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Use of snow data in a hydrological distributed model: different approaches for improving model realism

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Snow dynamic is a key hydrological process in alpine catchments. Although snow observations are more and more accurate and widely available, hydrological models still struggle to take advantage of them in calibration or assimilation processes.
This study presents different use of snow data to improve the simulations of a spatially distributed hydrology model , named MORDOR-TS (Rouhier et al. 2017). The study is conducted over the French Durance catchment at Cadarache (11738 km^2), discretised into 133 hydrological meshes of about 100 km^2. 34 streamflow time series are available between 1980 and 2012 and are split into two equivalent calibration and validation samples, according to a spatial split-sample test. Two types of snow data are also used: fractional snow cover (MOD10 product) and snow water equivalent (SWE) observed at 49 locations.
Four experiences are compared in terms of both performance of streamflow simulations and realism of snow dynamic. In Exp 1, the model is spatially calibrated on streamflow data only, without using snow observations. In Exp 2, fractional snow cover is integrated in a composite objective function, at each calibration station. In Exp 3, the snow model is off-line calibrated at the mesh scale using fractional snow cover. At last, in Exp 4, the snow model is off-line calibrated at the mesh scale using both fractional snow cover and SWE local measurements.
Regarding the streamflow validation sample, the four experiences lead to very similar results in terms of streamflow simulations. However, both the fractional snow cover and the SWE are much better represented when using snow information in the calibration process.
In the end, this study show that we can efficiently constrain the snow processes and improve the overall realism of a hydrological model by adding spatialised and local snow information in the calibration process.