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Using different remote sensing data to improve snow cover area representation

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The crucial role of an accurate estimation of the snow cover fraction distribution in mountain hydrology increases in low and warm latitudes, where water scarcity makes the snowpack a fundamental resource. In Mediterranean mountain regions, the snow has a seasonal character; it is not permanent during all year or the whole cold season, which is also variable year to year because of the highly variable and sometimes extreme climatic conditions. These characteristics results in a very heterogeneous snow cover distribution, usually in not easy to access areas that lack ground monitoring systems. Remote sensing information constitutes one of the best ways to monitor the snow cover evolution; however, this high variability sometimes conditions the suitability of the available sources of information needed to best represent the snow processes involved.

This study proposed the combination of three different remote sensing data sources to improve the seasonal representation of the snow cover fraction (SCF) distribution in Sierra Nevada Mountains in southern Spain, a representative example of snow areas in semiarid regions: 1) terrestrial photography; 2) Landsat imagery (spectral mixture analysis); and 3) MODIS products (MOD10.A1) to improve the estimation of the snow cover fraction distribution over mountain areas at different scales. For this, three different study sites were selected over the study area: 1) a detail-scale piece of area (900 m^2) at the snow monitoring point of Refugio Poqueira in the Guadalfeo River basin (South face of Sierra Nevada Mountains); 2) a hillslope-scale area (2,5 km^2) nearby the latter but in the North face; and 3) a large-scale area (4585 km^2) over the 3479 m.a.s.l. altitude in Sierra Nevada. The analysis was performed during the hydrological year 2010-2011.

The results show that terrestrial photography, whose spatial and temporal resolution can be adapted to the process under study, constitutes the best technique to monitor snow dynamics at both the detail and hillslope scales. At such scale, terrestrial photography is able to reproduce the complex interaction between microtopography and snow, and also captures the quick changes in the snowpack evolution during the different melting periods that occur during the snow season over these areas. Therefore, the occurrence of mixed pixels, composed by snow and no-snow areas, mainly during such snowmelt periods and in border areas , which usually results in overestimations of SCF by coarser resolution data sources, was corrected using terrestrial photography. This overestimation was reduced in both cases after the correction, with RMSE of 0.08 m^2m^{-2} and 0.25 m^2m^{-2} for Lansdsat and MODIS, respectively, at the detail scale area, and RMSE of 0.09 $m^2m^{-2}$and 0.18 $m^2m^{-2}$for Lansdsat and MODIS, respectively, at the hillslope scale area. At the large-scale analysis, as expected, MODIS overestimated the Landsat-obtained snow cover area with a RMSE of 0.02 m^2m^{-2}. At this scale terrestrial photography is not a feasible option yet due to the impossibility of covering a huge area with an only image. Nevertheless, the monitoring of pilot areas at this scale using a ground camera network constitutes a promising step to improve the snow cover representation by means of data fusion algorithms with these three data sources.