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A comparison of dynamical and statistical downscaling methods for regional wave climate projections along French coastlines.

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Wave climate forecasting is a major issue for numerous marine and coastal related activities, such as offshore industries, flooding risks assessment and wave energy resource evaluation, among others. Generally, there are two main ways to predict the impacts of the climate change on the wave climate at regional scale: the dynamical and the statistical downscaling of GCM (Global Climate Model).

In this study, both methods have been applied on the French coast (Atlantic , English Channel and North Sea shoreline) under three climate change scenarios (A1B, A2, B1) simulated with the GCM ARPEGE-CLIMAT, from Météo-France (AR4, IPCC). The aim of the work is to characterise the wave climatology of the 21st century and compare the statistical and dynamical methods pointing out advantages and disadvantages of each approach.

The statistical downscaling method proposed by the Environmental Hydraulics Institute of Cantabria (Spain) has been applied (Menendez et al., 2011). At a particular location, the sea-state climate (Predictand Y) is defined as a function, Y=f(X), of several atmospheric circulation patterns (Predictor X). Assuming these climate associations between predictor and predictand are stationary, the statistical approach has been used to project the future wave conditions with reference to the GCM.

The statistical relations between predictor and predictand have been established over 31 years, from 1979 to 2009. The predictor is built as the 3-days-averaged squared sea level pressure gradient from the hourly CFSR database (Climate Forecast System Reanalysis, http://cfs.ncep.noaa.gov/cfsr/). The predictand has been extracted from the 31-years hindcast sea-state database ANEMOC-2 performed with the 3G spectral wave model TOMAWAC (Benoit et al., 1996), developed at EDF R&D LNHE and Saint-Venant Laboratory for Hydraulics and forced by the CFSR 10m wind field. Significant wave height, peak period and mean wave direction have been extracted with an hourly-resolution at 110 coastal locations along the French coast. The model, based on the BAJ parameterization of the source terms (Bidlot et al, 2007) was calibrated against ten years of GlobWave altimeter observations (2000-2009) and validated through deep and shallow water buoy observations.

The dynamical downscaling method has been performed with the same numerical wave model TOMAWAC used for building ANEMOC-2. Forecast simulations are forced by the 10m wind fields of ARPEGE-CLIMAT (A1B, A2, B1) from 2010 to 2100. The model covers the Atlantic Ocean and uses a spatial resolution along the French and European coast of 10 and 20 km respectively. The results of the model are stored with a time resolution of one hour.

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