The marine and coastal hazards of Mediterranean cyclones

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The correct reproduction of sea-level and wave dynamics during extreme marine events is crucial for evaluating and managing the storm impact. In this work, we use an unstructured and coupled hydrodynamic-wave modelling system applied to the Mediterranean Sea for evaluating the impact of cyclones - in terms of sea level and waves - in both the open sea and the near-shore regions. The adopted modelling system comprises the SHYFEM hydrodynamic model, two-way coupled with the WW3 wave model, thus accounting for the wave-current interaction in deep and shallow waters. The hydrodynamic and wave numerical computations are performed on the same spatial domain representing the Mediterranean Sea using an unstructured grid with a resolution varying from 10 km in the open sea to less than 1 km at the coasts. A 1994-2020 hindcast simulation is performed using the Copernicus European Regional ReAnalysis (CERRA) as meteorological forcing. The hindcast is extensively validated against tide gauges, wave buoys, and satellite-borne instruments showing a good performance for specific storm events and mean conditions in different areas of the Mediterranean Sea. The sea level and wave results have been analysed for more than 1100 cyclones allowing the evaluation of storm impact indicators of each single event. The processed results are then used to classify the Mediterranean cyclones by their marine impact. To better characterise the impact of the most extreme cyclones, we performed additional numerical experiments forcing the ocean models with high-resolution (2.8 km resolution domain following the cyclone centre) WRF surface forcing.