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

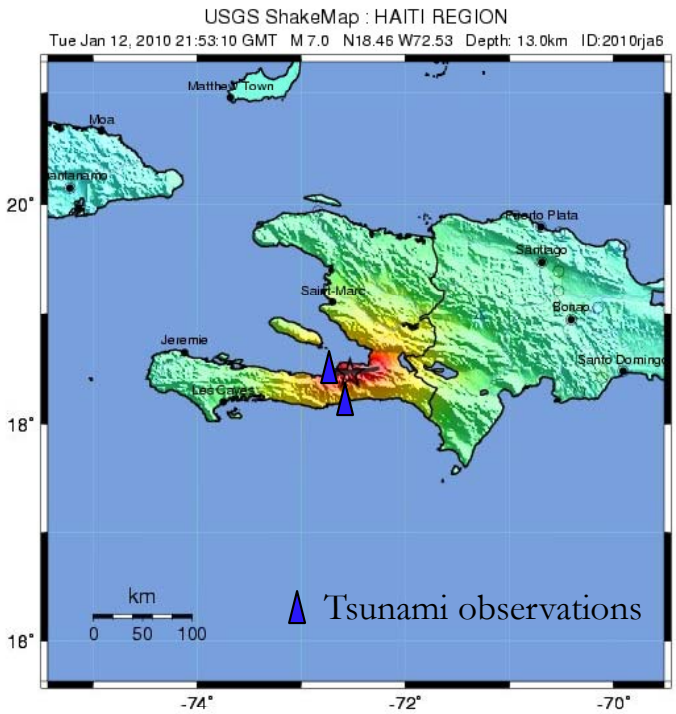
September 29, 2009

Mw 8.0, Max. Runup: 16.3 m

Fotos por Gordon Yamasaki , NOAA

Haiti Earthquake and Tsunami

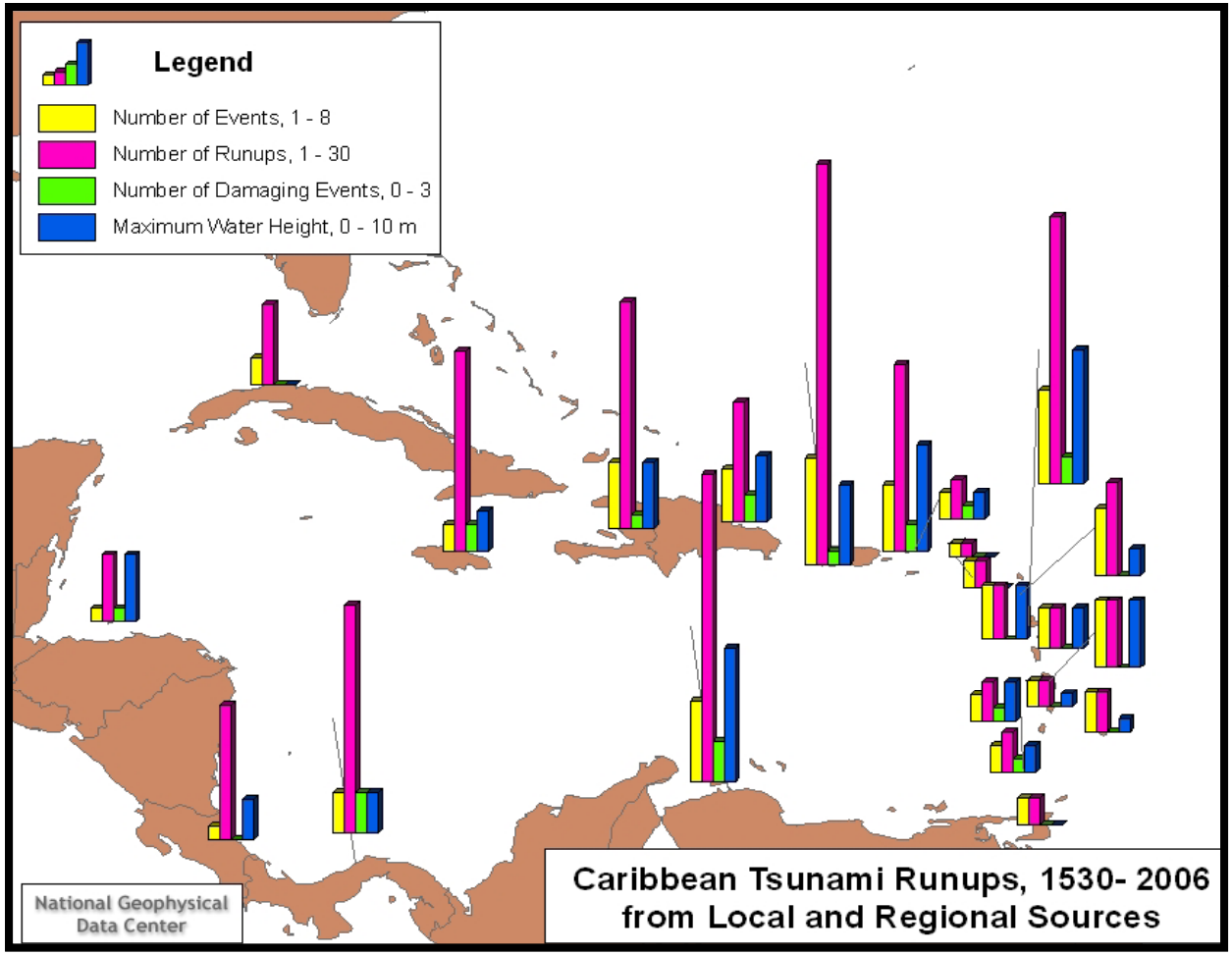
Jan. 12, 2010, Mw 7.0, > 200,000 dead (EQ)



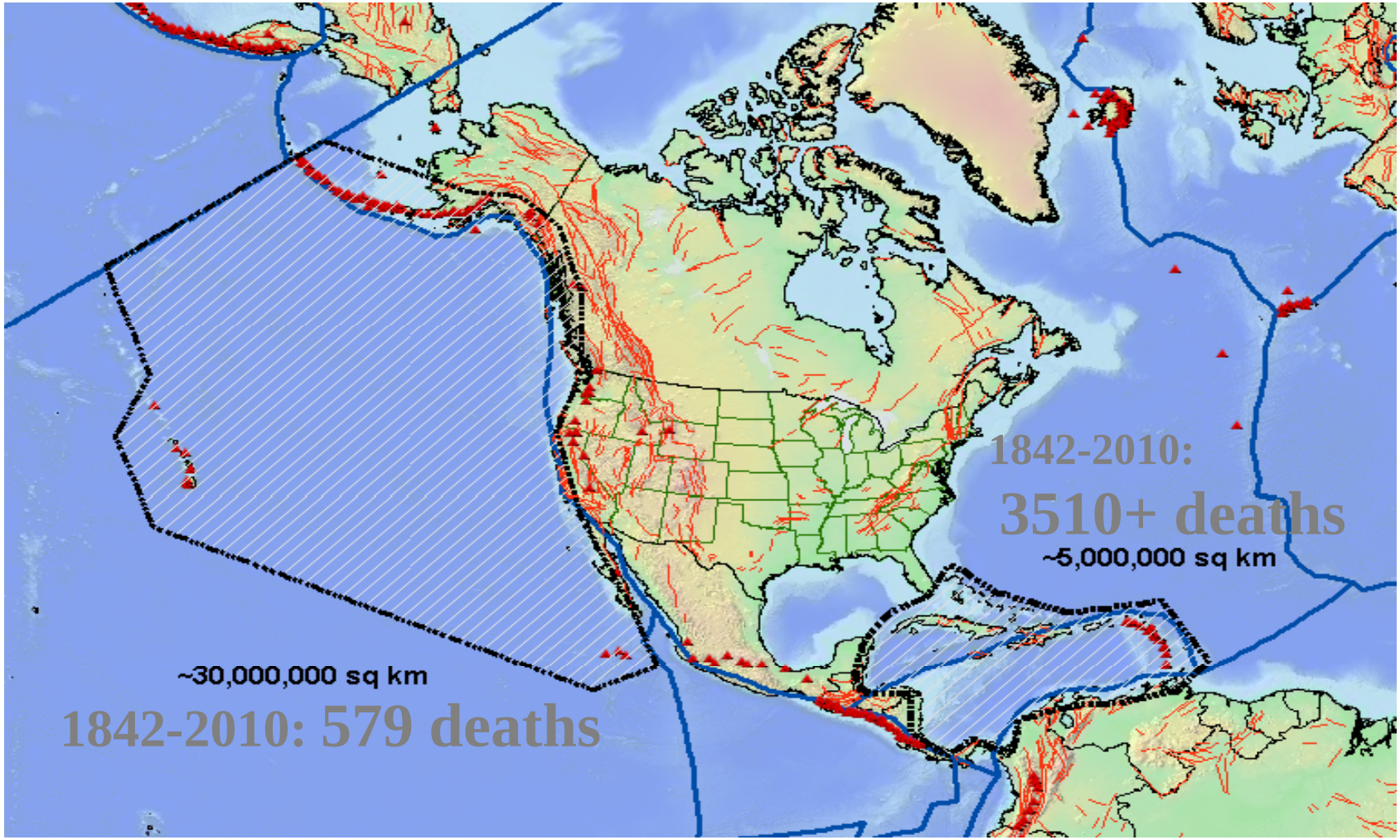
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	*8.1-16*	*16-31*	*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.

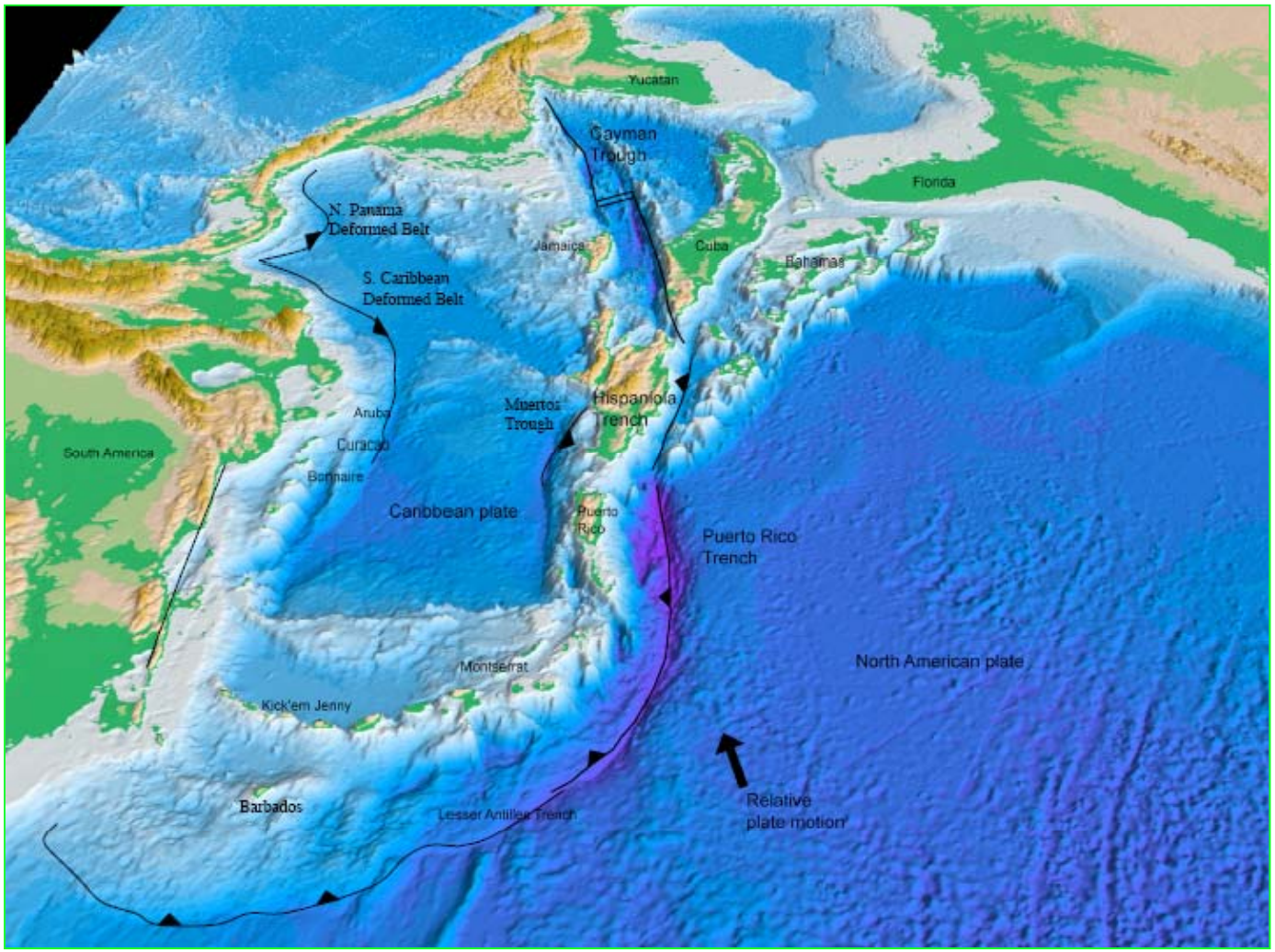
Tsunamis in the Caribbean



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 !***



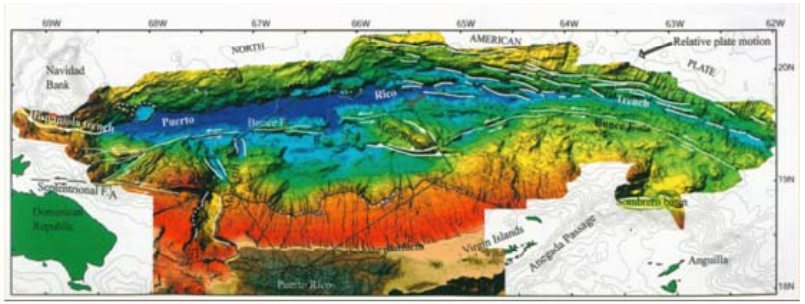
Hazard Assessment: Identification of the Tsunamigenic Sources

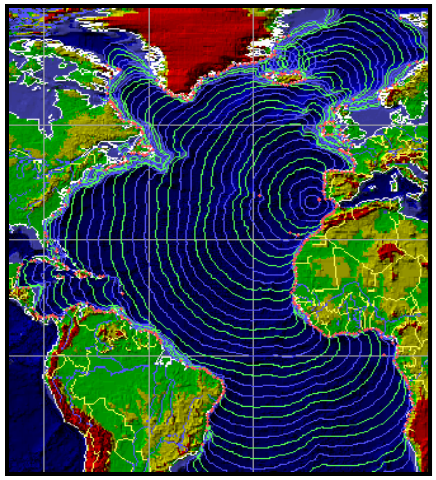


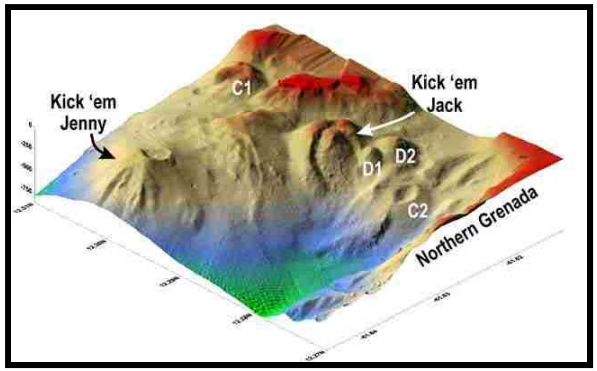
From U. ten Brink, USGS

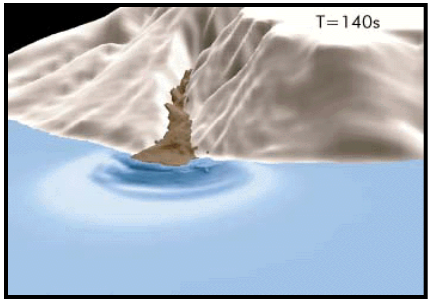
Other Caribbean Tsunamigenic Sources, ***Also Mostly short-fused***

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

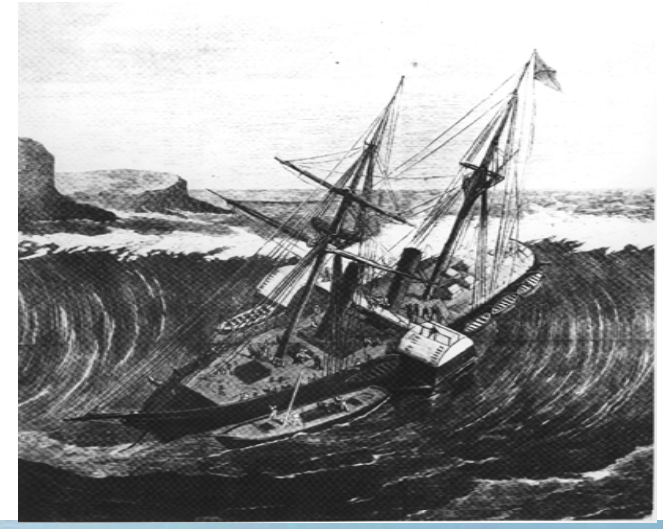








The risk from tsunamis has increased dramatically due to population growth, coastal infrastructure development and tourism



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

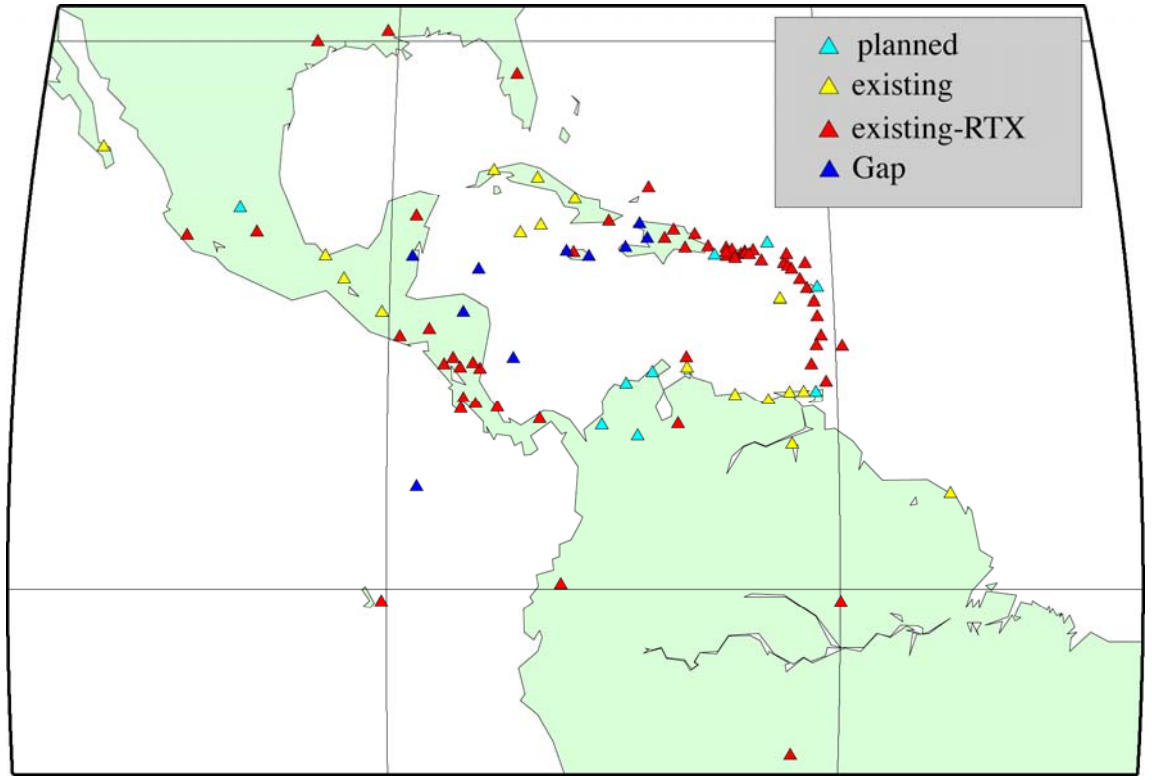
End to End ICG CARIBE EWS

- 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.

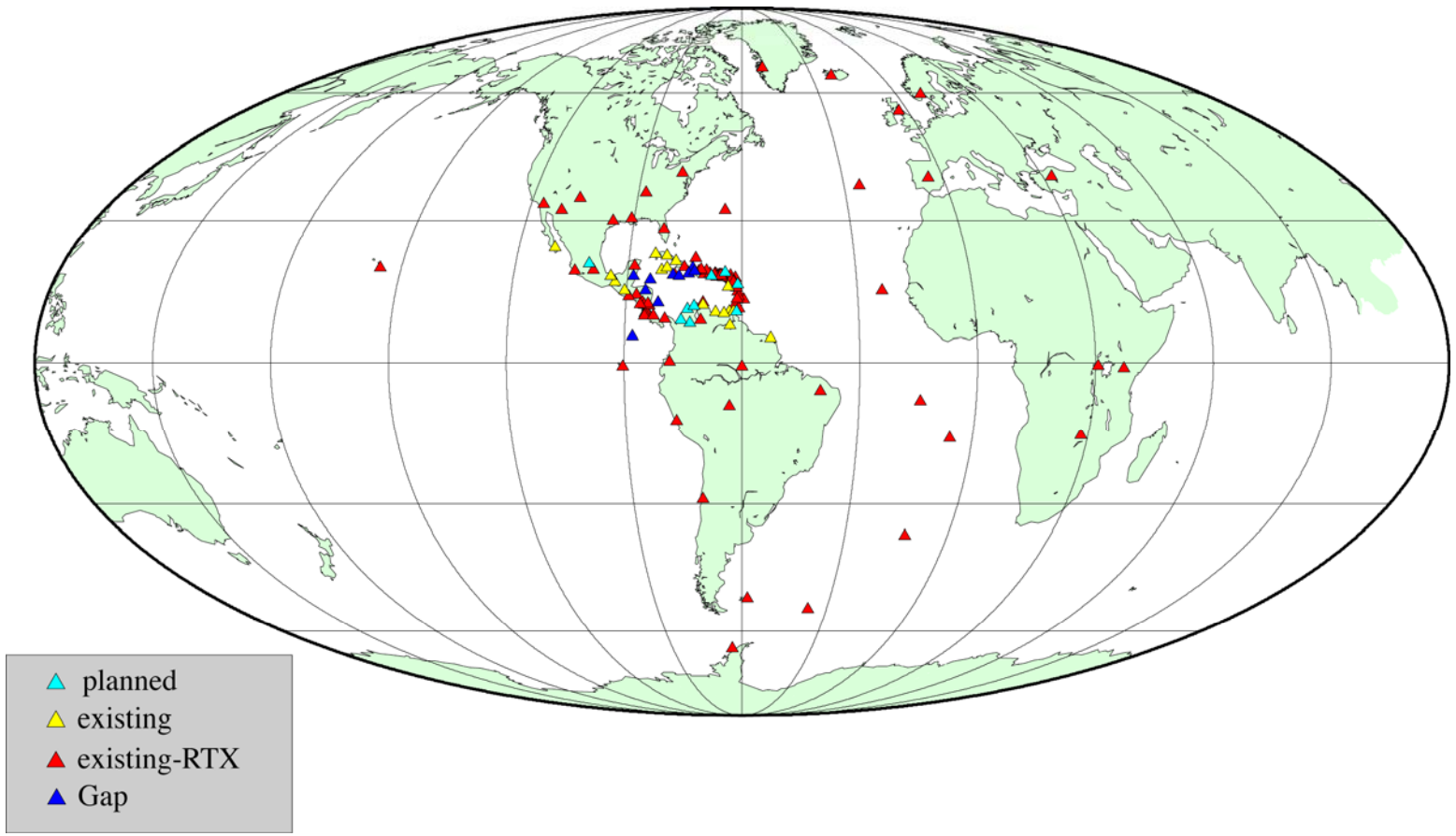
Monitoring Components of Tsunami Warning System

- 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.

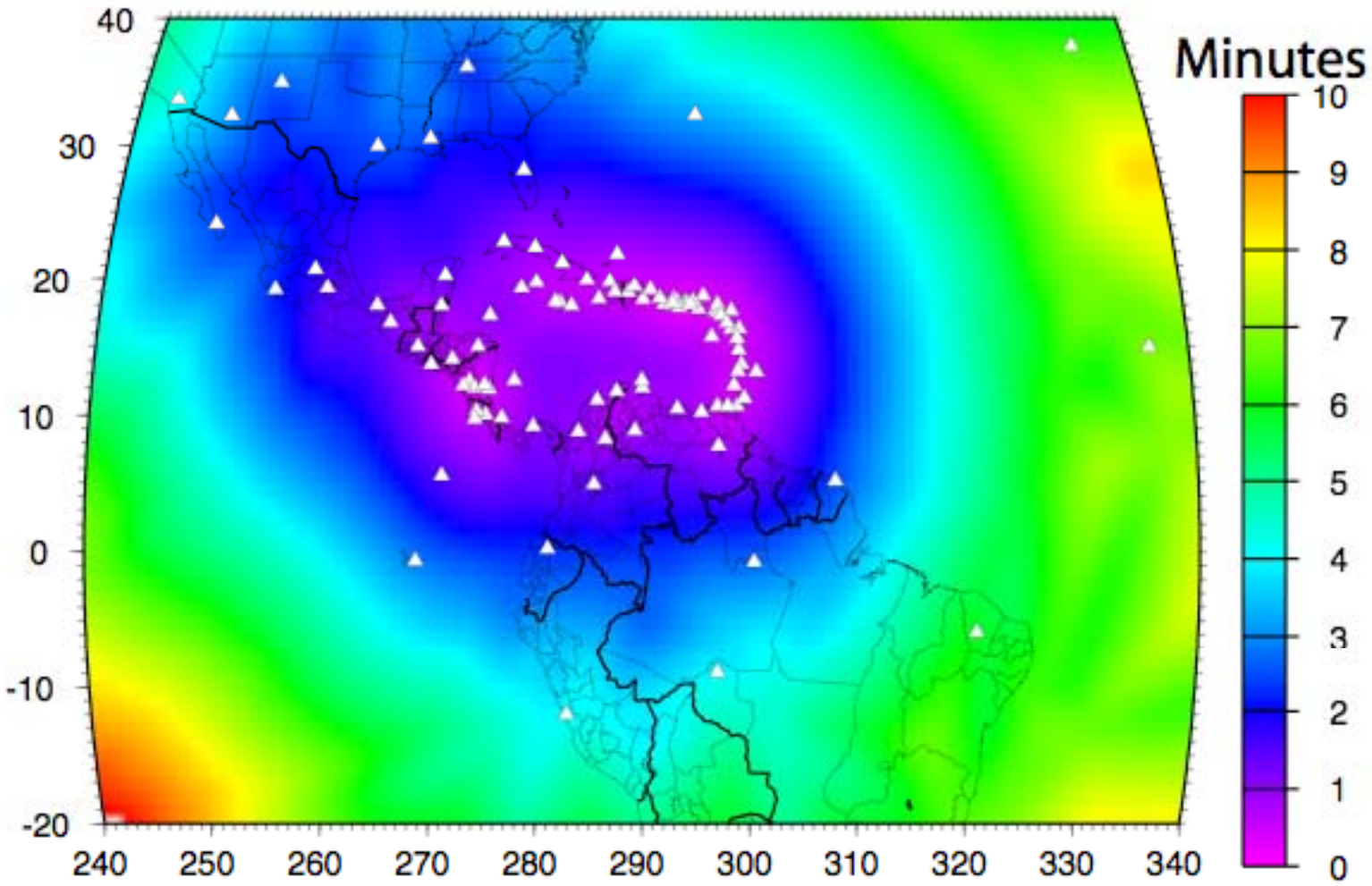
Caribbean Stations Monitored for Caribe EWS



Core Stations for Caribe EWS

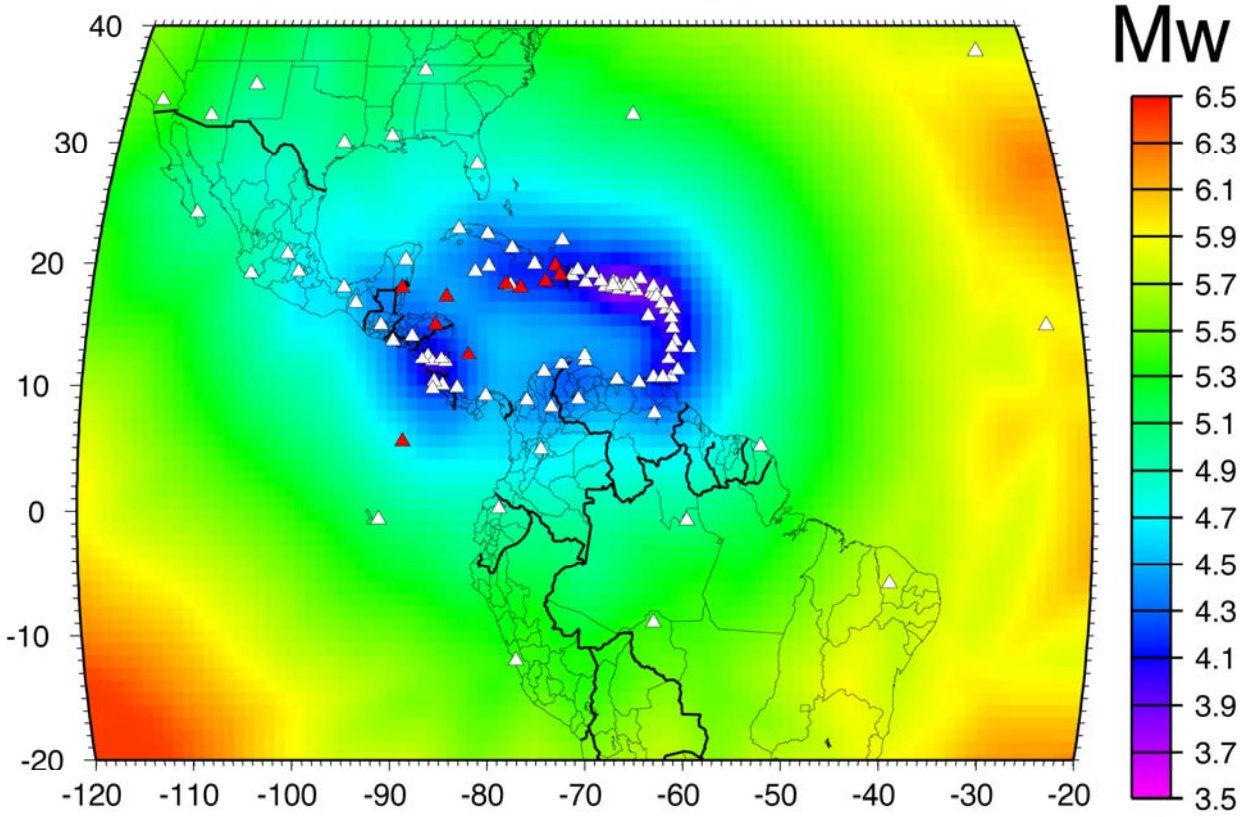


5 Station P-wave detection time
for 121 CORE stations.



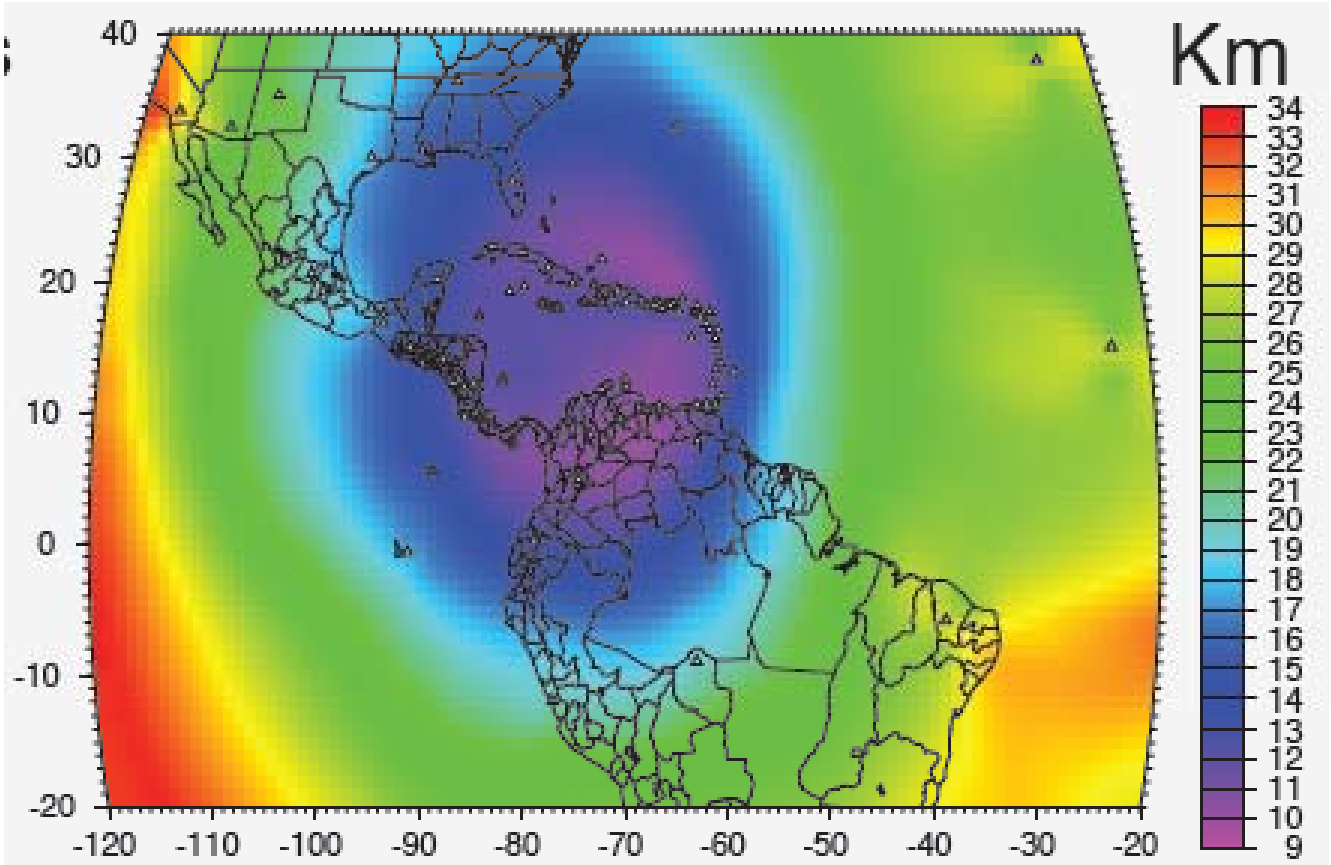
Contribution of Dan McNamara, USC

5 Station Mw detection threshold for 121 CORE stations



Contribution of Dan McNamara, USGS

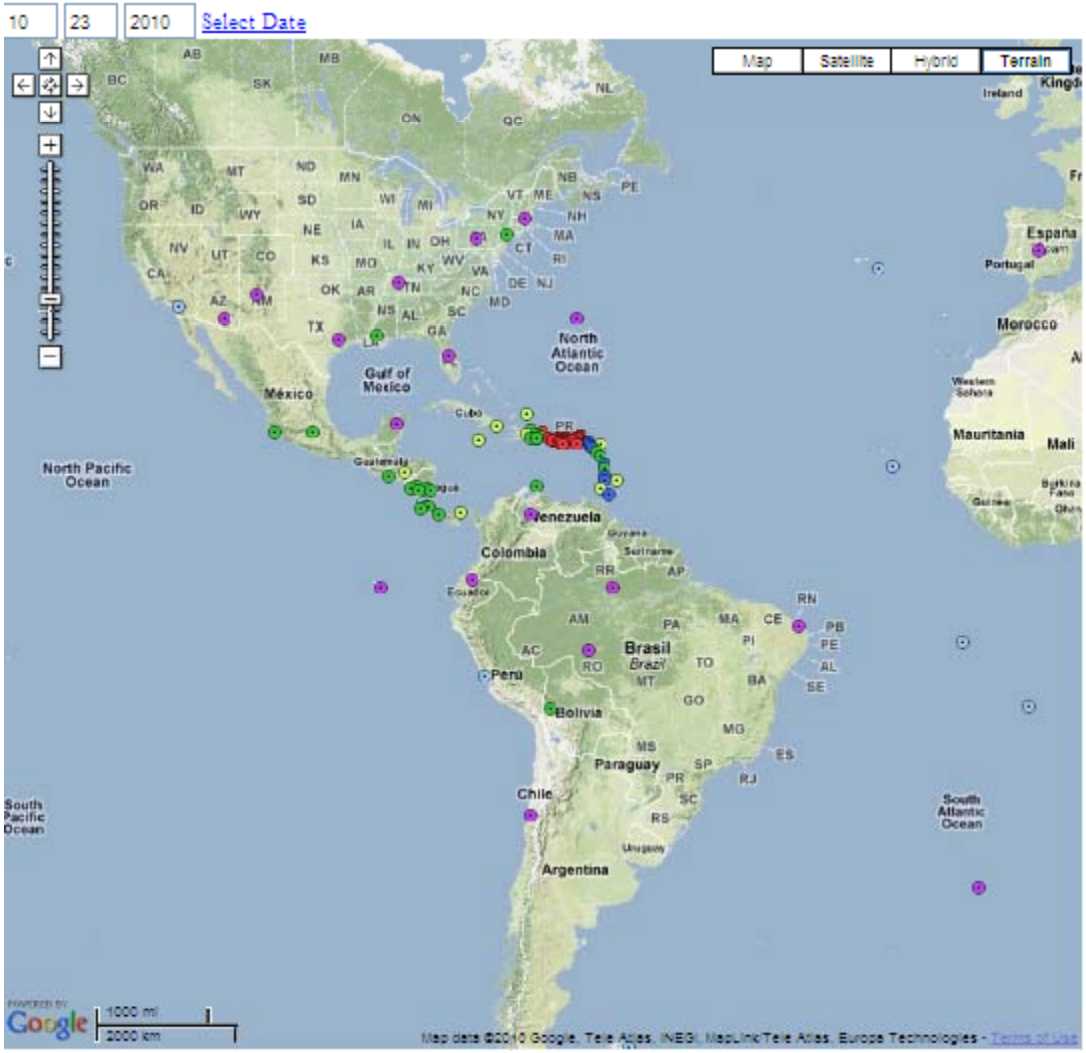
Theoretical Earthquake Location Error



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 fist arrival at each real-time station.

Contribution of Dan McNamara, USGS

Seismic Stations Available in Real Time for the CEWS

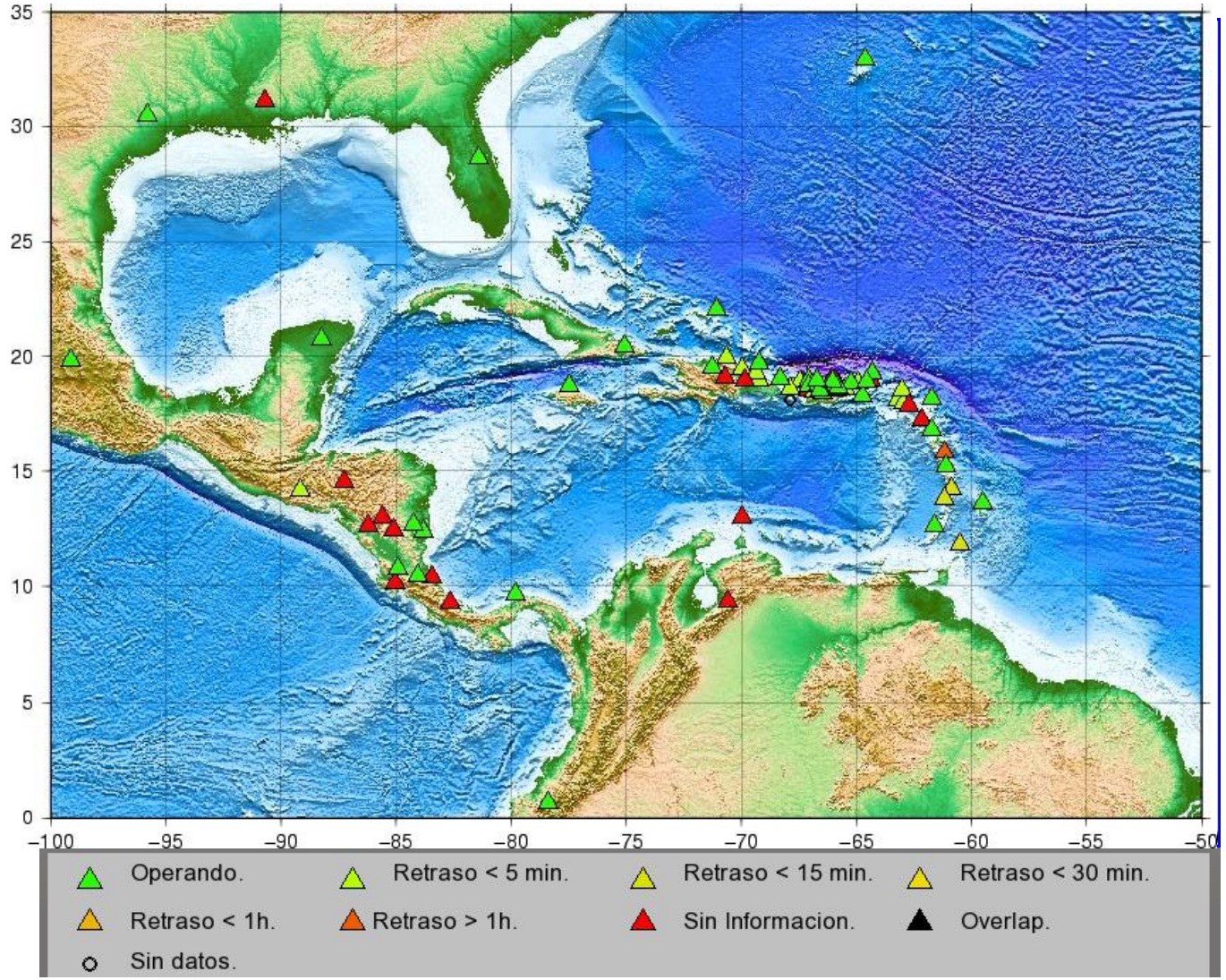


Stations Live at PRSN

Conributing 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

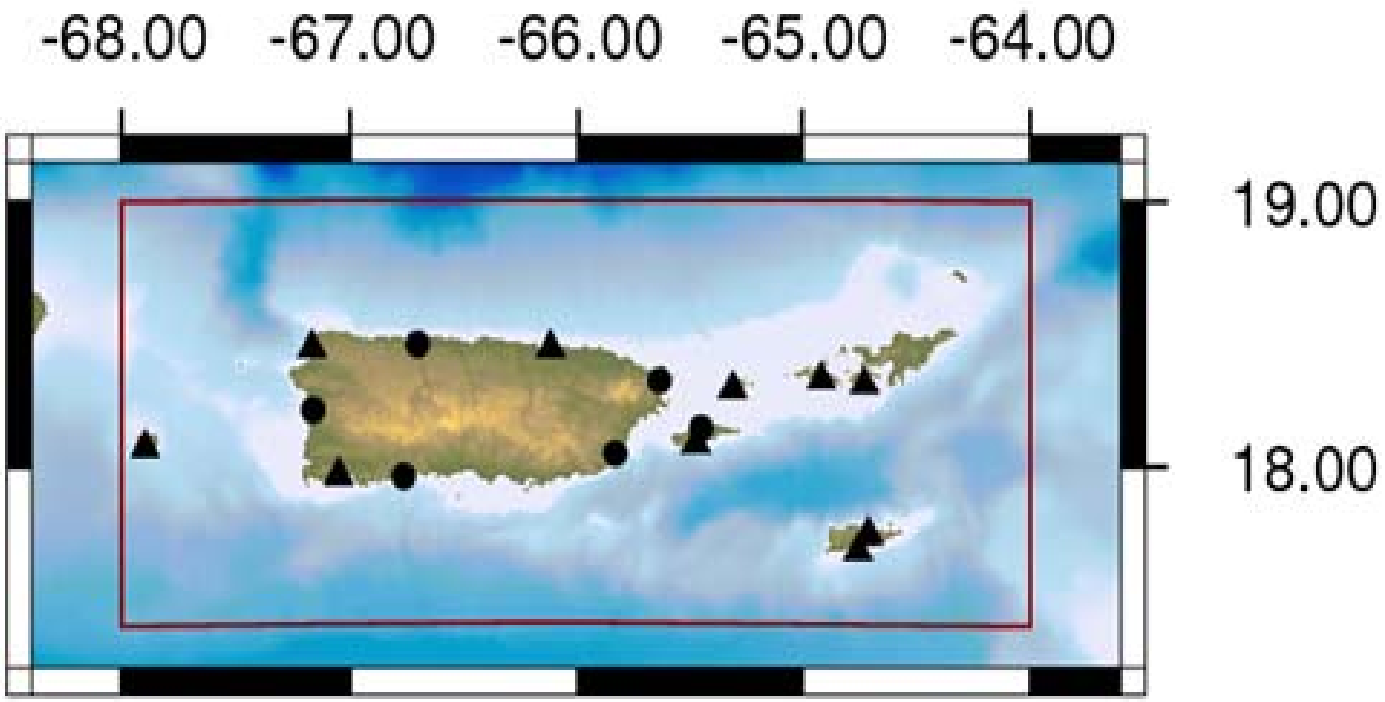


Areas with Gaps

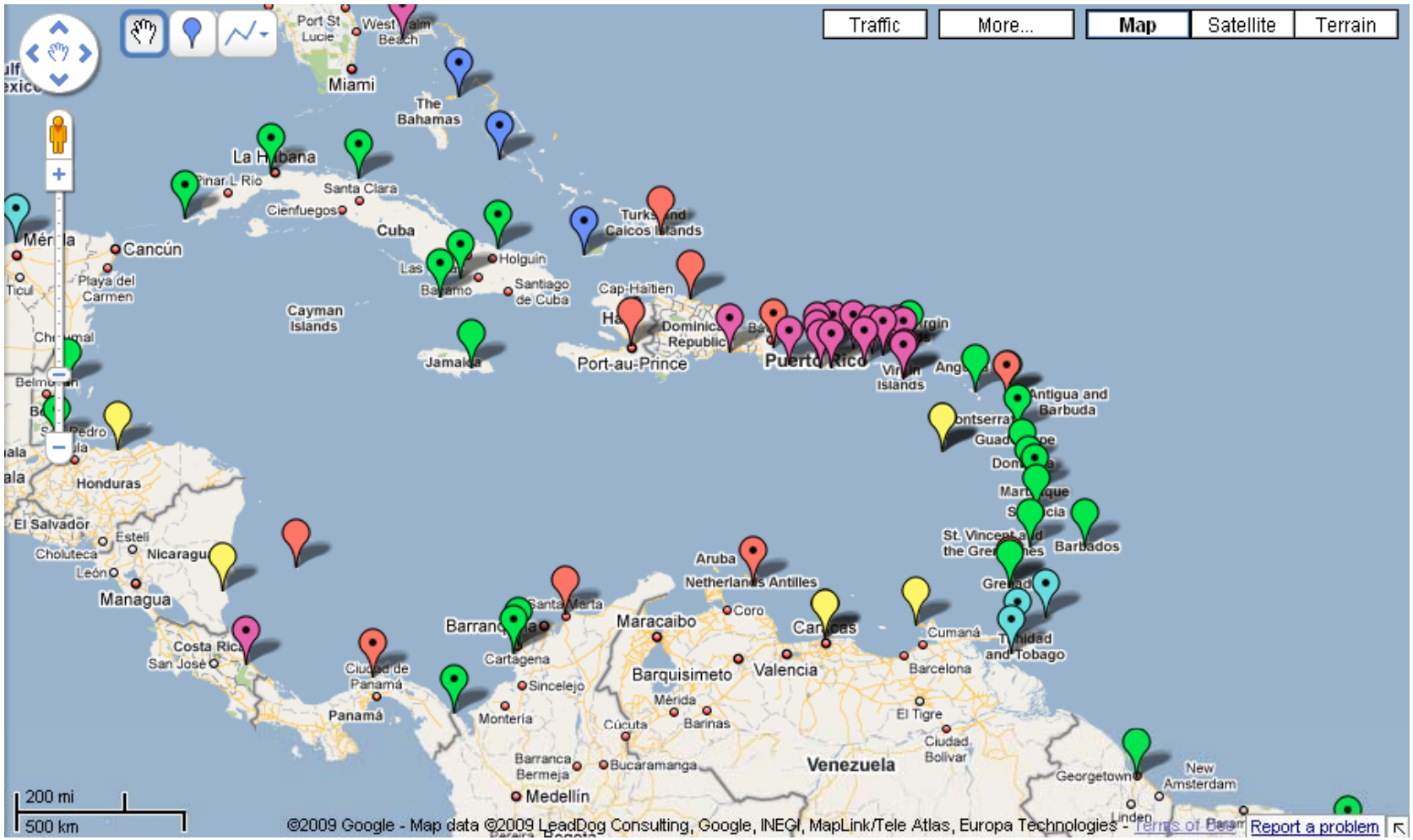
New seismic stations available in RT as of Haiti EQ

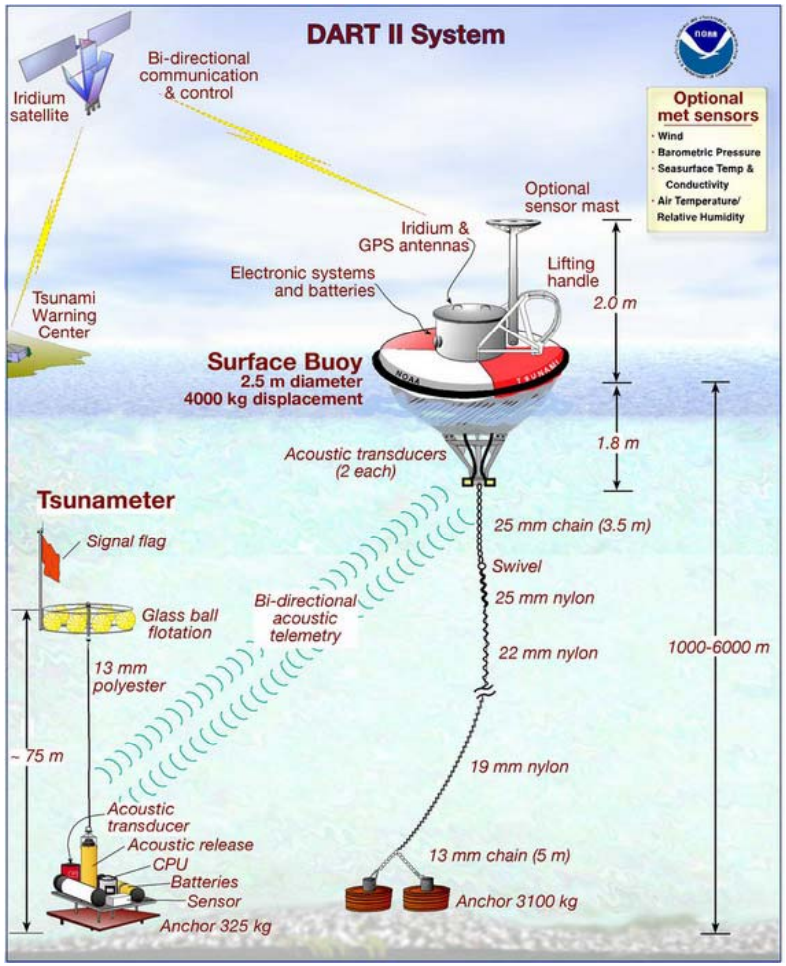
Haiti: Canada; Dom. Republic: ISU

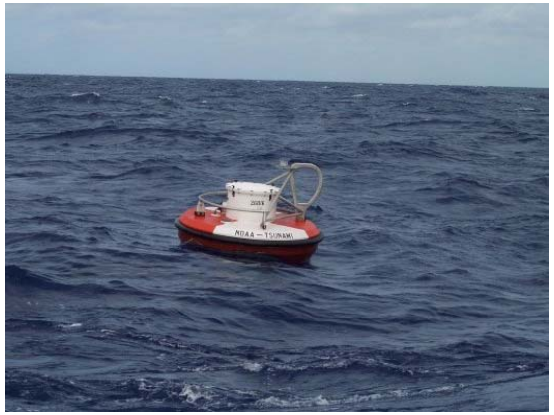
RSPR/FEMA & NOAA Mareógrafos TsunamiReady



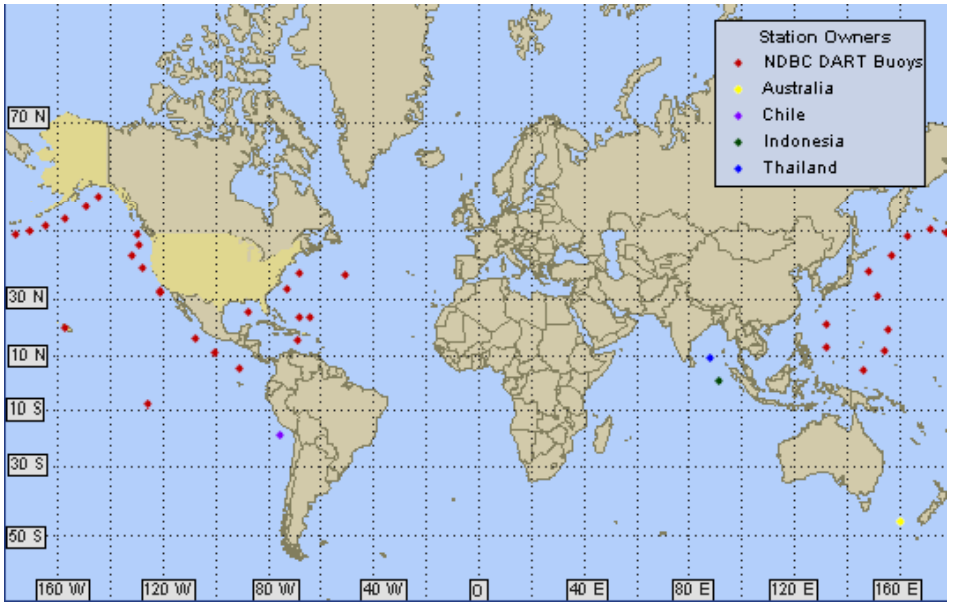
Core Stations Caribbean Sea Level Network



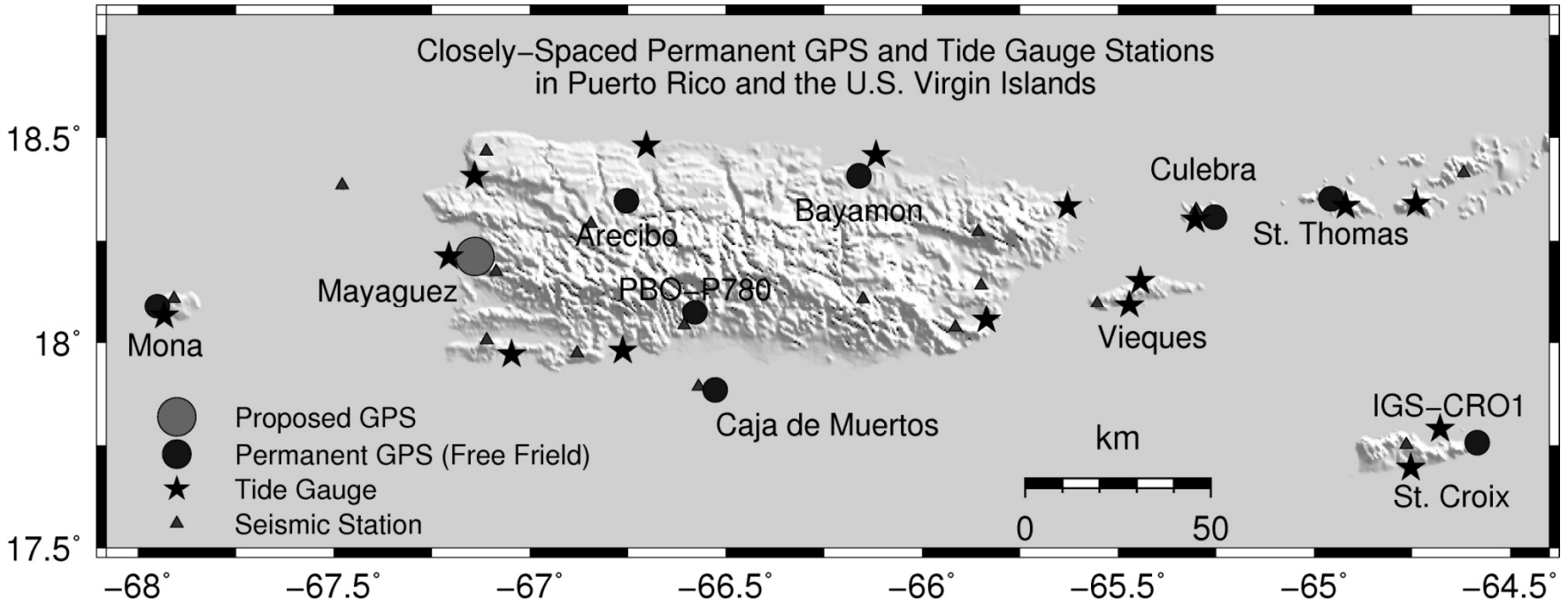




NOAA DART Buoys



High Rate GPS Network of the PRSN



Mayaguez Collocated Sea Level and Tide Gauge station

- 1rst 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.

Universidad de Puerto Rico
Recinto Universitario de Mayagüez
Departamento de Geología

RED SÍSMICA DE PUERTO RICO

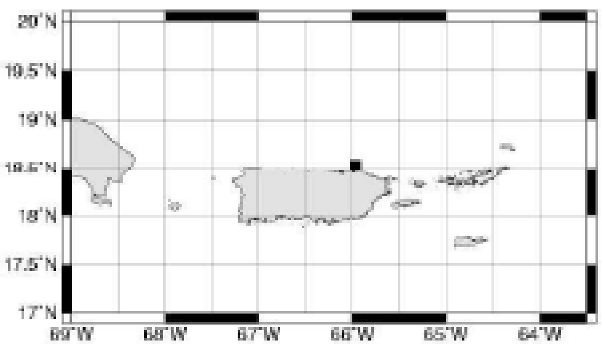
BOLETÍN 1

EVENTO SISMICO/TSUNAMI

FECHA:	Noviembre 03 2009
HORA LOCAL:	11:11:36
LATITUD:	18.54 Norte
LONGITUD:	65.96 Oeste
LOCALIZACION:	14.4 Km al Noroeste de Loiza,PR 18.3 Km al Noreste de San Juan,PR
PROFUNDIDAD:	78 Km
MAGNITUD:	2.77 Md
INTENSIDAD MAXIMA 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 micro 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.

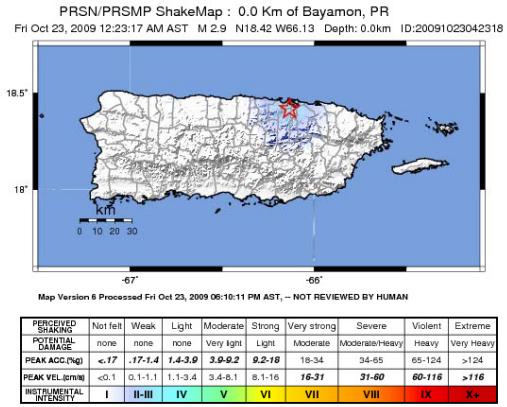
No hay peligro para Puerto Rico e Islas Vírgenes

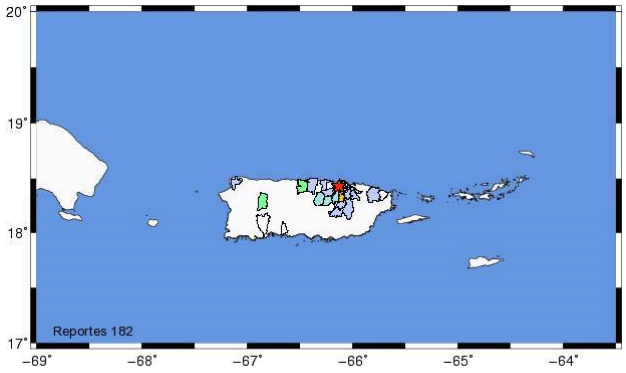


PRSN Online Earthquake/Tsunami Products

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 -66.13
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

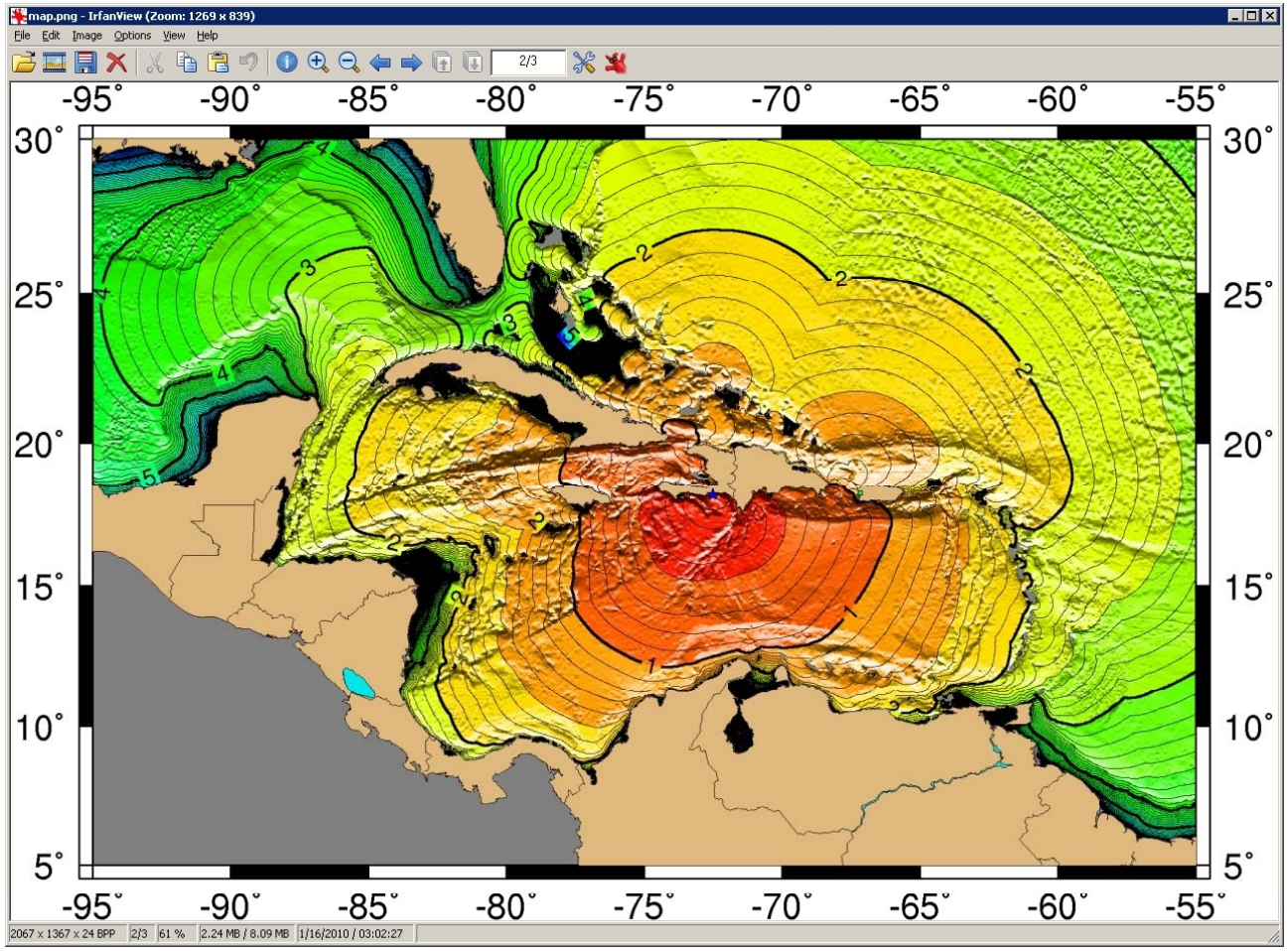




RED SISMICA DE PUERTO RICO - ESCALA DE MERCALLI MODIFICADA

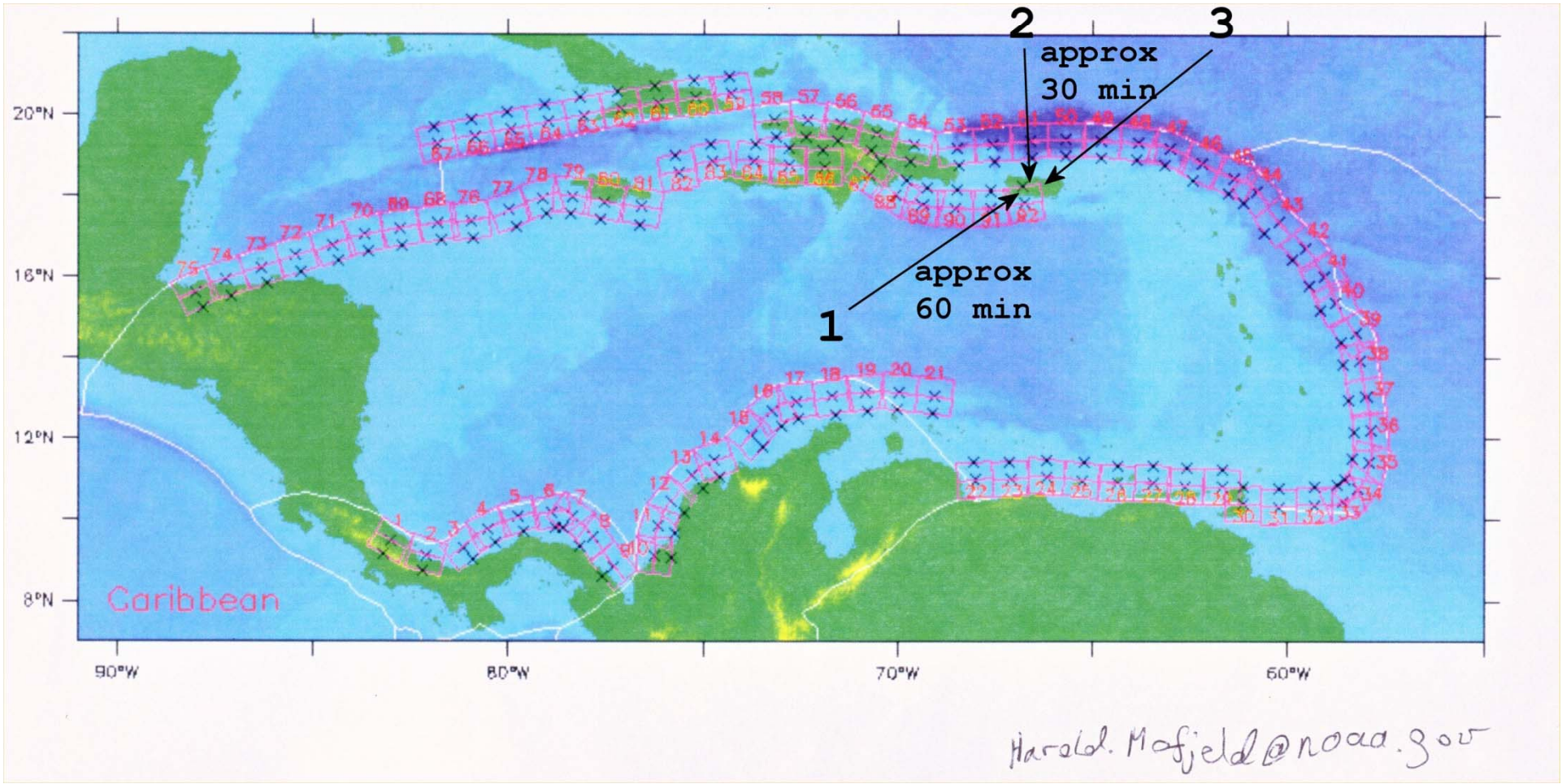
MOVIMIENTO PERCIBIDO	Ninguno	Debil	Ligero	Moderado	Fuerte	Muy Fuerte	Severo	Violento	Extremo
EFECTOS ASOCIADOS	Ninguno	Ninguno	Ninguno	Minimos	Ligeros	Apreciables	Significativos	Mayores	Muy Fuertes
INTENSIDAD	I	II – III	IV	V	VI	VII	VIII	IX	X+

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)



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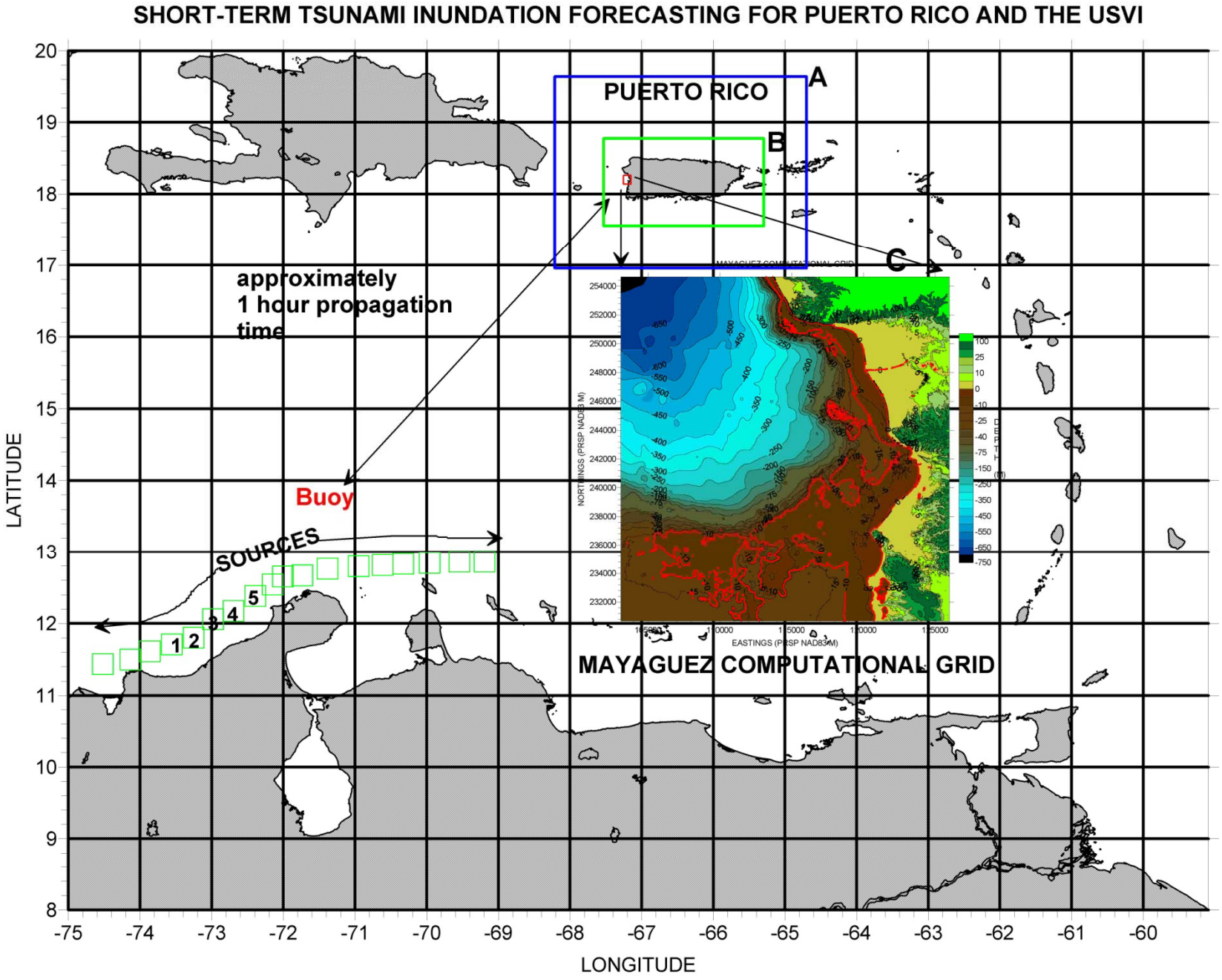


Communications and Dissemination

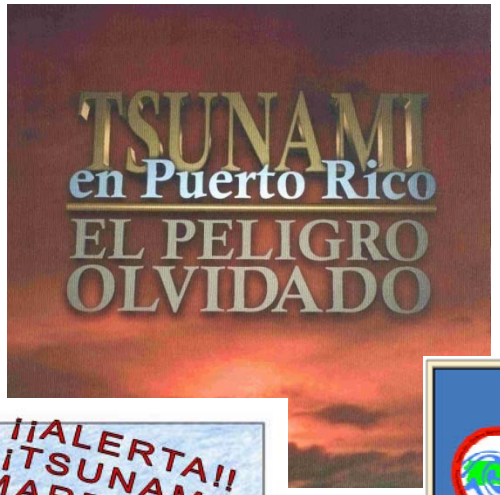
NOAA Weather Radio All Hazards

Preparedness, Readiness and Resilience

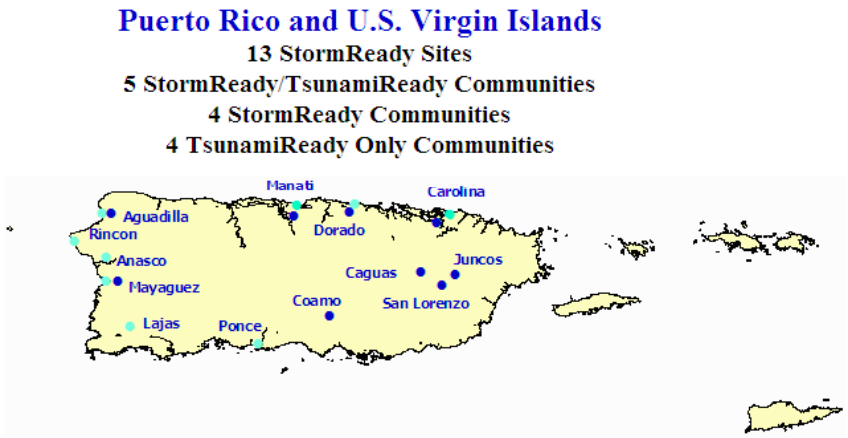
Initiatives need to be taken at the local level to assure that appropriate actions are taken before, during and after a tsunami or potential tsunami event.
ICG CEWS has received funding from EU/Italy to establish the English language **Caribbean Tsunami Information Center** to facilitate these activities.


Workshops


EQ and Tsunami Drills



NOAA TsunamiReady Designations



StormReady/TsunamiReady Blue and Cyan Dots StormReady Communities: Blue Dot TsunamiReady: Cyan Dot	
• Aguadilla • Anasco • Caguas • Carolina • Coamo • Juncos • Dorado	• 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.

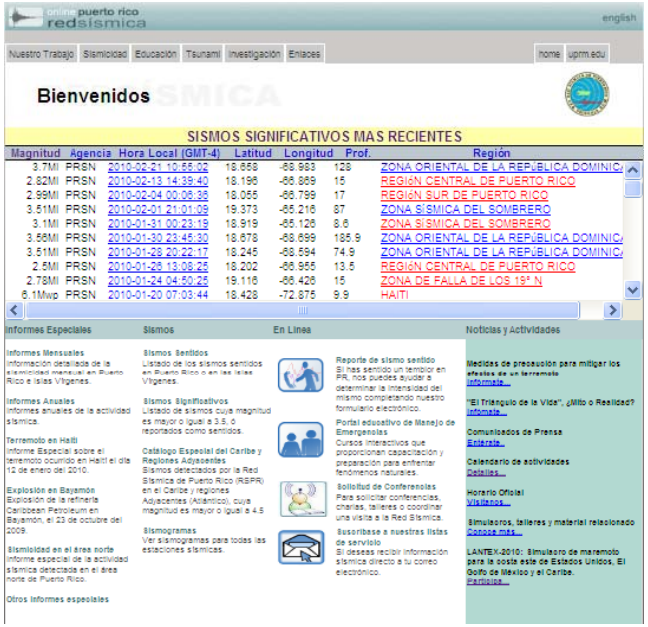
- For the very large events need to evaluate the utilization of real time strong motion or GPS data to better estimate the tsunami potential
- High quality data is needed to calculate fast (5 minutes) regional moment tensors for estimation of tsunami potential.
- The establishment of a CTWC and CTIC 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 and 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



Thanks for your support and attention