A WAVE HINDCAST FOR THE GREAT BAY AREA (CHINA) BASED ON WWMIII WAVE MODEL

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INTRODUCTION
Hong Kong is a dynamic coastal city located in the southern part of China, adjacent to the South China Sea. As a densely populated urban area, Hong Kong is highly vulnerable to the impacts of coastal hazards, including waves, storm surges, and sea-level rise. The study of waves is therefore of critical importance for understanding and mitigating the risks associated with these hazards. Hong Kong waters are characterized by a complex coastline, with numerous bays, inlets and islands. The territory encompasses a total area of approximately 1,100 square kilometres, and is home to over 7 million people. Hong Kong is also an important hub for shipping and commerce, with one of the busiest container ports in the world. The main objective of this study is to build, validate a hindcast wave climate dataset of the past 52 years and assess the energy content of the domain for potential renewable energy exploitation. The wave hindcast will cover part of the South China Sea and the Great Bay Area (pearl River Estuary and the Hong Kong Waters) and will represent an important dataset for several future studies for this area (e.g. coastal structure designs, costal adaptation projects).

METHODS
In this research, we implemented SCHISM (Semi-implicit Cross-scale Hydroscience Integrated System Model, Zhang et al., 2016) and WWM III (Wind-Wave-Model, Roland,2008for simulating wind generated waves. The simulation outputs are then compared to the main wave parameters (spectral significant wave height, mean wave direction and peak period) recorded by the only two existing wave gauge stations in Hong Kong: West Lamma Station (114.076701°, 22.220764°) and Kau Yi Chau Station (114.064397°, 22.264870°). Along-track altimeter data are also considered in order to better assess the quality of the results. A sensitivity analysis was performed varying the mesh size (minimum mesh size from 200 m to 1500 m close to the coastlines), the integration time of the wave module and the set of parameters for the source terms. The model is forced with wind data coming from the ERA5 dataset and bias-corrected with altimeter wind data from the IFREMER dataset. In Figure 1 the full domain is shown together with a zoom of the Hong Kong Waters.

RESULTS AND DISCUSSION
A significant part of the study addressed the validation of the model, which was performed by comparing the results of a set of simulations with seven events having a time window of approximately two months that occurred between 1998 and 2020. Several statistics were computed to evaluate the accuracy of the numerical simulations using the significant wave height (H_{m0}) and the peak period (T_P) as target variables as suggested by Mentaschi et al., 2013 and Mentaschi et al., 2023. In all simulations the correlation coefficient for H_{m0} was found between 0.68 and 0.9, whereas a lower correlation is found for the peak period. In the latter case, we noticed that the wave buoy measurements showed a cut for the lower periods that might have influenced the overall comparison.

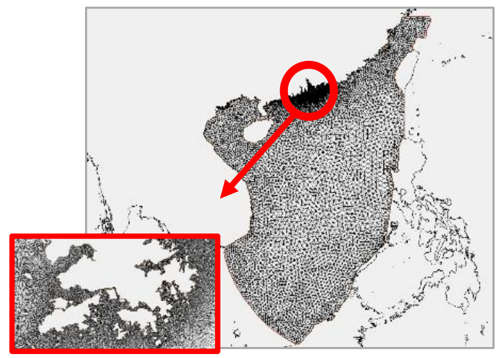

Figure 1. Study area and details in the Hong Kong region.

In conclusion, the comparisons of wave height show a good agreement with high correlation coefficients even though peak values are underestimated. Simulated peak wave periods follow the mean pattern of the observations however, wave stations don't seem to capture values below a certain threshold (~2s-3s). Mean wave direction outputs show discrepancies probably caused by the coarsening of the mesh and onset of boat wakes. Once the model was validated, we produced a high-resolution hindcast between 1980 and 2022 which is needed in order to identify the optimal locations for renewable energy production.

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