Progress Report
University of Hawaiʻi Sea Level Center

Period of Activity: 01 October 2022 – 30 September 2023

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Budget Summary
FY 2023: $1,923,976
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University of Hawai‘i Sea Level Center

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1. Project Summary

The University of Hawai‘i Sea Level Center (UHSLC) ensures that water-level data from tide gauges around the world are collected, quality assessed, distributed, and archived for use in climate, oceanographic, ocean engineering, and geophysical research, as well as for operational purposes (e.g., tsunami and surge monitoring; satellite-altimeter drift monitoring; high-tide monitoring and forecasting). These GOMO-funded activities represent U.S. support for the international Global Sea Level Observing System (GLOSS), which operates under the auspices of the Joint Collaborative Board (JCB) between the World Meteorological Organization (WMO) and the Intergovernmental Oceanographic Commission (IOC).

The UHSLC operates 84 tide-gauge stations, including approximately 20% of the active stations in the GLOSS core network (GCN, Figure 1), which is a widely distributed set of research-grade tide-gauge stations that form the ‘backbone’ of the global in-situ water-level observing network. UHSLC involvement in the international network assures that research-quality data are available from otherwise sparsely sampled areas of the global ocean, and that developing nations have access to training, technical support, and data processing services as needed. Near-real-time data from stations operated by the UHSLC are essential for monitoring and modeling efforts undertaken by NOAA/NWS tsunami warning centers. The UHSLC also maintains 12 continuous GPS receivers co-located with tide-gauge stations due to the importance of accounting for land motion when using tide-gauge data for satellite altimeter validation, as well as documenting the contributions of land motion to local sea-level trends.

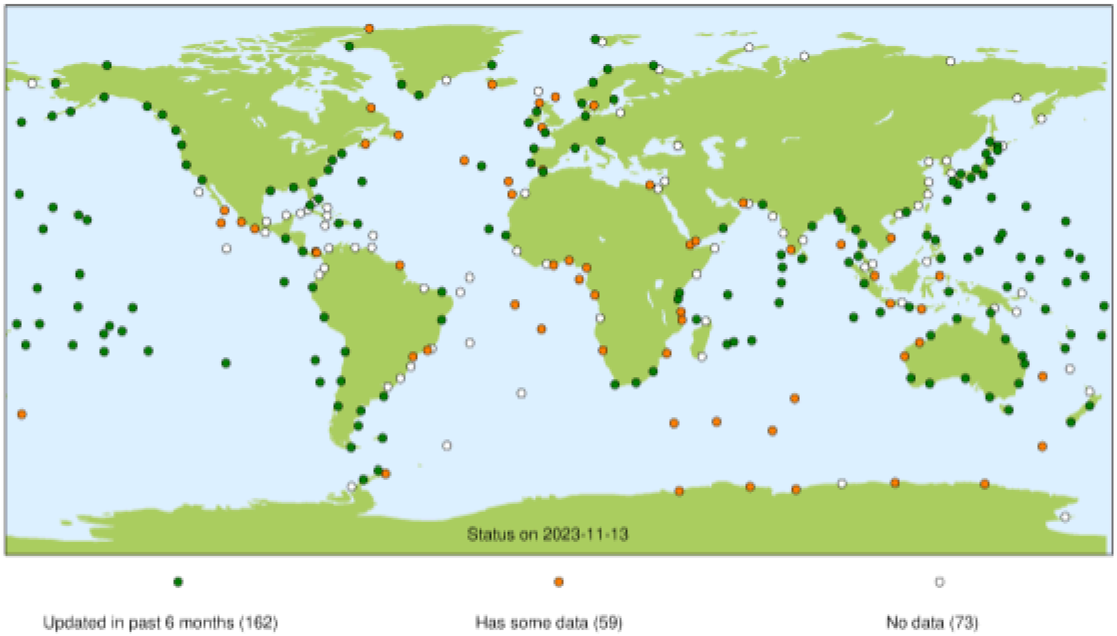

*Figure SEQ Figure * ARABIC 1: Status of GLOSS Core Network stations in the UHSLC Fast Delivery database as of November 11, 2023.*

The UHSLC serves as a primary data assembly center in the GLOSS framework. UHSLC staff members coordinate monthly and yearly data collection from more than 60 international agencies to ensure that high-frequency data from over 500 globally distributed tide gauge stations flows continuously into the UHSLC data center. UHSLC databases focus on high-frequency tide gauge data that are essential for capturing the variability and impacts associated with tides, tsunamis, severe storm surges, and minor flooding episodes. A key benefit of having a data assembly center in a university setting is that UHSLC scientists actively utilize tide-gauge data for climate and oceanographic research, which provides ongoing assessments of data quality and develops new use cases for the data. The datasets are also widely used in the international research community with typically 50 to 100 peer-reviewed publications per year citing UHSLC datasets (see section 4).

2. Scientific and Observing System Accomplishments

2.1. Activities funded by the NOAA Global Ocean Monitoring and Observing Program (GOMO)

2.1.1 Data Management and Services

UHSLC is the primary GLOSS data assembly center for high-frequency (hourly or higher sample rate) tide-gauge data from the global network of stations. There are three levels in the UHSLC data-management and quality-assurance hierarchy:

1. Each day, one-minute-averages of water-level data from stations maintained or co-operated by the UHSLC are downloaded in near-real time via the Global Telecommunication System (GTS). A data analyst inspects the data to ensure that the station is functioning and that the time series meet basic quality criteria. Outliers are identified and flagged, and timing and level shifts are noted for later evaluation. This level of processing helps to ensure that the UHSLC station data are of maximum benefit to operational users concerned with sea level extremes, including tsunami warning and storm surge agencies. Daily data screenings were performed without issue during FY2023.
2. At monthly intervals, the UHSLC receives hourly-averaged data provided by station operators that have undergone preliminary quality assurance testing to form the Fast Delivery database. We rely on the originators of the data to provide the Fast Delivery data as they can assess quality issues associated with each station in a manner that cannot be accomplished in a centralized fashion, particularly when station maintenance visits occur, and level and timing shifts become a concern. The Fast Delivery dataset provides tide-gauge data in a time frame commensurate with operational satellite altimeter comparisons, typically with a 4- to 6-week delay. Currently, 162 GCN stations have provided data to the Fast Delivery assembly center at the UHSLC in the last six months (Figure 1). Data management objectives for the Fast Delivery database were met during FY2023, as the database was expanded to accommodate new data collected from national and international agencies.
3. The UHSLC teams with a NOAA/NCEI Scientist (Ayesha Genz) to update the Joint Archive for Sea Level (JASL), also known as the Research Quality (RQ) database. The Research Quality data are typically made available within one year of collection after undergoing a complete quality assessment to ensure that water levels have been referenced to local benchmarks and that the data are vertically stable relative to the station datum. Data management objectives for the RQ database have been altered in recent years since the retirement of the former NOAA/NCEI Regional Science Officer working on JASL/RQ (Pat Caldwell). There has been a substantial delay since the last full update to the JASL/RQ dataset in 2020 due to (1) the long delay within NOAA/NCEI in hiring a replacement for Caldwell; (2) the time needed for the new NOAA/NCEI scientist to learn the database structure and data-collection/quality-control procedures; and (3) the need for the new scientist to rewrite and/or modernize much of the operation's code base for processing the data and metadata. Much progress has been made by the new NOAA/NCEI scientist and UHSLC colleagues during FY2023, and we anticipate a complete update to the JASL/RQ database during FY2024.

Beyond these data-management and quality-assurance activities, the UHSLC continuously serves these data to users around the world via a variety of mechanisms. Data-services objectives were met during FY2023, as the project's ERDDAP server, OpenDAP server, and data-acquisition tables were maintained without interruption. We continued to ensure the security of our data and the up-time of data access, by continuing to perform server upgrades and maintenance activities, which are reinforced by the location of our servers in an on-campus computing facility with state-of-the-art cooling systems and back-up power generators.

Improving data services continued to be an area of focus for the UHSLC during FY2023, including significant progress toward a transition in the primary storage format for our real-time and historical data. The primary data storage format is currently a distributed collection of text files organized into a hierarchy of directories. We are transitioning toward hosting our own instance of TimescaleDB, a database based on PostgreSQL optimized for time series data, which will be managed by a Django web backend. The combination of these platforms greatly expands the possibilities for UHSLC to develop internal and public-facing tools that enable data interactivity and decision-making. We are currently entering a phase where our legacy data flow is being operated in parallel with portions of our updated data-management framework. For example, UHSLC programmers have implemented a preliminary version of a TimescaleDB instance that is ingesting real-time data from stations operated by UHLSC. This enabled the development of a new internal tool for identifying stations having issues and assessing the causes of problems. Such a tool has not been possible in the past, because loading data from the text-based legacy formats is too slow to be useful. Note this tool is not meant to be a public-facing platform for interacting with UHSLC data, but it is a demonstration of the power of our new framework that will improve our ability to develop public tools and products.

The value of ongoing UHSLC efforts to provide tide-gauge sea-level data to the research community is supported by usage statistics. Based on Google Scholar and DOI searches, we determined that data obtained directly from the UHSLC were utilized in at least 41 peer-reviewed research articles during the FY2023 period covered by this report, October 2022–September 2023. It is important to note, however, that the effective usage of UHSLC data in peer-reviewed literature exceeds the number of studies quoted above. UHSLC data are ingested into other widely cited GLOSS datasets, such as the Global Extreme Sea Level Analysis Version 3 (GESLA-3). UHSLC data are the foundation for GESLA-3, which is focused on aggregating as many high-frequency tide-gauge sea-level records as possible from around the global ocean. GESLA-3 was released during November 2021 and contains data from 114 countries. The UHSLC JASL/RQ dataset contributed data from 97 of those countries to GESLA Version 3, most of which would not be represented at all in GESLA if not for the UHSLC contribution. The GESLA-3 dataset is widely used, including in the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6), and the dataset was utilized in at least 36 additional publications during FY2023 beyond those that obtained UHSLC data directly. The UHSLC PI continues to maintain a python library for reading and sub-setting the text-based files that make up the GESLA-3 dataset.

In addition to the databases described above, informational products form UHSLC are used in climate monitoring and reporting activities, such as the sea-level section in the BAMS State of the Climate Report (authored by UHSLC scientists) and the Pacific Islands Regional Climate Assessment (PIRCA) process. Finally, we note that an international group of at least four independent teams used UHSLC tide-gauge data during FY2023 for operational validation of satellite altimetry (NOAA Laboratory for Satellite Altimetry, NASA MEaSUREs, University of Tasmania, AVISO/CNES). We also continued to operate and maintain our own data tools that support public interest and decision-making:

- The Station Explorer enabled users to access near-real-time sea-level data as it is collected; access often-requested information such as tide calendars, tidal datums, and benchmarks; and place recent sea-level extremes into historical context and relate extremes to what is expected during any given time of the year.
- Sea-Level Forecast and Pacific Sea-Level Monitoring pages provided users with important information to help interpret and prepare for high sea-level events.
- A tide-gauge-based estimate of global mean sea level that serves as an index of sea-level rise on change on NOAA's Climate.gov.

2.1.2 Tide-Gauge Network

Tide-gauge network and station maintenance objectives were met during FY2023 but deviated from the proposed targets due to a change in priorities for this fiscal year. Specifically, the UHSLC was tasked with installing four new tide-gauge stations in American Sāmoa: one on the main island of Tutuila in the village of ʻAuʻasi; one on Aunuʻu (a small island to the east of Tutuila); and two stations in the remote Manuʻa islands—one each on the islands of Ofu (Figure 2) and Taʻū. These new installations required significant planning by UHSLC technicians and required two visits for each of the locations (one for planning and one for installation). As such, UHSLC performed standard maintenance and upgrade visits to nine existing tide-gauge locations, whereas the proposed target is fourteen. However, eight additional installation site visits to the four new American Sāmoan stations were made that were not part of the proposed targets. The tide-gague sites visited by UHSLC technicians during FY2023 and the work performed at each location are summarized in Table 1. Note that many of the visits now include upgrading stations to Iridium communications, which has been planned by the UHSLC for years, and we now have the data-acquisition infrasturucture in place to receive Iridium transmissions and transmit these data to the WMO Global Telecommunication System (GTS). In addition to site visits, UHSLC technicians performed a number of remote maintenance and service operations by working with our local contacts and partners. These included but are not limited to: remotely arranging repair of a tide house damage in Zanzibar; helping technicians in Peru select a radar sensor for their gauges; remotely arranging for tide-house refurbishment in Yap; and sending equipment and remotely assisting with installation of sensors in Brazil (two sites), Seychelles, and Malaysia.

The proposed annual target for GPS mainatenance is three visits to existing GPS installations co-located with tide gauges. This target was met, as three GPS sites were visited and upgraded in Malakal, Saipan, and Honolulu. The proposed annual target for GPS installations is one new GPS site. We did not meet this target due to logistical delays in a planned visit to Indonesia that would have resulted in a new GPS installation in Ambon. This visit has since been made but occurred early during FY2024. We expect to install an additional new GPS station during FY2024, allowing us to exceed the target of one new GPS installation during FY2024 and compensate for missing the target during FY2023. All GPS/GNSS data from UHSLC stations were provided to the GLOSS TIGA data center as planned.

FY23 Station Visits

Targets	Checkbox Key	
14 UHSLC Core Stations (GOMO)	**M**	Routine maintenance (new batteries, clean solar panels, clean switches, etc.)
5 Pacific Tsunami Stations (NWS)	**U**	Upgrade / New hardware
5 Caribbean Tsunami Stations (NWS)	**R**	Repair existing hardware
	L	Leveling

Core Stations

	UH ID	Name	Country	M	U	R	L	**Activity Notes** (ENC = ecoder / float gauge, PRS = pressure sensor, RAD = radar, SWs = switches)
1	3	Baltra	Ecuador	☑	☑	☑	☑	Upgrade to SL3 logger, new RAS radar, new antenna, new PRS, new switches and support, stilling well support structural improvments, GPS rover occupation, general service
2	30	Santa Cruz	Ecuador	☑	☑	☑	☑	Upgrade to SL3 logger, new RAS radar, new PRS, AC power option setup, GPS rover occupation, general service
3	7	Malakal	Palau	☑	☑	☐	☑	Update to Xlink w/ Iridium, New OTT radar (RA3), new absolute PRS w/ Barometer, general service
4	8	Yap	Micronesia (Federated States of)	☑	☑	☑	☑	Update to Xlink & Iridium, new RAS radar, new absolute PRS w barometer, new RAD, GPS rover occupation, general service
5	28	Saipan	United States of America (the)	☑	☑	☐	☑	Update to Xlink w/ Iridium, New Vega C22 Radar(RA2), new absolute PRS w/ Barometer, Leveling to CNMR GPS, general service
6	54	Chuuk	Micronesia (Federated States of)	☑	☑	☐	☑	Completed remote install, new absolute PRS w barometer, new RA2, GPS rover occupation, repair of found GNSS gauge, established benchmark network, general service
7	108	Male, Hulule	Maldives	☑	☑	☑	☑	New gauge and location w/ Xlink & Iridium, two RADs, absolute PRS w barometer, GPS rover occupation, new benchmarks & minor repair of old gauge for overlap
8	109	Gan	Maldives	☑	☑	☐	☑	Update to Xlink & Iridium, new RAS radar, new absolute PRS w barometer, new RAD, GPS rover occupation, new mast and solar system
9	117	Hanimaadhoo	Maldives	☑	☑	☑	☑	Update to Xlink & Iridium, new radar, new absolute PRS w barometer, GPS rover occupation, general service
10	409	Ofu (American Samoa)	United States of America (the)	☐	☑	☐	☑	**2 VISTS!** New station installed with 1 radar and 1 pressure sensor. Xlink500 with iridium.
11	408	Tau (American Samoa)	United States of America (the)	☐	☑	☐	☑	**2 VISTS!** New station installed with 1 radar and 1 pressure sensor. Xlink500 with iridium.
12	404	Auasi (American Samoa)	United States of America (the)	☐	☑	☐	☑	**2 VISTS!** New station installed with 1 radar and 1 pressure sensor. Xlink500 with iridium.
13	407	Aunuu (American Samoa)	United States of America (the)	☐	☑	☐	☑	**2 VISTS!** New station installed with 1 radar and 1 pressure sensor. Xlink500 with iridium.

Pacific Tsunami Stations

	UH ID	Name	Country	M	U	R	L	Activity Notes
1	91	La Libertad	Ecuador	☑	☑	☑	☑	Upgrade to SL3 logger, new RAS radar, new antenna, new PRS, new switches, stilling well support structural improvments, active GNSS station tie, general service
2	87	Quepos	Costa Rica	☑	☑	☑	☑	Upgrade to SL3 w/ Iridium. New PRS w/ Temp. Matched radar offsets. Identified new Perminent GPS and got contact info.
3	82	Acajutla	El Salvador	☑	☑	☑	☑	Upgrade to Iridium, add RLS, new PRS, New Batts, New SW, remove BUB, antenna SL2. Leveling

Caribbean Tsunami Stations

	UH ID		Country	M	U	R	L	Activity Notes
1	268	Limon	Costa Rica	☑	☑	☑	☑	Upgrade to SL3 w/ Iridium. New PRS w/ Temp, Radar moved, New SWs, some structural work modified.
2	739	El Porvenir	Panama	☑	☑	☑	☑	**2 VISITS!** Added RLS, PRS, new batts, remove BUB and move SWs. Return to add Iridium and replace mast.
3	738	Santa Marta	Colombia	☑	☑	☑	☑	Reinstall station, new batts, site survey for new location in 2024
4	777	Puerto Plata	Dominican Republic (the)	☑	☑	☑	☑	Moved station. Repositioned the 2 radars. New PRS. New C22 radar. Changed batteries. Added BMs. GPS rover and leveling.
5	776	Punta Cana	Dominican Republic (the)	☑	☑	☑	☑	Added a 3rd radar C22. Changed elevation of the SWs. GPS rover and leveling. Change BAT. Repair solar panel.

Table 1: *Summary of UHSLC station visits and field activity during FY2023.*

When not in the field, UHSLC technicians continued to test and investigate sources of error and bias in existing and new radar sensors. This includes a new collaboration with the NOAA Center for Operational Oceanographic Products and Services (CO-OPS) to exchange sensors and investigate similarities and differences in the performance of senosr models currently in use by each group.

2.1.3 Research

UHSLC researchers participated in multiple research projects and reports leading to peer-reviewed articles in FY2023. Efforts that were specifically supported by GOMO included:

- Contributions to a paper written in collaboration with scientists at NOAA CO-OPS that details a novel statistical approach to predict the daily likelihood of high tide flooding at coastal locations throughout the U.S. (*Dusek et al.*, 2022).
- Contributions to a paper written in collaboration with scientists at NASA Goddard and NOAA/NCEI that examines ten case studies in time series of sea-level data from UHSLC databases where satellite altimetry can be used to diagnose the nature of vertical offsets in the data (*Ray et al.*, 2023). These results are crucial for understanding how to interpret trends and variability in tide-gauge data.
- Leading the sea-level section in the peer-reviewed "State of Climate in 2022" Report published by the Bulletin of the American Meteorological Society (*Thompson et al.*, 2022). This is an important annual activity of the UHSLC to document and interpret observed changes and variations in sea level around the globe during the past year.
- The UHSLC PI served on the 18-member peer-review panel selected by the National Academies of Sciences, Engineering, and Medicine (NASEM) for the Fifth National Climate Assessment (NCA5). This panel produced an extensive 344-page report (*NASEM*, 2023), which was itself a peer-reviewed document, that details changes and improvements to NCA5, representing a significant contribution of time and effort on behalf of the UHSLC project.

Figure SEQ Figure * ARABIC 2: *Photo of the new UHSLC tide gauge installed on the island of Ofu in the remote Manu'a Islands, which are part of American Sāmoa.*

The research program of the UHSLC builds on the foundation of scientific expertise and technical knowledge supported by GOMO. UHSLC scientists leverage this foundation to seek funding from additional agencies (both within NOAA and external agencies) and to collaborate with others in the scientific community on research across a broad spectrum of topics related to oceanography and climate. With non-GOMO NOAA funding we continued work in collaboration with NOAA CO-OPS on validating the perfomance of a 43-year reanalysis of hourly coastal water levels for the Atlantic Ocean and the Gulf of Mexico, which was funded by NOAA and conducted by the Renaissance Computing Institute using the ADvanced CIRCulation (ADCIRC) model. We also received non-GOMO NOAA funds from Inflation Reduction Act, which we are using to collaborate with NOAA/NECI on developing a suite of sea-level monitoring indices and training workshops for the Pacific region. During FY2023, UHSLC scientists authored and co-authored a number of papers through non-NOAA funding sources as well, which inlcuded works on the contributions to high-tide flooding in the United States; nonstationarity in the sea-level annual cycle around the global ocean; and the impact of assimilating satellite altimetry data in seasonal sea-level forecasts.

2.2. Activities funded by NOAA/NWS Tsunami Program

Support from the NOAA/NWS Tsunami Program enables UHSLC to maintain nine tide gauge stations in the Caribbean Sea and eleven tide gauge stations in the Pacific Ocean in support of regional tsunami detection and sea level monitoring. The Caribbean portion of the project was developed in collaboration with the NWS and Puerto Rico Seismic Network (PRSN). The UHSLC oversees the operation of the stations and provides ongoing technical support, data processing, and quality assessment services. The Pacific portion of the project is primarily focused on the maintenance of tsunami tide-gauge stations previously maintained by the Pacific Tsunami Warning Center (PTWC). UHSLC involvement ensures that the stations remain operational and transmitting real-time, high-frequency data while also complying with GLOSS requirements for oceanographic and climate research.

The annual targets for NOAA/NWS-funded work are to make maintenance visits to five Caribbean and five Pacific tsunami tide-gauge stations. Five stations were visited for routine maintenance in the Caribbean (Table 1), which met the expected five-station target. For the Pacific Ocean, three stations were visited for routine maintenance by UHSLC technicians (Table 1), which did not meet the five-station visit target. The reason for not meeting the five-station targe in the Pacific is the extensive work done in American Sāmoa, which required a disproportionate amount of effort to complete relative to our typical station visits. The Tsunami Program was one of the motivating enitities for new installations in American Sāmoa due to tectonic activity detected in the Manuʻa islands and the potential for dangerous tsunami that could impact American Sāmoa. Thus, we view the installation of multiple new stations in the region as fulfilling the gap in proposed and performed maintenance visits in the Pacific region.

Station up-time is an important measure of project success given the necessity of real-time data for tsunami monitoring. We estimate station up-time by calculating the percentage of valid real-time data transmissions received out of all possible transmissions for each station on the Global Telecommunication System (GTS) during FY2023. Of the 20 UHSLC-operated tsunami gauges operational during the last fiscal year, 10 exceeded 98% up-time, and 16 exceeded 90% up-time (Table 2). The station at Santa Marta was the primary problem station during FY2023, achieving only 7.8% up-time due to being uninstalled by local authorities as part of construction project. UHSLC technicians visited this site during September 2023 to install a temporary station and to seek out a new permanent site. We will revisit the site again during FY2024 to reinstall the gauge at its new permanent site.

Percentage of valid real-time GTS data transmissions during FY 2023

Pacific tsunami gauges			Caribbean tsunami gauges		
UH ID	**Name**	**%**	**UH ID**	**Name**	**%**
392	Cocos Island, Costa Rica	94.0	737	San Andres, Colombia	95.9
087	Quepos, Costa Rica	85.4	738	Santa Marta, Colombia	7.8
091	La Libertad, Ecuador	97.9	268	Limon, Costa Rica	83.3
082	Acajutla, El Salvador	93.9	878	Bullen Bay, Curacao	95.5
017	Hiva Oa, France	99.1	786	Roseau, Dominica	98.4
031	Nuku Hiva, France	99.3	777	Puerto Plata, Dominican Rep.	99.4
093	Callao, Peru	89.1	776	Punta Cana, Dominican Rep.	99.9
094	Matarani, Peru	98.8	789	Prickley Bay, Grenada	97.6
092	Talara, Peru	98.8	739	El Porvenir, Panama	99.3
371	Legaspi, Philippines	99.1			

014	French Frigate, USA	99.7

Table 2: *Percentage of valid real-time data transmissions (out of all possible transmissions) on the Global Telecommunication System (GTS) for each UHSLC tsunami tide gauge during FY2023.*

3. Outreach and Education

The UHSLC places a high priority on outreach and education, particularly in the Pacific Islands region. UHSLC staff members responded regularly to questions from stakeholders regarding the interpretation of tide-gauge data, the nature of extreme sea-level events, and the current status of global and regional sea-level rise. UHSLC staff provided tide calendars based on UHSLC tide gauge data to a variety of public and private entities (can be accessed via the web: https://uhslc.soest.hawaii.edu/stations/), and we also publish and disseminate a monthly sea-level forecast discussion that is widely used by local entities around the Pacific to prepare for periods of elevated sea level and potential flooding. During FY2023, members of the UHSLC mentored three post-doctoral scholars and supported and worked with four graduate students and two undergraduate students on their thesis research.

4. Publications and Reports

4.1. Publications by Principal Investigators

4.1.1 Published

Dusek, G., W. V. Sweet, **M. J. Widlansky**, **P. R. Thompson**, and J. J. Marra, 2022: A novel statistical approach to predict seasonal high tide flooding. *Frontiers in Marine Science*, **9**, 1073792, https://doi.org/10.3389/fmars.2022.1073792.

Thompson, P. R., **M. J. Widlansky**, and Coauthors, 2022: Sea level variability and change [in "State of the Climate in 2019"]. *Bulletin of the American Meteorological Society*, **104**, S146–S206, https://doi.org/10.1029/2022JC019342.

Ray, R. D., **M. J. Widlansky**, A. S. Genz, **P. R. Thompson**, 2023: Offsets in tide-gauge reference levels detected by satellite altimetry: ten case studies. *Journal of Geodesy*, **97**, 110, https://doi.org/10.1007/s00190-023-01800-7.

National Academies of Science Engineering and Medicine (including **P. R. Thompson** on the 18-member peer-review panel), 2023: *Review of the Draft Fifth National Climate Assessment*. National Academies Press, Washington, DC.

4.2. Other Relevant Publications

4.2.1 Publications that cite/use UHSLC datasets (not related to work of PIs)

The following represents a small sample of 41 peer-reviewed journal articles and reports published during FY2023 that utilize data obtained directly from UHSLC.

Brown, J. M., A. Hibbert, L. M. Bricheno, E. Bradshaw, and A. E. Becker, 2023: Tides at a coast. A Journey Through Tides, 247–281, https://doi.org/10.1016/b978-0-323-90851-1.00019-4.

Guo, J., H. Zhang, Z. Li, C. Zhu, and X. Liu, 2023: On Modelling Sea State Bias of Jason-2 Altimeter Data Based on Significant Wave Heights and Wind Speeds. Remote Sensing, 15, 2666, https://doi.org/10.3390/rs15102666.

Sefton, J. P., A. C. Kemp, S. E. Engelhart, J. C. Ellison, M. A. Karegar, B. Charley, and M. D. McCoy, 2022: Implications of anomalous relative sea-level rise for the peopling of Remote Oceania. Proceedings of the National Academy of Sciences, 119, https://doi.org/10.1073/pnas.2210863119.

Song, J., and Coauthors, 2023: Data driven pathway analysis and forecast of global warming and sea level rise. Scientific Reports, 13, https://doi.org/10.1038/s41598-023-30789-4.

Wood, M., and Coauthors, 2023: Climate-induced storminess forces major increases in future storm surge hazard in the South China Sea region. Natural Hazards and Earth System Sciences, 23, 2475–2504, https://doi.org/10.5194/nhess-23-2475-2023.

Xie, W., G. Xu, H. Zhang, and C. Dong, 2023: Developing a deep learning-based storm surge forecasting model. Ocean Modelling, 182, 102179, https://doi.org/10.1016/j.ocemod.2023.102179.

5. Data and Publication Sharing

UHSLC data management follows the implementation plan of the Global Sea Level Observing System (GLOSS), which operates under the auspices of the Joint Collaborative Board (JCB) between the World Meteorological Organization (WMO) and the Intergovernmental Oceanographic Commission (IOC). The GLOSS implementation plan (http://www.gloss-sealevel.org/library/gloss-implementation-plan) outlines how and where various tide gauge sea level datasets are stored and accessed from the GLOSS data centers. We apply the GLOSS data standards and data management directives to all UHSLC data whether part of the GLOSS network or not. UHSLC datasets are available in a variety of formats from our data access page (https://uhslc.soest.hawaii.edu/datainfo/). Near-real-time data from stations operated by the UHSLC can be viewed on our station pages (https://uhslc.soest.hawaii.edu/stations/)

6. Project Highlight Slides

Highlight slides are provided in a separate file.