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Field measurements of extreme waves in the intertidal zone, Aran Islands, Ireland

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Recent research has shown that interaction with bathymetry can lead to wave height amplification of up to a factor of 12. These extreme waves are important for coastal erosion and very large boulder movement but long-term field records in such high-energy conditions are challenging to acquire, and very scarce. Over three winters (2016-2019) we deployed custom-built pressure sensors in the intertidal zone at three locations, varying from a near vertical cliff to a flat bedrock platform, on the Aran Islands off the west coast of Ireland.

Reconstruction of surface elevation from pressure sensor measurements in shallow water is difficult, and only very recently have methods been derived that accurately reconstruct heights and shapes of progressing waves close to the breaking limit in shallow water. Under these conditions, hydrostatic pressure assumptions do not return accurate wave heights, and non-linearity must be taken into account. The situation becomes even more non-linear, however, if water depth decreases very rapidly, as is common at steep rocky coasts. In these cases, the assumption of progressing waves does not hold, and many waves are breaking. This greatly complicates interpretation of pressure-sensor data from the intertidal zone. In addition, very shallow water (from zero to a few metres) leads to very large ratios of wave height to water depth, beyond standard analytical wave theories. Waves may break onto the sensor or be reflected from cliffs, which is not covered by the progressing-waves assumption. Smoothing or filtering is needed to compensate for spurious oscillations in the higher order corrections, but the frequency of those oscillations can be similar to actual physical wave crests, and distinguishing between them is difficult.

Solving these problems is vital for understanding the interplay between high-energy waves and rocky coastlines. We present attempts to apply surface reconstruction methods to field data and the significant issues/uncertainties encountered. Results highlight the need for independent validation and alternative measurement techniques.