

# Mechanisms for changes in severe storms over the United Kingdom

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## Introduction

During the 1980s and 1990s, the UK insurance industry lost billions of dollars through claims relating to storm damage (ABI, 2003). Most available ‘storminess’ indicators are not of high enough resolution (either spatially or temporally) to resolve the small-scale, fast moving events that cause the most damage. Given their devastating effects, stations in the UK with long-term 3-hourly pressure records were analysed in order to better resolve these severe storm events. Pressure changes are also likely to be a more robust measure of trend and variability than wind speed, for example, which is more sensitive to the site moves and instrumentation changes that can cause inhomogeneities (WASA 1998). An absolute mean sea-level pressure (MSLP) change over 3 hours of 10hPa, chosen from forecasting classifications for severe gales, was set as the threshold to define a ‘severe storm event’ at an individual station.

## Data

Twenty-one stations in the UK had at least 45 years of 3-hourly MSLP digital data. Each severe storm event defined between October and March was carefully hand-checked against Daily Weather Records (DWR). Several hundred errors were detected, mostly related to transcription errors prior to 1980, about the time automatic digitization was introduced. Analysis of the station trends of severe storm events before and after quality control showed some significant differences, highlighting the importance of this type of ‘hands-on’ quality control.

## Results

From the distribution of severe storms, the average number of events at each station and the spatial structure of all the stations, the UK was split up into 3 regions (north, central and south), each containing 7 stations (Alexander et al., 2005). A ‘regional’ severe storm was defined if at least two of the seven stations in a region detected the same event (events had to be separated by at least 12 hours). For each region, the probability density functions (PDFs) from 2 multi-decadal time periods were compared, the start date of the first period chosen between 1957 and 1959 depending when all stations in that region had started reporting. In the northern region (Fig. 1a) there is no clear change from one period to the next. The distributions for the central (Fig. 1b) and particularly the southern (Fig. 1b) UK regions show a marked shift towards very severe events in the most recent decades.

Positive values of the North Atlantic Oscillation (NAO) index, defined as the pressure difference between the Azores and Iceland, are related to stormier conditions over the North Atlantic. Seasonal NAO indices (Jones et al. 1997) were compared with the number of severe storms over the UK during Jan-Mar (Fig. 2a) and Oct-Dec (Fig. 2b). The downturn in the NAO since the early 1990s corresponds to a similar decrease in the number of severe storms during this time. The trend in severe storms has significantly increased in both seasons although it is unlikely that ‘storminess’ has significantly changed over the past 200 years in northern Europe (Barring and von Storch, 2004). Decadally filtered values in Jan-Mar are highly correlated (0.82) with the number of storms over the UK. However, there is a much smaller negative correlation (-0.21) between the NAO and the number

of severe storms over the UK in Oct-Dec, perhaps indicating a shift of the large scale circulation pattern during this season. Comparison with a homogenised daily MSLP dataset, known as EMSLP (Ansell et al., 2005), from a recent EU project, EMULATE, shows that the trends in winter (Jan/Feb) are mostly dominated by an NAO-like pattern while the pre-winter (Nov/Dec) period is mostly dominated by a Scandinavian low/Azores high pattern.

## Conclusions

Severe storm events over the UK significantly increased over the second half of the 20<sup>th</sup> century. Central and southern UK regions show a tendency towards more very severe storms in latter decades. However, given the relatively short timescale we can not say with certainty that these events are unusual over longer time periods. An NAO-like pattern produces most of the severe storms in winter with a Scandinavian low/Azores high pattern dominating in autumn.

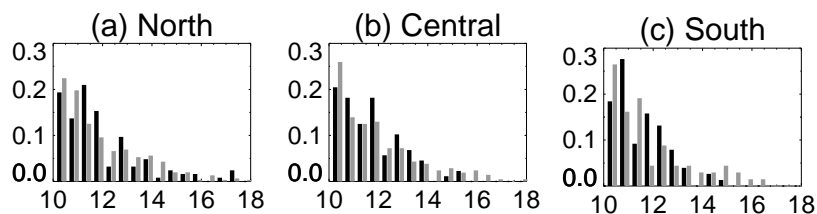


Fig. 1: Probability distribution functions of absolute 3-hourly pressure changes above 10hPa for (a) northern UK (b) central UK and (c) southern UK. The x-axis denotes the magnitude of 3-hourly pressure changes. Black bars indicate the period (a) 1959-1982, (b) 1957-1980, and (c) 1958-1981. Grey bars represent the period after this to 2003.

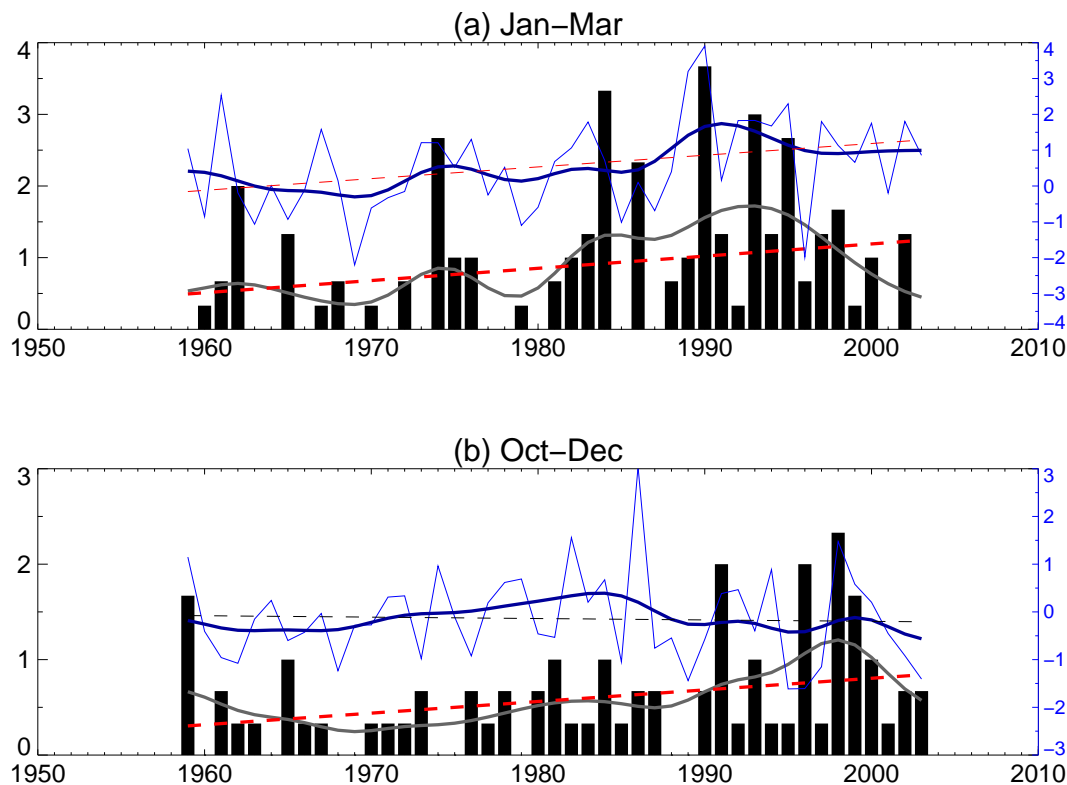


Fig. 2: Time series of seasonal UK extreme storm events (black bars) for the seasons indicated along with the seasonal NAO index (blue). The left hand y-axis represents the number of 'severe storms', while the right hand y-axis denotes the NAO index in standardized units. The smoothed lines represent the decadal averaged values calculated using a 21-term binomial filter for the NAO index (dark blue) and the number of severe storms (dark grey). The dashed line is a least-squares fit to the data. Red signifies the trend is significant at the 5% level using a non-parametric Mann-Kendall test.

## References

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