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Sensitivity of snow process simulations to precipitation-phase transition method in forested and open areas

A. Lundberg (1) and D. Gustafsson (2)

(1) Division of Applied Geology, Luleå Technical University LTU, Luleå, Sweden, (2) Land and Water Resources Engineering, Royal Institute of Technology KTH, Stockholm, Sweden (davidg@kth.se)

Modeling of forest snow processes is complicated and especially problematic seems to be the separation of precipitation phase in climates where a large part of the precipitation falls at temperatures near zero degrees Celsius. When the precipitation is classified as snow, the tree crowns can carry an order of magnitude more canopy storage as compared to when the precipitation is classified as rain, and snow in the trees also alters the albedo of the forest while rain does not. Many different schemes for the precipitation phase separation are used by various snow models. Some models use just one air temperature threshold (TR/S) below which all precipitation is assumed to be snow and above which all precipitation is classified as rain. A more common approach for forest snow models is to use two temperature thresholds. The snow fraction (SF) is then set to one below the snow threshold (TS) and to zero above the rain threshold (TR) and SF is assumed to decrease linearly between these two thresholds. Also more sophisticated schemes exist, but three seems to be a lack of agreement on how the precipitation phase separations should be performed. The aim with this study is to use a hydrological model including canopy snow processes to illustrate the sensitivity for different formulations of the precipitation phase separation on a) the simulated maximum snow pack storage b) the interception evaporation loss and c) snow melt runoff. In other words, to investigate of the choice of precipitation phase separation has an impact on the simulated wintertime water balance. Simulations are made for sites in different climates and for both open fields and forest sites in different regions of Sweden from north to south. In general, precipitation phase separation methods that classified snowfall at higher temperatures resulted in a larger proportion of the precipitation lost by interception evaporation as a result of the increased interception capacity. However, the maximum snow accumulation was also increased in some cases due to the overall increased snowfall, depending on canopy density and precipitation and temperature regimes. Results show that the choice of precipitation phase separation method can have an significant impact on the simulated wintertime water balance, especially in forested regions.