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Detection and tracking of individual surface breaking waves from a fixed stereo video system

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Sea surface wave breaking is the dominant process that results in dissipation of ocean surface wave energy. During the breaking process, wave energy is converted into turbulent kinetic energy, and if significantly energetic, entrains air which facilitates air-sea gas transfer and scatters light to create the signature whitecap. Exploiting the broadband scattering of light by the surface whitecaps, this study uses a fixed stereo video system to detect and track individual air-entraining surface breaking waves at wind speeds of up to 16 m/s. The sea surface foam (whitecap) from a breaking event is detected in grayscale images using a brightness thresholding technique based on the image pixel intensity histogram. The movement of individual whitecaps is estimated with optical flow and is used to track whitecaps between consecutive frames. Once breaking events have been tracked through their lifetime, fundamental properties of the whitecap such as the time-evolving foam area [m^2], breaking speed [m/s], average crest length [m] and foam area growth and decay timescales [s] are extracted and subsequently aggregated into whitecap statistics. The geometric, kinematic and dynamic quantities obtained for individual whitecaps via this tracking method are used in conjunction with the volume-time-integral method developed in Callaghan et al 2016 to estimate the energy dissipated by each individual whitecap and to then develop an empirical frequency-dependent whitecap energy dissipation source term.