

Rogue Waves in the Southern North Sea

A statistical evaluation of 329.000.000 waves

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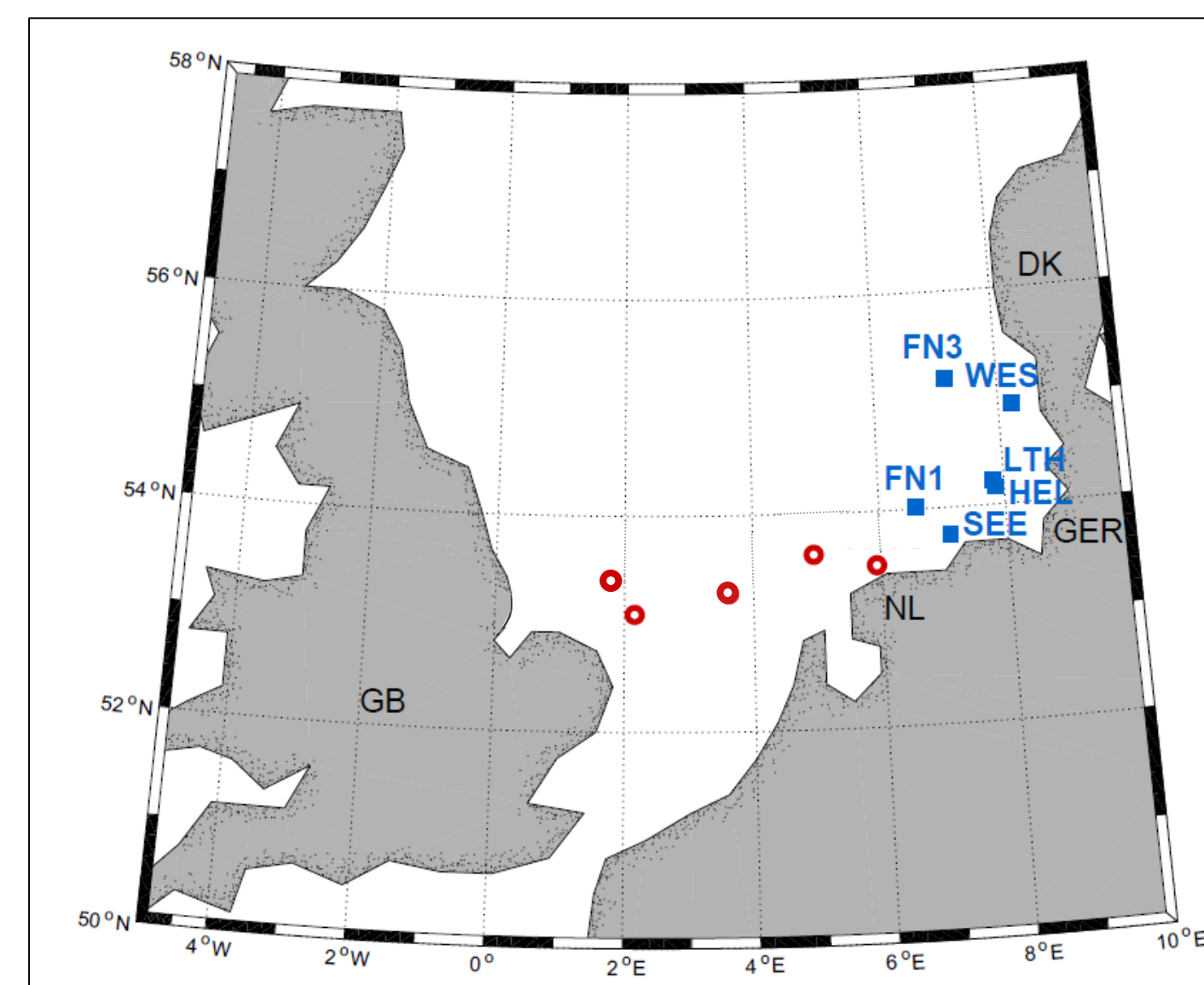
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Setup

Measurement region

Data from five radar stations and six wave buoys were available in a common time period from 2011 through 2016.

790.000 quality-controlled **half-hour samples** containing **329 mio. individual waves** were statistically analysed.

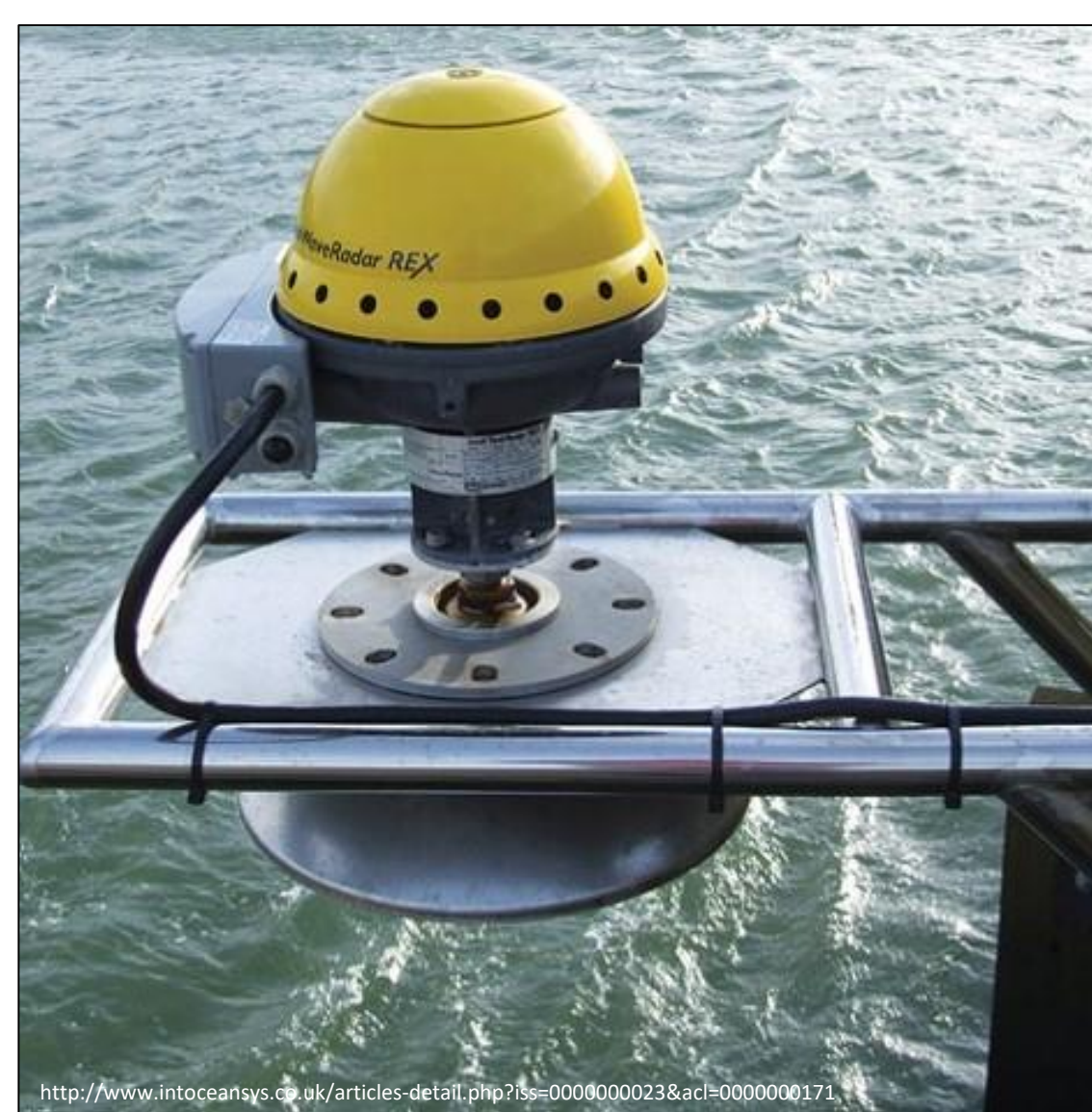


Measurement region: southern North Sea.
Red circles: radar stations. Blue squares: wave buoys.

Measurement systems



The **waverider buoy** Mk III is fixed to the seafloor by chains and a rubber band, allowing the floating body to follow the sea surface. Measurement frequency: 1.28 Hz.



The **radar device** is fixed to a platform and measures the air gap at a frequency of 2 Hz or 4 Hz.

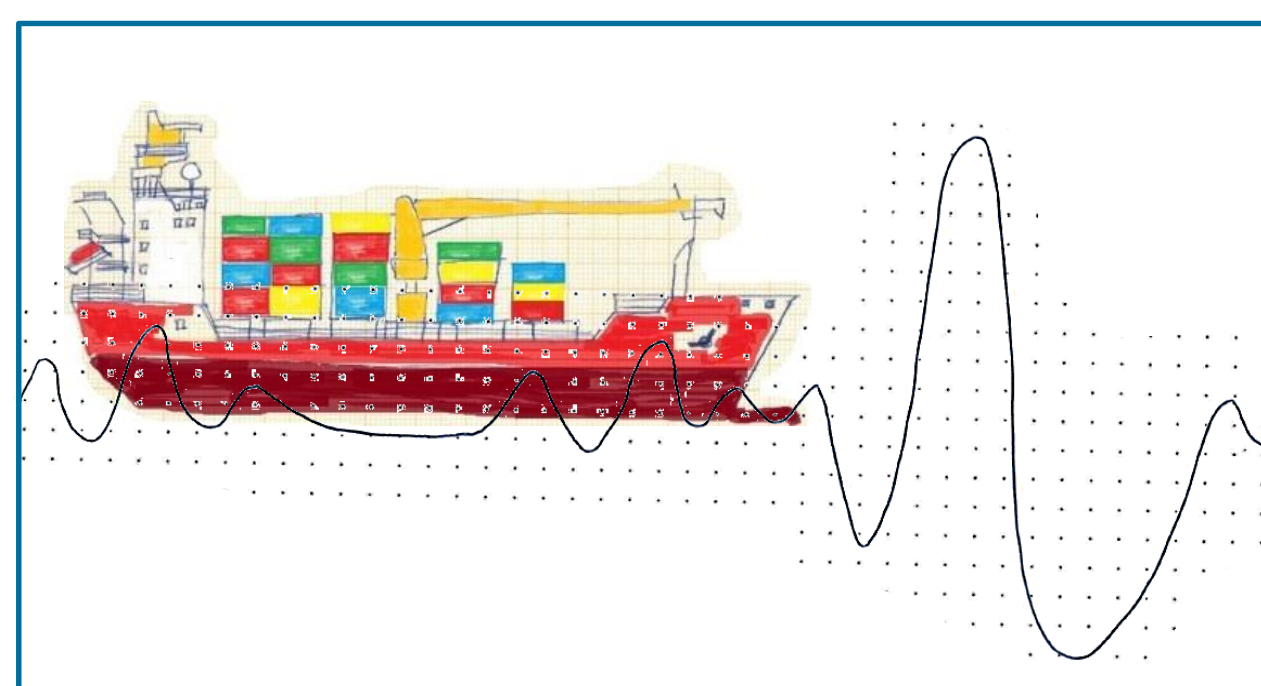
Definition

Here, a wave is rogue if

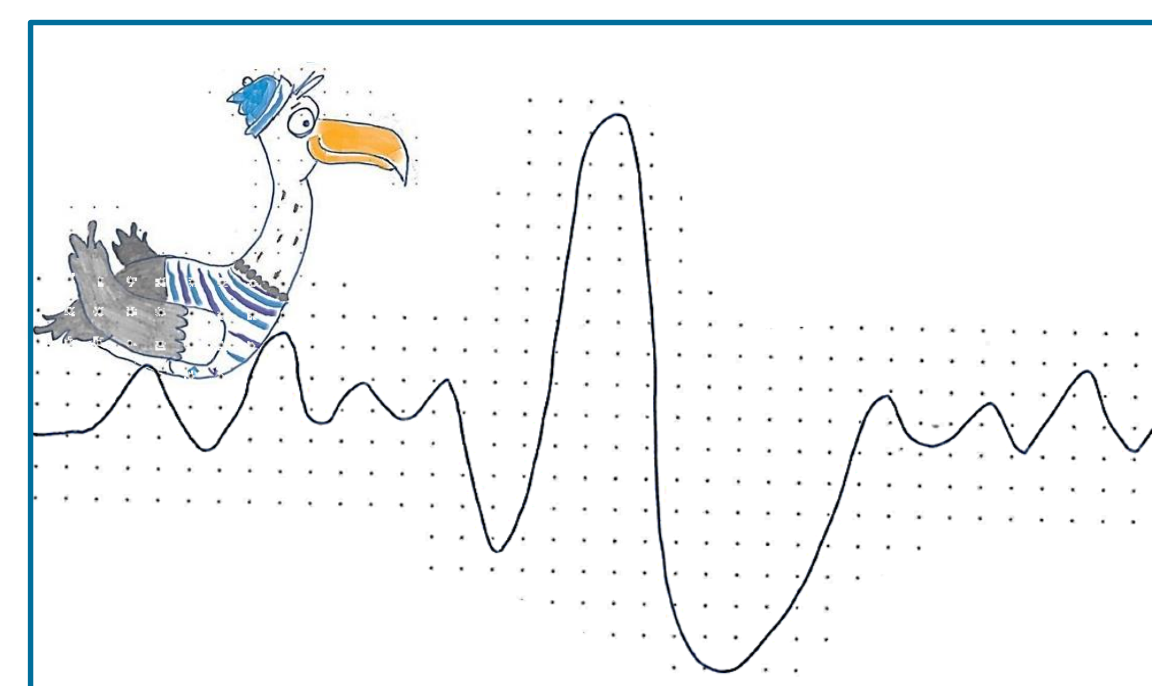
$$\frac{H}{H_s} > 2 \text{ AND/OR } \frac{C}{H_s} > 1.25$$

with **H**- wave height, **C** crest height, $H_s = H_{1/3}$ significant wave height.

All kinds of sea states were evaluated according to this relative definition- no matter if high or low:



OR



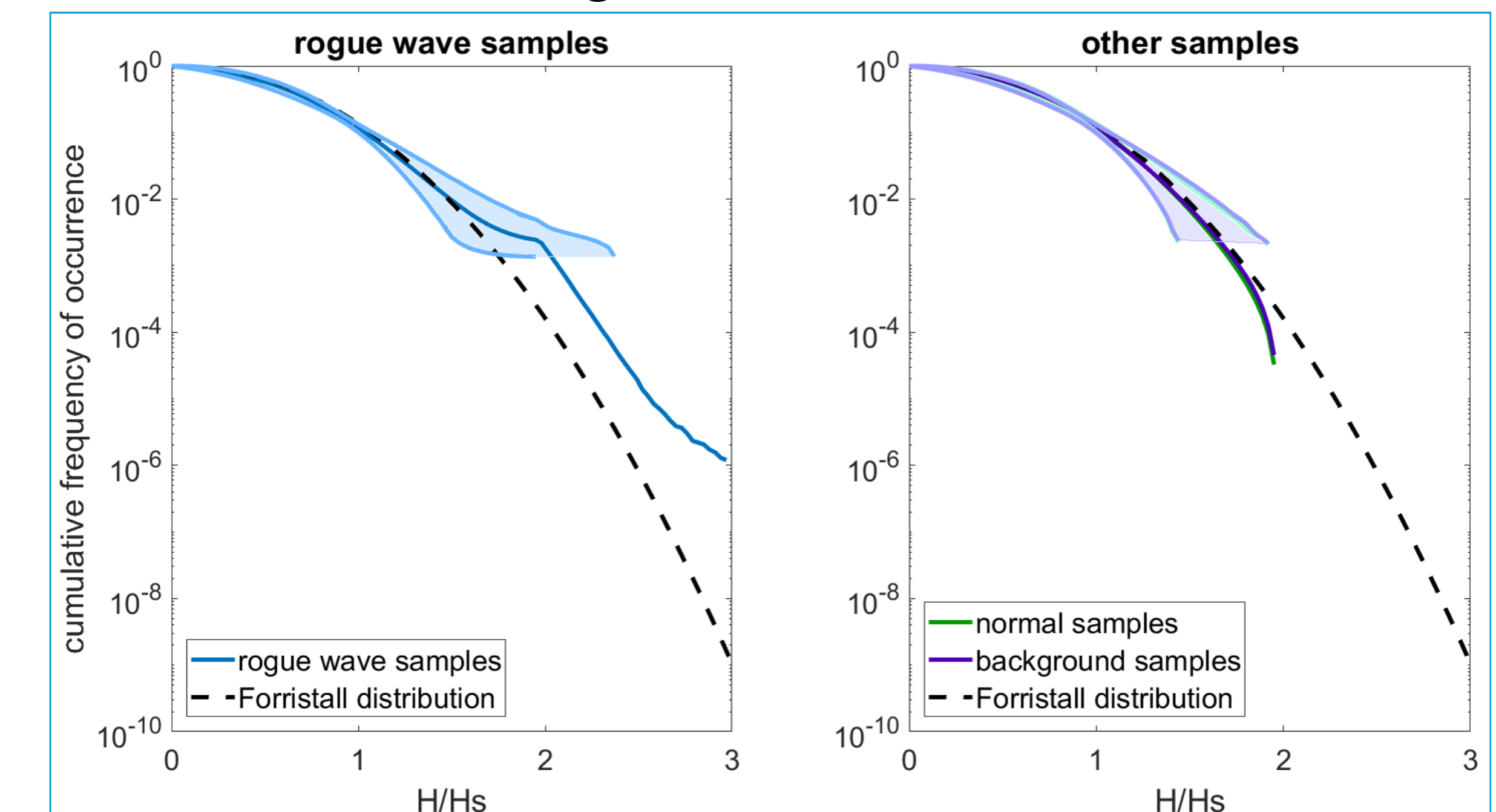
Conclusions

- More rogue waves identified at radar than at buoy stations. This may be due to the different measurement area or due to the different systems.
- No significant trend throughout the measurement period.
- No seasonality.
- More rogue waves found than predicted by Forristall's distribution
- The individual wave height distribution does not lead to conclusions on rogue wave occurrence.

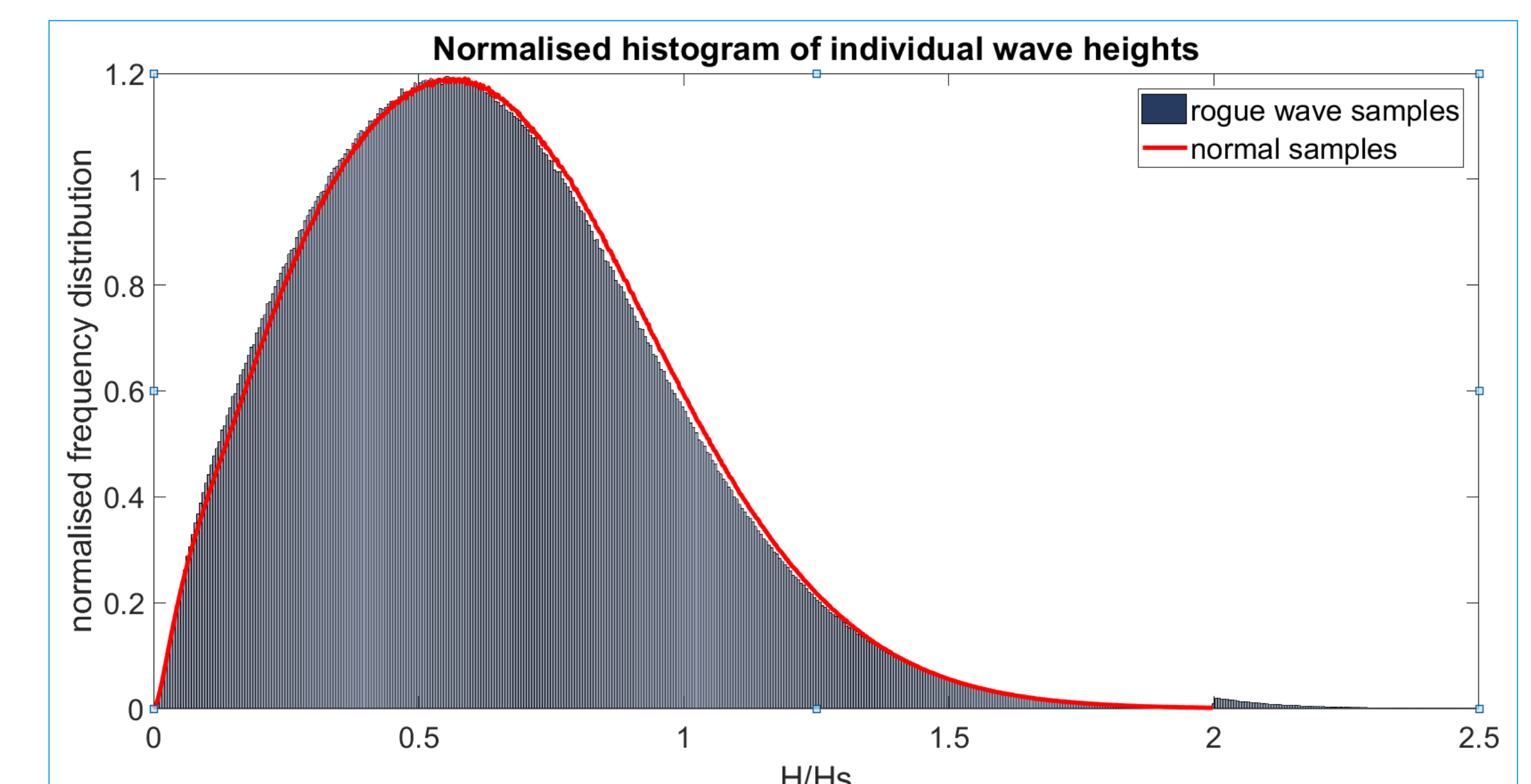


Results

Individual wave heights

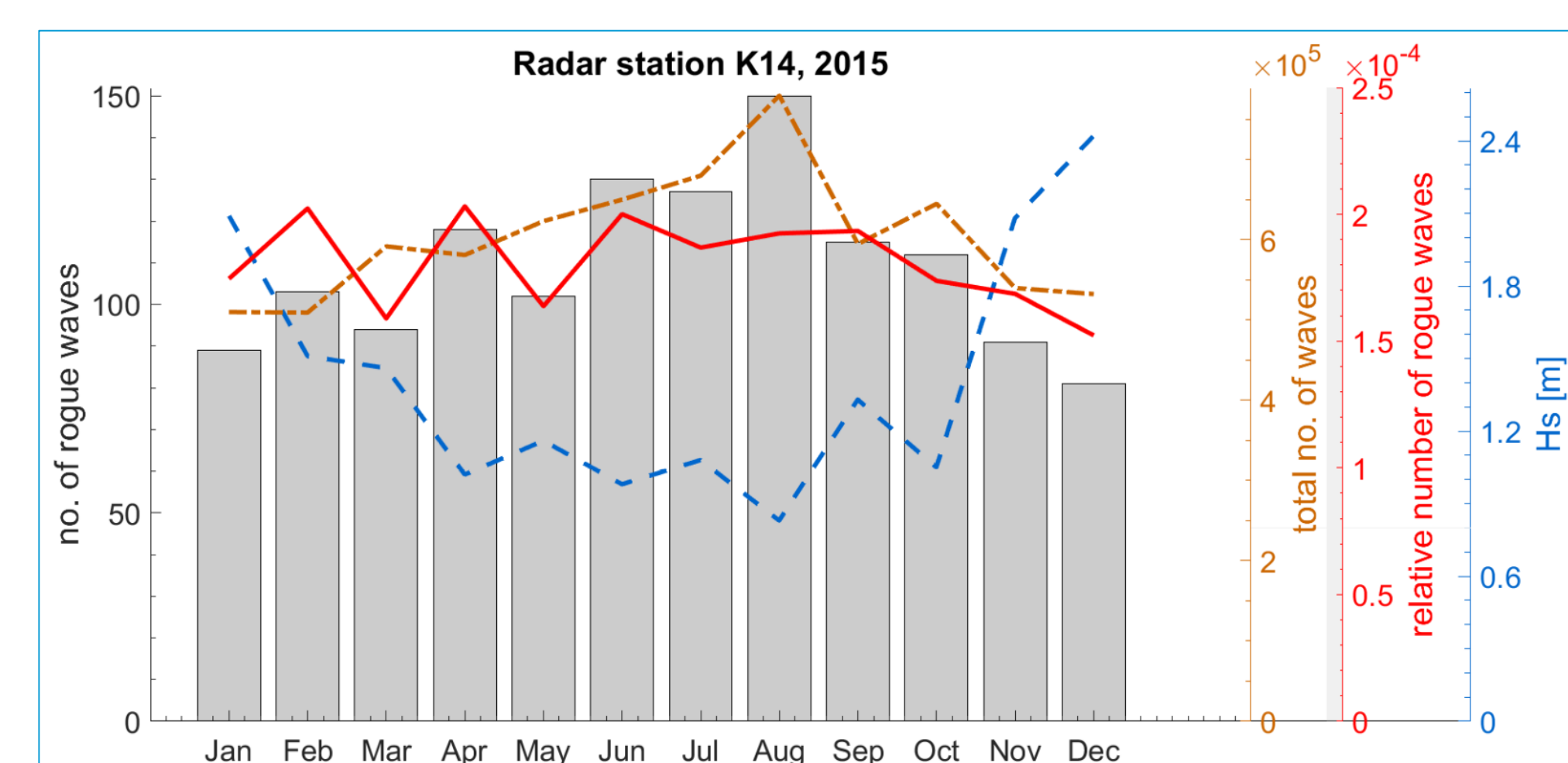


Cumulative frequency distribution, showing the excess frequency of certain wave heights.
Left plot: mean of frequency distributions from all rogue wave samples, including the 95th percentile.
Right plot: normal samples and samples from which the rogue wave has been removed ("background samples").
Forristall's distribution $P(H > H_0) = \exp(-(x/0.7218)^{2.126})$ is shown for comparison.



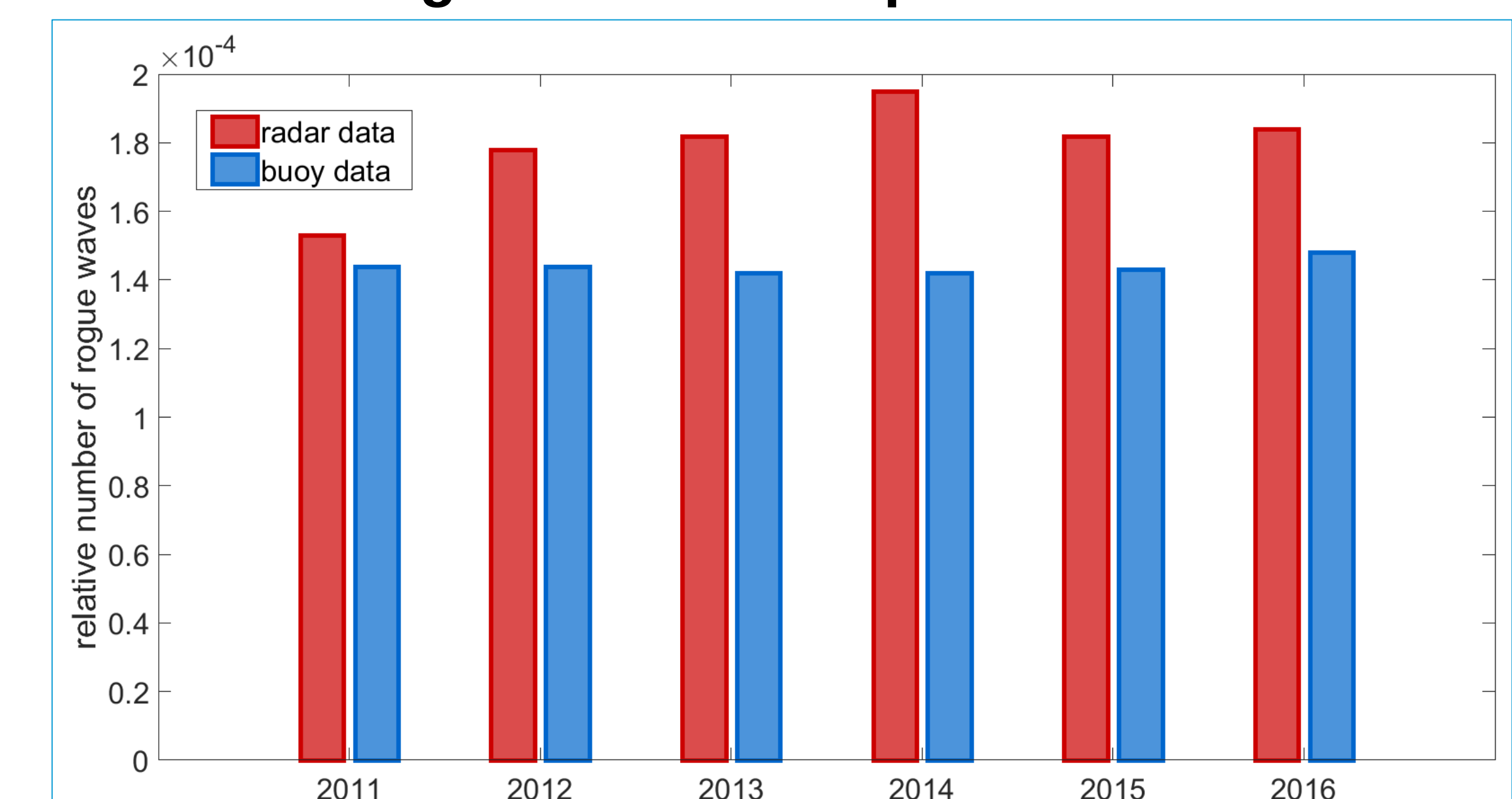
Histogram of individual wave heights, with the area sum normalised to 1.
Grey bars: samples that include a rogue wave. Red line: "normal samples" without a rogue wave.

General trends



grey bars- absolute amount of rogue waves. Generally higher in summer than in winter.
dash-dotted orange curve- total amount of measured waves. Also higher in summer.
dashed blue line - significant wave height. Waves are generally lower in summer.
red solid line - ratio of grey bars and the orange line. This **relative number of rogue waves** shows no significant seasonal trend.

Trends during measurement period



Relative number of rogue waves at radar and buoy stations throughout the measurement period.