Changes in maximum temperatures over the Ukraine territory under modern climate changes

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Introduction
The association between climate change and the frequency and intensity of extreme heat events is now well established. General circulation models of climate change predict that heatwaves will become more frequent and intense, especially in the higher latitudes, affecting large metropolitan areas that are not well adapted to them. This investigation is devoted to determination of temporal and spatial characteristics of maximum temperatures and heat waves for the Ukraine territory.

Data and methodology
Database contains the daily maximum temperature series from 9 meteorological stations of the Ukraine for the warm period, which is defined as a period of 153 days from May 1st to September 30th. For each station the observation period spans different years. The data were obtained from http://www.ecad.eu/.

The study was based on two methods. The first method is the Block Maxima Approach used to analyze the highest summer temperature for each year of the data. This approach helped indicate trends in the data but not any information about trends in the characteristics of heat waves.

The second approach, the Peaks over Threshold Approach, was applied to study the frequency of heat waves in four stations of Kyiv, Odesa, Poltava and Uzhhorod using their heat indices. The first heat index is TX95p defined as GC3/23(7/9). The second index (TX95p) is stated as the first one but 95th percentile was used instead of 90th percentile. The last index (TXA5) is calculated as the calendar day average maximum temperature increased by 5°C. Heat waves were determined as period of more than five consecutive days in which daily maximum temperature exceeds one of the indices.

For the each station the linear and stepped trends were determined. For 5 stations of Chernivtsi, Kharkiv, Kyiv, Odesa and Poltava a linear trend shows the decrease in maximum temperature. Strongly negative linear trend is observed in Kharkiv and Chernivtsi (difference of block maximum temperature of begin and end of observation period is 2.2°C in Kharkiv and 1.0°C in Chernivtsi). For the rest of the stations there is the increase in the year highest temperature.

For all stations stepped trend is characterized strong change in the mean value of block maximum temperature (the least difference in means is registered in Odesa – decreasing block maximum temperature by 0.8°C, and the greatest difference occurs in Simferopol – increase of maximum temperature by 2.7°C). In Kyiv and Lviv the stepped and linear trends don’t agree. It shows that in these stations there is different periodicity.

Conclusions and further development
In comparison with the 1961-1990 period for all stations in question number of heat waves is growing. The most intensive increase in heat wave frequency is observed in Kyiv for all indices, and the maximum number of heat waves is detected in Poltava for all indices. For Kyiv and Poltava the maximum number of heat waves (74 events in Kyiv and 109 in Poltava) is revealed by the TXA5 index and the minimum one (24 events in Kyiv and 51 in Poltava) is got using the TX90p index. The maximum heat wave frequency is registered in Poltava in 1901-1910 and in Kyiv in 2001-2010. In Odesa maximum number of heat waves is defined using the TX90p index (40 events) and in Uzhhorod the TX90p and TXA5 indices (30 and 32 cases, respectively) are equally effective for revealing heat wave events.