A NEW HYBRID APPROACH IN THE CALIBRATION OF BOUSSINESQ-TYPE WAVE BREAKING MODELS

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INTRODUCTION
Wave breaking is one of the main forcing mechanisms in coastal hydrodynamics, driving mean water levels and currents. Understanding its behavior is key in the goal of improving our comprehension of coastal morphodynamics variations. One way to improve our understanding is through the use of numerical models, such as phase-resolving numerical models based on the Boussinesq equations (Kirby, 2016), which are modified to include breaking by the inclusion of a breaking criteria and a dissipation mechanism. Since there is not a universal law capable of characterizing the wave breaking, the existing models must be calibrated. Traditionally, this is done by adjusting wave height profiles and other free surface statistical parameters without explicitly considering the time-space location and duration of the breaking process. Consequently, it is possible to calibrate a model that accurately represents wave elevation statistics parameters, such as wave height and wave set-up; however, it might not necessarily represent the breaking location-duration and therefore, the forcing.

BACKGROUND
Some researchers have included the initial position of the breaking process in the calibration of Boussinesq-type wave braking models. Okamoto and Basco (2006) proposed a Froude Number based breaking criterion, which was calibrated using only the initial position of the breaking process of regular waves in a constant slope beach, without considering the evolution of the water elevation during breaking. D'Alessandro and Tomasicchio (2008) proposed a new index called Breaking Celerity Index (BCI) as a trigger mechanism for breaking initiation, which was compared to experimental data of regular and irregular wave runs in a barred beach where both the initial position of the breaking process and the free surface elevation evolution were simultaneously recorded in the breaking region. However, a unique initial breaking position was considered for the irregular wave run, which is not a proper representation because in an irregular run waves do not break in the same position. None of the previously mentioned Boussinesq-type breaking models have included either a proper initial position for irregular waves or experimental data of breaking condition during the breaking process from its initiation until its cessation. However, simultaneous measurements of both free surface elevation and the breaking condition along the cross shore position have been recorded using wave gauges and video cameras, respectively (Catalan and Haller, 2008).

METHODOLOGY
We propose a new hybrid approach in the calibration of a Boussinesq-type wave model (Cienfuegos et al., 2010) and by combining both the mean square root wave height (H_{rms}) and the fraction of breaking waves (Q_b), which is defined for each cross shore position as the ratio of the number of breaking waves to the total number of waves. In order to show that using measurements of both the free surface elevation and the breaking condition results in a better parameter selection, two types of calibrations were done: First, the model was calibrated using only measurements from the wave gauges. This calibration was called "traditional calibration". Second, the model was calibrated using both wave gauges and video cameras. This calibration was called "proposed calibration".

EXPERIMENTAL DATA
Experimental data were obtained in the Large Wave Flume (LWF) in the O.H. Hinsdale Wave Research Laboratory at Oregon State University, OR. The experimental runs were performed in a barred profile under both regular and irregular wave conditions. In Figure 1 the bottom profile is shown. Free surface elevation and the breaking location were simultaneously recorded using wave gauges and video cameras, respectively (Catalan and Haller, 2008).

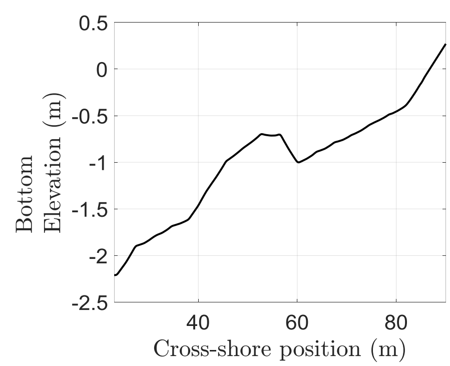

Figure 1 – Flume bottom profile

RESULTS AND DISCUSSION
As part of our results from the irregular wave run, in Figure 2 it can be seen that when choosing different model parameters there is no considerable change in the evolution of the mean wave breaker height, but the fraction of breaking waves presents a noticeable difference. As seen in Figure 3, the proposed hybrid approach allows us to improve the parameter selection of the model in terms of a better prediction of the initial location of the breaking process. However, this approach fails in estimating the maximum number of the fraction of breaking waves at the bar. This presents a challenge to existing wave breaking models, which may need to be adjusted to improve the breaking location estimation, both in terms of an accurate breaking criterion model and a proper breaking wave dissipation model.

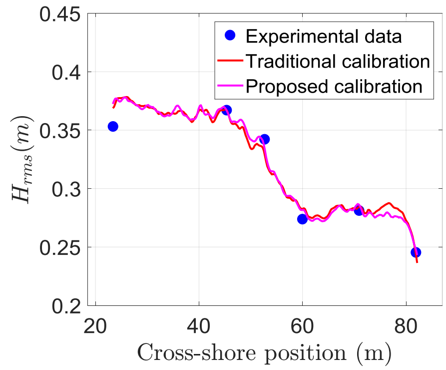

Figure 2 – Spatial evolution of the mean square root wave height (H_{rms})

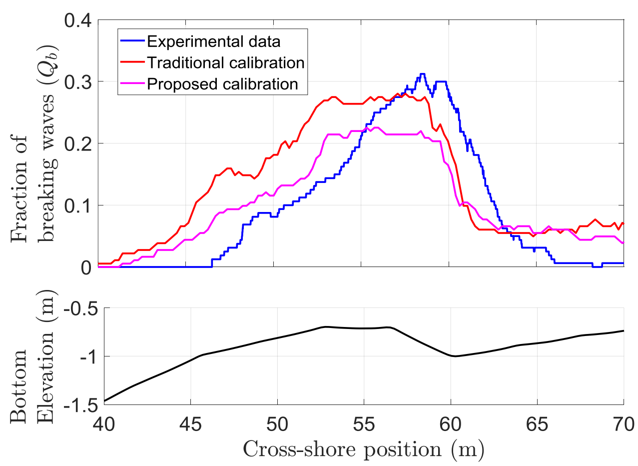

Figure 3 – Spatial evolution of the fraction of breaking waves (Q_b)

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