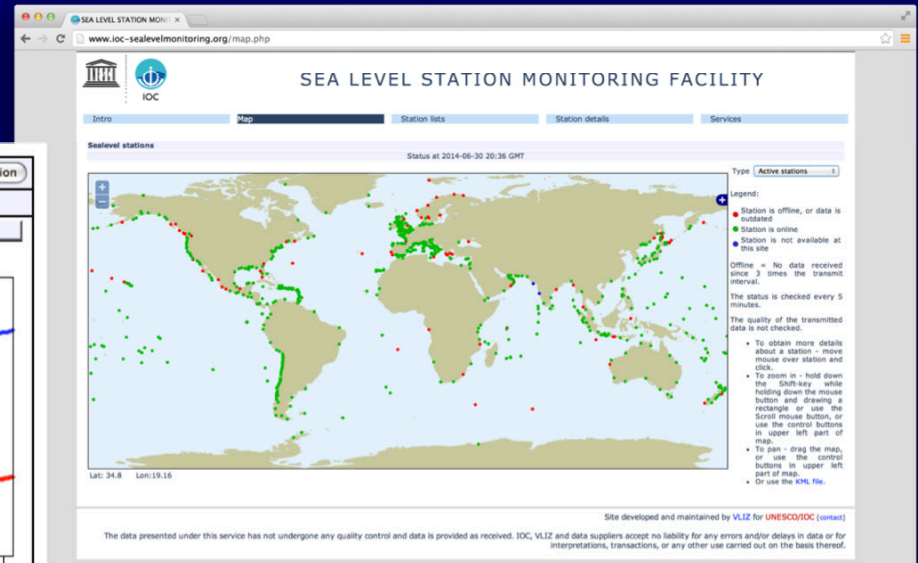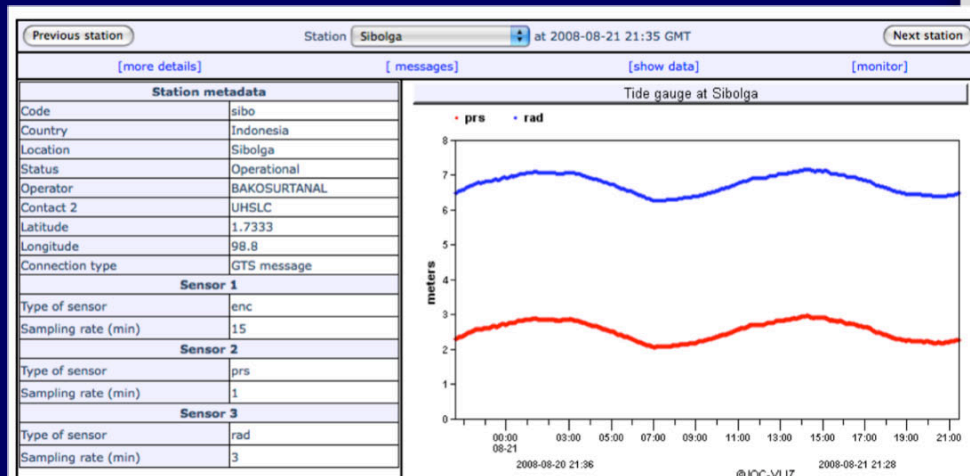
Global Historical Databases

- **WDS-Geophysics/NCEI**
  online - Web online
  offline – TsuDig (2009)
- **ITDB** – Russia
  offline (1990s)

Features:

- **GIS display**
- **EQ, Tsunamis, Run-ups**
- **Seismic, Sea Level networks**
- **Event sorting**
- **Travel Times**

Contact: itic.tsunami@noaa.gov
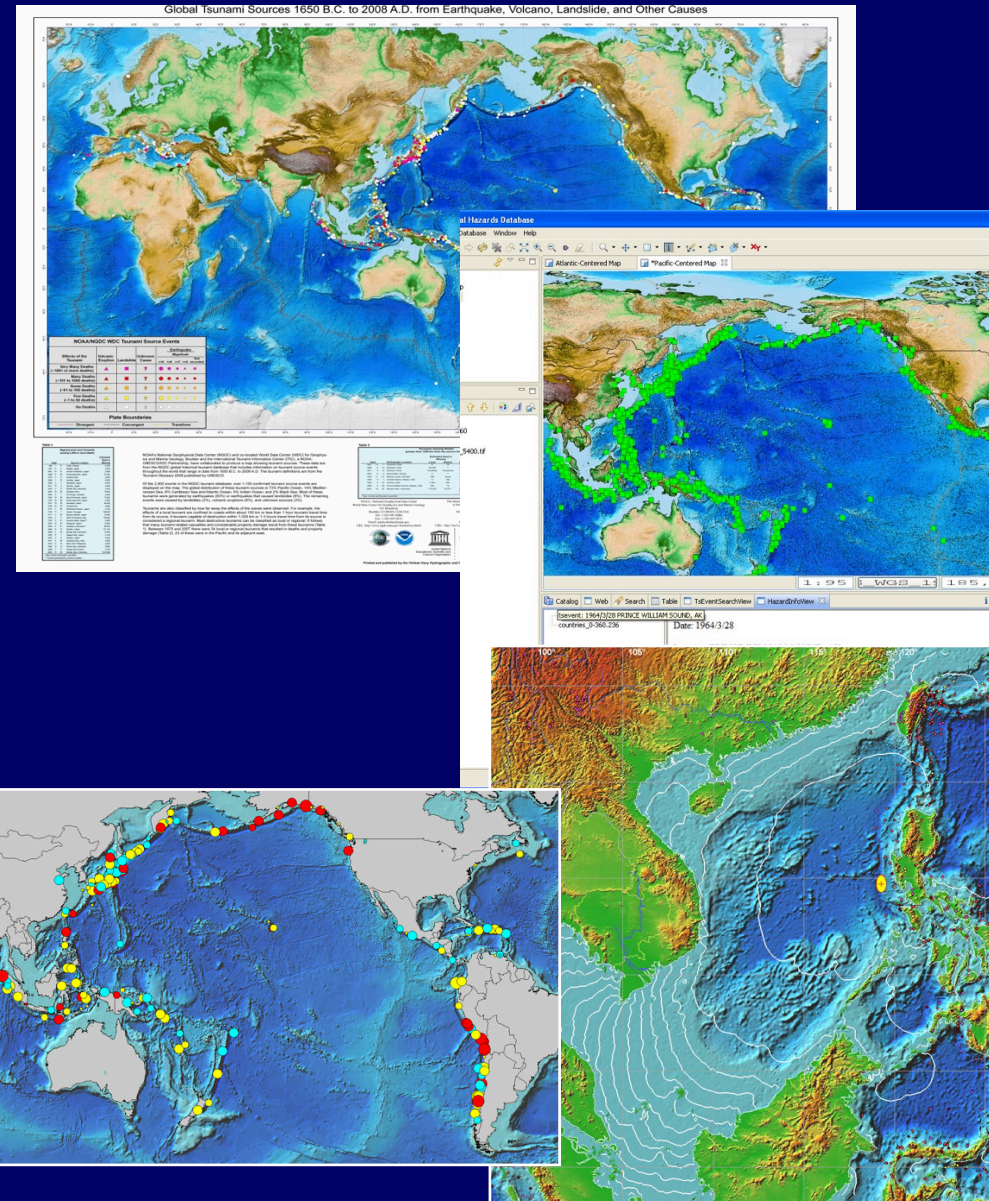
Tsunami Travel Time Calculation and Map Display

- **PC-Windows, Linux, Unix, Mac OSX**
- **Calculation**
- **Map display (GMT)**
- **Used by PTWC**
- **Examples, Simple scripts**
- **Accuracy on bathymetry Etopo1 (1-min) and coarser grids**
- **Available to TWFP / govt agencies**
- **TTT GUI for easy use (2021)**
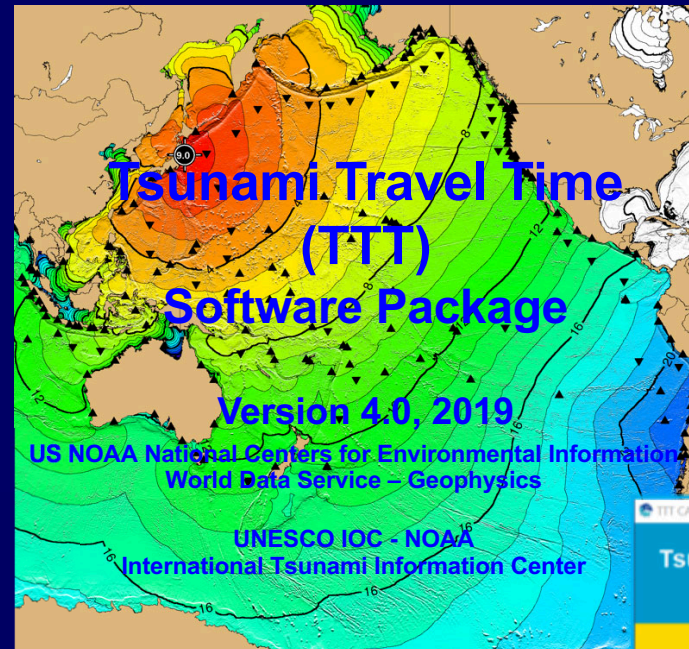
Contact: paula.dunbar@noaa.gov, laura.kong@noaa.gov

Tsunami Travel Time (TTT) Software Package

Version 4.0, 2019

US NOAA National Centers for Environmental Information
World Data Service – Geophysics

UNESCO IOC - NOAA
International Tsunami Information Center

Tsunami Travel Time Calculator

Input information stored in TTT_Input.txt
Output stored in C:\TTT Package\Examples

Please Enter Title You Would Like For Map:	Pago Pago
Source Latitude (decimal degrees, N(+), S(-)):	-14.33333
Source Longitude (decimal degrees, E(+), W(-)):	-170.71667
Please Select Region the Ocean Event is Occurring in:	Pacific
Pacific Ocean Selected, Please Select Zoomed PO Region to Plot:	SW Pacific

Please Note: Output times at locations arrival times are calculated correctly only for events years 1970-2038)

Select What You Would Like Outputted	Tsunami Travel Time

Select bathymetry grid file to use, 15min recommended for fast run.

Options are (arc min): 60, 30, 20, 15, 10, 5, 2, 1:	20
Plot Sea Level Stations?	Yes
Plot Historical Earthquakes? (Centennial List)	No

Reset Inputs   Generate Image

12

Tsunami Coastal Assessment Tool
TsuCAT

Christopher Moore, Dr. Diego Arcas, Marie Eble
NOAA Center for Tsunami Research (NCTR)

Dr. Laura Kong
ITIC

Dr. Charles McCreery
PTWC

TsuCAT v4.2, Oct 2020

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
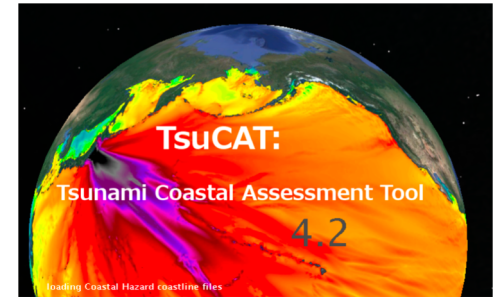
TsuCAT: Coastal Impact DB Tool

Deep-Ocean Offshore Max Ampl – Historical seismicity
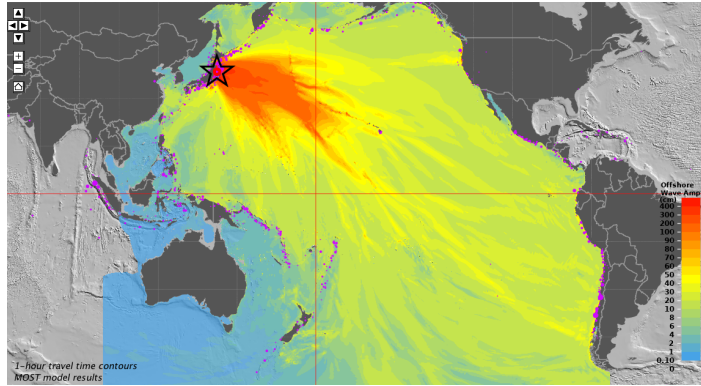
Coastal Hazard Guidance Ampl (CHG)
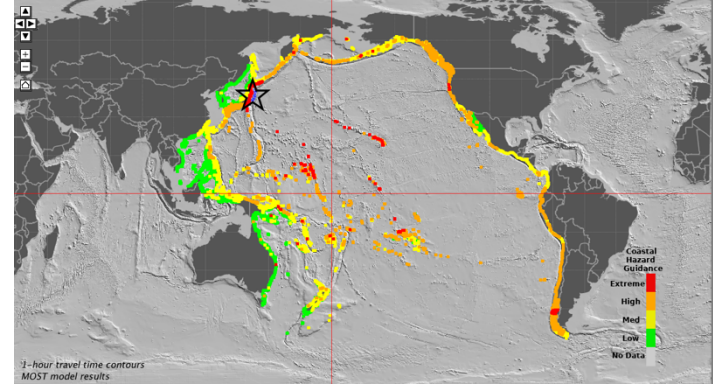
Offshore – CHG – Tsunami Travel Times (TTT)
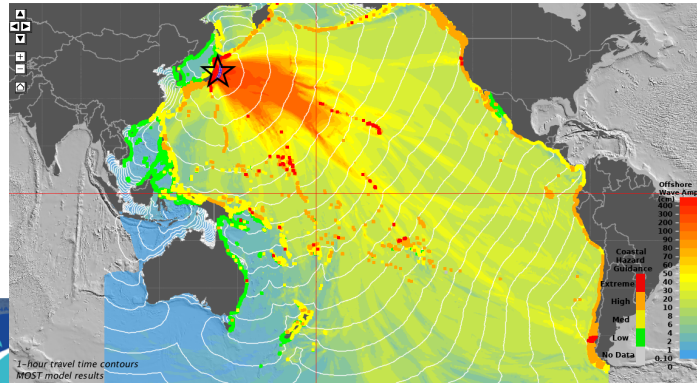
PTWC Coastal Polygons – TTT
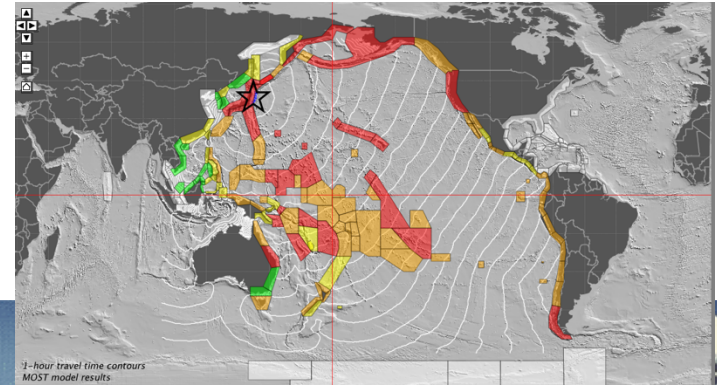
TsuCAT – Generate Exercise messages

☐ **PTWC Public Text and Enhanced Products for events in TsuCAT pre-computed database**

☐ **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 Exercise Messages – 1957 Kamchatka M9.0

A NATIONAL TWC SOP

1. **RECEIVE EQ INFO**
   - *RTED / CISN, Tsunami Bull Board* - *Tsunami Service Providers (PTWC, JMA, IOTWMS TSP, others)*
   - *National alarm (seismic network), Feel shaking, Phone call*
2. **IF LARGE EQ, THEN QUICKLY ISSUE TSUNAMI MESSAGE**
3. **DETERMINE WHEN TSUNAMI WILL ARRIVE (automate)**
   - *TTT (sea level stations, towns), PTWC message, TsuCAT, TsuDig*
   - *National Tsunami DB (gives arrival times)*
4. **DETERMINE HISTORICAL TSU HAZARD – QUERY DB**
   - *Tsunami Historical Database (online, offline), TsuCAT*
   - *National Tsunami TB*
   - *Pre-computed National Inundation Scenarios, Real-time forecast*
5. **MONITOR SEA LEVEL STATIONS TO CONFIRM TSUNAMI**
   - *Tide Tool, IOC Sea Level Monitoring Facility*
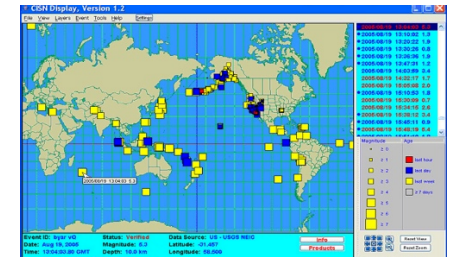   - *National Sea Level network*
6. **RECEIVE / ISSUE MORE INFO (update EQ/forecast, observ), INFORM MEDIA**
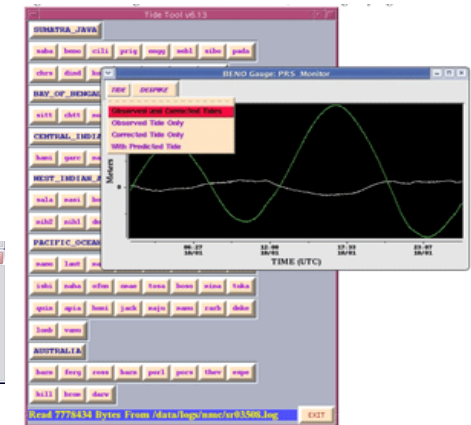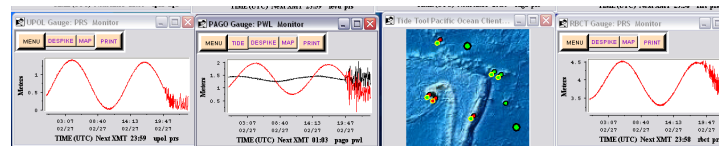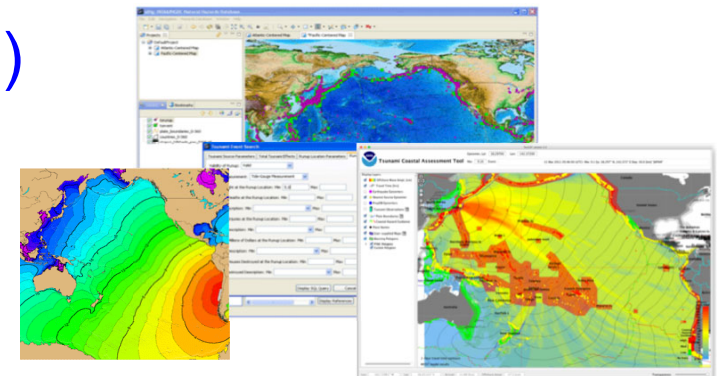7. **CANCEL WHEN NO DAMAGING TSUNAMI WAVES**

- Real time Earthquake Display / California Integrated Seismic Display (USGS) (real-time)

- **Sea Level monitoring (real-time)**
  - **Tide Tool – TWC sea level monitor (PTWC)**

- Tsunami Historical Database (NCEI, ITIC)
  - **Online – NCEI**
  - **Offline – TTT, TsuDig**
    TsuCAT scenario database

Thank You

Laura Kong

UNESCO/IOC – NOAA International Tsunami Information Center

ITIC, IOC, USGS, PTWC, NCEI, WDS-Geophysics, RANET, PMEL