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The long-term behaviour of snow cover over complex terrain in Southwestern Germany

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Southwestern Germany is characterised by complex topography, including a number of isolated highlands which peak at about 1000-1500 m a.s.l. as well as extensive lowlands. Dynamic atmospheric circulation patterns generate variable winter weather conditions, including both relatively warm winters with snow cover restricted to the highest elevations as well as moderately cold and precipitation rich phases which bring snow to practically the whole region. While in the lowland plains the hydrological importance of snow is negligible, the long-term snow storage in the mountain crests as well as short-term melting processes throughout the winter in the middle elevations are key aspects for flood generation and water supply. Our study aims at investigating the long-term behaviour of the spatio-temporal patterns of snow duration, snow depth and snow water equivalent and at detecting any trends from climate variability and change. Results from the analysis will be fed to hydrological models in order to improve the simulation of snow-related processes such as snow interception or short-term snow melt in complex terrain. Our analysis extends over major parts of Southwestern Germany and the neighbouring Alsace (ca. 35,000 km^2).

The applied method combines tools from remote sensing with interpolated ground measurements and hydrological modelling. First, the standard MODIS snow products (8-day snow cover images of the Aqua and Terra sensors from the National Snow and Ice Data Center) were used to represent the snow cover in 500 m spatial resolution. Since there is a significant proportion of cloud cover and misclassifications on the MODIS snow cover images an algorithm was developed which takes into account the elevation (from a DEM) as well as interpolated air temperatures from meteorological stations. By this means daily values of snow cover were derived which were then corrected and verified against measured snow data. Our results allow a detailed view on the spatial and temporal behaviour of the snow cover in the study area over the period 2002-2013. Further, the snow module of a hydrological model has been calibrated against the data. It has then been applied with measured meteorological data in order to generate long-term time series of snow cover parameters and to evaluate trends for different sub-regions and elevation zones of the study area. Recently, additional field experiments with regard to the determination of snow interception in forests have been realized. Our contribution will present the applied method and discuss selected results.