Anthropogenic influence on European storm climate and possible impacts for the region of Hesse, Germany

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In this study, projections of future winter storm losses are estimated for the federal state of Hesse. The project focuses on the question whether or not regionally differentiated loss projections for the future periods 2031-2060 and 2071-2100 are possible at all, given the coarse resolution of future climate projections, and how these loss projections might turn out. The study is based on the SRES-A1B Scenario (*Special Report on Emission Scenarios* (*SRES*)) of the *Intergovernmental Panel on Climate Change (IPCC, 2007*) which represents one possible evolution of socio-economic factors worldwide, incl. information on population development and economic pathways.

As the assessment of future losses caused by European winter storms is subject to large uncertainties (compare e.g. Leckebusch et al., 2007), this study aims to develop and evaluate different methods for this to provide suitable measures of uncertainty for stakeholders and policy makers, in addition to the climate change signal itself. By a combination of dynamical and statistical approaches (e.g. with multi-model ensemble simulations), different kinds of uncertainties (statistical as well as model uncertainties) of resulting climate change signals can be systematically assessed.

Results of all investigated methods consistently show an increase in losses for Hesse of +13% to +27% for the period 2031-2060 and increases of +19% to +76% for the period 2071-2100. The wide range of projections indicates the large statistical uncertainty of these estimates. Furthermore we find indications for an increase in the variability of losses, from which an increase (in number and strength) of the extreme events with high losses can be deduced.

Regional differences in potential future risks can be deduced, although the different methods do not show completely coherent signals. The use of a statistical method indicates a stronger increase of losses in central Hesse, while for the southwestern part weaker increases are found. The use of a dynamical method shows strong increases of losses in the northeast of Hesse, while again for the southwest weaker increases are found.

Accordingly, resulting mean projections show slightly weaker signals in western (southwestern) parts of Hesse, while for northern and eastern parts of Hesse stronger increases in future loss risks are derived. For the region Frankfurt/Offenbach as an example, an above-average increase in potential losses is found which is of particular relevance due to the high insurance density in this region.

In summary, for the region Hesse a generally increased loss potential of winter storms under changed climate conditions with enhanced greenhouse gas concentrations is found. The identification of regional differences in the future loss risk is possible, however, the interpretation of these differences is restricted by the large uncertainties quantified in this project.