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Passive acoustic determination of wave breaking dissipation rate across the spectrum

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The ambient sound near the ocean surface is controlled by many processes, while wave breaking becomes the dominant factor once it occurs. Laboratory experiment shows that a severer breaker will result in a higher sound level and a larger mean bubble size. This relationship indicates a potential to extract information about wave breaking from acoustic records. Based on both laboratory and field experiments, a passive acoustic method has been developed to determine the wave breaking dissipation rate across the spectrum which had been extremely difficult to obtain in the open sea. The laboratory experiments were carried out in a flume at the University of Adelaide. Waves of different amplitudes and periods were generated and triggered to break by an underwater obstacle. The wave profiles before and after breaking were measured by two capacitance probes to calculate their breaking severities. The acoustic noise emitted by bubbles was recorded by a hydrophone located right under the breaking zone and the mean bubble sizes were computed on the basis of the relationship between bubble radius and acoustic frequency. A non-dimensional empirical formula between breaking severity and mean bubble size was established then applied to acoustic measurements in Lake George, New South Wales, Australia. Acoustic pulse amplitude, power spectral density of acoustic spectrum and the ratio between acoustic pulse amplitude and period were analyzed to identify the acoustic pulses truly produced by bubbles. The mean bubble sizes of each breaker were deduced from the acoustic records and further converted into their breaking severities. Combined with the wave scale information extracted from wave surface records, the spectral dissipation rates in Lake George were finally obtained. The acoustic based results are compared with various kinds of whitecapping dissipation source terms of WAVEWATCH III® and their differences are discussed.