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Outline:

- 1. USACE ERDC CHL Wave Information Study (WIS) - brief overview
- 2. USACE National Coastal Wave Climate
- 3. USACE Quality Controlled, Consistent (QCC) Measurement Archive
  - 1. National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) National Data Buoy Center (NDBC)
  - Fisheries and Oceans Canada Marine Environmental Data Section (MEDS)





National Oceanic and Atmospheric Administration's National Data Buoy Center Center of Excellence in Marine Technology











## Research Oceanographer, Coastal Processes Branch

- PI responsibilities for USACE projects:
  - National Coastal Wave Climate (NCWC) work unit
  - Wave Information Study (WIS) operational and R&D work units



#### PROBLEM

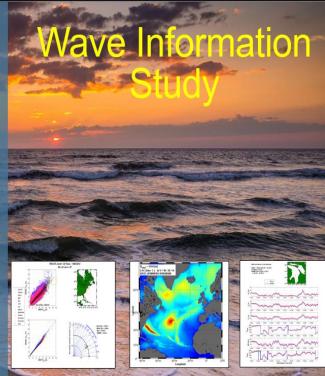
- Knowledge of the wave climatology is required for planning, design, construction, and maintenance of USACE projects in the coastal zone
- Information is scarce due to the lack of measurements at locations over timescales long enough to be statistically significant
- This lack of information is a critical 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, to retain continuity
- Validate the model estimates to measurements
- Provide easy access to the estimates and tailored products specific to project needs

#### IMPACT

- Fully automated hindcast system with limited manual intervention
- Model simulations cost-effective compared
- measurements
- Timely web site updates with new wave estimates



- The Wave Information Study (WIS): wave climatology needed for planning & design, construction & maintenance of USACE coastal projects – observations too expensive, so WIS fills in the gaps
- WIS provides long-term (~1970) wave estimates along all US coasts, including the Great Lakes, for pre-selected output locations
- Hindcast wave estimates (height, wave period, and direction) and directional spectral estimates
- USACE ERDC CHL WIS Portal: <u>https://wisportal.erdc.dren.mil/</u>

NATIONAL COASTAL WAVE CLIMATE (NCWC)

## FY20-22 THRUSTS

Question: How accurate are the wave measurement data that are used for USACE WIS validation, wave related R&D and wave model improvements?

Goal: Clean Data for Assimilation – USACE wave applications and climate trend analyses

- A. Observational data storage errors develop a clean, quality controlled measurement archive.
  - NOAA NWS National Data Buoy Center (NDBC)
  - Fisheries and Oceans Canada Marine Environmental Data Section (MEDS)
- Uses: Instrument and Platform evaluations:
  - NDBC hull size and wave instrumentation variations

Uses: Wave Power Trends:

Using USACE QCC measurement archive and WIS data to track spatial and temporal variation in wave fields.











National Oceanic and Atmospheric Administration's **National Data Buoy Center** Center of Excellence in Marine Technology

# A. NDBC OBSERVATIONAL DATA STORAGE SOURCES



### NOAA NWS National Data Buoy Center (NDBC)

- Cleanest data manually QC by NDBC MCC data analysts.
- Individual annual files for stdmet and spectral data formats differ over the years
- No metadata besides date and time, e.g. no GPS positions or instrumentation metadata
- No secondary (redundant) sensor data
- Contains unidentifiable data from:
  - time periods where the buoys were adrift
  - during service periods (when the buoys were physically on board ships for maintenance)
- No uncorrected spectral data (c<sup>m</sup><sub>11</sub>), which is necessary if the user would like to calculate their own integral wave data

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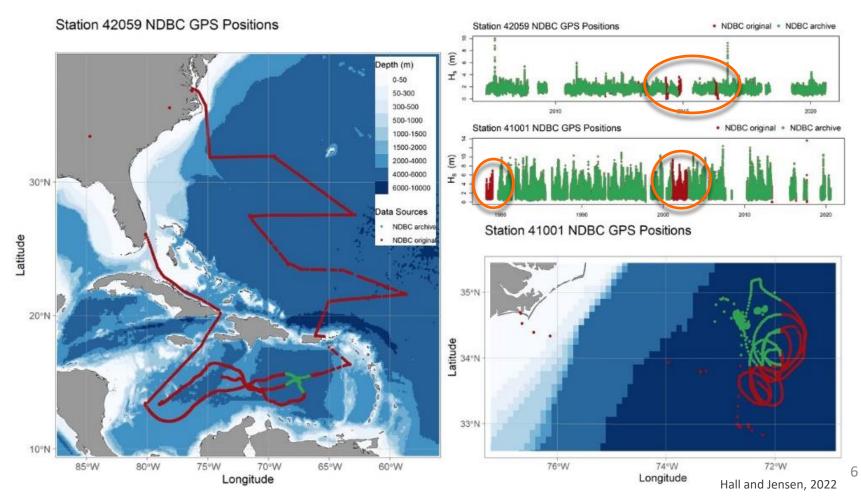
## NOAA National Center for Environmental Information (NCEI)

- Official archived for NOAA, i.e. the 'best' NDBC data
- Data pulled from real-time NDBC data stream - subjected to a very broad, automatic QC protocols
- Single year\_month netCDF file for all data – formats differ over the years
- Includes metadata, e.g. GPS positions and instrumentation metadata
- Instrumentation metadata is inconsistent throughout the years, as well as within each file's payloads
- Includes primary and secondary sensor outputs
- Contains identifiable data from
  - time periods where the buoys were adrift
  - during service periods (when the buoys were physically on board ships for maintenance).
- Includes all spectral wave information, including uncorrected spectral data (c<sup>m</sup><sub>11</sub>)

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ψ tre         tre         D           ψ tret2         be manuta tree         D           ψ tree_yen_20         tree         D           ψ tree_yen_20         tree         D           ψ tree_yen_20         tree         D           ψ tree_yen_20         tree set street free_gency         D           ψ tree_yen         tree set street free_gency         D	▷ Disave_sensor_1	payload_2/wave_sensor_1	-
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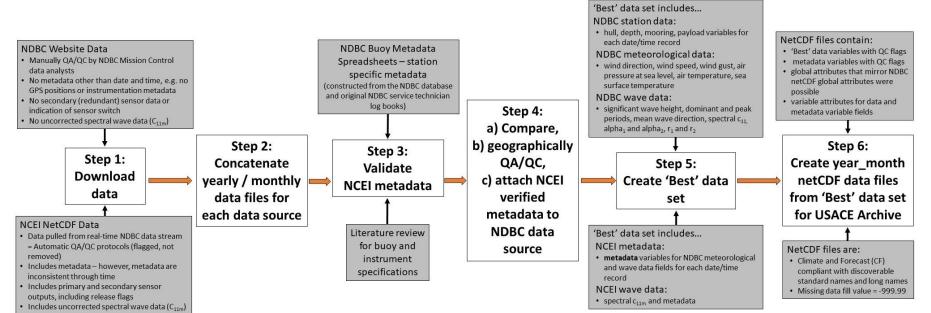
# A. NDBC OBSERVATIONAL DATA STORAGE ERRORS

## NDBC Stations 42059 and 41001 locations before and after geographical QA/QC



A. NDBC OBSERVATIONAL DATA STORAGE ERRORS

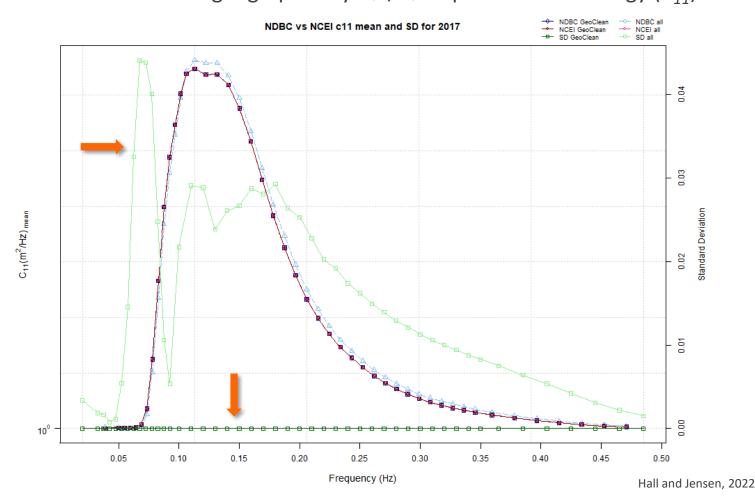




netCDF formats change frequently over time



## NDBC station 41008 geographically QA/QC spectral wave energy $(C_{11})$







www.nature.com/scientificdata

(1) Check for updates

#### Both re-published in the UNESCO / IOC Ocean Best **Practices (OBP) Repository:**

Repository of community practices in Ocean Research. Applications and Data/Information Management https://repository.oceanbestpractices.org/

Hall, C. & R.E. Jensen. 2022. USACE Coastal and Hydraulics Laboratory Quality Controlled, Consistent Measurement Archive. Scientific Data 9:248. https://doi.org/10.1038/s41597-022-01344-z

OBP Repo: https://repository.oceanbestpractices.org/handle/11329/2063



Hall, C. & R.E. Jensen. 2021. Utilizing Data from the NOAA National Data Buoy Center. ERDC/CHL CHETN-I-100. Vicksburg, MS: U.S. Army Engineer Research and Development Center. http://dx.doi.org/10.21079/11681/40059 **OBP** Repo: http://dx.doi.org/10.25607/OBP-1087



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Utilizing Data from the NOAA National Data Buoy Center

By Candice Hall and Robert E. Jensen

ERDC/CHL CHETN-I-??

**MONTH 2021** 

PURPOSE: This Coastal and Hydraulics Engineering Technical Note (CHETN) guides users through the quality control (QC) and processing steps that are necessary when using archived U.S. National Oceanic and Atmospheric Administration (NOAA) National Data Buoy Center (NDBC) wave and meteorological data. This CHETN summarizes methodologies to geographically clean and QC NDBC measurement data for use by the U.S. Army Corps of Engineers (USACE) user community.

INTRODUCTION: The USACE acknowledges that "Estimates of wave conditions are needed in almost all coastal engineering studies" (USACE 2002, II-1-1). The expense to monitor waves along all U.S. coasts can become cost prohibitive; however, the importance of wave measurements is real. The USACE has adopted a paradigm of strategically positioning wave measurement sites to maximize their effectiveness and filling in the gaps with model estimates. To satisfy this requirement, in the 1970s, the USACE developed the Wave Information Studies (WIS) that computes long-term (over 4 decades), hourly wave estimates along all U.S. coastlines, including the Great Lakes and U.S. island territories (USACE 2020).

The WIS wave estimates require in situ buoy wave data for validation and calibration similar to that of Ortiz-Royero and Mercado-Irizarry (2008); Reguero et al. (2012); Rusu and Guedes Soares (2012); Van Nieuwkoop et al. (2013); Stopa and Cheung (2014); Stopa and Mouche (2016). One source of WIS validation data is the NDBC network of meteorological and wave measurement buoys.

NDBC has deployed buoys with wave measurement capabilities around the U.S. coastline and the Great Lakes since the 1970s. Long-term time series data from a single buoy site have experienced multiple instrumentation modifications and data archival upgrades with advances in technology. Between 1970 and 2020, NDBC has deployed at least eight directional wave measurement systems for operational or experimental use (e.g., Steele et al. 1985; NDBC 1996; NDBC 2003; Teng et al. 2007; Crout et al. 2008; Teng et al. 2009; Riley et al. 2011; Hall et al. 2018a; Riley et al. 2019).

While NDBC has worked hard to minimize the effects of the modifications on its data (e.g., Teng and Timpe 1995; Teng et al. 2007; Riley and Bouchard 2015; Hall et al. 2018a), different versions of these data are archived in multiple online locations, each with their own set of storage protocols. If these data are used without prior knowledge of these archival idiosyncrasies, use of the measured data in wave-related research activities may be compromised. This CHETN summarizes the steps required to achieve the best available time-series datasets for all buoy data collected by NDBC since the 1970s

Approved for public release; distribution is unlimited



#### **OPEN** USACE Coastal and Hydraulics DATA DESCRIPTOR Laboratory Quality Controlled, **Consistent Measurement Archive**

Candice Hall (21,2 22 & Robert E. Jensen

The US Army Corps of Engineers (USACE) utilizes the National Oceanic and Atmospheric Administration (NOAA) National Data Buoy Center (NDBC) buoy measurements for validation of their wave models and within coastal applications. However, NDBC data are accessible via multiple archives; each with their own source-specific storage, metadata, and guality control protocols, which result in inconsistencies in the accessible data. Therefore, USACE has developed an independent, quality controlled, consistent (QCC) Measurement Archive that captures the best available NDBC observations with verified metadata. This work details the methodology behind this USACE QCC Measurement Archive showcasing improvements in data quality via geographical location and wave parameter examples Note that this methodology only removes known erroneous data, it does not verify data quality from an alternate source. This self-describing, USACE QCC Measurement Archive therefore provides a database of consistently stored, geographically QA/QC'd NDBC data and metadata.

#### Background & Summar

One of the U.S. Army Corps of Engineers (USACE) missions is to oversee operations and maintenance activitie in the coastal waters of the U.S. These activities include sediment transport, hardened structures, harbor navigability, climate resilience and coastal protection, all of which require knowledge and assessment of the wave climate. For practical assessments, USACE wave related technologies require accurate and homogeneous wave measurements from in stiu observational platforms.

To that end, USACE sponsored an investigation into uncertainty errors in the wave measurement systems that are used for evaluating products such as their Wave Information Study (WIS), a wave hindcast effort that serves as the basis for resolving the U.S. wave climate. Of particular interest are measurement errors that may compromise wave model evaluations. These errors may be indistinguishable from wind forcing or wave model deficiencies, and may transfer into other USACE wave and coastal applications.

One source of validation data is the National Oceanic and Atmospheric Administration (NOAA) National Data Buoy Center (NDBC) in situ buoy meteorological and wave measurements. As of 2022, NDBC publishes their data via two different streams: real time and historical. The real time data feed undergoes broad, automated QA/QC protocols' to meet emergency management and forecasting agency latency commitments that require swift publication to the Global Telecommunications System (GTS). These 'Real Time Data' files are also published within individual stations pages on the NDBC website as tabular files that are continually updated and cover the last forty-five days (e.g. https://www.ndbc.noaa.gov/station\_realtime.php?station = 41009). Once latency commitments are met, NDBC manually QA/QCs<sup>1</sup> these data and stores them within station

specific 'Historical Data' text files on their website on a monthly basis (e.g. https://www.ndbc.noaa.gov/station ory.php?station = 41009). As per NOAA requirements, NDBC archives their data on a monthly basis in the official NOAA archives, which are found at the National Center for Environmental Information (NCEI; https:// /marine-environmental-buoy-database/). NDBC collates their website data annualb www.ncel.noaa.gov/a and copy these data, in a Unidata's Network Common Data Form (netCDF) format, for storage on the NDBC Distributed Oceanographic Data Systems framework (DODS; https://dods.ndbc.noaa.gov/thredds/catalog/ data/catalog.html). Essenttally, the NDBC website and the DODS may be considered as a single source of NDBC historical data that are stored in different formats

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SCIENTIFIC DATA | (2022) 9:248 | https://doi.org/10.1038/s41597-022-01344-z

A. MEDS OBSERVATIONAL DATA STORAGE



#### Fisheries and Oceans Canada Marine Environmental Data Section (MEDS)

- Wave data: <u>https://www.meds-sdmm.dfo-mpo.gc.ca/isdm-gdsi/waves-vagues/data-donnees/index-eng.asp</u>
- Single files for historical bulk wave parameters (.csv) and metadata (.csv)
- Single year to date (y2d) files (.fb)
- Annual spectral data files (.fb)

Configuration	All CSV Data	Year to Date of Spectral Data	Annual Files of Spectral Data	File Size (KB)
• meta c45149.csv				27
				2,128
				182
			€ <u>C45149 2000.ZIP</u>	545.9
			€ <u>C45149 2001.ZIP</u>	770.7
			€ <u>C45149 2002.ZIP</u>	1,149.6
			€ <u>C45149 2003.ZIP</u>	1,514.5
			€ <u>C45149 2004.ZIP</u>	1,390.2
			() <u>C45149 2005.ZIP</u>	1,562.6
			€ <u>C45149 2006.ZIP</u>	1,351.5
			(C45149 2007.ZIP	976.4
			() <u>C45149 2008.zip</u>	375.1
			() <u>C45149 2009.zip</u>	1,349.1
			() C45149 2010.zip	1,575.8
			€ <u>C45149 2011.ZIP</u>	957.3
			() C45149 2012.ZIP	1,147.1
			€ <u>C45149 2013.ZIP</u>	1,421.5
			() C45149 2014.zip	1,449.3
			() C45149 2015.zip	1,576.5
			€ <u>C45149 2016.ZIP</u>	1,243.0
			@ c45149_2017.zip	1,347.5
			€ <u>C45149 2018.ZIP</u>	926.2
			@ <u>C45149 2019.ZIP</u>	1,016.6
			€ <u>C45149 2020.zip</u>	1,106.1
			€ <u>C45149 2021.zip</u>	1,211.2

Actions:

- Data extracted from various formats for consistency
- Available metadata sourced and merged with concatenated files
- Data were QC'd as per MEDS QC codes
- Exported as year\_month netCDF files

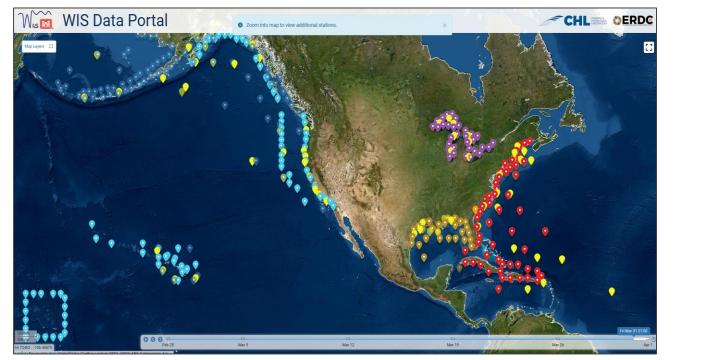
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					DIR 0.00000E+00WSPD
					STP 0.42097E+02LTG\$
	NG\$ 0.66081E			0.1000021022	JII 0.1205/21021104
	.00VWH\$ 0.0				
	0.3906E-02				0 14518-01
	0.3906E-02				
	0.7813E-02				
0.1348E+00	0.7813E-02	0.2596E-04	0.1445E+00	0.1172E-01	0.4719E-04
0.1563E+00	0.1172E-01	0.3600E-04	0.1699E+00	0.1563E-01	0.3327E-04
0.1875E+00	0.1953E-01	0.4361E-04	0.2090E+00	0.2344E-01	0.5283E-04
0.2344E+00	0.2734E-01	0.5050E-04	0.2676E+00	0.3906E-01	0.3940E-04
0.3086E+00	0.4297E-01	0.3216E-04	0.3652E+00	0.7031E-01	0.4882E-04
	0.4297E-01 0.1016E+00		0.3652E+00	0.7031E-01	0.4882E-04
0.4512E+00	0.1016E+00 S Lake Hur	0.5342E-04 on	C45149		
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0.4512E+00 AE 43.5330 0.21000E+03K 0.33113E+02I 0.33113E+02I 0.1272E-01 0.1953E-01 0.3516E-01 0.3516E-01 0.3516E-01 0.5585E-01	0.1016E+00 S Lake Hur 81.9670 5 DDIR 0.22000E SSPD 0.98910E 0.03906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02	0.5342E-04 on 8.0[2000 5 8 +01WSPD 0.36 +03ATMS 0.16 0.11CF\$ 0.20 0VCMX 2.22V 0.1662E-01 0.1254E-01 0.5203E-02 0.3074E-03 0.3522E-04 0.3285E-03	C45149 923 34. 000E+01GSPD 900E+02DRYT 000E+01LRP\$ TFK 2.20VTI 0.1563E-01 0.3906E-01 0.3906E-01 0.5649E-01 0.66250E-01	1 0.100E+C 0.0000E+00M 0.18500E+025 25 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02	01 1 13 3 2 41 DTR 0.00000E+00WSPT SSTP 0.42097E+02LTG\$ 0.1607E-01 0.8355E-02 0.2386E-02 0.3285E-03 0.2780E-04 0.9185E-04 0.3322TE-04 0.3322TE-04
0.4512E+00 AE 43.5330 0.2100E+030 0.00000E+000 0.83113E+02I 0.02VCAR 0 0.3906E-02 0.1172E-01 0.1953E-01 0.2734E-01 0.4297E-01 0.4297E-01 0.5078E-01 0.5641E-01	0.1016E+00 S Lake Hur 81.9670 S 5DD1R 0.22000E NG\$ 0.66081E .00VMHS 0.0 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02	0.5342E-04 on 8.0 [2000 5 8 +01WSPD 0.36 -01LCF\$ 0.20 0VCMX 2.22W 0.1662E-01 0.5203E-02 0.3524E-01 0.3254E-04 0.3252E-04 0.3252E-04 0.3252E-04	C45149 923 34. 000E+01GSPD 000E+02DRYT 000E+01LRF6 TFK 2.20VTF 0.7813E-02 0.1563E-01 0.3225E-01 0.3906E-01 0.4668E-01 0.6250E-01 0.6250E-01	1 0.100E+0 0.0000E+00W 0.18500E+02S 95 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02	01 1 13 3 2 41 IDIR 0.00000E+00WSPI SSTP 0.4207E+02LTG5 0.1607E-01 0.8355E-02 0.2586E-02 0.3285E-03 0.2780E-04 0.3127E-04 0.3325E-04 0.3365E-04
0.4512E+00 AE 43.5330 0.21000E+03 0.00000E+030 0.3113E+021 0.172E-01 0.1953E-01 0.3516E-01 0.3516E-01 0.4297E-01 0.5578E-01 0.5578E-01 0.65858E-01 0.6641E-01	0.1016E+00 S Lake Hur 81.9670 5 DDIR 0.22000E SSPD 0.98910E NGS 0.66081E 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02	0.5342E-04 on 8.0 2000 5 8 +03WSPD 0.36 +03ATMS 0.16 0.1254E-01 0.1254E-01 0.5203E-02 0.9374E-03 0.3252E-04 0.3285E-03 0.3292E-04 0.299E-04 0.299E-04	C45149 923 34. 000E+01GSPD 000E+01CRPG TFK 2.20VTT 0.1563E-01 0.3125E-01 0.344E-01 0.344E-01 0.3468E-01 0.55469E-01 0.55469E-01 0.7031E-01	1 0.100E+0 0.0000E+000 0.18500E+025 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02	01 1 13 3 2 41 DTR 0.00000E+00WSPT SSTF 0.42097E+02LTG\$ 0.1607E-01 0.0355E-02 0.2266E-02 0.3265E-03 0.2780E-04 0.3762E-04 0.3762E-04 0.3762E-04
0.4512E+00 AE 43.5330 0.2100E+030 0.00000E+000 0.3906E-02 0.172E-01 0.2734E-01 0.3516E-01 0.4297E-01 0.5855E-01 0.5855E-01 0.6641E-01 0.7422E-01 0.42297E-01	0.1016E+00 S Lake Hur 81.9670 5 JDIR 0.22000E SSPD 0.98910E .007WH\$ 0.0 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02	0.5342E-04 on 8.0 2000 5 8 +01WSPD 0.36 +01WSPD 0.36 -01LCF\$ 0.220 0VCMX 2.22V 0.1662E-01 0.1254E-01 0.5203E-02 0.3322E-04 0.3292E-04 0.3295E-04 0.387E-04	C45149 923 34. 000E+020RXT 000E+02DRXT 000E+02DRXT 000E+02DRXT 000E+01LRP4 0.7813E-02 0.1563E-01 0.3345E-01 0.3345E-01 0.4688E-01 0.4688E-01 0.4628E-01 0.6250E-01 0.7031E-01 0.7913E-01 0.8594E-01	1 0.100E+0 0.0000E+00W 0.18500E+02S 28 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02	01 1 13 3 2 41 IDIR 0.00000E+00WSPI SSTF 0.4209TE+02LTG\$ 0.8355E-02 0.2386E-02 0.3285E-03 0.270EE-04 0.3372TE-04 0.3762E-04 0.3376E-04 0.3367E-04 0.3461E-04
0.4512E+00 AE 43.5330 0.21000E+03 0.00000E+03 0.02002E+03 0.02002E+03 0.02002E+03 0.02002E+03 0.02002E+03 0.1172E-01 0.4595E-01 0.4597E-01 0.5595E-01 0.6595E-01 0.6595E-01 0.6595E-01 0.6595E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01 0.6203E-01	0.1016E+00 S Lake Hur 81.9670 S DDIR 0.22000E SSPD 0.98910E NNS\$ 0.66081E 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02	0.5342E-04 on 8.0 2000 5 8 +01WSPD 0.36 +03XTMS 0.16 -01LCF\$ 0.20 0.UCMX 2.22V 0.1662E-01 0.1254E-01 0.1254E-01 0.3285E-03 0.3285E-04 0.2295E-04 0.3887E-04 0.3885E-04	C45149 923 34. 000E+010SPD 900E+02DRYT 000E+01LRP5 0.7813E-02 0.1563E-01 0.3206E-01 0.4563E-01 0.4568E-01 0.4568E-01 0.5669E-01 0.5669E-01 0.7613E-01 0.7813E-01 0.99375E-01	0.100E+0 0.0000E+00U 0.18500E+025 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02	01 1 13 3 2 41 DTR 0.00000E+00WSPT SSTP 0.42097E+02LTG\$ 0.1607E-01 0.8355E-02 0.2886E-02 0.3285E-03 0.2780E-04 0.3727E-04 0.3762E-04 0.3762E-04 0.3762E-04 0.3762E-04 0.4217E-04 0.2540E-04
0.4512E+00 <b>X</b> 0.21000E+03 0.21000E+03 0.30000E+03 0.3006E+02 0.3906E+02 0.3906E+02 0.1172E-01 0.1953E+01 0.2734E+01 0.585E+01 0.585E+01 0.585E+01 0.422F+01 0.585E+01 0.4225E+01 0.5894E+01 0.5976E+01	0.1016E+00 S Lake Hur 81.9670 5 BDIR 0.22000B SDIR 0.22000B 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0	0.5342E-04 on 8.0 2000 5.8 +01WSPD 0.36 -01LCF\$ 0.20 0.1254E-01 0.1254E-01 0.5203E-02 0.3522E-04 0.3252E-04 0.3295E-04 0.3285E-04 0.3865E-04 0.3685E-04	C45149 923 34, 000E+020RYT 000E+02DRYT 000E+02DRYT 000E+01LRPG 0.7813E-02 0.1563E-01 0.3234E-01 0.3206E-01 0.4688E-01 0.4688E-01 0.4688E-01 0.7931E-01 0.7931E-01 0.7931E-01 0.7937E-01 0.3594E-01 0.9375E-01 0.1016E+00	1 0.100E+0 0.00000E+003 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02	01 1 13 3 2 41 IDIR 0.00000E+00WSFI SSTP 0.42097E+02LTG3 0.8355E-02 0.2386E-02 0.3285E-03 0.9185E-04 0.3327E-04 0.3362E-04 0.3362E-04 0.3367E-04 0.4617E-04 0.3347E-04
0.4512E+00 AE 43.5330 0.21000E+03 0.00000E+002 0.3313E+021 0.1953E-01 0.4595E-01 0.4595E-01 0.4297E-01 0.4297E-01 0.55078E-01 0.6641E-01 0.6641E-01 0.8595E-01 0.8694E-01 0.8904E-01 0.9765E-01 0.9765E-01 0.1055E+00	0.1016E+00 S Lake Hur \$1.9670 5 DDTR 0.22000E SPD 0.98910E NNS\$ 0.66081E 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02	0.5342E-04 on 8.0 2000 5 8 +01W3PD 0.36 -01LCF\$ 0.20 0.0VCMX 2.22V 0.1662E-01 0.5203E-02 0.3203E-03 0.3203E-03 0.3205E-04 0.3205E-04 0.3805E-04 0.3805E-04 0.3605E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.3805E-04 0.380	C45149 923 34. 000E+010SPD 900E+02DRYT 000E+01DRPG 0.1563E-01 0.3125E-01 0.3244E-01 0.3244E-01 0.4688E-01 0.55459E-01 0.55459E-01 0.7313E-01 0.7313E-01 0.8594E-01 0.9375E-01 0.1113E+00	0.100E+0 0.0000E+00 0.18500E+02 5 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02 0.3906E-02	01 1 13 3 2 41 IDIR 0.00000E+00WSFI SSTP 0.42097E+02LTGS 0.1607E-01 0.8355E-02 0.2385E-02 0.3285E-03 0.2780E-04 0.3327E-04 0.3362E-04 0.3367E-04 0.3367E-04 0.2540E-04 0.3247E-04 0.3247E-04
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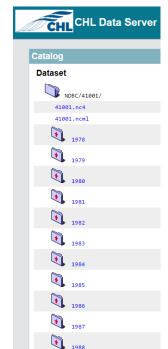
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1. USACE ERDC CHL WIS Portal: https://wisportal.erdc.dren.mil/

2. USACE ERDC CHL Data Server (Thredds): NDBC & MEDS https://chlthredds.erdc.dren.mil/thredds/catalog/buoys/catalog.html







ERDC Knowledge Core

3. 1970 – 2021 Static NDBC Archive in the ERDC Knowledge Core:

Hall, C. & R.E. Jensen. 2022. USACE QCC NDBC Measurement Archive. ERDC Knowledge Core, Engineer Research and Development Center, Coastal and Hydraulics Laboratory. <u>http://dx.doi.org/10.21079/11681/43121</u>



# QUESTIONS?

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