Late Pleistocene glaciation in the Eastern Carpathians – a holistic view

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The Eastern Carpathians (EC) are the most extensive (600 km long) part of the Carpathians, but only 1.6 % of this area rises above 1500 m asl which mostly was enough high to support Pleistocene glaciers. Landforms of former glaciation are preserved here in 14 isolated mountain massifs that stretch over 300 km in the territory of Ukraine and Romania from the Polonyna Rivna (1480 m asl) in the NW to the Gurghiu Mountains (1775 m asl) in the SW. Here we present the first complete inventory of glaciation in the EC based on geomorphological mapping of glacial cirques (N=214) and maximal moraines together with GIS-based glacier reconstruction, and AABR 1.6 ELA calculation of 147 former glaciers. On the base of the EC glacier dataset, we propose a quantitative approach to define three distinct stages of glacial landscape development, which is based on the relationship between the glacial ELA and mountain hypsometry. The comparison between spatial trends of LGM ELA and modern temperature-precipitation ELA (tpELA) in the study area gives insight into the pattern and magnitude of atmospheric circulation and dominated moisture advection during the full glacial conditions in Central Europe.
The EC were occupied by relatively small cirque and cirque-valley glaciers, with a mean area of 1.04 km2 and a mean length of 1.81 km, developed mainly on poleward slopes. Only in the strongest glaciated massifs (Chornohora, Rodna, Svydovets) glaciers were developed on both poleward and equatorward slopes. The spatial distribution of LGM ELA and cirque floor altitudes show a steep NW-SE rise of 600 m over a distance of 300 km (2-2.5 m/km) which mimics the pattern and magnitude of the modern climatic (temperature-precipitation) ELA (2.4 m/km) reflecting the importance of moisture advection by the west and northwest winds from the European Lowland and Pannonian Basin. The exceptionally low LGM ELA position in the Ukrainian Carpathians can be explained by the regional topographic predisposition for orographic induced precipitation which plays a crucial role in glacier mass balance in windy and dry LGM climate.