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A numerical modelling experiment to simulate snow-canopy processes on a virtual mountain

U. Strasser (1) and M. Warscher (2)

(1) Department of Geography and Regional Science, University of Graz, Heinrichstr. 36, 8010 Graz, Austria (ulrich.strasser@uni-graz.at / Fax: +43 316 380 9886), (2) Institute for Meteorology and Climate Research, Atmospheric Environmental Research (IMK-IFU), Kreuzeckbahnstr. 19, 82467 Garmisch-Partenkirchen, Germany (michael.warscher@imk.fzk.de / Fax: +49 8821 183 243)

Mountain forests are primarily composed of evergreen conifer species which retain their needles throughout the year and, therefore, intercept snow efficiently throughout the winter. Snow interception and sublimation in a canopy have been identified as important hydrological processes with complex mass and energy exchanges. The processes affecting a snow cover beneath a forest canopy are distinct from those in the open: on one hand, the meteorological conditions relevant for the energy transfer at the snow surface beneath the canopy are different, and on the other hand, a certain amount of precipitation is retained in the interception storage of stems, branches and needles. Snow that is intercepted in the canopy can melt, fall down, or sublimate into the air masses above the canopy. This latter process leads to a reduction of precipitation accumulated and stored in the ground snowpack.

A forest canopy can have opposing effects on the snow cover beneath the trees, depending on many factors such as canopy density, gap size and distribution, geographical position and meteorological conditions. The canopy alters both the shortwave and the longwave radiation balance of the snow cover and affects the turbulent fluxes of sensible and latent heat by re¬ducing the wind speed at the snow surface. Likewise, humidity and temperature underneath a canopy differ from those in the open. Since vegetation canopies strongly affect the snow surface energy balance, the result can be a modified amount of SWE at a certain date, and a change in the duration of snow coverage. All the snow–canopy interaction processes have significant effects on the amount and timing of meltwater release from forested areas which can cover significant portions of the area of mountainous catchments.

In our modelling exercise we have constructed a cone-shaped, virtual mountain covered with a geometrically regular pattern of forest stands and clearings. The meteorological data we use to drive the snow-canopy model are recorded datasets from two stations for which the real horizontal and vertical distances are preserved in the simulation domain. The model is then applied for three winter seasons with different snowfall intensities and distribution. Results show the effects of the above-mentioned processes on the pattern of the ground snow cover, its duration and the meltwater release.