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Advective heat transport and boundary layer decoupling controlling the melt dynamics of a patchy snow cover

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Once the mountain snow-cover gets patchy in the course of the ablation season two processes are expected to increase in magnitude: the advective heat ransport and the near-surface boundary layer decoupling. These two processes, which have an opposite effect on sensible heat transport onto the snow surface, are, however, not well understood. The aim of this study is to investigate the effects of locally developing atmospheric stratification over snow patches. Especially stable internal boundary layers over cold surfaces can result in a decoupling of the near-surface air from the warmer atmosphere. In this investigation we are particularly interested in the effect of boundary layer decoupling on the net sensible heat flux towards the snow surface. At two experimental sites we applied local eddy flux measurements over snow patches at three different heights above the snow surface.

The measurement results suggested wind velocity, turbulence intensity, wind fetch distance and topographical curvature to be driving factors for boundary layer growth above patchy snow covers. These factors also control the efficiency of advective heat transport to contribute to snow ablation. The turbulence data clearly show that boundary layer decoupling inhibits the transfer of additional energy to the snow cover potentially gained from advective heat transport, leading to an upward flux of sensible heat above the stable internal layer. The atmospheric decoupling primarily occurs for shallow stable internal boundary layers, calm winds and low friction velocities. Contrary, the transfer of sensible heat towards the snow cover is promoted by high mechanical turbulence initiated by strong winds. Advective heat transport is shown to be especially effective under these conditions. Thus, strong winds additionally increase the role of advective heat transport by decreasing boundary layer decoupling. Furthermore, concave topographies reduce snow ablation by enhancing the potential of boundary layer decoupling. The atmospheric decoupling is thus shown to be a key mechanism in snow patch survival.