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Sensitivity of atmospheric gravity waves to surface roughness and surface heat fluxes

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Dynamic downscaling of atmospheric flow over Iceland have revealed that downslope wind maxima are not merely a seldom extreme event, but that they are a prominent climatological signal. Based on a case from the FLOHOF campaign of observations over and around Hofsjökull glacier, the impact of surface roughness and surface fluxes on the wind flow are explored by means of several numerical tests. The simulations reveal a very strong sensitivity of the downslope acceleration to the surface roughness: a rough surface almost destroys the downslope windstorm at the surface, but increases the winds aloft above the downstream slope. The surface heat fluxes have a complex impact on the flow: for a smooth surface, they decelerate moderately the downstream flow and increase the flow at the top and upstream. Over a rough surface, the surface fluxes decrease the wind speed downstream, but do not have any clear impact upstream. The variability of the impact of the surface fluxes on the wind speed can be understood by refering to the vertical wind profile and turbulent mixing and by the fact that increased fluxes have a negative effect on the mountain-generated gravity wave through reduced static stability.

This study is not only of general relevance through its exploration of factors affecting dowslope acceleration of stably stratified flow, but it is also of interest because of the glaciers retreating rapidly in a changing climate.