

UNIVERSITY OF HAWAI'I SEA LEVEL CENTER



Operations and Research

Phil Thompson

*Associate Professor, UH Department of Oceanography
Director, UH Sea Level Center*

Matthew Widlansky

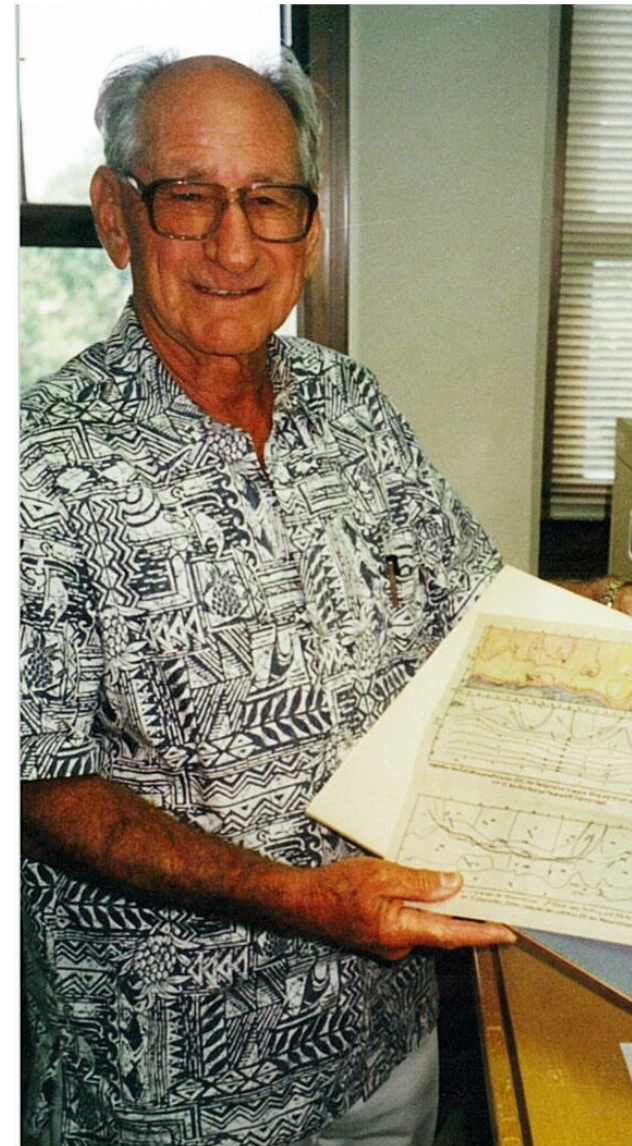
*Research Scientist, UH Department of Oceanography
Associate Director, UH Sea Level Center
Email: mwidlans@hawaii.edu*



History

Using sea level to understand El Niño

- **Klaus Wyrcki**
 - Created a network of tide gauges across the Pacific.
 - Used sea level observations to make **fundamental advancements** in the modern understanding of El Niño.
- The **Pacific tide-gauge network** and **sea-level database** expanded under large international climate research efforts.
 - North Pacific Experiment (NORPAX, 1971–1980)
 - Tropical Ocean Global Atmosphere program (TOGA, 1985–1994)
- The **University of Hawaii Sea Level Center (UHSLC)** became an operational NOAA-funded entity in 1993.

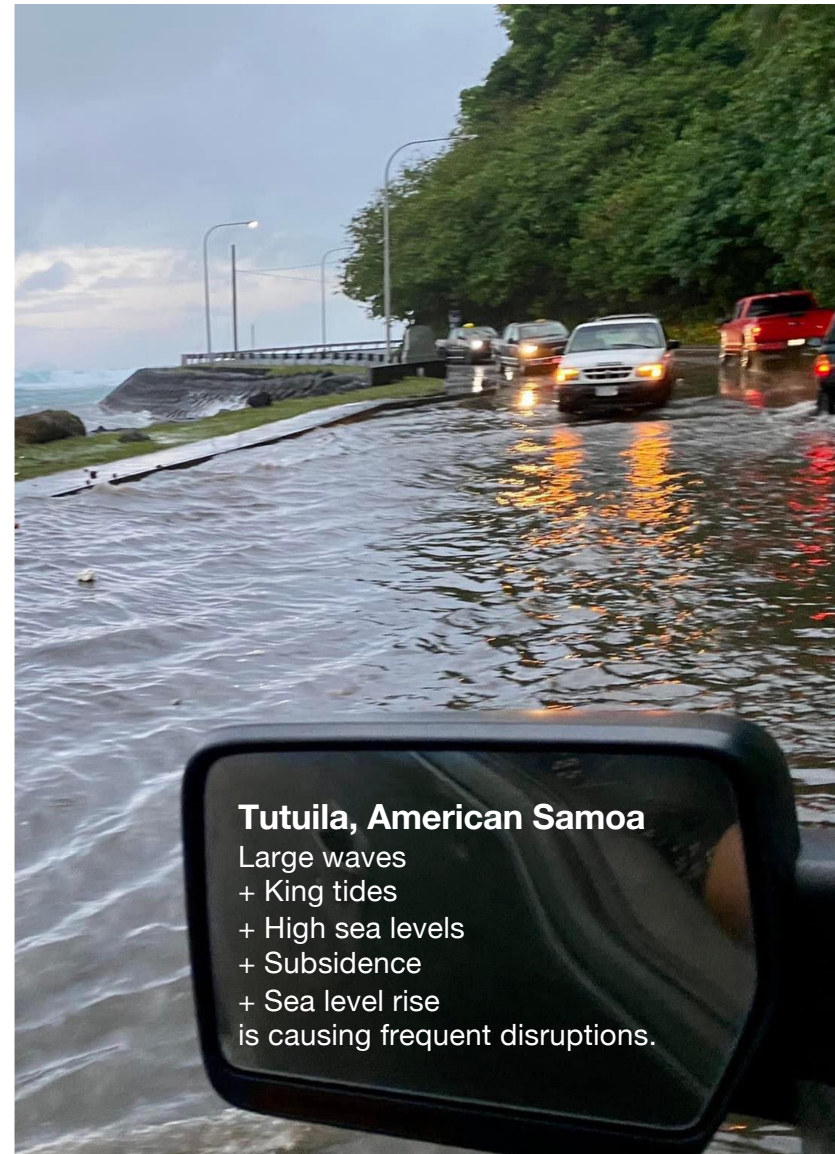


Global tide-gauge network

Global Sea Level Observing system (GLOSS)

What are tide-gauge observations used for?

- Coastal sea-level trends and climate impacts
- Tsunami warning and modeling
- Storm surge monitoring and research
- Tide predictions and vertical datums
- Calibration and validation of satellite altimetry
- Any many others ...



Global tide-gauge network

Global Sea Level Observing system (GLOSS)

What is GLOSS?

- Established by UNESCO-IOC in 1985
- Part of GOOS; reports to IOC; coordinates with the Joint WMO-IOC Collaborative Board (JCB)
- Goal is to establish and maintain a well-designed, high-quality **in situ sea-level observing network** to support a broad user base
- Provides oversight, coordination, and capacity development

★ The UHSLC is the primary U.S. partner in GLOSS.

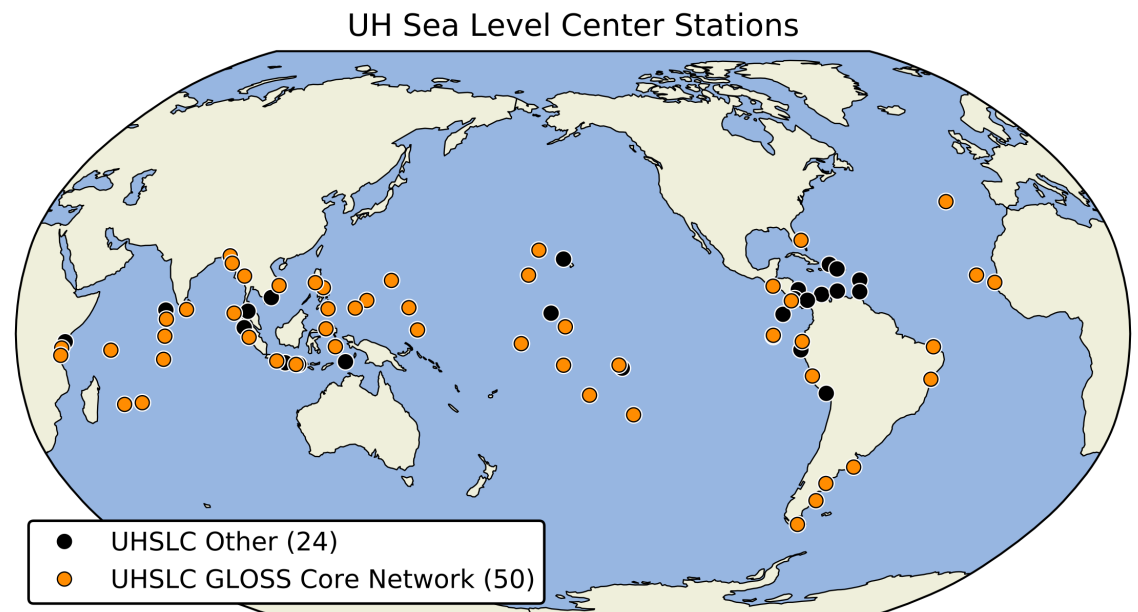


UH Sea Level Center

Role in GLOSS and NOAA

1. Operate a global network of 74 tide gauges

- Including about 20% of operational gauges in the GLOSS Core Network.
- Many in under-resourced locations
- Build capacity in host countries



UH Sea Level Center

Role in GLOSS and NOAA

1. Operate a global network of 74 tide gauges

- Including about 20% of operational gauges in the GLOSS Core Network.
- Many in under-resourced locations
- Build capacity in host countries



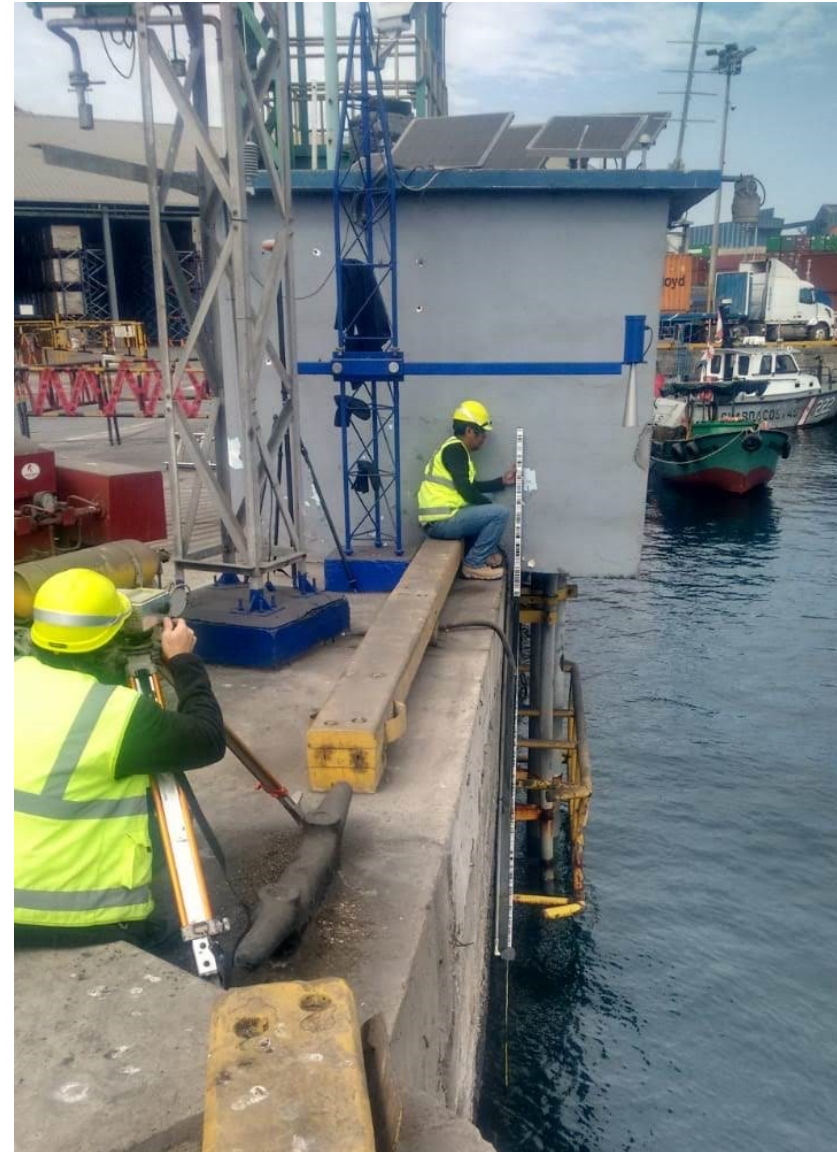
UH Sea Level Center

Role in GLOSS and NOAA

1. Operate a global network of 74 tide gauges

- Including about 20% of operational gauges in the GLOSS Core Network.
- Many in under-resourced locations
- Build capacity in host countries

UHSLC technician working with a colleague in Indonesia.



UH Sea Level Center

Role in GLOSS and NOAA

2. Curate global tide-gauge data sets

- Datasets contain approximately **18k years of data** from almost 700 sites across 97 countries.
- UHSLC aggregates, quality controls, and distributes the tide-gauge data.
- Data curation is performed in partnership with a Hawai'i-based NCEI liaison (Ayesha Genz).
- UHSLC datasets are **cited 50–100 times per year** in peer-reviewed literature.



UH Sea Level Center

Role in GLOSS and NOAA

3. Research and product development

- Diverse portfolio of extramural research leveraging UHSLC resources and expertise
- Current projects funded by **multiple NOAA Programs** (MAPP, Pacific RISA, CO-OPS)
- Additional projects funded by NASA, USGS, DoD, and ONR
- Topics include:
 - Seasonal sea-level forecasts
 - 21st century projections of high-tide and compound flooding.
 - Assessing NOAA's 40-year reanalysis of hourly coastal water levels

The screenshot displays the UH Sea Level Center website. At the top, the URL is uhslc.soest.hawaii.edu/sea-level-forecasts. The page features the University of Hawaii Sea Level Center logo and logos for NOAA and the Pacific Islands Climate Adaptation Science Center. The main heading is "Sea Level Forecasts".

Two text boxes provide information:

- The first box states: "This product provides an outlook of monthly sea level anomalies for the next one to two seasons. We combine sea level forecasts with astronomical tide predictions to provide more accurate predictions of coastal water level compared to tide predictions alone." It includes a "READ MORE" button.
- The second box states: "This seasonal forecast product is *experimental*. For short-term forecasts (daily to weekly), please see the High Sea Level Forecast for your region. Neither the seasonal nor the weekly product is accurate when a tsunami or tropical cyclone threatens your coastline."

The central feature is a map titled "Model forecast (CFSv2: initialized 20210401-20210430) Lead = 3.5 months (202107)". The map shows sea level anomalies in centimeters across the Pacific Ocean, with a color scale from -40 to 40. Major cities like San Francisco, Los Angeles, and La Jolla are marked in the North Pacific, while others like Honolulu, Guam, and various Pacific Islands are marked in the tropical and equatorial regions. A legend below the map shows values from -6 to 6, with the number 3 highlighted in orange. A note says "Mouseover for past and future months."

At the bottom, there are tabs for "Discussion", "Forecasts", "Tides", and "Impacts". The "Forecasts" tab is active. Below the tabs, it says "Updated 16 April 2021" and "Above-normal sea levels are occurring in the equatorial western Pacific and in the tropical central Pacific away".

UH Sea Level Center

Role in GLOSS and NOAA

What are we working on now?

- Increase online data **interactivity** and value-added calculations
 - 10- and 100-year flood levels; sea-level trends; etc.
- Transition the UHSLC tide-gauge network to **Iridium** communications
 - Minimize data loss
 - Improve efficiency of maintenance operations
- Expand sea-level observing network in **American Samoa** for climate and tsunami applications
 - Main island (Tutuila) and other populated islands (Aunu'u, Ofu-Olosega, and Ta'u)

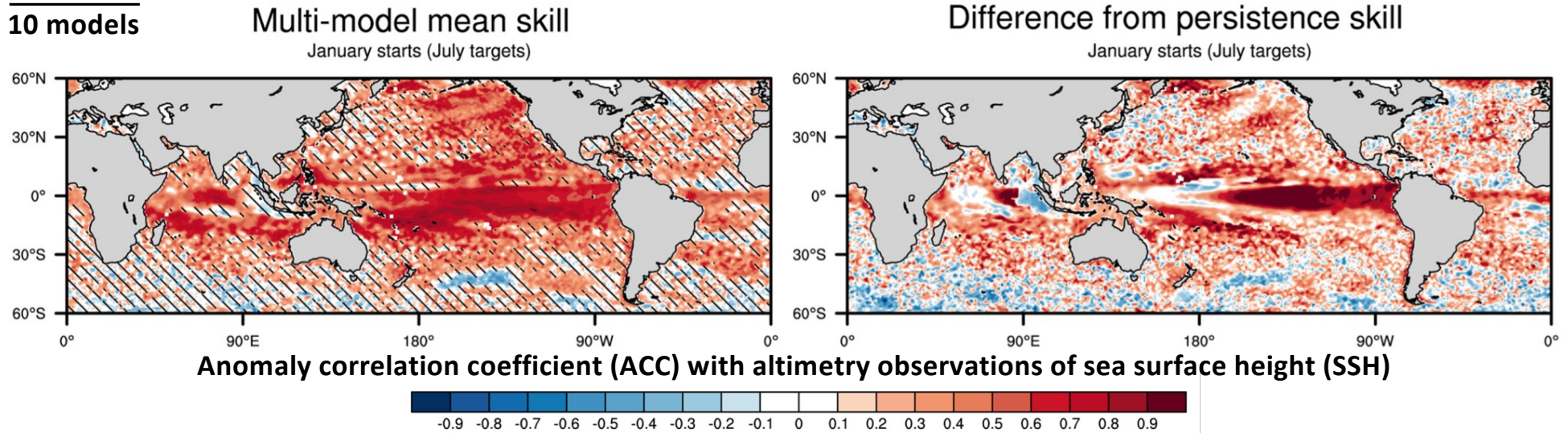


Aunu'u, American Samoa

Subsidence + SLR is causing frequent disruptions.

Multi-model seasonal sea level forecasts for the U.S. Coast

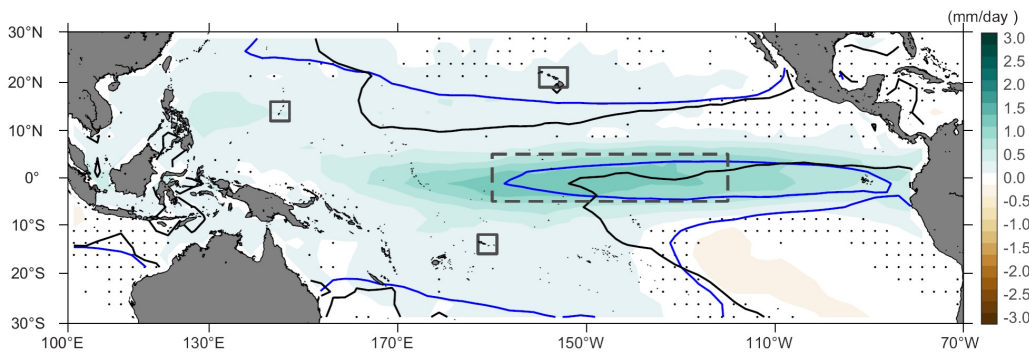
Climate forecast systems are skillful in most of the tropics ([Pacific Islands product](#)), but perform poorly at higher latitudes and along some coasts (problematic for the U.S. East Coast).



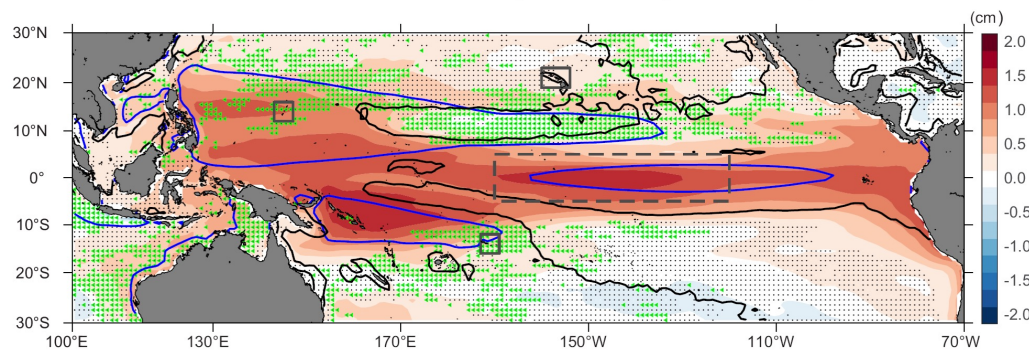
Analysis published by Xiaoyu Long (Postdoc @ UHSLC, 2017–2021)

Assessing CMIP6 combined projections of changing sea levels and enhanced extreme rainfall events for determining coastal flood risks in the U.S.-affiliated Pacific Islands

Rainfall interannual standard deviation change for 3 °C of global warming

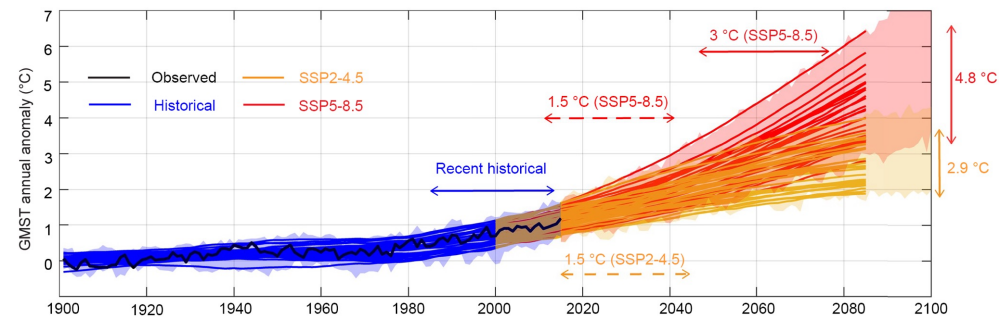


SSH interannual standard deviation change for 3 °C of global warming



We assess climate changes for particular warming amounts, which constrains uncertainty related to the future global warming rate ([CMIP6 atlas](#)).

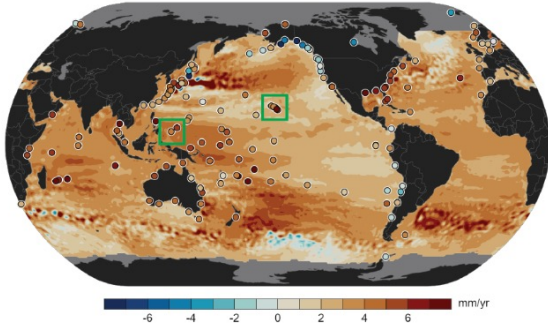
Global mean warming



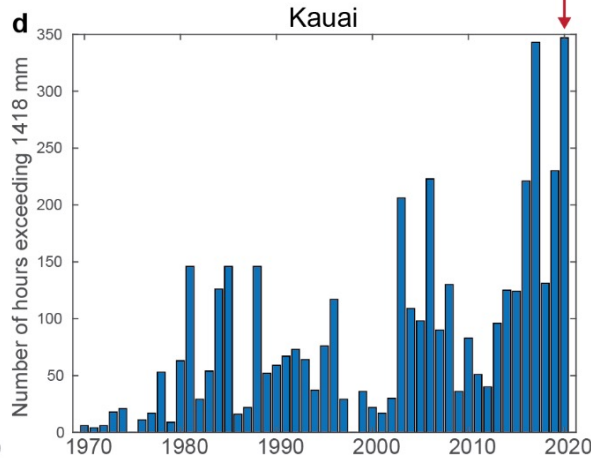
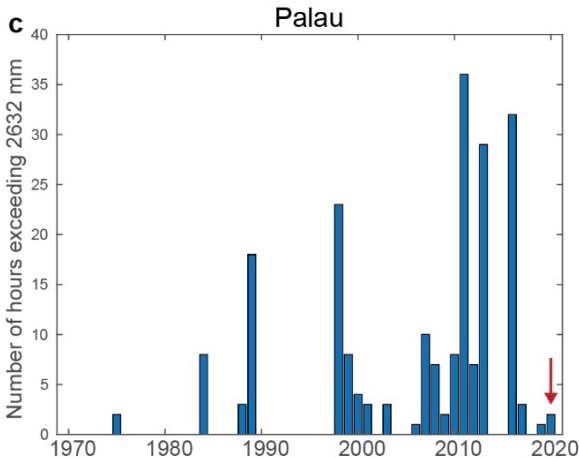
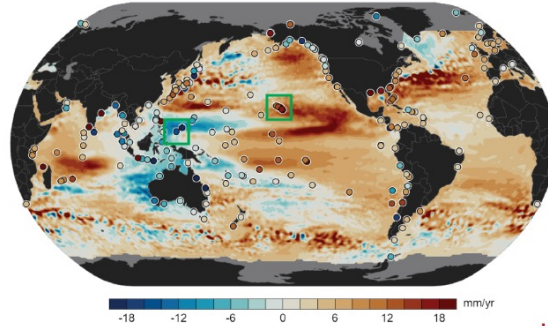
Analysis published by Laxmikant Dhage (Postdoc @ UHSLC, 2020–2022)

Tracking and Communicating Sea Level Conditions for Coastal Disturbances in Hawai'i and the USAPI

a Sea level trends (1993–2020)



b Sea level trends (2011–2020)



Hours exceeding local extreme water level thresholds for each year

UHSLC contributes to the Pacific Islands Regional Climate Assessment ([PIRCA](#)).

Web portal for additional sea level climatology and extremes information ([Station Explorer](#)).

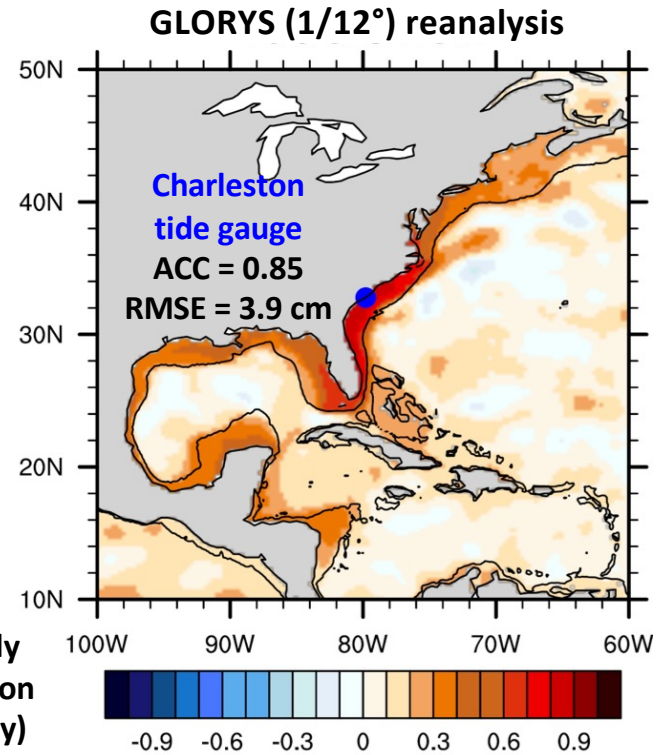
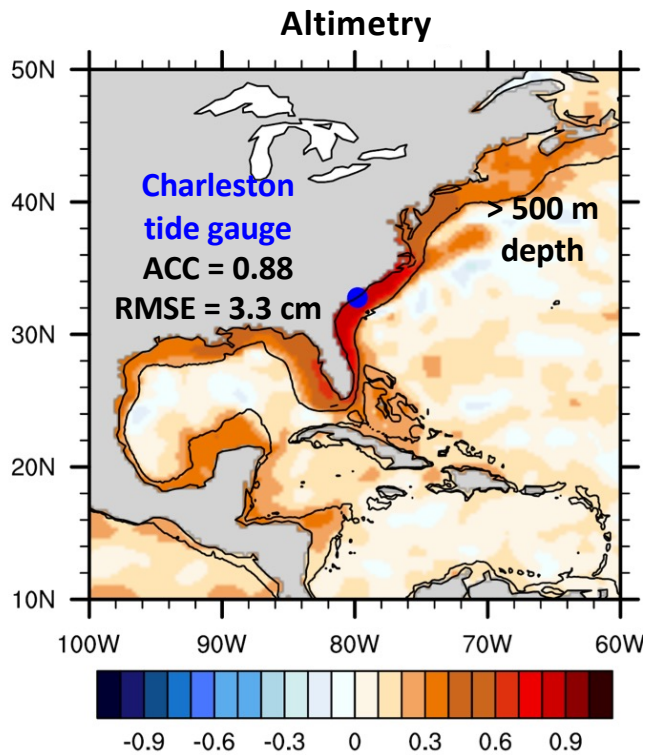
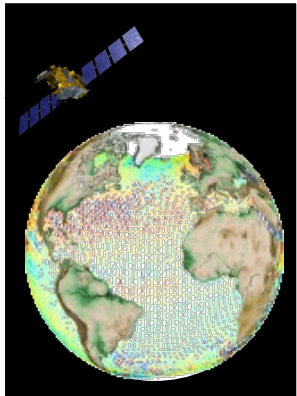


FY2022

(PI: Widlansky)

Monitoring the climatology and extremes of coastal sea levels for the U.S. Coast

New ocean model reanalyses assimilating satellite observations of sea surface height are simulating more realistic coastal sea level variability (U.S. East Coast improvement).



Analysis in preparation by Xue Feng (Postdoc @ UHSLC, Sep 2022–present)

National Assessment of Contemporary and Future Coastal Flooding

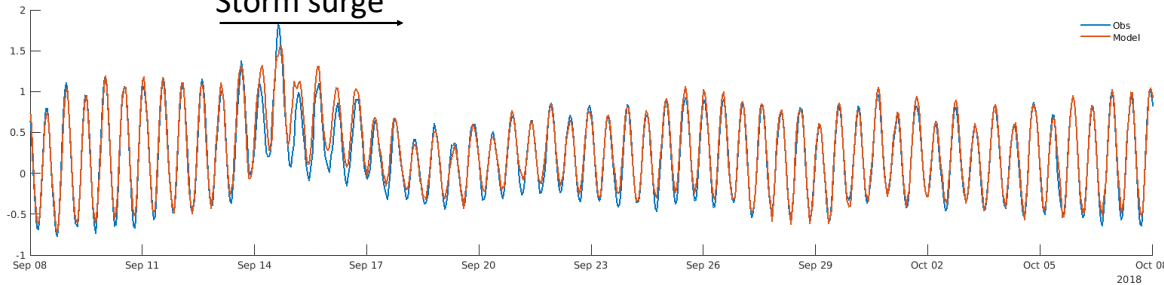
FY2022
(UHSLC)

Assessment of NOAA's 40-year reanalysis of hourly water levels (~500 m coastal resolutions). Year 1 focus is validating model performance (tides and non-tidal residuals).

Observed and Simulated water levels Hurricane Florence (2018)

Wrightsville Beach, NC

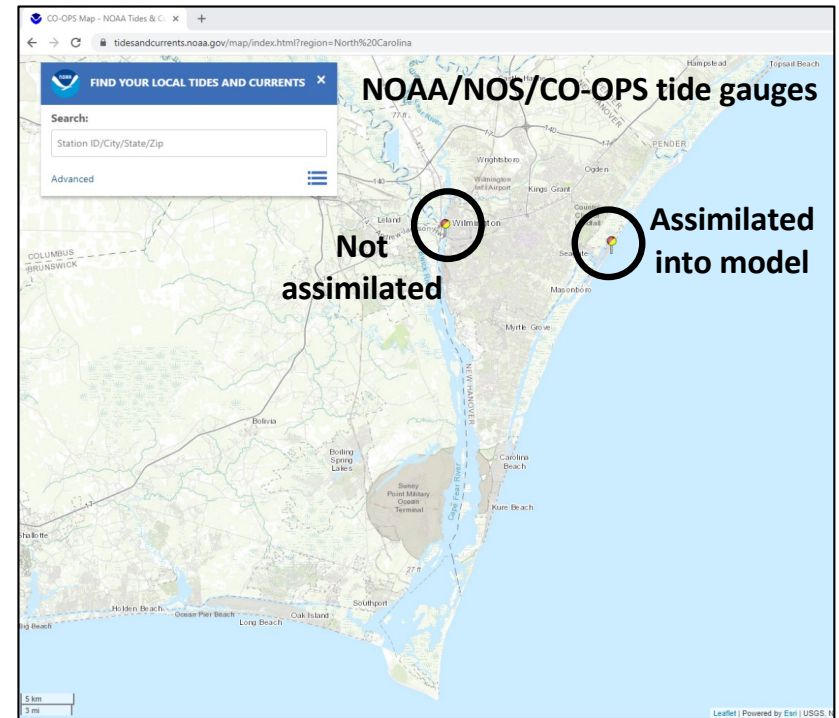
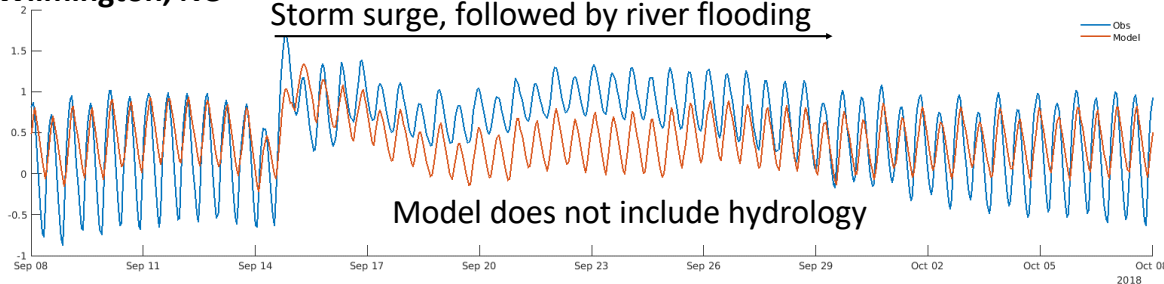
Storm surge



Wilmington, NC

Storm surge, followed by river flooding

Model does not include hydrology



Analysis in preparation by Linta Rose (Postdoc @ UHSLC, Oct 2022–present)