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Energy

WAVE FORCAST FOR SHORT TERM POWER PREDICTION AND NETWORK INTEGRATION

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Introduction

The marine environment and the response characteristics of any engineering system exposed to it are inherently non-linear. Traditional analysis of the wave climate, however, uses spectral methods, which implies assumptions of linearity and short-term stationarity. In contribution to SuperGen Marine WorkStream 7, aiming to 'ensure that the effects of non-linearity and non-stationarity of the marine resource on wave and tidal current energy conversion are well understood and satisfactorily mitigated', this assessment seeks to answer:

How can more detailed sea descriptors, such as bandwidth and spectral shape, and the effects of time changes in the wave field, be used to predict short-term power production and ultimately calculate energy supply?

Aims and Objectives

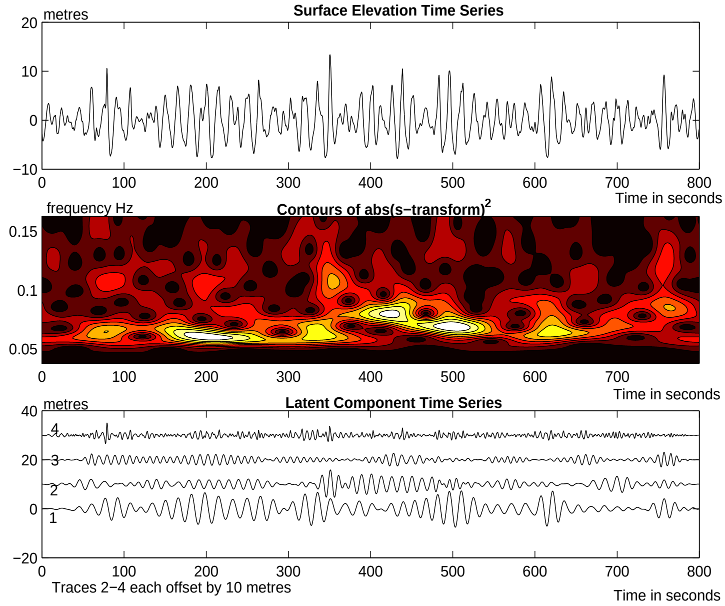
Drawing from existing full-scale wave data and employing modeling techniques developed during SuperGen Marine Phase 1, initial investigations will include:

- Acquiring an understanding of marine energy conversion and power transmission network operation.
- Achieving comprehension of shallow water wave hydrodynamics.
- Reviewing the methods of non-stationary, non-linear time series analysis, with particular reference to short-crested waves in shallow water.
- Generation of sample wave records from numerical simulations of the local wave field, using a non-linear wave model with idealised bathymetry.
- Analysis of existing full-scale and experimental data together with simulated data to compare the accuracy of different methods of short-term forecasting.
- Transformation of these forecasts using the existing generator model to obtain predictions of power output.

Methodology

In development of procedures for the purpose of forecasting power production, this study is likely to initially employ the S-transform technique of time-frequency analysis and time series decomposition.

The below example draws from a previous assessment [1], showing in the upper plot the water surface elevation of 800 seconds of wave data from a North Sea storm (Jan 1st 1995), in the centre, a time-frequency contour plot derived from the S-transform matrix (where light patches indicate high energy concentrations) and in the lower plot, component time series produced by adaptive inversion of the S-transform matrix.



Upon project completion we hope to have achieved quantification of the accuracy of the techniques available for power prediction, enabling determination of power production (within a probabilistic framework) from suitable time series records of sea state.

References

1] M. Olagnon and G. A. Athanassoulis. 'Rogue Waves 2000', Le Quartz, Brest, France, 28-29 November (2000)

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