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Wave climate projections using statistical downscaling for the Gold Coast (Australia)

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Projections of future wave climate at the regional level are essential to develop climate change adaptation strategies for coastal areas. In our research we looked at wave climate projections along the Gold Coast, with a detailed assessment for Palm Beach, one of the most problematic coastal stretches. We adopted a statistical downscaling approach which is based on the statistical relationship between a local wave variable (predictand) and a global atmospheric variable (predictor). This is an efficient method to project regional wave climate based on the output of General Circulation Models (GCMs) forced by different emission scenarios, the main source of information of possible future climates.

The methodology used relies on data availability for the area of study. In this case we used sea level pressure fields from 1 h x 0.5º resolution CFSR reanalysis to define the predictor. A CSIRO 1º spatial resolution wave hindcast was chosen to define the predictand; this was particularly reliable due to its long-term directional spectral information. A hybrid methodology was used before statistical downscaling to transfer wave climate to the study area as the CSIRO wave reanalysis was not available at high resolution in shallow water.

In our method, the predictor is defined by the dynamical spatial patterns of atmospheric conditions considering the local area and the wave generation area in order to take into account the swell and sea wave components. A daily atmospheric field database is developed and classified in circulation patterns (weather types) using PCA and the k-means algorithm. The corresponding predictand are the sea states at the coastal area (Hs, Tm, and directional spectra). The total wave distribution at the target point can be reconstructed from the distribution of sea states and its corresponding probability of each weather type.

This method allows estimating how local wave climate can be affected by changes on the atmospheric patterns, calculating the probability of the climate patterns from the carbon-forced GCM outputs for the future. Results of future wave climate projections for the Gold Coast are then analysed and discussed.