# GENERATING AND CONTROLLING HEAT WAVES IN UKRAINE

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**Introduction.** Heatwaves, characterized by persistently extreme high temperatures, have become increasingly frequent and intense in recent decades. These phenomena, driven by global climate change, have catastrophic consequences for public health, the economy, and ecosystems. Given the forecasts for an increased likelihood of heatwaves in the future, it is crucial to comprehensively study the physical mechanisms that cause their formation and maintenance.

The aim of this study is to identify large-scale conditions and circulation anomalies that contributed to the establishment and persistence of abnormally hot weather during eleven of the most intense heatwave episodes that occurred in Ukraine between 1961 and 2020.

To detect blocking processes, fields of geopotential height on the 500 hPa isobaric surface from NCEP/NCAR for 00 and 12-hour periods [1] and fields of averaged temperature at 2 meters, sea level atmospheric pressure, geopotential height at 500 hPa, zonal wind speed, and relative humidity [2] during the heatwave period were used at nodes of a regular latitude-longitude grid with a resolution of 2.5ºx2.5º for the region bounded by 30° to 85° N and 0° to 60° E.

Backward trajectories for air particles were constructed using the NOAA HYSPLIT Trajectory Model [3].

**Results.** The study identified 11 cases of mega-heatwaves observed in Ukraine. The most powerful heatwaves were considered those with an average HWMId index value (proposed in [4]) greater than the threshold of 15 and a maximum value over 20. A compilation of mega-heatwaves from 1961–2020 was made and kindly provided by colleagues from the Meteorology and Climatology Department at Taras Shevchenko National University of Kyiv, Professor O. Shevchenko and Professor S.I. Snizhko.

In this work, each episode of mega-heatwaves was classified according to the heatwave classification proposed in [5], which was based on the analysis of sea-level pressure fields, temperature advection at 850 hPa, and the position of the jet stream at 300 hPa.

According to this classification, all five cases were classified into two types: radiation-advection, where the radiation factor plays the most significant role, and advection-radiation, where the advection factor plays the most significant role.

The most intense heatwave occurred in July-August 2010, when a 55-day-long anticyclone over European Russia caused abnormally hot and dry weather in the northern hemisphere, with daily temperature anomalies reaching 10°C in the boundary layer. This was classified as a radiation-advection type (subtype A1).

The 2015 heatwave, which lasted longer and covered Ukraine, formed in a branch of the Azores anticyclone with temperature anomalies up to 6–7°C. It also followed the radiation-advection type and had anticyclonic circulation in the upper troposphere.

The 1994 heatwave lasted 16 days and affected less than 20% of Ukraine, with anomalies of up to 6°C. Blocking was visible in the Tibaldi-Molteni index, and a Rossby wave and anticyclone appeared in the upper troposphere.

In 1964, a prolonged heatwave with temperature anomalies of up to 5°C formed in the Azores anticyclone, with a Rossby wave in the upper troposphere. Blocking was significant at the start and end of the period.

In 2012, two heatwaves occurred. The first, less intense, had anomalies up to 6°C, with weak anticyclonic circulation. The second, more intense, lasted 14 days and was classified as advection-radiation type (B2), with warm air from North Africa and reinforced by heat from the Caucasus and Iranian Plateau.

The 2007 heatwave, associated with a high-pressure belt extending from the Azores anticyclone, had significant temperature anomalies and anticyclonic circulation in the upper troposphere, classified as radiation-advection type (A2).

In 2002, a heatwave in the Azores high-pressure ridge had temperature anomalies of up to 5–6°C, with a Rossby wave and cutoff anticyclone in the upper troposphere.

The 1996 heatwave lasted 17 days, affecting a fifth of Ukraine, and formed in a branch of the Azores anticyclone, with the jet stream splitting in the upper troposphere.

In 2016, the heatwave in the Azores ridge had significant anticyclonic circulation and concentrated temperature anomalies near the surface, classified as subtype A1.

The 2019 heatwave, covering almost all of Europe, was associated with a high-pressure band from the Atlantic and a Rossby wave, classified as subtype A2.

## REFERENCES

1. https://www.esrl.noaa.gov/psd/
2. https://psl.noaa.gov/data/composites/day/
3. https://psl.noaa.gov/data/atmoswrit/trajtool/
4. Russo S., J. Sillmann and E.M. Fischer, 2015, Top ten European heatwaves since 1950 and their occurrence in the coming decades. Environ. Res. Lett.10, 124003
5. Sfîcă, Lucian, Adina-Eliza Croitoru, Iulian Iordache, and Antoniu-Flavius Ciupertea. 2017. "Synoptic Conditions Generating Heat Waves and Warm Spells in Romania" Atmosphere 8, no. 3: 50. https://doi.org/10.3390/atmos8030050.