# Ensemble estimates of future climate from the COWCLIP dataset

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Multiple coupled interactions characterize the atmosphere and the oceans driving many aspects of geophysical processes, and ultimately affecting the climate. Understanding potential changes in wind wave extremes is of paramount importance to assess future potential impacts on coastlines, marine operations and construction. A climate change signal has been thoroughly demonstrated in the mean values of surface winds and wind waves, but a reliable analysis of changes in the extremes is still missing.

Extreme Value Analyses (EVA) are commonly used for long-term estimates of extreme ocean storms, however the climate is usually considered stationary. Furthermore, common statistical approaches are uncertain due to short and inhomogeneous time series. Models are incapable of accurately representing extreme events, and wind and wave observations that are used to calibrate the models, are often biased at the extremes. Therefore, these uncertainties hinder a robust evaluation of long term return periods, with low confidence in the results.

The present work deals with these uncertainties, applying an innovative ensemble technique for the EVA of significant wave height (SWH) 100 year return period differences between the historical (1979-2005), and the end of the 21st Century (2081-2100) climates. The dataset consists of an ensemble of global wave model -WAVEWATCH III- SWH. These are outputs of the wave model forced with 7 different Global Climate Model surface wind fields from the Climate Model Intercomparison Project phase 5 (CMIP5). The inter-model independence and identical distribution of the extremes allow common statistical approaches. Thus, the SWH highest peaks are pooled from the 7-model ensemble and the resulting data series is representative of a time interval larger than the return period sought, strongly increasing confidence levels in the estimates.

An ensemble Peak Over Threshold (ensPOT) approach and an ensemble Annual Maxima approach (ensAM) have been applied. The RCP8.5 high emission scenario (CMIP5), shows similar trends in the SWH for extended areas of the oceans, with a distributed increase of wave height extremes particularly in the Southern Ocean, arguably related to an increase in frequency of the extreme events. The regions of the global oceans affected by local climate variability -such as Tropical Cyclones-, still present high uncertainty due to model incapability of representing these phenomena at current resolution. However, the constant improvement of global models and their progressively finer resolution will further increase the level of confidence using this approach.