DISTRIBUTION OF WAVE HEIGHTS AND PERIODS FOR MULTI-MODAL SEAS AT US NAVY'S WAVE ENERGY TEST SITE, HAWAII

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Hawaii has a complex wave climate due to its mid-Pacific location and massive archipelago. The multi-modal sea states include swells generated by extratropical storms in the North Pacific and year-round Westerlies and mid-latitude cyclones in the South Pacific as well as locally generated trade wind waves. The commonly used bulk wave parameters, such as significant wave height, peak period, and peak direction, provide an overall description of the spatial and temporal variations of wave fields for energy assessment and characterization [1], but provide little information on the distribution of individual waves experienced by installations in the ocean. The wave height and period distributions are of significant engineering interest, and not yet fully understood, especially for mixed seas [2].

There are 14 offshore and nearshore wave buoys around the Hawaiian Islands with continuous records of the sea surface elevation and the deduced wave spectrum and parameters at 30-min intervals. This provides a valuable dataset for statistical analysis of the individual wave height and period. The distributions are site-specific due to selective sheltering of the multi-modal seas by islands and headlands. In this pilot study, we performed a detailed analysis of buoy measurements at 80 m water depth within the US Navy's Wave Energy Test Site (WETS) from 2014 to 2017. Wave spectra with multiple peaks occur more than 90% of the time, negating the use of conventional distributions based on narrow-banded spectra. Statistical analysis of the 30-min time series shows the total number of waves, in the range of 200-330 per 30 minutes, follows a nonlinear relation to the mean wave period. The wave height follows the Weibull distribution with a maximum value around 1.5 times the significant wave height. This additional understanding of statistical wave distribution at WETS for a given significant wave height provides guidance of relevance to infrastructure and wave energy converter design and assessment at WETS.

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