



# The Tsunami and Other Coastal Hazards for the Caribbean and Adjacent Regions (CARIBE EWS): 11 Years Advancing Readiness

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Deputy Manager, CTWP

Sea Level Operators Training, October 17-21, 2016

Over the past 500 years more than 75 tsunamis have killed 4484 people

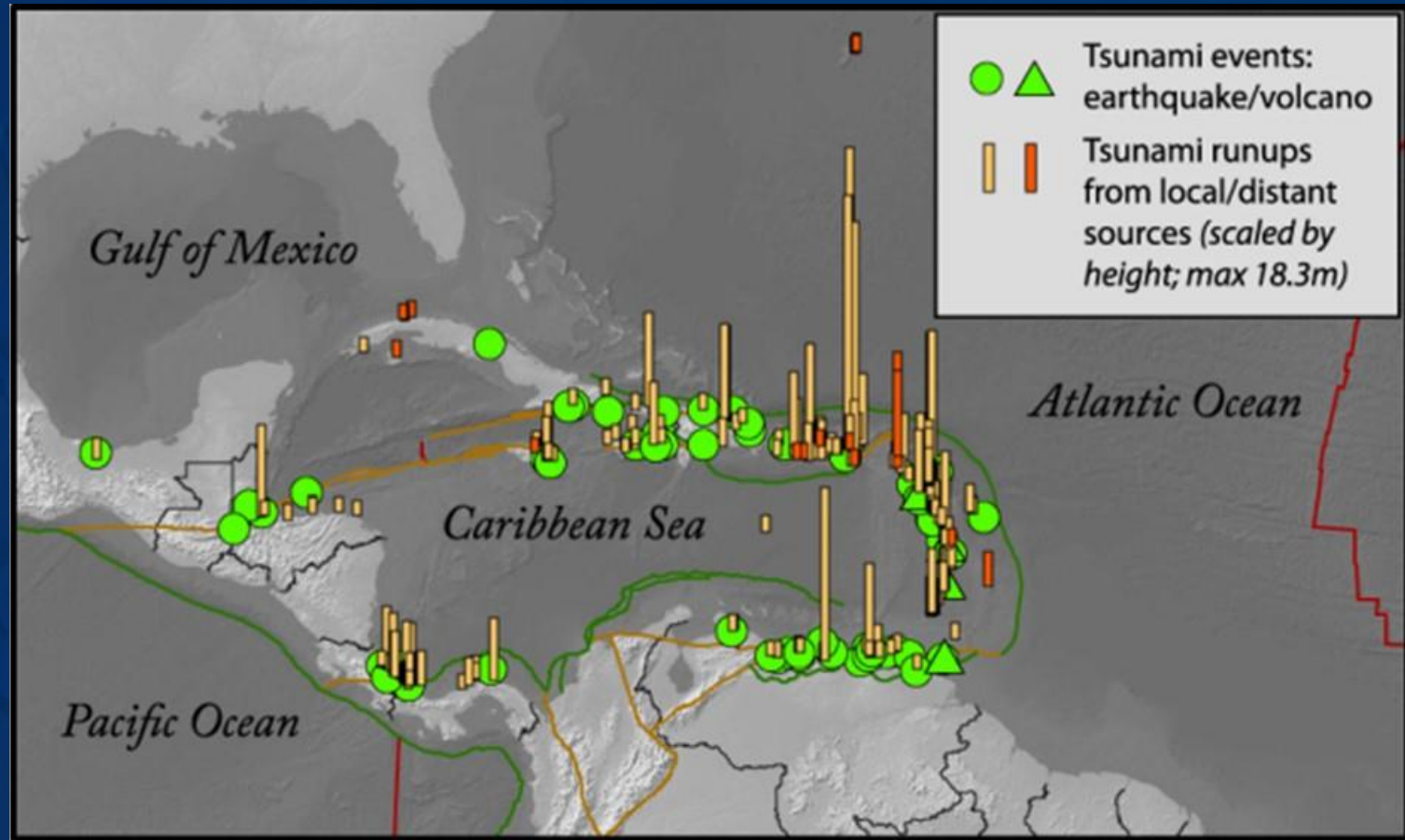


Figure published in: von Hillebrandt-Andrade, Christa, 2013. Minimizing Caribbean Tsunami Risk, Science, Vol. 341pp. 966-968.

# Then and Now



1867- US Virgin Islands  
30 deaths



1918- Puerto Rico  
140 deaths



1946- Dominican Republic  
1790 deaths







# Caribe EWS Officers WG and TT

- **Chair – Christa von Hillebrandt-Andrade (USA)**
- **Vice Chairs**
  - **Gerard Metayer (Haiti)**
  - **Milton Puentes (Colombia)**
  - **Paul Martens (Sint Maarten-Kingdom of Netherlands)**
- **WG 1- Tsunami Monitoring and Detection Systems – Jean Marie Saurel (France), Marcelino Hernandez (Vice Chair for Sea Level)**
- **WG2 - Tsunami Hazard Assessment – Silvia Chacón (Costa Rica)**
- **WG 3 - Tsunami Related Services – Antonio Aguilar (Venezuela)**
- **WG 4 –Preparedness, Readiness and Resilience – Patrick Tyburn (Martinique – France)**
- **TT CTIC Business and Sustainability Plan – Pedzi Grigori (Curacao, Kingdom of Netherlands)**
- **TT CARIBE WAVE 17 - Patrick Tyburn (Martinique – France)**
- **TT Volcanic Activity and potential Tsunamis - Paul Martens (Sint Maarten-Kingdom of Netherlands)**
- **Group of Experts for Other coastal hazards - TOR and composition to be determined**



# UNESCO IOC Intergovernmental Coordination Group for Tsunami and Other Coastal Hazards for the Caribbean and Adjacent Regions (CARIBE EWS)

ICG XI – Cartagena, Colombia, April 5-7, 2016

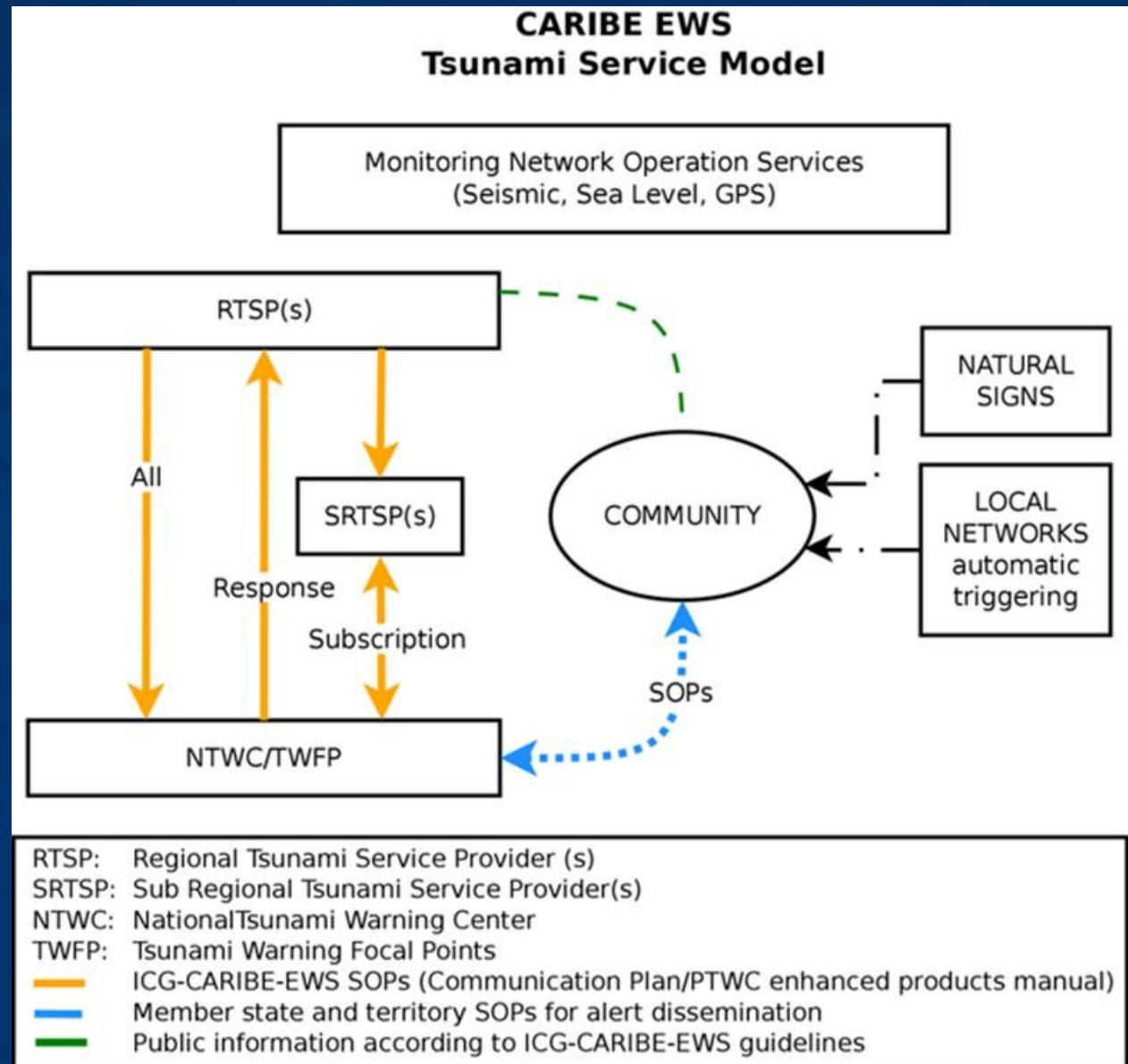


**Next Meetings**

**2017: San Jose, Costa Rica and 2018: TBD**



# CARIBE EWS Service Model- Community Centered



# US NWS Caribbean Tsunami Warning Program



- Established by NOAA NWS in 2010
- Located in Mayagüez, Puerto Rico
- Supports sea level, seismic and GNSS monitoring efforts, Tsunami Operational Procedures training, CARIBE WAVE exercises, TsunamiReady Program
- Provides local and regional support for PTWC and PTWC products



# Seismic and Sea Level Data Contributions



**Seismic Stations –  
increase from 10 to 126–  
tsunami bulletins can be  
issued in 5 minutes**

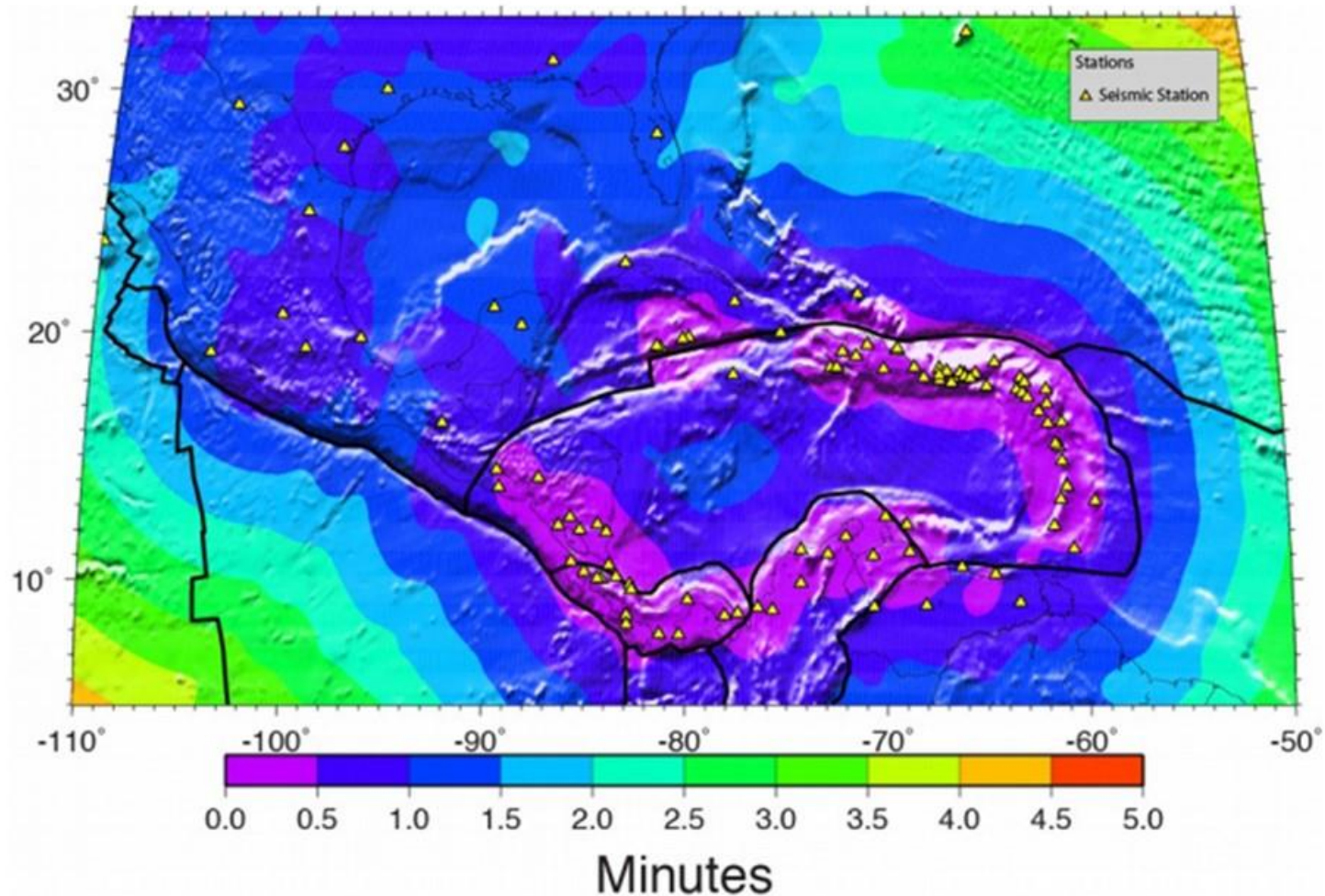
**Sea Level Stations – 5 to  
77 stations – tsunami  
detection dropped from 3  
hours to 5-30 minutes**

Sea Level Stations



**Need for continuous  
training and capacity  
building for sea level and  
seismic network  
operators.**

# $M \geq 4.5$ Earthquake Detection Time as of 2016 (Source: USGS)



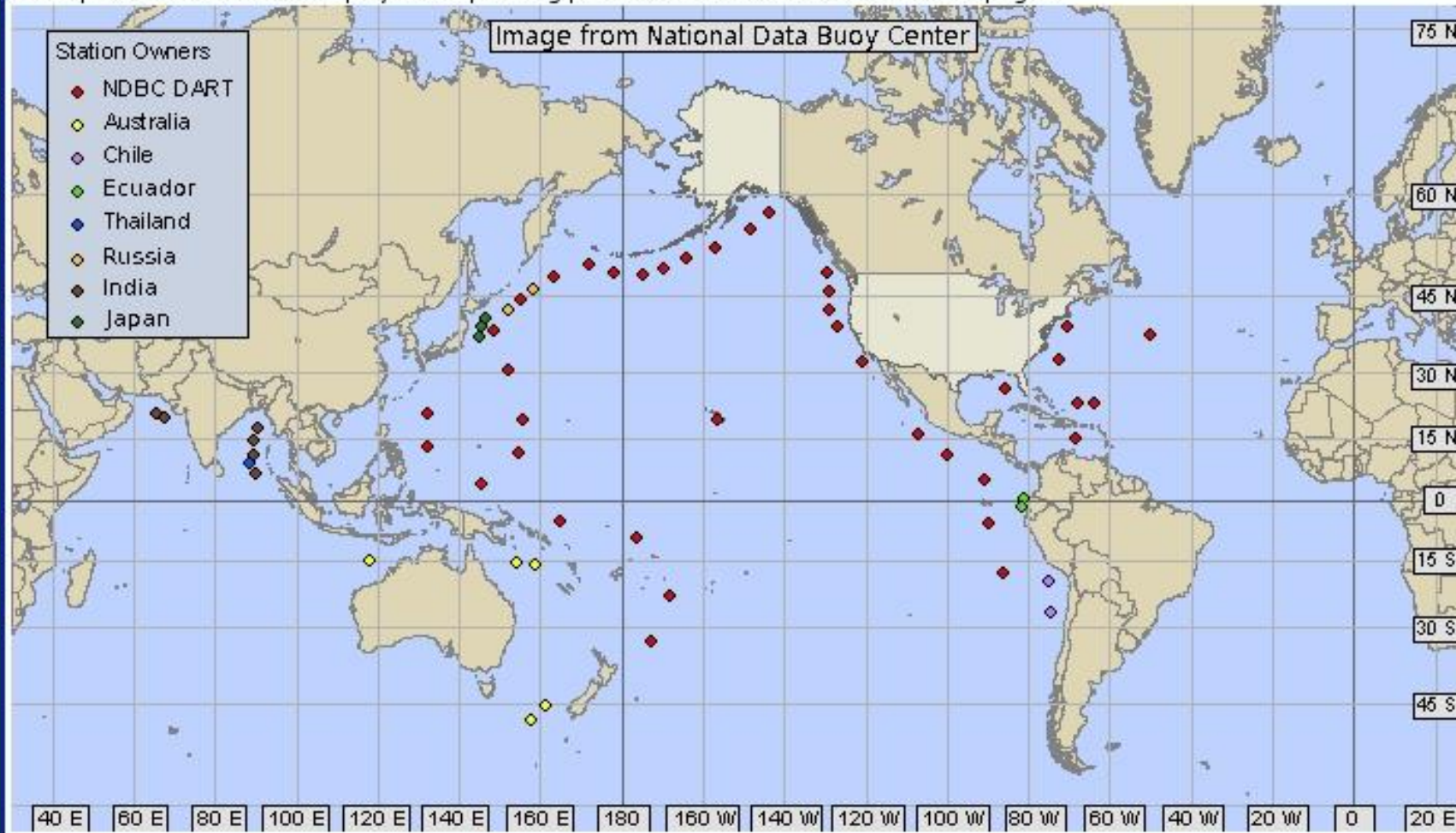
## ***Sea level network***

- Total of 79 contributing stations in real-time, mainly on GOES satellite 5 and 6 minutes slots
- Follow up by CTWP of data availability and improvements in the number of contributing stations
- The DART buoy of the Caribbean had been declared lost in December 2014 was recovered in early 2015. Currently the mid Atlantic DART is adrift

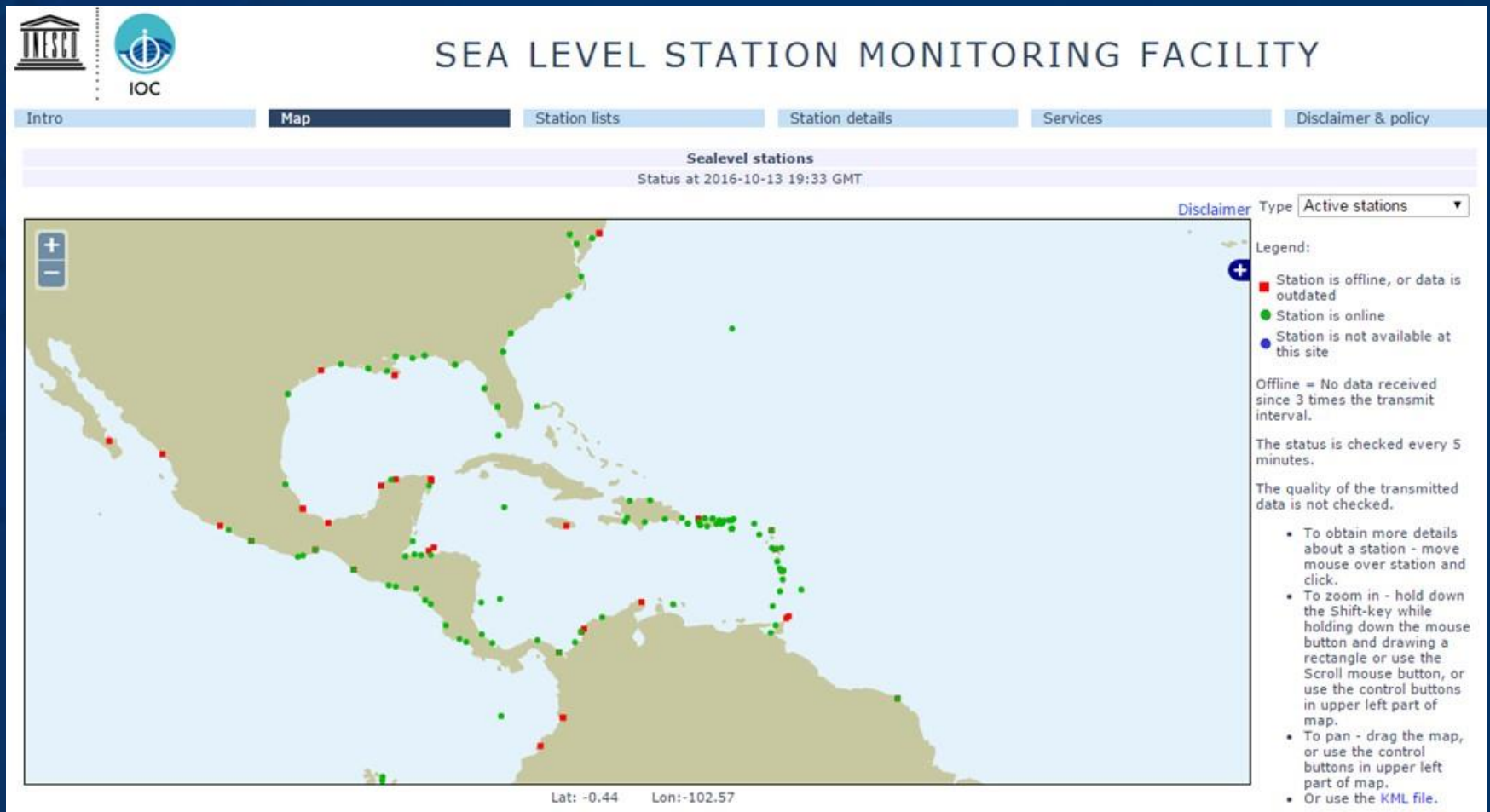


# DART buoys network

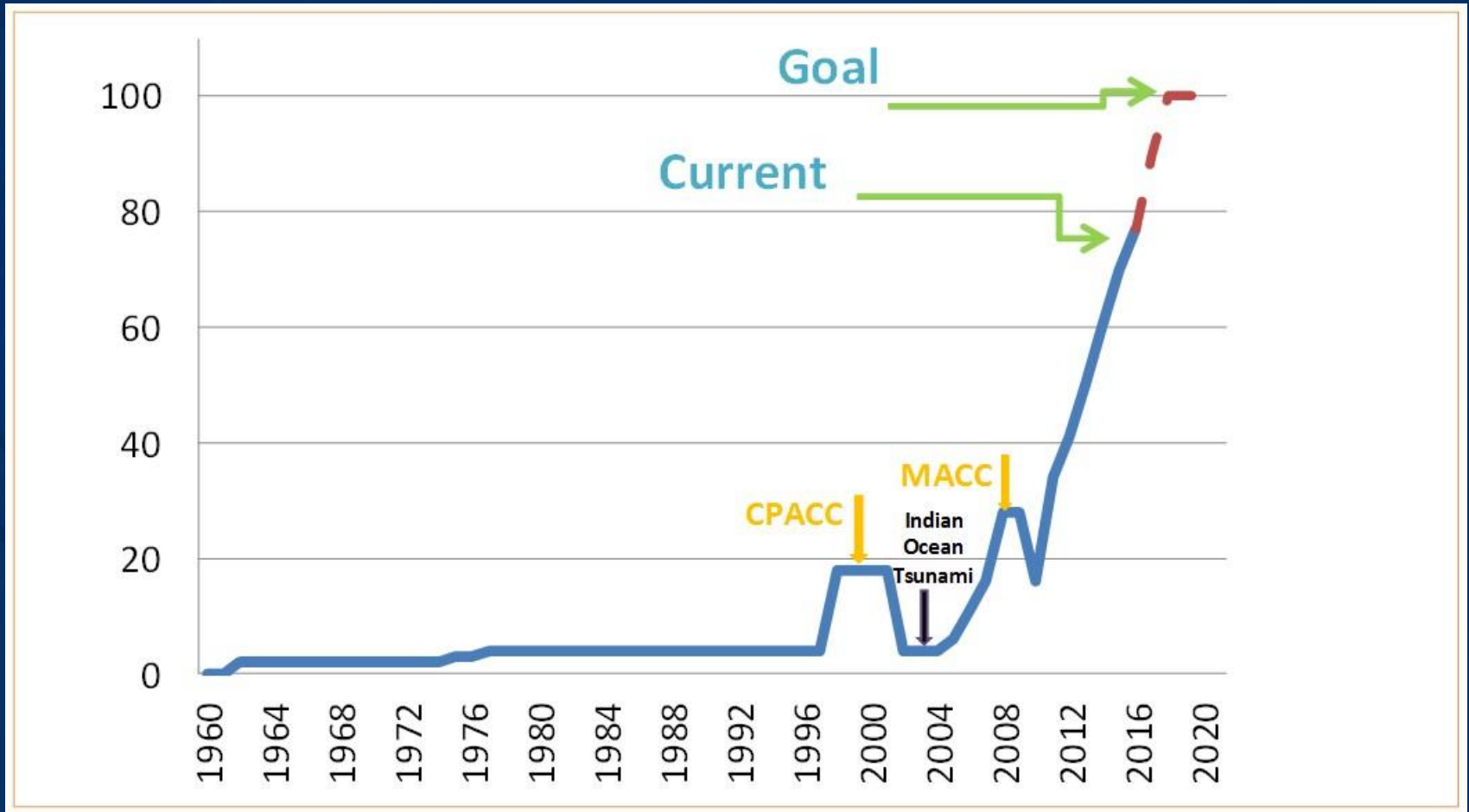
Place pointer on station to display corresponding plot or click on station to view station page.



# Sea level network from IOC sea-level website (all near real-time stations)



# CARIBE EWS Coastal Sea Level Monitoring Stations Progression (1960-2020)



CPACC and MACC were Projects executed by the Caribbean Community Center for Climate Change

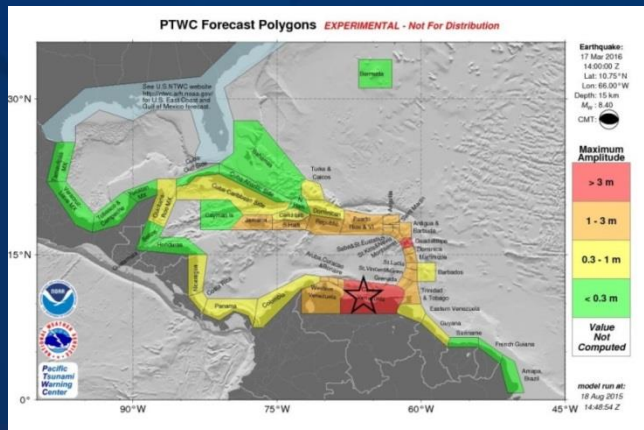


# *Sea level network*

- 2016 capability reports show improvements in the network since 2014
- Improvements include :
  - Costa Rica/Panama/Colombia coast
  - Jamaica region
  - Yucatan peninsula
  - Saint Lucia
- Other sea level stations should be contributing soon (Anguilla and Turks and Caicos)
- CTWP in dialogue with the US TWC, PRSN and IOC monitors the network (data availability/ latency, real-time capability maps....)

# US PTWC (Hawaii) is the CARIBE EWS Tsunami Service Provider

- Serving the region since 2005
- Began the issuance of the Enhanced Products as of March 1, 2016, official RTSP as of June, 2016
- Countries are responsible for issuing Warning, Advisories, Watches, etc...
- PTWC will also begin covering the domestic service for Puerto Rico and Virgin Islands – becoming sole CARIBE EWS provider.



# Critical National Connection

- Tsunami National Contact and Warning Focal Point(s), all but 1 country has made designations.
- Many countries still in process of designating National Tsunami Warning Centers
- **It is the responsibility of the Countries to issue the Tsunami Warnings, Watches, Advisories, NOT the PTWC**





# Tsunami Ready: 51 Communities Recognized to Date in the CARIBE EWS Region

Categories	Completed
<b>MITIGATION</b>	
Mit-1. Have designated and mapped tsunami hazard zones	✓
Mit-2. Have a public display of tsunami information	✓
<b>PREPAREDNESS</b>	
Prep-1. Produce easily understood tsunami evacuation maps as determined to be appropriate by local authorities in collaboration with communities	✓
Prep-2. Develop and distribute outreach and public education materials	✓
Prep-3. Hold at least three outreach or educational activities <u>annually</u>	✓
Prep-4. Conduct an annual tsunami community exercise	✓
<b>RESPONSE</b>	
Resp-1. Address tsunami hazards in the community's emergency operations plan (EOP)	✓
Resp-2. Commit to supporting the emergency operations center (EOC) during a tsunami incident if an EOC is opened and activated	✓
Resp-3. Have redundant and reliable means for a 24-hour warning point (and EOC if activated) <u>to receive</u> official tsunami threats	✓
Resp-4. Have redundant and reliable means for 24-hour warning point and/or EOC <u>to disseminate</u> official tsunami alerts to the public	✓



# St. Kitts and Nevis Tsunami Ready Pilot Mitigation

## 1. Define Tsunami Hazard Zone

- No tsunami inundation modeling was available due to lack of bathymetry, ComMIT was run but results are of limited use.
- *Baseline tsunami zone was used (30 m/1.6 km inland)*

## 2. Public Display of Tsunami Information

- 70 signs were procured for SKN

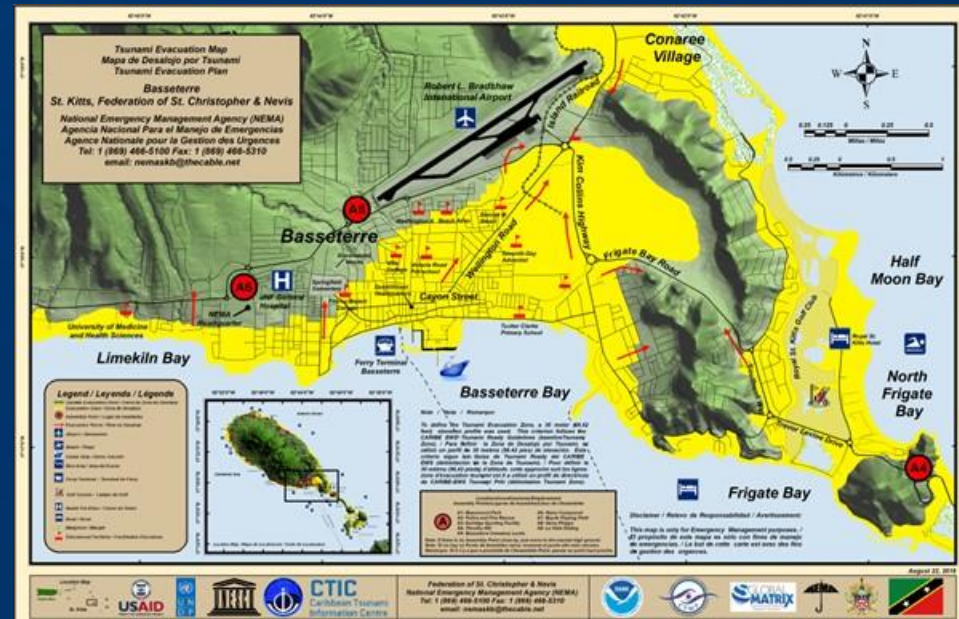




# Preparedness

## 3. Tsunami Evacuation Map

- 1200 maps of Saint Kitts
- 400 maps Basseterre, Saint Kitts
- 1200 maps of Nevis
- 400 maps of Charlestown







**Tsunami Messages for St. Kitts and Nevis**  
 Mensajes de Tsunami para St. Kitts y Nevis  
 Messages de Tsunami pour Saint Kitts et Nevis

**Warning Aviso Advertencia**

**Advisory Advertencia Avertissement**

**Watch Vigilancia Velle**

**Information Información Información**

**What is a Tsunami? ¿Qué es un Tsunami? / C'è la tsunam o qu'è tsunam?**

**Tsunami Hazard Zone**  
 In Case of Tsunami, Go to High Ground or Inland

**History / Historia / Histoire**

**Tsunami Safety Rules**  
 Reglas de Seguridad en Caso de Tsunami  
 Consignes de Sécurité en cas de Tsunami

**Always be prepared. A tsunami may occur anytime. In case of an earthquake, protect yourself. Stop, cover and hold on. Run away from the coast or to a high place if you feel a strong or long earthquake. GET a bulletin on the fact of the sea level, HIGHS a strong or loud noise from the sea and/or RECEIVE an official tsunami warning message.**

**Étre toujours préparé, un tsunami peut survenir à tout moment. En cas de séisme, protégez-vous. Arrêtez, couvrez-vous et tenez-vous. Éloignez-vous de la côte ou à un lieu plus élevé si vous sentez un séisme fort ou prolongé. RECEVEZ un bulletin officiel de l'état de la mer, HIGHS un bruit fort ou un bruit venant de la mer et/ou RECEVEZ un message officiel d'alerte au tsunami.**

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# Preparedness

## 4. Public Education and Outreach Materials

### TSUNAMI SAFETY RULES

- 1 ALWAYS BE PREPARED, A TSUNAMI MAY OCCUR ANYTIME**
  - Prepare a family emergency plan
  - Prepare a safety backpack including headlamps and first aid kit
  - Identify danger zones, assembly locations, designated evacuation routes or the safest way to reach higher ground safely with the help of your local disaster management officials
- 2 IN CASE OF AN EARTHQUAKE PROTECT YOURSELF**
  - Drop
  - Cover
  - Hold on

**DROP COVER HOLD**
- 3 RUN TO HIGH GROUND IF ANY OF THESE WARNING SIGNS OCCUR AT THE COAST**
  - FEEL a very strong or long earthquake (it is difficult to walk, there are falling objects, damage to structures, earthquake lasts for about 1 minute or more)
  - SEE a sudden rise or fall (proving the ocean floor, rocks and fish) of the sea level
  - HEAR a strange or loud noise (can be a ruck) coming from the sea, or receive official tsunami warning messages by siren, radio, television, commercial radio or emergency alert radio
- 4 MOVE AWAY FROM HAZARDOUS AREAS (IN PREFERENCE ORDER DEPENDING ON YOUR LOCATION OR SITUATION)**
  - Run away from the coast to an assembly point or higher ground
  - Go to the third floor of a building or higher
  - Climb a tree
  - If time permits, search for nearby structures to enter, 100-400 meters deep
- 5 STAY IN THE SAFE AREA UNTIL LOCAL AUTHORITIES INDICATE THAT THE DANGER HAS PASSED, THIS MAY TAKE MANY HOURS**

Coordinating Sources: US NWS Caribbean Tsunami Warning Program, the Pacific Risk Science Review & NCCER New Zealand and the International Tsunami Information Center

### Getting Ready For TSUNAMIS

**Warning Information**

Tsunami Warning Centers issue tsunami alert messages as advice to designated Tsunami Warning Facilities.

These messages provide preliminary earthquake information and indicate whether or not there is a tsunami threat.

When tsunami waves are expected, the bulletin also includes information on the coastline that could be impacted, the expected arrival times and tsunami observations that have been made.

Only national and local government agencies have the authority to make decisions regarding the official state of alert in their area and any actions to be taken in response.

Messages may be updated, withdrawn, possibly downgraded, or cancelled so you MUST monitor and follow the advice of your national and local authorities, but also be on alert for the initial tsunami warning signs. Local authorities may issue evacuation orders, but these may not be enough time, so EVACUATE if you recognize the initial warning signs.

**What is a Tsunami?**

A tsunami (from NANI-mee) is a series of waves caused by a major disturbance of a body of water. These waves can arrive in minutes, but may continue for hours. Tsunamis can be generated by a large coastal or underwater earthquake, landslide or volcanic eruption. Large meteorite impacts may also trigger tsunamis. All known sources capable of causing tsunamis are found within the Caribbean and its adjacent regions, and there are also distant sources across the Atlantic. Some countries within the region are also exposed to tsunamis along their Pacific coasts.

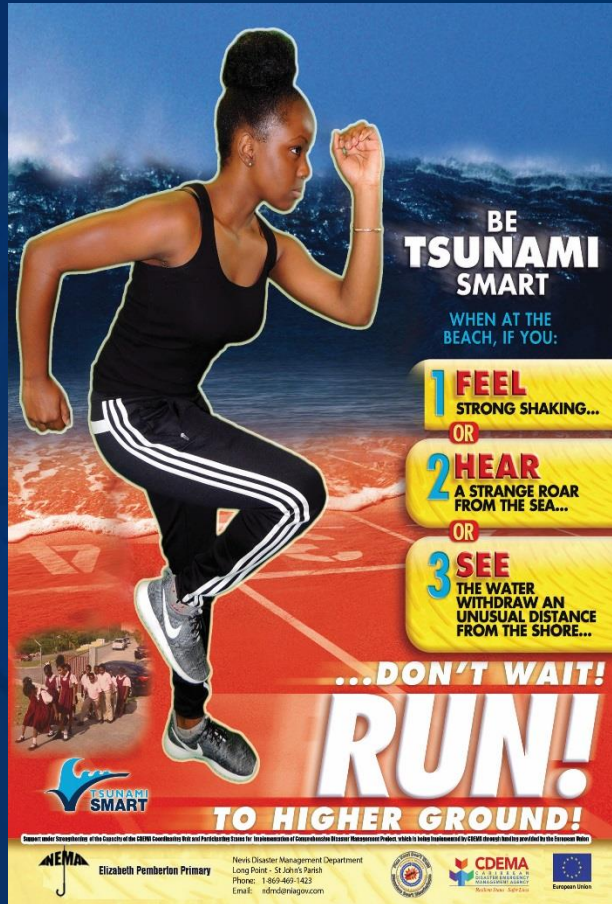
**Can Tsunamis occur in the Caribbean and Adjacent Regions?**

At least 75 tsunamis have impacted the Caribbean and adjacent regions in the past 500 years. Of these, almost 25 have caused deaths, and since 1842 it is estimated that more than 3000 people have been killed by these events. In the 2010 tsunami in Haiti, reports indicate that at least 7 have been lost. Based on this historical evidence, the region can expect to experience approximately 4 destructive tsunamis per century. It is estimated that over 300,000 residents and visitors are exposed daily along the shores to this threat.

**A Guide for the Caribbean and Adjacent Regions**

Published December 2012

# Public Awareness



- Radio Program: From Danger to Safety
- Tsunami Smart Campaigns
- Jingles, Songs, Poetry, Drama,
- Puppetry
- Posters, Pamphlets
- Public Service Announcements (PSA's)
- Social Media
- Local Knowledge



# 6. Annual Participation in Exercise – CARIBE WAVE

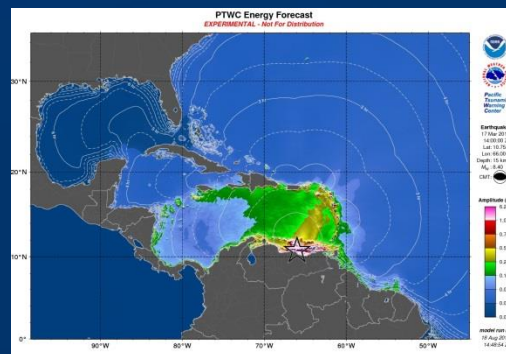
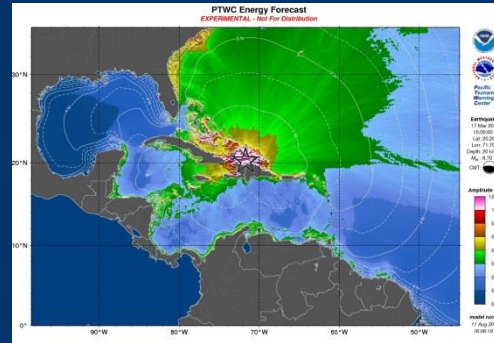
## Preparedness

### 5. Educational Outreach Activities (3 per year)



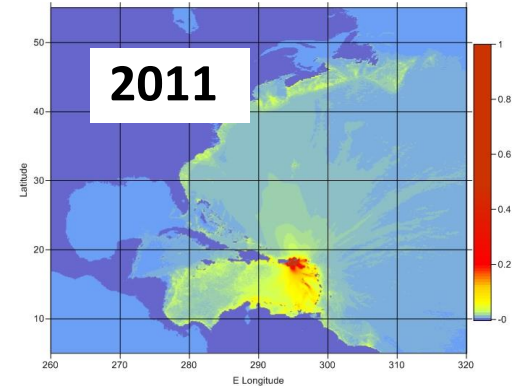
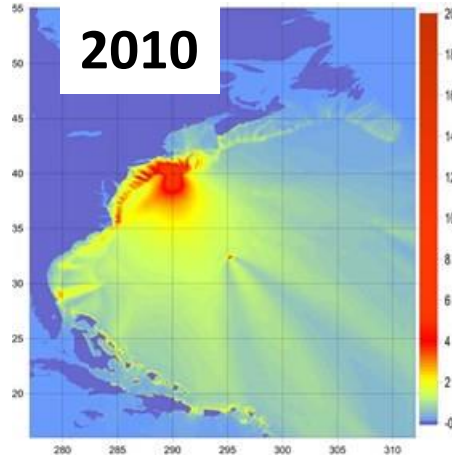
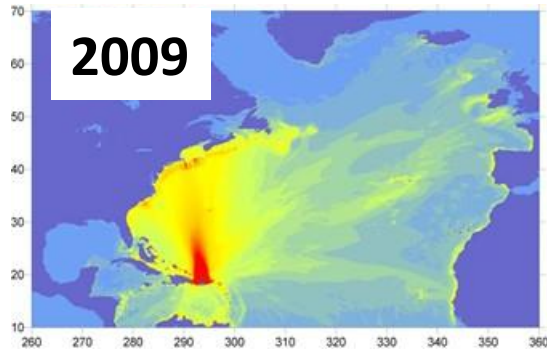
# A Regional Tsunami Exercise, CARIBE WAVE, is held every March. Most Recent, March 17, 2016

- 331,000 participants,
- In 2016 every MS participated
- Scenarios developed with Local experts
- Communications and response plans tested





# Scenarios (Earthquakes and Submarine Landslides)



Lantex 2012 - Tsunami Propagation Forecast

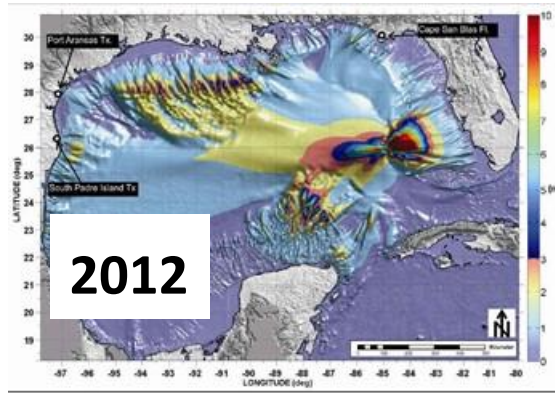
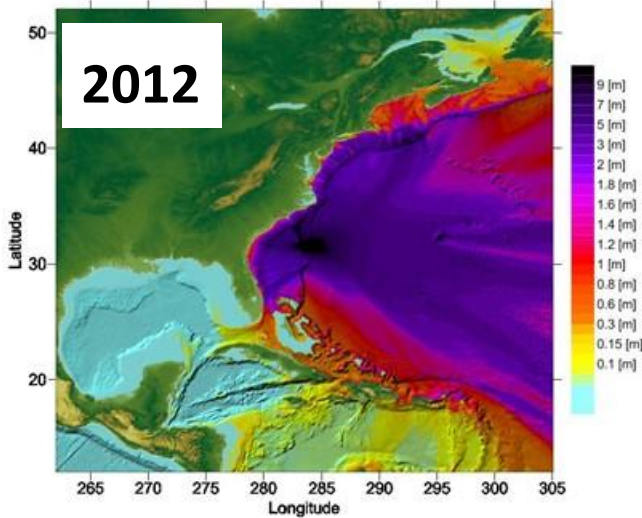
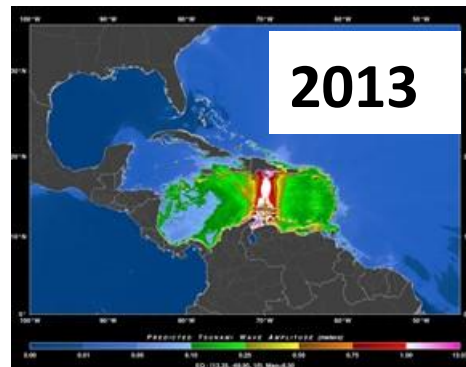
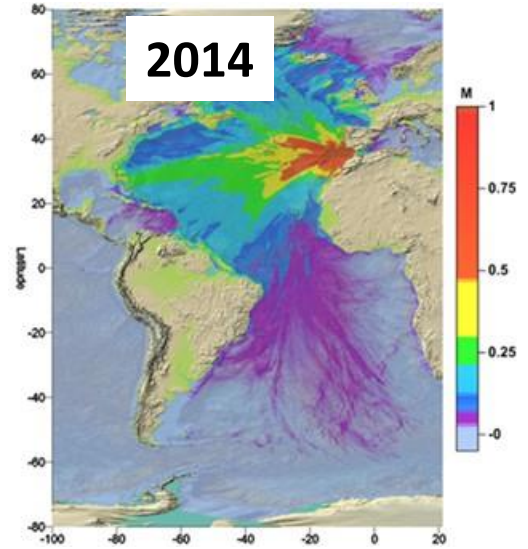
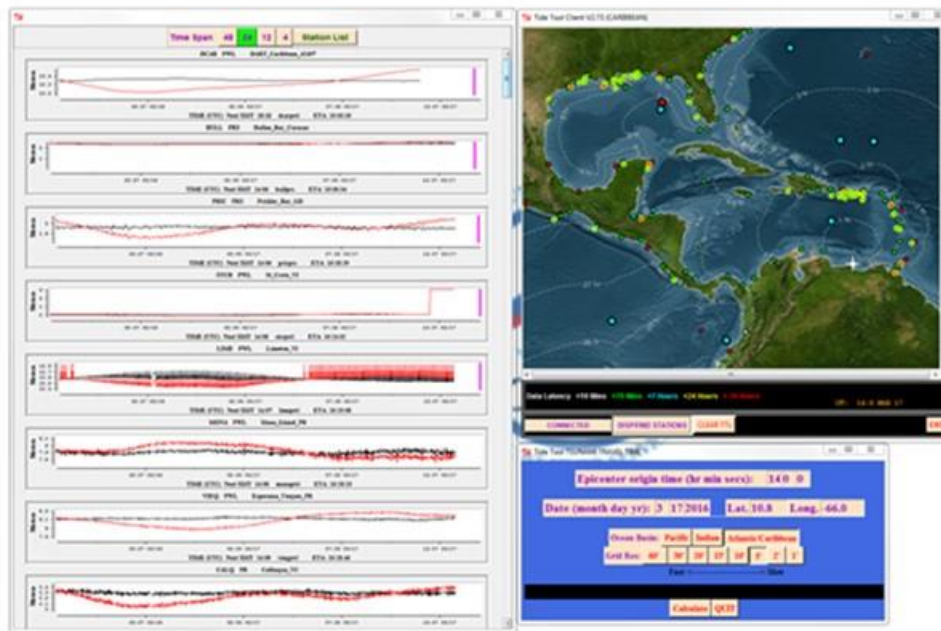


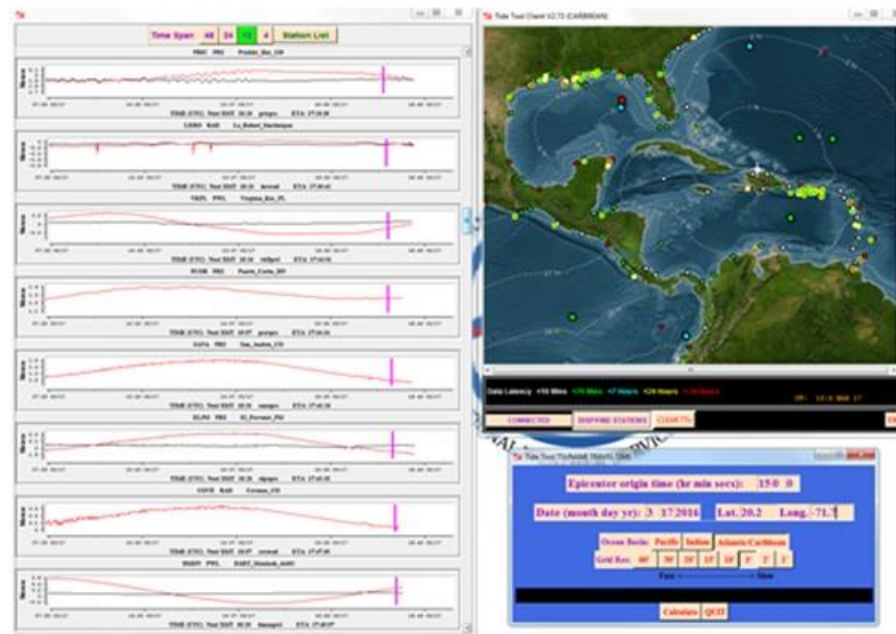
Figure 40. West Florida landslide maximum wave amplitude using 60 arc-seconds grid resolution.







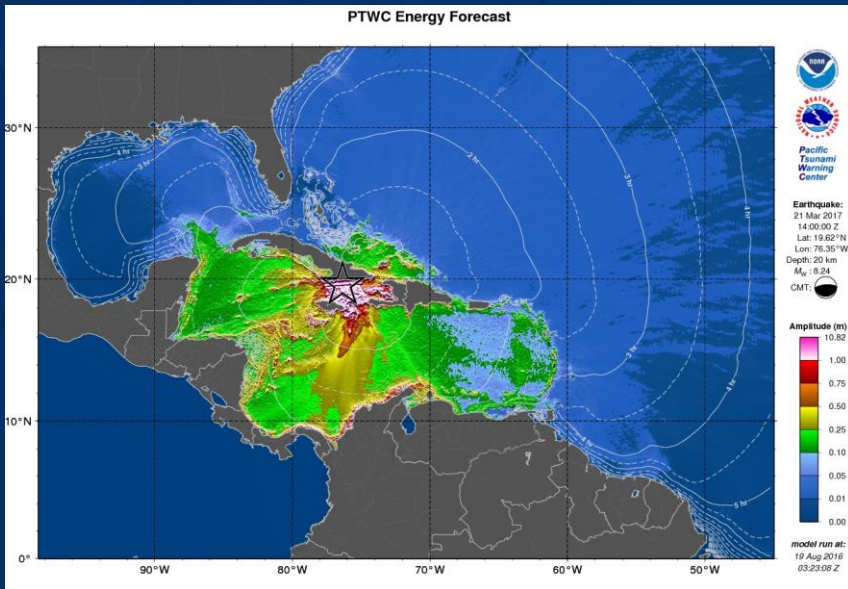
Screen shot showing Tide Tool data for the CARIBE WAVE 16 Venezuela Scenario.



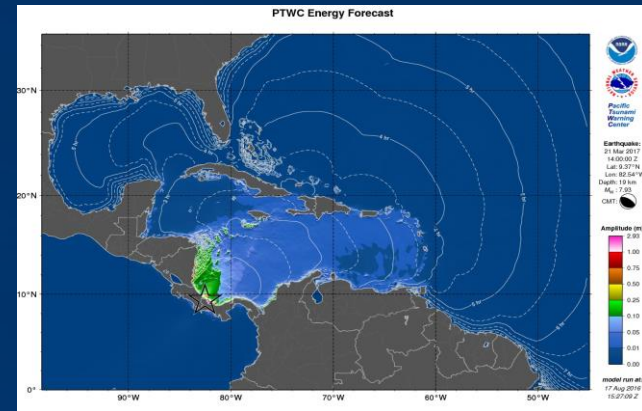
Screen shot showing Tide Tool data for the CARIBE WAVE 16 Northern Hispaniola Scenario.

# Next CARIBE WAVE exercise March 21, 2017

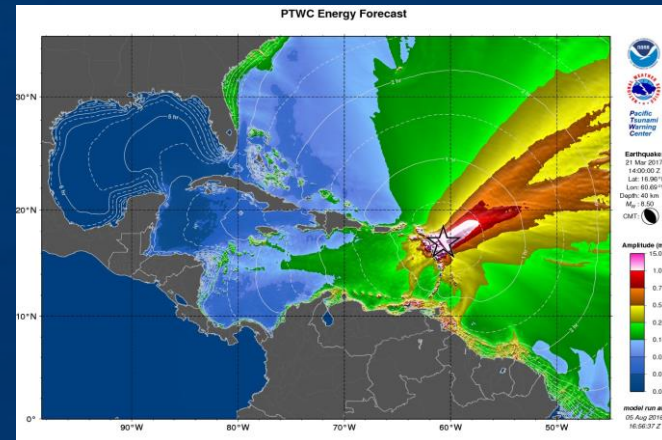
## Cuba Scenario



## Costa Rica Scenario



## Northeastern Antilles Scenario



Coordinated by the Caribbean Tsunami Warning Program with the Caribbean Tsunami Information Center with oversight from a CARIBE EWS Task Team



# Caribbean Tsunami Information Center

- Established in 2013 thru an MOU between UNESCO and Govt. of Barbados
- Organization and conduct of training and capacity building activities as well as facilitating preparedness and awareness projects
- Has had some fiscal challenges, but thanks to funding from UNESCO and Kingdom of Netherlands, secured thru 2017, in the process of reopening.





# Closing Remarks

- 100's of thousands of lives and billions of dollars at risk in the Caribbean and Adjacent Regions from Tsunamis
- Sea level data is critical for the monitoring, detection and forecasting component of the warning system
- CARIBE WAVE is proving to be one of the main platforms to engage the 48 Countries and Territories and an excellent opportunity to review sea level operations
- As of 2016, the UN has recognized November 5 as World Tsunami Awareness Day and for the Americas the UN ISDR has selected the Caribbean for its focus activities.