



Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (UNESCO-IOC-Caribe EWS)

26th Annual Symposium on Caribbean Geology
Dept. Geology, UPRM

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February 24, 2010

NOAA Caribbean Tsunami Center

- Caribbean Tsunami Warning Center in the region by 2010 (resolution ICG-CEWS II).
- NOAA established on February 1, 2010 the Caribbean Tsunami Center collocated with the PRSN, first step of a three phased approach for the potential establishment of a Caribbean Tsunami Warning Center.
- Main tasks: Improve seismic and sea level data availability and tsunami forecasting, education and research capabilities in the region.

Sumatra Indonesia, 26 de diciembre de 2004, 10 km, M 9.0



Antes



Después

American Samoa Tsunami

September 29, 2009

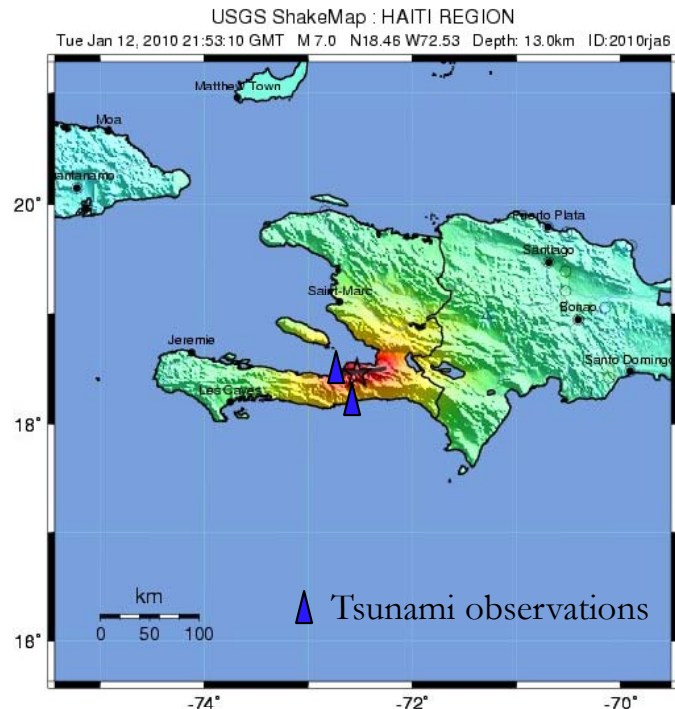
Mw 8.0, Max. Runup: 16.3 m



Fotos por Gordon Yamasaki , NOAA

Haiti Earthquake and Tsunami

Jan. 12, 2010, Mw 7.0, > 200,000 dead (EQ)

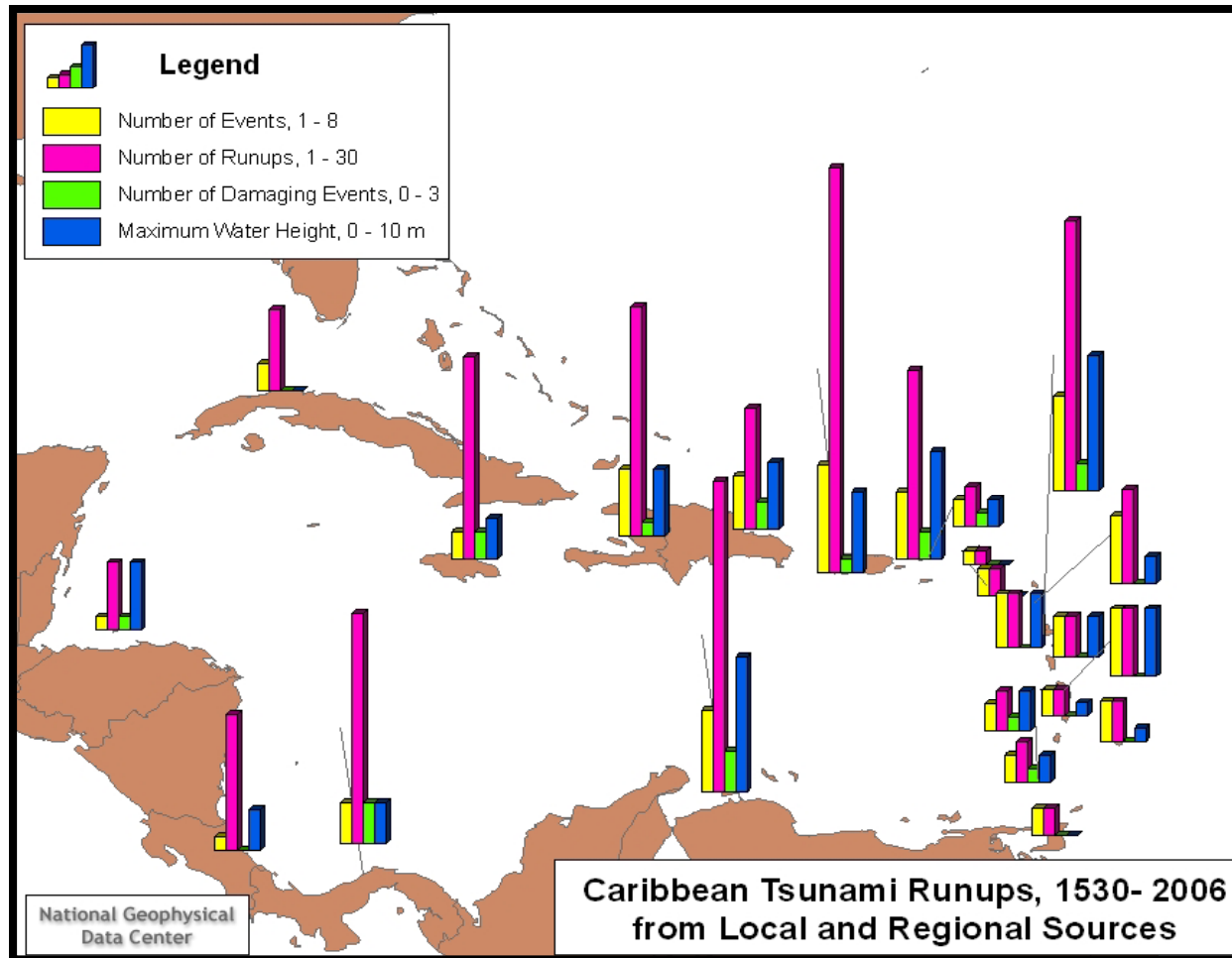


PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	None	Very Light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-18	18-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

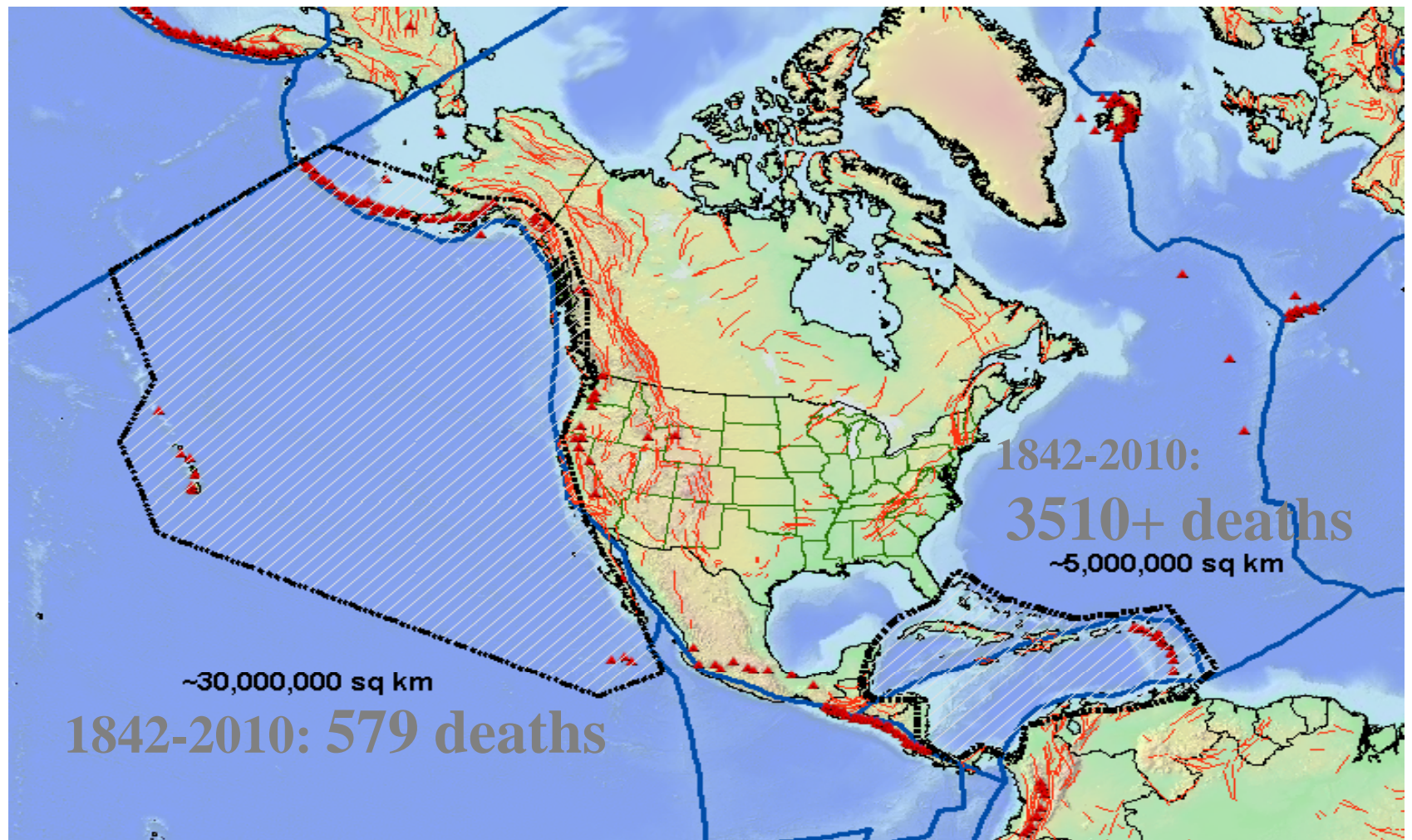


The tsunami apparently took the lives of at least seven villagers in the town of Petit Paradis, on Haiti's western coast.

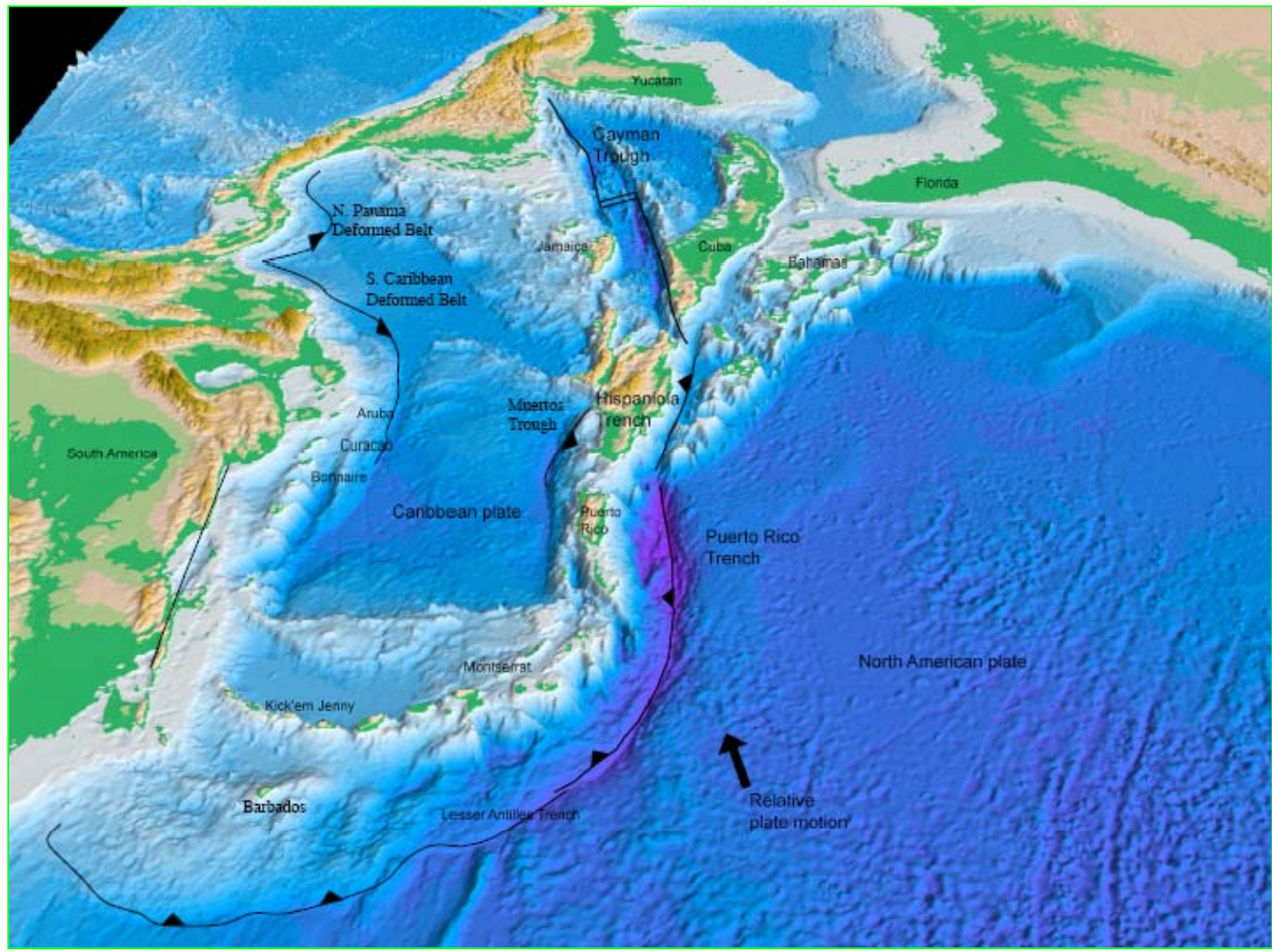
Tsunamis in the Caribbean



Tsunami deaths since 1842 in two key areas, the northeastern Pacific (Alaska, Hawaii, West Coast States) & the Caribbean Basin (includes Puerto Rico & US Virgin Islands). **The Caribbean basin with only 1/5 the area has 6x more deaths !**



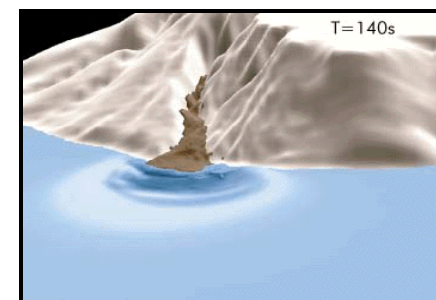
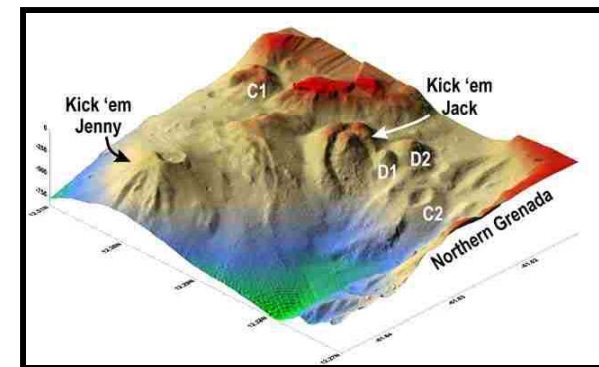
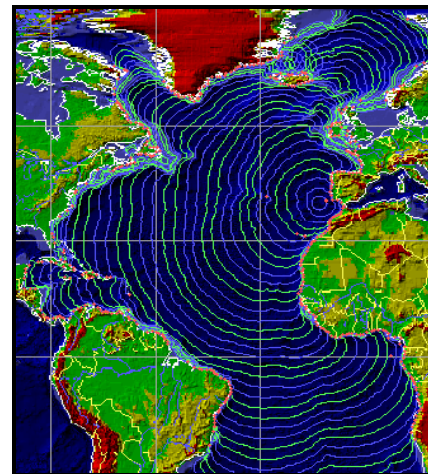
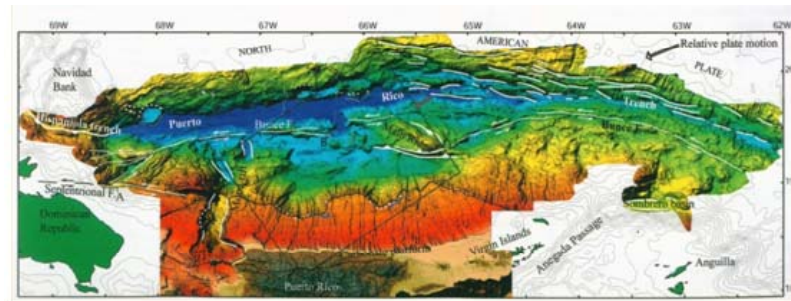
Hazard Assessment: Identification of the Tsunamigenic Sources



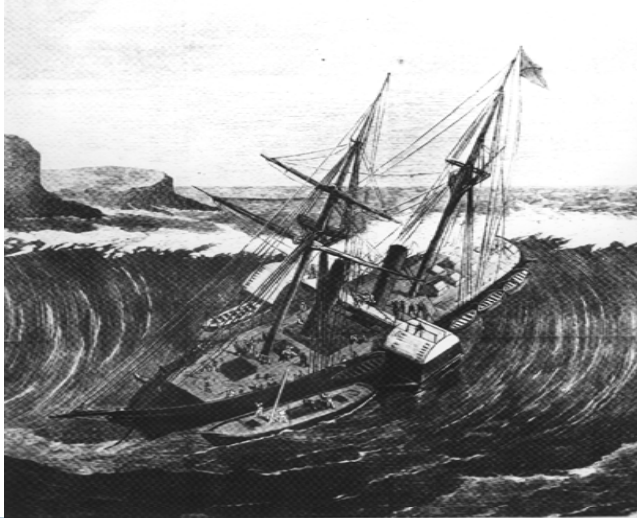
From U. ten Brink, USGS

Other Caribbean Tsunamigenic Sources, Also Mostly short-fused

- Subaerial and Submarine Landslides
- Subaerial Volcanoes- Soufriere Hills, Montserrat
- Submarine Volcanoes-Kick 'em Jenny
- Tele-tsunami (e.g. "Lisbon" Nov. 1, 1755)



The risk from tsunamis has increased dramatically due to population growth, coastal infrastructure development and tourism



US Virgin Islands, 1867

US Virgin Islands, today



During high season, there can be as many as 25,000 people arriving on cruise ships during a day. During low season, as much as 15,000 people/day.

Intergovernmental Coordinating Group for the Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (ICG CARIBE EWS)

- UNESCO/IOC body
- 30 member states, commonwealths, territories
- Established in 2005
- 4 Sessions have been held in Barbados, Venezuela, Panama and Martinique
- Next session: March 15-17, Managua Nicaragua



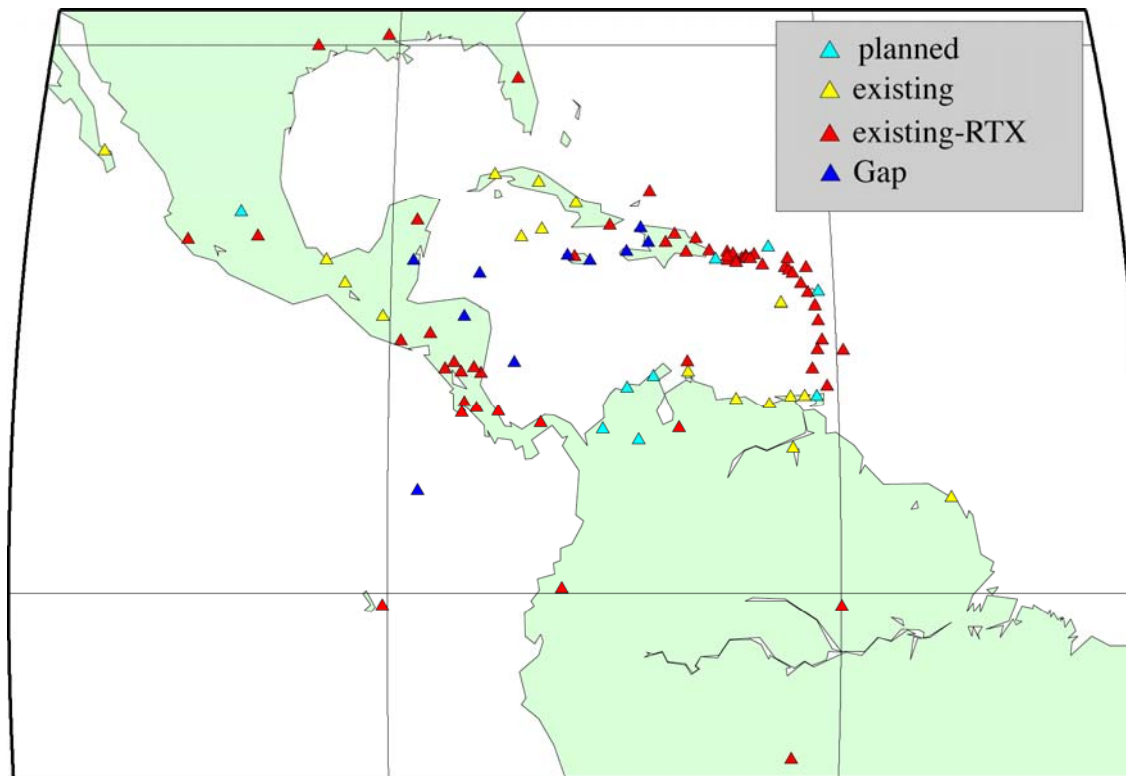
End to End ICG CARIBE EWS

- Member States designate
 - Tsunami National Contacts (government authority, represent the MS at meetings and coordinate national tsunami working groups)
 - Tsunami Warning Focal Points (institution with 24/7 operations for at minimum to receive and disseminate the tsunami event messages)
 - A delegate in each of the working groups
 - Hazard assessment
 - Monitoring, Detection Systems and Warning Guidance
 - Warning Dissemination and Communication
 - Preparedness, Readiness and Resilience.

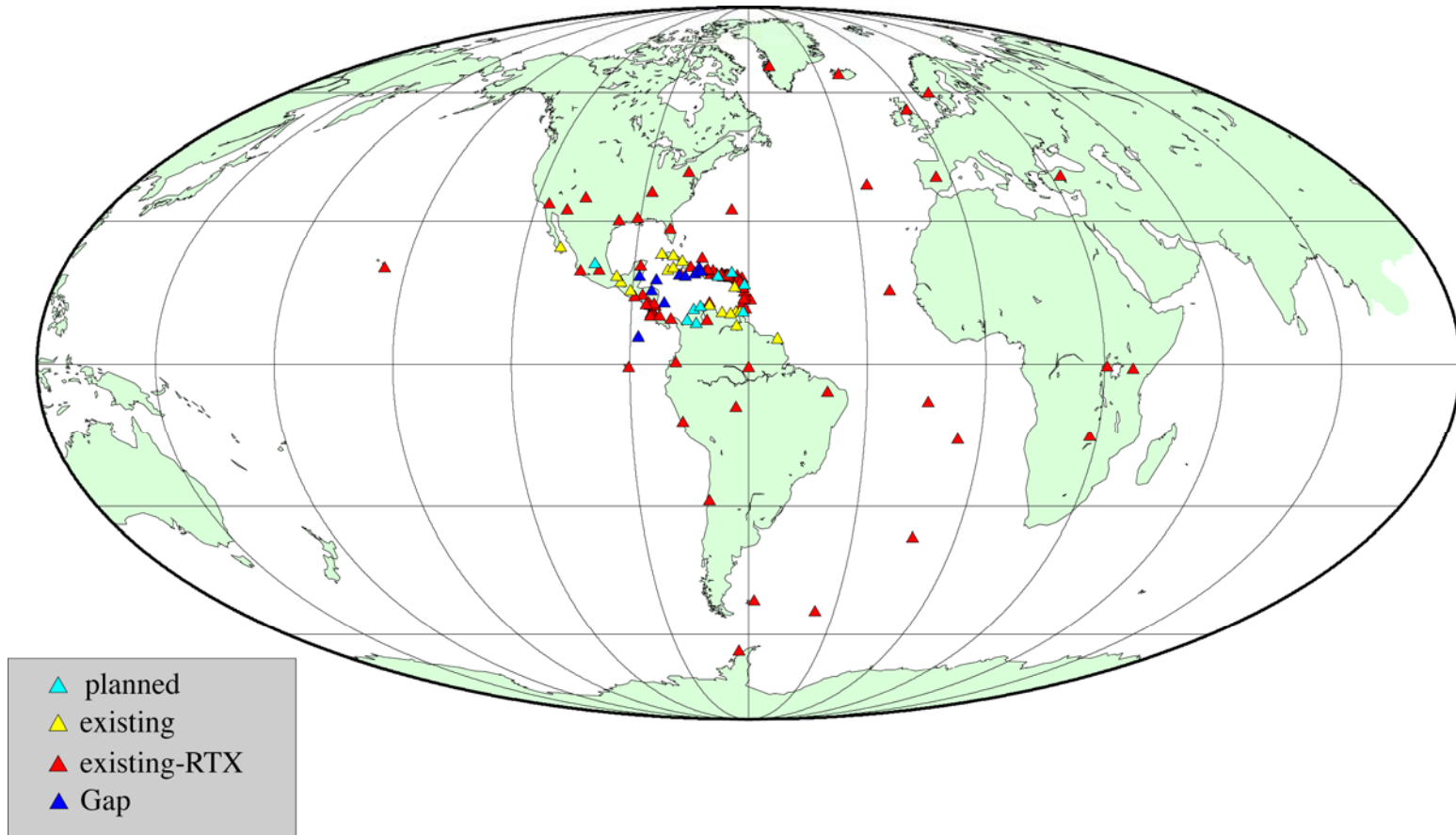
Monitoring Components of Tsunami Warning System

- Seismic monitoring-accurate and timely detection, determination and dissemination of hypocentral parameters. Initial performance criteria: messages for all earthquakes M 4.5 or greater within 5 minutes of origin time.
- Sea Level Monitoring
 - Tide Gauges-confirmation of tsunami heights and arrival times at coastal locations, validate tsunami inundation models
 - DART Buoys-confirmation of tsunamis and real time forecasting of tsunamis
- Other geophysical instrumentation, GPS, hydroacoustic sensor – developing technology and infrastructure.

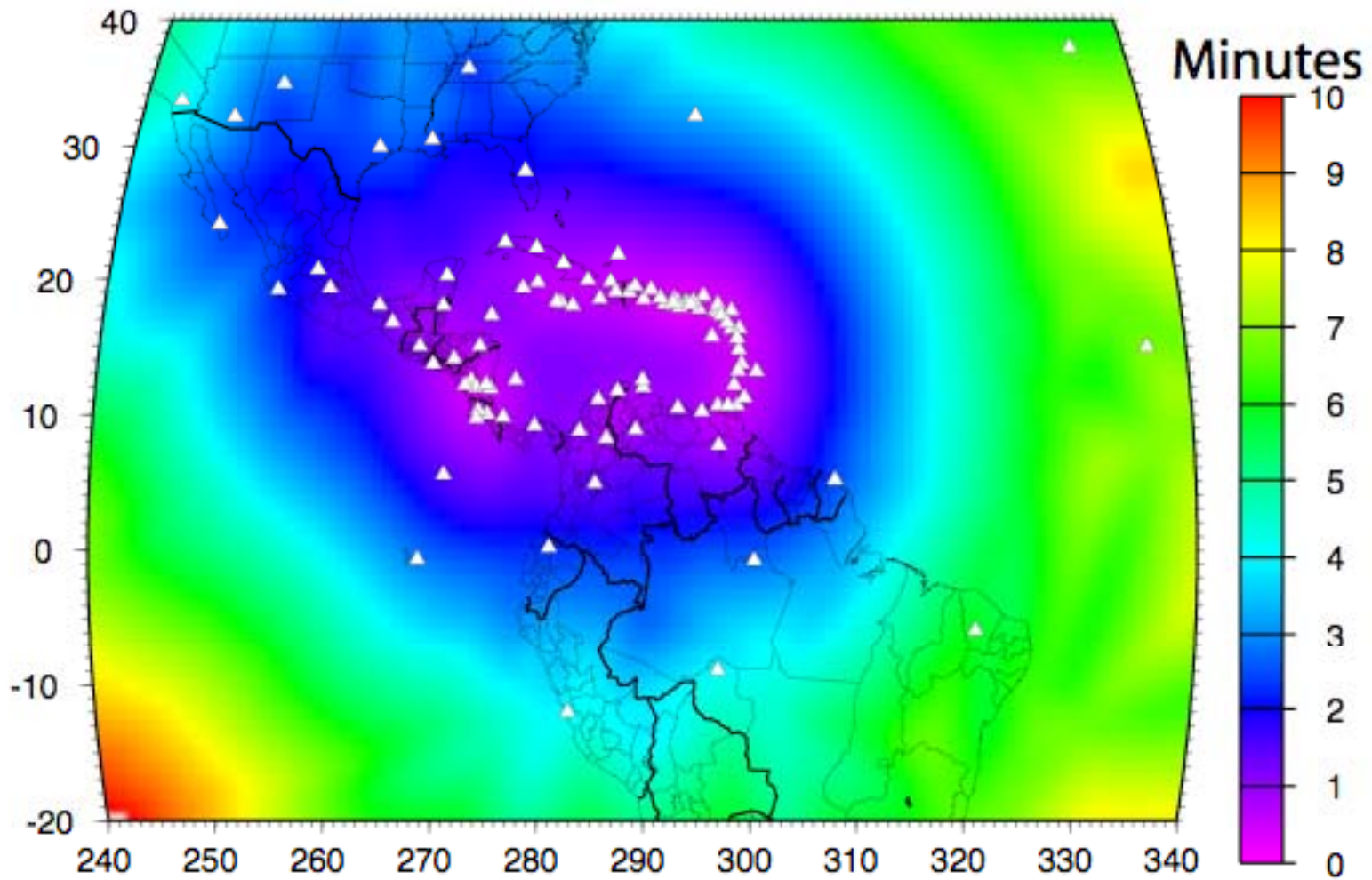
Caribbean Stations Monitored for Caribe EWS



Core Stations for Caribe EWS

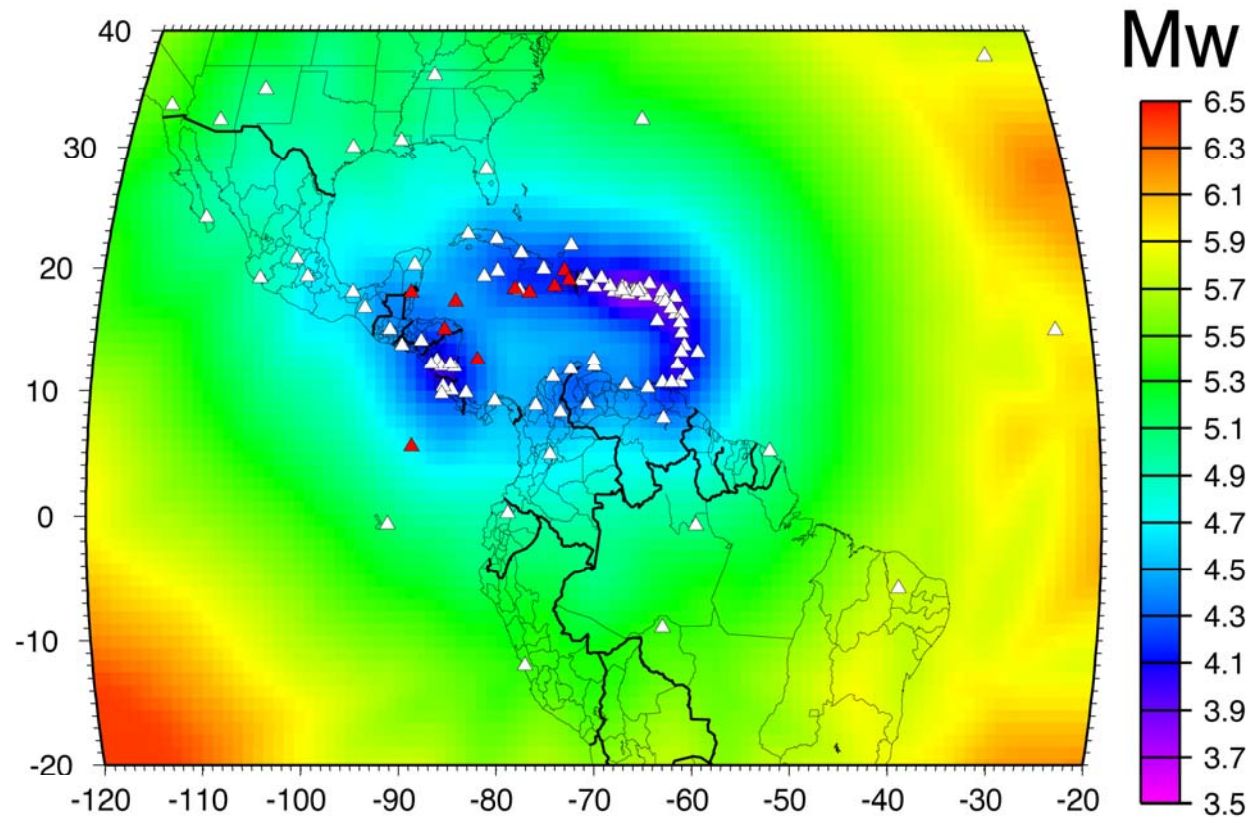


5 Station P-wave detection time
for 121 CORE stations.



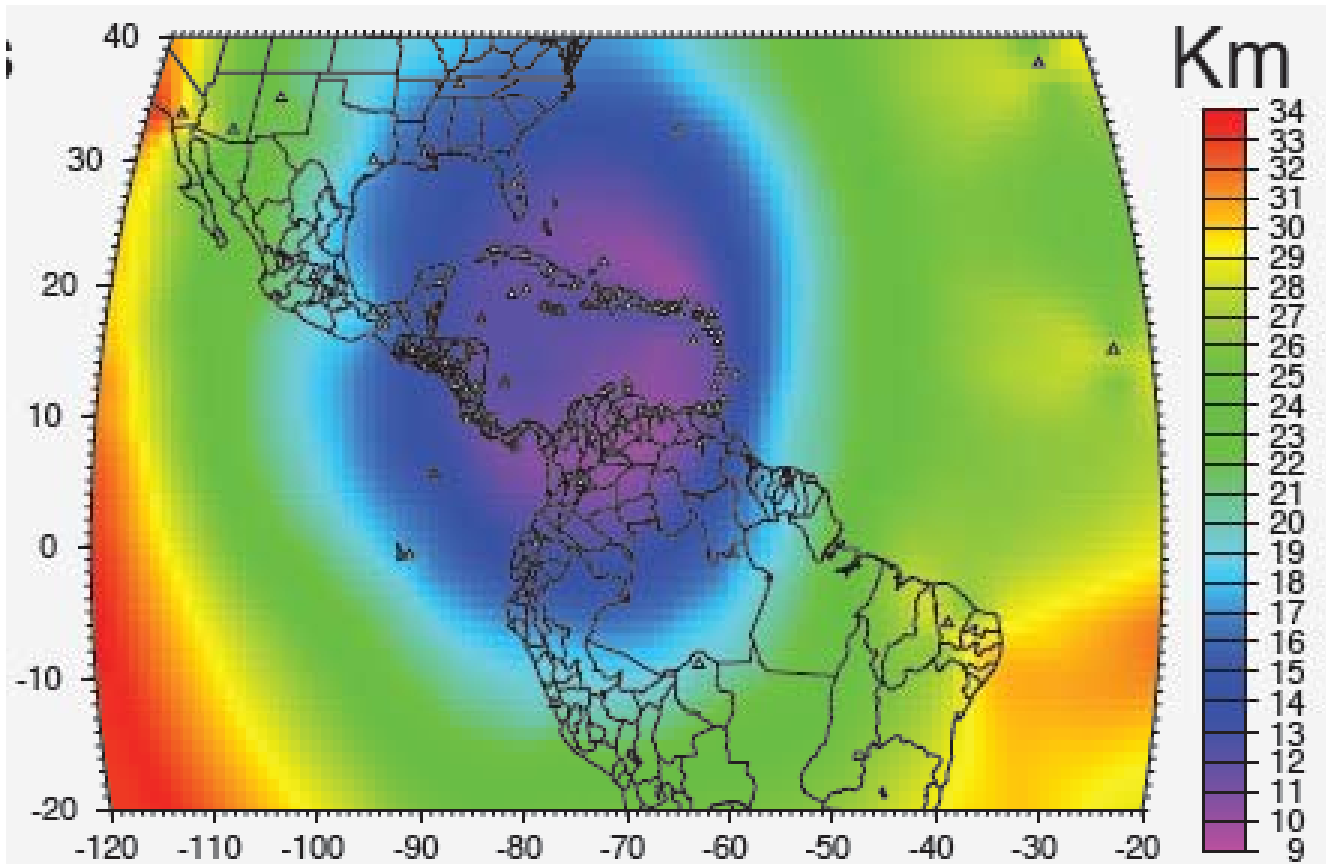
Contribution of Dan McNamara, USC

5 Station Mw detection threshold for 121 CORE stations



Contribution of Dan McNamara, USGS

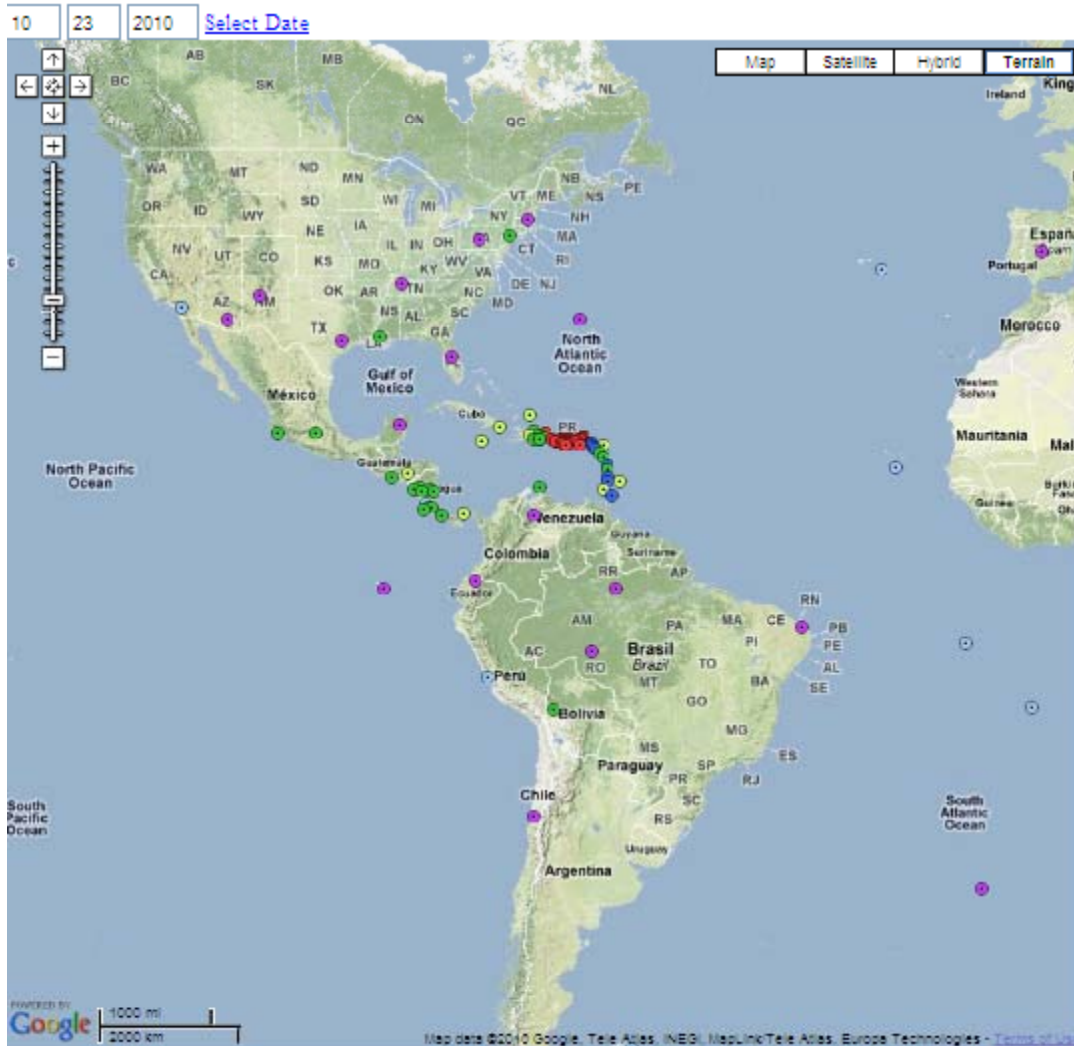
Theoretical Earthquake Location Error



The map above shows the theoretical earthquake location error for complete 121 station core network. We map the length of the major axis of the error ellipse in km. For this preliminary analysis we assume Surface source and use a P-wave first arrival at each real-time station.

Contribution of Dan McNamara,
USGS

Seismic Stations Available in Real Time for the CEWS

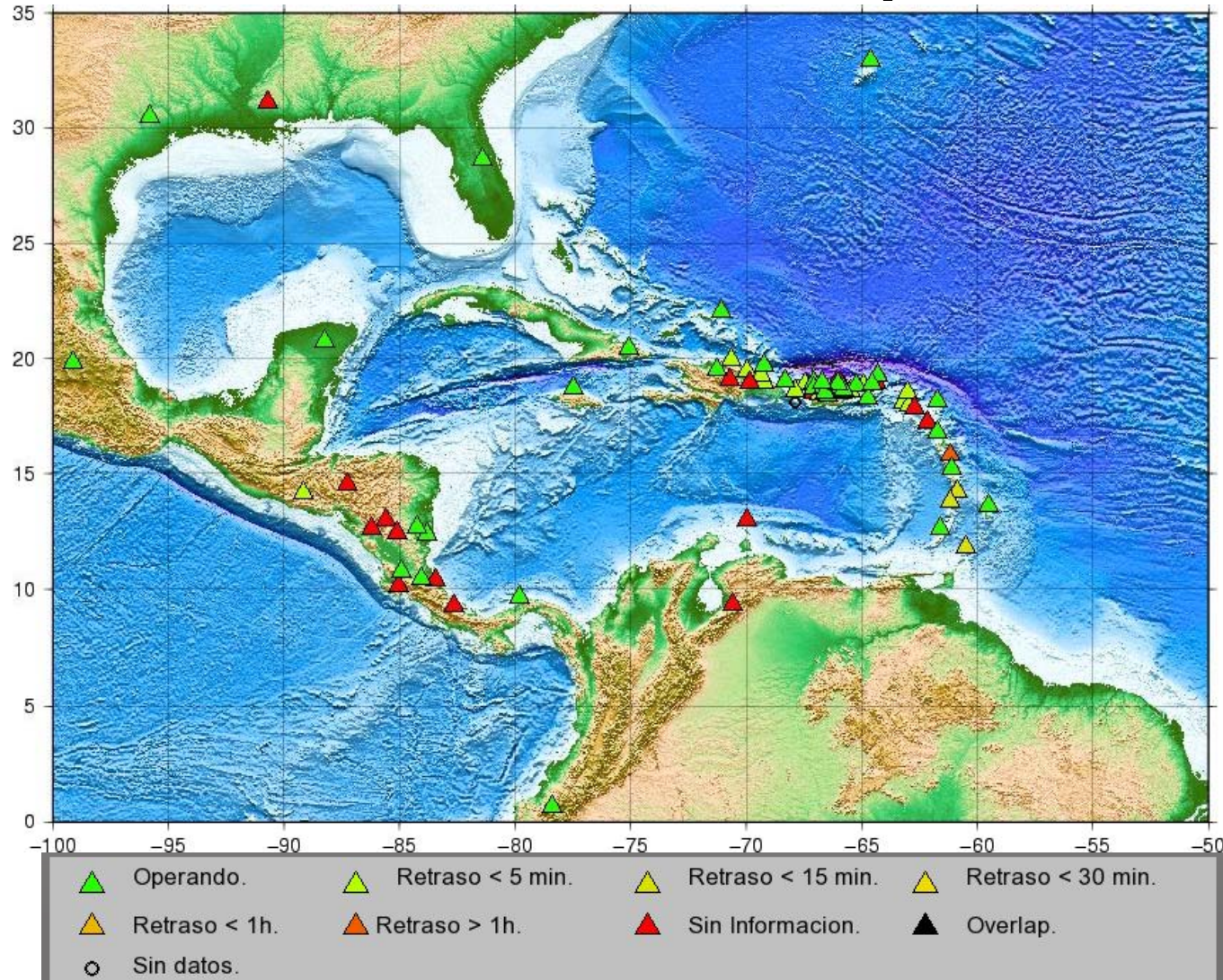


Stations Live at PRSN

Contributing Networks

- U. Colima, Mexico
- RS El Salvador
- INETER, Nicaragua
- OVSICORI, Costa Rica
- Baru Network, Panama
- Montserrat Volcano Observatory
- Martinique Volcano Observatory
- KNMI, Dutch Antilles
- Puerto Rico Seismic Network
- Seismological Institute, DR
- USGS Caribbean Seismic Network
- ANSS-USGS
- INGEOMINAS
- GSN

Status Seismic Stations in Real Time for the CEWS, per PRSN



Areas with Gaps

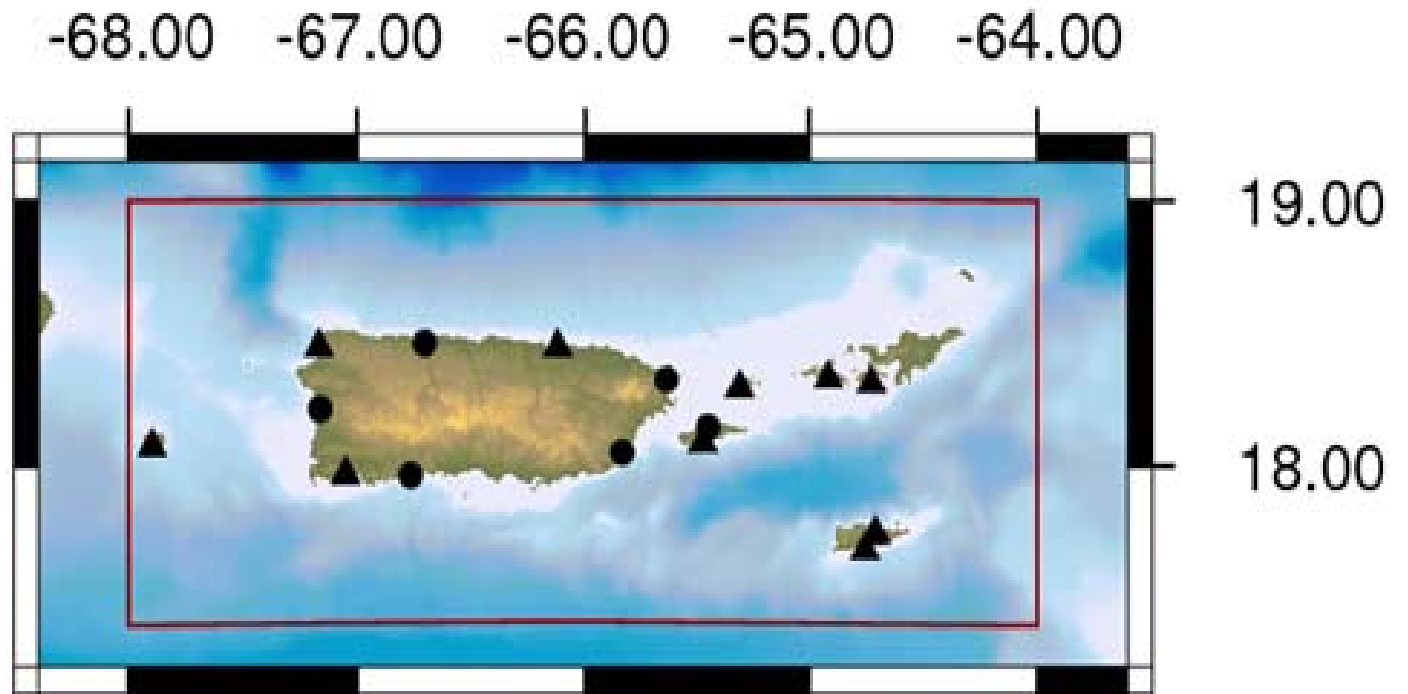


New seismic stations available in RT as of Haiti EQ

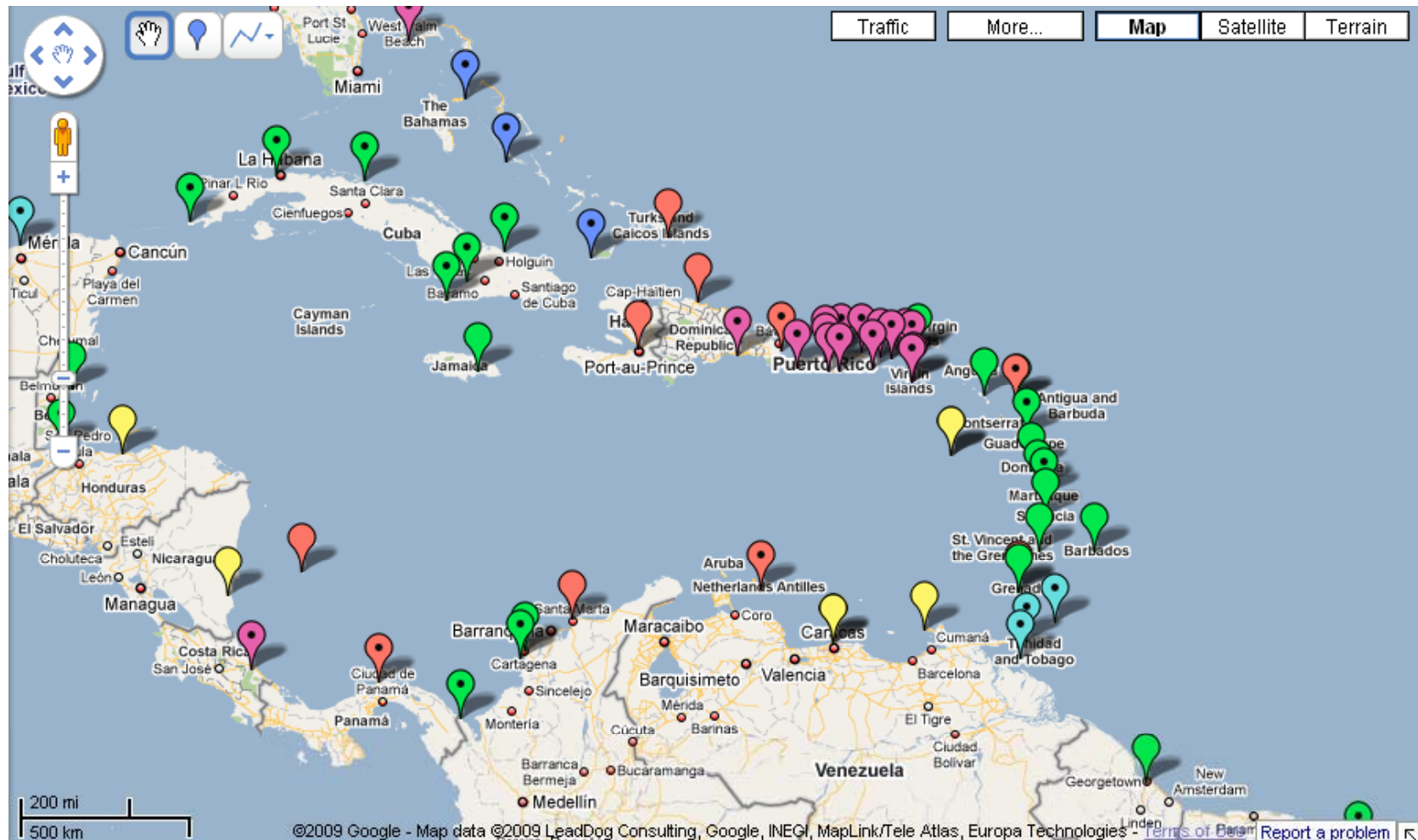
Haiti: Canada; Dom. Republic: ISU



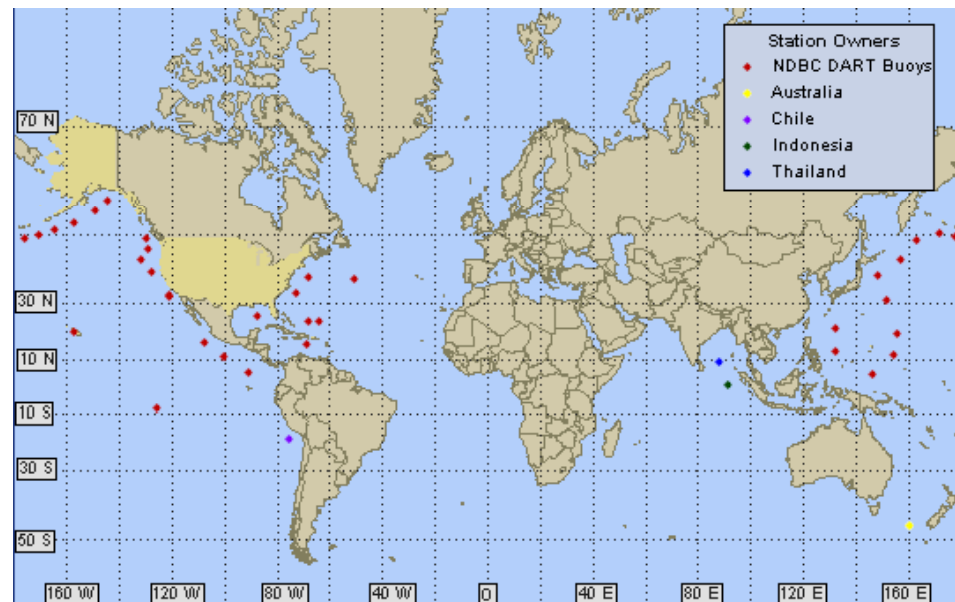
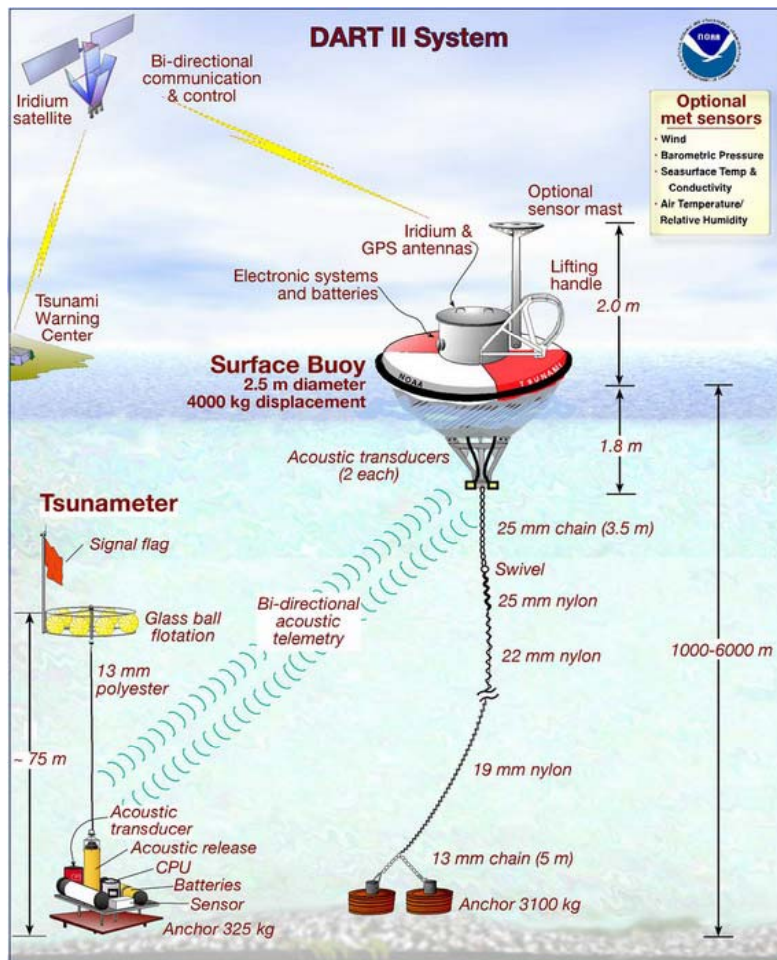
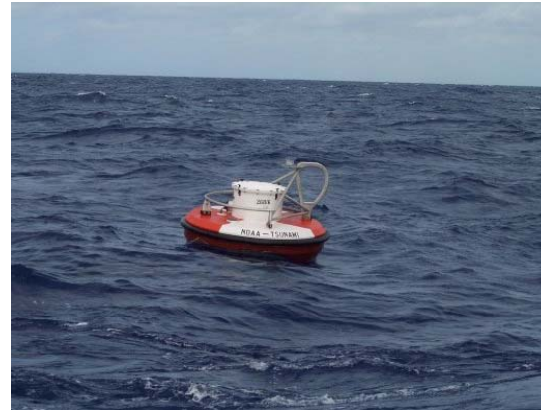
RSPR/FEMA & NOAA Mareógrafos TsunamiReady



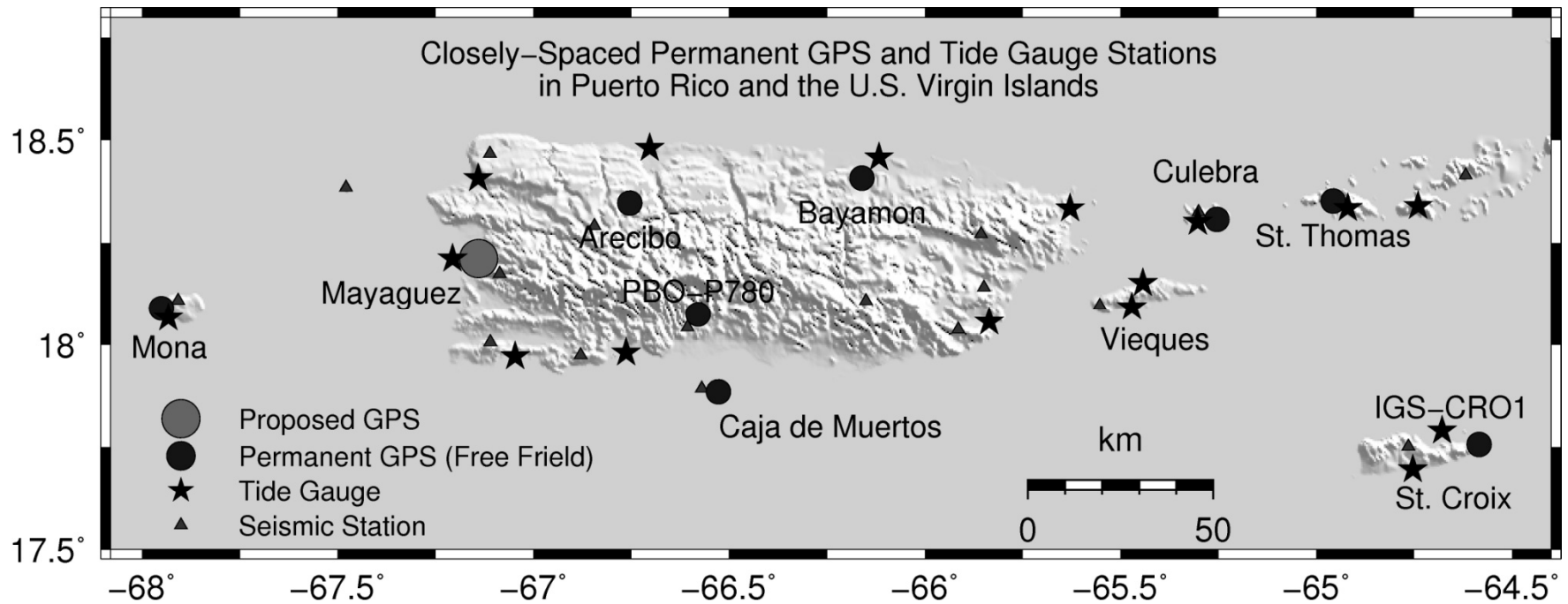
Core Stations Caribbean Sea Level Network



NOAA DART Buoys

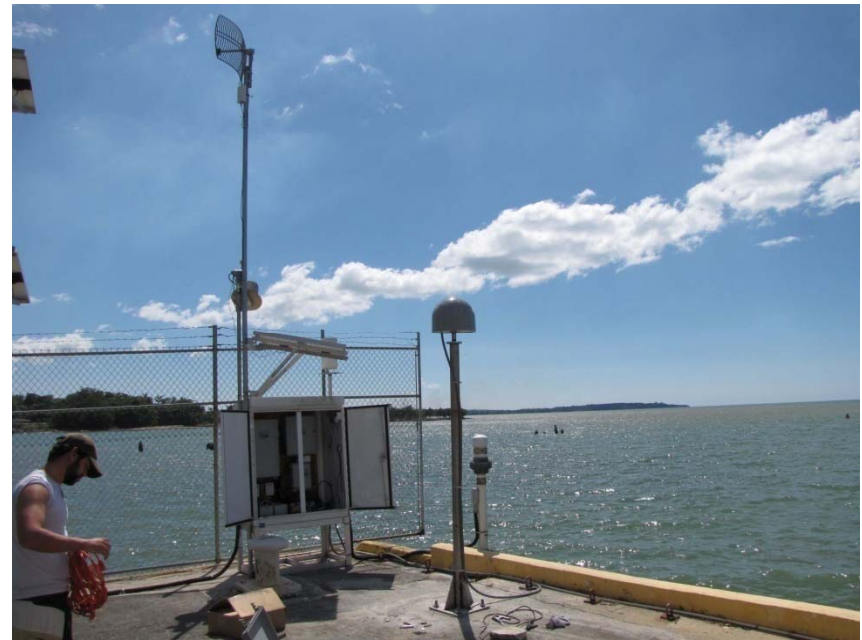


High Rate GPS Network of the PRSN



Mayaguez Collocated Sea Level and Tide Gauge station

- 1st collocated GPS at Caribbean Tide Gauge stations
 - What's changing, the sea level or the ground
 - In response to an EQ
 - Long term sea level observations
- Close proximity will permit leveling between tide gauge and GPS



Current Tsunami Warning Service Providers

- Pacific Tsunami Warning Center
 - Provides Interim Tsunami Warning Guidance Service to the non US Caribbean and adjacent regions
- West Coast and Alaska Tsunami Warning Center
 - Provides Interim Warning Service to Puerto Rico and the USVI (US Government)
 - Backup to the PTWC
- Puerto Rico Seismic Network
 - Provides 24 x 7 tsunami warning service to Puerto Rico and the USVI and BVI (local governments protocol)
- Caribbean Tsunami Warning Center (in development phase)

Puerto Rico Seismic Network



Planned -PRSO

Backup
Earthquake
and Interim
Tsunami
Warnings
are
provided by
the USGS
and
WCATWC.



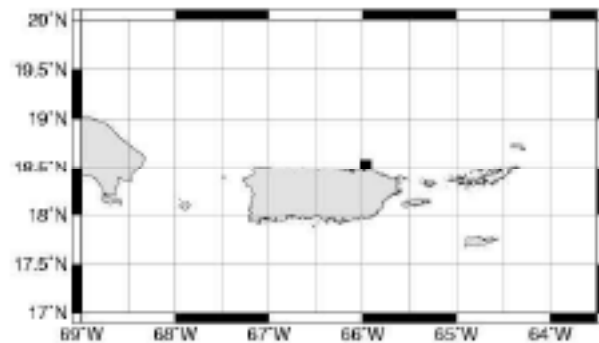
BOLETÍN 1

EVENTO SISMICO/Tsunami

FECHA:	Noviembre 03 2009
HORA LOCAL:	11:11:36
LATITUD:	18.54 Norte
LONGITUD:	65.56 Oeste
LOCALIZACION:	14.4 Km al Noroeste de Loiza, PR 18.3 Km al Noroeste de San Juan, PR
PROFUNDIDAD:	78 Km
MAGNITUD:	2.77 MM
INTENSIDAD MÁXIMA ESTIMADA:	II en San Juan, PR
NIVEL DE ALERTA DE TSUNAMI:	No hay peligro de tsunami para Puerto Rico e Islas Vírgenes
FECHA DE EMISION:	2009-11-3 11:52:04

La Red Sísmica de Puerto Rico (RSPR) recibió informes de que este temblor sísmico fue reportado como sentido en San Juan, PR, con una intensidad máxima de II (escala Mercalli modificada, MM). Al momento de generar este boletín no se han reportado daños y no se espera que ocurran.

No hay peligro para Puerto Rico e Islas Vírgenes



Generado automáticamente el 03/11/2009 11:52:04



Red Sísmica de Puerto Rico
<http://redsismica.uprm.edu> Teléfono: 787-833-8433
Centro de Alerta de Tsunami de la Costa Oeste & Alaska
<http://westwacrh.noaa.gov>
4 Niveles de Mensajería de Tsunami



- ¡Peligro!
- ¡Corra a tierras altas!
- Siga las instrucciones de emergencia.

Aviso

Advertencia

- Posibles corrientes locales fuertes y peligrosas.
- Manténgase escuchando las instrucciones locales de emergencia.

- Peligro potencial.
- Permanezca alerta para más información.

Vigilancia

- Permanezca tranquilo.
- No hay peligro.
- Una cuenca oceánica distante puede estar en riesgo.

Declaración de Información



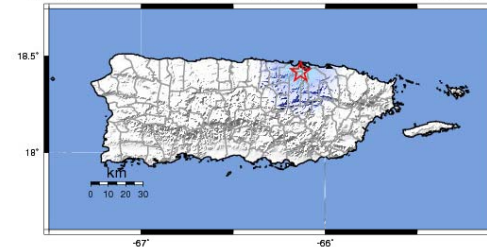
PRSN Online

Earthquake/Tsunami Products

Intensidad Máxima Estimada	VI en Toa Baja, PR
Fecha	Oct 23 2009 04:23:17 UTC Oct 23 2009 00:23:17 Hora local
Región	PUERTO RICO
Distancias	2.34 Km al Sur-Sureste de Cataño,PR 8.3 Km al Oeste-Noroeste de San Juan,PR
Magnitud	2.9 Md
localización	Latitud 18.42 Longitud -86.13
Profundidad	0 Km
Nivel de Alerta de Tsunami Fecha y Hora de emisión	No hay peligro de tsunami para Puerto Rico e Islas Vírgenes 2009-10-23 16:47:10
ID	20091023042318

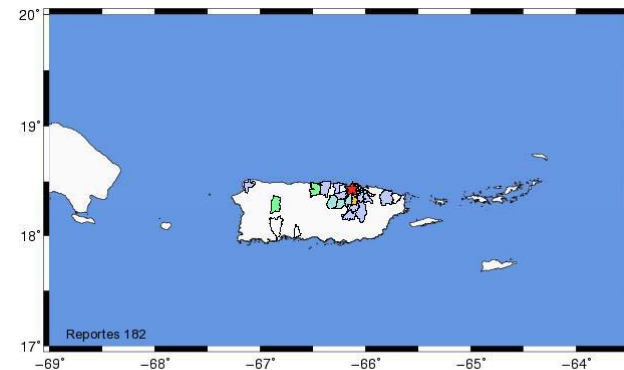
<http://redsismica.uprm.edu>

PRSN/PRSNP ShakeMap : 0.0 Km de Bayamon, PR
Fri Oct 23, 2009 12:23:17 AM AST M 2.9 N18.42 W86.13 Depth: 0.0km ID:20091023042318



Map Version 6 Processed Fri Oct 23, 2009 06:10:11 PM AST, -- NOT REVIEWED BY HUMAN

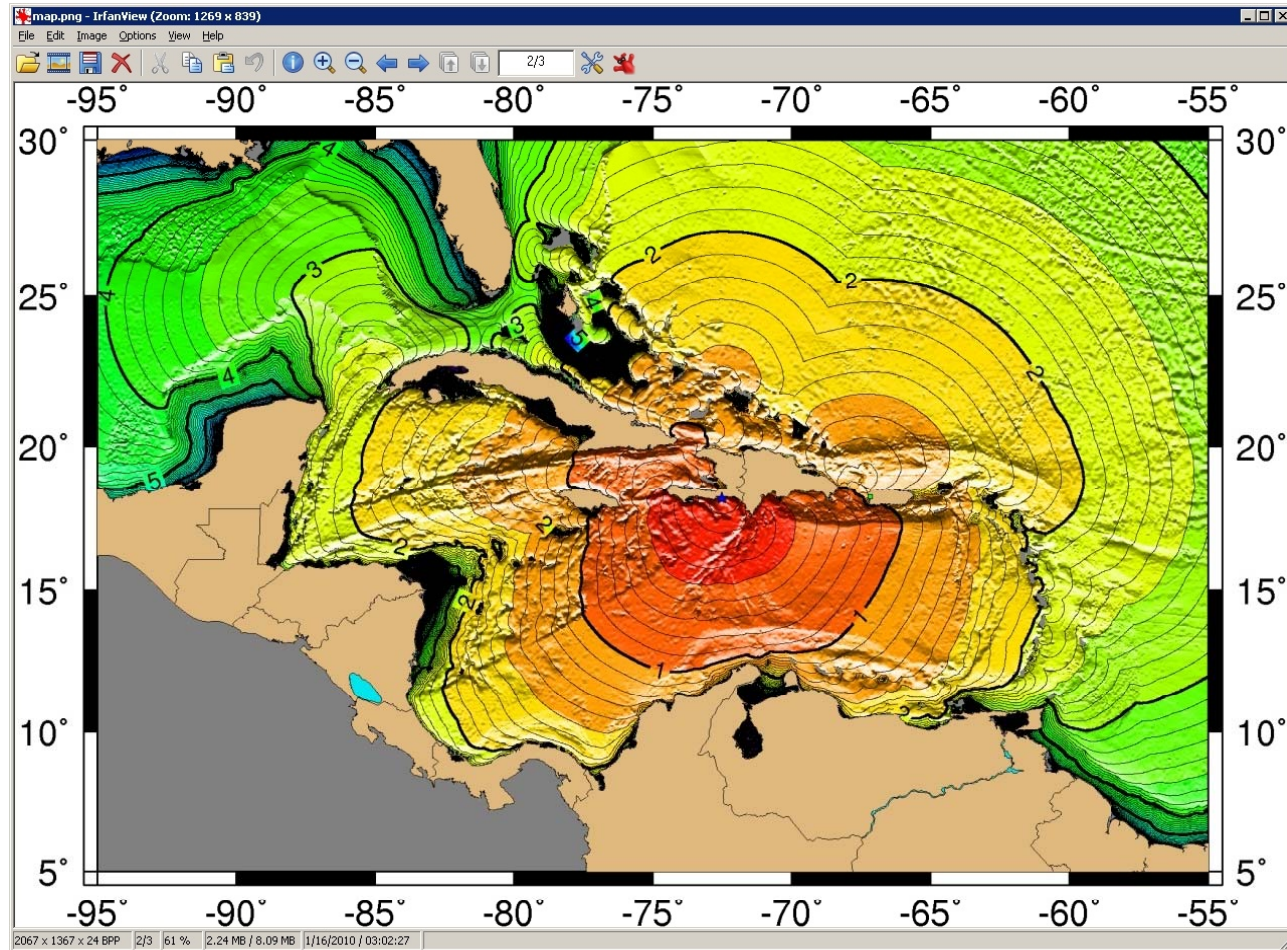
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACCELERATION	<.17	.17-1.4	1.4-3.0	3.0-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VELOCITY	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+



RED SISMICA DE PUERTO RICO - ESCALA DE MERCALLI MODIFICADA

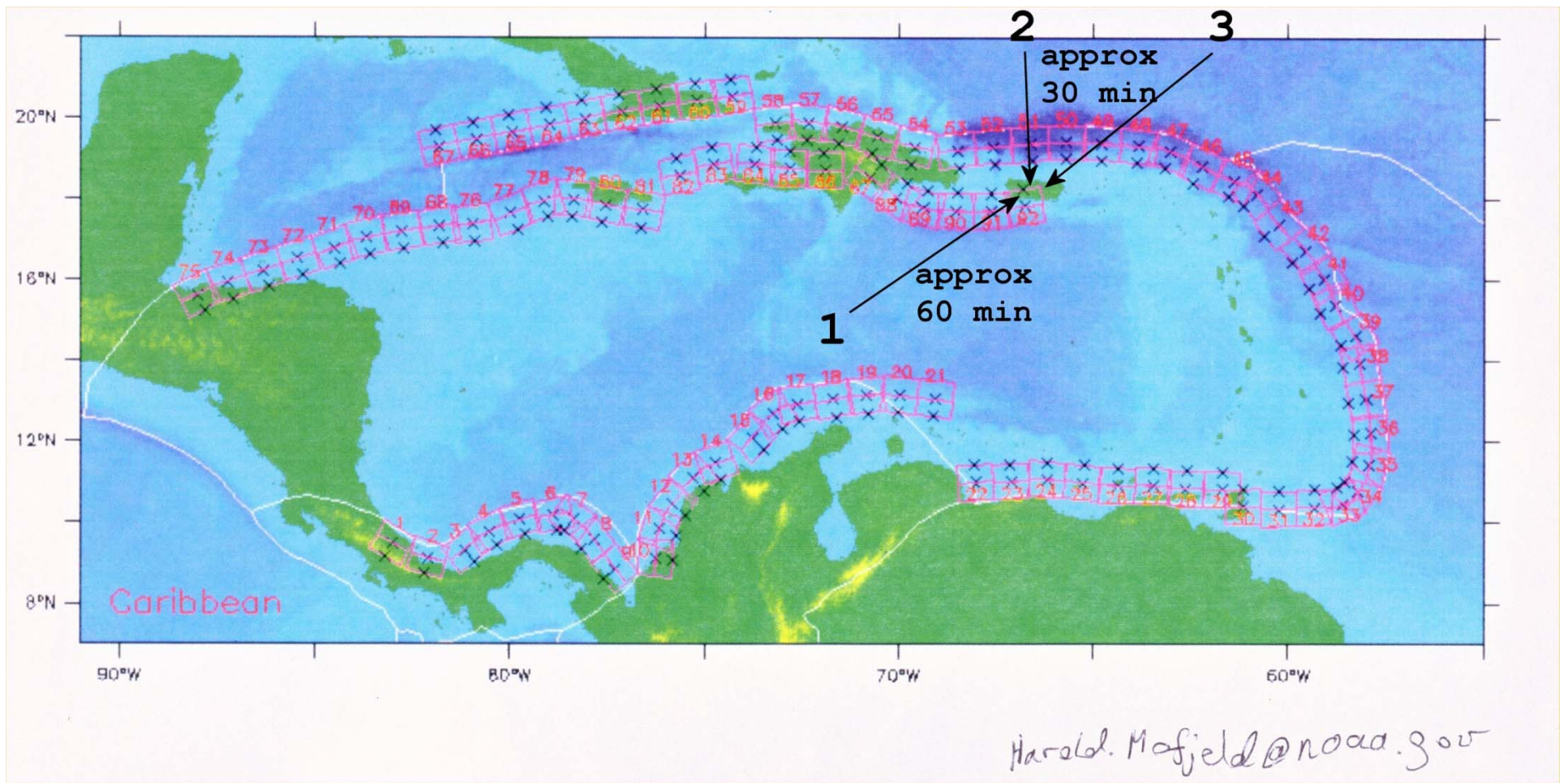
MOVIMIENTO PERCIBIDO	Ninguno	Debil	Ligero	Moderado	Fuerte	May Fuerte	Severo	Violento	Extremo
EFFECTOS ASOCIADOS	Ninguno	Ninguno	Ninguno	Minimos	Ligeros	Apreciables	Significativos	Mayores	May Fuertes
INTENSIDAD	I	II-III	IV	V	VI	VII	VIII	IX	X+

PRSN Travel Time Model for Haiti Tsunami



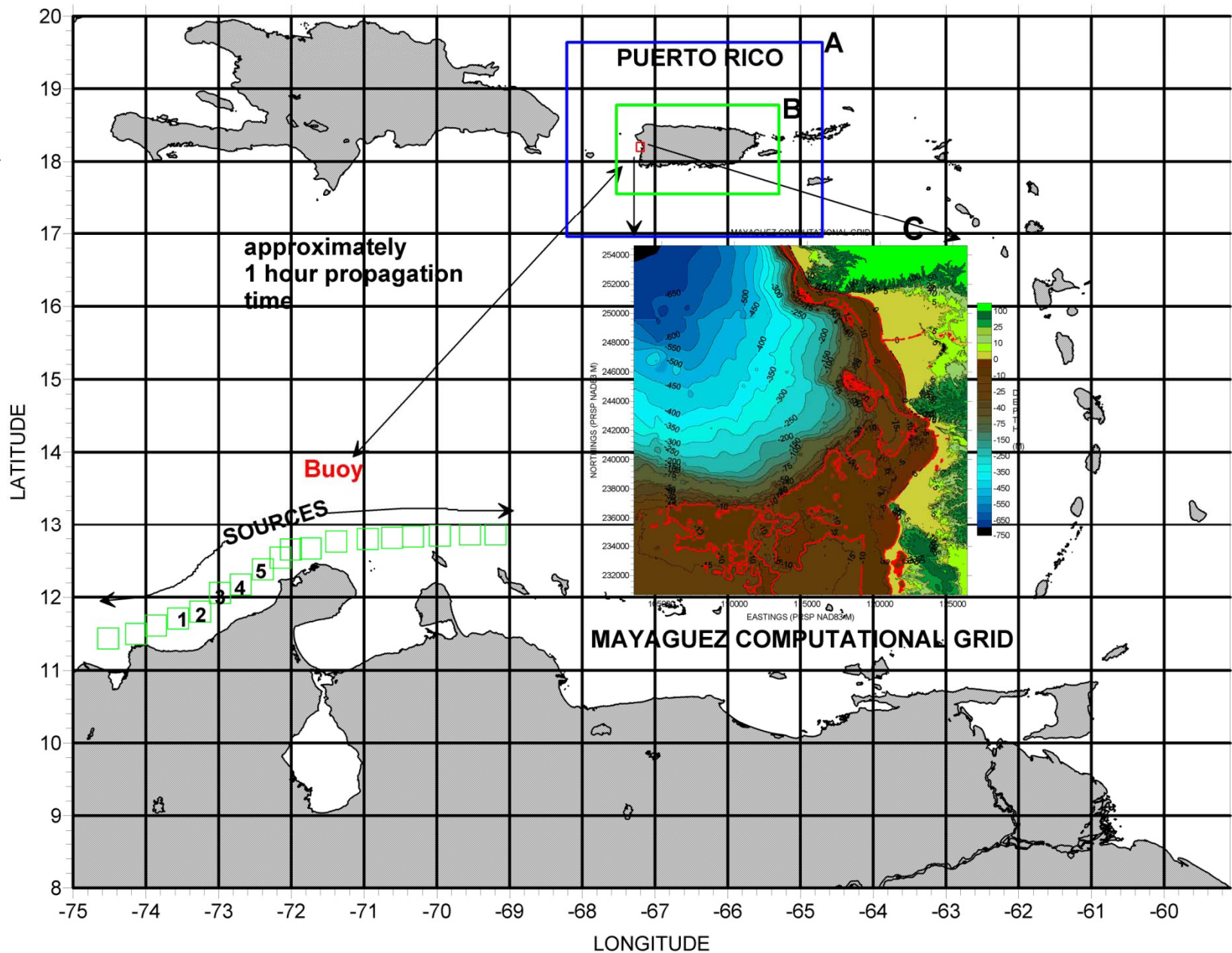
Presently Ongoing Tsunami Modeling Work for NOAA/PMEL

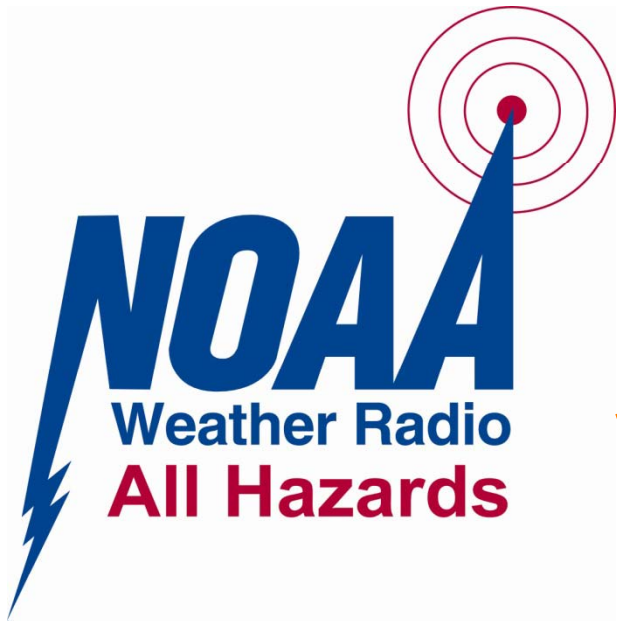
Unit source locations according to USGS (ten Brink and Geist)



SHORT-TERM TSUNAMI INUNDATION FORECASTING FOR PUERTO RICO AND THE USVI

Presently
Ongoing
Tsunami
Modeling
Work for
NOAA /
PMEL





Communications and Dissemination



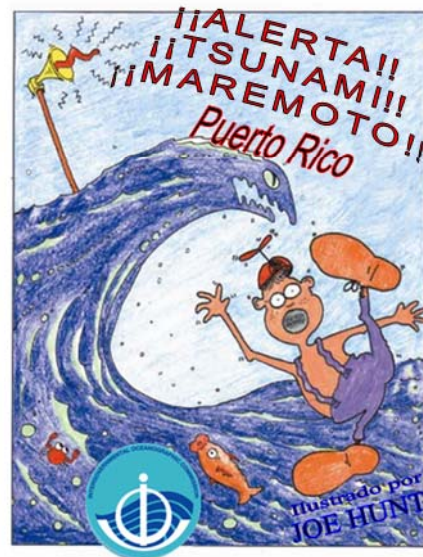
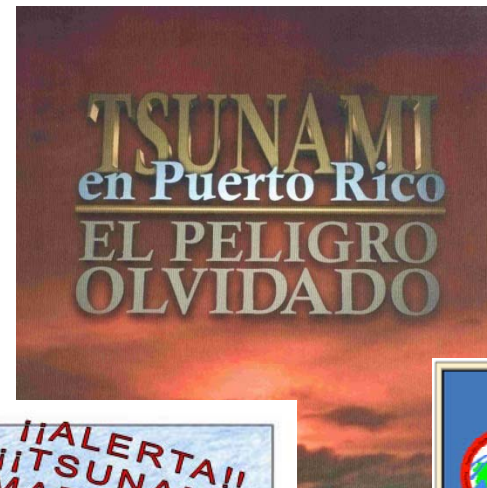
Preparedness, Readiness and Resilience

Initiatives need to be taken at the local level to assure that appropriate actions are taken before, during and after a tsunami or potential tsunami event.

ICG CEWS has received funding from EU/Italy to establish the English language **Caribbean Tsunami Information Center** to facilitate these activities.



EQ and Tsunami Drills



NOAA TsunamiReady Designations

Puerto Rico and U.S. Virgin Islands

13 StormReady Sites

5 StormReady/TsunamiReady Communities

4 StormReady Communities

4 TsunamiReady Only Communities



StormReady/TsunamiReady Blue and Cyan Dots

StormReady Communities: Blue Dot
TsunamiReady: Cyan Dot

- | | |
|--|--|
| <ul style="list-style-type: none">• Aguadilla• Anasco• Caguas• Carolina• Coamo• Juncos• Dorado | <ul style="list-style-type: none">• Lajas• Manati• Mayaguez• Ponce• Rincon• San Lorenzo |
|--|--|

- 24 hour tsunami warning reception and dissemination point
- Local emergency response plan
- Signage
- Evacuation Map
- Education and outreach activities, including drills

Concluding Comments/Concerns

- The development of the Caribe EWS has really helped improve the availability and quality of seismic data in the region which is a true asset
- Very important that the infrastructure and capabilities of the almost 30 local and subregional networks continue to be strengthened, some of them with TWC capabilities.
- Very important that the contributions and the authority of the station operators be recognized by the CEWS.
- Challenge of determining the “critical” magnitudes, eg. 6.5=evacuate, 6.4=no evacuation for local PR earthquakes; 7.8=evacuate, 7.7=no evacuation for regional earthquakes.
- Establish more breakpoints to avoid overwarning

Cont.

- For the very large events need to evaluate the utilization of real time strong motion or GPS data to better estimate the tsunami potential
- High quality data is needed to calculate fast (5 minutes) regional moment tensors for estimation of tsunami potential.
- The establishment of a CTWC and CTIC will raise the profile of the Caribbean tsunami hazard and risk in the region, will help give faster warnings, effective advisory service before, during and after an event and accessible capacity building platforms for the region.
- The CEWS has a multi coastal hazard perspective, so as we develop a system that will mitigate the effects of tsunamis, we also are developing key components for other hazards like earthquakes, storm surges and sea level rise.

Our Mission: Avoid this...



Thank you very much

More information...

- PRSN
 - <http://redsismica.uprm.edu>
- NOAA Tsunami Site
 - <http://tsunami.gov>
- PRTWMP website with tsunami inundation maps
 - <http://poseidon.uprm.edu>
- UNESCO IOC Caribe EWS

SISMOS SIGNIFICATIVOS MAS RECIENTES

Magnitud	Agencia	Hora Local (GMT-4)	Latitud	Longitud	Prof.	Región
3.7MI	PRSN	2010-02-21 10:55:02	18.858	-88.983	128	ZONA ORIENTAL DE LA REPUBLICA DOMINICANA
2.52MI	PRSN	2010-02-13 14:39:40	18.190	-88.899	15	REGION CENTRAL DE PUERTO RICO
2.59MI	PRSN	2010-02-04 00:08:38	18.056	-88.759	17	REGION SUR DE PUERTO RICO
3.61MI	PRSN	2010-02-01 21:01:09	19.373	-88.218	87	ZONA SIMICA DEL SOMBRERO
3.1MI	PRSN	2010-01-31 00:23:15	18.919	-88.128	8.8	ZONA SIMICA DEL SOMBRERO
3.65MI	PRSN	2010-01-30 23:45:30	18.878	-88.699	185.9	ZONA ORIENTAL DE LA REPUBLICA DOMINICANA
3.61MI	PRSN	2010-01-28 20:22:17	18.245	-88.594	74.9	ZONA ORIENTAL DE LA REPUBLICA DOMINICANA
2.6MI	PRSN	2010-01-26 13:08:28	18.202	-88.955	13.5	REGION CENTRAL DE PUERTO RICO
2.78MI	PRSN	2010-01-24 04:50:26	19.116	-88.428	15	ZONA DE FALLA DE LOS 19° N
6.1Mwp	PRSN	2010-01-20 07:03:44	18.428	-72.875	9.9	HAITI

CARIBBEAN TSUNAMI HAZARD
 Proceedings of the NSF Caribbean Tsunami Workshop
 San Juan, Beach Hotel, Puerto Rico 30 - 31 March 2004

edited by Aurelio Mercado-Irizarry (University of Puerto Rico, USA) & Philip Liu (Cornell University, USA)

This book aims to present the overall existing tsunami hazard in the Caribbean Sea region, a region which is typically only associated with hurricanes. It initially presents an overview of all of the existing tsunami-causing factors found in the region: earthquakes, sub-aerial and submarine landslides, and submarine explosions. This is followed by field evidence of recent and pre-historic tsunami events, which gives credibility to all of this effort. The next section is a description of the tsunami hazard mitigation efforts being carried out locally and in collaboration with national and international programs. The final part is dedicated to the presentation of related recent research results.

August 28, 2008

TSUNAMI THE FORGOTTEN DANGER
 VIDEO DOCUMENTARY
 NEW DVD VERSION AVAILABLE FOR DOWNLOAD!

The tsunami documentary produced in Puerto Rico. This video includes the history, hazards, and protective measures concerning tsunamis. The video was prepared by JAM Media (San Juan, P.R.) and it has been freely distributed to many schools, governmental and private agencies. To obtain copies of the documentary (VHS or DVD) contact the Puerto Rico Seismic Network. Teléfonos: 787-833-8433, 787-265-5452.

Three DVD quality versions available for download. On IE right button click on image and select "Save Target As...". Warning: This are very large files! Broadband (DSL or Cable Internet) recommended. If you're on dial-up use a download manager.

West Coast and Alaska Tsunami Warning Center

Latest Event

2010/02/23 12:57:45 (UTC)
 Swathless / Magnitude 4.7
 Location: 25 miles/40 Km S of Adak, Alaska
 20104

Please click here to see the area-of-responsibility (AoR) for the WC/ATWC and the PTWC.

The NWS operates two Tsunami Warning Centers and the International Tsunami Information Center

West Coast/ Alaska Tsunami Warning Center (WC/ATWC)

The WC/ATWC provides tsunami warning guidance for all U.S. coastal states (except Hawaii), the Canadian coastal provinces, Puerto Rico, and the Virgin Islands.

Richard H. Hagemeyer Pacific Tsunami Warning Center (PTWC)

The PTWC provides tsunami warning guidance for Hawaii and countries in the Pacific Ocean, Indian Ocean, and Caribbean Sea.

International Tsunami Information Center (ITIC)

Operated by the NWS on behalf of the Intergovernmental Oceanographic Commission of UNESCO, the ITIC supports the IOC's Tsunami Program which focuses on the coordination of tsunami warning and mitigation systems globally. The ITIC provides direct support to Member States in the Pacific by monitoring and recommending operational improvements to the Tsunami Warning System in the Pacific, and by working with countries to increase tsunami awareness and preparedness, and promote education and research.

Is your community prepared for the next destructive tsunami?

TsunamiReady Program

A program designed for recognition for Communities that have met certain standards of tsunami preparedness.

Thanks for your support and attention