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WDRT: A toolbox for design-response analysis of wave energy converters

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ABSTRACT

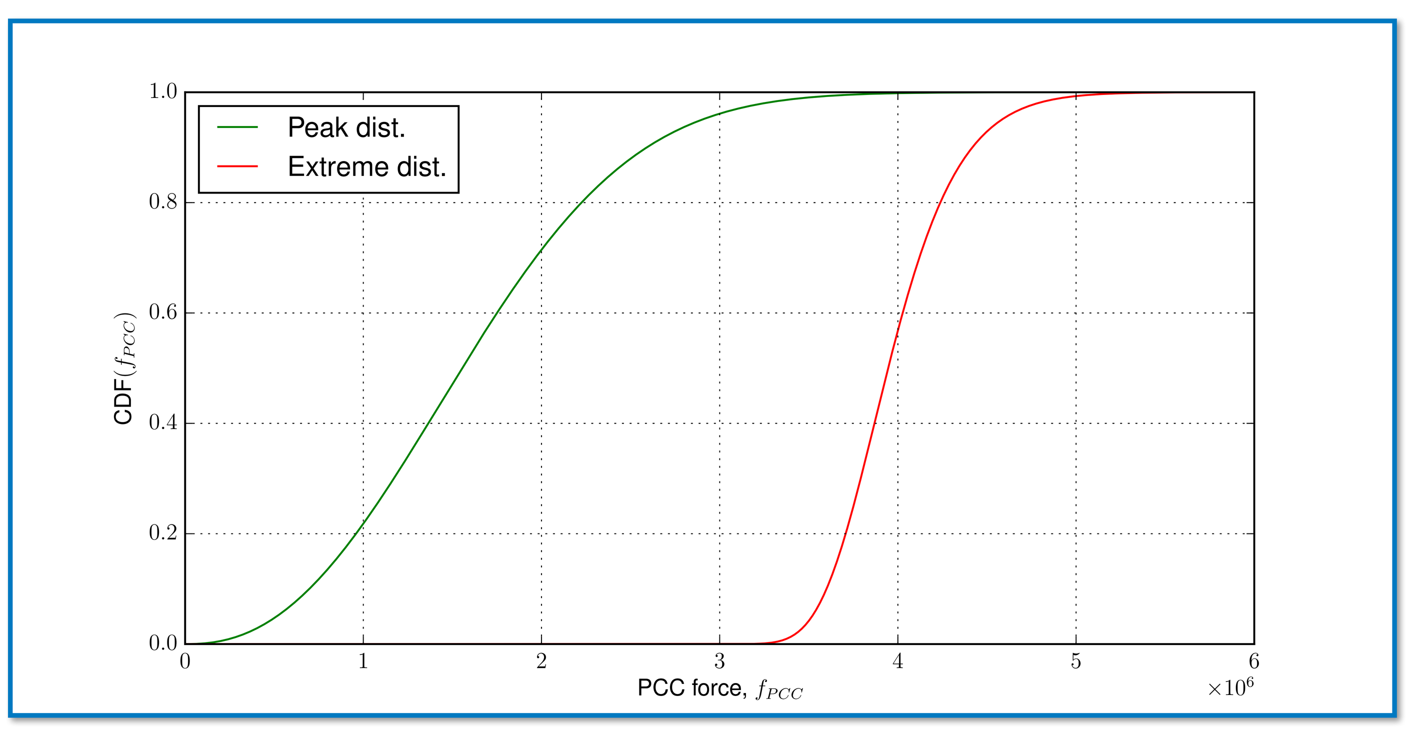
In this paper, we present a numerical toolbox for design- response analysis of wave energy converters (WECs). The "WEC Design Response Toolbox (WDRT)" was developed during a series of efforts to better understand and improved the WEC survival design process. The WDRT has been designed as a tool for researchers and developers, enabling the straightforward application of statistical and engineering methods needed for design response analysis of a WEC, including characterization of environmental extremes, extreme response statistics, fatigue analysis and design wave composition. This pa- per gives a brief overview of the WDRT including its capabilities and underlying theory.

TOOL FEATURES

- Python-based
- Collection of functions (and examples) for analyzing results from numerical or physical modeling
- Built to interface with WEC-Sim (as well as other tools)
- Open-source & GitHub release & Online Doc

SHORT-TERM EXTREME RESPONSE – develop sea state specific extreme response distributions

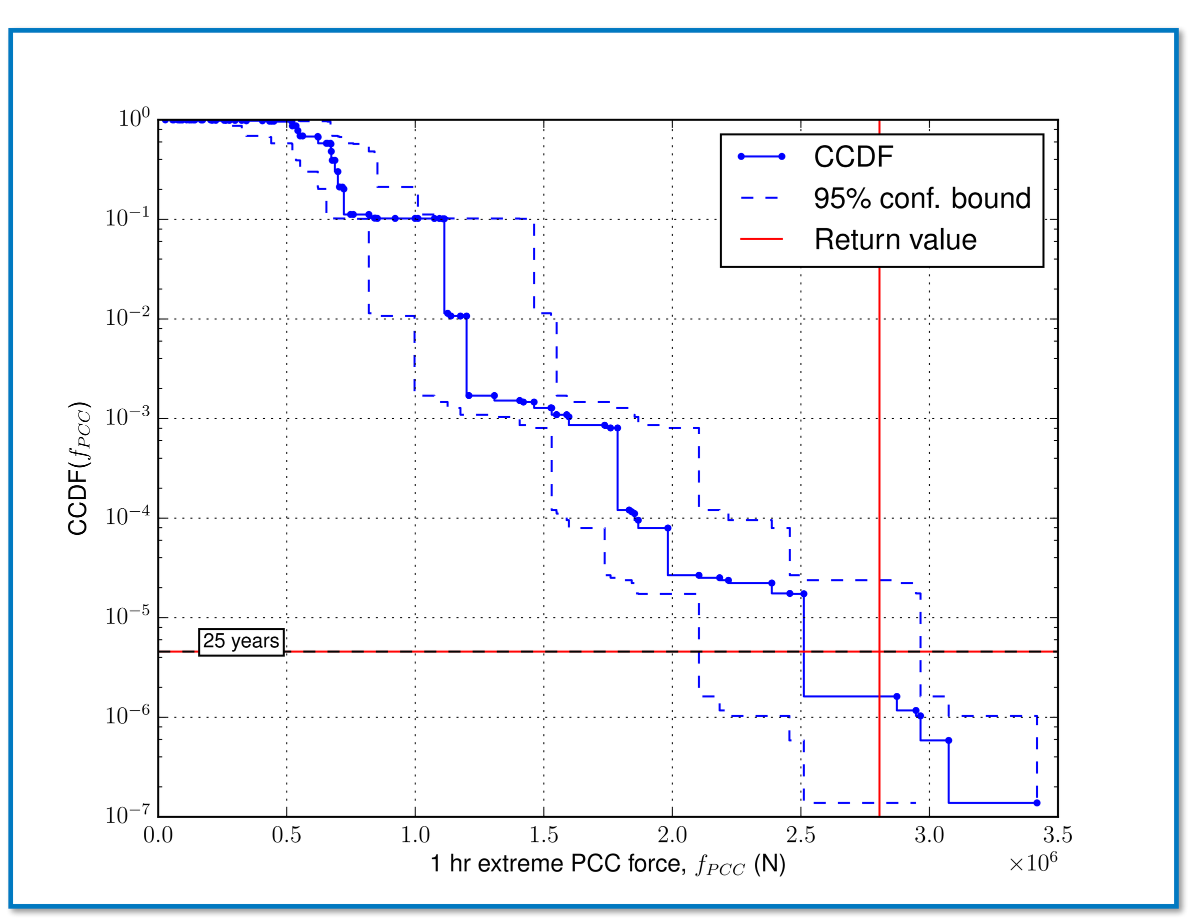
- Multiple methods allow for flexibility in analysis
  - All-peaks Weibull
  - Weibull tail-fit
  - Peaks-over-threshold
  - Block-maxima
- Goodness-of-fit plotting to validate analysis success



Example Peaks Distribution and Short-Tem Extreme Distribution

LONG-TERM EXTREME RESPONSE – develop design response for specific deployment location and period

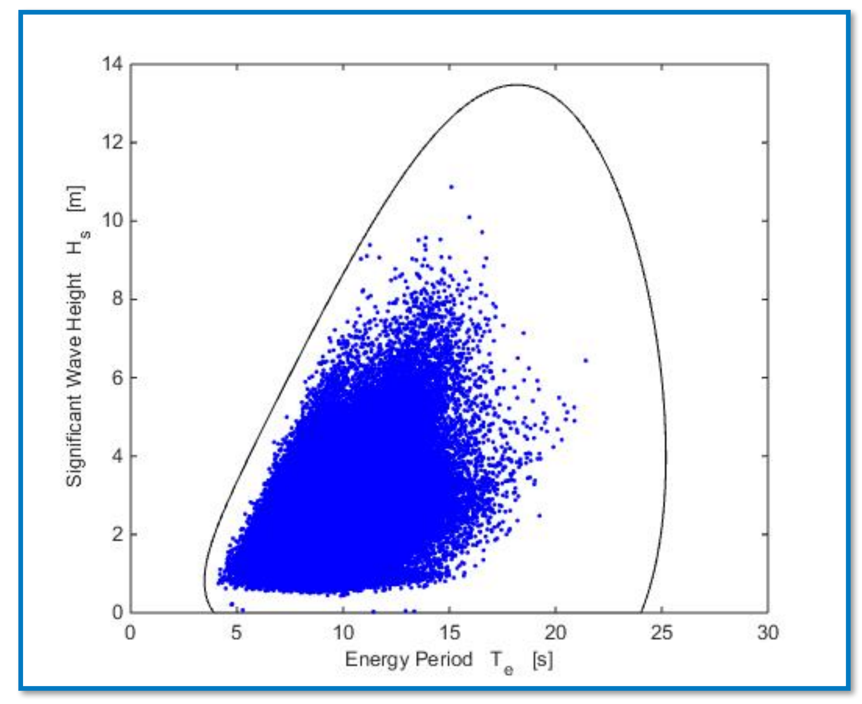
- "Contour" and "Full sea state" approaches offer flexibility in analysis
- Built-in uncertainty analyses can inform factor-of-safety considerations



Long Term Extreme Complementary Cumulative Probability Distribution For PCC Force

ENVIRONMENTAL CHARACTERIZATION - characterization of extreme waves and development of contour lines based on empirical data

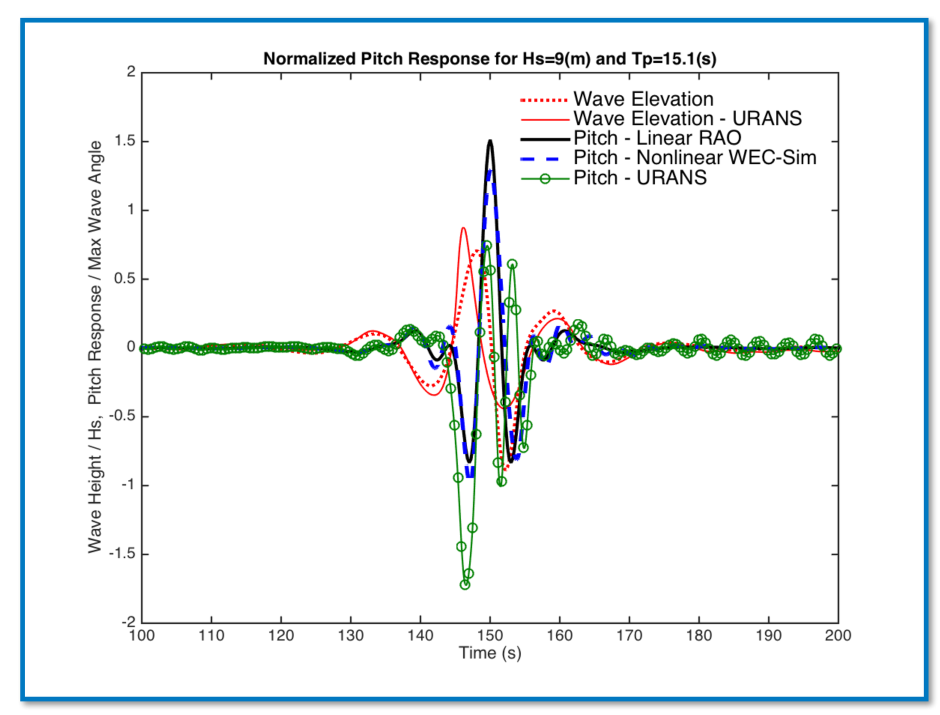
- Modified method uses principle component analysis (PCA); improved performance over traditional I-FORM
- Alternative method utilizing kernel density estimation (KDE) approach to be added soon for additional robustness



100 Year Extreme Sea-State Contour For NDBC 46022

EQUIVALENT DESIGN WAVE - represent entire sea states in limited time for efficient simulation

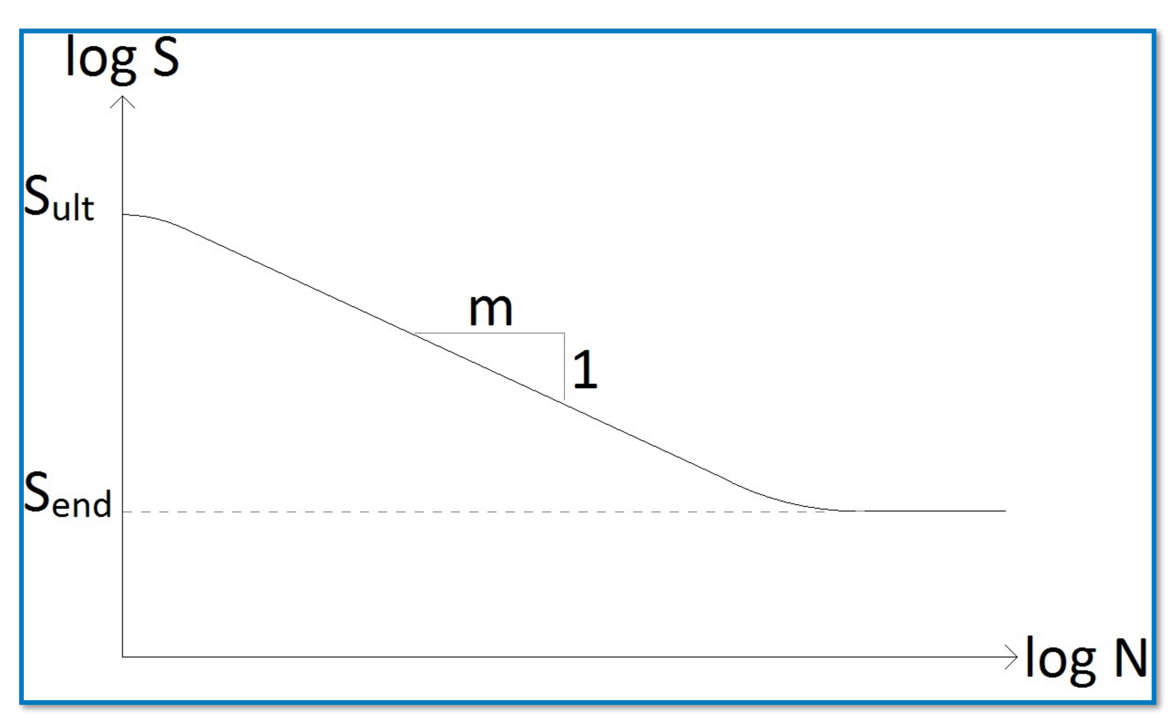
- Assumes device nonlinear dynamics to be a perturbation from a linear response
- Most-likely extreme response (MLER) approach



Pitch Response From The MLER Method

FATIGUE - quantification of an equivalent static load to account for fatigue loading

- Performs a rain-flow count of the load history
- Cumulative damage of variable loading approximated by Palmgren-Miner rule



Pitch Response From The MLER Method

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