LONGTERM TRENDS OF THE WAVE CLIMATE OFF THE COAST OF ROME

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Wave statistics are essential for the correct design of any coastal and harbour project. Their definition has improved significantly in the last decades due to accurate extended buoy records and improved spectral synoptic hindcasting models. Amongst others (www.dicca.unige.it/meteocean/model.html) (Mentaschi et al, 2013), the reliable Copernicus ECMWF ERA5 spectral model (WW3) is now available over the Mediterranean Sea on hourly basis since 1959 with a mesh of 50 km. The coast near Rome in the Lazio Region is exposed to the semiclosed microtidal Tyrrhenian Sea with larger fetches from the southern sector. Prevailing winds come instead from the W and NW where fetches are smaller due to the natural protection of the two big islands of Corse and Sardinia. Various accelerometric buoys have been operating in different periods (Fig. 1) and these data have been used for an accurate calibration of the ERA5 model combined with SWaN for nearshore wave transfer with 10 km resolution (Bellotti et al. 2021).

Fig. 1 - Buoy locations, grid points for DICCA and ERA5

Excellent comparison of observed and predicted synchronous hourly wave parameters (Hs, Tp, Dir) is shown in Fig. 2 for the specific site of Civitavecchia. Moreover a specific detailed calibration has been carried out for the extreme storm peaks (Hs>3 m) in an asynchronous way (within a time window of 48 hours) for a point off Civitavecchia (#1933 at -125m): the data of 49 independent storm peaks measured at six nearby buoys operating in the period 1980-2020 (suitably transferred to the same point) have been correlated with the corresponding model peak, showing an average difference of only 4%, while for DICCA data it was >10% (Fig. 3).

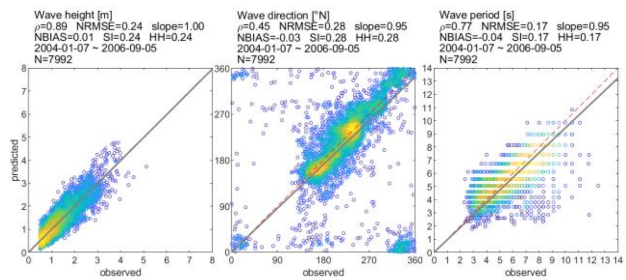

Fig. 2 - Comparison of measured (RON) and predicted (with combined ERA5+SWAN models) wave parameters Hs, Tp, Dir at Civitavecchia (adapted from Bellotti et al., 2021)

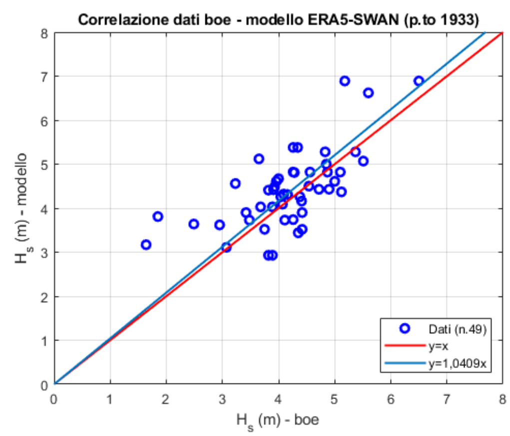

Fig. 3 - Correlation of model/measured("boe") storm peaks off Civitavecchia 1979-2020 (adapted from Bellotti et al., 2021)

Then the full set of 109 calibrated hindcasted storm peaks at the nearshore point CIV2 (-40m) have been statistically analyzed, also dividing the storms into the two main sectors. Some results are shown in (Fig. 4). It is interesting to note the three largest peaks with Hs>5 m occur regularly every 20 years and two of these three peaks come from the "secondary" Southern sector (170-225°N).

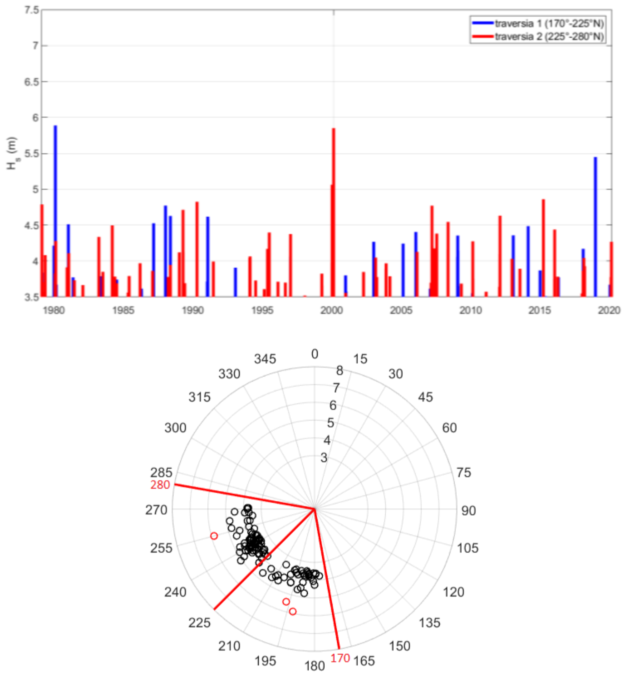

Fig. 4 - Temporal (up) and polar (down) distribution of 109 independent storm peaks Hs>3.5 m off Civitavecchia (CIV2 at -40m) in the period 1979-2020, divided in the two sectors.

Moreover the occurrence of storm waves with Hs>4m over 4 consecutive decades is shown to be variable and cyclical in terms of direction (Fig. 5).

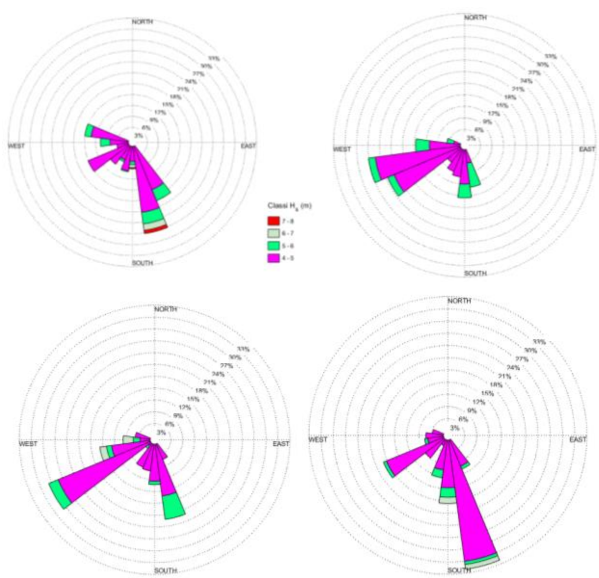

Fig. 5 - Extreme wave climate off Civitavecchia in the decades 1979-88, 89-98, 99-08, 09-18 (Hs>4 m)

Extending the analysis to the 64 year period 1959-2023, the distribution of yearly seasonal peaks shows that the most severe fall/winter storms (from October to April) are generally decreasing in intensity, while they tend now to occur more frequently in the "calm" summer months (from May to September) as shown in Fig. 6. In particular the climate change seems to increase the frequency and intensity of summer tropical cyclones ("Medicanes") with consequent unexpected storms during the good season when coastal works are active and vulnerable.

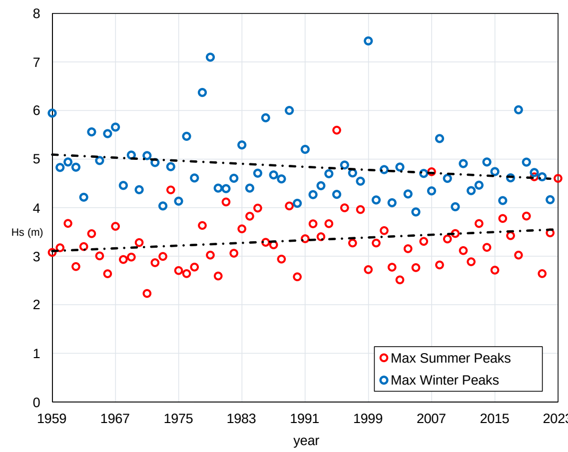

Fig. 6 – Comparison of summer and winter peak distributions.

As shown in Fig. 7 the trend in net wave energy flux since 1959 appears to be decreasing in intensity too

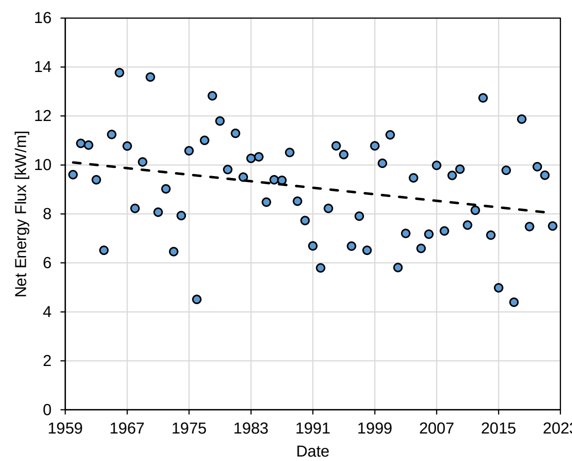

Fig. 7 – Net wave energy flux off Civitavecchia (1959 - 2023)

REFERENCES

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