Geophysical Research Abstracts
Vol. 12, EGU2010-12441, 2010
EGU General Assembly 2010
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Statistical Modelling of the Wind Damage from Convective Events in Europe

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Downbursts and tornados arising from thunderstorms can cause severe property damage. The damage from individual events is orders of magnitude lower than the damage from single large-scale winter storms like Lothar in 1999. However, the average annual loss (AAL) due to such "high-frequency" events is still of the order of billions of Euros simply because they occur much more often than the "low frequency" winter storms. Because these events are so numerous a detailed physically-based modelling approach, similar to that used for modelling the losses due to the low frequency storms, is very difficult. As an alternative, we describe a statistical model, based on physical considerations.

The basis for our model is a statistical relationship between the synoptic situation, as derived from NCEP/NCAR reanalysis data, and observed insured losses, both for several years and for several countries in Europe. The obvious idea of trying build a multiple linear regression model that predicts the loss data from the synoptic data fails due to heteroscedasticity in the losses. Instead, we have built a model that separates the occurrence and the severity of high frequency events. With respect to occurrence, we model the probability of a loss occurring at all as a function of the synoptic situation. We use a generalized linear regression with a logit transfer function to predict the 2-state variable (loss or no loss) as a function of convection indices. With respect to severity, we model the probability-density function (pdf) of the observed loss ratio (expressed by location and scale parameters) as a function of convection indices. The parameters are fitted using Maximum Likelihood. We have tested a number of convection indices and we have only used those which are found to contribute significantly in case that a loss occurs. This approach yields a pdf of loss magnitude as a function of day and location given that a loss occurs and the synoptic situation is known.

Sets of statistically significant convection indices are found for both models, which implies that the models can reasonably be combined to create a high-frequency wind-loss model. This combined model is then driven with NCEP/NCAR reanalysis data for Europe for the last 40 years and annual average loss ratios per country are estimated.

The presentation briefly discusses the approach used to model convection and explains why simple multiple linear regression fails. The necessity of the transformation of loss data and an objective criterion for the selection of convection parameters are demonstrated and the results of the application of the model to some countries in Europe are shown.