MODELING SYNTHETIC WAVE STORMS WITH A REALISTIC SHAPE EVOLUTION: APPLICATIONS TO STORM-INDUCED COASTAL IMPACTS

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ABSTRACT
Coastal risk assessments rely upon the precise quantification of storm-induced coastal impacts. For example, a reliable estimation of coastal flooding and erosion depends on a reliable process-based numerical modeling and the utilization of realistic input climate data, which must include realistic wave energy characterization and an accurate representation of storm shape characteristics. However, although advanced numerical-based models are broadly applied, most of studies focused on assessing future risk in coastal areas arising from elevated sea water levels or alterations in shoreline conditions commonly consider a symmetrical triangular storm profile, characterized by the assumption that the wave energy maxima occurs at the midpoint of the storm duration. This communication presents a new wave storm-based emulator with (1) a multivariate sea-state parameters characterization and (2) realistic storm evolution representation. It is achieved by coupling (1) a multivariate extreme value analysis with the emulation of maxima compound events with large return period values and (2) autoregressive models, to capture time evolution at the storm scale. The methodology has been applied in a coastal location in Spain, showing its applicability to support decision-making in the context of climate change adaptation under deep uncertainty, providing more realistic results. An analysis comparing a traditional approach with the novel storm-based emulator for assessing coastal flooding will also be presented.

INTRODUCTION
Wave storm shape evolution is key aspect for performing a reliable coastal impacts estimation. According to Duo et al. (2020), considering a symmetrical triangular storm profile can induce relative errors in coastal flooding estimation larger than 20%, with a higher tendency towards underestimation. This communication presents a novel storm-based emulator with a realistic storm shape evolution. Taking multivariate wave databases at hourly time-scale (i.e., reanalysis or climate change projections), a better estimation of storm-induced coastal impacts can be performed.

STORM-BASED EMULATOR WITH A REALISTIC SHAPE EVOLUTION
The novel storm-based emulator couples multivariate extreme value analysis (Lucio et al., 2020) and autoregressive models (Solari et al., 2018) to capture changes in wave parameters over storm duration. Copula functions are applied to model relationships between sea-state parameters (H_s at the storm peak, maximum T_p during the storm, wave direction at the storm peak and storm duration). Next, the expected evolution of wave parameters over the duration of a storm is achieved through a two-step process. Firstly, a classification of different normalized storm evolutions is conducted. Secondly, autoregressive vector models are implemented to characterize its stochastic behavior. The methodology was applied in a coastal location on the Maresme Coast in Spain, utilizing the GOW reanalysis database to construct a statistical model for inferring sea storms characteristics. In this case, a real and highly impactful wave storm event that occurred in 2020 was selected as an example (Figure 1). Subsequently, 10,000 synthetic sea storms (ST) have been simulated, showing a good agreement between the observed storm shape and the synthetic storms with a higher probability of occurrence.

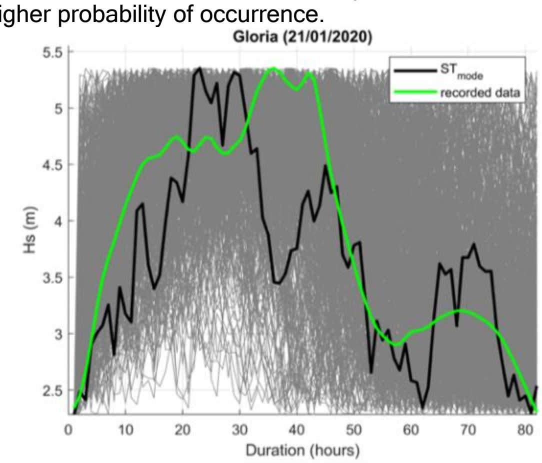

Figure 1 - Green line: Real storm evolution. Grey lines: 10,000 synthetic sea storms. Black line: Synthetic storm (ST) with a higher probability of occurrence.

CONCLUSIONS
This communication introduces a novel storm-based emulator featuring a realistic representation of storm evolution. Given the pivotal role of realistic coastal hazard modeling in facilitating reliable risk assessments, this emulator aims to improve the estimation of storm-induced coastal impacts.

REFERENCES
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