

FUTURE WAVE CLIMATE IN THE MEDITERRANEAN SEA FROM AN ENSEMBLE OF 33 GCM-RCMS

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INTRODUCTION

The generation and propagation of waves towards the coastal regions during storm events, in combination with storm surges, are a major coastal hazard. Although the Mediterranean Sea is characterized by a fetch-limited environment, the generation and/or passage of extra-tropical cyclones over its surface often originates powerful waves. An illustrative example includes recorded significant wave heights higher than 8 m during the Gloria storm in 2020 (Amores et al., 2020), that caused extensive damage in the eastern coasts of Spain. As climate numerical models consistently converged towards a global warming climate over the past few decades, it is thus crucial to evaluate how wave climate will be responding to future climate conditions.

This study investigates the wave climate projected across the Mediterranean region using an ensemble of high-resolution wave numerical simulations of unprecedented size.

DATA AND METHODS

The wave numerical simulations were forced using 16 GCM-RCMs of the European Coordinated Regional Climate Downscaling Experiment (EURO-CORDEX), providing wind fields with 3-h (7 simulations) and 6-h (26 simulations) temporal resolutions and 0.11° (~12.5 km) spatial resolution, for both the historical and future period (continuously from 1970 to 2100). The wave generation and propagation were performed integrating WaveWatch III (version 5.16; The WAVEWATCH III®Development Group 2019; hereinafter WW3) and SCHISM (Zhang et al., 2016) spectral wave models. These simulations (indicated in Table 1) are combined with the 17 EURO-CORDEX GCM-RCMs dataset from Lira-Loarca et al. (2023), resulting in an ensemble of 33 GCM-RCMs wave numerical simulations. Outputs provide wave bulk parameters at approximately 10 km spatial resolution and 3-h temporal resolution (1-h for the 3-h forcing wind fields). The assessment of the overall future wave climate is performed through the examination of the seasonal variability, by considering the December-February (Winter), March-May (Spring), June-August (Summer), and September-November (Fall) along with wave storminess, and changes in 100-year return levels by mid and end century. The return level computation is performed fitting a Generalized Pareto Distribution (GPD) to a set of exceedances over a threshold, following “Automated threshold selection technique” developed by Thompson et al. (2009), based on the stability of GPD parameters (scale and shape), and aiming at reducing the degree of interpretation on the location parameter. Furthermore, we incorporate the inherent variability within the ensemble to characterize the outcomes.

GCM	RCM	Wave model (dt)
CNRM-CERFACS CNRM-CM5	RACMO22E	WW3 (6)
MOHC-HadGEM2- E	RACMO22E	WW3 (6)
MPI-M-MPI-ESM-L	RACMO22E	WW3 (6)
NCC-NorESM1-M	RACMO22E	WW3 (6)
CNRM-CERFACS	COSMO- crCLIM-v1-1	SCHISM (6)
NCC-NorESM1-M	REMO2015	SCHISM (6)
IPSL-IPSL-CM5A- MR	REMO2015	SCHISM (6)
MPI-M-MPI-ESM- LR	RegCM4-6	SCHISM (6)
MPI-M-MPI-ESM- LR	COSMO- crCLIM-v1-1	SCHISM (6)
CNRM-CERFACS- CNRM-CM5	ALADIN63	SCHISM (3)
CNRM-CERFACS- CNRM-CM5	REMO2015	SCHISM (3)
CNRM-CERFACS- CNRM-CM5	RegCM4-6	SCHISM (3)
IPSL-IPSL-CM5A- MR	REMO2015	SCHISM (3)
MOHC-HadGEM2- ES	ALADIN63	SCHISM (3)
MPI-M-MPI-ESM- LR	RegCM4-6	SCHISM (3)
NCC-NorESM1-M	ALADIN63	SCHISM (3)

Table 1: Additional GCM-RCMs simulations to the Lira-Loarca et al. (2023) dataset.

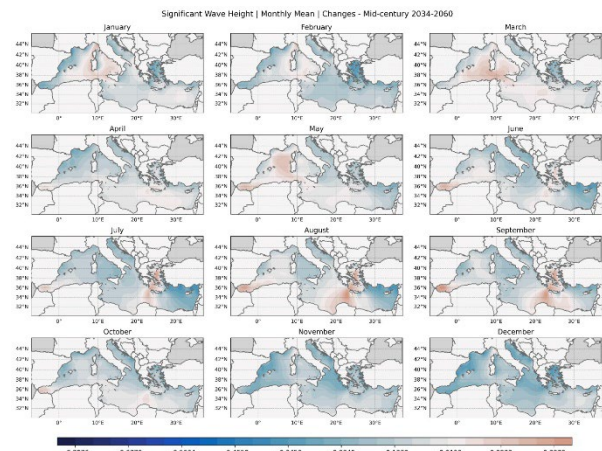


Figure 1 - Changes in Monthly mean of Significant wave height between the historical period (1979-2005) and mid-century (2034-2060)

PRELIMINARY RESULTS

Overall, first results suggest a limited model consensus in some areas of the Mediterranean, showing higher dispersion between models than in the projected changes towards the end of the century. Despite this, most regions exhibit significant multi-model agreement, for instance indicating a reduction of the wave climate intensity in winter towards the end of the century (see Figure 2), leading to reduced significant wave height return levels.

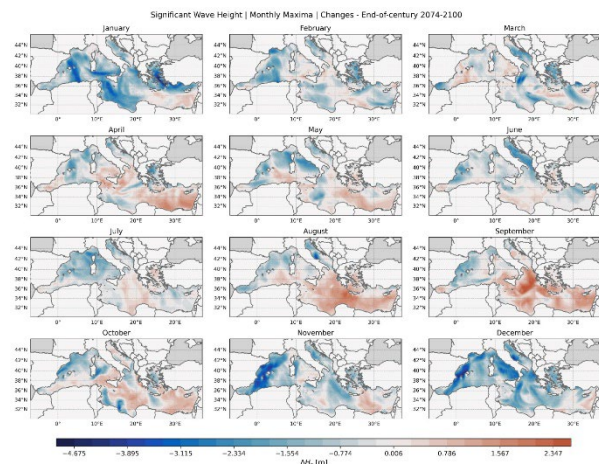


Figure 2 - Changes in Monthly max of Significant wave height between the historical period (1979-2005) and end-century (2074-2100)

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