Quantifying and understanding the collective risk of mid-latitude storms

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Natural hazards such as windstorms, flood and hail can have serious consequences for society when they occur. It is necessary for decision makers to be able to quantify the risk from individual events as well as from multiple occurrences of the same type of hazard (collective risk). A common assumption in hazard modelling is that the frequency of occurrence of events and the intensity of individual events are independent. A deviation from that assumption of independence would have strong implications for the insurance/reinsurance industry. Here we show that for some regions European extratropical cyclones do not follow the assumption of independence.

Time series of counts and mean vorticity of extratropical cyclones are constructed for the October-March extended winters using the NCEP-NCAR reanalysis.

A positive correlation is found to exist between the winter counts and mean vorticity of extratropical cyclones over North West Europe which is significant at the 95% level. The observed correlation for extratropical cyclones over Europe is shown to be driven by joint forcing of the frequency and intensity by large scale flow patterns. The relationship between the frequency and intensity can then be reproduced by separately regressing them against suitable teleconnection patterns.

Having investigated the correlation between the frequency and intensity for European windstorms the implications for the collective risk are further explored. Cantelli bounds are used to investigate the effect of including correlation on the extremes of the collective risk of extratropical cyclones. Results suggest that assuming independence between the frequency and intensity underestimates the collective risk from extratropical cyclones by 20% or more in some regions.