Examining field measurements during the December 2012 storm in the North Sea

Richard Gibson
Marios Christou
Graham Feld

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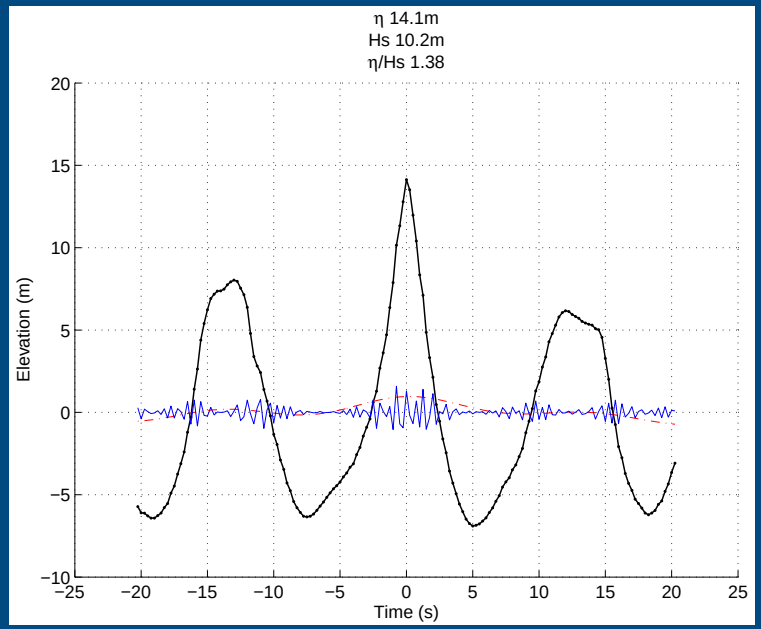
Introduction

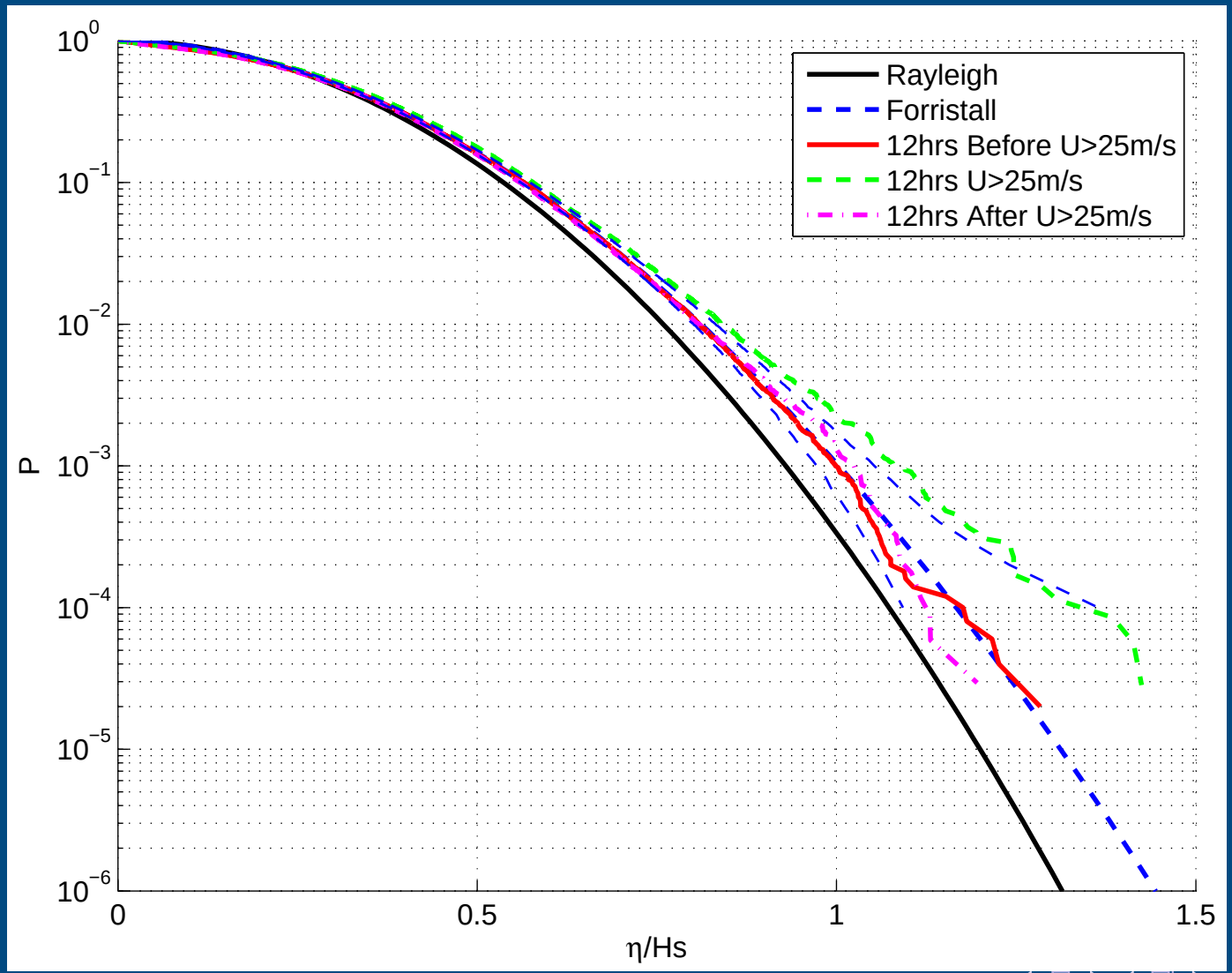
Storm 14-15 December 2012

- Central North Sea
- Maximum Significant Wave Height 12m
- Spectral Peak Period 13s
- Nineteen rogue waves measured over eight platforms
  - $\eta/Hs \geq 1.25$
  - $H/Hs \geq 2$



Results

Strong correlation between deviation from second-order crest statistics and wind speed

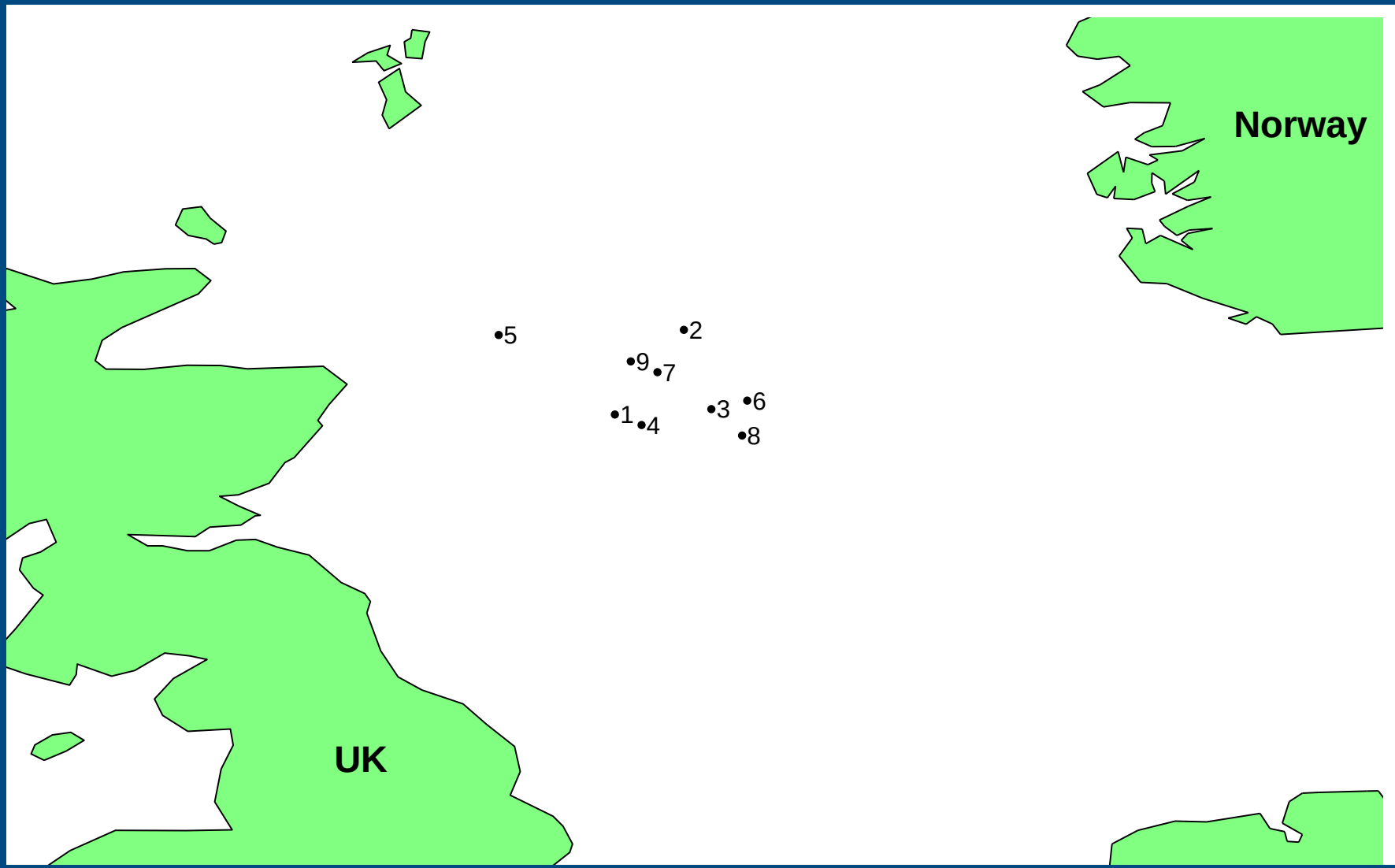


Conclusions

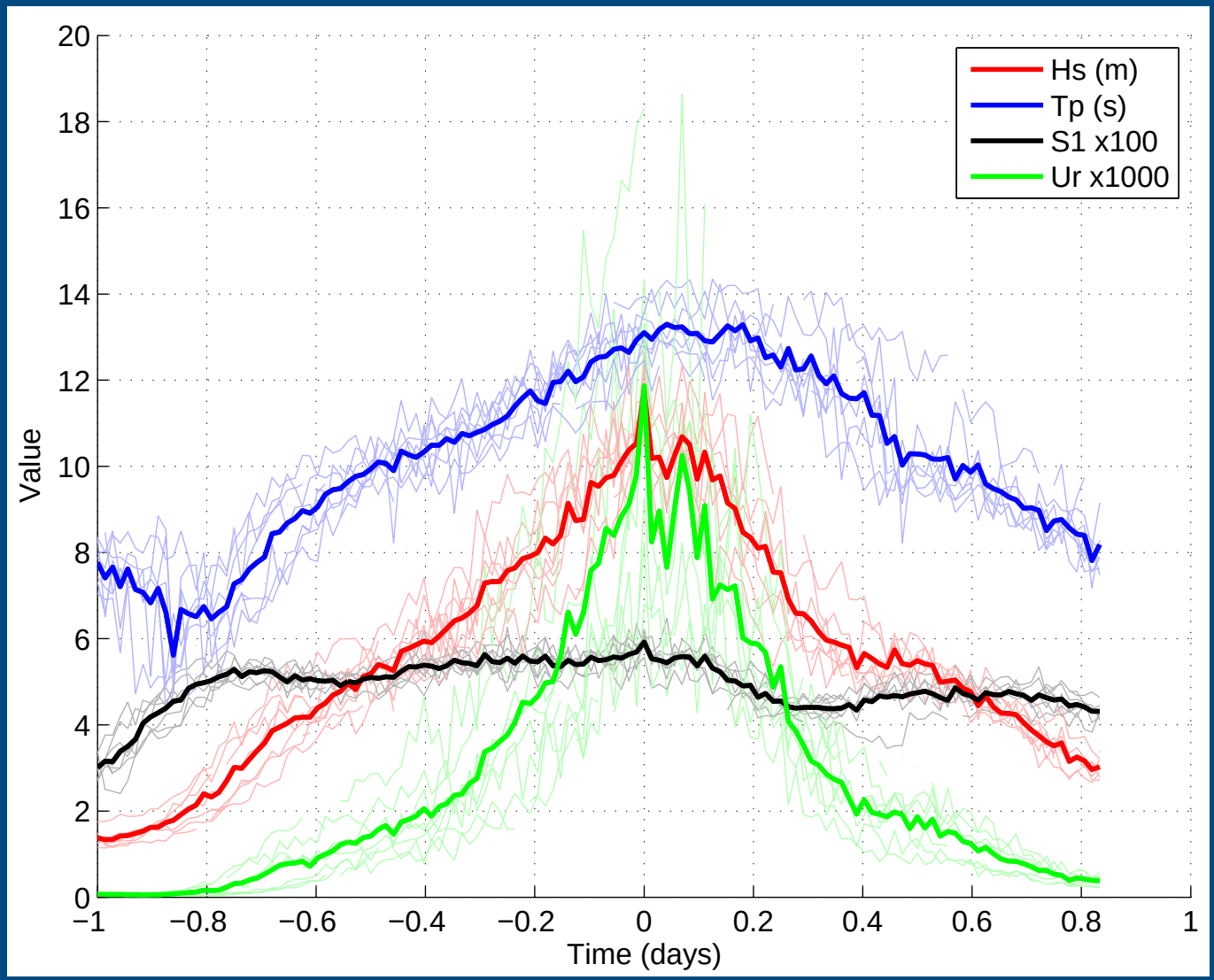
1. Severe steep storm 14-15 December 2012
2. Significant departure from second-order crest elevation distribution during periods with large wind speed and sea-state steepness
3. Some departure from standard wave height distributions during periods with large wind speed and sea-state steepness
4. Results are independent of sensor location and the measurement device

Platforms

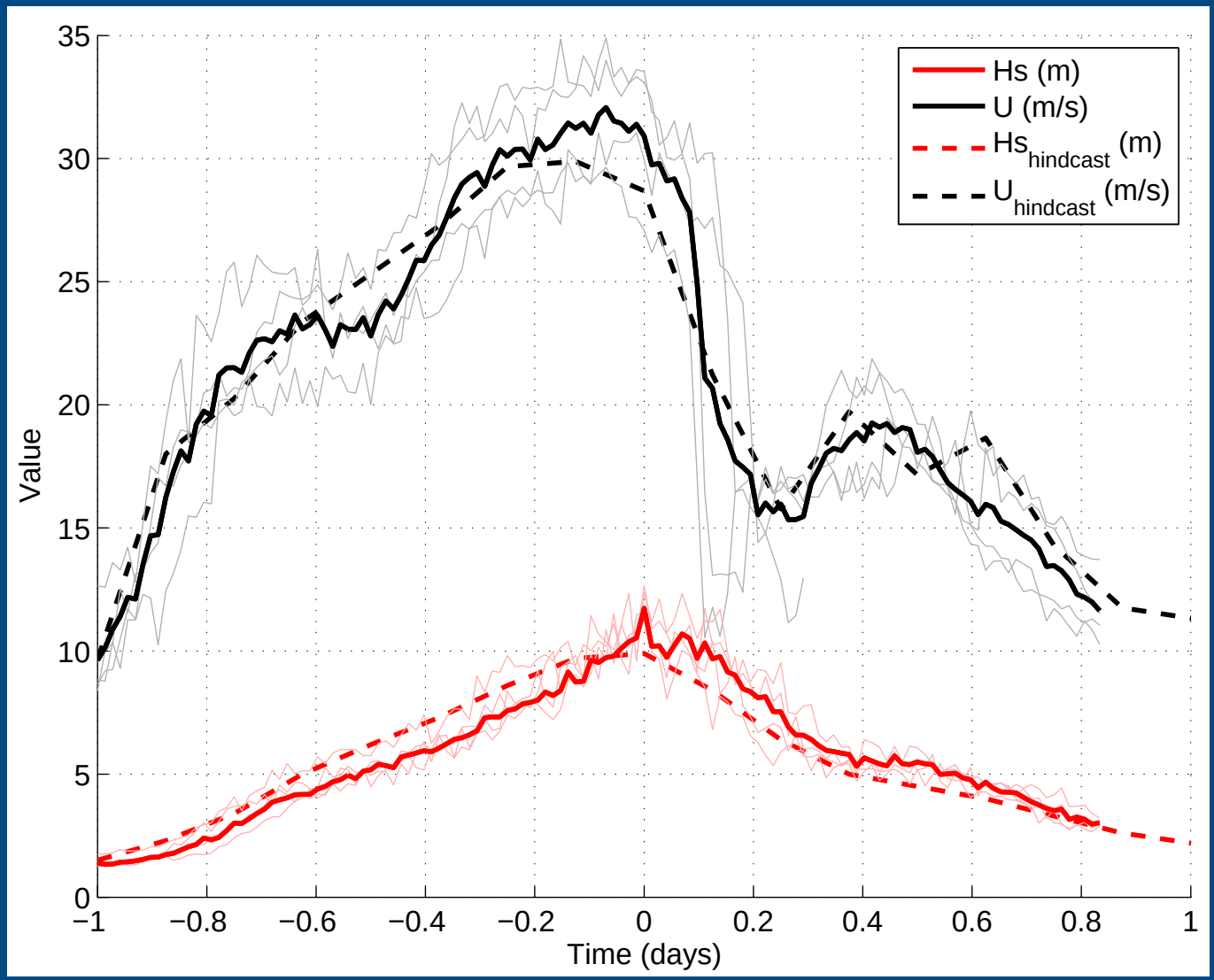
Eight fixed platforms with Saab wave radars
One FPSO with a directional waverider buoy



Storm

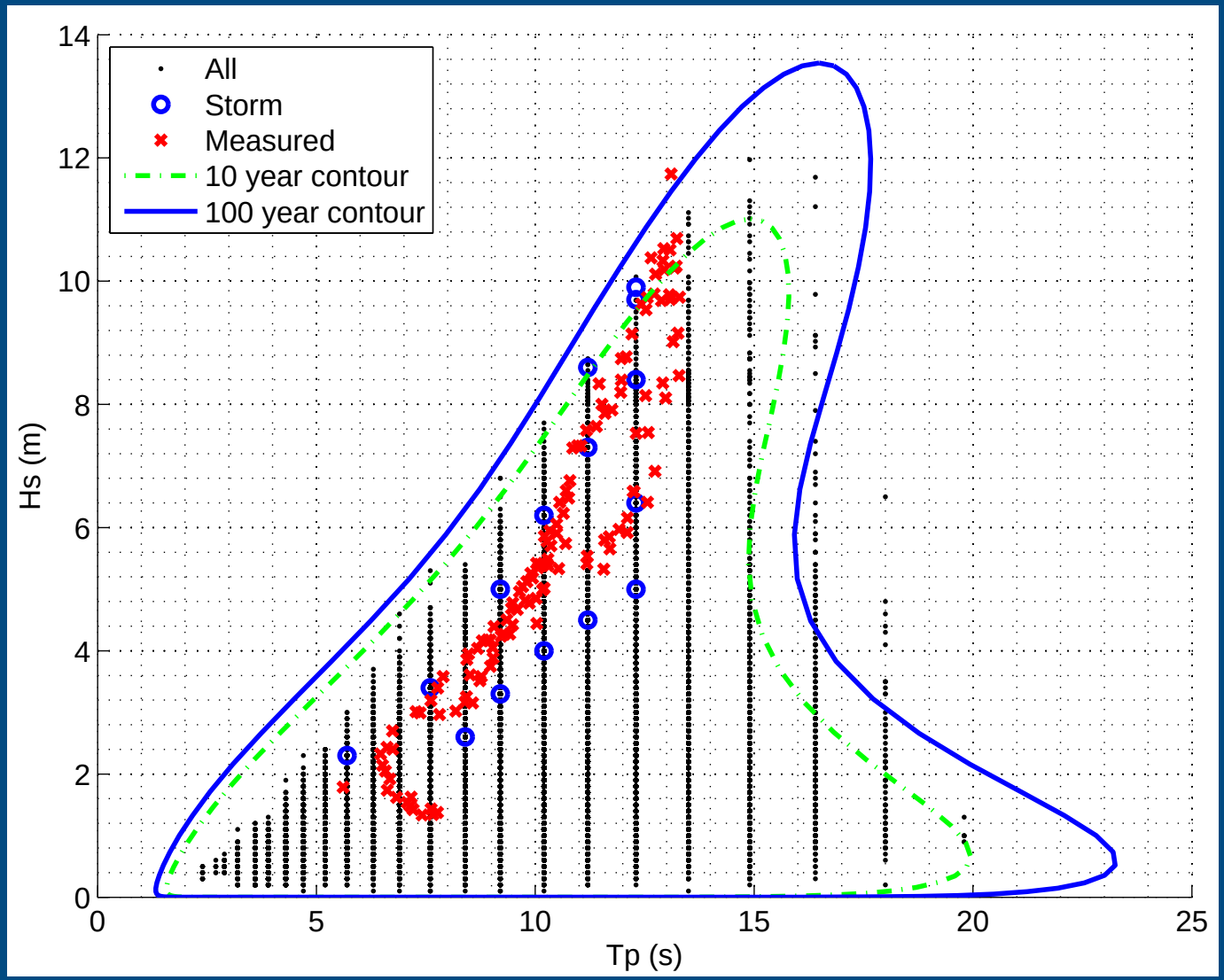

Hs (m)
Tp (s)
S1 x100
Ur x1000
Value
Time (days)
20
18
16
14
12
10
8
6
4
2
0
−1
−0.8
−0.6
−0.4
−0.2
0
0.2
0.4
0.6
0.8
1

Storm


Hs (m)
U (m/s)
Hs hindcast (m)
U hindcast (m/s)
Value
Time (days)
35
30
25
20
15
10
5
0
−1
−0.8
−0.6
−0.4
−0.2
0
0.2
0.4
0.6
0.8
1

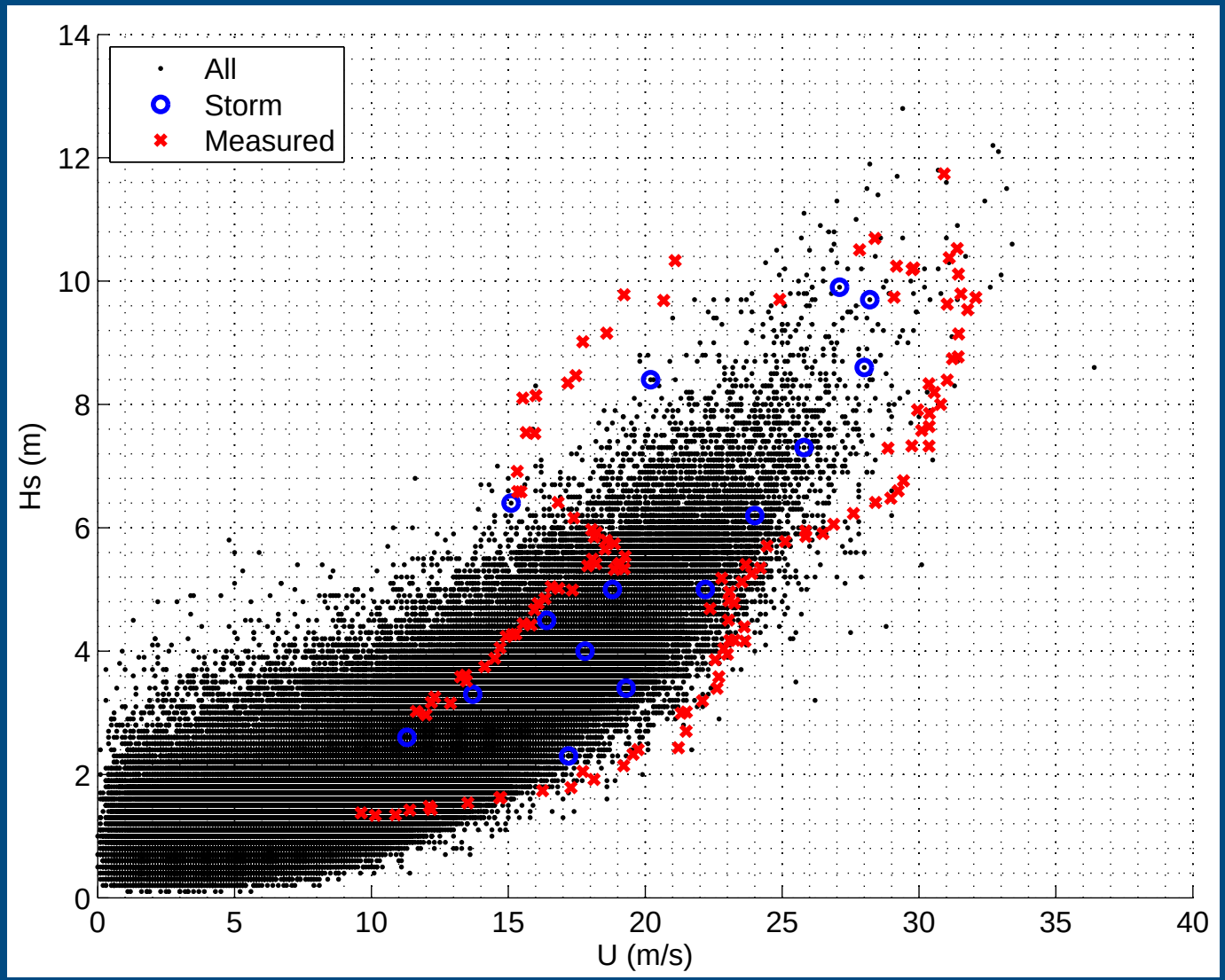
Storm

Steep sea states around the peak of the storm

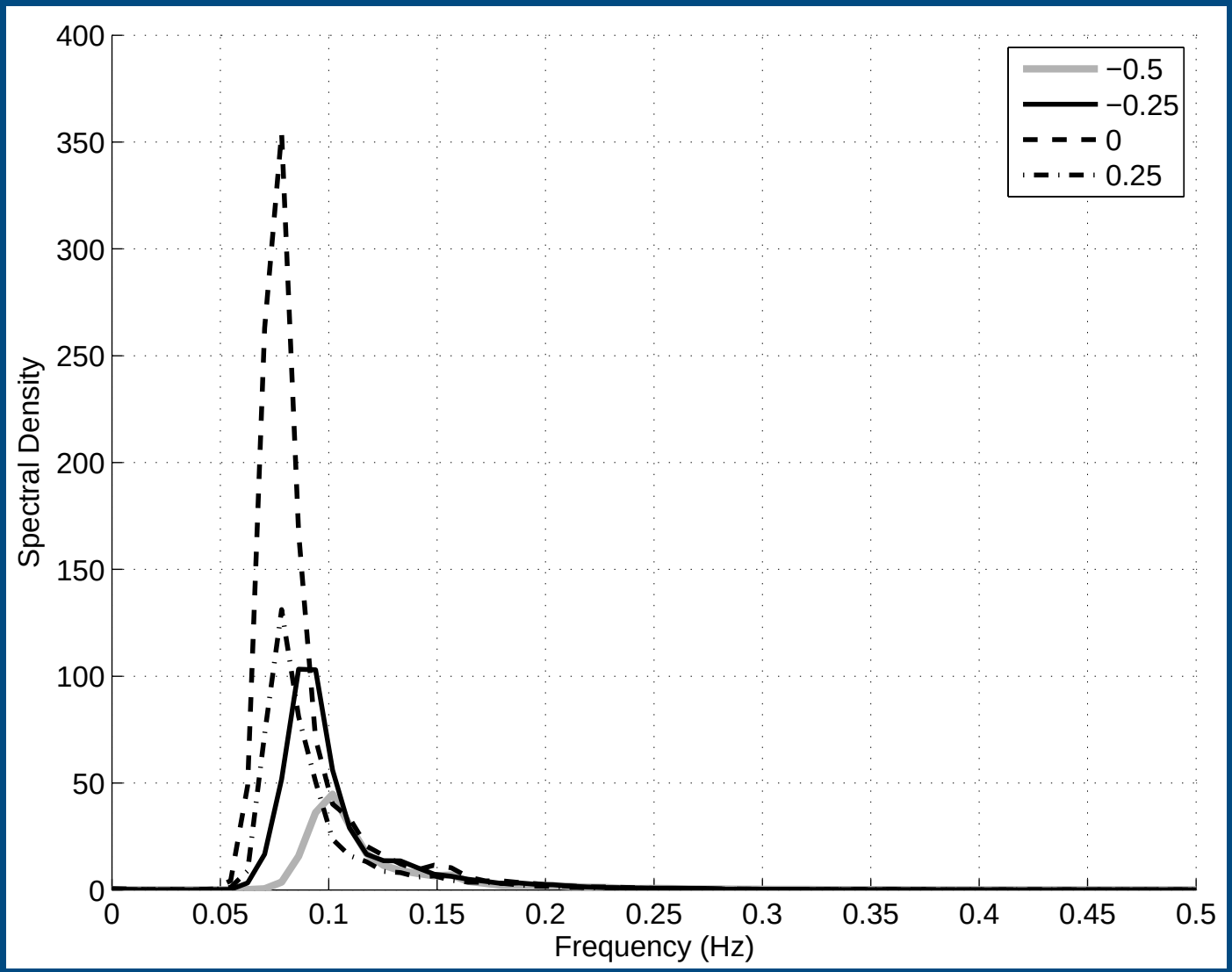


Storm

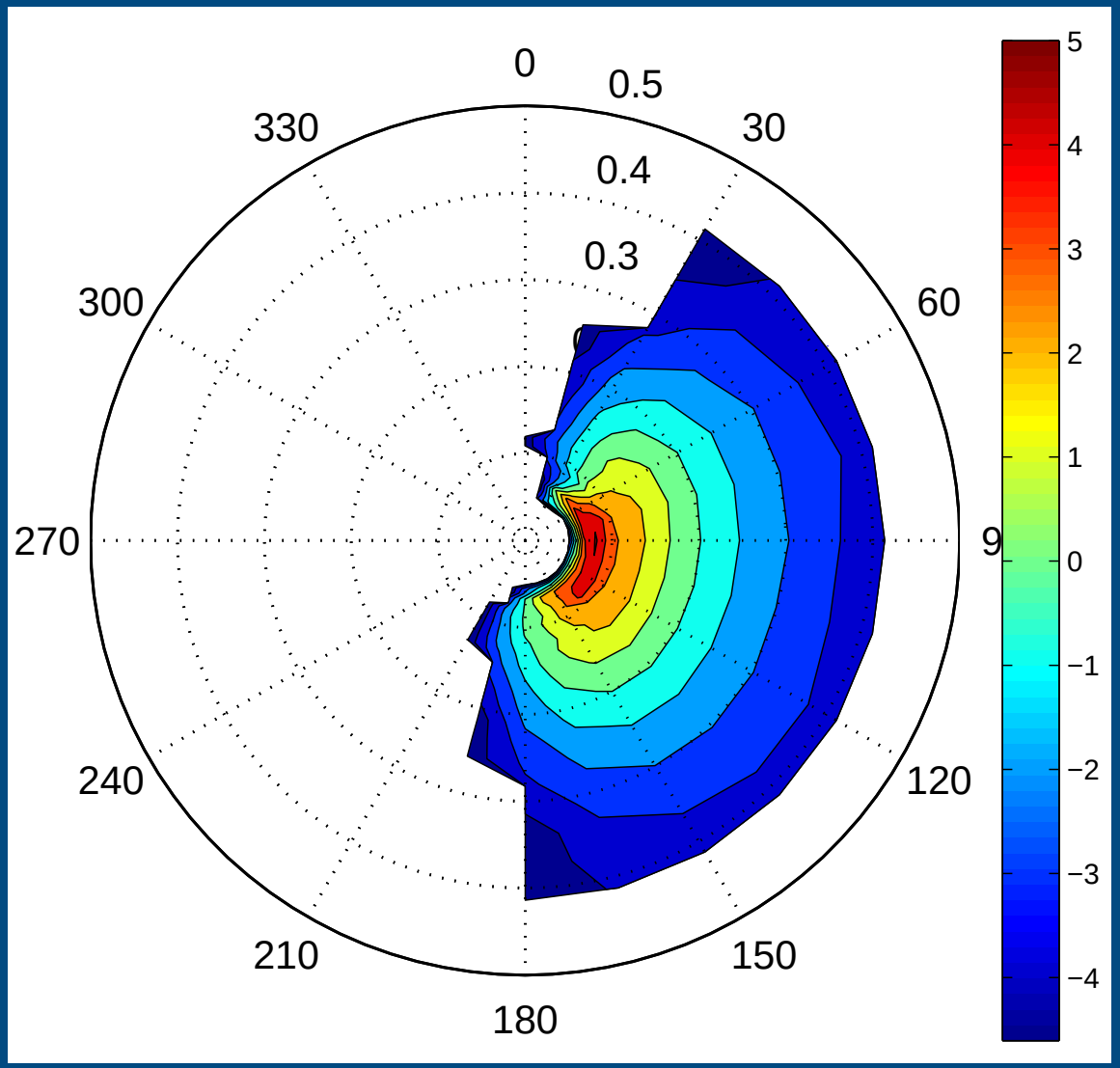
Strong winds around the peak of the storm



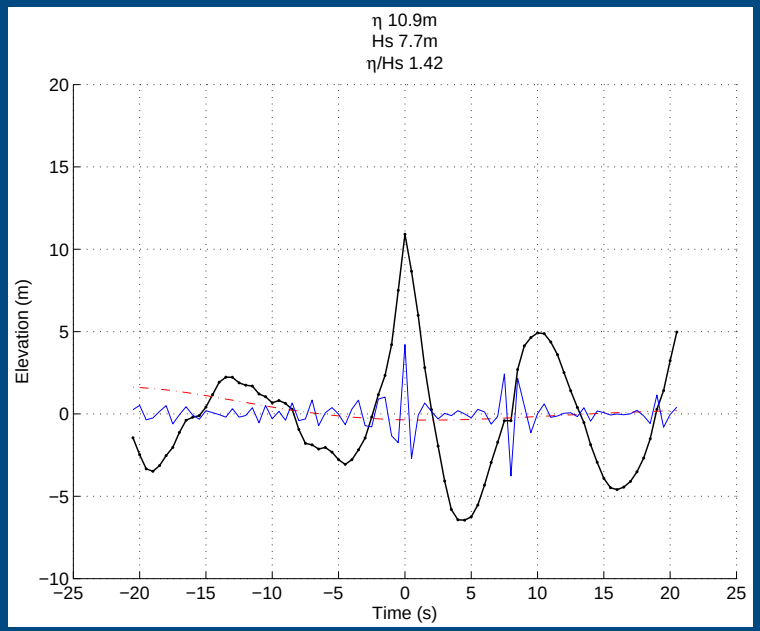
Spectra

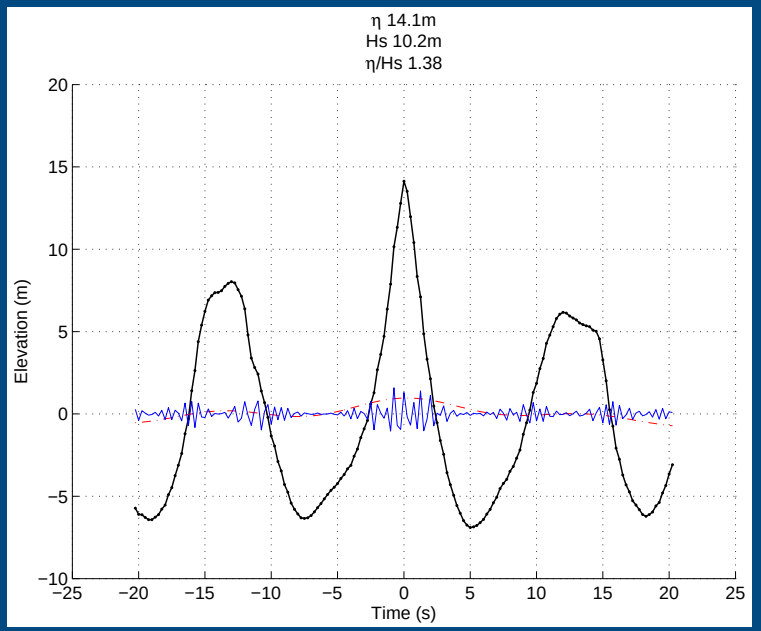

−0.5
−0.25
0
0.25
Spectral Density
Frequency (Hz)
0
50
100
150
200
250
300
350
400
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5

Spectra

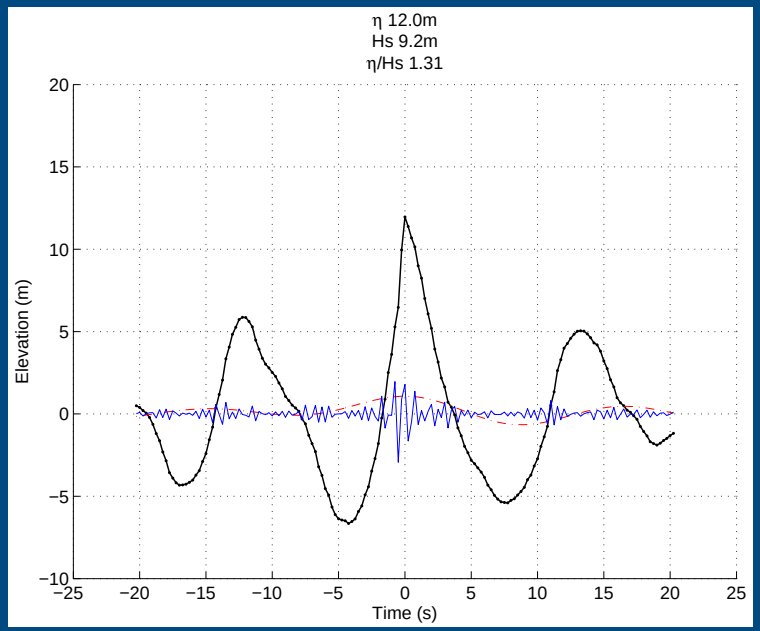


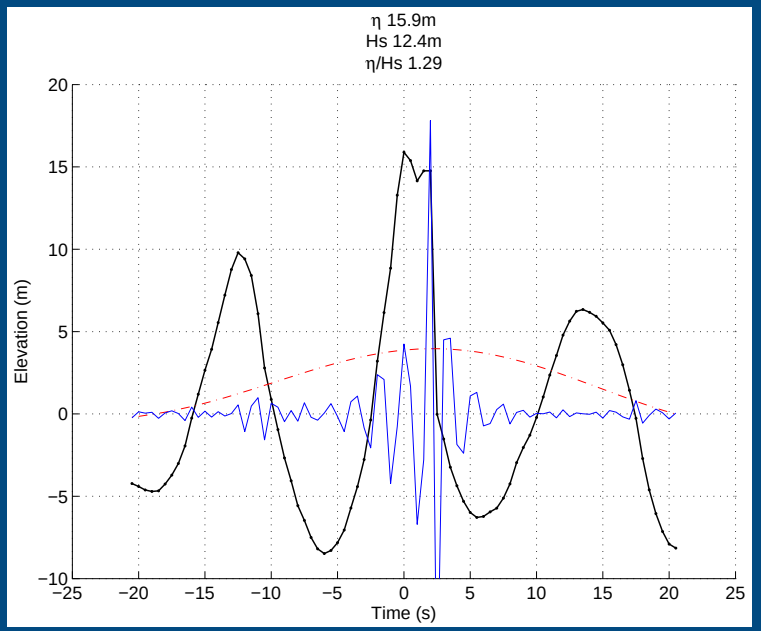
Wave Profiles





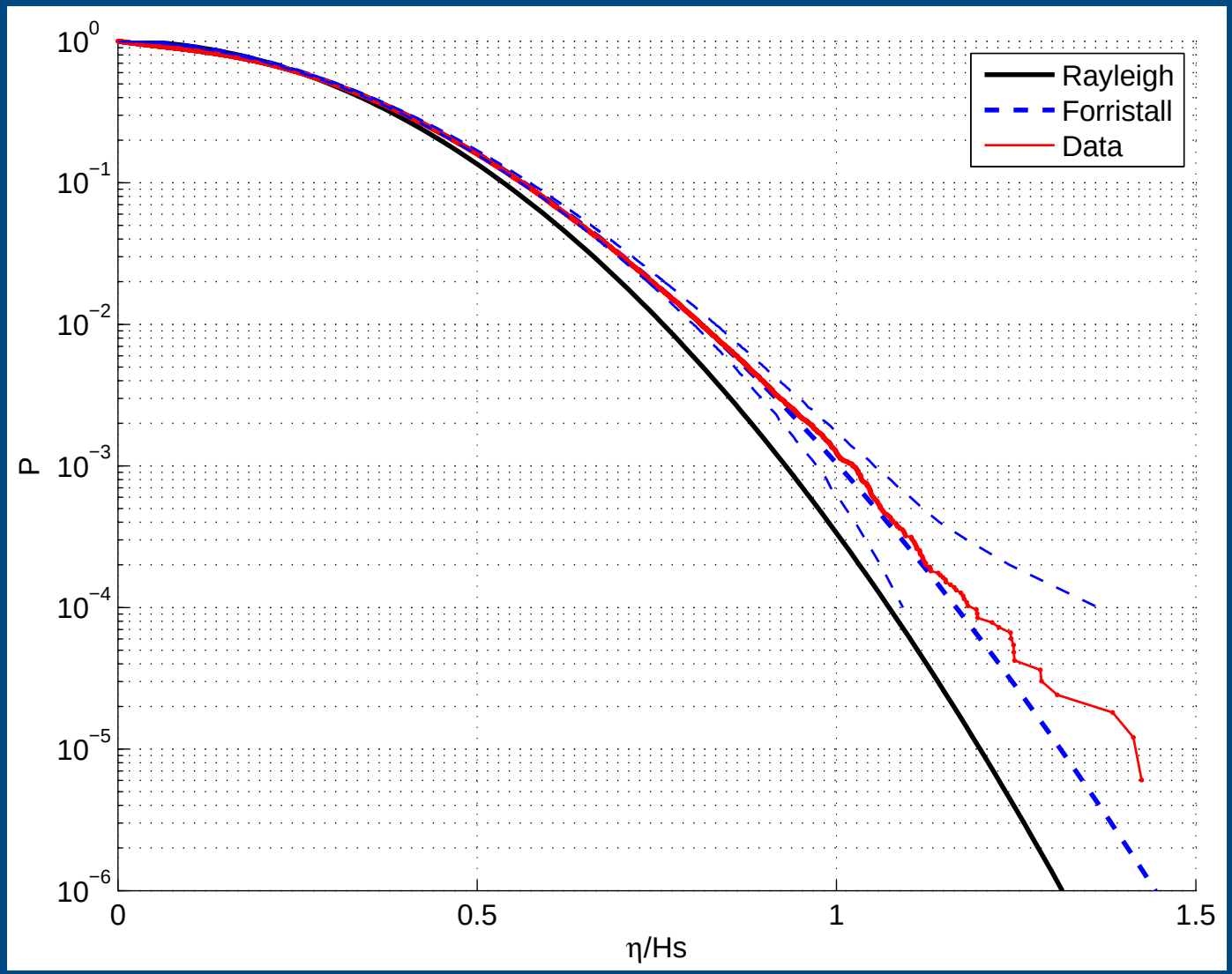
Wave Profiles





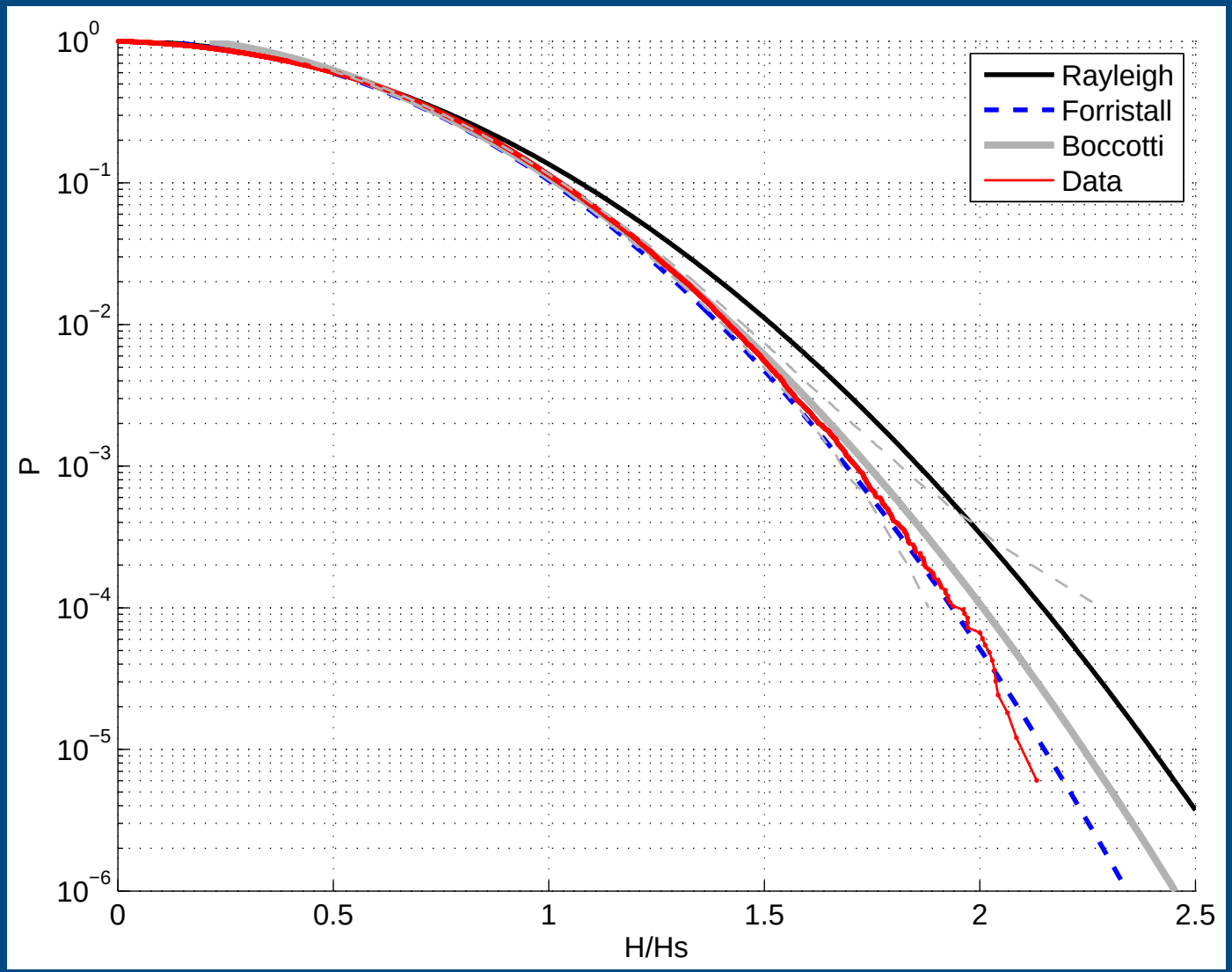
Crest Statistics: entire storm

No significant deviation from second order theory



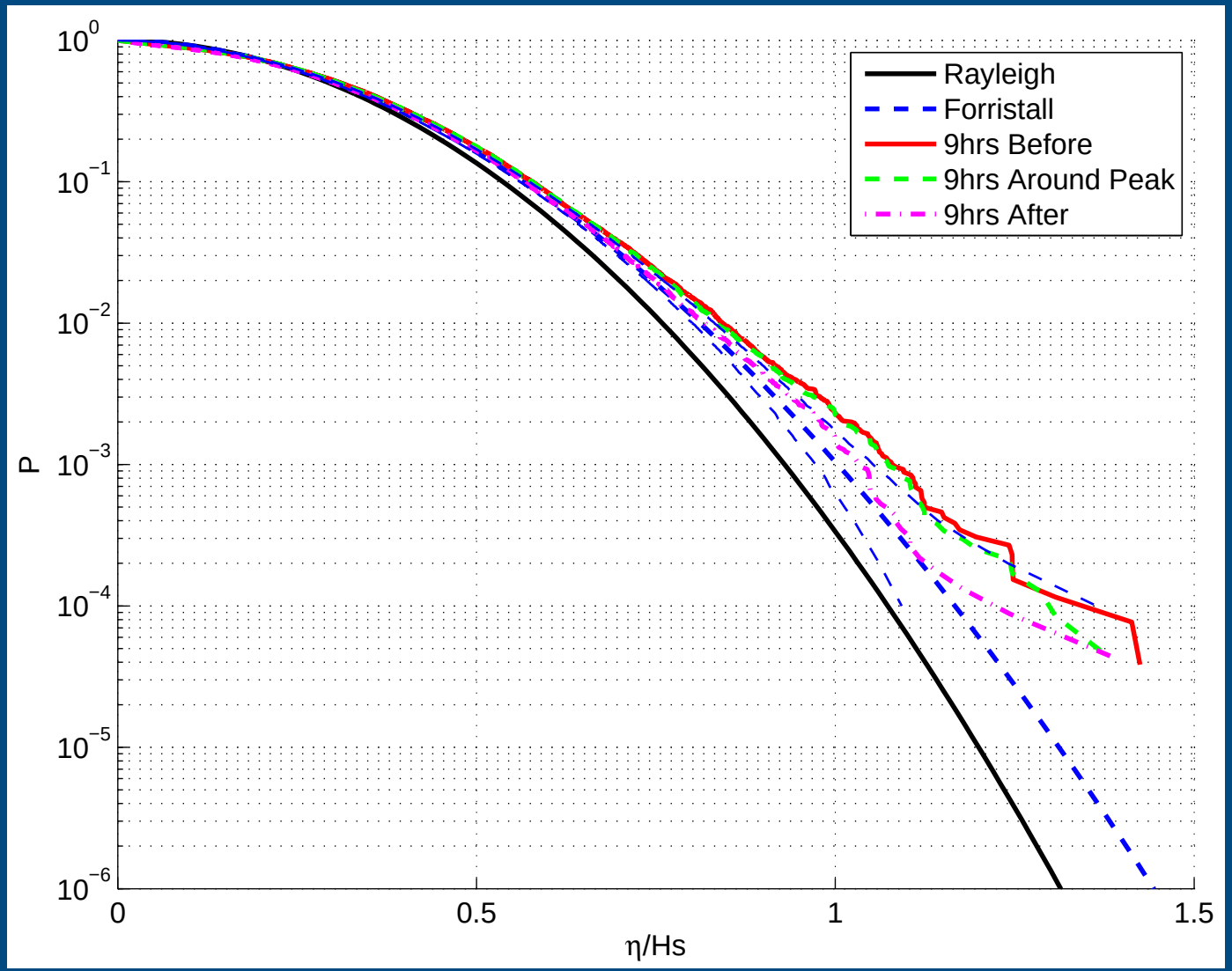
Wave Height Statistics: entire storm

No significant deviation from standard wave height distributions



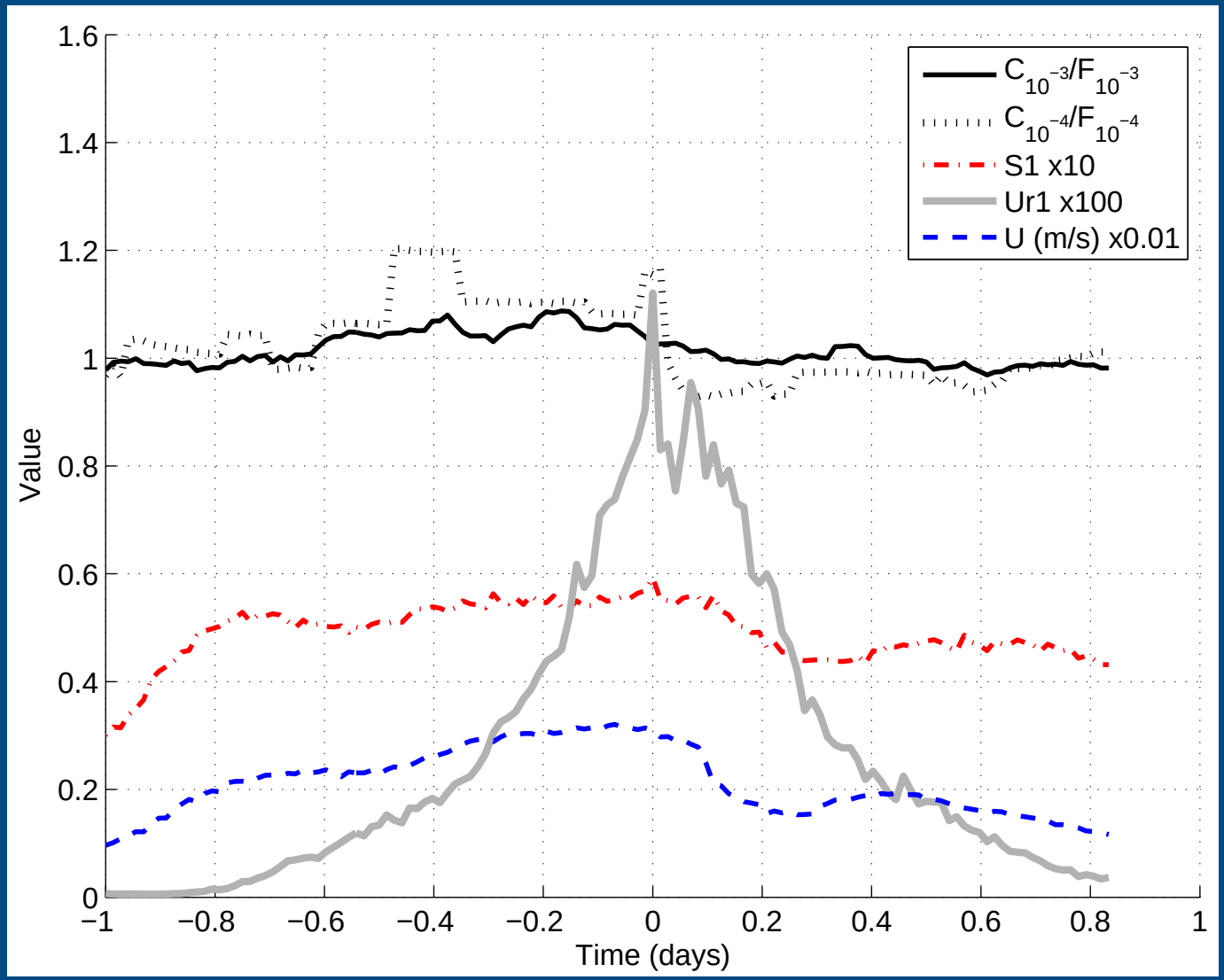
Crest Statistics

Crest distributions for nine hour windows at different points in the storm



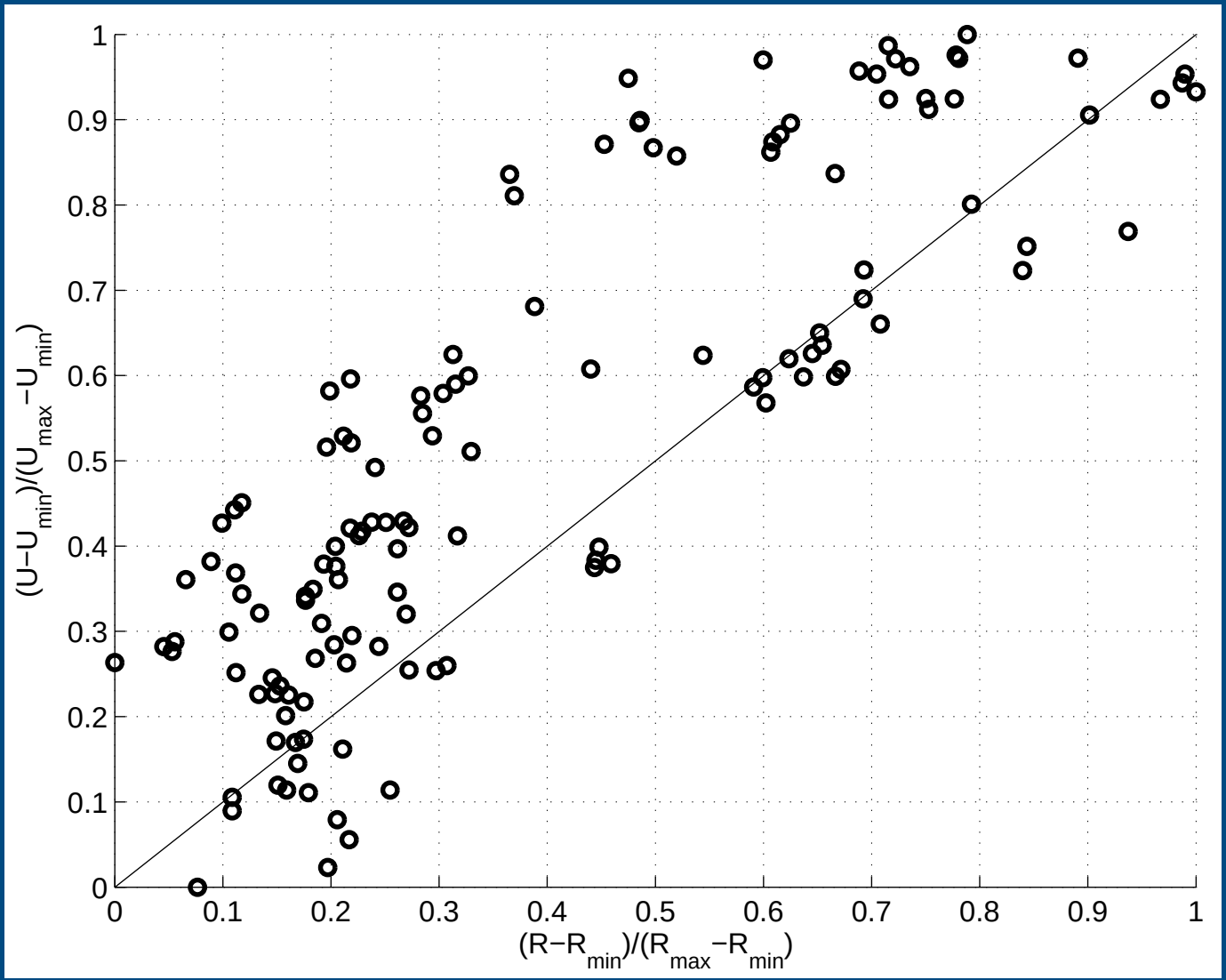
Crest Statistics

Ratio of empirical crest elevations to second order theory

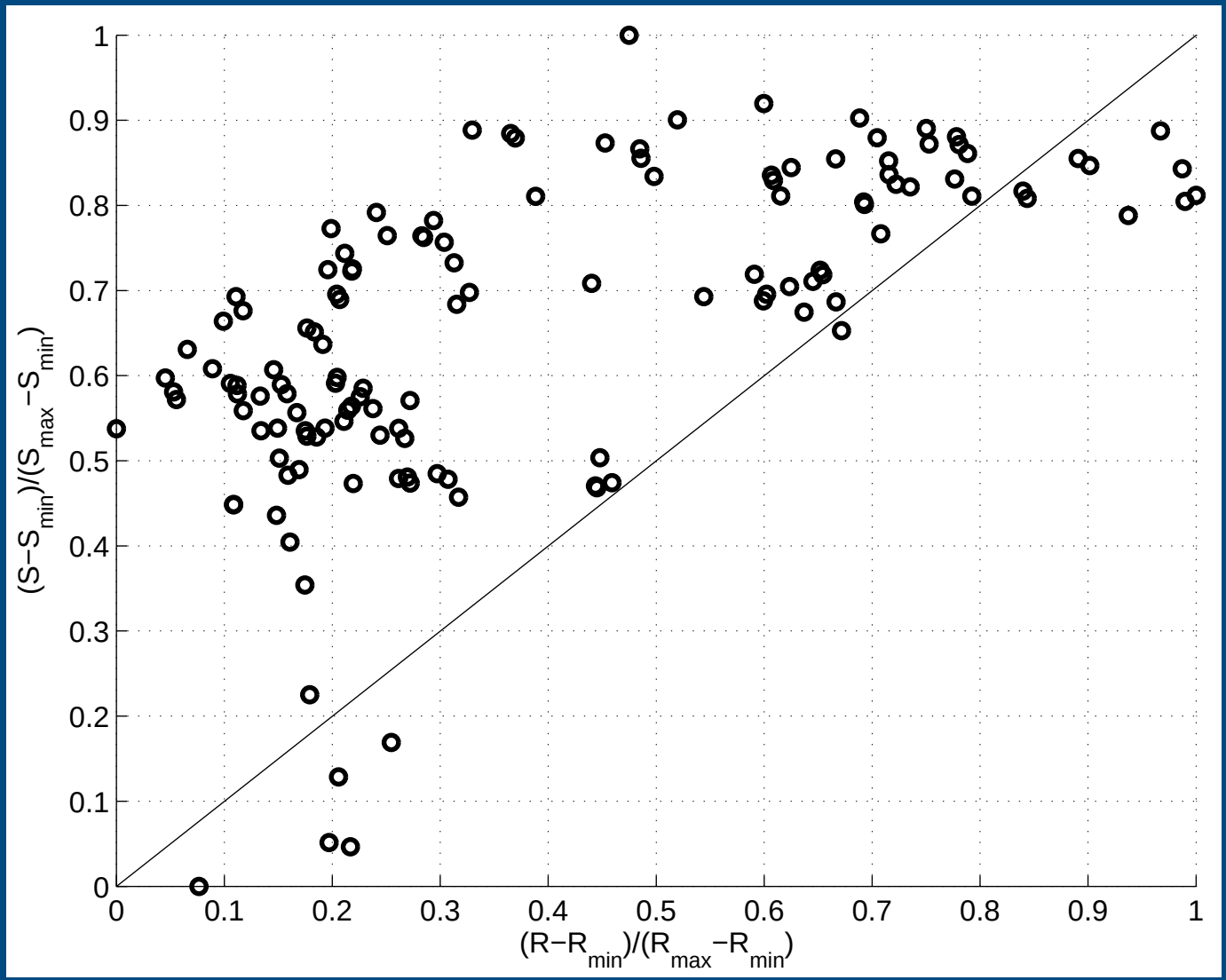


Correlation with Wind Speed

Correlation between deviation of crest elevation from second order theory and wind speed

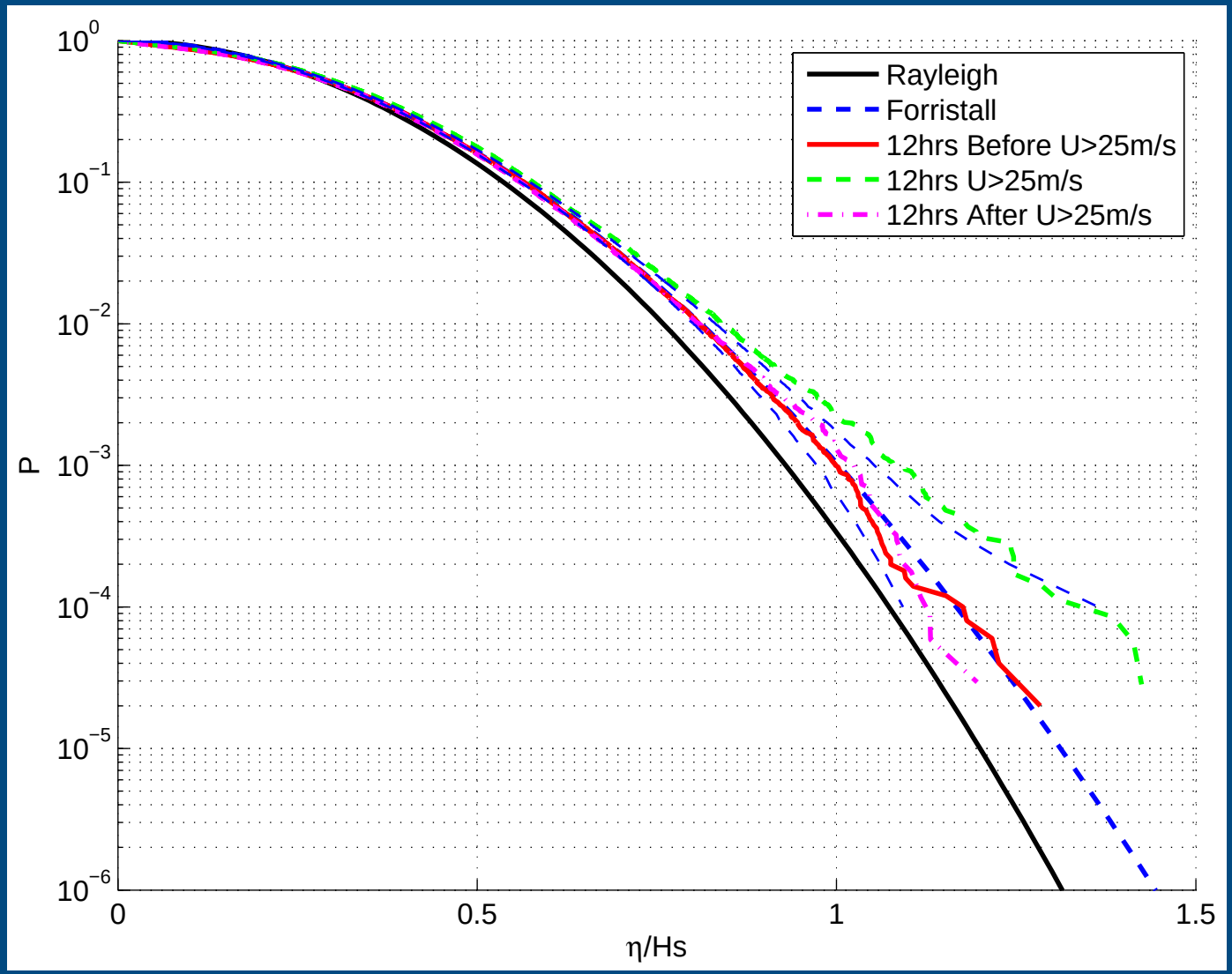


Correlation with Sea State Steepness



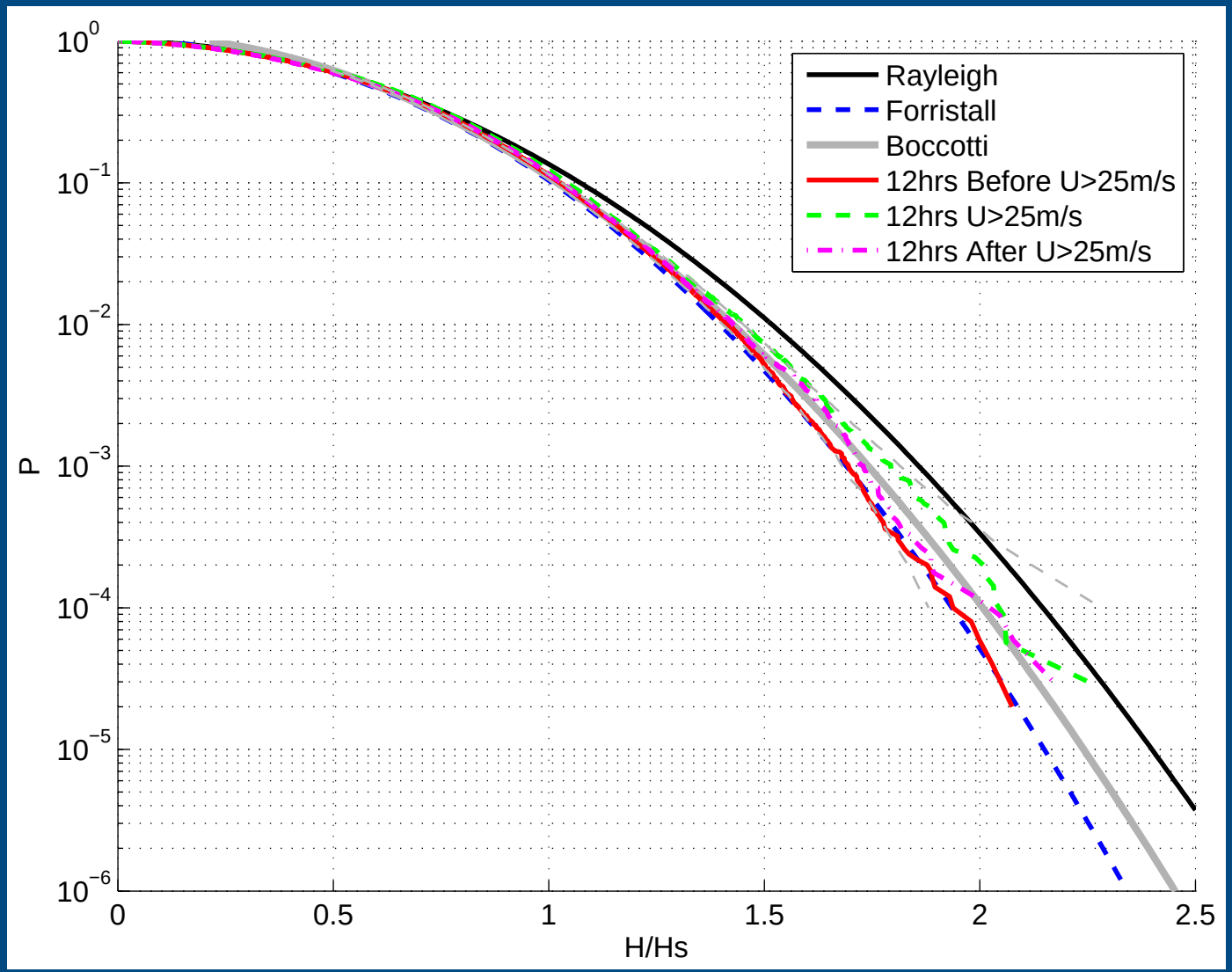
Crest Statistics

Crest distributions conditional on wind speed



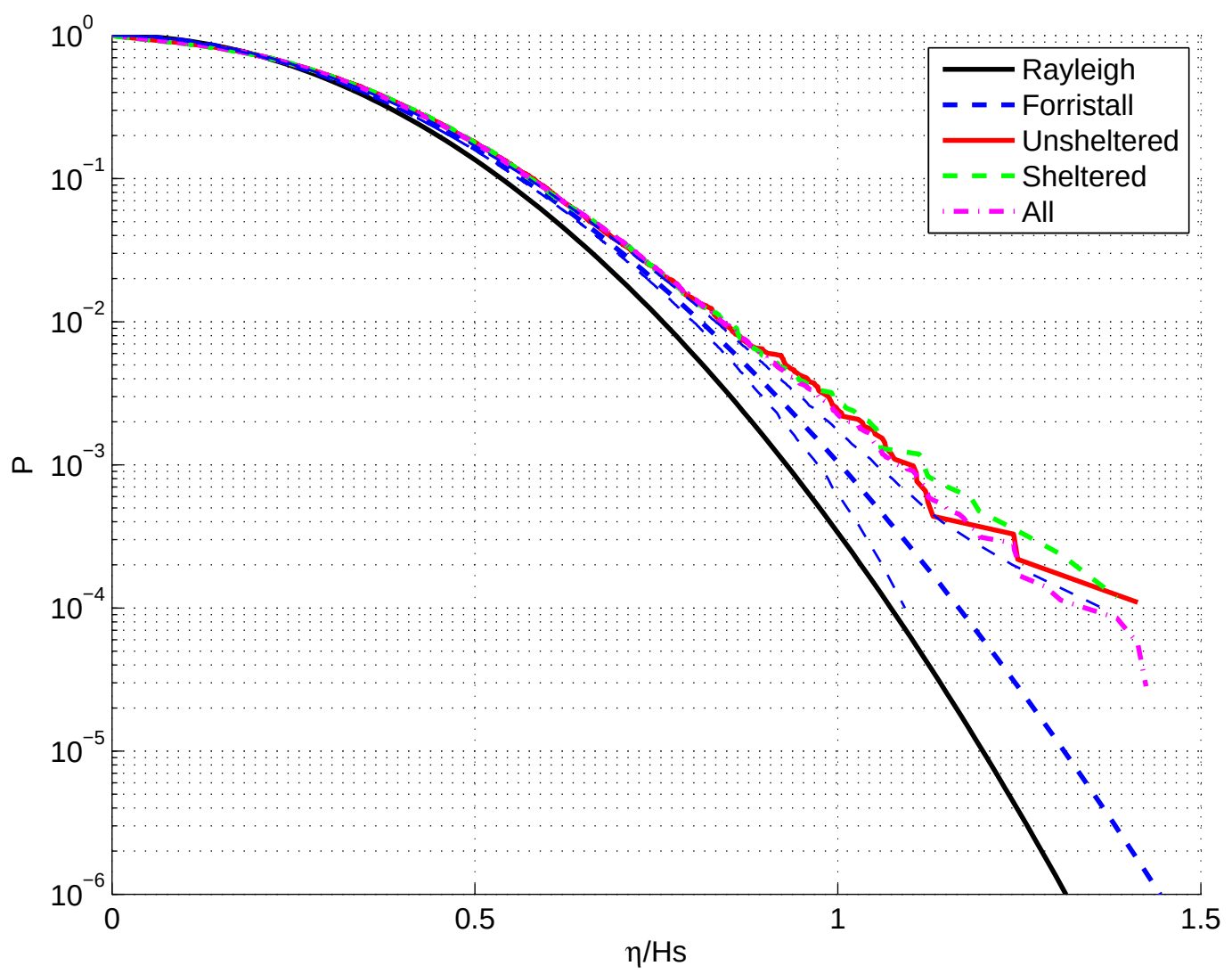
Wave Height Statistics

Wave height distributions conditional on wind speed



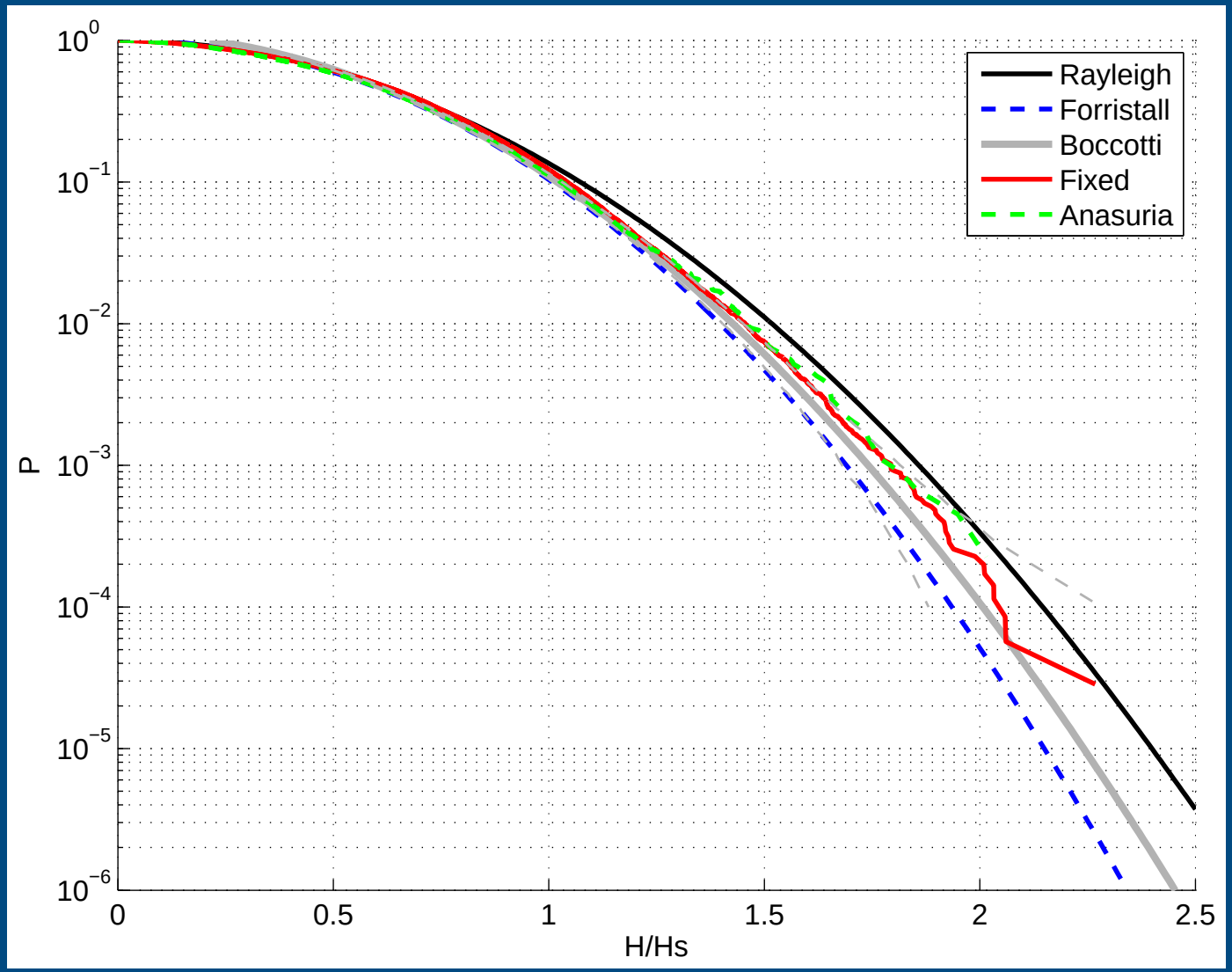
Upwave and Downwave Sensors

The effect of sensor location



Radar and Buoy Measurements

Comparison between wave heights measured by the buoy and the radars



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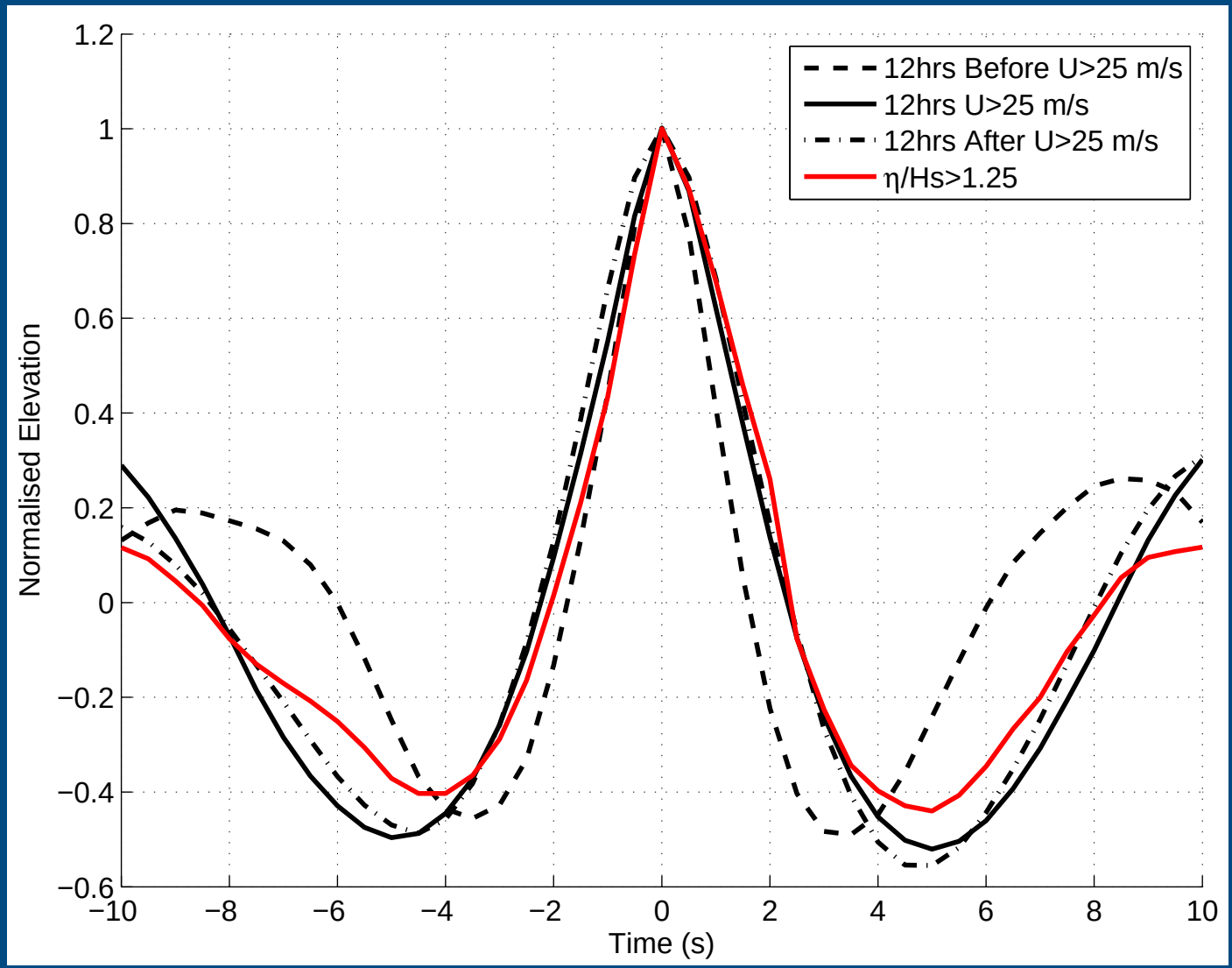
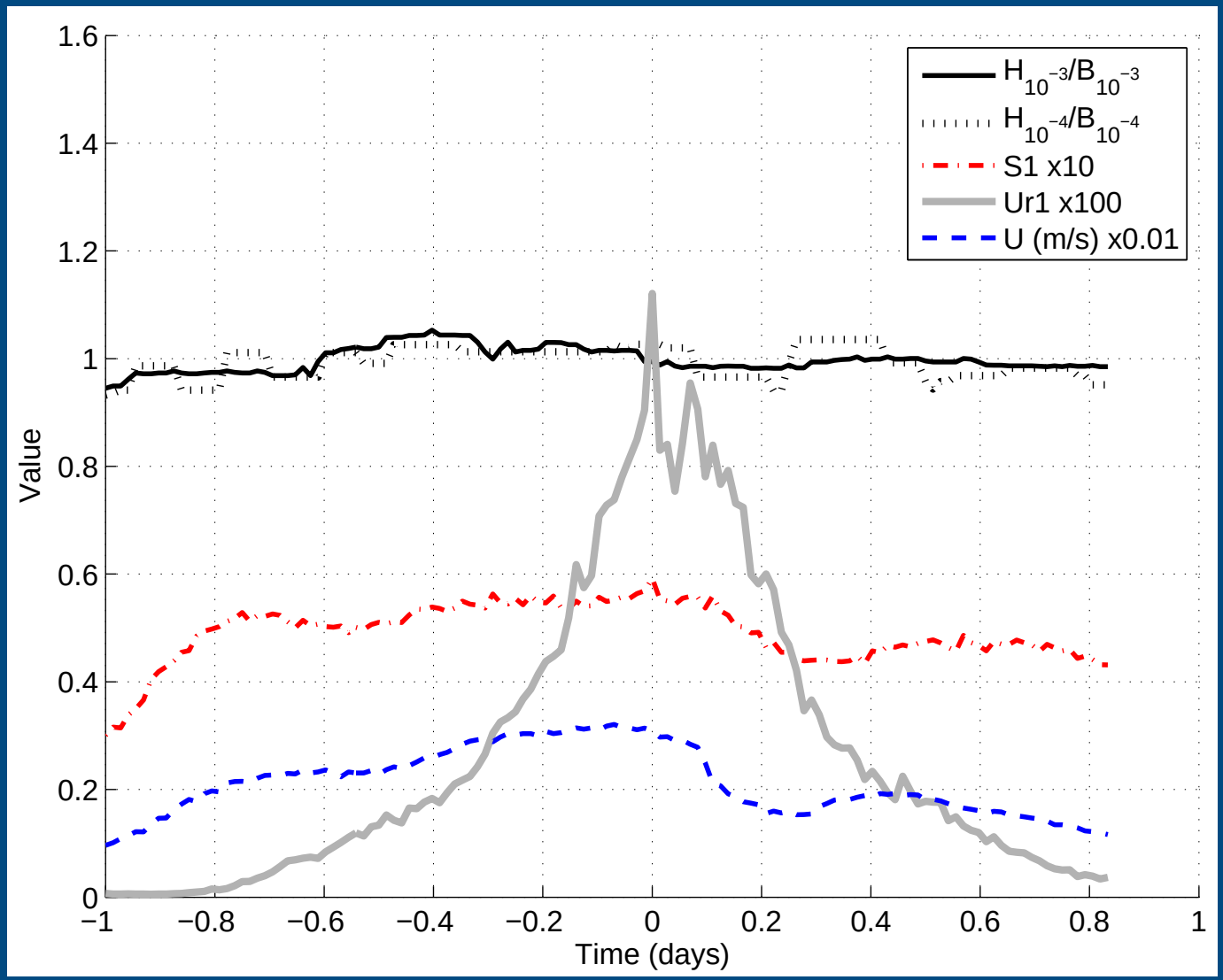
4. Results are independent of sensor location and the measurement device

Wave Profiles

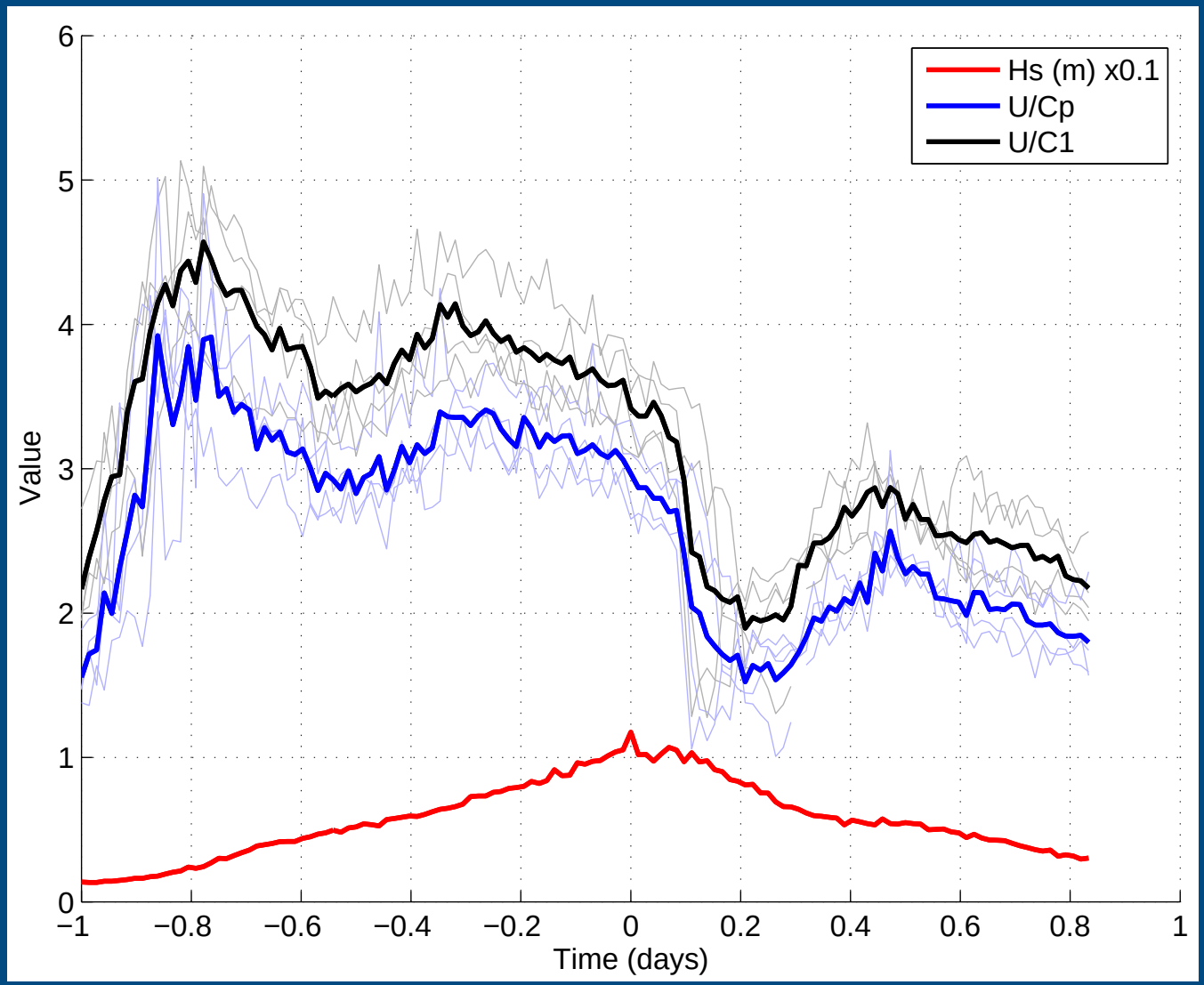
Average shape consistent with focussed wave events



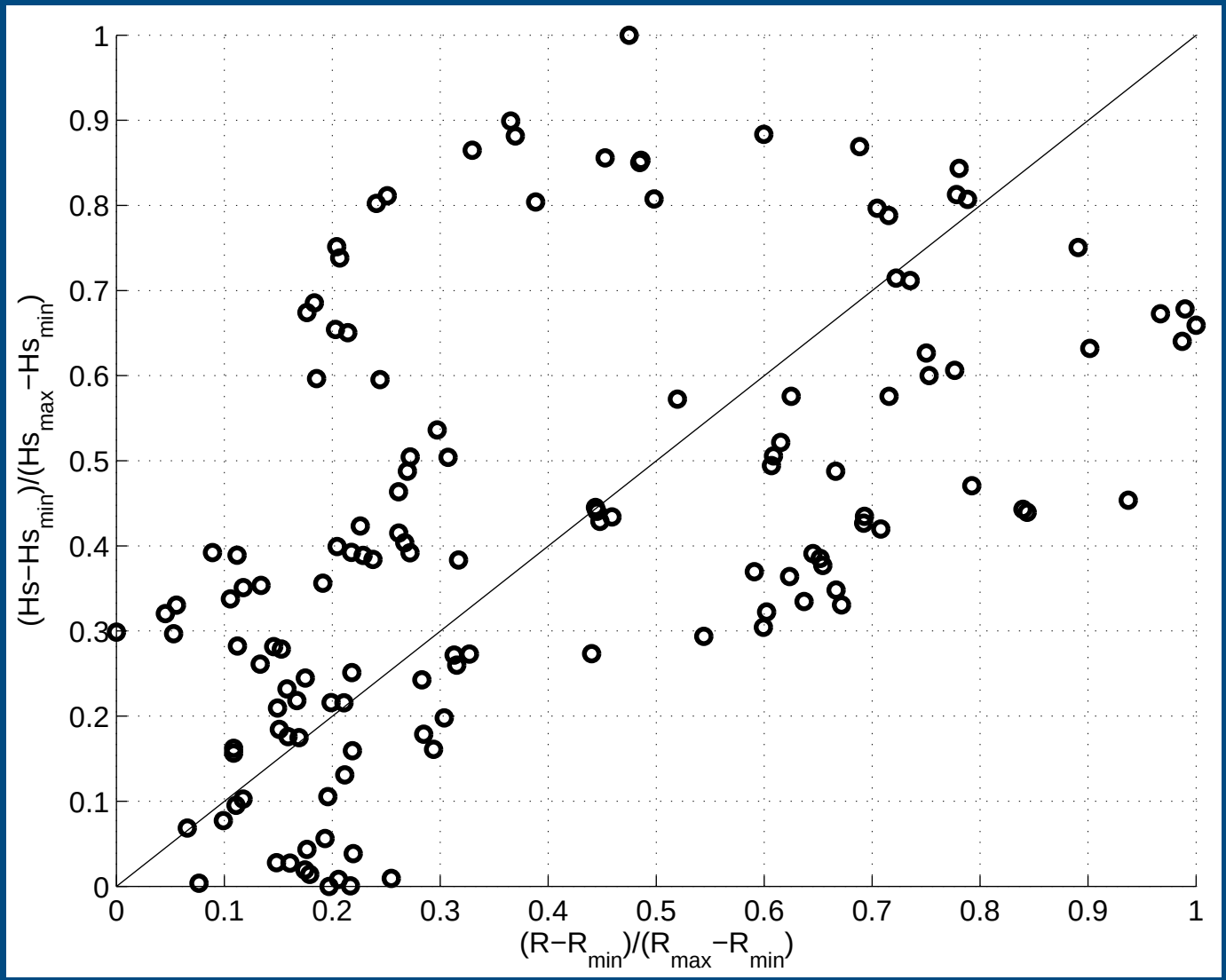
Ratio


1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Value
−1
−0.8
−0.6
−0.4
−0.2
0
0.2
0.4
0.6
0.8
1
Time (days)
H10−3/B10−3
H10−4/B10−4
S1 x10
Ur1 x100
U (m/s) x0.01

Wind speed


Hs (m) x0.1
U/Cp
U/C1
Value
Time (days)
6
5
4
3
2
1
0
−1
−0.8
−0.6
−0.4
−0.2
0
0.2
0.4
0.6
0.8
1

Correlation Hs



Correlation Ur