Experiments on the inversion of pressure measurements to surface displacement.
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We have derived a fully nonlinear, closed-form mapping from time series of pressure measurements at an arbitrary depth in the fluid column to time series of surface displacement, from the full Stokes boundary value problem for steady water waves. From this nonlocal, implicit, fully-nonlinear mapping we have derived several explicit, asymptotic formulae for various parameter regimes, one of which we propose for use in applications. We compare the full mapping and the approximations with numerically generated soliton solutions of the Stokes boundary value problem and with laboratory experiments on solitons. We compare the linear mapping typically used in applications, and our proposed, nonlinear mapping with experimental results using periodic waves (cnoidal waves) as well as waves that break the assumption of a steady wavefield, such as reflected waves and wave groups. We find that in all cases the proposed asymptotic mapping, which allows for nonlinear interactions, provides a better estimate of the spectrum of the waves and about 5% more accuracy in predictions of the maximum wave amplitudes.

A Joint work with Bernard Deconinck, Katie Oliveras, Vishal Vasan