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## Effects of an abrupt depth change on weakly nonlinear surface gravity waves: deterministic and stochastic analysis

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This work focuses on two different aspects of the effect of an abrupt depth transition on weakly nonlinear surface gravity waves: deterministic and stochastic. It is known that the kurtosis of waves can reach a maximum near the top of such abrupt depth transitions. The analysis is based on three different approaches: (1) a novel theoretical framework that allows for narrow-banded surface waves experiencing a step-type seabed, correct to the second order in wave steepness; (2) experimental observations; and (3) a numerical model based on a fully nonlinear potential flow solver. To reveal the fundamental physics, the evolution of a wave envelope that experiences an abrupt depth transition is examined in detail; (a) we show the release of free waves at second order in wave steepness both for the super-harmonic and sub-harmonic or ‘mean’ terms; (b) a local wave height peak that occurs near the top of a depth transition – whose exact position depends on several nondimensional parameters – is revealed; (c) furthermore, we examine which parameters affect this peak. The novel physics has implications for wave statistics for long-crested irregular waves experiencing an abrupt depth transition. We show the connection of the second-order physics at work in the deterministic and stochastic cases: the peak of wave kurtosis and skewness occurs in the neighborhood of the deterministic wave peak in (b) and for the same parameters set composed of a seabed topography, water depths, primary wave frequency and steepness, and bandwidth.