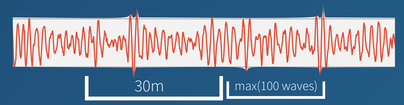
Raw data

CDIP buoys:
160 locations
4 billion waves / 700 years of time series
1.28 - 2.56 Hz sampling rate

Processing

We compute characteristic sea state parameters and map them to observed wave heights, with extensive quality control. The resulting **dataset** (> 1TB) is **freely available** [1].



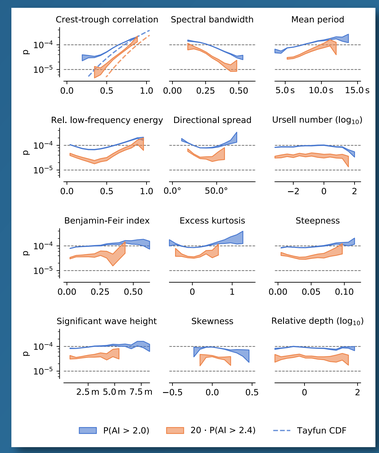
significant wave height
wave steepness
skewness
kurtosis
total energy
energy in various frequency bands
Benjamin Feir index
...

Data mining

For which sea state parameters do we see the **largest variation in rogue wave probability**?

As it turns out, **crest-trough correlation** (parameter r in Tayfun distribution) is the single most informative parameter for waves. [2] Benjamin-Feir index and kurtosis are uninformative.

For rogue crests, we find that **steepness** and **Ursell number** are most important, in line with weakly nonlinear theory.



Inferring the causes of real-world rogue waves

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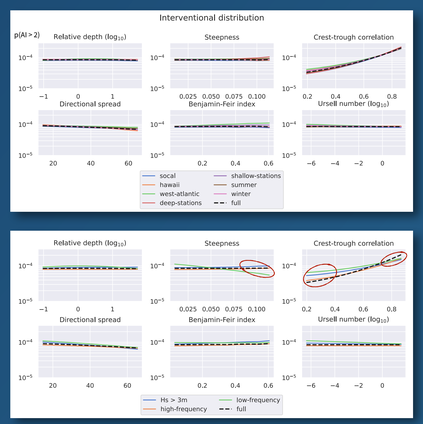
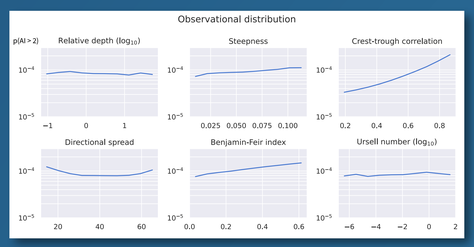
Evaluation



This is **invariant** across a wide range of **data subsets**.

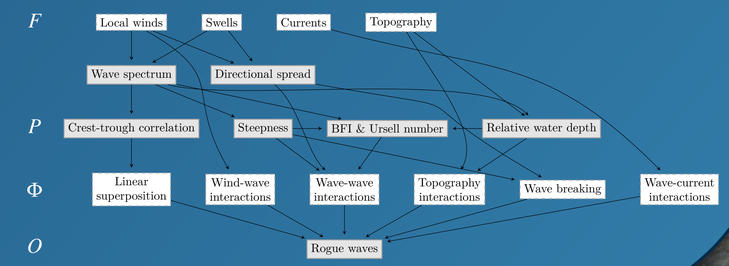
However, there are **some subsets** that **cannot be explained** with this model. This could imply that our causal graph is still **incomplete**.

Fitting this causal model to observations via logistic regression, we find that **only crest-trough correlation and directional spread** have significant contributions. The resulting rogue wave probabilities match the observed ones very well.



Causal graph

As a next step, we formulate a **causal model** of oceanic rogue waves. This is a **directed graph** that specifies how macroscopic features F relate to parameters P, physical effects Φ, and observations O. This allows us to train a model that estimates the causal influence of each parameter.



Publications

[1] Häfner, Dion, Johannes Gemmrich, and Markus Jochum. "FOWD: A Free Ocean Wave Dataset for Data Mining and Machine Learning." Journal of Atmospheric and Oceanic Technology (2021).

[2] Häfner, Dion, Johannes Gemmrich, and Markus Jochum. "Real-world rogue wave probabilities." Scientific reports (2021).

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