Performance evaluation of the newly operational NDBC 2.1-m hull

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USACE QCC MEASUREMENT ARCHIVE

Outline:

1. USACE National Coastal Wave Climate
2. Performance evaluation of the newly operational NDBC 2.1-m hull

NATIONAL COASTAL WAVE CLIMATE (NCWC) FY20-22 THRUSTS

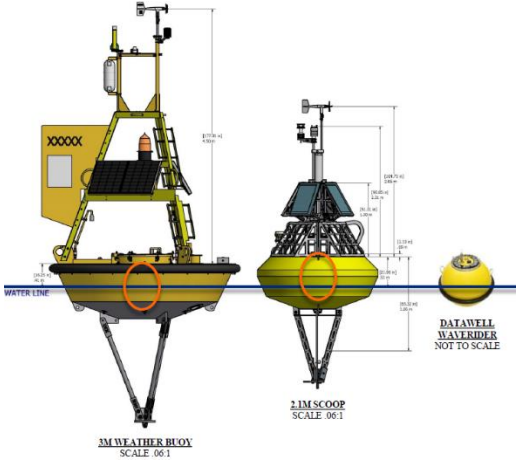
Question: How accurate are the wave measurement data that are used for USACE WIS validation, wave related R&D and wave model improvements?

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

A. Observational data storage errors – develop a clean, quality controlled measurement archive.
   - Combining NDBC website (no metadata – QA/QC) & National Centers for Environmental Information (NCEI) website (low QA/QC, real-time feed)
   - Canadian wave data: Marine Environmental Data Section Archive

B. Instrument and Platform evaluations:
   - **NDBC hull size and wave instrumentation variations**

A. Wave Power Trends:
   - Using USACE QCC measurement archive and WIS data to track spatial and temporal variation in wave fields.



B. WAVE OBSERVATIONS INSTRUMENTATION UNCERTAINTY

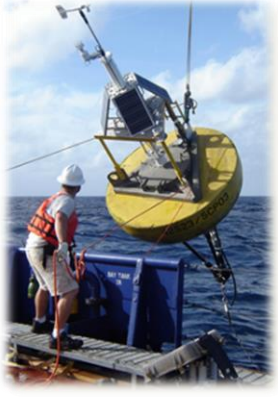
12-m Discus Buoy

10-m Discus Buoy

NDBC Hull Evolution

6-m NOMAD

3-m Weather Buoy



3-m SCOOP Foam Hull

2.1-m SCOOP Foam Hull

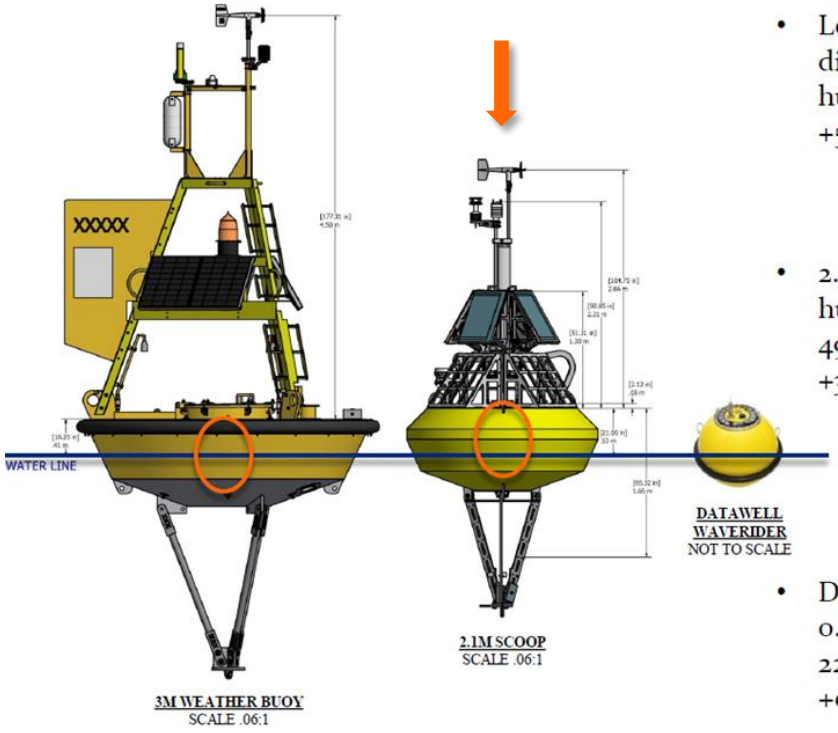
B. NDBC PLATFORM UNCERTAINTY

Observational Hull Type and Wave Sensor Variations:

Hall, C., Jensen, R.E. & D.W. Wang. 2022a. Performance evaluation of the newly operational NDBC 2.1-m hull. *Journal of Atmospheric and Oceanic Technology*. https://doi.org/10.1175/JTECH-D-21-0172.1 (early release).

2.1-m hull wave data:

- *Significant wave height (H_{m0}) and average wave period (T_a)*
- *Mean wave direction at peak frequency [$\alpha_{m\,(f)}$] and directional spread at peak frequency [$\sigma_{m\,(f)}$] results*
- *Spectrally*:
  - increase in energy retention in lower frequency spectral range
  - improved high frequency spectral accuracy > 0.25 Hz for short seas and wind chop wave component regions.

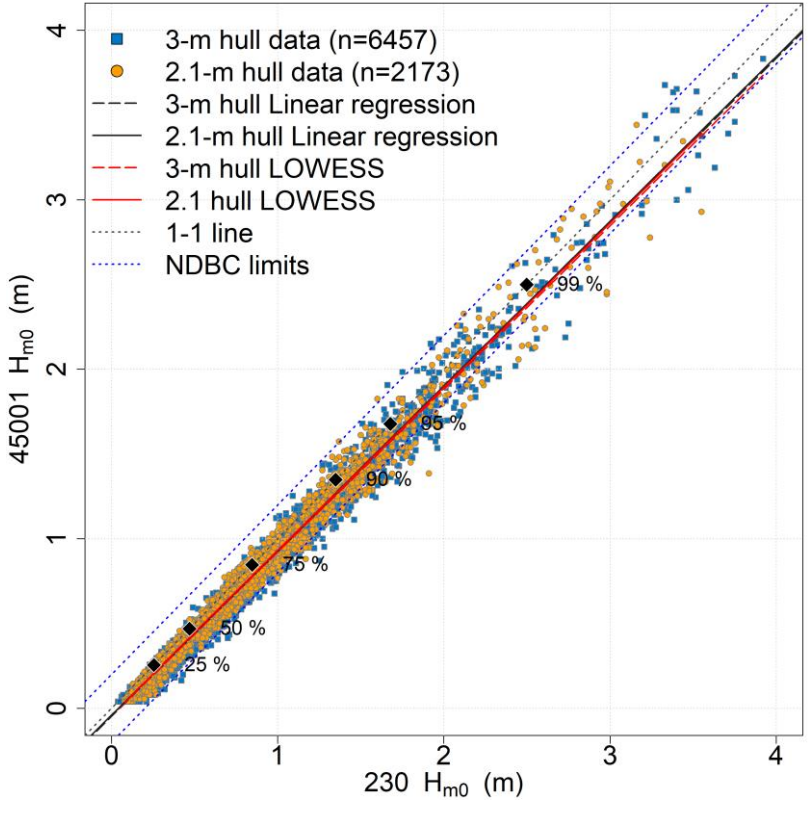


- Legacy 3-m diameter aluminum hulls: ~1724 kg, +5 m height
- 2.1-m diameter foam hulls: 492 kg, +3.2 m height
- Datawell Waverider: 0.9-m diameter, 225 kg, +0.5 m height

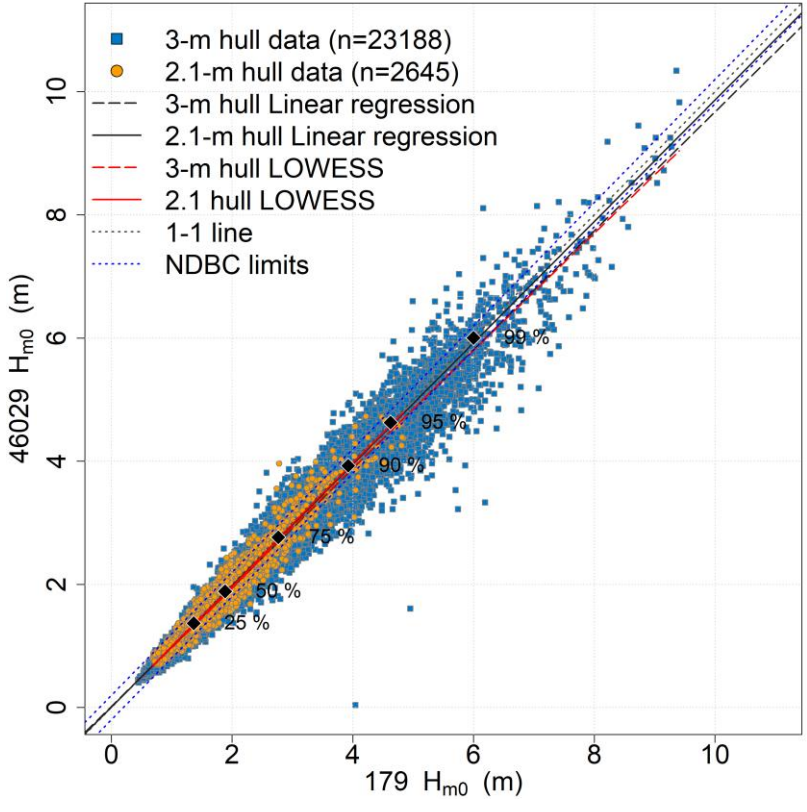
Hall et al., 2022a

Significant wave height (H_{m0})

Great Lakes



Pacific Ocean



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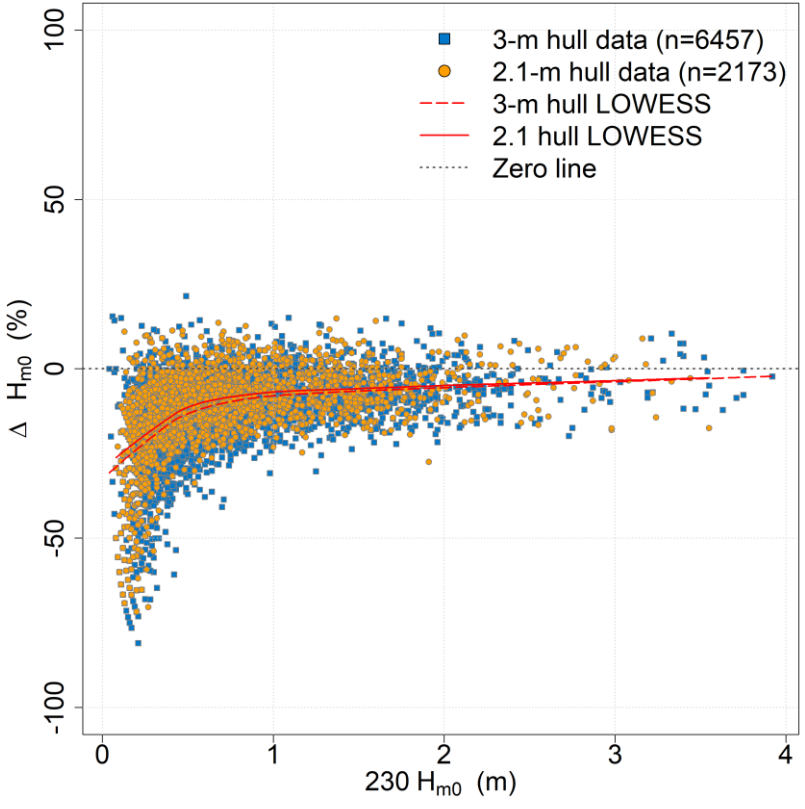
Significant wave height (H_{m0})

Great Lakes



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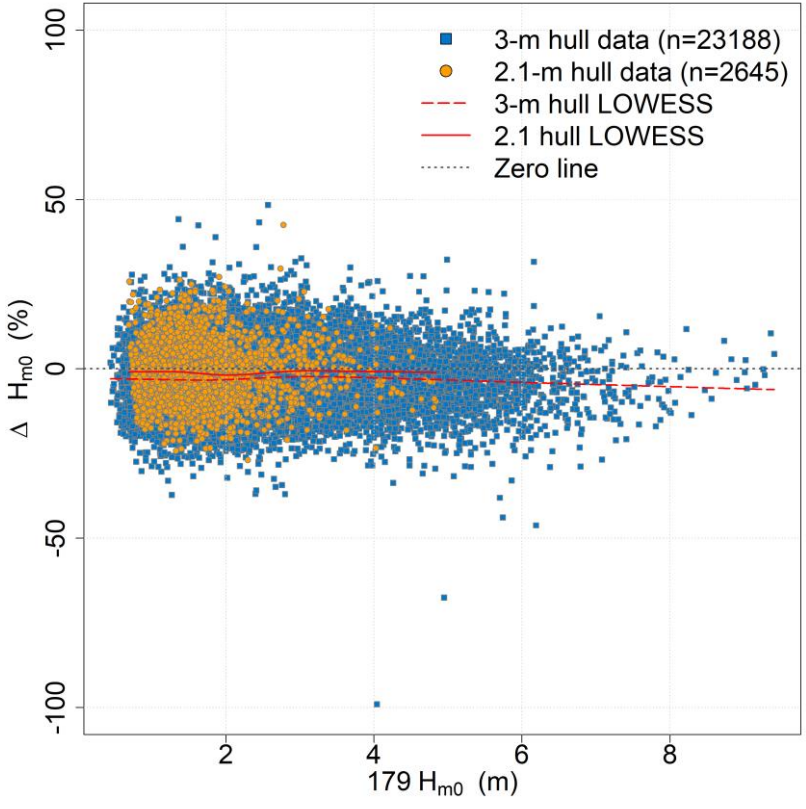

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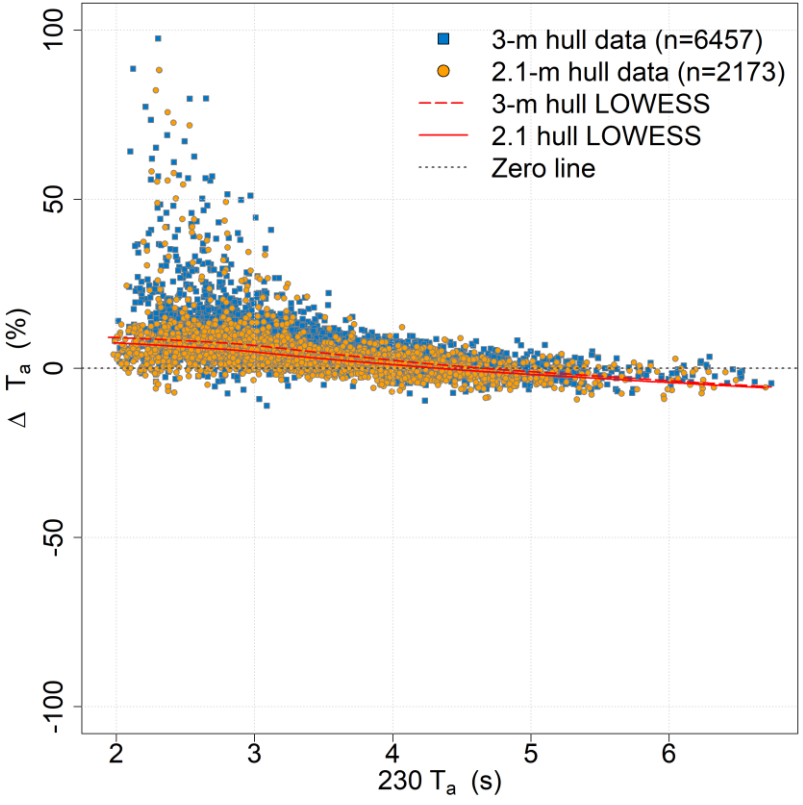
Average wave period (T_a)

Great Lakes



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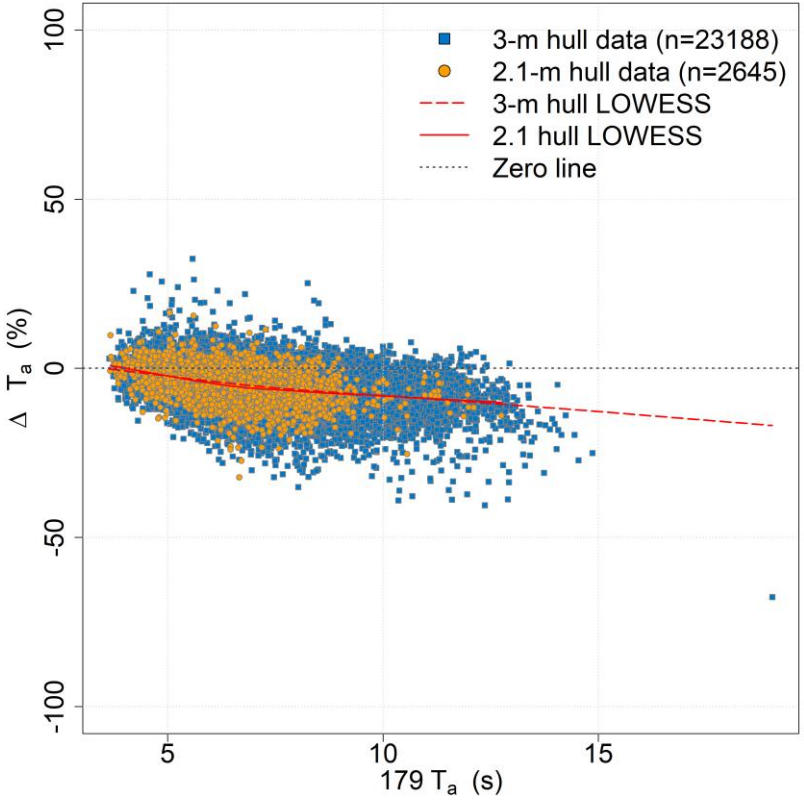


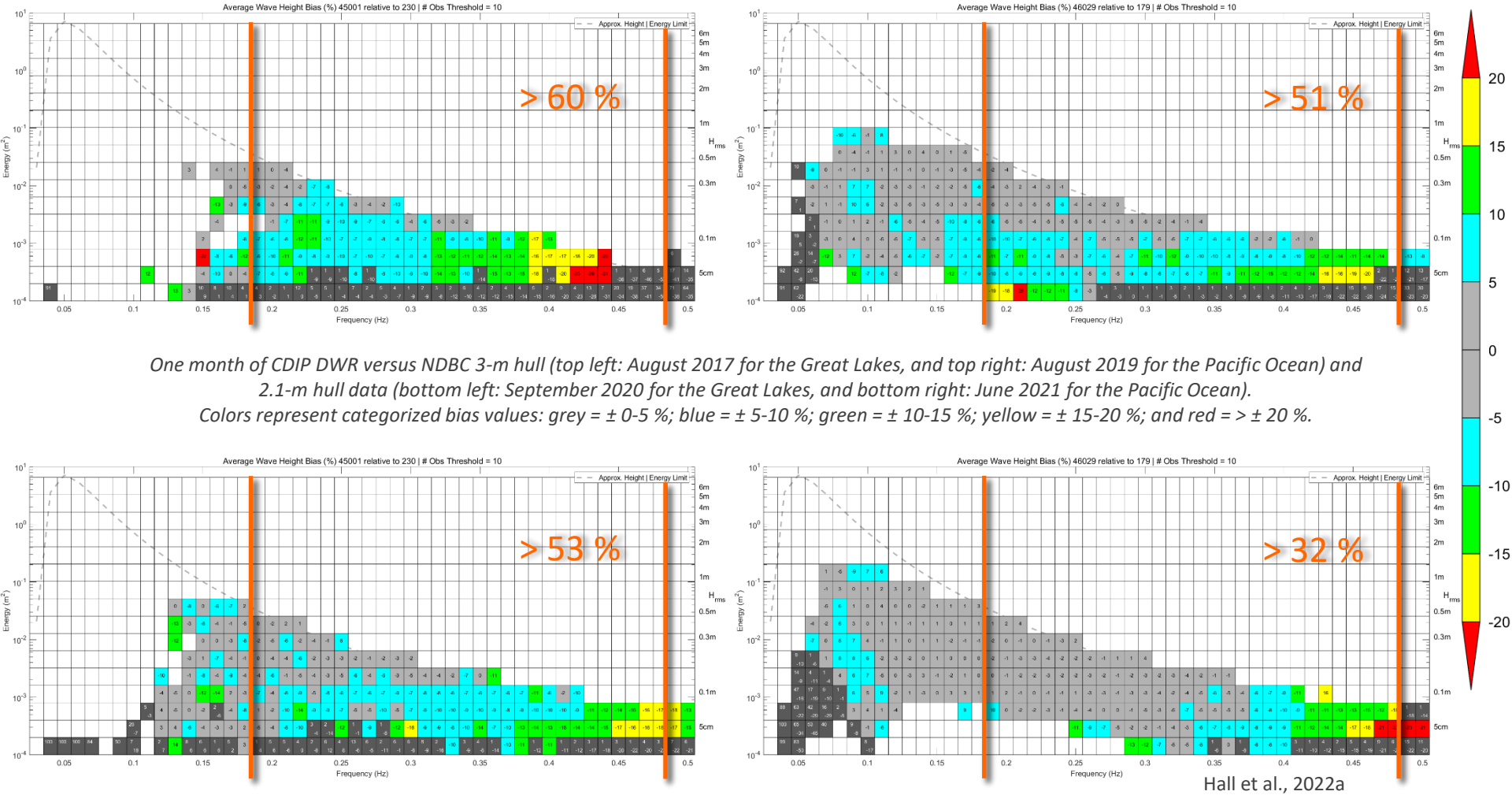
Hall et al., 2022a

WAVEVAL SPECTRA (V2.0)

Great Lakes

Average wave height bias (in %) binned per frequency bands

Pacific Ocean



One month of CDIP DWR versus NDBC 3-m hull (top left: August 2017 for the Great Lakes, and top right: August 2019 for the Pacific Ocean) and 2.1-m hull data (bottom left: September 2020 for the Great Lakes, and bottom right: June 2021 for the Pacific Ocean).
Colors represent categorized bias values: grey = ± 0-5 %; blue = ± 5-10 %; green = ± 10-15 %; yellow = ± 15-20 %; and red = > ± 20 %.

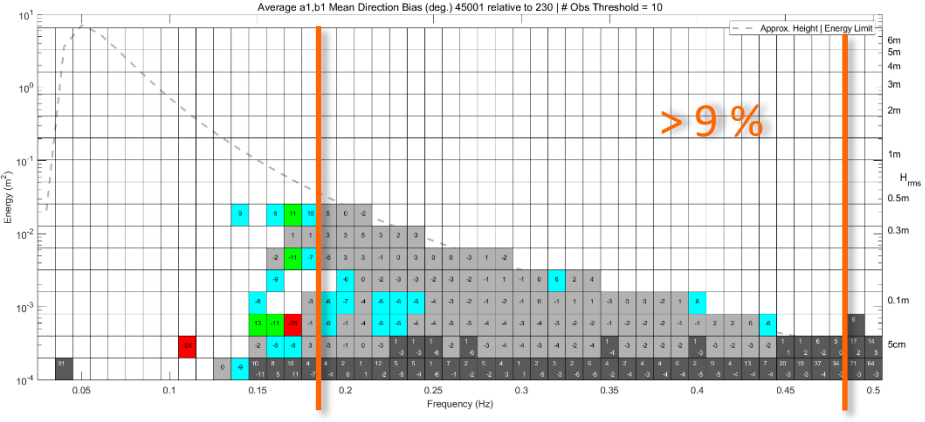
Hall et al., 2022a

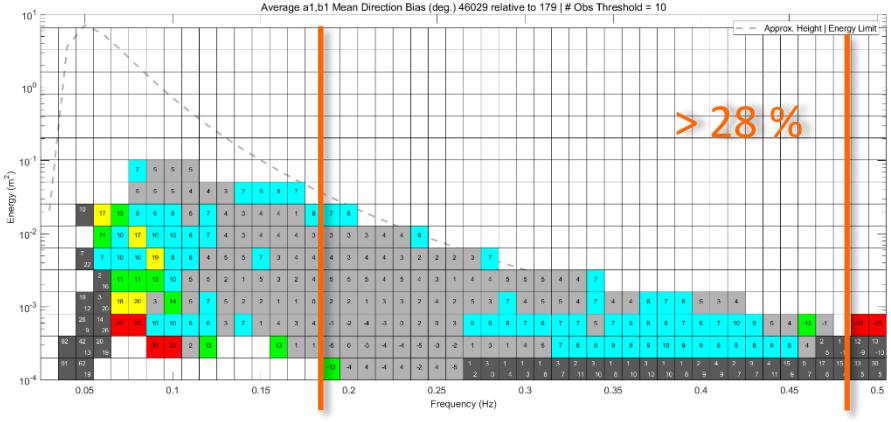
WAVEVAL SPECTRA (V2.0)

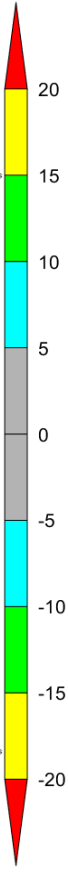
Great Lakes

a1, b1 mean direction bias (in degrees) per frequency bands

Pacific Ocean







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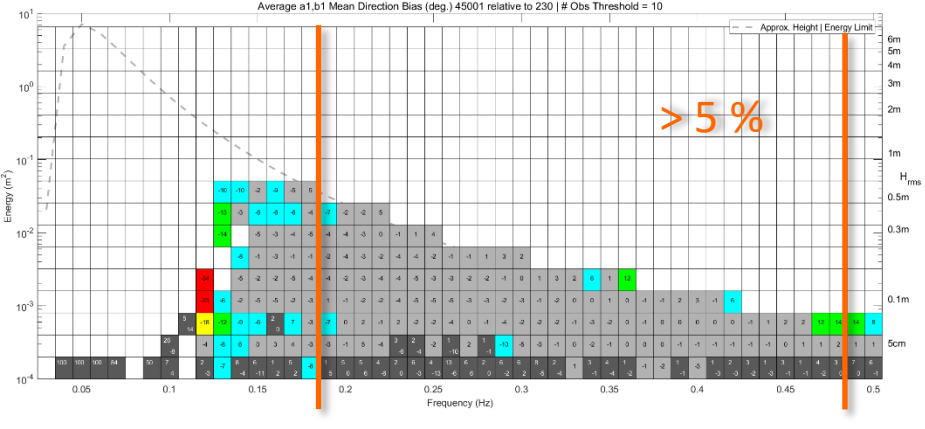
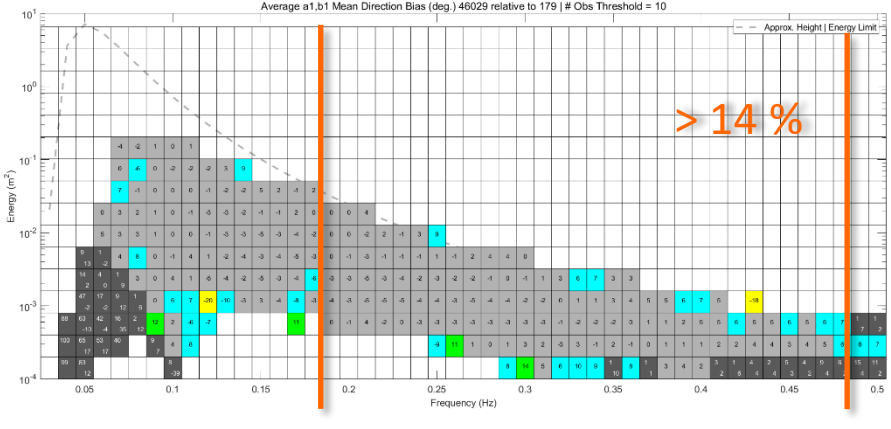


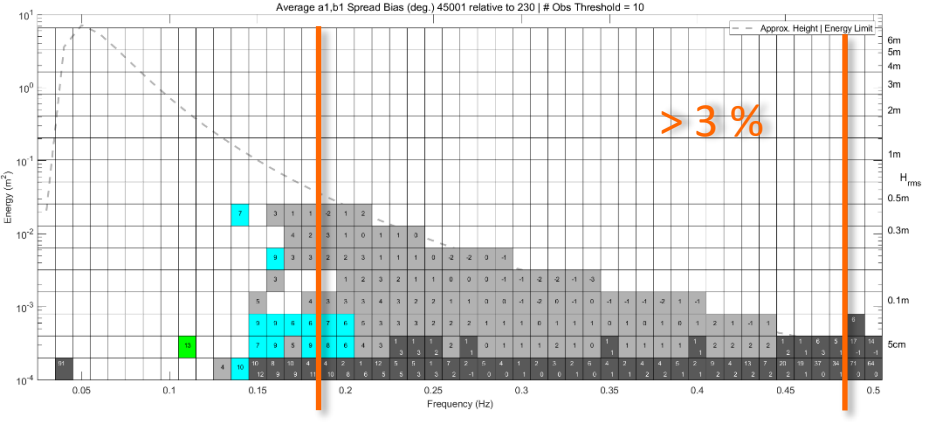


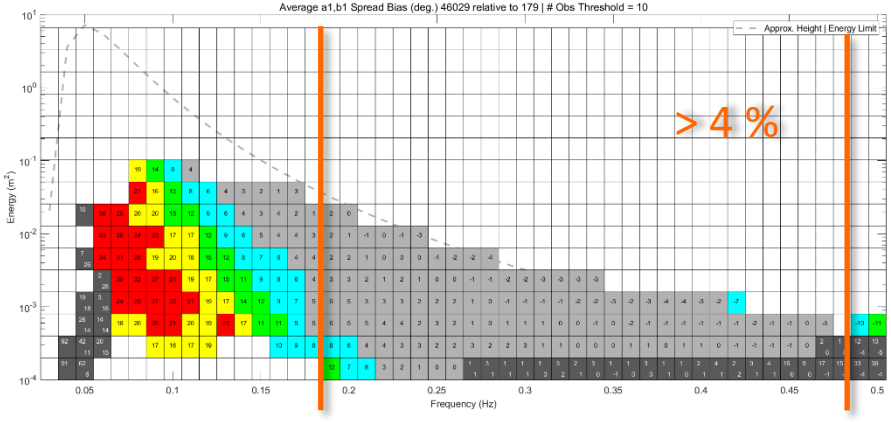
WAVEVAL SPECTRA (V2.0)

Great Lakes

Average a1, b1 spread bias (in degrees) per frequency bands

Pacific Ocean





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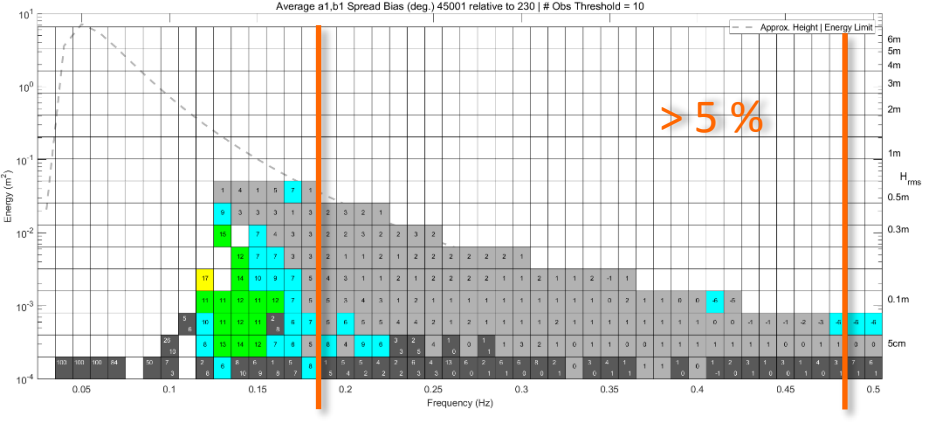
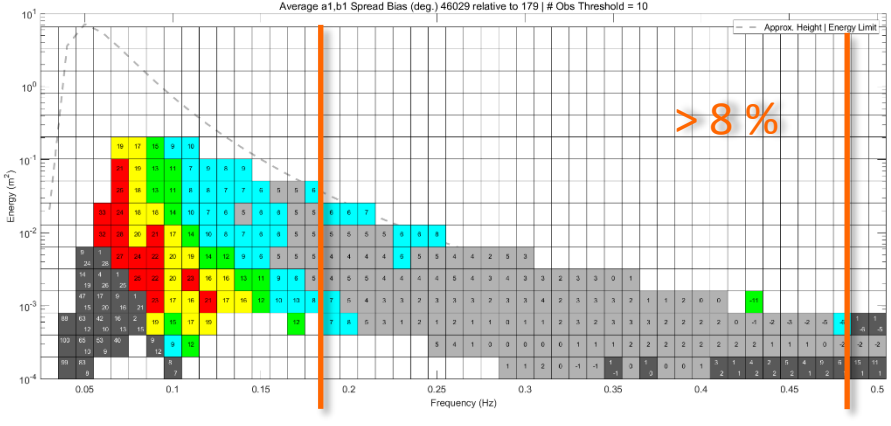
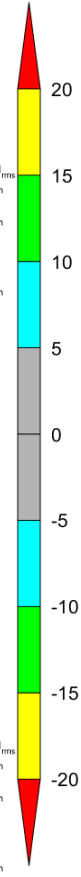
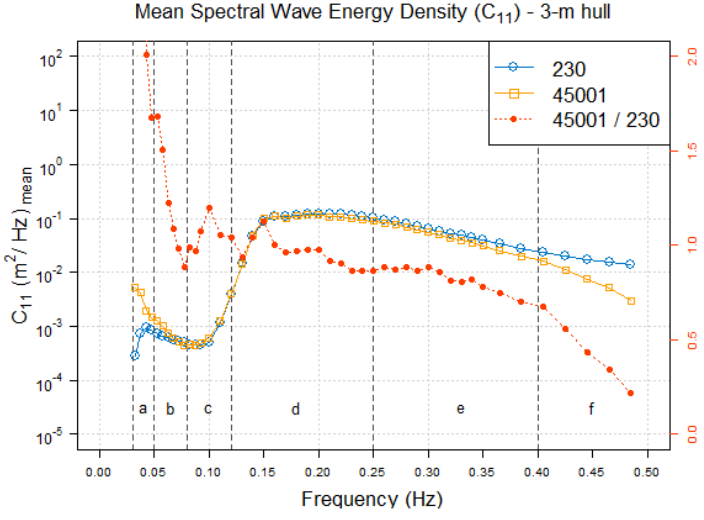
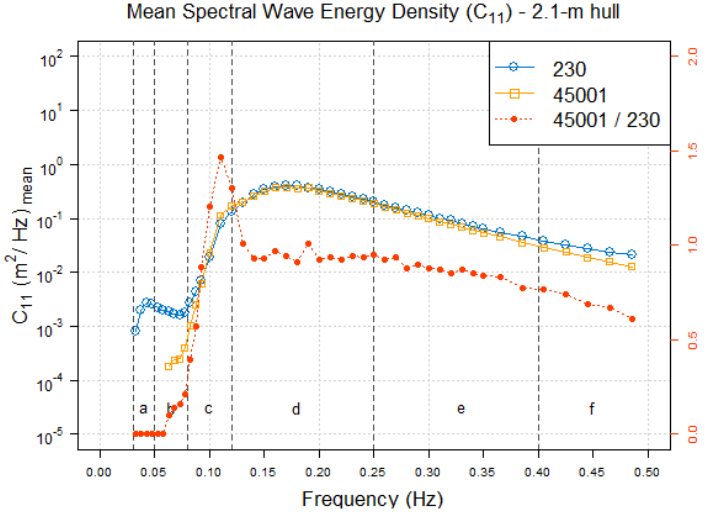


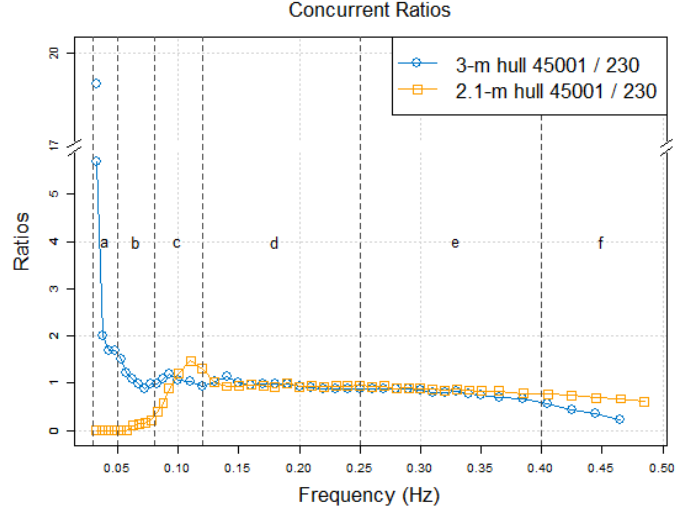


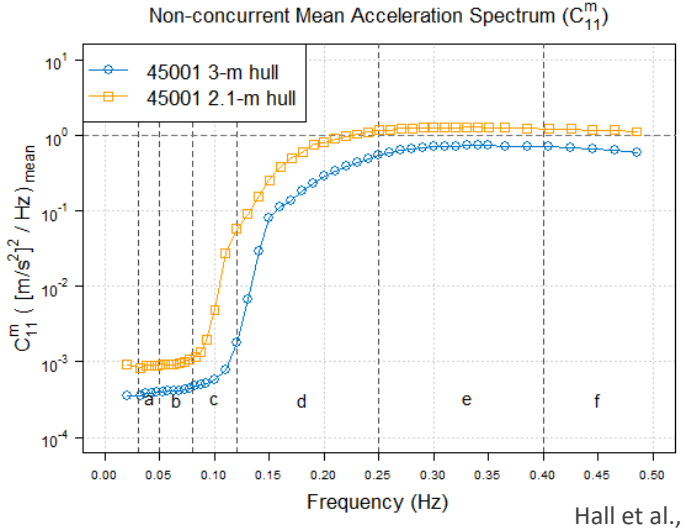


GREAT LAKES MEAN SPECTRAL WAVE ENERGY DENSITY









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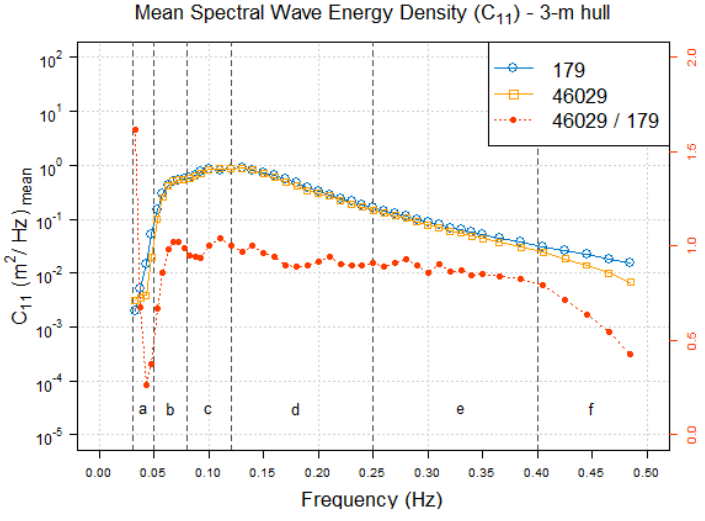
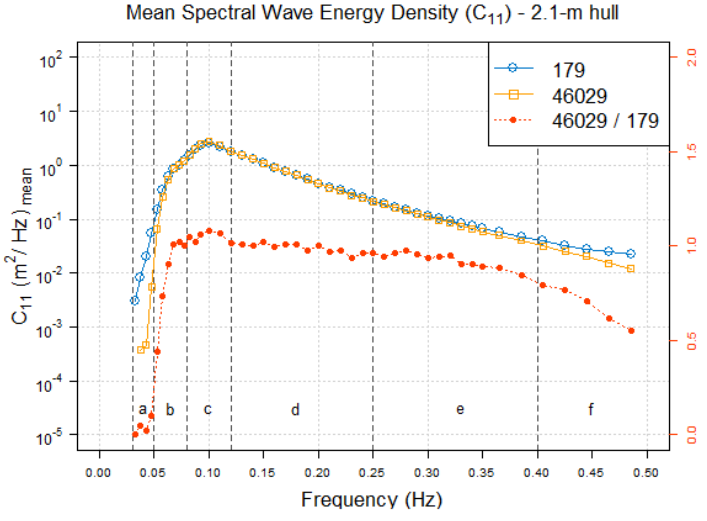
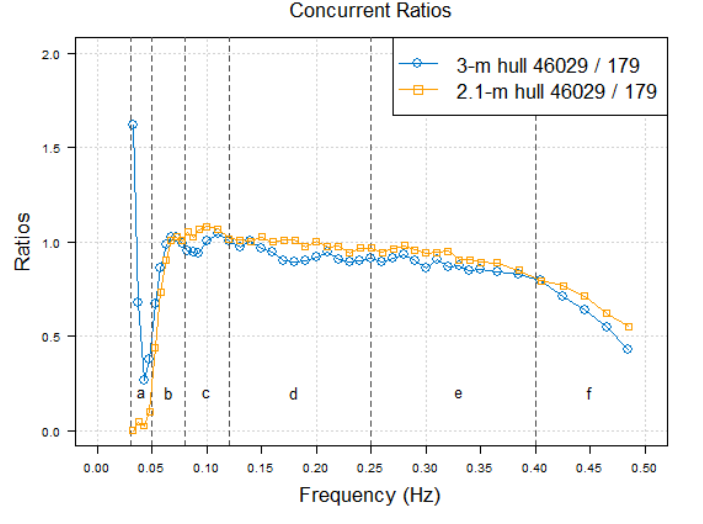
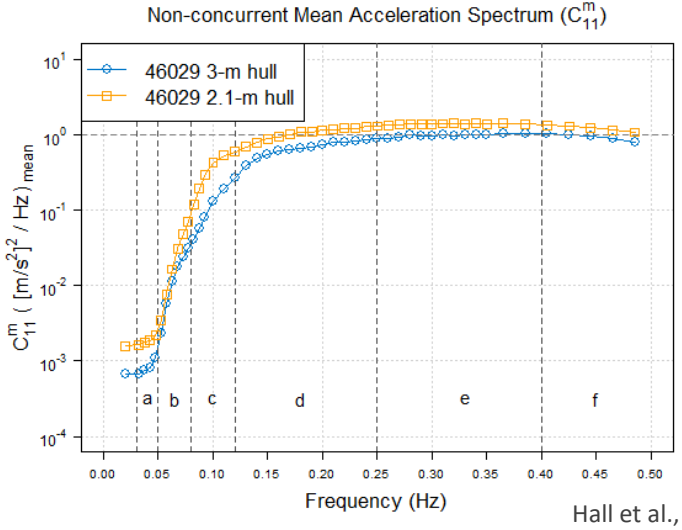
PACIFIC OCEAN MEAN SPECTRAL WAVE ENERGY DENSITY









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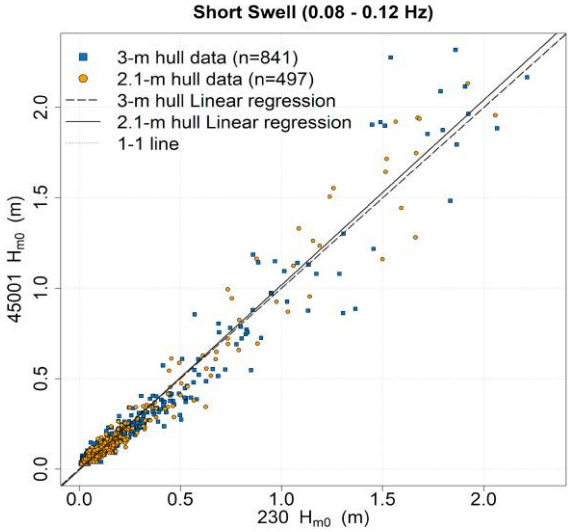
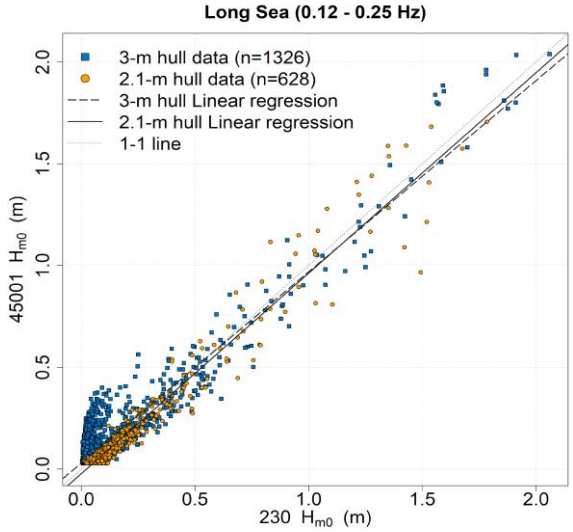
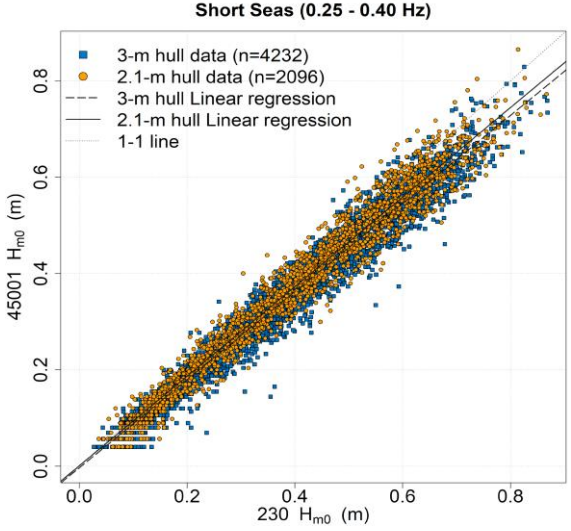
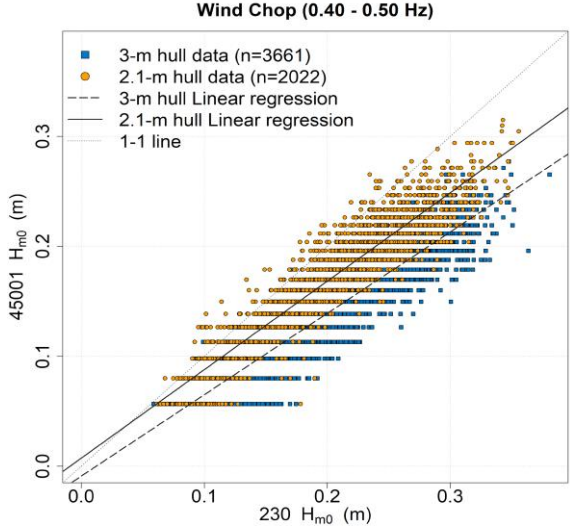
GREAT LAKES WAVE COMPONENTS









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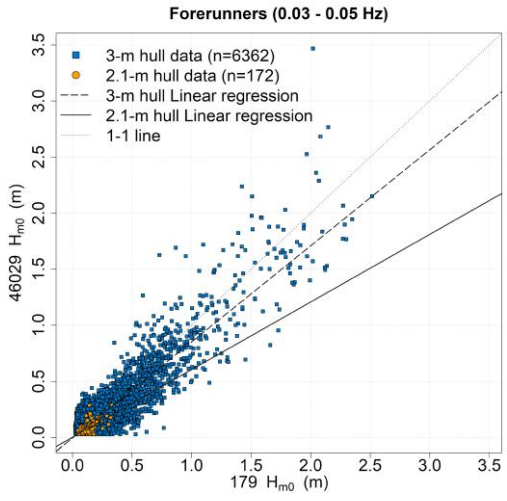

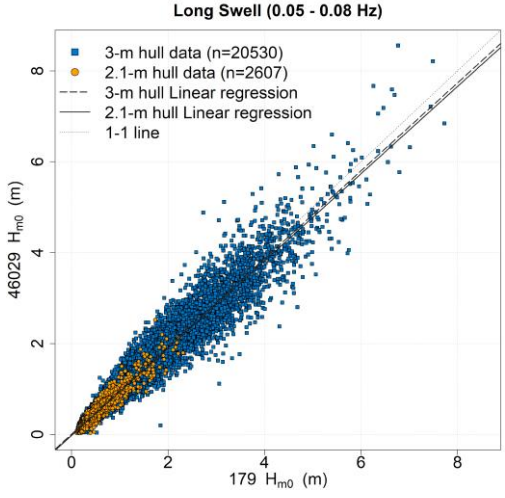

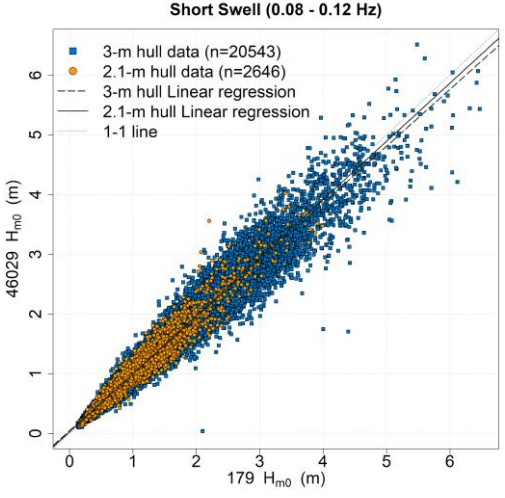

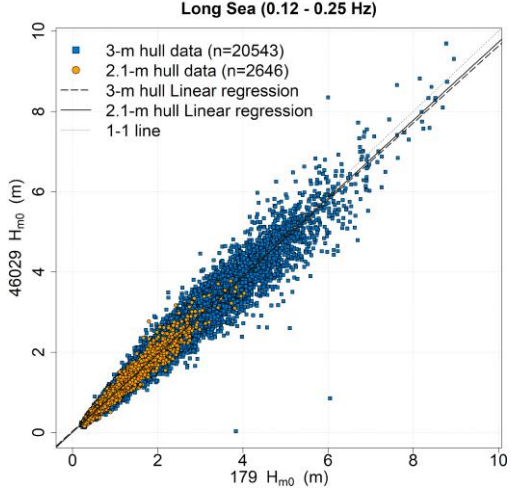

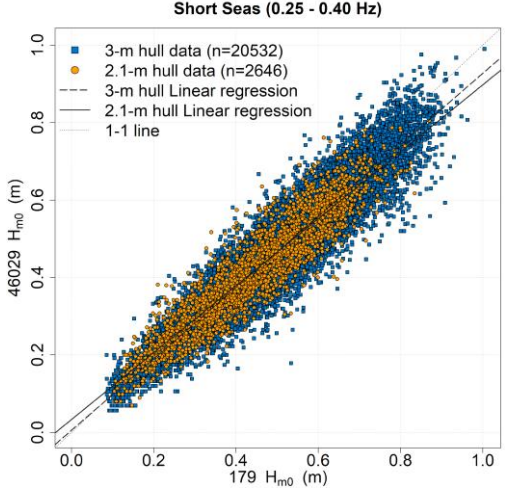

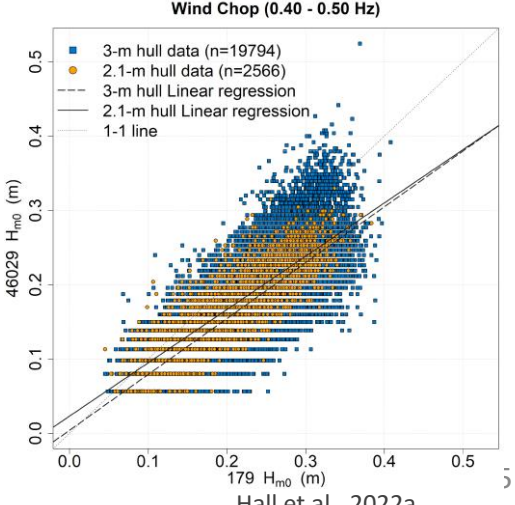

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SUMMARY

2.1-m hull wave data:

- *Significant wave height (H_{m0}) and average wave period (T_a)*: **increased accuracy**
- *Mean wave direction at peak frequency [$\alpha_{m\,(f)}$] and directional spread at peak frequency [$\sigma_{m\,(f)}$] results*: **consistent**
- *Spectrally*: **improved *signal-to-noise ratio***
  - increase in energy retention in lower frequency spectral range
  - improved high frequency spectral accuracy > 0.25 Hz for short seas and wind chop wave component regions.
- Confidence in use of NDBC wave data to drive wave model technologies, improvements and validations.

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QUESTIONS?

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