U.S. National Sea Level Report

Contributions to the Global Sea Level Observing System

NOAA NWLON Station in Honolulu, Hawaii showing GNSS antenna, microwave and acoustic water level sensors

March 2025

University of Hawai`i
Sea Level Center

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1.0 Introduction

Sea Level observations in the United States are carried out by a number of organizations ranging from federal to academic in nature, this report focuses on nine entities that comprise the U.S. contributions to GLOSS. These organizations are listed below and include website urls and identify Principal Leads.

The National Oceanic and Atmospheric Administration (NOAA) National Ocean Service (NOS)/ Center for Operational Oceanographic Products and Services (CO-OPS)

CO-OPS operates the National Water Level Observation Network (NWLON), a network of 210 continuously operating real time water level stations that provides the national standards for tide and water level observations and reference datums used for nautical charting, coastal engineering, international treaty regulation, and boundary determination. Twenty-seven of the stations are in the GLOSS Core Network. The standards for maintaining the NWLON are closely aligned with GLOSS standards and each station is configured to maximize the utility of the data across as many applications as possible, including real time navigation, marine boundary determination, and tsunami detection. The oldest continuously operating station is San Francisco (9414290) which started collecting data in July 1854. A total of twenty-three stations have more than 100 years of data.

CO-OPS also runs the Physical Oceanographic Rear-time System (PORTS®) which is a partner-funded decision support tool that collects and disseminates observations of water levels, currents, salinity, bridge air gap and meteorological parameters to primarily support marine navigation. As of the end of 2024 there were 61 water level stations with in the PORTS network. These stations are installed to NWLON/GLOSS standards and many have been installed for over twenty years. These stations provide additional long term high quality data for many applications. A map of these stations is located in section 2.1.1.

Director: Dr Marian Westley (marian.westley@noaa.gov)
Website: https://tidesandcurrents.noaa.gov/
Address: 1305 East West Highway
Suite 6650
Silver Spring, Maryland, USA 20910

The University of Hawaii Sea Level Center (UHSLC)

The UHSLC operates a globally distributed network of 74 tide-gauge stations, including 52 in the GLOSS Core Network, many of which are in remote or under-resourced locations that would not otherwise support long-term sea-level monitoring. The UHSLC also serves as a primary data assembly center in the GLOSS framework. UHSLC staff perform the task of coordinating monthly and yearly data collection from more than 60 international agencies to ensure that hourly tide-gauge data from over 500 globally distributed tide-gauge stations are collected and disseminated to the global research and operational oceanography communities. UHSLC datasets are utilized

across a number of research fields and are cited 50–100 times per year in peer-reviewed literature.

Director: Philip Thompson (philiprt@hawaii.edu)
Website: https://uhslc.soest.hawaii.edu/
Address: 1000 Pope Road
MSB 317
Honolulu, HI 96822

International Tsunami Information Center (ITIC)
The International Tsunami Information Center (ITIC) is operated by the National Oceanic and Atmospheric Administration's (NOAA's) National Weather Service (NWS) Pacific Region Headquarters to serve as a national and international tsunami information resource assisting U.S. States / Territories / Commonwealths, U.S. Compact of Free Association countries, countries throughout the Pacific, the Caribbean, and around the world to mitigate the effects of tsunamis. The ITIC operates the ITIC Caribbean Office (ITIC-CAR) in Mayagűez, Puerto Rico to support the Caribbean region.

The ITIC-CAR supports domestic and international tsunami warning services and programs in the Caribbean and adjacent regions. The office focuses on strengthening and sustaining the tsunami observational system as well as the continued enhancement of tsunami outreach, education and readiness, including the implementation of the TsunamiReady® and international Tsunami Ready Programs.

Within NOAA, it works closely with the U.S. Tsunami Warning Centers (National Tsunami Warning Center and Pacific Tsunami Warning Center); the NWS San Juan Weather Forecast Office responsible for disseminating tsunami products to Puerto Rico and the U.S. Virgin Islands; the NOAA Center for Tsunami Research and the National Ocean Service for water level monitoring.

Director: Dr. Laura Kong (laura.kong@noaa.gov)
Website: https://tsunami.ioc.unesco.org/en/pacific
Address: 1845 Wasp Blvd.
Bldg. 176
Honolulu, HI 96818

Manager of the Caribbean Tsunami Warning Program: Christa von Hillebrandt-Andrade (christa.vonh@noaa.gov)
Website: https://www.weather.gov/ctwp/
Address: 259 Alfonso Valdés
Building D UPRM
Mayagüez, Puerto Rico 00680

NOAA National Weather Service (NWS)/National Tsunami Warning Center (NTWC)
The NTWC is located in Palmer, Alaska, is responsible for the preparation and dissemination of tsunami information to their respective Designated Service Area (DSA). The NTWC DSA is defined as the coasts and coastal waters of Canada and all U.S. States except Hawaii.

NTWC operates and maintains a network of approximately eleven coastal tide gauge stations in Alaska and California as part of the NOAA Tsunami Program. The data collected are used to meet tsunami warning responsibilities.

Director: James Gridley (james.gridley@noaa.gov)
Website: https://tsunami.gov/
Address: 910 S. Felton St.
Palmer, AK 99645 USA

NOAA National Weather Service (NWS)/Pacific Tsunami Warning Center (PTWC)
The PTWC is located on Ford Island in Pearl Harbor, Oahu, Hawaii, is responsible for the preparation and dissemination of tsunami information to their respective Designated Service Area (DSA). The PTWC DSA is defined as Hawaii, American Samoa, Guam, the Commonwealth of the Northern Mariana Islands, U.S. insular possessions in the Pacific, Puerto Rico, the U.S. Virgin Islands, the British Virgin Islands, and the coasts and coastal waters of all other countries participating in the Pacific Tsunami Warning and Mitigation System (PTWS), and the Caribbean and Adjacent Regions Tsunami and Other Coastal Hazards Early Warning System (CARIBEEWS); excluding regions within the NTWC DSA.

PTWC operates and maintains a network of approximately 13 coastal tide gauge stations in Hawaii as part of the NOAA Tsunami Program. The data collected are used to meet tsunami warning responsibilities.

Director: Charles McCreery (charles.mccreey@noaa.gov)
Website: https://tsunami.gov/
Address: Building 176
1845 Wasp Boulevard
Honolulu, HI 96818 USA

NOAA National Weather Service (NWS)/National Data Buoy Center (NDBC)
NDBC operates and maintains the Deep-ocean Assessment and Reporting of Tsunamis (DART) network of 39 deep ocean bottom pressure sensors in the Pacific and Atlantic Oceans as part of the NOAA Tsunami Program. It also integrates DART data from sensors operated by other countries and organizations. The data collected are used to meet tsunami warning responsibilities.

Director: William Burnett (William.h.burnett@noaa.gov)
Website: https://ndbc.noaa.gov/
Address: Bldg. 3205

Stennis Space Center, MS 39529 USA

NOAA Laboratory for Satellite Altimetry (LSA)

The LSA, a branch in the Center for Satellite Applications and Research (STAR), conducts research and develops, delivers, and maintains NOAA's satellite and satellite-based data product algorithms and associated software, products, and services in the areas of ocean, surface water hydrology, sea ice and polar dynamics, and marine geophysics. The LSA develops experimental and operational applications using combinations of satellite data, including radar altimetry, lidar, sea surface temperature, and in situ ocean observations. LSA performs calibration and validation of satellite data as part of commissioning of new satellite missions and as part of product maintenance and sustainment. It processes and analyzes these satellite data in order to determine sea level change and ocean heat content, estimate inland water levels, monitor waves and marine winds, measure and characterize sea ice, construct maps of the marine gravity field and bottom topography, and applications for oceanic-atmospheric prediction and assessing global climate change. The LSA performs user engagement, including for forecasting and data assimilation support and quality assessment/quality control, to assure that operational processing of satellite data meets national requirements for forecasts and assimilation activities for regional and global predictive models and for monitoring of various ocean and cryosphere phenomena, particularly those that pose hazardous conditions. The LSA works with NOAA's CoastWatch to distribute sea level products and services.

LSA Chief: Eric Leuliette (eric.leuliette@noaa.gov)
Website: https://www.star.nesdis.noaa.gov/sod/lsa/
Address: 5830 University Research Court, E/RA3
College Park MD 20740-3818

NOAA Global Ocean Monitoring and Observing Program (GOMO)

The GOMO Program supports the ocean component of the Global Ocean Observing System (GOOS) and enables long-term, high quality, timely, global observational data, information and products. Stakeholders include climate, Arctic, weather, and ocean research communities, forecasters, and other service providers and users. GOMO supports the networks that make up the sustained ocean observing system for climate. These networks include: tide gauge stations, dedicated ships, ships of opportunity, ocean reference stations, Arctic observing systems, tropical moored buoys, surface drifting buoys, Argo profiling floats, data and assimilation subsystems, and product delivery.

Director: David Legler (david.legler@noaa.gov)
Website: https://globalocean.noaa.gov/
Address: 1315 East West Highway
Suite 2824
Silver Spring, Maryland, USA 20910
1-301-427-2460

NOAA National Environmental Satellite, Data, and Information Service (NESDIS)/National Centers for Environmental Information (NCEI)

NCEI collects, quality controls, and archives research-quality hourly-resolution tide gauge data, from GLOSS and non-GLOSS networks. These data are quality-controlled and de-tided to create value-added products for the NOAA Tsunami Program.

Director: Derek Arndt (derek.arndt@noaa.gov)
Website: https://ncei.noaa.gov/
Address: 151 Patton Avenue,
Asheville, NC 28801 USA
1-866-732-2382

2.0 Sea Level Observing Network Maps & Tables

2.1 Sea Level Networks

2.1.1 NOAA National Water Level Observation Network (NWLON)

NOAA/NOS CO-OPS maintains the NWLON, an observation network of 210 permanent water level stations on the coasts and Great Lakes. This system follows the GLOSS standards and allows NOAA to provide a broad range of products and data to its users and stakeholders. These hardened and resilient stations deliver accurate water level data that is critical for safe and efficient marine navigation, real time tsunami detection, and for the protection of infrastructure along the coast. NWLON is used for computing tide and water level reference datums used for nautical charting, coastal engineering, international treaty regulation, and boundary determination. Twenty-seven NWLON stations are part of the GLOSS Core Network. Of those stations, seven stations have collocated GNSS receivers tied to the tidal bench mark network. The majority of the remaining stations have GNSS within the 1 km GLOSS requirement.

NOAA NWLON Stations

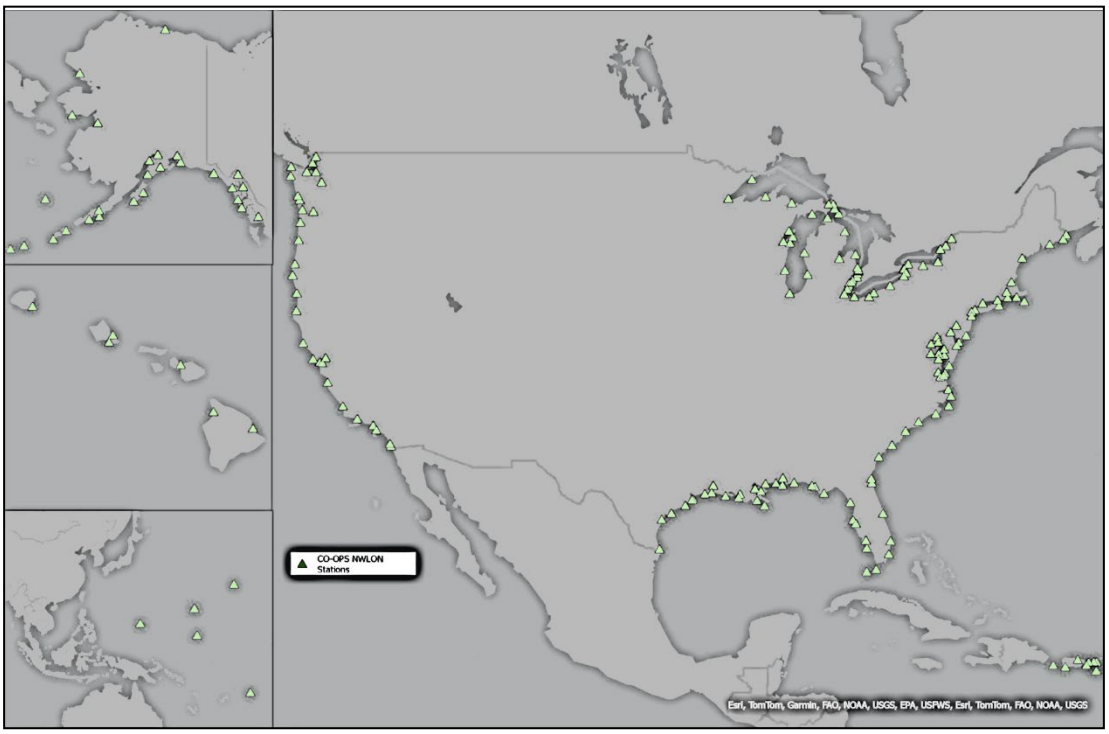

Figure 1. Network Map for stations comprising NOAA's National Water Level Observation Network. The listing of stations can be found in Appendix 1.

PORTS® Water Level Stations

Figure 2. Locations of water level stations associated with PORT®

2.1.2 University of Hawaii Sea Level Center

The University of Hawaii Sea Level Center (UHSLC) operates an international network of 84 sea level gauges whose data is used by both local users and international research organizations including the UNESCO IOC Sea Level Monitoring web site. Real time data from the network is also fed to the international tsunami network. 52 UHSLC stations are part of the GLOSS Core Network.

UHSLC Stations

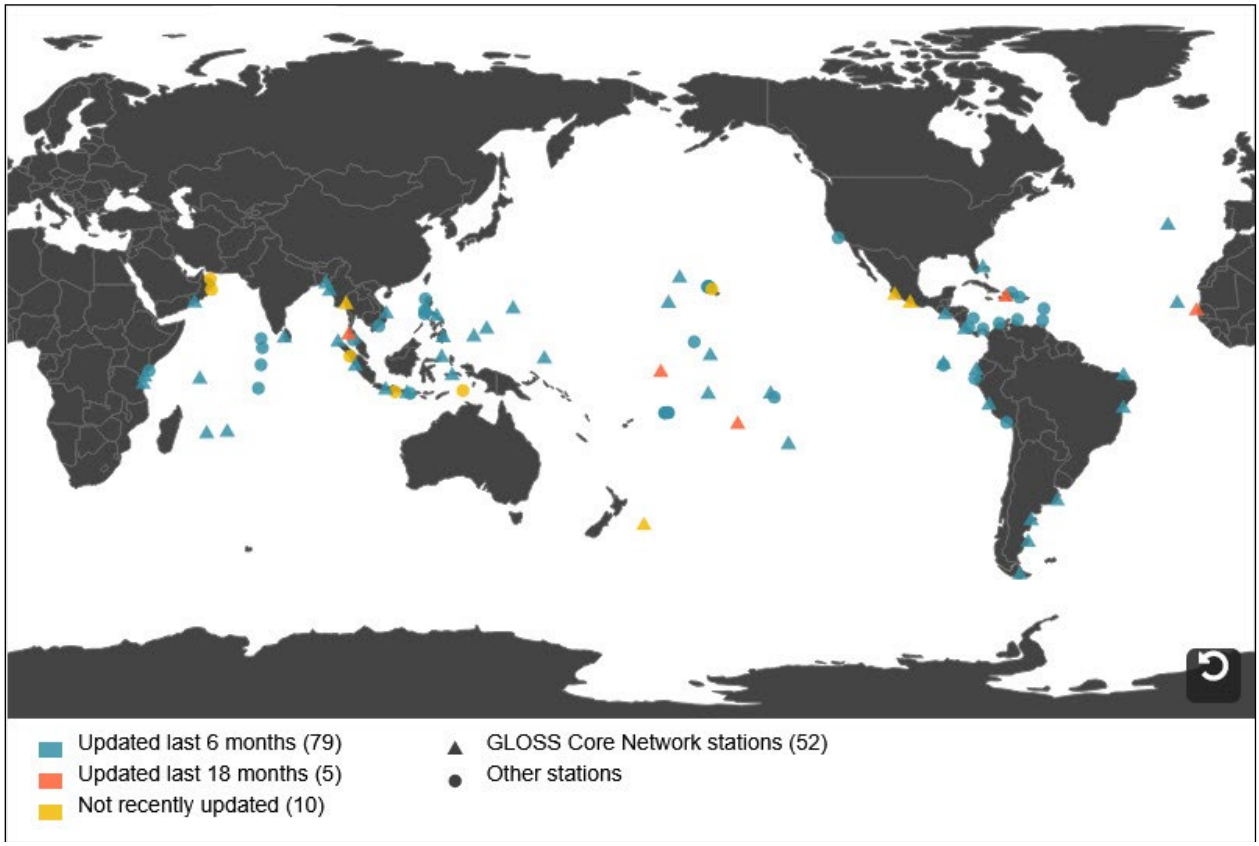

Figure 3. Water level stations comprising UHSLC's network. The listing of stations can be found in Appendix 2

2.1.3 Caribbean Regional Network

The Caribbean Regional sea level network is a collection of approximately 152 coastal sea level and DART stations covering 48 countries, states and territories in the Caribbean and Western Atlantic. The network is supported by UNESCO'S Intergovernmental Oceanographic Commission, Intergovernmental Coordination Group for Tsunamis and other Coastal Hazards Warning System for the Caribbean Sea and adjacent regions (CARIBE-EWS). A subset of the stations is also part of other networks listed in this report.

In support of CARIBE-EWS, the ITIC-Caribbean Office has been providing monthly reporting on the sea level data availability to the operators and stakeholders and has organized conference call/webinars to review sea level data issues. With PTWC, it coordinates with NESDIS the assignment of GOES IDs for new stations in the region. ITIC-CAR also follows up with NOAA, PTWC and the IOC to ensure that stations that are transmitting over GOES or through other platforms are also made available to the IOC Sea Level Data Facility and to the U.S. Tsunami Warning Centers.

Caribbean Tsunami Observing Network

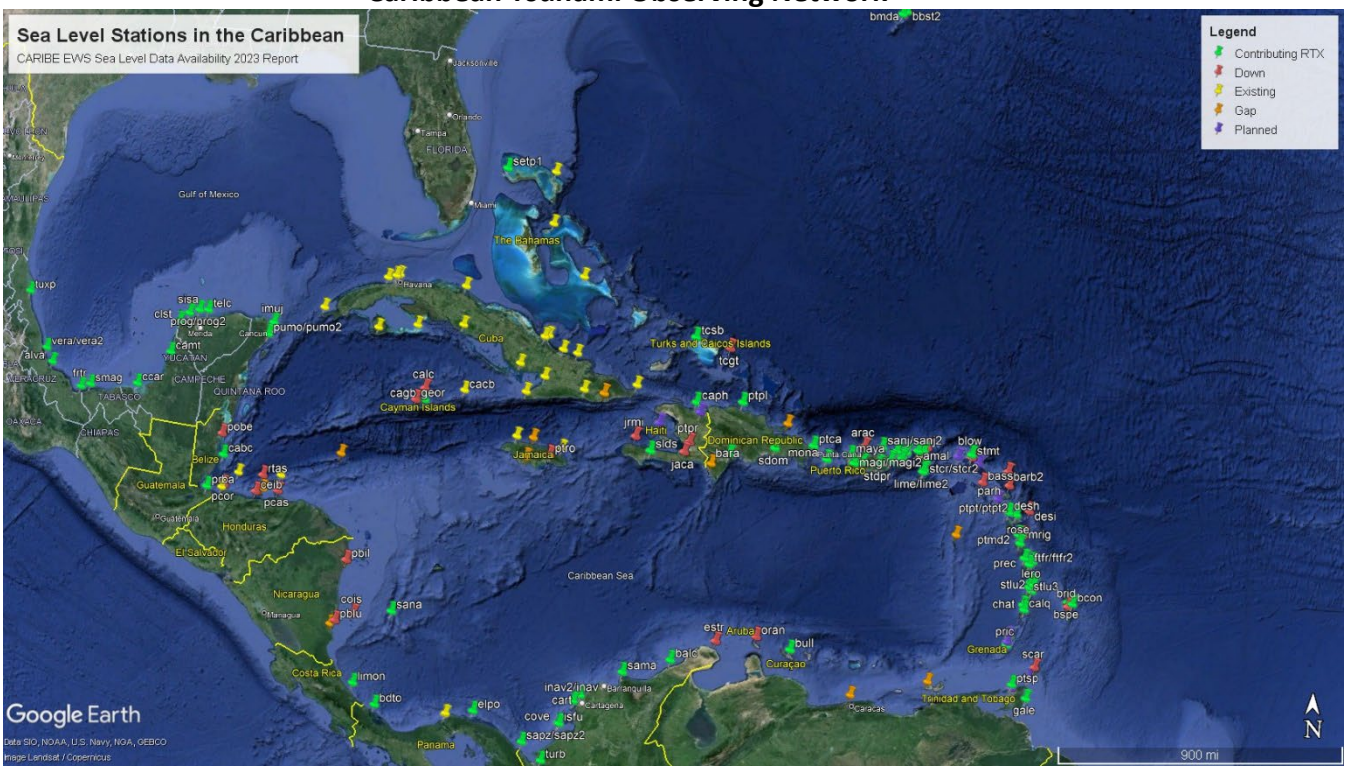

Figure 4. Station map for the Caribbean Tsunami Observing Network – Sea Level (December 2021). The listing of stations can be found in Appendix 3

2.1.4 National Tsunami Warning Center Water Level Stations

NOAA's National Weather Service funds eleven water level stations in Alaska and California to support tsunami detection and research. These stations are capable of reporting at 15-second intervals, fast enough to capture details associated with the arrival of tsunami waves. Public access to these data is through the following web link:
https://tidesandcurrents.noaa.gov/tsunami/

NTWC Stations

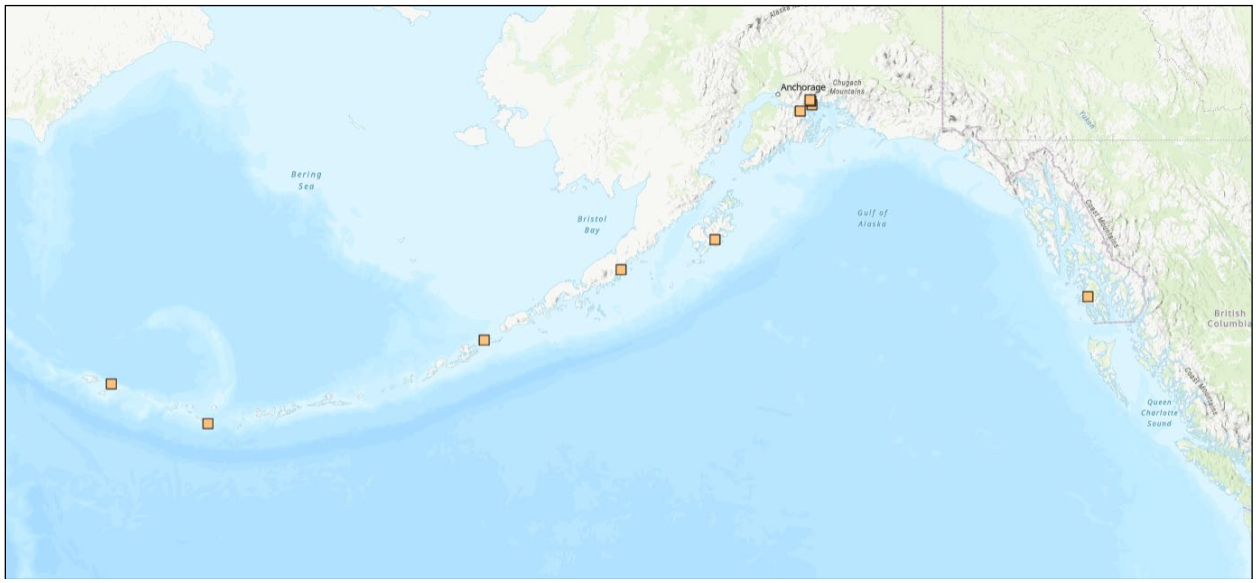

Figure 5. National Tsunami Warning Center Tide Gauges. The listing of stations can be found in Appendix 4.

2.1.5 Pacific Tsunami Warning Center Water Level Stations

NOAA's National Weather Service funds thirteen water level stations in Hawaii and Pacific Islands to support tsunami detection and research. These stations are capable of reporting at 10-second intervals, fast enough to capture details associated with the arrival of tsunami waves. Public access to these data is provided through NCEI (https://doi.org/10.25921/mand-3524).

PTWC Stations

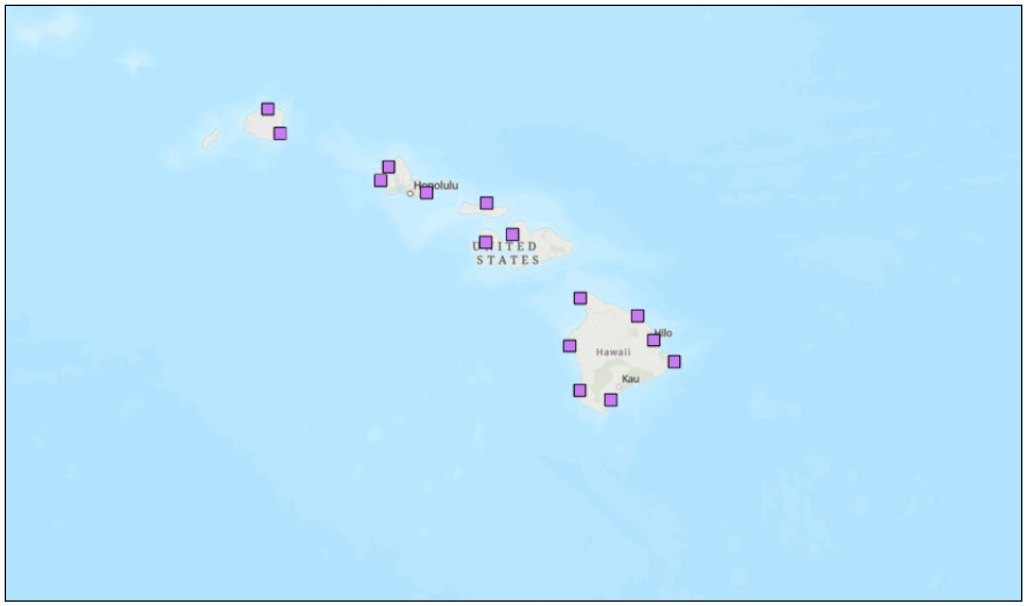

Figure 6. Pacific Tsunami Warning Center tide gauges. The listing of stations can be found in Appendix 5.

2.1.6 National Data Buoy Center DART Ocean Bottom Pressure Stations

NDBC operates a network of 39 Deep-ocean Assessment and Reporting of Tsunamis (DART) ocean bottom pressure sensors in the Pacific and Atlantic Oceans. DART® systems consist of an anchored seafloor bottom pressure recorder (BPR) and a companion moored surface buoy for real-time communications (Gonzalez et al., 1998). An acoustic link transmits data from the BPR on the seafloor to the surface buoy.

The BPR collects temperature and pressure at 15-second intervals. The pressure values are corrected for temperature effects and the pressure converted to an estimated sea-surface height (height of the ocean surface above the seafloor) by using a constant 670 mm/psia. The system has two data reporting modes, standard and event. The system operates routinely in standard mode, in which four spot values (of the 15-s data) at 15-minute intervals of the estimated sea surface height are reported at scheduled transmission times. When the internal detection software (Mofjeld) identifies an event, the system ceases standard mode reporting and begins event mode transmissions. In event mode, 15-second values are transmitted during the initial few minutes, followed by 1-minute averages. Event mode messages also contain the time of the initial occurrence of the event. The system returns to standard transmission after 4 hours of 1-minute real-time transmissions if no further events are detected.

DART Stations

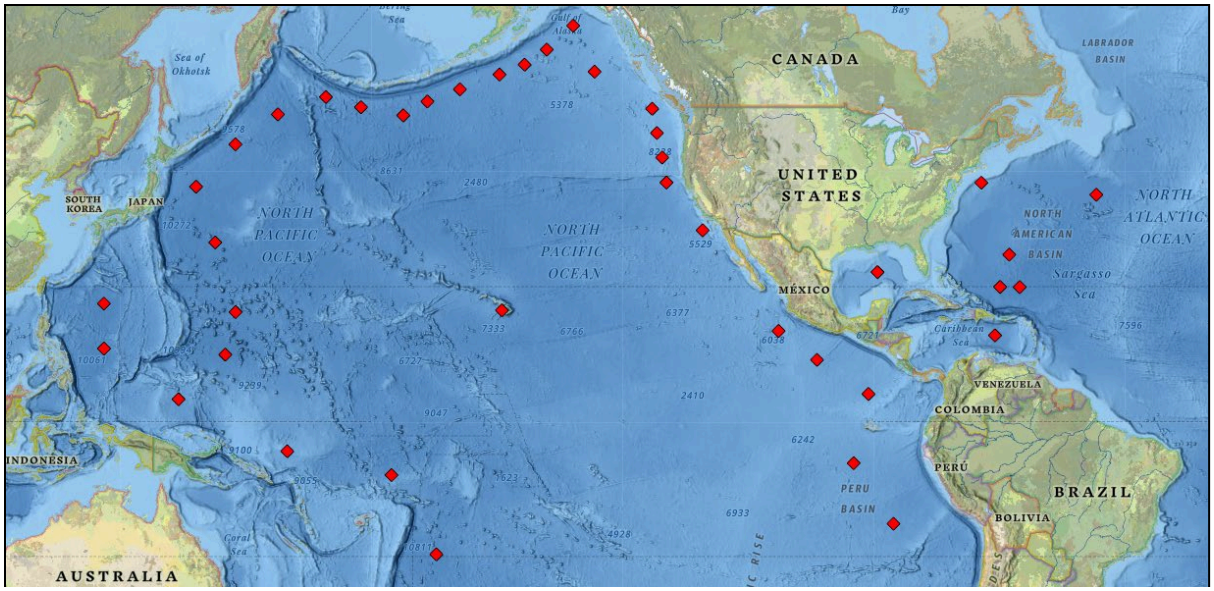

Figure 7. National Data Buoy Center DART ocean bottom pressure stations. The listing of stations can be found in Appendix 6.

2.2 Satellite Altimeter Observations

Below is a map of the estimated sea level trend based on data from TOPEX/Poseidon (T/P), Jason-1, Jason-2, and Jason-3, which have monitored the same ground track since 1992. In April 2022 Sentinel-6 Michael Freilich succeeded Jason-3 as the reference mission for monitoring sea level change. (The measurement of long-term changes in global mean sea level can provide an important corroboration of predictions by climate models of global warming. Satellite altimeter radar measurements can be combined with precisely known spacecraft orbits to measure sea level on a global basis with unprecedented accuracy. A reference series of satellite missions that started with TOPEX/Poseidon (T/P) in 1992 and continued with Jason-1 (2001–2013), Jason-2 (2008–2019), Jason-3 (2016–present), and Sentinel-6MF (2020–present) estimate global mean sea level every 10 days with an uncertainty of 3–4 mm.

Jason-3, launched 17 January 2016, is a joint effort between NOAA, the National Aeronautics and Space Administration, France's Centre National d'Etudes Spatiales (CNES) and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT).)

https://www.star.nesdis.noaa.gov/socd/lsa/SeaLevelRise/LSA_SLR_timeseries.php

Satellite Altimetry

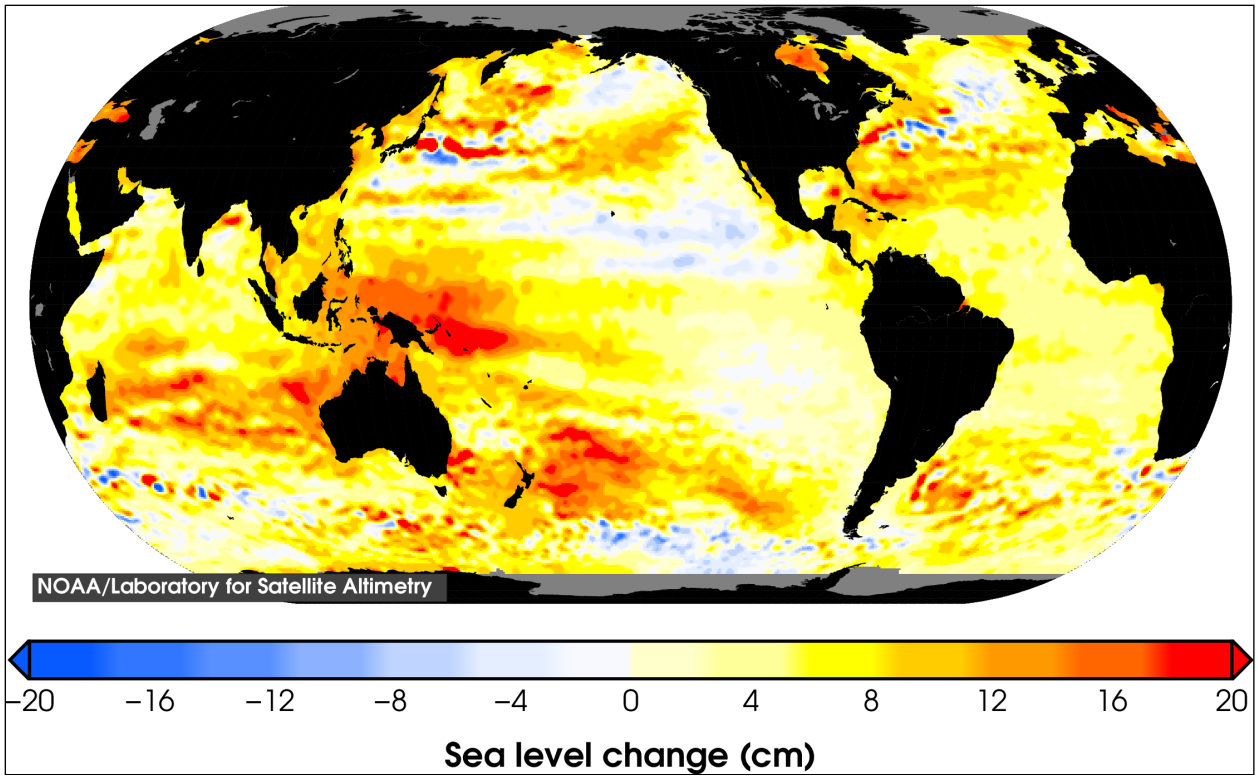

Figure 8. Map of total sea level change from TOPEX/Poseidon, Jason-1,-2,-3 and Sentinel-6 since 1993

The following graphic is a plot of the global mean sea level rise based on TOPEX/Poseidon (T/P), Jason-1, Jason-2, Jason-3, and SSMF data.

Satellite Derived Global mean sea level

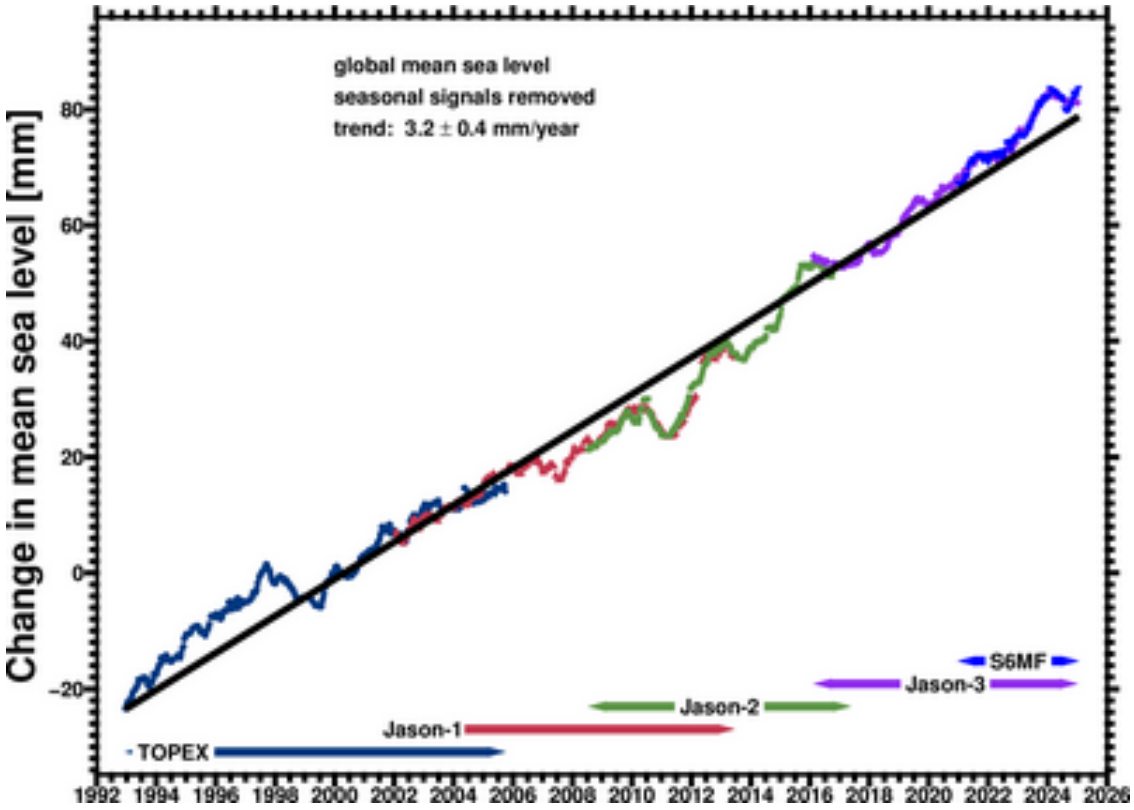

Figure 9. Global mean sea level trend from satellite altimetry

2.3 US GLOSS Sea Level Stations

The Table below lists the U.S. GLOSS Core Network stations along with the nearest GPS station as reported by SONEL

Table 1 – US GLOSS Core Network Water Level Stations

GLOSS ID	Station Name	Lat.	Long.	Country/State	Organization	Nearest GPS	Distance to WL station (m)	GPS Latitude	GPS Longitude
8	Mombasa	-4.07	39.657	Kenya	U Hawaii	None			
18	Port Louis	-20.155	57.495	RDRG	U Hawaii	None			
19	Rodrigues	-19.668	63.418	Mauritius	U Hawaii	RDRG	554	-19.6809	63.4162
26	Diego Garcia Is.	-7.2833	72.4000	United Kingdom	U Hawaii	DGAR	2900	-7.2903	72.3938
27	Gan	-0.7000	73.1667	Maldives	U Hawaii	ADDU	467	-0.6906	73.1501
28	Male, Hulule	4.1667	73.5000	Maldives	U Hawaii	HULE	1179	4.1927	75.5281
33	Colombo	6.935	79.858	Sri Lanka	U Hawaii	SGOC	5313	6.8921	79.8742
36	Chittagong	22.247	91.825	Bangladesh	U Hawaii	None			
37	Akyab (Sittwe)	20.14	92.903	Myanmar	U Hawaii	None			
45	Padang	-1	100.367	Indonesia	U Hawaii	IPA0	732	-0.9438	100.3690
49	Benoa	-8.745	115.21	Indonesia	U Hawaii	BNOA	193	-8.7465	115.2099
68	Ambon	-3.683	128.183	Indonesia	U Hawaii	None			

69	Bitung	1.44	125.193	Indonesia	U Hawaii	BTNG	1233	1.4389	125.1904
71	Davao	7.122	125.663	Philippines (the)	U Hawaii	None			
72	Legaspi	13.15	123.75	Philippines (the)	U Hawaii	None			
73	Manila	14.585	120.968	Philippines (the)	U Hawaii	MANL	1769	14.5982	120.9727
74	Nome	64.5000	-165.4400	Alaska	NOAA	AB11	8317	64.5645	-165.3734
75	Qui Nhon	13.775	109.255	Viet Nam	U Hawaii	None			
100	Sand Point	55.3333	-160.5000	Alaska	NOAA	AB07	2584	55.3493	-160.4768
102	Unalaska	53.8833	-166.5333	Alaska	NOAA	AV09	950	53.8756	-166.5418
105	Wake Is.	19.2833	166.6167	Marshall Is.	NOAA	None			
106	Midway Is	28.2167	-177.3667	Hawaii	NOAA	None			
107	French Frigate Shoals	23.8667	-166.2833	Hawaii	U Hawaii	None			
108	Honolulu	21.3000	-157.8667	Hawaii	NOAA	HNLC	1	21.3032	-157.8645
109	Johnston Is.	16.7333	-169.5333	Hawaii	U Hawaii	None			
111	Kwajalein	8.7333	167.7333	Marshall Is.	NOAA	None			
116	Chuuk	7.45	151.85	Fed. Micronesia	U Hawaii	None			
117	Kapingamarangi	1.1000	154.7833	Fed. Micronesia	U Hawaii	None			
118	Saipan	15.2333	145.7333	North Mariana Is.	U Hawaii	CNMR	600	15.2297	145.7431
119	Yap, Caroline Is.	9.5167	138.1333	Fed. Micronesia	U Hawaii	None			
120	Malakal	7.3333	134.4667	Belau	U Hawaii	PALA	3125	7.3409	134.4755
138	Rikitea	-23.125	225.047	France	U Hawaii	RKTG	2	-23.1178	-134.9690
140	Papeete	-17.532	210.433	France	U Hawaii	PAPE	1	-17.5331	-149.5727
141	Moulmein	16.465	97.622	Myanmar	U Hawaii	None			
142	Nuku Hiva	-8.93	219.918	France	U Hawaii	None			
143	Penrhyn	-8.5900	-158.0667	Cook Islands (the)	U Hawaii	None			
144	Pago Pago, American Samoa	-14.2833	-170.6833	A. Samoa	NOAA	ASPA	7082	-14.3261	-170.7224
145	Kanton Is., Phoenix Is.	-2.4900	-171.4300	Kiribati	U Hawaii	None			
146	Christmas Is., Line Is.	1.9833	-157.4833	Kiribati	U Hawaii	None			
149	Apra Hbr, Guam, Marianas	13.4333	144.6500	Marianas	NOAA	GUUG	873	13.4332	144.8030
150	Seward	60.1167	-149.4333	Alaska	NOAA	AKSE	1554	60.1325	-149.43654
151	Prudhoe Bay	70.4000	-148.5267	Alaska	NOAA	DSL1	7684	70.3334	-148.4727
154	Sitka	57.0500	-135.3333	Alaska	NOAA	AKSI	396	56.0486	-135.33889
157	South Beach	44.3800	-124.0300	Oregon	NOAA	None			
158	San Francisco	37.8000	-122.4667	California	NOAA	UCSF	4850	37.7630	-122.4482
159	La Jolla (Scripps Pier)	32.8667	-117.2667	California	NOAA	N551	1	32.8669	-117.2752
167	Quepos	9.4	275.833	Costa Rica	U Hawaii	None			
169	Baltra	-0.437	269.715	Ecuador	U Hawaii	GLPS	1715	-0.7427	-90.3036
172	La Libertad	-2.2	279.083	Ecuador	U Hawaii	None			

173	Callao	-12.05	282.85	Peru	U Hawaii	CALL	1435	-12.0629	-77,1493
181	Ushuaia	-54.805	291.705	Argentina	U Hawaii	AUTF	3994	-54.8395	-68.3036
182	Acajutla	13.583	270.167	El Salvador	U Hawaii	None			
190	Puerto Deseado	-47.75	294.083	Argentina	U Hawaii	PDES	14	-47.7536	-65.9147
191	Puerto Madryn	-42.763	294.968	Argentina	U Hawaii	None			
192	Mar del Plata	-38.05	302.45	Argentina	U Hawaii	MPL2	6	-38.0356	-57.5311
206	San Juan	18.4667	-66.1167	Puerto Rico	NOAA	N240	1	18.4589	-66.1164
211	Settlement Point	26.7167	-78.9833	Bahamas	U Hawaii	BHMA	3411	26.6899	-78.9670
216	Key West	24.5500	-81.8000	Florida	NOAA	CHIN	400	24.5505	-81.8071
217	Galveston (Pier 21)	29.3167	-94.8000	Texas	NOAA	N301	3	29.3168	-94.7995
219	Duck	35.1833	-75.7500	North Carolina	NOAA	NCD4	190	36.1817	-75.7513
220	Atlantic City	39.3500	-74.4167	New Jersey	NOAA	NONE			
221	Bermuda, St. Georges Is.	32.3667	-64.7000	Bermuda	NOAA	BRSG	706	32.3702	-64.6961
245	Ponta Delgada	37.735	334.328	Portugal	U Hawaii	PDEL	1550	32.7476	-25.6628
253	Dakar	14.677	342.58	Senegal	U Hawaii	DAKA	3772	14.6845	-17.4651
287	Hilo	19.7333	-155.0667	Hawaii	NOAA	None			
288	Pensacola	30.4000	-87.2167	Florida	NOAA	N302	8	30.4038	-87.2114
289	Fort Pulaski	32.0333	-80.9000	Georgia	NOAA	N003	2	32.0347	-80.9031
290	Newport	41.5000	-71.3333	Rhode Island	NOAA	N001	2	41.5043	-71.3261
291	Cilicap	-7.752	109.017	Indonesia	U Hawaii	CLCP	62	-7.7508	109.0175
297	Zanzibar	-6.155	39.19	Tanzania (United Republic of)	U Hawaii	ZNZB	7351	-6.2184	39.2106
302	Adak	51.8667	-176.6333	Alaska	NOAA	AB21	2034	51.8642	-176.6626
329	Palmeira	16.755	337.017	Cabo Verde	U Hawaii	TGCV	5	16.7548	-22.9828
332	Virginia Key	25.7317	-80.1617	Florida	NOAA	N300	1	25.7314	-80.1620
334	Salvador	-12.967	321.483	Brazil	U Hawaii	SALV	3902	-13.0087	-38.5124
336	Fortaleza	-3.717	321.533	Brazil	U Hawaii	CEFT	490	-3.7108	-38.4729
339	Pt. La Rue	-4.672	55.528	Seychelles	U Hawaii	SEY1	5558	-4.6737	55.4790
347	Sabang	5.888	95.317	Indonesia	U Hawaii	None			

3.0 Specific Highlights

3.1 Bench Mark Recovery at Scripps Institution of Oceanography, California

Figure 10. Panoramic view of Scripps Pier in La Jolla, California

Tide Gauge Bench Mark (TGBM) Networks are a critical component for monitoring datum stability at water level stations. They are used to detect any vertical drift in sensors and ensure accurate estimates of relative sea level change. Connecting TGBM networks to geometric and physical reference frameworks greatly enhances their functionality by enabling the estimation of local relative and absolute sea level change, land movement, and aiding in the construction of coastal infrastructure. Maintaining TGBM networks is essential for ensuring the accuracy of long-term sea level records.

The Scripps Institution of Oceanography (SIO) at the University of California, San Diego (UCSD), is home to the La Jolla tide gauge (National Oceanic and Atmospheric Administration (NOAA) Station 9410230, GLOSS Station 159), one of the longest-running sea level monitoring stations in the United States. This station is critical to global climate research and sea-level rise assessments. However, in January 2020, a major renovation project at the SIO Center for Coastal Studies inadvertently destroyed several TGBMs within the tide station network, potentially severing the linkage between the tide gauge and its long-term geodetic reference network.

Recognizing the situation's urgency, NOAA's National Geodetic Survey (NGS) initiated an emergency recovery effort in collaboration with UCSD Capital Program Management, Facilities Management, the NOAA's Center for Operational Oceanographic Products and Services (CO-OPS), and private contractors. The project involved establishing a new geodetic control network to replace the lost bench marks and ensure the continued stability of the tide gauge record.

Recovering and Rebuilding the Tidal and Geodetic Networks

Figure 11. Installing new bench mark

The bench mark recovery effort involved conducting a site geodetic survey using First-Order leveling procedures, a highly precise method for measuring elevation differences that ensures accurate height data, to re-establish horizontal and vertical control. The project aimed to integrate the newly established control points into NOAA's National Spatial Reference System (NSRS) and maintain alignment with modern geodetic and sea level monitoring standards.

This project included several key technical aspects, including:

Bench Mark Recovery and Installation

The project was initiated when two NOAA bench marks were lost during the renovation's demolition phase. The project team salvaged the original markers, along with several others discovered during the process, and integrated their historical data into the new network, ensuring continuity with past geodetic records.

New high-accuracy bench marks (control points) were added through first-order leveling procedures establishing and integrating them with NOAA's NSRS. Each new bench mark was paired with two reference bench marks to ensure redundancy, long-term stability, and survivability.

Geodetic Surveys and Data Integration

Figure 12. Surveying recently installed bench marks

Multi-session static Global Navigation Satellite Systems (GNSS) data collection was conducted at the four newly established bench marks, and the new marks were connected to the remaining TGBM network through first-order differential leveling.

All GNSS data was processed through Online Positioning User Service (OPUS), NGS's operational system, ensuring integration with NOAA's NSRS (NAD83(2011) epoch 2010.0 datum and geoid model GEOID18). These observations were tied to five continuous operating reference stations (CORS), permanent GNSS stations that continuously record and transmit positioning data to enhance positional stability and geodetic accuracy.

Enhancing Infrastructure Resilience—The newly established passive control network provides a stable geodetic framework for future research, ensuring that SIO's tide gauge data remain a reliable component of NOAA's National Water Level Observation Network (NWLON) and the Global Sea Level Observing System (GLOSS).

Project Outcomes and Impact

The successful recovery effort yielded several key results:

1) **Restoration of the Geodetic Network**—The La Jolla tide gauge is now securely tied to a high-accuracy vertical reference system, preserving over 100 years of sea-level observations.
2) **Sustainable Geodetic Infrastructure**—The new bench marks enhance the detection of vertical land motion at the tide gauge site, improving long-term sea level rise assessments.

3) **Improved Cross-Agency Collaboration**—The project serves as a model for integrating geodetic expertise into coastal infrastructure planning, ensuring that future construction projects account for the preservation of geodetic control.

    - This success was made possible through the collaborative efforts of **Johnson Frank & Associates, Inc.**, which led the surveying and geodetic recovery efforts, with key contributions from:
    - **Dana J. Caccamise II (NOAA/NGS)** – Project oversight, stakeholder coordination, and technical guidance
    - **Jeff Oyler (NOAA/CO-OPS)** – Tide gauge integration and leveling expertise
    - **Brian Ward (NOAA/NGS)** – Survey planning and quality assurance
    - **Alan D. Frank (Johnson Frank & Associates, Inc.)** – Project management and GNSS survey execution
    - **UCSD Capital Program Management & Facilities Management** – Site coordination and infrastructure planning

4) **Scientific and Public Recognition**—The project was presented at the regional meeting, highlighting the critical role of geodetic bench marks in maintaining high-precision sea level records.

Acknowledgments

This recovery effort was made possible by collaborating with multiple organizations and individuals, whose expertise was essential to its success.

Through this effort, NOAA and its partners reduced the risk of losing a foundational climate and oceanographic research dataset. The restored bench marks will continue to serve as vital references for global sea level monitoring, reinforcing NOAA's role as a steward of long-term environmental data.

4.0 Data Availability and Product Delivery

4.1 Sea Level Networks

4.1.1 NOAA National Water Level Observation Network

CO-OPS maintains a comprehensive website, which allows users full access to all data and products on a 24 X 7 basis (http://tidesandcurrents.noaa.gov). All raw observed data (6-minute data with quality control flags attached) are automatically available over the website after the data collection systems receive each hourly transmission and after they undergo the quality control checks. Derived data products are made available through the website after verification. Data and products are archived at NCEI (https://doi.org/10.25921/dt9g-2p60).

4.1.2 University of Hawaii Sea Level Center

The UHSLC website hosts a variety of products, in addition to providing access to sea-level data. Products include: tide gauge and altimeter trends and comparisons, climatologies of sea-level extremes, and seasonal sea-level forecasts. http://uhslc.soest.hawaii.edu/

UHSLC maintains three databases for global sea level data. They are:

Joint Archive for Sea Level (JASL)

JASL is a collaborative arrangement between NCEI, the World Data Center for Oceanography, Silver Spring, and the UHSLC. The JASL is responsible for the collaborative archive referred to as the Research Quality Data Set.

The JASL data set is designed to be user friendly, scientifically valid, well-documented, and standardized for archiving at international data banks. JASL data are provided internally by the UH Sea Level Network and by over 60 agencies representing over 70 countries.

Fast Delivery Database

The Fast Delivery Database supports various international programs, in particular Climate variability and predictability (CLIVAR) and Global Climate Observing System (GCOS). The database has been designated by the IOC as a component of the GLOSS program. The fast delivery data are used extensively by the altimeter community for ongoing assessment and calibration of satellite altimeter datasets.

High Frequency Data

Near Real-Time Data (collection + up to a three hour delay, H-3 delay) and daily filtered values (J-2 delay) are provided, primarily for stations that UHSLC directly operates and maintains. UHSLC has committed to hosting the GLOSS High Frequency database in collaboration with the Institute of Flanders (VLIZ).

4.1.3 Tsunami Warning Operations: Sea Level Monitoring – Tide Tool and IOC Sea Level Monitoring Facility

Tide Tool is an operations tool developed and supported by the Pacific Tsunami Warning Center for the decoding, display, and manipulation of sea level data (coastal and DART deep ocean stations) transmitted over the WMO Global Telecommunications System (GTS) and other platforms. The tool continuously decodes sea level in real-time and displays the time series on a computer screen, along with station status and metadata. Map clients enable easy viewing. Tsunami travel time and expected arrival time information are available from 2014. It is used at many tsunami warning centers for the monitoring and reporting of tsunamis. Non-operational versions exist for data transmissions through the internet and for archived data. Available since 2005. As new stations have become available the PTWC updates the Tide Tool system.

- To obtain the software, and for further information and questions, please contact Stuart Weinstein, Asst Director, NOAA Pacific Tsunami Warning Center

(stuart.weinstein@noaa.gov), or Laura Kong, Director, UNESCO/IOCNOAA International Tsunami Information Center (laura.kong@noaa.gov).

The monthly, bi annual and annual sea level station reports, as well as sea level operators meeting reports can be accessed on the ITIC-CAR website at https://www.weather.gov/itic-car/stations

The IOC Sea Level Monitoring Facility has a global interactive map of most of the sea level stations operational with remote communication systems (GOES, FTP, etc.): http://www.ioc-sealevelmonitoring.org/

The Puerto Rico Seismic Network (PRSN) also operates 10 sea level stations in Puerto Rico, British Virgin Islands and the Dominican Republic. Their website is http://redsismica.uprm.edu They share their data through the IOC Sea Level Monitoring Facility, it is also available on Tide Tool.

4.1.4 National Tsunami Warning Center Network

NTWC operates a network of approximately eleven coastal tide gauges in Alaska and California. The latest data from NTWC water level data stations can be found on the NOS Tides and Currents site (https://tidesandcurrents.noaa.gov/tsunami/) and older data and quality-controlled and de-tided products can be obtained from NCEI (https://doi.org/10.25921/23vy-9z62).

4.1.5 Pacific Tsunami Warning Center Network

PTWC operates a network of approximately thirteen coastal tide gauges in Hawaii. PTWC water level data and quality-controlled and de-tided products can be obtained from NCEI (https://doi.org/10.25921/mand-3524).

4.1.6 National Data Buoy Center DART Network

NDBC operates a network of 39 Deep-ocean Assessment and Reporting of Tsunamis (DART) ocean bottom pressure sensors in the Pacific and Atlantic Oceans. The latest data from NDBC can be found at https://www.ndbc.noaa.gov/obs.shtml?lat=13&lon=-173&zoom=2&pgm=tsunami, while older data and quality-controlled and de-tided products can be obtained from NCEI (https://doi.org/10.7289/V5F18WNS).

4.2 Satellite Altimetry

The LSA website includes resources and links to a variety of satellite altimeter products. LSA's projects include monitoring sea level rise, near real-time product validation, sea-ice products, and sea floor topography. Jointly with EUMETSAT, LSA maintains the Radar Altimeter Database System, which includes homogenized data from the reference series of TOPEX/POSEIDON, Jason-1, Jason-2, Jason-3, and Sentinel-6 Michael Freilich and other missions suitable for sea level change studies (Geosat, Geosat Follow-On, ERS-1, ERS-2, Envisat, CryoSat-2, SARAL/AltiKa,

Sentinel-3A, and Sentinel-3B). RADS is used for LSA's product generation and calibration/validation. See the following links for additional information
https://www.star.nesdis.noaa.gov/socd/lsa/
https://www.star.nesdis.noaa.gov/socd/lsa/RADS.php

For operational users, LSA produces high-resolution sea level and wave observations for data assimilation and for forecasters. Along-track observations of waves and multi-mission, daily near-real time maps of sea level anomalies and geostrophic currents are distributed through NOAA CoastWatch web link below
https://coastwatch.noaa.gov/cwn/product-families/sea-surface-height.html

Satellite Heat Content Suite for the North Atlantic, the North Pacific, the South Pacific are distributed daily through the Office of Satellite and Product Operations. See link below.
https://www.ospo.noaa.gov/Products/ocean/ocean_heat.html

Monthly, the LSA produces global and regional time series and maps of mean sea level for climate applications. These data are used with GRACE and Argo observations to monitor the sea level budget in the annual State of the Climate report. See link below.
https://www.star.nesdis.noaa.gov/socd/lsa/SeaLevelRise/.

4.3 National Centers for Environmental Information (NCEI) Products

NCEI archives analog and digital coastal tide gauge data and ocean bottom pressure data, digitizes analog data as funding permits, and performs quality-control and tidal analysis of the high-resolution data. These data include:

- Coastal Tide Gauge Data: hourly and 1-minute water level data from CO-OPS (about 145 stations), Hourly data from other GLOSS-member nations (about 540 stations) and high-resolution water level data from the PTWC (about 13 stations, since 2013) and NTWC (7 stations, since 2014). NCEI also archives 6-minute, hourly, daily, and monthly mean water levels for all NOS stations, and 15-second data for tsunami events.
- Analog Tide Gauge Records (Marigrams): NCEI stewards select pre-digital-age tide gauge data (1854–1981) capturing tsunami events. (The graphic representation of water level as a function of time on paper is called a marigram.)
- DART Ocean Bottom Pressure Data: High-resolution 15-second data recovered from the seafloor by NDBC (39 stations, since 2008, including non-DART bottom pressure recorder data from 1983 and forward).

NCEI provides quality-controlled water level data, computed astronomical tides, details on the harmonic tidal analysis results, and spectra to assess the quality of the de-tiding. Researchers use the quality-controlled data to validate tsunami propagation and storm surge models, improve forecasts and numerical models necessary for sound management, and plan coastal communities.

APPENDIX 1: NOAA NWLON Stations in the United States

The table below lists all currently installed NOAA NWLON water level stations along with their GLOSS, PSMSL, and JASL IDs. For completeness, this list includes NWLON stations installed in the U.S. portion of the Great Lakes and St. Lawrence River. Below this table is a second table containing NOAA stations that are not part of the NWLON but are transmitted to one of sea level data archive centers. More information on these stations can be obtained at the following website: https://tidesandcurrents.noaa.gov/. NOAA/CO-OPS operate additional stations in partnership with local entities for navigation and storm surge observations that also disseminate 1 minute for tsunami detection. The full list of tsunami capable stations can be found at: https://tidesandcurrents.noaa.gov/tsunami/#

Active NOAA NWLON Water Level Stations							
Station ID	**Station Name**	**Year Installed**	**Latitude**	**Longitude**	**GLOSS ID**	**PSMSL ID**	**JASL ID**
1611400	Nawiliwili, HI	1954	21.9544	-159.3561		756	058a
1612340	Honolulu, HI	1905	21.3067	-157.867	108	155	057b
1612401	Pearl Harbor, HI	2023	21.3667	-157.9633			434a
1612480	Mokuoloe, HI	1957	21.4331	-157.79		823	061a
1615680	Kahului, Kahului Harbor, HI	1946	20.895	-156.4767		521	059a
1617433	Kawaihae, HI	1988	20.0366	-155.8294		2128	552a
1617760	Hilo, Hilo Bay, Kuhio Bay, HI	1946	19.7303	-155.0556	287	300	060a
1619910	Sand Island, Midway Islands	1947	28.2117	-177.36	106	523	050a
1630000	Apra Harbor, Guam	1948	13.4431	144.6556	149	540	053a
1770000	Pago Pago, American Samoa	1948	-14.2767	-170.6894	144	539	056a
1820000	Kwajalein, Marshall Islands	1946	8.7317	167.7361	111	513	055a
1890000	Wake Island	1950	19.2907	166.6176	105	595	051a
8311030	Ogdensburg, NY	1900	44.7017	-75.494			
8311062	Alexandria Bay, NY	1983	44.331	-75.9345			
8410140	Eastport, ME	1929	44.9033	-66.985		332	740a
8411060	Cutler Farris Wharf, ME	1963	44.657	-67.2047		1524	
8413320	Bar Harbor, ME	1947	44.3922	-68.2043		525	
8418150	Portland, ME	1910	43.6567	-70.2467		183	252a
8443970	Boston, MA	1921	42.355	-71.0517		235	741a
8447930	Woods Hole, MA	1932	41.5236	-70.6711		367	742a
8449130	Nantucket Island, MA	1963	41.2853	-70.0964		1111	743a
8452660	Newport, RI	1930	41.5044	-71.3261	290	351	253a
8454000	Providence, RI	1938	41.8067	-71.4006		430	

8461490	New London, Thames River, CT	1938	41.355	-72.0867		429	744a
8467150	Bridgeport, CT	1932	41.1758	-73.184		1068	
8510560	Montauk, NY	1947	41.0483	-71.9594		519	279a
8516945	Kings Point, NY	1998	40.8103	-73.765		2322	
8518750	The Battery, NY	1920	40.7006	-74.0142		12	745a
8531680	Sandy Hook, NJ	1910	40.4669	-74.0094		366	
8534720	Atlantic City, NJ	1911	39.3567	-74.4181	220	180	264a
8536110	Cape May, NJ	1965	38.968	-74.9597		1153	746a
8545240	Philadelphia, PA	1989	39.93	-75.1417		135	
8551910	Reedy Point, DE	1956	39.5583	-75.5733		786	
8557380	Lewes, DE	1919	38.7828	-75.1192		224	747a
8570283	Ocean City Inlet, MD	1978	38.3283	-75.0911		2292	
8571421	Bishops Head, MD	2005	38.2206	-76.0386			
8571892	Cambridge, MD	1980	38.5742	-76.0722		481	
8574680	Baltimore, MD	1902	39.2669	-76.5793		148	
8575512	Annapolis, MD	1978	38.9833	-76.4816		311	
8577330	Solomons Island, MD	1937	38.3172	-76.4508		412	
8594900	Washington, DC	1924	38.873	-77.0217		360	
8631044	Wachapreague, VA	1978	37.608	-75.6858		2293	
8632200	Kiptopeke, VA	1951	37.1652	-75.9884		636	
8635027	Dahlgren, VA	1970	38.3198	-77.0366			
8635750	Lewisetta, VA	1970	37.9954	-76.4646		2324	
8637689	Yorktown USCG Training Center, VA	2004	37.2265	-76.4788			
8638610	Sewells Point, VA	1927	36.947	-76.33		299	
8638863	Chesapeake Bay Bridge Tunnel, VA	1975	36.9667	-76.1133		1635	749a
8651370	Duck, NC	1977	36.1833	-75.7467	219	1636	260a
8652587	Oregon Inlet Marina, NC	1974	35.795	-75.5481		2325	
8654467	USCG Station Hatteras, NC	2010	35.2086	-75.7042		2294	
8656483	Beaufort, NC	1964	34.72	-76.67		2295	
8658120	Wilmington, NC	1908	34.2275	-77.9536		396	750a
8658163	Wrightsville Beach, NC	2004	34.2133	-77.7867			
8661070	Springmaid Pier, SC	1976	33.655	-78.9183		1444	
8665530	Charleston, Cooper River Entrance, SC	1899	32.7808	-79.9236		234	261a
8670870	Fort Pulaski, GA	1935	32.0367	-80.9017	289	395	752a
8720030	Fernandina Beach, FL	1898	30.6714	-81.4658		112	240a
8720218	Mayport (Bar Pilots Dock), FL	1995	30.3982	-81.4279		316	753a
8721604	Trident Pier, FL	1994	28.4158	-80.5931		2123	774a
8722670	Lake Worth Pier, FL	1970	26.6128	-80.0342		1696	
8723214	Virginia Key, FL	1994	25.7317	-80.1617	332	1858	755a
8723970	Vaca Key, FL	1970	24.711	-81.1065		1701	

8724580	Key West, FL	1913	24.6	-81.8079	216	188	242a
8725110	Naples, FL	1965	26.1317	-81.8075		1107	757a
8725520	Fort Myers, FL	1965	26.648	-81.871		1106	
8726520	St Petersburg, Tampa Bay, FL	1946	27.7606	-82.6269		520	759a
8726724	Clearwater Beach, FL	1973	27.9783	-82.8317		1638	773a
8727520	Cedar Key, FL	1914	29.1336	-83.0309		428	
8728690	Apalachicola, FL	1967	29.7244	-84.9806		1193	760a
8729108	Panama City, FL	1973	30.1523	-85.7		1641	
8729210	Panama City Beach, FL	1989	30.2133	-85.8783			761a
8729840	Pensacola, FL	1923	30.4044	-87.21	288	246	762a
8735180	Dauphin Island, AL	1966	30.25	-88.075		1156	763a
8737048	Mobile State Docks, AL	1980	30.7046	-88.0396		2327	
8741533	Pascagoula NOAA Lab, MS	2005	30.368	-88.5631			
8747437	Bay Waveland Yacht Club, MS	1978	30.325	-89.325		2215	
8760922	Pilots Station East, SW Pass, LA	2004	28.932	-89.4075			
8761305	Shell Beach, LA	1979	29.8683	-89.673		2296	
8761724	Grand Isle, LA	1979	29.263	-89.957		526	765a
8761927	New Canal Station, LA	1982	30.0272	-90.113		2328	
8762482	West Bank 1, Bayou Gauche, LA	2003	29.7886	-90.4203			
8764044	Berwick, Atchafalaya River, LA	2003	29.6675	-91.2376			
8764227	LAWMA, Amerada Pass, LA	2005	29.4496	-91.3381			
8766072	Freshwater Canal Locks, LA	2005	29.5517	-92.3052			
8767816	Lake Charles, LA	1932	30.2236	-93.2217			
8768094	Calcasieu Pass, LA	1933	29.7682	-93.3429			
8770570	Sabine Pass North, TX	1985	29.7284	-93.8701		1835	766a
8771341	Galveston Bay Entrance, North Jetty, TX	2000	29.3573	-94.7248			
8771450	Galveston Pier 21, TX	1904	29.31	-94.7933	217	161	775a
8772447	Freeport, TX	2006	28.9433	-95.3025		2297	
8773146	Matagorda City, TX	2012	28.71	-95.9139			
8774770	Rockport, TX	1937	28.0217	-97.0467		538	769a
8775870	Bob Hall Pier, Corpus Christi, TX	1983	27.5808	-97.2164		1903	770a
8779770	Port Isabel, TX	1944	26.0612	-97.2155		497	772a
9014070	Algonac, MI	1926	42.621	-82.527			
9014080	St Clair State Police, MI	1971	42.812	-82.486			
9014087	Dry Dock, MI	1899	42.9453	-82.443			
9014090	Mouth of the Black River, MI	1900	42.9747	-82.4189			

9014096	Dunn Paper, MI	1955	43.0033	-82.4217			
9014098	Fort Gratiot, MI	1970	43.0069	-82.4225			
9034052	St Clair Shores, MI	1968	42.4732	-82.8792			
9044020	Gibraltar, MI	1989	42.0917	-83.1867			
9044030	Wyandotte, MI	1930	42.2023	-83.1475			
9044036	Fort Wayne, MI	1970	42.2983	-83.0933			
9044049	Windmill Point, MI	1897	42.3575	-82.93			
9052000	Cape Vincent, NY	1916	44.1303	-76.332			
9052030	Oswego, NY	1990	43.4642	-76.5118			
9052058	Rochester, NY	1860	43.269	-77.6258			
9052076	Olcott, NY	1967	43.3384	-78.7273			
9063007	Ashland Ave, NY	1957	43.1	-79.0599			
9063009	American Falls, NY	1900	43.0811	-79.0614			
9063012	Niagara Intake, NY	1963	43.0769	-79.0139			
9063020	Buffalo, NY	1860	42.8774	-78.8905			
9063028	Sturgeon Point, NY	1989	42.6913	-79.0473			
9063038	Erie, PA	1959	42.1539	-80.0925			
9063053	Fairport, OH	1935	41.7598	-81.2811			
9063063	Cleveland, OH	1860	41.5409	-81.6355			
9063079	Marblehead, OH	1959	41.5436	-82.7314			
9063085	Toledo, OH	1904	41.6936	-83.4723			
9063090	Fermi Power Plant, MI	1963	41.96	-83.257			
9075002	Lakeport, MI	1955	43.1417	-82.4933			
9075014	Harbor Beach, MI	1860	43.8464	-82.6431			
9075035	Essexville, MI	1977	43.6404	-83.8468			
9075065	Alpena, MI	2006	45.063	-83.4286			
9075080	Mackinaw City, MI	1900	45.8	-84.7211			
9075099	De Tour Village, MI	1977	45.9925	-83.8982			
9076024	Rock Cut, MI	2001	46.2648	-84.1912			
9076027	West Neebish Island, MI	2006	46.2833	-84.205			
9076033	Little Rapids, MI	2008	46.4858	-84.3017			
9087023	Ludington, MI	1895	43.9474	-86.4416			
9087031	Holland, MI	1894	42.773	-86.2128			
9087044	Calumet Harbor, IL	1905	41.7297	-87.5383			
9087057	Milwaukee, WI	1989	43.002	-87.8876			
9087068	Kewaunee, WI	1974	44.464	-87.501			
9087072	Sturgeon Bay Canal, WI	1905	44.7956	-87.3143			
9087079	Green Bay, WI	1980	44.541	-88.0072			
9087088	Menominee, MI	2005	45.0959	-87.5899			
9087096	Port Inland, MI	1964	45.9699	-85.8715			
9099004	Point Iroquois, MI	1930	46.4845	-84.6309			
9099018	Marquette C.G., MI	1991	46.546	-87.3786			
9099044	Ontonagon, MI	1959	46.874	-89.3242			

9099064	Duluth, MN	1860	46.7758	-92.092			
9099090	Grand Marais, MN	1966	47.7486	-90.3413			
9410170	San Diego, CA	1906	32.7142	-117.1736		158	569a
9410230	La Jolla, CA	1924	32.8669	-117.2571	159	256	554a
9410660	Los Angeles, CA	1923	33.7199	-118.2729		245	567a
9410840	Santa Monica, CA	1932	34.0083	-118.5		377	578a
9411340	Santa Barbara, CA	1974	34.4031	-119.6928		2126	
9412110	Port San Luis, CA	1933	35.1688	-120.7542		508	565a
9413450	Monterey, CA	1973	36.605	-121.8881		1352	555a
9414290	San Francisco, CA	1854	37.8063	-122.4659	158	10	551a
9414750	Alameda, CA	1939	37.7717	-122.3		437	
9415020	Point Reyes, CA	1975	37.9961	-122.9767		1394	
9415144	Port Chicago, CA	1976	38.056	-122.0395		2330	
9416841	Arena Cove, CA	1978	38.9146	-123.7111		2125	573a
9418767	North Spit, CA	1977	40.7663	-124.2172		1639	576a
9419750	Crescent City, CA	1933	41.7456	-124.1844		378	556a
9431647	Port Orford, OR	1924	42.739	-124.4983		1640	557a
9432780	Charleston, OR	1964	43.345	-124.322		1269	575a
9435380	South Beach, OR	1967	44.6254	-124.0449	157	1196	592a
9437540	Garibaldi, OR	1866	45.5545	-123.9189		1285	
9439040	Astoria, OR	1853	46.2073	-123.7683		265	572
9440422	Longview, WA	1985	46.1061	-122.9542			
9440910	Toke Point, WA	1922	46.7075	-123.9669		1354	564a
9441102	Westport, WA	1982	46.9043	-124.1051			
9442396	La Push, WA	1924	47.9133	-124.637		2298	
9443090	Neah Bay, WA	1934	48.3703	-124.6019		385	558a
9444090	Port Angeles, WA	1975	48.1247	-123.4411		2127	
9444900	Port Townsend, WA	1971	48.1129	-122.7595		1325	
9447130	Seattle, WA	1899	47.6026	-122.3393		127	
9449424	Cherry Point, WA	1971	48.8633	-122.758		1633	
9449880	Friday Harbor, WA	1932	48.5453	-123.0129		384	
9450460	Ketchikan, AK	1919	55.3319	-131.6261		225	571a
9451054	Port Alexander, AK	1924	56.2466	-134.6477		2299	
9451600	Sitka, AK	1938	57.0517	-135.3417	154	426	559a
9452210	Juneau, AK	1936	58.2988	-134.4106		405	
9452400	Skagway, AK	1943	59.4508	-135.328		495	
9452634	Elfin Cove, AK	1938	58.1947	-136.3469		2300	
9453220	Yakutat, Yakutat Bay, AK	1940	59.5483	-139.733		445	570a
9454050	Cordova, AK	1949	60.5583	-145.755		566	583a
9454240	Valdez, AK	1964	61.1242	-146.3631		1353	562a
9455090	Seward, AK	1925	60.12	-149.4267	150	266	560a
9455500	Seldovia, AK	1964	59.4405	-151.7199		1070	561a
9455760	Nikiski, AK	1971	60.6833	-151.398		1350	

9455920	Anchorage, AK	1964	61.2375	-149.8904		1067	
9457292	Kodiak Island, AK	1984	57.7303	-152.5139		567	039b
9457804	Alitak, AK	1929	56.8974	-154.248		2301	
9459450	Sand Point, AK	1972	55.3317	-160.5043	100	1634	574a
9459881	King Cove, AK	1917	55.0599	-162.3261		2302	
9461380	Adak Island, AK	1943	51.8633	-176.632	302	487	040a
9461710	Atka, AK	2006	52.232	-174.1726		2303	
9462450	Nikolski, AK	2006	52.9406	-168.8713			
9462620	Unalaska, AK	1955	53.8792	-166.5403	102	757	041b
9463502	Port Moller, AK	1960	55.9857	-160.5739			
9464212	Village Cove, St Paul Island, AK	1977	57.1253	-170.2852		2304	
9468333	Unalakleet, AK	1977	63.8714	-160.7843			
9468756	Nome, Norton Sound, AK	1944	64.4946	-165.4396	74	1800	595a
9491094	Red Dog Dock, AK	2003	67.5758	-164.0644			
9497645	Prudhoe Bay, AK	1990	70.4114	-148.5318	151	1857	579a
9751364	Christiansted Harbor, St Croix, VI	1981	17.7477	-64.6984		2118	
9751381	Lameshur Bay, St John, VI	1983	18.3182	-64.7242		2119	
9751401	Lime Tree Bay. St. Croix, VI	1977	17.6947	-64.7538		1447	254a
9751639	Charlotte Amalie, VI	1975	18.3358	-64.92		1393	255a
9752235	Culebra, PR	2005	18.3009	-65.3025		2120	
9752695	Esperanza, Vieques Island, PR	2005	18.0939	-65.4714		2209	
9755371	San Juan, La Puntilla, San Juan Bay, PR	1962	18.4592	-66.1164	206	1001	245a
9759110	Magueyes Island, PR	1954	17.97	-67.0464		759	246a
9759394	Mayaguez, PR	1975	18.2176	-67.1588			
9759413	Aquadilla, Crash Boat Beach, PR	2024	18.4583	-67.1650		2121	
9759938	Mona Island, PR	2006	18.0899	-67.9385		2122	

Additional Active NOAA Water Level Stations							
Station ID	**Station Name**	**Year Installed**	**Latitude**	**Longitude**	**GLOSS ID**	**PSMSL ID**	**JASL ID**
1631428	Pago Bay, Guam	2004	13.4283	144.7967		2130	037a
2695540	Bermuda, St. Georges Island	1988	32.3733	-64.7033	221	363	259b
2695535	Bermuda, Bermuda Biological Station	2016	32.3700	-64.6950			

Active NOAA PORTS® Water Level Stations				
Station ID	**Station Name**	**Year Installed**	**Latitude**	**Longitude**
1612401	Ford Island,HI	2023	21.36750	-157.96380
8419870	Seavey Island,ME	2020	43.08000	-70.74166
8447386	Fall River,MA	1999	41.70431	-71.16411
8447636	New Bedford Harbor,MA	2023	41.62117	-70.91372
8452944	Conimicut Light,RI	1999	41.71667	-71.34333
8454049	Quonset Point,RI	2000	41.58680	-71.41100
8465705	New Haven,CT	1999	41.28330	-72.90830
8519483	Bergen Point West Reach,NY	1981	40.63669	-74.14169
8537121	Ship John Shoal,NJ	2002	39.30500	-75.37500
8539094	Burlington,NJ	2002	40.08000	-74.87333
8540433	Marcus Hook,PA	2002	39.81167	-75.40944
8546252	Bridesburg,PA	2016	39.98333	-75.07500
8548989	Newbold,PA	2001	40.13731	-74.75189
8551762	Delaware City,DE	2001	39.58170	-75.58830
8555889	Brandywine Shoal Light,DE	2002	38.98667	-75.11333
8573364	Tolchester Beach,MD	1994	39.21333	-76.24500
8573927	Chesapeake City,MD	2003	39.52670	-75.81000
8636580	Windmill Point,VA	1994	37.61611	-76.29000
8639348	Money Point,VA	1997	36.77831	-76.30169
8679598	Kings Bay MSF Pier,GA	2022	30.77810	-81.49140
8720219	Dames Point,FL	2013	30.38670	-81.55830
8720226	Southbank Riverwalk,FL	2001	30.32000	-81.65830
8720357	I-295, Buckman Bridge,FL	2003	30.35408	-81.61175
8722956	South Port Everglades,FL	2018	26.08170	-80.11670
8726374	Port Manatee,FL	1991	27.63833	-82.56250
8726607	Old Port Tampa,FL	1996	27.85778	-82.55278
8726674	East Bay,FL	2019	27.92310	-82.42140
8736897	Coast Guard Sector Mobile,AL	2007	30.64831	-88.05831
8760721	Pilottown,LA	2011	29.17831	-89.25831
8761955	Carrollton,LA	2009	29.93289	-90.13547
8762075	Port Fourchon, Belle Pass,LA	2003	29.11425	-90.19925
8764314	Eugene Island, North of, LA	2015	29.36750	-91.38389
8767961	Bulk Terminal,LA	2009	30.19019	-93.30081
8770475	Port Arthur,TX	2015	29.86708	-93.93100

8770520	Rainbow Bridge,TX	2015	29.98000	-93.88170
8770613	Morgans Point, Barbours Cut,TX	1993	29.68169	-94.98500
8770777	Manchester,TX	2015	29.72622	-95.26578
8771013	Eagle Point,TX	1993	29.48000	-94.91831
8771367	Sabine Offshore Light, TX	2021	29.46900	-93.72000
8773259	Port Lavaca,TX	2015	28.64060	-96.60980
8773701	Port O'Connor,TX	2015	28.44586	-96.39556
8775132	La Quinta North,TX	2022	27.88040	-97.27350
8775222	Viola Turning Basin,TX	2021	27.84119	-97.52036
8775237	Port Aransas,TX	2016	27.83970	-97.07250
8775241	Aransas, Aransas Pass,TX	2016	27.83660	-97.03910
8775244	Nueces Bay,TX	2021	27.83275	-97.48594
8775283	Enbridge,TX	2021	27.92306	-82.42139
8775296	USS Lexington,TX	2015	27.81490	-97.38920
9076060	U.S. Slip,MI	1903	46.50081	-84.34036
9076070	S.W. Pier,MI	1870	46.50111	-84.37261
9414523	Redwood City,CA	1997	37.50670	-122.21000
9414863	Richmond.CA	1995	37.92300	-122.40958
9415102	Martinez-Amorco Pier,CA	2013	38.03464	-122.12519
9439099	Wauna,OR	2010	46.16167	-123.40889
9439201	St Helens,OR	2002	45.86330	-122.79620
9440083	Vancouver,WA	2002	45.63169	-122.69700
9440357	Kalama,WA	2002	45.98367	-122.83461
9440569	Skamokawa,WA	2002	46.26670	-123.45200
9440581	Cape Disappointment,WA	2015	46.30000	-124.00000
9445958	Bremerton,WA	2021	47.55000	-122.55000
9446484	Tacoma, WA	1997	47.27583	-122.41778

APPENDIX 2: University of Hawaii Sea Level Center GLOSS Stations

The stations listed are GLOSS Stations operated by or in collaboration with UHSLC. More information on these stations can be found at the following website: http://uhslc.soest.hawaii.edu/

GLOSS ID	Name	Country	Latitude (ºN)	Longitude (ºE)	GPS
8	Mombasa	Kenya	-4.07	39.657	
18	Port Louis	Mauritius	-20.155	57.495	
19	Rodrigues	Mauritius	-19.668	63.418	RDRG
26	Diego Garcia	United Kingdom	-7.29	72.393	DGAR
27	Gan	Maldives	-0.687	73.152	ADDU
28	Male, Hulule	Maldives	4.183	73.517	HULE
33	Colombo	Sri Lanka	6.935	79.858	SGOC
36	Chittagong	Bangladesh	22.247	91.825	
37	Akyab (Sittwe)	Myanmar	20.14	92.903	
45	Padang	Indonesia	-1	100.367	IPA0
49	Benoa	Indonesia	-8.745	115.21	BNOA
68	Ambon	Indonesia	-3.683	128.183	
69	Bitung	Indonesia	1.44	125.193	BTNG
71	Davao	Philippines (the)	7.122	125.663	
72	Legaspi	Philippines (the)	13.15	123.75	
73	Manila	Philippines (the)	14.585	120.968	MANL
75	Qui Nhon	Viet Nam	13.775	109.255	
107	French Frigate	United States of America (the)	23.868	193.712	
109	Johnston	United States of America (the)	16.738	190.47	
116	Chuuk	Micronesia (Federated States of)	7.45	151.85	
117	Kapingamarangi	Micronesia (Federated States of)	1.098	154.777	
118	Saipan	United States of America (the)	15.227	145.742	CNMR
119	Yap	Micronesia (Federated States of)	9.517	138.133	
120	Malakal	Palau	7.33	134.463	PALA
138	Rikitea	France	-23.125	225.047	RKTG
140	Papeete	France	-17.532	210.433	PAPE
141	Moulmein	Myanmar	16.465	97.622	
142	Nuku Hiva	France	-8.93	219.918	
143	Penrhyn	Cook Islands (the)	-8.977	201.947	
145	Kanton	Kiribati	-2.81	188.282	
146	Christmas	Kiribati	1.985	202.523	
167	Quepos	Costa Rica	9.4	275.833	

169	Baltra	Ecuador	-0.437	269.715	GLPS
172	La Libertad	Ecuador	-2.2	279.083	
173	Callao	Peru	-12.05	282.85	CALL
181	Ushuaia	Argentina	-54.805	291.705	AUTF
182	Acajutla	El Salvador	13.583	270.167	
190	Puerto Deseado	Argentina	-47.75	294.083	PDES
191	Puerto Madryn	Argentina	-42.763	294.968	
192	Mar del Plata	Argentina	-38.05	302.45	MPL2
211	Settlement Point	Bahamas (the)	26.69	281.017	BHMA
245	Ponta Delgada	Portugal	37.735	334.328	PDEL
253	Dakar	Senegal	14.677	342.58	DAKA
291	Cilicap	Indonesia	-7.752	109.017	CLCP
297	Zanzibar	Tanzania (United Republic of)	-6.155	39.19	ZNZB
329	Palmeira	Cabo Verde	16.755	337.017	TGCV
334	Salvador	Brazil	-12.967	321.483	SALV
336	Fortaleza	Brazil	-3.717	321.533	CEFT
339	Pt. La Rue	Seychelles	-4.672	55.528	SEY1
347	Sabang	Indonesia	5.888	95.317	
	San Andres	Colombia	12.583	278.3	
	Santa Marta	Colombia	11.235	285.778	
	Cocos Island	Costa Rica	5.557	272.952	
	Limon	Costa Rica	10	276.967	
	Bullen Bay	Curacao	12.187	290.98	
	Roseau	Dominica	15.313	298.61	
	Puerto Plata	Dominican Republic (the)	19.798	289.298	
	Punta Cana	Dominican Republic (the)	18.505	291.625	
	Santa Cruz	Ecuador	-0.755	269.687	
	Hiva Oa	France	-9.81	220.973	
	Prickley Bay	Grenada	12.005	298.235	
	Lembar	Indonesia	-8.732	116.072	
	Prigi	Indonesia	-8.28	111.73	
	Saumlaki	Indonesia	-7.982	131.29	
	Sibolga	Indonesia	1.75	98.767	
	Lamu	Kenya	-2.272	40.903	
	Langkawi	Malaysia	6.432	99.765	
	Hanimaadhoo	Maldives	6.767	73.173	
	El Porvenir	Panama	9.558	281.052	
	Matarani	Peru	-17.002	287.892	
	Talara	Peru	-4.582	278.718	

	Barbers Point	United States of America (the)	21.32	201.88	
	Palmyra Island	United States of America (the)	5.883	197.912	
	Vung Tau	Viet Nam	10.34	107.072	

APPENDIX 3: CARIBE-EWS Sea Level Stations

This list, updated in June 2022, includes stations that are operated by NOAA, as well as other contributing organizations. In addition to existing stations and those that are contributing in near real time, the list includes stations that are down, planned, gap or unknown. Additional information on these stations can be found at the following website: https://caribewave.org

CARIBE-EWS PRIORITIZED INVENTORY OF COASTAL SEA LEVEL STATIONS - June 2022
INTERNATIONAL TSUNAMI INFORMATION CENTER - CARIBBEAN OFFICE OCTOBER 27, 2022

Type of sensors: pwl (primary water level) - rad (radar) - prs (pressure) - ecs (acoustic echo sounder) - bub (bubbler) - wls (water level sensor) - flt (float) - aqu (Aquatrack) - pr1 (1st pressure)

Station location	Station Code (IOC)	Station Code (PTWC)	Type of Sensors	Country	Latitude	Longitude	Status	Operator
Blowing Point	blow	blow	rad	Anguilla	18.171	-63.093	Contributing RTX	Anguilla DDM
		blow	ra2					
Barbuda	barb	barb	pwl	Antigua and Barbuda	17.590	-61.820	Contributing RTX	NOS/NOAA
		barb	bwl					
	barb2		pwl					
Parham (Camp Blizard), Antigua	parh	parh	aqu	Antigua and Barbuda	17.150	-61.783	Down	Antigua & Barbuda Meteorological Services CPACC/MACC
Oranjestad	oran	oran	prs	Aruba	12.517	-70.033	Down	Aruba Department of Meteorology
		oran	rad					
Settlement Point	stpt/setp1	stpt	prs	Bahamas	26.420	-79.010	Contributing RTX	University of Hawaii Sea Level Center
	stpt/setp2	stpt	rad					
	stpt/setp3	stpt	ra2					
	stpt/setp4	stpt	ecs					
Lee Stocking Island, Exuma	-		-	Bahamas	23.460	-76.060	Existing	Bahamas Department of Meteorology CPACC
Matthew Town, Inagua	-		-	Bahamas	20.050	-77.220	Existing	Bahamas Department of Meteorology CPACC

Nassau Harbour, New Providence	-		-	Bahamas	25.050	-77.220	Existing	Bahamas Department of Meteorology CPACC/MACC
Treasure Cay, Abaco	-		-	Bahamas	26.674	-77.283	Existing	Bahamas Department of Meteorology CPACC
Bridgetown Port	brid	brid	aqu	Barbados	13.100	-59.617	Unknown	Caribbean Institute of Meterology and Hydrology, CPACC/MACC.
Port St. Charles	ptsc	ptsc	rad	Barbados	13.263	-59.645	Down	Coastal Zone Management Unit with ICSECA Funds
Pelican Fort	-		-	Barbados	13.111	-59.631	Removed	Coastal Zone Management Unit
Conset Bay	-		-	Barbados	13.200	-59.500	Removed	Coastal Zone Management Unit
Speightstown	-		-	Barbados	13.300	-59.600	Removed	Coastal Zone Management Unit
Carrie Bow Cay	cabc	cabc	rad	Belize	16.803	-88.082	Down	Smithsonian Institute
		cabc	prs					
Belize City	-		-	Belize			Planned	Belize Met Service/CIMH/NOC
Belize	-		-	Belize	17.500	-88.200	Existing	Belize Dept. Meterology - CPACC/MACC
Port of Belize	pobe	pobe	ra1	Belize	17.473	-88.201	Down	National Meteorological Service of Belize (Belize)
		pobe	ra2					
St. Georges Cruise Pier	bmsg	bmsg	aqu	Bermuda	32.38	-64.676	Contributing RTX	UK Hydrographic Office
		bmsg	rad					
St. Georges Island / Esso Pier	bmda	bmda	pwl	Bermuda	32.367	-64.700	Unknown	NOS/NOAA Station ID: 2695540

Bermuda Biological Station	bbst	bbst	pwl	Bermuda	32.370	-64.695	Down	National Ocean Service-NOAA (USA)
	bbst2	bbst	bwl		32.370	-64.695		National Ocean Service-NOAA (USA)
Bermuda Somerset	bmso	bmso	aqu	Bermuda	32.278	-64.875	Contributing RTX	UK Hydrographic Office
		bmso	rad					
Road Town Harbor, Tortola	tort	tort	pwl	British Virgin Islands	18.425	-64.608	Down	BVI Dept. of Disaster Management
Cayman Brac	cacb		aqu	Cayman Islands	19.743	-79.769	Existing	UK Hydrographic Office
			rad					
George Town	cagt		aqu	Cayman Islands	19.295	-81.383	Existing	UK Hydrographic Office
			rad					
Gun Bay	cagb		aqu	Cayman Islands	19.312	-81.089	Existing	UK Hydrographic Office
			rad					
Little Cayman	calc		aqu	Cayman Islands	19.667	-81.104	Existing	UK Hydrographic Office
			rad					
Cartagena	cart		rad	Colombia	10.390	-75.533	Contributing RTX	Instituto de Hidrología, Meteorología y Estudios Ambientales de Colombia (IDEAM)
San Andres	sana	sana	prs	Colombia	12.550	-81.767	Contributing RTX	DIMAR/UHSLC
		sana	rad					
		sana	bub					
Santa Marta	sama	sama	prs	Colombia	11.235	-74.222	Contributing RTX	DIMAR/UHSLC
		sama	rad					
		sama	bub					

Capurganá	-		-	Colombia	8.516	-77.328	Removed	Instituto de Hidrología, Meteorología y Estudios Ambientales de Colombia (IDEAM)
Sapzurro	sapz	sapz	bub	Colombia	8.660	-77.365	Down	Dirección General Marítma (DIMAR)
		sapz	rad					
	sapz2	sapz	bub					
		sapz	prs					
		sapz	rad					
Islas del Rosario	-		-	Colombia	10.183	-75.667	Removed	Instituto de Hidrología, Meteorología y Estudios Ambientales de Colombia (IDEAM)
Isla Naval	inav2		bub	Colombia	10.181	-75.750	Contributing RTX	DIMAR
			rad					
	inav		bub					
			prs					
			rad					
Coveñas	cove	cove	bub	Colombia	9.409	-76.205	Unknown	DIMAR
		cove	prs					
		cove	rad					
Puerto Estrella	estr	estr	prs	Colombia	12.355	-71.314	Unknown	DIMAR
		estr	rad					
Limón	limon	limn	prs	Costa Rica	9.989	-83.020	Down	RONMAC; Upgraded in 2010 NOAA/UHSLC
		limn	rad					
		limn	ra2					
Cabo Cruz	-		-	Cuba	19.840	-77.728	Existing	Oficina Nacional de Hidrografía y Geodesia
Cabo San Antonio - Morros de Piedra	-		-	Cuba	21.900	-84.907	Existing	Oficina Nacional de Hidrografía y Geodesia
Gibara	-		-	Cuba	21.108	-76.125	Existing	Oficina Nacional de Hidrografía y Geodesia
Isabela de Sagua	-		-	Cuba	22.940	-80.013	Existing	Oficina Nacional de Hidrografía y Geodesia

Manzanillo	-		-	Cuba	20.340	-77.147	Down	Oficina Nacional de Hidrografía y Geodesia
Guantanamo	-		-	Cuba	19.910	-75.190	Gap	National Ocean Service
Casilda	-		-	Cuba	21.750	-79.983	Existing	Oficina Nacional de Hidrografía y Geodesia
Maisí	-		-	Cuba	20.233	-74.133	Down	Oficina Nacional de Hidrografía y Geodesia
Mariel Boca	-		-	Cuba	23.020	-82.756	Existing	Oficina Nacional de Hidrografía y Geodesia
Bahia de la Habana	-		-	Cuba	23.138	-82.346	Existing	Oficina Nacional de Hidrografía y Geodesia
Nuevitas Punta de Practicos	-		-	Cuba	21.606	-77.099	Existing	Oficina Nacional de Hidrografía y Geodesia
Puerto Padre	-		-	Cuba	21.203	-76.601	Existing	Oficina Nacional de Hidrografía y Geodesia
Nuevitas Bufaderos	-		-	Cuba	21.561	-77.235	Down	Oficina Nacional de Hidrografía y Geodesia
Siboney	-		-	Cuba	23.100	-82.467	Existing	Oficina Nacional de Hidrografía y Geodesia
Santiago de Cuba	-		-	Cuba	20.020	-75.838	Down	Oficina Nacional de Hidrografía y Geodesia
Santa Cruz del Sur	-		-	Cuba	20.703	-77.982	Existing	Oficina Nacional de Hidrografía y Geodesia
Carapachibey	-		-	Cuba	21.443	-82.901	Down	Oficina Nacional de Hidrografía y Geodesia
Cayo Loco	-		-	Cuba	23.100	-82.467	Existing	Oficina Nacional de Hidrografía y Geodesia
Cayo Largo	-		-	Cuba	21.623	-81.546	Down	Oficina Nacional de Hidrografía y Geodesia

La Coloma	-		-	Cuba	23.100	-82.467	Existing	Oficina Nacional de Hidrografía y Geodesia
Willemstad	-		-	Curacao	12.104	-68.942	Removed	Meteorological Dept. Curacao NOAA/UHSLC
Bullen Bay	bull	bull bull bull	prs rad rad2	Curacao	12.104	-68.942	Down	Meteorological Dept. Curacao/UHSLC
Portsmouth	-		-	Dominica			Planned	Ocean Wise
Marigot	mrig		rad	Dominica	15.548	-61.283	Unknown	Ocean Wise
Roseau	rose	rose	prs rad bub	Dominica	15.300	-61.400	Contributing RTX	UHSLC replaced sea level CPACC/ MACC;
Portsmouth	ptmd2	ptmd ptmd ptmd	pr1 rad ra2	Dominica	15.577	-61.458	Contributing RTX	Dominica Meteorological Service
Barahona	bara	bara bara	prs rad	Dominican Republic	18.208	-71.092	Contributing RTX	ONAMET/PRSN
Puerto Caucedo/San Andres/Santo Domingo	sdom	sdrd	pwl	Dominican Republic	18.421	-69.629	Unknown	ONAMET/PRSN
Puerto Plata	ptpl	ppla ppla ppla	prs ra2 rad	Dominican Republic	19.799	-70.702	Contributing RTX	UHSLC/ONAMET
Punta Cana	ptca	pcan pcan pcan	prs ra2 rad	Dominican Republic	18.505	-68.376	Contributing RTX	UHSLC/ONAMET
Bahía de Luperón	-		-	Dominican Republic			Gap	ONAMET
Bahía de Samaná	-		-	Dominican Republic	19.200	-69.219	Gap	ONAMET
Bayahibe	-		-	Dominican Republic			Gap	INDRHI
Pedernales	-		-	Dominican Republic	17.926	-71.655	Gap	INDRHI
Puerto de Santo Domingo	-		-	Dominican Republic	18.458	-69.913	Removed	INDRHI
Ile Royale	iler iler2	iler iler	rad rad	French Guiana	5.284	-52.587	Unknown	SHOM / DDE, RONIM

Prickly Bay	pric	pric	prs	Grenada	12, 05	-61.733	Contributing RTX	UHSLC replaced sea level CPACC/ MACC
		pric	rad					
		pric	bub					
Sauteurs	-		-	Grenada	12.100	-61.750	Planned	Seismic Research Center
The Sisters Island	-		-	Grenada	12.300	-61.700	Planned	Seismic Research Center
Pointe à Pitre	ptpt	ptpt	rad	Guadeloupe	16.224	-61.531	Contributing RTX	Service hydrographique et océanographique de la marine (France)
	ptpt2	ptpt	rad					
Deshaies Harbour	desh	desh	rad	Guadeloupe	16.305	-61.796	Contributing RTX	IPGP
La Désirade Island, Grande Anse Marina Harbour	desi	desi	rad	Guadeloupe	16.303	-61.072	Contributing RTX	IPGPFR
Puerto Barrios	prba	prba	prs	Guatemala	15.695	-88.622	Contributing RTX	INSIVUMEH
		prba	rad					
Harbour Master Boathouse	HMB		-	Guyana	6.810	-58.168	Existing	Maritime Administration Department
Market Place Georgetown	-		-	Guyana	6.767	-58.167	Existing	MACC/Hydromet Dept.
Rosignol	-		-	Guyana	6.26666	-57.533	Unknown	CPACC
Parika	-		-	Guyana	6.85000	-58.417	Unknown	CPACC
Cap Haitien	caph	caph	bub	Haiti	19.759	-72.193	Contributing RTX	UNESCO/SEMANAH
		caph	prs					
		caph	ra2					
Jacmel	jaca	jaca	prs	Haiti	18.231	-72.535	Unknown	UNESCO/SEMANAH
		jaca	rad					
Port au Prince	ptpr	ptpr	prs	Haiti	18.534	-72.380	Down	UNESCO/SEMANAH
		ptpr	rad					
Gonaives	-		-	Haiti	19.450	-72.070	Planned	SEMANAH
Port de Paix	-		-	Haiti	19.080	-73.367	Planned	SEMANAH
Jeremie	jrmi	jrmi	prs	Haiti	18.643	-74.110	Contributing RTX	SEMANAH
			rad					
St. Louis du Sud	slds	slds	prs	Haiti	18.227	-73.618	Contributing RTX	SEMANAH
			rad					
Guanaja Island	-		-	Honduras	16.455	-85.876	Existing	COPECO
Omoa	-		-	Honduras	15.778	-88.047	Existing	COPECO

Puerto Cortes	pcor	pcor	prs	Honduras	15.843	-87.959	Down	COPECO
Puerto De Castilla, Trujillo	-		-	Honduras	15.923	-85.951	Existing	COPECO
Roatan N	-		-	Honduras	16.333	-87.450	Existing	COPECO
Punta Gorda Harbor, Roatan S	rtas	rtas	prs	Honduras	16.346	-86.540	Down	COPECO
Tela Harbor	tela	tela	prs	Honduras	15.784	-87.453	Unknown	COPECO
Utila Island	util		prs	Honduras	16.096	-86.895	Unknown	COPECO
Cabotaje Harbor, La Ceiba	ceib	ceib	prs	Honduras	15.790	-86.760	Down	COPECO
Cochino Pequeño	-		-	Honduras	15.950	-86.500	Gap	
Swan Island	-		-	Honduras	17.400	-83.800	Gap	
Port Royal	ptro	ptro	rwl	Jamaica	17.926	-76.846	Down	Jamaica Meteorological Service UNAVCO
		ptro	swl					
Montego Bay	-	-	-	Jamaica	18.460	-77.942	Existing	Meteorological Service P.R. China
Port Antonio	-	-	-	Jamaica	18.183	-76.454	Existing	Meteorological Service P.R. China
Discovery Bay, Jamaica	-	-	-	Jamaica	18.450	-77.400	Gap	Meteorological Service CPACC/MACC
Alligator Pond	-	-	-	Jamaica	17.850	-77.600	Gap	Meteorological Service CPACC/MACC
Fort de France Harbour	ftfr2	ftfr	rad	Martinique	14.602	-61.063	Contributing RTX	SHOM, RONIM, Meteo-France
	ftfr	ftfr	rad					
Le Precheur Harbour	prec	prec	prs	Martinique	14.808	-61.227	Contributing RTX	local authorities
Le Robert	lero	lero	prs	Martinique	14.683	-60.933	Contributing RTX	General Council of Martinique
		lero	rad					
Alvarado	alva	alva	flt	Mexico	18.760	-95.760	Contributing RTX	UNAM
Celestun	clst	clst	flt	Mexico	20.865	-90.405	Down	UNAM
Ciudad del Carmen	ccar	ccar	flt	Mexico	18.617	-91.817	Contributing RTX	UNAM
Lerma Campeche	camt	camt	flt	Mexico	19.812	-90.595	Down	UNAM
Frontera	frtr	frtr	flt	Mexico	18.150	-94.270	Down	UNAM

Isla Mujeres	imuj	imuj	flt	Mexico	21.217	-86.717	Contributing RTX	UNAM
		imuj	rad					
Progreso	prog/prog2	prog	rad	Mexico	21.303	-89.667	Down	UNAM
Puerto Morelos, Q. R.	pumo	pumo	flt	Mexico	20.830	-86.870	Contributing RTX	UNAM/UNAVCO
	pumo2	pum2	rwl					
			swl					
			rad					
Sanchez Magallanes	smag	smag	flt	Mexico	18.290	-93.855	Unknown	UNAM
Sisal	sisa		rad	Mexico	21.161	-90.048	Unknown	UNAM
Tuxpan	tuxp	tuxp	flt	Mexico	20.970	-97.400	Unknown	UNAM
Telchac	telc	telc	flt	Mexico	21.340	-89.308	Down	UNAM
Veracruz	vera	vera	rad	Mexico	19.192	-96.124	Contributing RTX	UNAM
	vera2	vera	flt					
Montserrat	-	-	-	Montserrat	16.742	-62.190	Gap	
Corn Island	cois	pcoi	prs	Nicaragua	12.327	-83.068	Down	INETER
Blue Fields	-		-	Nicaragua	11.891	-83.857	Gap	RONMAC/INETER
Puerto Bilwi	pbil	pbil	prs	Nicaragua	14.019	-83.383	Down	Central American Tsunami Advisory Center (Nicaragua)
Puerto Cabezas	-		-	Nicaragua	14.020	-83.380	Gap	RONMAC/INETER
Puerto El Bluff	pblu	pblu	prs	Nicaragua	11.998	-83.692	Down	Central American Tsunami Advisory Center (Nicaragua)
El Porvenir	elpo	elpo	prs	Panama	9.559	-78.968	Contributing RTX	U. Panama, NOAA/UHSLC
		elpo	rad					
		elpo	bub					
Bocas del Toro	bdto	bdto	prs	Panama	9.351	-82.258	Contributing RTX	Smithsonian Tropical Research Institute
		bdto	rad					
Galeta Point	-	-	-	Panama	9.402	-79.861	Existing	UHSLC/IG-UPA
Limon Bay	-	-	-	Panama	9.367	-79.883	Existing	UHSLC/IG-UPA
Aguadilla	agua	agua	pwl	Puerto Rico	18.457	-67.165	Down	PRSN
Arecibo	arac	arec	prs	Puerto Rico	18.481	-66.702	Contributing RTX	PRSN
	aracS	arec	pwl					
Culebra Island	cule	cule	pwl	Puerto Rico	18.301	-65.303	Contributing RTX	NOS/NOAA
		cule	bwl					
	cule2	cule	pwl					

Fajardo	faja	faja	pwl	Puerto Rico	18.334	-65.631	Contributing RTX	PRSN
Gauyanilla		gypr	pwl	Puerto Rico	18.005	-66.766	Contributing RTX	PRSN
Isabel II, Vieques	isab	viqu	pwl	Puerto Rico	18.153	-65.444	Contributing RTX	PRSN
		viqu	bwl					
La Esperanza, Vieques	vieq	vieq	pwl	Puerto Rico	18.094	-65.471	Contributing RTX	NOS/NOAA
		vieq	bwl					
Magueyes Island	magi	magi	pwl	Puerto Rico	17.970	-67.046	Contributing RTX	NOS/NOAA
		magi	bwl					
	magi2	magi	pwl					
Mayagüez	maya	maya	pwl	Puerto Rico	18.218	-67.159	Contributing RTX	NOS/NOAA
		maya	bwl					
Mona Island	mona	mona	pwl	Puerto Rico	18.090	-67.939	Contributing RTX	NOS/NOAA
		mona	bwl					
Salinas	-	sapr	pwl	Puerto Rico	17.949	-66.226	Contributing RTX	PRSN
San Juan	sanj	sanj	pwl	Puerto Rico	18.459	-66.116	Contributing RTX	NOS/NOAA
		sanj	bwl					
	sanj2	sanj	pwl					
Yabucoa	yabu	yabu	pwl	Puerto Rico	18.055	-65.833	Down	PRSN
		yabu	bwl					
Peñuelas	penu	penu	pwl	Puerto Rico	17.973	-66.762	Removed	PRSN
Caja de Muertos	camu	camu	pwl	Puerto Rico	17.888	-66.528	Removed	PRSN
Baseterre (Coast Guard Base)	bass	bass	prs	St. Kitts & Nevis	17.290	-62.710	Down	CPACC/MACC; Upgraded by UNESCO/ NEMA
		bass	rad					
Dennery Harbour	stlu2		rad	St. Lucia	13.911	-60.886455	Contributing RTX	Saint Lucia Met Service
			pr1					
			pr2					
Soufriere	stlu3		rad	St. Lucia	13.85356	-61.0596	Contributing RTX	Saint Lucia Met Service
			par1					
			pr2					
Vieux Fort Bay	stlu4		rad	St. Lucia	13.7208	-60.95277	Contributing RTX	Saint Lucia Met Service
			pr1					
			pr2					
Ganter's Bay	stlu	stlu	prs1	St. Lucia	14.016	-60.997	Contributing RTX	Saint Lucia Met Service/CIMH/NOC
		stlu	prs2					
		stlu	rad					
Calliaqua (Coast Guard Base)	calq	calq	pr1	St. Vincent & the Grenadines	13.130	-61.196	Contributing RTX	CPACC/MACC; Upgraded by UNESCO/ NEMO
		calq	pr2					

Chateau Bel-Air	chat		rad	St. Vincent & the Grenadines	13.291	-61.240	Contributing RTX	
Gustavia	-		-	St. Barthelemy	17.883	-62.850	Planned	Collectivite de St. Barthelemy
Saint Martin Island	stmt	stmt	prs	St. Martin	18.083	-63.085	Down	Collective de St. Martin
		stmt	rad					
Cedros Bay	cdtt	cdtt	rad	Trinidad and Tobago	10.094	-61.865	Unknown	Trinidad and Tobago Hydrographic Unit, Originally CPACC
Charlotteville	chrl	chrl	rad	Trinidad and Tobago	11.324	-66.549	Unknown	CPACC Trinidad and Tobago Hydrographic Unit
Point Fortin	pnfo	pnfo	rad	Trinidad and Tobago	10.183	-61.700	Unknown	Trinidad and Tobago Hydrographic Unit
Port Of Spain	ptsp	ptsp	rad	Trinidad and Tobago	10.650	-61.517	Contributing RTX	Trinidad and Tobago Hydrographic Unit, CPACC/MACC
Scarborough	scar	scar	rad	Trinidad and Tobago	11.167	-60.733	Down	Trinidad and Tobago Hydrographic Unit
Toco Trinidad	-		-	Trinidad and Tobago	10.833	-60.933	Planned	Trinidad and Tobago Hydrographic Unit
Point Galeota	gale	ptga	rad	Trinidad and Tobago	10.130	-60.990	Contributing RTX	Land an Surveys Division, Hydrographic Unit (Trinidad & Tobago)
Point a Pierre	-		-	Trinidad and Tobago	10.517	61.515	Planned	
Grand Turk	tcgt	tcgt	aqu	Turks and Caicos	21.434	-71.150	Contributing RTX	UK Hydrographic Office
		tcgt	rad					
Sapodilla Bay, Providenciales	tcsb	tcsb	aqu	Turks and Caicos	21.741	-72.285	Contributing RTX	UK Hydrographic Office
		tcsb	rad					
Charlotte Amalie, St. Thomas	amal	amal	pwl	USVI	18.335	-64.920	Contributing RTX	NOS/NOAA
		amal	bwl					
Christiansted Harbor, St. Croix	stcr	stcr	pwl	USVI			Contributing RTX	
		stcr	bwl		17.750	-64.705		NOS/NOAA
	stcr2	stcr	pwl					

Lameshur Bay, St. John	lame	lame	pwl	USVI	18.318	-64.724	Contributing RTX	NOS/NOAA
		lame	bwl					
	lame2	lame	pwl					
Lime Tree Bay, St. Croix	lime	lime	pwl	USVI	17.684	-64.754	Contributing RTX	NOS/NOAA
		lime	bwl					
	lime2	-	-					
Aves Island	-		-	Venezuela	15.700	-63.600	Gap	
Punta Arenas, Margarita Island	-		-	Venezuela	10.970	-64.400	Gap	
La Guaira	-		-	Venezuela	10.617	-66.933	Gap	Instituto Geografico de Venezuela Simon Bolivar

APPENDIX 4: NOAA National Tsunami Warning Center Coastal Tide Gauge Stations

The table below lists all currently installed NOAA NTWC water level stations.

Active NOAA NTWC Water Level Stations							
Station ID	**Station Name**	**Year Installed**	**Latitude**	**Longitude**	**GLOSS ID**	**PSMSL ID**	**JASL ID**
9411166	Ventura, CA	2014	34.2518	-119.2671			
9450552	Craig, AK		55.4887	-133.1426			
9457526	Old Harbor, AK		57.0514	-153.3071			
9458912	Chignik, AK		56.3052	-158.3811			
9460261	Shemya, AK		52.7282	174.0658			
9460901	Amchitka, AK		51.4079	179.2919			
9462693	Akutan, AK		54.1333	-165.7777			
9454958	Whittier, AK		60.7778	-148.6665			
9454779	Barry Arm, North Shore, AK		61.0383	-148.1172			
9454793	Barry Arm, Point Doran, AK		61.0702	-148.1657			
9454759	Esther Passage, AK		60.9433	-148.0555			

APPENDIX 5: NOAA Pacific Tsunami Warning Center Coastal Tide Gauge Stations

The table below lists all currently installed NOAA PTWC water level stations.

Active NOAA PTWC Water Level Stations							
Station ID	**Station Name**	**Year Installed**	**Latitude**	**Longitude**	**GLOSS ID**	**MSL ID**	**JASL ID**
1611408	Nawiliwili, Kauai, HI		21.9544	-159.3561			
1611691	Hanalei, Kauai, HI		22.2125	-159.4982			
1612352	Makapu'u, Oahu, HI		21.3199	-157.6688			
1612482	Waianae, Oahu, HI		21.4498	-158.1970			
1612647	Haleiwa, Oahu, HI		21.5930	-158.1056			
1613662	Kalaupapa, Molokai, HI		21.2100	-156.9800			
1614465	Kaumalapau, Lanai, HI		20.7867	-156.9908			
1615629	Lahaina, Maui, HI		20.8721	-156.6787			
1617004	Kapoho, Hawaii, HI		19.4993	-154.8197			
1617180	Honokohau, Hawaii, HI		19.6689	-156.0235			
1617243	Hilo, Hawaii, HI		19.7303	-155.0553			
1617720	Mahu Kona, Hawaii, HI		20.1843	-155.9010			
1617725	Laupahoehoe, Hawaii, HI		19.9921	-155.2401			
1618431	Milolii, Hawaii, HI		19.1851	-155.9074			
1618578	Honuapo, Hawaii, HI		19.0845	-155.5509			

APPENDIX 6: NOAA National Data Buoy Center DART Ocean Bottom Pressure Stations

The table below lists all currently installed NOAA NDBC DART ocean bottom pressure stations.

Active NOAA DART Buoy Stations			
Station ID	**Location**	**Latitude**	**Longitude**
21413	SOUTHEAST TOKYO - 700NM ESE of Tokyo, JP	30.5170	152.1270
21414	AMCHITKA - 170 NM South of Amchitka, AK	48.9630	178.2370
21415	ATTU - 175 NM South of Attu, AK	50.1530	171.8970
21416	KAMCHATKA PENINSULA - 240NM SE of Kamchatka Peninsula, RU	48.1200	163.4300
21418	NORTHEAST TOKYO - 450 NM NE of Tokyo, JP	38.7230	148.8360
21419	KURIL ISLANDS - 209NM SE of Kuril Is.	44.4010	155.6530

21420	SOUTHEAST MIYAZAKI - 260NM Southeast of Miyazaki	28.9120	134.9680
21D18	Adrift from 21418	40.1579	169.4740
21D20	Adrift buoy from 21420	36.6311	165.6540
32411	WEST PANAMA - 710 NM WSW of Panama City, Panama	4.9580	-90.8680
32413	NORTHWEST LIMA - 1000 NM WNW of Lima, Peru	-7.4210	-93.4840
41420	NORTH SANTO DOMINGO - 328NM NNE of Santo Domingo, DO	23.3490	-67.3940
41421	NORTH ST THOMAS - 300 NM North of St Thomas, Virgin Is.	23.3730	-63.9020
41425	SOUTHWEST BERMUDA - 200 NM SSW of Hamilton, Bermuda	28.6670	-65.6230
42407	SOUTH PUERTO RICO - 230 NM Southwest of San Juan, PR	15.2290	-68.1880
42409	GULF OF AMERICA - 247 NM South of New Orleans, LA	24.8467	-90.3073
43412	SOUTHWEST MANZANILLO - 240 NM SW of Manzanillo, MX	16.0030	-106.9890
43413	SOUTH ACAPULCO - 360NM South of Acapulco, MX	10.9490	-100.0300
44402	SOUTHEAST BLOCK CANYON - 130 NM SE of Fire Island, NY	39.2880	-70.6350
44403	SABLE ISLAND BANK - 437 NM E of Boston, MA	41.9100	-61.6430
46402	SOUTH DUTCH HARBOR - 220 NM SSE of Dutch Harbor, AK	50.9830	-163.9430
46403	SOUTHEAST SHUMAGIN ISLAND - 186 NM SE of Shumagin Is, AK	52.6630	-156.7780
46404	WEST ASTORIA - 230 NM West of Astoria, OR	45.8630	-128.7610
46407	NEWPORT - 210NM West of Coos Bay, OR	42.7150	-128.8250
46408	NIKOLSKI - 212 NM South of Umnak Is, AK	49.6660	-169.8760
46409	SOUTHEAST KODIAK - 210 NM SE of Kodiak, AK	55.3180	-148.5470
46410	SOUTH CORDOVA 188NM SSE of Cordova, AK	57.6440	-143.7340
46411	MENDOCINO - 150 NM West of Mendocino Bay, CA	39.3350	-127.0700
46413	SOUTH-SOUTHEAST ADAK - 243 NM SSE of Adak Island, AK	48.0450	-173.8970
46414	SOUTHEAST CHIRIKOF - 165 NM SE of Chirikof Island, AK	53.7660	-152.4160
46415	SOUTHWEST JUNEAU - 370 NM SW of Juneau, AK	53.0370	-139.8800
46416	WEST VANCOUVER - 442NM West of Vancouver, BC, Canada	49.9010	-134.3950
46419	NORTHWEST SEATTLE - 300 NM WNW of Seattle, WA	48.8160	-129.6140
51407	HAWAII - 34NM West of Kailua-Kona, HI	19.6300	-156.5770
51425	NORTHWEST APIA - 370 NM NW of Apia, Samoa	-9.5110	-176.2580
52401	NORTHEAST SAIPAN - 610 NM ENE of Saipan	19.2850	155.7390
52402	SOUTHEAST SAIPAN - 540NM ESE of Saipan	11.9300	153.8950
52403	NORTH MANUS - 345NM North of Manus Is , New Guinea	4.0260	145.6160
52404	NORTH PHILIPPINE SEA - 750 NM NE of Manila,PI	20.6290	132.1390
52405	SOUTH PHILIPPINE SEA -725 NM West of Agana, Guam	12.9910	132.2390
52406	NORTHEAST SOLOMON - 370NM NE of Guadalcanal	-5.3730	164.9900