# TsuInfo Alert

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## The Twelfth CARIBE WAVE Exercise in the Caribbean and Adjacent Regions


By Stephanie Soto and Christa von Hillebrandt,
UNESCO/IOC-NOAA International Tsunami Information Centre Caribbean Office


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Over 420,000 people from 48 countries and territories in the Caribbean and Adjacent regions participated in the annual tsunami exercise, CARIBE WAVE 2023. This exercise was held on 23 March, 2023 with the purpose of validating and advancing tsunami resilient communities in the region. It also supports one of the indicators of the UNESCO IOC Tsunami Ready Recognition Programme. The region has had a long history of devastating tsunamis and the exercise helps at -risk communities to prepare for this infrequent, but high impact hazard. Two hypothetical scenarios were simulated for CARIBE WAVE 23, a tsunami generated by a magnitude 7.6 earthquake located in the Gulf of Honduras, and another generated by a flank collapse of Mount Pelée volcano, Martinique. The volcanic scenario was used to test experimental procedures and products for a tsunami generated by volcanic activity. It was up for each of the 48 Member States and Territories to choose between the two scenarios and decide the level of participation and activity for their country.


Pictures from the different activities during CARIBE WAVE. From top right to left; Costa Rica, Venezuela, Puerto Rico, Mexico, Pacific Tsunami Warning Center, Aruba, Colombia, and Guadeloupe.

The Pacific Tsunami Warning Center (PTWC), the regional Tsunami Service Provider (TSP), and the Central American Tsunami Advisory Center (CATAC), a proposed TSP, issued a "Dummy" message at 1400 UTC through the different warning systems to start the exercise and test communications with the Tsunami Warning Focal Points (TWFPs) and the National Tsunami Information Centres (NTWCs). As of 1407 UTC, the PTWC and CATAC issued via email the simulated tsunami products to officially designated TWFPs and NTWCs based on the two hypothetical scenarios. Each country then decided if and how to disseminate messages in their area of responsibility. The NWS San Juan Forecast Office activated the NOAA Weather Radio and the EAS for Puerto Rico and the US Virgin Islands. The Puerto Rico Seismic Network shared their simulated products with their stakeholders.


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**NATIONAL TSUNAMI HAZARD MITIGATION PROGRAM LIBRARY CATALOG**:
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## The Twelfth CARIBE WAVE Exercise in the Caribbean and Adjacent Regions

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UNESCO/IOC-NOAA International Tsunami Information Centre Caribbean Office

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Full-scale exercises, seminars, and communication tests were some of the many activities that were organized for CARIBE WAVE. According to the TsunamiZone website (tsunamizone.org), which manages the registration system, the majority of the participants from across the region were from K-12 Schools and Districts. State Government and Colleges and Universities also had high levels of participation as well as a significant number of businesses, health care organizations, hotels and tourism and volunteer radio groups. A marked increase of people with disabilities was also noted. According to TsunamiZone, 129, 472 people from Puerto Rico registered, while for the United States Virgin Islands, which conducted its drills on March 16, the total number of registrants was 17,904 (almost 17% of its total population). Organizations and individuals also shared their participation in the exercise through social media platforms, reaching 1.8 million people worldwide.

The exercise is organized within the framework of the UNESCO/IOC Intergovernmental Coordination Group for Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (ICG/CARIBE-EWS). The CARIBE WAVE task team through the NOAA International Tsunami Information Center Caribbean Office with the support of the Caribbean Tsunami Information Center and the Pacific Tsunami Warning Center coordinates this annual tsunami exercise. Information on CARIBE WAVE 23 and past exercises is available at caribewave.org.

## Caribe Wave 2023 Evacuation Exercise: Segundo Ruiz Belvis Elementary School in Mayagüez, Puerto Rico

By Roy Ruiz, Ednet Lopez - UPRM, Dept. of Geology, Puerto Rico Seismic Network (PRSN)

As part of the Caribe Wave 2023 exercise, an evacuation drill was carried out at the Segundo Ruiz Belvis (SRB) Elementary School, in Mayagüez, Puerto Rico. This local exercise aims to test and evaluate how the school will receive tsunami messages, to test the emergency communication system, and evaluate the school's tsunami response plans.

The school's safety committee contacted the Puerto Rico Seismic Network (PRSN) Tsunami Program staff requesting support for the coordination and logistics of the evacuation exercise. The Seismic Network, in coordination with personnel from the school community, State and Municipal Emergency Management Office, developed and conducted this evacuation drill. Located within the tsunami evacuation zone, right in front of Mayagüez Bay, this school serves a total of 262 people, 192 students and 70 staff members. This school also serves children from both regular and special education streams (75% of the student population). Part of the school population includes children on the autism spectrum (12.5%), children in wheelchairs (2%), deaf (1.5%) and down syndrome (3%). Those students received specific assistance by their teachers and staff members during the evacuation drill.

The SRB school's safety committee was in charge of designing the evacuation plan. This plan has two parts, one is an internal evacuation to the inner courtyard, and the other is an external evacuation to Vista Verde Shopping Center, which is the tsunami assembly point. The school was divided into three zones. All classrooms and spaces have an evacuation sketch and assigned emergency areas and exits.

The PRSN Tsunami Program personnel held three workshops, one for the staff and two for the students. The personnel reviewed the evacuation plan, the evacuation routes and all the tsunami safety information. During the exercise the school received the test tsunami message by the NOAA Weather Radio and immediately the administrative assistant activated the school bell to alert students and teachers about the evacuation. Participants evacuated the school in just three minutes and completed the tsunami evacuation route in less than 20 minutes.

For future work, the SRB school is planning to complete the TsunamiReady Supporter recognition with the help of the Local Emergency Management Office personnel. Other evacuation drills and tsunami activities were conducted along the island as part of the Caribe Wave 2023 exercise with over 125,000 registered participants. These activities help to continue tsunami preparedness in Puerto Rico.

PRSN Tsunami Program wants to extent a special acknowledgement to the Municipality of Mayagüez, local officers, first responders, the Puerto Rico Emergency Management Bureau (State and Regional office) and its commissioner for all the support during the exercise.

## California Tsunami Preparedness Week 2023

By The California Tsunami Program, a partnership between the California Governor's Office of Emergency Services (Cal OES) and the California Geological Survey (CGS)

Tsunami Preparedness Week is held annually in California every March. This year it took place from March 25th through 31st, 2023. Tsunami Preparedness Week is really a bit more like "Tsunami Preparedness Month" as Cal OES and CGS were busy promoting tsunami preparedness activities in California coastal communities throughout the month of March. Tsunami Preparedness Week activities included outreach events, exercises, webinars, and social media.

Cal OES and NWS staff record messages in English and Spanish for the EAS broadcasts during the Tsunami Warning Communications Test

The California Tsunami Program participated in three tsunami exercises as part of Tsunami Preparedness Week activities. On March 29th, a Tsunami Warning Communications test was conducted in the Northern California coastal counties of Del Norte, Humboldt, and Mendocino. This exercise was led by the National Weather Service Eureka Forecast Office and tested the regional Emergency Alert System (EAS) with broadcasts through radio and TV and included the activation of tsunami sirens. Local emergency management and coastal communities participated by sharing tsunami preparedness information on social media, coordinating tsunami walks, and sending reverse 911 messages through local alerting systems.

The California Tsunami Program facilitated a state-wide Tsunami Response Playbook Communications exercise on March 29th following the Northern California test. This annual exercise included emergency management representatives from California's coastal counties, cities, maritime communities, U.S. Military (Coast Guard, Marines), school districts and universities, National Weather Service, and other federal, state and local partners. The purpose of the exercise is to practice real-time event communications and information exchange regarding the tsunami Playbook recommendations provided by the State to local officials during a tsunami event.

Wilmington Community Bike Ride participants riding along one of the evacuation routes

Both exercises are scheduled annually during California's Tsunami Preparedness Week and help strengthen tsunami alerting and response capabilities from the Federal to State to Local level.

On April 1st, the Tsunami Program participated in the first annual Wilmington Community Bike Ride. The ride was conducted in partnership with the Thrillz Bike Group and the City of Los Angeles Emergency Management Department. Participants began their ride at the Wilmington Waterfront Park and rode their bikes along an identified tsunami evacuation route for that area. After the ride, participants and local community members visited tsunami information booths at the park hosted by the city of Los Angeles, Port of Los Angeles, Los Angeles Fire Department, University of Southern California – Southern California Earthquake Center, and Cal OES to learn about the hazard in their community and gather resources to begin preparing.

## LANTEX23: NTWC National Exercise Supports U.S. & Canadian Atlantic Coast Preparedness

Dr. Summer Ohlendorf, Dave Snider, Dr. Peggy Johnson, Kara Sterling
U.S. National Tsunami Warning Center, Palmer, Alaska

The U.S. National Tsunami Warning Center (NTWC) held its 2023 LANTEX exercise for the East coasts of the continental U.S and Canada on March 2, 2023. This exercise provides an opportunity for emergency management organizations throughout the region and other NTWC core partners to exercise their operational lines of communications, review their tsunami response procedures, and promote tsunami preparedness. Regular exercising of response plans is critical to maintain readiness for an emergency. This is particularly true for tsunamis which are infrequent but high-impact events.

This 12th annual LANTEX exercise featured:

- Three live conference calls hosted by NTWC scientists
- NTWC live support in a Google Chat room for NOAA/NWS partners, including images to support partner situational awareness (such as maps of the tsunami energy (Figure 1) and travel time)
- A source location and magnitude informed by NTHMP modeling, which directed energy up the Atlantic coast from Florida to Canada
- Condensed exercise timeline during tsunami propagation and response to increase partner participation while reducing overall exercise duration

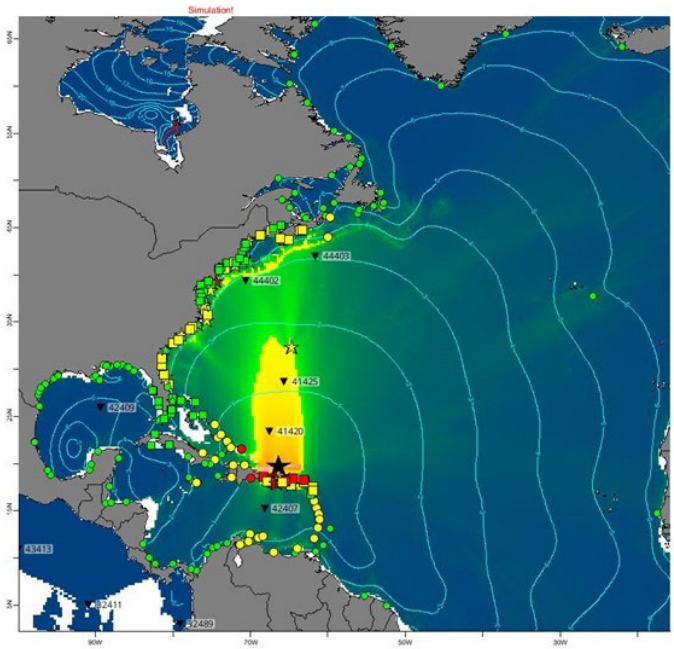


Figure 1. Tsunami energy and forecast map for the LANTEX23 scenario (epicenter at black star). Teal contours show one hour increments of tsunami travel time. Black inverted triangles show locations of Deep Ocean Assessment and Reporting of Tsunamis (DART) buoy system locations. Colored circles, squares and stars show preliminary forecasted coastal wave heights: green < 1ft, 1ft < yellow < 3ft, red > 3 ft.

The 2023 exercise used a tsunami source along the Puerto Rico Trench that was designed to propagate energy up the Atlantic coast to Canada (Figure 1). Echoing the situation in a real event, NTWC simulated that the full magnitude of an earthquake this large could not be captured in five minutes when the first bulletin was issued. This required the magnitude to be upgraded in a later message. For LANTEX23, a simulated magnitude upgrade from M8.2 to M8.7 prompted an adjustment in alert status from a Watch in Message #1 to an Advisory in Message #2.

The exercise kicked off with a variation on NTWC's monthly Communications Test at 0830 AKDT / 1230 EDT. Participants were encouraged to play along in real time, even if their area was not forecast to receive significant impacts from this exercise source. NTWC practiced decision support for partners in real-time during the scenario by

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U.S. National Tsunami Warning Center, Palmer, Alaska

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conducting conference calls at key points in the exercise and including supporting information in a NOAA Google Chat Room both during and between calls (Figure 2). Participants in the live exercise included at least 6 NWS Weather Forecast Offices: WFO Melbourne, WFO Lake Charles, WFO Miami, WFO Jacksonville, WFO Wilmington, WFO Gray/Portland; at least 4 local /state Emergency Management agencies, and international partners from Environment and Climate Change Canada, Natural Resources Canada, and the Canadian Hydrographic Survey.

The National Tsunami Warning Center encourages all partners to complete the post-exercise survey, whether they participated in the exercise or not, letting NTWC staff know how they can more effectively support tsunami training and preparedness with LANTEX24.

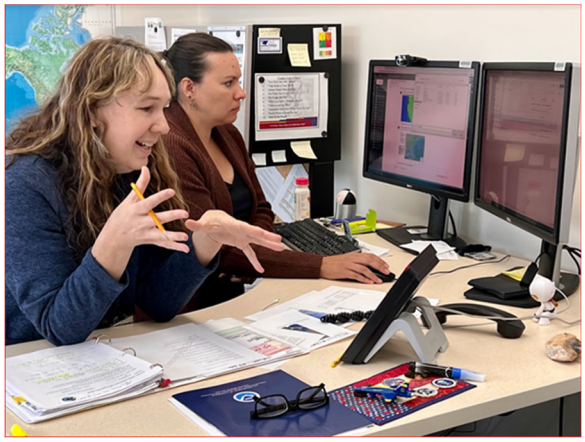


Figure 2. Conference call #1 was delivered by Lead Duty Scientist Kara Sterling (L), while Science and Operations Officer Dr. Summer Ohlendorf (R) provided supporting images in a Google Chat Room for NOAA/NWS partners.

## NWS Melbourne & TsunamiReady Partner Indian River County Participate in LANTEX 23 Exercise

By Jessie Smith, National Weather Service Melbourne, FL

As a part of the Atlantic Coast Tsunami Exercise (LANTEX23), the National Weather Service office in Melbourne, Florida attended a tabletop exercise organized by Indian River County on March 2, 2023. Led by Rachel Ivey, the Emergency Management Planner for the county, the exercise focused on a shallow earthquake occurring along the Puerto Rico Trench that produced a tsunami that would impact the entire US Atlantic coastline. Over the 4-hour exercise window, numerous updates were issued that reflected the impact the tsunami would have on the local beach communities of Indian River County.

Participants included representatives from all county municipalities, law enforcement agencies and flood mitigation divisions, with discussions covering the science of tsunamis, how the most vulnerable communities would be impacted and steps to aid in recovery after a tsunami. Several action items were identified, including scheduling public seminars on the importance of tsunami awareness in the State of Florida, as well as the need for tsunami evacuation signs at beach access points.

NWS Melbourne would like to recognize the partnership of Indian River County as a TsunamiReady County - the first on the US Atlantic Coast!

## British Columbia Tsunami Preparedness Week 2023

By PreparedBC, Ministry of Emergency Management & Climate Readiness

In British Columbia, Canada, Tsunami Preparedness Week is the second week of April, which falls on April 9th to 15th this year.


**Why an awareness week?—**British Columbia is a seismically active province, and coastal areas of BC are at risk of a tsunami. We want people who live in, visit, or know someone who lives in a coastal community to learn about this hazard and ways to get prepared.

On the west coast of Vancouver Island, a tsunami in 1700 destroyed the village of Loht'a and killed thousands of people. In 1964, a tsunami destroyed more than 50 homes and damaged more than 350 in Port Alberni. A tsunami advisory was issued for parts of BC's coast on January 15, 2022, due to volcanic activity in the Tonga archipelago, but thankfully did not result in any significant damage or injuries.

Tsunami waves may take hours to arrive, but we know that a strong earthquake near land could generate a tsunami that arrives in just minutes. We want people to prepare in advance by knowing their tsunami notification zone, where to go to stay safe and how to get important local information.

**High Ground Hike—**Launched in 2016, High Ground Hikes are community events held during Tsunami Preparedness Week. We support communities at-risk of tsunamis to host an event that gives residents (and visitors) an opportunity to practice reaching a tsunami-safe location.

Visit the PreparedBC High Ground Hike page for a list of resources and participating communities.

**PreparedBC: Earthquake and Tsunami Guide—**Just in time for Tsunami Preparedness Week, we've translated the PreparedBC: Earthquake and Tsunami Guide into four additional languages – French, Simplified Chinese, Traditional Chinese and Punjabi. This guide is a must-read for anyone on B.C.'s coast, and explains what to do before, during and after these events.

**About PreparedBC—**PreparedBC is British Columbia's official emergency preparedness public education program serving Indigenous communities, local authorities, schools and everyone else who wants to be prepared! For all this and more, visit www.PreparedBC.ca.

- Learn more about tsunami preparedness: www.preparedbc.ca/tsunamis
- PreparedBC on Facebook: https://www.facebook.com/PreparedBC
- PreparedBC on Twitter: https://twitter.com/PreparedBC

## Translating Technical Tsunami Modelling into User-friendly Public Education Materials in BC's Capital Region

By Alison Roberts, Capital Regional District, British Columbia

A challenge we faced north of the border in British Columbia, Canada, was how to translate highly technical tsunami modelling and mapping into a simple, user-friendly public education product that would empower two types of audiences: those inside the tsunami hazard zone who should leave the area following a strong earthquake, and those outside of the tsunami hazard area, who should stay where they are.

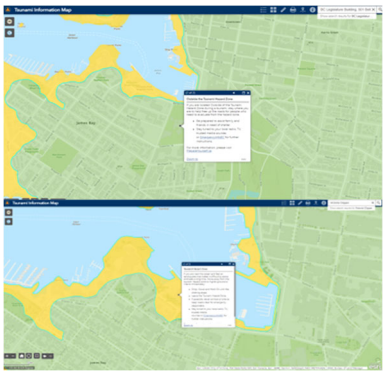


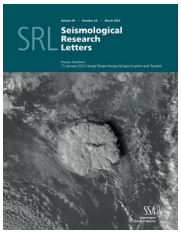
Figure 1. The Capital Region's Tsunami Information Portal provides targeted address specific safety information for those outside and inside of the Tsunami Hazard Zone

The Capital Region Tsunami Information Portal combines the inundation extents of the 11 different tsunami sources modelled by the Capital Region Coastal Flood Inundation Mapping Project into a single Tsunami Hazard Zone. The portal takes inspiration from the National Tsunami Hazard Mitigation Program, City of Seattle's Hazard Explorer, Washington and Oregon State's NVS Tsunami Evacuation Zone mapping products, and Auckland New Zealand's Hazard Viewer.

The Tsunami Information Portal was developed through collaborative engagement with more than 100 representatives from dozens of organizations including the Capital Regional District, which is comprised of 13 municipalities, and three electoral areas, as well as nine First Nations along with provincial and federal agencies, post-secondary institutions, and Washington State. The portal acts as a one-stop shop by centralizing tsunami risk mapping for capital region communities.

The Tsunami Information Portal provides a practical tool demonstrating the benefit of multiple disciplinary practices including Earth and Ocean Sciences, Geographic Information Science, and Social Sciences being applied to build an understanding of tsunami risk and encourage personal and household preparedness.

## Seismological Research Letters March 2023 Special Edition on Hunga Tunga Tsunami

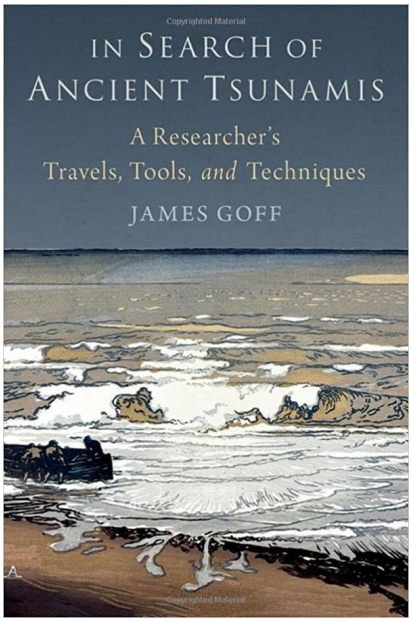



- Tsunami Early Warning of the Hunga Volcanic Eruption Using an Ocean Floor Observation Network Off the Japanese Islands https://doi.org/10.1785/0220220098
- The Hunga Tonga–Hunga Ha'apai Eruption of 15 January 2022: Observations on the International Monitoring System (IMS) Hydroacoustic Stations and Synergy with Seismic and Infrasound Sensors https://doi.org/10.1785/0220220240
- High-Precision Characterization of Seismicity from the 2022 Hunga Tonga-Hunga Ha'apai Volcanic Eruption https://doi.org/10.1785/0220220250
- Earth's Upper Crust Seismically Excited by Infrasound from the 2022 Hunga Tonga–Hunga Ha'apai Eruption, Tonga https://doi.org/10.1785/0220220252
- Remote Seismoacoustic Constraints on the January 2022 VEI 4 Eruption in Tonga https://doi.org/10.1785/0220220233
- Ocean-Wave Gradiometry: Visualizing and Extracting Propagation Features of the 15 January 2022 Tsunami Wavefield with Dense Ocean-Bottom Pressure Gauge Arrays https://doi.org/10.1785/0220220151

## NEW BOOK: In Search of Ancient Tsunamis A Researcher's Travels, Tools, and Techniques

By James Goff

*In Search of Ancient Tsunamis* takes readers on a journey through the science of tsunamis and acts as a "how to" guide in the geology, geomorphology, anthropology, and archaeology of these devastating phenomena. The book draws on examples from around the world and includes numerous personal accounts of field and laboratory experiences.




This journey through tsunami science is framed within the search for ancient tsunamis in the northern part of Chile, a desert environment that requires all the skillsets available to the tsunami researcher. This is a region where numerous attempts to find evidence have failed largely due to the hostile environment that refuses to play by the rules. The story is told through the very personal lens of the author with first-hand accounts of the trials and tribulations of fieldwork and local eccentricities, of serendipitous events, and a growing awareness and understanding of a wide variety of techniques that can be applied to the science. The journey is populated with side stories engaging the reader with deeper insights into the countries, study areas, joys and disappointments of carrying out scientific research across the globe. It is both a very personal story as well as an in-depth look at the science involved in an increasingly sophisticated and interdisciplinary search to better understand the true nature of tsunamis. It contains the wisdom of elders, "Eureka" moments of discovery, and a look at the very latest developments of understanding the effects of ancient tsunamis on prehistoric human populations.

**CITATION:** Goff, James, 2023, In Search of Ancient Tsunamis—A Researcher's Travels, Tools, and Techniques: Oxford University Press, 280 p.

## UPCOMING NTHMP & RELATED EVENTS

- July 11-20, 2023—IUGG General Assembly/Joint Tsunami Commission Meeting and Session (Berlin, Germany) https://www.iugg2023berlin.org/
- July 31-Aug 4, 2023—NTHMP Summer Meeting (Portland, OR) https://nws.weather.gov/nthmp/index.html
- September 19-24, 2023—AEG Annual Meeting (Las Vegas, NV) https://www.aegannualmeeting.org/
- December 12-16, 2022—AGU Fall Meeting (Chicago, IL) https://www.agu.org/fall-meeting