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Contribution of high resolution remote sensing data to the modeling of the snow cover the in Atlas Mountains

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Snow melt from the Atlas Mountains watersheds represent an important water resource for the semi-arid, cultivated, lowlands. Due to the high incoming solar radiation and low precipitation, the spatial-temporal variability of the snowpack is expected to be strongly influenced by the topography. We explore this hypothesis using a distributed energy balance snow model (SnowModel) in the experimental watershed of the Rheraya River in Morocco (225 km^2). The digital elevation model (DEM) in SnowModel is used for the computation of the gridded meteorological forcing from the automatic weather stations data. We acquired three Pléiades stereo pairs in to produce an accurate, high resolution DEM of the Rheraya watershed at 4 m posting. Then, the DEM was resampled to different spatial resolutions (8 m, 30 m, 90 m, 250 m and 500 m) to simulate the snowpack evolution over 2008-2009 snow season. As validation data we used a time series of 15 maps of the snow cover area (SCA) from Formosat-2 imagery over the same snow season in the upper Rheraya watershed. These maps have a resolution of 8 m, which enables to capture small-scale variability in the snow cover.

We found that the simulations at 90 m, 30 m and 8 m yield similar results at the catchment scale, with significant differences in areas of very steep topography only. From February to April, an overall good agreement was observed between the simulated SCA and the Formosat-2 SCA at 8 m and 90 m. Before the melting season, true positive (TP) column of confusion matrix is close to 1, but it drops to 0.6 during the melting season. Heidke Skill Score is higher than 0.7 for the most of the validation dates and averages 0.8. On the contrary, 500 m simulation underestimates the SCA throughout the snow season and the TP score is always inferior to the one obtained at 8 m and 90 m.

We further analyzed the effect of topography by comparing the distribution of meteorological and snowpack variables along north-south and east-west transects. This analysis indicates that the impact of the topography on the simulated SWE and snow melt is mainly driven by changes in the solar radiations and the precipitations.