

## **Changes in the distribution of isotherms across the Carpathian Mountains in response to climate warming**

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Air temperature is a crucial climate variable in the monitoring of climate change effects, especially in high-elevation regions highly sensitive to the recent warming. The study highlights the spatial changes and the vertical anomalies of the observed temperature trends associated with displacements of some important isotherms, relevant for the typology of periglacial process (e.g. 2°, 0°, 2°, 3°C) and the spread of forest vegetation (10°C), across the Carpathian Mountains range. The analyses are based on homogenized daily mean, minimum and maximum temperature available at 0.1° resolution (~10 km) for 1961-2010, developed within the CARPATCLIM project ([www.carpatclim.eu](http://www.carpatclim.eu)).

The changes in isotherm distribution were investigated for each season by comparing distinct three 30-year time-slices (1961-1990, 1971-2000 and 1981-2010) at regional scale, with focus on the five Carpathian Mountains regions.

The results show consistent spatial changes, suggesting a strong northward displacement of isotherms in winter and summer and a slightly less one in spring. The strongest changes associated to the isotherms of average and maximum temperature occur the strongest in the areas beyond 47°N latitude, distinguishing extended areas of the Northwestern Carpathians, the Northeastern Carpathians and Southwestern and Southern Carpathians. In summer, the vertical displacement of all isotherms were found significant over the entire Carpathian domain, with changes of up to 0.6-0.8°C for minimum temperature isotherms and over 0.8-1.0°C for the average and maximum temperature. In autumn, most visible changes were assigned to maximum temperature isotherms, especially when comparing the time-slices overlapping the last 40 years of the study period, yet at a weaker magnitude compared to other seasons (below 0.6°C). The spatial changes in the distribution of isotherms are relevant for the timing and intensity of processes in the areas with active seasonal ground freezing (above 2'000 m) and for the vertical variations of the climatic treeline in the naturally forested areas of the Carpathian range.

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