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Operational assimilation of snow depth maps for improved real time runoff nowcasting with spatially distributed hydrological models

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Remote sensing applications to hydrology

Representative real time information on snow depth and snow water equivalent is needed for several practical purposes, above all avalanche warning and flood forecast and control in spring. This study deals with snow depth and cover maps for updating the snow water equivalent simulated by an operational spatially distributed hydrological model.
An evaluation of operational simulations of snow water equivalent and snow cover distribution for the winter season 2005/2006 will be presented for two Swiss basins. The simulations will be computed by adopting the real-time version of the PREVAH model (Precipitation Runoff EVApotranspiration HRU Model). PREVAH is currently implemented for flood forecast in the Linth basin (central Switzerland).
Model simulations are compared to three sources of snow cover information: a) the operational Swiss wide snow depth map (1x1 km^2 resolution) based on a combination of snow depth ground observations from a dense measurement network and operational NOAA-AVHRR snow cover map. b) a NOAA-AVHRR sub-pixel snow-cover product (1x1 km^2 resolution) with estimation snow cover fraction at sub-pixel scale. c) an interpolated map of snow depth, estimated using information from stations close to the target area.
Evaluations are performed by mean of categorical statistics. Results show, that the hydrological model is well able to provide reliable information on snow cover distribution. The accuracy with respect to the operational snow depth maps is always higher than 90%. The accuracy between the AVHRR snow cover maps and the model simulations is above 90% in the phase of snow accumulation until end of March and sinks below 80% during the ablation period.
We adopted simple assimilation routines, which allow updating the snow cover distribution within the adopted hydrological model. The spatial variability of snow depth and snow cover is obtained from the available maps derived from ground observations and AVHRR. The spatial variability of the simulated snow water equivalent is adjusted to matching the observed variability. The impact of the snow water equivalent update for local estimation of runoff generation and snow ablation will be demonstrated.
The estimation of the final snow ablation days could be improved for almost all stations providing the snow depth measurements. First results indicate that changes in runoff generation for the two basins are rather small. On the other hand the runoff generation from the sub-basins show a stronger reaction to the redistribution of snow within the model domain. Any improvement in the simulation of a catchment internal response represents a step towards better estimations of snowmelt in ungauged basins.