BASIC INFORMATION

1. ICG/CARIBE EWS Tsunami National Contact

Tsunami National Contact (TNC)

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1st alternate (24 Hr phone):
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Carolina, Puerto Rico  00979 USA
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**National Tsunami Warning Centers**

**U.S. National Tsunami Warning Center (NTWC)**
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National Weather Service Alaska Region National Tsunami Warning Center
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**Pacific Tsunami Warning Center (PTWC)**
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National Weather Service- Pacific Region
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3. Tsunami Advisor

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4. Local Tsunami Procedures (if a local tsunami hazard exists)

A local tsunami is a tsunami generated from a nearby source, generally less than 200 km away. The source can be an earthquake, landslide, or a volcanic eruption. The waves can arrive on shore within minutes of the triggering event.

The responsibility for issuing tsunami warning information to the Caribbean, Central America, and adjacent areas is shared by NOAA’s two warning centers: Pacific Tsunami Warning Center (PTWC) and the National Tsunami Warning Center (NTWC). The Area of Responsibility (AOR) of the NTWC includes the East Coast and Gulf of Mexico of the U.S., Eastern Canada, and in the interim also includes Puerto Rico and the Virgin Islands. PTWC, also in the interim, covers the rest of the Caribbean and Western Atlantic (Figure 1).

In order to improve consistency of services for the Caribbean, responsibility for domestic Tsunami Watch, Warning and Advisory Messages and Tsunami Information Statements for Puerto Rico and the US and British Virgin Islands will be transferred from the National Tsunami Warning Center (NTWC) to the Pacific Tsunami Warning Center (PTWC). This transfer will be effective September 1, 2015. The content of the products will not substantially change, but both the international and domestic products for the Caribbean will now be based on the same tsunami forecasting analyses, therefore improving consistency.
The Centers detect, locate, size, and analyze earthquakes throughout the world. Earthquakes that activate the Centers’ alarm system initiate an earthquake and tsunami investigation which includes the following four basic steps: automatic and interactive characterization of the earthquake; detection and measurement of tsunami waves; tsunami forecasting; and dissemination of information through various means.

Products issued by the NTWC for its AOR are warning, advisory, watch, and information statement. Each has a distinct meaning relating to local emergency response. In summary:

<table>
<thead>
<tr>
<th>NOTIFICATION LEVEL</th>
<th>STATUS</th>
<th>SUGGESTED ACTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warning</td>
<td>Inundating wave possible</td>
<td>Full Evacuation Suggested</td>
</tr>
<tr>
<td>Advisory</td>
<td>Strong Currents Likely</td>
<td>Stay away from the shore</td>
</tr>
<tr>
<td>Watch</td>
<td>Danger level not yet known</td>
<td>Stay alert for more info</td>
</tr>
<tr>
<td>Information</td>
<td>Minor waves at most</td>
<td>No action suggested</td>
</tr>
</tbody>
</table>

Based on seismic data analysis or forecasted amplitude; NTWC will issue the appropriate product. Initial forecast based solely on advanced seismic analysis which determines the fault geometry. Forecasted amplitude not dependent on sea-level data initially. Sea-level data can be used to revise the forecast when available.

- Warnings and Advisories suggest that action be taken.
- Watches are issued to provide an early alert for areas that are distant from the wave front, but may have danger. Once the danger level is determined, the watch is upgraded to a warning or advisory, or canceled.
- A Tsunami Information Statement (TIS) is issued to inform emergency management officials and the public that an earthquake has occurred, or that a tsunami warning, watch or advisory has been issued for another section of the ocean. In most cases, information statements are issued to indicate there is no threat of a destructive basin wide tsunami and to prevent unnecessary evacuations as the earthquake may have been felt in coastal areas. An information statement may, in appropriate situations, caution about the possibility of destructive local tsunamis.

For local earthquakes either a tsunami warning or an information statement is issued. For regional and teleseismic events, advisory and watch statements might also be issued.

Figure 2. Procedure chart for National Tsunami Warning Center. At the top is the source zone of the earthquake, below the area of impact, if different from source zone.

As of May 2014, NTWC issues a companion message in Spanish for all events in the Atlantic which require message issuance.

On June 16, 2014 a warning/advisory criteria change was implemented for Puerto Rico and the Virgin Islands. Warnings (had been issued for any quakes in the region magnitude 6.5 or greater) are now issued for earthquakes in the region magnitude 7.1 and greater. Advisories
are issued for earthquakes in the magnitude range 6.5 to 7.0. The region is the area from 17.0N to 21.0N and 63.5W to 68.25W.

Tsunami messages (warnings, advisories, watches, and information statements) issued by the TWCs are disseminated by a variety of means including dedicated text circuits such as the Global Telecommunications System (GTS) and Aeronautical Information System Replacement (AISR, previously known as Aeronautical Fixed Telecommunications Network, AFTN), the Emergency Managers Weather Information Network (EMWIN), National Warning System (NAWAS) dedicated voice circuit, the Advanced Weather Interactive Processing System (AWIPS), email, fax and commercial telephone to the officially designated responsible government agencies (Tsunami Warning Focal Points) in each jurisdiction. The Puerto Rico State Emergency Management Agency and the Virgin Islands Territorial Emergency Management Agency as Tsunami Warning Focal Points, carry out their procedures for alerting the public (with interoperability systems, sirens or by other means), and for alerting the responding agencies such as the police, fire departments, and rescue units and media outlets. The National Weather Service San Juan Forecast Office activates the Emergency Alert System (EAS) for Puerto Rico and the US Virgin Islands to interrupt commercial radio and television with a message, and by broadcasting tsunami information over the NOAA All-Hazards Weather Radio (NWR). The multiple ways for the Tsunami Warning Center to disseminate the messages are presented in Figure 3.

Figure 3. Tsunami message communication methods

The PTWC has interim responsibility for issuing tsunami information and watch bulletins for all coasts of the Caribbean region and adjacent seas with the exception of Puerto Rico and the Virgin Islands, which is currently issued tsunami forecasts by NTWC.
responsibilities are by agreement and in coordination with the UNESCO/IOC Tsunami Program. The Pacific Tsunami Warning Center is also the back-up to the NTWC, and the NTWC is the back-up Center for PTWC.

The TWCs will monitor a local tsunami using all available means which includes seismic data, information from sea level gauges and buoys, information from the media, and reports received by telephone from the public or through government agencies. Based on these data and when it is determined that the threat has passed, the tsunami warning/watch/advisory will be canceled by the TWCs. A TWC cancellation, however, does not mean it is safe to return to evacuated areas. This determination must be made by local authorities based upon local information about any continuing wave conditions and other hazards that may be present such as fires or downed power lines. It is these local conditions that make it essential for pre-coordination amongst key organizations within each nation responsible for protecting the public during a warning and emergency response to a tsunami event.

For local events, the populations and government agencies are being educated to immediately run for higher ground or to the upper stories of a building in the case of very hard ground shaking. Government agencies are being trained to activate immediately their response plans. It is probable that official warning information may not come in time for tsunamis from nearby sources. People must understand their local tsunami risks.

5. Distant Tsunami Procedures (when a distant tsunami hazard exists)

Both PTWC and NTWC monitor the seismicity of the entire Caribbean/Atlantic region 24x7 for large earthquakes that may cause a destructive distant tsunami and they perform independent rapid preliminary analyses of such earthquakes. To avoid confusion, both Centers use the same earthquake parameters in their products based on the following arrangement. NTWC is the authoritative source for the preliminary parameters of earthquakes that occur north of 23 degrees N latitude, in the Gulf of Mexico, and near Puerto Rico and the Virgin Islands (Figure 1). PTWC is the authoritative source for the preliminary parameters of earthquakes that occur elsewhere in the Caribbean and Atlantic region.

In order to improve consistency of services for the Caribbean, responsibility for domestic Tsunami Watch, Warning and Advisory Messages and Tsunami Information Statements for Puerto Rico and the US and British Virgin Islands will be transferred from the National Tsunami Warning Center (NTWC) to the Pacific Tsunami Warning Center (PTWC). This transfer will be effective September 1, 2015. The content of the products will not substantially change, but both the international and domestic products for the Caribbean will now be based on the same tsunami forecasting analyses, therefore improving consistency.

Each Center also monitors data from Caribbean and Atlantic real-time reporting coastal and deep-ocean sea-level stations as the tsunami propagates outward from the source and passes each gauge. This not only facilitates the detection and measurement of tsunami waves, but the data can be used to constrain numerical forecast models. Based upon all available data and forecasts the warnings, watches, or advisories will be continued, upgraded or canceled.
Similar to the procedures described above for local tsunamis, distant tsunami products issued by PTWC and NTWC are disseminated by a variety of means including dedicated circuits, email, fax and/or telephone to the responsible government agencies. The responsible agencies then carry out their own procedures for alerting the public (with sirens or by other means) and alert responding agencies such as the police, fire departments, and rescue units. Within the U.S., TWC warnings are also simultaneously sent to Weather Forecast Offices (WFOs) that assist with the public dissemination and local interpretation by activating the Emergency Alert System (EAS) to interrupt commercial radio and television with a message, and by broadcasting tsunami information over the NWR. Tsunami messages may also be received and subsequently interpreted and re-disseminated by the media.

The NTWC collaborates closely with the Puerto Rico Seismic Network (PRSN) for earthquakes and potential tsunamis in the region. The PRSN also provides guidance to the Emergency Management Agencies in Puerto Rico and the U.S. and British Virgin Islands, and the media and WFO San Juan as well as the Dominican Republic National Meteorological Office (ONAMET).

PTWC and NTWC will monitor a distant tsunami using all available means including data from seismic stations, sea level gauges, information from the media, and reports received by telephone from the public or through government agencies. Based on these data and when it is determined that the threat has passed, the tsunami watch/warning/advisory will be canceled. A TWC cancellation, however, does not mean it is safe to return to evacuated areas. This determination, known as “all clear”, must be made by local authorities based upon local information about any continuing wave conditions and other hazards that may be present such as fires or downed power lines.

6. Sea Level Network

The United States supports an extensive sea level network in the Pacific, Atlantic, and the Caribbean. In Puerto Rico and the U.S. Virgin Islands data is used for a variety of purposes including climate change, navigation, coastal management, storm surge warning, and tsunami detection and measurement. Gauges are operated by many regional entities including: PTWC, NTWC, NOAA National Ocean Service (NOS), NOAA National Data Buoy Center (NDBC), PRSN, the University of Hawaii Sea Level Center (UHSLC) and nations in the region. Many of these stations make up the, international Global Sea-Level Observing System (GLOSS), coordinated by UNESCO IOC. These stations are included in the map of sea level stations in the Caribbean (Figure 4). A brief synopsis of the various gauges follows:

**NOAA National Ocean Service (NOS)**

NOS’s Center for Operational Oceanographic Products and Services (CO-OPS) operates most of the U.S. coastal stations including 210 long-term stations comprising the National Water Level Observation Network (NWLon). These multi-purpose gauges each have, at a minimum, a primary and backup sensor and data collection platform. High-frequency 1-minute water level data are collected and transmitted every 6 minutes over one of the two U.S. meteorological satellites (GOES-E or GOES-W), telephone, IP modem, or Iridium. Data are also sent to the TWCs. In addition to the nine NWLon stations located in Puerto Rico and the U.S. Virgin Islands, NOS also operates a real-time station in Barbuda and Bermuda, as well as many stations along the US Gulf and
The PRSN and NOS changed responsibilities for the Mayaguez and Aguadilla sea level station in Puerto Rico. NOS upgraded and is now operating the Mayaguez station, while PRSN installed a new station in Aguadilla.

GLOSS (Global Level of the Sea Surface). GLOSS is an international programme conducted under the auspices of the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) of the World Meteorological Organisation (WMO) and the Intergovernmental Oceanographic Commission (IOC). GLOSS aims at the establishment of high quality global and regional sea level networks for application to climate, oceanographic and coastal sea level research. The programme became known as GLOSS as it provides data for deriving the ‘Global Level of the Sea Surface’. The GLOSS introduced tsunami requirements for their tide gauges after the 2004 Indian Ocean Tsunami. There were many non-operational stations in the GLOSS Core Network and CTWP is working with GLOSS and other sea level partners to update the Core Network as defined for the CARIBE EWS region.

University of Hawaii Sea Level Center (UHSLC) A number of GLOSS and tsunami coastal gauges in the Pacific and Atlantic are operated by the UHSLC. UHSLC gauges have a primary and backup sensor, and are typically operated for a specific application. Most gauges sample at 1 sample per minute with data sent over either a GOES satellite or the Japan meteorological satellite (GMS) with a transmission interval of either 5 or 15 minutes. With financial support from NWS and with the PRSN, the UHSLC has upgraded/provided maintenance to all nine tsunami ready stations in the Carribean (Costa Rica, Dominican Republic (2) and Curacao, Colombia (2), Panama, Dominica and Grenada) in the inter-sessional period. All these stations transmit every 5 minutes and also meet GLOSS standards for sea level observations and are currently providing data to appropriate Warning Centers, Weather Service Offices and the IOC Sea Level Monitoring Facility.

NOAA NWS National Data Buoy Center (NDBC) The U.S. operates 32 tsunami stations in the Pacific Ocean and seven in the Atlantic, Gulf of Mexico, and the Caribbean Sea. The tsunameters employ the second-generation Deep-ocean Assessment and Reporting of Tsunamis (DART® II) technology. The technology uses a recorder on the seafloor that samples the pressure at 15-s intervals and communicates with a surface buoy. The technology has two-way communication between the TWCs or NDBC and the pressure recorder on the seafloor. These tsunameters have a standard mode that communicates every 6 hours with a 15-minute subsampling of the full 15-sampling intervals. All tsunameters have a triggered mode that replaces the standard mode. The triggering can be initiated by either the tsunami detection algorithm embedded with the seafloor recorder or externally using the two-way communications. The triggered mode provides a few minutes of the 15-s full resolution data and then approximately three hours of one-minute averages that are sent every few minutes. The tsunameter will return to standard mode of operations after three hours of triggered mode unless re-triggered. NDBC receives the data via Iridium from the tsunameters and reformats the data into messages for distribution on the GTS and NOAAPORT under the GTS bulletin header SZNT01 KWNB for the Atlantic, Caribbean, and Gulf of Mexico tsunameters. NDBC also posts the data to its website. NDBC’s Data Assembly Center (DAC) continuously monitors the tsunameters and validates triggers with the designated TWC. Data from these stations are critical for constraining tsunami forecast models. During the inter-sessional
period, of 7 DARTs in the Caribbean and Western Atlantic, 5 were operational and NOAA is seeking to repair the DARTs in the Gulf and Caribbean.

The Puerto Rico Seismic Network (PRSN) of the University of Puerto Rico at Mayagüez (UPRM) operates 6 sea level stations in Puerto Rico. These stations are NOAA NOS compliant and were funded by FEMA and the UPRM and installed and with the support and guidance of NOS between 2006 and 2008. All of these stations also meet GLOSS standards for sea level observations and are currently providing data to appropriate Warning Centers and Weather Service Offices. The data are transmitted every 6 minutes on GOES. The data can be accessed on the homepage of the PRSN, Tides and Currents site of NOAA, and Tides on Line site of NOAA and the IOC Sea Level Data Facility. With funds provided by the US, the PRSN also is providing support for the operation of a sea level station in Tortola (British Virgin Islands), Puerto Caucedo, east of Santo Domingo, in the Dominican Republic which transmits every 5 minutes and Barahona province of the Dominican Republic which was installed in 2012, as well as the station installed in Cap-Haïtien, Haiti. Currently, the PRSN is receiving near real time data at 1spm (one sample per minute) which help to improve the sea level monitoring around Puerto Rico.

Ten sea level gauges were installed as part of the Project Mainstreaming Adaptation to Climate Change (MACC) of the Caribbean Community Center for Climate Change in 2008. Each of the stations is equipped with an Aquatrak water level sensor and a meteorological instruments package. NESDIS provided 1 hour transmission slots for these stations located in Guyana, Barbados, Dominica, Grenada, Saint Vincent and the Grenadines, St. Kitts and Nevis, St. Lucia, Jamaica, Belize and Bahamas. These stations were to be maintained by each of the countries where the gauge was installed. Of these stations, currently none of the original stations are operational. Thru separate projects, two completely new stations were reinstalled at Dominica and Grenada as part of the UHSLC project, while the stations of Saint Vincent and the Grenadines and St. Kitts and Nevis were replaced as part of a UNESCO project in 2013. Funds are still needed to replace stations in St. Lucia, Belize and Guyana, Antigua.

The UNESCO Tsunami Unit thru funding it was able to secure installed 6 additional sea level stations that meet tsunami and GLOSS standards in Haiti (2), Cayman Islands, Guatemala, St. Kitts and Nevis and St. Vincent and the Grenadines. These stations were installed in 2013-2014. NESDIS provided 5 minute GOES slots for transmission, PTWC integrated the stations into Tide Tool and they were also included in the UNESCO IOC Sea Level Monitoring Facility. CTWP helped coordinate these efforts and also visited the station in St. Kitts.

UNAVCO, the GPS Consortium supported by US National Science Foundation, has also installed two new tide gauge stations in Port Royal, Jamaica and Puerto Morelos, Mexico as part of the COCONet project. The tide gauge stations consist of a Sutron radar level recorder, pressure sensor, two GPS instruments (one on the pier and one within 5 km of the pier), and a meteorological instrument. UNAVCO worked with colleagues at NOAA, the University of Hawaii, the Puerto Rico Seismic Network, and other Caribbean tide gauge network operators to find the best targets for collocation to augment the current network. All tide data are transmitted via GOES satellite and available at the IOC tide gauge database,
The Port Royal tide gauge station is called PTRO and the Puerto Morelos tide gauge station is called PUMO2 in the IOC archive and also were integrated into Tide Tool. They also provided GPS upgrades to the sea level stations of Boca del Toro (Panama) and are planning to do the same for Barahona (Dom. Republic).

The Smithsonian Institution installed a sea level station in Bocas del Toro, near the border with Costa Rica. It is a tsunami ready station transmitting every 5 minutes and can be viewed on the IOC Sea Level Monitoring Facility. The SI is planning on installing another tide gauge on Carrie Bow Cay off Belize.

The CTWP has been providing monthly reports on the sea level data availability to the operators and stakeholders and has organized a bimonthly conference call/webinars to review sea level data issues. With PTWC it has coordinated with NESDIS the assignment of GOES ID's for new stations in the region. It also supported that stations that were transmitting over GOES are now available also thru the IOC Sea Level Data Facility and to the Warning Centers. As new stations have become available the PTWC has made upgrades to the Tide Tool system which is used at many water and warning centers for the monitoring and reporting of tsunamis. The atest Tide Tool available at ftp://ftp.soest.hawaii.edu/ptwc/TideTool_ftp/

- The Caribbean Tsunami Warning Program provides a connection to an interactive map of all the existing, planned, required sea level stations in the Caribbean: http://www.srh.noaa.gov/srh/ctwp/

- The IOC Sea Level Monitoring Facility has an interactive map of most of the sea level stations operational in the Caribbean with remote communication systems (GOES, FTP, etc.). In coordination with CTWP, 8 new stations were added or now decoded and being displayed: http://www.ioc-sealevelmonitoring.org/

- The followings links provides a connection to a interactive map (with time series) of the tide stations in the NOS system: http://tidesonline.nos.noaa.gov/monitor.html, http://co-ops.nos.noaa.gov/

- National Data Buoy Center provides a map of the tsunameter (DART) stations: http://www.ndbc.noaa.gov/dart.shtml

- The following link provides a list of the Tide Stations of the NOS: http://co-ops.nos.noaa.gov/map/

- The following link provides information on the sea level stations operated by the PRSN or regional stations received via GOES http://redsismica.uprm.edu
7. Seismic Network

The United States supports an extensive seismic network in the Pacific, Atlantic, and the Caribbean regions. These stations are a part of the Global Seismographic Network (GSN) and are operated by the U.S. Geological Survey (USGS), University of San Diego (IDA stations), and the Incorporated Research Institutes for Seismology (IRIS), and regional networks including the Puerto Rico Seismic Network (PRSN). Figure 5 below shows the locations of these stations plus the stations from regional seismic network currently sending data in real time. Data for all the US stations and many other regional networks are freely available in real time through the IRIS Data Management Center and/or the PRSN. Some seismic stations are equipped with strong motion sensors and GPS.

As of May 2015, 135 of the 145 designated core existing real-time seismic stations available to the Warning Centers. In addition several new stations in Haiti Jamaica, Cuba and Colombia were added to the network during the inter-sessional period. With these stations, the performance standards established by WG1 have been met. Specifically, earthquakes (>M4.0) can be detected within 1 minute throughout much of the Caribbean. The remaining exceptions to this standard for detection are northern South America and portions of Mexico.

The USGS also operates 5 strong motion sensors in Haiti for the purpose of studying local site amplification due to earthquake shaking in Port-au-Prince. The Puerto Rico Strong
Motion program (University of Puerto Rico at Mayaguez) also operates 12 strong motion sensors in the Dominican Republic, in support to the ISU (Instituto Sismologico Universitario). While the TWCs do not currently use triggered strong motion data, this might be a direction of future development in order to improve the general monitoring capability of the designated core seismic network.

http://earthquake.usgs.gov/monitoring/gsn/

http://earthquake.usgs.gov/monitoring/anss/regions/pr/

http://redsismica.uprm.edu

http://www.iris.edu/gmap/_CARIBE-EWS

Figure 5. Seismic stations that are contributing to the TWC and IRIS, CARIBE EWS Virtual Seismic Network (as of May 14, 2015)

8. GPS

Global Positioning Systems (GPS) are now being integrated into tsunami warning systems. They can be used to help characterize the size of large earthquakes in the region. Also, when co-located with tide gauges, GPS data are useful for calibrating absolute sea-level measurements.
The Puerto Rico Seismic Network also operates a GPS Network which was funded by the National Science Foundation (NSF) Major Research Instrumentation Program (EAR-0722540, August 1, 2007-July 31, 2009). It currently consists of 9 high rate continuously transmitting stations. One of its primary objectives is to provide additional information to help size and characterize very large earthquakes in the region. All of the permanent GPS stations are equipped with a Trimble NetRs GPS receiver or TopCon and Choke ring antenna. Continuous data are simultaneously logged to three sessions with different sampling rate, 15-sec per sample, 1-sec per sample (1 Hz), and 10-samples per second (10 Hz). The 15-sec interval session is designed for traditional plate motion study purpose. The 1-Hz session is designed for both earthquake study and RTK surveying purposes. The 10-Hz session is specially designed for recording seismic waves. Daily 15-sec interval data and hourly 1-sec interval data are automatically downloaded to the PRSN and the UNAVCO Data Archiving (http://facility.unavco.org/data/data.html). While 10-Hz data will be downloaded only when necessary, in response to specific triggering events such as a large earthquake, volcanic crisis, traveling ionospheric disturbance, or specialized survey. These high-rate data (10 Hz) can be stored on the receiver as long as 8 days. Currently the PRSN is installing a reference station en Mayaguez UPR Campus.

Figure 6. Existing Puerto Rico Network and Partnerships

In 2010 the National Science Foundation started funding the Continuously Operating Caribbean GPS Observational Network (COCONet). The Continuously Operating Caribbean GPS Observational Network (COCONet) is scheduled for completion in FY2015. When completed, the network will produce high-quality, low-latency data and data products from
83 new and refurbished continuously operating GPS / meteorological stations (cGPS-MET) in the Caribbean region as well as bring data into the COCONet data archive from over 61 existing GPS stations in the region. To date, UNAVCO engineering personnel have performed site reconnaissance at 81 locations, submitted land use permits for all 81 sites, received permits for 78 sites, and currently have 71 cGPS-MET stations installed (See Figure 7).

The Trans-boundary Land and Atmospheric Long-term Observational and Collaborative Network (TLALOCNet) is a combined atmospheric and tectonic cGPS-MET network in Mexico, funded by the National Science Foundation and managed by UNAVCO for interrogation of climate, atmospheric processes, the earthquake cycle, and tectonic processes of Mexico and environs. TLALOCNet will span all of Mexico and link existing GPS infrastructure in North America and the Caribbean. The TLALOCNet siting plans calls for 6 new cGPS-MET stations and 19 upgrades to existing stations in Mexico, with a contribution of 13 new stations from the Universidad Nacional Autónoma de México (UNAM). To date, there have been 14 stations completed.

COCONet and TLALOCNet will serve atmospheric objectives by providing more precise estimates of tropospheric water vapor, which will enable a better understanding of airborne moisture processes. Data and data products from both COCONet and TLALOCNet will be freely available to researchers, educators, students, and the private sector.

The National Geodetic Survey (NGS) also has five non-real-time GPS stations installed in Puerto Rico, the Virgin Islands, Bermuda and Barbados.
TLALOCNet network. Red dots represent the 12 remaining planned COCONet stations (new and refurbished) and 12 planned TLALOCNet stations. The stars represent the proposed tide gauge locations (with 2 additional GPS sites per location). The diamonds represent existing tide gauge stations where 1 GPS stations will be added to constrain the motion of the pier. The existing “contributing” GPS stations (n=61+), which either already or are soon to be delivering data to the COCONet archive, are not shown in this map.

In 2016, NOAA and NASA will begin a project exploring forecasting methodologies using GPS that may bring more information about near field events to forecasters more quickly.

During the inter-sessional period no tsunamis occurred within the Caribbean and adjacent seas region. PTWC responded to several thousand earthquakes worldwide and issued 355 Observatory Messages in response to those events with its preliminary earthquake parameters. Tsunami Information Statements were issued to Member States of the CARIBE-EWS by PTWC in response to one large earthquake in the Caribbean and four large earthquakes in the Atlantic. A summary of those statements is provided below. PTWC also produced and disseminated simulated products for the two scenarios used in the CARIBE WAVE 2015 exercise carried out on March 25, 2015.

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<th>Lat</th>
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NTWC issued 30 Informational Statements for Puerto Rico and the Virgin Islands for events of M>4.0 within the PR/VI region and greater than 6.5 in the Atlantic, including a magnitude 6.4 earthquake north of Puerto Rico which was very close to the 6.5 warning level on that date. Several earthquake events across the region were large enough to be felt by the public and because of the attention generated by these events, numerous inquiries were made to WFO San Juan, PRSN, PTWC and the NTWC about the warning system status and development.

10. Web sites (URLs) of national tsunami-related information on the internet
U.S. Tsunami Website –
http://www.tsunami.gov
Caribbean Tsunami Warning Program
http://www.srh.noaa.gov/srh/ctwp
10A. Summary of recent tsunami warning and mitigation system improvements

- **TsunamiReady.** The TsunamiReady Program, developed by the National Weather Service, is designed to help cities, towns, counties, universities and other large sites in coastal areas reduce the potential for disastrous tsunami-related consequences. Since June 20, 2001, TsunamiReady has helped community leaders and emergency managers strengthen their local operations. TsunamiReady communities are better prepared to save lives through better planning, education and awareness. In order for a community to be recognized it must meet with a set of operational, educational and planning requirements.

- Two new TsunamiReady™ communities were recognized since the last meeting: In addition, the following communities renewed their recognition status:
Puerto Rico now has 44 TsunamiReady communities; these represent 100% of coastal communities. Work is underway in 2 additional communities which are inland but have a tsunami threat.

- Seventeen tsunami-ready communities are applying this fiscal year to renew their TsunamiReady status.
- With funds from different sources, currently 71 all hazard sirens were installed in Puerto Rico.
- The USVI also met all the requirements for being recognized as TsunamiReady in April 2014. The recognitions were given to St. Croix, St. John and St. Thomas and adjacent islands. VITEMA continues to strengthen tsunami education and awareness in the Territory All materials are available online at: [http://www.vitema.vi.gov](http://www.vitema.vi.gov) and also a video featuring USVI students can be accessed at: [http://www.youtube.com/watch?v=jbOgD9A7w64&feature=youtu.be](http://www.youtube.com/watch?v=jbOgD9A7w64&feature=youtu.be)

- The BVI also completed the requirements for TsunamiReady recognition as part of the UNESCO/NWS Pilot Project and was recognized at ICG IX also as TsunamiReady. It is the second non US territory to be recognized in the Caribbean and continues to strengthen its tsunami preparedness.

- Anguilla was recognized as the first international TsunamiReady community in 2011. Anguilla renewed for the next three years its TsunamiReady recognition status in September 2014.

- CTWP continues to receive TsunamiReady inquiries from other Caribbean nations and has offered overviews of the program to stakeholders throughout the region.

**Caribbean Tsunami Warning Center.**

**US Position on a Caribbean Tsunami Warning Center (CTWC)**

The United States, in collaboration with its national and international partners, has made significant advances in the enhancement of tsunami outreach and education capacity in the Caribbean as well as strengthening the Caribbean Regional Tsunami monitoring systems. Caribbean nations are now better positioned to respond to the tsunami threat due to sustained outreach and education efforts and significant investments in [monitoring or observing]. Over 150 new seismic and sea-level monitoring systems have been installed across the region, making the Caribbean Basin one of the world’s most densely sensed areas in terms of tsunami detection. Since it is availability of sensing data, and not physical location of a warning facility that drives forecast accuracy, NOAA has determined that the combination of existing U.S. Tsunami Warning Centers and the Caribbean Basin’s extensive monitoring systems can continue to effectively serve as the primary source of top-level tsunami forecast guidance for the region. Thus, the best use of resources to further advance capability in the region is through the continued enhancement of tsunami outreach and education capacity, in addition to observational systems within the framework of the proposed CARIBE EWS tsunami services model. NOAA will therefore concentrate additional resources—as available—on staffing, regional sensing, outreach, education,
training, and decision support services. This will be accomplished through the National Weather Service Caribbean Tsunami Warning Program, supported as required by the International Tsunami Information Center, and in partnership with the University of Puerto Rico Mayaguez, the Caribbean Tsunami Information Center and stakeholders.

The United States has determined this approach to be the most sustainable way to continue to deliver top-level tsunami detection, forecast, warning, mitigation, and decision support capabilities to the Caribbean.

The US is supporting the development of the CARIBE EWS Tsunami Service Model to be consistent with the UNESOC IOC ICG framework.

**Caribbean Tsunami Warning Program.** On February 1, 2010 NWS established the Caribbean Tsunami Warning Program (http://www.srh.noaa.gov/srh/ctwp), co-located with the Puerto Rico Seismic Network (PRSN) at the University of Puerto Rico in Mayaguez. The CTWP continues to work with local, national and international stakeholders and partner to improve tsunami monitoring (Sea Level, Seismic and GPS), warning (existing and new warning and forecast models), communications and education and preparedness efforts, including the TsunamiReady program. Below are some of the activities that were carried out by the CTWP during the inter-sessional period (May 2014-May 2015) in support of CARIBE EWS.

- **Staffing.** The CTWP is currently staffed by the Manager and seven Students. A contractor is in the process of being hired to provide support to the CTWP activities.
- **Facilities.** The CTWP is located on the UPRM Campus. By June 2015, along with the PRSN expects to complete its move to a refurbished facility that will house both the facilities. UPRM. **Tsunami Warning and Forecasting.** CTWP is collaborating with NOAA’s Pacific Marine Environmental Laboratory (PMEL) for the development, validation and implementation of an Internet-based Tsunami Forecasting System (TWEB). The CTWP organized two online trainings on this experimental system. All the NTWC domestic tsunami products were translated into Spanish and are being issued along with the English products during events.
- **Communications.** In addition to the CTWP website (http://www.srh.noaa.gov/srh/ctwp), the Program also maintains a Facebook Fan Page (3715 Fans, up from 300 in 2014) and Twitter account. It also uses Webinar and Conference Call facilities for meetings with stakeholders.
- **Seismic Data.** The CTWP provided monthly reports on Seismic Data Availability for the stations contributing to PRSN and IRIS under CARIBE EWS.
- **Sea Level Data.** CTWP maintains a database on sea level stations in the Caribbean and Western Atlantic. CTWP co-hosted with the PRSN the Fourth Caribbean Sea Level Operators Workshop for November 2014 in Puerto Rico. PTWC, CTWP and NOAA’s National Satellite Service jointly advise on the assignment of GOES slots for sea level data transmission.
- **GPS.** CTWP maintains communications with the US NSF COCO Net (Caribbean GPS Network) project team in support of GPS applications for sea level monitoring and tsunami warning operations. The CTWP has also been in discussion with NASA
about conducting a pilot project to explore the integration of GPS data into the Tsunami Warning System.

- **Training.** The CTWP provided training to hotel and tourism officials of the Dominican Republic on tsunamis in July 2014 and participated as instructor in one SOP Tsunami Workshop in Mexico.

- **Education and Outreach.** The CTWP participated in education and outreach efforts in Puerto Rico, USVI, BVI, Dominican Republic, Barbados and Mexico. It provides education and outreach materials in hard copies and also thru its Web Site and Social Media.

- **TsunamiReady.** In 2014-2015, CTWP continued to collaborate with Puerto Rico and US Virgin Islands to further strengthen the TR program. 2 communities in PR became TR, bringing up to 44 the number of TR communities in Puerto Rico. CTWP also continues to support joint UNESCO – NWS TsunamiReady recognition Pilot Project launched in 2011. In the Intersessional period provide briefings to Dominican Republic and St. Kitts and Nevis on the Program. CTWP also participated in a US effort to update the TR requirements and the CARIBE EWS Task Team to roll out a similar program within the Caribbean.

- **Exercises.** The CARIBE WAVE/LANTEX 2015 regional tsunami exercise was conducted on March 25, 2015. The CTWP supported the organization of the test along with the TWCs and international stakeholders as the CARIBE EWS Task Team Lead. 48 Member States and Territories participated in the exercise and almost 145,000 people were registered -- a decrease from 2014, but still almost three times the participation in 2013.

- **Meetings.** Christa von Hillebrandt hosted and helped organize Task Team meetings for Caribbean Community Performance Based Recognition Program in April 2015 in Mayaguez. It also participated in the Tsunami Services Model task team in Colombia in December 2014.

**Tsunami Communication Tests in the Caribbean.** During the inter-sessional period, PTWC continued to conduct monthly communication tests to all of the CARIBE-EWS designated Tsunami Warning Focal Points on the first Thursday of each month at 1530 UTC. PTWC also conducted two unscheduled “no notice” communication tests on May 14, 2014 - the first at 1520 UTC to all TWFP contacts by all methods, and the second only to official TWFP email addresses maintained by the IOC. Results of all tests are provided in PTWC’s Interim Advisory Services Report. PRSN established a pilot project to test monthly a new SMS gateway system to alert local Tsunami Warning Focal Points.

**Paleo Tsunami Research.** The USGS has funded research in both the USVI and the BVI to detect pre-historical tsunami events. In February/March field studies were conducted in both of these territories.

- **British Virgin Islands.** A group of scientists from USGS, NOAA, the University of Puerto Rico at Mayagüez and Institut Physique du Globe de Paris (IPGP) and consultant Martitia Tuttle continue to make progress in identifying several tsunami events on the island of Anegada. The most recent event was dated in the 1650-1800 range (1755 Lisbon event?), an earlier event in the 1200-1450 range and a third event which has still not been dated. Local, regional and teleseismic events are being evaluated as sources.
UPR Graduate Student, Zamara Fuentes and Consultant Martitia Tuttle with the field support of Dr. Roy Watlington of the USVI continue to conduct paleo tsunami studies in St. Thomas and offshore islands. The initial findings point towards two or more overwash deposits, including shelly sand and large corals, in several salt ponds. They hope to return to St. Thomas. Dissertation is expected to be next December.

UPR Scientist and Martitia Tuttle (Consultant) have also been conducting and planning additional reconnaissance in northeastern Puerto Rico and nearby islands.

USAID and USGS Caribbean Activities
From 2007 to the present, USAID/OFDA has supported a number of tsunami training activities for regional disaster professionals and scientists throughout the Latin America and Caribbean region:

- Between 2007 and 2011, USAID/OFDA supported various seismologists and other regional scientists, as well as disaster managers from Antigua and Barbuda, Chile, Ecuador, El Salvador, Nicaragua, and Saint Lucia, to attend a two-week international tsunami training program at NOAA’s International Tsunami Information Center (ITIC).
- In 2012, USAID/OFDA provided $35,000 to support the ITIC Training Program, including course materials and the participation of four scientists and disaster managers from the region.
- In 2013, USAID/OFDA provided $60,000 to ITIC to conduct two regional workshops entitled “Strengthening Tsunami Warning and Emergency Response Standard Operating Procedures.” Workshops were held for Central American scientists in El Salvador in February 2013, and in Chile, for South American scientists, in March 2013. ITIC designed the workshops to strengthen procedures for national tsunami warning and emergency response in Eastern Pacific and Caribbean countries and provide instruction on the new Pacific Tsunami Warning Center (PTWC) international tsunami forecast products. The trainings were a collaborative effort of ITIC and IOC-UNESCO, with funding from USAID/OFDA and USGS. Participants included representatives from the national tsunami warning centers and national disaster management offices of Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, and Peru.
- In 2014, USAID/OFDA provided $65,000 to support two additional ITIC trainings, scheduled for Mexico and Ecuador in April and June, respectively. Following the trainings, PTWC Regional Working Groups for the Central American Pacific Coast and Southeast Pacific will meet to discuss the further needs and actions required for effective implementation of the new PTWC products, among other topics.

Tsunami Modeling Training. No ComMIT courses were conducted during the intersessional period. Webinar trainings and a potential course for Central America is under discussion.

Tsunami Inundation Mapping for the US Virgin Islands. The NOAA/National Geophysical Data Center completed high resolution digital elevation models (DEM) for the US Virgin Islands. These DEMs have been upgraded with better elevation data so that inundation models can better represent the hazard. Previous DEMs often showed the
elevation as the tree height and were not fully functional for use in inundation modeling. The US NTWC is using the updated DEMs along with tsunami inundation models to generate improved estimates of maximum expected flood zones. Evacuation maps were prepared for the US Virgin Islands with funding provided by the US NWS through the Puerto Rico Seismic Network in coordination with the CTWP. Given that tsunami modeling is still pending for the USVI, these evacuation maps were based on default wave heights and land penetration which are to be determined based on tsunami inundation modeling already performed in neighboring islands (82 ft elevation and 1 mile inland).

**Tsunami Forecasting.** NOAA Pacific Marine Environmental Laboratory (PMEL) has developed the Short-term Inundation Forecast for Tsunamis (SIFT) system. In 2013, SIFT was implemented into tsunami warning operations at NTWC and PTWC. SIFT includes high-resolution tsunami flooding forecast capability for 7 Caribbean locations in Puerto Rico (Arecibo, Fajardo, Mayagüez, Ponce and San Juan) and US Virgin Islands (Charlotte Amalie and Christiansted). PMEL is also developing TWEB -- an Internet-based Tsunami Forecast System, as web interface to SIFT forecast results and capabilities. This application exposes two web-based clients. The forecast client exposes the full tsunami forecasting user-interface with functionality to generate propagation forecast, do inversions, and run flooding forecast where these are available. This client also allows a privileged user to selectively expose model results to the second TWEB client. The second TWEB client, is a view-only client with no forecast capabilities, but allows users to view only the results selected to be exposed by the forecast user. View-only client development is mostly complete, while the forecast client capabilities are being implemented as we build the intermediate software tiers between the web infrastructure and the SIFT software back-end. While the layout implementation of the forecast client is complete, development is now focused on the web-based TWEB inversion capability and functionality. These web-based clients are served from a three tier server implementation of which development is progressing well. The first version of the SIFT to TWEB tier is complete, and all application tier housekeeping, user management and user authentication functionality is complete. The user-authenticated TWEB functionality outside the PMEL firewall is being exposed on an experimental basis. TWEB training was offered for some stakeholders as part of CARIBE WAVE and forecasts were made for several earthquakes which were above the trigger for TWEB, but not large enough to generate a tsunami for the Caribbean. The CTWP coordinated with PMEL and a TWEB webinar was offered on March 10 and 22 people participated in the 1.5 hour training.

**EMWIN.** The U.S. conducted a regional training on and deployment of the Emergency Managers Weather Information Network (EMWIN) in the Caribbean and Central America, held in Puerto Rico in February 2011 and another workshop in May 2011 in Aruba with funding provided by the US Agency for International Development (USAID) Office of US Foreign Disaster Assistance (OFDA). Thru this initiative 37 EMWIN stations have been deployed throughout the region at National Meteorological Hydrological Services (NMHSs), emergency management entities, and related agents. In Puerto Rico, as part of the TsunamiReady program a total of 45 stations are being deployed for a total of almost 60 EMWIN stations in the region. Additional training with OFDA support in Barbados which was originally planned for June 2014 is now scheduled for May 25-29, 2015.
GOES-12 was replaced by GOES-13 in mid April, 2010. With the new satellite EMWIN and Data Collection Platform (DCP) collection will remain largely the same, however many older EMWIN receivers still need to be upgraded by the users. Some of these needs were covered with the PASA Project above, but there still may be systems that need upgrade support.

**Caribbean Tsunami Information Center.** The CTIC was launched in November 2013. NOAA has been supporting CTIC since 2011. During the intersessional period:

- The International Tsunami Information Center (ITIC) and Caribbean Tsunami Warning Program have both supported requests for tsunami materials from countries in the region.
- The International Tsunami Information Center (ITIC) and Caribbean Tsunami Warning Program have both supported requests for tsunami materials from countries in the region. ITIC is providing its stock of materials to the CTIC for its use and distribution to Member States.
- CTWP and ITIC provided requested feedback on new educational and outreach materials, as well as the new website.
- ITIC with CTIC organized three Tsunami SOP workshops in Dominican Republic (2013), Barbados (2013) and Mexico (2013).
- ITIC with USAID support conducted one PTWC Pacific New Products training for Latin American Countries hosted by Ecuador in June 2014.
- CTWP has also supported EMWIN training CTIC is organizing for the end of May.

US will seek to formally recognise the CTWP contributions as a complementary function of the CTIC under the IOC framework and encourage other member states to also contribute their resources to support the CTIC.

**International Tsunami Information Center.** The UNESCO/IOC – NOAA International Tsunami Information Center reports on the following international capacity building and other tsunami activities in support of the ICG/CARIBE-EWS during 2013-2015:

- Conducted 3 IOC-ITIC Regional Training Workshops on Strengthening Tsunami Warning and Emergency Response Standard Operating Procedures and the Development of the Pacific Tsunami Warning Center (PTWC) New Caribbean (ICG/CARIBE) International Tsunami Products (ITP-CAR1 (November 4-8, 2013), CAR2 (November 18-22, 2013), CAR3 (April 1-5, 2014)) per the request of ICG/CARIBE-EWS-VIII. The efforts trained nearly 100 TWFP and GMO government officials from 32 countries. USAID/OFDA supported participant travel, along with UNDP and IOC.
- New and/or revised awareness and education materials:
  - Tsunami, The Great Waves (general information booklet)
  - English - IOC Brochure 2012-4, IOC, ITIC, LDG (France), NOAA, Revised 2014
  - Tsunami Glossary (technical, includes science and warning systems)
  - English - IOC Technical Series 85, ITIC, Revised 2013; Addendum 2015 (draft)
  - Global Tsunami Sources, (36” x 27.5”) - UNESCO/IOC- NOAA ITIC, NGDC, WDC
The ITIC, in cooperation with Chile, produced a 6-minute outreach video aimed at strengthening public and stakeholder agency knowledge of, and confidence in, tsunami alerts that save lives and reduce property damage. The video chronicles the tsunami warning chain for a M9.5 earthquake off Northern Chile as Pacific Tsunami Warning Center (PTWC) staff quickly analyze seismic and sea level data, forecast tsunami wave heights, and disseminate their threat assessments to country National Tsunami Warning Centers around the Pacific. Woven into this fast-paced video are vignettes highlighting tsunami warning and emergency response actions by centers and communities starting immediately after the earthquake in Chile and Peru, and after receiving the PTWC alerts in Samoa and Hawaii, and in Australia, Japan, Indonesia, and the Philippines.

Printed

- Surviving a Tsunami - Lessons from Chile, Hawaii, and Japan 2014 [20,016 copies]
- Great Waves 2014 [20,016 copies]
- Tsunami source posters 2014 [7,280 copies]
- Tsunami icosahedron globe maps 2014 [50,000 copies]
ed 2014) provides a flexible framework for undertaking surveys, their guiding principles and protocols data types, and observations to be taken to standardize data collection.

- Support requests for and technical assistance to install and provide training on ITIC-distributed Tsunami Warning Decision Support Tools, including the USGS-NOAA CISN, PTWC TideTool Sea Level Monitoring, ITIC-NGDC TTT (Tsunami Travel Time), ITIC Tsunami Bulletin Board list serve, and NGDC-ITIC TsuDig Historical Database offline GIS tool.

**COMET online training modules.** Five online training modules are available: Tsunamis, Tsunami Warning Systems, Tsunami Community Preparedness, TsunamiStrike! and TsunamiStrike! for the Caribbean. The Tsunami Strike! Caribbean Edition offers an interactive learning experience in which learners take on the role of a journalist writing an article for a news magazine. Although developed aimed at Intermediate and High School students, it is also a great tool for all ages to learn more about tsunamis in the Caribbean.

**US Participation in ICG Working Group Meetings**

- Christa von Hillebrandt and Stuart Weinstein (PTWC) attended Sea Level Training Workshop and WG1 Sea Level meeting in November 2014 in Puerto Rico. Kay Metcalf (NESDIS), Stephen Gill and James Taylor (NOS) attended the workshop via webinar.
- Christa von Hillebrandt helped organize, supported logistics and attended Task Team meeting for the development of a Caribbean Community Performance Based Recognition Program in April, 2015.
- Mike Angove and Christa von Hillebrandt attended the Task Team on CARIBE EWS Tsunami Service Model in Colombia in December, 2014
- Diego Arcas (NOAA-PMEL) attended the WG2 expert meeting on Tsunami Evacuation in Colombia in December, 2014

**The Puerto Rico Seismic Network continues to provide support to the region:**

- A completely reinforced and up-to-date communication infrastructure will be ready next summer for the PRSN.
- Supports seismic station in Aruba. Support to the Haiti seismic and tsunami program via a cooperation research project with UNESCO.
- Helping to maintain 9 tide gauges stations in the Caribbean through the UH PRSN collaborative project.
- Provides support to the Seismological Institute of the Dominican Republic (ISU)
- Provides support for the maintenance of two sea level stations in Dominican Republic (Santo Domingo and Barahona).
- Technical groups were received by the Puerto Rico Seismic Network from a number of countries in the region. A short course for sea level network operators was held in Mayaguez in November 2014.
- PRSN is making improvements to a tide gauge web base tool kit to evaluate the tide gauge data availability.
- A new system to receive and monitor sea level data @1spm is currently active. This system include an alarm algorithm to timely detect any variation in the sea level.
- Two Tide Gauges stations were re-installed, Caja de Muertos Island and Aguadilla.
PRSN personnel participate in the TOWS, and in the ICG Caribe working groups.

- A full scale exercise was held in March, the Borinqueneer response was an opportunity to performing state roles and responsibilities during emergencies including earthquakes, tsunamis, chemical spills, fires, etc.
- A tsunami response template for hotels and resorts was developed and shared with an exposed facility in PR Metropolitan Area (Courtyard by Marriott Isla Verde).
- A comprehensive tsunami education program for visitors was developed which includes: installation of tsunami signs in 13 "balnearios" around the island, educational material for visitors, workshops for Lifeguards about tsunamis and evacuation plans for its facilities.
- Nine Tsunami Curriculum workshops were held in Puerto Rico. Over 50,000 manuals were distributed to the participants (Teachers, students and administrators)
- PRSN participated as Invited Expert/Observer in the ICG - Tsunami Recognition Task Team Meeting held in Mayaguez, PR on 08 APRIL 2015.
- A comprehensive research on tsunami guidelines for the maritime community is under way.

10B. Summary of plans of future tsunami warning and mitigation system improvements

- PTWC will continue to provide the interim tsunami services to the CARIBE EWS and will take over from the US NTWC the domestic products for Puerto Rico and the Virgin Islands. The PTWC is in a position to begin the implementation of the then enhanced products for the CARIBE EWS as part or the proposed Tsunami Service Model.

- CTWP will continue to prepare and distribute for CARIBE EWS monthly reports on seismic data availability at PTWC, US NTWC and PRSN for tsunami warning services and at IRIS for long time archival in support of CARIBE EWS WG1 and also host bi-monthly webinars for seismic network operators.

- The CTWP continues to collaborate with the Tsunami Research Team of NOAA Pacific Marine Environmental Laboratory (PMEL) Web Enabled Tsunami Forecast Tools project. The purpose is to present the research and development environment for tsunami warning experts, emergency management practitioners, scientists, and engineers to maintain accurate, standardized tsunami forecasting and, at the same time, to improve the scientific understanding of tsunamis and tsunami-related impacts that would lead to better forecast and warning techniques. The web-based application will support the CARIBE EWS efforts for improved forecast capabilities based on the latest science as well as operational standards and procedures.

- To enhance sea level data availability for tsunami and other coastal observation and warning systems in the Caribbean, the CTWP:
  - Is preparing for CARIBE EWS monthly reports on sea level data availability in the region. These reports are distributed thru email and posted on the website of the CTWP. CTWP also can continue to coordinate bi-monthly conference calls/webinars of sea level network operators.
CTWP will continue to support the implementation and maintenance of US TsunamiReady program in Puerto Rico and the US Virgin Islands, as well as the proposed community recognition program which will replace the UNESCO/NWS TsunamiReady Pilot Project for international stakeholders and other readiness efforts subject to available funding. CTWP will continue to support regional tsunami exercises and will finalize report on CARIBE WAVE 2015 and support 2016 exercise.

NOAA has provided funding to PRSN for the conduct of seismic network operators training workshop and WG1 meeting in 2015/2016. CTWP can also support the conduct of this training.

USGS, IRIS, UNAVCO, NSF are supporting with the Centro Sismologico Nacional of the University of Chile on May 25-29, 2015 in Chile a workshop on National Geophysical Networks in Latin America: Best Practices, Challenges and Opportunities for Collaboration. It will review best practices in the planning, installation, operation, and maintenance of modern networks of geophysical instruments. Many of the networks contributing to CARIBE EWS will be participating.

NOAA and USAID/OFDA plan to continue to cooperate with CTIC in the coming year and ITIC and CTWP will work with CTIC to support their work plan. Activities are subject to available funding by NOAA, CTIC, ITIC, CTWP, IOC, USAID/OFDA, and other sources, and approval by the ICG-VIII). Activities to be considered are:

- Co-organize or conduct tsunami capacity building in collaboration with IOC and in coordination with CTIC and CTWP. Possible trainings:
  - PTWC New Enhanced Products training for TWFPs / DMOs (ITP-International, 1 week hosted by country)
  - Accept at least 1 person to ITIC Training Programme - Hawaii tsunami training (2 week, Hawaii, in 2014)
- Provide ITIC / IOC tsunami awareness materials, including in Spanish and French in collaboration with Chile SHOA and CTWP.
- Input to CTIC work plan, assist in carrying out activities, and provide feedback to CTIC.
- Support for Saint Kitts and Nevis to conduct a pilot project of the proposed CARIBE EWS Community Recognition Program based on US TsunamiReady Program
- Support for Central America evacuation map project led by ITIC but will include Caribbean Coast
- NOAA and NASA are planning to exploring the real-time GNSS (Global Navigation Satellite System) for more rapid earthquake source determination.

NOAA and USAID/OFDA plan to continue to cooperate with CTIC in the coming year and ITIC and CTWP will work with CTIC to support their work plan. Activities are subject to available funding, and approval by the ICG-CARIBE-EWS-X). Activities included are:

- Co-organize or conduct tsunami capacity building in collaboration with IOC and in coordination with CTIC. Possible trainings:
  - PTWC New Enhanced Products training for TWFPs / DMOs (ITP-International, 1 week hosted by country)
■ ITIC Training Programme - Hawaii tsunami training (2 week, Hawaii, August 27 – September 4, 2015)
  ○ Provide ITIC / IOC tsunami awareness materials, including in Spanish and French in collaboration with Chile SHOA and CTWP.
  ○ Input to CTIC work plan, assist in carrying out activities, and provide feedback to CTIC on its parallel construction.

● The Puerto Rico Seismic Network (PRSN), supported by NOAA/NWS Tsunami Program, will continue to support of the regional partners in improving their warning system, some specific tasks include: Will relocate Samana seismic station in Dominican Republic to a safer location.

● ITIC, in cooperation with IOC, USAID/OFDA and country partners, will be developing a new course ‘Essential Tsunami Preparedness: Tsunami Plans, Maps, and Procedures’. It is intended to be a standardized training course and process for the production of reliable and practical community-level tsunami evacuation maps. Applying globally standardized tools and methodologies, the course and process will consist of a linked set of tsunami training workshops on
  · Evacuation Planning
  · Evacuation Map Development (inundation modeling and map creation)
  · Tsunami Warning & Emergency Response SOPs
  · Conducting Tsunami Exercises (including evacuation)

The process will consider cases where modeling is and is not available, demonstrate the application of different levels of tsunami modeling to construct inundation maps, work through the process of creating a community-owned evacuation map, with appropriate routing, safe area assembly, signage, and finally, use an exercise to test emergency response operational readiness of communities. In April 2015 at the Twenty-sixth session of the ICG/PTWS, Member States endorsed this priority focus and established a Task Team on Evacuation Planning and Mapping, to provide guidance. The course will be piloted in Central America in 2015-2016, and could be piloted elsewhere subject to funding.

JCOMM Regional Marine Instrumentation Center (RMIC) Workshop on Marine Instrumentation for Region IV is being planned on the Mississippi Gulf Coast, USA for February 22 - 24, of 2016. The workshop on Marine Instrumentation for Region IV will be an opportunity to focus on a targeted topic of interest in the marine instrumentation community shared across Region IV. The NOAA National Data Buoy Center is currently receiving feedback on the theme for the workshop's technical program that will appeal to the majority interest of the region. Please save the dates for this workshop if you are interested in attending and contact Natalie Guess at nguess@magnolia-ba.biz to stay informed about this upcoming event.
11. EXECUTIVE SUMMARY

The U.S. government support for the ICG CARIBE-EWS is an inter-agency collaboration led by NOAA/NWS, and engages the USGS and Department of State, including USAID/OFDA.

The U.S. continues to operate two Tsunami Warning Centers in support of the Intergovernmental Coordination Group for Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (ICG/CARIBE-EWS). These Centers, the Pacific Tsunami Warning Center (PTWC) in Pearl Harbor, Hawaii, and the National Tsunami Warning Center (NTWC) in Palmer, Alaska, have real-time or near real-time access to data from large arrays of seismic and sea level stations spanning the world. The PTWC provides information statements and watch bulletins to the greater Caribbean region. The NTWC provides Tsunami Warnings, Advisories, Watches, and Information Statements, and interpretative information to Puerto Rico and the Virgin Islands. Each TWC acts as a backup for the other. The TWCs collaborate closely with the Puerto Rico Seismic Network for earthquakes and potential tsunamis in the region. September 1, PTWC will assume Warning Service for the Puerto Rico and Virgin Islands to improve regional forecast consistency.

The US has actively supported the Caribe EWS’s development of a Tsunami Service Model that aligns with the UNESCO IOC Framework. The aim is to put the Community at the center of the activities.

As of February 1, 2010 NWS established the Caribbean Tsunami Warning Program, co-located with the Puerto Rico Seismic Network at the University of Puerto Rico in Mayagüez. The CTWP has been providing support for observational stations, collaborating with new forecast tools, offering technical and scientific guidance to stakeholders in the region and providing education and preparedness support in the region. The US seeks to continue to enhance capabilities of the CTWP as a vital tsunami education, outreach and mitigation component of NOAA’s Tsunami Warning System. CTWP works closely with the US NWS International Tsunami Information Center and the Caribbean Tsunami Information.

The National Weather Service has recognized 47 TsunamiReady communities in the US Caribbean and together with UNESCO as part of a pilot project has jointly recognized Anguilla and the BVI. US looks forward to working and supporting the proposed CARIBE EWS Tsunami Community Recognition Program based on TsunamiReady.

The US continued to support the enhanced sea level network thru capacity building efforts and communication platforms in the case of sea level (GOES). Advances in seismic networks and GNS are also supported by UNAVCO, PRSN, and USGS.

USAID/OFDA in collaboration with NOAA continues to support CTIC and other capacity building efforts for member states in the CaribeEWS.