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Factors influencing the ground thermal regime of rock glaciers in the marginal periglacial environments of Southern Carpathians

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Ground-surface thermal (GST) measurements in high mountains are frequently used to examine the near-surface energy exchange fluxes. GST records are also used to determine if microclimatic conditions at the rock glacier surface are suitable for permafrost preservation. GST is commonly measured with miniature temperature data loggers. A decade record (2011-2021) of GST and air temperature from twenty sites in the Southern Carpathians are analyzed in this work. The controlling role of meteorological, topographical and subsurface characteristics on the GST regime was carefully examined. Snow cover and air temperature have the primary role in controlling the inter-annual differences and evolution of GST. At all the sites, the occurrence of permafrost was limited to areas characterized by coarse openwork debris, the reduced income of solar radiation and high altitudes (above 2000 m). The high porosity of coarse debris enhances an intense cooling of the ground due to efficient ventilation effects. In the case of active rock glaciers, the very low ground surface temperature regimes result from the combined effect of the ice-rich frozen debris, snow characteristics and ground airflow (convection and advection) within the loose debris. The permafrost distribution is patchy because the controlling topo-climatic factors reveal a small-scale variability. Thus, high variations of the thermal conditions at the surface of the investigated rock glaciers may occur over relatively small distances (e.g., a few hundred meters). Today the climatic conditions in the Romanian Carpathians permit only the preservation of thin frozen layers at sites where local topo-climatic factors and surface characteristics are favourable.