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Air temperature and precipitation variability in the Polish Carpathians

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Mountain regions, especially those at high altitudes, are considered to be among the best indicators of climate change due to the low degree of human impact on these ecosystems and their interactions with general atmospheric circulation. It is worth emphasizing that any environmental modification, especially in air temperature or precipitation, has significant consequences on hydrological, ecological and even societal systems, especially at high altitudes, where direct human-based factors are of minor importance.

The aim of this study is to investigate the variability of air temperature and precipitation across the Carpathian region in Poland (i.e. Western Carpathians) within the past 160 years (1851-2010) and future climate projections for 2021-2100 in the context of ongoing climate change and its possible environmental impact. The magnitude of the changes is established across the region, taking into account its spatial differentiation, as well as its vertical profile.

The results confirm that the Western Carpathian region has been warming faster than the global or hemispheric averages; however, it must be noted that the magnitude of these changes, as well as their additional environmental impact, is seasonally and elevation dependent. The foothills have experienced more intensive temperature increases during summer, whereas winters have warmed more at the summits. This warming has been particularly pronounced over the last few decades and will continue in the oncoming years. The distribution of the annual temperature modelled for selected periods provides evidence of the upward shift of vertical climate zones in the Polish Carpathians, which reach approximately 350 meters, on average. Since the humidity conditions, as expressed by the precipitation amount, are trendless and highly spatially differentiated, increasing temperature will drive more intense evaporation and might ultimately cause moisture failure what indicates further ecological consequences as ecosystems expand or become extinct and when there are changes in the hydrological cycle.