**Compound nearshore extreme events under climate change: A long-term analysis**

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**Abstract**

Coastal systems and low-lying areas are highly exposed to climate change and sea-level rise, triggering impacts with adverse consequences for coastal communities and economic activity. Hazards related to wave climate in a context of climate change are increasing risks derived from coastal flooding, coastal erosion as well as decreasing port competitiveness due to an operability loss. Then, an accurate characterization of wave hazards should be performed prior to evaluate climate change-induced impacts in coastal areas. Such long-term modeling is based on the latest offshore high-resolution climate projections and a reliable description of wave transformation processes from deep water to nearshore. High-resolution climate projections are composed by continuous-time multivariate time series representing offshore wave climate variabilities over fixed temporal windows (past and future time periods) under the current and future climate change scenarios. In particular, high-resolution climate projections applied in this work are composed by five general circulation models (GCMs) dynamically modeling at hourly time-scale offshore wave climate in the baseline and RCP4.5 and RCP8.5 scenarios, both in the short-term (mid-century) and long-term (end of the century). By, firstly, applying advanced statistical techniques to capture statistical relationships between extreme climate drivers in an offshore location, and secondly, applying a high-fidelity wave propagation strategy which includes sea-level rise evolution in time, downscaled nearshore extreme events are obtained. Because such time-series keep the multivariate behavior between climate drivers at the same time that SLR-induced wave transformation processes are taken into account (i.e. wave breaking), a realistic representation of future joint probability of occurrence of wave extreme events at coastal areas can be performed. It is motivated because according to Zscheischler et al. (2018) and Wahl et al. (2015), not considering combination of climate drivers could involve an underestimation of impacts posed by climate change. To overcome such issue, a novel trivariate joint probability modeling of extreme events is presented. It involves characterizing the relationships of dependency between the significant wave height, the peak wave period and the still-water level as the main climatic drivers of the coastal processes to be studied (i.e. wave run-up or armor layer stability). It allows understanding how future wave climate events evolves as climate change progresses instead of focusing on an isolate climate driver. During the talk, a representative case study on the Spanish coast will be used for illustrating how implementing the proposed three-dimensional frequency analysis. Obtaining nearshore extreme time-series allows calculating the future multivariate distributions as well as the related probability of occurrence. It allows moving from traditional univariate and bivariate analysis to a multidimensional approach.