

Surface Temperature and Energy Budget of Snow-Covered Complex Terrain

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ABSTRACT

The surface temperature controls the temporal evolution of the snowpack, playing a key role in physical processes such as snowmelt. It shows large spatial variations in mountainous areas because the surface energy budget is affected by the particular processes that occur in these areas, such as the modulation of the illumination by the local slope, the shadows and the re-illumination of the surface from surrounding slopes. The topography effects are often neglected in models, considering the surface as flat and smooth. Here we aim at estimating the surface temperature and the energy budget of snow-covered complex terrains in order to evaluate the role of the different processes that control the spatial variations. For this, a modelling chain is implemented to derive surface temperature from *in situ* radiometric and meteorological measurements. The main component is the rough surface ray-tracing (RSRT) model, based on a photon transport Monte Carlo algorithm to quantify the incident and reflected radiation on every facet of snow-covered areas described by a mesh. It is coupled to a surface scheme in order to estimate the energy budget. To assess the model performance, we use *in situ* measurements and satellite thermal observations (TIRS sensor aboard Landsat-8) in the Col du Lautaret area, in the French Alps. The satellite images are corrected from atmospheric effects with a single-channel algorithm. The results of the simulations show (i) an agreement between the simulated and observed surface temperature for a diurnal cycle in winter; (ii) the spatial variations of surface temperature are on the order of 5 to 10 °C between opposed slope orientations; (iii) that the importance of the few topographic effects considered here is variable, with a bias to a reference simulation of almost 1 K when being disabled. It is therefore necessary to account for the effects to estimate the spatial variations of the energy budget and surface temperature of snow-covered complex terrain.

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