Geophysical Research Abstracts
Vol. 14, EGU2012-9346-1, 2012
EGU General Assembly 2012

Widespread evidences of hoarfrost formation at a rock glacier in the Seckauer Tauern, Austria

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The mechanism of deep reversible air circulation (the so called “chimney effect” or “wind tube”) is known to be a process of ground overcooling in the lower and deeper parts of porous sediments and related landforms such as scree slopes or intact and relict rock glaciers. Warm air outflow emerging from relatively small voids within these mostly coarse-grained sediment bodies is sometimes noticeable. However, easier to identify are associated phenomena such as snowmelt windows, snow cover depressions and hoarfrost formations. Generally, these indications for warm air outflow are found at the upper part of scree slopes or the rooting zone of rock glaciers. Here we present widespread field evidences of hoarfrost from the pseudo-relict Schöneben Rock Glacier in the Seckauer Tauern Range, Austria located at E14°40’26” and N47°22’31”. Herewith, a pseudo-relict rock glacier is defined as an intermediate rock glacier type between a relict and a climatic-inactive rock glacier, hence a relict rock glacier with locally isolated patches of permafrost. The rock glacier covers an area of about 0.11km^2, ranges from ca. 1720 to 1905 m a.s.l., and consists predominantly of coarse-grained gneissic sediments with blocks up to a size of several cubic metres at the surface. In particular the lower part and some ridges in the central and upper part are covered by dwarf pines (pinus mugo) mirroring the flow structure of the previously active rock glacier. Isolated permafrost occurs presumably at the rooting zone of the rock glacier as indicated by evidences from a neighbouring rock glacier in a comparable setting. Field observations in November 2011 showed widespread occurrences of hoarfrost crystals growing around the funnel edge indicating the sublimation of vapour from warm funnels. Such hoarfrost sites were found at more than 50 single locations distributed over the entire rock glacier from the tongue to the rooting zone generally. The occurrence of hoarfrost can get classified into the following classes: (a) at foot slope positions, (b) along linear structures or depressions of the rock glacier, (c) below vegetation patches of dwarf pines, (d) at the interface between younger fine-grained sediments (derived from debris flows) and the coarse-grained former rock glacier surface, and finally (e) hoarfrost occurrence at the rock glacier body without any identifiable structure in the vicinity. Examples from these different hoarfrost classes are presented and discussed.