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Effect of climate change on the return period of heat waves

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Global land temperatures in 2003 were about 1˚C above the end of the 19^{th} century, making it one of the warmest year on record. Europe experienced its most intense heat wave on record causing more than 15 000 extra death. Using Hadley Centre climate model simulations it is estimated that the antropogene climate change has already doubled the risk of such heat waves.

Extremely warm events can be identified by different ways: internationally agreed predefined indices as day count exceeding a fixed threshold, percentile threshold, heat wave duration, etc., or special human comfort indices based on (inter)nationally developed heat stress categories.

Calculating climate indices requires at least daily resolution of homogeneous time series without inhomogeneities, like stations move to other locations, changes in observation practice. In this paper homogenized daily maximum temperature data series from the beginning of the 20th century are analyzed. Global warming may effect changes in the occurrence of extreme warm weather events. The significance of the fitted linear trend to number of 'summer days' is tested. The Hungarian heat stress categories were developed in 2005 (I. level: at least 3 consecutive days with 25 ˚C daily mean forecast, II. level: at least 3 consecutive days with 27 ˚C daily mean forecast). Number of days in heat waves on different levels are calculated and their changes are examined in the long time observation series.

Statistical methods are needed for identifying changes in the behaviour of extremes. We estimate future possible changes in tail probabilities and return values of extreme events. Extreme value theory estimates the return level or return period of an extreme meteorological event, e.g. warm events in the next 50, 100 or 1000 years. An event with a return period of 50 years for example is expected to occur, on average once

every 50 years. Terminology, such as the 100-year return level only meaningful under the assumption of stationarity in a process. Non-stationarity apparent due to different climate patterns in different periods, or in the form of trends possibly due to long term climate changes.

In this paper we demonstrate the usual extreme value limit models on the Hungarian daily maximum temperature data. The apparent trend in the data raises doubts about the suitability of a model which assumes a constant distribution through the whole interval. In this particular example, it seems plausible, that the daily maximum temperatures has been changed linearly over the observation period, but that in other respects, the distribution is unchanged. The daily maximum series are divided into different, partly overlapping periods: 1901-1989, 1961-1990 and from 1989 which is the first year of the last most intense warming can be detected in observations. Extremely warm days above a specific threshold are modelled by Generalized Pareto Distribution. We decided to apply a threshold model, because it uses more information than a model is based only block maxima e.g. highest or the lowest value in a year. The results are expressed as the return period taking on various values. From the eighties, when man-made changes are included, warm extreme events are likely to occur much more frequently.