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Reply on RC2

Chuan Li et al.

Author comment on "Observations of extreme wave runup events on the US Pacific Northwest coast" by Chuan Li et al., Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2020-425-AC2, 2021

We thank the reviewer for their assessment. We recognize that the analysis could be made clearer, further elaborated, and aided by inclusion of additional figures. We aim to do this in our revision. Please see our responses below for some clarifications.

Regarding low frequency moments: we do compare results from m-3 to m0, which shows that m-3 performs better (lines 345-346). We have also tried other spectral moments, such as m-1 and m-2. We can add comparisons between these moments and m-3 in the revision as well. Regarding a non-dimensional proportionality, we have computed a relationship in which both parameters in x and y are in dimensions of m (see attached Figure 1). We note that the relationship is not quite as strong as the dimensional relationship. Nonetheless, we think this shows that a reasonable non-dimensional relationship does exist. We will add this to the revision.

Regarding tide gages: the reviewer is correct that higher frequency water level fluctuations are filtered out. The tide gages samples at 1 Hz and report averages over 1 min. However, the extreme runup events captured on video show that their frequency is much longer than the frequencies of incident waves. As we stated in the paper, the frequency of the extreme runup events in the videos are close to the roughly 5 minutes peaks from the tide gages. We will further clarify this point in our revision.

We appreciate the reviewer's comment regarding our model. We've in fact gone back to the model and improved its formulation due to the reviewer's comments. Instead of using a deep-water formulation for the infragravity waves from offshore to shallow water, we are now using a formulation (also from Longuet-Higgins and Stewart 1962, equation 3.26) that is valid at all water depths:

$$\zeta = - 1/ 2 \, g \, a^2 \, (2c_g / c - 1 / 2) / (gh - c_g^2)$$

where ζ is the infragravity wave water level, g is acceleration of gravity, a is incident wave amplitude, h is water depth, c_g is group celerity, and c is incident wave celerity. We also feel that the description of our model simulation could be made much clearer, which we will do in our revision.

The model is simple in the sense that it is essentially the analytical solution of infragravity wave water level given by Longuet-Higgins and Stewart (1962) using our environmental conditions. Except here we limit the growth rate when incident waves are in shallow

water, per the laboratory results of Battjes et al. (2004) and van Dongeren et al. (2007). Please see Figures 2 and 3 (attached) for results from our model, which we will include in our revised manuscript. Figure 2 shows the incident wave amplitude profile while Figure 3 shows the infragravity wave amplitude profile. We use linear wave theory to compute the incident wave amplitudes, which are then used to calculate radiation stress. The radiation stress is then used in Longuet-Higgins and Stewart's (1962) analytical solution to calculate infragravity wave water levels. The infragravity wave water levels are then used to calculate infragravity wave amplitude (Figure 3). We do not attempt to calculate the infragravity wave amplitude once the infragravity wave is expected to break (based on a wave height to water depth ratio of 0.5, changed from 0.78 in the previous version). The dashed line shows when incident waves reach shallow water. The dotted line shows when incident waves start to break.

As a result of this analysis, we compute maximum infragravity wave heights of roughly 6.5 m and 1.1 m respectively for 25 s and 10 s incident waves. We agree that 6.5 m is a rather large infragravity wave, but we think that a large infragravity is to be expected since the observed extreme runup events were also very large. However, we also feel that our model compares reasonably well against field data. For example, Fiedler et al. 2018 (in their Fig. 2) measured a maximum cross-shore infragravity wave height of close to 0.9 m at roughly 5 m water depth from approximately 10 s and 3 m offshore waves (their Fig. 1). When we ran their case, we computed maximum infragravity wave height of about 1.1 m at roughly 6.3 m water depth.

Please also note the supplement to this comment:
https://nhess.copernicus.org/preprints/nhess-2020-425/nhess-2020-425-AC2-supplement.pdf