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Present and future wave climate analysis along the French mainland Atlantic coast, using wave dynamical downscaling

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Change in ocean wave climate has many implications regarding offshore and coastal hazards. Therefore, knowledge of past and future wave conditions is essential. This study focuses on the Bay of Biscay and more particularly on the French mainland Atlantic coast, where datasets of wave conditions were acquired by buoys (Biscay buoy, CNRM, 1998-2010; Biscarrosse buoy, CELM, 1980-2010, ...), modelling (ANEMOC, 1979-2002; Dodet et al. (2010), 1953-2009) and modelling including data-assimilation (ERA-40 reanalysis/ECMWF, 1957-2002). However, present collected data does not provide sufficient long-term and high-resolution information for studying past and future wave climate along the Aquitanian coast (France).

A dynamical downscaling approach is then applied to convert available global wind fields into nearshore wave conditions. Waves are generated and propagated all over the North Atlantic Ocean (first grid: spatial resolution 0.5°) to the Bay of Biscay (second grid: spatial resolution 0.1°) using the WAVEWATCH III (NOAA/NCEP) model with Ardhuin et al. (2010) parameterization. These ocean-scale simulations provide the wave boundary conditions for a third grid encompassing the French Atlantic coast with higher resolution (1 km). For this last grid, the code SWAN is used, taking into account the bottom effects. This wave modelling system, forced by the ERA-40 reanalysis wind fields (1.125° grid, every 6 hours, from 1958 to 2001) allows generating and propagating waves till the Aquitanian coast. It is calibrated and validated against eleven oceanic and coastal buoys measurements.

This modelling system provides wave fields from 1958 to 2001, covering the Bay of Biscay. Offshore and nearshore wave fields are analysed in terms of multi-decadal trends and inter-annual variability. No significant trends are computed in the Bay of Biscay over the period 1958-2001, except for the summer wave heights from 1970 to 2001 (+0.5 cm/y at Biscay buoy). The inter-annual variability of wave heights, periods and directions in the Bay of Biscay is investigated in terms of correlation with Northern Hemisphere teleconnection patterns indices. It highlights a strong correlation with the Northern Atlantic Oscillation and the East Atlantic Pattern indices.

Concerning future wave climate, the RETIC simulations (performed with the atmospheric general circulation model ARPEGE) provide future wind fields for a present control period and three emissions scenarios (A1B, A2 and B1). Potential future wave climates are modelled, using these wind fields with the above system. The comparison of the Bay of Biscay wave fields for different emissions scenarios and regarding the present wave climate will be interesting to evaluate the potential impact of the climate change on the French mainland Atlantic coast.

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