# Tsunami Hazards and Preparedness in Ventura County




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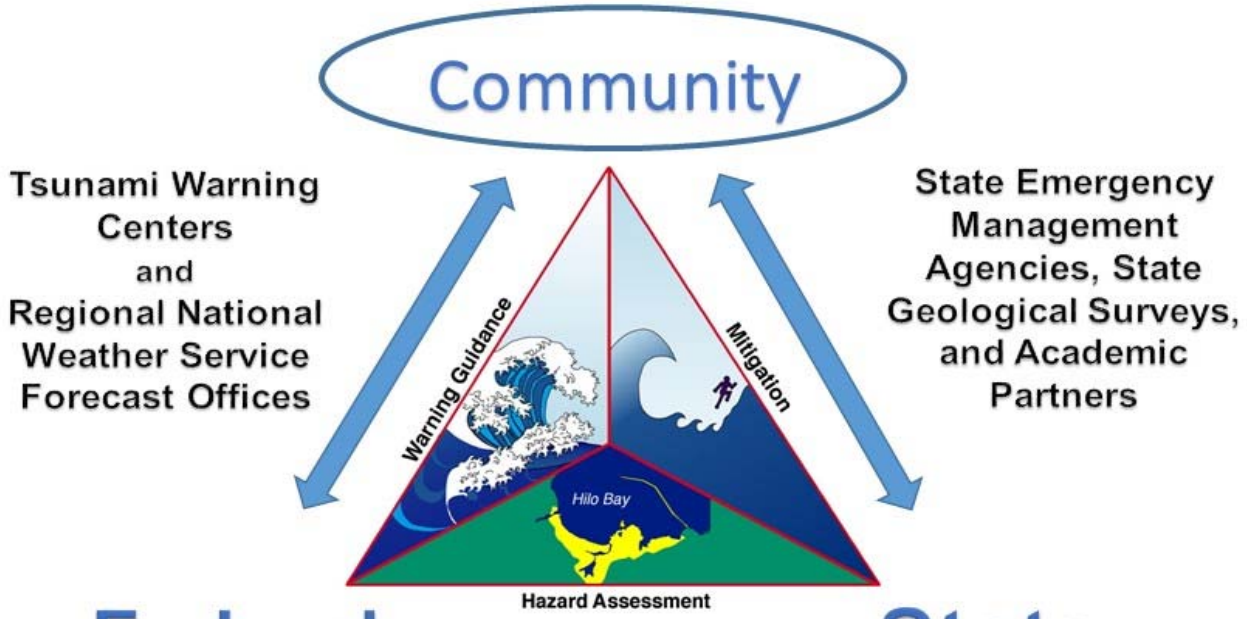
**Partners =**

# U.S. National Tsunami Hazard Mitigation Program




**National Tsunami Hazard Mitigation Program**

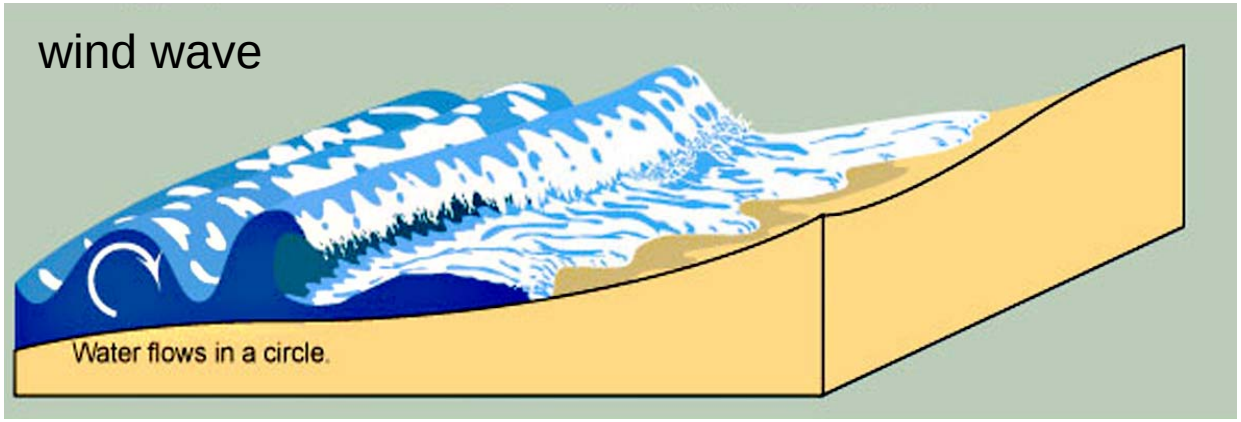
Coordinating Committee
Mapping and Modeling Subcommittee
Mitigation and Education Subcommittee
Warning Coordination Subcommittee

Search “NTHMP tsunami program”

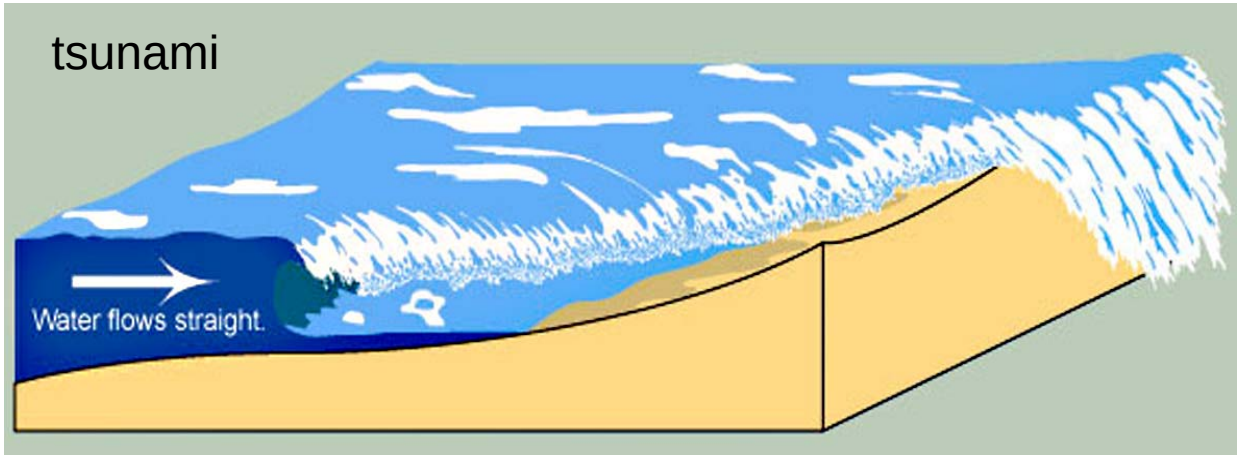
**California Tsunami Hazard Mitigation and Preparedness Program**

CalOES, CGS, National Weather Service (NOAA), with Tsunami Steering Committee of 20 county emergency managers and various government agency representatives

# What is a tsunami?




Curling, breaking waves, water flows in for less than a minute




Very long surges, water flows in for tens of minutes

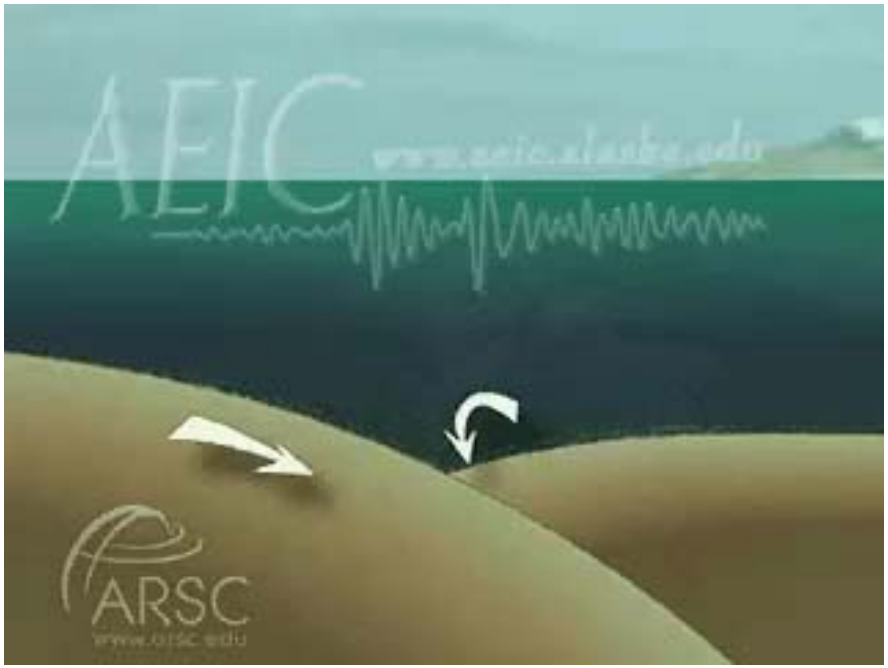
# Other tsunami facts….

- **A tsunami always has many waves**
- **This first wave is almost never the largest**
- **The danger period can last 24 hours or more!**
  **(like the March 11, 2011 tsunami in California)**

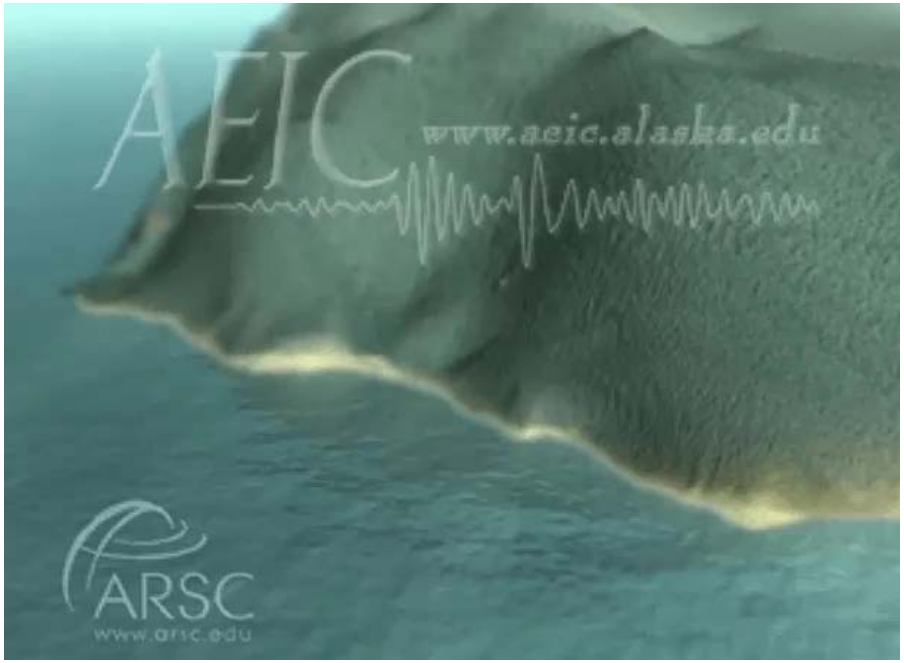
*Third surge arriving at Ko Phi Thailand, December 26 2004*

# What causes a tsunami?

**Submarine faults**




**Submarine/Subaerial landslides**



**March 11, 2011 Tohoku-oki tsunami**
**Location: Sendai Plain, Japan - Tsunami arrives one hour after M9.0 earthquake**


Sendai Plain
Before tsunami
¼ mile
©2010 Google


Sendai Plain
After tsunami
¼ mile
©2010 Google

**Aneyoshi Bay (5 months after tsunami)**


Aneyoshi Bay
(5 months
after tsunami)

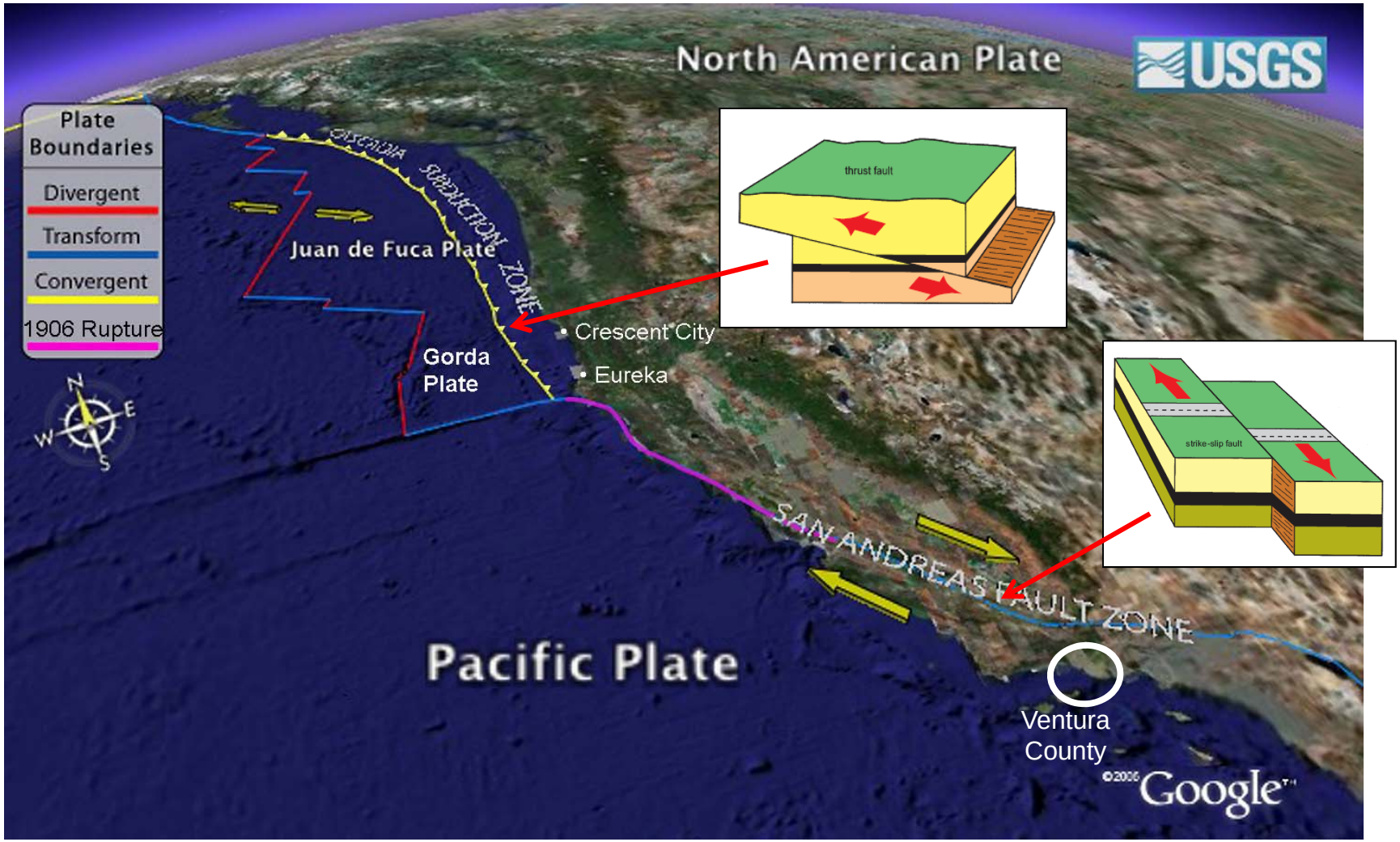
**Aneyoshi Bay (5 months after tsunami)**


Aneyoshi Bay
(5 months
after tsunami)

**Aneyoshi Bay (5 months after tsunami)**

Search “EERI Wilson 2011 Tohoku tsunami”

# California has its faults!



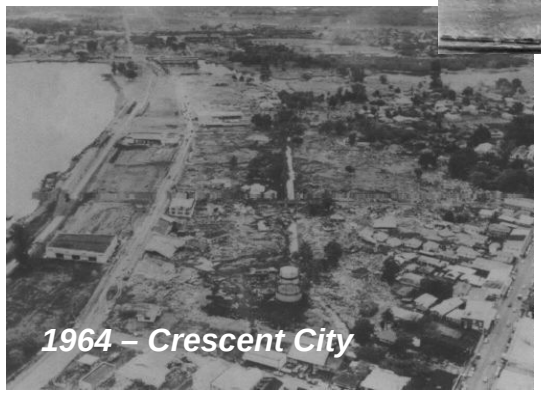
# Significant Historical Tsunamis in California

- Eight significant trans-Pacific tsunamis (1946, 1952, 1957, 1960, 1964, 2006, 2010, and 2011) over past 70 years.
- Each of these events caused damage in California, with 1946, 1960, and 1964 causing inundation.
- Local tsunami events are less common but the most significant one was 1700 Cascadia (no written US record).

Search “CGS California tsunami history”


*1946 – Half Moon Bay*


*1960 – Crescent City*


*1964 – Crescent City*

# Notable Historical Tsunamis in Ventura County

Run-up amplitude, in feet, above normal tide conditions

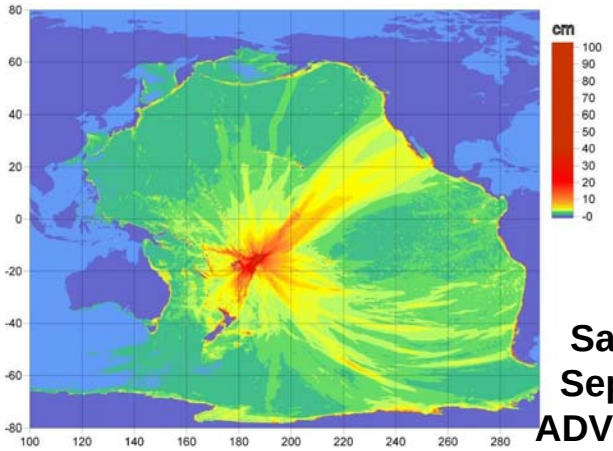
OBS = observed tsunami activity
NR = No damage or severe conditions reported

- Distant Source - Tsunamis without felt earthquakes

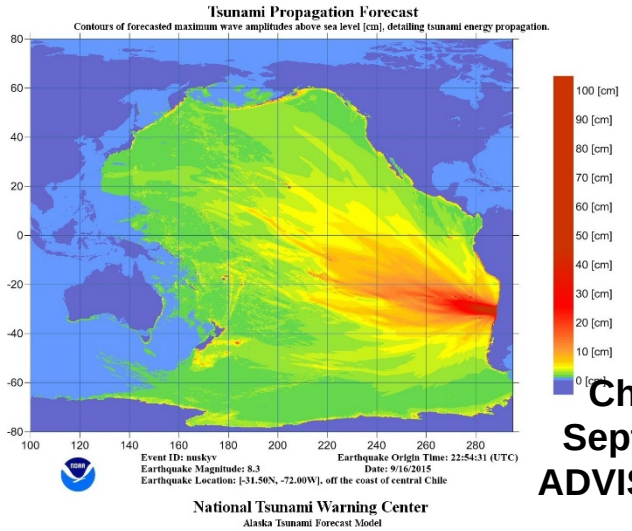
- Local Source - Earthquake and tsunami together

| Date | Magnitude-Source area | Tsunami location | Run-Up/Amp | Remarks |
|---|---|---|---|---|
| 12/21/1812 | Local M7 earthquake triggered potential submarine landslide | Ventura | 7 ft | Tsunami damage to San Miguelito Chapel |
| 4/1/1946 | M8.8 – Aleutian Islands | Ventura | OBS | Single wave to the high-water mark |
| | | Port Hueneme | 3 ft | Minor berthing problem for ship |
| | | Ormond Beach | 5ft | Sand swept over railroad tracks near beach |
| 11/4/1952 | M9.0 - Kamchatka | Port Hueneme | 2 ft | NR |
| 3/9/1957 | M8.6 - Aleutian Islands | Port Hueneme | 2 ft | High run-up occurred 6 hours after first wave |
| 3/28/1964 | M9.2 Alaska | Ventura | OBS | Tide dropped eight feet |
| | | Oxnard | OBS | Large swells reported |
| 9/29/2009 | M8.0 – Samoa | Ventura | OBS | Several buoys moved near mouth of harbor |
| 2/27/2010 | M8.8 – Chile | Ventura | 3 ft | Over 20 docks damaged ($300-500k) |
| | | Oxnard | 3 ft | Damage to docks from large boat wake |
| | | Port Hueneme | 4 ft | NR |
| 3/11/2011 | M9.0 - Japan | Ventura | 4 ft | Damage to dock and several boats ($150k) |
| | | Oxnard | 4 ft | Minor damage to docks |
| | | Port Hueneme | 5 ft | NR |

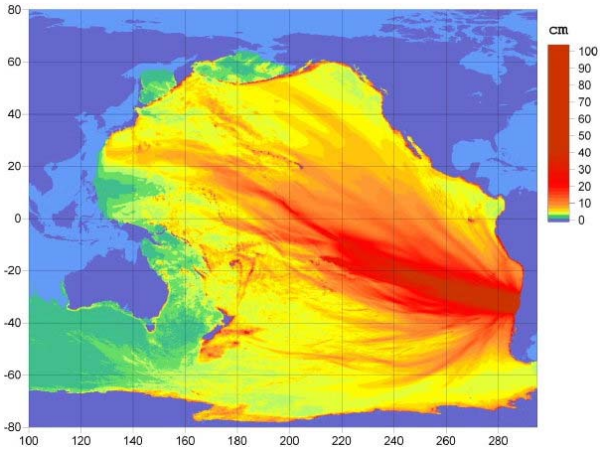
CGS CALIFORNIA GEOLOGICAL SURVEY · Cal OES GOVERNOR'S OFFICE OF EMERGENCY SERVICES · USC UNIVERSITY OF SOUTHERN CALIFORNIA · NOAA · FEMA · THE NATIONAL TSUNAMI HAZARD MITIGATION PROGRAM (U.S.)




**Samoa**
**Sept ’09**
**ADVISORY**



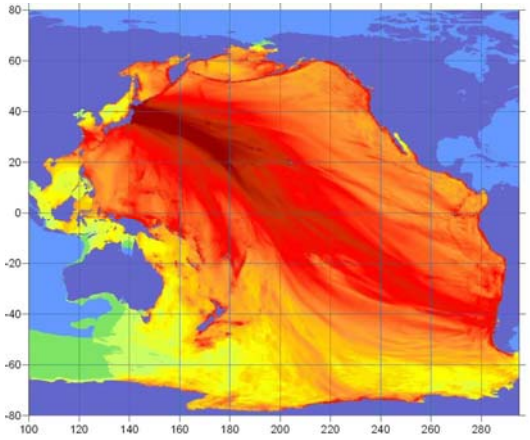

**Chile**
**Sept ’15**
**ADVISORY**

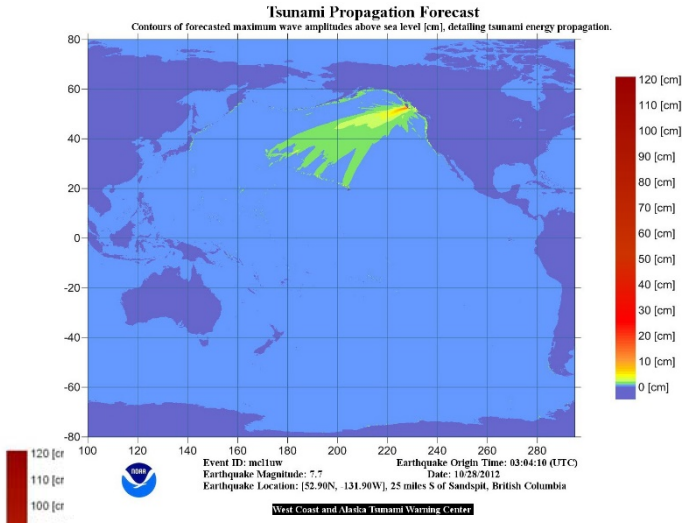



**Chile**
**Feb ’10**
**ADVISORY**

**Recent California Tsunami Advisory- and Warning-level Events**

**5 in Last 7 Years**






**British Columbia**
**Oct ’12**
**ADVISORY**

**Japan**
**March ’11**
**WARNING/ADVISORY**

# 2011 Tohoku Tsunami in California

- Large tidal fluctuations = 16 feet in Crescent City (largest surges at low tide)
- Strong currents/debris in harbors
- Potential dangerous tsunami conditions lasted for more than 24 hours.
- Impacts: one fatality; two dozen harbors damaged; Official = $50M; Total ~$100M

*March 11, 2011 Tohoku Tsunami in California; video at 11AM (about 3 hours after first arrival of tsunami) within Santa Cruz Harbor*

Search “CGS 2011 tsunami in California”

# Damage and Effects from Recent Tsunamis in Ventura County



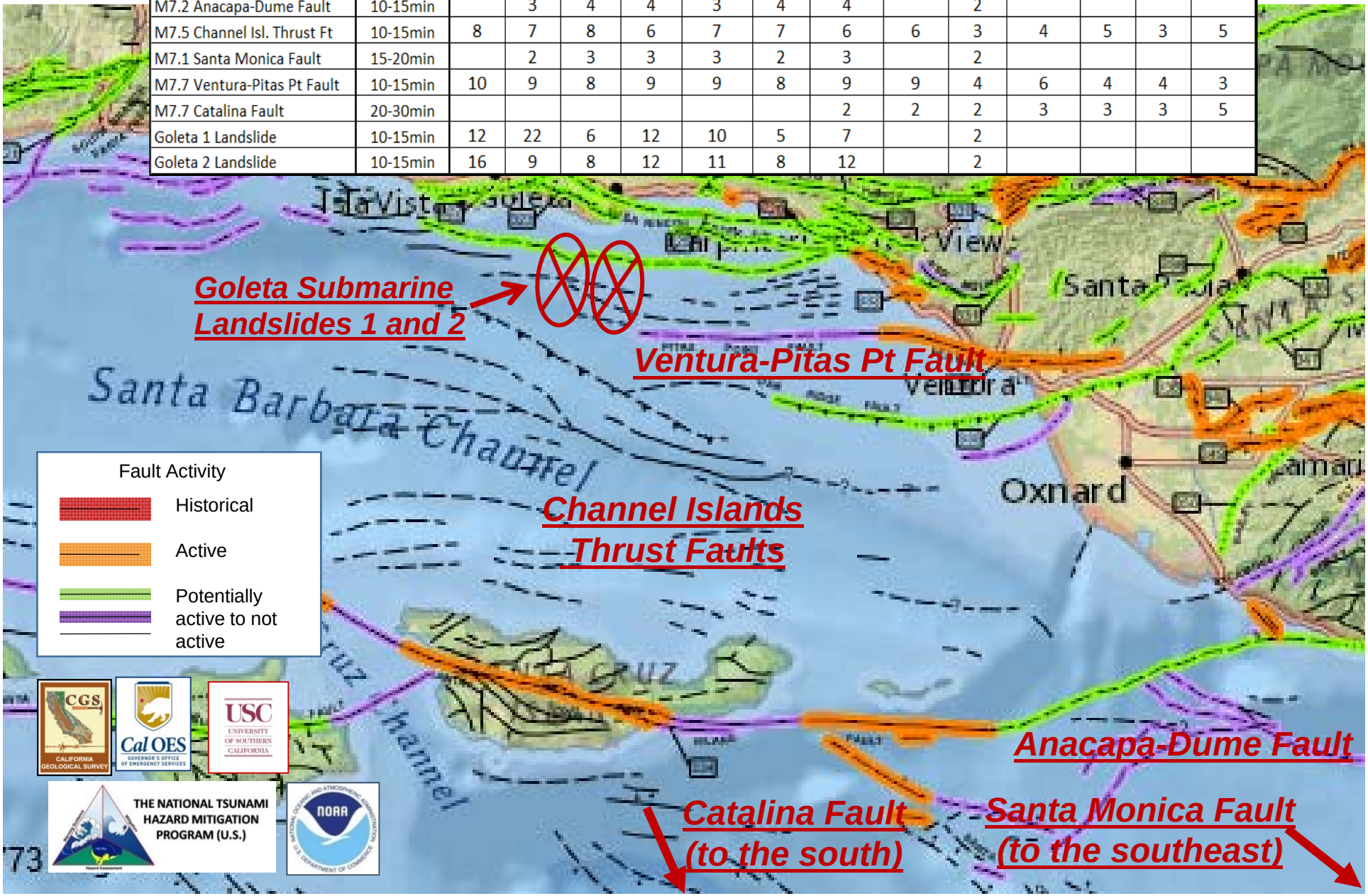
***Damage in Ventura Harbor after 2010 Chile***

***Area of damaged dock in Ventura Harbor after 2011 Japan***

***Active tsunami at mouth of Ventura Harbor during 2015 Chile***

# Local Tsunami Source Scenarios for Ventura County (in feet above Mean Sea Level)

| TSUNAMI SOURCES | Approximate Travel Time | Punta | Pitas Point | Dulah | Ventura River | Pierpoint | Ventura Harbor | Oxnard Mandalay | Ox Hbr Entrance | Ox Hbr Channel | Port Hueneme | Oxnard Pier | Point Mugu | Solromar |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M7.2 Anacapa-Dume Fault | 10-15min | | 3 | 4 | 4 | 3 | 4 | 4 | | 2 | | | | |
| M7.5 Channel Isl. Thrust Ft | 10-15min | 8 | 7 | 8 | 6 | 7 | 7 | 6 | 6 | 3 | 4 | 5 | 3 | 5 |
| M7.1 Santa Monica Fault | 15-20min | | 2 | 3 | 3 | 3 | 2 | 3 | | 2 | | | | |
| M7.7 Ventura-Pitas Pt Fault | 10-15min | 10 | 9 | 8 | 9 | 9 | 8 | 9 | 9 | 4 | 6 | 4 | 4 | 3 |
| M7.7 Catalina Fault | 20-30min | | | | | | | 2 | 2 | 2 | 3 | 3 | 3 | 5 |
| Goleta 1 Landslide | 10-15min | 12 | 22 | 6 | 12 | 10 | 5 | 7 | | 2 | | | | |
| Goleta 2 Landslide | 10-15min | 16 | 9 | 8 | 12 | 11 | 8 | 12 | | 2 | | | | |



# Local-Source Tsunami

## Earthquake followed by tsunami


## What should people do?

**Natural "WARNING" signs**

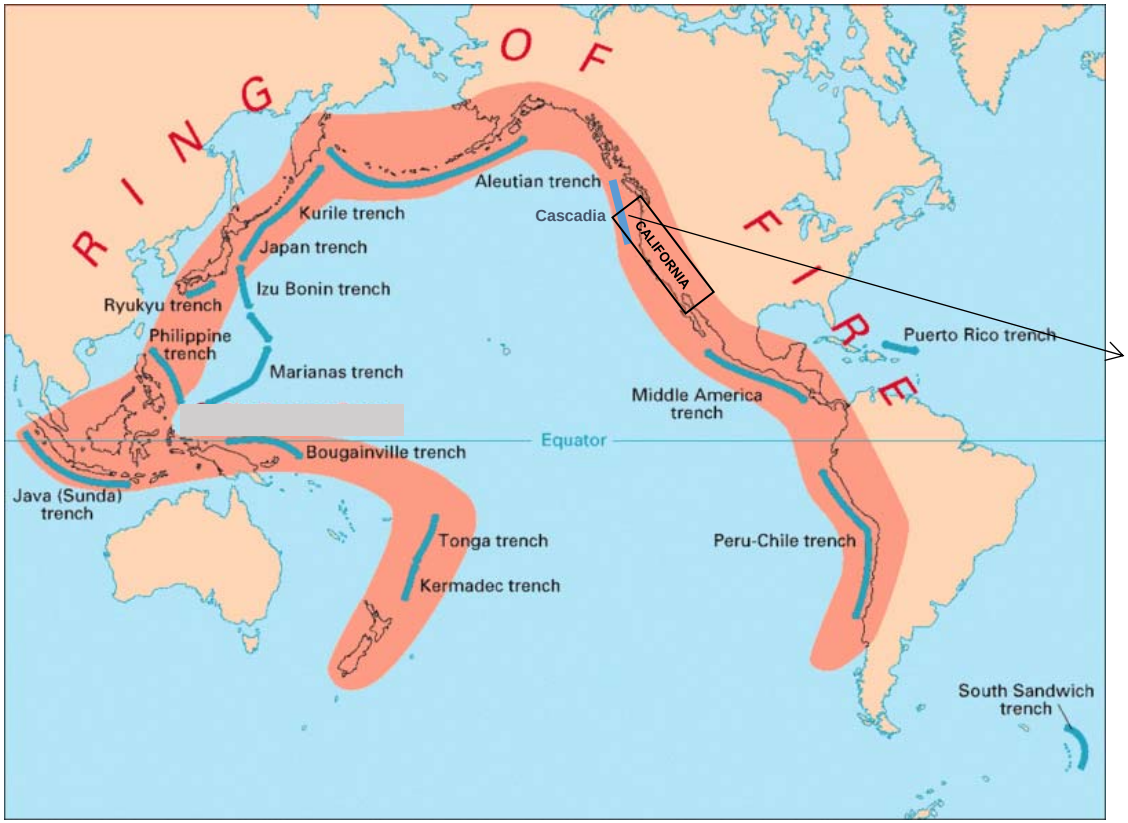
- **FEEL … Strong earthquake shaking**
- **SEE … Water receding exposing sea floor**
- **HEAR … A loud ocean roar**

**If one or more of these natural warning signs occurs, go immediately to high ground or inland and stay there ….**

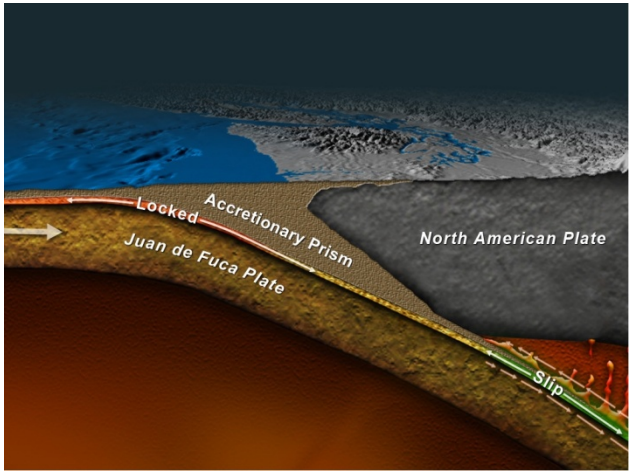
**You may only have minutes before a tsunami arrives.**

# Tsunami without felt earthquake

**Distant sources:  Large earthquakes along Pacific “Ring of Fire”**

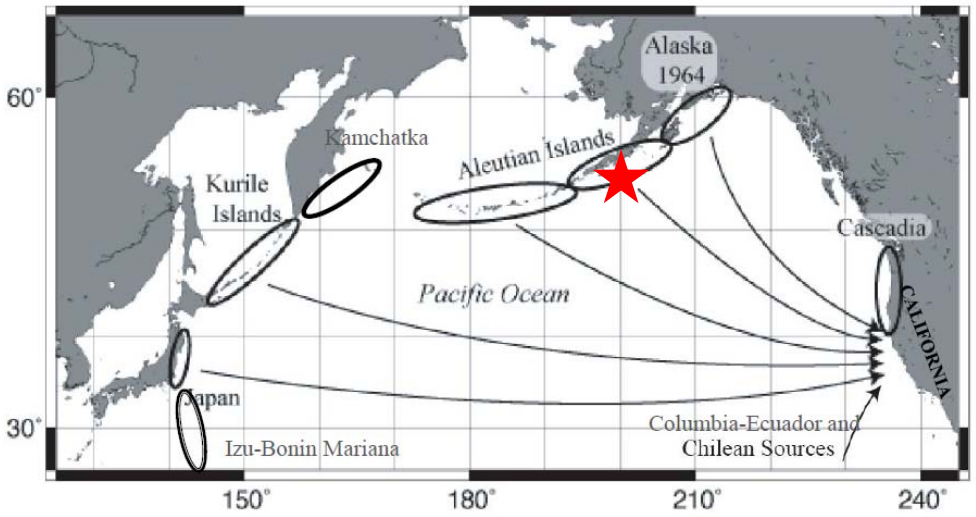



**Example:  Cascadia Subduction Zone**



# Distant Source Tsunami Scenarios for Ventura County

(in feet above Mean Sea Level)




| | TSUNAMI SOURCES | Approximate Travel Time | Punta | Pitas Point | Dulah | Ventura River | Pierpoint | Ventura Harbor | Oxnard Mandalay | Ox Hbr Entrance | Ox Hbr Channel | Port Hueneme | Oxnard Pier | Point Mugu | Solromar |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Local Sources | M7.2 Anacapa-Dume Fault | 10-15min | | 3 | 4 | 4 | 3 | 4 | 4 | | 2 | | | | |
| | M7.5 Channel Isl. Thrust Ft | 10-15min | 8 | 7 | 8 | 6 | 7 | 7 | 6 | 6 | 3 | 4 | 5 | 3 | 5 |
| | M7.1 Santa Monica Fault | 15-20min | | 2 | 3 | 3 | 3 | 2 | 3 | | 2 | | | | |
| | M7.7 Ventura-Pitas Pt Fault | 10-15min | 10 | 9 | 8 | 9 | 9 | 8 | 9 | 9 | 4 | 6 | 4 | 4 | 3 |
| | M7.7 Catalina Fault | 20-30min | | | | | | | 2 | 2 | 2 | 3 | 3 | 3 | 5 |
| | Goleta 1 Landslide | 10-15min | 12 | 22 | 6 | 12 | 10 | 5 | 7 | | 2 | | | | |
| | Goleta 2 Landslide | 10-15min | 16 | 9 | 8 | 12 | 11 | 8 | 12 | | 2 | | | | |
| Distant Sources | M9 Cascadia-full rupture | 1hr | | 4 | 4 | 4 | 4 | 5 | 4 | | 2 | | | | |
| | M9.2 Alaska 1964 EQ | 5hr | 7 | 7 | 7 | 7 | 7 | 8 | 6 | 5 | 5 | 5 | 5 | 4 | 5 |
| | M8.9 Central Aleutians I | 5hr | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 5 | 8 | 4 | 4 | 3 | 3 |
| | M8.9 Central Aleutians II | 5hr | | 4 | 4 | 4 | 4 | 4 | 3 | | 2 | | | | |
| | M9.2 Central Aleutians III | 5hr | 10 | 9 | 10 | 9 | 10 | 10 | 10 | 9 | 10 | 7 | 7 | 5 | 6 |
| | M9 Kamchatka 1952 EQ | 9hr | | | | | | | 3 | 5 | 5 | 3 | 3 | 3 | 3 |
| | M8.8 Kuril Islands II | 9hr | | 3 | 3 | 3 | 3 | 3 | 2 | | 2 | | | | |
| | M8.8 Kuril Islands III | 9hr | | 3 | 3 | 3 | 3 | 3 | 3 | | 2 | | | | |
| | M8.8 Kuril Islands IV | 9hr | | 3 | 3 | 3 | 3 | 3 | 3 | | 2 | | | | |
| | M8.8 Japan II | 10hr | | 3 | 3 | 3 | 4 | 4 | 3 | | 2 | | | | |
| | M9.5 Chile 1960 EQ | 13hr | | 4 | 4 | 4 | 4 | 4 | 4 | | 2 | | | | |
| | M9.4 Chile North | 13hr | 7 | 6 | 8 | 6 | 6 | 7 | 7 | 7 | 2 | 5 | 5 | 4 | 4 |
| | **Maximum Runup - Local Source** | | **17** | **23** | **9** | **13** | **12** | **9** | **12** | **10** | **5** | **7** | **6** | **4** | **6** |
| | **Maximum Runup - Distant Source** | | **11** | **10** | **11** | **10** | **11** | **11** | **10** | **10** | **10** | **7** | **7** | **5** | **7** |

THE NATIONAL TSUNAMI HAZARD MITIGATION PROGRAM (U.S.)

CGS CALIFORNIA GEOLOGICAL SURVEY

Cal OES GOVERNOR'S OFFICE OF EMERGENCY SERVICES

NOAA

# Tsunami Notification WR8

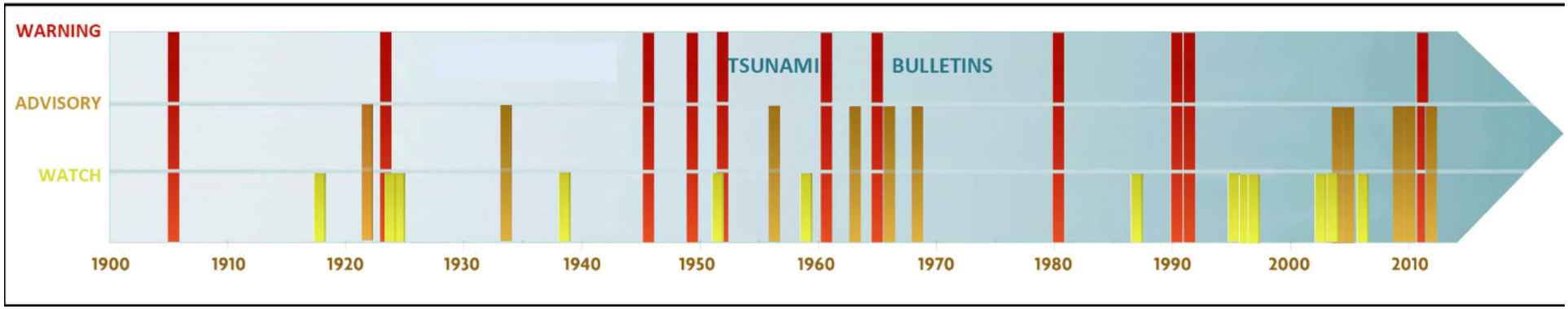

Deep Ocean Assessment and Reporting of Tsunami (DART) Buoy

**Slide 24**

**WR8** Important to make it clear that the "Tsunami Notifications" are only realiable for tsunamis coming from a distant source.
Wilson, Rick@DOC, 3/13/2017

# National Tsunami Warning Center (NTWC)

# History of Tsunamis in California



# Official NOAA/NWS Alert Bulletins

**Tsunami WARNING** (>3 feet)

Widespread inundation is imminent or occurring
Full Evacuation Suggested, Move to Higher Ground

**Tsunami ADVISORY** (1 foot to 3 feet)

Strong currents are imminent or occurring
Move Away From Shore, Harbors, Marinas

**Tsunami WATCH**

Potential Tsunami - May Impact Your Area
Stay Alert For More Info, May be upgraded to Warning/Advisory

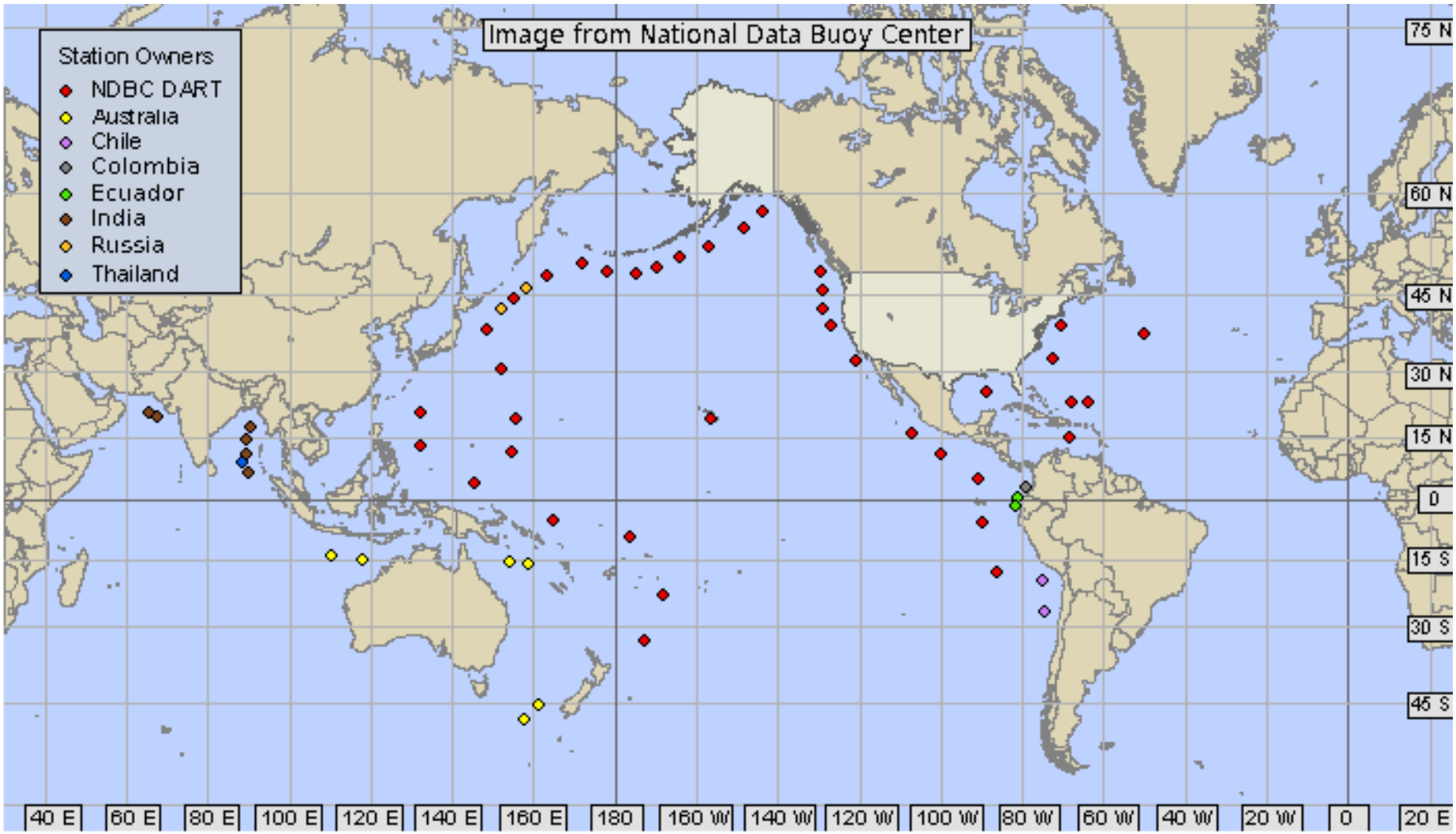
**Tsunami INFORMATION**

Minor Waves at Most

No Action Suggested

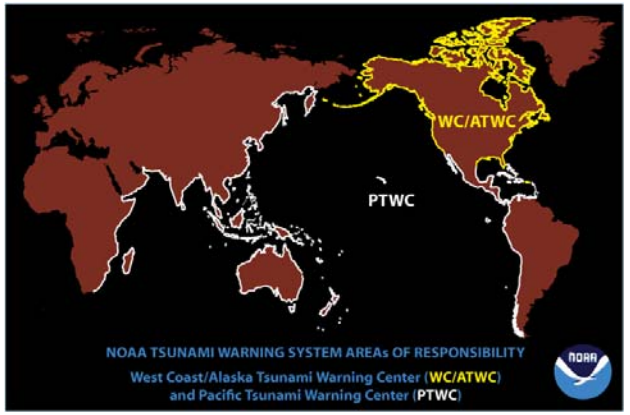
http://wcatwc.arh.noaa.gov/Products/msgdefs.htm

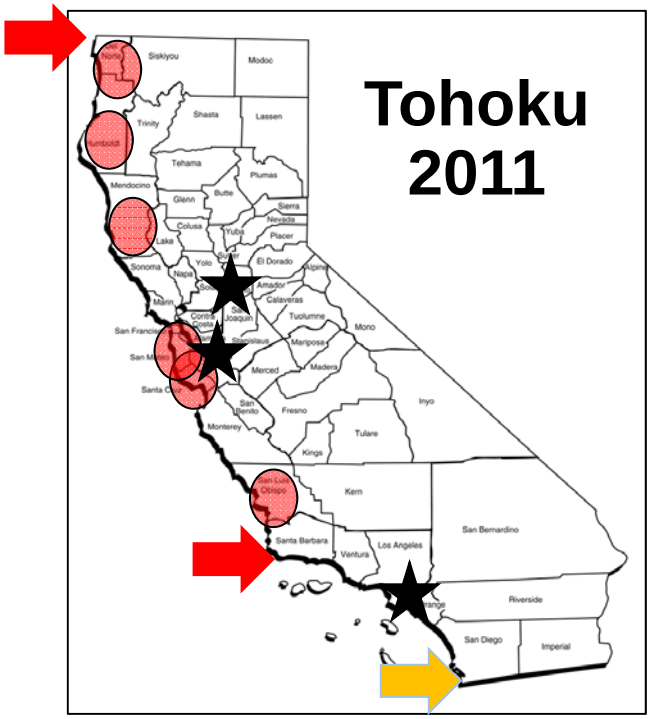
# Deep-ocean Assessment and Reporting of Tsunamis (DART®)



# Initial State Response to: WARNING and/or ADVISORY

- **PARTICIPATE in CALLS WITH NATIONAL TSUNAMI WARNING CENTER**
- **ACTIVATE STATE EOC's (SOC / REOC)**
- **CONDUCT CALLS WITH EMERGENCY MANAGERS IN 20 COASTAL COUNTIES (EOC / DOC)**

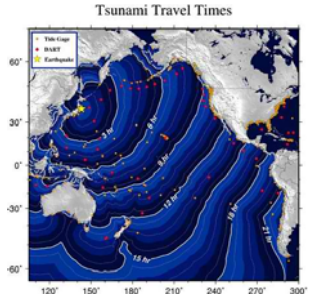


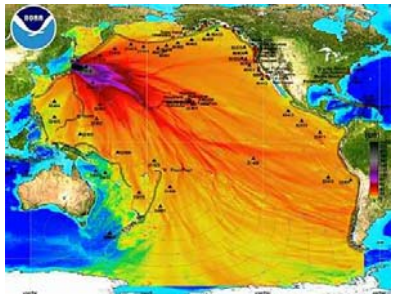



# Information exchanged during NTWC calls:

**Specific areas/locations of heightened concern based on**

- **“Start of Tsunami” Times**
- **Expected Wave Heights**
- **Concurrent Tide Conditions**



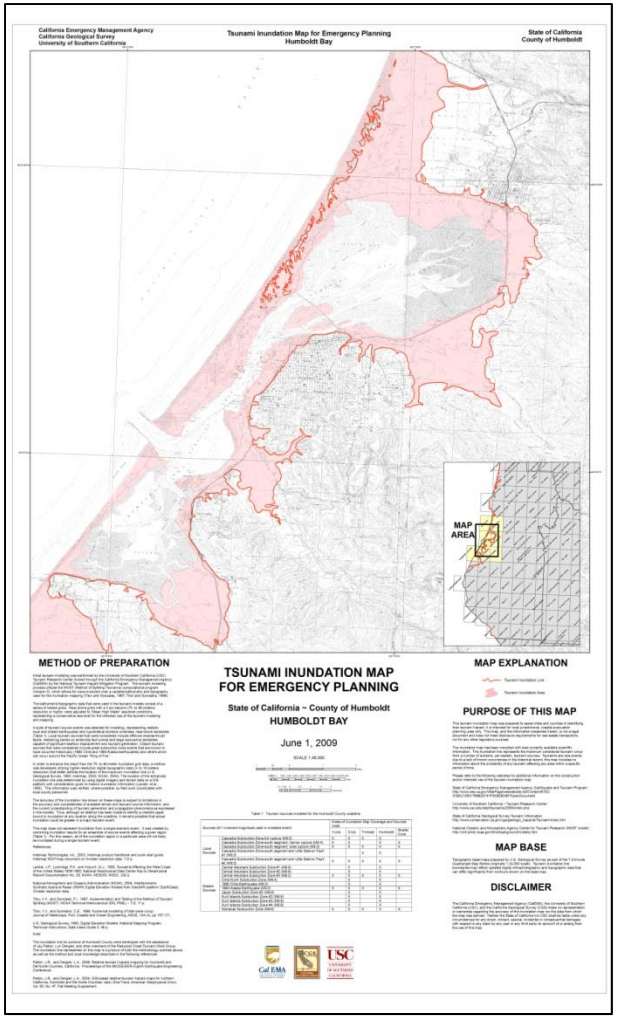



**Current & projected status of WARNING / ADVISORY / WATCH**

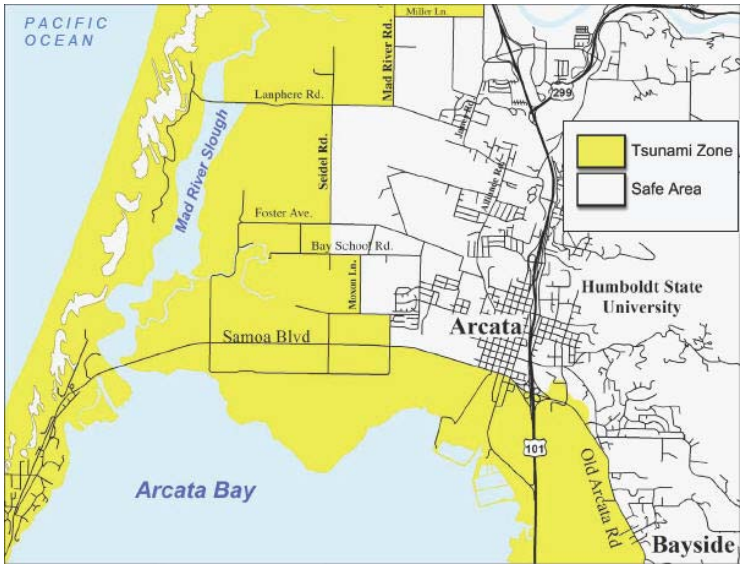
**What will be in the next bulletin?  When it will come out?**

**Any specific questions or clarifications from states and entities**

# EXISTING: Evacuation Map & Plan




Inundation Map




Evacuation Map

County / City Evacuation Plan / ConOps

1. "Evacuate Sector (1) South of Main Street and West of First Street"
2. "Evacuate Sector (2) West of PCH between Newport Blvd. and 60th St."
3. Etc.

# Distant-Source Tsunami

## Tsunami without felt earthquake




# What should people do?

## Official Warning

**You may be notified of a Tsunami Warning or Advisory has been issued by:**

- **TV or radio stations, internet**
- **Door-to-door contact by emergency personnel**
- **Reverse 911 call**
- **NOAA weather radios**
- **Outdoor sirens (could be police/fire)**

**If you receive an official warning, seek high ground and find out more information from the TV, radio, or internet.**

**Follow directions of emergency personnel.**

# What Should I Do To Prepare?

Be Informed – Know if you are in tsunami zone and where safe areas are nearby

Be Prepared – Make a Family Plan

Listen to Instructions from Local Emergency Responders

Move Inland and/or to Higher Ground

Walk the Evacuation Route if Possible

Last Resort!!!  If You Cannot Evacuate the Area, Go to the Third or Higher Floor of a Sturdy Building

If You Are Outside the Tsunami Hazard Zone – Take No Action/Stay There


*State tsunami inundation map for Ventura area*

# Tsunami Inundation Map

**To download inundation maps:**
**www.tsunami.ca.gov**

**GoogleEarth file under**
**“Download Spatial Data”**

**Thank you!**


**Email:** Rick.Wilson@conservation.ca.gov

Kevin.Miller@caloes.ca.gov

Yvette.LaDuke@caloes.ca.gov

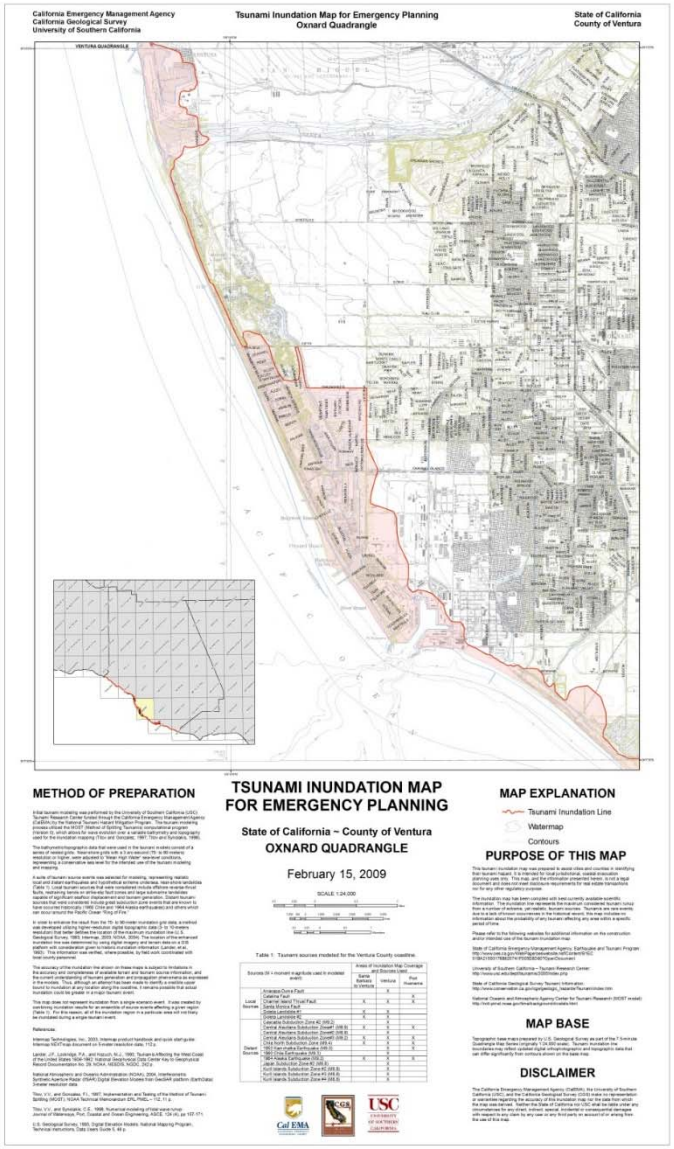
Eric.Boldt@NOAA.gov


**Websites:** http://www.quake.ca.gov

http://www.tsunami.ca.gov

http://myhazards.ca.gov

http://tsunamizone.org




*State tsunami evacuation map for Oxnard area*