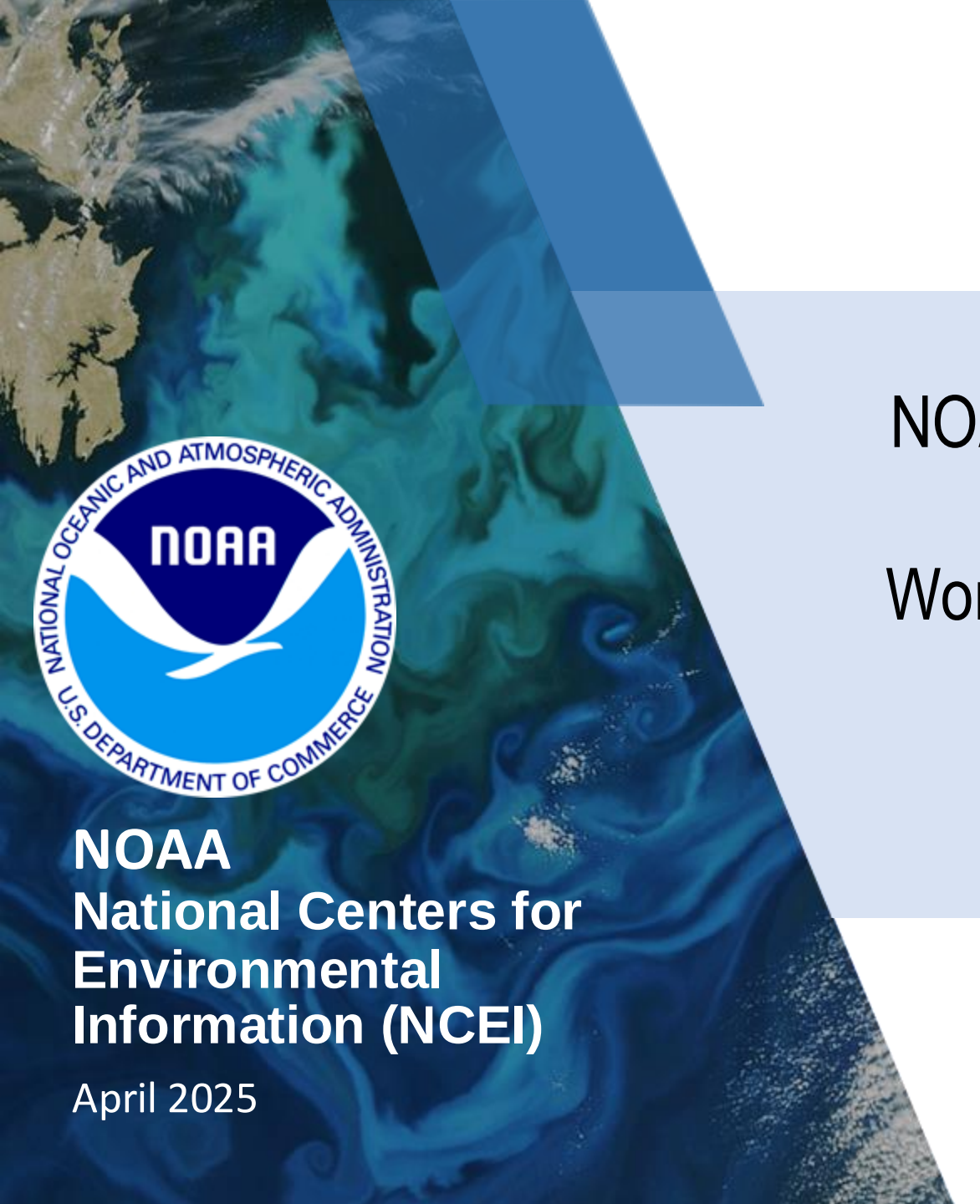


NOAA
National Centers for Environmental Information (NCEI)

April 2025

NOAA National Centers for Environmental Information (NCEI)
World Data Service for Geophysics (WDS)

Nicolas Arcos
Boulder, Colorado, United States

Background

Two global historical tsunami databases maintained separately by:

- NOAA National Centers for Environmental Information (NCEI, formerly National Geophysical Data Center (NGDC)) and co-located World Data Service for Geophysics (WDS)
- Novosibirsk Tsunami Laboratory, Institute of Computational Mathematics and Mathematical Geophysics (NTL/ICMMG)

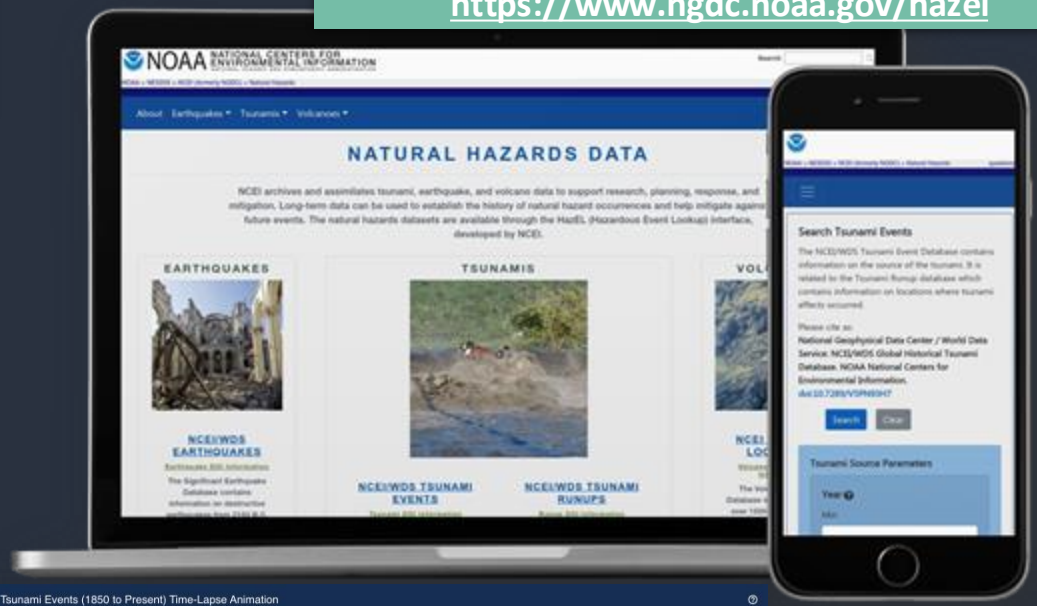
Historical Tsunami Data

Know the past to better understand the future

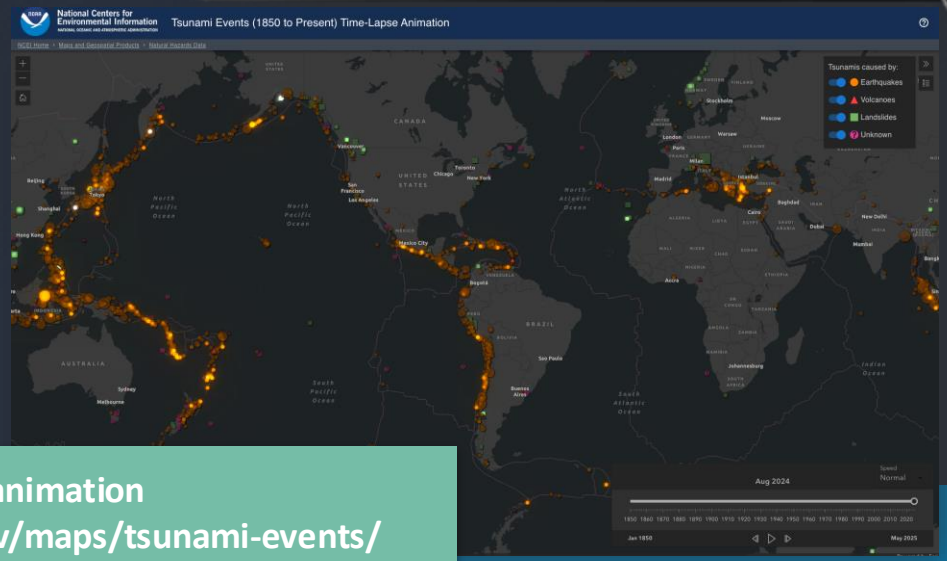
2,900+ **global** tsunami events
(over 1,500 confirmed)

32,000+ **global** runup observations
(i.e., wave observations)

Search forms *and* API
https://www.ngdc.noaa.gov/hazel



Geospatial search *and* map services
https://www.ncei.noaa.gov/maps/hazards/



Interactive animation
https://www.ncei.noaa.gov/maps/tsunami-events/

Historical Tsunami Data

Tsunami Event: Date, time, location, tsunami cause, magnitude, validity, maximum water height, damage, deaths, injuries from the source and tsunami separately, references, etc.

Tsunami Event Validities:

- High (validity 3-4)
  - recorded on seismograph and tide gauge
  - prior to instrumental recordings, reported by many reliable and independent sources many reports of deaths, damage, and observations of waves in many locations
- Low (validity 1-2)
  - prior to instrumental recordings, described by only one source
  - reported to be earthquake-caused, but not listed in local earthquake catalogs
  - possibly storm events
- Seiche (validity 0) (*IUGG input recently changed this; no longer applies to river/lake disturbances*)
- Erroneous (validity -1)

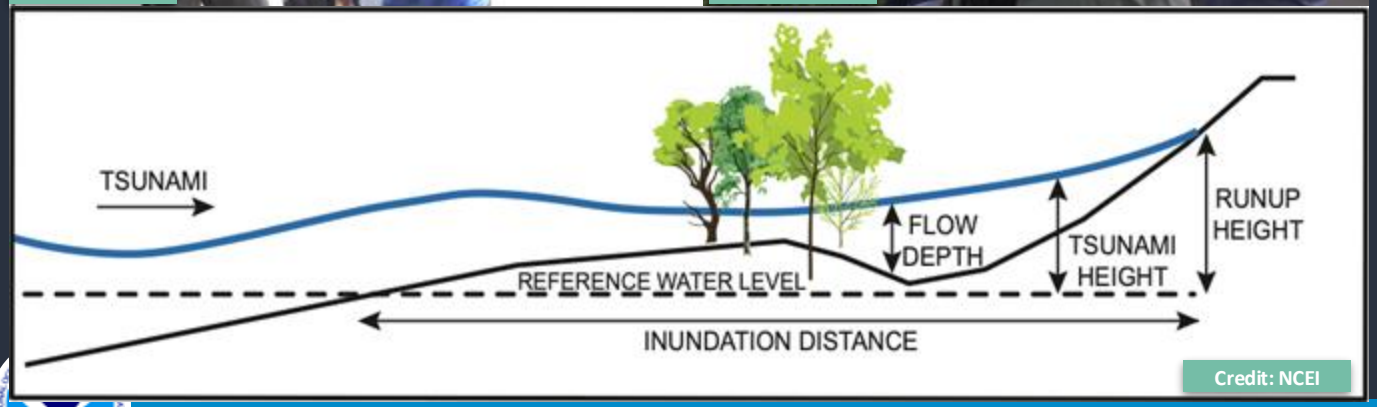
Historical Tsunami Data

Tsunami Runup (i.e., tsunami wave observations):

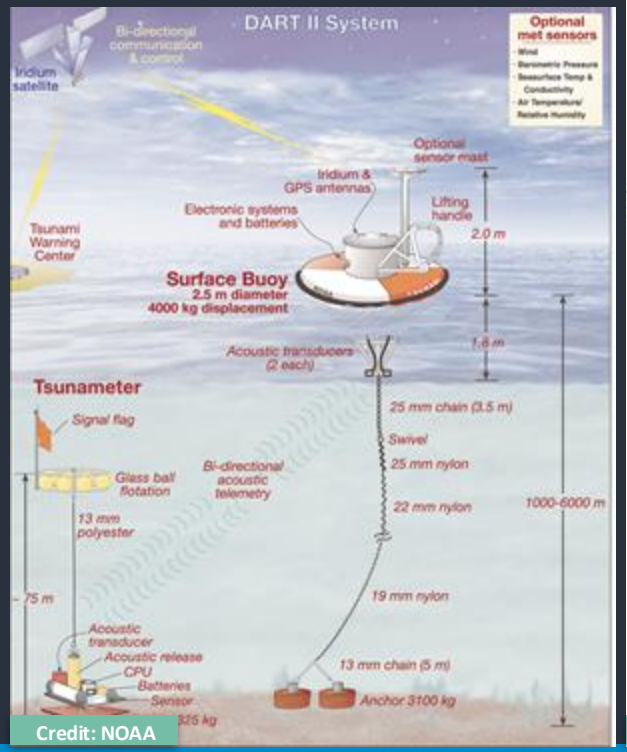
Type of measurement (e.g., tide gauge, eyewitness, BPR, post-event survey),water heights, inundation distance, arrival times, wave periods, first motion, damage, deaths, injuries, references, etc.


Credit: ITIC

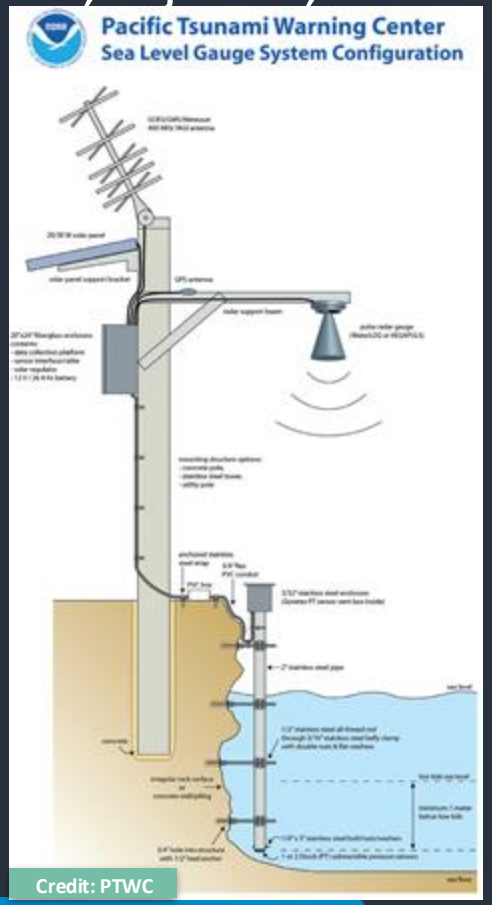

Credit: ITIC



Credit: NCEI



Credit: NOAA

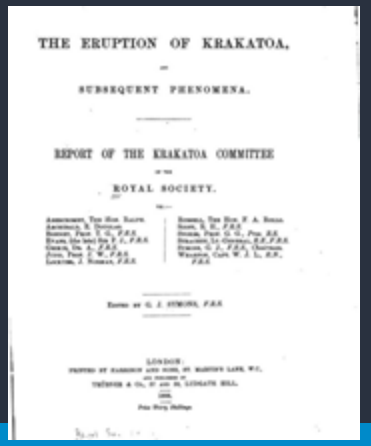


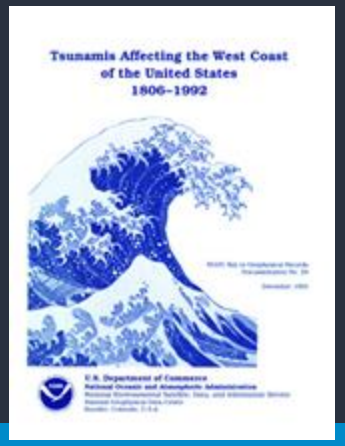
Credit: PTWC

Source Documents

Over 8,000 documents that describe damage and effects from tsunami, earthquake, and volcano events. Types of documents:

- Diaries, ships logs, newspaper reports
- Tsunami, Earthquake, Volcano catalogs
- Tsunami Warning Centers
- Regional or National Earthquake Information Centers
- International Tsunami Information Center
- Web articles, e-mail, journal articles
- International Tsunami Survey Teams



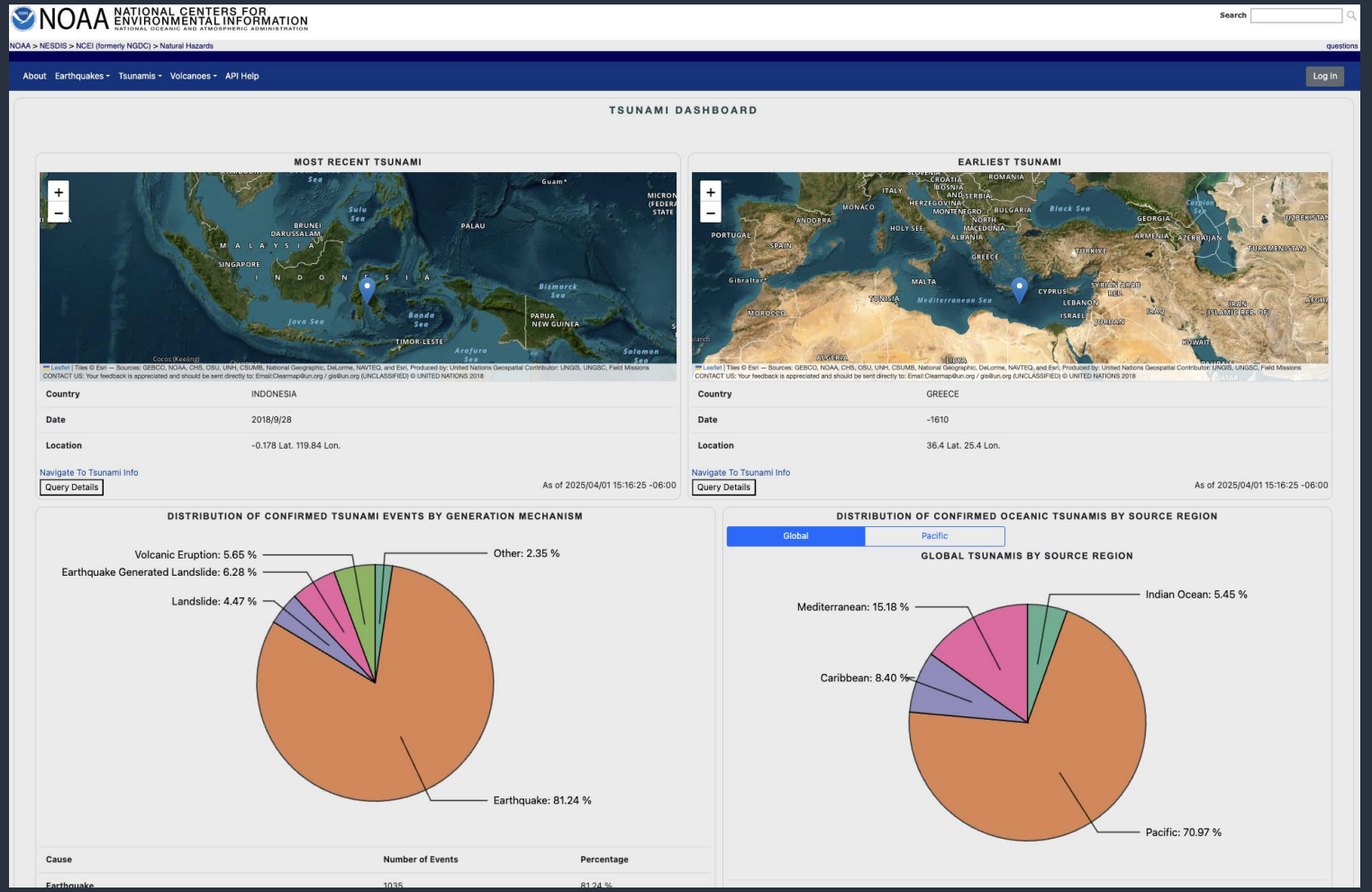


Historical Tsunami Data Dashboard
– *in development*

Instant access to tsunami data visualization without having to navigate a more scientifically detailed search form.

Aids in..

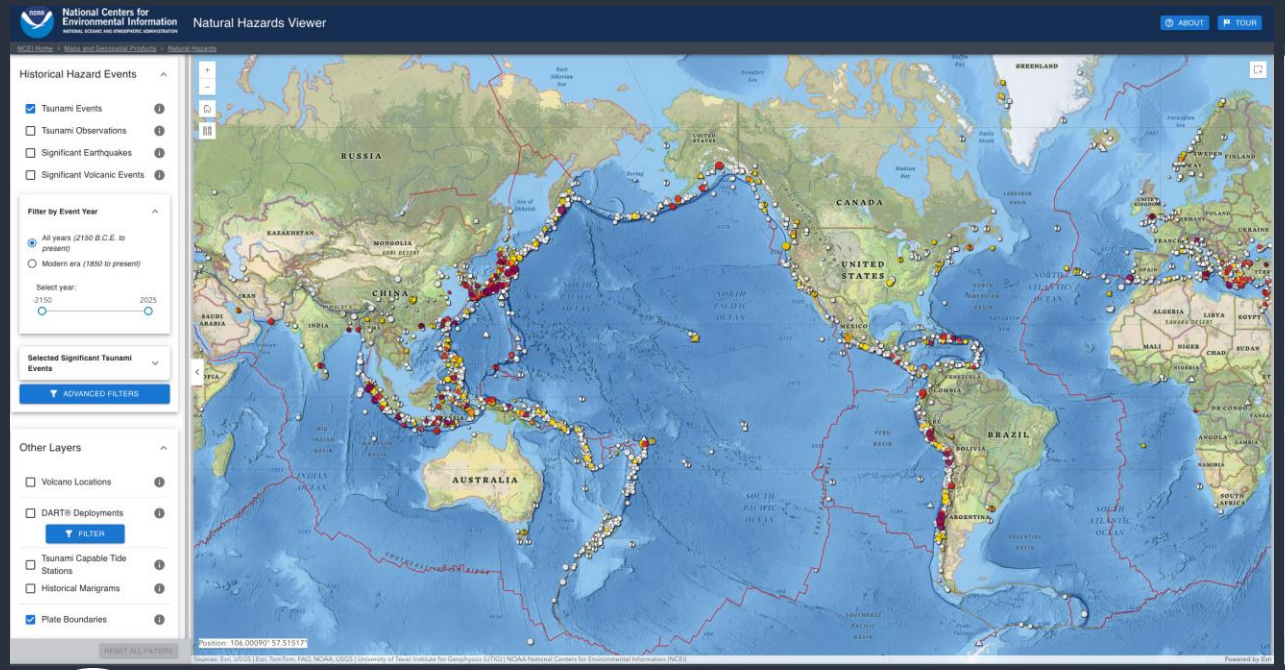
- improving consistency;
- answering simple and/or common questions.

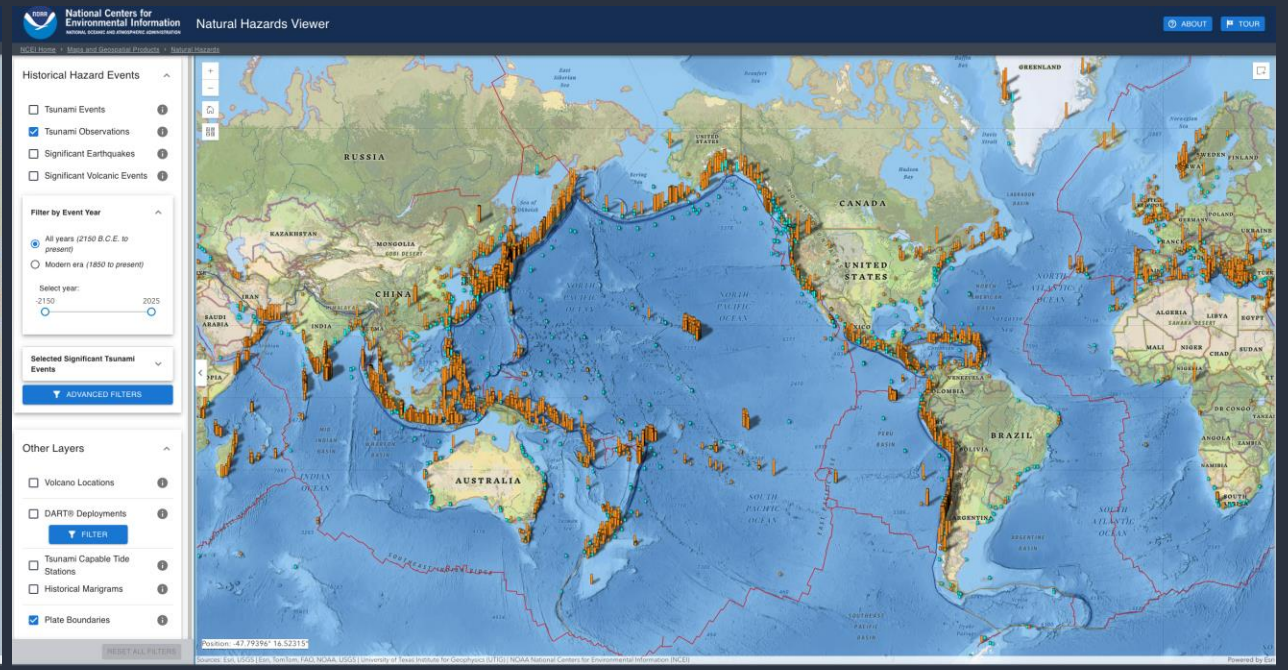


Historical Tsunami Data Dashboard
– *in development*

The NCEI Natural Hazards Viewer is currently being re-designed using modern web technologies/frameworks.

- Users will see increased performance/responsiveness, better usability on mobile devices, and improved accessibility.





Support Tsunami Warning Systems and Risk Assessments

A global tsunami database's focus is to enable data acquisition, management, and exchange that supports Tsunami Warning Centers and Risk Assessments.

- Helps establish warning criteria
- Validate inundation and evacuation mapping
- Situational awareness of duty scientists
- Used to place the event in historical context to explain to partners or media
- The additional information & references component is valuable because it includes event descriptions that are extracted from the referenced item.

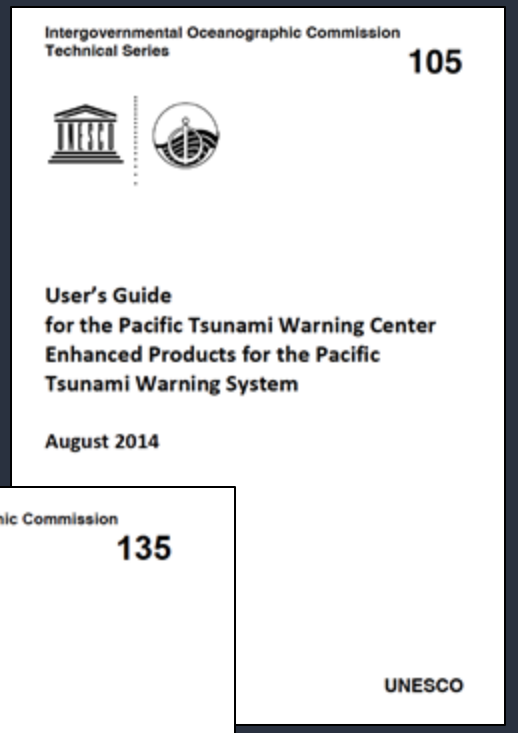
The cataloging of smaller tsunami events is critical to help characterize tsunami sources and impacts.

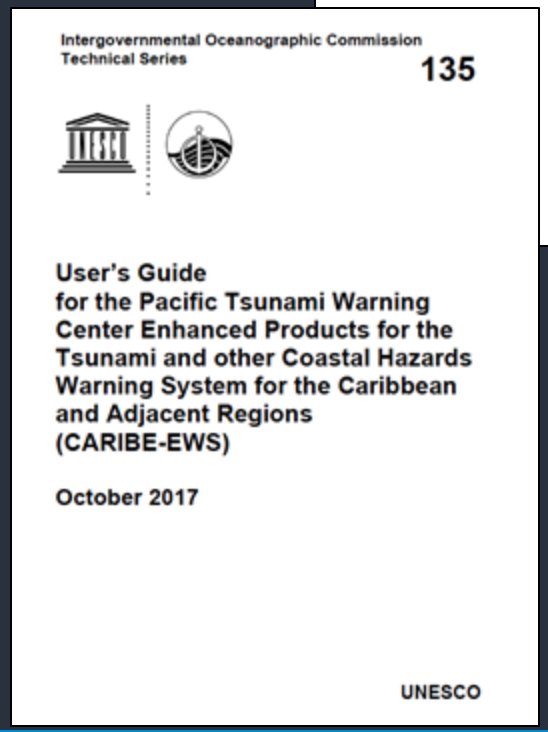
Small(er) events

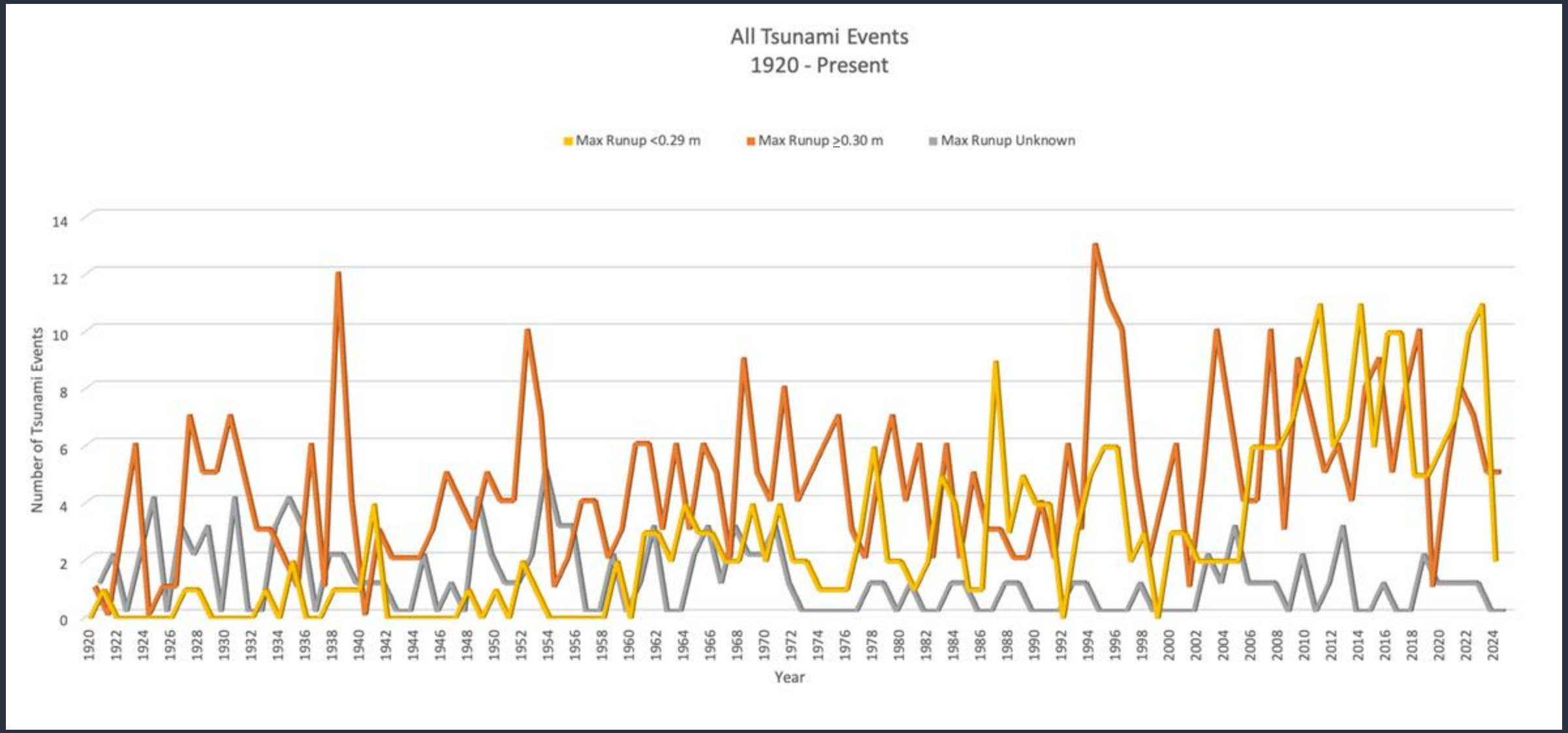
For the purposes of this discussion, events **below 0.3 meters** considered “small events”.

Criteria based NOAA’s Pacific Tsunami Warning Center User Guide (2014 ,2017), which has four categories of amplitudes relative to the tide: i) **less than 0.3** m, ii) 0.3 to less than 1 m, iii) 1 m to 3 m, and iv) greater than 3 m.

“A tsunami that is forecast to have less than 0.3 meter fluctuations from the tide level is generally not a hazard” (IOC, 2014)






All Tsunami Events
1920 - Present
Max Runup <0.29 m
Max Runup ≥0.30 m
Max Runup Unknown
Number of Tsunami Events
0
2
4
6
8
10
12
14
1920
1922
1924
1926
1928
1930
1932
1934
1936
1938
1940
1942
1944
1946
1948
1950
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024
Year

Challenges in collecting data

Global historical tsunami databases continue to expand on Soloviev and Go (1974, 1975), Iida (1984), and Landers and Lockridge (1989), as well as all the initiatives and data sharing of all ITST scientists.

However, global database are now very reliant on searching peer-reviewed publications for new information.

- Data scientists may not be aware of new publications
- Data in peer-reviewed publications not easily transferable to database format (Though significant improvements in consistency in recent years)
- Smaller localized events may only be reported in local media, and/or peer-reviewed journals not typically focused on tsunami science
- Language translation software exists, but still not aware of publication

Opportunities

At ICG/PTWS meetings, Member States report on “Information on Tsunami Occurrences”. **<u>This information is extremely important for global historical databases.</u>**

Existing Challenges:

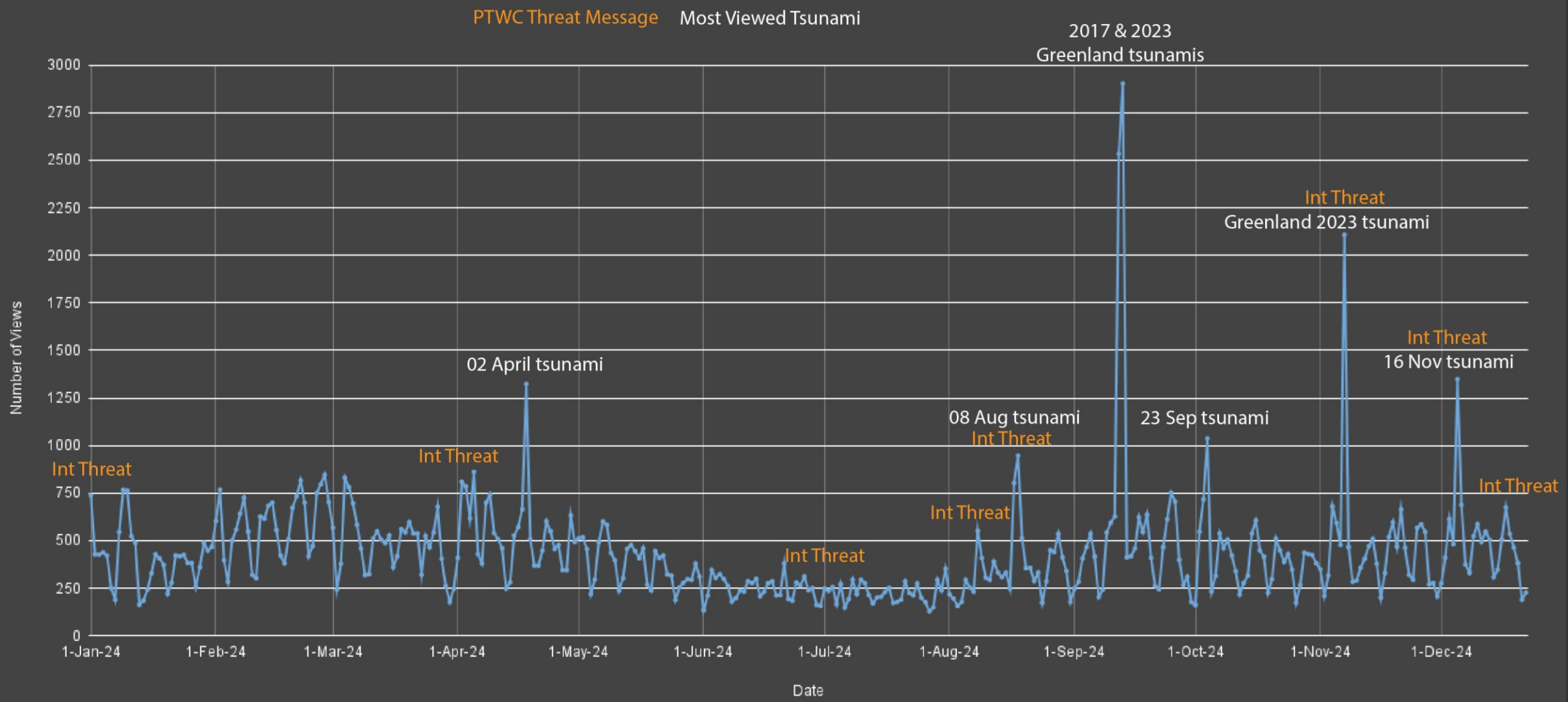
- typically national/government agencies, so researcher data analysis may not be included;
- limited observation data is provided but confirms tsunami occurrence;
- limited by number of Member States reporting.

UNESCO/IOC framework facilitated the development of the Post-Tsunami Survey Field Guide, led by ITIC. This guide has furthered consistency in data collection following a tsunami event.

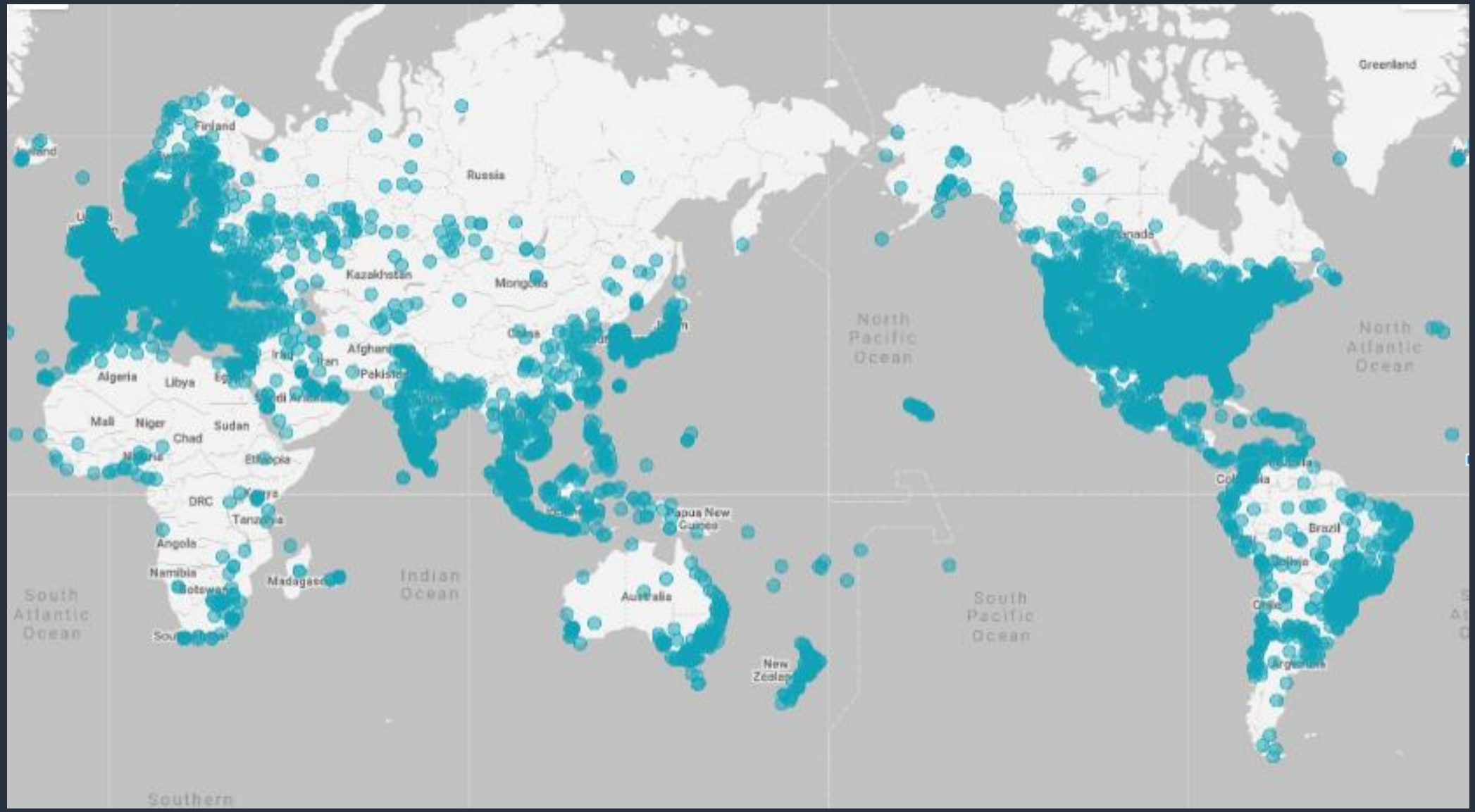
The International Tsunami Information Centre (ITIC) Tsunami Bulletin Board (*email listserv*)

Data effectively distributed for some events, including: 6 Feb 2023 (Kahramanmaraş), 15 Jan 2022 (Hunga Tonga-Hunga Ha'apai), 12 Aug 2021 (South Sandwich).

<u>This is a valuable data sharing platform that continues to be used by global historical databases.</u>



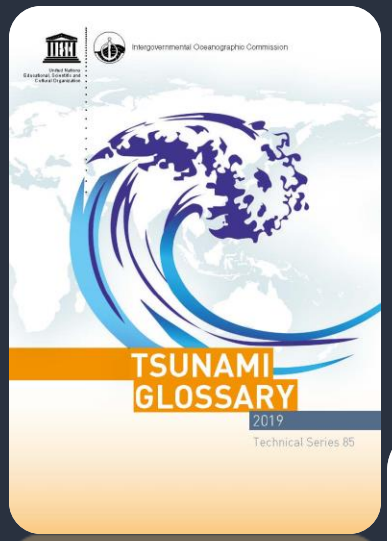
2024 NCEI/WDS Tsunami Database *views via search forms*: **156,000+**

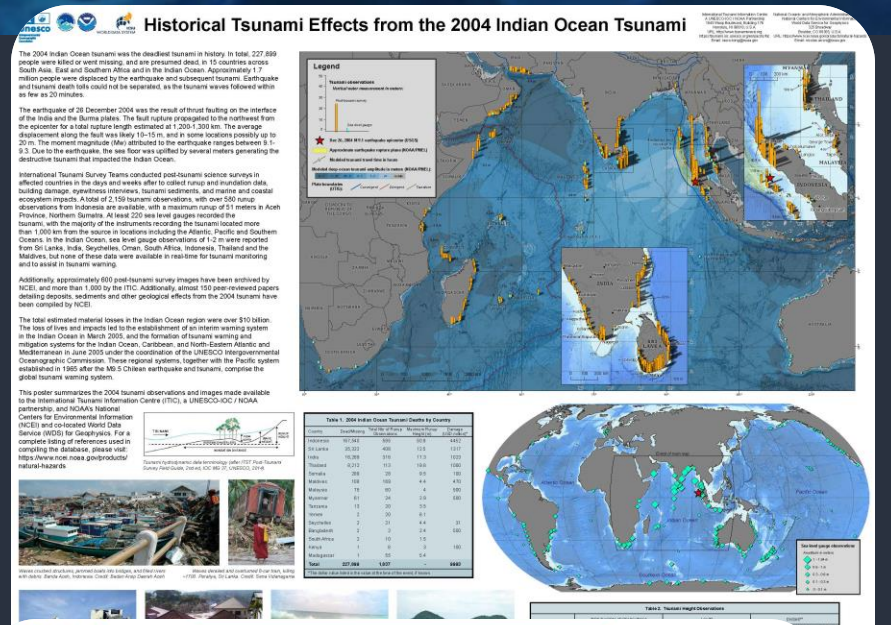


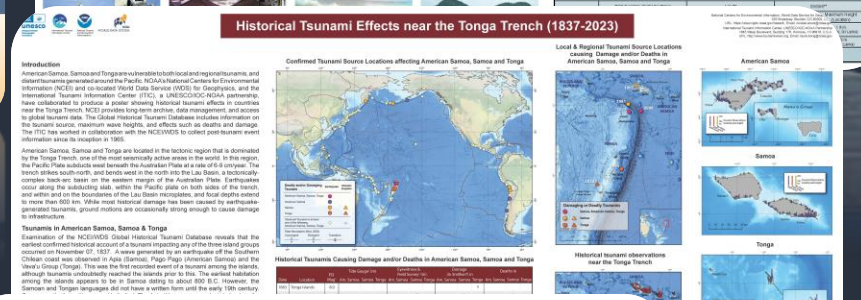
2024 NCEI/WDS Tsunami Database Unique Users: 93,000+ (*across 197 countries**)

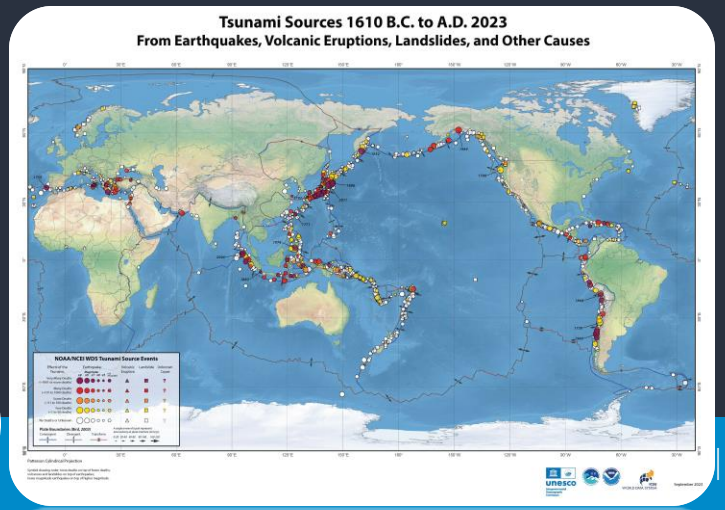
Partnership w/ ITIC

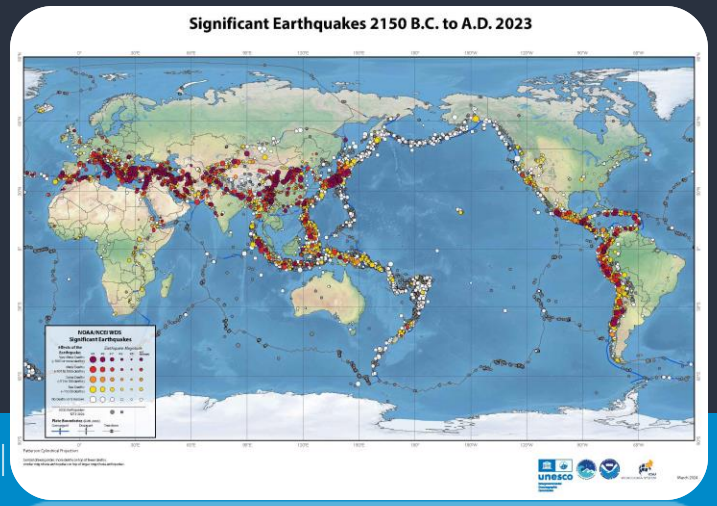
- Global posters - ***update***
  - Tsunami Sources
  - Significant Earthquakes
  - Significant Volcanic Eruptions
- Historical Tsunami Effects: 2004 Indian Ocean Tsunami poster- ***new***
- Historical Tsunami Effects: Tonga Trench (1837–2023) Poster – ***update***
- Tsunami Glossary - ***update***

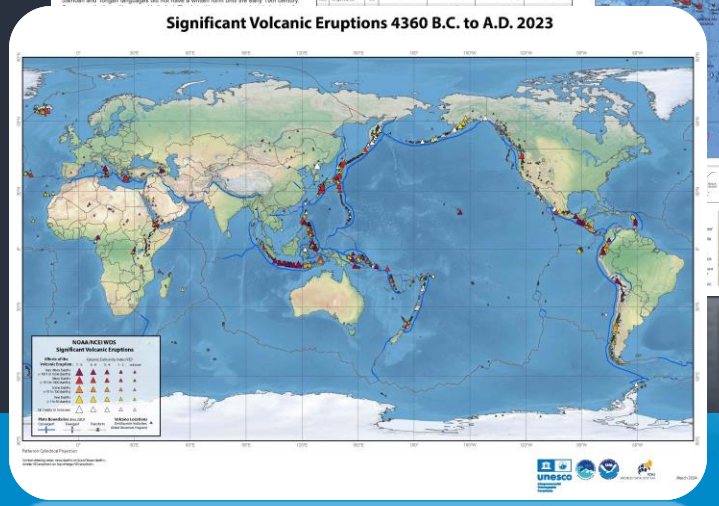












How to access NCEI/WDS tsunami data

Data download through search forms: https://www.ngdc.noaa.gov/hazel/

API: https://www.ngdc.noaa.gov/hazel/view/swagger

Natural Hazard Map Viewer: https://www.ncei.noaa.gov/maps/hazards/

Tsunami Interactive Time-lapse (since 1850): https://www.ncei.noaa.gov/maps/tsunami-events/

Map Services: https://gis.ngdc.noaa.gov/arcgis/rest/services/web_mercator/hazards/MapServer

Natural Hazards Images: https://www.ngdc.noaa.gov/hazardimages

DART® Bottom Pressure Recorder Data Inventory: https://www.ngdc.noaa.gov/hazard/dart/

https://www.ngdc.noaa.gov/hazard/bpr/ (pre-DART)

U.S. Tsunami Program Coastal Water Level Data Inventory: https://www.ngdc.noaa.gov/hazard/tide/

Questions?

nicolas.arcos@noaa.gov
haz.info@noaa.gov