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Extreme nearshore wave amplification over a variable bathymetry

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Storm waves devastate coastlines. These waves are generated out at sea by gale forces in large weather events. As the waves propagate toward land, the effects of dispersion, reflection, interference, and other nonlinear effects combine with the influence of the bathymetry to amplify the waves as they interact with the coastline.

In Ireland, the effects of these waves are seen in coastal erosion and the movement of very large boulders. This can occur on cliff-top platforms up to 50 metres above sea level and over 100 metres inland, with boulders up to 100 tonnes. Detailed mapping of boulder deposits show movements of metres for some of the largest boulders. This suggests the powerful wave conditions during storms.

We model the propagation of wave packets towards cliffs over representative bathymetries of the west coast of Ireland. Numerical simulations show the extreme wave events that can occur - steep, amplified, near-breaking waves hitting the cliffs. We demonstrate the extreme amplification of non-breaking waves that temporarily (during cliff runup) exceed previously well-considered geometric and kinematic limits. These wave conditions are ideal candidates for cliff overtopping surges, causing major inland damage.