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Upscaling wind tunnel observation of drifting snow sublimation to the mountain range scale

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It is still in debate how much snow (moisture) is lost from the surface to the atmosphere during drifting snow events in the vast Arctic and Antarctic plains and during warm wind storms (Föhn) in mountain areas. A better understanding of this phenomenon is required to judge the global water balance, assess climate scenarios and investigate the local hydrologic balance in Alpine terrain. We performed wind tunnel investigations of drifting snow sublimation over a snow cover to understand the feed-back between single grain sublimation and atmospheric moisture content. The feed-back on the boundary layer is assessed using a simple one-dimensional turbulent mixing model. The wind tunnel results and the model simulations show that theoretical predictions by Thorpe and Mason describe adequately the single grain sublimation. The model simulations reveal that saturation effects limit the overall sublimation during drifting snow events. Depending predominantly on the particle number density and humidity, the overall sublimation is, however, much larger than for a non-drifting snow surface and is further enhanced through solar radiation.

In order to apply the wind tunnel results to the real world, the validated sublimation model is applied to a steep mountain ridge under the assumptions of local equilibrium and stationarity. Based on the results, a parameterization is developed, which should be able to describe snow drift sublimation and moisture feed back for larger areas and complex terrain. Problems of up-scaling from the individual grain to the mountain range scale are discussed together with model assumptions of stationarity, which may be in contradiction with the highly intermittent process of drifting and blowing snow. In the future, the overall effect of snow drift sublimation on the local water balance will be investigated.