



UNITED STATES DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND
ATMOSPHERIC ADMINISTRATION



NOAA/NWS Tsunami Program

Mike Angove
NOAA/NWS Tsunami Program Lead

1 Feb 2016



NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION



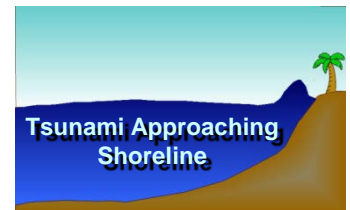
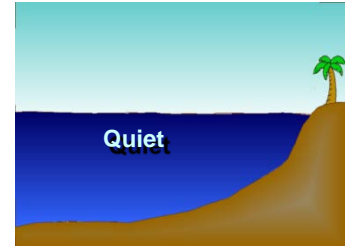
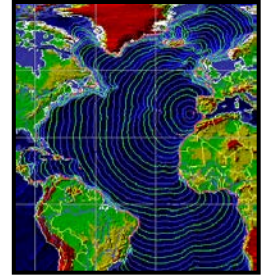
Tsunami Program Mission

To provide support and manage the NOAA Tsunami Program on both domestic and international fronts, including reliable tsunami detection, forecasts, and warnings and education and outreach to promote community resilience



What Is a Tsunami?

- Series of “shallow water” waves *generated in the deep ocean* by:
 - Large undersea earthquakes,
 - Undersea landslides,
 - Undersea volcanic activity,
 - certain-weather-related phenomena, and meteorites
- In the deep ocean, tsunamis move up to 600 mph and may only be a few inches high at the surface
- At coasts, water and energy are focused into a series of powerful waves

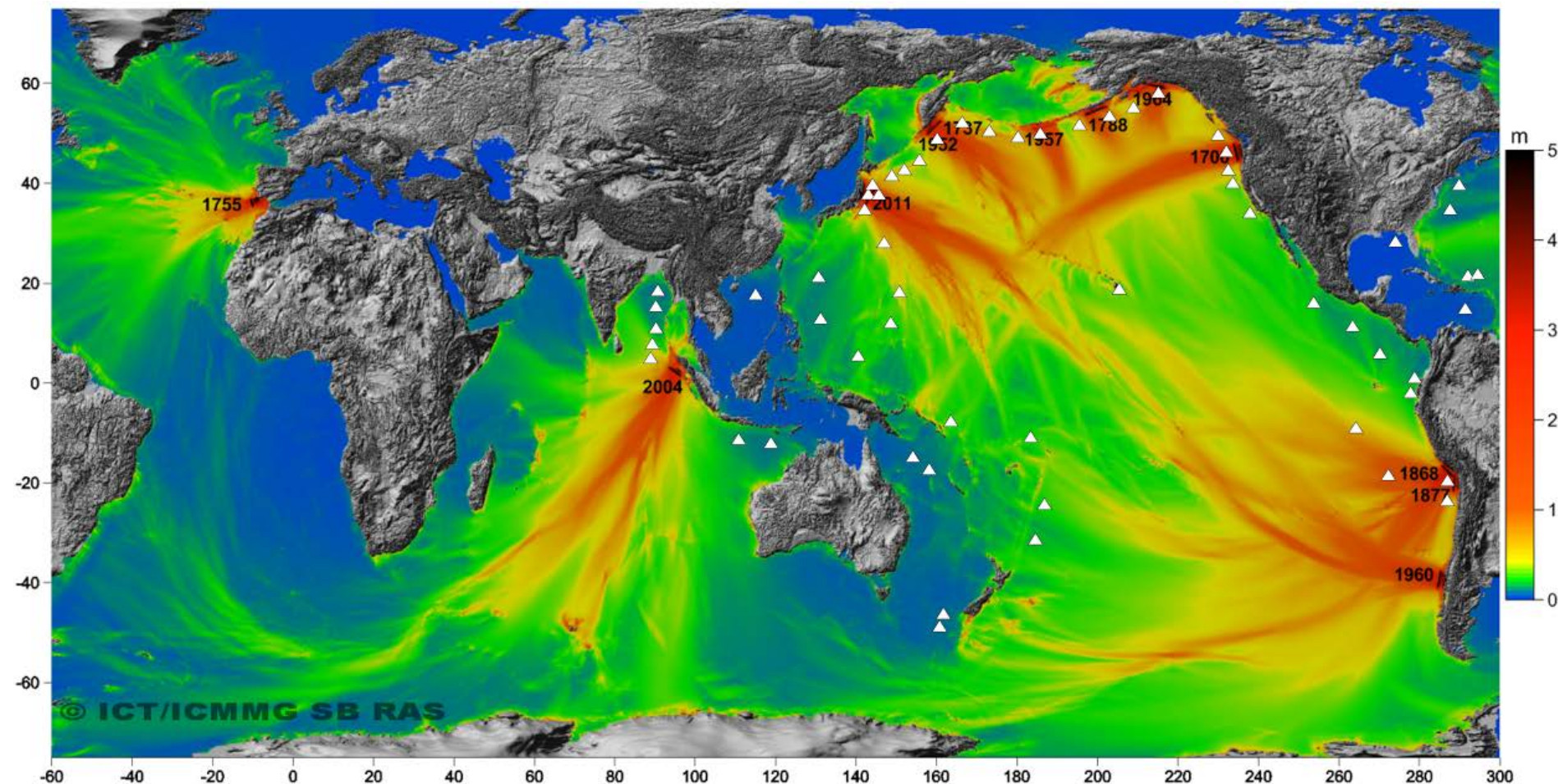




NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION



DART Locations and Historical Mega-Tsunamis

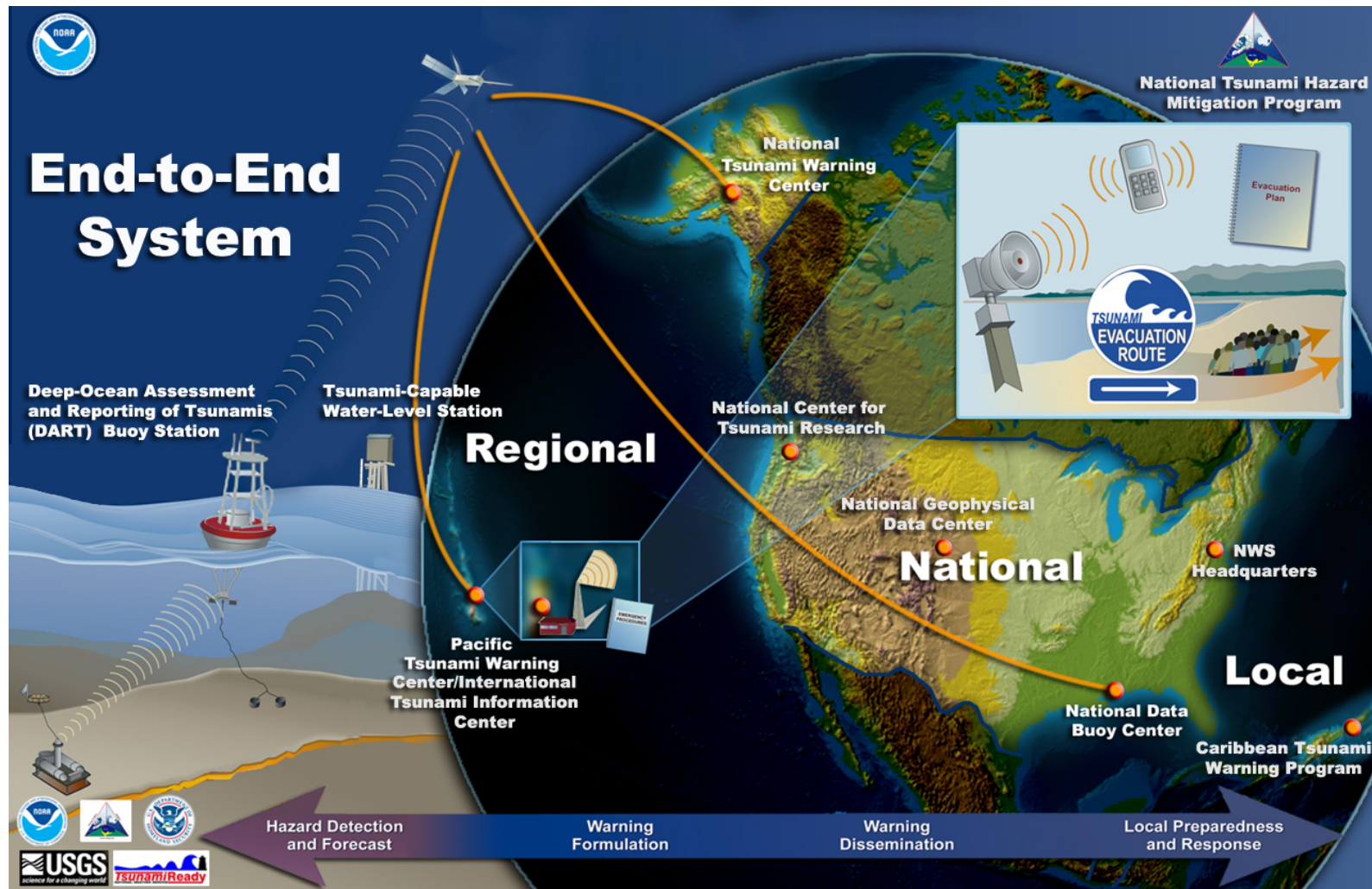




NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION



U.S. Tsunami Warning System

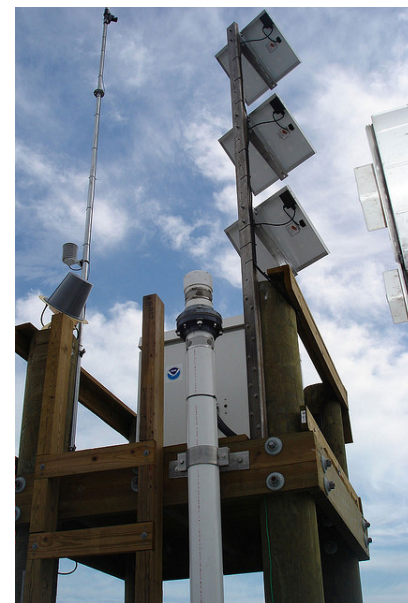


NOAA/NWS Tsunami Program



Detection and Observation

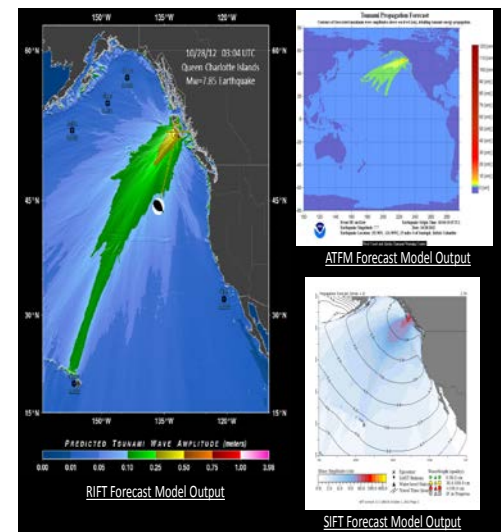
- Seismic Networks
 - Alaska, Hawaii, Caribbean
- Sea-Level Networks
 - 39 Deep-Ocean Assessing and Reporting of Tsunamis (DART) observation systems
 - National Data Buoy Center
 - Coastal sea-level stations
 - Center for Operational Oceanographic Products and Services (188)
 - Tsunami Warning Centers (21)





Forecasting and Warning

- National Tsunami Warning Center
- Pacific Tsunami Warning Center
- Pacific Marine Environmental Laboratory (models)
- National Centers for Environmental Information (coastal elevation and historical archive)



National Tsunami Warning Center, Palmer, Alaska



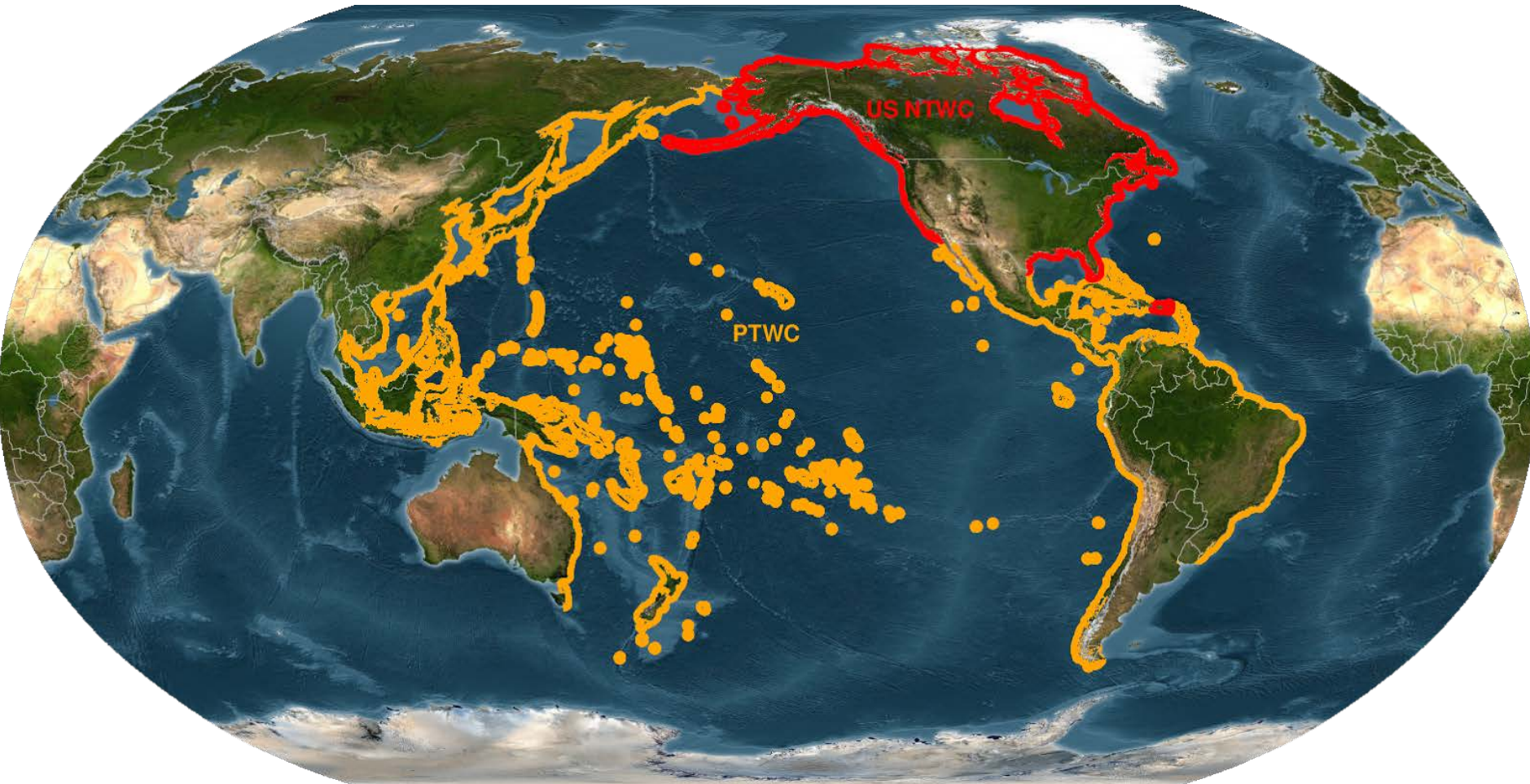
Pacific Tsunami Warning Center (at the NOAA Daniel K. Inouye Regional Center), Honolulu, Hawaii



NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

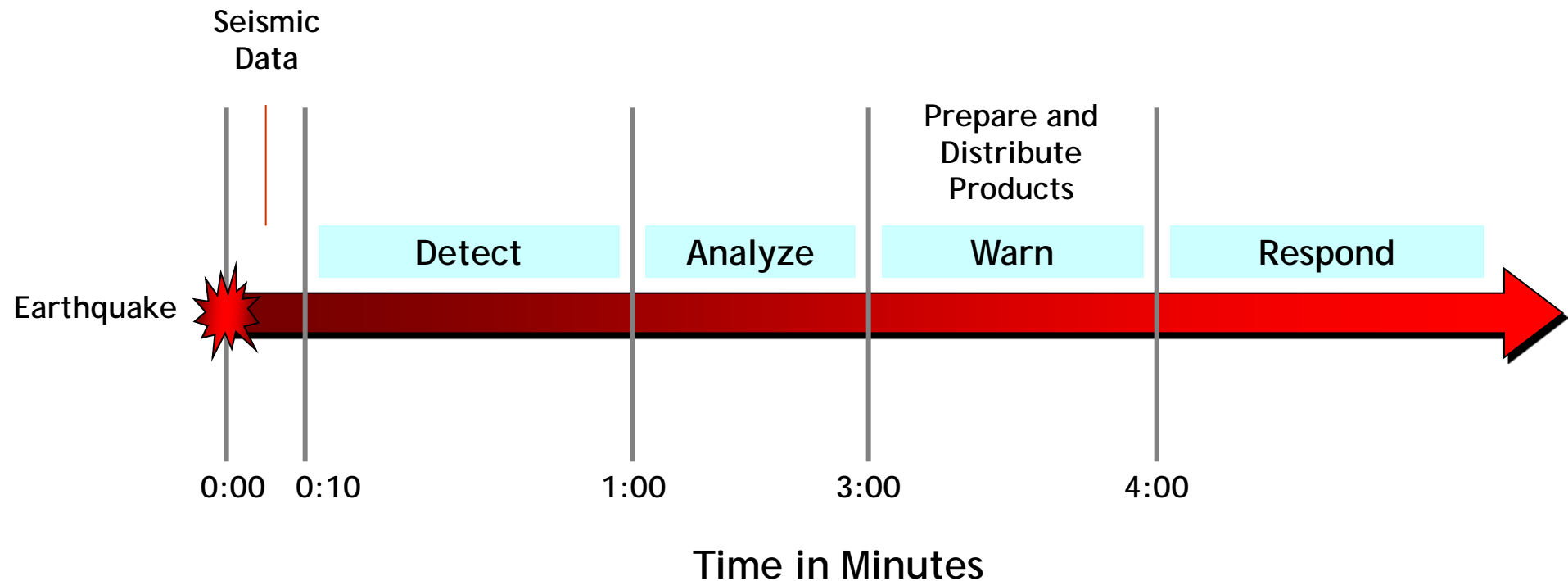


U.S. Tsunami Warning System Coverage





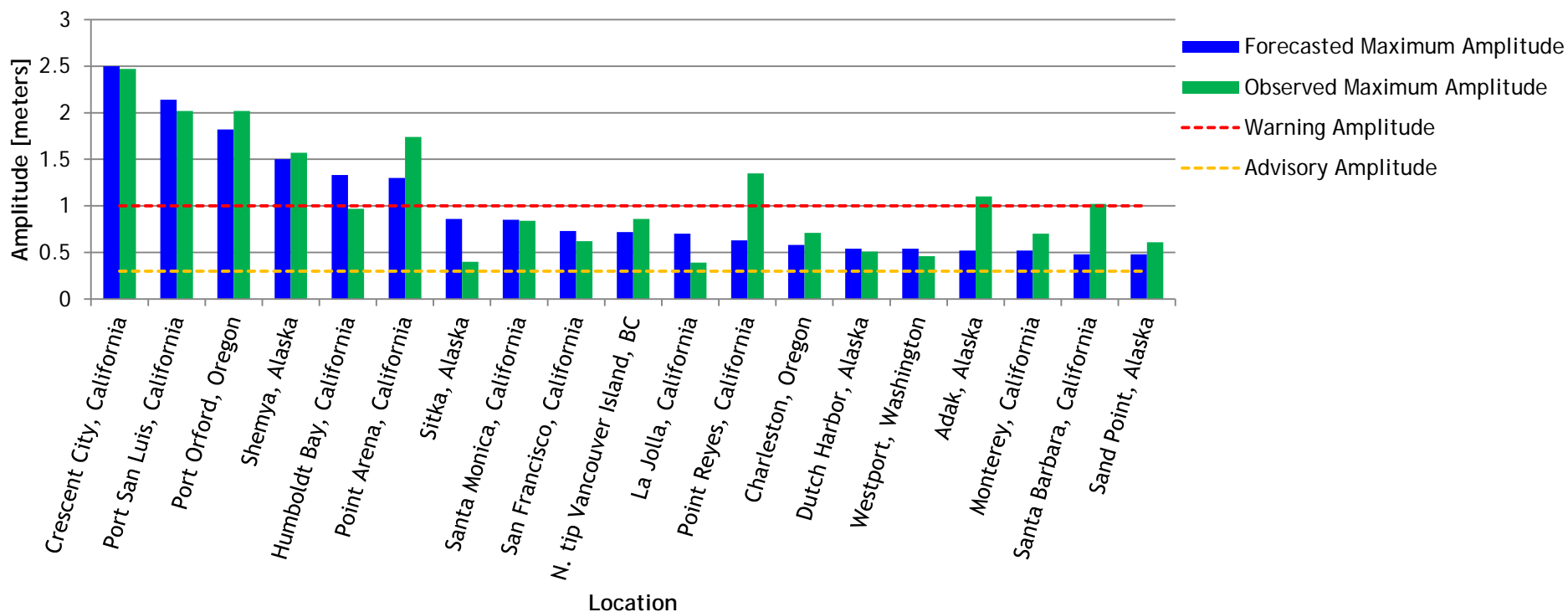
Typical Tsunami Response Timeline: Domestic Earthquake





Japan 2011 Tsunami Forecast and Observed Wave Heights

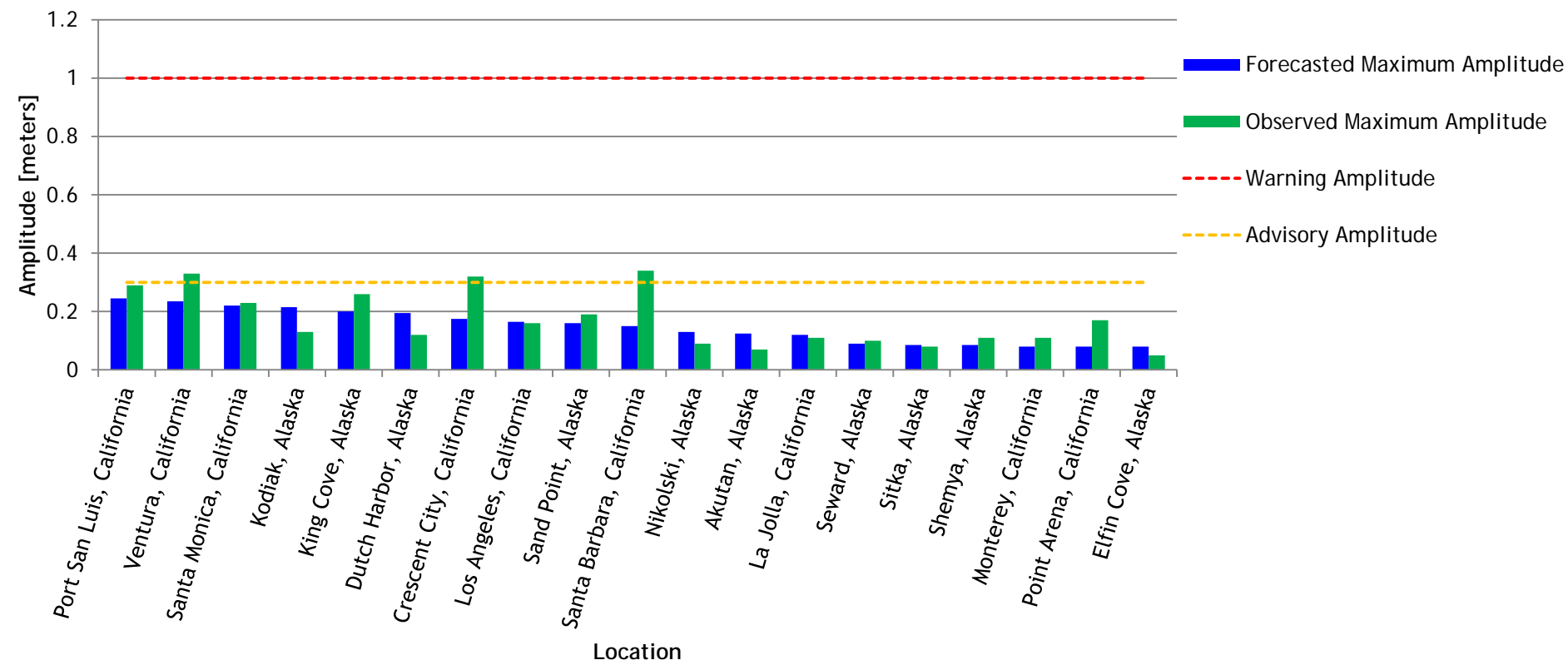
Maximum Tsunami Amplitudes March 11, 2011 - Honshu, Japan





Chile 2015 Tsunami Forecast and Observed Wave Heights

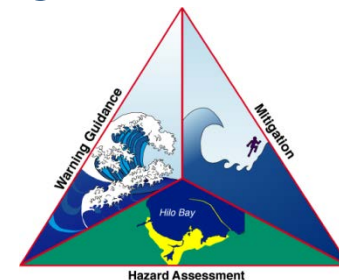
Maximum Tsunami Amplitudes September 16, 2015 - Chile





Preparedness and Mitigation

- National Tsunami Hazard Mitigation Program
 - NOAA, Federal Emergency Management Agency, U.S. Geological Survey, 28 states and territories
- TsunamiReady Program
 - 189 U.S. communities (11 new in FY15)
 - New implementation guidelines adopted FY16
- Weather Forecast Offices





International Coordination

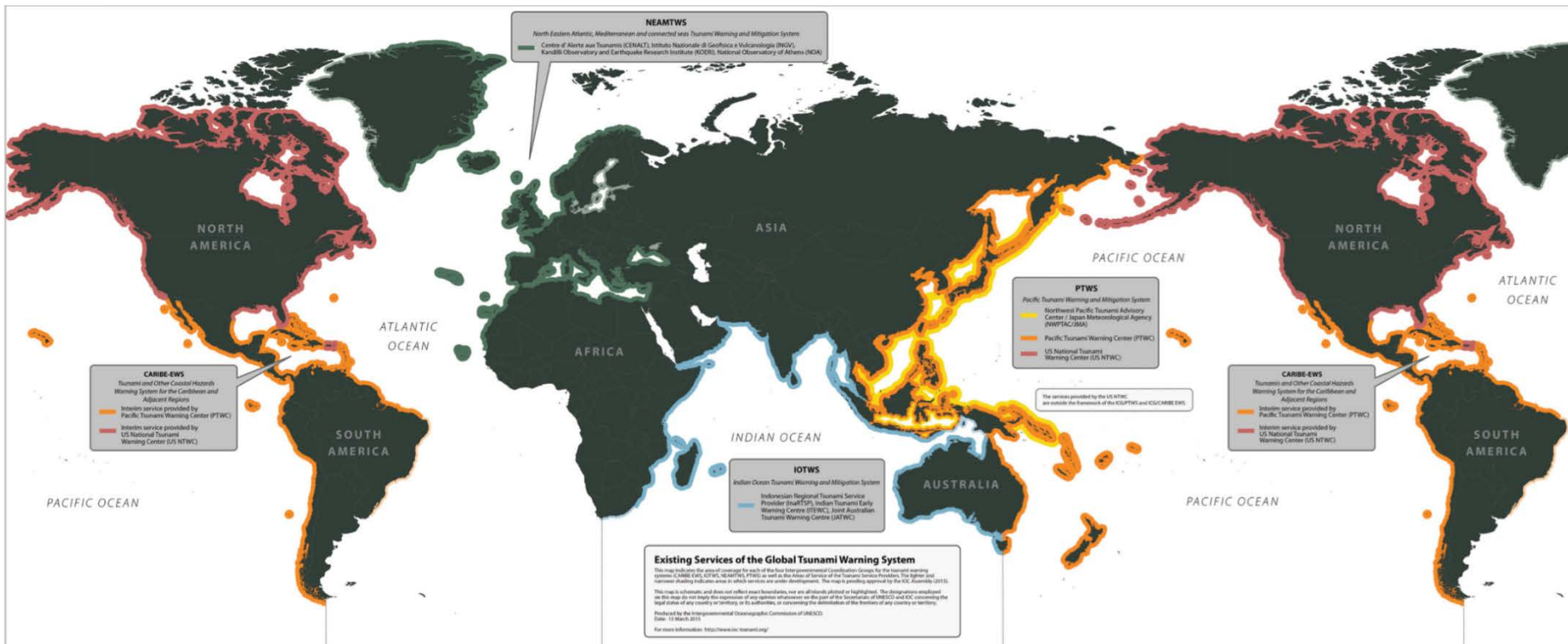
NOAA supports the UN's Intergovernmental Oceanographic Commission's coordinated tsunami warning and mitigation systems in the Pacific and Caribbean, providing forecast and observation guidance and education and preparedness services:

- Pacific Tsunami Warning Center
- International Tsunami Information Center
- Caribbean Tsunami Warning Program
- National Weather Service Headquarters





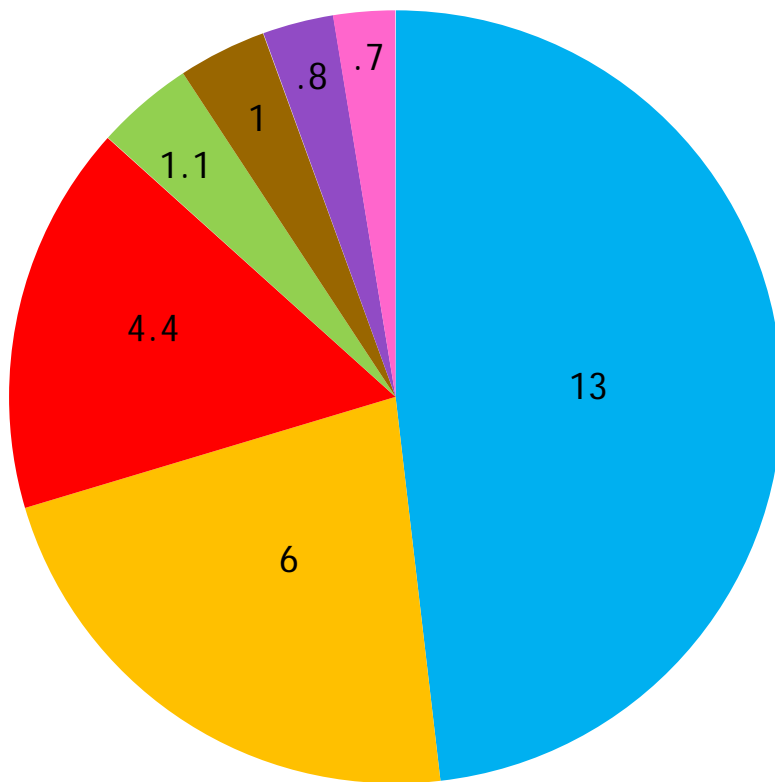
Global Tsunami Warning System





FY15 Budget (ROM)

FY15 Appropriations: \$27M



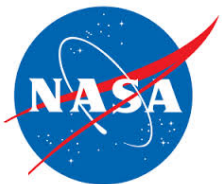
- Sea Level Observations Operations & Maintenance
- State Partner Grants
- Tsunami Warning Center Operations
- Research and Development
- Dedicated Preparedness & Mitigation Activities (ITIC/CTWP)
- National Centers for Environmental Information
- Program Support & Administration



Research and Development

Priority				Operational Need	FY16 Research Efforts	Operational Sponsor
CTWP	ITIC	NTWC	PTWC			
1		1	1	Impact-based DSS	1. Operationalize <u>Tweb</u> <ul style="list-style-type: none"> Evacuation lines/maps overlay Dissemination tool 2. International forecast guidance 3. Exercise scenarios 4. Guidance for addressing very large, infrequent tsunami events 5. Hazard level based on scenario runs using <u>ComMIT</u> (SIMS/country developed grids/available grids)	1. NTWC/PTWC 2. ITIC 3. CTWP 4. CTWP 5. ITIC
		2	2	Improved assimilation of EXISTING data to constrain tsunami source	1. Assimilate existing cabled observing data 2. Assimilate coastal stations into SIFT 4.0 3. GPS/GNSS 4. DEM (NCEI recurring)	1. NTWC/PTWC 2. NTWC/PTWC 3. NTWC/PTWC 4. NTWC/PTWC
		3	3	Accurate near-real-time tsunami detection and measurement	1. DART 4G 2. GPS Shipping (FY14-16) 3. FO Cabling (OBS PPA) 4. HF Radar	1. NDBC 2. PTWC 3. ? 4. NTWC
		4	4	Accurate coastal tsunami model forecasts for any source and any AOR coastline OR Near-real-time tsunami detection and measurement for source determination and/or forecast validation OR Improved tsunami forecasts	1. SIM (NCTR recurring) 2. Incorporate tsunami amplitude into storm surge/tide forecasts and vice versa 3. Drive SIMS from RIFT 4. Currents/ duration	1. NTWC/PTWC 2. ? 3. PTWC 4. NTWC/PTWC
		5	5	Reduce model run times and forecast latency	1. SIFT-capable GPU version	1. NTWC/PTWC
		6	6	Real-time model utilization and integration techniques <ul style="list-style-type: none"> Uncertainty Confidence 	1. Optimize forecast accuracy with existing techniques	
		7	7	Faster generation of initial tsunami alert message (better earthquake characterization)	1. USGS/Int'l sensor density 2. Seismic processing improvements 3. GPS/GNSS	


GPS/GNSS Tsunami Early Warning



Dr. Gerald Bawden
NASA Science Mission Directorate



 **SCRIPPS INSTITUTE OF OCEANOGRAPHY** UC San Diego

 **University of California Berkeley**
Seismological Laboratory



CWU | **UNAVCO**



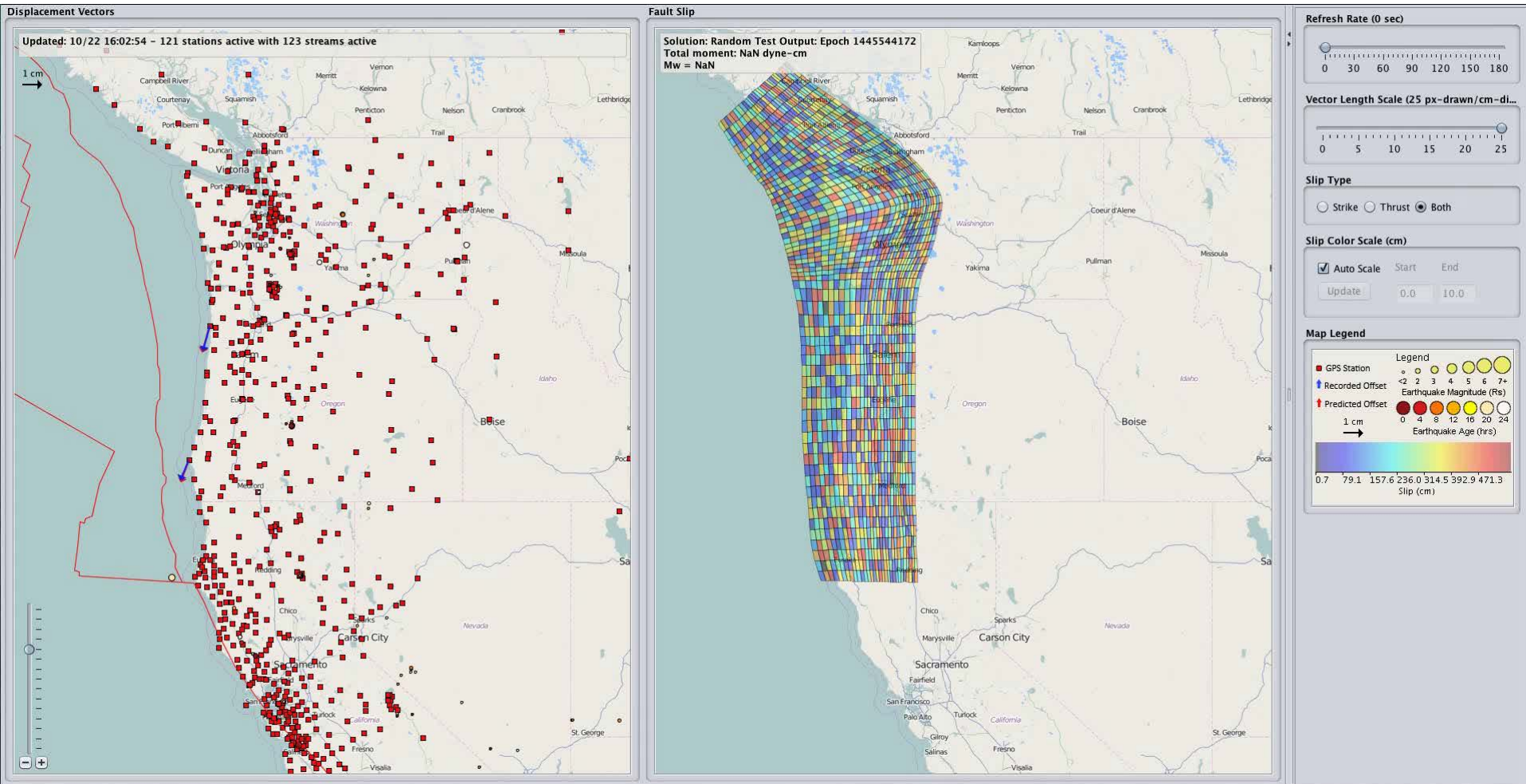
Jet Propulsion Laboratory N OF
California Institute of Technology UC San Diego





GNSS Earthquake Source Model

Running in real-time on a fixed fault surface





Project Overview



We propose a joint NOAA–NASA project to integrate and validate the prototype real-time GNSS-Tsunami Early Warning (GNSS-TEW).

This prototype GNSS-TEW would be installed on a self-contained server and would be tested in parallel with TWC protocols for two tsunamigenic regions with sufficient and available real-time GNSS data.

The NTWC will establish test protocols for Cascade subduction zone in the Pacific Northwest. The PTWC will likely use Japan as a demonstration location; access to real-time GNSS data from Japan will need to be gained before this region has been finalized.



Q&A

NOAA/NWS Tsunami Warning Program

PM: Michael.angove@noaa.gov

DPM: Rocky.lopes@noaa.gov

<http://www.tsunami.gov>