PRACE GEOGRAFICZNE, zeszyt 108

Instytut Geografii UJ
Kraków 2000

Raino Heino

CHANGES OF CLIMATE EXTREMES – FACT OR FICTION?

Abstract: A review has been made on the recent work on climatic extremes. Special emphasis is given for recent Nordic studies of extremes. Changes in maximum and minimum temperatures follow, in broad terms, the corresponding well-documented mean temperature changes. Minimum temperatures, however, have increased more than maximum temperatures, although both have increased. As a result, the diurnal temperature range has mostly decreased during the present century. Two extreme-related precipitation characteristics, the annual maximum daily precipitation and the number of days with precipitation $\geq$ 10 mm, show no major trends or changes in their interannual variability.

Key words: climate, extremes, temperature, precipitation.

1. Introduction

Climatic extremes raise nowadays great attention. The media is delivering real-time images of various climatic extremes around the world. There is a general "feeling" that the weather has become more extreme. Are the extremes nowadays really more extreme than previously? Several studies indicate that this is not true. What about the role of slow change in the composition of the atmosphere, i.e. intensified greenhouse effect? Has globally observed climate warming caused any increase of regional extreme climatic events? This is just reviewed by the Intergovernmental Panel on Climate Change. Its previous report (IPCC 1996) did not find any evidence about the increase of extreme weather events or climate variability in a global sense. However, changes of some extremes and climate variability indicators were found on regional scales.

Long-term monthly records of temperature and precipitation extremes have been prepared for the North-European region (Denmark, Finland, Iceland, Norway, and Sweden). For most of the stations data back to the early 1880s are included. Main focus has been put on daily maximum and minimum temperatures and 1-day maximum precipitation (cf. Førland et al. 1998a). Programs for fitting extreme value distribution

(EVD) functions to long Nordic temperature series have also been developed for calculating of return periods of rare events (Helminen 1997).

In addition, another study of climatic extremes (Heino et al. 1999) consisting of some Nordic and Central-European countries was made as a follow-up of the workshops on extremes in June 1997 (cf. Karl et al. 1997).

2. Temperature Extremes

Daily maximum and minimum temperatures (Tmax, Tmin) are basic climatic parameters, which have been observed since the beginning of the 20th century in most European countries. However, these long-term records have not yet been fully used. The motivation of many recent studies to investigate Tmax and Tmin was the paper by Karl et al. (1993). They showed that the Tmin of the global landmass increased three times more quickly than the corresponding Tmax during the period 1951-1990.

As a result of the trends in annual maximum and minimum temperatures it was detected a decreasing trend in the diurnal temperature range (DTR) over a large area of the globe. No human-induced local effects could provide a satisfactory basis for the widespread decrease in the DTR, while among many possibly natural variables, changes in cloudiness gave the best explanation of the decline.

Heino (1994) studied the changes of Tmax and Tmin in Finland since the 1950s. The features of cold and warm episodes are well reflected in the results. In addition, minimum temperatures showed a greater increase than maximum temperatures on an annual basis. A slight DTR-decrease in Finland by appr. 0.5°C was observed since the 1950s. The corresponding seasonal changes were also studied. It appeared that the decrease in the annual DTR is mostly explained by decreases in spring and summer, while the DTR in winter has remained at about the same level despite large inter-decadal changes. Cloudiness data from the stations used in the DTR calculations were found to be strongly correlated (about -0.8) with DTR on a monthly and seasonal basis. Since cloudiness has experienced a recent increase, this appears to be a reasonable explanation of the DTR changes in Finland as well.

It should be emphasised that the DTR is more sensitive to non-homogeneities than is the mean temperature. For example, relocation in a coastal area can give higher (inland relocation) or lower (relocation towards the coast) DTR-values, while the mean temperature would be less affected.

In the analysis presented in Tuomenvirta et al. (1998) the mean maximum and minimum temperatures were studied for trends using the Nordic datasets. This was the first attempt to build a comprehensive collection of extreme temperatures in the Nordic region. However, the homogeneity testing and adjusting is still needed before further studies of trends. Especially long-term time series may suffer from systematic biases raising from screen and site changes.

Mean maximum and minimum temperatures have increased in Fennoscandian region since the 1950s, but decreased in Greenland, while trends in the Nordic Seas are small. Diurnal temperature range has been decreasing significantly in all the study

area. To a large extent it can be explained by cloud cover increase and a strengthening of the westerly flow over Fennoscandia.

Diurnal temperature range in Finland, Norway and Sweden has a remarkable agreement between the three country series since the 1910s. The reliable part of the DTR series (1931-1995) shows that there has been a 0.2-0.4°C decreases in the DTR during the last 40 years. The earlier, less reliable part, of the series suggests that the DTR was in the 1920s and 1930s at almost as low level as during the last decade.

3. Precipitation Extremes

Within the Nordic project, a dataset of monthly values of maximum 1-day precipitation was established. The dataset mainly covers the period 1890-1996, and contains more than 80 series from the Nordic countries. Preliminary analyses made by Førland et al. (1998b) indicate that there are large differences in the trend patterns even for neighbouring stations. Long-term national trends of 1-day maximum precipitation were also studied. The trend patterns were not very clear, but the maximum of the 1930s and a recent increasing tendency, however, were evident.

By applying the Gumbel distribution to annual series (WMO 1981) return period values were also calculated. Higher frequencies of „extraordinary" rainfalls in the 1930s and since the 1980s were recognized. Periods of high 1-day precipitation values seem to coincide well with hot summers.

Meteorological yearbooks have typically contained standard statistics on the number of days with precipitation exceeding specific amounts. The number of days with precipitation exceeding 10 mm is one of the key elements for studying climatological extremes. However, Heino et al. (1999) did not found any long-term changes, except the increasing trends in Western Norway due to orography and circulation changes.

4. Nordic Atlas of Climatic Extremes

As a part of the Nordic project, TVEITO et al. (1998) prepared a Nordic Atlas of Climatic Extremes for the six key elements (mean maximum and minimum temperature + DTR, absolute highest and lowest temperatures and maximum 1-day precipitation). The statistics are presented both as annual values on maps (point values and analyzed values), and for some features also as tables with monthly statistics. Altogether 20 maps and 9 tables are included in the Atlas. Separately, absolute values of the whole network are reviewed on monthly and annual basis.

5. Concluding Remarks

Research of climatic extremes is nowadays one of the key topics in climatology and one of the main emphasis when preparing the Third IPCC Assessment (to be published in early 2001). The extremes often correspond to the events causing the

greatest hazards to society and ecosystems. The probabilities of various extreme events and estimates of their return are of great value for the planning process. With good quality data, it is possible to study temporal variations of climatic extremes, and to improve the reliability of estimates related to the extremes.

Nordic cooperation has made it possible to create a unique dataset on climatic extremes as well as a number of scientific studies on extreme meteorological events. The next step in the cooperation is to fix the existing personal contacts on a firmer basis. A plan for this is accepted by the Nordic NMS Directors in 1999, and a NORDKLIM co-operation is now progressing well.

Acknowledgements

Nordic scientists working with climatic extreme referred here are mostly listed in Førland et al. (1998a). The work has been made by the Nordic colleagues as a part of their routine works, but additional financial support was received from the Nordic Council of Ministers.

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Raino Heino
Finnish Meteorological Institute
Helsinki
Finland