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Trend analysis of the wave storminess: the wave direction

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Climate change has an important role in the current scientific research because of its possible future negative consequences. Concerning the climate change in the coastal engineering field, the apparent sea level rise is one of the key parameters as well as the wave height and the wave direction temporal variations.

According to the IPCC (2007), during the last century the sea level has been increasing with a mean rate of 1.7 ± 0.5 mm/yr. However, at local/regional scale the tendency significantly differs from the global trend since the local pressure and wind field variations become more relevant. This appears to be particularly significant in semi-enclosed areas in the Mediterranean Sea (Cushman-Roisin et al., 2001). Even though the existing unsolved questions related to the sea level rise, the uncertainty concerning the wave height is even larger, in which stormy conditions are especially important because they are closely related to processes such as coastal erosion, flooding, etc. Therefore, it is necessary to identify possible existing tendencies of storm related parameters.

In many studies, only the maximum wave height and storm duration are analysed, remaining the wave direction in a second term. Note that a possible rotation of the mean wave direction may involve severe consequences since most beach and harbour defence structures have been designed assuming a constant predominant wave incidence. Liste et al. (2004) illustrated this fact with an example in which a rotation of only 2 degrees of the mean energy flux vector could produce a beach retreat of 20 m. Another possible consequence would be a decrease of the harbour operability: increased frequency of storms in the same direction as the harbour entrance orientation would influence the navigability.

The present study, which focuses in the Catalan coast (NW Mediterranean Sea), aims to improve the present knowledge of the wave storminess variations at regional scale, specially focusing on the wave directionality. It is based on 44 year hindcast model data (1958-2001) of the HIPOCAS project, enabling to work with a longer time series compared to the existing measured ones. 41 nodes of this database are used, containing 3 hourly simulated data of significant wave height and wave direction, among other parameters.

For storm definition, the Peak Over Threshold (POT) method is used with some additional duration requirements in order to analyse statistically independent events (Mendoza & Jiménez, 2006). Including both wave height and storm duration, the wave storminess is characterised by the energy content (Mendoza & Jiménez, 2004), being in turn log-transformed because of its positive scale. Separately, the wave directionality itself is analysed in terms of different sectors and approaching their probability of occurrence by counting events and using Bayesian inference (Agresti, 2002). Therefore, the original data is transformed into compositional data and, before performing the trend analysis, the isometric logratio (ilr) transformation (Egozcue et al., 2003) is done.

In general, the trend analysis methodology consists in two steps: 1) trend detection and 2) trend quantification. For 1) the Mann Kendall test is used in order to identify the nodes with significant trend. For these selected nodes, the trend quantification is done, comparing two methods: 1) a simple linear regression analysis complemented with the bootstrap technique and 2) a Bayesian analysis, assuming normally distributed data with linearly increasing mean.

Preliminary results show no significant trend for both annual mean and maximum energy content except for some nodes located to the Northern Catalan coast. Regarding the wave direction (but not only considering stormy conditions) there is a tendency of North direction to decrease whereas South and Southeast direction seems to increase.