

Heat waves over Ukraine detected by HCWI

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Heat and Cold Wave Index (HCWI) is implemented in the Copernicus European Drought Observatory (EDO). HCWI is used to detect and monitor periods of extreme-temperature anomalies (i.e. heat waves) that can have strong impacts on human activities and health. This is one of the climate indexes that takes into account both HW duration and intensity. The HCWI indicator is computed for each location (grid cell), using the methodology developed by Lavaysse et al. (2018), and based on the JRC's MARS AGRI4CAST database of daily meteorological observations. In accordance with EDO, HW defined as events of at least three consecutive “hot” days. In this context, a “hot day” is a day with both daily air minimum and maximum temperatures (Tmin and Tmax) are above their daily threshold values, calculated as the 90th percentile values of Tmin and Tmax for that calendar day during the 30-year climatological baseline period (1981-2010).

As a result of analysis of the series of daily air temperature for 1980-2021 there are 83 HW events that met the criteria for defining this event, which is used in this study, were recorded in Ukraine (on the average 2 events per year). At the same time, the uneven manifestation of this atmospheric phenomenon in time is clearly traced with the allocation of two half-periods, the duration of which is 21 years. For the first half-period (1980-2000) 29 events of HW were recorded, and for second half-period (2001-2021) – already 54 events. It should be noted that 1-2 events of HWs were usually recorded in Ukraine per year until 2001, but in the second half-period their frequency increased to 2-3 events, and in some years reached to 4-5 events per year.

According to the EDO methodology, the minimum duration for which the HW is recorded is 3 days. The maximum length of HW over Ukraine for the study period 1980-2021 ranged from 4 (1984) to 20 (2010 and 2013) days. So, the average duration is 4.2 days, and the average maximum length of HW is 9.45 days. The results of the study show that all indicators characterizing the duration of HW increased during study period. If for

1980-2000 the average duration of heat waves was 3.8 days, then for 2001-2021 the average duration increased to 4.3 days. The average maximum length of HW increased more significantly – from 7.4 to 11.5 days in the second half-period.

To characterize the intensity of HW, as a rule, the cumulative T_{\max} during a single HW is used. J. Kysely (2010) notes that this characteristic is the most convenient for wave intensity evaluation. Usually, the cumulative T_{\max} during an individual HW is calculated as the sum of the differences between the maximum daily air temperature and a certain limit value, depending on the HW definition. However, such an indicator can also be the temperature of hottest day of the HW event. It was used in a recent work about Ukraine (Shevchenko et al., 2020). The intensity of the HW determined according EDO as the maximum air temperature extreme. Over Ukraine, the hottest HW events for the study period were with a maximum daily temperature of 41.4 °C (2010), and mean (1980-2021) temperature extreme of the HW over Ukraine is 32.2 °C.

The “coolest” HWs were in 1980, 1982, 1984 and 1990, and the hottest HW were in 2022, 2007 2010 and 2017, when the temperature extreme exceeded 40 °C. That was expected that the hottest waves are in the south of Ukraine, where the temperature extreme reached 45.8 °C (1999) and 46.8 °C (2021).