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Application of JPEG 2000 Wavelet Compression to Multibeam Echosounder Mid-water Acoustic Refectivity Measurements

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Application of JPEG 2000 Wavelet Compression to Multibeam Echosounder Mid-water Acoustic Reflectivity Measurements

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Now at
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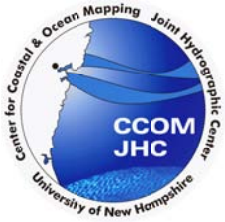

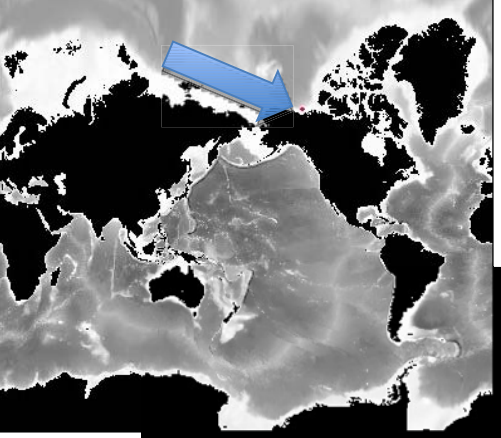

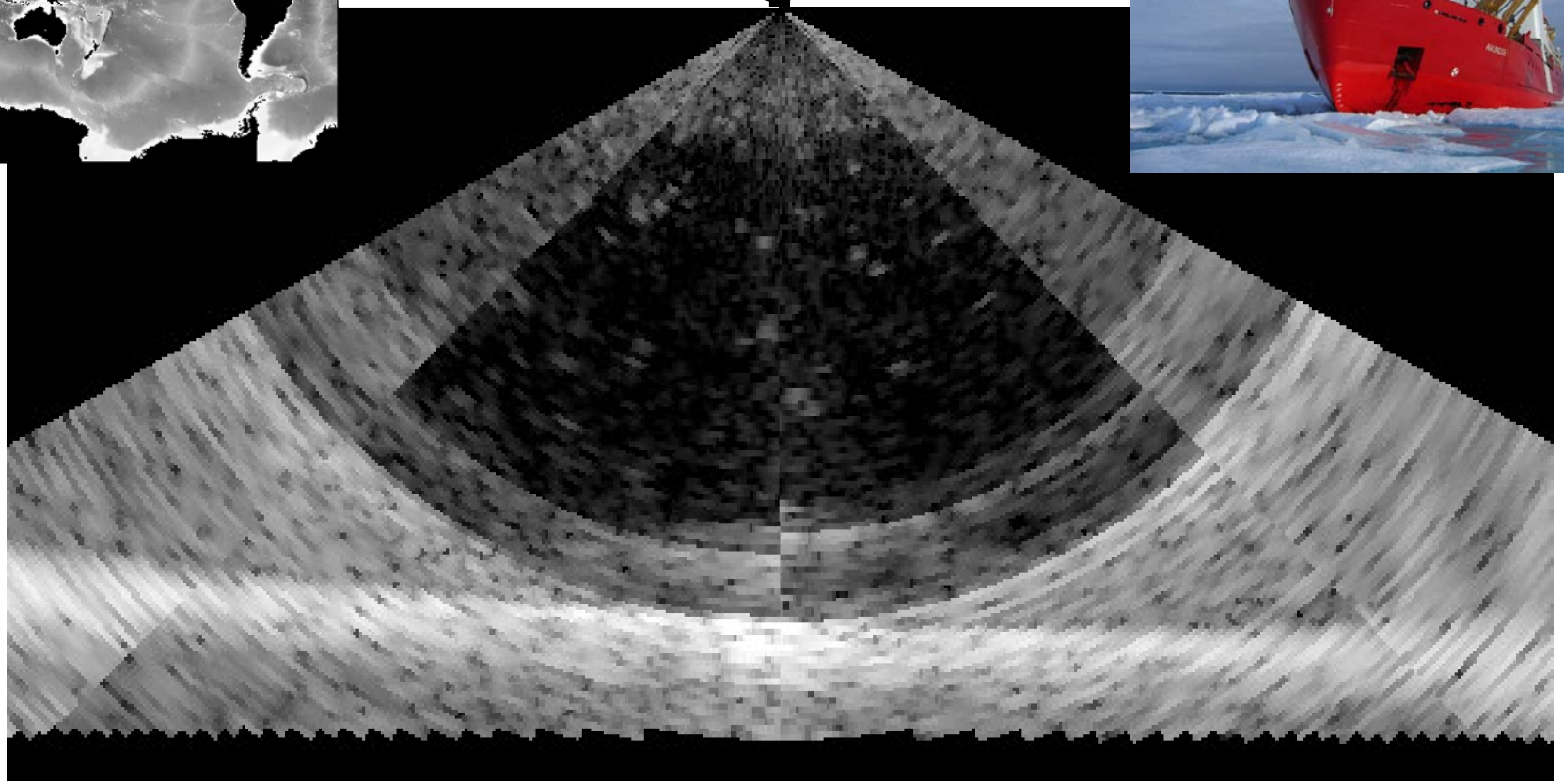

CCGS Amundsen – Mackenzie Shelf, 2009-10-01
EM302 30 kHz MBES (1.0ºx2.0º)

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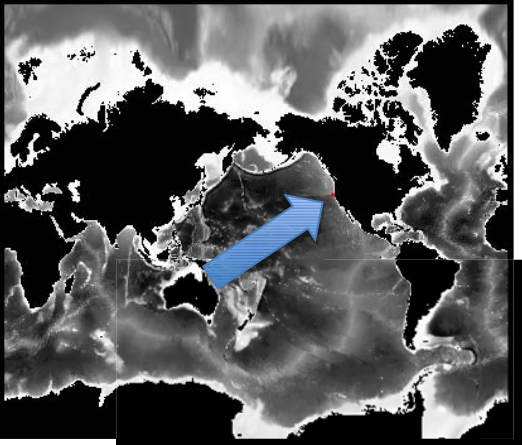

NOAAS Okeanos Explorer – Northern California Margin
EM302 30 kHz MBES (0.5ºx1.0º)

2,500 m

5,000 m

J. V. Gardner, M. Malik, and S. Walker. Plume 1400 Meters High Discovered at the Seafloor off the Northern California Margin. Eos Trans. AGU, 90(32), 2009

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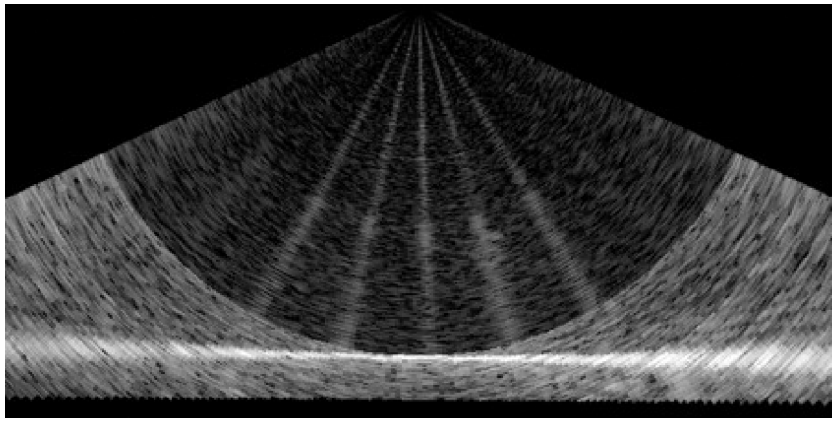
Data Storage Requirements

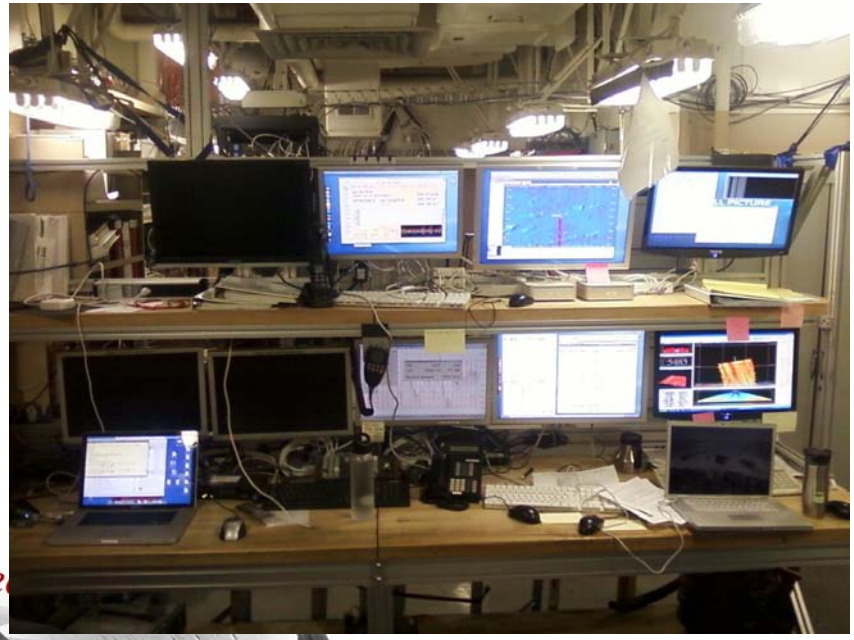
- Logging WC data increases file sizes:
  - CCGS Amundsen, 2009 field season
    - 135 days at sea, *continuous* MBES logging
    - "Regular" data: 860 GB (.all files)
    - Water column data: 783 GB (.wcd files)

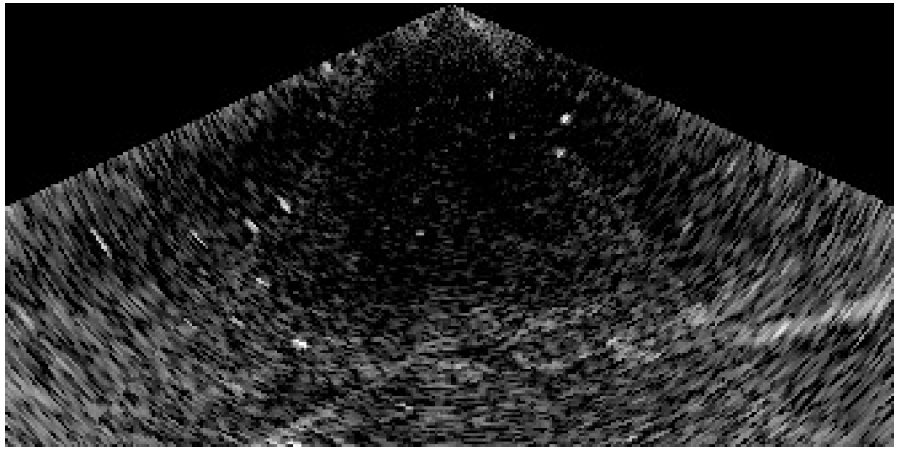
- File size grows by factor of 2-8, depending on water depth and angular sector
- Some (most?) don't bother logging WC, *especially in shallow water*



Recording “Interesting” Data only

How do you define “interesting”?





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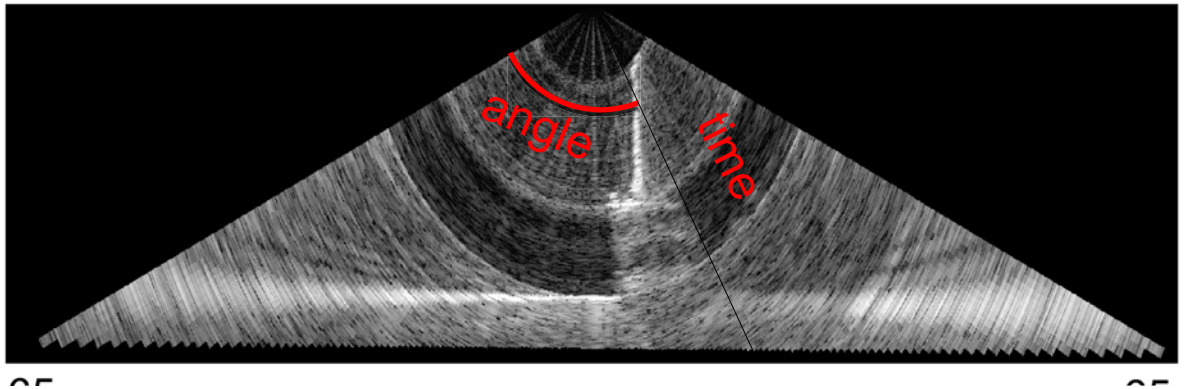
787

Solution?

- Courtney (2008) applied JPEG2000 to seismic & sidescan and suggested use for MBES
- JPEG2000:
  - Discrete Wavelet Transform (DWT)
  - Lossless and Lossy methods available
- JasPer implementation of JPEG2000
  - Freely available open source library
  - Reasonably documented
  - Implemented in many open source applications

R. Courtney. Storage and dissemination of SEGY data in JPEG2000 format. In Proc. Shallow Survey 2008, Oct2008.

Implementation



time

Beam/angle

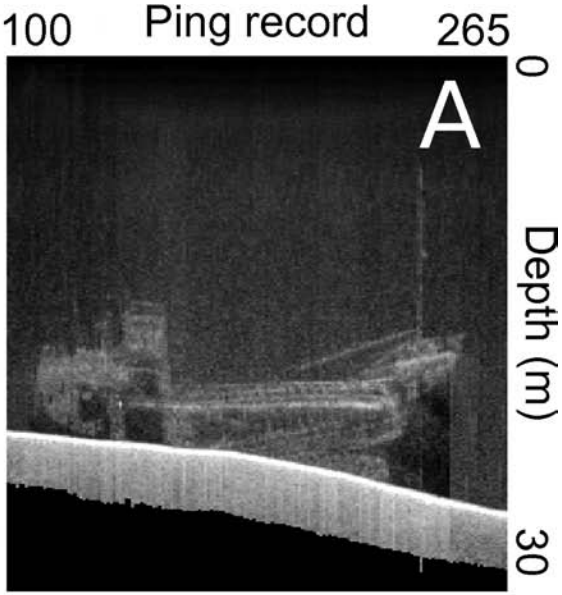
Raw

JPEG2000 image is stored along with WC datagram header along with metadata

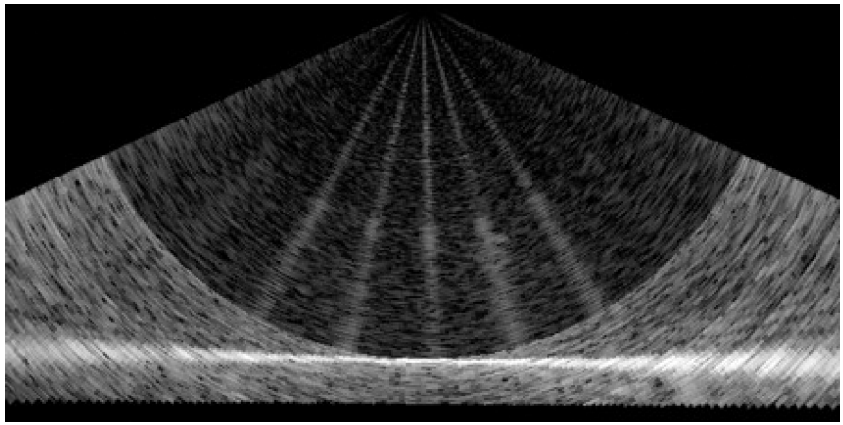
Ping-by-ping approach is ideally suited for real-time compression

JPEG2000 (20:1)

Evaluation

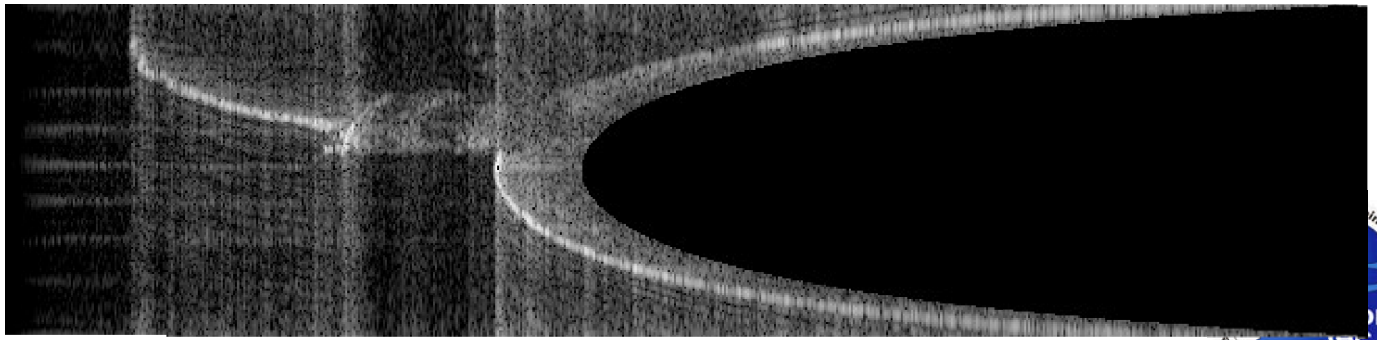


- MV G.B. Church, purposely sunk in 1991
- Mapped with EM3002 in 2006 (CCGS Otter Bay)
- 12 passes, only 1 pass fully imaged mast (1,064MB of data, 899MB of WC)
- Wreck imaged over 170 pings

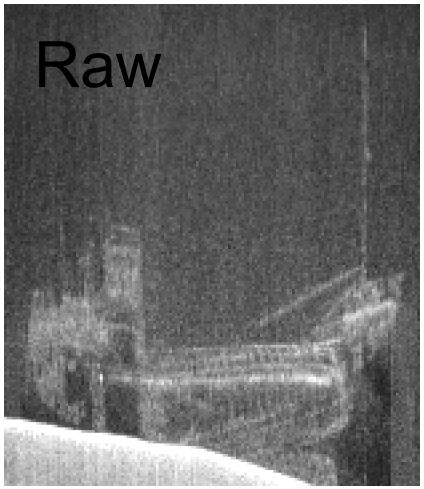


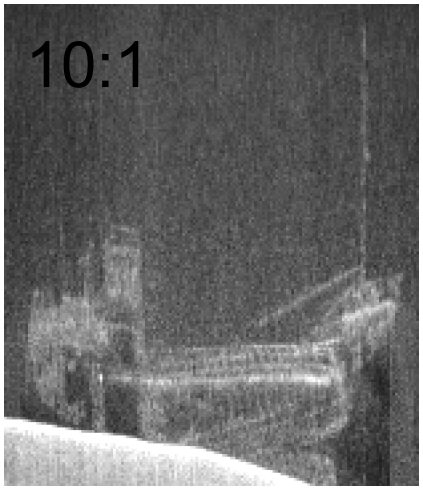
Results: Lossless Compression

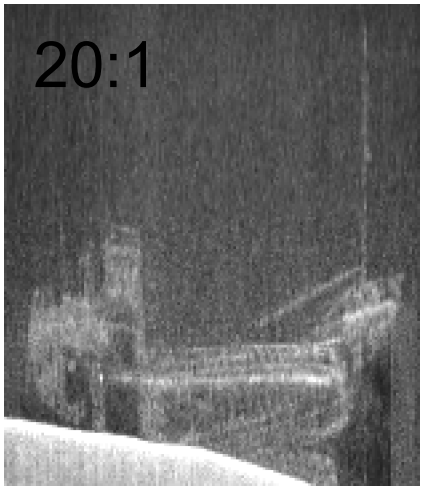
- Ratios 2.5:1 (raw image compared to JPEG2000)
- Effective ratio only 1.5:1 due to zero padding
- Still better than WinZip:
  - JPEG2000: packs down file size to 68%
  - Lempel-Ziv: packs down file size to 75%

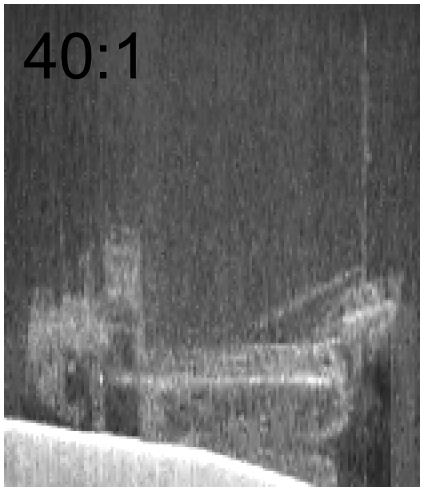


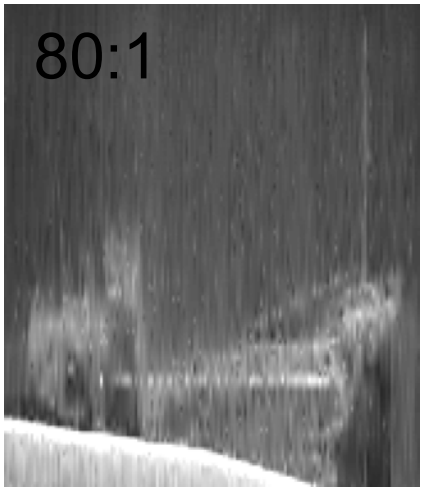
Results: Lossy Compression

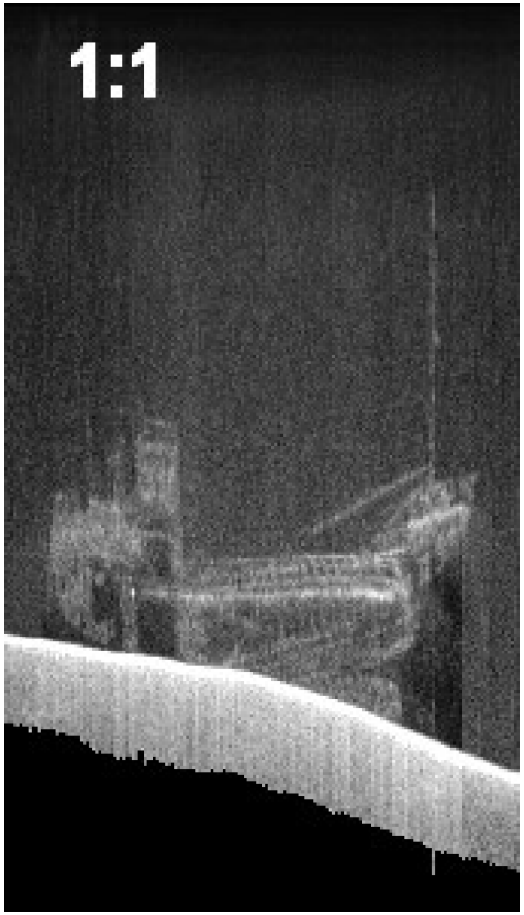












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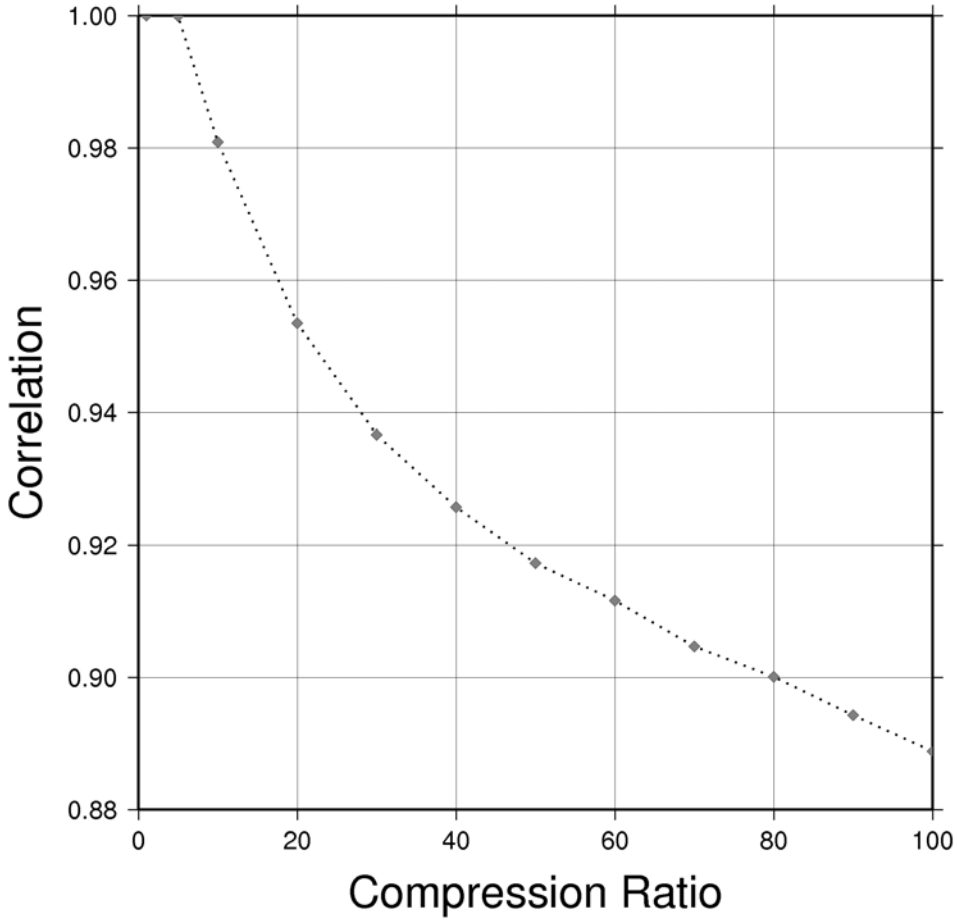
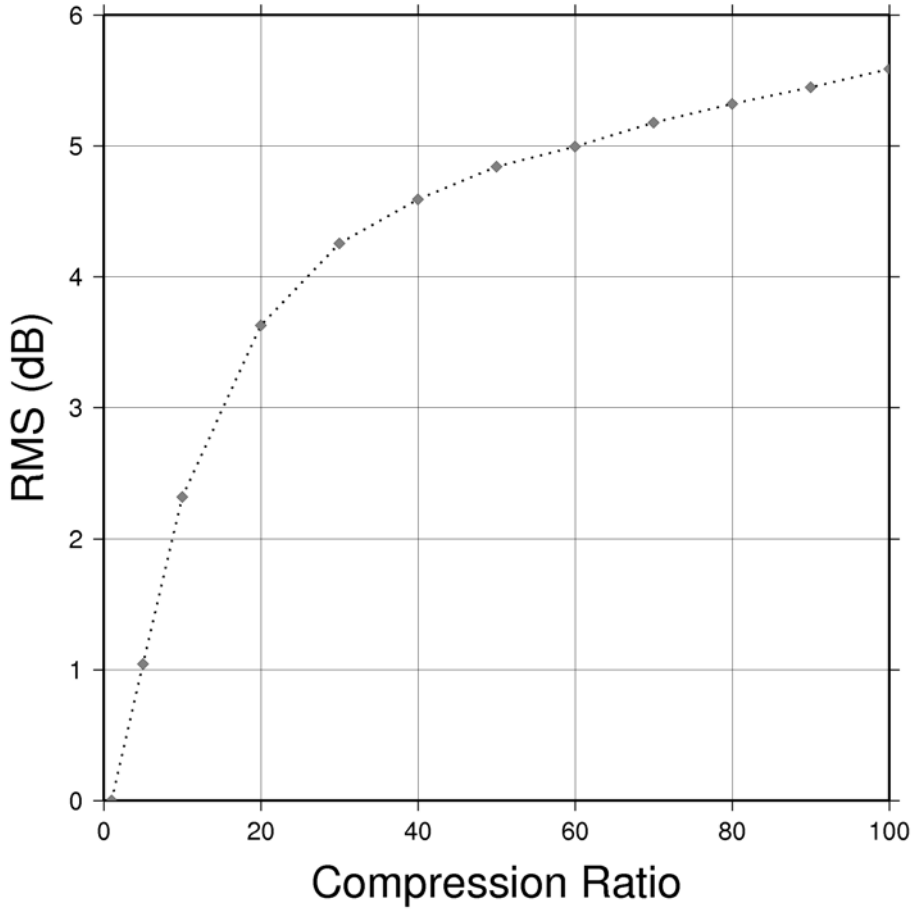
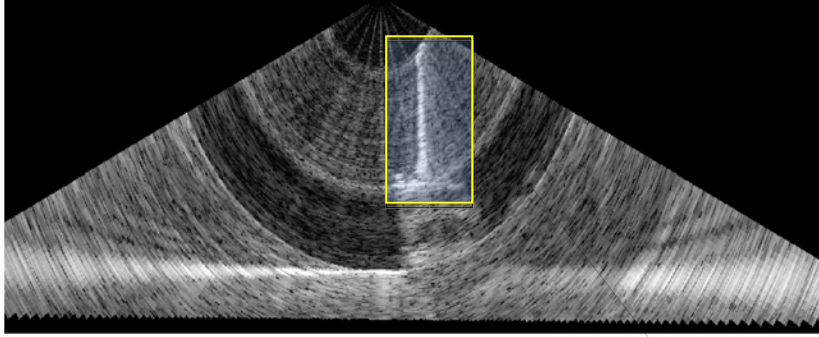
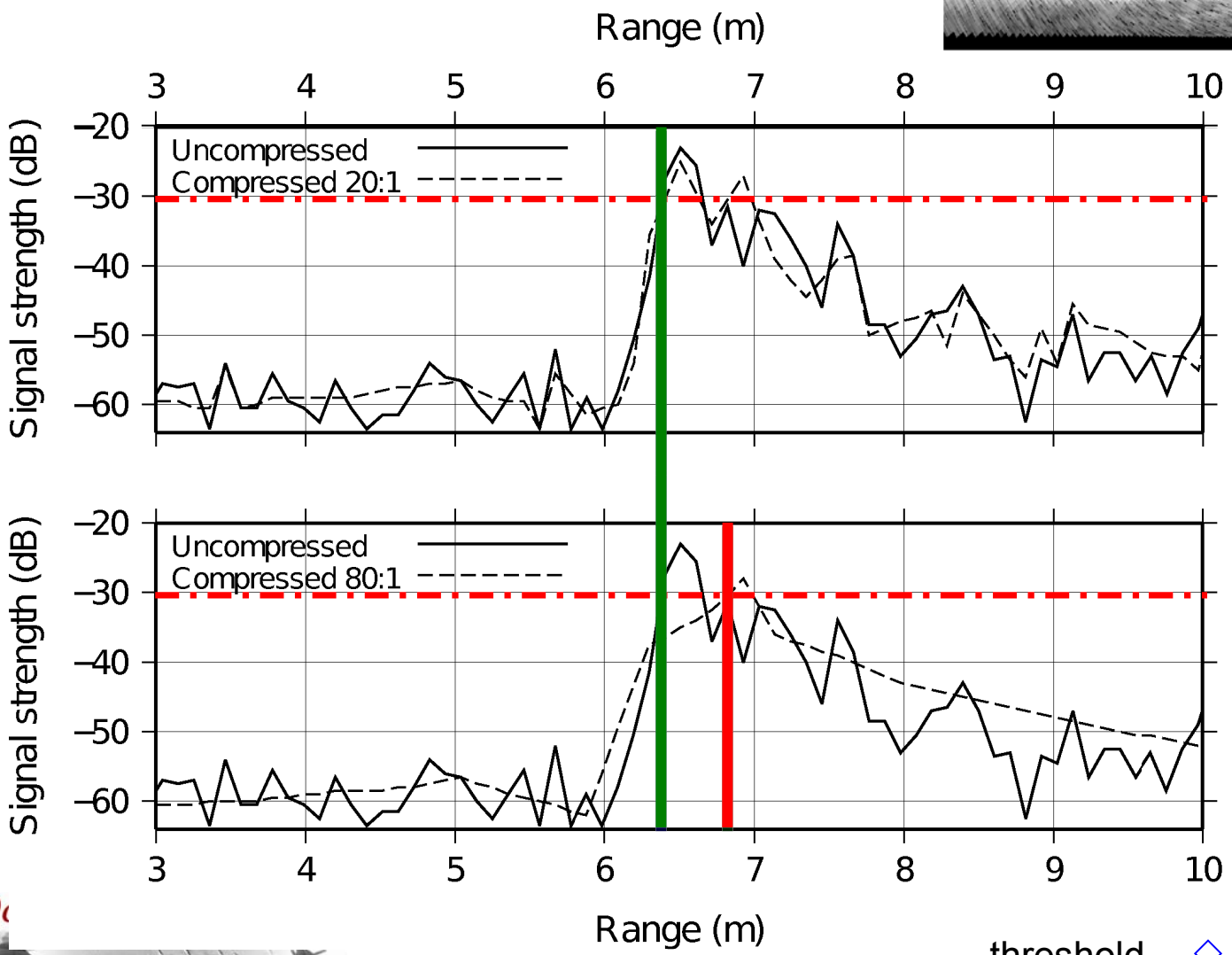
Quantifying Effects of Lossy Compression

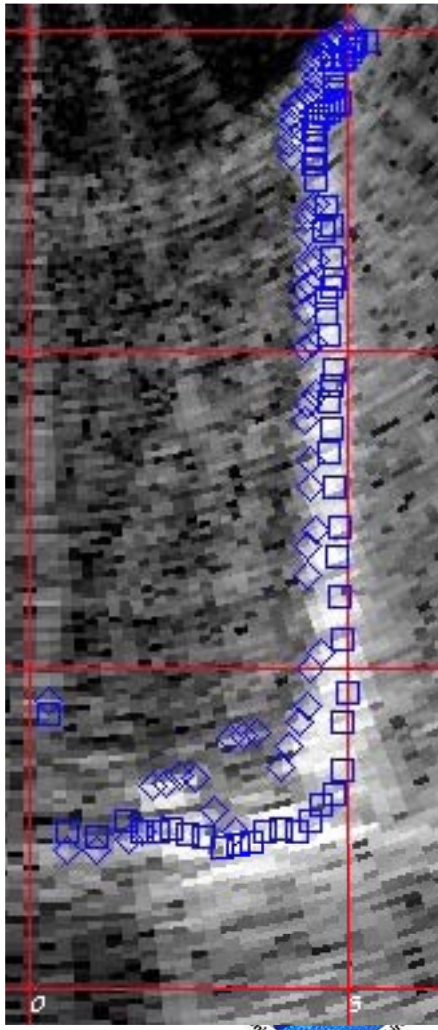




Wreck Measurement

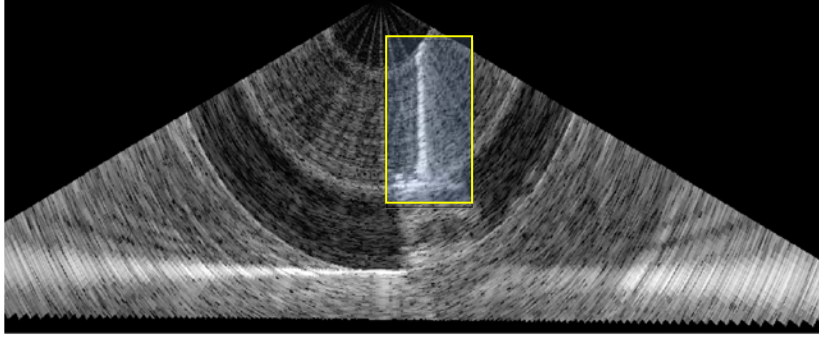




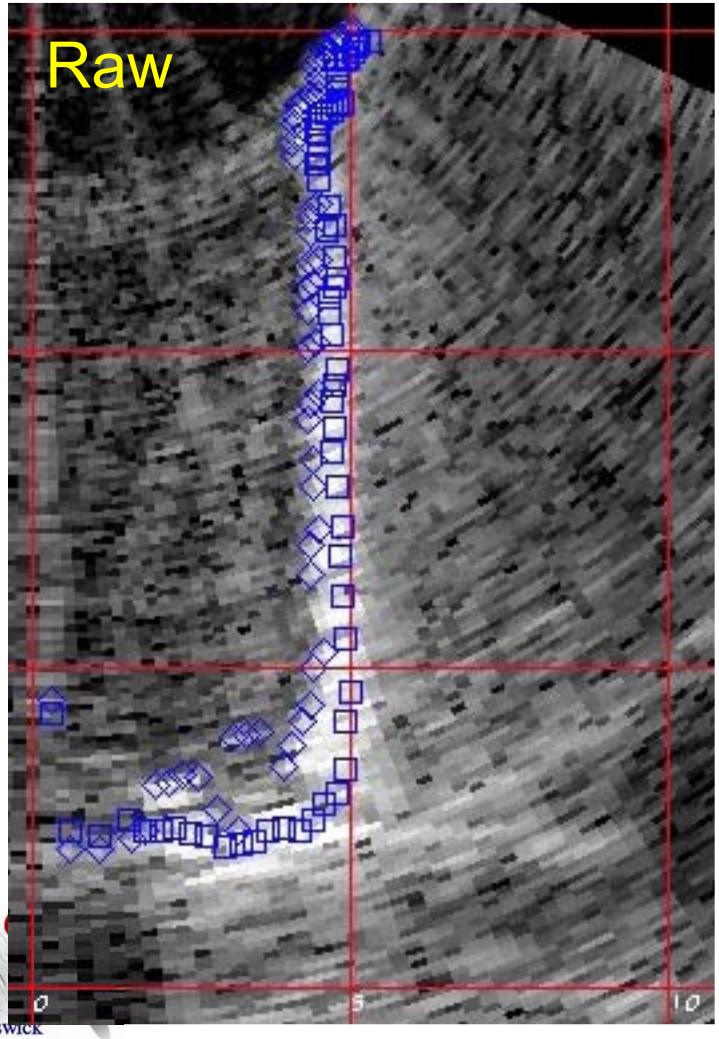


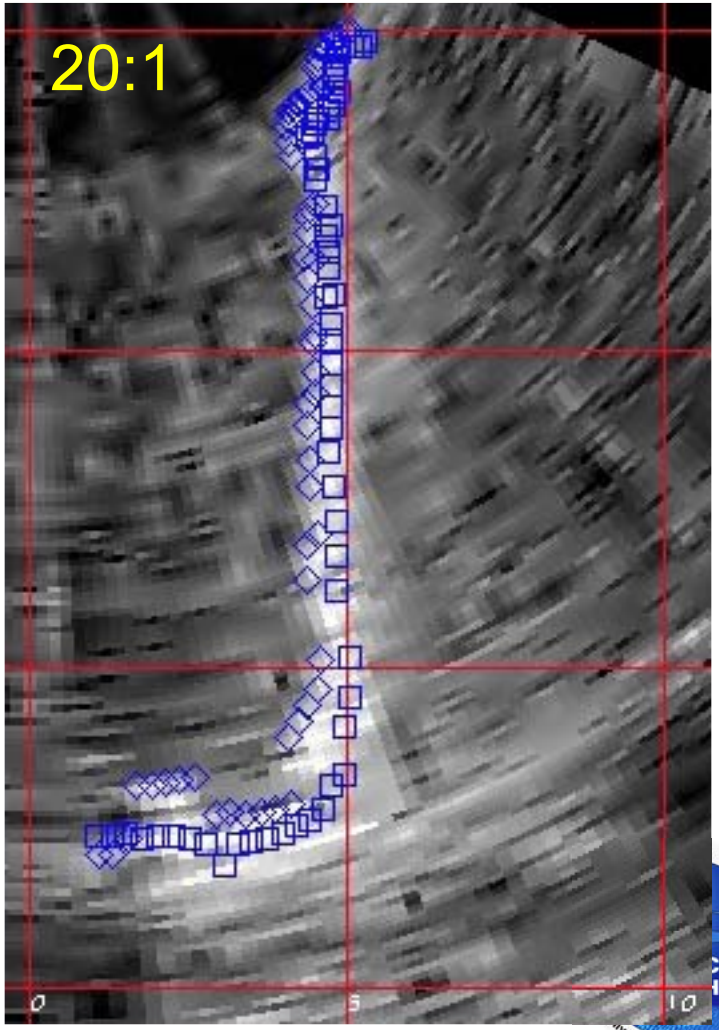
threshold ◇
wmt □

Wreck Measurement

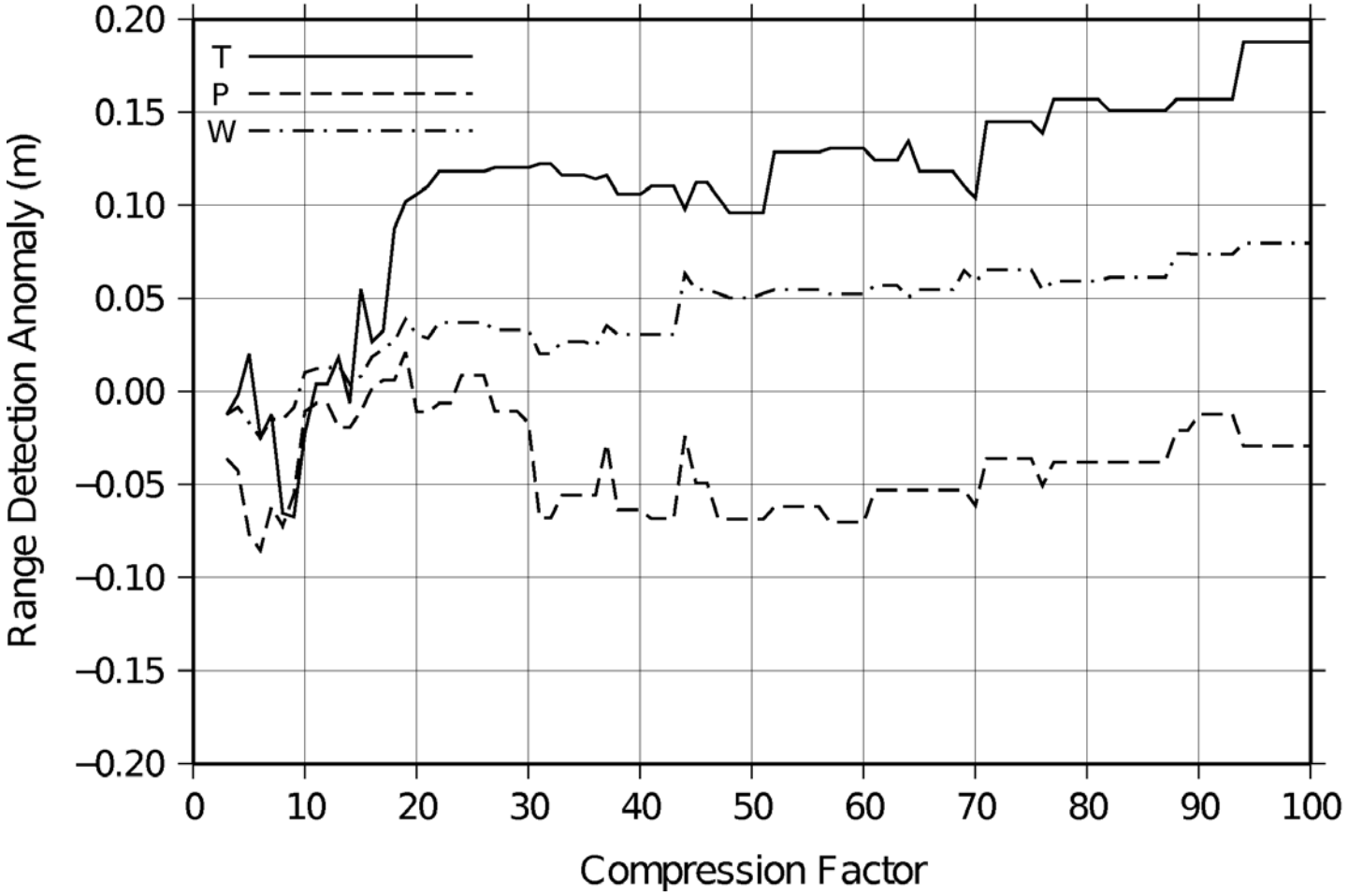


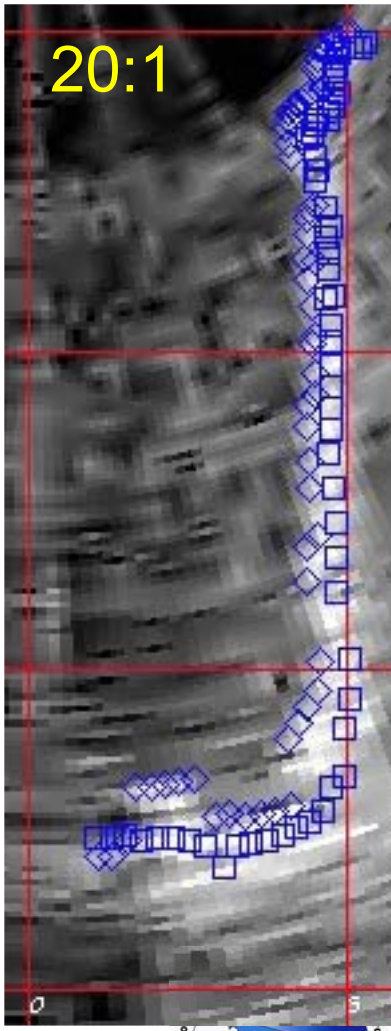
threshold ◇
wmt □





Mean Anomaly





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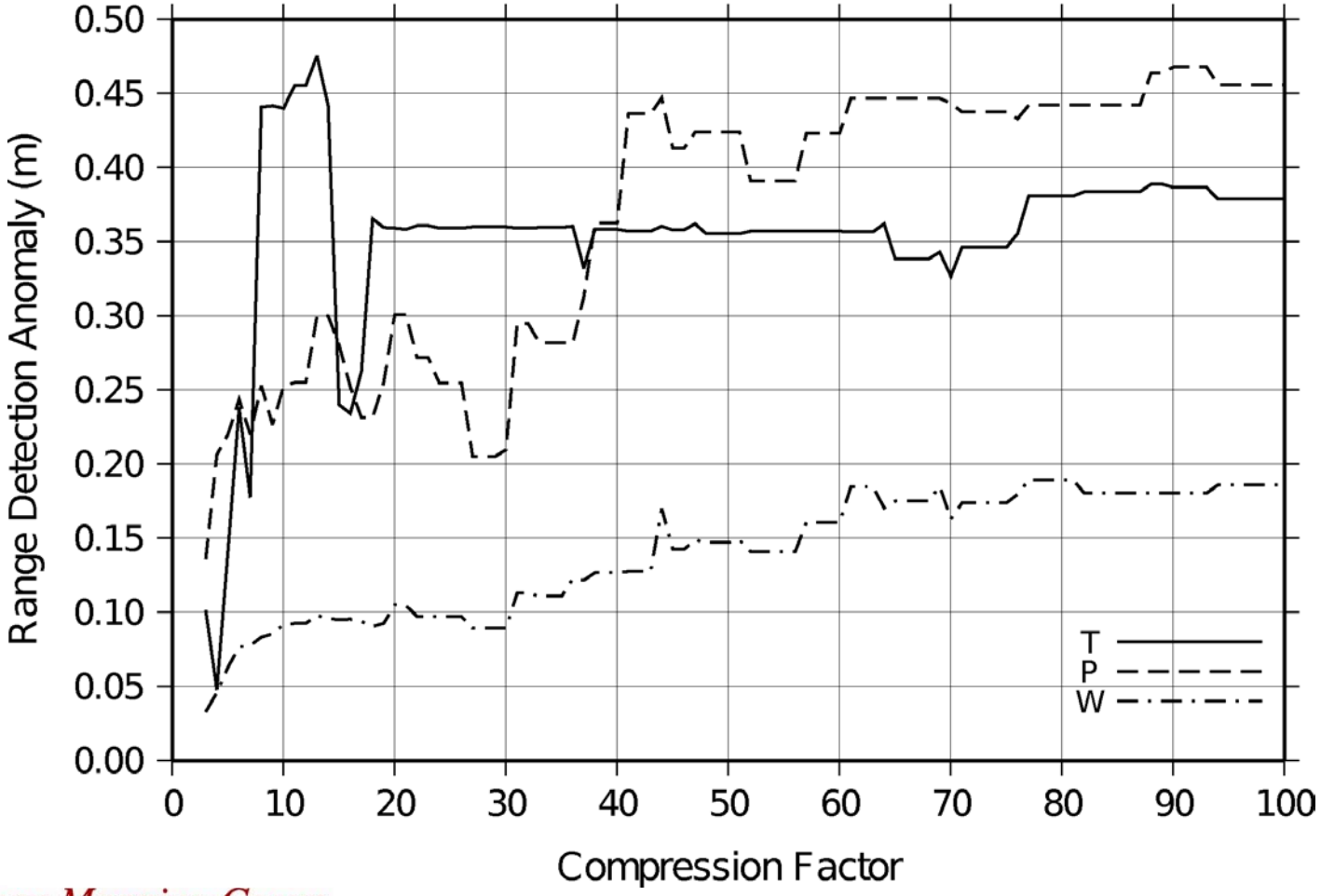
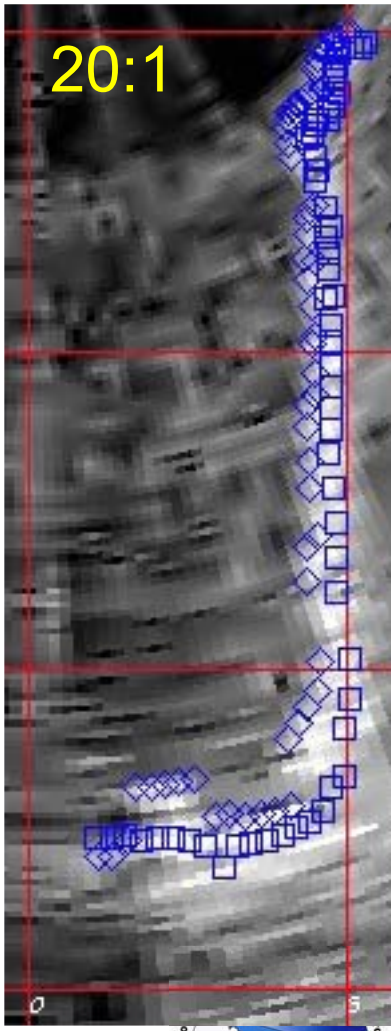
Anomaly Std. Deviation





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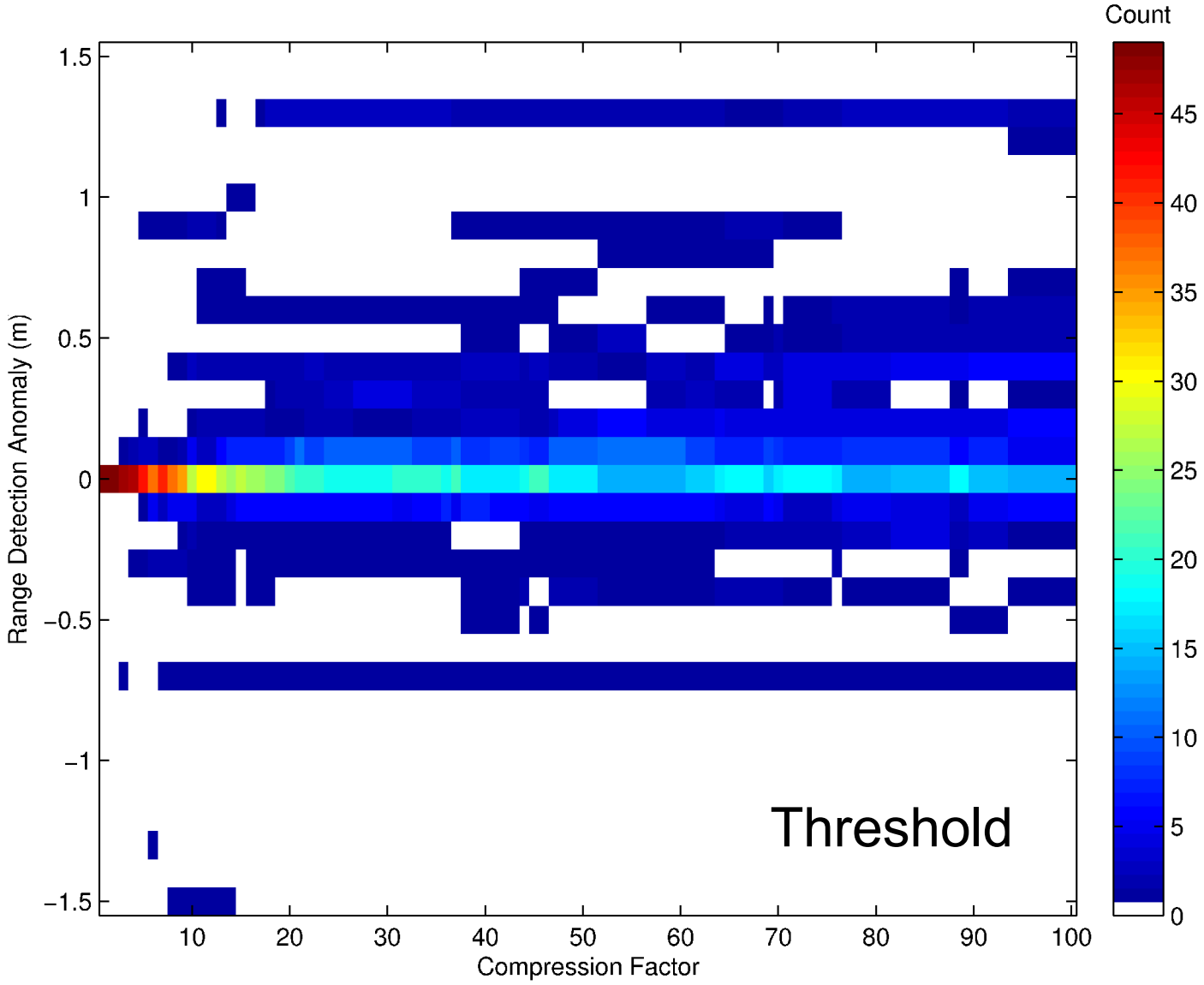
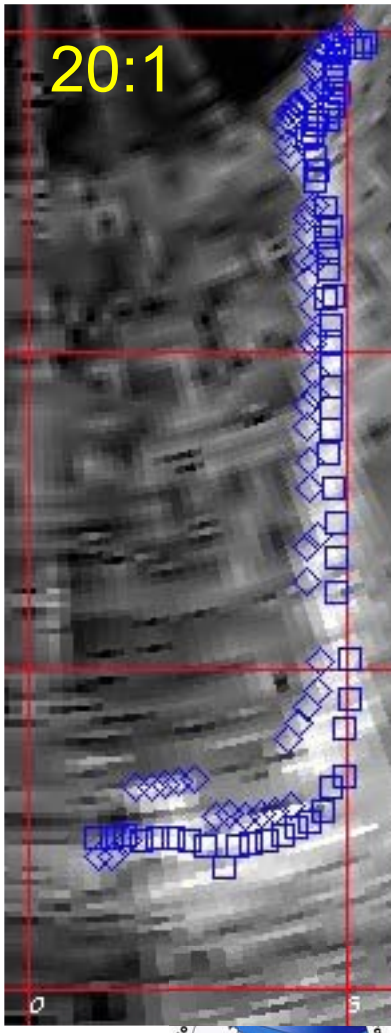
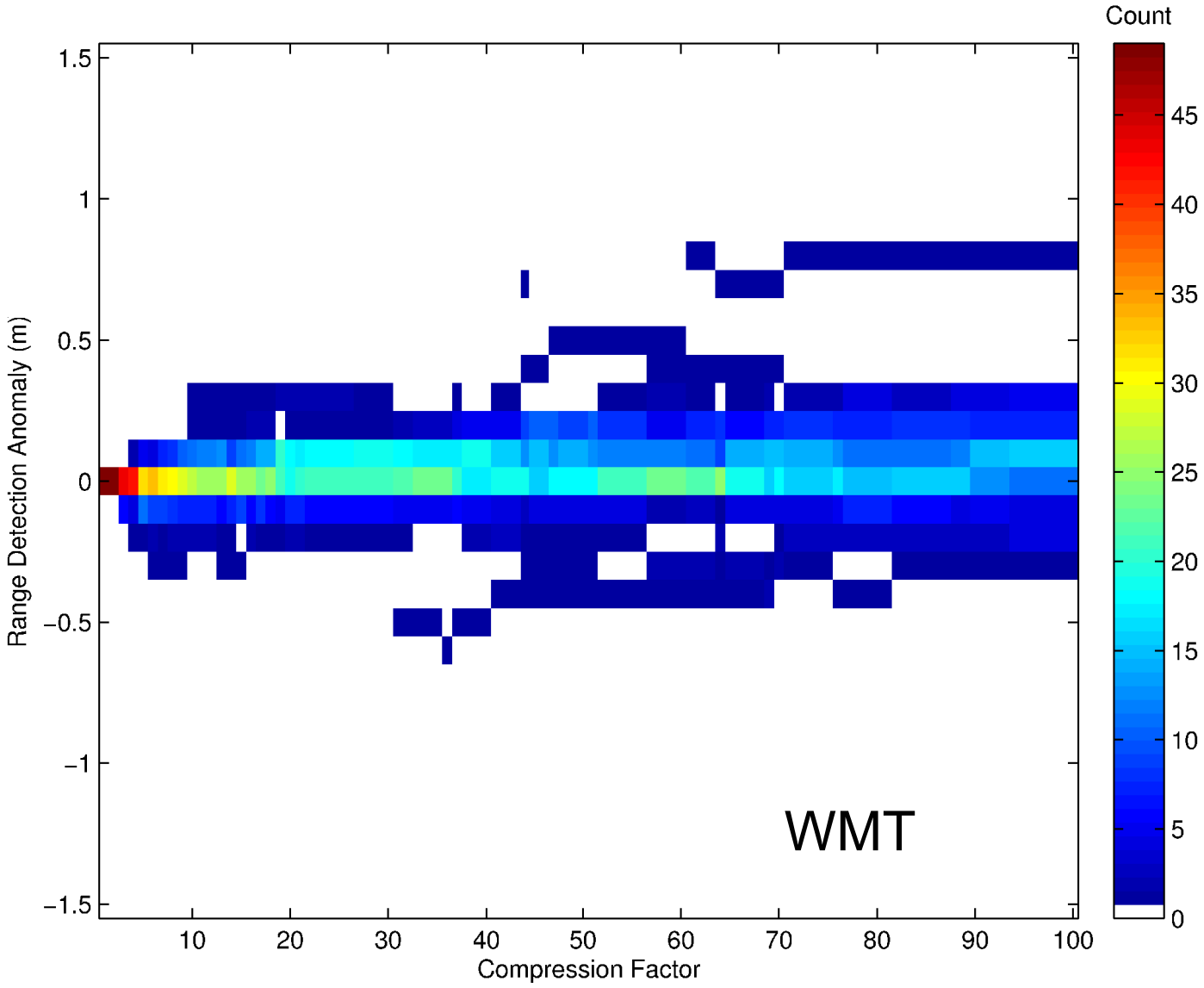
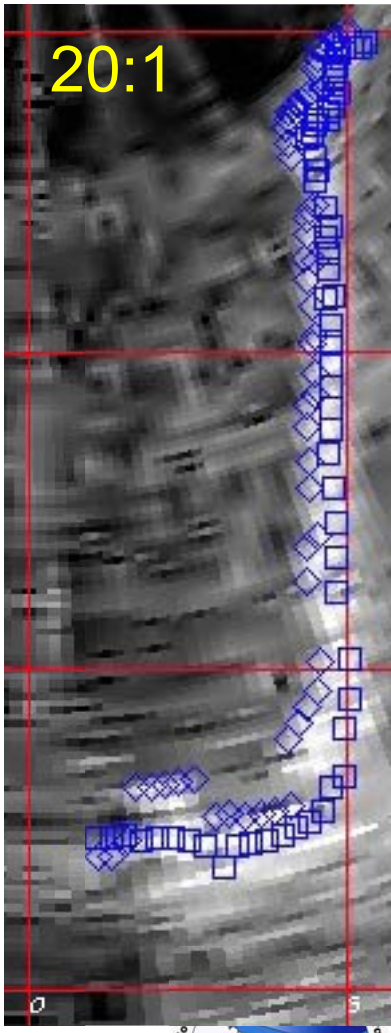
Wreck Measurement Performance





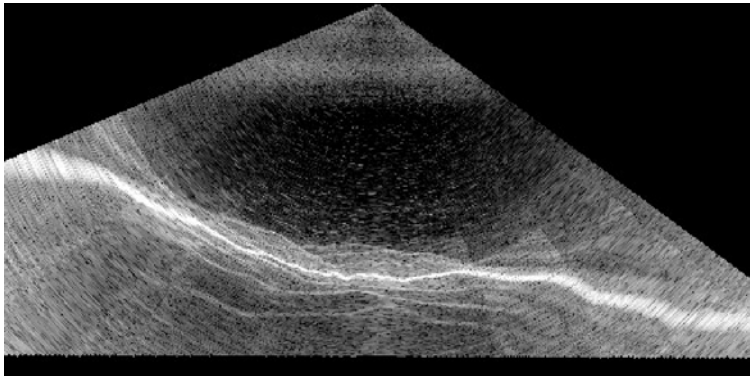
Wreck Measurement Performance





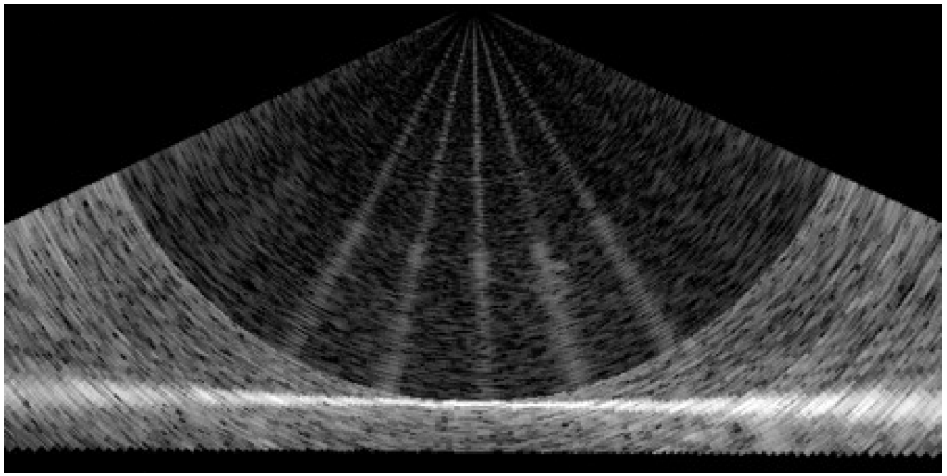
Conclusion

- JPEG 2000 compression easily applicable to MBES water column data
- Lossless:
  - ratios of 1.5:1 achievable
- Lossy:
  - 20:1 seems a good compromise for hydrographic purposes
  - Application specific metrics should be devised
- Compression enables discovery



Take Home Message?

- Lossy compression applied in real-time would allow for continuous WC recording in shallow water
  - Help fulfill hydrographic “detection” requirements
  - Provide invaluable contextual information for data cleaning



Acknowledgements

- ArcticNet NCE
- Sponsors of the OMG
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- Robert Courtney, GSC (Atlantic)

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Questions?