



Joint WMO-IOC Technical Commission
for Oceanography and Marine Meteorology

Wave Measurement Evaluation and Testing Phase II

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Scientific and Technical Workshop of the Data Buoy Cooperation Panel

2 October 2012

Fremantle, AUSTRALIA

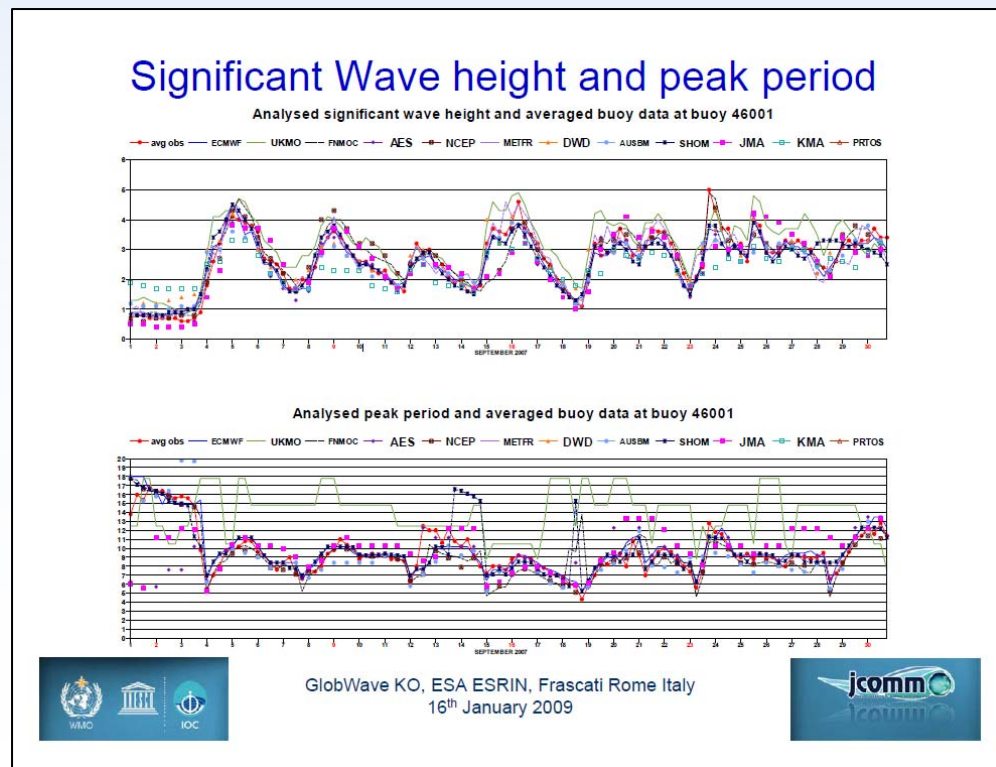
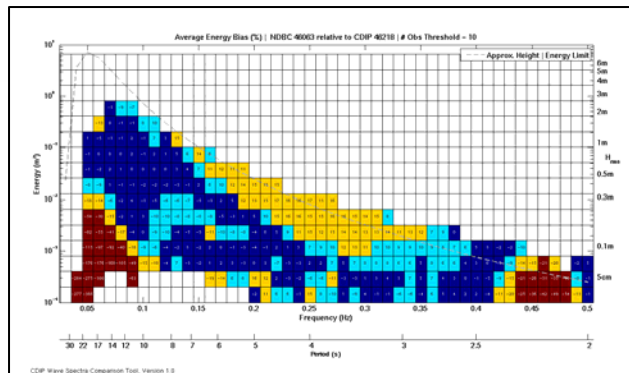


WMO



IOC/UNESCO

- Overview of Process
- Preliminary Results
 - Co-located results
 - Dual Sensor / Single Hull
- Continued Assessments
- Summary / New Testing
- Recommendations



- First-5

- Assumptions

- Directional estimates: poorly defined



- $E(f)$: frequency spectra similar sensor to sensor

- Analysis packages: did not introduce differences

- Hull / Mooring: lower order contribution

- Impact

- Weather Prediction Center evaluation process

- Integral wave parameters (H_{mo} , T_p , θ_{mean})

- Wave Model Improvements

- Still relying on integral wave parameters

- Tolerances: 0.25 to 0.50-m

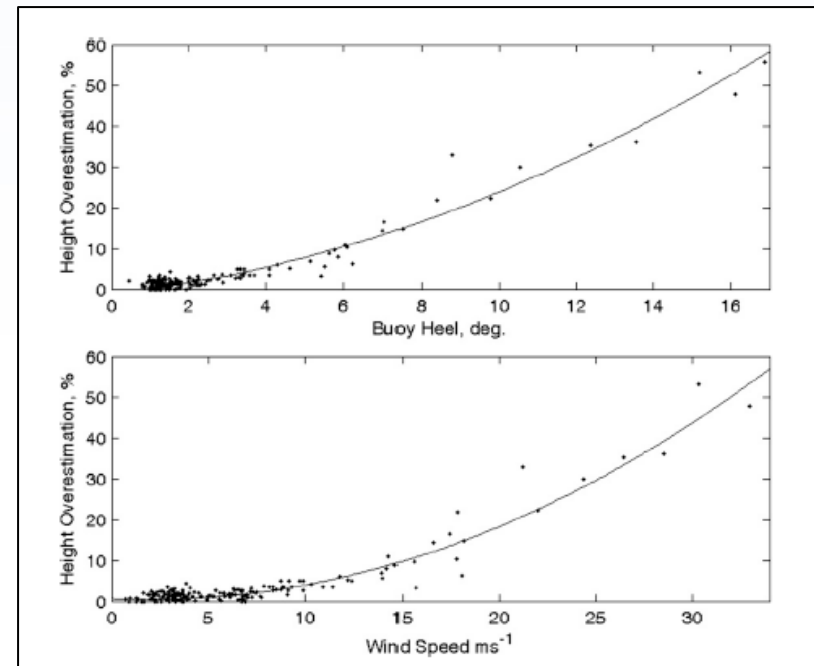
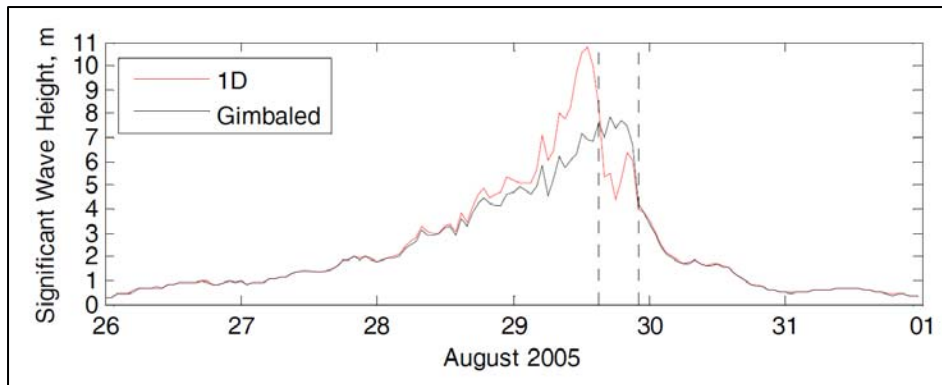
- Climate Variation

- Specification of extreme storm events



Why Do We Need to Test and Evaluate

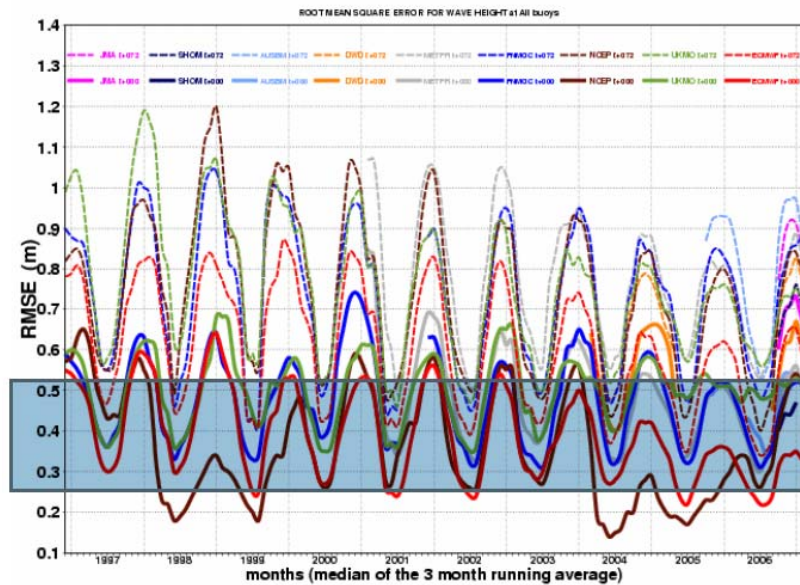
- Bender et al. (2010)
 - Strapped Down 1D accelerometers
 - ~3-m over-estimation in H_{mo}
 - Buoy Heel
 - Payload correctable
- Test (3 Sites / NDBC 3D buoys)



Why Do We Need to Test and Evaluate

FROM: JCOMM Wave Forecast Verification Project

Example: RMSE for wave height at all buoys



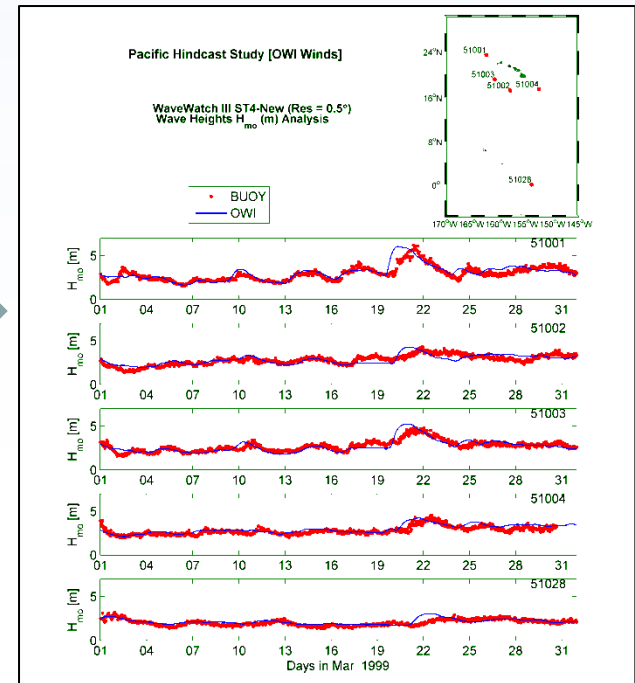
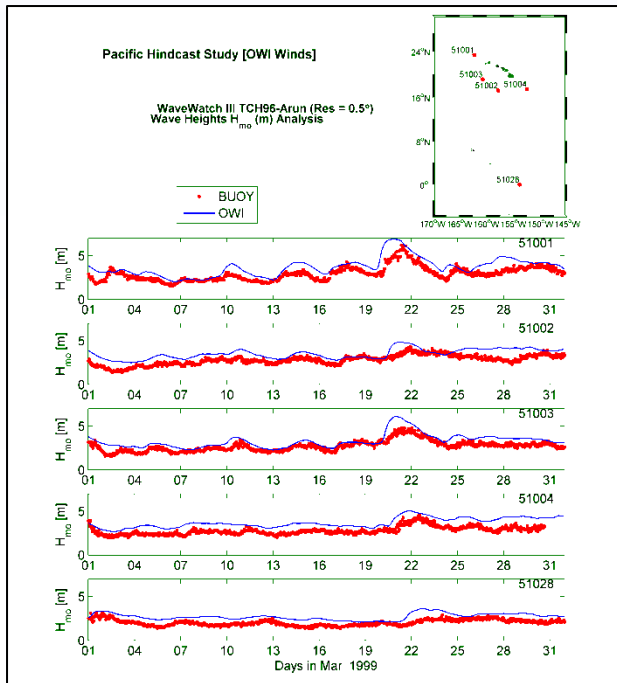
GlobWave KO, ESA ESRIN, Frascati Rome Italy
16th January 2009



Is the accuracy in measurements limiting the metric for performance in WPC's estimates?

Why Do We Need to Test and Evaluate

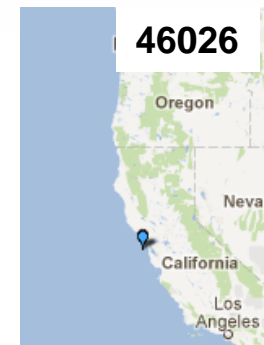
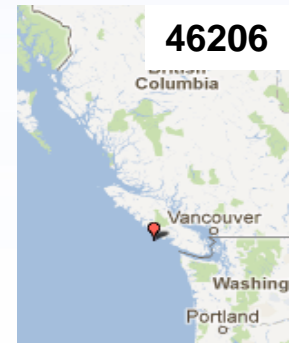
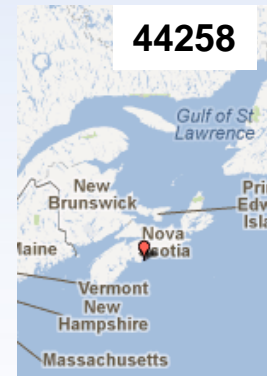
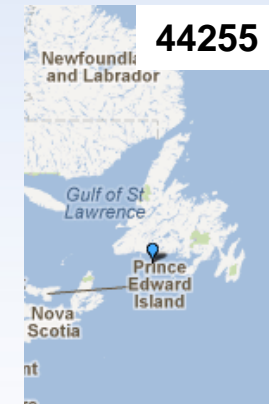
- Hindcasts / Wave Model Improvements
 - Rely on point-source measurements
 - Evaluation process: H_{mo} , T_p , θ_{mean}
 - Implementation based on $E(f)$



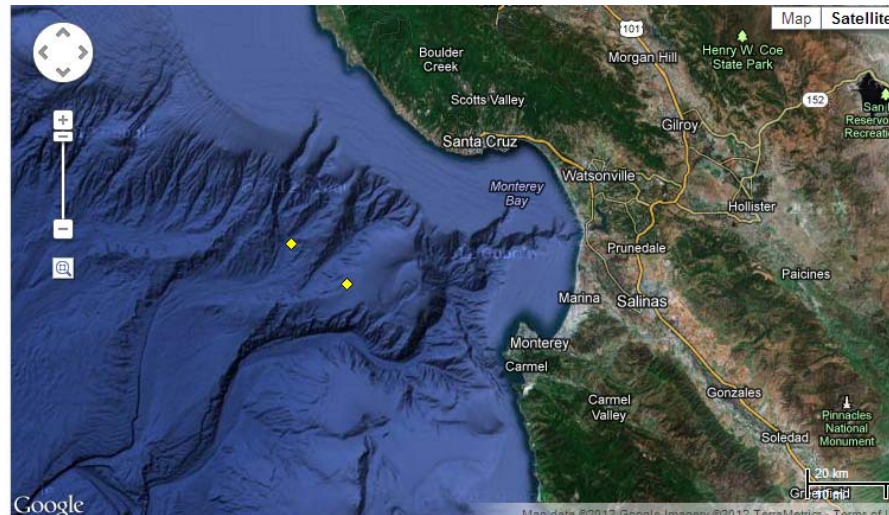
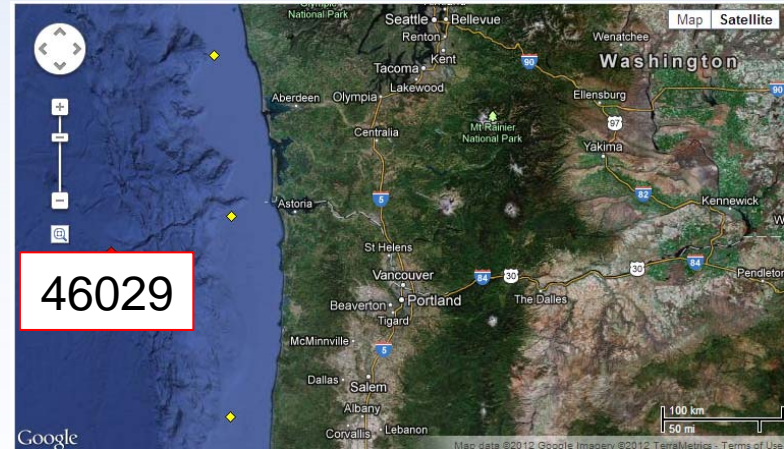
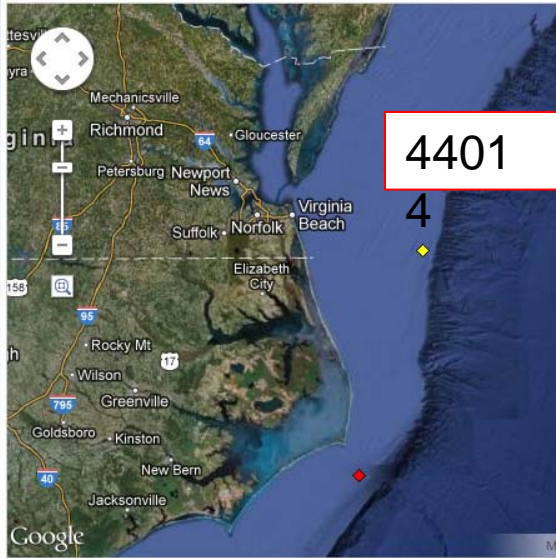
Is the accuracy in measurements limiting wave model improvements?

Evaluation Procedure: Co-located

- Series of evaluations (con't)
 - Co-Located Evaluation
 - Atlantic (44255: 6N / MSC & AXYS)
 - Atlantic (44258: 3D / MSC & AXYS)
 - Pacific (46185: 3D / MSC & AXYS)
 - Pacific (46206: 3D / MSC & AXYS*)
 - Pacific (46026: 3D / 3DMG)
 - Dual Sensor Single Hull
 - Pacific 46029 (3D HIPPY and 3DMG+)
 - Pacific 46042* (3D HIPPY and 3DMG+)
 - Atlantic 44014 (3D HIPPY and 3DMG+)

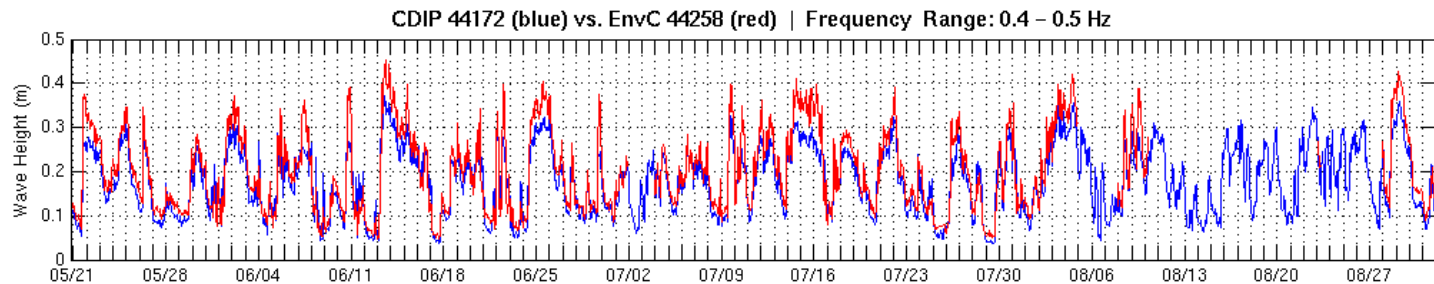
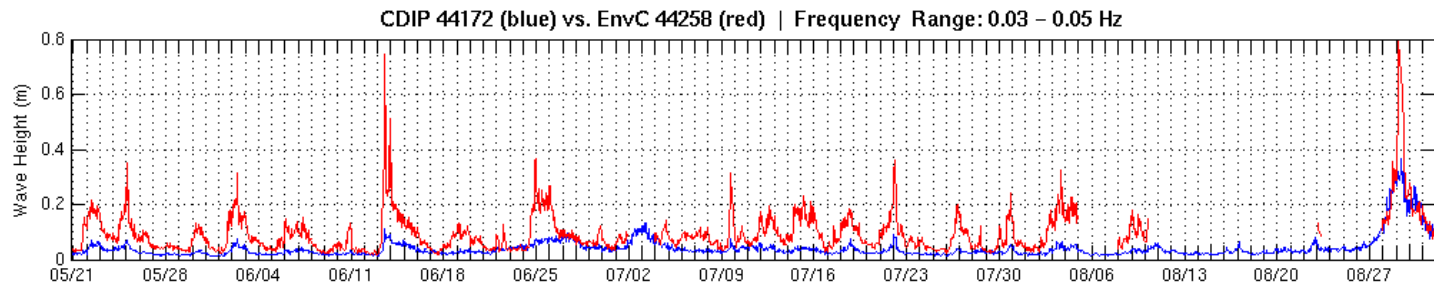
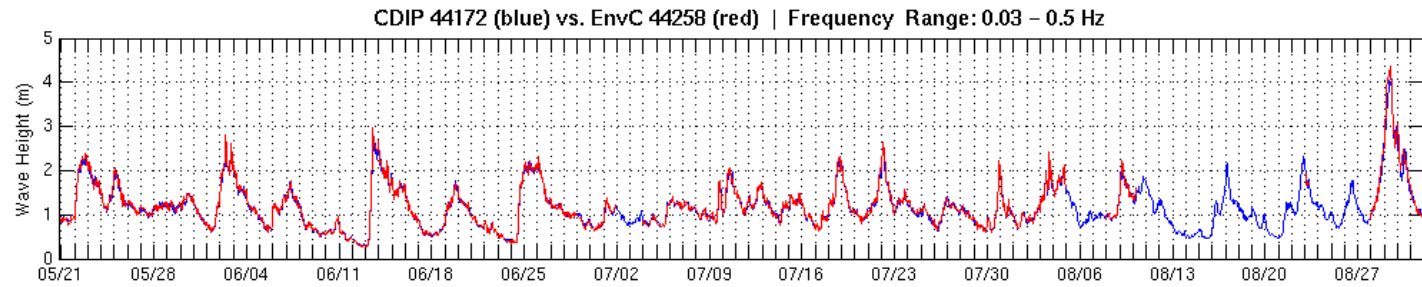


Evaluation Procedure: Co-located



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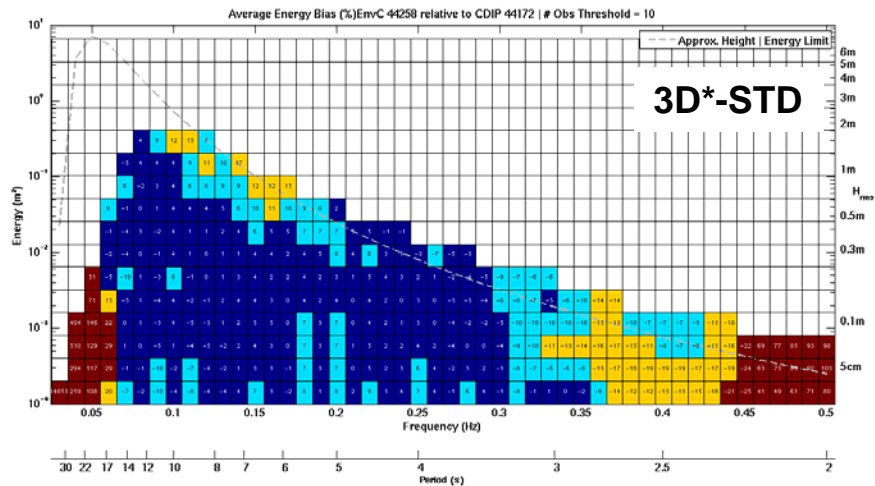
Time Series Analysis for specific differences



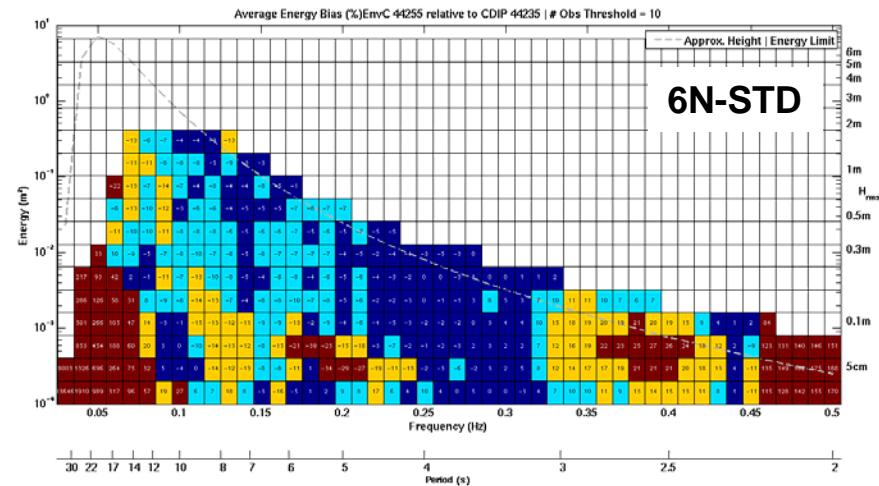
Halifax 44258: 3D / AXYS

Evaluation Procedure: Co-located

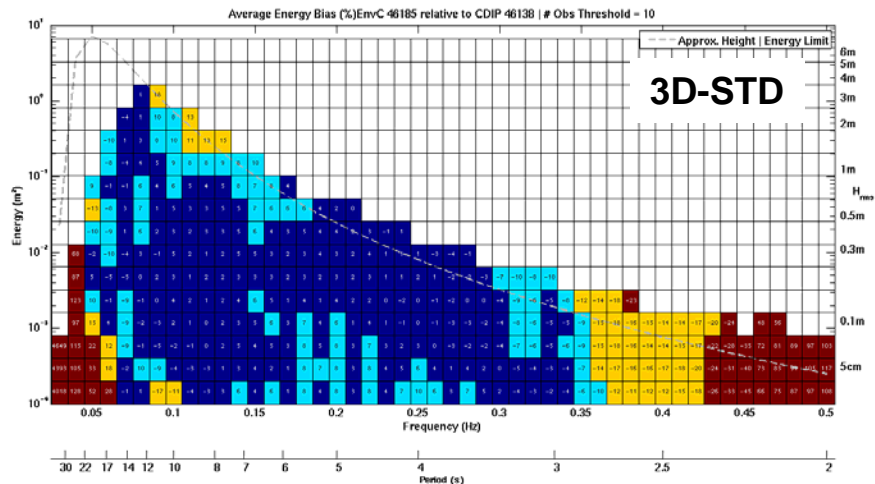
Bias in Energy: Sensor / Hull / Payload Package



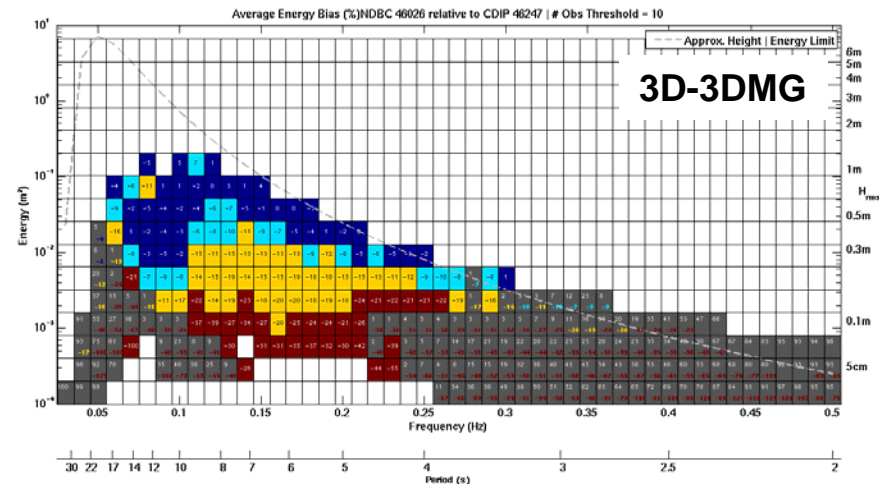
Wave Spectra Comparison Tool, Version 2.0



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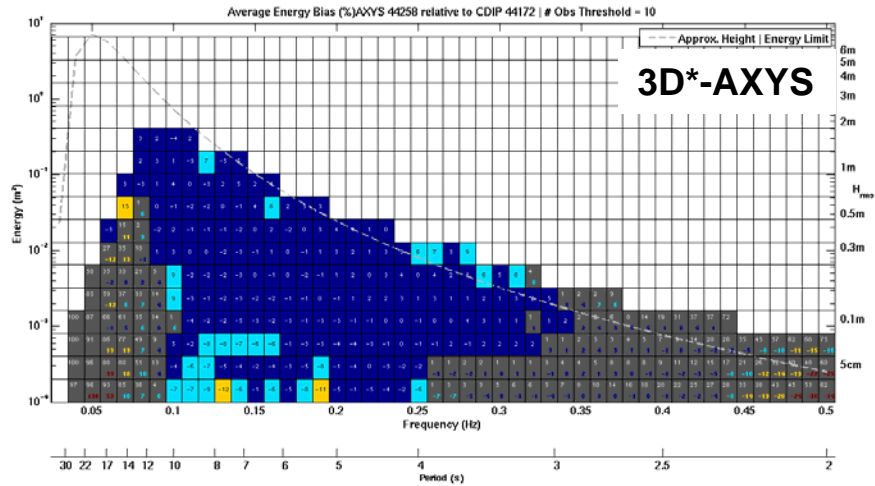
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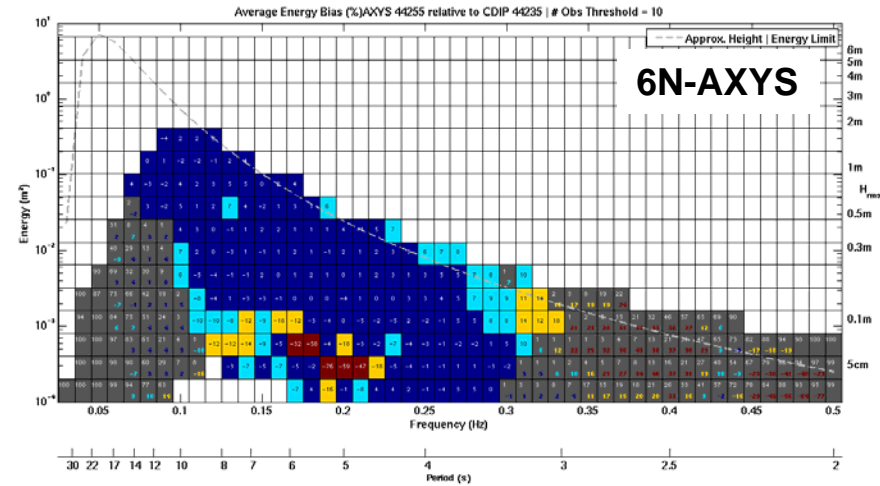
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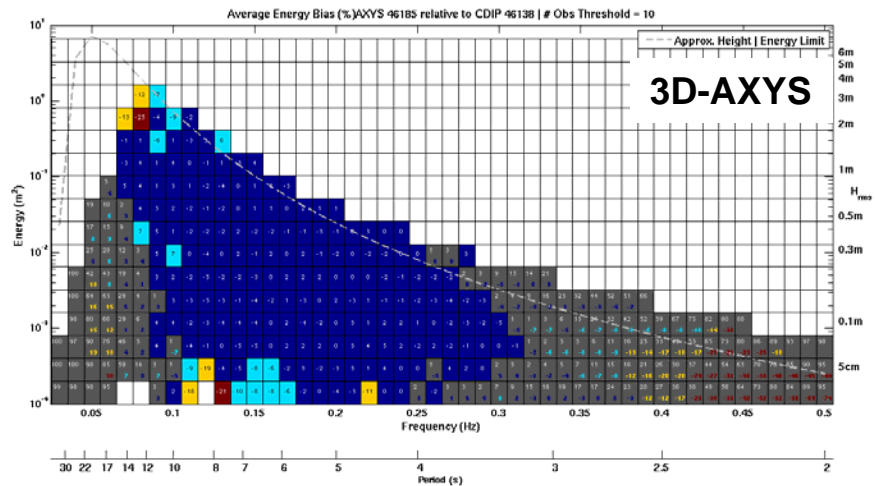
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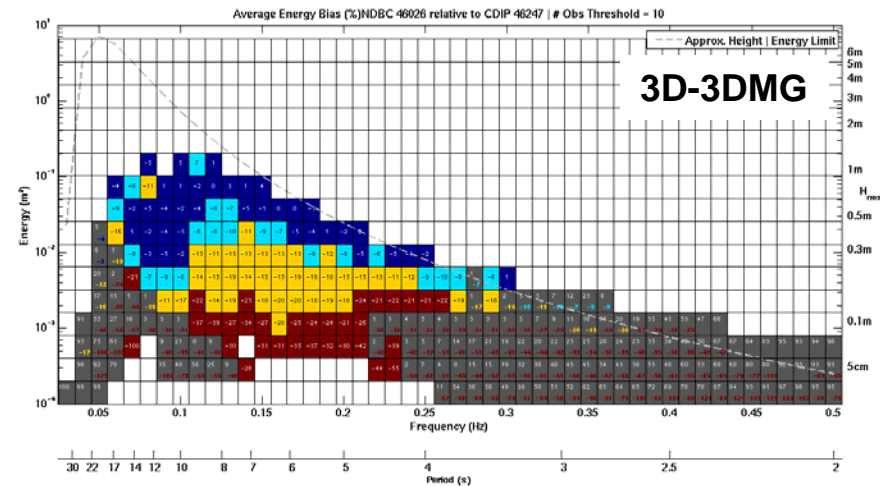
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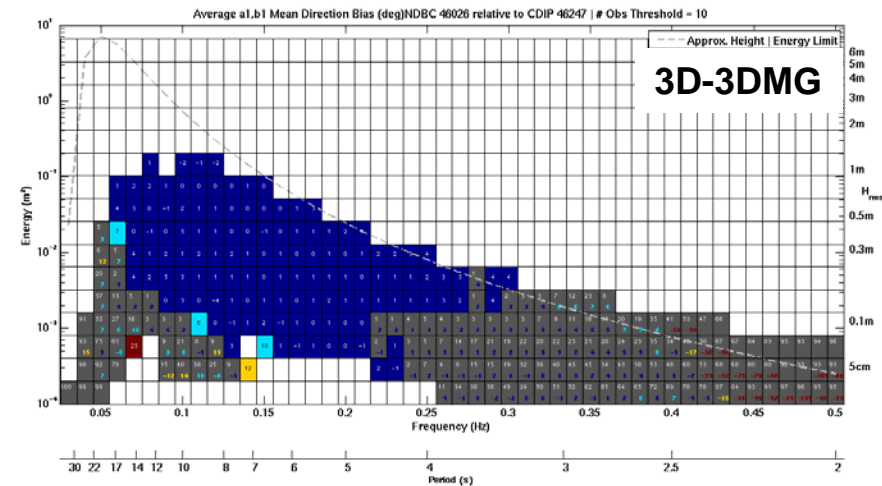
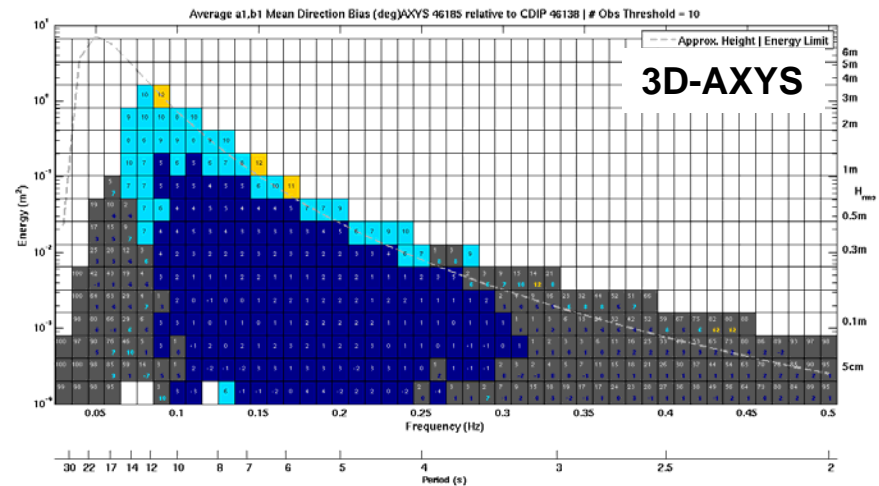
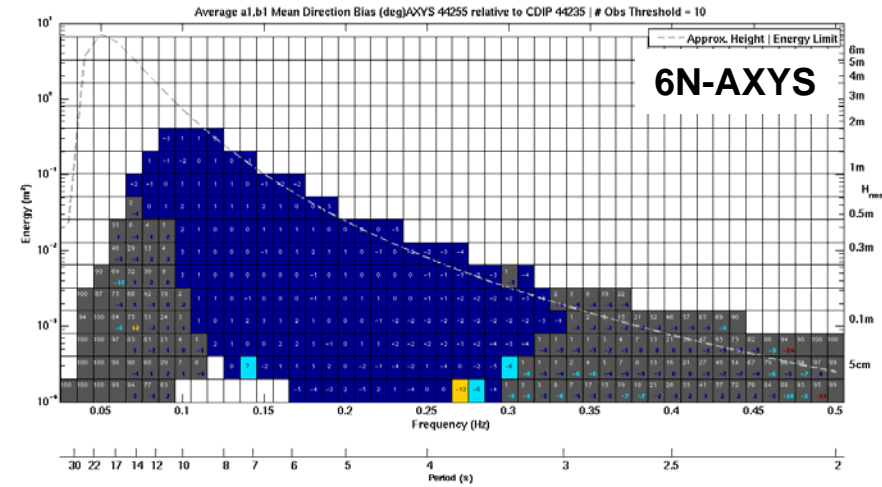
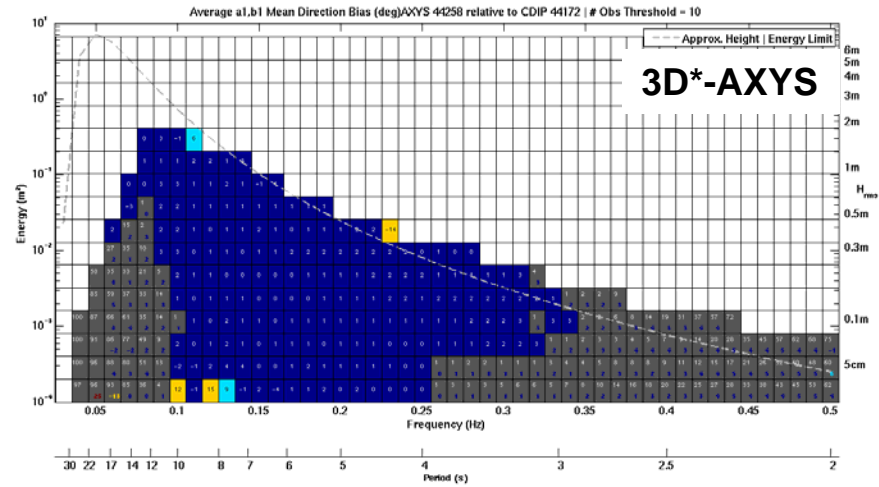
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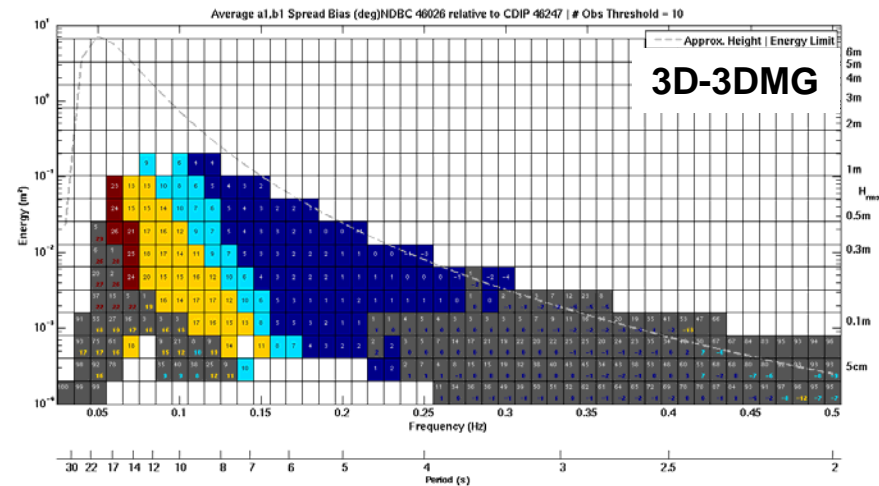
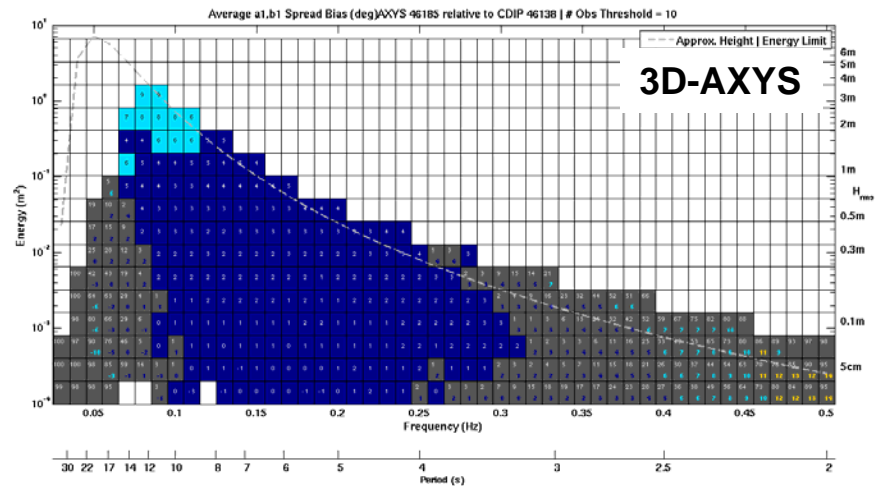
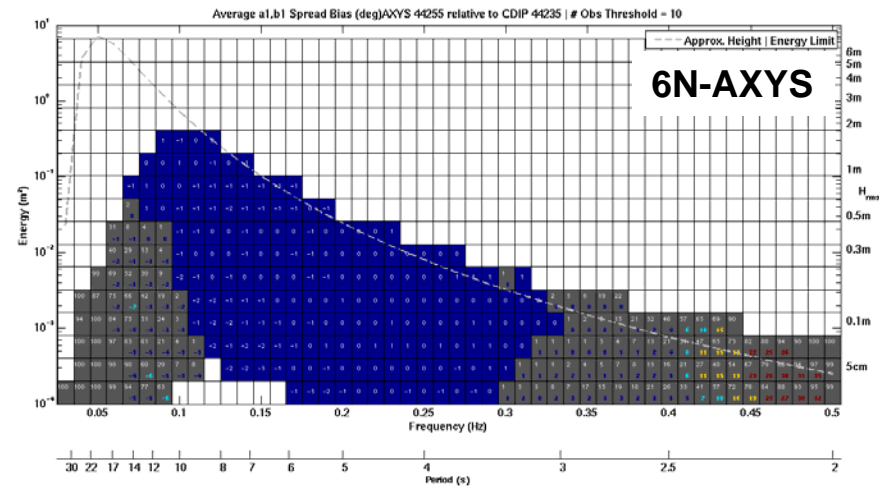
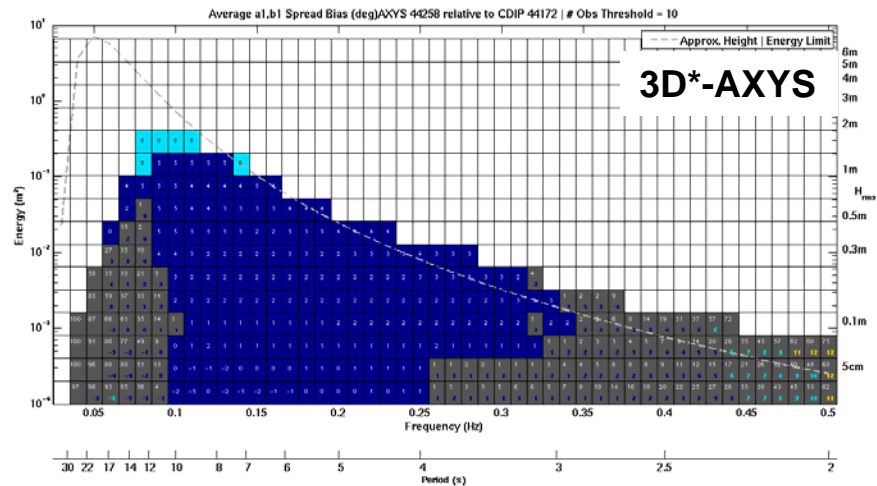
Evaluation Procedure: Co-located

Bias in Direction: Sensor / Hull / Payload Package



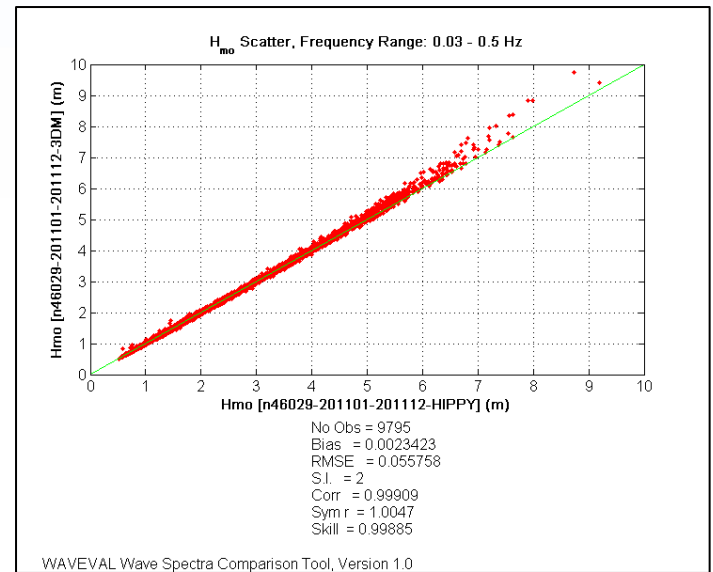
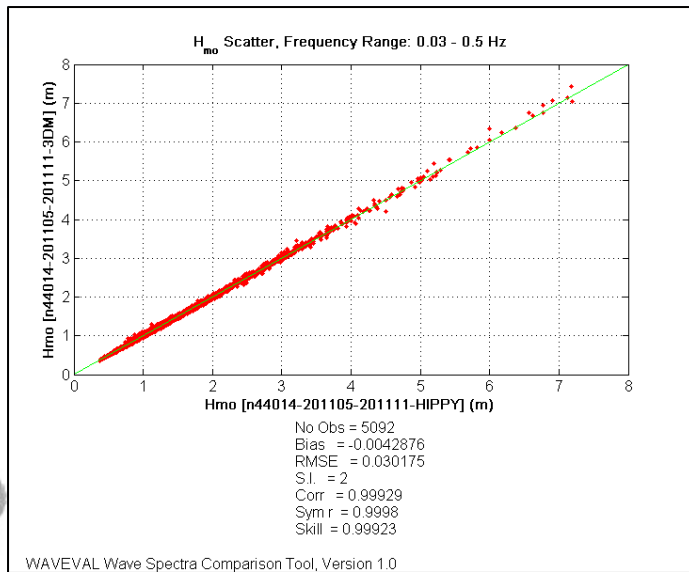
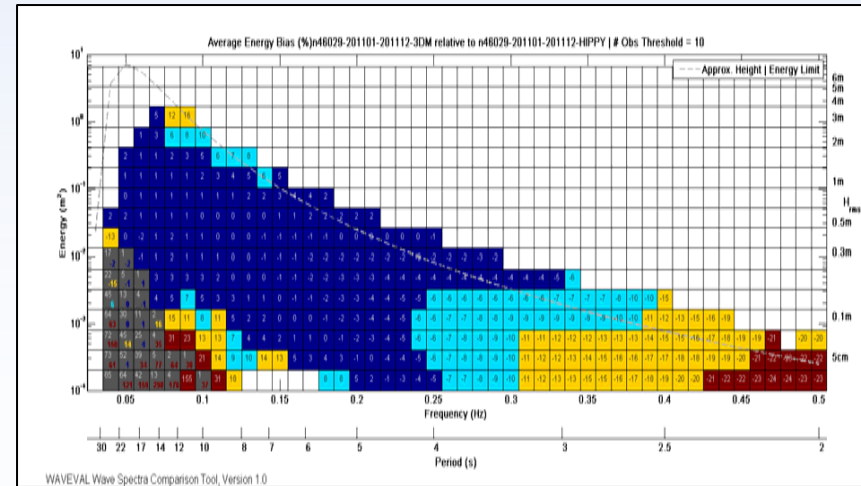
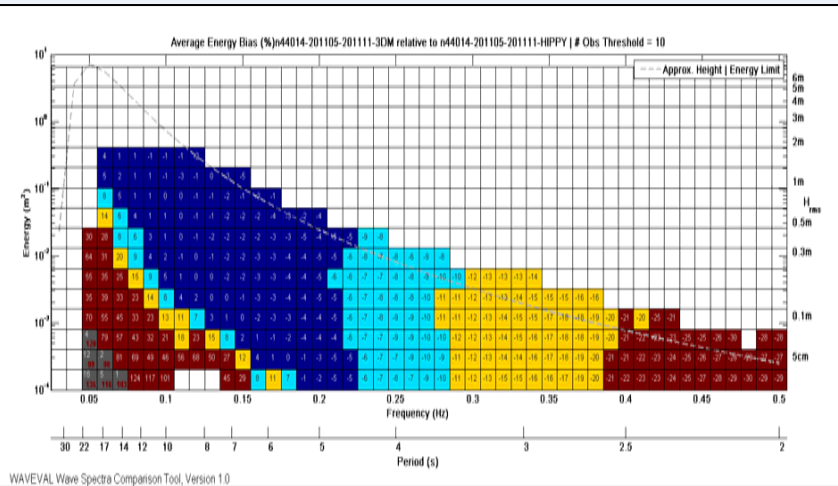
Evaluation Procedure: Co-located

Bias in Directional Spread: Sensor / Hull / Payload Package



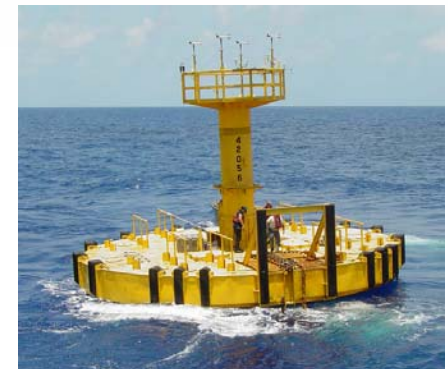
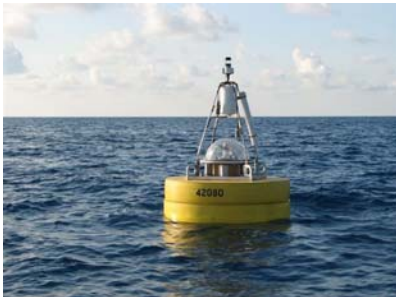
Evaluation Procedure: Co-located

Analysis of Dual Sensor: 3DMG+ and HIPPY



Evaluation Preliminary Conclusions

- The AXYS system replicates DWG data
 - Still some biases (low and high frequency ranges)
 - Directional estimates thru 2nd and 3rd moments consistent
 - Co-located positions were “controlled” tests
 - Directional windows small < 90-deg
- NDBC’s 3DMG motion sensor contains biases
 - Compared to DWG and HIPPY (dual sensor package)
 - The Bender et al. (2010) correction *seems* to work
 - Multi-sensor evaluation continues



- Continue to Test and Evaluate
 - Commitment to the Buoy Farm (NOAA/NDBC)
 - AXYS (Triaxys Buoy / Sensor)
 - ASIS (potential ONR support)
 - Welcome all !!
 - Continuation of data collection
 - Co-Located Sites Further Offshore (MSC)
 - Dual Sensor Sites (USACE)

- NDBC 6N NOMAD NECESSARY (USACE)
 - Inclinator / ARS / 3DMG / HIPPY
 - Payloads: DACT / ARES / DDWM
 - ~\$245K: Built 2013 and Deployed for 2 yrs



- Evaluation of Buoy Farm Data Sets Monterey, CA
 - 2.4D to be deployed (NDBC)
 - Re-deployment of DWR* (NDBC)
- Evaluation of dual sensor data
- Meta data for historical wave measurement platforms
 - **Sensor**, payload, analysis packages
- Bench Test analysis packages (IEEE, time series, etc)
- Real-time data transmission of time series
- Continued to be a learning process
 - Building a data base
 - Refining WaveEval Tools
 - Archiving all comparisons
- Best Practices: Need to know what we are measuring first

