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"COMPARISON OF EXTREME STORMS IN THE NORTH ATLANTIC AND MEDITERRANEAN".

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ABSTRACT. A spectral characterization of two extreme storms is made using numerical wave hindcasts performed with the WAM model and wave buoys records in two different basins: the North Atlantic Ocean and the Mediterranean Sea. The results show that despite the different magnitude of the storms the directional wave spectra had similar distribution over frequencies and directions. All the single peaked spectra associated with the Quirin storm one of the major North Atlantic extratropical storms show a maximum spectral peak around 0.05 Hz. For the storms in the Mediterranean, having lower wave energy, the absolute peak (swell) corresponding to the peak of the storm was found at a frequency around 0.08 Hz. The North Atlantic Quirin storm had longer duration (in average 6-7 days) than the Mediterranean storms (4-5 days). The maximum peak period in the North Atlantic was higher than 20 seconds in contrast with the 12.5 seconds maximum of the Mediterranean storms. However, the lowest directional spreading associated to the extreme values of the Hs (significant wave height) was found to be similar in both basins (24º).

Methods

Numerical simulations were conducted by applying the state-of-the-art spectral phase averaged wave model WAM454 (Günther and Berehns (2011); Komen et al., 1994) forced with the reanalysis of NOAA NCEP (CFSR-Climate Forecast System reanalysis (Saha et al., 2010)).

The simulations for the North Atlantic were performed for the period of 1st-28th February 2011 to study one of major extratropical North Atlantic storms (Quirin) that reached the power of a hurricane according to the Saffir–Simpson scale. To study two of the major storms observed in the Western Mediterranean the WAM hindcast was set for November 2001.

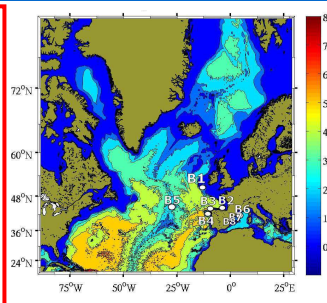
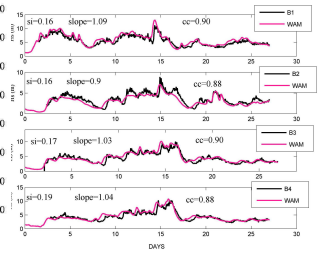


Fig. 1. Area of study



ig. 2 Validation for the Hs at the North Atlantic locations B1,B2,B3, B4.

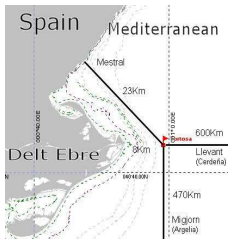


Fig.3 Delt Ebre fetch representation and the location of the Tortosa wave buoy (red flag).

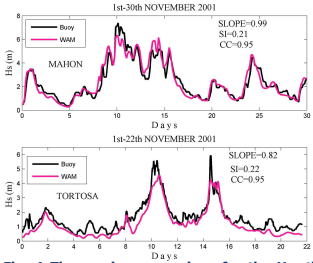


Fig. 4 Time series comparison for the Hs: the WAM hindcast against the wave buoys records in the Mediterranean at Tortosa (B8) and Mahón.

The North Atlantic extratropical storm Quirin

In February 2011, the North Atlantic storm Quirin produced the ideal conditions for the study of extreme sea states. This system was the last of four deep lows with hurricane-force winds that developed in close succession over the northern Atlantic (Bancroft 2011). Quirin was south of Newfoundland on 13th of February, according to NOAA Ocean Prediction Center synoptic analysis charts. The CFSR wind field for 14th February at 00 UTC shows wind speed of about 35 m/s (left panel, Fig.5). Quirin storm reached hurricane force winds of about 44 m/s according to observations of different satellite altimeters. JASON-2 altimetry observed Hs of about 20.1 m on the 14th ; similar values of Hs can be seen in Fig. 5 (right panel) obtained from the WAM model hindcast.

Energy Balance Equation

$$\frac{\partial F(\sigma,\theta,\phi,\lambda,t)}{\partial t}+\nabla\cdot\left(C_g F\right)=S(\sigma,\theta,\phi,\lambda,t)$$

WAM454 model $S_{tot}=S_{in}+S_{nl}+S_{ds}+S_{bf}$

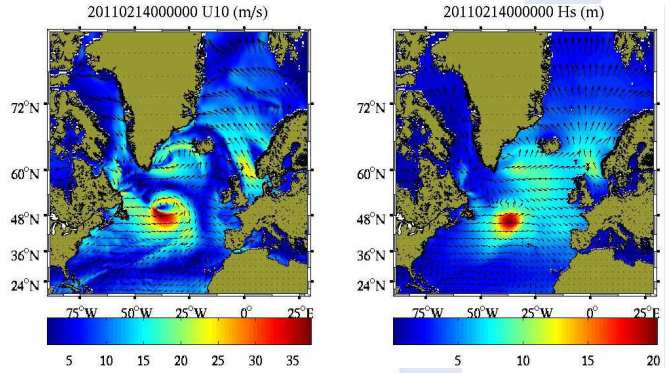


Fig.5 The extratropical storm Quirin from the CFSR reanalysis (NOAA) wind field (left). WAM Hs map (right) for 14th February 2011 at 00 UTC.

The Mediterranean storms of 2001

During November of 2001, two extreme events were observed on the Western Mediterranean, characterized mainly by strong NE winds. The first one occurred in 9–13 of November 2001, with north-easterly winds (26 m/s) in the north western part of the basin. The Tortosa buoy registered a value of Hs of 5.62 m during this period. The second one occurred in 13–17th of November 2001 and was characterized by strong winds from the North (Tramuntana) of 24 m/s in the Gulf of Lyons in a combination with a Mistral wind in the Delt Ebre with 15 m/s. The buoy of Tortosa registered an Hs of 5.95 m during this period. Figure 3 shows a WAM Hs map corresponding to the first storm of 11th November 2001 at 12 UTC showing maxima values higher than 6 meters. According to the XIOM wave buoys the first storm had a duration of 95 hours (3 days and 23 hours) from 9th November 2001 at 0 UTC up to 12th November 2001 at 23 UTC. The second storm began on 13th November at 10 UTC and ended on 17th November at 00 UTC for duration of 3 days and 14 hours (86 hours) (Table 3).

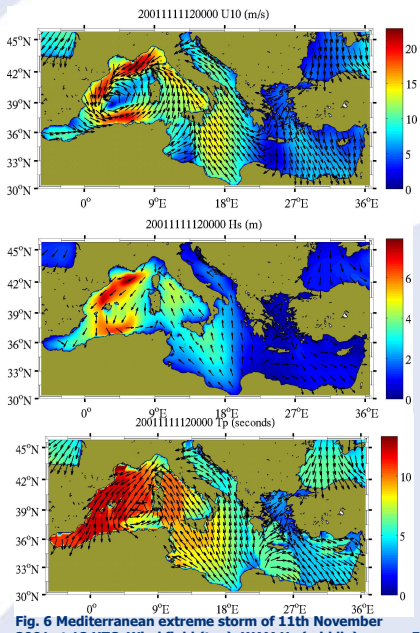


Fig. 6 Mediterranean extreme storm of 11th November 2001 at 12 UTC. Wind field (top), WAM Hs (middle), WAM Tp (bottom).

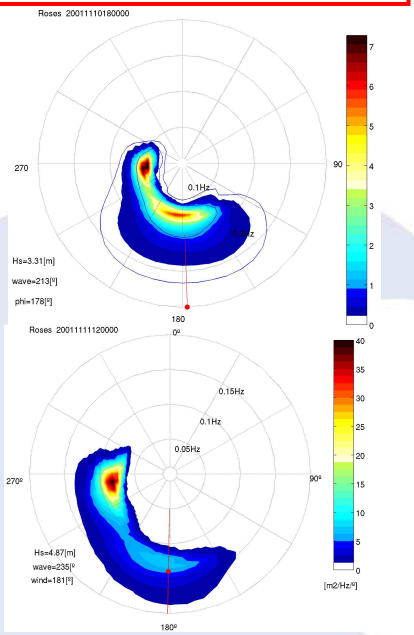


Fig. 8 Mediterranean WAM directional wave spectra at B6 for 10th November 2001, 18 UTC (top) and 11th (bottom) at 12 UTC.

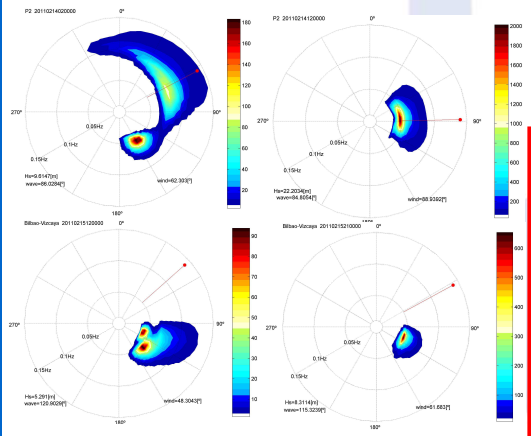


Fig. 7 North Atlantic WAM directional wave spectra before the extreme value of Hs (left panels) and during the peak of the storm (right panels). B5-P2 (top) and B2-Bilbao –Vizcaya (bottom). Red arrow-wind direction.

CONCLUSIONS. From these preliminary results it can be concluded that directional spectra of the extreme sea states in the Mediterranean can be similar to those in the North Atlantic in terms of the energy strength and shape. In the future a set of extreme storms will have to be analyzed before more general conclusions can be drawn.

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