Analysis of heat wave occurrences in the Carpathian basin using regional climate model simulations

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Human health is very likely affected by regional consequences of global warming. One of the most severe impacts is probably associated to temperature-related climatological extremes, such as heat waves. In the coming decades hot conditions in most regions of the world are very likely to occur more frequently and more intensely than in the recent decades. In order to develop adaptation and mitigation strategies on local scale, it is essential to analyze the projected changes related to warming climatic conditions including heat waves.

In 2004, a Heat Health Watch Warning System was developed in Hungary on the basis of a retrospective analysis of mortality and meteorological data to anticipate heat waves that may result in a large excess of mortality. In the frame of this recently introduced Health Watch System, three levels of heat wave warning are applied. They are associated to the daily mean temperature values, and defined as follows:

- Warning level 1 (advisory for internal use) is issued when the daily mean temperature exceeds 25 °C.
- Warning level 2 (heat wave watch) is issued when the daily mean temperature for at least 3 consecutive days exceeds 25 °C.
- Warning level 3 (heat wave alert) is issued when the daily mean temperature for at least 3 consecutive days exceeds 27 °C.

In the present study, frequency of the above climatic conditions are analyzed using regional climate model (RCM) experiments are analyzed for the recent past and the coming decades (1961-2100) for the Carpathian basin. At the Dept. of Meteorology, Eotvos Lorand University two different RCMs have been adapted: RegCM (with 10 km horizontal resolution, originally developed by Giorgi et al., currently, available from the International Centre for Theoretical Physics, ICTP) and PRECIS (with 25 km horizontal resolution, developed at the UK Met Office, Hadley Centre). Their initial and lateral boundary conditions have been provided by global climate models ECHAM and HadCM3, respectively. For both RCMs A1B emission scenario was used. The climatic conditions of 1961-1990 (as a reference), and 2021-2050, 2071-2100 future periods are evaluated using bias corrected daily mean temperature outputs of both RegCM and PRECIS. Based on the results the following main conclusions can be drawn: (i) Heat waves are very likely to occur more frequently in the 21st century than in the reference period, 1961-1990. (ii) By the end of the 21st century heat warning level 3 is projected to occur with similar frequency as the heat warning level 1 in the reference period. (iii) By the end of the 21st century the average first occurrence of the heat warning days is simulated to shift earlier, and the average last occurrence later, than in the reference period – thus the length of the heat wave season is projected to become remarkably larger. (iv) For each time slices (both reference and future periods), PRECIS simulations suggest a more often occurrence of heat warning cases in the Carpathian basin than the RegCM experiments.