Waves and Climate Change in the North-East Atlantic

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Wave height in the North Atlantic has been observed to increase over the last quarter-century, based on monthly-mean data derived from observations. Empirical models have linked a large part of this increase in wave height with the North Atlantic Oscillation (NAO), a measure of the North Atlantic meridional air pressure gradient and the strength of the prevailing westerly winds, producing a predictive model. The positive phase of the NAO corresponds to stronger westerly winds. Wave models provide a tool to study impacts of various climate change scenarios and investigate physical explanations of statistical results. In this case we use a wave model of the NE Atlantic. Model tests were carried out, using synthetic wind fields, varying the strength of the prevailing westerly winds and the frequency and intensity of storms, the location of storm tracks and the storm propagation speed. The strength of the westerly winds is most effective at increasing mean and maximum monthly wave height. The frequency, intensity, track and speed of storms have little effect on the mean wave height but intensity, track and speed significantly affect maximum wave height parameters.

'Storminess' versus strength of westerlies

Two possible explanations for the increase in wave height with NAO are (a) an increase in the mean zonal wind, increasing the build-up of waves over several days or (b) an increase in 'storminess' i.e. the frequency and intensity of storms (mid-latitude baroclinic systems rather than tropical warm-core hurricanes). There have been significant increases in the number of severe storms over the UK since the 1950s (Alexander et al., 2005), which appear to be related to changes in the NAO to a more positive phase.

The model is forced by synthetic wind fields built up from an analysis of a typical NAO+ winter month – January 1993. The background wind field, consisting of prevailing SW winds is shown in Figure 1 and an idealised storm is constructed as in Figure 2. The strength and track of this storm can be varied as in Table 1 and results are shown in Figure 3.

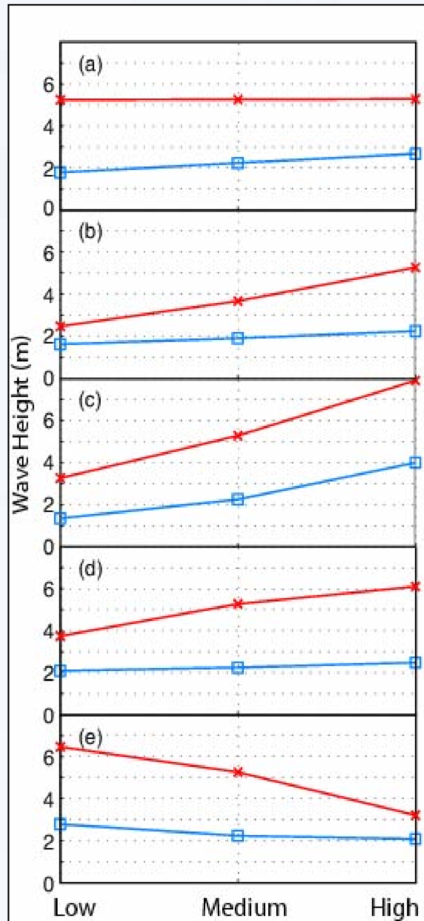

Figure 3. Effect of (a) storm frequency (b) storm intensity (c) relative strength of westerlies (d) storm track and (e) storm translation speed on wave height. Red crosses = monthly maximum, blue squares = monthly mean

Feature	Low	Med	High
(a) Frequency of storms ($month^{-1}$)	3	**6**	9
(b) Intensity of storms ($m\ s^{-1}$)	10	15	**20**
(c) Relative Strength of westerlies	0.5	**1**	1.5
(d) Direction of storm track	ENE	**NE**	NNE
(e) Storm translation speed ($km\ h^{-1}$)	25	**50**	100

Table 1: Matrix of model tests for results in figure 3

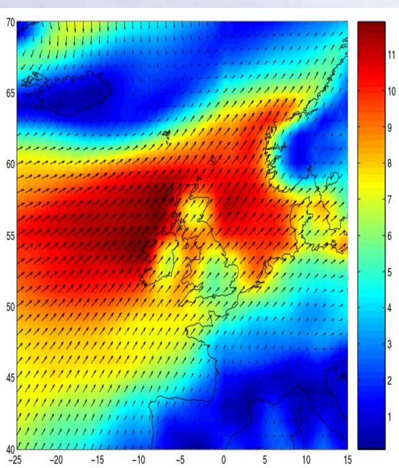

Figure 1. Mean atmospheric conditions for January 1993. Coloured shading/contours is wind speed in m/s, arrows indicate direction of flow.

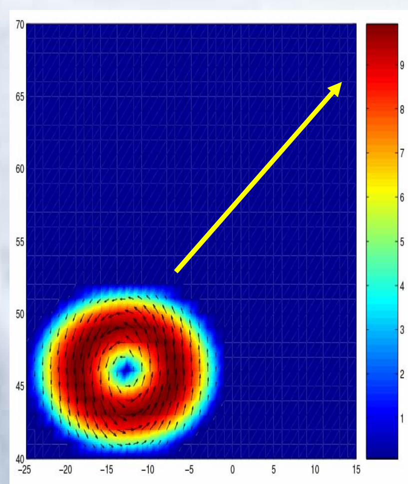

Figure 2. Idealised storm with maximum wind speed 10m/s

References
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