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Space-time evolution of soil moisture, evapotranspiration and snow cover patterns in a dry alpine catchment: an interdisciplinary numerical and experimental approach

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The project Climate Change in South Tyrol aims to study the effects of climate change (CC) on the water balance and the consequences for the vegetation in a dry Alpine region, using an innovative multidisciplinary approach that combines modelling and experimentation. Regional climate scenarios predict a temperature increase and a summer precipitation decrease for the European Alps. This will likely lead to drier conditions, especially during the vegetation growth period. As this evolution will be more problematic in already dry regions, the inner Alpine continental Mazia Valley (South Tyrol, Italy) was chosen as study area in 2009 for long-term ecological research.
As a preliminary case study, the extreme 2002-2003 water year was selected to simulate a retrospective water balance at catchment scale, using the hydrological model GEOtop. The model proved to simulate realistic values for the spatial and temporal dynamics of soil moisture, evapotranspiration, snow cover and runoff production, depending on soil properties, land cover, land use intensity and catchment morphology.
In the study area of Mazia Valley 13 monitoring stations were installed in fall 2009 to continuously measure soil moisture, biomass production, as well as standard micrometeorological variables. The stations were distributed over the whole catchment to encompass its variability in elevation, slope aspect, soil properties, and land cover. Furthermore, snow depth and snow water equivalent were recorded at representative points throughout the catchment. In addition, the spatial distribution of the snow cover was determined by means of remote sensing and the discharge of the catchment was measured as integrating hydrological variable.
The use of different types of data permits a multi-scale validation of the model, in order to close the water balance and accurately estimate the space-time evolution of soil moisture, evapotranspiration and snow cover both at the plot and at the catchment scale. A first analysis of the comparison of model simulations and measured data is presented for the 2009 – 2010 winter season.
The results of this study will help to evaluate the problem of increasing water scarcity in mountain ecosystems due to CC and to build thus a valuable base for appropriate adaptation strategies.