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Influence of a vegetation cover on the snow melt energy balance measured with a high density snow monitoring station network

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A high density network consisting of numerous (55) novel, low cost, standalone snow monitoring stations (SnoMoS) was used to measure snow depth and the climatic variables controlling the energy balance in three catchments in the Black Forest, a typical mid latitude medium elevation mountain range. In each catchment a stratified sampling design was set-up to cover the observed range of elevations and exposures. To investigate the influence of the forest cover on snow processes, SnoMoS pairs were installed with one station under the forest canopy and another one on an adjacent open field site. Furthermore, station clusters were established with SnoMoS being placed in close proximity to each other at the forest edge as well as under conifer and deciduous forests with differing stand densities. The meteorologic variables measured with the SnoMoS network (air pressure, air temperature, relative humidity, incoming global radiation, wind speed, snow surface temperature) allowed for a direct estimation of the individual energy balance components for different topographic situations and different vegetation cover.

The strong influence of vegetation cover on the micrometeorology was evident in the measured data. The most important differences were observed in wind speed and incoming global radiation. Wind speed, the main driver of the turbulent fluxes of sensible and latent heat was on average 80% lower compared to open sites. A mean reduction of incoming global radiation of 89% (95% for conifers) was observed under the forest canopy. These observed differences are well reflected when comparing the calculated snow melt energy balance components for open versus forested sites. The net shortwave radiation component is the most important term at open field sites, whereas net longwave radiation is the crucial component for the snow energy balance within forests. A severe underestimation of the snow melt energy balance was observed when ignoring the added longwave emission from the vegetation itself. The turbulent fluxes are only important during very windy, overcast days in open areas. The study shows the relative importance and quantifies the contributions of the individual snow melt energy balance components for forest locations with differing canopy characteristics and different topographic properties compared to adjacent open field sites.