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Modelling Wind Loss from Convective Events in Europe – Hazard, Vulnerability, Exposure

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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. Instead, we have built a model that separates the occurrence probability 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 probability of loss as a function of convection indices. With respect to severity, we model the expected loss ratio as a function of convection indices.

Both models are built by stepwise regression on the basis of 32 convective indices and supplementary environmental and economic factors.

Sets of highly significant indices are found for both models. The resulting model structure is in line with conceptual views of how local severe storms create loss. This implies that the models can reasonably be combined to create a high-frequency wind-loss model. The combined model is then driven with NCEP/NCAR reanalysis data for Europe for the last 40 years. Each year is run 200 times yielding a statistical event set of 271 million events in 8000 synthetic years.

The knowledge of regional vulnerability functions and a detailed exposure database allows for the estimation of annual average loss ratios on postcode resolution and for different lines of business (e.g. residential, commercial and industrial buildings and contents).

The presentation discusses the approach used to model local convective storms. It explains why a 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. Finally, results of the application of the whole model chain from the meteorological hazard over the vulnerability functions and the exposure database to the estimated losses are shown.