

# 2005 Tsunami Workshop



California Coastal Commission

Eureka Hearing

15 September 2005

# AGENDA

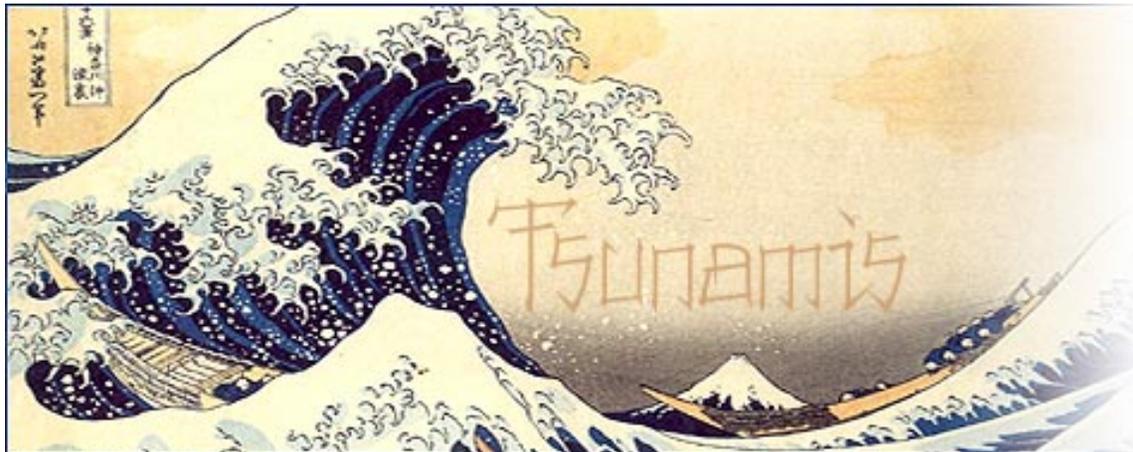
- Lessons Learned from Indian Ocean Tsunami and Gorda Plate Earthquake
- Tsunamis and the California Experience
- Tsunami Preparedness
- Education
- Federal, State and Local Level Efforts
- Discussion and Questions

# Lessons Learned

26 Dec. 2004 Sumatran Earthquake (~M 9.1)

14 June 2005 Gorda Plate Earthquake (~M 7.2)

- Mechanisms of a Tsunami
- What Worked and What Didn't Work
- Long-term Lessons



from *The Great Wave Off Kanagawa*, by Katsushika Hokusai, 1823-29, Color woodcut

# California's Tsunami Concerns



- ~ 1 million people live in vulnerable inundation areas
- Many thousands visit California's beaches & vulnerable inundation areas

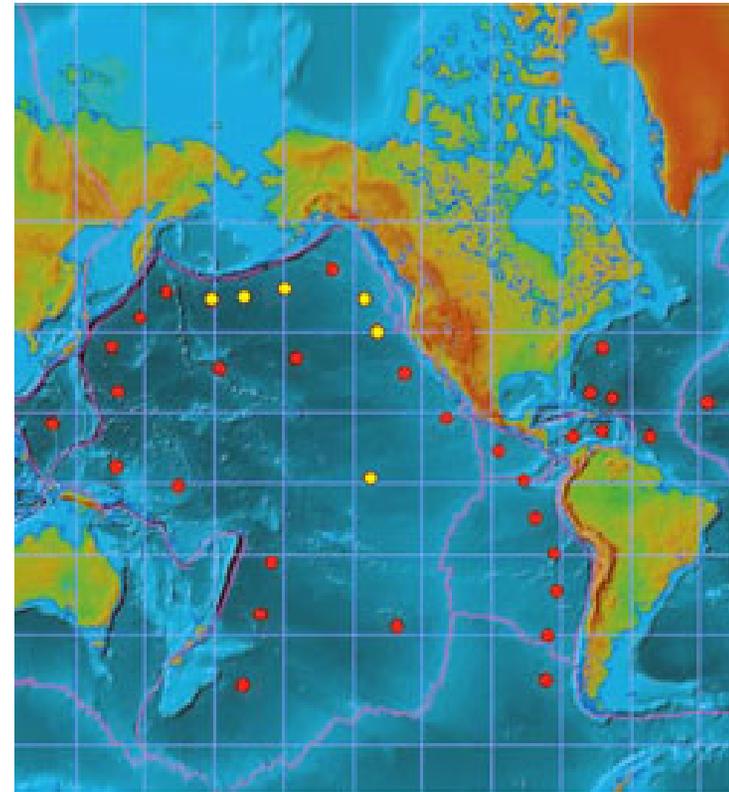
# Mechanisms of a Tsunami



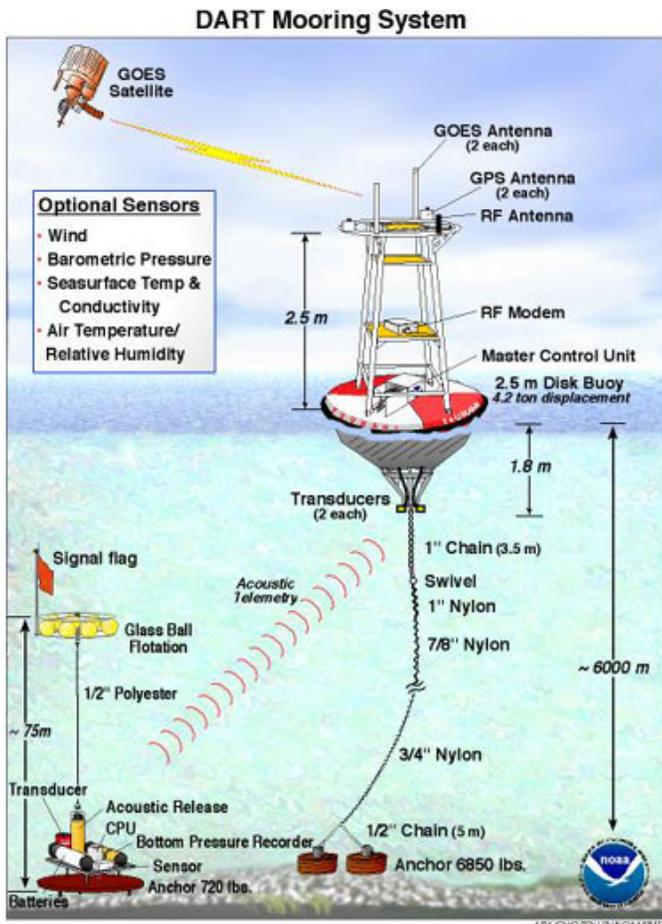
- **Earthquake**
- **Extreme negative wave**
- **Noise**



# Tsunami Detection



Yellow dot: In place  
Red dot: Proposed



Courtesy of PMEL

- Deep-water Buoys Detect Far-Field Events

## Tsunami warning issued by WC/ATWC the evening of June 14, 2005

TO - TSUNAMI WARNING SYSTEM PARTICIPANTS IN  
ALASKA/BRITISH COLUMBIA/WASHINGTON/OREGON/CALIFORNIA  
FROM - WEST COAST AND ALASKA TSUNAMI WARNING CENTER/NOAA/NWS  
SUBJECT - TSUNAMI WARNING BULLETIN - INITIAL  
BULLETIN NUMBER 1  
ISSUED 06/15/2005 AT 0256 UTC

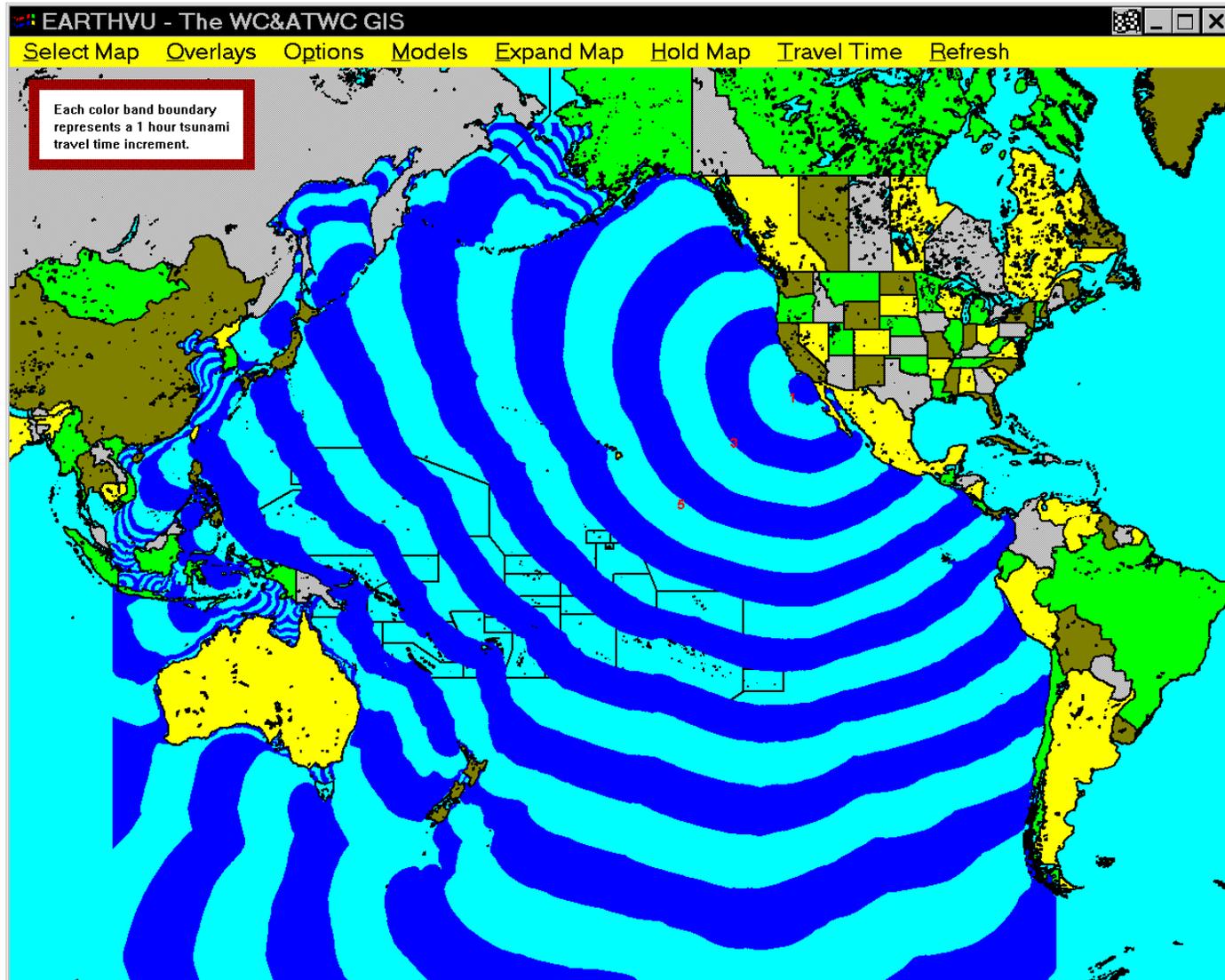
...A TSUNAMI WARNING IS IN EFFECT FOR THE COASTAL AREAS  
FROM THE CALIFORNIA-MEXICO BORDER TO THE NORTH TIP OF  
VANCOUVER I.-BC. INCLUSIVE...

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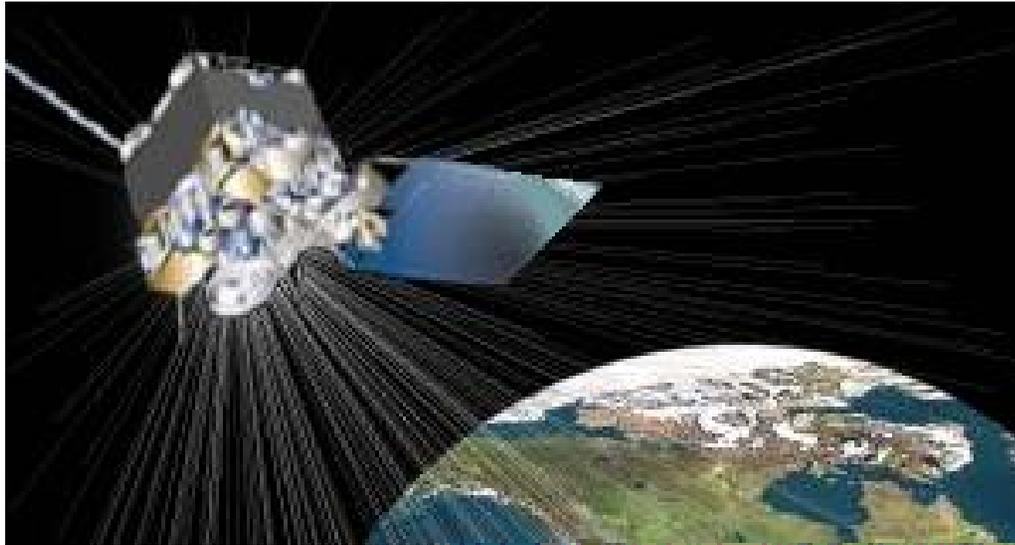
### EVALUATION

IT IS NOT KNOWN - REPEAT NOT KNOWN - IF A TSUNAMI EXISTS BUT A  
TSUNAMI MAY HAVE BEEN GENERATED. THEREFORE PERSONS IN LOW  
LYING COASTAL AREAS SHOULD BE ALERT TO INSTRUCTIONS FROM THEIR  
LOCAL EMERGENCY OFFICIALS. **PERSONS ON THE BEACH SHOULD MOVE TO  
HIGHER GROUND IF IN A WARNED AREA.** TSUNAMIS MAY BE A SERIES OF  
WAVES WHICH COULD BE DANGEROUS FOR SEVERAL HOURS AFTER THE  
INITIAL WAVE ARRIVAL.

# Tsunami Detection







# Inundation Mechanisms



The Tsunami that struck Male in the Maldives, Photo from Wikipedia.

- **Flows up to 11 miles/hr**
- **Waves carry debris and rubble**
- **Drawdown creates new drainage channels; scours existing channels**
- **Changes nearshore bathymetry**

# Karon Beach



Wide and high sand dune protected houses/businesses

# Natural Buffers and Protection



Crescent City, 1964: Photo Courtesy of Orville Magoon

# Constructed Barriers



Hotel in Sri Lanka, photo courtesy of Dr. Perera.

Seawall at Phuket International Airport, courtesy of Dr. David Kriebel

# Response of Building Types

- Elevated structures with open lower stories fared best & provided vertical evacuation
- Perpendicular orientation fared better than parallel orientation
- Reinforced concrete fared better than masonry or wooden structures
- Underground garages were flooded
- Strong foundations were necessary for all building types; landscaping provided scour protection



Photo Courtesy of John Headland,  
ASCE Sri Lanka  
Team

# Special Structures



- **Roads and Rails**
- **Bridges**
- **Utility Lines and Life Lines**
- **Confined Areas**
  - **Garages**
  - **Subways**
  - **Tunnels**



Photos of Galle – Matara Rail line, Sri Lanka, courtesy of Dr. Perara

# Special Structures

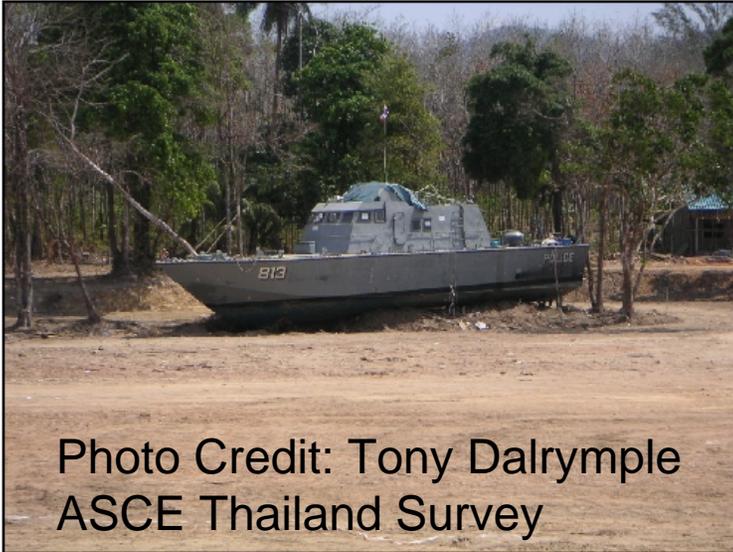


Photo Credit: Tony Dalrymple  
ASCE Thailand Survey



Photo credit: David Ames,  
ASCE India Survey Team

- **Breakwater damage**
- **Vessel Movement; vessel damage**
- **Sediment scour and deposition**
- **Intake Structures Exposed**

# Long-Term Consequences

- **Debris**
- **Water Pollution**
- **Salt-saturated soils**
- **Social Disruption**
- **Setbacks and  
Redevelopment Options**



