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Wave climate extremes from the Sea State CCI satellite data

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The knowledge of ocean extreme wave climate is of significant importance for a number of coastal and marine activities (e.g. coastal protection, marine spatial planning, offshore engineering). This study uses the recently released Sea State CCI v1 altimeter product to analyze extreme wave climate conditions at global scale. The dataset comprises 28-years inter-calibrated and denoised significant wave height data from 10 altimeter missions.

First, a regional analysis of the available satellite information of extreme waves associated with both, tropical and extratropical cyclones, is carried out. As tropical cyclones, we analyze two intense events which affected the Florida Peninsula and Caribbean Islands: Wilma (in October 2005) and Irma (in August 2017) hurricanes. As extratropical cyclones, we focused on the extreme waves during the 2013-2014 winter season along the Atlantic European coasts. The extreme waves associated with these events are identified in the satellite dataset and are compared with in situ and high-resolution simulated data. The analysis of the satellite data during the storm tracks and its comparison against other data sources indicate that satellite data can provide added value for the analysis of extreme wave conditions that caused important coastal damages.

After assessing the quality of extreme wave data measured by altimeters from this regional analysis, we explore a method to characterize wave height return values (e.g. 50yr return period significant wave height) from the multi-mission satellite data. The method is validated through comparisons with return values estimated from long-term wave buoy records. The extreme analysis is based on monthly maxima of satellite significant wave height computed over marine areas of varying extensions and centered on a target location (e.g. the wave buoy location for comparison and validation of the method). The extension of the areas is defined from a seasonal study of the spatial correlation and the error metrics of the satellite data against the selected coastal location. We found a threshold of 0.85 correlation as the isoline to select the satellite data subsample (i.er. larger areas to select satellite maxima are found during winter seasons). Finally, a non-stationary extreme model based on GEV distribution is applied to obtain quantiles of low probability. Outcomes from satellite data are validated against extreme estimates from buoy records.