Geophysical Research Abstracts
Vol. 12, EGU2010-5542, 2010
EGU General Assembly 2010

Estimating Changes in Extreme Climate in Europe: Selected Methodical Aspects

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Estimating the future risk of extremes in the climate system (temperature, precipitation) has a high socioeconomic relevance: heatwaves and floods may lead to thousands of fatalities and billions of EUR economic damages. Estimating the climate risk is also a scientific challenge, owing to the scarcity of documented events (extremes are rare) and the nonstationarity of the problem (with climate changes also risk changes may come). Here we study methodical aspects of statistical estimation of risk changes and analyse past observations from, and future climate model projections for, the European continent. First, statistical tests help the analyst to reject or accept the null hypothesis of time-constant rate of occurrence of an extreme (probability per time unit). We compare the test after Mann and Kendall with the test after Cox and Lewis by means of Monte Carlo simulations and show that the latter has a clearly higher power (detectability). Second, we outline the advantages of nonparametric risk estimation with kernel functions and bootstrap resampling, which permit construction of confidence bands for the estimated occurrence rate. Third, we explore methods of climate model bias correction based on data pairs of observations and model output. The correction is shown to depend not only on the variables analysed, but also possibly on the extremal data type (peaks-over threshold, block extreme, percentile). We present an analysis of changes in extreme precipitation in the Lower Saxony region for the interval from mid-19th century to the end of the 21st century (KLIFF project).