Response to comments of Referee 2:
"Runup parameterization and beach vulnerability assessment on a barrier island: a downscaling approach"

(C2000)

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Anonymous Referee #2:

This is a good paper on run-up parametrisation using a combination of statistical and numerical methods. The paper applies existing methodologies to assess the vulnerability of a beach located in North Yucatan (Mexico), the topic is certainly relevant for the wide coastal engineering community.

RESPONSE:
We acknowledge the reviewer for his/her fruitful comments that will contribute to improve the manuscript.

The paper is generally well structured and well written, with the exception of the conclusions that appear to be a summary of the paper rather than drawing actual conclusions.

RESPONSE:
We thank the reviewer for pointing out such drawback in the conclusions. Therefore, the conclusions section will be re-written in the revised version of the manuscript as follows:

"Extreme water levels on a barrier island located on the northern Yucatan peninsula are investigated using a downscaling approach based on wave hindcast information. Wave runup on the study area presents a dependency on offshore wave height and tidal elevation. A new parameterization which incorporates saturation and tidal modulation is derived from the downscaling information. Both downscaling results and the runup parameterization provided similar results in terms of return periods and the storm impact at this location. The uncertainty analysis on the impact of employing wave hindcast information suggests that it does not significantly affects the extreme water level analysis. Future work will be devoted to conduct the model calibration using runup measurements and the inclusion of the storm surge contributions in the extreme water levels. These two aspects need to be addressed in order to achieve a more reliable analysis of beach vulnerability in this area."

However, the paper lacks of an uncertainty analysis. In particular given the discrepancy between the hindcast and ADCP measurement at NODE12972 it will be interesting to know the impact of the overestimation of Hs by the numerical model on the computation of the paper. Can this be discussed and possibly quantified?

RESPONSE:
We thank the referee for rising this issue which deserves our attention. As the reviewer noticed, there are important discrepancies between in situ data and wave hindcast information. The differences can be ascribed to the relative coarse resolution of the wind data employed to generate the 30-year wave hindcast by Appendini et al. [2013, 2014], for resolving wave generation by local winds and the lack of high-resolution bathymetry available for this area in the ETOPO1 [Amante and Eakins (2009)]. Figures R2.1 and R2.2 clearly illustrate the wave hindcast potential and limitations under different wave conditions.

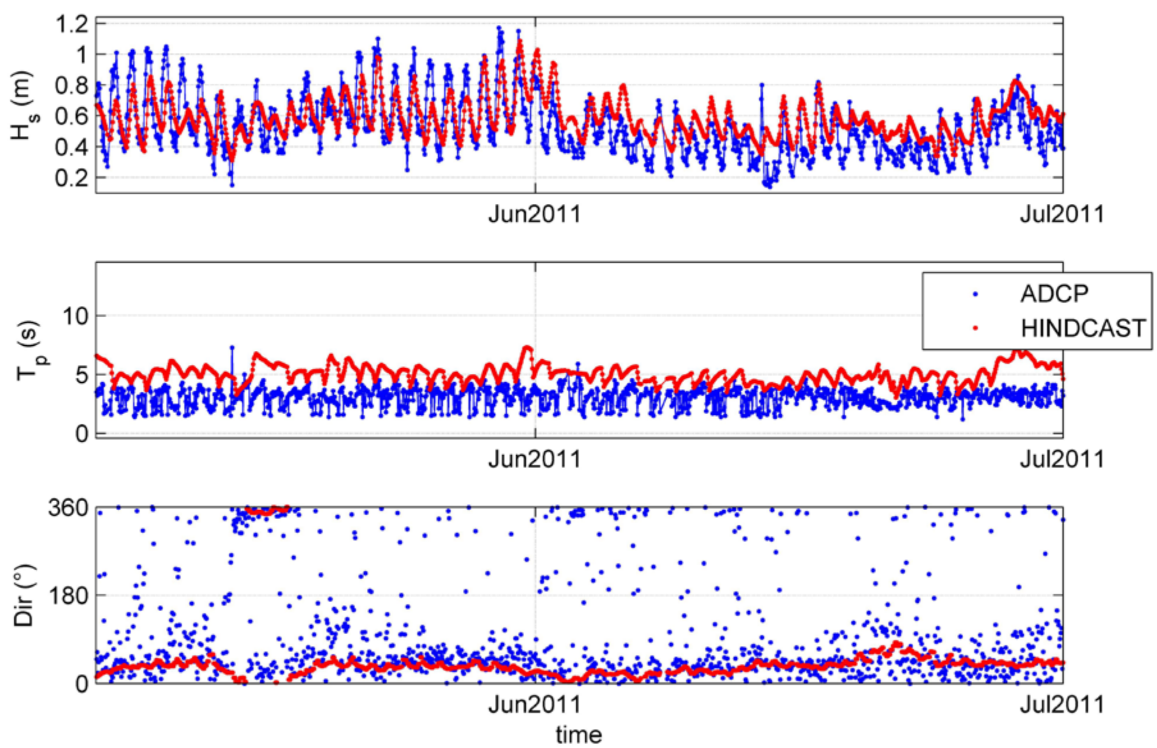

Figure R2.1.- Mean wave conditions associated with sea breezes in the study area.

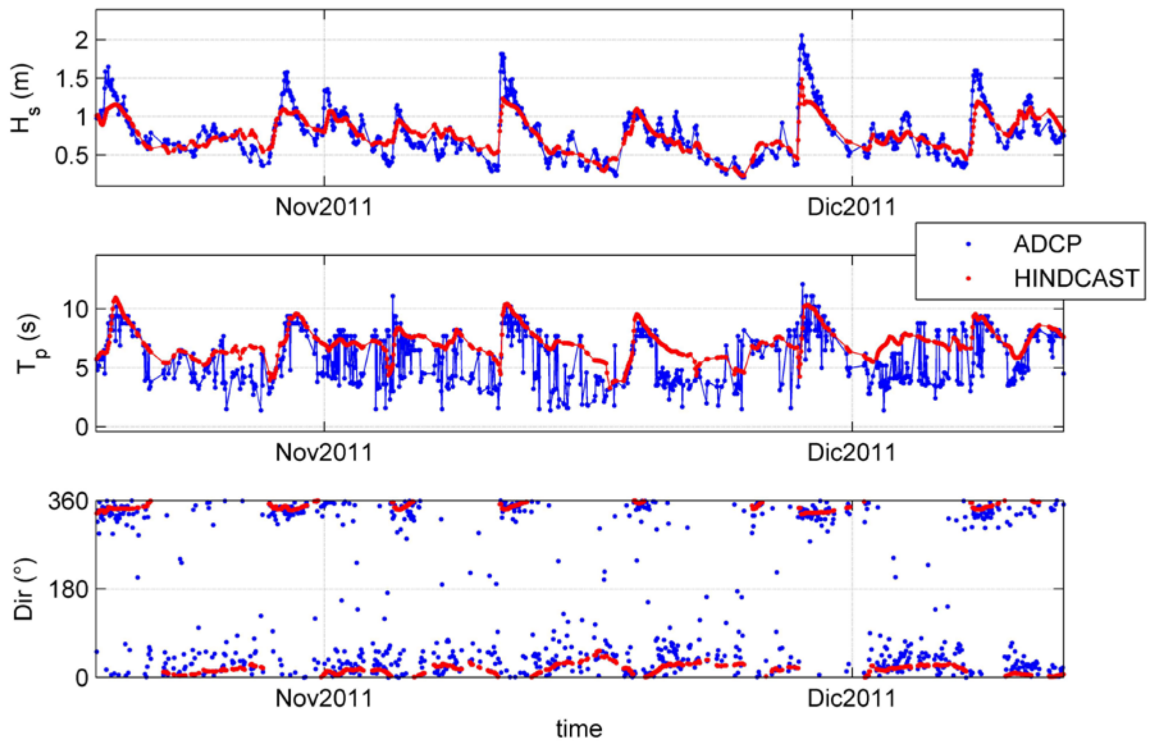

Figure R2.2.- Extreme wave conditions associated with Nortes in the study area.

Figure R2.1 shows the model-data comparison at the ADCP location during mean sea-breeze conditions associated to local winds. Wave height, peak period, and wave direction are clearly not well reproduced by the wave hindcast information due to the aforementioned limitations. For instance, the peak period is signficantly overpredicted (Figure R2.1, mean panel) and wave direction corresponding to seaward wave propagation (Figure R2.1, lower panel), associated to land-breezes, is not resolved by the wave hindcast. However, for wave conditions associated to large-scale events, as winter storms (Nortes) occurring at this area, the wave hindcast improves the prediction for wave height, peak period, and wave direction (see Figure R2.2) but consistently undepredicts the maximum wave height during the peak of the storms (Figure R2.2, upper panel).

In order to evaluate the impact associated to driving the model with wave hindcast information, we employed the same methodology followed in this work but using the ADCP wave data. We selected 60 conditions for the 3-year measurements period in order to conduct the simulation of beach runup. The same analysis is conducted using wave hindcast information during this 3-year period. Figure R2.3 shows a comparison between reconstructed time series of R2% obtained from measured and hindcasted wave data for the same time period which was used in Figure 3 in the discussion paper. Wave runup obtained from hindcasted wave data is poorly reproduced for less energetic conditions but satisfactorily describes the *upper envelope* of wave runup values with respect to measured wave data (Figure R2.3a). Runup estimates seems reliable for storm waves despite differences in offshore wave height (see Figure 3). These differences can be ascribed to the fact that the runup calculations based on hindcast information are compensated by the slight overprediction of the peak wave period. Due to this compensation by the wave period, extreme runup heights retrieved from model runs with the hindcasted data as input, are in good agreement with those retrieved from the model runs with measurements as input (Figure R2.3b). For mean wave conditions, however, the runup is significantly overpredicted.

A summary of the extreme runup statistics are shown in Table R2.1 for all wave conditions and storm conditions. The correlation coefficient for the whole period is very poor (r2=0.43 and rmse=0.23) owing to limitation on the wave hindcast resolution for resolving local processes (i.e., sea/land- breezes) forcing mean wave conditions. On the other hand, the correlation increases significantly (r2=0.80 and rmse=0.16) when constraining the analysis to storm waves only. For storm conditions, relative errors of the runup statistics between hindcast and measured data are smaller than 20% with a relative error of only 4% for to the maximum R2%. The latter suggests that the methodology employed in the present work is valid since we are focused on the study of extreme events. However, the use of high-resolution wind fields for driving wave generation models is necessary for the study of wave runup under mean conditions.

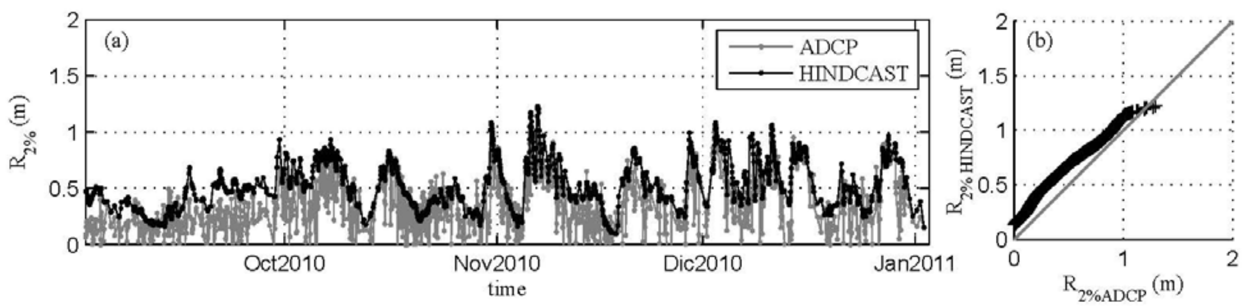

Figure R2.3 (a) Reconstructed timeseries of $R_{2\%}$ for a selected period obtained by using measured (ADCP) and hindcasted wave data and (b) QQ plot showing the comparison between $R_{2\%}$ obtained using hindcasted and measured wave conditions for the whole 3-year period .

Table R2.1.- Extreme runup statistics for measured and hindcasted wave conditions during a 3-year time period (2011-2013). The error analysis and statistics correspond to all wave conditions and only storm conditions.

Ru2% STATISTICS	**(a) All wave conditions**		**(b) Storm ("Norte") conditions only**	
	ADCP	**Hindcast**	**ADCP**	**Hindcast**
r2 (rmse)	0.43 (0.23)		0.80 (0.16)	
Maximum	1.72	1.65	1.72	1.65
Mean	0.25	0.43	0.46	0.55
Median	0.24	0.40	0.45	0.52
STD	0.31	0.30	0.36	0.35

The revised manuscript will include a new subsection in the Discussion section presenting this analysis

In summary the paper requires minor corrections, including a discussion of the uncertainty in the model.

RESPONSE:
Minor corrections and a discussion on the uncertainty will be included in the revised manuscript following the referee's suggestions.

Minor points:
Section 3.7: I wonder if this is needed as it is basically repeating Sallenger (2000) classification. Maybe a table summarising the four conditions would be sufficient.

RESPONSE:
We agree on this with the reviewer. The text in section 3.7 is repetitive and a reference to Sallenger (2000) together with a summarizing table should be sufficient. The text in the manuscript will be revised accordingly and a new table containing the four storm impact levels will be included in the manuscript as follows:

The model defines four storm impact regimes (Table R2.2) depending on the relative height of the storm-induced water level to morphologic characteristics of the beach .These heights are defined as: R_{low} *(the sum of storm surge, astronomical tide, and wave setup),* R_{high} *(the sum of storm surge, astronomical tide, and* $R_{2\%}$*),* D_{high} *(dune crest) and* D_{low} *(dune toe).”*

Table R2.2.- Storm impact scale regimes according to Sallenger (2000) and Stockdon et al. (2007),

Regime	Description
Swash	$R_{high}<D_{low}$
Collision	$D_{high}>R_{high}>D_{low}$
Overwash	$R_{high}>D_{high}$
Inundation	$R_{low}>D_{high}$

Discussion: the future research on this topic should go in Conclusions rather than in discussion.

RESPONSE:
The future research on this topic will be moved to the end of the Conclusions section in the revised manuscript.