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Experiments on wind-driven heat exchange processes over melting snow

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Snowmelt runoff predictions in alpine catchments are challenging because of the high spatial variability of the snow cover driven by various snow accumulation and ablation processes. In spring, the coexistence of bare and snow-covered ground engages a number of processes such as the enhanced lateral advection of heat over partial snow cover, the development of internal boundary layers, and atmospheric decoupling effects due to increasing stability at the snow cover. The interdependency of atmospheric conditions, topographic settings and snow coverage remains a challenge to accurately account for these processes in snow melt models.
In this experimental study, we used an Infrared Camera (VarioCam) pointing at thin synthetic projection screens with negligible heat capacity. Using the surface temperature of the screen as a proxy for the air temperature, we obtained a two-dimensional instantaneous measurement. Screens were installed across the transition between snow-free and snow-covered areas. With IR-measurements taken at 10Hz, we capture the dynamics of turbulent temperature fluctuations over the patchy snow cover at high spatial and temporal resolution. From this data we were able to obtain high-frequency, two-dimensional windfield estimations adjacent to the surface.

Preliminary results show the formation of a stable internal boundary layer (SIBL), which was temporally highly variable. Our data suggest that the SIBL height is very shallow and strongly sensitive to the mean near-surface wind speed. Only strong gusts were capable of penetrating through this SIBL leading to an enhanced energy input to the snow surface.

With these type of results from our experiments and further measurements this spring we aim to better understand small scale energy transfer processes over patch snow cover and it’s dependency on the atmospheric conditions, enabling to improve parameterizations of these processes in coarser-resolution snow melt models.