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Experiments on the near-field and far-field wave effects of WEC arrays

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Wave energy conversion is an active and growing industry and the deployment of multiple Wave Energy Converters (WECs) in large scale arrays appears to be imminent. However, there is a significant gap in our present knowledge of the near-field and far-field effects of WEC arrays. This gap comes from the lack of observational data. It is somewhat similar to the "Chicken or the Egg" problem. We cannot validate our predictions of the far-field effects of WEC arrays until we have data, which requires that WEC arrays first be deployed.

To help fill this data gap, we have performed laboratory experiments using five (1:33 scale) moored, point-absorbing WECs (Columbia Power Technology "Mantas"). Using several different array configurations, the WECs were subjected to a range of wave conditions—both regular waves and directional seas. The experimental setup was extensive. There were 28 in-situ instruments (wave gages and current meters), which were arranged in instrument arrays designed to resolve the directionally-spread incident wave field, the wave scattering within the WEC-array, and the modified wave field in the lee of the array including the waves that reach the nearshore (far-field) zone.

Also, a commercial motion tracking system was used to track the position, speed, and acceleration of the WECs using a swarm ($\sim$90) of attached LED's. The WEC motion tracking data can be used as input to the numerical models for wave transformation as well as for WEC performance and design. These data can also be used to estimate the power producing performance of different WEC-array arrangements.

Finally, a bi-static camera system was installed in order to provide a 3D wave imaging capability through binocular stereo. This capability was directed at analyzing the scattered wave field within the WEC-array at high resolution. The constructive and destructive wave interference patterns produced within the array are difficult to resolve with single in-situ gages, but can significantly affect the array performance and the far-field waves.

The experimental plan included both 3-WEC and 5-WEC array configurations as well as single WEC characterization test. Results indicate there are measurable differences in WEC performance that are dependent on the number of individual WECs in the array and the location of a given WEC within the array. In this work we will analyze how wave conditions, array configuration, and WEC location within the array affect WEC performance. We will analyze how WEC array size and orientation affect the far-field hydrodynamics.