A Frequency Dependant Method For The Simulation of Disturbances Around a Small Scale Wave Farm Using a Boussinesq Simulation

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Overview

This research shows the development and application of a new method for modelling the nearshore wave disturbances from a small array of hypothetical oscillating wave surge converters. This method applies a frequency dependant absorption where the devices reflected, absorbed and transmitted characteristics are shown using a realistic power transfer function. The results demonstrate the application of a new method and provide a detailed map of the spatial change in wave energy around devices, highlighting the regions of importance.

Model setup

As the focus of this report is to asses a new method of simulating devices within the BW model a simplified test bathymetry with a constant depth of 10m was used. This model uses a regular grid mesh with a 2m resolution. This allows the deep water terms to be excluded as all waves are considered to be in shallow/intermediate water depth

WEC simulation

The simulation of WECs was achieved by the application of porosity layers. While the use of a porosity layer within the BW model provide no frequency dependant absorption, the summation of multiple simulations with a varying porosity values provides a linear frequency dependant absorption. An example transformation from a wave spectrum to a representative monochromatic combined sea is shown below in Fig. 1.

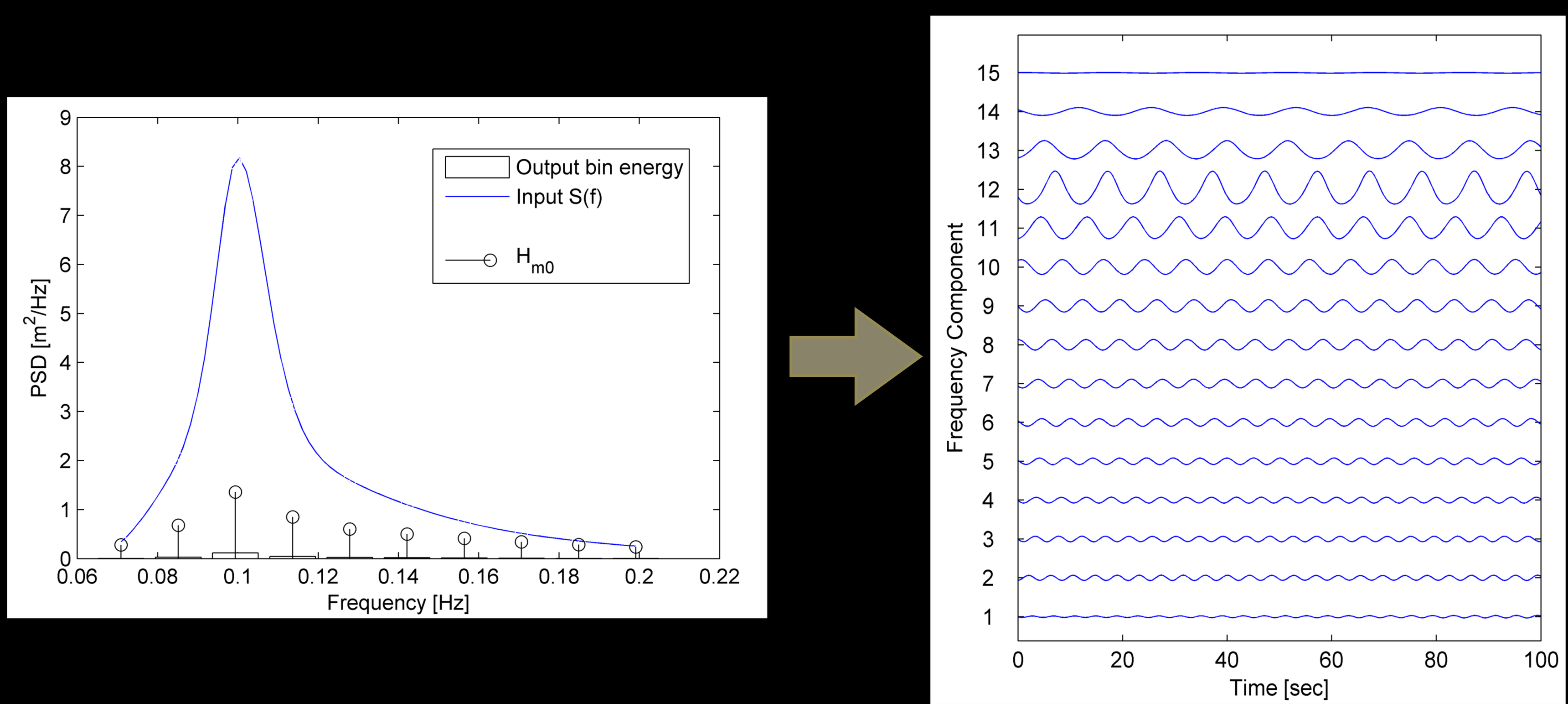

Fig. 1 Transformation of input frequency to energy representative wave components.

To model the presence of a hypothetical WEC a frequency dependant PTF (Power Transfer Function) must be identified. This study used a de-normalised PTF taken from a physical scaled lab experiment (Fig. 2) [2]. The absorption for each frequency component was then taken and transferred to a respective porosity value.

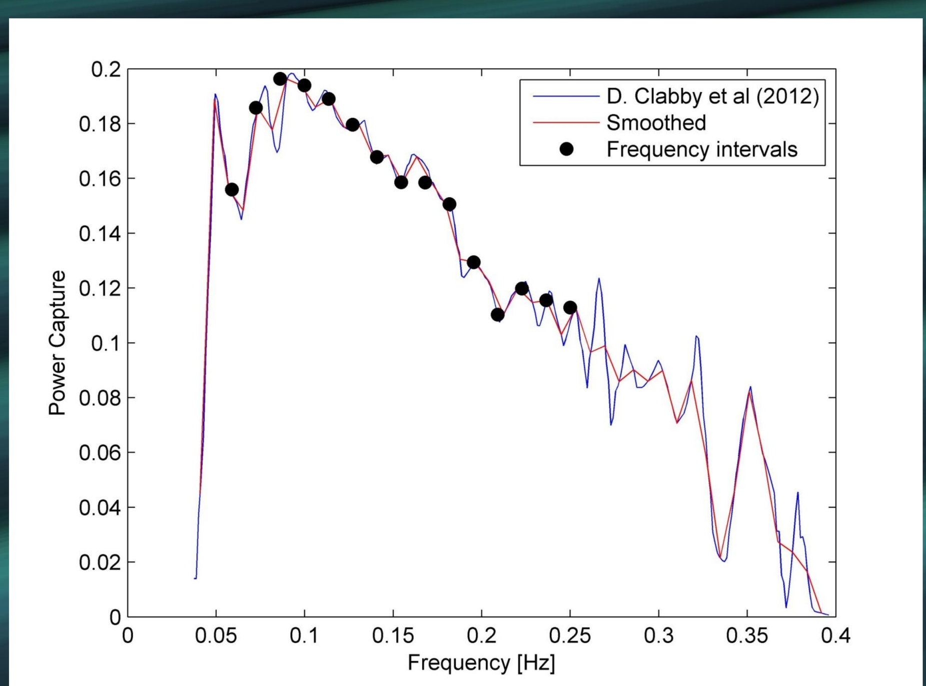

Fig. 2 Identified PTF for and oscillating wave surge converter.

Results

The simulation results for each frequency component are given in terms of an energy equivalent H_{m0}. These results were then converted into energy and summed. To ensure no side wall interaction are included within the simulation a wave speed dependant post processing was applied.

The results for a multiple device can be seen in Fig. 3. A box has been drawn within the domain to show the pristine data where no sidewall reflections occur and high frequency wave forms have fully propagated across the area of interest. The interpretation of the results below can be split into the up-wave and down-wave regions. The basic observations are as follows

Up-wave
- Complex disturbance pattern
- Peak reflection coefficient of 0.9

Down-wave
- More regular wake-like disturbance pattern
- Peak transmission coefficient of 0.58

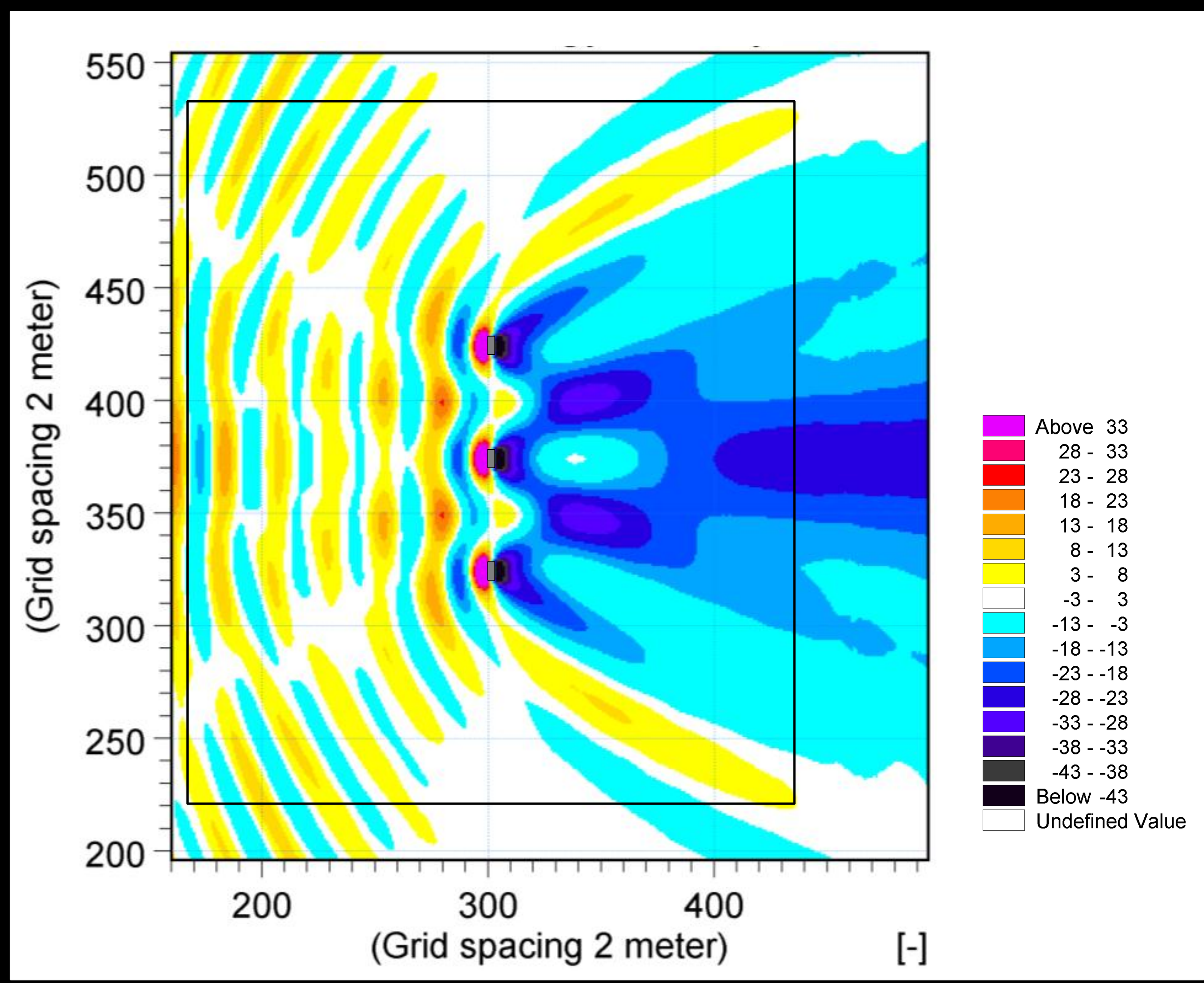

Fig. 3 Percentage change in wave energy around multiple hypothetical oscillating wave surge converter.

The combined effects of the multiple devices cause a larger magnitude in the mid-field maxima and minima. This results in the potential increase in wave energy of 24% in front of the device or a reduction of 30% behind the devices.

Conclusion

These results demonstrate the successful application of a new method of simulating frequency dependant WEC s with outputs showing a theoretically realistic disturbance. While the results show promise the level of programming for a the simulation setup is daunting. However further work is being conducting on the affects of spatially varying bathymetry on WEC wave disturbances.

Acknowledgments

This study was funded thought the European Regional Development Fund. Support from the TerraWatt project provided the DHI software licence. Addition support was also provided by the Hebridean Marine Energy Futures.

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