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Combination of snowpack modelling and TLS observations to analyze small scale spatial varaiability of snowpack energy and mass balance

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Improving the comprehension on how the different energetic balance components affect the snowpack mass balance during the melting period is important from a hydrological point of view. An accurate Snow Water Equivalent (SWE) distribution is needed for this objective, but unfortunately SWE measurement over large areas is not feasible nowadays. This distribution can be provided by a snowpack model but simulations often differ from the real state, because some physical processes are not yet properly modelled. In this study, we take advantage of distributed snowpack simulations corrected throughout the snow season with several snow depth distributions measured with a Terrestrial Laser Scanner (TLS). This allows us to obtain a more realistic SWE evolution and analyse its relations with the snowpack surface energy balance during the melting period considering small scale spatial variability.

For 2012, 2013 and 2014 snow seasons several intensive TLS snow depth data acquisitions were accomplished at Izas Experimental catchment; a 52ha study site located in central Spanish Pyrenees with an elevation that ranges between 2050 to 2350m above sea level. The detailed snowpack model Crocus has been used for simulating the snowpack evolution at 5m grid spacing during these three snow seasons, driven by downscaled meteorological fields from the SAFRAN reanalysis. Shadow effects on direct solar radiation are explicitly considered in the snowpack simulation. When a snow depth distribution map measured with the TLS was available, the simulation was stopped and the modelled snow depth distribution was adjusted to match observations. Afterwards the snow simulation was restarted, being subsequently simulated a more realistic snowpack distribution.

Considering this improved simulation, the components of the surface energy balance simulated by Crocus were analysed in relation to the simulated mass balance dynamics during the melting period. In such a way a Principal Component Analysis (PCA) has been applied to the simulated energy fluxes. PCA has identified zones in which the energy fluxes have spatial similarities, grouping the fluxes into principal components. The spatial importance of the PCA components related to the spatial evolution of the mass balance improves the understanding of small scale snow melting processes. Results have shown the reliability of correcting modelled snowpack distribution with information derived from TLS. They have also highlighted the topographic dependence of the energetic balance components and its influence on snow mass balance evolution.