



Late Pleistocene and Holocene palaeoclimate, glacier and treeline reconstruction based on geomorphic evidences in the Mongun-Taiga massif (south-eastern Russian Altai)

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Pleistocene-Holocene extent of glaciers and dynamics of the landscape in south-eastern Russian Altai is still a matter of discussions. The effects of climate-induced fluctuations of the glaciers and the upper treeline of the Mongun-Taiga mountain massif (50°16'30" N, 90°08'E) were, therefore, reconstructed on the basis of in-situ, multiannual observations, geomorphic mapping, radiocarbon and surface exposure dating, relative dating (such as Schmidt-hammer and weathering rind) techniques and palaeoclimate-modelling. Present glaciation of Mongun-Taiga mountain massif (3970 m a.s.l.) is represented by 30 glaciers having a total area of 20.2 km². There are 3 distinct groups of moraines which are referred to MIS 4, MIS 2 and MIS 1. During the maximal advance of the glaciers, their area was 26-times larger than now and the equilibrium line of altitude (ELA) was about 800 m lower. Assuming that the maximum glacier extent took place during MIS 4, then the average summer temperatures were 2.7 °C cooler than today and the amount of precipitation 2.1 times higher. Buried wood trunks by a glacier gave ages between 60 to 28 cal ka BP and were found 600 – 700 m higher than the present upper treeline. This evidences a distinctly elevated treeline during MIS 3a and c. With a correction for tectonics we reconstructed the summer warming to have been between 2.1 and 3.0 °C. During MIS 3c, the glaciated area was reduced to less than 0.5 km² with an increase of the ELA of 310 – 470 m higher than today. Due to higher precipitation, the glaciated area during MIS 3a was close to the current ELA. Exposure dating (10Be) would indicate that the maximum glacier extension was 24 ka BP, but the results are questionable. From a geomorphic point of view, the maximum extent can more likely be ascribed to the MIS4 stage. We estimate a cooling of summer temperature of – 3.8 to – 4.2 °C and a decrease in precipitation of 37–46% compared to the present-day situation. Samples of wood having an age of 10.6 – 6.2 cal ka BP were found about 350 m higher than the present treeline. It seems that the summer temperature was 2.0 – 2.5 °C higher and annual precipitation was double that of the present-day. For that period, the reconstructed glaciation area was 1 km² less than today. Three neoglacial glacier advances were detected. The glaciers covered about double the area during the Little Ice Age (LIA), summer cooling was 1.3 °C with 70% of the present-day precipitation. The reconstructed amplitude of climatic changes and the shift of the altitudinal zones show that the landscape has reacted sensitively to environmental changes and that dramatic changes may occur in the near future.