Geophysical Research Abstracts, Vol. 8, 10109, 2006
SRef-ID: 1607-7962/gra/EGU06-A-10109

A Statistical Test for Spatial and Temporal Clustering of Extra-Tropical Cyclones over Europe

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Extra-tropical cyclones cause substantial wind damage in Europe each winter, with peak gusts frequently exceeding 100kmh. However, especially catastrophic events occur when series of storms follow each other in close proximity, both in space and time. Such storm clusters can cause billions of euros of damage. For example, in early 1990 a series of eight windstorms caused over 10 billion euro of insured losses. In December 1999, windstorms Lothar and Martin, both passing over France within three days of each other, jointly caused more than 80 fatalities, destroyed 10% of total area of forest in France alone, and caused total losses around 19 billion euro in France, Germany Belgium and Switzerland. Modelling of the probability of clustered damage events occurring is important to the insurance industry, which requires an adequate representation of the risk of these large losses.

In a recent study, Mailier et al. (2003) used a point-process approach to find evidence for clustering of extra-tropical cyclones in association with large scale weather patterns. Large scale teleconnection patterns cause multiple cyclones to follow similar tracks. According to the authors, this leads to clusters over Europe containing over five storms per month on average.

Here, we apply an adaptation of Ripley's K function (Cressie, 1993) to detect clustering of storms. Our analysis accounts for the spatio-temporal scales of storms without making assumptions regarding the clustering process. This leads to the development of a hierarchical model for the frequency of clustered storms. This study is based on the complete catalogue of northern hemisphere storms, detected in 53 years of reanalysis data by an automatic tracking algorithm, which was also used in Mailier et al.

(2003).

Bibliography Mailier, P.J., D.B. Stephenson, C.A.T. Ferro, K.I. Hodges. (In Press). Serial Clustering of Extratropical Cyclones. Monthly Weather Review. N. Cressie. 1993. Statistics for Spatial Data, revised edition, Wiley, NY