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Welcome, the RBR Webinar will begin shortly…

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Tides & Waves

Eric Siegel

Wave Height Measurements

- Statistical representation of the complex wave field
- Walter Munk defined significant wave height to mathematically express the height estimated by a "trained observer" at sea

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Wave & Tide Loggers

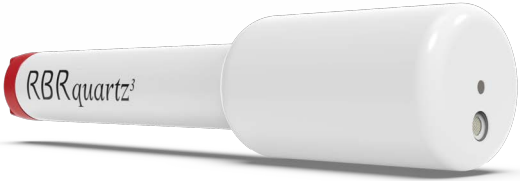
RBR*solo*³ D|wave16 (or |tide16)

RBR*duet*³ T.D|wave16 (or |tide16)

RBR*virtuoso*³ D|wave16 (or |tide16)

RBR*duo*³ T.D|wave16 (or |tide16)

RBR*concerto*³ C.T.D|wave16 (or |tide16)



RBR*quartz*³ Q|wave16 (or |tide16)

RBR*maestro*³ C.T.D|wave16 (or |tide16)

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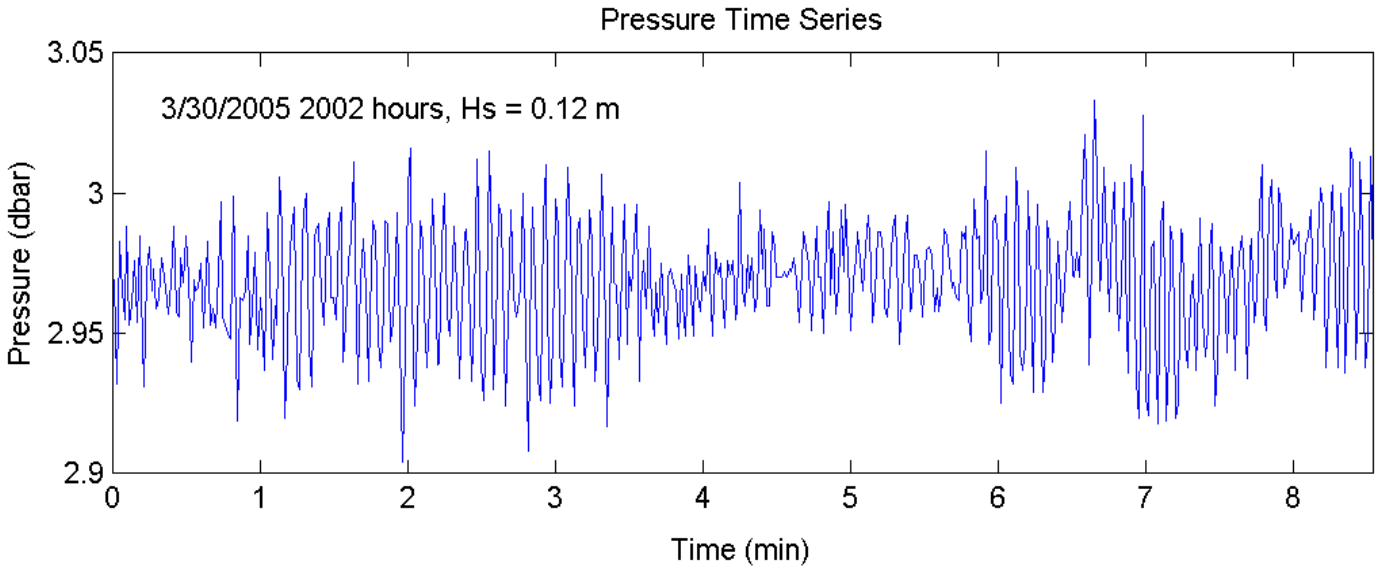
Ocean Waves



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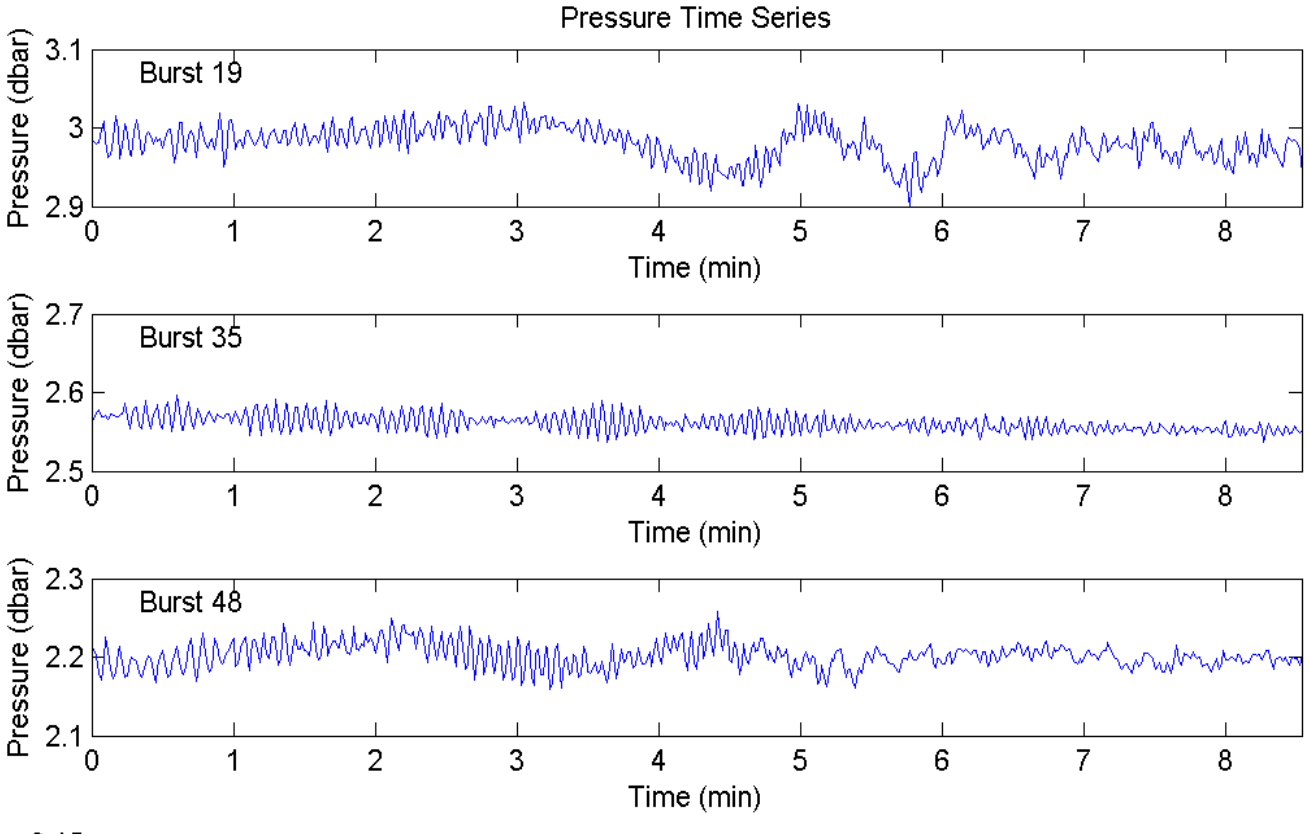
Confused Seas



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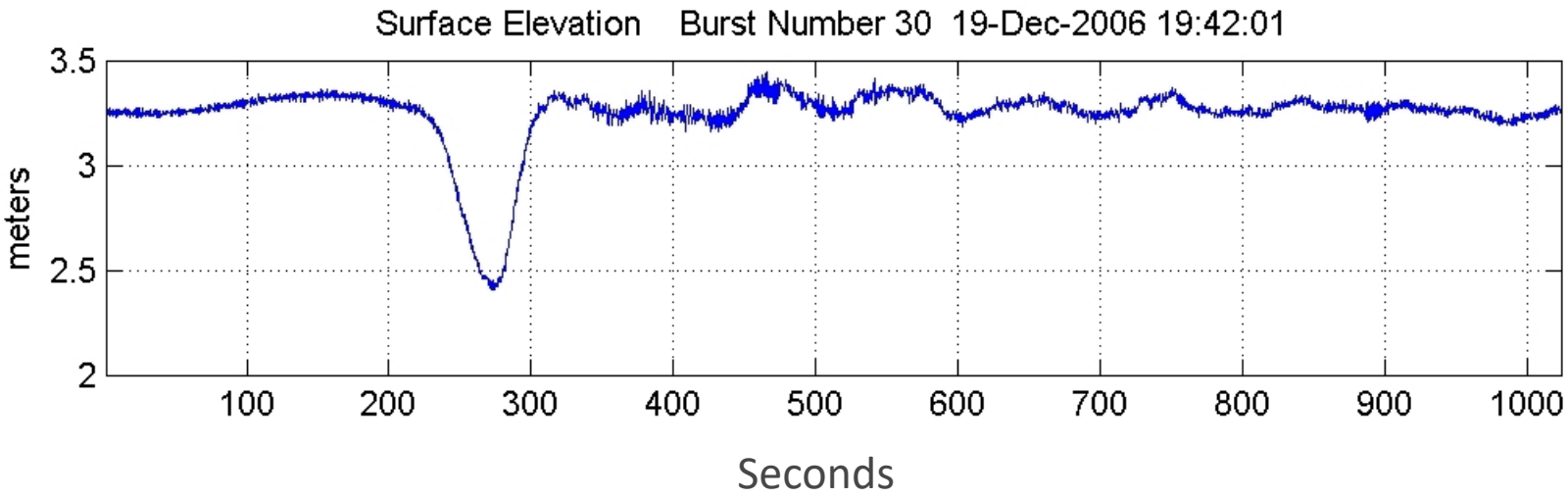
Ship Waves



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Wave Properties

Wave Height (m)	**Wave Period** (s)
• Significant wave height (H_s, $H_{1/3}$, H_{m0})	• Significant wave period
• 1/10 wave height	• 1/10 wave period
• Maximum wave height	• Maximum wave period
• Average wave height	• Average wave period
Other Variables	
• Wave energy (J/m^2)	
• Tidal slope (m/hour)	

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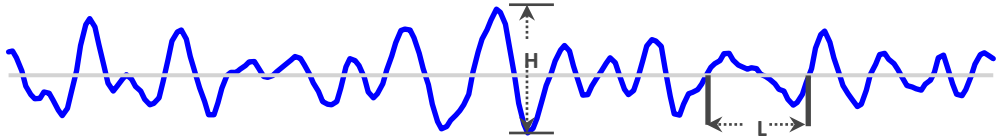
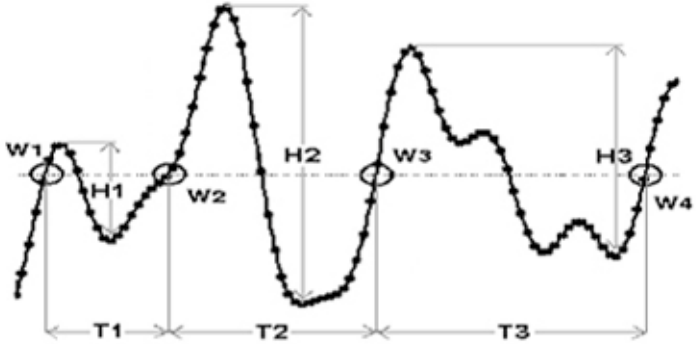
Calculating Wave Height

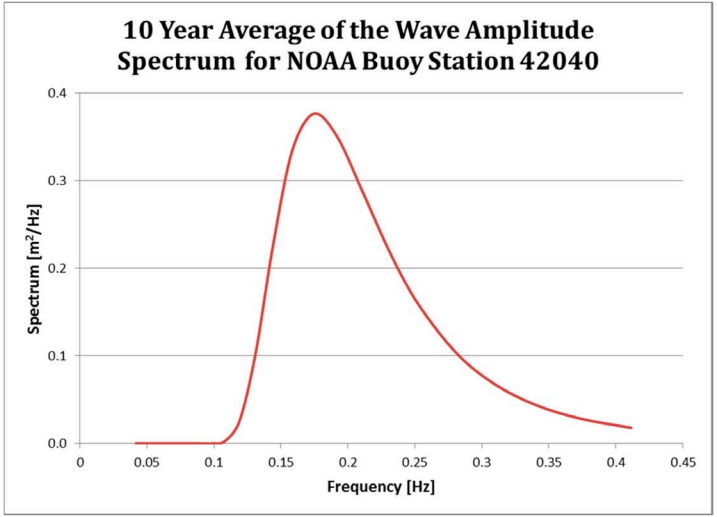
Measure time series of pressure



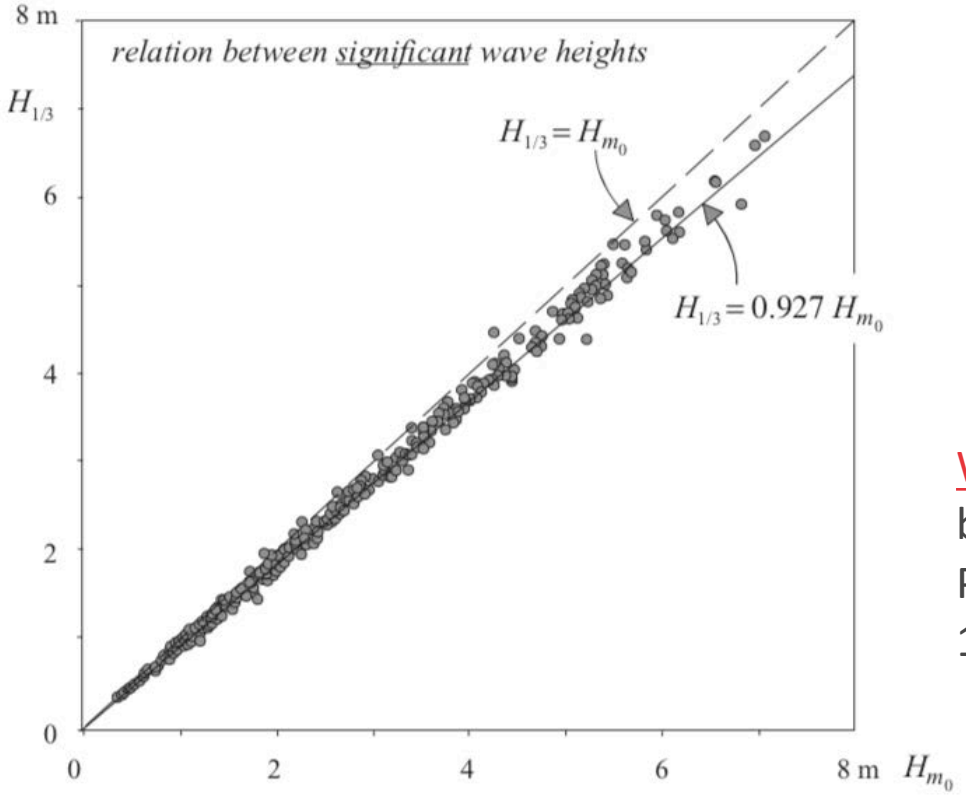


- **Method 1:** Time Domain (zero up-crossing)
  = Calculate mean of the 1/3 largest waves in a record
  = $H_{1/3}$

- **Method 2:** Frequency Domain
  = Transform time series into power spectra
  = $H_{m0} = 4\sqrt{area}$



H_s Time Domain ($H_{1/3}$) vs Frequency Domain (H_{m0})



Waves in Oceanic and Coastal Waters, by Leo H. Holthuijsen. Contemporary Physics - CONTEMP PHYS. 52. 75-75. 10.1080/00107514.2010.529511.

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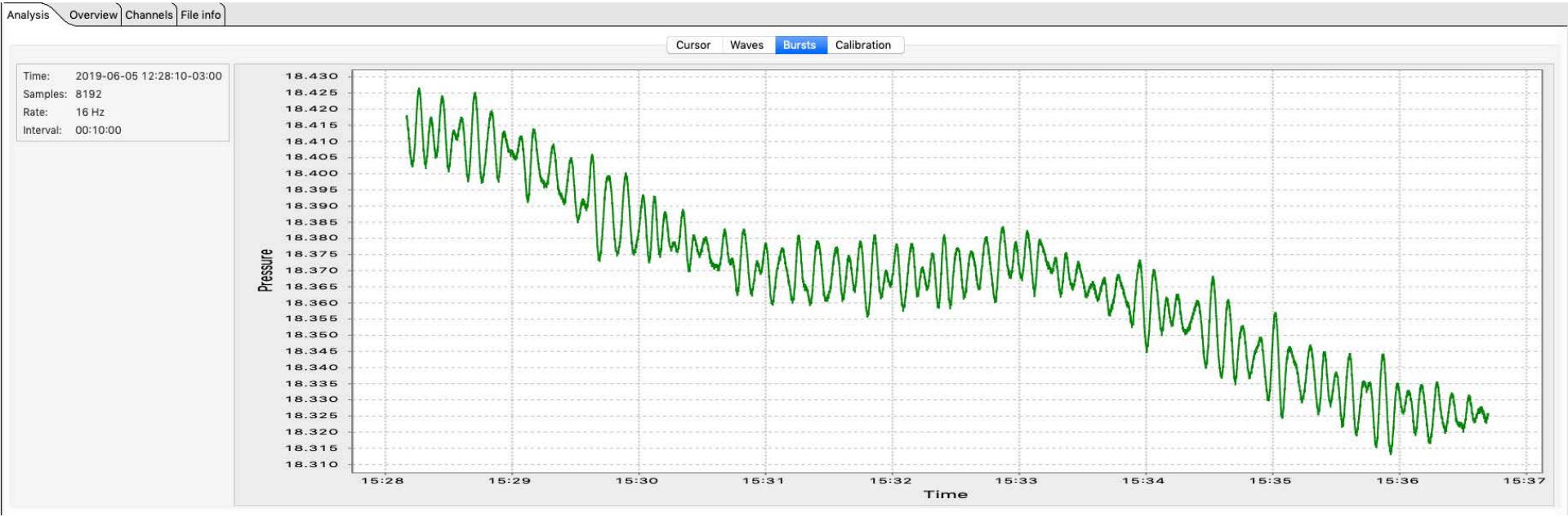
Ruskin Wave Processing – raw wave burst



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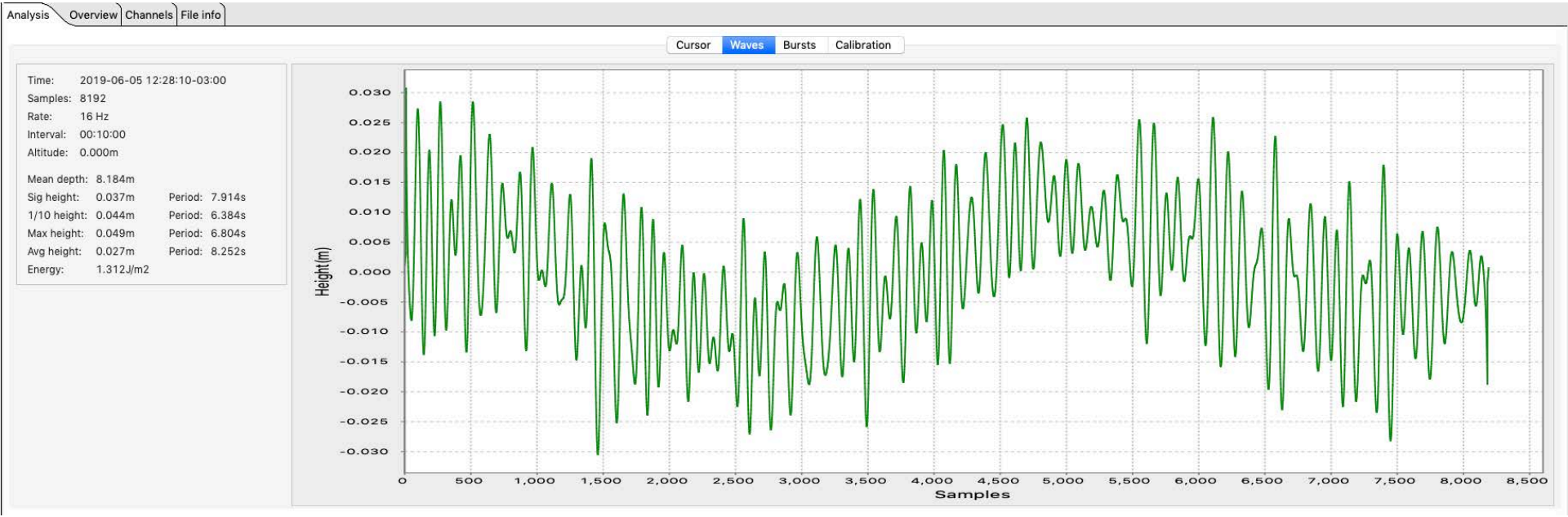
Ruskin Wave Processing – remove trend, remove mean



- Zero up-crossing
- Order from smallest to largest
- Calculate statistics

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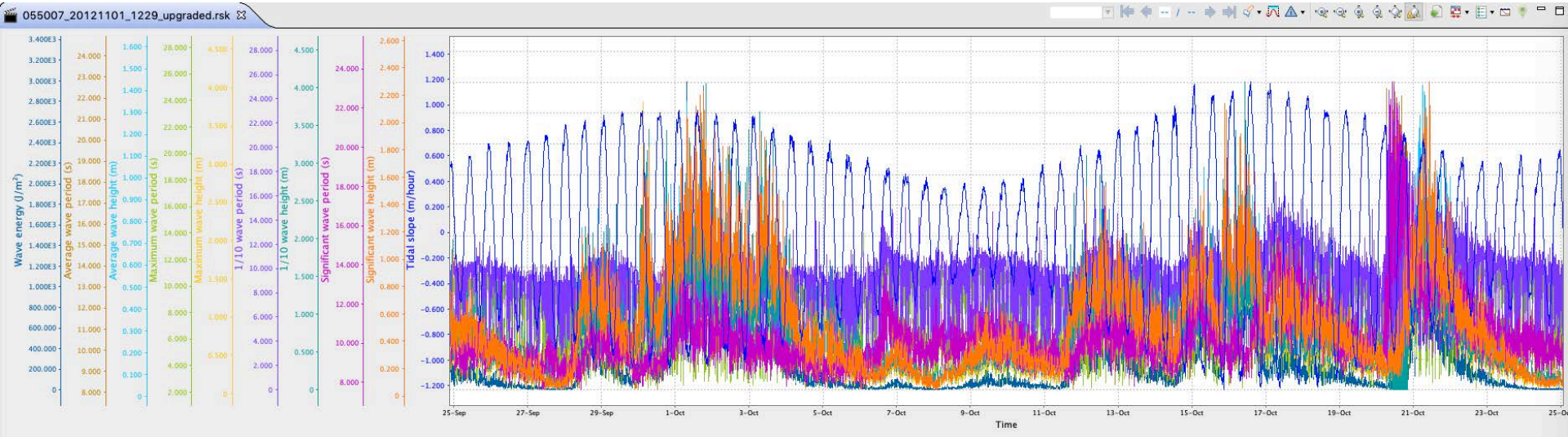
Ruskin Wave Processing



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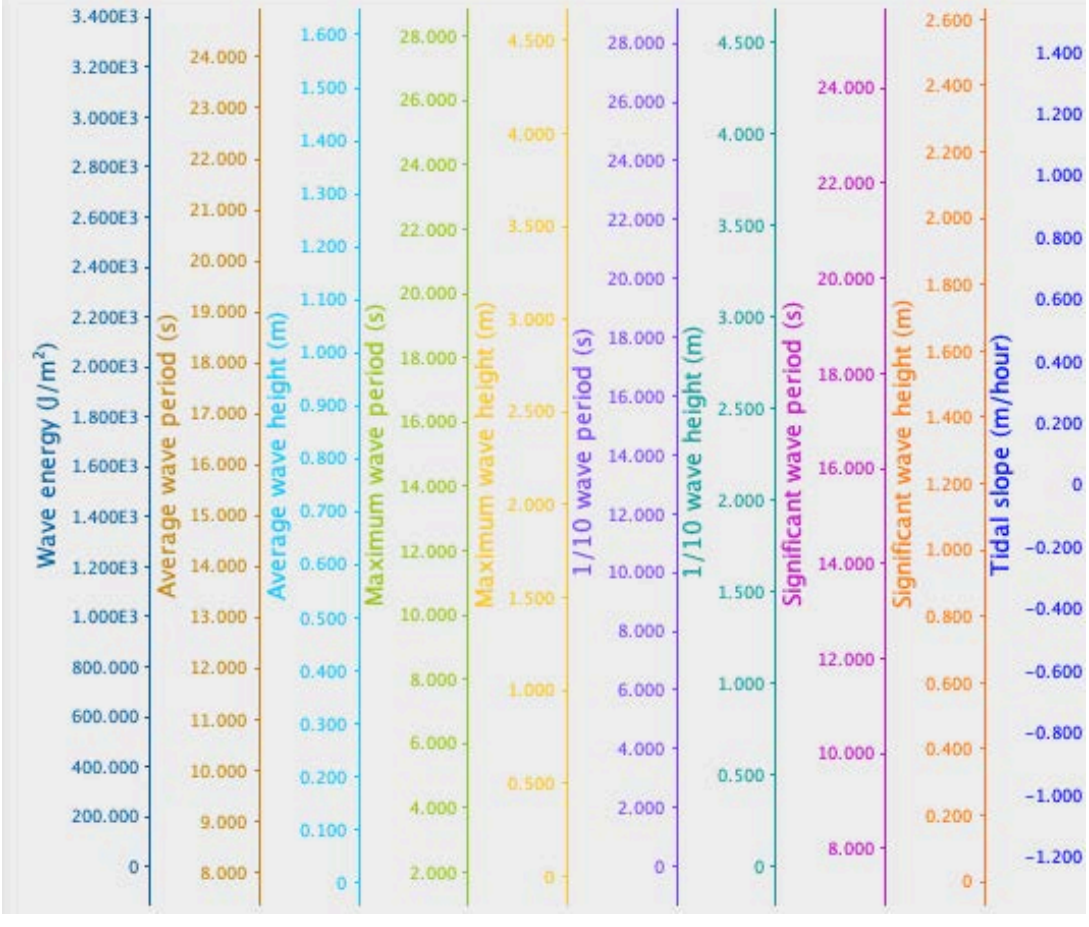
Ruskin Wave Processing



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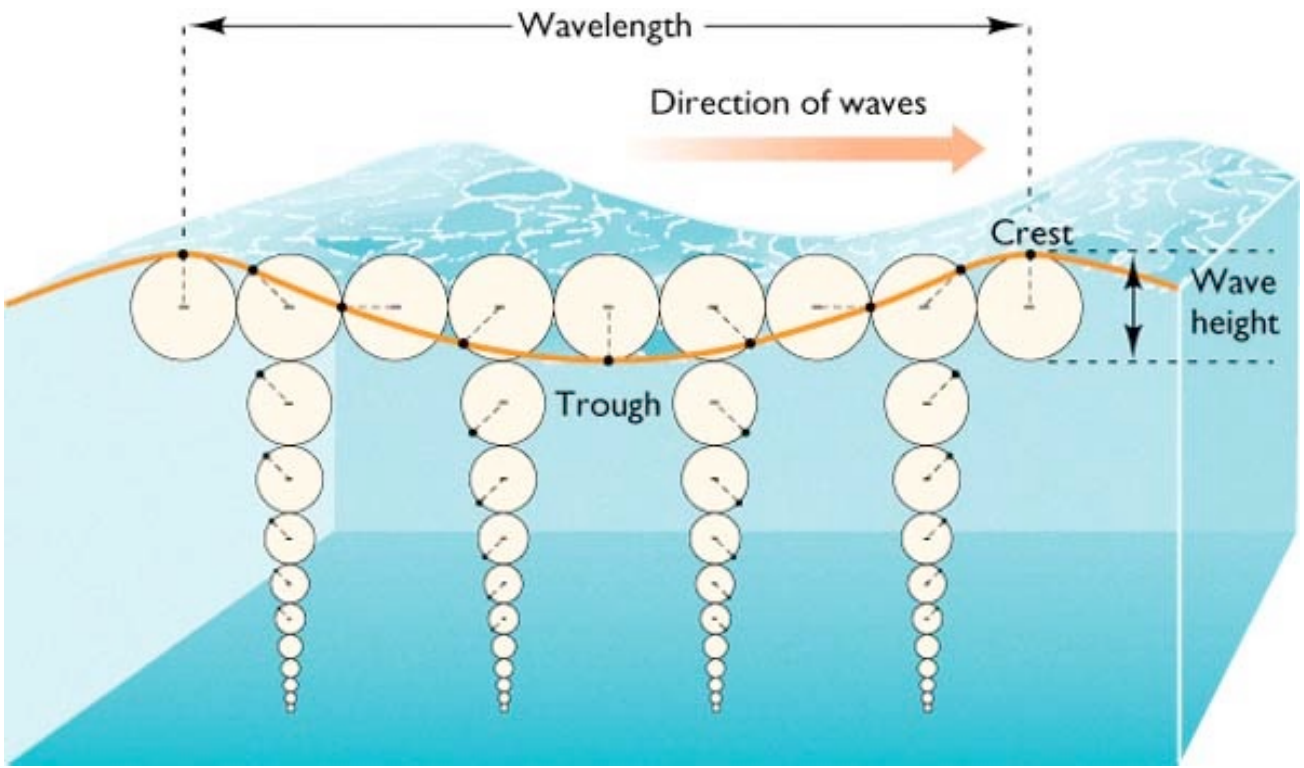
Sampling Considerations

Sample Rate



Attenuation of Pressure

- High frequency (short wave length) pressure signal is attenuated very quickly with depth
- Deploy in shallow water
- Don’t need to sample very quickly if deployed in deeper water

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Sample Rate

Nyquist frequency is important to consider

- If you sample a 1 Hz,
  the fastest wave you can resolve is 2 sec (0.5 Hz)

- If you sample a 2 Hz,
  the fastest wave you can resolve is 1 sec (1 Hz)

- If you sample a 4 Hz,
  the fastest wave you can resolve is 0.5 sec (2 Hz)

- If deeper than 3 m, no need to sample faster than 1 Hz
- But no downside to sampling faster

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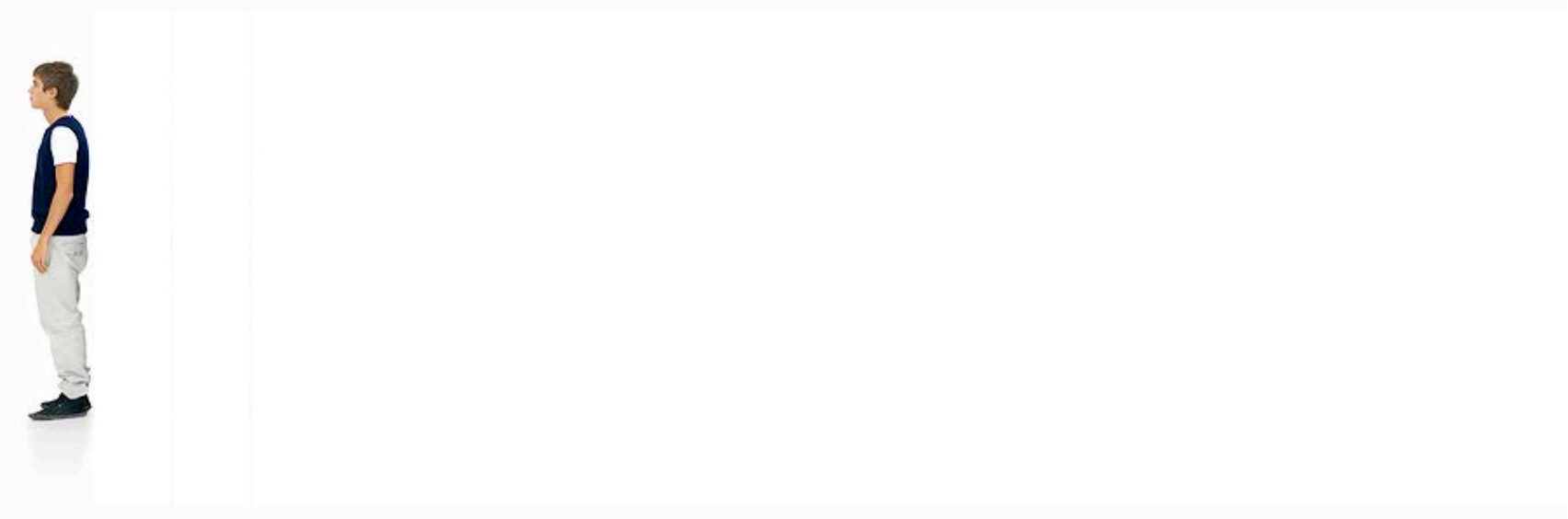
Burst Duration



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Well Sampled Waves

Number of samples & sampling frequency

Combination should amount to '*well sampled*'

- 100 wave cycles sampled per burst (*site dependent)*
- Examples
  - 10 sec period requires min 17 min burst (10 x 100 = 1000 sec)
  - 5 sec period requires 8.5 min burst (5 x 100 = 500 sec)

	1024	2048	4096	8192
2 Hz	8.5 min	17 min	34 min	68 min
4 Hz	4.3 min	8.5 min	17 min	34 min
8 Hz	2.1 min	4.3 min	8.5 min	17 min
16 Hz	1 min	2.1 min	4.3 min	8.5 min

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common settings

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common settings

swell

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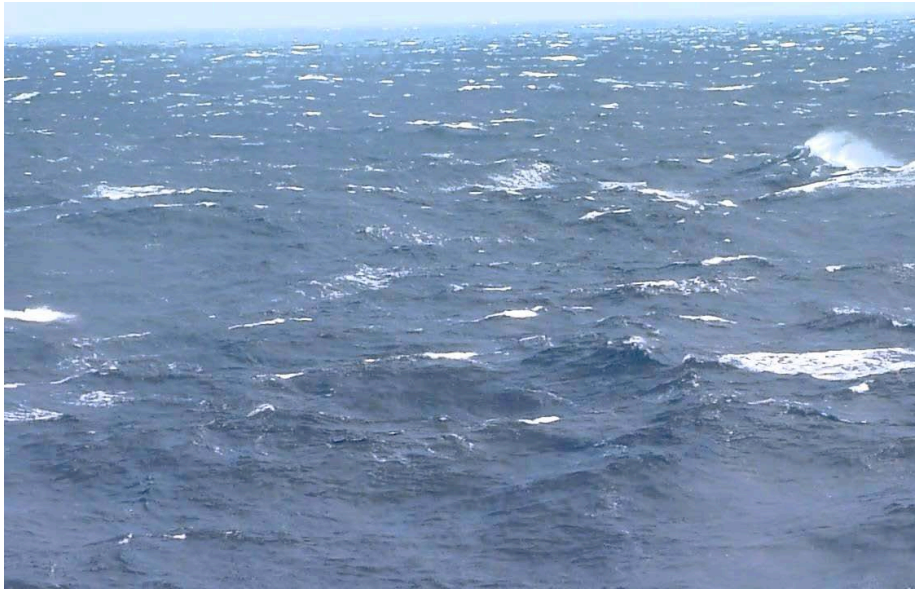
Burst Interval

Open Ocean



1 – 3 hours

Enclosed Bay

20 min – 1 hour

Depends on battery, memory, and deployment duration

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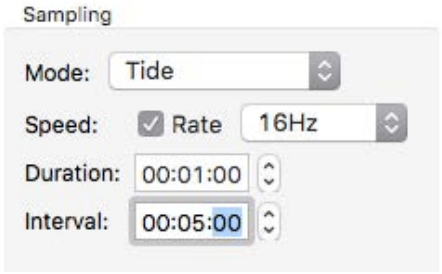
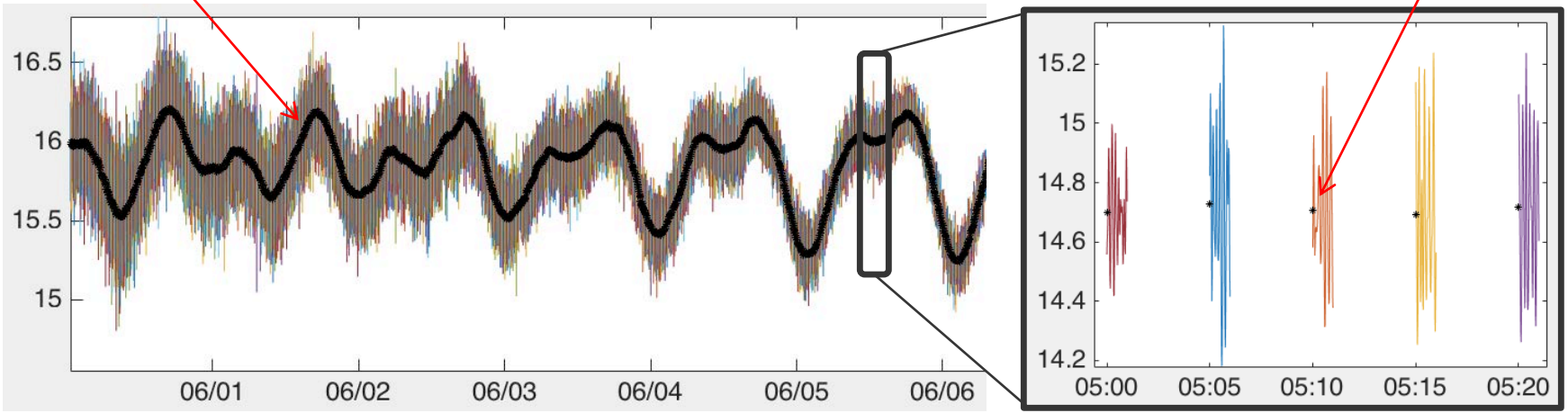
Configuring Ruskin

|tide16



Filter out higher frequency variation

Only averaged data is saved



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wave16

Wave
"Burst"
Sampling

Sampling

Mode: Wave

Speed: 16Hz

Duration: 32768

Interval: 01:00:00

0.25 Instrument altitude (m)

10.0 Mean depth of water (m)

Wave bandwidth: 0.0005 to 0.1889 Hz

Wave periods: 5.29 to 2048.00 secs

Height above bottom

Estimate water depth

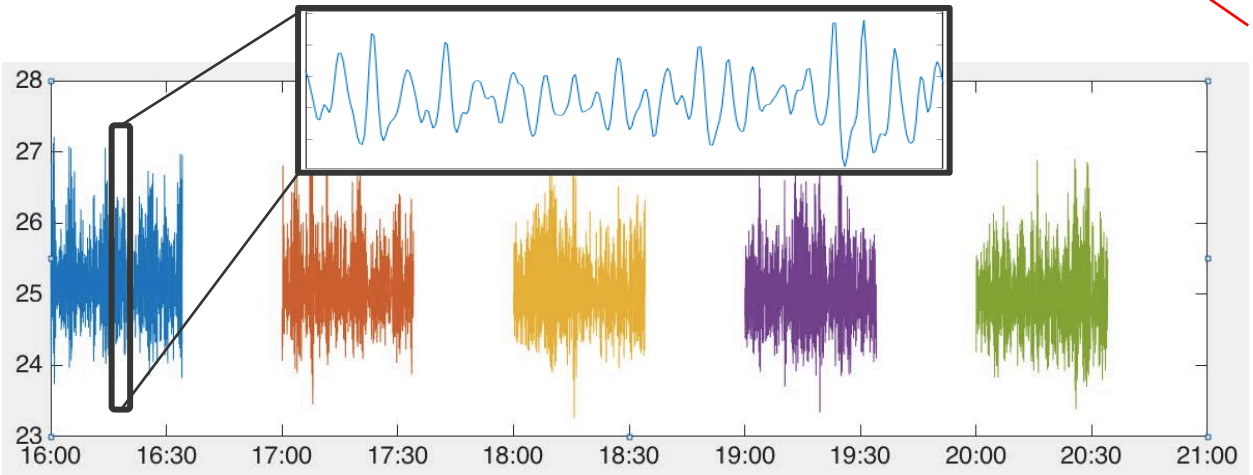
Estimate wave period limitations

~34 min

Every

1 hour

(32768 ÷ 16 ÷ 60)



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Frequency Limitations

Mode: Wave
Speed: 16Hz
Duration: 4096
Interval: 00:30:00
1.0 Instrument altitude (m)
2 Mean depth of water (m)
Wave bandwidth: 0.0039 to 0.4952 Hz
Wave periods: 2.02 to 256.00 secs

Mode: Wave
Speed: 16Hz
Duration: 4096
Interval: 00:30:00
1.0 Instrument altitude (m)
10 Mean depth of water (m)
Wave bandwidth: 0.0039 to 0.1899 Hz
Wave periods: 5.27 to 256.00 secs

Mode: Wave
Speed: 16Hz
Duration: 4096
Interval: 00:30:00
1.0 Instrument altitude (m)
5 Mean depth of water (m)
Wave bandwidth: 0.0039 to 0.2732 Hz
Wave periods: 3.66 to 256.00 secs

Mode: Wave
Speed: 16Hz
Duration: 4096
Interval: 00:30:00
1.0 Instrument altitude (m)
20 Mean depth of water (m)
Wave bandwidth: 0.0039 to 0.1338 Hz
Wave periods: 7.48 to 256.00 secs

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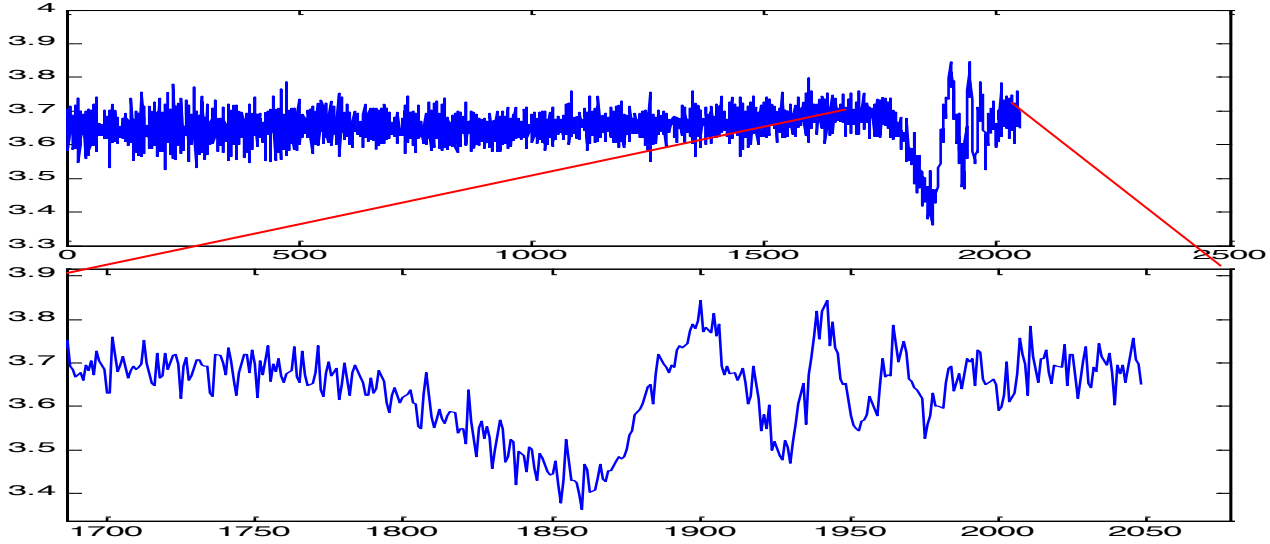
Measuring Ship Waves (Transient Waves)

- Linear wave theory doesn't apply
- Ship waves are mixed with regular waves
- Can't use standard wave metrics
- Must collect all raw pressure data



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Resources

https://docs.rbr-global.com/support/ruskin/features/waves/wave-overview

https://docs.rbr-global.com/support/faq/software-and-firmware-questions/how-does-ruskin-process-tide-and-wave-data

https://docs.rbr-global.com/support/faq/software-and-firmware-questions/what-s-the-difference-between-tide-and-wave-mode-in-ruskin

https://rbr-global.com/support/matlab-tools

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Upcoming Webinars

Future Webinars

CTD and sensor calibrations

Greg Johnson

June 24, 2020 at 12PM EDT

Learn about the RBR calibration procedure for conductivity, temperature, pressures, and other sensors, and how you can maintain, verify, and calibrate some sensors in the field.

Register for the Webinar

Webinar 2.0

Customer Experiences

Speakers Invited

info@rbr-global.com

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