USACE CODS WAVE INFORMATION STUDY (WIS)

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U.S. ARMY

US Army Corps of Engineers

CODS WAVE INFORMATION STUDY (WIS)

Outline:

1. WIS Purpose and Updates
2. FY23 USACE District WIS Applications
3. WIS Sources
4. WIS Data Portal Updates
    i. Select WIS Data Portal Products
    ii. FY23 WIS Data Portal User Analytics
5. FY23 USACE District WIS Projects

1: T. Frank, Apr 26, 2020: https://www.scientificamerican.com/article/storm-surge-maps-will-warn-coastal-residents-of-potential-deadly-floods/
2: World Meteorological Organization (WMO), 2022: https://public.wmo.int/en/our-mandate/focus-areas/natural-hazards-and-disaster-risk-reduction/storm-surge
3: S. Creange, Oct 7, 2016: https://www.highmountainchurch.org/storm-surge/

WIS PURPOSE AND UPDATES

PROBLEM

- Knowledge of the wave climatology is required for planning, design, construction, and maintenance of USACE projects in the coastal zone
- Information is scarce due to the lack of measurements at locations over timescales long enough to be statistically significant.
- This lack of information is a critical problem for USACE operations, and project maintenance near the coast.

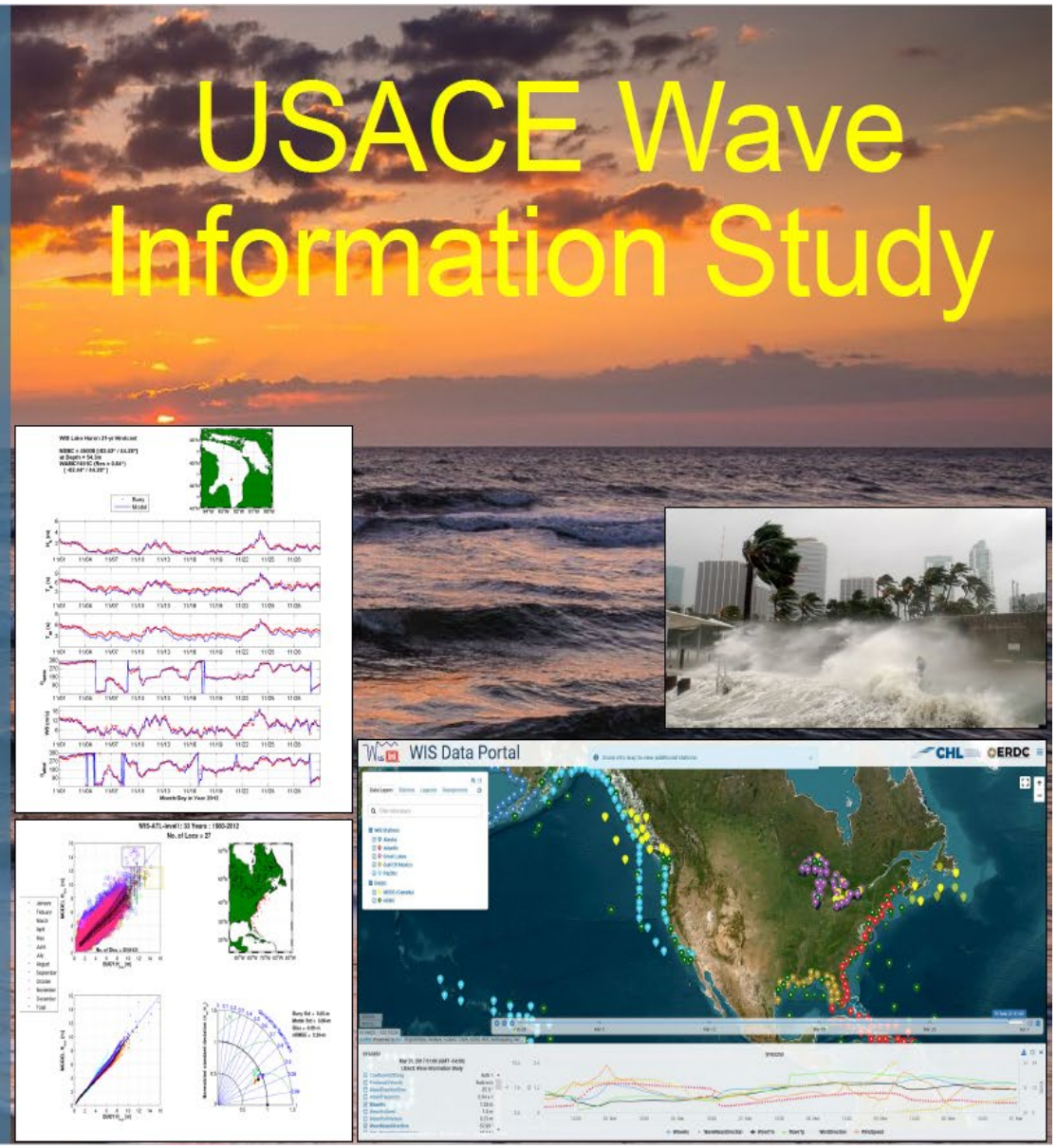
SOLUTION

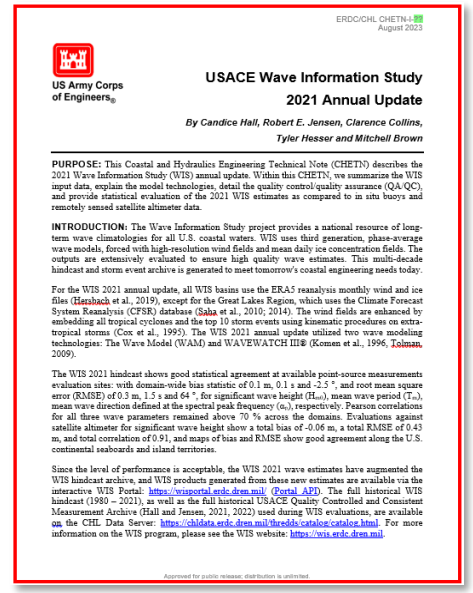
- Generation of long-term coastal wave estimates using spectral wave models forced by high quality wind fields
- Validation of the model estimates to all available in situ and remotely sensed observations
- Easy access to the WIS estimates and tailored, interactive products via the WIS Data Portal: https://wisportal.erdc.dren.mil/ and API: https://wisportal.erdc.dren.mil/wis-api/apidocs
- WIS email address: WISInfo@erdc.dren.mil

IMPACT

- Fully automated forty-year hindcast of wave climatologies at pre-selected output locations for all U.S. coastal waters, including the Great Lakes.
- Applications anywhere reliable hindcast wave climate information is needed for coastal risk management, civil works operations and planning, and coastal research
- These multi-decade hindcasts and storm event archives are generated to meet tomorrow's coastal engineering needs today.

April 2023





ERDC/CHL CHETN-I-
August 2023

US Army Corps of Engineers

USACE Wave Information Study 2021 Annual Update

By Candice Hall, Robert E. Jensen, Clarence Collins, Tyler Hesser and Mitchell Brown

PURPOSE: This Coastal and Hydraulics Engineering Technical Note (CHETN) describes the 2021 Wave Information Study (WIS) annual update. Within this CHETN, we summarize the WIS input data, explain the model technologies, detail the quality control/quality assurance (QA/QC), and provide statistical evaluation of the 2021 WIS estimates as compared to in situ buoys and remotely sensed satellite altimeter data.

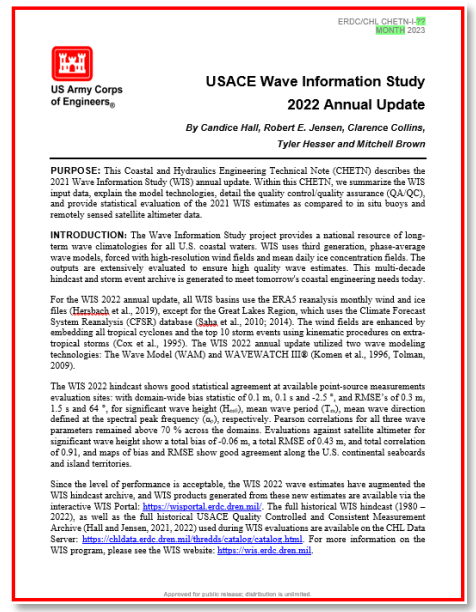
INTRODUCTION: The Wave Information Study project provides a national resource of long-term wave climatologies for all U.S. coastal waters. WIS uses third generation, phase-average wave models, forced with high-resolution wind fields and mean daily ice concentration fields. The outputs are extensively evaluated to ensure high quality wave estimates. This multi-decade hindcast and storm event archive is generated to meet tomorrow's coastal engineering needs today.

For the WIS 2021 annual update, all WIS basins use the ERA5 reanalysis monthly wind and ice files (Hersbach et al., 2019), except for the Great Lakes Region, which uses the Climate Forecast System Reanalysis (CFSR) database (Saha et al., 2010; 2014). The wind fields are enhanced by embedding all tropical cyclones and the top 10 storm events using kinematic procedures on extra-tropical storms (Cox et al., 1995). The WIS 2021 annual update utilized two wave modeling technologies: The Wave Model (WAM) and WAVEWATCH III® (Komen et al., 1996, Tolman, 2009).

The WIS 2021 hindcast shows good statistical agreement at available point-source measurements evaluation sites: with domain-wide bias statistic of 0.1 m, 0.1 s and -2.5 °, and root mean square error (RMSE) of 0.3 m, 1.5 s and 64 °, for significant wave height (H_{m0}), mean wave period (T_m), mean wave direction defined at the spectral peak frequency (α_0), respectively. Pearson correlations for all three wave parameters remained above 70 % across the domains. Evaluations against satellite altimeter for significant wave height show a total bias of -0.06 m, a total RMSE of 0.43 m, and total correlation of 0.91, and maps of bias and RMSE show good agreement along the U.S. continental seaboards and island territories.

Since the level of performance is acceptable, the WIS 2021 wave estimates have augmented the WIS hindcast archive, and WIS products generated from these new estimates are available via the interactive WIS Portal: https://wisportal.erdc.dren.mil/ (Portal API). The full historical WIS hindcast (1980 – 2021), as well as the full historical USACE Quality Controlled and Consistent Measurement Archive (Hall and Jensen, 2021, 2022) used during WIS evaluations, are available on the CHL Data Server: https://chldata.erdc.dren.mil/thredds/catalog/catalog.html. For more information on the WIS program, please see the WIS website: https://wis.erdc.dren.mil.

Approved for public release; distribution is unlimited.



ERDC/CHL CHETN-I-
MONTH 2023

US Army Corps of Engineers

USACE Wave Information Study 2022 Annual Update

By Candice Hall, Robert E. Jensen, Clarence Collins, Tyler Hesser and Mitchell Brown

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Top 10 CW Products

WIS PURPOSE AND UPDATES

- **The Wave Information Study (WIS) program provides a national resource of long-term wave climatologies at pre-selected output locations for all U.S. coastal waters, including the Great Lakes.**

- Full historical WIS hindcast (1980 – 2022)
- Full historical USACE QCC Measurement Archive (1980 – 2022)

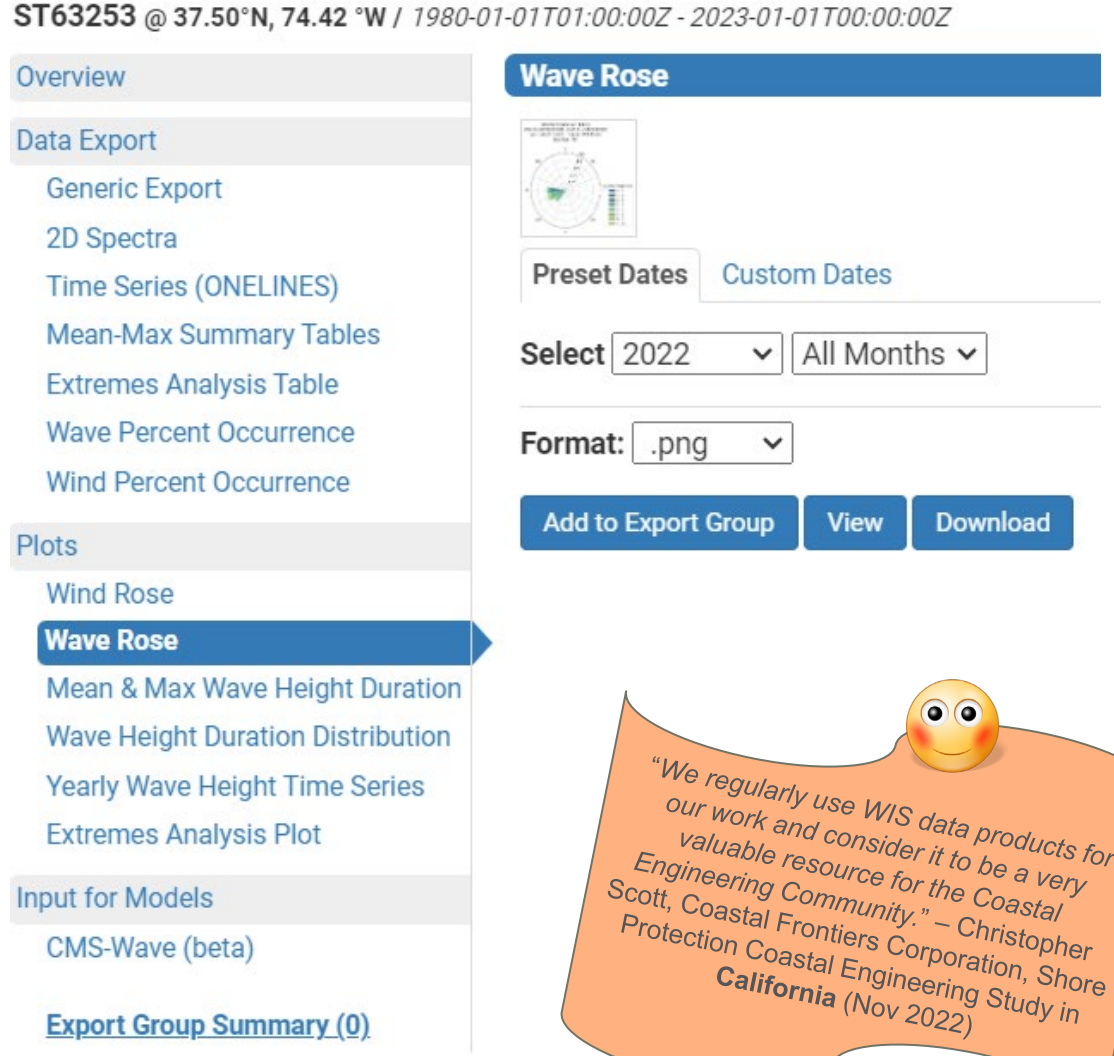
- **WIS Data Portal Products:**

  - **Standard variables**: Hindcast wave estimates (height, wave period, and direction), directional spectral estimates, as well as many, many more...

  - **Interactive products**: 2D Spectra, Mean-Max wave height summaries, extreme analyses and wind/wave percent occurrences (tables and plots).

  - **Model inputs**: CMS-Wave beta testing phase - this tool takes wave energy spectra information from the WIS estimate station and transforms that spectrum to one that represents an offshore location which is closer to land (and at a shallower depth).

- **Ultimately, these multi-decade hindcasts and storm event archives are generated to meet tomorrow's coastal engineering needs today**.



"We regularly use WIS data products for our work and consider it to be a very valuable resource for the Coastal Engineering Community." – Christopher Scott, Coastal Frontiers Corporation, Shore Protection Coastal Engineering Study in **California** (Nov 2022)

FY23 USACE DISTRICT WIS APPLICATIONS

Applications: Anywhere reliable hindcast wave climate information is needed for coastal risk management, civil works operations and planning, and coastal research studies.

Emergency Management / O&M

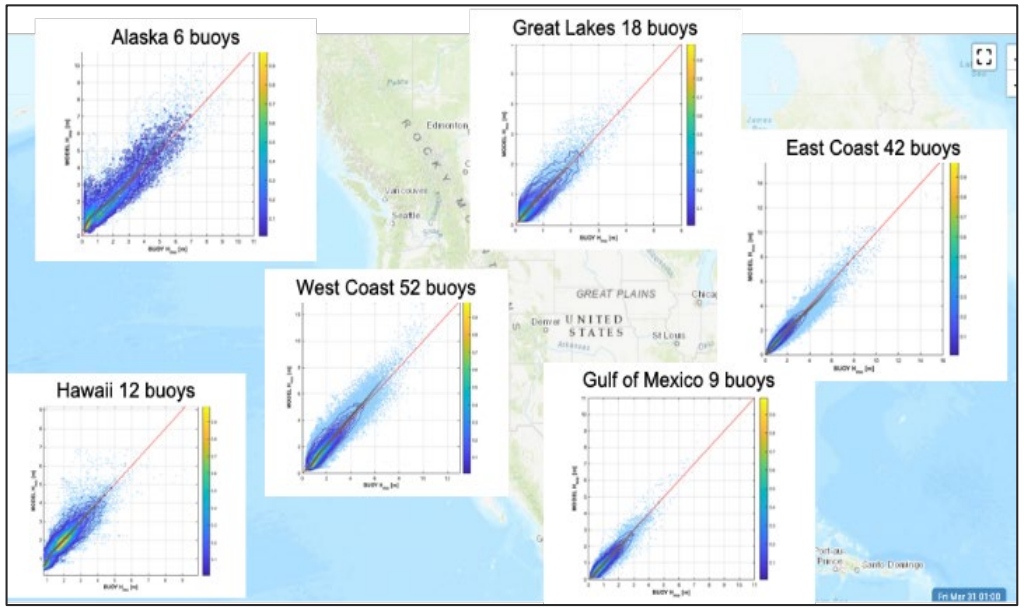
Coastal Structures / Harbors

Beach Protection

Ship Design

Select FY23 uses:

1. Coastal Flooding Emergency Management - rapid estimates of potential coastal flooding at higher water levels
2. Site-specific wave climate – summary statistics for both extreme analysis and typical conditions – easy-access, visual tools to communicate to the public
3. Design of coastal structures - wave conditions at design phase and feasibility phases
4. Harbor performance metrics - Used to define deep water boundary conditions for wave modeling to determine design wave heights and evaluate harbor performance - estimate durations of time waters adjacent to the project site were calm enough for different classes of vessels to operate to support economic analysis of the harbors.
5. Revetment design – nearshore extreme wave heights and periods
6. Beach run-up simulations – offshore wave conditions
7. Rip Currents - correlation of offshore WIS data to nearshore wave data
8. Nearshore wave modeling forcing
9. Ship motion models – seaway statistics



Ocean and Great Lake Coastal Protection

10. Geomorphic vulnerability index – Wave climate information to identify vulnerable locations around Lake Michigan.

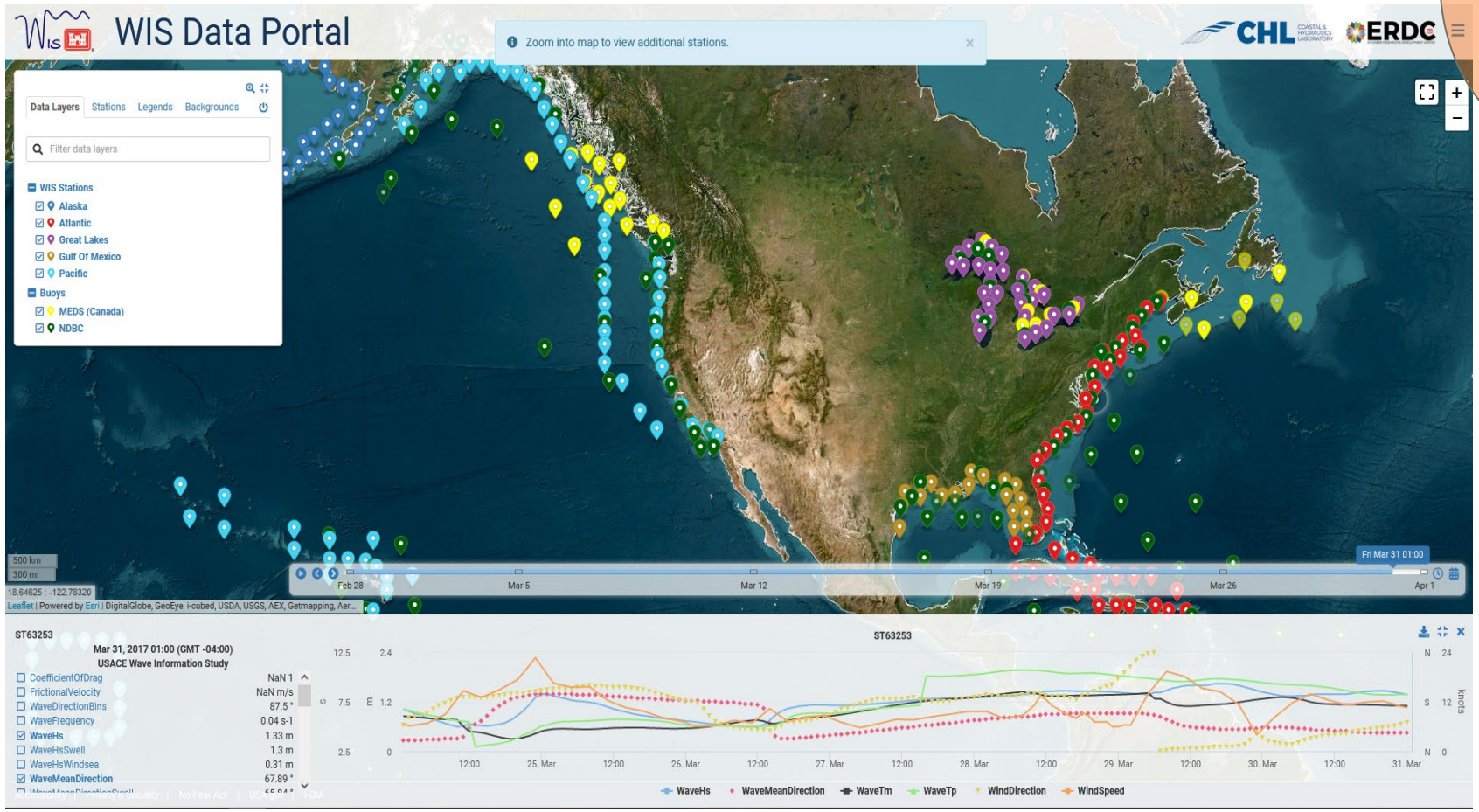
11. Sediment Transport / Beneficial use of dredged sediment – transformed the WIS hindcasts to the nearshore and estimate the sediment transport capability of a site for the beneficial use of dredged sediment.

WIS SOURCES

1. WIS Program website: https://wis.erdc.dren.mil. Informational (no data), link to the WIS Portal.
2. WIS Data Portal: https://wisportal.erdc.dren.mil/. Interactive, data download.
3. WIS Data Portal API: https://wisportal.erdc.dren.mil/wis-api/apidocs
4. CHL Data Server (Thredds): https://chlthredds.erdc.dren.mil/thredds/catalog/catalog.html
5. WIS V&V: USACE Quality Controlled Consistent (QCC) Measurement Archive (NDBC & Canadian MEDS): https://chldata.erdc.dren.mil/thredds/catalog/buoys/catalog.html

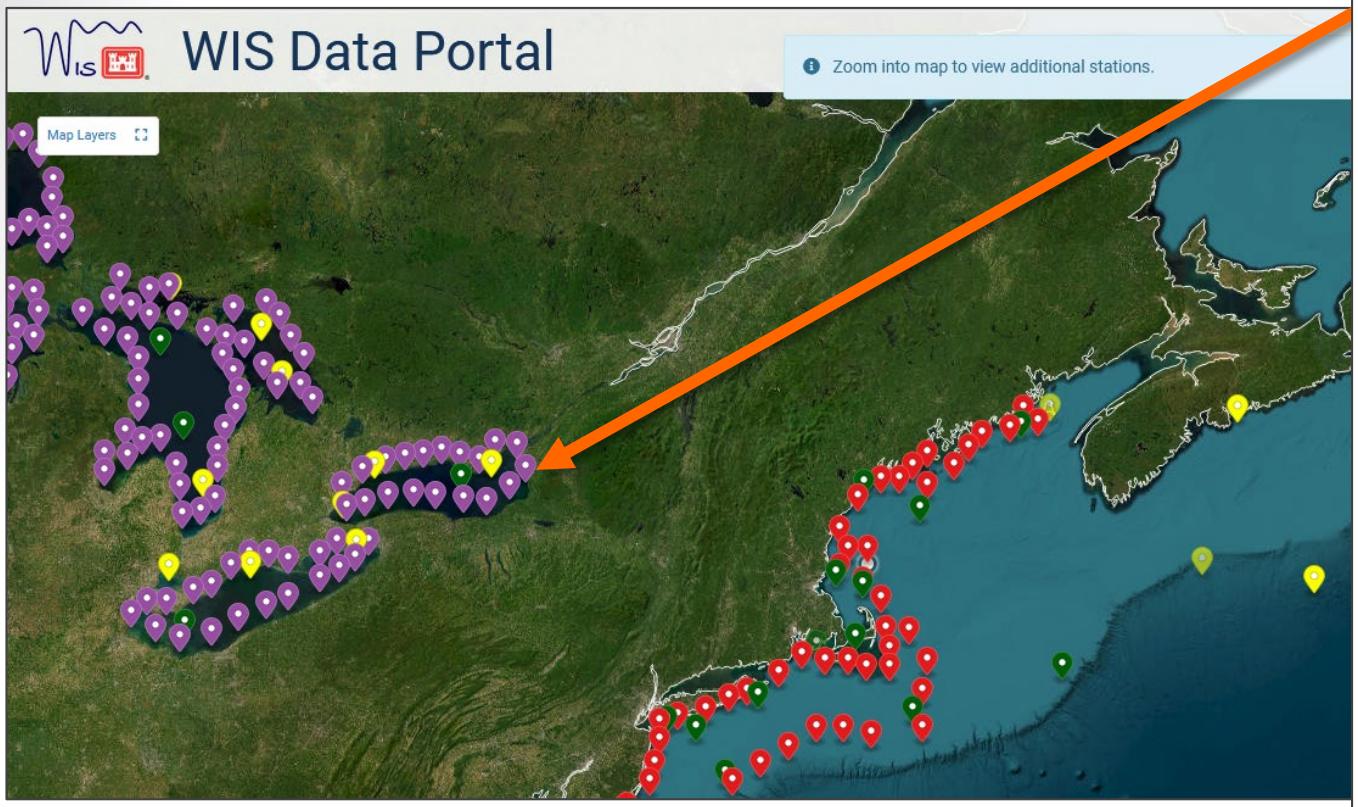
"I really like the new and improved portal and products. Thank you!" – Beth Sciaudone, Moffatt & Nichol, **North Carolina** (May 2023)

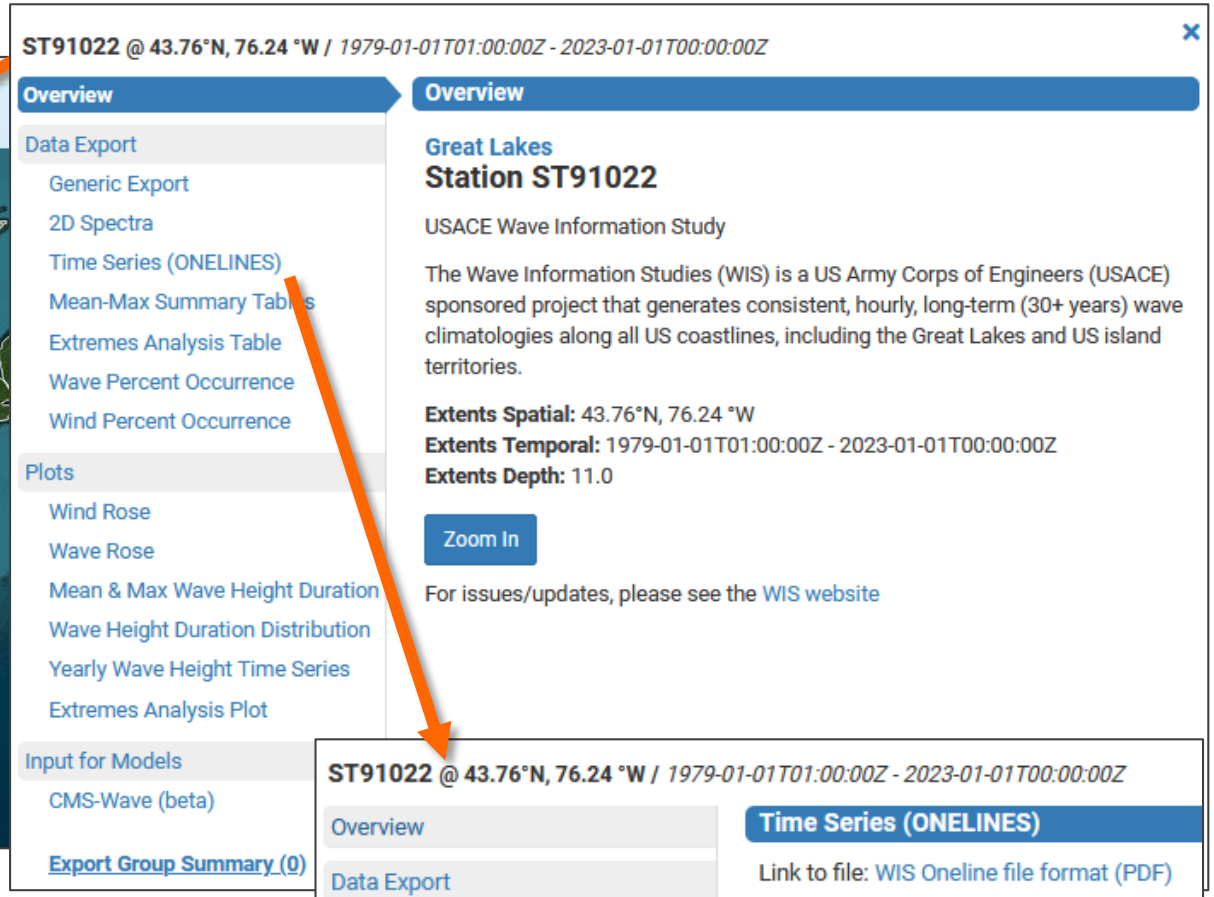
"Thank you so much. This WIS database is such a great asset for practicing engineers." – Rajesh Srinivas, project in **St. John County**, **Florida** (Oct 2022)

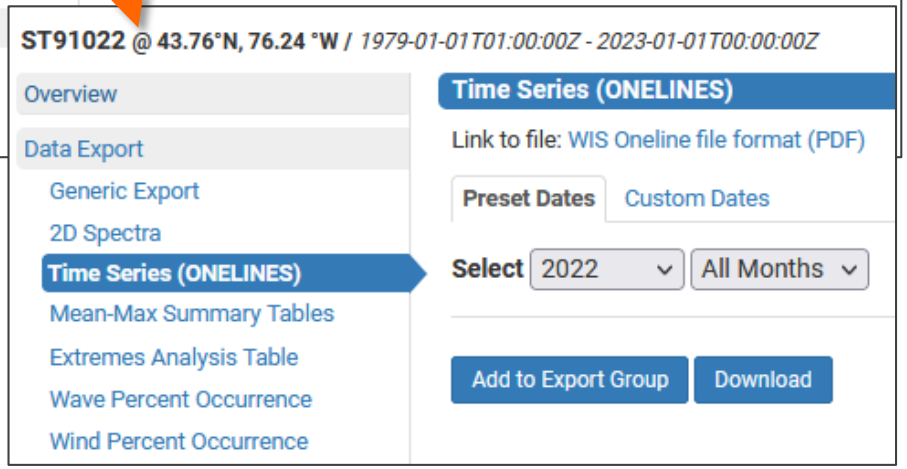


"*We greatly appreciate your efforts and the WIS products that helps us in designing the best shore protection for the **Great Lakes***" – Mauricio Wesson, SmithGroup (Sep 2023)

WIS DATA PORTAL UPDATE



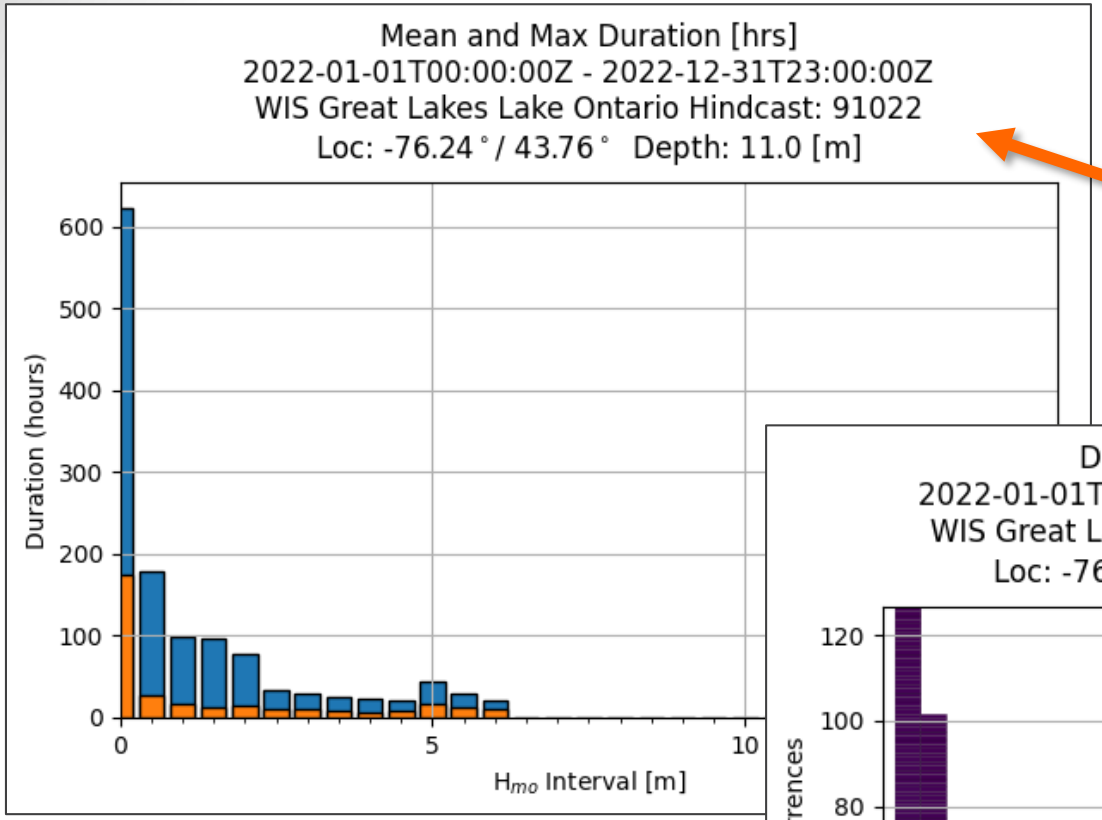


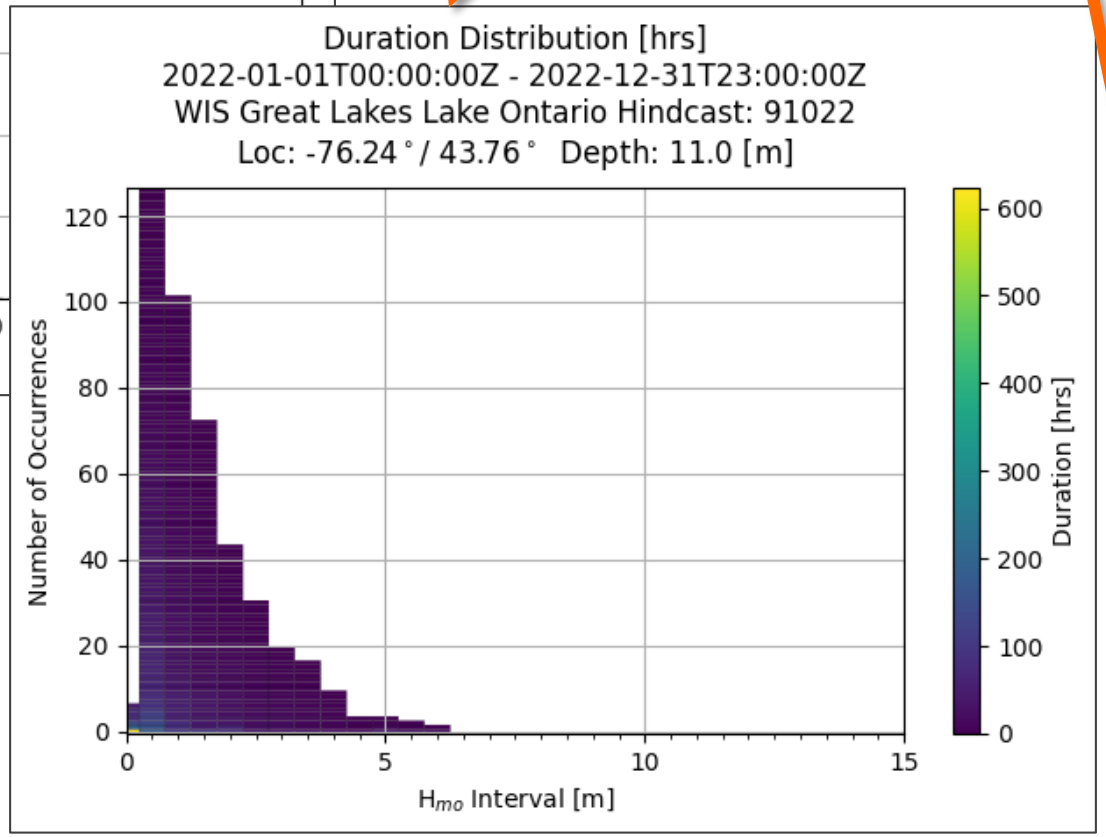


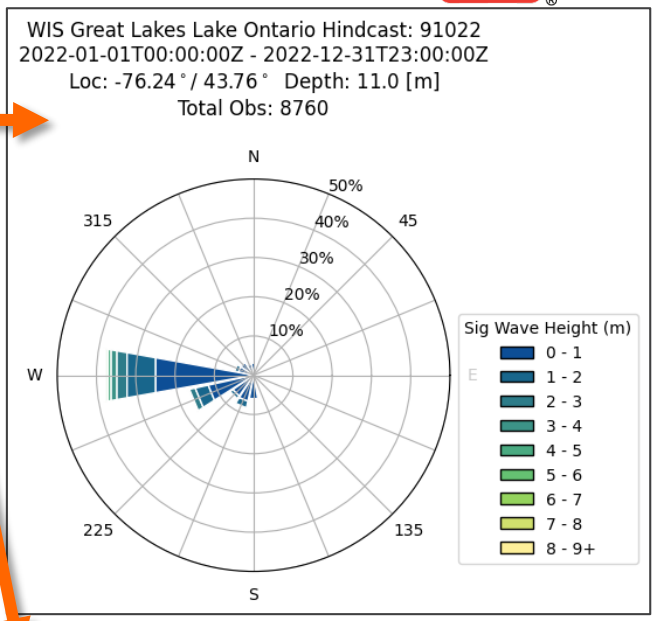
Zoom capabilities to isolate a WIS or Buoy Site

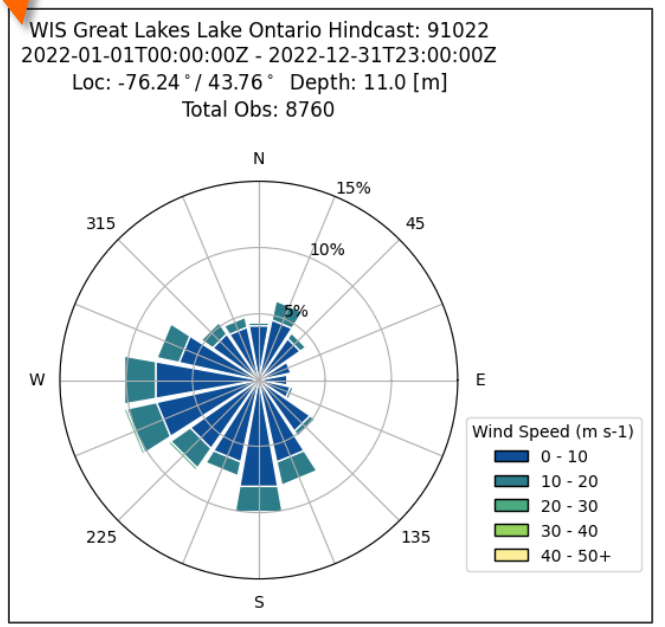
- Download preset or custom POR – All Years & All Months; Select Year & All months; All Years & Select Month.
- Static and interactive product generation – For all tables and plots
- Export individual or Group products – For tables: .csv or .nc; for plots: .png, .svg. or .pdf.

SELECT WIS DATA PORTAL PRODUCTS



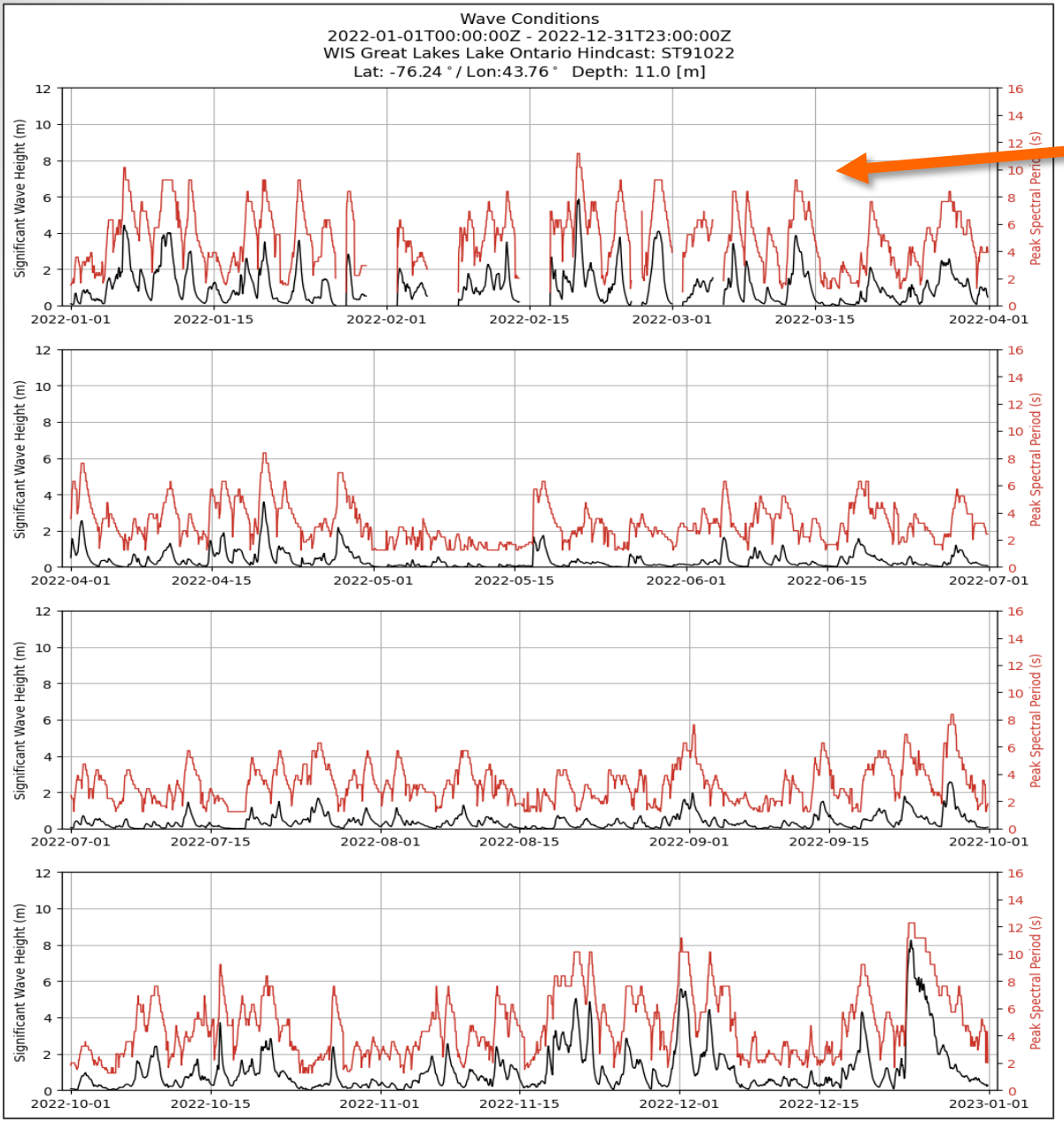






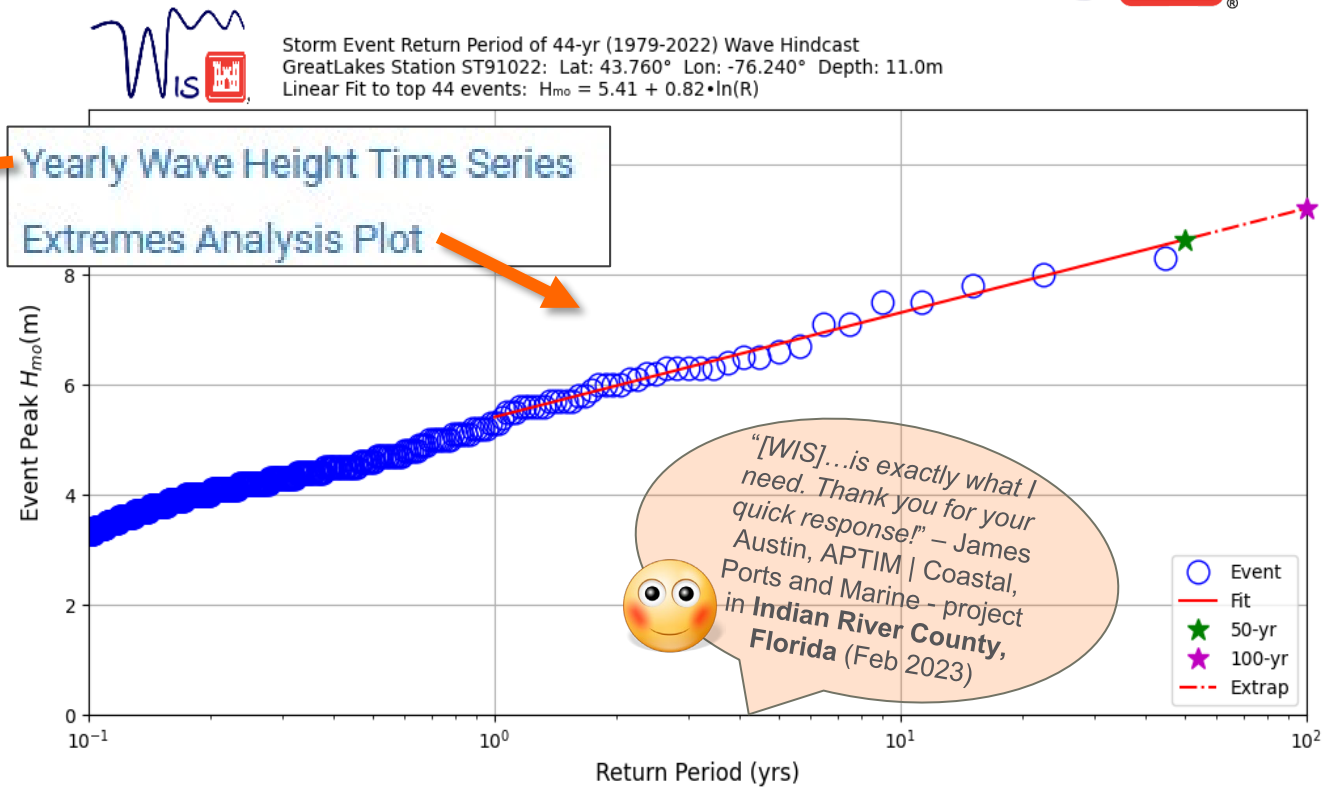
"Special thank you for taking the time to resolve, educate, and delivery the data. Your WIS portal is so valuable for what engineers do in-and-around our coastal environments. I look forward to using the data and applying the results to real world projects"– Joel Amendolara, SmithGroup – project in the **Great Lakes** (Sep 2023)

SELECT WIS DATA PORTAL PRODUCTS



Yearly Wave Height Time Series

Extremes Analysis Plot



"[WIS]…is exactly what I need. Thank you for your quick response!" – James Austin, APTIM | Coastal, Ports and Marine - project in **Indian River County, Florida** (Feb 2023)

Top 10 Events based on Peak H_{mo}

Event	Date/Time(UTC)	H_{mo}	T_p	θ_{mean}	Event	Date/Time(UTC)	H_{mo}	T_p	θ_{mean}
1	2019/11/01 11:00	8.0	12.1	260.0	6	2021/12/12 04:00	7.1	11.8	261.0
2	2019/02/25 12:00	7.8	12.1	260.0	7	2018/04/04 23:00	6.7	11.2	260.0
3	2003/11/13 17:00	7.5	11.9	260.0	8	2013/01/31 16:00	6.6	11.2	260.0
4	1979/04/06 20:00	7.5	11.9	259.0	9	2013/01/20 16:00	6.5	11.1	260.0
5	2000/12/18 07:00	7.1	11.2	259.0	10	2011/10/16 02:00	6.5	11.1	260.0

An event is defined as any period when H_m > 1.00m

θ_{mean} is direction that waves are arriving from

SELECT FY23 USACE DISTRICT WIS PROJECTS

1. **Port of Nome** Modification, Phase 1 design (**Alaska District**)
2. **Barrow** Coastal Erosion, Phase 1 design (**Alaska District**)
3. **Akutan Harbor** Tribal Partnership Program Study (**Alaska District**)
4. **Dutch Harbor** Navigation Channel Feasibility Study (**Alaska District**)
5. **Elim Harbor** Tribal Partnership Program Feasibility Study (**Alaska District**)
6. **St George Harbor** GI Feasibility Study (**Alaska District**)
7. **Kodiak Island Airport** Runway Extension (**Alaska District**)
8. **St George Breakwater** Repairs (HDR, Inc., for the **Alaska District**)
9. **Little Diomede Helipad** Improvements (**State of Alaska DOT**)
10. **East Hagatna**, Guam Section 14 Study (**Honolulu District**)
11. **Ofu Airport**, Am Samoa Section 14 Study (**Honolulu District**)
12. Agat Mayors Office, **Guam** Section 14 Study (**Honolulu District**)
13. **Agat Bay** Regional Shoreline Assessment (**Honolulu District**)
14. American Samoa Climate Change Vulnerability Study (**Honolulu District**)
15. **Laupahoehoe Harbor** Breakwater Repair Final Design Report, Island of Hawaii (**Honolulu District**)
16. **Haleiwa Harbor** and Shore Protection Project, RSM and Section 1122 Beneficial Use Studies (**Honolulu District**)
17. **Hilo Harbor** Breakwater Resiliency Study (**Honolulu District**)
18. **Saipan**, Beach Rd. CSRM FS (**Pacific Ocean Division**)
19. **East San Pedro** Ecosystem Restoration FS (**Los Angeles District**)
20. **San Diego County** Shoreline CSRM FS (**Los Angeles District**)
21. **Carpinteria [California]** Shoreline CSRM FS (**Los Angeles District**)
22. **Westward Beach** Shore Protection Coastal Engineering Study (**Los Angeles County Department of Beaches and Harbors**)
23. **Adamson Wall** Shore Protection Coastal Engineering Study (**Los Angeles County Department of Beaches and Harbors**)
24. **Bay Mills** Feasibility Study (**Detroit District**)
25. **Holland** Rip Current Study (**Detroit District**)
26. **Grand Haven** Wave Absorber Design (**Detroit District**)
27. **Keweenaw Stamp** Sands Feasibility Study (**Detroit District**)
28. **Lexington Harbor** Planning Assistance to States Study (**Detroit District**)
29. Community fact sheets for outreach events with the State of **Michigan** (**Detroit District**)
30. **Marshal Islands - Kwajalein Atoll Shoreline Protection** (HDR, Inc. for the **U.S. Army Space and Missile Defense Command**)
31. **Monroe County** Roadway Vulnerability Assessment (HDR, Inc., for **Monroe County Sustainability Office**)

QUESTIONS

For more info: WISinfo@usace.army.mil

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WIS

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