IMPACTS OF CLIMATE CHANGE ON STORMINESS

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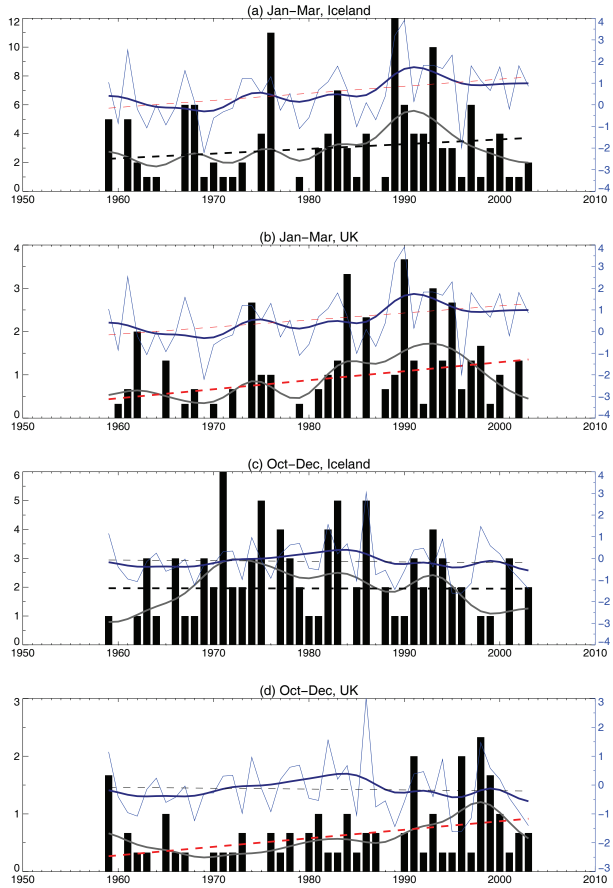
Executive Summary

Severe storms, which may be defined as 3-hourly changes in atmospheric pressure that exceed an extreme magnitude, have been quality-controlled and analysed at 21 stations in the UK and 7 stations in Iceland, with records extending back for at least 45 years for the October to December and January to March months (Alexander *et al.,* 2005). Current 'gale' indices are mostly unable to resolve these severe storm events (Hickey, 2003; Smits *et al.,* 2005), highlighting the advantage of this method and others (Alexandersson *et al.,* 2000) which use high resolution pressure observations for detecting and analysing 'devastating' storms over this part of the North Atlantic.

Using such measures, it has been demonstrated that Iceland, with a much higher percentage of severe storms than the UK, has exhibited significant distribution differences between the periods before and after 1980, with a tendency towards less extreme severe events in latter decades. In contrast, although the UK has a smaller number of severe storms, there has been a tendency towards larger magnitude events in recent decades. Northern UK shows a mixed pattern of change. There are many more regional severe events in recent decades but no significant distribution change between the two periods studied and no significant increase in severe storms. The central and southern UK regions show a tendency towards more 'very severe' storms in recent decades with the number of severe events in central UK having more than doubled. Although southern UK shows little change in the number of severe events, there is evidence for their intensification in the most recent decades. Numerical modelling studies, such as Weisse *et al.* (2005), have suggested that the average number of storms per year has increased near the exit of the North Atlantic storm track and over the southern North Sea since their simulation began in 1958, but the increase has attenuated later over the North Sea and the average number of storms per year is decreasing over the North-East Atlantic since about 1990-1995.

The difference between the distributions of severe storms between Iceland and the UK may imply a possible shift in the North Atlantic storm track. The long-term trend in severe storms in January to March is mostly related to variations in the North Atlantic Oscillation (NAO). Whilst this is not generally the case in October to December over the UK, an exception to this is the non-significant relationship between the NAO and severe storms during these months, the reason for which is not clear though it may be related to the quasidecadal signal in the El Nino Southern Oscillation (ENSO) phenomenon (Allan *et al,* 2003; Meinke *et al.,* 2005). Nevertheless, the mechanisms for these changes have not yet been investigated thoroughly as we do not yet have access to the very high temporal and spatial resolution climate model simulations that would be required for such a study.

Although it is unlikely that ‘storminess’ in general has significantly changed over the past 200 years in northern Europe (Bärring and von Storch, 2004) it is unclear whether this applies to very intense small-scale storms. Efforts are underway in the Hadley Centre at the Met Office to extend the 3-hourly pressure change analysis back to 1920 over the UK, while the potential exists to investigate whether very long term pressure data series with coarser 12-hourly resolution at about 6 locations in the UK back into the 18th-19th century can provide a truly centennial scale picture of severe storm nature and changes.



Time series of seasonal extreme storm events (black bars) for the regions and seasons indicated along with the seasonal NAO index (blue). The left hand y-axis represents the number of ‘severe storms’ occurring over the two regions, while the right hand y-axis denotes the NAO index in standardized units. The smoothed lines represent the decadally averaged values (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. Source: Alexander *et al*. (2005).

Key sources of Information

Alexander, L.V., S.F.B. Tett and T Jonsson, 2005: Recent observed changes in severe storms over the United Kingdom and Iceland. *Geophys. Res. Lett.,* 32, L13704, doi:10.1029/2005GL022371.

Alexandersson, H., H. Tuomenvirta, T. Schmidth and K. Iden, 2000: Trends of storms in NW Europe derived from an updated pressure data set. *Climate Res.,* 14, 71-73.

Allan, R.J., C.J.C. Reason, Lindesay J.A. and Ansell T.J., 2003: 'Protracted' ENSO episodes and their impacts in the Indian Ocean region. *Deep-Sea Research II*., Special Issue on the Physical Oceanography of the Indian Ocean: from WOCE to CLIVAR. 50, (12-13), 2331-2347.

Bärring, L. and H. von Storch, 2004: Scandinavian storminess since about 1800. *Geophys. Res. Lett.,* 31, doi:10.1029/2004GL020441, 2004.

Hickey, K.R., 2003: The storminess record from Armagh Observatory, Northern Ireland, 1796-1999. *Weather,* 58, 28-35.

Meinke, H., deVoil, P., Hammer, G., Power, S., Allan, R., Stone, R., Folland, C.K. and Potgieter, A., 2005: Rainfall variability at decadal and longer time scales: Signal or noise? *J. Climate,* 18, 89-96.

Smits, A., A.M.G. Klein Tank and G.P. Konnen, 2005: Trends in storminess over the Netherlands, 1962-2002. *Int. J. Climatol.,* 25, 1331-1344, DOI:10.1002/joc.1195.

Weisse, R., H. von Storch and F. Feser, 2005: Northeast Atlantic and North Sea storminess as simulated by a regional climate model 1958-2001 and comparison with observations. *J. Climate*, 18, 465-479.

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