Geophysical Research Abstracts,
Vol. 11, EGU2009-8333-2, 2009
EGU General Assembly 2009

Thermal regime and freeze-thaw action in alpine rockwalls: A comparison of sites in the Austrian, Swiss and Japanese Alps during the period 2006-2008

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Temperature measurements in bedrock give a good indication for the effects of air temperature anomalies on ground thermal conditions and for the intensity of near-surface physical weathering in the bedrock. This contribution presents, discusses and compares temperature records from a total of 12 surface boreholes in rockwalls with different slope orientations in the alpine periglacial zone of the Austrian (n=9: granitic gneiss, augengneiss, mica schist, gneiss and calcareous mica schist), the Swiss (n=2; green schist and dolomite) and the Japanese (n=1: sandstone) Alps. Up to three temperature sensors have been installed at each surface borehole at vertical depths of 0/3 cm, 10 cm and 40 cm. At most of the 12 sites, continuous data from autumn 2006 to summer 2008 were available for this study. Therefore, the data base allowed the comparison between the unusual warm winter 06/07 (e.g. the autumn of 2006 was more than 3°C warmer from the northern side of the Alps to southern Norway if compared to the 1971-2000 average) and the rather normal winter 07/08 in the European Alps. By contrast, both winters 06/07 and 07/08 were normal at the Japanese study site. Focus within the analysis was laid on the variation of the mean and extreme daily temperatures at the rock surface and at depth, the variation of the daily temperature range, the number of freeze-thaw cycles as well as the effects of aspect and snow cover on the thermal regimes in the bedrock. Results show for instance that the duration of the winter snow cover in 07/08 at all 11 sites of the European Alps was 1.2 to 5.2 times longer compared to the winter 06/07. The reduced winter snow cover caused substantial higher number of diurnal freeze-thaw cycles at all 11 sites in 06/07. By contrast, the duration of the winter snow cover at the Japanese site in 07/08 has been shorter as during 06/07 causing slightly more diurnal freeze-thaw cycles in 07/08. This indicates, that supposed warmer winters at mid-latitude mountain ranges with less precipitation as snow in the future will enhance diurnal freeze-thaw cycles and the intensity of near-surface physical weathering in the bedrock.