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A climate-based multivariate extreme emulator of met-ocean-hydrological events for coastal flooding

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Atmosphere-ocean general circulation models (AOGCMs) are useful to analyze large-scale climate variability (long-term historical periods, future climate projections). However, applications such as coastal flood modeling require climate information at finer scale. Besides, flooding events depend on multiple climate conditions: waves, surge levels from the open-ocean and river discharge caused by precipitation. Therefore, a multivariate statistical downscaling approach is adopted to reproduce relationships between variables and due to its low computational cost.

The proposed method can be considered as a hybrid approach which combines a probabilistic weather type downscaling model with a stochastic weather generator component. Predictand distributions are reproduced modeling the relationship with AOGCM predictors based on a physical division in weather types (Camus et al., 2012). The multivariate dependence structure of the predictand (extreme events) is introduced linking the independent marginal distributions of the variables by a probabilistic copula regression (Ben Ayala et al., 2014).

This hybrid approach is applied for the downscaling of AOGCM data to daily precipitation and maximum significant wave height and storm-surge in different locations along the Spanish coast. Reanalysis data is used to assess the proposed method. A commonly predictor for the three variables involved is classified using a regression-guided clustering algorithm. The most appropriate statistical model (general extreme value distribution, pareto distribution) for daily conditions is fitted. Stochastic simulation of the present climate is performed obtaining the set of hydraulic boundary conditions needed for high resolution coastal flood modeling.

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