

Modelling the spatial moments of SWE, taking into account changes in snow free areas

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In a previous paper, a method for estimating the spatial frequency distribution of snow water equivalent (SWE) was put forward. The accumulate snow reservoir, was modelled as a sum of correlated (in time) gamma distributed variables. This methodology was constrained to estimate the moments of spatial SWE for snow covered areas and the resulting spatial frequency distribution is described as “conditional”, i.e. conditional on snow. In order to implement the method in hydrological models, we have to take into account the change of snow coverage and thus provide the unconditional moments of the spatial distribution.

The spatial variance of SWE for both an accumulation- and a melting event is evaluated through the covariance matrix. For accumulation events, we have only positive elements, whereas for melting events, we have both positive and negative contributions. The negative contributions become dominant only after a period into the melting season. At the onset of the melting season, the spatial variance thus continues to increase for later on to decrease. This behaviour is consistent with observations and by some authors dubbed the “hysteretic” effect.

The conditional and unconditional moments are estimated by the following procedure. The input values (rainfall and potential melting) are unconditional, but are made conditional by adjusting for changes in snow coverage. Then conditional moments are estimated. The unconditional moments are then estimated using the conditional moments and the snow coverage. The modelled conditional and unconditional moments are in close agreement with the observed.