Gulf Coast Tsunamis: What You Need to Know

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Tsunami Program Manager
NWS Lake Charles

What we'll talk about

- What are tsunamis?
- What are the risks?
- What are the hazards?
- How do tsunami warning communications work?

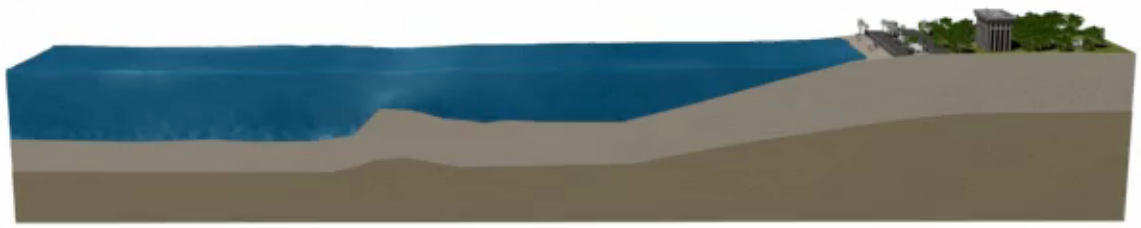
What is a Tsunami?

From Japanese meaning wave (nami) in a harbor (tsu).

A series of fast moving waves with extremely long length and period. Move up to 550 mph in the open ocean, then slow down as the reach shallow water and the shore line, increasing in size.

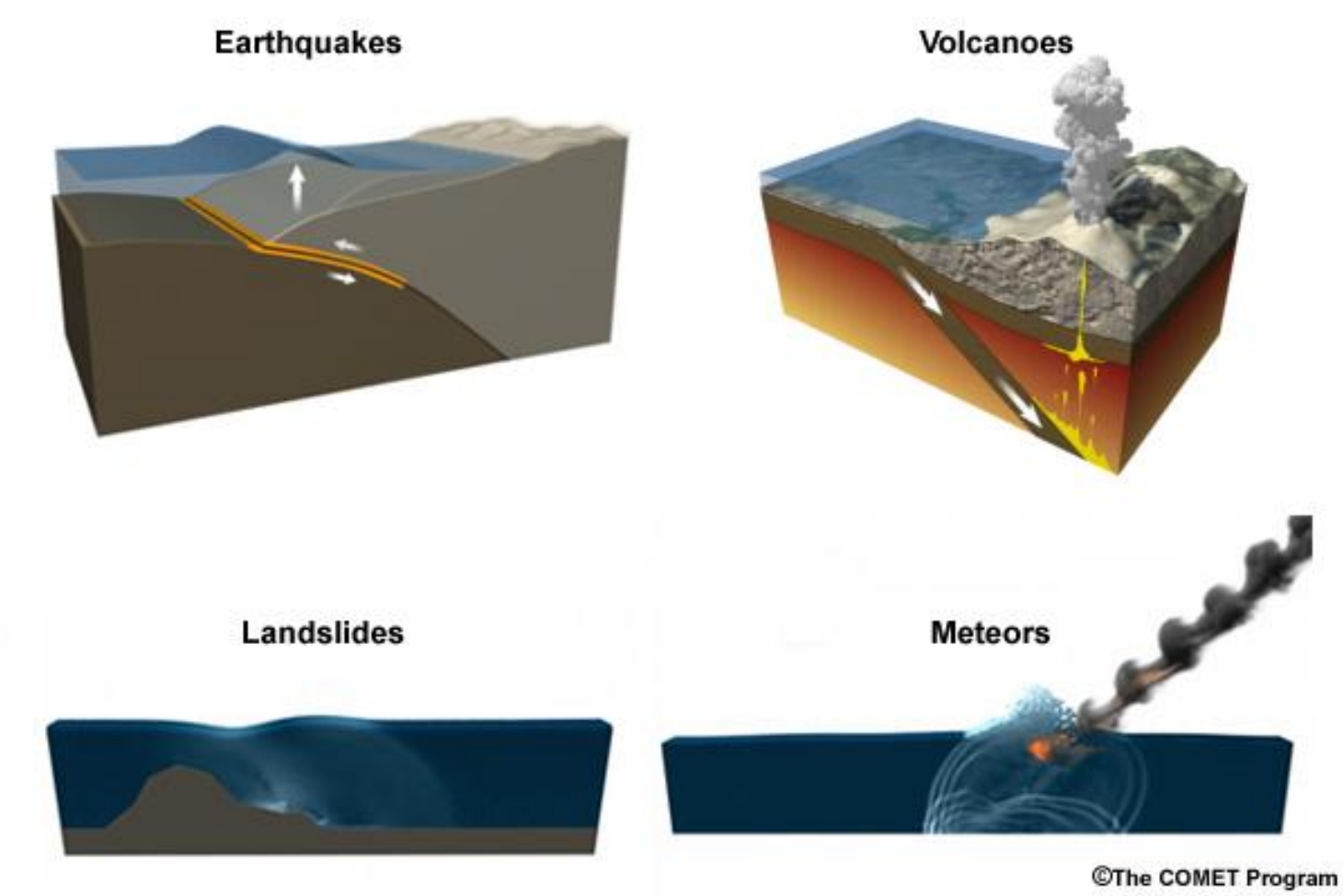
Incorrectly called Tidal Wave, as a tsunami resembles more of a rapid increase in water levels and currents, then one giant breaking wave.

What is a tsunami?



(Click to play animation)

What causes tsunamis?



Earthquake - Tsunami Relationship

- Earthquake sources
  - NGDC: 85% of all tsunamis triggered by earthquakes
  - Many of the rest triggered by slumps which were triggered by earthquakes
- Seismic data best available data to estimate tsunami potential outside of tsunami recordings (at this time)

Earthquake Characteristics which Influence Tsunami

- Size – or Magnitude
  - Related to fault length/width/slip
- Fault depth
  - Deeper -> less surface displacement
- Fault mechanism
  - Horizontal or Vertical Slip?
- Depth of Water above source
  - Not a stone in pond vs. deep ocean
- Distance from shore (onshore)
  - The further from the ocean, the less likely to displace sea water

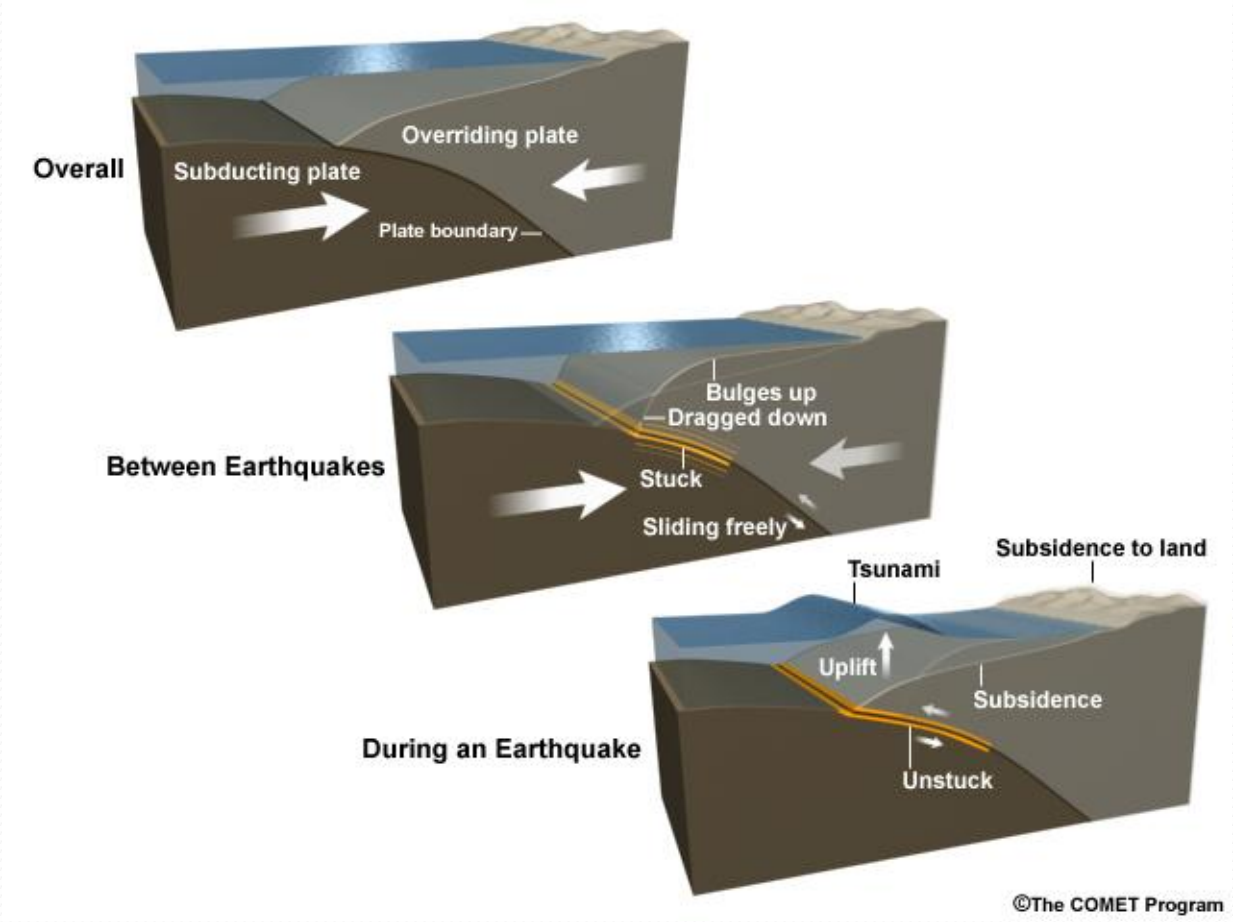
Earthquake Characteristics which Influence Tsunami Earthquake Magnitude

Magnitude	Total number of earthquakes (west coast, BC, and) in potential tsunami generation areas (1900-2004)	Number of events which produced a tsunami >= 0.5m amp.	Maximum amplitude (m)	Maximum “reach” – max. epicentral distance with recorded amp. >= 0.5m (km)	Percentage of occurrence
5.0-5.9	3549	1	3	16	0.028%
6.0-6.4	422	0			0%
6.5-7.0	266	2	2.2	28	0.75%
7.1-7.5	55	3	3	146	5.5%
7.6-7.8	10	2	1+	870	20%
7.9+	13	7	525	Tele-tsunamis	59%

Earthquake Characteristics which Influence Tsunami Earthquake Depth

Hypocentral Depth (km)	Number Tsunamis (entire database since 1900)	% of total tsunamis	Total # of earthquakes since 1900; M >= 7
< 50	343	90%	1300
50-100	35	9%	140
> 100	2	<1%	70

Typical earthquake tsunami

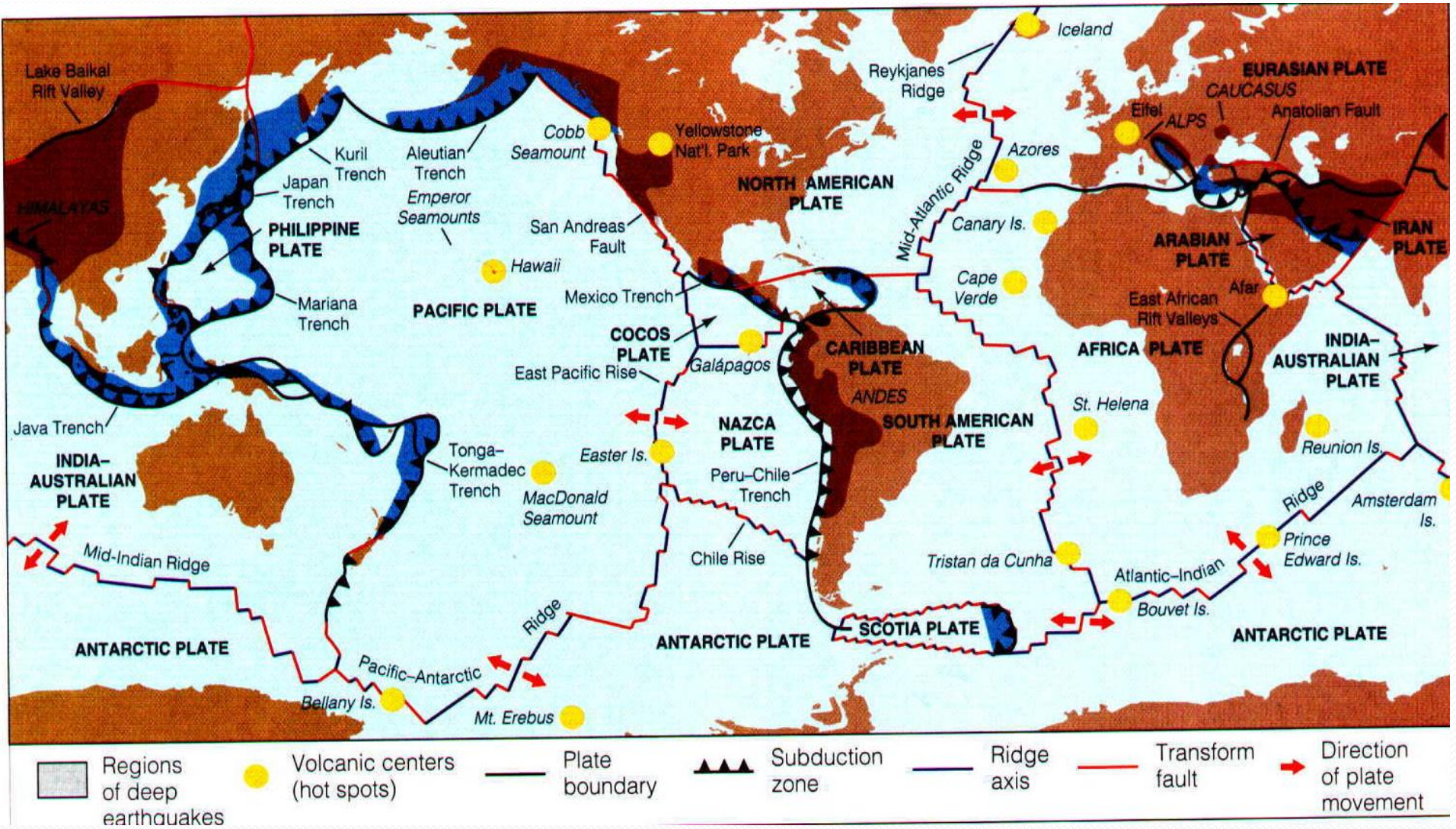


Gulf of Mexico Tsunami Risk – Earthquake Source

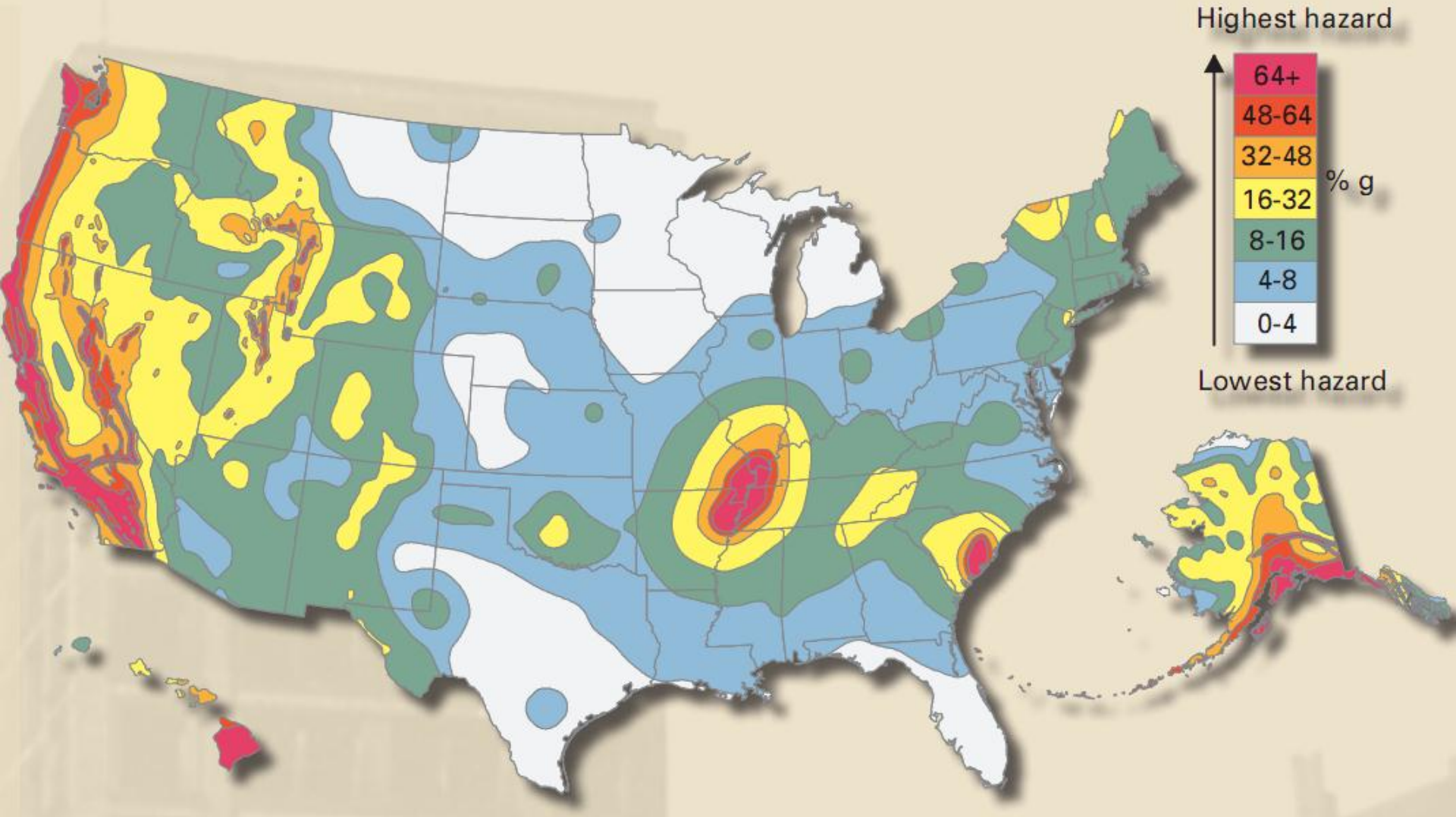
- **Earthquake Source in Gulf – No Credible Risk (Unless Associated Landslide Occurs)**

- **Earthquake Outside Gulf - No Credible Risk**

Plate Tectonic Map

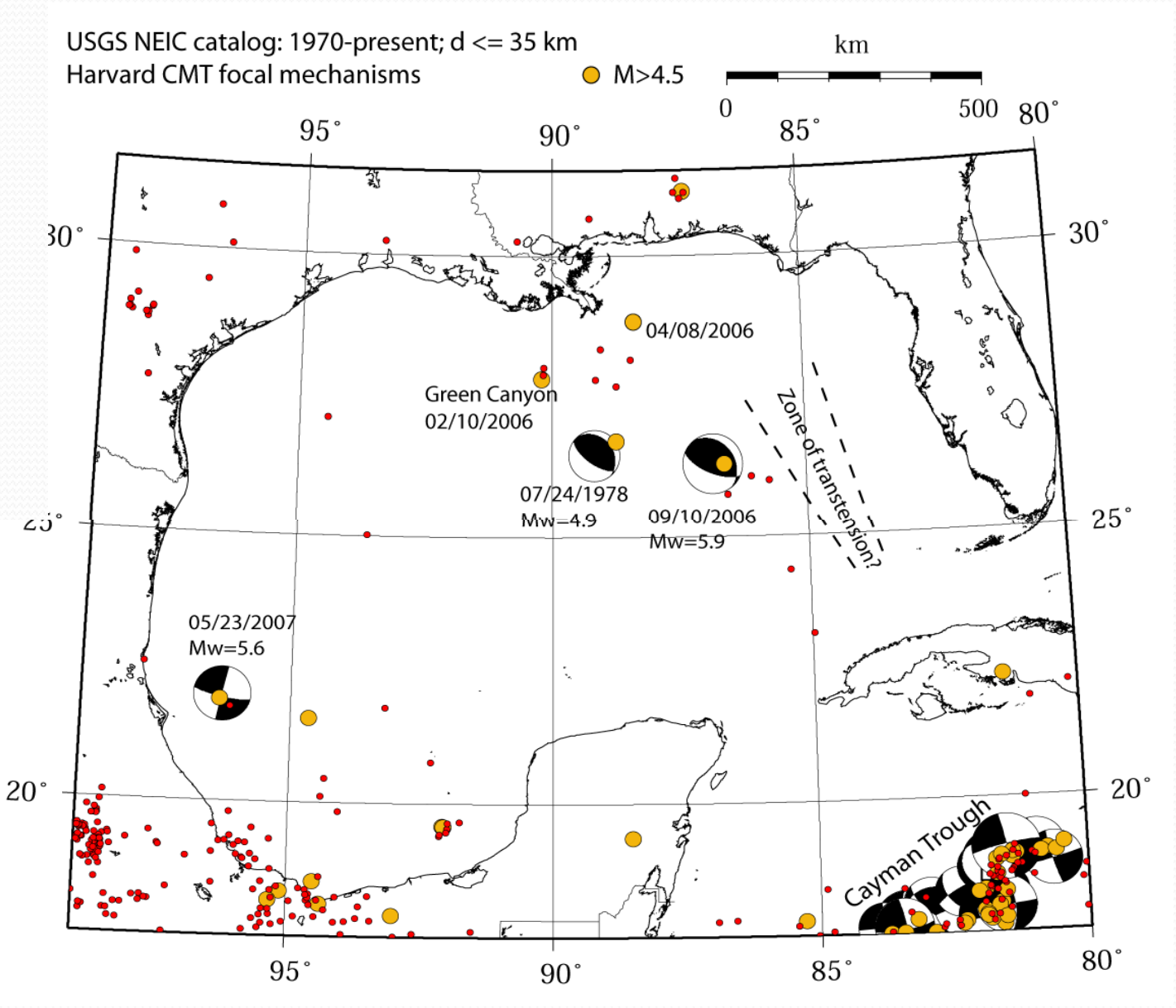


National Earthquake Risk

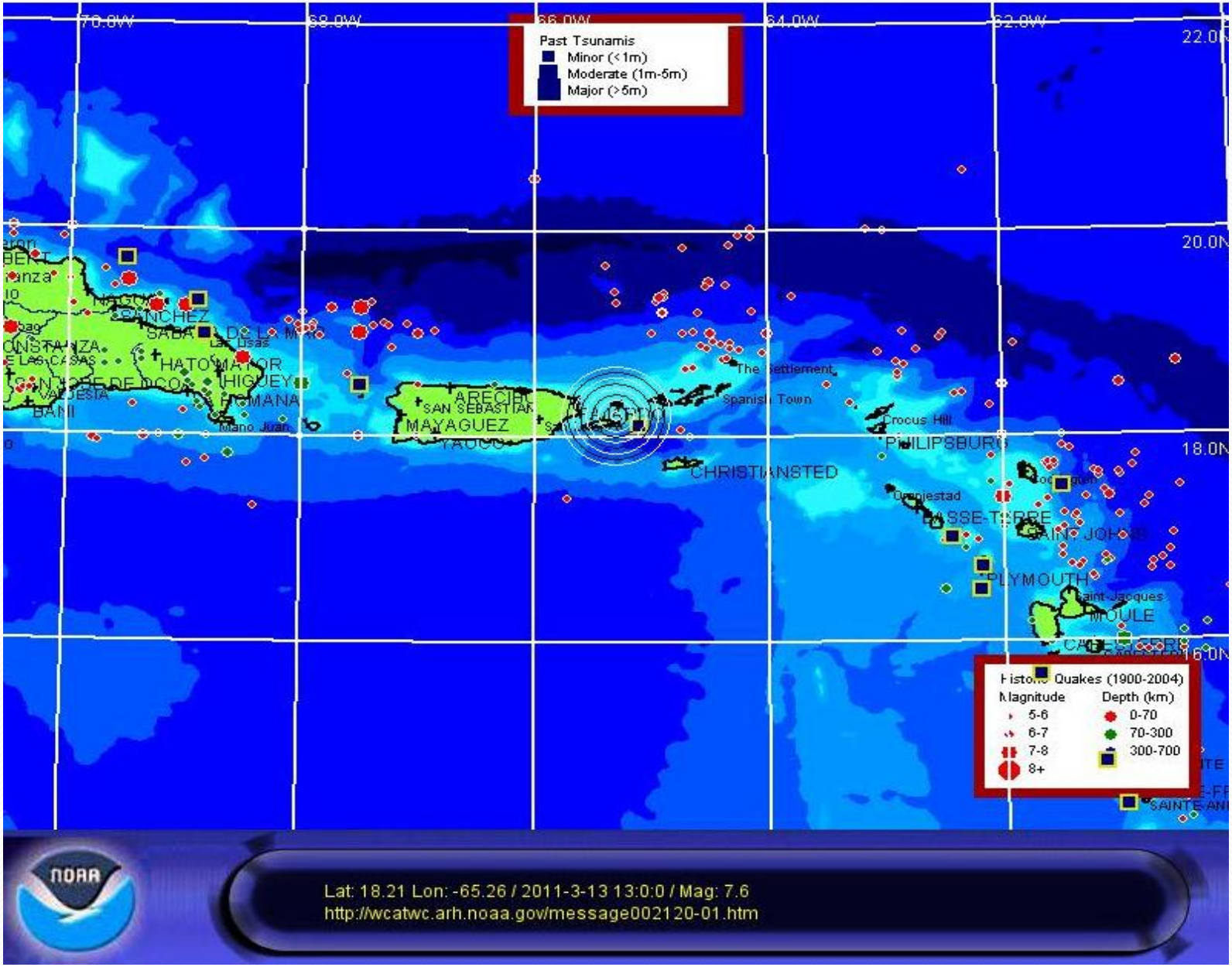


*Colors on this map show the levels of horizontal shaking that have a 2-in-100 chance of being exceeded in a 50-year period. Shaking is expressed as a percentage of **g** (**g** is the acceleration of a falling object due to gravity).*

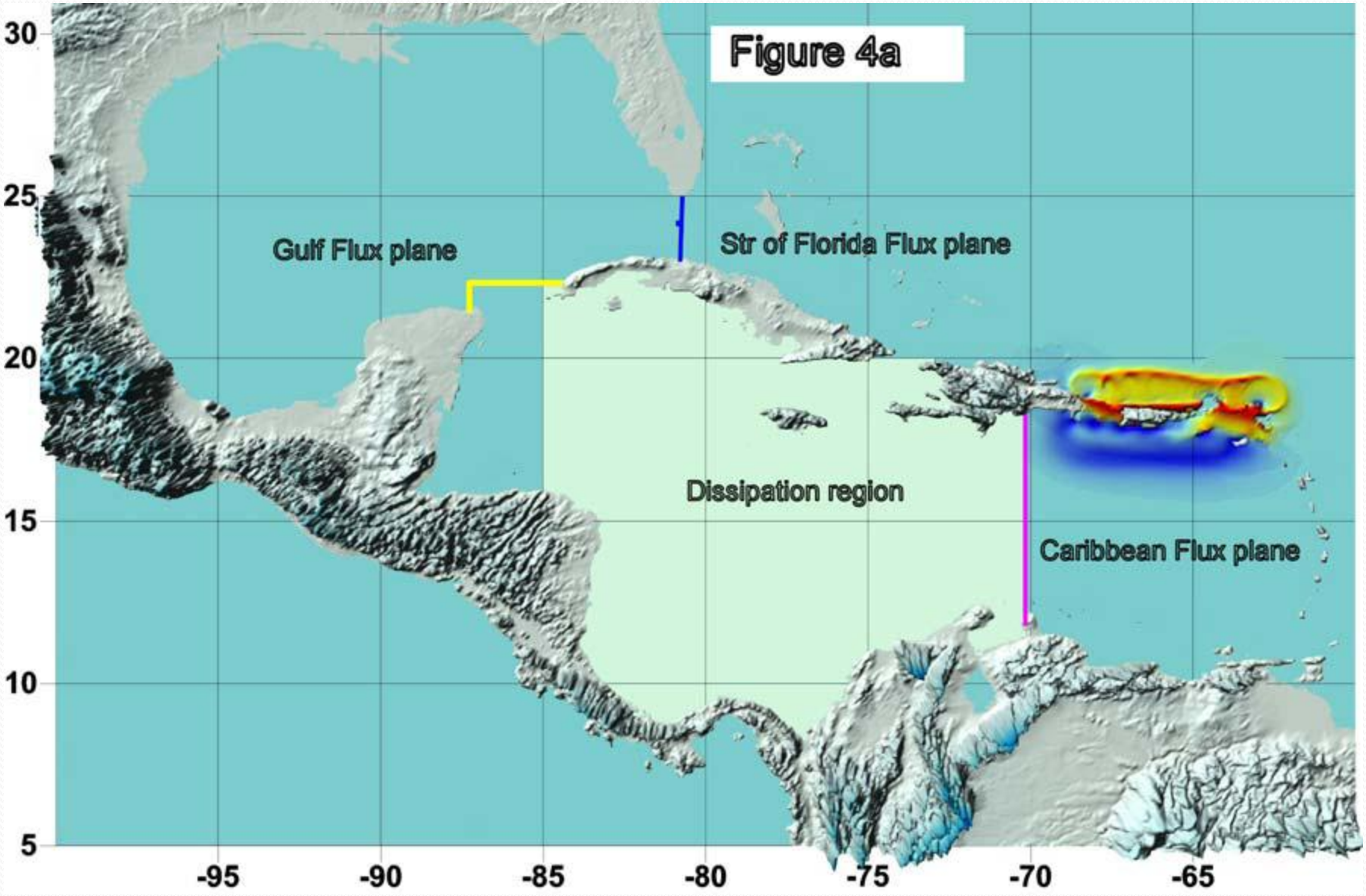
EARTHQUAKE IN GULF



Puerto Rico Trench Earthquakes



Tsunamigenic Dissipation Zone



PUERTO RICO TRENCH SIMULATION

Atlantic Simulation.wmv

VOLCANIC ERUPTIONS AND FLANK COLLAPSE SOURCE

- NONE EXPECTED
- GULF OF MEXICO SHIELDED FROM CANARY ISLAND/AZORES EVENT

ASTEROID SOURCE

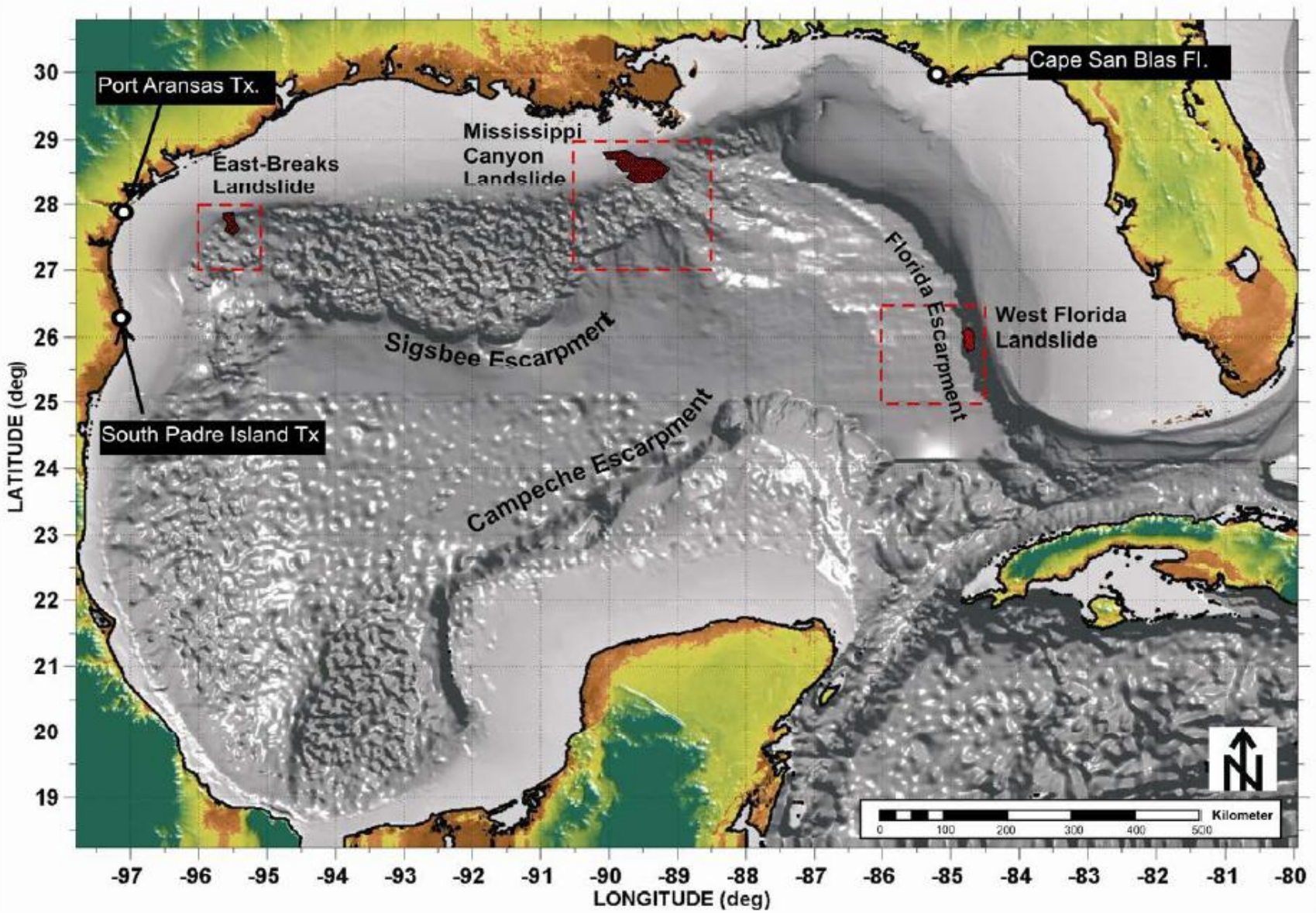
- **Asteroid** (**Apophis**, April 13, 2029 and 2036, orbit will be 18,300 miles from Earth: closer than geosynchronous satellite orbit, new study shown no impact in 2029, but 1 in 45,000 chance of impact in 2036)

- **PROBABILITY REALY LOW.**

SUBMARINE LANDSLIDE SOURCE

- **MINIMAL… HOWEVER CREDIBLE THREAT**
- **EARTHQUAKE 5.5M ALONG SLOPE**
- **GLACIAL MATERIAL COLLAPSE**
- **GAS HYDRATE**

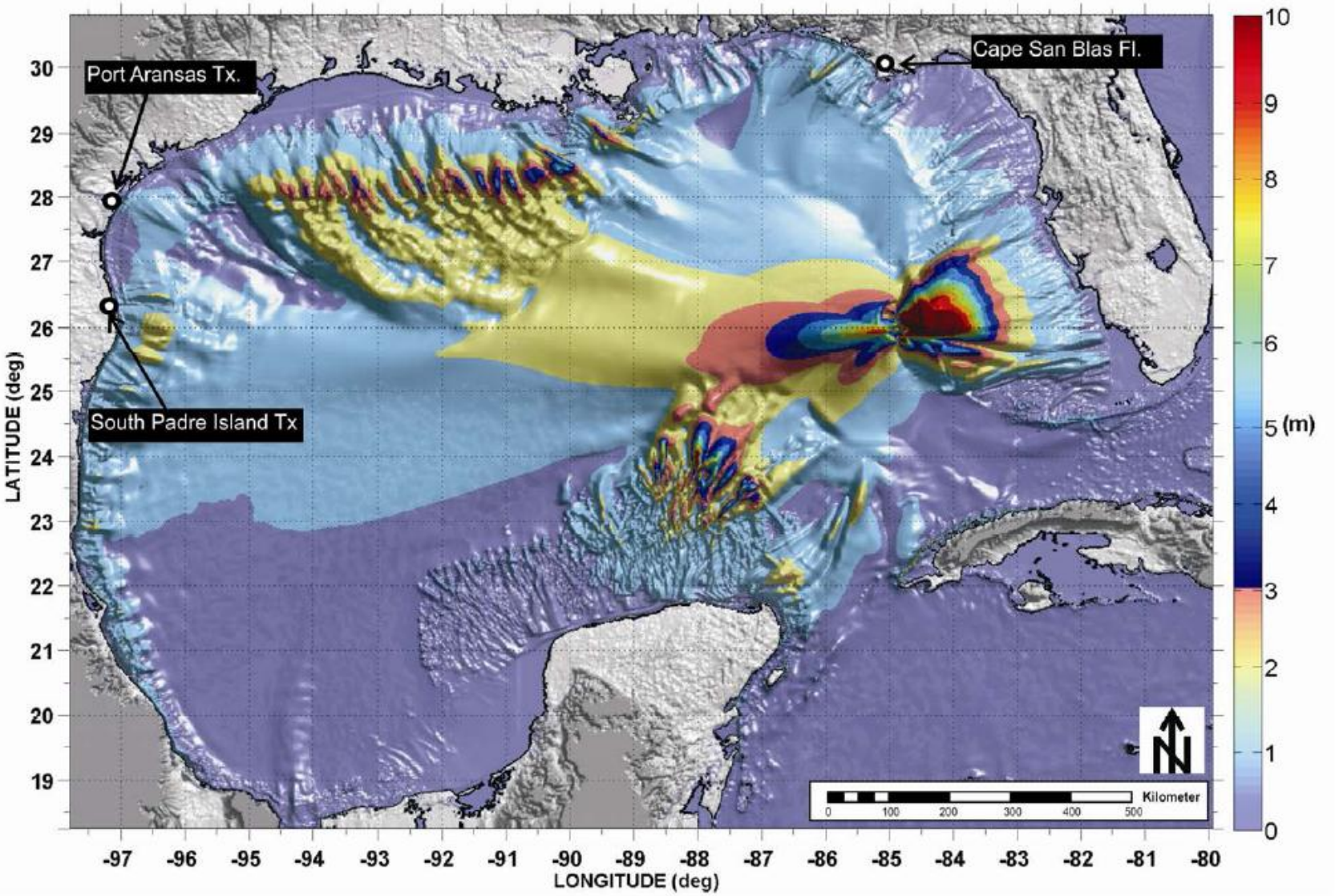
SUBMARINE LANDSLIDE ZONES



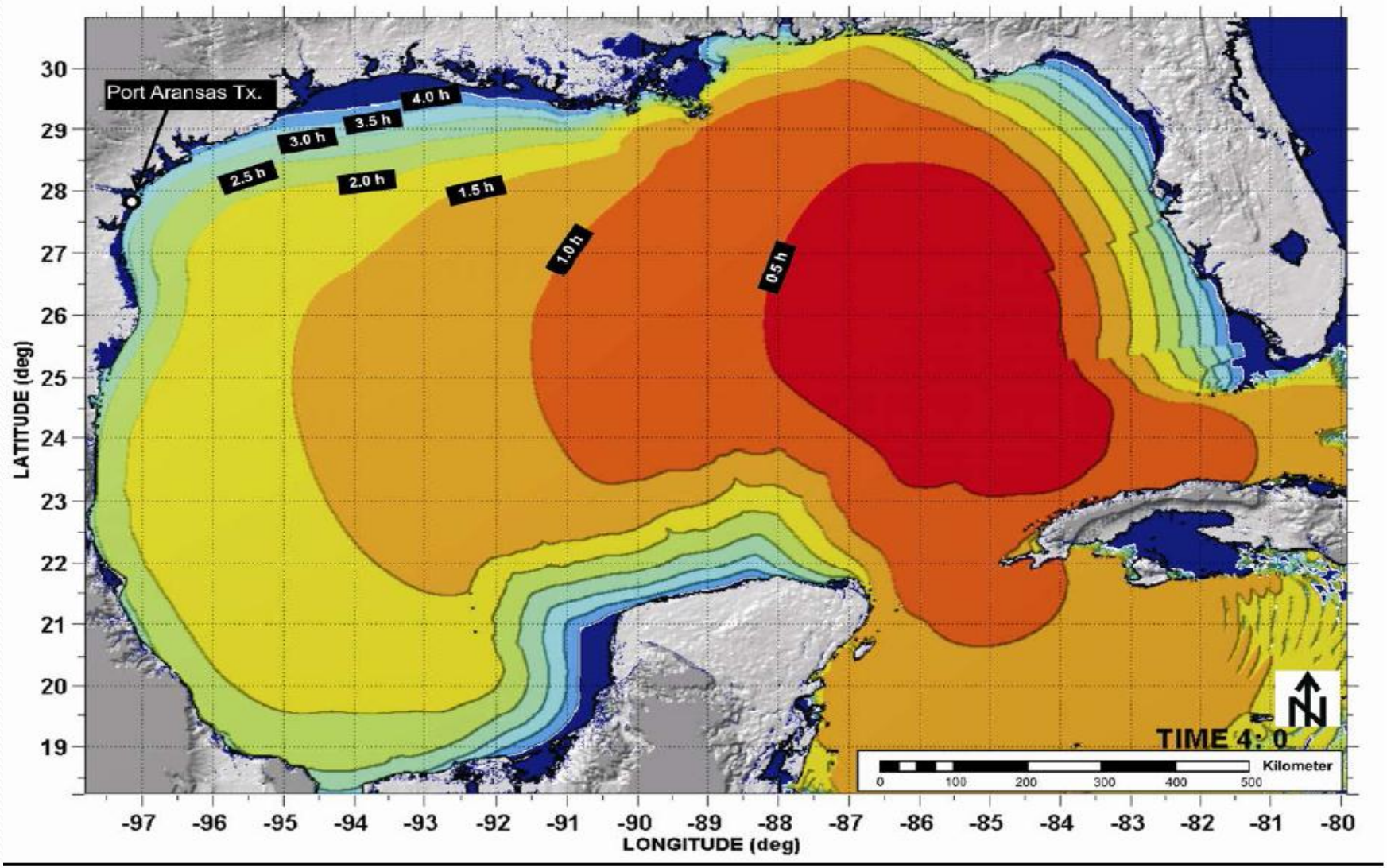
Gulf of Mexico Submarine Landslide Video

Credit: Steven Ward UC-Santa Cruz

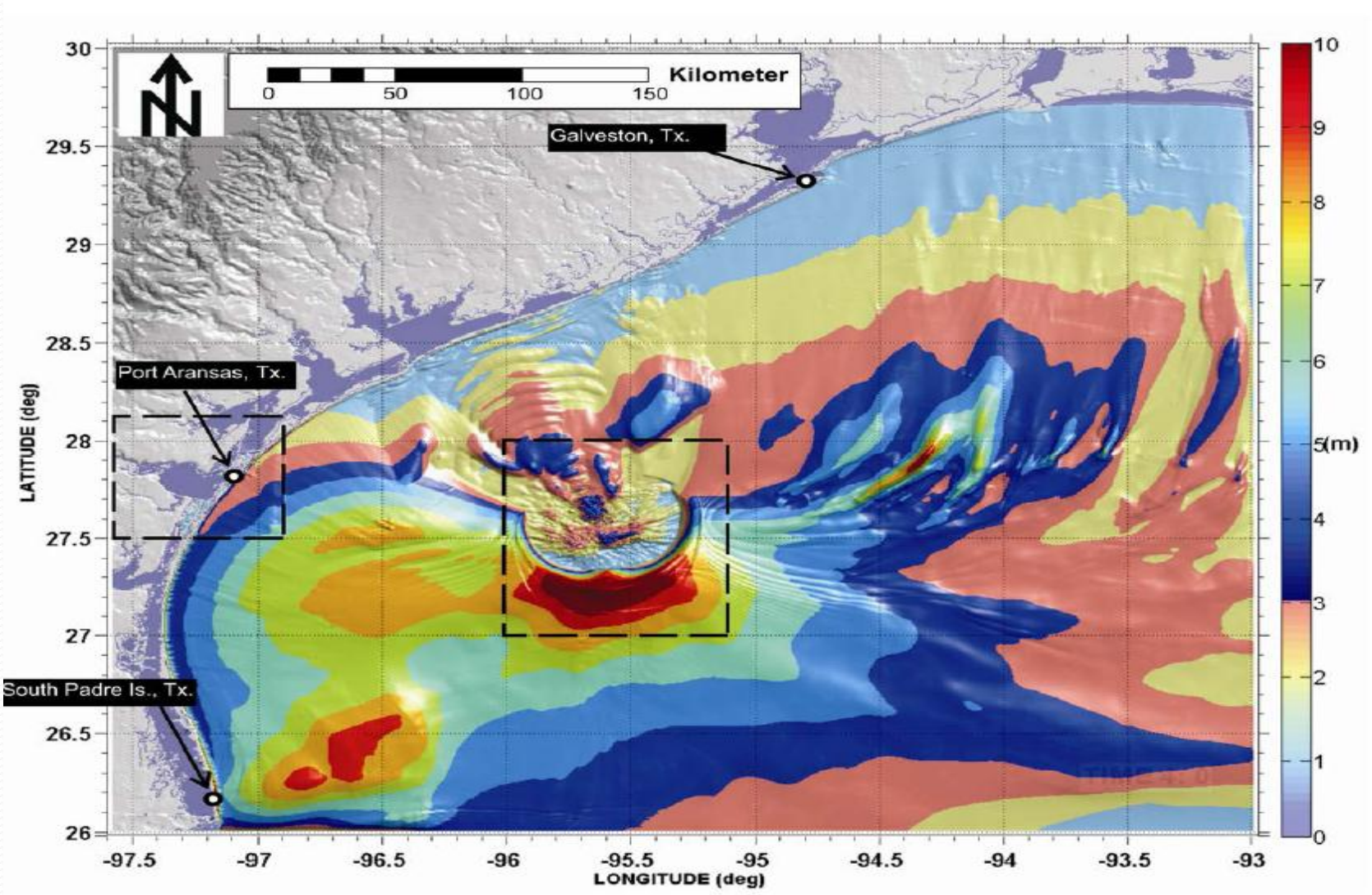
WEST FLORIDA EXAMPLE



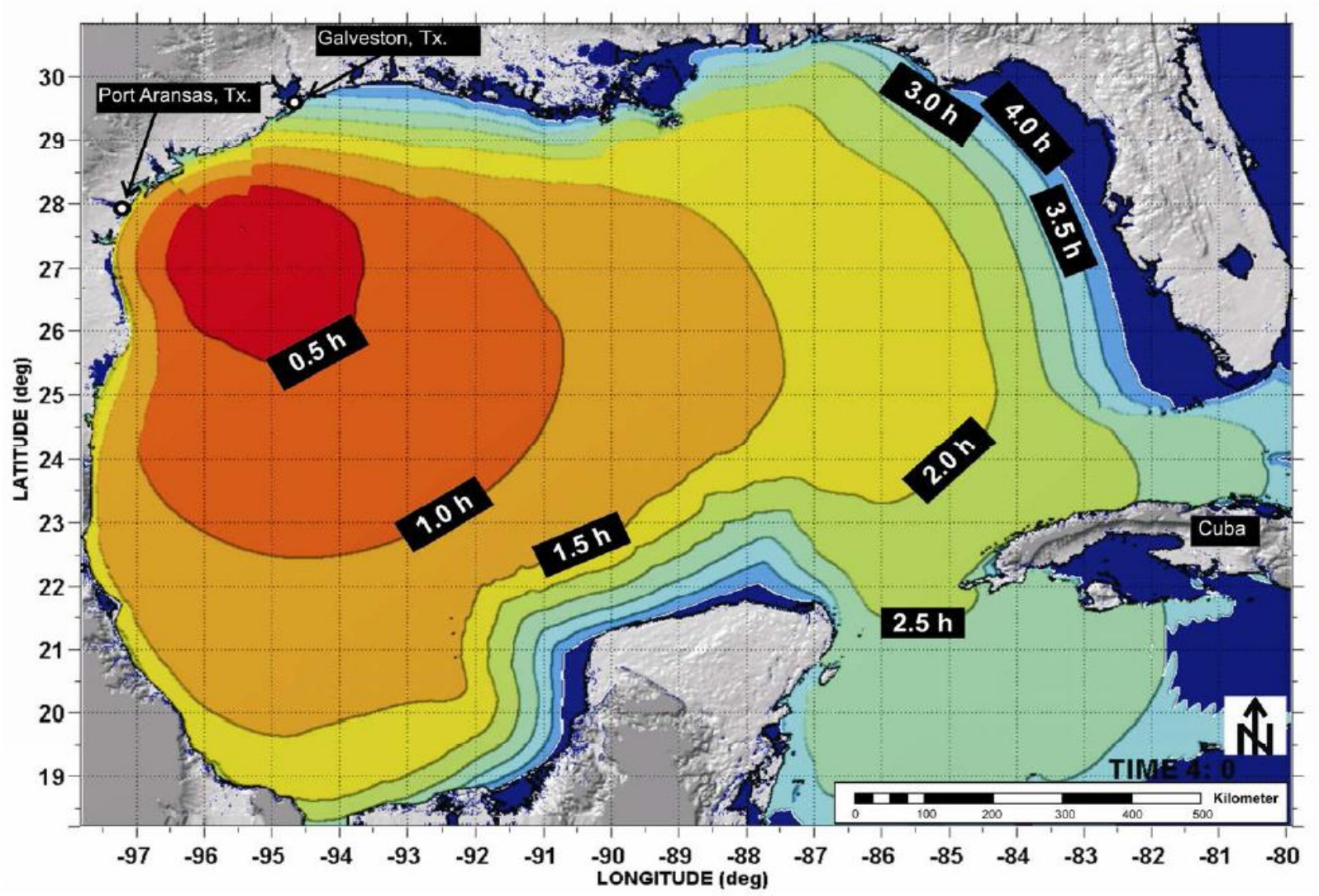
WEST FLORIDA EXAMPLE



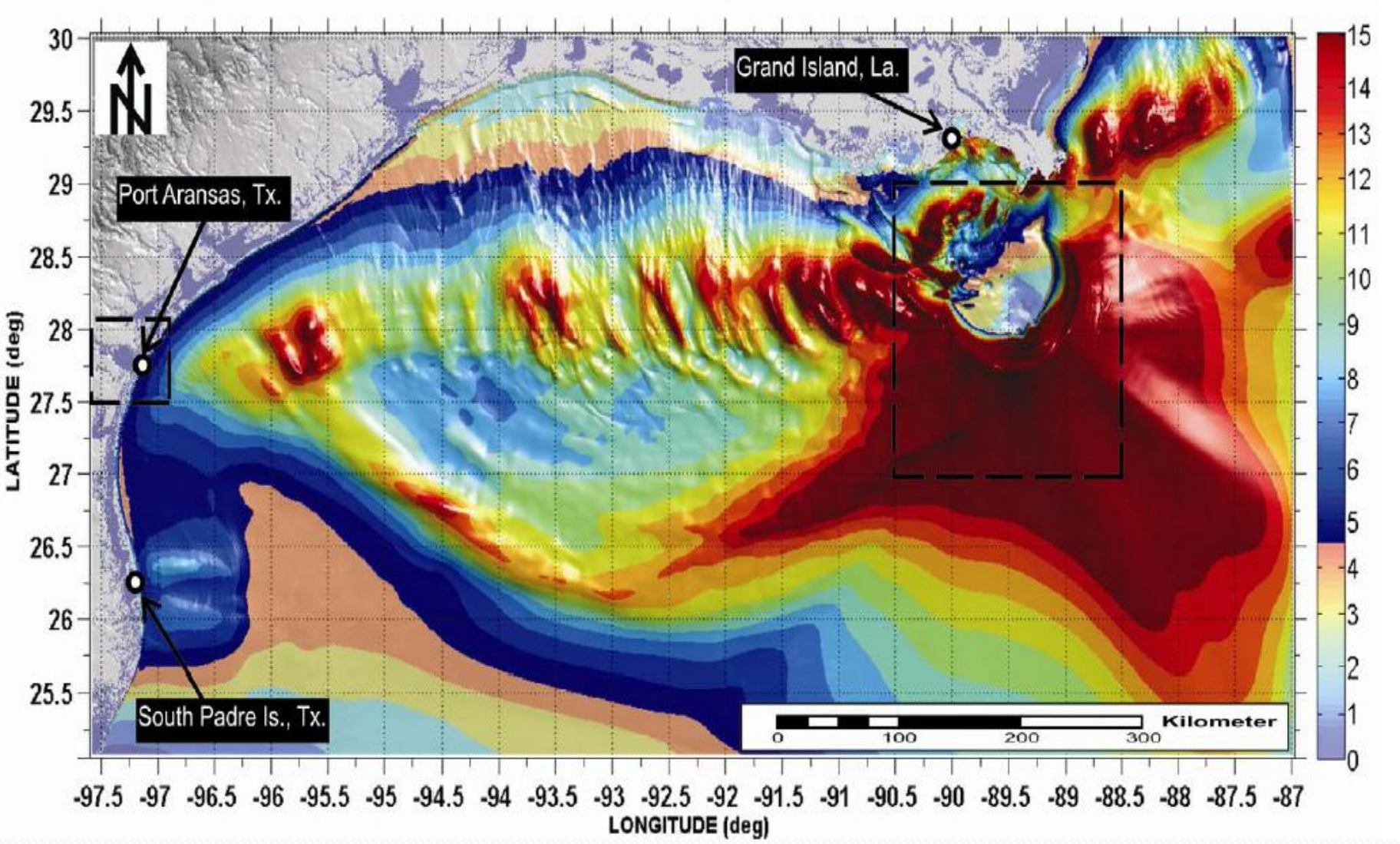
EAST BREAKS EXAMPLE



EAST BREAKS EXAMPLE



MISSISSIPPI CANYON EXAMPLE



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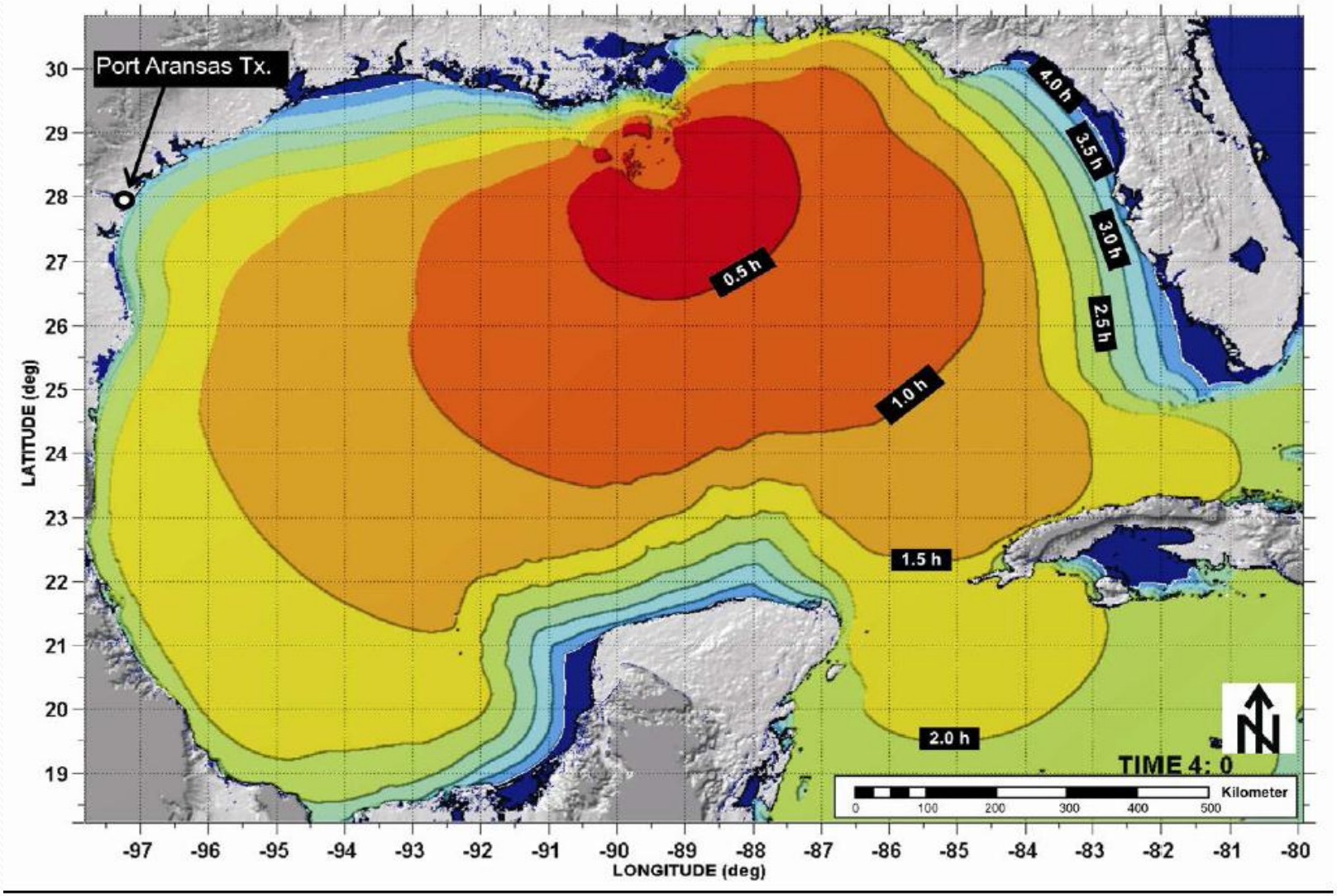


SUBMARINE LANDSLIDE NOTES

- **GOOD NEWS – RETURN RATE ON EVENT ESTIMATED TO BE EVERY 1000'S OF YEARS.**

- **BAD NEWS – UNLESS SIGNIFICANT SEISMIC EVENT ASSOCIATED WITH LANDSLIDE…WILL LIKELY BE UNDETECTED UNTIL REACHES DART BUOY OR THE COAST…SO VERY LITTLE WARNING TIME.**

What are the Hazards?

- **Flooding**
- **Damage From Wave Action/Strong Currents**
- **Secondary Impacts/Closing of Ship Channels**
- **Salt Water Intrusion**

Tsunami Hazards – Flooding

Risk – Road Closures.

- Hazardous Debris…Chemicals, Fuels.

- Worse Case…Destruction of Structures, Drowning of Livestock.

Natori, Japan March 11, 2011 Picture from National Geographic

Tsunami Hazards – Strong Currents

Risk – People Swimming/Wading
- Marinas/Boat Launches

Tsunami Hazards-
Loss of Commerce/Closing of Ship Channels

- Some of the Busiest Sea Ports in the Country.
-Over 120 Million Tons of Cargo Annually.
- Petroleum, Food Products, Forestry, Military.
- Largest Liquefied Natural Gas (LNG) Facilities.

Port of Beaumont

Sabine Pass LNG Facility

Tsunami Hazards – Salt Water Intrusion

Risk – Seven National Wildlife Refuges

- **Over 257,000 Acres in NWS Lake Charles' Area.**
- **Feeding/Resting Areas For Migratory Waterfowl.**
- **McFaddin – Largest Freshwater Marsh Texas Coast.**
- **Bayou Teche – Habitat For Louisiana Black Bear… A Threatened Species.**

How do tsunami warning communications work?

Where they come from…

How they are relayed…

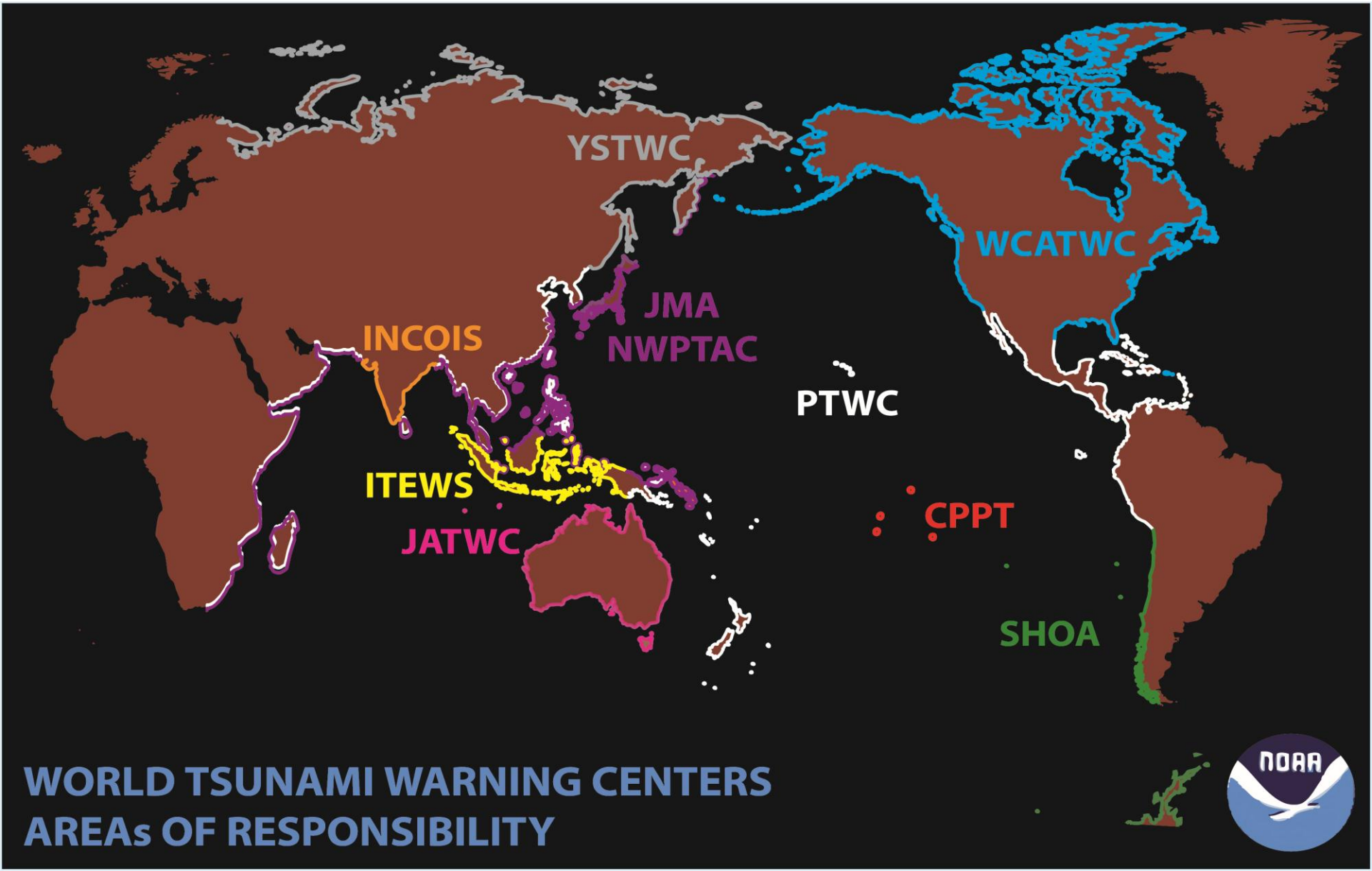
Definitions…

Tsunami Warning Systems – United States History

- 1949 Honolulu Observatory established
  - Co-located with existing Magnetics Observatory
  - Used data sent via teletype from seismic observatories
  - Established in time for major tsunamis of the 50s/60s
- 1967 Alaska Tsunami Warning System established
  - Followed tsunami destruction due to 1964 Gulf of Alaska earthquake
  - Originally 3 centers; later combined into 1.
- 1968 Pacific Tsunami Warning Center established
  - Officially expanded scope of Honolulu Observatory to other nations

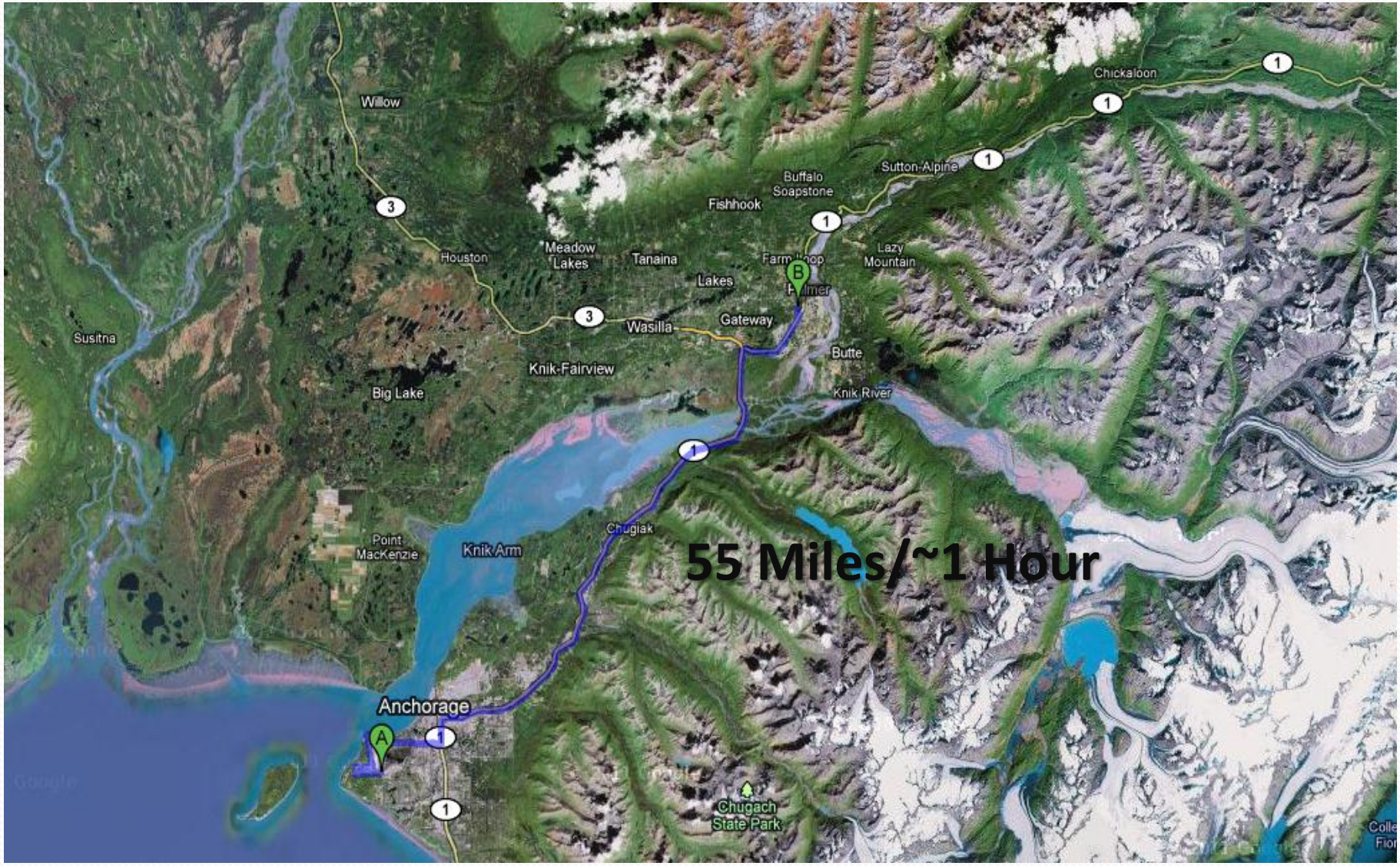
YSTWC - Yuzhno-Sakhalinsk Tsunami Warning Center
INCOIS - Indian National Centre for Ocean Information Services
ITEWS - Indonesia Tsunami Early Warning System
JATWC - Joint Austalia Tsunami Warning Centre

WCATWC - West Coast and Alaska Tsunami Warning Center
JMA NWPTAC - Japan Meteorological Agency
North West Pacific Tsunami Alert Center
PTWC - Pacific Tsunami Warning Center
CPPT - Centre Polynésien de Prévention des Tsunamis
SHOA - Servicio Hidrográfico y Oceanográfico de la Armada



WORLD TSUNAMI WARNING CENTERS
AREAs OF RESPONSIBILITY

National Tsunami Warning Center



National Tsunami Warning Center

TSUNAMI WARNING SYSTEM TRAINING
PALMER, ALASKA
APRIL 5-7, 2011

National Tsunami Warning Center Operations

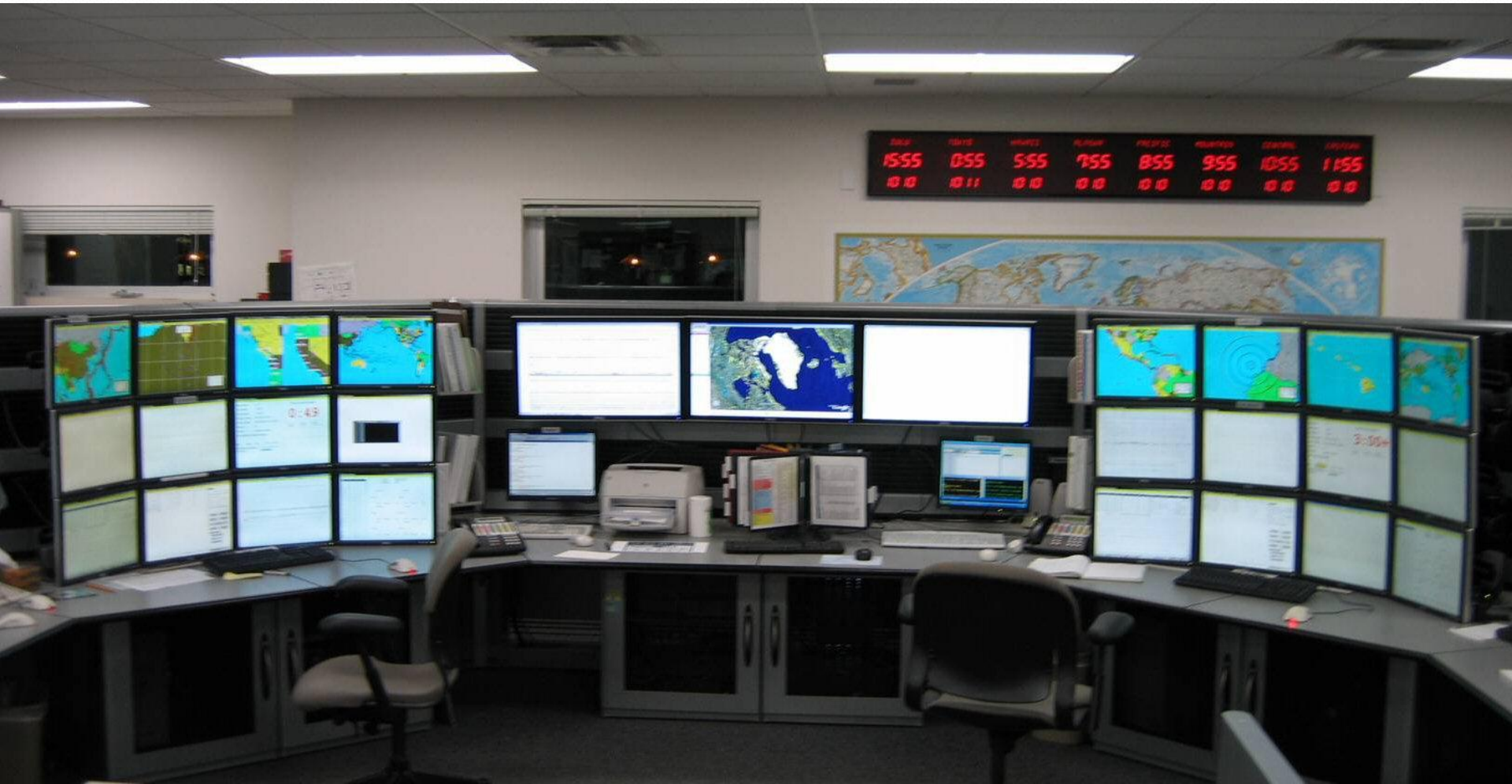
- NTWC -

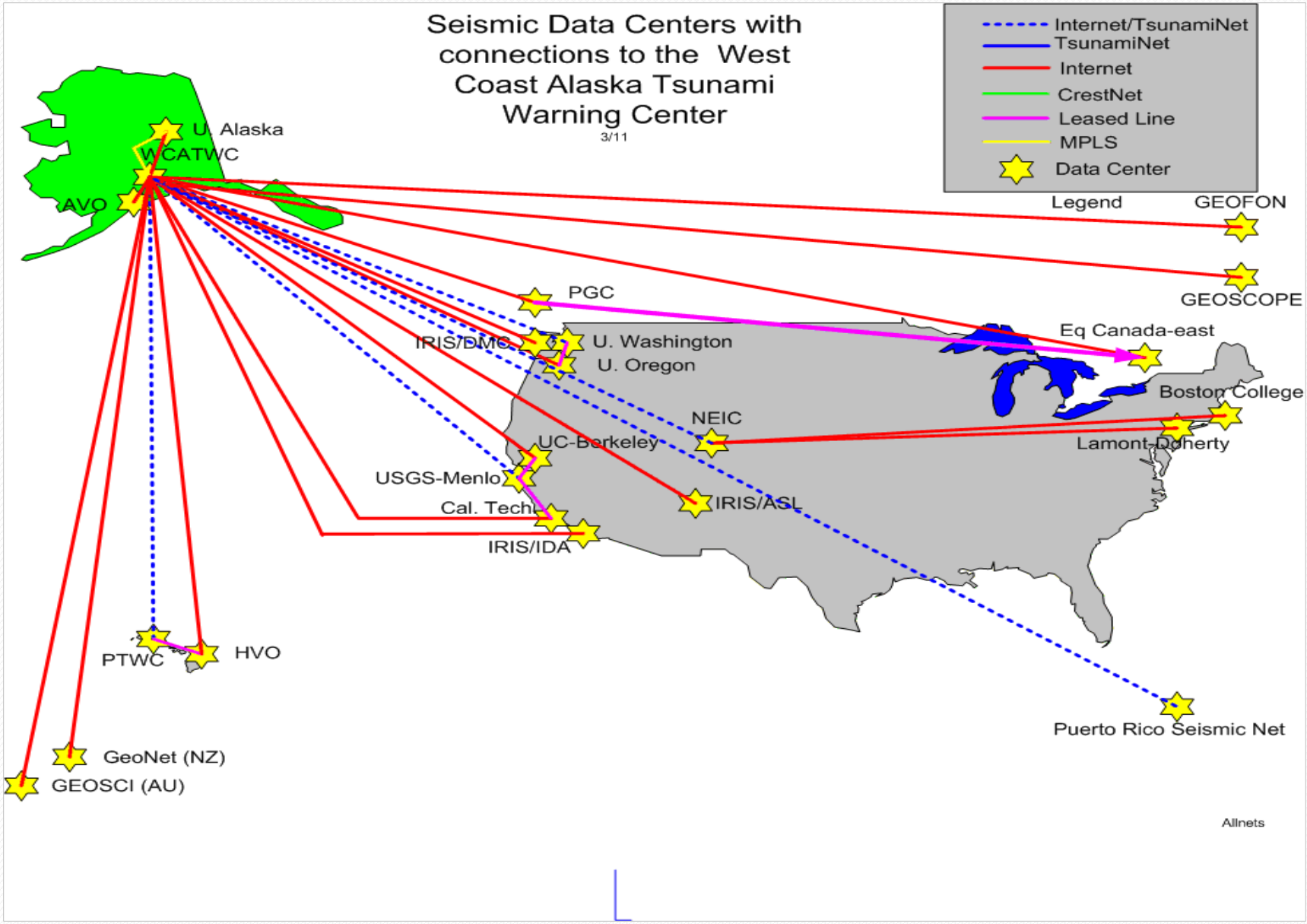
  10 Watch Standers /

  2 on duty 24/7/365

  issues forecasts for the Gulf Coast based on
  - Seismic and ocean data
  - Model forecasts

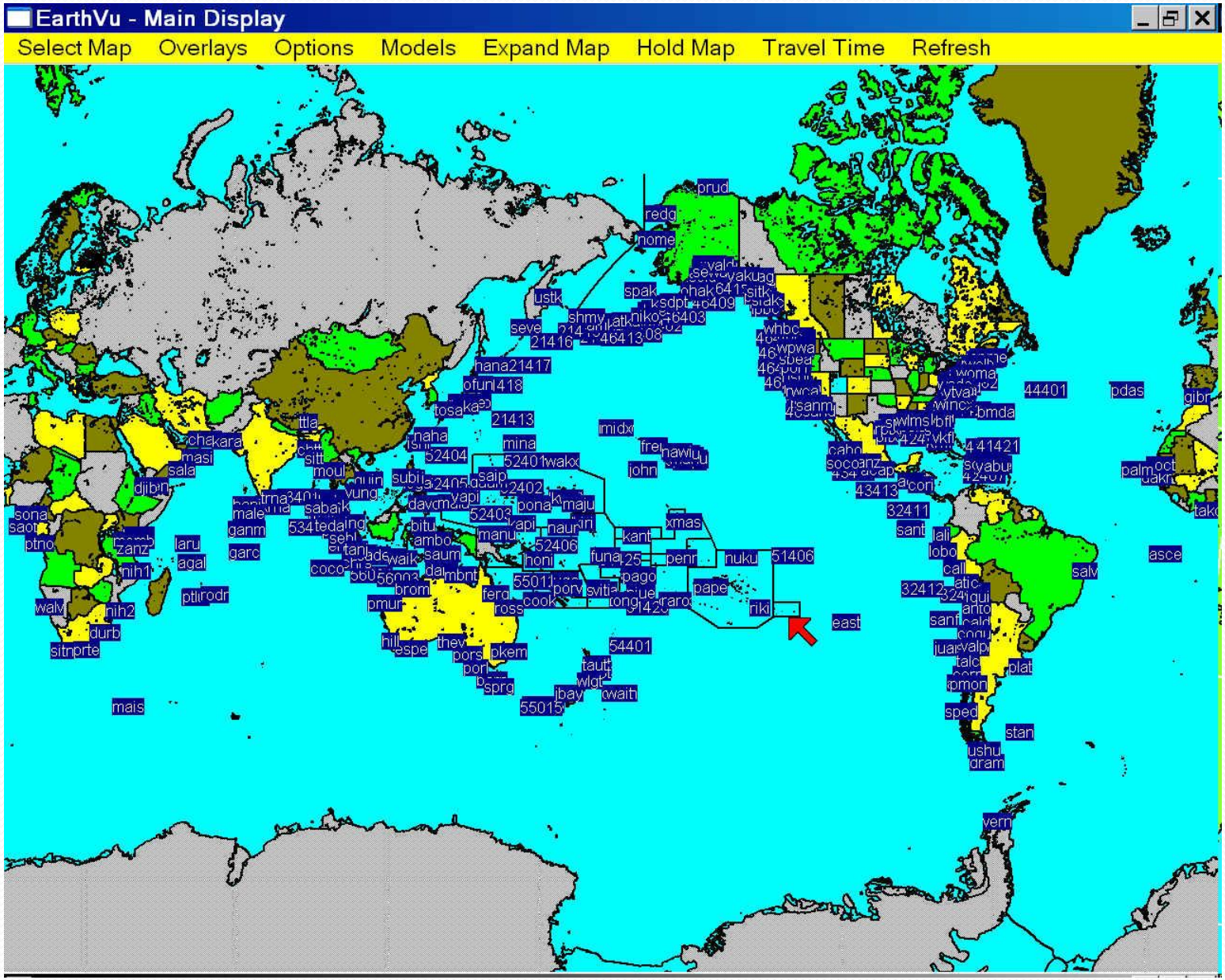
National Tsunami Warning Center Operations Area



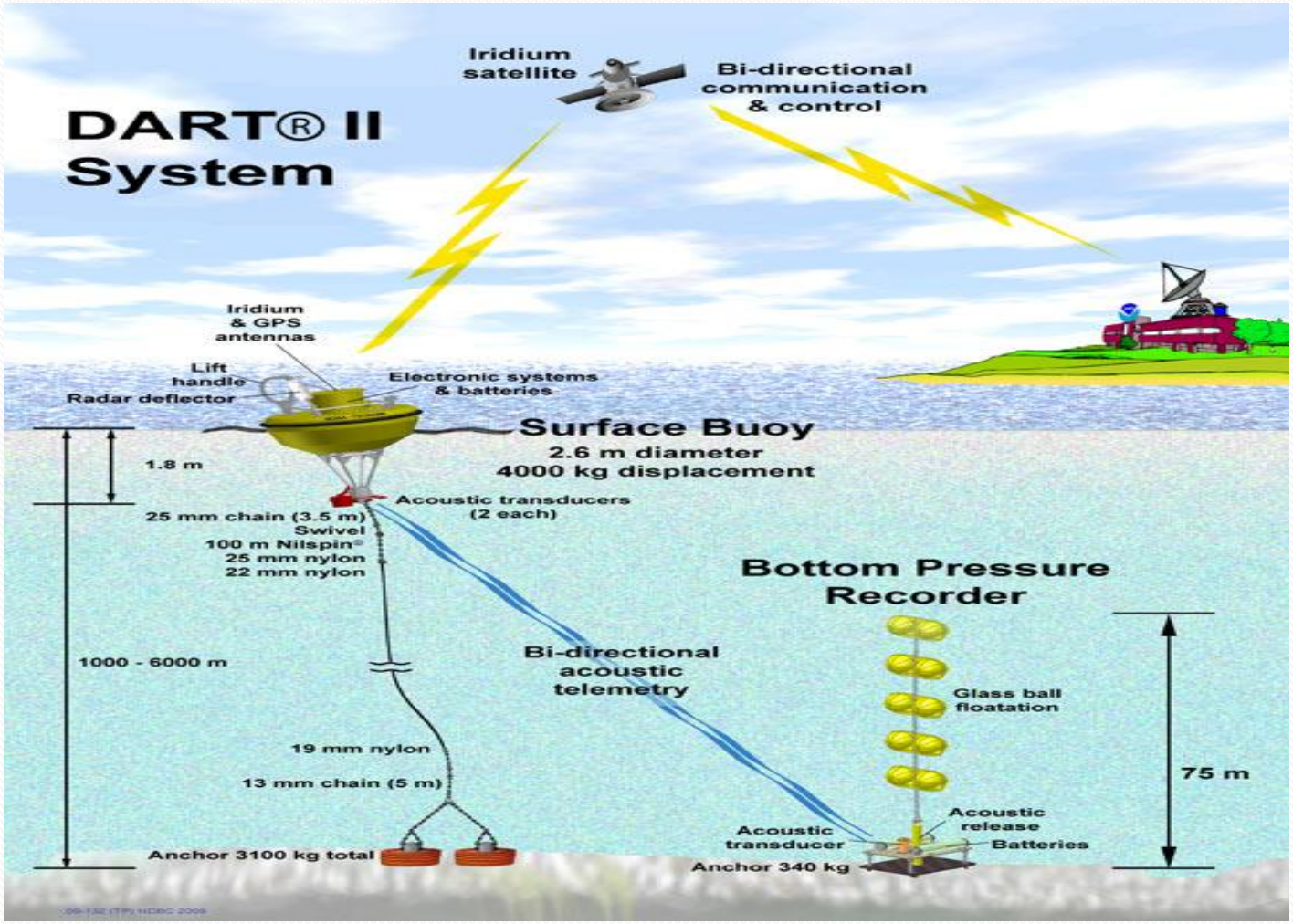


Data from 23 data centers consisting of 60 seismic networks with 462 seismic stations recorded at WCATWC. Data arrives via dedicated data circuits, internet, virtual private networks and a private satellite network. Almost all data has multiple routing for backup purposes.

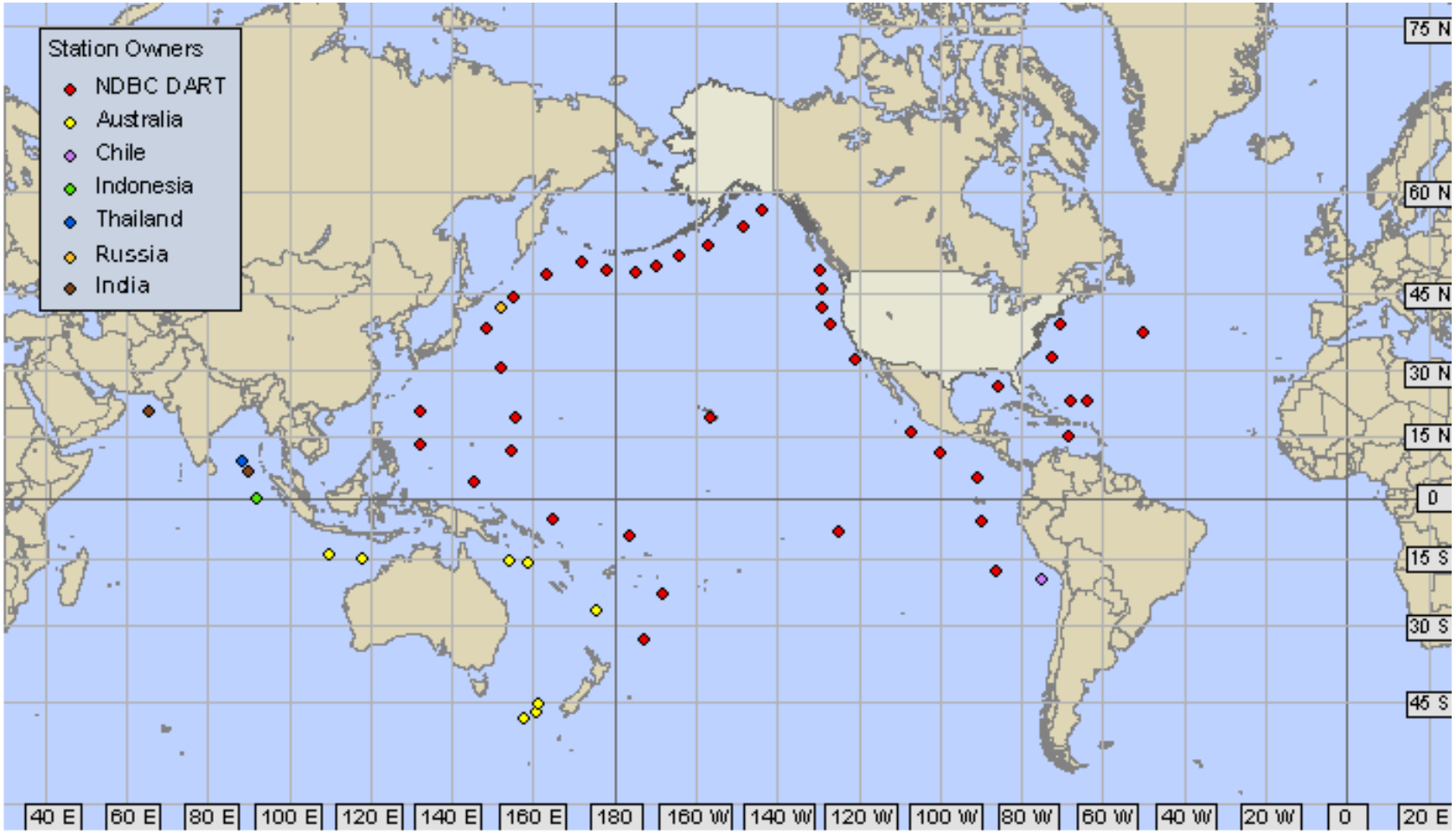
Tide Gauges Used at NTWC



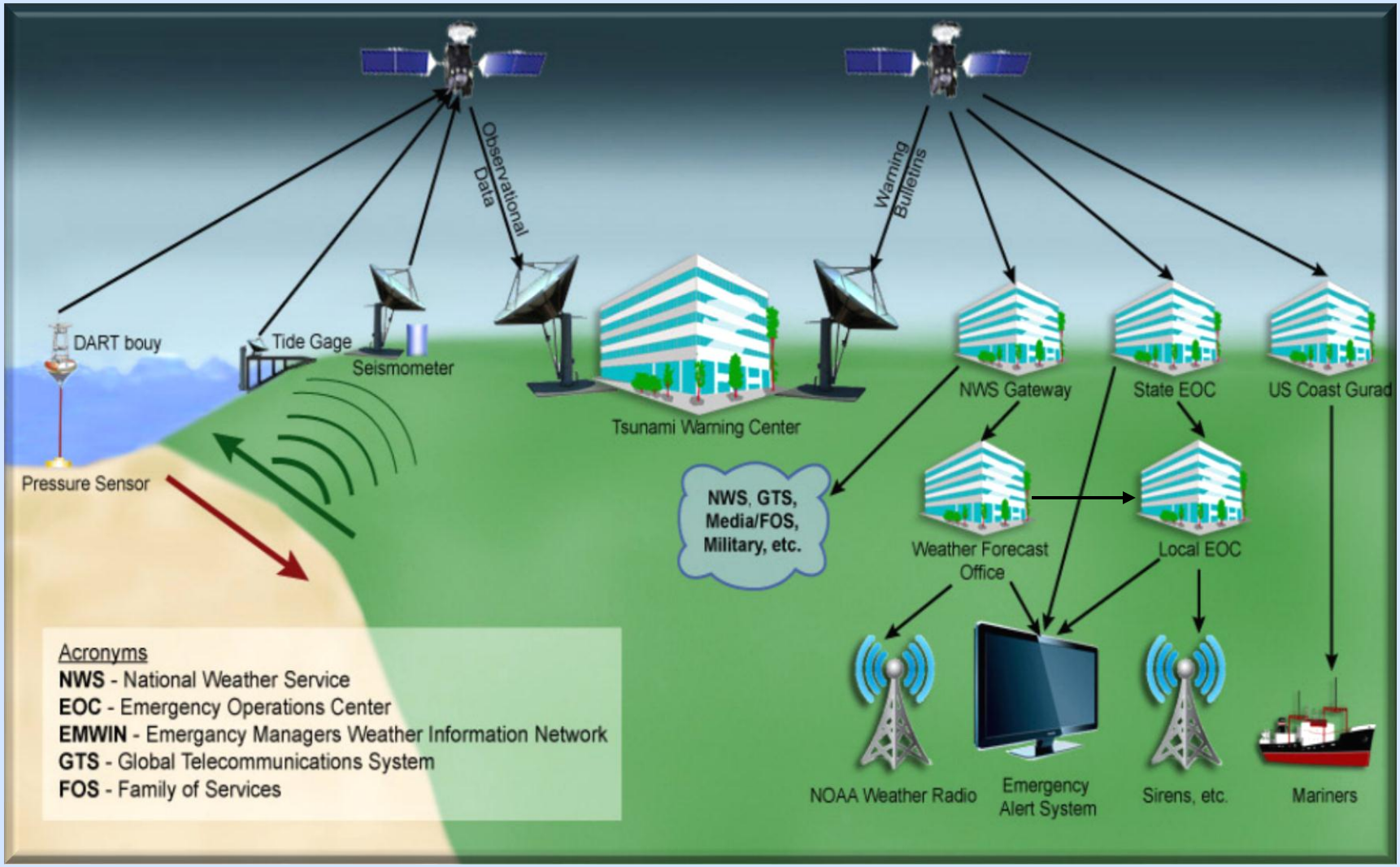
DART = Deep-ocean Assessment and Reporting Tsunamis



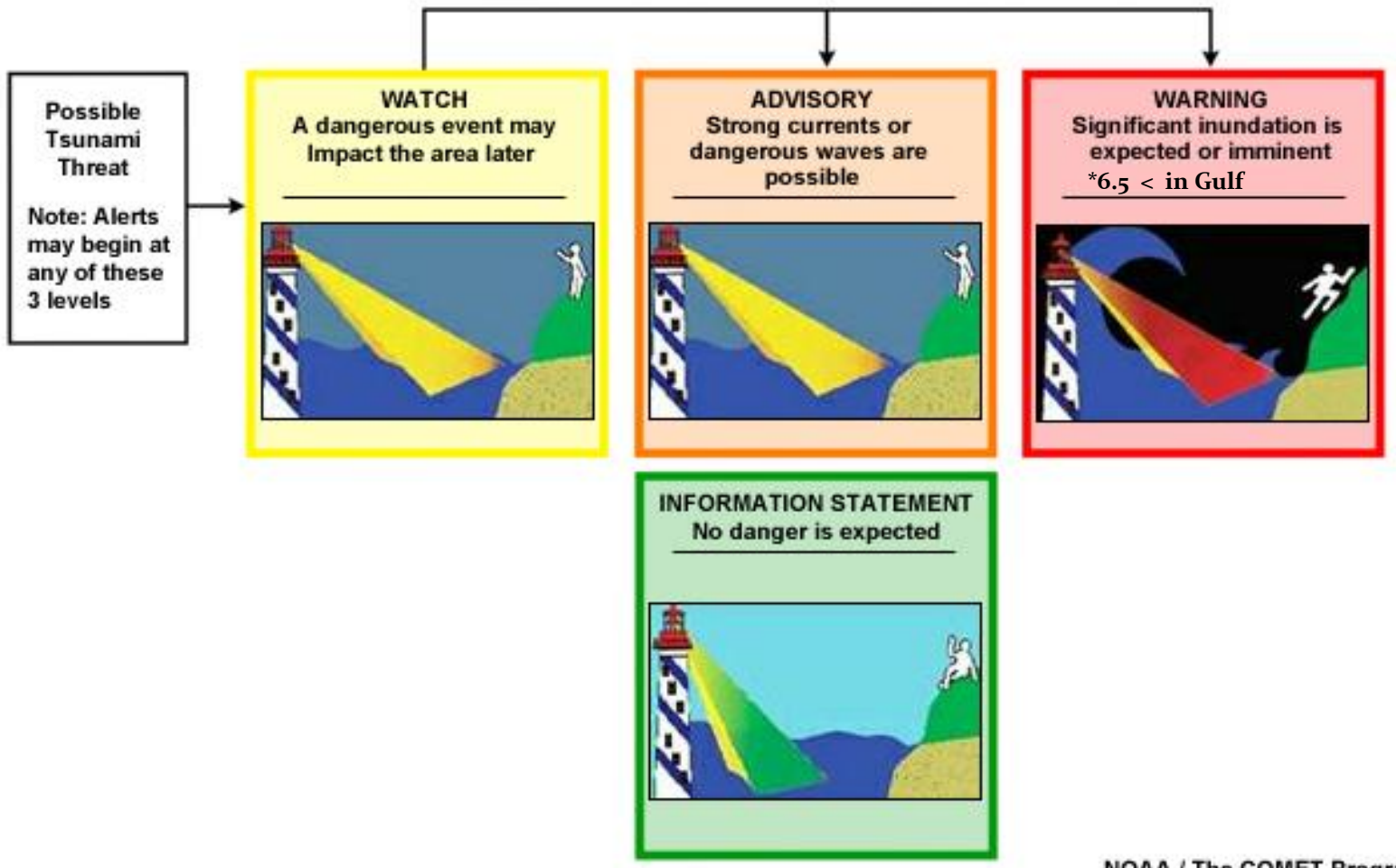
Location of DARTs
3-22-2012



Communications Redundancy



Tsunami Warning Levels



NTWC BREAKPOINTS FOR WFO LCH

High Island Texas to Morgan City Louisiana

Includes Southeast Texas Counties:
Jefferson…Orange

Includes Louisiana Parishes:
Cameron…Vermilion…Iberia…Saint Mary

Gulf of Mexico has Lower Tsunami Hazard Compared to Other Hazards

However

Do not forget the **Back Swan** Theory

Be on guard for the

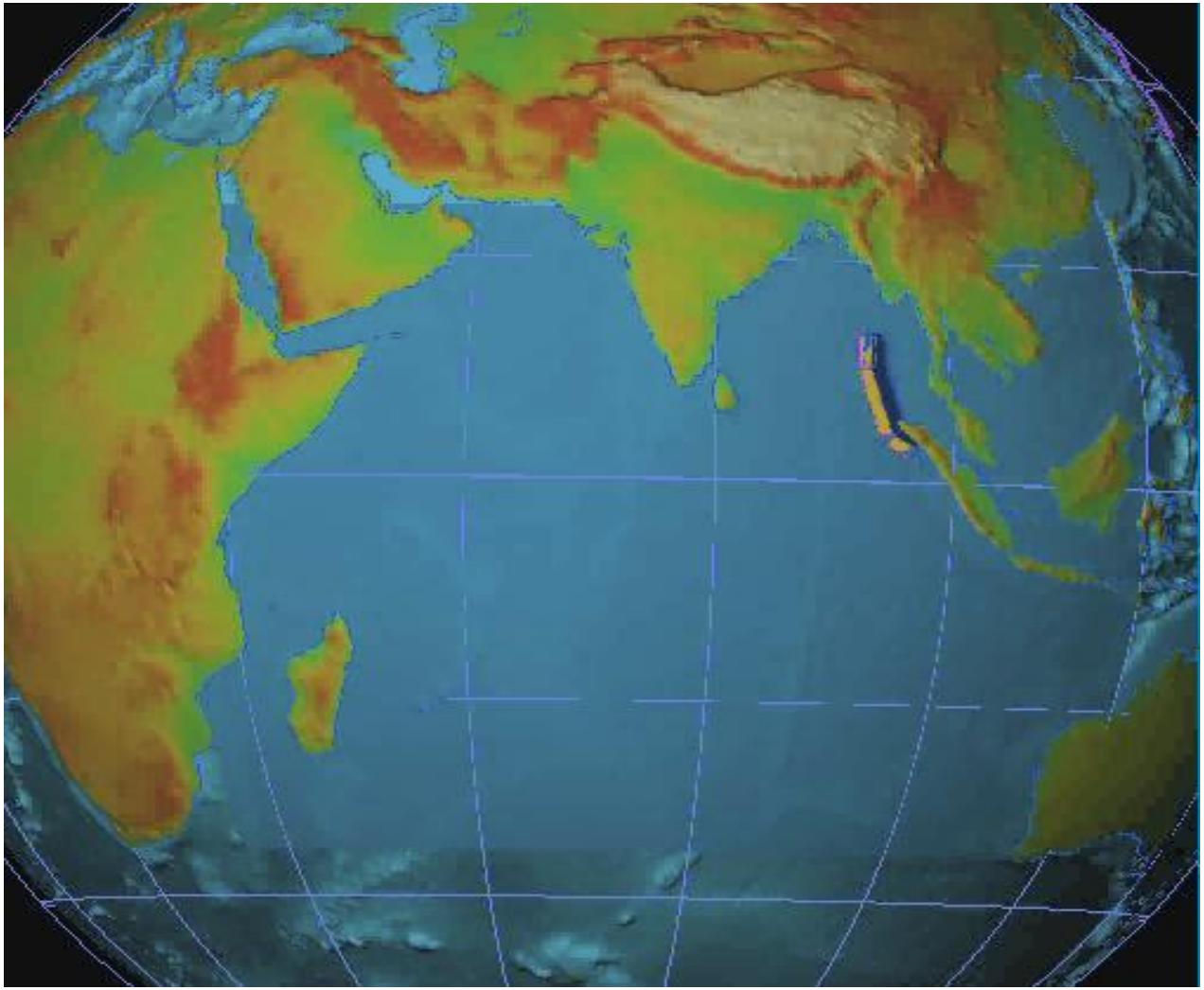
"Can Not Exist Event",

the large impact, hard to predict, and rare event beyond the realm of normal expectation.

Tsunamis:
They May Be Rare…
Let's Still Prepare!

Interesting Tsunami Slides

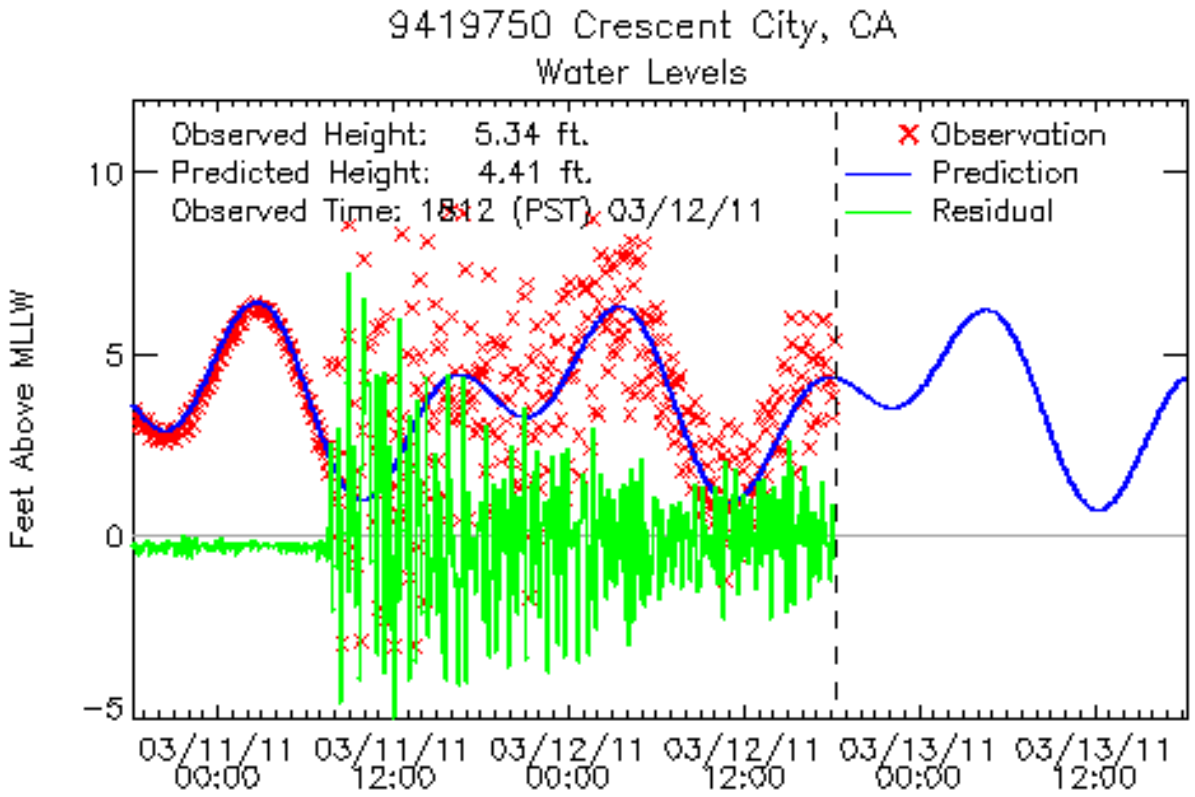
Indian Ocean Tsunami December 26, 2004



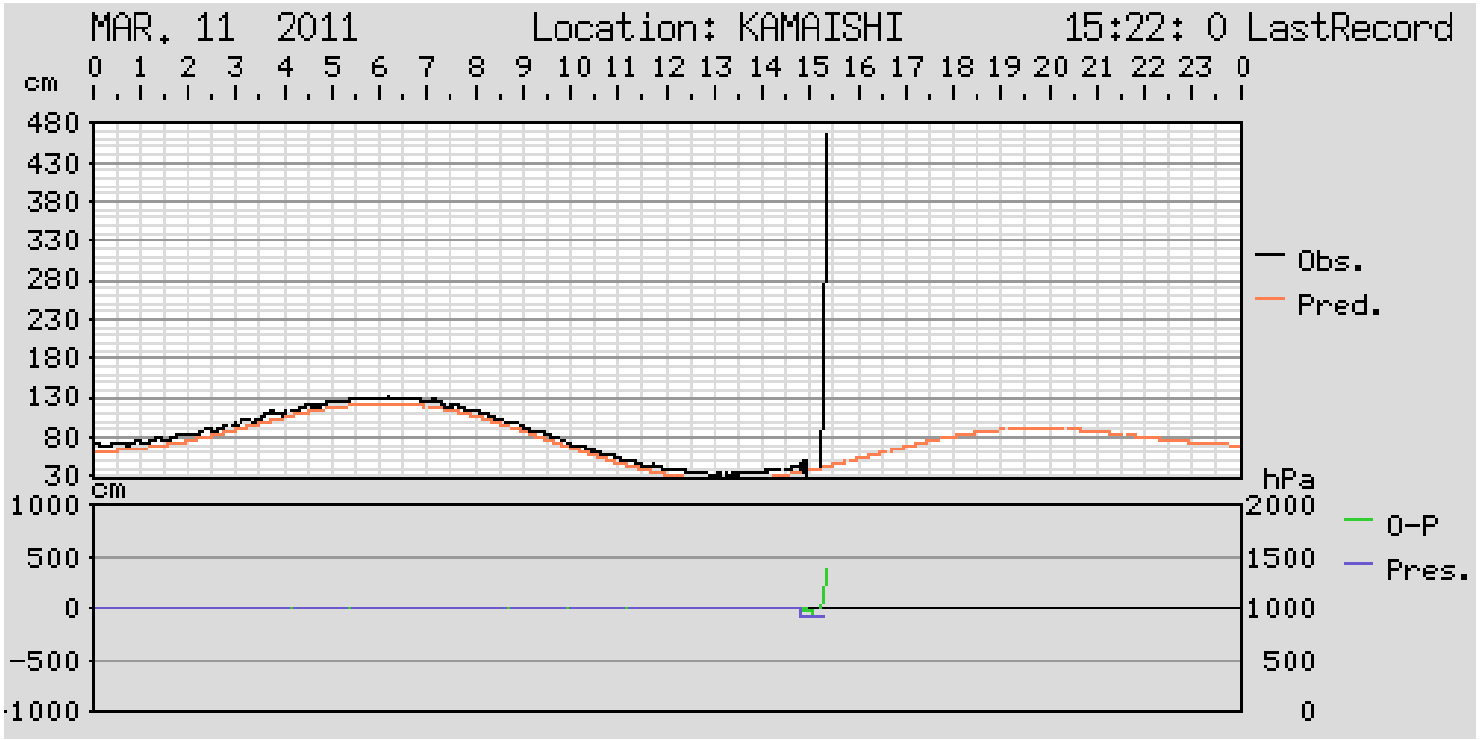
Indian Ocean Tsunami 2004 Thailand

(Click to play animation)

Japan Tsunami 3-11-11
Crescent City, CA



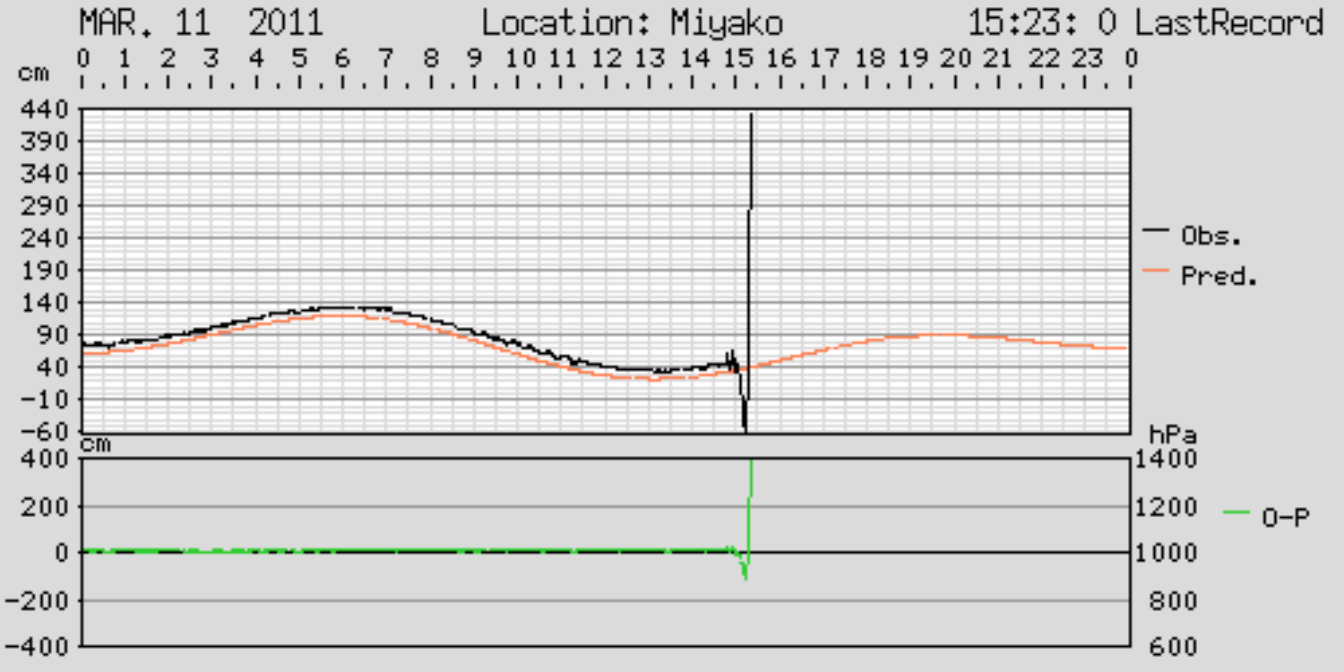
Japan Tsunami 3-11-11
Kamaishi, JA



Recorded Over 15 Ft Before It Stopped.

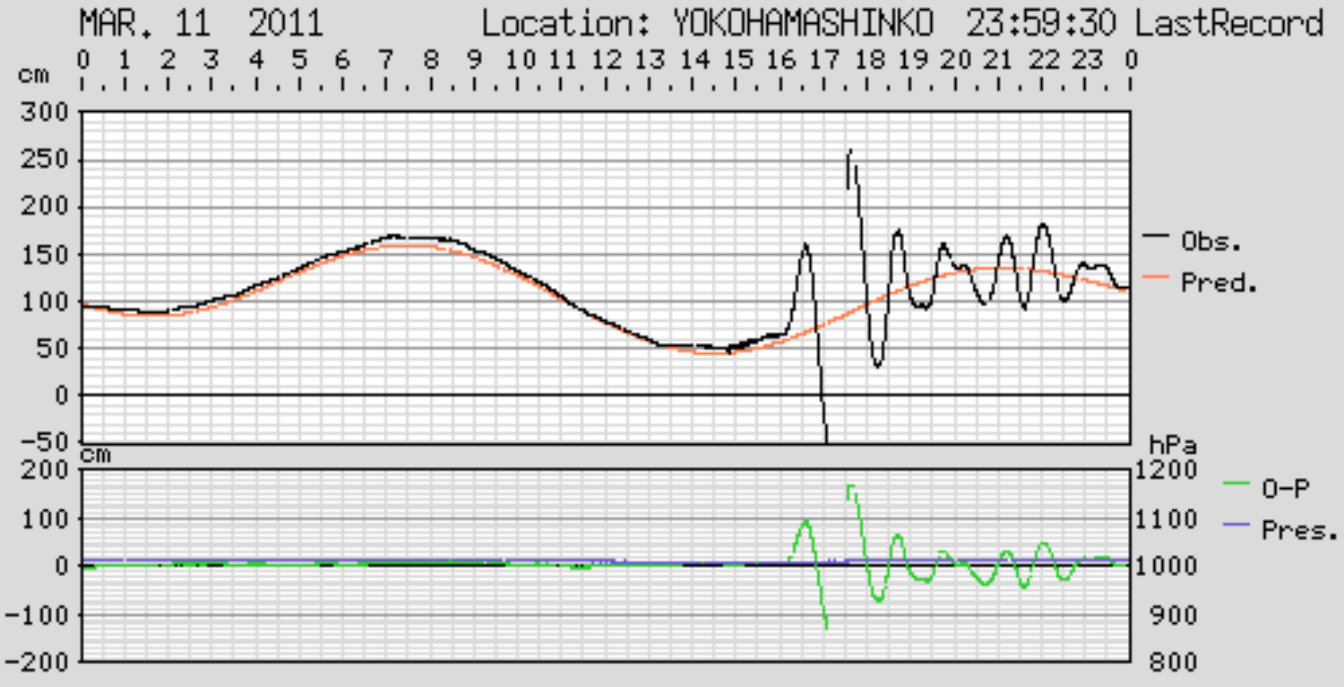
Japan Tsunami 3-11-11

Miyako, JA



Recorded Almost 2 Foot Drop Before Rise

Japan Tsunami 3-11-11
Yokohama, JA



Gauge Shows Tsunami Series of Waves

JAPAN EAS EARTHQUAKE WARNING

- Video 4 Min 45 Sec

Japan_s Earthquake and Tsunami Early Warning System [SaveYouTube.com].mp4